Rijkswaterstaat
Ministry of Infrastructure and Water Management

Reading Guide for the market consultation documents in English

Market consultation

The market consultation was intended to engage in a dialogue and gather information from the business community. The focus in this market consultation was primarily on Rijkswaterstaat's seagoing dredging operations. The aim of this market consultation was to test assumptions, ideas and directions that Rijkswaterstaat has with regard to achieving its sustainability goals through procurement. But also to learn from companies how the transition can be shaped as effectively and efficiently as possible according to them. Rijkswaterstaat can use the insights obtained from the market consultation in the development of the 2030 sustainability procurement strategy.

Structure of the market consultation & translated documents

The documents used during the course of the market consultation for the preliminary announcement, preparation for market consultation, plenary meeting & sub-sessions and conclusion & feedback results market consultation were all published in Dutch on TenderNed.

For the translation of the market consultation documents into English, the documents have been divided according to the structure of the market consultation.

Preliminary announcement

To inform market participants about the market consultation, a preliminary announcement (December 23, 2022) was published on TenderNed. This document has not been translated into English because it is only a preliminary announcement.

Preparation for market consultation

In preparation for the market consultation, the market consultation documents and annexes were published on TenderNed on January 10, 2023. These documents have been translated into English and consist of the following:

- Market Consultation
- Annex A Market consultation questionnaire
- Annex B TPKV roadmap
- Annex C Basic and ambition level inland-domestic
- Annex D Basic and ambition level seagoing

Plenary meeting and sub-sessions

Companies who expressed an interest in the market consultation and in performing (seagoing) dredging works were registered. After that, Rijkswaterstaat held a plenary meeting with these companies on January 24, 2023. The documents related to the plenary meeting (presentations given) and the elaboration of the sub-sessions were published on TenderNed on February 14, 2023. These documents have been translated into English and consist of the following:

- Report plenary meeting market consultation TPKV
- Annex 1 given presentation
- Annex 2 answers mentimeter
- Annex 3 details of sub sessions

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Conclusion and feedback results market consultation

Part of the market consultation was a written questionnaire. After submitting the written questions, parties were invited by Rijkswaterstaat to an interview. Rijkswaterstaat only scheduled individual interviews with parties who completed the written questionnaire. Based on this, the outline of the findings from the questionnaires and individual interviews were prepared. The anonymised summary of all responses is also included; this contains the more elaborate and detailed findings. These documents have been translated into English and consist of the following:

- Report of written and individual feedback
- Annex 1 Overview of anonymous-summarised replies

Rijkswaterstaat decided, for the sake of completeness, to translate two more documents, the first being an analysis of the Roadmap for the Transition to a Carbon Neutral and Circular Infrastructure which was commissioned by Rijkswaterstaat and carried out by the Economic Institute for Construction (EIB) in response to market developments in Coastline and Fairway maintenance. The second document concerns the entire roadmap of the transition path Coastline and Fairway Maintenance (TPKV). These documents have been translated into English and are the following:

- Report EIB
- Report roadmap TPKV

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

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Market consultation Coastline & Fairway maintenance Procurement strategy Transition Path

Market consultation for the Coastline & Fairway maintenance Transition Path (TPKV in Dutch) for translation into a procurement strategy for the seagoing dredging operations of Rijkswaterstaat

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	0.7	MN: annexes added
	1.0	MN: layout and definitive

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1 Introduction

1.1. Introduction to the market consultation

For the process of conversion from the roadmap for the Coastline & Fairway maintenance Transition Path (TPKV in Dutch) to Rijkswaterstaat projects, a procurement strategy will be elaborated. Because the transition and the procurement strategy affect the companies with which we work, we wish to engage in dialogue with them for feedback and information. In that dialogue, we will present our dilemmas, ideas and approach for discussion and evaluation by stakeholders.

In this market consultation, the emphasis will be on seagoing (saltwater) dredging operations. At a later stage we will also determine the procurement strategy for inland dredging operations. Here, the focus is on limiting emissions; the circular processing of the dredged spoils produced is beyond the scope of this market consultation.

1.2. Background

This document was prepared by Rijkswaterstaat for a market consultation about the procurement strategy for the TPKV. The aim of the procurement strategy is to translate the TPKV into actual purchases over the coming years.

The Ministry of Infrastructure and Water Management (IenW) has drawn up the Carbon neutral and Circular Infrastructure projects (KCI in Dutch) strategy, together with Rijkswaterstaat and ProRail. This strategy is based on the ambition as client for infrastructure projects to ensure by 2030 that all our work is fully carbon neutral and circular, with the high-value reuse of materials, and a halving of the use of primary raw materials. The programme for the KCI strategy will be implemented via transition paths. These transition paths represent the IenW working areas with the greatest climate impact: road construction, construction works, coastline and fairway maintenance, road, dike and rail equipment, rail infrastructure and rail power supply.

1.3. General: the transition we are facing

Mitigating climate change, retaining biodiversity and improving air quality are the three greatest challenges facing society at this time. At the same time society is struggling with a housing crisis, while a smoothly functioning infrastructure is of critical importance.

Through its use of materials and energy, the construction sector is one of the contributors to these problems but the sector has also an important role to play in solving the issues identified. Improved sustainability is essential for a future-proof construction sector. For the hydraulic engineering sector, there is also an export opportunity: to become front runners in sustainable hydraulic engineering.

The Ministry of IenW, Rijkswaterstaat, ProRail, local and regional authorities, businesses and knowledge institutions are therefore working together to implement the nationwide Clean and Zero Emission Construction (SEB) programme and the KCI strategy of IenW.

In its KCI strategy, IenW has included the ambition of taking the step towards full carbon neutral and circular working practices by 2030, both for its own organisation and for the construction and management of the national infrastructure in the Netherlands.

The SEB programme contains the following targets for reducing and preventing emissions from construction by 2030:

- Reduction of nitrogen emission from construction equipment by at least 60% compared with 2018:
- Reduction of the emission of greenhouse gases by mobile equipment and construction logistics by at least 0.4 Mtonnes (Climate Agreement 2019):
- Improvement to health of at least 75% by reduction of particulate matter emissions from mobile equipment (Clean Air Agreement 2016).

Clean and Zero Emission Construction (SEB) (Goals)			Carbon Neutral and Circular Infrastructure (Ambitions)	
Nature recovery (NOx)	Health (PM10)	Climate ($CO_{2\,eq}$)	Climate ($CO_{2\,eq}$)	Raw materials
Structural approach to nitrogen	Clean Air Agreement	Climate Agreement	Climate Agreement	Raw materials agreement
60% reduction in nitrogen compared with 2018	75% reduction in damage to health compared with 2016	0,4 Mtonnes CO_2 reduction compared with 2019	No net CO_2 equivalent emissions	50% reduction in use of raw materials and high-value use of products and materials
2030	**2030**	**2030**	**2030**	**2030**

1.4. From joint roadmap and growth path to procurement strategy

To realise these aims and ambitions SEB and KCI, together with the stakeholders in the construction sector, have prepared a roadmap that describes the route towards sustainability in 2030. Rijkswaterstaat has prepared the roadmap for the TPKV as input for the SEB and KCI roadmap. For more information, visit the websites www.duurzame-infra.nl and www.opwegnaarseb.nl. For the sake of completeness, the relevant information is supplied with a specific link in annexes B, C and D. The roadmap and growth paths attached here are still the subject of administrative consultation and there are variants in layout and accent, but in terms of content they have been fixed since May 2022.

An integral part of this roadmap is an growth path, in which a series of requirements are laid down for a basic level and an ambition level in different periods, with ever stricter sustainability requirements on the energy carriers and emission classes of engines. Once they have been adopted, these must be translated into the purchases made by all public clients. In that connection, Rijkswaterstaat will be considering implementation in the contracting for the coming seagoing (saltwater) and (at a later stage) inland/domestic dredging operations. The purpose of this market consultation is to engage in dialogue on these issues and to garner information from the private sector.

1.4.1 Focus of the TPKV. From 2030 onwards, the ambition is to carry out fairway maintenance and coastline management in a manner that is carbon neutral and circular.
The transition path is the driver behind this challenge for change.

In terms of coastline and fairway maintenance, circular implementation will focus on the high-value reuse of the soil and dredged materials, and a halving of the use of primary raw materials. Protection of the stock of sand and sediment is an essential underlying principle. The circular design and use of the material for equipment is one step further, that we will eventually also have to take. However, for the short term, this is not a focus area for TPKV.

In terms of the carbon neutrality challenge, the focus is on limiting the emissions of greenhouse gases (CO_2 equivalents) by the projects. At the same time, as well as limiting CO_2 equivalents, we will wherever possible restrict particulate matter, nitrogen oxides and other harmful emissions, to the maximum possible. The eventual ambition is to conduct all our work zero emission.
Here zero emission is taken to mean: carbon neutral (=net adding no more CO_2eq to the atmosphere, well to propeller) and no more other harmful emissions (such as sulphur, nitrogen

oxide and particulate matter). We expect zero emission to continue to represent a major challenge in the short term, certainly across the whole of the chain, but it is the future.

In this framework, the TPKV will examine the possibilities of not or reduced dredging, dredging more smartly/with less transport distance and dredging with lower or zero emissions. In achieving lower emissions, the focus will be on making floating dredging equipment more sustainable.

1.4.2 Scope of the TPKV

We distinguish between 3 types of operations (between brackets the dredging equipment to which these operations relate):

- Coastline maintenance (seagoing dredging equipment)
- Saltwater fairway maintenance (seagoing dredging equipment);
- Freshwater fairway maintenance and other dredging operations (domestic/inland dredging equipment).

In particular in respect of seagoing (saltwater) dredging equipment, we must also deal with players on the international market. They will be the area of focus in this market consultation.

In the same way that there are plenty of challenges, there are also plenty of opportunities. We can specifically achieve progress by identifying, from the perspective of cooperation, which innovations are needed, what is already attainable and in what areas we can raise the bar further. This is a multiyear approach, and a way of ensuring that we stick to the course we have set for ourselves.

In 2021, we made a start in sketching the outlines of the steps to be taken and the pace to be achieved for the period through to 2030, which we then elaborated in a roadmap. We work alongside parties who have the same goals and who wish to maintain that same pace, while challenging and inviting the rest to join in. We are currently faced with the task of making the translation to implementation in our projects and with that in mind we have drawn up a procurement strategy.

1.5. Reading this document

As outlined above in the general introduction, in chapter one, a great deal of information is already available about the transition path, and on many fronts we are already working closely with the market. This market consultation therefore ties in with an ongoing dialogue about sustainability in tender procedures. Chapter two of this document considers the background to the TPKV procurement strategy in more detail. This includes an outline description of a number of dilemmas faced. To deal with those dilemmas, chapter three presents a series of practical potential ideas for procurement scenarios that could become an integral part of our procurement strategy. Chapter four describes the procedural aspects and planning of the market consultation, including a description of what you can and cannot expect from this consultation. Finally, annex A contains a list of questions addressed to interested market parties, to which Rijkswaterstaat is keen to receive answers.

2 Procurement strategy for the TPKV

2.1. Translating ambitions into actual purchases

The level of ambition at the Ministry of IenW is high: to carry out all work in a manner that is carbon neutral and circular by 2030. A roadmap has been prepared for arriving at that point. However, achieving the goal requires more than just a roadmap. It also calls for the practical translation of the roadmap into projects. For that purpose, Rijkswaterstaat is currently preparing a procurement strategy in the search for the most effective and efficient means of achieving/facilitating the transition via the procurement process. At the same time, we are aware of the limitations of procurement tools, and as such we are also focused on policy and regulations: in other words, those areas in which we can exercise an influence. The international character of the market for seagoing (saltwater) dredging equipment - with the accompanying policy and regulations - is a critical area for attention.

2.2. Operating principles for the procurement strategy

For Rijkswaterstaat, before preparing a procurement strategy for the transition to carbon neutral and circular implementation of its dredging operations, a number of operating principles had to be identified. Although not debatable for Rijkswaterstaat, these principles may be subject to different judgements and interpretation. Feedback in that respect is of course always possible.

The operating principles for the procurement strategy are:

- Security of supply in implementing the planned operations must remain guaranteed (coastline and navigation channels in good order);
- Maximum effect on the targets (see §1.3);
- Retaining a competitive and sustainable market;
- Favourable market effects for sustainable contractors/market parties; - Favourable cost effects for clients.

In addition, in respect of the explanation that follows, the working hypotheses listed below are relevant:

- All options are open to discussion;
- At present, Rijkswaterstaat outsources tasks, but the fallback option is to do more itself (ownership of own vessels and/or deployment of own capacity);
- If the decision were taken to intervene further in the value chain, this decision must be well-founded, with all less far-reaching interventions carefully argued and excluded, and the market duly consulted;
- The procurement strategy benefits from: sufficient resources, attainable technical solutions, sufficient consistency and future-proofing, and sufficient aggregation of demand to deliver impact.

2.3. The necessity for cooperation

This transition is a major challenge. As such, it is a transition we will be undertaking in collaboration with the market and other levels of government. We are therefore specifically seeking to cooperate with other public clients and with companies (each with the individual responsibility for translation and implementation in their own organisation).

In the first instance, Rijkswaterstaat will concentrate on its own tasks in relation to making its dredging operations more sustainable, since these tasks are its primary responsibility. We will also specifically seek out cooperation with other levels of government, both national and international, and will make every effort to achieve the national and sector-wide goals of the Ministry of Infrastructure and Water Management.

Through cooperation, we will also be fulfilling the final operating principle ‘sufficient aggregation of demand’ outlined in the previous section (see §2.2); the demand provided by Rijkswaterstaat on its own in not sufficient to bring about a transformation in the entire sector. Moreover, technical attainability, sufficient consistency and future proofing will also benefit from cooperation. Against that background (among others) we will seek the following cooperation:

- Rijkswaterstaat will participate in the Buyer Group Sustainable Dredging, in which water boards, provincial and municipal authorities work together in the field of procurement;
- Together with the Port of Rotterdam Authority, Rijkswaterstaat will initiate cooperation with the Dutch seaports and a number of international authorities and seaports in Northern/Western Europe;
- Cooperation with the market for achieving common and supported steps. Cooperation in respect of the roadmap and the growth path will be continued in respect of this procurement strategy and its further implementation over the coming years.

2.4. Growth paths

Over the past few months, in consultation among others with TNO, Deltares, the Unie van Waterschappen (Association of Water Boards), the Vereniging van Waterbouwers (Association of Hydraulic Engineers) and the Port of Rotterdam Authority, a roadmap has been prepared.

With regard to circularity, we have noted that protecting the current stock and the high-value reuse of sediment via policy and regulations could still be further optimised. The related actions and specifications in time are currently still being developed, and will in time require further effort and cooperation.

With regard to emissions, it is noted that we are well positioned to specify what is expected of the stakeholders from the sector, in which period. Two growth paths have been prepared for inland/domestic freshwater dredging equipment and two growth paths for seagoing (saltwater) dredging equipment. For both inland/domestic and seagoing dredging equipment, a basic level and an ambition level have been set for the growth paths. These are reproduced in annexes C and D. A distinction is made according to emission classes for the engines and sustainable energy carriers. Read annex B for further details.

Measures		Indicators
1. Cleaner engines	a. Tier emission requirements	Tier emission requirements I to III
	b. CCR emission standards	CCR 0 to Stage V - IWP/IWA/NRE
2. Use renewable energy carriers	a. Biofuels according to RED II annex IXa/IXb	% renewable energy carriers
	b. Renewable Fuel of Non-biological Origin (RFNBO)*	

* At least a CO_2 reduction of 70%

Table: Overview of measures for reducing emissions in growth paths.

2.5. Translation from growth paths to procurement

The next step is to apply the growth paths in the tender procedures. To make it possible to translate measures aimed at cleaner engines and the use of renewable energy carriers into projects and their tender procedures, there are a number of possibilities. We make a distinction between the different levels of the growth paths.

2.5.1 The basic level: minimum requirements, supplemented with ECI at project level? The basic level for the growth paths could be issued as the minimum requirements in all our projects (in other words, at basic level, no further distinction for the various projects in the Rijkswaterstaat portfolio). The requirement could then be formulated as follows:

1. In the period of implementation, the engines of the floating dredging equipment must at least satisfy the TIER/CCR classes applicable in accordance with the table for the basic level of the growth path.
2. For implementation, in the dredging equipment, the contractor must at least make use of the minimum percentage of renewable energy carriers for the applicable period of the basic level of the growth path, defined according to the requirements formulated therein.

Although this does define the requirements on the equipment and the energy carriers, this definition relates only to the minimum requirements for competing for the work. It does say something about the renewable energy carriers and about the emissions that are permitted to be released through the consumption of those energy carriers, but it says nothing about the total energy consumption or about the total emissions of the work in question. Further attention will be needed for those aspects.

This could be achieved via the environmental costs indicator (ECI) of the project, at the moment of tendering, or by including this as a BPQR award criterion or as a requirement for a maximum ECI value in the contract, by including an ECI cap or an emissions cap in the contract.

We look forward to receiving your feedback on all of the ideas outlined above, and the alternative described in the text block, during the market consultation.

Alternative: not the same minimum requirements for all projects.

An alternative is conceivable! It is also possible for Rijkswaterstaat (or another client) to not operate the same minimum requirements at basic level for all projects. This is possible because the percentage of renewable energy carriers is measured across the total contract portfolio of the client. This means that there is space within the portfolio to designate projects in which work may only be carried out using renewable energy carriers, and projects where this is not a requirement (e.g. if for specific projects there are budgetary problems or doubts about the availability of supply in the market, or if other risks are identified). For the remainder below, we will take the first approach (all projects with the same minimum requirements at basic level) as the operating principle because of the simplicity and continuity for the market.

2.5.2. The ambition level: challenging with dilemmas

The ambition level of the growth paths is viewed by many as extremely challenging, certainly to the periods towards 2030. If Rijkswaterstaat incorporates this ambition level in its procurement activities in the same way as proposed above for the basic level (see §2.5.1), this may engender certain risks. However, the ambition level is the road we need to follow to satisfy the ambitions of the Ministry of IenW, and we wish to offer front runners on the market an opportunity to fulfil their ambitions, together with us. Rijkswaterstaat has however recognised a number of dilemmas. For that reason, in the sections below, a series of ideas are presented about which we wish to engage in dialogue with you.

2.6. Dilemmas for procurement

There are a number of dilemmas that emerge in drawing up a procurement strategy for the carbon neutral and circular implementation of the dredging operations. In part, those same dilemmas were expressed in the indications received in the past from our consultations with market parties. Below is a summary of the topics and the underlying dilemmas. First formulated in general terms and then focused specifically on procurement strategy. They are elaborated and grouped in a slightly different manner, but relate above all to the procurement dilemmas.

General **dilemmas TPKV**	**Challenge for the procurement strategy**
The mismatch between the ambitious timeframe and the natural replacement rhythm on the market makes the process costly	Cooperation and contract size and duration can help on the market side but the need for a sustainable competitive market remains. What market effects will this trigger?

The (available) techniques and charging infrastructure are surrounded by many uncertainties in application in the maritime sector and certainly given the high peak power loads in the dredging sector, but the time is short: what investments should we make?	'Specified' or 'functional' techniques? In the case of 'specified' techniques should we also include arrangement of the bunkering and charging infrastructure or should we leave those aspects to the market? Or should we in fact take a step further in the value chain, and also aim at the development of techniques? Is that appropriate for a tendering organisation for civil engineering works?
Measures that contractors can take now (biodiesels) do not appear sufficient for achieving the eventual goal of becoming carbon neutral. Should we or should we not invest money in these measures now?	Growth paths set the direction for emissions and renewable energy carriers. However: How should sustainability funding be spent? On the one hand: the money we spend on cleaner engines and fuelling with biodiesels (Short Term solution) cannot be spent on zero emission dredging equipment (Long Term solution)? On the other hand: postponing will not lead to an increase in demand and is undesirable, because aiming for emission reduction is also urgent and essential in the short term.
The international nature of the market for seagoing (saltwater) dredging equipment makes the demand for international cooperation greater, but also demands perseverance: mismatch with the short timeline ambition	Increase sustainability of own projects but at the same time aim for cooperation with others. Do both. Occupying front runner position and simultaneously moving forwards together will be a balancing act.
Current focus on emissions from equipment but material and design must not be forgotten. Laws and regulations can have a major influence in this area	This focus must be maintained, but it cannot be influenced by purchasing actions: • continue to develop the design side and circular approach in asset management • and re-evaluate policy and regulations with the Ministry of IenW and EU.

Below more explanatory notes and background to what we perceive as dilemmas for this procurement strategy. We wish to engage in dialogue with the market on these topics.

2.6.1. Dilemma: A viable timetable versus urgency

A high ambition has been set (carbon neutral by 2030) and given the climate impact, there is every reason to make haste in reducing greenhouse gas emissions. Moreover, based on the calls for clean air and reduction of the emissions of nitrogen oxide, the pressure from society to act quickly is also considerable. At the same time we are involved with a sector in which the economic and certainly also the technical lifecycle of the dredging equipment is very long (on average 15-30 years) such that an accelerated round of investments could result in higher depreciation costs. Moreover, introducing sustainable dredging equipment must remain achievable also in terms of new build capacity and the prerequisite infrastructure and regulatory parameters. In addition, techniques that have an impact on clean air or nitrogen oxide (e.g. LNL or SCR), sometimes have little (or even negative) impact on greenhouse gas emissions, but can be taken more quickly.

2.6.2. Dilemma: The need for fully elaborated attainable technology versus encouraging multiple technologies

In order to make the dredging equipment more sustainable, a form of technology will have to be found that satisfies the sustainability goals. That same technology must also deliver what is needed (production level required by Rijkswaterstaat/clients, and sustainability). Furthermore, the same technology must also be viable in terms of logistics and legislation (for example in respect of safety and bunker capacity). At present it is not yet clear which technology of the future will 'eventually come out on top'. Points for discussion include technical viability (e.g. green hydrogen and green methanol in fuel cells), safety (e.g. ammonia) and sustainability (e.g. biofuels and their biomass origin and actual footprint). The questions have partially been answered in the growth path. We have for example imposed the requirement that biofuels must satisfy category 3&4 RED II, annex IXa and RFNBOs will be permitted/encouraged. However, Rijkswaterstaat will not select a single definitive technology.

However, if from a certain period we want a single technology to be encouraged and available on a large scale, a great deal of energy will have to be invested in the appropriate conditions. At the same time, it is generally not the client who specifies the technology, and in that connection the client will also have to take account of discriminating requirements. Functional tendering may in fact result in the creation of a variety of technologies, for which the infrastructure and other conditions can then not be satisfied on a large scale, in time. If the contractors must then become self-sufficient in their energy supply, this may result in limited availability in other areas, but could also represent both a risk and an opportunity for the contractors. We are already seeing multiple different energy infrastructures emerge.

2.6.3. Dilemma: Uniformity versus launching customers/clients

If all clients focus on something different and all develop their own instruments, it is difficult for companies to identify the correct investments. On the other hand, if everyone waits for someone else to make the first move and for all agreements to be completely clear, it will take a very long time before a start is made on investing in sustainable dredging equipment and before projects are implemented in a more sustainable manner. The alternatives that a client may come up with result in dilemmas of their own. A procurement strategy that distinguishes between front runner projects and peloton projects can make a contribution but the front runner portfolio must be large enough to ensure payback on the investments. Another alternative is that the client itself opts to do more for a particular technology but the question then is how the entire sector can keep up, and what the cost effects will be for the client.

2.6.4. Dilemma: need for multi-year security versus policy freedom

New technologies often demand innovations with investments (CAPEX) or higher operating costs (OPEX). A piece of equipment that runs on hydrogen, for example, may require additional investments, while running on biofuels may incur additional costs per litre. Because every social euro is scarce, and because it is the task of the infrastructure managers to manage the infrastructure and not necessarily to purchase innovations, very careful consideration must be given to where to spend the funds. In addition, Rijkswaterstaat operates according to the principle: all the work we do is done sustainably! And that calls for innovation.

At the same time, on the part of the companies required to take investment decisions, a degree of certainty about the direction to be followed will be needed. A short period of sustainability requirements may well not result in sustainable investments that can be written off in the longer term. There will be a clear call for security about the quality of the direction to be followed and a wait- and-see attitude may well be adopted if government attaches more importance to policy freedom and cost savings than to its sustainability ambitions. Nonetheless, in our opinion, the direction for all legislation is both clear and unavoidable, which appears to only leave room for discussions about the pace.

Another question for any entrepreneur is whether the money will be spent on the types of project in which they are interested and whether they will be awarded those projects in the tender procedure. The payback capacity is essential for the continuity of the company. At the same time, however, there are also opportunities from new technologies because they are backed by a solid business case. If green hydrogen becomes available cheaply and on a large scale, irrespective of the sustainability gain it represents, it could be extremely attractive for an entrepreneur. For the time being, however, we estimate that we are on the eve of a major transition, with all the technological uncertainty that entails. On the one hand it encourages innovations but on the other hand it may slow down investments.

2.6.5. Dilemma: To make innovations ourselves or together with others, or to encourage competition in tenders?

Rijkswaterstaat outsources projects and as a rule leaves innovations to the market. However, certain innovations will not be developed on time or not without additional encouragement. For that reason, Rijkswaterstaat has adopted the role of Launching Customer for certain innovations. For example, for Innovation in Coastline Maintenance (IKZ), Rijkswaterstaat has already launched a tender procedure according to the innovation partnership concept. In addition, a number of processes are already underway, with learning space in contracts, extension options and tender procedures with specific sustainability awarding criteria (such as the ECI/ECI value), the aim of which is to learn together and to share knowledge. At the same time, we see that the upscaling of innovations is always difficult, and our eventual goal is not to innovate, but to produce sustainably. That sometimes seems to require even more effort. The question is what role clients can best play in relation to the equipment that normally speaking does not belong to the client itself. Should they purchase that equipment themselves? Should they develop it together or should they invest? Or should they encourage equipment to be developed in competition, by establishing the right procurement conditions for projects? All of these options have advantages and disadvantages as well as uncertainties in relation to costs, achieved objectives, tendering policy and working methods. The starting point may well be the last option referred to above, but it remains uncertain whether we are in a position to ensure the establishment of the appropriate conditions and whether the developments will take place rapidly enough. One option may well be to move up the value chain towards the shipyards, but that would require a very different approach, which in turn would come with its own new uncertainties.

2.7. Potential ideas for procurement scenarios

It is therefore our belief that the basic level of the growth paths can be approached according to the method of minimum requirements, to which ECI is added as an awarding criterion (see § 2.5.1.)

To achieve the ambition level, we could do the same thing, but we also recognise a number of dilemmas specific to that ambition level. Specifically for achieving the ambition level, we have considered a number of procurement scenarios. These are described in more detail in the next chapter.

3 Potential ideas for procurement scenarios in detail

This chapter describes a number of procurement scenarios for the front runner projects, that allow us to translate our ambition level into purchases. The underlying principle is not that we select a single scenario that we then implement strictly. A mix of scenarios would appear to be the more obvious answer. That in turn requires a careful consideration of which scenarios or which measures are most effective for which scope. For the time being, however, we wish to assess among stakeholders what they consider the benefits and disadvantages of the various scenarios. Hence their presentation in this document as potential ideas, without us as yet having the ideal mix (if such a mix in fact exists at all). During the market consultation, we are keen to hear the ideas of the market on these matters.

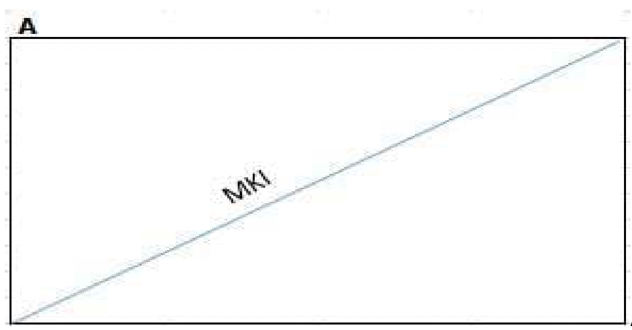
3.1. Explanatory notes to the pictures

For each scenario a picture has been drawn to assist the exchange of ideas. Below brief explanatory notes:

- In the pictures below, for all scenarios, the horizontal axis represents time;
- The vertical axis requires some imagination. It is a representation of the allocation of work packages to contracts. Everything shown in white can continue in the current manner; anything in blue represents the change to the contract allocations for example for coastline protection. At present (in the case of coastline maintenance), this is carried out every year with a small number of tenders, each with an implementation period of two years. In considering a different allocation, the white section of the picture is as it were left empty, while the blue sections represent the sections of the work packages that are 'cut out' for that scenario.

NB: This is not a science nor is it an undisputed representation. Its intention, however, is to produce a sketch of the scenarios and to show the distinction. If you find yourself distracted, do not waste too much time, and try to view it as an outline of the whole process.

3.2. Scenario 1 Steeply rising ECI (ECI value) and sustainability requirements



A MKI = ECI

Horizontal: time; Vertical: work packages; blue line: ECI weight and sustainability requirements (ever-increasingly requirements)

This scenario assumes the current situation in which the awarding criterion ECI (ECI value) will be applied in (practically) all tender procedures to encourage sustainability measures. Analogous to the working method for the basic level for all projects, in this case, for the ambition level (the front runner projects), the starting point will be minimum requirements from the growth path and ECI (ECI value) as an awarding criterion.
On the basis of a low ECI value, tendering parties can achieve a greater notional discount than companies with a less sustainable bid. These awarding criteria will be combined with the minimum requirements as contained in the growth path at ambition level. As 2030 approaches, these requirements will become ever stricter.

In addition to minimum requirements and awarding criteria, the following aspects will play a role in this scenario: which and how many front runner projects, and up to what percentage of the total project portfolio? Which valuation of ECI (ECI value)?

In this scenario, the way in which the programming and the combination of lots / contracts are carried will not change compared with current practice.

One dilemma in this scenario is that we are not certain of achieving the target of implementing carbon neutral projects by 2030, if we focus only on the minimum requirements and ECI (ECI value) as awarding criterion. How certain is it that we will be offered zero-emission dredging equipment in 2030, if we were to opt only for this working method?

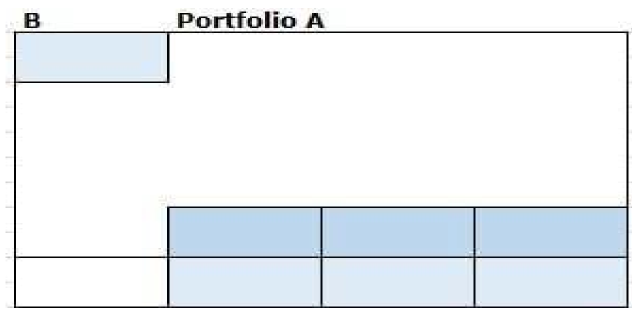
Because we do expect to continue working with ECI (ECI value) as an awarding criterion in the short term, we are also looking for ways of using ECI (ECI value) to focus more strongly on substantial sustainability measures.

The list of questions contains a number of questions that will encourage joint discussion on these points.

Parameters for this scenario:

- ECI (ECI value) must be suitable or made suitable for the target of becoming carbon neutral by 2030;
- (growth of) sustainability requirements must be laid down for a period of years, appropriate to the growth path towards carbon neutral.

3.3. Scenario 2 Contractual portfolio approach



Horizontal: Time; Vertical: Work packages

Between now and 2030, a growing share of the work package will be tendered in a portfolio; subsequent parts will be earned for good performance in the field of sustainability (of course the basic precondition is compliance with all other quality requirements from the contract (on schedule, on budget, product quality, etc.). See also the guide for the contractual portfolio approach that can be requested via this webpage). The total term of a portfolio can be up to 10 years. During that time, the requirements on sustainability will become ever stricter. These requirements will already be announced upon tendering. One possibility is combining the work packages for fairway and coastline maintenance.

When tendering, the contractor must have a vision and a plan on sustainability throughout the term of the contract. For each subsequent part, an indication must be given of how the sustainability requirements will be satisfied.

Because programming is unable to look 10 years ahead, volumes will be contractually specified, but the precise locations and designs per year will not be known at the moment of tendering. These will have to be specified in the contract via an agreed process and calculation method, for the later years.

After a few years, the entire volume of work will be put out to tender in portfolio contracts. This scenario does not exclude the possibility that strict requirements will be imposed on sustainability for the remaining work through to 2030, beyond the portfolio contracts, on the basis of ECI (value).

Parameters for this scenario:

- The long-term turnover/volumes will have to be laid down in the contracts. This will require a degree of effort in adapting the current working method with policy, programming, conditioning and procurement/contract management;
- (growth of) sustainability requirements must be laid down for a period of years, appropriate to the growth path towards carbon neutral.

3.4. Scenario 3 Large-scale contracts (plot size and contract duration)

C Grote contracten= Large-scale contracts

Horizontal: Time; Vertical: Work packages

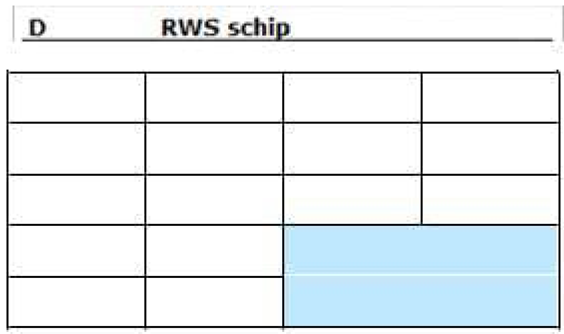
Major contracts offer a contractor or consortium of contractors the opportunity to (partially) earn back the necessary investments in sustainability. In this/these major contract(s), maximum requirements are laid down in respect of sustainability. In this scenario, we assume that both for fairway and coastline maintenance, Rijkswaterstaat will work towards major contracts in terms of volume and long contract term requiring zero emission implementation. For Coastline maintenance, 'major' will refer to 6 million cubic metres per year over a 10-year period, but there is of course room for further optimalisation according to this market consultation.

Zero emission will be the operating principle and in that respect no further distinction need be made in the awarding process. On the other hand, possibly the pace at which zero emission is achieved and certainly the costs will make a difference. The underlying principle in this scenario is to place the bar high for the requirements for sustainability from the start date of the contract. However, account must be taken of the fact that investment appetite on the part of the tenderer will only emerge following awarding of the contract, such that the tender procedure will have to be started and the tender awarded well in advance of the implementation (up to several years?). Because programming is unable to look 10 years ahead, during the tendering procedure, volumes will be laid down: precise locations and designs per year will follow at a later stage, analogous to the contractual portfolio approach from scenario 2.

Parameters for this scenario:

- The long-term turnover/volumes will have to be laid down in the contracts. This will require a degree of effort in adapting the current working method with policy, programming, conditioning and procurement/contract management;
- Awarding well ahead of implementation, in order to facilitate investment in new equipment.

3.5. Scenario 4 Rijkswaterstaat buying and/or leasing vessel



D RWS schip= Rijkswaterstaat buying/leasing vessel

Horizontal: Time; Vertical: Work packages

This scenario refers to the purchase and/or lease of a single zero emission dredging vessel by Rijkswaterstaat, suitable for carrying out work on the Dutch coast and in the major seagoing (saltwater) navigation channels. The operation of the vessel will be outsourced. The idea is that the single vessel in question will be able to demonstrate that the work can be carried out zero emission. The underlying idea is that as quickly as possible, the private sector will once again take over these tasks from Rijkswaterstaat. If no interest in these tasks emerges, and for its part Rijkswaterstaat accrues positive experiences, a fallback option would be for Rijkswaterstaat to order more vessels, but that is not the intention.

Via an Innovation Partnership (e.g. in a follow-up to the already launched innovations in the Coastline protection programme or via a public tender, Rijkswaterstaat will purchase or lease an zero emission dredging vessel. The initial idea is a trailing suction hopper dredger with a hopper capacity of 3500-5500 m^3.

A trailing suction hopper dredger of this size can complete approximately one-third of the annual work package for coastline protection. For the remainder of the work package for Rijkswaterstaat, at least at the start, tendering will continue as usual, according to the other scenarios.

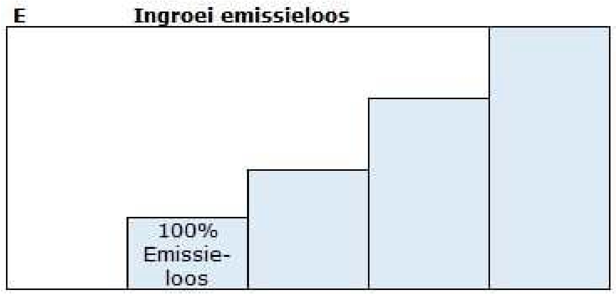
In the event of the purchase or lease of a single vessel, the vessel will fulfil a front runner and learning experience function. It will be a way of proving the technology and will offer both Rijkswaterstaat and the market an opportunity to acquire experience. One knowledge sharing issue remains open: the operating principle is that the knowledge acquired will be openly shared with all stakeholders.

If the current operating method is continued at Rijkswaterstaat, according to the programme, not a single project but the operation (service) will be tendered out annually, biannually or otherwise periodically. The contractor will supply the crew and expertise, and will conduct the designated operations with a trailing suction hopper dredger supplied or specified by the client. A tender for the operation for multiple years (up to 5 years) is also possible in this scenario. In that case, the same parameters will apply, namely that the internal working method at Rijkswaterstaat will have to be adapted with programming.

Parameters for this scenario:

- Exit strategy required for the future (5-15 years?). Rijkswaterstaat has no intention of taking over the suppletion work from the market.

3.6. Scenario 5 growth of zero emission



Ingroei emissieloos=growth of zero emission

Horizontal: Time; Vertical: Work packages

In this scenario, parts of the work package for Coastline protection will be tendered subject to the requirement of zero emission working. The growth path to 2030 lies in the volume of the work package; a growing proportion of the work will be tendered with the requirement of zero emission working. In terms of requirements and awarding criteria, this is similar to scenario 3 of major zero emission contracts; only the scale and term will comply with the current working method. As such, this scenario also shares similarities with the first scenario, except that in that case ECI (ECI value) is the awarding criterion, and the requirements on the equipment comply with the ambition level of the growth path. In this scenario, those elements are replaced by the requirement 'zero emission'.

One possible alternative in this scenario is that well in advance, Rijkswaterstaat makes it clear that from 2030 onwards (or if possible earlier?) <u>all</u> operations will be tendered with the requirement zero emission. If this proposal is embedded as a fixed given, the market will have the opportunity to prepare by making the necessary investments in zero emission dredging equipment, in time. The supplementary parameters from government for a successful organisation of the market have not yet been laid down, but are crucial to the success of this scenario.

Parameters for this scenario:
- The requirement 'zero emission from 2030' must be immovable for the confidence of the market;
- The technology for working zero emission must be available on time and effective;
- For security of supply of the performance (coast and fairways in good order), sufficient time and a fallback option will be essential.

3.7. Table of Basic characteristics of scenarios

Below again the most important differences, but on this occasion in table form.

	1 Steeply rising ECI (ECI value) and sustainability requirements	**2 Contractual Portfolio approach**	**3 Large-scale contracts**	**4a RWS buying vessel**	**4b RWS leasing vessel**	**5 Growth of zero emission**
Tender Awarding Criterion	ECI value	ECI value	BPQR (not ECI)	BPQR	BPQR	BPQR (not ECI)
Minimum requirements	Ambition level growth path	Ambition level growth path	zero emission dredging equipment	zero emission dredging equipment	zero emission dredging equipment	zero emission dredging equipment

Scope contracts	No change	Aggregation in time	Up to approx. 50% of work package	Supplies and service	service	No change
Term of Contacts	No change	5-10 years	Approx. 10 years	2-5 years	2-5 years	No change
Specific feature / point of concern	% front runner projects still to be corrected	Performance management on sustainability	Tender awarding long in advance of execution	Exit strategy needed; Link works to dredging equipment	Performance management on implementation; Link works to dredging equipment	Time of first and % zero emission projects still to be corrected
Change in way of working RWS-side	None	Adjust programming	Adjust programming	Management of ship + procurement of service	Procurement of service	None

4 Procedure for the market consultation

4.1. Aim

For the process of translation from the roadmap for the TPKV to the Rijkswaterstaat projects, a procurement strategy will be elaborated. Because the transition and the procurement strategy affect the companies with which we work, we wish to engage in dialogue with them for feedback and information. In that dialogue, we will present our dilemmas, ideas and approach for discussion and evaluation by stakeholders. In this market consultation, the emphasis will be on seagoing (saltwater) dredging operations. At a later stage we will also determine the procurement strategy for inland dredging operations. Here, the focus is on limiting emissions; the circular processing of the dredge spoils produced is beyond the scope of this market consultation.

The aim of this market consultation is to test Rijkswaterstaat's assumptions, ideas and potential solutions in relation to achieving the sustainability targets through procurement among companies. At the same time, we want to learn from the companies how the transition can be designed as effectively and efficiently as possible. The insights generated during the market consultation will be used by Rijkswaterstaat in elaborating its procurement strategy.

4.2. Target group

During the market consultation, Rijkswaterstaat is keen to engage in dialogue with enterprises interested in carrying out (seagoing) dredging operations.

This includes experts in the field of:

- investment decisions in the sustainability of dredging equipment
- tender procedures with space for sustainability and innovation
- ECI, LCAs and renewable energy carriers in relation to dredging operations

4.3. Registration

Companies interested in the market consultation are welcome to participate and deliver their contribution. If you are interested in taking part, please register before the ‘latest date for registration for market consultation’ as specified in §4.7. Registration must be submitted via the messaging module on TenderNed with the relevant publication (taking the following into account). Upon registration you are asked to provide the following information:

- Name;
- Position;
- Organisation;
- Email address of participant;

- Mobile telephone number of participant.

For the plenary meeting, a maximum of 2 participants may be registered, per organisation. No maximum applies to any individual discussions .

4.4. Structure of the market consultation

The market consultation will consist of various elements:

- Plenary meeting and sub-sessions;
- Written list of questions;
- Individual discussions;
- Conclusion and feedback of results of market consultation.

4.4.1. Plenary meeting and sub-sessions;

The meeting will start with a presentation in which Rijkswaterstaat will provide a brief explanation about the TPKV followed by an explanation of potential ideas for the procurement strategy. Sub-sessions will then be organised to discuss the issues and dilemmas within the TPKV in more detail. The plenary meeting and sub-sessions will be held on the date specified in §4.7, namely 24 January 2023.

The location will be:

De Roskam (conference room: Brewer) (Website)
Plein 25
3991 DL Houten

4.4.2. Written questionnaire

Part of the market consultation is a written questionnaire. We are keen to receive the responses to the questions listed in Annex A as digital input before the date specified in §4.7. For this purpose, a separately attached answer form can be used, which can be downloaded via TenderNed (AT-2023-01: Coastline and Fairway Maintenance Transition Path (TPKV). Using this questionnaire, Rijkswaterstaat can assess the topics and obtain information from companies.

4.4.3. Individual discussions

Following submission of the written questions, parties will be invited to attend a meeting with Rijkswaterstaat. Rijkswaterstaat will only plan individual meetings with those that have completed the questionnaire. The purpose of these discussions is to gain a greater insight into the written answers and to obtain any additional information from the companies.

RWS will not supply any additional and/or further information: companies invited to attend the individual meetings will explicitly have no advantage compared with other parties. The individual discussions will take place during the period specified in §4.7.

4.4.4. Completion of the market consultation and feedback of results

Rijkswaterstaat will conclude the market consultation by publishing a report of the consultation on TenderNed. The report will list the most important conclusions of the market consultation. In connection with this report, Rijkswaterstaat specifically informs market parties of the following:

1. The published report will be open to the public. Companies grant permission to Rijkswaterstaat to use their answers and any other information and/or details supplied by them, in this report. Rijkswaterstaat will ensure that no commercially sensitive information is included in the report.
2. The answers and other information and details will be included in the report in anonymised form. The report will list the participating companies.
3. Rijkswaterstaat will handle the input from participating parties in confidence.
4. Given the common nature of this transition and to encourage cooperation with the Netherlands' neighbouring countries, the report will also be translated into English.

4.5. Other provisions

The market consultation is subject to the following conditions:

- The market consultation is without obligation for all parties involved;
- No payment will be made for participation in the market consultation;
- The market consultation is entirely separate from any tender procedures to be organised;
- By participating in the market consultation, companies will not acquire a preferential position in respect of each other in the event of a tendering procedure. Participation will also not result in exclusion from a tendering procedure;
- Companies may derive no rights from the information issued in the framework of the market consultation;
- Rijkswaterstaat is not bound by the results of the market consultation, but will use the insights gained in the elaboration of the procurement strategy.

4.6. Communication

The contact person for this market consultation will be: Harry Zondag, who can be contacted by email at: harry.zondag@rws.nl. All communication relating to this market consultation will be issued via the messaging module of TenderNed. It is not permitted to approach other employees of Rijkswaterstaat, consultants or assistants of Rijkswaterstaat or other participating tendering services about this market consultation, either directly or indirectly.

4.7. Schedule

Rijkswaterstaat will operate the following schedule for the market consultation:

Activity	Date
Publication of market consultation document on TenderNed	10 January 2023
Closing date for registration for market consultation	17 January 2023
Sending (definitive) invitations	x
Plenary meeting	24 January 2023 (9.30-16:30)
Closing date for submitting completed questionnaire	31 January 2023
Individual meetings	Week 6 to 8 2023 (7 to 21 February)
Completion and publication of results	21 March 2023

Rijkswaterstaat is responsible for sticking to this schedule, but dates may change due to unforeseen circumstances. Stakeholders may derive no rights from the above schedule.

Annex A: Market consultation questionnaire

Your details

Name of Organisation	
Position	
E-mail address	
Telephone number	
May we approach you if further explanation is necessary?	
Would you be prepared to attend an individual interview for this purpose?	
If so: are there specific topics that you would want to discuss during the individual interview?	
Which Rijkswaterstaat specialists would you like to be present for that?	

General

1)	Rijkswaterstaat's ambition is to be carbon neutral from 2030: in your opinion, which requirements must the procurement strategy meet if this target is to be met?
2)	How can we, the client, encourage innovation and sustainability and prevent disinvestment?
3)	Which factors determine whether you, a company, can recoup an investment/measure to increase sustainability)?. Could you state that specifically and quantitatively for the following elements? - contract scope • In m³ per year • financial scope per year • in contract term years
4)	Could you describe how Rijkswaterstaat's procurement strategy could generate enough security that you would be prepared to invest in zero emission dredging equipment? Please specify the extent to which you view the following instruments as being sufficient to meet your readiness to invest (explain how you see that): • Policy? • tender/contract? • Covenants? • National legislation? • International legislation?

Suggestions for current procurement method and ECI (ECI value)

5)	What do you feel are the current barriers to you, a company, to investing (or being able to invest) in zero emission dredging equipment? Explain.
6)	Does the current working method offer you sufficient incentives to invest in zero emission equipment? Explain.
7)	How high does the ECI value have to be for your company to offer zero emission dredging equipment? Explain.

8)	At present, you can calculate the ECI with your own LCAs and use it as category 1 data. One drawback of this is that clients are sometimes presented with very different calculations for the same fuel category. What is your view on the exclusion of category 1 data and the restriction to category 3 data? Or, to put it another way: What is your position in relation to the idea of working with generic aggregated data, excluding your own LCAs? And what preconditions or 'rules of engagement' are needed in that case?
9)	In order not just to model the emissions but also to validate the ECI calculations, we could specify emission readings. What is your position on this?
10)	How do you view making a maximum performance requirement for a fixed sustainability budget a tender condition?
11)	What is your view on a maximum permitted ECI (or an emissions cap) for projects?
12)	Do you have any other requirements or suggestions for improvements to the current working method, using ECIs as an award criterion?

The growth paths

13)	If we, as a client, set the requirements of the basic level (the peloton) as the minimum for our tender procedures, would you still be able to bid in all periods? Explain.
14)	If we, as a client, set the requirements of the ambition level (front runner) as the minimum for our tenders (or a part thereof), would you still be able to bid in all periods? Explain.
15)	How many 'front runner' contracts per year could we put on the market? Answer in terms of m^3 per year and/or as a percentage of the total work package. Explain.

The scenarios - general

16)	What do you think of the five scenarios described? What is the ideal mix as far as you are concerned?
17)	Is one of them your preferred scenario? If so, which scenario and why?
18)	Are there any scenarios you wouldn't consider: in other words, scenarios you would prefer to block out? If so, which scenario and why?

The scenarios, specifically scenario 1: ECI

19)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.
20)	What effect does this scenario have for your readiness to invest in zero emission dredging equipment?
21)	How do you view the consequences for additional costs for the client for this scenario compared with the other scenarios?
22)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?
23)	Do you have any recommendations on the use of this scenario?

24)	Which of the revenue models for front runners is included in this scenario/solution and where is there room for improvement, if any?

The scenarios, specifically scenario 2: contractual portfolio approach

25)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.
26)	What effect does this scenario have on your readiness to invest in zero emission dredging equipment?
27)	How do you view the consequences for extra costs for the client for this scenario compared with the other scenarios?
28)	How do you view the market effects for you as a party on the market in this scenario compared with the other scenarios?
29)	Do you have any recommendations on the use of this scenario?
30)	Which of the revenue models for front runners is included in this scenario/possible solution and where is there room for improvement, if any?

The scenarios, specifically scenario 3: Large-scale contracts

31)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.
32)	What effect does this scenario have on your readiness to invest in zero emission dredging equipment?
33)	How do you view the consequences for extra costs for the client for this scenario compared with the other scenarios?
34)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?
35)	Do you have any recommendations on the use of this scenario?
36)	Which of the revenue models for front runners is included in this scenario/possible solution and where is there room for improvement, if any?

The scenarios, specifically scenario 4: Rijkswaterstaat buying and/or leasing of vessel

37)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.
38)	What effect does this scenario have on your readiness to invest in zero emission dredging equipment?
39)	How do you view the consequences for extra costs for the client for this scenario compared with the other scenarios?
40)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?
41)	Do you have any recommendations on the use of this scenario?
42)	Which of the revenue models for front runners is included in this scenario/possible solution and where is there room for improvement, if any?
43)	Would you be interested in bidding to become an operator on a Rijkswaterstaat vessel?
44)	How could the experiences of what you have learnt about purchase or lease of this vessel become accessible for the sector?
45)	What is a good exit strategy for this scenario?

The scenarios, specifically scenario 5: growth of zero emission

46)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.
47)	What effect does this scenario have on your readiness to invest in zero emission dredging equipment?
48)	How do you view the consequences for extra costs for the client in this scenario compared with the other scenarios?
49)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?
50)	Do you have any recommendations on the use of this scenario?
51)	Which of the revenue models for front runners is included in this scenario/possible solution and where is there room for improvement, if any?

Technology/Knowledge and Innovation

52)	How do you, a company, view the imposition of measures to reduce nitrogen, particulate matter and a combination of nitrogen/particulate matter?
53)	What do you expect will happen in relation to the availability of the biofuels specified in RED II, annex IXa, in years to come?
54)	We view biofuels as transition fuels on the way to REDII, category 4, the so-called RFNBOs. What is your view of this in the period from now until 2030? And for after that?
55)	Which energy carriers, possibilities in fuel and technology should Rijkswaterstaat be encouraging with its procurement strategy?
56)	When will it be possible for you, a company, to work without emissions?
57)	Where do you have knowledge gaps in relation to carbon neutrality, circular economy and zero emission working and how could these gaps be closed?
58)	How can we optimise the development and sharing of knowledge? What preconditions are necessary for this?

Risks, planning and financing

59)	What indexation for alternative energy carriers can we, the client, use?
60)	How can we, the client, mitigate/keep manageable the price and productivity risks for both companies and clients?
61)	What is the expected effect on costs of zero emission working on: (give quantitative answers)
	a) CAPEX: in % compared with traditional diesel vessels?
	b) OPEX: in % compared with traditional diesel vessels for the following aspects:
	c) –% Productivity profit (-) or loss (+) per m^3-hopper-hour
	d) –% fuel costs more expensive (+) or cheaper (-)
	e) –% maintenance more expensive (+) or cheaper (-)
	f) –% crewing costs more expensive (+) or cheaper (-)

	g) –% depreciation more expensive (+) or cheaper (-)
	h) In total: CAPEX + OPEX in % expected price per m^3-hopper-hour more expensive (+) or cheaper (-)
62)	How should the risks and/or costs be distributed between companies and clients in relation to sustainability?

Your starting position

63)	To what extent are sustainability and investment intertwined and organised in your enterprise?
64)	Which investment programmes do you, a company, expect to engage in?
65)	As a company, how do you view your position if competitiveness on sustainability becomes the most important criterion in tender procedures?
66)	For which other clients do you, a company, work in coastal and fairway maintenance projects? Are the clients you work for moving in the same direction and have they already asked you similar questions as part of a market consultation?
67)	How do you, a company, view the speed of emission requirements all around us (from the IMO, EU and other customers)?

Finally

68)	Do you, as a company, have any other ideas about making floating dredging equipment more sustainable in relation to coastline and fairway maintenance?
69)	What else would you like to say in relation to the establishment of a procurement strategy for coastline protection and saltwater/freshwater fairways?
70)	Is there anything else you'd like to say about this market consultation?
71)	If you could give a mark out of ten for this market consultation, what would it be? Explain.

Annex B: TPKV roadmap

Coastline and Fairway Maintenance Transition Path (TPKV) roadmap

Annex C: Basic and ambition level fairway maintenance freshwater

Annex D: Basic and ambition level seagoing dredging equipment

ANNEX A: Market Consultation Questionnaire

FOREWORD/how to complete this questionnaire

- Use the form below to respond to the market consultation AT-2023-01: Coastline and Fairway Maintenance transition path (TPKV)
- Please complete and return the form by 31 January 2023 at the latest
- Please send the completed form using the messaging module on TenderNed.
- Where possible, answer briefly and to the point, but be as specific and as clear as possible. (for example: This is how we see it: ...., because ....)

Your details

Name of organisation	
Position	
E-mail address	
Telephone number	
May we approach you if further explanation is necessary?	
Would you be prepared to attend an individual interview for this purpose?	
If so: are there specific topics that you would want to discuss during the individual interview?	
Which Rijkswaterstaat specialists would you like to be present for that?	

General

1)	Rijkswaterstaat's ambition is to be carbon neutral from 2030: in your opinion, which requirements must the procurement strategy meet if this target is to be met?	
2)	How can we, the client, encourage innovation and sustainability and prevent disinvestment?	
3)	Which factors determine whether you, a company, can recoup an investment/measure to increase sustainability? Could you state that specifically and quantitatively for the following elements? - contract scope • In m^3 per year	

	• financial scope per year • in contract term years	
4)	Could you describe how Rijkswaterstaat's procurement strategy could generate enough security that you would be prepared to invest in zero emission dredging equipment? Please specify the extent to which you view the following instruments as being sufficient to meet your readiness to invest (explain how you see that): • Policy? • Tender/contract? • Covenants? • National legislation? • International legislation?	

Suggestions for current procurement method and ECI (ECI value)

5)	What do you feel are the current barriers to you, a company, to investing (or being able to invest) in zero emission dredging equipment? Explain.	
6)	Does the current working method offer you sufficient incentives to invest in zero emission equipment? Explain.	
7)	How high does the ECI value have to be for your company to offer zero emission dredging equipment? Explain.	
8)	At present, you can calculate the ECI with your own LCAs and use it as category 1 data. One drawback of this is that clients are sometimes presented with very different calculations for the same fuel category. What is your view on the exclusion of category 1 data and the restriction to category 3 data? Or, to put it another way: What is your position in relation to the idea of working with generic aggregated data, excluding your own LCAs? And what preconditions or 'rules of engagement' are needed in that case?	
9)	In order not just to model the emissions but also to validate the ECI calculations, we could specify emissions readings. What is your position on this?	
10)	How do you view making a maximum performance requirement for a fixed sustainability budget a tender condition?	

11)	What is your view on a maximum permitted ECI (or an emissions cap) for projects?	
12)	Do you have any other requirements or suggestions for improvements to the current working method, using ECIs as an award criterion?	

The growth paths

13)	If we, as a client, set the requirements of the basic level (the peloton) as the minimum for our tender procedures, would you still be able to bid in all periods? Explain.	
14)	If we, as a client, set the requirements of the ambition level (front runner) as the minimum for our tenders (or a part thereof), would you still be able to bid in all periods? Explain.	
15)	How many 'front runner' contracts per year could we put on the market? Answer in terms of m^3 per year and/or as a percentage of the total work package. Explain.	

The scenarios - general

16)	What do you think of the five scenarios described? What is the ideal mix as far as you are concerned?	
17)	Is one of them your preferred scenario? If so, which scenario and why?	
18)	Are there any scenarios you wouldn't consider: in other words, scenarios you would prefer to block out? If so, which scenario and why?	

The scenarios, specifically scenario 1: ECI

19)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.	
20)	What effect does this scenario have for your readiness to invest in zero emission dredging equipment?	
21)	How do you view the consequences for additional costs for the client for this scenario compared with the other scenarios?	
22)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?	
23)	Do you have any recommendations on the use of this scenario?	
24)	Which of the revenue models for front runners is included in this scenario/solution and where is there room for improvement, if any?	

The scenarios, specifically scenario 2: contractual portfolio approach

25)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.	
26)	What effect does this scenario have on your readiness to invest in zero emission dredging equipment?	
27)	How do you view the consequences for extra costs for the client in this scenario compared with the other scenarios?	
28)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?	
29)	Do you have any recommendations on the use of this scenario?	
30)	Which of the revenue models for front runners is included in this scenario/possible solution and where is there room for improvement, if any?	

The scenarios, specifically scenario 3: Large-scale contracts

31)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.	
32)	What effect does this scenario have for your readiness to invest in zero emission dredging equipment?	
33)	How do you view the consequences for extra costs for the client in this scenario compared with the other scenarios?	
34)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?	
35)	Do you have any recommendations on the use of this scenario?	
36)	Which of the revenue models for front runners is included in this scenario/possible solution and where is there room for improvement, if any?	

The scenarios, specifically scenario 4: Rijkswaterstaat buying and/or leasing of vessel

37)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.	
38)	What effect does this scenario have on your readiness to invest in zero emission dredging equipment?	
39)	How do you view the consequences for extra costs for the client in this scenario compared with the other scenarios?	
40)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?	
41)	Do you have any recommendations on the use of this scenario?	
42)	Which of the revenue models for front runners is included in this scenario/possible solution and where is there room for improvement, if any?	
43)	Would you be interested in bidding to become an operator on a Rijkswaterstaat vessel?	
44)	How could the experiences of what you have learnt about purchase or lease of this vessel become accessible for the sector?	
45)	What is a good exit strategy for this scenario?	

The scenarios, specifically scenario 5: growth of zero emission

46)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.	
47)	What effect does this scenario have on your readiness to invest in zero emission dredging equipment?	
48)	How do you view the consequences for extra costs for the client in this scenario compared with the other scenarios?	
49)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?	
50)	Do you have any recommendations on the use of this scenario?	
51)	Which of the revenue models for front runners is included in this scenario/possible solution and where is there room for improvement, if any?	

Technology/Knowledge and Innovation

52)	How do you, a company, view the imposition of measures to reduce nitrogen, particulate matter and a combination of nitrogen/particulate matter?	
53)	What do you expect will happen in relation to the availability of the biofuels specified in RED II, annex IXa, in years to come?	
54)	We view biofuels as transition fuels on the way to REDII, category 4, the so-called RFNBOs. What is your view of this in the period from now until 2030? And for after that?	
55)	Which energy carriers, possibilities in fuel and technology should Rijkswaterstaat be encouraging with its procurement strategy?	
56)	When will it be possible for you, a company, to work without emissions?	
57)	Where do you have knowledge gaps in relation to carbon neutrality, circular economy and zero emission working and how could these gaps be closed?	
58)	How can we optimise the development and sharing of knowledge? What preconditions are necessary for this?	

Risks, planning and financing

59)	What indexation for alternative energy carriers can we, the client, use?	
60)	How can we, the client, mitigate/keep manageable the price and productivity risks for both companies and clients?	
61)	What is the expected effect on costs of zero emission working on (<u>give quantitative answers</u>):	
	a) CAPEX: in % compared with traditional diesel vessels?	
	b) OPEX: in % compared with traditional diesel vessels for the following aspects:	
	c) –% Productivity profit (-) or loss (+) per m^3-hopper-hour	
	d) –% fuel costs more expensive (+) or cheaper (-)	
	e) –% maintenance more expensive (+) or cheaper (-)	
	f) –% crewing costs more expensive (+) or cheaper (-)	
	g) –% depreciation more expensive (+) or cheaper (-)	
	h) In total: CAPEX + OPEX in % expected price per m^3-hopper-hour more expensive(+) or cheaper (-)	

62)	How should the risks and/or costs be distributed between companies and clients in relation to sustainability?	

Your starting position

63)	To what extent are sustainability and investment intertwined and organised in your enterprise?	
64)	Which investment programmes do you, a company, expect to engage in?	
65)	As a company, how do you view your position if competitiveness on sustainability becomes the most important criterion in tender procedures?	
66)	For which other clients do you, a company, work in coastal and fairway maintenance projects? Are the clients you work for moving in the same direction and have they already asked you similar questions as part of a market consultation?	
67)	How do you, a company, view the speed of emissions requirements all around us (from the IMO, EU and other customers)?	

Finally

68)	Do you, as a company, have any other ideas about making floating dredging equipment more sustainable in relation to coastline and fairway maintenance?	
69)	What else would you like to say in relation to the establishment of a procurement strategy for coastline protection and saltwater/freshwater fairways?	
70)	Is there anything else you'd like to say about this market consultation?	
71)	If you could give a mark out of ten for this market consultation, what would it be? Explain.	

Date: December 2022

Coastline and Fairway Maintenance Transition Path Roadmap

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

‘To realise the ambition of carbon neutral and circular coastline and fairway maintenance by 2030, we have drawn up a roadmap, together with a number of different companies.’

Introduction

- To achieve the Dutch targets for climate, nature and clean air, the Ministry of Infrastructure and Water Management (I&W) is working to make our infrastructure more sustainable.
- Based on the ‘Dutch government strategy towards Carbon Neutral, Circular Infrastructure Projects’ (KCI), the ambition is that all projects in the civil engineering sector (GWW) are carried out in a fully carbon neutral and circular manner by 2030.
- Based on the Clean and Zero emission Building (SEB) programme, targets have also been formulated in the field of nature (nitrogen), climate (CO_2)) and clean air (particulate matter and nitrogen) that are linked to the introduction of more sustainable mobile equipment and construction logistics.
- To put the KCI and SEB programmes into practice, five transition paths have been identified, and a roadmap drawn up for each path. This document presents the roadmap for the transition path ***Coastline and Fairway Maintenance.***

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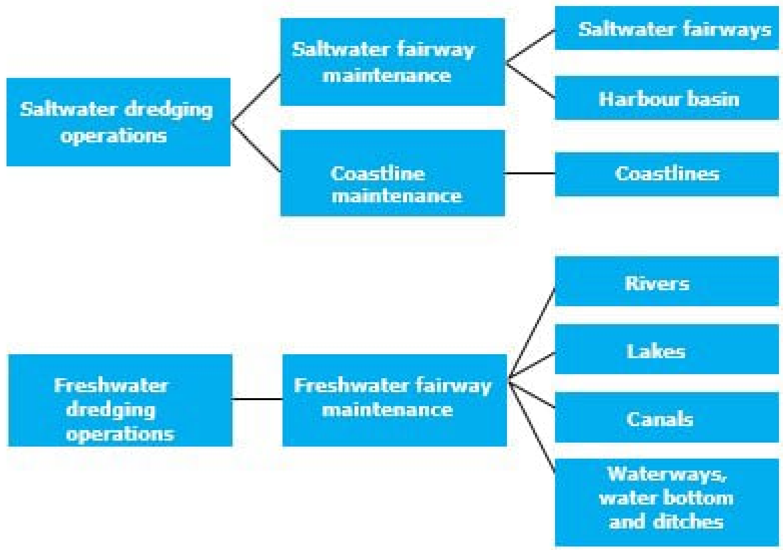
Scope of the transition path

- **Scope:** Coastline and Fairway Maintenance refers to the Dutch dredging operations aimed at maintaining coastal defences at delta height, and maintaining fairways at sufficient depth (vessel draught). We distinguish between two types of dredging operations:
  - **Seagoing 'saltwater' dredging operations.** These relate to maintenance of the Dutch coastline, the saltwater fairways and harbour basins.
  - **Domestic/Inland 'freshwater' dredging operations.** These are dredging operations for the construction, deepening and broadening of rivers, lakes and canals. Freshwater dredging operations also include small dredging operations such as ditch and watercourse maintenance.
- **Dredging equipment and Material:** In addition to the two types of dredging operations, two growth paths are also featured in the roadmap. The first relates to the reduction of emissions (nitrogen, particulate matter, CO_2) of floating **dredging equipment** and the second relates to the high-value (circular) use of dredged material/soil in other words **material**.



Sources: Rijkswaterstaat.

Goals and ambitions

Goals and ambitions of KCI and SEB

SEB
The goal of the SEB programme is to improve nature, the climate and health by reducing the emissions from equipment, vehicles and vessels in the construction sector and to satisfy the targets and ambitions from the structural approach to nitrogen, the Climate Agreement, the Carbon neutral and Circular Infrastructure Projects strategy and the Clean Air Agreement.

KCI
Based on the ‘Dutch government strategy for Carbon Neutral and Circular Infrastructure Projects’, the ambition is that all projects in the civil engineering sector (GWW) are carried out in a fully carbon neutral and circular manner by 2030. In this way, the KCI programme complies both with the Climate Agreement and the Commodity Agreement, and contributes to achieving the goals of the SEB.

Clean and Zero Emission Construction (SEB) (Goals)			Carbon Neutral and Circular Infrastructure (Ambitions)	
Nature recovery (NOx)	Health (PM10)	Climate ($CO_{2\,eq}$)	Climate ($CO_{2\,eq}$)	Raw materials
Structural approach to nitrogen	Clean Air Agreement	Climate Agreement	Climate Agreement	Raw materials agreement
60% reduction in nitrogen compared with 2018	75% reduction in damage to health compared with 2016	0,4 Mtonnes CO_2 reduction compared with 2019	No net CO_2 equivalent emissions	50% reduction in use of raw materials and high-value use of products and materials
2030	**2030**	**2030**	**2030**	**2030**

Goals and ambitions

Goals and ambitions of the roadmap

Roadmap
There are areas of overlap but also differences between the two programmes. KCI operates according to an ambition with a focus on the reduction of CO_2 equivalents and the consumption of primary raw materials. SEB has no targets in respect of raw materials, but does set specific targets for nitrogen, particulate matter and carbon dioxide.

This integrated roadmap contributes to each of these ambitions and targets. In real terms, this means that the transition path for Coastline and Fairway Maintenance will make a contribution to achieving the following ambitions and targets by 2030.

Emissions from vessels	**Aim no. 1** We will reduce emissions of nitrogen (NOx) when extracting, transporting and using dredged material by 60% compared with 2018.
	Ambition no. 2 We will not emit any more CO_2 equivalents when extracting, transporting and using dredged material.
	Aim no. 3 We will reduce emissions of particulate matter (PM_{10}) when extracting, transporting and using dredged material in (freshwater or saltwater) fairway maintenance by 75% compared with 2016.
Use of soil and dredged material	**Ambition no. 4** We will maintain the value of soil and dredging material by reusing it in a high-quality way.
	Ambition no. 5 We protect resources of dredged material and soil by safeguarding its quality and by using it sparingly.

Vision, ambition and tie-in with initiatives & policy: Dredging equipment

Vision

- By focusing on the goals & ambitions outlined in this roadmap, the extraction, transport and application of dredged material must be carried out by 2030 with a considerable reduction in greenhouse gas emissions. Vessels are powered by 'clean' energy through the use of different renewable energy carriers. The emission of nitrogen and particulate matter will also be reduced in the near future.

Ambitions & targets

- **By 2030, net zero emission of $CO2_2$ eq.** during the extraction, transport and application of dredged material (ambition from KCI).
- **By 2030, 75% reduction** in particulate matter emissions (hard target from the SEB).
- **By 2030, 60% reduction** in nitrogen emissions (hard target from SEB).

Tie-in with other initiatives & policy

- The vision and ambitions tie in with the agreements and targets set in the **Climate Agreement, Commodity Agreement**, programme for a Circular Netherlands, and **the European Green Deal**.
- They also tie in with the agreements in the **Clean Air Agreement** to reduce pollutant emissions by at least 35% in 2035 compared with 2015 (also for CO_2 reduction) for inland shipping.[1]
- This roadmap also ties in with the **Green Deal on Maritime and Inland shipping & Ports**, in which multiple emission reduction targets are set for domestic/inland and seagoing shipping, in which work is undertaken jointly to encourage zero emission vessels and to create room for experimentation (physical/policy) for circular activities.[2]

Sources: Rijkswaterstaat; **1** 'Clean AirAgreement: Health benefits for everyone in the Netherlands.' (2020);
2. 'Green Deal on Maritime and Inland shipping and Ports' (2019).

Vision, ambition and tie-in with initiatives & policy: Material (dredged material / soil)

Vision

- Soil and dredged material released in the civil engineering sector is reused at the highest value possible. There is a clear framework for dealing with soil and dredged material that cannot (any longer) be used.
- Security of supply for the use of soil and dredged material is safeguarded nationwide and is focused on the (preventive) protection of the resources and allocating sufficient space for extraction.
- Policy and regulations for the (high-value/circular) use of (contaminated) soil and dredged material is explainable and viable. Knowledge can be applied and developed in project implementation and for improving policy and regulations.
- It is clear under what conditions materials from other cycles can (temporarily) be used as a replacement for soil/dredged material.

Ambitions & targets

- **By 2030, stocks of dredged material/soil are protected** by protecting the quality and through the economic use thereof (ambition from KCI).
- **By 2030, the value of soil and dredged material is preserved** through the highest possible value reuse (ambition from KCI).

Tie-in with other initiatives & policy

- **Soil and water quality policy:** Based on these policy fields, (strict) parameters are imposed on the use of (contaminated) soil and dredged material.
- **Waste policy:** Based on this policy field, (strict) parameters are imposed on the use of (contaminated) soil and dredged material.
- **Rijkswaterstaat Materials strategy:** To make the use by Rijkswaterstaat of other materials than dredged material/soil circular, Rijkswaterstaat has elaborated a separate strategy (and roadmap).

Sources: Rijkswaterstaat.

Scope of the transition path

- **Dredging equipment: Saltwater hydraulic engineering fleet - saltwater dredging operations** Within the saltwater hydraulic engineering fleet, in total between 15 and 30 different vessels per year spend a period working in the Netherlands on saltwater coastline and fairway maintenance. These vessels are not exclusively operated in the Netherlands. The companies in question often operate worldwide and the specific deployment of vessels for the Netherlands is carried out on the basis of availability and tender specifications. According to absolute numbers, this disrupts the picture of the actual task. We therefore prefer to speak here about the numbers of cubic metres of dredged material in situ. In total, each year approximately 23 million tonnes of material are dredged.

- **Dredging equipment: Freshwater hydraulic engineering fleet - freshwater dredging operations.** Freshwater fairway maintenance is carried out on behalf of municipal and provincial authorities, water boards and Rijkswaterstaat. If we consider the freshwater hydraulic engineering fleet in the Netherlands, we note that around 600 freshwater hydraulic engineering ships and push vessels are active (TNO). The fleet consists of around 345 freshwater hydraulic engineering ships and a further 269 push vessels with a very small auxiliary motor on board, for hydraulics. The composition of the freshwater hydraulic engineering fleet comprises a large variety for the different primary tasks (for example vessels deployed for dredging operations or for example for the construction and maintenance of quay walls and locks). The technical characteristics and operational deployment of these vessels varies widely.

- **Material**. According to the Rijkswaterstaat Monitoring and Registration system (MARS), in total approximately 24 million cubic metres of material are moved each year during saltwater dredging operations. Estimates (expert judgement) suggest that approximately 20 million cubic metres of material are dredged each year, in freshwater dredging operations.

	Number
Suction dredger (stationary)	46
Cutter suction dredger (stationary/mobile)	23
Suction Hopper dredger	10
Bucket suction dredger	6
Grab (hopper) dredger	41
Silt pusher	14
Piling barge	19
Auxiliary equipment (support)	32
Hopper Barge	34
Push vessel	269
Other vessels	120
Total	614

Overview of number of vessels in the freshwater hydraulic engineering fleet

	Million m_3
Saltwater dredging operations.	
Coastline maintenance - foreshore	6.6 m_3
Coastline maintenance - beach	4.4 m_3
Fairway maintenance - saltwater	13.0 m_3
Total saltwater	**24.0 m_3**
Freshwater dredging operations.	
Fairway maintenance - freshwater (dredging sludge)	10.0 m_3
Fairway maintenance – freshwater (earthmoving)	10.0 m_3
Total freshwater	**20.0 m_3**
Total saltwater & freshwater	**44.0 m_3**

Overview of number of cubic metres dredged material

Sources: Rijkswaterstaat.

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The saltwater dredging market is international, capital-intensive and features a large number of players

Value chain structure: dredging equipment saltwater

	Raw materials & components	Manufacturers vessels / dredging equipment	Energy suppliers	Dredgers	Clients
Players	• Engine manufacturers • Fuel cell manufacturers • Dredging pump suppliers • Steel manufacturers	• Shipbuilders • Maritime engineering • GTIs	• International oil companies (in part also clients for dredging companies for offshore and offshore wind). • Bunker stations	Major international players that generate 80% of turnover outside the Netherlands • Market pressure due to entry of smaller players and Chinese state-owned companies	• Rijkswaterstaat • Provincial authorities • Port authorities • Coastal asset managers and foreign port authorities
Operations	• Extraction and production of raw materials (e.g. metals)'	• Design and construction of (dredging) vessels	• Supplying energy for vessel propulsion	• Dredging • Beach nourishment	• Issuing orders
Products / services	• Building engines, dredging pumps		• Ship diesel (sometimes also HVO or GTL) • LNG	• Beach team for beach nourishment • Surveys and monitoring	• Infrastructure (safety, accessibility, quality of life)

Market characteristics

1. **The saltwater dredging market is international with a small number of major players. Smaller players are joining.**
2. **The saltwater dredging market is capital-intensive, features long-term depreciation and requires payback periods for customer requirements**
3. **Construction of vessels / dredging equipment (freshwater & saltwater) is a small niche market with a few players and specialists customers.**

Sources: Interviews/workshops with Rijkswaterstaat.

Freshwater dredging market is more national and features many small and medium enterprise (SME) players

Value chain structure: dredging equipment freshwater

	Parts suppliers (engines, cranes, pumps)	Vessel / dredging equipment suppliers	Energy suppliers	Dredgers	Client
Players	• Engine manufacturers • Fuel cell manufacturer	• Shipbuilders	• (International) oil companies and bunker stations	• Miscellaneous	• Rijkswaterstaat • Provincial authorities • Water boards • Municipal authorities • Ports and companies
Operations	• Development and sale (often mechanical engineering)	• Construction and assembly of vessels	• Sale of requested fuels	• Sale and rental of dredging equipment • Performing dredging operations	• Placing/Issuing orders
Products / services	• Cranes, engines, dredging pumps	• Cutters, crane vessels, WID, plough dredgers, trailing suction hopper dredgers, • Mowing boats, excavators,	• Fuels: diesel, biodiesel	• Dredging operations, sometimes for nature projects (KRW, PAGW) or dykes construction	• Infrastructure (safety, accessibility, quality of life)

Market characteristics

4 **The freshwater dredging market is more national and features many SME players**

5 **Freshwater dredging market is capital intensive.**

6 **Rijkswaterstaat and water boards are responsible for 60% of demand for freshwater dredging.**

Sources: Interviews/workshops with Rijkswaterstaat.

The market for dredged material/soil is primarily national but is based on EU regulations, and import of soil/dredged materials from EU to the Netherlands also takes place.

Value chain structure: dredged material / soil

	Use of dredged material /	Client	Disposal of dredged material
Players	• National and international policymakers • Dredgers active in both the freshwater and saltwater dredging market • Mineral extractors • Soil banks	Private parties • Government (Rijkswaterstaat, Provinces, Water boards, Municipalities)	• National and international policymakers • Waste processors (major private European parties) with branches in the Netherlands • Landfill site managers (private and government such as Rijkswaterstaat)
Operations	• Excavation, transport and building with dredged material/soil	• Placing orders	• Recovery • Landfill
Products / Service	• ‘Groundwork’ (above and below water)	• Infrastructure and/in the living environment	• Secondary construction materials (aggregates) • Landfills

Market characteristics

7 **The market for dredged material / soil is in principle based on European rules (level playing field).**

8 **Land use is becoming increasingly important for climate adaptation and reduction is not an option.**

9 **Rijkswaterstaat and water boards supply approx. 90% of waste soil/dredged material.**

10 **The Netherlands is a front runner on the EU market for waste (soil) processing and imports waste from abroad.**

Sources: Interviews/workshops with Rijkswaterstaat.

The market dynamics have implications for the market transformation strategy

Market dynamics freshwater, saltwater & soil / dredged material

	Market characteristics	Market dynamics
Salt	1) Equipment for saltwater dredging market is deployed worldwide; market is international with just a few major players.	• Demand from the Netherlands is small compared with overall demand, so limited influence. • New (minor) players, from China or the freshwater market, mean more competition.
Salt	2) The saltwater dredging market is capital-intensive and with long payback times.	• Investments are large, depreciation is long term and the payback time is dependent on the capacity utilisation of dredging equipment. This means high risks and limited use of alternatives / renewable powertrains (with the exception of LNG & HVO).
Salt	3) The construction of vessels / dredging equipment (freshwater and saltwater) is a small niche market with multiple players and specialist customers.	• Dredging companies aim for optimum capacity utilisation of equipment, not optimum sustainability aspects.
Fres	4) Freshwater dredging market is more national with many (minor) players. 5) Freshwater dredging market is also capital-intensive. 6) Government agencies (water boards and Rijkswaterstaat) are responsible for 70% of demand for freshwater dredging in the Netherlands.	• Multiple national players in competition. • Also for freshwater dredging market, investments are large, with long payback time. • Greater influence on the market from government.
Soil / dredged	7) The market for dredged material / soil is in principle national, but based on European rules (level playing field). 8) Land use is becoming increasingly important for climate adaptation and reduction is not an option. 9) Rijkswaterstaat and water boards supply approx. 90% of waste soil/dredged material. 10) The Netherlands is a front runner on the EU market for waste (soil) processing and imports waste from abroad.	• The use of soil in the Netherlands is becoming increasingly important to 'keep feet dry' and to adapt to the changing climate. Less dredged material / soil use is not achievable. • Rijkswaterstaat and water boards supply approx. 90% of Dutch waste soil/dredged material that in accordance with the waste policy is partially drawn from the stock of dredged material / soil (may not be used). At the same time, the Netherlands is a front-runner on the EU market for waste processing. For example, companies import tar asphalt granulate (and soil) from abroad for processing in the Netherlands. • The stock of soil is becoming scarce due to lack of space and soil pollution from the discharge of pollutants. Residual materials from other chains are not available in sufficient volumes to fully replace soil.

Implication market transformation

- **International cooperation and demand aggregation:** For the saltwater dredging market, it is not possible to enforce improved sustainability from the Dutch market alone. For that reason, cooperation is needed at international IMO (world) level and EU level (for example via standards, legislation, demand aggregation).
- **Welcoming newcomers:** New players to the saltwater dredging market can facilitate a front runner approach and ensure that other companies start to move.
- **Encouraging competition in sustainability:** Multiple parties make it possible for front runners to stand out and to encourage competition on sustainability.
- **National market and influence from government:** Government can focus on sustainability via legislation & procurement (more via further demand aggregation).
- **Optimised policy for high-value land use:** The (EU) playing field (policy) for high-value use of (waste) dredged material/soil (and soil replacements) can be optimised to counter shortages and to encourage circular soil use.

Sources: Interviews/workshops with Rijkswaterstaat.

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Environmental impact – baseline measurement saltwater dredging operations

For the baseline measurement for dredging equipment we have used data from TNO (2022) from the report *'Inventarisatie en categorisatie huidige en toekomstige aanbod duurzame vaartuigen'* ('Inventory and categorisation of current and future supply of sustainable vessels'). This report was commissioned on by the Ministry of Infrastructure and Water Management. For the baseline measurement on material we consider the high-value reuse and protection of the stocks of soil and dredged material.

Table: Annual emissions for saltwater dredging operations (2021)

Activity	Million m^3	Mtonnes CO_2		Ktonnes NOx		tonnes PM_{10}	
Coastline maintenance foreshore	6.6	0.01	0.03	0.2	0.3	4.7	7.5
Coastline maintenance beach	4.4	0.01	0.03	0.2	0.3	4.2	7.9
Saltwater fairway maintenance	13.0	0.05	0.10	0.6	1.3	15.9	31.2
Total	**24.0**	**0.07**	**0.16**	**1.0**	**1.9**	**24.7**	**46.6**

Source: Operational data from hydraulic engineers, Determination of environmental impact of Coastline maintenance projects (TNO, 2020), Methods for calculating the emissions of transport in the Netherlands (Geilenkirchen et al, 2021).

As this table shows, for this calculation, a bandwidth is maintained. Fuel consumption per cubic metre can vary widely between different operations carried out (for example the deployment of different types of vessels, the type of material dredged or the sailing distance to the project).

Environmental impact – baseline measurement freshwater dredging operations

For the freshwater hydraulic engineering fleet, TNO also produced an estimate of the emission levels. The calculation of CO_2 emissions is based on an estimate of fuel consumption and the number of engine operating hours. The calculation of NOx and PM are based on the number of engine operating hours, the number of litres consumed, the engine age class and the total engine output. These are multiplied on the basis of the emission factors based on emission measurements in practice.

Table: Annual emissions for freshwater dredging operations (2021)

	Number	CO_2 ktonnes	NO_x, tonnes	PM_{10} tonnes
Suction dredger (stationary)	46	21	162	5.1
Cutter suction dredger - stationary/mobile	23	4	35	1.0
Suction hopper dredger	10	9	89	2.4
Bucket suction dredger	6	2	22	0.5
Grab (hopper) dredger	41	17	135	3.6
Silt pusher	14	0	1	0.0
Piling barge	19	7	32	0.9
Auxiliary equipment (support)	32	2	22	0.7
Hopper Barge	34	13	116	3.1
Push vessel	269	1	6	0.2
Other vessels	120	1	15	0.5
Total	**614**	**76**	**634**	**18**

Source: Final report investigation of sustainability options freshwater hydraulic engineering fleet (TNO 2022)

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Types of measures

- We use various types of measures and indicators in the growth path. We do this to determine which minimum requirements should be set for each period. Table 1 shows the measures employed in the growth path.

Cleaner engines

- Making engines cleaner relates to the cleaning of propulsion engines, work engines and auxiliary engines on vessels. New dredging equipment to be introduced to the market must satisfy the equivalent emission requirements based on (European) legislation. This is divided into two different categories. Saltwater propulsion is designated with Tier emission requirements. Freshwater propulsion must comply with/is laid down in the CCR standards. Table 2 briefly explains each of these categories.

- Since 1 January 2019, the NRMM stage V emission standard has gradually been introduced (CCR standard for freshwater propulsion). The Stage V standard imposes considerably lower emission limit values. The EU stage V engines for domestic/inland shipping are divided into three categories: IWP, IWA and NRE. See table 3 for an explanation of these categories.

Table 1: types of measures and indicators

Types of reduction measures	Indicators
1. Cleaner engines a. Tier emission requirements b. CCR emission standards	 Tier emission requirements I to III CCR0 to Stage V - IWP/IWA/NRE
2. Use of renewable energy carriers a. Conventional biofuels b. Biofuels in accordance with RED annex IXa and IXb c. Renewable Fuel of Non-biological Origin (RFNBO) c. Renewable electricity	% renewable energy carriers

Table 2: CCR standard and Tier emission requirements

IMO Tier emission requirements saltwater propulsion	CCR standard for freshwater propulsion
Tier I (2000 - 2010)	CCRI (2003, 2006).
Tier II (2011 - 2020)	CCRII (2007, 2018).
Tier III (2021)	Stage V – IWP – IWA – NRE (2019)

Table 3: engine categories for EU stage V engines

Engine categories for NRMM stage V emission standards
Engine category IWP This category includes engines of 19 kW or more, exclusively used on inland navigation vessels for direct or indirect propulsion or intended for that purpose.
Engine category IWA Auxiliary engines with an output equal to or in excess of 19 KW used exclusively on inland shipping vessels are covered by category IWA.
Engine category IWA Engine category NRE relates to engines that although not directly intended for use on inland navigation vessels may nonetheless be used for that purpose. This relates specifically to engines with an output of less than 560 kW used instead of the engines in categories IWP or IWA.

Sources: Rijkswaterstaat.

Types of measures

Renewable energy carriers

- Europe has set targets for the use of renewable fuels. These targets are monitored in the European directive on the basis of which countries report. In the Netherlands, this is a task of the National Emissions authority (NEa). In the RED II Directive the use of renewable energy carriers is regulated. RED II distinguishes between four types of renewable energy carriers.
    - Category 1: conventional biofuels.
    - Category 2: biofuels from waste streams (including UCO (used cooking oil) and animal fat). At present this is the most widely used category (>90%).
    - Category 3: advanced biofuels.
    - Category 4: Renewable Fuels of Non Biological Origin (RFNBO) such as electricity, hydrogen and e-fuels

Biofuels

There is currently discussion about when biofuels can be viewed as 'renewable'. We apply the European Directive RED II Annex IVa. All biofuels originating from raw materials from list A (Annex IX Part A RED II) are seen as renewable biofuels (or category 3). This therefore does not apply to part B of Annex IX (categories 1 and 2). The entire European Directive can be viewed here.

Renewable Fuels of Non-Biological Origin (RFNBO)

In addition to biofuels, RFNBO are also defined as a category (category 4). Other RFNBO refers to energy carriers such as electricity, hydrogen and e-fuels. E-fuels are an emerging class of carbon-neutral replacement fuels. These are synthetic fuels made from renewable electricity and CO2 extracted from the air. E-fuels are not yet technologically well developed and are expected to only play a minor role through to 2030.

Sources: Rijkswaterstaat.

Growth path

- The growth paths describe the process according to which the sector can achieve the targets based on requirements to be imposed on floating (dredging) equipment, divided into four time periods. The growth paths were developed on the basis of the target scope for nitrogen, particulate matter, CO_2, the technical attainability and the costs. The underlying principle is that the measures must on the one hand be both realistic and feasible, and on the other sufficiently challenging to achieve the ambitions and targets. After all, autonomous development alone will deliver insufficient result.

- There are two levels for each growth path. The basic level for the 'peloton' and the ambition level for the 'front runners'.
    - **Basic level floating dredging equipment:** contains all requirements included in contracts from public clients. The requirements at this level consist of a combination of emission standards (tier requirements and/or CCR standards) and a percentage of the operations that must be carried out with renewable energy carriers.
    - **Ambition level floating dredging equipment:** lists the ambition requirements according to which emissions will be further reduced. Front runners among clients must translate these requirements in their contracts for the (front runner) projects. They can also impose requirements that go beyond the requirements in the table. The requirements at this level consist of a combination of emission standards (tier requirements and/or CCR standards) and a percentage of the operations that must be carried out with renewable energy carriers.

- For each period, there are minimum requirements in respect of the dredging equipment to be deployed for a project (the basic level). These minimum requirements will be gradually tightened up. The requirements must be applied in contracts and permits. The requirements do not apply retroactively to current contracts or already awarded projects. In long-term contracts, the turning points are specified. As well as including minimum requirements, clients can also further challenge and encourage the market, for example via an awarding criterion focused on the deployment of zero emission vessels (the ambition level).

Sources: Rijkswaterstaat.

Growth path – basic level seagoing dredging equipment

Coastline and saltwater fairway maintenance (seagoing dredging equipment) - Basic level Rijkswaterstaat - Port Authority					
Vessel type		**Period 1 2022 through to 2024**	**Period 2 2025 through to 2027**	**Period 3 2028 through to 2029**	**Period 4 From 2030**
"Trailing suction hopper dredgers, Grab hopper dredger, grab dredger, cutter suction dredger, suction hopper dredger, water injection dredger"	Engines	Minimum emissions in compliance with Tier class I*/**	Minimum emissions in compliance with Tier class I*/**	Minimum emissions in compliance with Tier class II*/**	Minimum emissions in compliance with Tier class III*/**
	Energy carriers	At least 10% renewable energy carriers	At least 20% renewable energy carriers	At least 40% renewable energy carriers	At least 60% renewable energy carriers

** Certified tier I to III or retrofit compliant with emission standards in compliance with Tier I to III*

*** With the exception of vessels with a hopper capacity >15,000 m3 that can be demonstrated necessary for performance of the work*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Sources: Rijkswaterstaat.

Growth path – basic level freshwater fairway maintenance

Fairway maintenance freshwater - Basic level Rijkswaterstaat - Provinces - Municipalities - Water boards					
Vessel type		**Period 1** **2022 through to 2024**	**Period 2** **2025 through to 2027**	**Period 3** **2028 through to 2029**	**Period 4** **From 2030**
Hopper barge, silt pushers, auxiliary equipment (survey vessels, tugs and push boats), small cutter suction dredgers** other small waterborne dredging equipment	Engines	No requirement	No requirement	Minimum emissions in accordance with CCR II*	Minimum emissions in accordance with CCR II*
	Energy carriers	At least 20% renewable energy carriers	At least 35% renewable energy carriers	At least 60% renewable energy carriers	At least 75% renewable energy carriers
"Grab hopper dredger, grab dredger, cutter suction dredger, bucket wheel suction dredgers, hopper barges, piling barges, support vessels, suction hopper dredger"	Engines	No requirement	No requirement	Minimum emissions in accordance with CCR II*	Minimum emissions in accordance with stage V (IWP-IWA)*
	Energy carriers	At least 20% renewable energy carriers	At least 35% renewable energy carriers	At least 60% renewable energy carriers	At least 75% renewable energy carriers

** Certified CCR I to stage V (IWP-IWA) inclusive or retrofit compliant with the emission standards in accordance with CCRI to stage V (IWP-IWA)*

*** Small cutter suction dredgers are suction dredgers deployed solely on zone 4 waters.*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Sources: Rijkswaterstaat.

Growth path – ambition level seagoing dredging equipment

Coastline and saltwater fairway maintenance (seagoing dredging equipment) - Ambition Rijkswaterstaat - Port Authority					
Vessel type		**Period 1 2022 through to 2024**	**Period 2 2025 through to 2027**	**Period 3 2028 through to 2029**	**Period 4 From 2030**
"Trailing suction hopper dredgers, Grab hopper dredger, grab dredger, cutter suction dredger, suction hopper dredger, water injection dredger"	Engines	Ambition 20% Tier class III*	Ambition 50% Tier class III*	Emissions in accordance with Tier class III*	Emissions in accordance with Tier class III*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 90% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or RE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 10% RFNBOs or RE

** Certified Tier I to III or retrofit compliant with the emission standards in accordance with Tier I to III*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Explanatory note 5: RE stands for renewable electricity & RFNBOs stands for renewable fuels of non-biological origin

Sources: Rijkswaterstaat.

Growth path – ambition level freshwater fairway maintenance

Fairway maintenance freshwater - Ambition level Rijkswaterstaat - Provinces - Municipalities - Water boards					
Vessel type		**Period 1 2022 through to 2024**	**Period 2 2025 through to 2027**	**Period 3 2028 through to 2029**	**Period 4 From 2030**
Hopper barge, silt pushers, auxiliary equipment (survey vessels, tugs and push boats), small cutter suction dredgers** other small waterborne dredging equipment	Engines	No requirement	Ambition 10% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 40% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 70% emissions in accordance with stage V (IWP-IWA- NRE)*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 85% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or HE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 15% RFNBOs or RE
"Grab hopper dredger, grab dredger, cutter suction dredger, bucket wheel suction dredgers, hopper barges, piling barges, support vessels, suction hopper dredger"	Engines	No requirement	Ambition 25% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 60% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 100% emissions in accordance with stage V (IWP-IWA- NRE)*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 85% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or HE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 15% RFNBOs or RE

** Certified CCR I to stage V (IWP-IWA) inclusive or retrofit compliant with the emission standards in accordance with CCRI to stage V (IWP-IWA)*

*** Small cutter suction dredgers are suction dredgers deployed solely on zone 4 waters.*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

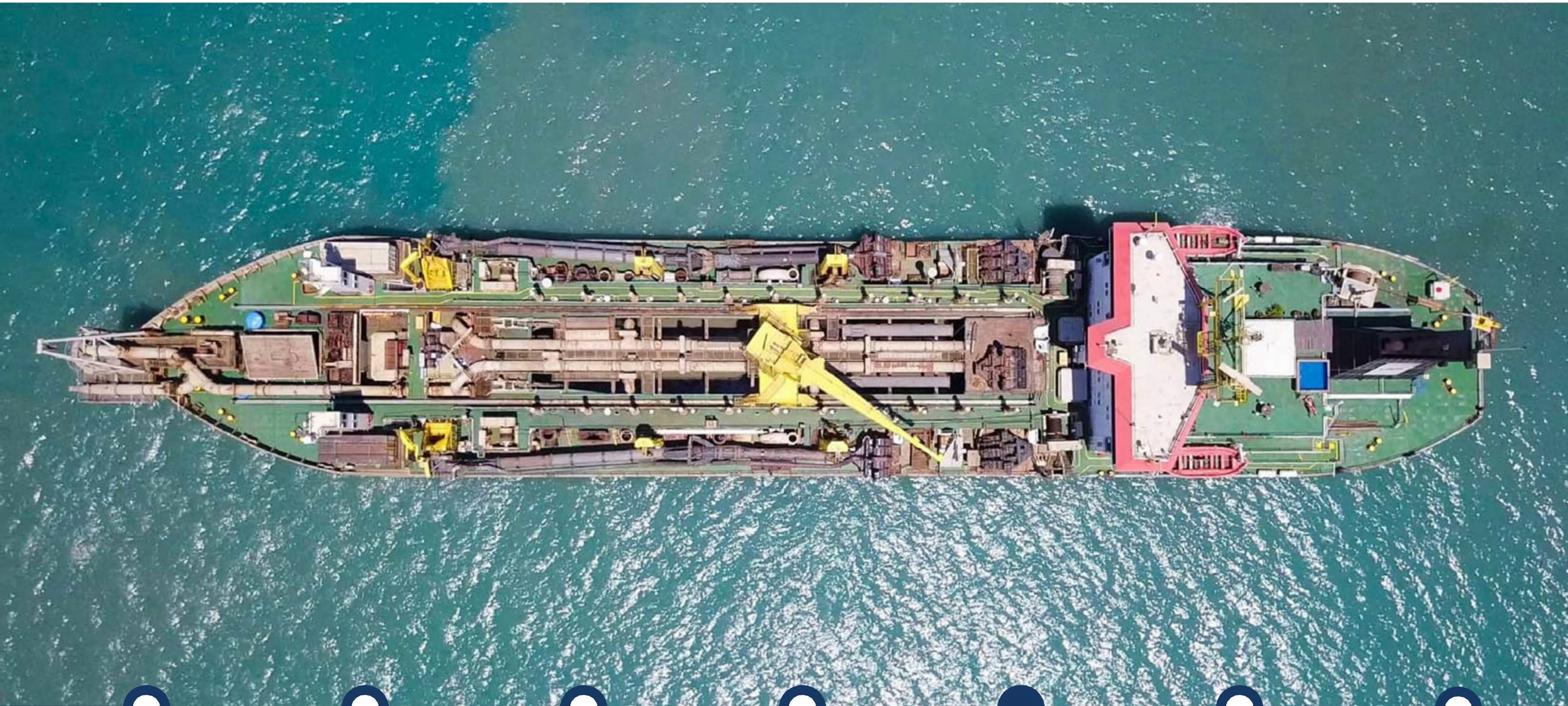
Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Explanatory note 5: RE stands for renewable electricity & RFNBOs stands for renewable fuels of non-biological origin

Sources: Rijkswaterstaat.



1. Context of transition path

2. Value chain & market dynamics

3. Baseline measurement

4. Measures & growth paths

5. Expected impact

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Expected impact: reduction path

Scenarios

- The reduction path shows the expected reduction in harmful emissions expressed in CO_2 emission, NOx emission and PM10 (particulate matter) emission for the sector. The reduction path therefore shows the expected effect of the growth path. The reduction path is expressed in two different scenarios, an autonomous and a challenging & feasible scenario.
    - **Autonomous scenario:** this scenario is based on not taking additional measures, thereby delivering no acceleration in emission reduction. It is expected that emissions will gradually fall over the years through technological developments, but that this reduction will be limited.
    - **Challenging and feasible scenario:** the reduction path for the scenario challenging and feasible is drawn up on the basis of the growth path 'Basic level floating dredging equipment'. These are the minimum requirements imposed.

Table: impact of the autonomous reduction path

		2021	2025	2030	2021 - 2030
Salt water	CO_2 – Mtonnes	0.12	0.11	0.11	5%
	NOx – Ktonnes	1.50	1.34	1.10	-27%
	PM – tonnes	35.7	35.7	35.7	0%
Freshwater	CO_2 – Mtonnes	0.055	0.051	0.045	-18%
	NOx – Ktonnes	0.47	0.46	0.43	-10%
	PM – tonnes	13	12	11	-17%

Table: autonomous - versus challenging and feasible scenario saltwater dredging operations

	2021	2030 autonomous	% compared with 2021	2030 challenging	% compared with 2021
CO_2 – Mtonnes	0.12	0.11	5%	0.06	45%
NOx – Ktonnes	1.50	1.10	-27%	0.42	-70%
PM – tonnes	0.04	0.04	0%	0.04	0%

Table: Autonomous - versus challenging and feasible scenario freshwater dredging operations

	2021	2030 autonomous	% compared with 2021	2030 reduction path	% compared with 2021
CO_2 – Mtonnes	0.055	0.045	-18%	0.021	-61%
NOx – Ktonnes	0.47	0.43	-10%	0.16	-67%
PM – tonnes	0.013	0.011	-17%	0.002	-85%

Sources: Rijkswaterstaat expert judgement.

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Courses of action

Course of action	Explanation
Policy	• The policy course of action reflects on the policy measures that can be taken to reduce the emissions from floating equipment. This course of action also identifies a number of management measures relating to the organisation of initiatives from the roadmap.
Market and procurement	• The market and procurement course of action considers the procurement toolbox that can be employed in further realising the reduction of emissions. For example the use of ECI, additional BPQR criteria or the introduction of uniform tender procedures. All these elements must be combined in a procurement strategy.
Knowledge and innovation	• The knowledge and innovation course of action relates to innovation (developing, applying, testing and evaluating knowledge), uniformity (making suitable for standardisation/upscaling) and production (rendering knowledge/innovation for the best value for money). For all of these phases, knowledge and experience is needed that as far as possible we will develop with our partners and combine for the ambitions and targets of the transition path.
Financing	• This course of action describes the financial incentives that can be deployed by government to further encourage the transition. This relates both to 'pricing up' or making polluting activities more expensive and 'rewarding' activities that reduce emissions.
Material (dredged material and soil)	• This course of action is based on the actions needed to realise the ambitions set for dredged material and soil. To outline, within this course of action, three categories of action are considered necessary. These are policy-based improvements, knowledge development and technical improvements in operation.
Other	• The actions in this theme relate specifically to information management, the establishment of governance and the organisation of programme management.

Sources: Rijkswaterstaat.

Themes per course of action

Course of action sub-themes	Explanation
Policy	
Policy forming	• These actions relate to the policy that has to be formed in order to achieve the targets. An example is drafting a policy on biofuels.
Cooperation	• These actions relate to collaborating with multiple companies to learn from each other and to form a uniform policy for companies. For example, the harmonisation of procurement strategy by public clients and consultation with and inclusion of the entire sector in the transition strategy.
Market and procurement	
Strategy	• The actions within the theme Strategy under the market and procurement course of action, relate to the development and forming of an appropriate procurement strategy for achieving the ambitions as laid down in this transition path.
Procurement instruments	• These actions relate to the instruments that can be deployed in order to ensure that conceived strategies are implemented. Possible examples are ECI requirements on the dredging equipment or an emission performance label.
Financing	
Promoting	• The actions in this theme describe what is needed in order to encourage the right developments (and to reward front-runners).
Innovation	• Within this theme, actions relate to which initiatives and innovations should be deployed, and how they need to be financed.

Sources: Rijkswaterstaat.

Themes per course of action

Course of action sub-themes	Explanation
Knowledge and Innovation	
Research	• The actions in the research course of action relate to the organisation or following of relevant studies with a low Technology Readiness Level (TRL) that may in the future make a major contribution to achieving sustainability targets. For example research by the Delft University of Technology into dredging with low peak power.
Demonstrations	• The actions in the field of demonstrations are more specific and relate to innovations that already have a slightly higher TRL. Demonstrations show what is and what is not effective, for example the demonstration ‘sailing through sludge’. The aim is to make the transition from research to demonstrations to implementation.
Implementation	• The actions in the implementation course of action are linked to actions needed for actually putting innovations into practice.
Material	
Policy-based improvements	• These actions are focused on (re)forming policy on dredged material and soil. Changing the policy frameworks and regulations (the playing field) is a powerful instrument. Policy-based actions can have a greater impact than actions in project implementation.
Knowledge development and innovation	• Knowledge development should be focused on helping to achieve the ambitions on dredged material. and soil. Knowledge development is aimed at improving the policy, the dredged material and soil itself, and improving the actual use of that material.
Technical improvements in implementation	An important subject for this theme is the value of reuse. A number of ideas are currently being investigated in this respect (clay from dredged material, rocks from dredged material, dredged material as a soil improver, etc.). As well as the implementation of work, this category can also relate to tendering policy by clients in the civil engineering sector.

Sources: Rijkswaterstaat.

Success factors, risks and monitoring & mitigation actions

Success factors	Risks	Monitoring & mitigating actions
1. Expertise **2. Clear, multiyear vision and accompanying resources and policy** **3. Energy transition and accompanying sustainable powertrains must be available** **4. Readiness of companies to invest** **5. New technologies must be able to handle production**	• No fixed policy and no resources	• Discuss and fix vision and resources for a number of years.
	• Energy transition is moving too slowly or focuses on other sectors	• Gain an insight in advance, and continue to monitor. • Where possible, reach agreements on the availability of renewable energy carriers.
	• International companies concentrate on less challenging clients due to uncertain payback times for investments.	• Together with the market, continue to monitor what is and is not possible. • Encourage international demand.
	• Fairways, coastal maintenance and other functions of the water systems and waterways must be maintained, new technologies represent a risk to guaranteeing this availability.	• Via trials and monitoring, ensure that innovations become scalable with sufficient production capacity. Otherwise slow down, or hold back some current means of production.

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Monitoring

Exactly what the monitoring system will look like is not yet certain, and is one of the outstanding actions. More work will be carried out on the precise structuring of the monitoring system, over the coming year. In this chapter, we do consider the different levels of monitoring that exist within the transition path.

- **Level 1: Monitoring effects in the sector**

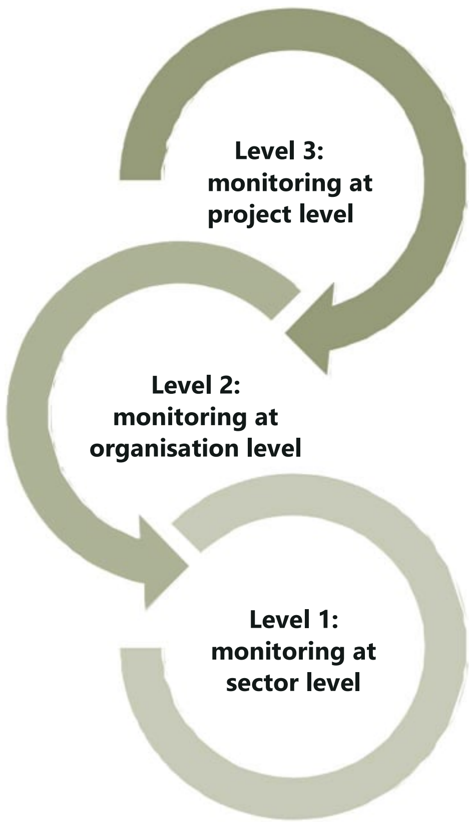
To be able to monitor the effects at sector level, use is made of the monitoring system that will be established for the SEB roadmap.

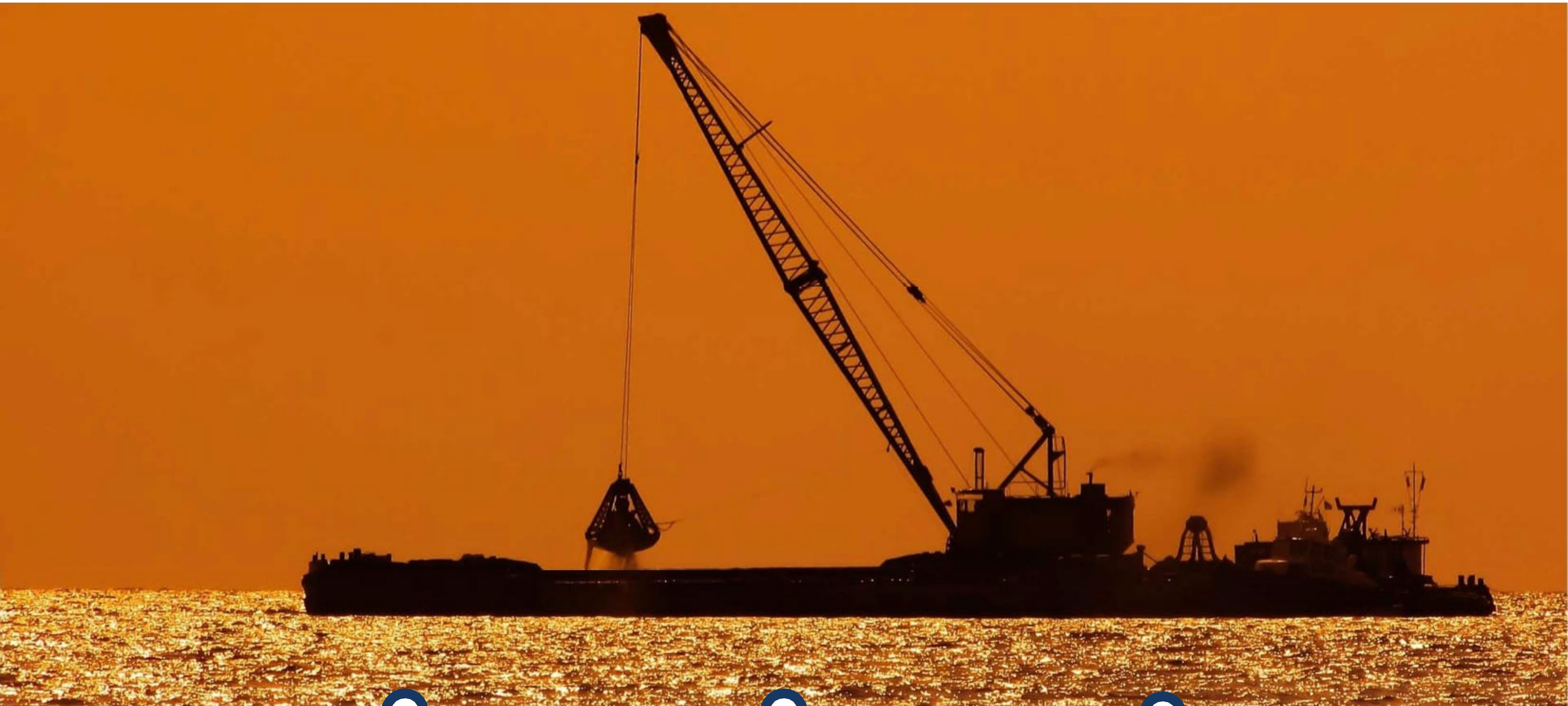
- **Level 2: Monitoring of the effects within Rijkswaterstaat**

In addition to monitoring at sector level, it is important that Rijkswaterstaat monitors the emission and reductions achieved by its own organisation. Unfortunately, it is not yet certain what form this will take within Rijkswaterstaat. For that reason, work will be carried out on a monitoring system in 2023.

- **Level 3: Monitoring the effects at project level**

Clients can monitor the expected emission reductions from the projects on which they impose additional requirements on sustainability. A variety of methods can be used for this purpose. For example the ‘Sustainable public procurement’ report and the ‘Emissions tool’.





ANNEX

1. Market transformation theory

2. Market transformation roles & possible actions

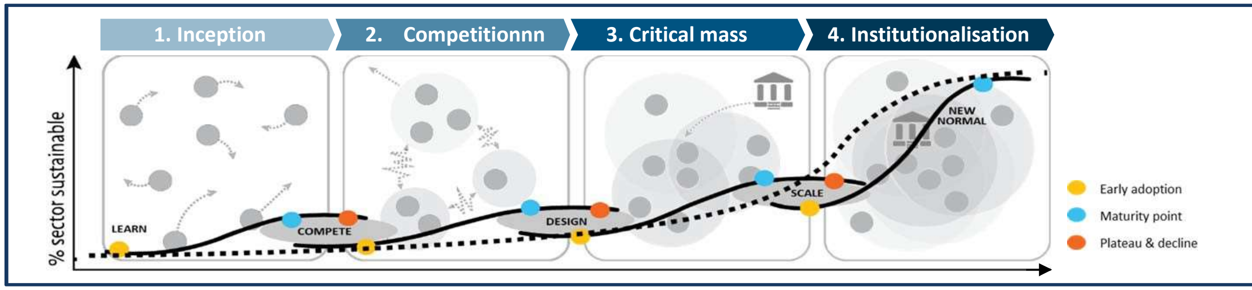
3. TransMissie key processes

The TransMissie© model – a new, integrated framework that can be used for developing and analysing transition strategies on the basis of the phases of Sustainable Market Transformation and the key processes of Mission-driven Innovation Systems

Analytical framework: TransMissie©

- The analytical framework used to develop the roadmap is Transmissie© - a unique combination of the phases and interventions of stakeholders from Sustainable Market Transformation[1] theory developed by NewForesight and Nijenrode Business University, and the seven key processes of Mission-driven Innovation Systems[2] (MIS) theory from the Copernicus Institute (see annex I-III).
- To arrive at a transformation strategy for this roadmap, a number of stages were implemented:
  1. **Mapping out the sustainability challenge:** Determining the scope, current environmental impact, vision for the future, and specific ambition for achieving the vision.
  2. **Analysis of the value chains and market dynamics:** Understanding the characteristics and (non-sustainable) dynamics of the market, and determining what is needed to bring about change.
  3. **Identifying measures and placing them in the transformation phases:** Identifying measures (technical and management solutions) and determining in which transformation phase they are currently found.
  4. **Drawing up a transformation strategy:** Determining which actions must be implemented and which stakeholders can play a role, in order to ensure that the key processes function smoothly and carry the measures to the next phase of transformation.

Transformation phases



How does the TransMissie framework work?

- Sustainable solutions pass through 4 phases – each phase has its own characteristics and each phase requires other interventions by different stakeholders.
- In every phase there are 7 key processes which have to function smoothly if the system is to be able to become more sustainable. The nature of the key processes changes through the phases.
- For a successful market transformation, the key is to identify which stakeholders must perform which interventions, in which phases in order to improve the key processes, to accelerate the emerging system and to apply pressure on the old system.

Transformation key processes

Sources: 1. Simons, Lucas and Nijhof, André. (2020). "Changing the Game: Sustainable Market Transformation Strategies."; 2. Elzinga et al. (2020) "Het Missie-gedreven Innovatiesysteem: Uitbreiding 'Technologisch Innovatie Systeem'-raamwerk ter monitoring van de Circulaire Economie." *Working Paper*. TransMissie© is a concept developed in partnership by NewForesight, Nyenrode and Copernicus institute

NewForesight creating shared opportunities | NYENRODE BUSINESS UNIVERSITEIT | Universiteit Utrecht

Translation of Figure:

Transformation key processes

NL	EN
Missie	Mission
1. Urgentie- en visieontwikkeling	1. Urgency and vision development
2. Kennisontwikkeling en -uitwisseling	2. Knowledge development and exchange
3. Marktontwikkeling	3. Market development
4. Creatie van geloofwaardigheid en legitimiteit van oplossingsrichting	4. Creating credibility and legitimacy of proposed solutions
5. Mobilisatie van financiële middelen en human capital	5. Mobilising financial resources and human capital
6. Sector coördinatie en organisatie	6. Sector coordination and organisation
7. Wetgeving en beleid aanpassen	7. Adapting legislation and policy

Market transformation theory is based on system thinking focused specifically on influencing the market dynamics by activating different stakeholders.

Annex I: Market transformation

What does the market transformation theory help us understand?

Market transformation theory helps us gain an insight into transformation to a more sustainable sector. It identifies **four phases** through which any sustainable solution must pass, each with its own characteristics. It also identifies the **seven key processes** that must function smoothly in order to advance a solution to the next phase. All phases must be completed in order to ensure a successful transformation.

How is it used?

Each phase is characterised by its own unique market dynamics, levels of organisation, barriers, risks and opportunities. The key processes must function smoothly in every phase, but the importance and nature of the key processes differs in each phase. This means that a different set of strategies and interventions is needed in every phase, in order to achieve and safeguard progress.

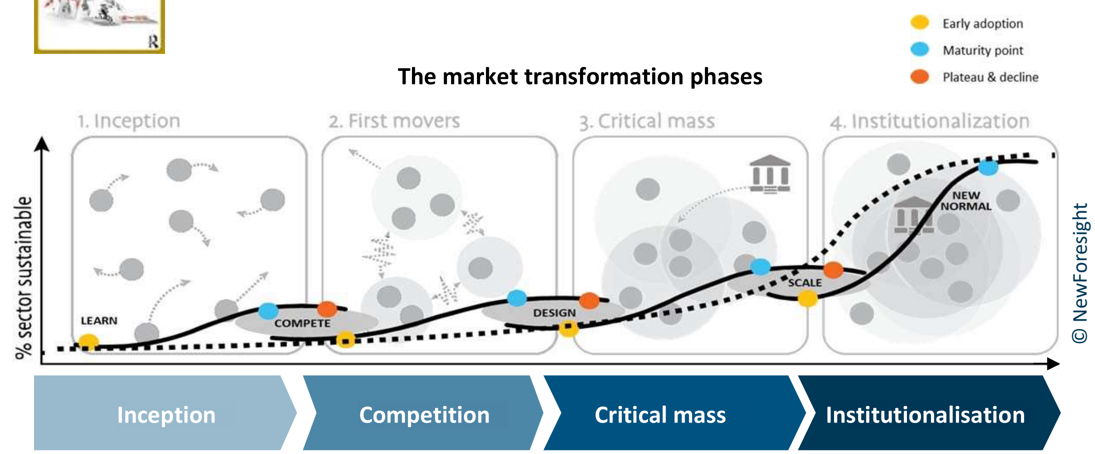
For a successful transformation, it is therefore crucial to identify who must do what and when in order to ensure the smooth functioning of the key processes and to advance solutions to the next phase. The different parties fulfil different roles and responsibilities in a transformation process (see Annex III) with a growing level of cooperation and coordination over time.

How can the theory be applied to this research?

The NewForesight Market transformation model is used to understand the degree of organisation and market dynamics in the relevant value chain and market, for a variety of sustainable measures. By understanding the phase in which a measure finds itself, strategies can be conceived for advancing the measure to the next phase of market transformation.

"Instead of a 'magic bullet' approach, sustainable market transformation requires that we understand the phase in which a solution is currently found; what the possible barriers are that prevent us from achieving progress; and what the success factors are for making the transition to the next phase."

The market transformation phases



*The 'Inception' phase is characterised by initial **awareness** of problems, and individual **pilot projects** for developing solutions.*

*The 'Competition' phase is characterised by **competition** based on sustainability by **front-runners** and the creation of **market incentives** for working towards solutions*

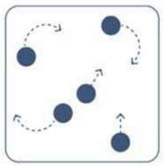
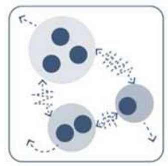
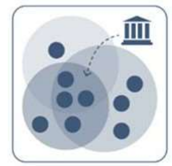
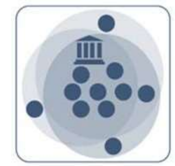
*The 'Critical mass' phase is characterised by **cooperation** and **creation** of the ideal **conditions for change.***

*The 'Institutionalisation' phase is characterised by **embedding the new normal**, for example in **legislation.***

Sources: Lucas Simons and André Nijhof (2020) "Changing the Game: Sustainable Market Transformation

In each phase of the market transformation, stakeholders must play a different role in ensuring that key processes run smoothly, and advance the solutions to the next phase.

Annex II: Market transformation roles & possible actions

	1. Inception	2. Competition	3. Critical mass	4. Institutionalisation
Government	• Initiate pilots • Encourage innovation • Grant subsidies	• Make vision and criteria clear • Recognise / reward front-runners • Sustainable procurement	• Create a vision and platforms • Remove policy obstacles • Purchase only from front-runners • Subsidise non-profitable top	• Take political responsibility • Establish/embed legislation • Offer financial incentives
Businesses	• Start with CSR • Support good causes • Participate in projects	• Stand out from others • Create or embrace standards, labels, rankings, indexes • Work together with your value chain	• Form and participate in platforms • Formulate a sector strategy • Draw up a non-competitive agenda	• Contribute to legislation • Positive lobby • Ensure that stragglers catch up
NGOs	• Organise campaign • Participate in projects • Draw up action agenda	• Reward front-runners / punish stragglers • Support company strategy • Accept company reality	• Participate in platforms • Play watchdog role • Aim for upscaling	• Discuss with politics • Monitor the development • Ensure transparency
Financial institutions	• Support good causes • Start CSR or own foundation • Launch projects	• Reward front-runners • Support your customers • Offer special green services	• Participate in platforms • Help with structuring measures • Positive corporate engagement	• Implement (investment) policy • Dare to exclude • Keep rewarding front-runners
Knowledge institutions	• Identify urgency • Formulate an agenda • Determine frameworks	• Research best practices • Monitor development • Identify improvement points	• Step in corporate ecosystems • Advise politics • Monitor development	• Emphasise continuous improvement • Optimise the institutions • Point out side effects

Sources: Lucas Simons and André Nijhof (2020) "Changing the Game: Sustainable Market Transformation

The following measures are identified that could contribute to achieving the ambitions and goals.

Measures (1/2)

Measures for achieving goals		Explanation
1. Alternative powertrains	1.1 Electric (battery and plug) freshwater dredger	• Battery or plug electric drive
	1.2 Hydrogen in fuel cell	• Supplies electricity, water and some heat. Only emission is water.
	1.3 Hydrogen in combustion engine	• Can be used mixed or unmixed as drop-in fuel in conventional piston engines, on condition the piston engine is suitable. Not zero emission. Thanks to high-temperature combustion, nitrogen and particulate matter are also emitted. With an additional emission measure such as SCR for nitrogen and DPF for particulate matter, a low-emission drive can be achieved.
	1.4 Methanol in combustion engine	
	1.5 Methanol in fuel cell	• Conversion from (green) methanol delivers electricity, a small amount of heat, water and CO_2.
	1.6 Biodiesel (HVO)	• This is a transition measure. Higher costs involved and makes no structural contribution to climate (is a one-off) and makes no contribution to the target scope for particulate matter and nitrogen without taking additional emission reduction measures.
	1.7 Biodiesel (third generation)	• This is a final solution. It relates to biofuels produced on the basis of algae.
	1.8 Hybrid powertrain (diesel - electric)	• Generator generates electricity for electric motors and pumps and possibly a shaft with propeller. Generator can in the future be replaced by a fuel cell or battery.

Sources: Rijkswaterstaat.

The following measures are identified that could contribute to achieving the ambitions and goals.

Measures (2/2)

Measures for achieving goals		Explanation
2. Cleaning options	2.2 Shorter transport distances	• Contractors already minimise transport for cost reasons (transport costs money). In addition, there are already certain statutory conditions that make less or shorter transport difficult.
	2.3 Stage V / TIER III	• Seagoing propulsion is TIER-classified. Depending on the year of construction, vessel type and size category. Inland propulsion is CCR standard: specifies nitrogen oxides, carbon monoxide, hydrocarbons, particulate matter limit values.
	2.4 SCR installation	• Aim of limiting emission of NO_x. NO_x is converted into N_2 and H_2O.
	2.5 DPF	• Removes soot particles from exhaust gases from a vessel and reduces PM10 (particulate matter).
3. Circular and high-value soil use	3.1 Protecting stocks	• Prevention of pollution of soil/dredged material, for example from waste substances discharged into water. • Keeping as much dredged material/soil in the system as possible. • Guaranteeing security of supply. For example by spatial reservation for sand extraction.
	3.2 High-value use of dredged material/soil	• Dredged material/soil used usefully and functionally in a high-value manner.

Sources: Rijkswaterstaat.

The measures for sustainable coastline and fairway maintenance are in different phases of market transformation

Phase of market transformation

'Immature': Solutions not yet ready for upscaling

Growth path: Solutions ready for upscaling or institutionalisation

	Phase 0: Creating	Phase 1: Projects & pilots	Phase 2:	Phase 3: Critical mass	Phase 4:
1. Alternative powertrains		1.2 Hydrogen in fuel cell	1.3 Hydrogen in		1.6 Biodiesel (HVO)
			1.4 Methanol in combustion engine		1.1 Electric (battery and plug) freshwater dredged
			1.5 Methanol in fuel cell		
		1.7 Biodiesel (third generation)		1.8 Hybrid powertrain (diesel - electric)	
2. Cleaning options	2.1 Shorter transport distance				2.2 Stage V / TIER III
					2.3 SCR installation
					2.4 DPF
3. Circular and high-value soil use		3.1 Protecting stocks			
		3.2 High-value use of dredged material/soil			

Sources: For a description of the market transformation phases, see appendix 1; placement of measures in phases by Rijkswaterstaat.

In every phase of a transition there are 7 key processes that must function smoothly.

Annex III: TransMissie key processes

Key process	*Core question*
1. Developing urgency and vision	• Is it clear there is a sustainability problem and are there grounds and urgency for change? • Is there a vision on what we need to achieve to solve the problem?
2. Developing and exchanging knowledge	• Do we know the potential solutions? • Is sufficient knowledge being developed to arrive at these solutions?
3. Market development	• Are front-runners (first movers) with new sustainable solutions recognised and rewarded? • Are niche markets created and are they scaled up?
4. Creation of credibility and legitimacy of proposed solutions	• Is it clear which solutions are desirable to realise the vision? • Do these solutions enjoy sufficient credibility and legitimacy?
5. Mobilising financial resources and human capital	• Are there sufficient financial resources and human capital to develop and scale up the desired solutions? • Are there sufficient resources for the smooth functioning of key processes?
6. Sector coordination and organisation	• Is there sufficient coordination between sector companies to develop sustainable solutions and is the sector organised in a way that makes these solutions the new normal?
7. Adapting legislation and policy	• Are legislation and policy adapted to develop and scale up new sustainable solutions and to dismantle the old, non-sustainable system?

TransMissie© model

- The TransMissie key processes build on Sustainable Market Transformation theory[1] and the functions of Mission Driven Innovation Systems (MIS) theory[2].
- **Note!** This is a draft version of the key processes and these will be developed & elaborated on further

Sources:

1. Simons, Lucas and Nijhof, André. (2020). "Changing the Game: Sustainable Market Transformation Strategies to Understand and Tackle the Big and Complex Sustainability Challenges of Our Generation."

2. Elzinga et al. (2020) "Het Missie-gedreven Innovatiesysteem: Uitbreiding 'Technologisch Innovatie Systeem'-raamwerk ter monitoring van de Circulaire Economie." *Working Paper.*

Underlying principles of the growth path for coastline and fairway maintenance

General

- The pace and scale of the measures reproduced in the growth path are based on the technical maturity of cleaning options, the economic feasibility and support/continued effect of the measures by the stakeholders involved. The pace and scale of the measures have also been validated in consultation with the sector and TNO.
- We follow the Renewable Energy Directive (RED II, European directive on renewable energy) for defining the renewable energy carriers. The following energy sources are defined as renewable:
  1. Advanced biofuels covered by RED II Annex IXa
  2. Renewable fuel of non-biological origin (RFNBO) with a CO_2 reduction of at least 70%
  3. Use of green electricity
- The two measures from the growth path relate to the following target scope:
  1. Cleaning engines by means of tightening the emission class have impact on the reduction of nitrogen and particulate matter. Seagoing dredging equipment represents an exception. Tightening up tier classes has no impact on the reduction of particulate matter. No additional measures have been taken to reduce the particulate matter emissions of seagoing dredging equipment because this has no impact on health benefits. Additional investments for reducing particulate matter for seagoing dredging equipment are therefore not cost-effective.
  2. The use of renewable energy carriers reduces CO_2 emissions.
- Compliance with the emission requirements relating to a specific emission class can be achieved by direct certification according to the standard in question for a new built vessel or by means of retrofit, whereby the emission standards that apply to the emission class in question are satisfied.
- The decision has been taken to not distinguish between different output classes in the categorisation of floating dredging equipment, in order to prevent so-called ‘avoidance behaviour’.

Underlying principles of the growth path for coastline and fairway maintenance

General

- To continue to invest cost effectively in more sustainable engines, it has been decided that emission class standards (tier classes and CCR standards) relate to the weighted average of the installed power on the entire vessel. This includes all main, auxiliary and work engines.
- The basic level and ambition level regarding the use of renewable energy carriers in period 4 is only possible in the event of large-scale purchase of biofuel and the use of the first vessels powered by green electricity or RFNBOs.
- The underlying principle is that the percentage of renewable energy carriers is measured according to the client contract portfolio. This has been done in order to provide space for individual projects where the use of renewable energy carriers is (more) difficult.

Freshwater/construction equipment

- The fleet comprises relatively large numbers of ‘old’ barges, piling barges and support vessels. More than 80% of these vessels are CCRI or lower. The minimum requirements from the basic level imposed in respect of the CCR standards in the 1st and 2nd period are limited, as a consequence. Efforts are however being encouraged to make the vessel types cleaner by aiming for an ambition in respect of stage V (IWA - IWP) in period 2.
- For small cutter suction dredgers and silt pushers, requirements higher than CCRII are not possible. Stage V engines are larger than the current engines and as such do not fit in the hull of these vessels. Of course the hull can be enlarged, but the vessels will then not fit below old bridges. This is particularly relevant for the water boards.
- The category grab (hopper) dredger, cutter suction dredgers and suction hopper dredgers is relatively new (2013 - 2016) compared with the category barges and other vessels. The basic and ambition level for the CCR standard is therefore set more ‘strictly’ for this category.

Underlying principles of the growth path for coastline and fairway maintenance

Freshwater/construction equipment

- The minimum requirements of the basic level for Stage V relate to IWP and IWA. See below the accompanying emission levels in grams per KWh. This is because the requirements set on an NRE are not attainable for a large proportion of the fleet.

Table 7
Stage V emission standards for engines in inland waterway vessels (IWP & IWA)

Category	Net Power	Date	CO	HC[a]	NOx	PM	PN
	kW		g/kWh				1/kWh
IWP/IWA-v/c-1	19 ≤ P < 75	2019	5.00	4.70[b]		0.30	-
IWP/IWA-v/c-2	75 ≤ P < 130	2019	5.00	5.40[b]		0.14	-
IWP/IWA-v/c-3	130 ≤ P < 300	2019	3.50	1.00	2.10	0.10	-
IWP/IWA-v/c-4	P ≥ 300	2020	3.50	0.19	1.80	0.015	1×10^{12}

[a] A = 6.00 for gas engines
[b] HC + NOx

Seagoing (saltwater) dreddging equipment

- It is both economically and technically unrealistic to impose minimum requirements on vessels with a hopper capacity in excess of 15,000 m3. For that reason, for the basic level in the growth path, an exception has been made for seagoing vessels larger than 15,000 m^3.
- Calculations by TNO show that 35% of the current fleet is excluded from? participation in the minimum requirement in accordance with Tier I in period 1. It has therefore been decided to not make the requirements for the basic level stricter, for the first period.
- For marine dredging equipment, stricter tier class requirements in period 2 have not been set. The reason for this is that in that case, possibly up to 50% of the available fleet would be excluded. It does not appear realistic to replace this amount of vessels in just 3 years.

Annex C Basic & ambition level fairway maintenance freshwater

Fairway maintenance freshwater - Basic level Rijkswaterstaat - Provinces - Municipalities - Water boards					
Vessel type		**Period 1 2022 through to 2024**	**Period 2 2025 through to 2027**	**Period 3 2028 through to 2029**	**Period 4 From 2030**
Hopper barge, silt pushers, auxiliary equipment (survey vessels, tugs and push boats), small cutter suction dredgers** other small waterborne dredging equipment	Engines	No requirement	No requirement	Minimum emissions in accordance with CCR II*	Minimum emissions in accordance with CCR II*
	Energy carriers	At least 20% renewable energy carriers	At least 35% renewable energy carriers	At least 60% renewable energy carriers	At least 75% renewable energy carriers
”Grab hopper dredger, grab dredger, cutter suction dredger, bucket wheel suction dredgers, hopper barges, piling barges, support vessels, suction hopper dredger”	Engines	No requirement	No requirement	Minimum emissions in accordance with CCR II*	Minimum emissions in accordance with stage V (IWP-IWA)*
	Energy carriers	At least 20% renewable energy carriers	At least 35% renewable energy carriers	At least 60% renewable energy carriers	At least 75% renewable energy carriers

** Certified CCR I to stage V (IWP-IWA) inclusive or retrofit compliant with the emission standards in accordance with CCRI to stage V (IWP-IWA)*

*** Small cutter suction dredgers are suction dredgers deployed solely on zone 4 waters.*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Fairway maintenance freshwater - Ambition level Rijkswaterstaat - Provinces - Municipalities - Water boards					
Vessel type		**Period 1 2022 through to 2024**	**Period 2 2025 through to 2027**	**Period 3 2028 through to 2029**	**Period 4 From 2030**
Hopper barge, silt pushers, auxiliary equipment (survey vessels, tugs and push boats), small cutter suction dredgers** other small waterborne dredging equipment	Engines	No requirement	Ambition 10% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 40% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 70% emissions in accordance with stage V (IWP-IWA- NRE)*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 85% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or HE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 15% RFNBOs or RE
”Grab hopper dredger, grab dredger, cutter suction dredger, bucket wheel suction dredgers, hopper barges, piling barges, support vessels, suction hopper dredger”	Engines	No requirement	Ambition 25% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 60% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 100% emissions in accordance with stage V (IWP-IWA- NRE)*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 85% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or HE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 15% RFNBOs or RE

** Certified CCR I to stage V (IWP-IWA) inclusive or retrofit compliant with the emission standards in accordance with CCRI to stage V (IWP-IWA)*

*** Small cutter suction dredgers are suction dredgers deployed solely on zone 4 waters.*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Explanatory note 5: RE stands for renewable electricity & RFNBOs stands for renewable fuels of non-biological origin

Annex D Basic & ambition level seagoing dredging equipment

Coastline and saltwater fairway maintenance (seagoing dredging equipment) - Basic level Rijkswaterstaat - Port Authority					
Vessel type		**Period 1** **2022 through to 2024**	**Period 2** **2025 through to 2027**	**Period 3** **2028 through to 2029**	**Period 4** **From 2030**
"Trailing suction hopper dredgers, Grab hopper dredger, grab dredger, cutter suction dredger, suction hopper dredger, water injection dredger"	Engines	Minimum emissions in compliance with Tier class I*/**	Minimum emissions in compliance with Tier class I*/**	Minimum emissions in compliance with Tier class II*/**	Minimum emissions in compliance with Tier class III*/**
	Energy carriers	At least 10% renewable energy carriers	At least 20% renewable energy carriers	At least 40% renewable energy carriers	At least 60% renewable energy carriers

** Certified tier I to III or retrofit compliant with emission standards in compliance with Tier I to III*

*** With the exception of vessels with a hopper capacity >15,000 m3 that can be demonstrated necessary for performance of the work*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Coastline and saltwater fairway maintenance (seagoing dredging equipment) - Ambition Rijkswaterstaat - Port Authority					
Vessel type		**Period 1 2022 through to 2024**	**Period 2 2025 through to 2027**	**Period 3 2028 through to 2029**	**Period 4 From 2030**
"Trailing suction hopper dredgers, Grab hopper dredger, grab dredger, cutter suction dredger, suction hopper dredger, water injection dredger"	Engines	Ambition 20% Tier class III*	Ambition 50% Tier class III*	Emissions in accordance with Tier class III*	Emissions in accordance with Tier class III*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 90% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or RE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 10% RFNBOs or RE

** Certified Tier I to III or retrofit compliant with the emission standards in accordance with Tier I to III*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Explanatory note 5: RE stands for renewable electricity & RFNBOs stands for renewable fuels of non-biological origin

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Date
25 January 2023

Annex(es)
1. Given presentations
2. Results Mentimeter
3. Details of sub sessions

REPORT

Market consultation meeting procurement strategy Coastline and Fairway Maintenance Transition Path (TPKV)

Meeting date	24 January 2023
Participants	Rijkswaterstaat & Port of Rotterdam Authority and the market. Participating market parties: Jan de Nul, Beens, Boskalis, Van den Herik, Van der Kamp, Van Oord, Heuvelman Ibis, DEME (Dredging International), De Boer (Dutch Dredging), Deal Drecht Cities (ZED-hub) and Vereniging van Waterbouwers.
Location	De Roskam, Plein 25, 3991 DL Houten
Copy to	TenderNed

Opening and welcome
Facilitator Frans Scheepens opened the day and presented the programme.

Mirjam Heuvelman (director Procurement and Contract Management Rijkswaterstaat PPO) welcomed everyone present and pointed out the following issues:

- The urgent need for improved sustainability is evident, and requires no further emphasis.
- Here we are dealing with the seagoing dredging market; inland dredging operations will be tackled later (or in parallel).
- Rijkswaterstaat is working simultaneously on four transition paths, and where possible the approach will be combined.
- Ambitions and objectives for improved sustainability are decisive; carbon neutral and circular infrastructure ambitions (KCI) and the Clean and Zero emission Building (SEB) targets.
- However, the operating principle is that the infrastructure (coastline and fairways) must remain in good order; it must not come under pressure.
- In our management and maintenance budgets, 2% has been set aside for improving sustainability over the coming years.
- In addition to space in new projects and tender procedures, existing contracts sometimes offer space and possibilities. Mirjam explicitly called upon the market to submit proposals for those aspects as well, to identify which opportunities can be achieved, for what budget.
- We realise that our tender processes take place in an international market and we are therefore specifically looking towards cooperation. The Port of Rotterdam Authority and Rijkswaterstaat already collaborate closely, and we are also looking for international cooperation with other clients from neighbouring countries.

- Let us start by sharing as much information as possible. If you require more in-depth information, contact colleagues at Rijkswaterstaat, including Harry Zondag.

Introduction to the Transition path
Katja van der Waal (programme manager Coastline and Fairway Maintenance Transition Path, TPKV) went on to introduce the objectives and operating principles of the transition path:
- First of all thank you for your cooperation and joint creation of the roadmap and the growth paths. We hope to continue our cooperation towards a procurement strategy and implementation.
- Her presentation appears in annex 1.

Questions and dialogue with the participants:
- Question: What is the origin of the ambition for carbon neutrality by 2030? Answer: From the Ministry of Infrastructure and Water Management. A strategy has been drawn up and communicated with the Lower House of the Dutch Parliament.
- Question: The KCI ambition states: ‘Net zero CO_2 equivalent emissions’. Does this relate to the emissions from vessels and does it apply to the entire supply chain? Answer: In determining emissions, we consider the entire supply chain and the LCA approach. The ‘0.4 Mtonnes reduction as compared with 2019’ for SEB targets applies to the entire construction sector, including the civil engineering sector.
- Question: Reference is made to 75% health benefits, but how do we translate that? Answer: For the time being we have translated it relatively simplistically to 75% less emissions of particulate matter. A precise link to health is difficult for us, and will also require a look at other harmful emissions. However, for us the Clean Air Agreement is the guideline.
- Question: the percentage of renewable energy carriers. Does that relate to a percentage of the fleet or a percentage of tenders? Answer: It relates to a portfolio of projects from the client. That is also one of the questions that recurs in the questionnaire.
- Question: About this percentage: For example in period 1 you have a number of projects; are a proportion of those projects sustainable and the rest ‘standard’? Answer: That is still under debate. For the time being we assume a simple and generic approach to Rijkswaterstaat projects: for all projects, the dredging equipment must satisfy the requirements from the basic level, and at project level the entire energy requirements for the project must be renewable for the specified percentage of energy carriers, according to the definitions. We of course also realise that the availability and technological readiness of innovations is relevant in this regard.

Finally, Katja suggested: It will be 2030 before we know it. What do we need to achieve the transition and the targets/ambition? What conditions will have to be met? That is our point of focus for today and the subject about which we are keen to engage in dialogue with you.

Intermezzo
Harry Zondag (strategic consultant for the dredging market at Rijkswaterstaat) informed the audience that Mirjam would have to leave soon and then asked her why she took the time to attend the market consultation at all?
Mirjam’s answer: To underline the urgency. It is important! In addition, her aim is to achieve greater openness in the sector, and she wanted to invite the participants to share information together. She called upon all stakeholders to help and to strengthen each other. At the end of the day, our Planet is at stake, as is the future for our children.

She wished everyone a positive meeting, and offered one further tip: do not hesitate to get in touch with Rijkswaterstaat.

Introduction to the procurement strategy and dilemmas
Harry continued and talked about the plan for the market consultation, see sheet 16 et seq. in annex 1 and the market consultation document.

- Today's market consultation is in particular intended to discuss how we can become more sustainable in the dredging sector. The dialogue is essential to this process.
- The written round contains a series of questions to which we are keen to receive answers. It is important that we work through this process carefully, together. Following receipt of the questionnaire, we will be happy to engage in dialogue with you.
- The report will also be translated into English to allow it to be shared internationally.

Harry explained the procurement strategy and pointed out that the autonomous development based on legislation and external factors also results in greater sustainability. The basic level of the growth path ensures a line towards approx. 60% sustainability (more imaginary, not an exact science!), but is not yet carbon neutral. However, it does represent some acceleration.
With the ambition level, via a series of scenarios, the objective can be achieved. The growth path was drawn up with support from people in the market. Support for the objectives of the basic level is already in place. For the ambition level there is some caution and differing opinions, but in mutual consultation, a conscious choice was made to specify and to maintain the visibility of the ambition for the higher level. Rijkswaterstaat is currently working to translate the growth paths into a procurement strategy, in which above all for the ambition level, elaborations and scenarios will still have to be worked out. This will result in a number of dilemmas.

Discussing the procurement dilemmas
On the basis of a series of questions and statements, Harry then explained the dilemmas from the market consultation document. The consultation will make use of a digital live survey via mentimeter.
All the questions and answers appear in annex 2.

Explanatory notes to the procurement scenarios
Harry then explained (see slide 41 et seq. in annex 1 and see the market consultation document) the operating principles for the procurement strategy, the various elements for achieving the ambition via procurement and the various scenarios.

LUNCH

Discussion of procurement scenarios (sub sessions)
Frans explained the afternoon programme. In sub sessions, in groups, the benefits and disadvantages of the five scenarios presented by Harry will be discussed. Annex 3 is a summary of the discussions from the various groups.

Ranking and reflection by participants
In addition to the benefits and disadvantages, annex 3 contains a primary response with preferences and rankings, for each group. This all indicates how

each group discussed the issues, and passed judgement 'purely based on feeling'. As far as possible, the argumentation is presented in the table with benefits and disadvantages (or: strong points and weak points).

Provisional findings during the plenary feedback:

- Ranking of the scenarios matches fairly well across the various groups.
- In particular scenarios 1 and 2 scored positively, and for one group in particular scenario 3 achieved a high score. The consensus was that this would probably be a group with large dredgers, but it turned out to be a more nuanced selection, one large and one SME (small and medium size enterprise) dredger. Explanation from the 'small' dredger: it is good to see a runup period; this growth period could help take the next step towards greater sustainability.
- Another group ranked the combination ECI in the standard and portfolio approach high, but with the aim of zero emission. The incentive in the portfolio approach must be zero emission.

Other proposed ideas:

- Do you really want to achieve 100% CO_2 reduction? The additional investment for the final 5% is extremely costly. That budget could possibly be better used more sustainably elsewhere.
- The appreciation of CO_2 reduction or ECI points must be clear and transparent.
- What about crossing national borders? Individual fleets in France and Germany were mentioned. The market is not positive on this point.
- Proposal from another group regarding scenario 4 C - produce a zero emission demonstration vessel according to the wishes/requirements, in exchange for 50 weeks of work per year. Complex due to the scale/spread and requirements on emissions. In that sense similar to scenario 3.
- In another group, scenarios 1 and 2 were linked. Erik put the question: what logical combination of scenarios do you see? Combination 3/5.
- For one group, the ranking was accompanied by explanatory texts. With portfolio, more ambition, for example zero emission with follow-up orders.
- Demonstration vessel yes, but make it a small vessel with different drive systems. Carry out tests and trials to learn more lessons. Educational project, not for purchasing production but as a learning unit. A Wadden hopper for the Wadden Islands, for example (=N2000 area). Demonstration vessel, collaborative form? In other words, we need to look further.
- Definition of zero emission - must be really very clear. And... zero emission is too ambitious (see 95% point above). There are always emissions somewhere in the chain.
- Being ambitious can take you a long way, without focusing blindly on the objective. What should you be looking at? For ECI, we look at the entire chain (LCA). Another question is whether you will make the leap if your goal is 95%? Why would you bother to make the leap if you are not going to succeed in reducing emissions to zero? Do not strive for some blind ambition. Calculate the required budget through to 2050. In addition, it is more efficient for everyone to aim for 95%, rather than only the front-runners.

Follow-up process and conclusion
How should we move forward, together? We are thinking of a mix of scenarios, in both time and projects. We will also have to keep in mind how you can take account of the savings you already achieve in existing orders.

Harry presented a sheet with data for the follow-up. Deadline for the written round is 31 January. Harry emphasised that completing the questionnaire is a really valuable resource. We would also very much appreciate an explanatory discussion. The report etc. will be published at the latest by 21 March.

- We will continue our cooperation with the Port of Rotterdam Authority.
  With neighbouring countries we plan to prepare a position paper.
  Harry will keep in touch with members of the Vereniging van Waterbouwers (Association of Hydraulic Engineers) on how to keep participants from this market consultation on board.
  There is also a buyer group with the water boards.
- Harry unveiled the ranking of part of the internal process at Rijkswaterstaat regarding the procurement strategy and the scenarios. He presented the estimate of what can be implemented and the target range which colleagues at Rijkswaterstaat scored in a quadrant. One participant took a photograph of the sheet. Harry informed those present that the picture was due to be included in the document accompanying the market consultation.
- Based on this ranking in the quadrant, scenario 1 was given a relatively low effect score. One participant pointed out: 'You can make scenario 1 as ambitious as you want; why have you scored the effect so low?'
  Answer: The idea was: when you keep the packages small, this has a limiting effect on the return on investment (ROI).
- Advice: Make it clear from the start where you want to be by 2030; then the market can prepare itself for that scenario.

Harry called upon everyone to take into account everything they had heard today in answering the questions. Rijkswaterstaat expressed the wish to be both reliable and predictable. Any mix in scenarios can also be implemented in phases, in both time and projects.

Process:
Question: Is it possible to be given more time to complete the questionnaire? It is a fairly long questionnaire, and more time would help in giving better answers.
Answer: Fine. We will publish on TenderNed that the submission date will be put back one week. The overall schedule will be shifted slightly as a consequence.

Closure and informal opportunity for networking
Katja thanked everyone for their contribution and the fascinating discussions. She wished everyone a safe journey home and/or follow-up discussions. Looking forward to seeing you soon!

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Carbon neutral and circular in 2030

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Welcome!

Coastline and Fairway Maintenance Transition Path (TPKV in Dutch) procurement strategy market consultation

Mirjam Heuvelman

Rijkswaterstaat Projects, Programmes & Maintenance Procurement and Contract Management Director

Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

Transition path Introduction

Goal, strategy and growth paths

Katja van der Waal

Roadmap working group

Outlines of the strategy (1)

- **Focus** on reducing emissions (dredging equipment) and boost circularity (material). It has to happen **in our production targets**/primary **social** duty.
- Short term: cleaner equipment (zero emission) and energy efficiency (SEB in Dutch) (no regrets measures), as soon as possible: switch to renewable energy carriers (Carbon Neutral and Circular Infrastructure, KCI in Dutch)
- We are a **reliable partner** in procurement, but policy and funding for this still demands a lot. The roadmap and procurement strategy will help in this respect. Framework for asset management and project portfolio in development.
- **Dependent in part** on energy transition and underlying policy (e.g. hydrogen vision, sustainability of biodiesels, European policy surrounding CO_2-taxes and trading).

Outlines of the strategy (2)

- **Procurement** is a faster, national/international **legislative and regulatory instruments** achieve more
- **Influence** standardisation and legislation in relation to **emissions** at EU level (domestic/inland market) and via IMO (market for seagoing equipment)
- Examine and improve legislation and regulation on **circularity of material** based on targets (make sure resources are protected and enable high quality use of soil/dredged material in practice)

Outlines of the strategy (3) (PROCUREMENT!)

- **Seagoing (saltwater) market** is international and capital-intensive, with long depreciation periods for dredging equipment and, at the same time, a small part of the marine world. Specific technological solutions are less well-developed (so there is a need for **international collaboration**)
- **Domestic/Inland (freshwater) market** is made up of a large number of smaller players, with plenty demand from government sources but, here too, capital-intensive with a long product lifespan for dredging equipment. Technological solutions achieved with smaller capacities will be within reach sooner; for instance electrification. (requires **clients to work together (buyer group)**)

Clean and Zero Emission Construction (SEB) (Goals)			Carbon Neutral and Circular Infrastructure (Ambitions)	
Nature recovery (NOx)	Health (PM10)	Climate ($CO_{2\ eq}$)	Climate ($CO_{2\ eq}$)	Raw materials
Structural approach to nitrogen	Clean Air Agreement	Climate Agreement	Climate Agreement	Raw materials agreement
60% reduction in nitrogen compared with 2018	75% reduction in damage to health compared with 2016	0,4 Mtonnes CO_2 reduction compared with 2019	No net CO_2 equivalent emissions	50% reduction in use of raw materials and high-value use of products and materials
2030	**2030**	**2030**	**2030**	**2030**

Focus on sustainability

- Circularity:
  - Reuse of sediment
  - Other materials etc.

- Carbon neutral:
  - Less dredging
  - Les transportation
  - No (restricted) emissions
    1. Greenhouse gas focus => KCI
    2. Greenhouse gas + nitrogen oxides + clean air => SEB

Creating dredging projects

Equipment en energy carriers

1: KCI
2: SEB

Emissions from vessels	**Aim no. 1** We will reduce emissions of nitrogen (NOx) when extracting, transporting and using dredged material by 60% compared with 2018.
	Ambition no. 2 We will not emit any more CO_2 equivalents when extracting, transporting and using dredged material.
	Aim no. 3 We will reduce emissions of particulate matter (PM_{10}) when extracting, transporting and using dredged material in (freshwater or saltwater) fairway maintenance by 75% compared with 2016.
Use of soil and dredging material	**Ambition no. 4** We will maintain the value of soil and dredging material by reusing it in a high-quality way.
	Ambition no. 5 We protect resources of dredged material and soil by safeguarding its quality and by using it sparingly.

Measures		Indicators
Cleaning of Engines	a. Tier emission standards	Tier emissie-eisen I t/m III
	b. CCR emission standards	CCR 0 t/m Stage V IWP/IWA/NRE
Use of renewable energy carriers	a. Biofuels compliant with RED II annex Ixa	% renewable energy carriers
	b. Renewable Fuel of Non-biological Origin (RFNBO)* *At least a CO_2-reduction of 70%	

Growth paths

- Basic and ambition level
- Domestic/inland (freshwater) and Seagoing (saltwater) equipment

Growth path basic level
Seagoing (saltwater) equipment

Coastline and saltwater fairway maintenance (seagoing dredging equipment) - Basic level Rijkswaterstaat - Port Authority					
Vessel type		**Period 1 2022 through to 2024**	**Period 2 2025 through to 2027**	**Period 3 2028 through to 2029**	**Period 4 From 2030**
"Trailing suction hopper dredgers, Grab hopper dredger, grab dredger, cutter suction dredger, suction hopper dredger, water injection dredger"	Engines	Minimum emissions in compliance with Tier class I*/**	Minimum emissions in compliance with Tier class I*/**	Minimum emissions in compliance with Tier class II*/**	Minimum emissions in compliance with Tier class III*/**
	Energy carriers	At least 10% renewable energy carriers	At least 20% renewable energy carriers	At least 40% renewable energy carriers	At least 60% renewable energy carriers

** Certified tier I to III or retrofit compliant with emission standards in compliance with Tier I to III*

*** With the exception of vessels with a hopper capacity >15,000 m3 that can be demonstrated necessary for performance of the work*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path for civil-engineering equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Growth path ambition level
Seagoing (saltwater) equipment

Coastline and saltwater fairway maintenance (seagoing dredging equipment) - Ambition Rijkswaterstaat - Port Authority					
Vessel type		**Period 1 2022 through to 2024**	**Period 2 2025 through to 2027**	**Period 3 2028 through to 2029**	**Period 4 From 2030**
"Trailing suction hopper dredgers, Grab hopper dredger, grab dredger, cutter suction dredger, suction hopper dredger, water injection dredger"	Engines	Ambition 20% Tier class III*	Ambition 50% Tier class III*	Emissions in accordance with Tier class III*	Emissions in accordance with Tier class III*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 90% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or RE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 10% RFNBOs or RE

** Certified Tier I to III or retrofit compliant with the emission standards in accordance with Tier I to III*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Explanatory note 5: RE stands for renewable electricity & RFNBOs stands for renewable fuels of non-biological origin

Growth path basic level
Domestic inland (freshwater) equipment

Fairway maintenance freshwater - Basic level Rijkswaterstaat - Provinces - Municipalities - Water boards					
Vessel type		**Period 1** **2022 through to 2024**	**Period 2** **2025 through to 2027**	**Period 3** **2028 through to 2029**	**Period 4** **From 2030**
Hopper barge, silt pushers, auxiliary equipment (survey vessels, tugs and push boats), small cutter suction dredgers** other small waterborne dredging equipment	Engines	No requirement	No requirement	Minimum emissions in accordance with CCR II*	Minimum emissions in accordance with CCR II*
	Energy carriers	At least 20% renewable energy carriers	At least 35% renewable energy carriers	At least 60% renewable energy carriers	At least 75% renewable energy carriers
"Grab hopper dredger, grab dredger, cutter suction dredger, bucket wheel suction dredgers, hopper barges, piling barges, support vessels, suction hopper dredger"	Engines	No requirement	No requirement	Minimum emissions in accordance with CCR II*	Minimum emissions in accordance with stage V (IWP-IWA)*
	Energy carriers	At least 20% renewable energy carriers	At least 35% renewable energy carriers	At least 60% renewable energy carriers	At least 75% renewable energy carriers

** Certified CCR I to stage V (IWP-IWA) inclusive or retrofit compliant with the emission standards in accordance with CCRI to stage V (IWP-IWA)*

*** Small cutter suction dredgers are suction dredgers deployed solely on zone 4 waters.*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path for civil-engineering dredging equipment (WDSM)

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Growth path ambition level
Domestic/inland (freshwater) equipment

Fairway maintenance freshwater - Ambition level
Rijkswaterstaat - Provinces - Municipalities - Water boards

Vessel type		Period 1 2022 through to 2024	Period 2 2025 through to 2027	Period 3 2028 through to 2029	Period 4 From 2030
Hopper barge, silt pushers, auxiliary equipment (survey vessels, tugs and push boats), small cutter suction dredgers** other small waterborne dredging equipment	Engines	No requirement	Ambition 10% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 40% emissions in accordance with stage V (IWP-IWA-NRE)*	Ambition 70% emissions in accordance with stage V (IWP-IWA-NRE)*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 85% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or HE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 15% RFNBOs or RE
"Grab hopper dredger, grab dredger, cutter suction dredger, bucket wheel suction dredgers, hopper barges, piling barges, support vessels, suction hopper dredger"	Engines	No requirement	Ambition 25% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 60% emissions in accordance with stage V (IWP-IWA-NRE)*	Ambition 100% emissions in accordance with stage V (IWP-IWA-NRE)*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 85% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or HE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 15% RFNBOs or RE

** Certified CCR I to stage V (IWP-IWA) inclusive or retrofit compliant with the emission standards in accordance with CCRI to stage V (IWP-IWA)*

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Now translate to procurement!

Dilemmas and scenarios today

Market consultation set-up

- Plenary session today
- Written session
- Individual session
- Participation gives you a voice, but not preferential treatment in tender procedures (non-participation doesn't give you that either)
- Minutes document is in outline form and anonymous (with an English version)

‘Rules of engagement’ for today

- Be open, honest and naive (OEN in dutch)
- Focus helps
- Everything you say will be used (but can't be used against you or traced back to you)

Rijkswaterstaat
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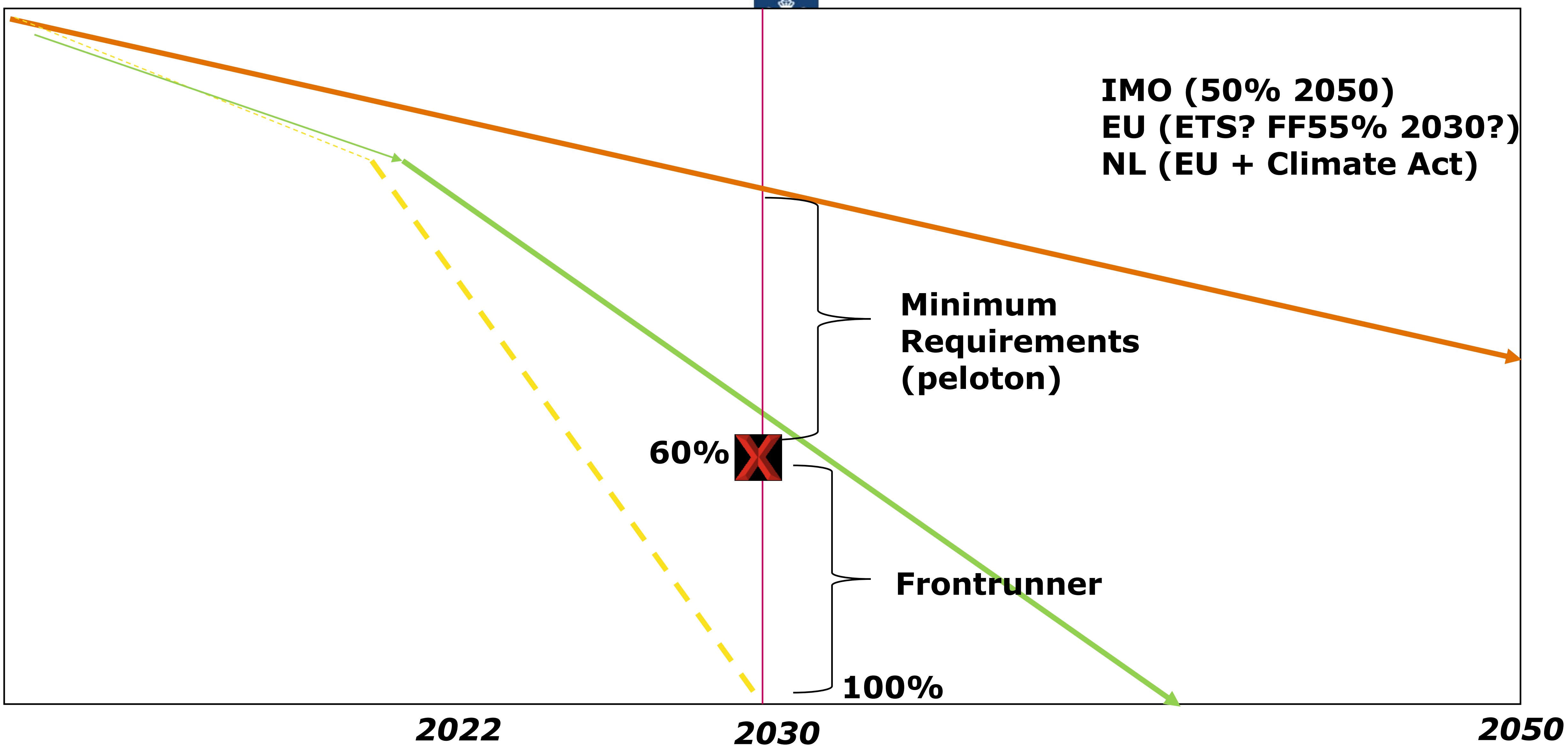
Procurement strategy

Dilemmas and options

Harry Zondag



- Autonomous; based on legislation and external factors
- Growth path basic level
- Growth path ambition level; multiple scenarios

From growth paths to procurement strategy

- Basic level for all projects as minimum requirements?
- Keep using ECI/ECI value in Best Price Quality Ratio (BPQR) to focus on 'more than the minimum' at project level, too
- Translate the procurement planning into frontrunner projects (and how many frontrunner projects can we get to by 2030?)
- A special strategy is needed for the frontrunner projects that goes further than basic level, and requires further development.

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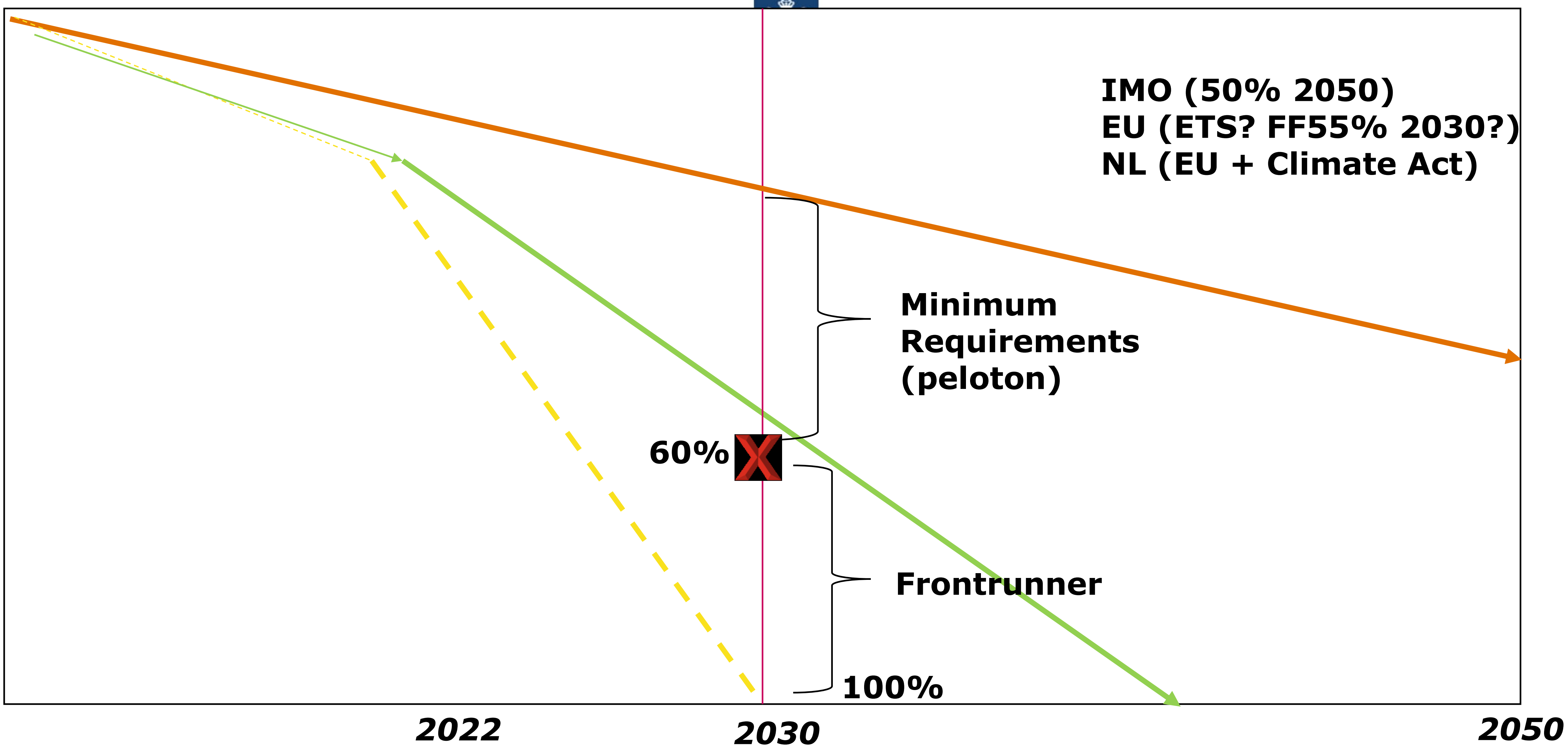
The procurement strategy



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Procurement strategy starting points

- Rijkswaterstaat production/primary process must be safeguarded at all times
- All options are on the table
- Tendering works, as a back-up option, do more ourselves (our own capacity).
- Where there are more radical interventions in the value chain, a case must be made for excluding all less radical interventions and communicating this to the market.
- Sufficient resources, feasible technical solutions, stable level of consistency and future resilience, sufficient demand aggregation to have an impact all benefit the procurement strategy.

Various elements aimed at achieving ambition via procurement

Number of aspects:

- Scope/aggregation/scale/duration
- Award criteria & minimum requirements & bonus/malus system
- Property and risk analyses
- Communicate and offer a measure of certainty towards the market through policy, covenants, legislation (?)

1. Steeply rising ECI (ECI value) and sustainability requirements

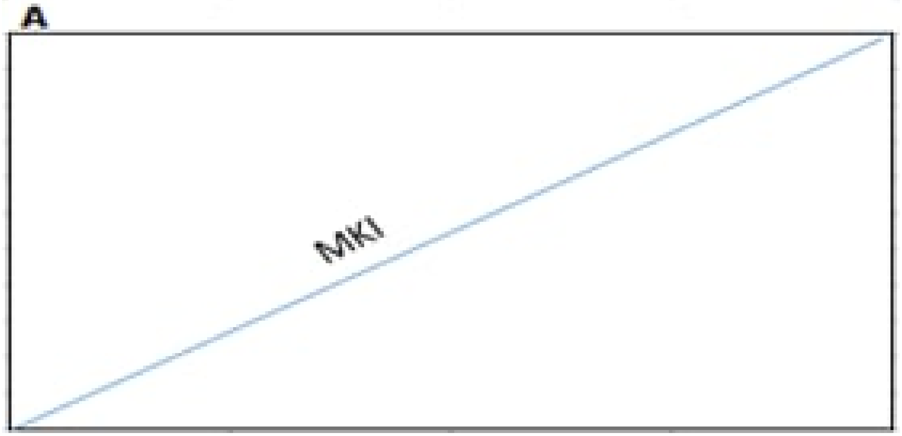
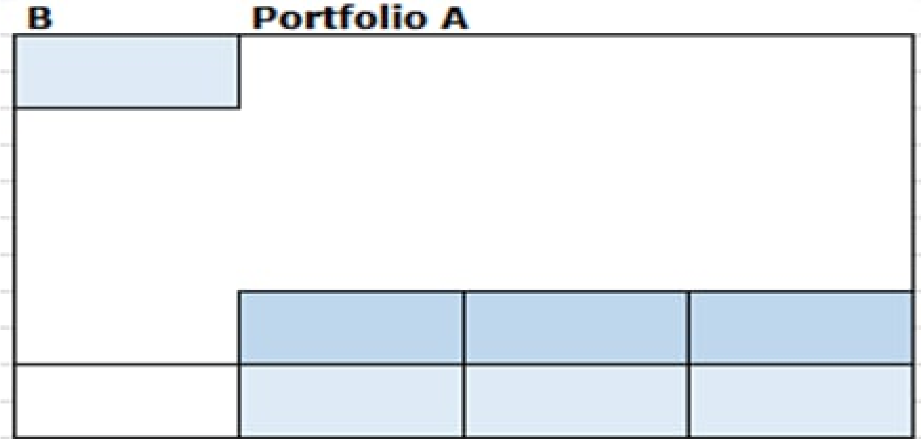


Figure A MKI= ECI

Create ROI by establishing and communicating policy

- Individual tender procedures for projects (coastline + fairway maintenance)
- Awards based on ECI (ECI value)
- Minimum requirements for air quality and climate change are increasingly being tightened, at a rate communicated in advance
- Makes a distinction between 'peloton' and ‘frontrunner’ projects, but % of frontrunner projects is increased at a rate communicated in advance.
- ECI valuation may also increase over the years. (apply Plan, Do, Check, Act method (PDCA)).

2. Contractual Portfolio Approach



Create ROI with policy and communication + contractual options

- Tender procedure for a portfolio contract under which a series of potential long-term contracts are awarded using performance management (fairway + coastline maintenance?)
- Award in terms of ECI and, potentially, a more rapid growth path
- Volumes, precise locations TBD (to be determined)
- Air-quality requirements and climate change are increasing with each project.
- Incorporate incentives for subsequent projects, with lower ECI and increased sustainability using performance-management
  - variant a: Do this within a single contract with a single contractor
  - variant b: Framework agreement with multiple plots and competition for larger-scale subsequent projects (from three to one, for example)

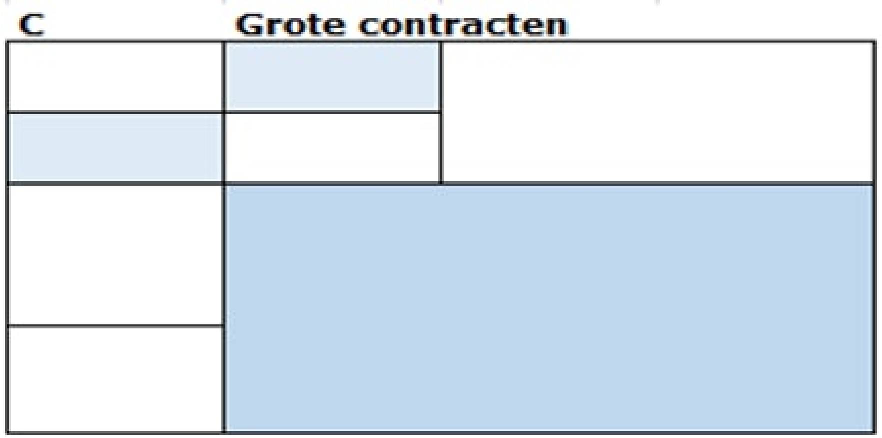


Figure C Grote contracten= Large-scale Contracts

3. Large-scale Contracts

Create ROI with scale of contract

- One tender procedure for long-running contract with long growth period
- Ambitious (disruptive) minimum requirements
- Award criteria price and security of supply?
- Volumes, precise locations TBD
- Long period between award and start of project
- Possibility of risk-bearing participation of client at development stage?

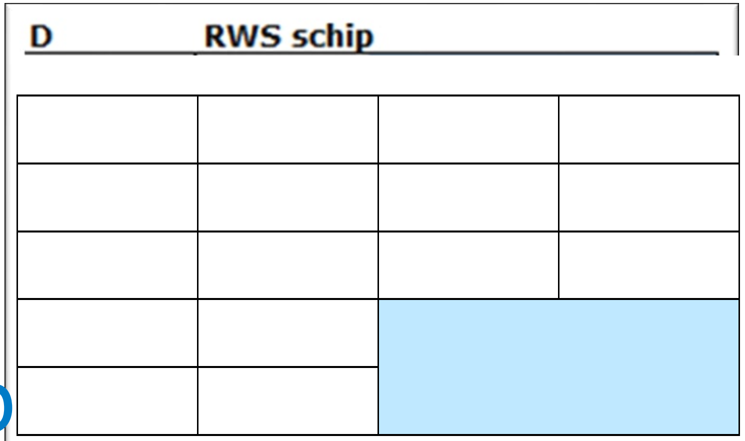


Figure D RWS schip= RWS buying/leasing ship

4.a Rijkswaterstaat (RWS) buying ship
4.b Rijkswaterstaat (RWS) leasing ship

Create ROI by bearing risk ourselves and making learning dimension transparent

- Client administers development of zero emission vessel itself (or a private lease company)
  (lease or purchase with sales guarantee after period of x years)
- Client makes vessel available, operation of vessel is regularly outsourced
- Knowledge sharing is important from development at draft stage, building and operation
- Create exit strategy because of temporary nature? Or is there room for expansion?

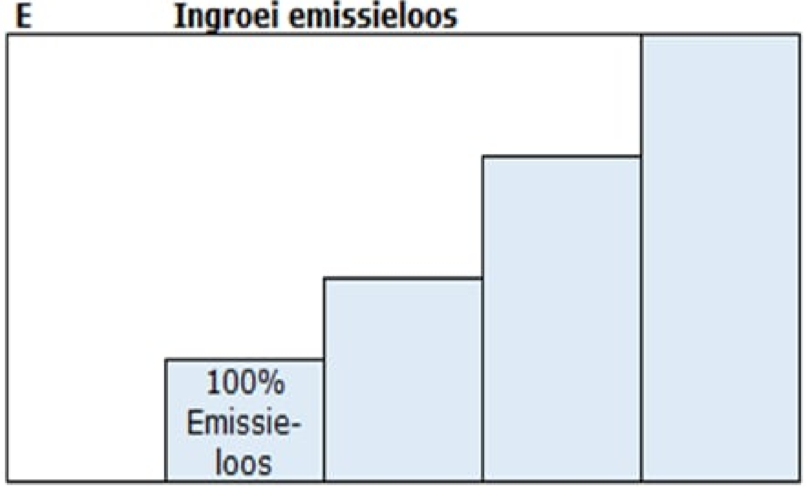


Figure E ingroei emissieloos = Growth of zero emission

5. Growth of zero emission

Create ROI with policy and communication

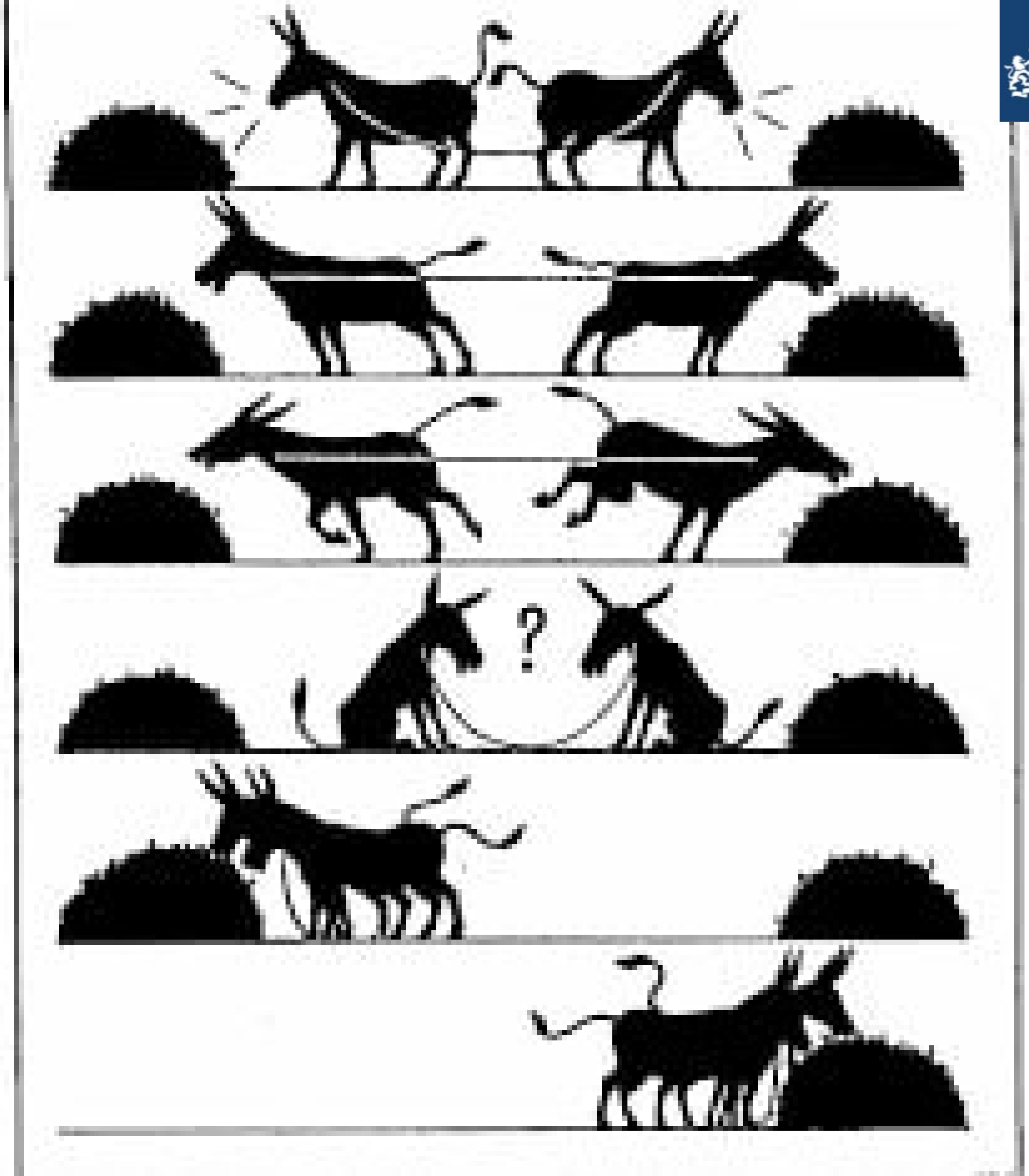
- Make 'zero emission' a requirement at this stage for a number of future tender procedures (goes further than carbon neutral)
- Award criteria price and security of supply (how?=> reserve capacity with lowest possible ECI?)
- Alternatively, specify 100% zero emission from a specific year (2029/30?) in tender specifications for all projects?

	1 Steeply rising ECI (ECI value)and sustainability requirements	2 Contractual Portfolio approach	3 Large-scale contracts	4a RWS Buying vessel	4b RWS Leasing vessel	5 Growth of zero emission
Tender Awarding Criterion	ECI value	ECI value	BPQR (no ECI)	BPQR	BPQR	BPQR (no ECI)
Minimum requirements	Ambition level growth path	Ambition level growth path	Zero emission dredging equipment	Zero emission dredging equipment	Zero emission dredging equipment	Zero emission dredging equipment
Scope contracts	No change	Aggregation in time	Up to approx. 50% of work package	Supplies and service	service	No change
Term of contracts	No change	5–10 years	About 10 years	2–5 yrs	2–5 yrs	No change
Specific feature / point of concern	% front runner projects still to be corrected	Performance management on sustainability	Tender awarding long in advance of execution	Exit strategy needed; Link works to dredging equipment	Performance management on execution; Link works to dredging equipment	Time of first and % zero emission projects still to be corrected
Change in way of working RWS-side	None	Adjust programming	Adjust programming	Management of ship + procurement of service	Procurement of service	None

Lunch until 12.45 uur

Sub-sessions

Break

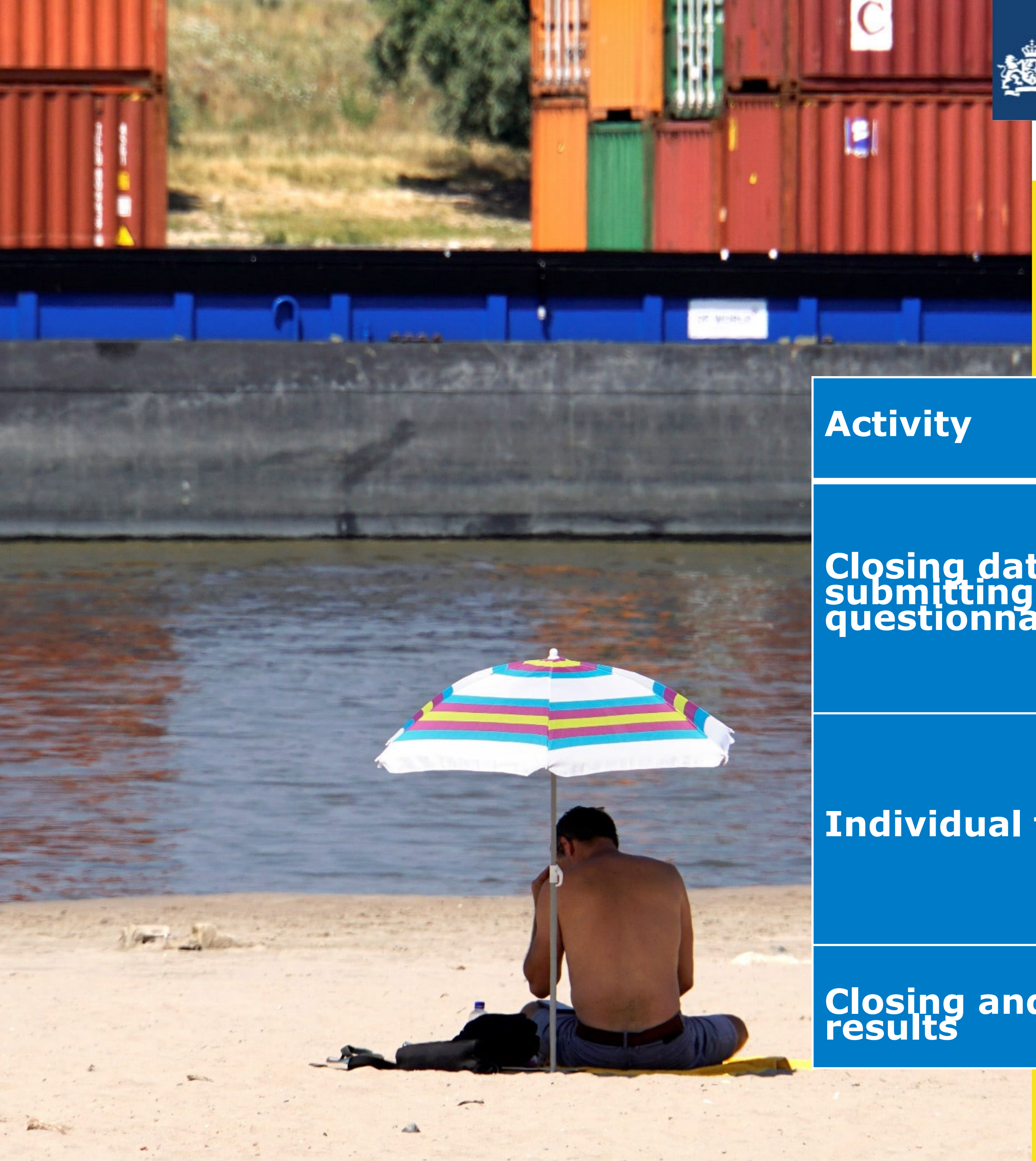


Where do we go from here?

- What did you notice?
- What is the general sense?

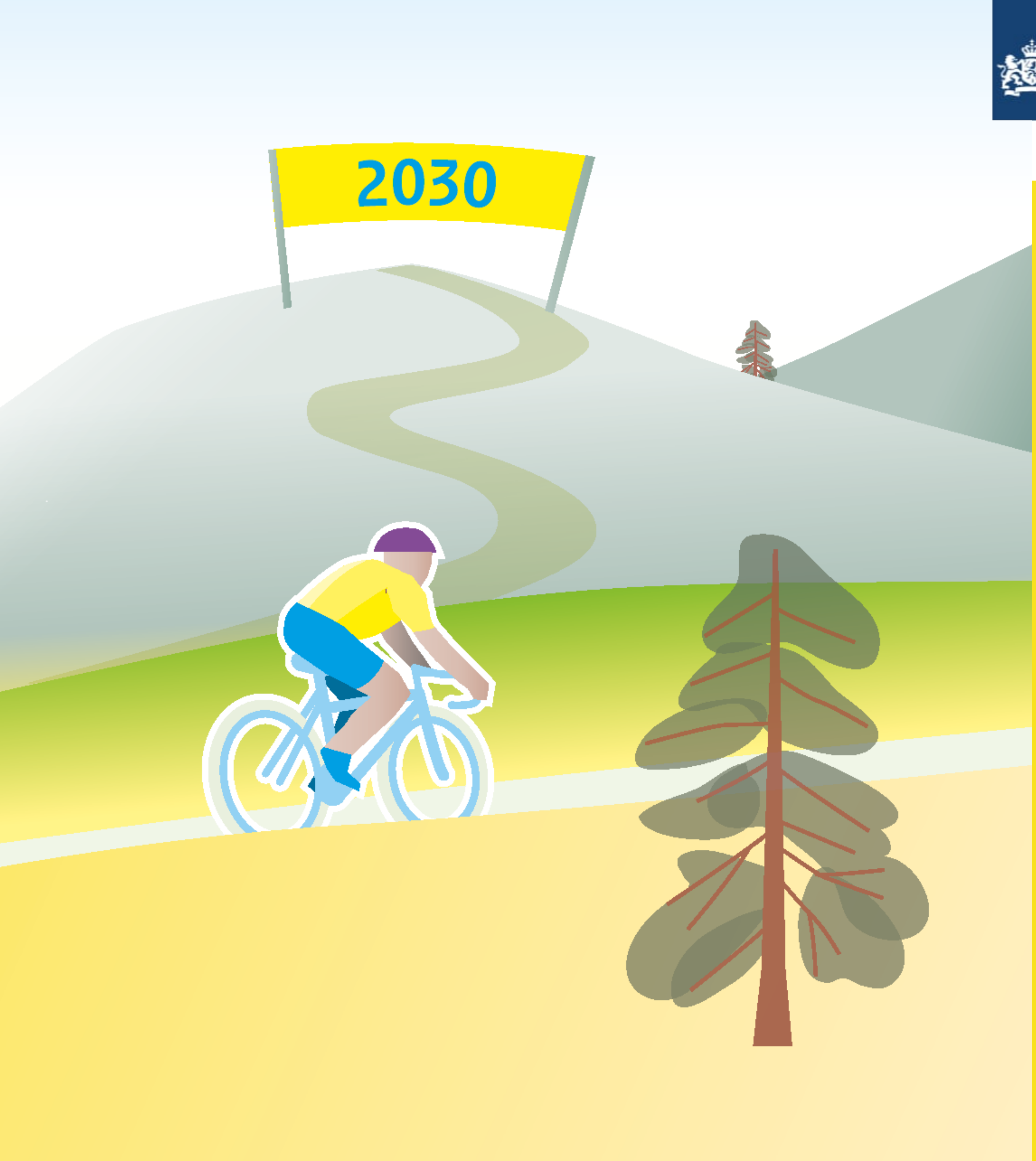
Market consultation (continued)

- Plenary session today
- Written session
- Individual session
- Participation gives you a voice, but not preferential treatment in tender procedures (non-participation doesn't give you that either)
- Minutes document is in outline form and anonymous (with an English version)



Continuation

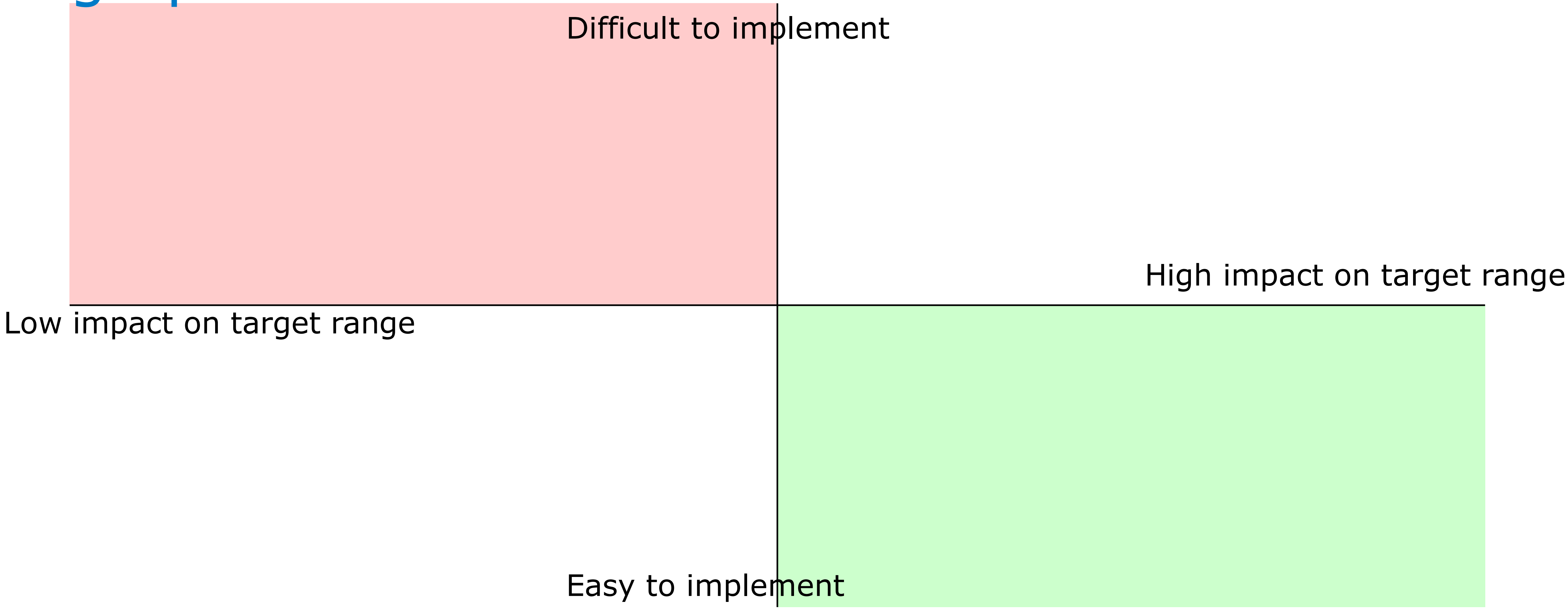
Activity	Date
Closing date for submitting completed questionnaire	31 januari 2023
Individual talks	Week 6 t/m 8 2023 (van 7 februari t/m 21 februari)
Closing and publication of results	21 maart 2023



Further processing of client input

- (internal) Rijkswaterstaat and Port of Rotterdam Authority
- With colleagues from surrounding countries
- Buyer group

Your estimation: plot the scenarios on this graph



Expected effect on target range versus challenge to implementation for each scenario

- **Preliminary conclusions:**
  - effects 1 and 3 are close to each other, but 3 is clearly more difficult to implement => better not to choose 3.
  - estimates for 4 and 5 vary widely; for 4, these are generally about the expected effect but for 5 over both aspects; 5 is more easy to implement than 4
  - In terms of effect and challenge to implementation scenario 2 seems attractive, if it can be made more effective

So there’s still enough of a challange...

- HELP!
- Please complete the questionnaire

Thanks

- Rainbowing?

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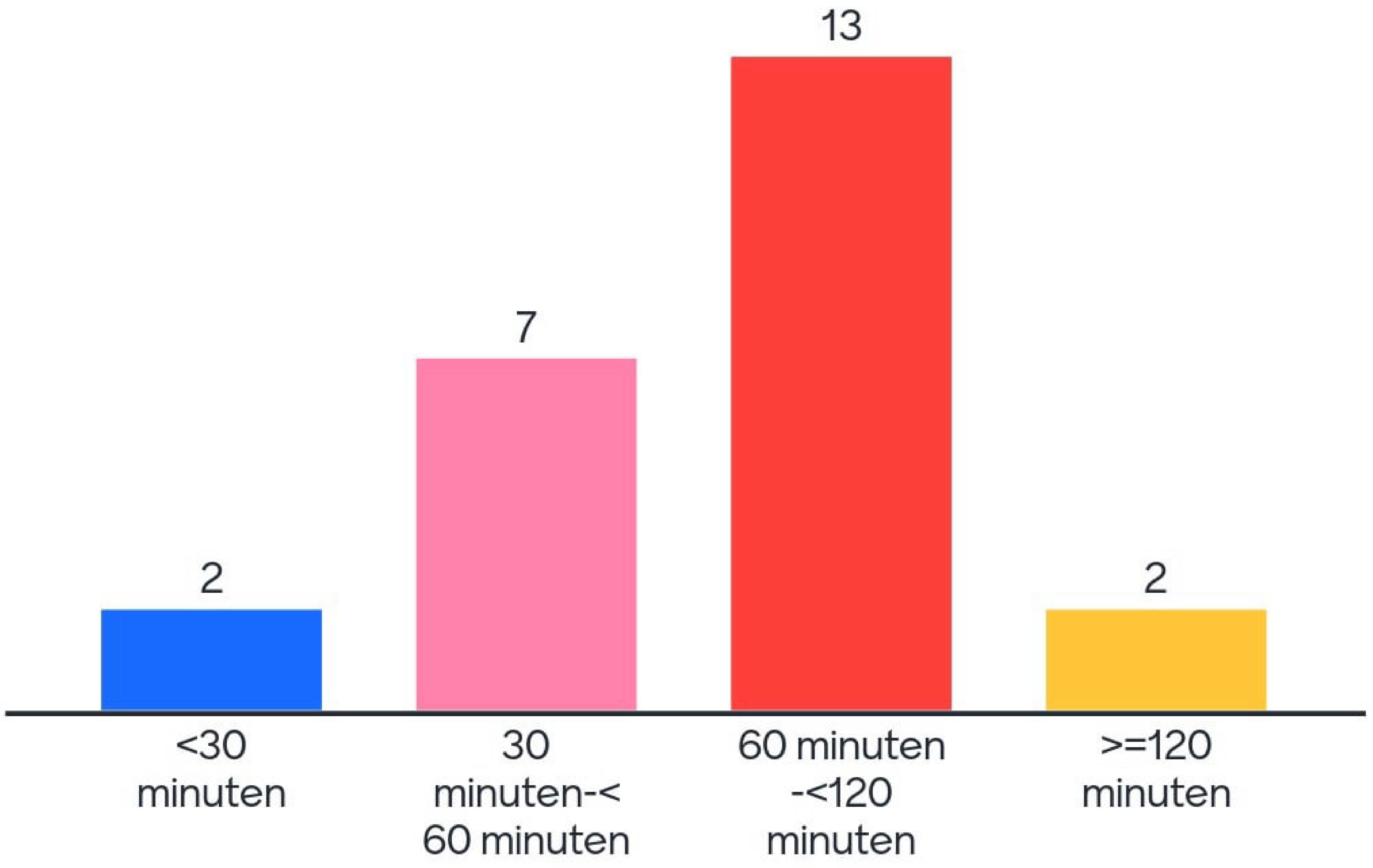
Mentimeter

Carbon Neutral and Circulair in 2030

How long did it take you to get to Houten?

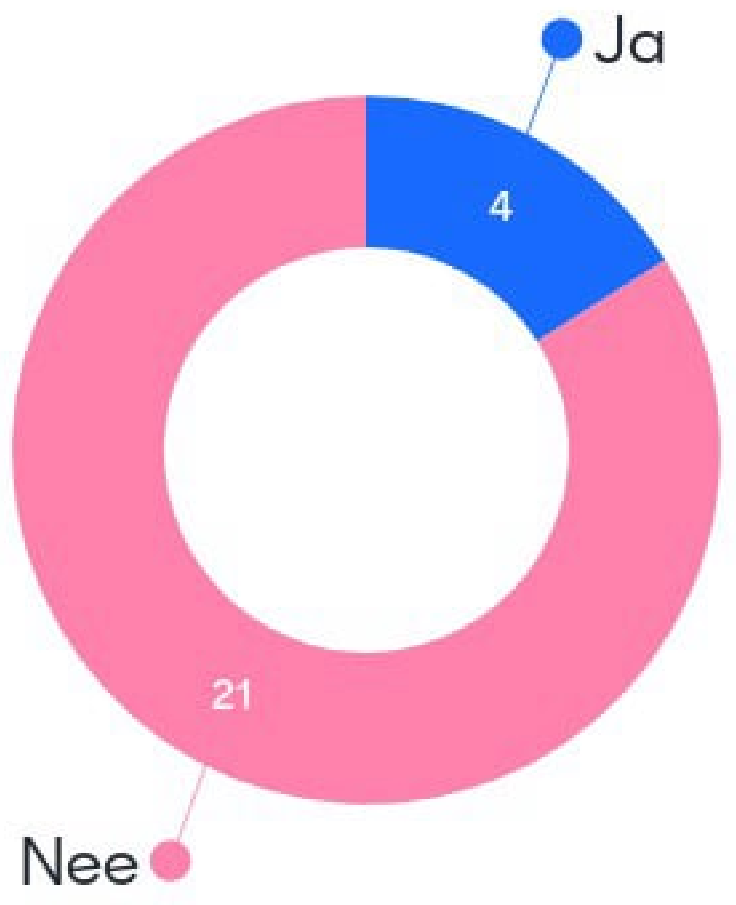
Mentimeter



minuten = minutes

24

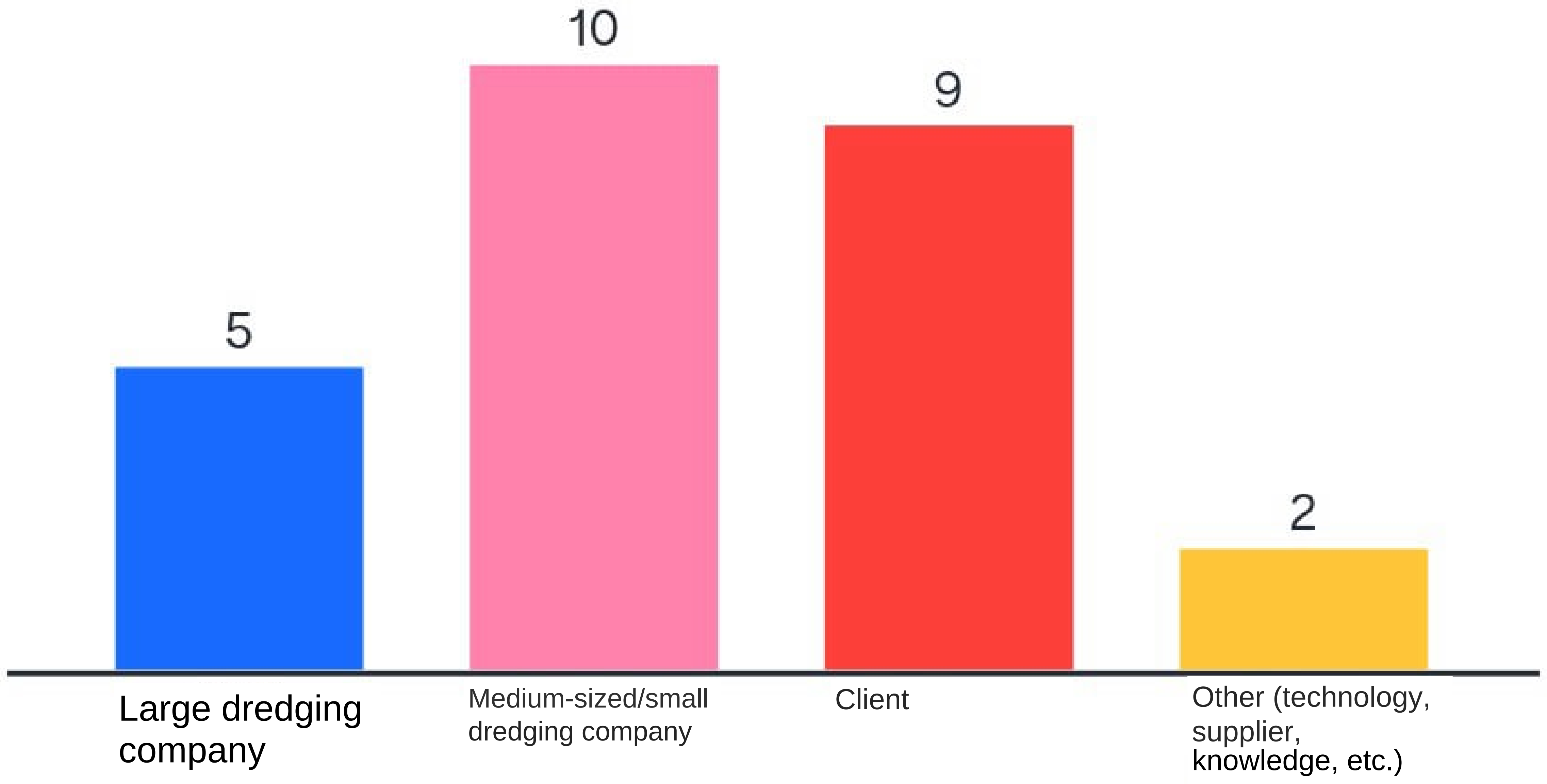
I'm going to the CEDA-NL lectures about the Fehmarnbelt project this afternoon



Ja/Nee = Yes/No

How would you classify your organisation?

Mentimeter



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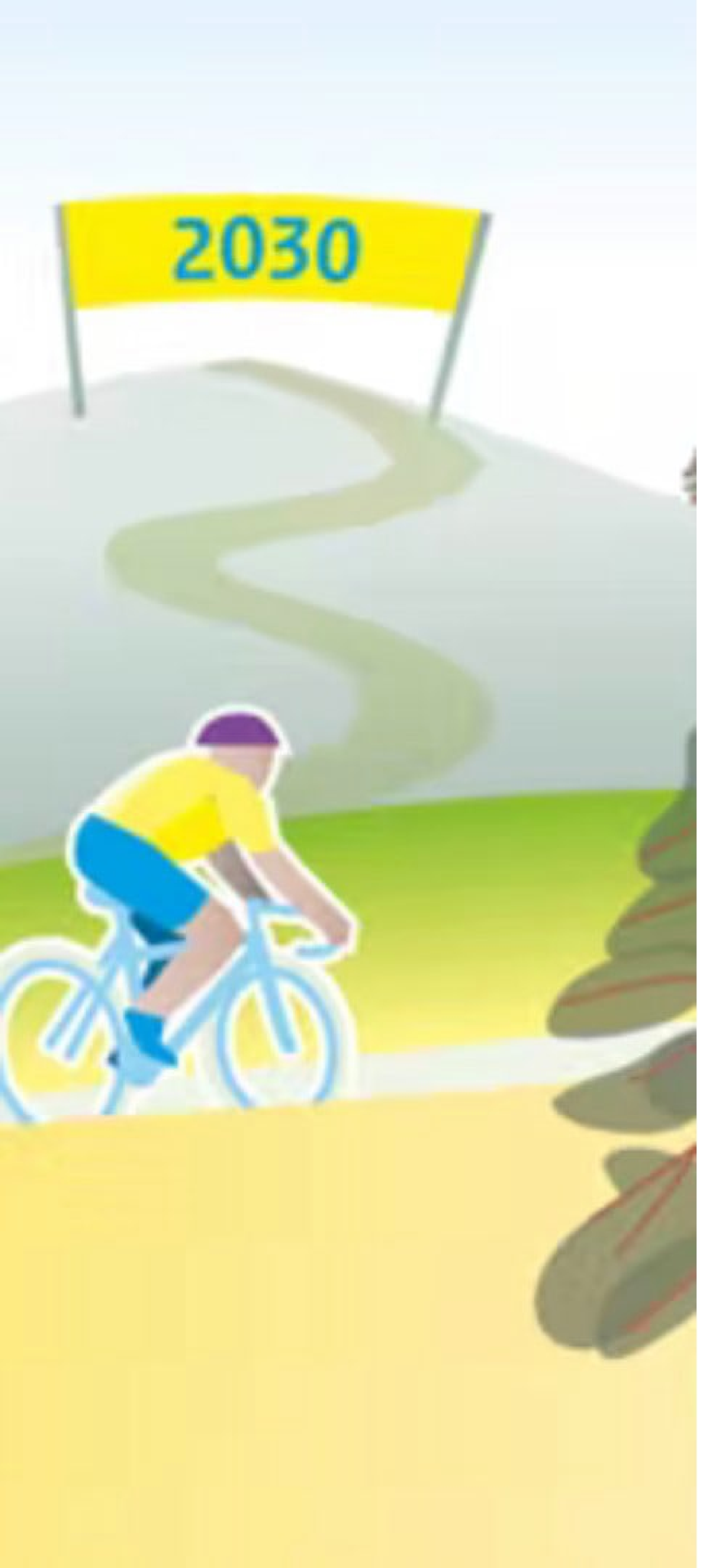
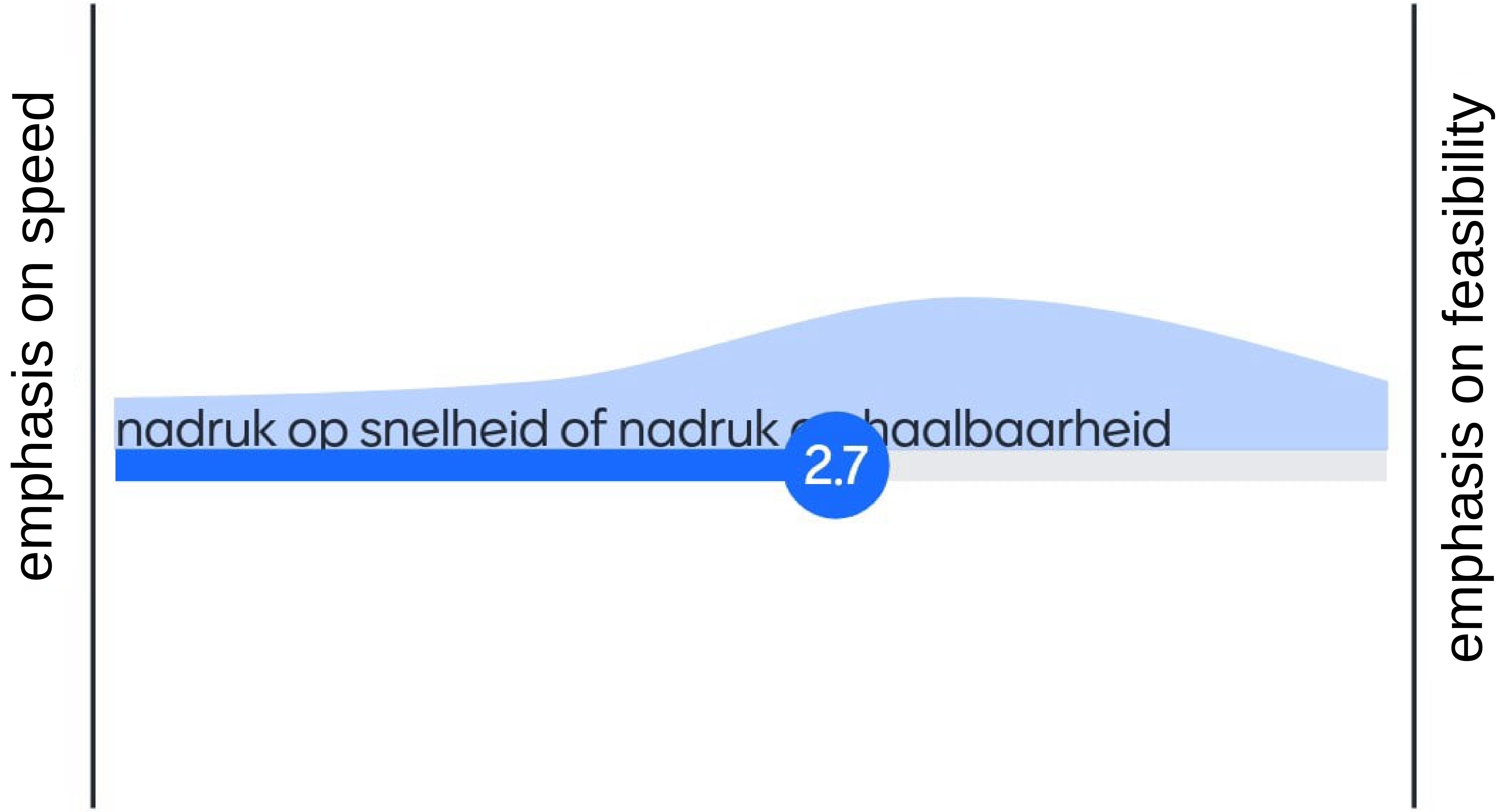


Where should the emphasis lie in your opinion: speed or feasibility?



emphasis on speed / emphasis on feasibility

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What are your arguments for this?

Mentimeter

Level playing field for SMEs and large corporations

Budget & capacity

Give front-runners space

It needs to be realistic

Feasible: in relation to investments

Rijkswaterstaat: don't let the momentum dissipate

Availability of technology and sustainable fuels

If a client increases the pressure, that will accelerate the transition

Technology for achieving carbon neutral dredging is not yet mature

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What are your arguments for this?

Mentimeter

Rijkswaterstaat: create clarity for the market as quickly as possible

Increase clarity rapidly. Without clarity it is difficult to make decisions, so it is an interactive process. Everyone is in a hurry, but is wary of making the wrong investment decision.

Feasibility makes it realistic

Some technology is already available NOW

No time to lose in relation to improving the climate

Don't wait to think about ambition, or even to focus on it in tender procedures.

The speed of tender procedures for sustainable projects must also remain feasible for SMEs

Speed, but first and foremost clarity. That's what makes it feasible (Rijkswaterstaat)

Chosen: 2. Speed ensures that targets are hit/there is a commitment to targets. This is technically feasible. But financial feasibility is a factor. And there must be a level playing field

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What are your arguments for this?

Mentimeter

It is a combination of both. Rijkswaterstaat opts for the higher level of ambition, so speed is essential. Feasibility is a pre-requisite for the basic level.

Acceleration and early tender procedures for contracts, leaving time for the contractor to offer a feasible solution with a large impact. Rijkswaterstaat

Quick and feasible: there is no future in fossil fuels as the consequences of climate change are already with us. We have no time to lose. But which solution and technology is the way forward?

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Focus on a single technology and do everything to facilitate it or keep open the possibility of more than one technology and see which one will be the “winner”?

Mentimeter

Focus on 1 technology

More than one technology

Focus on 1 technology or More than one technology

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What are your arguments for this?

Mentimeter

It is not (yet) possible to make a choice

Level playing field

In this period of transition there is still not enough known about which technology will ultimately prove to be the best.

At this point, it is not clear which technology is the winner. As long as that is the case it is important to keep options open.

Projects are different and demand different technologies in terms of location, scale and type of dredging equipment.

Freshwater requires different dredging equipment, different technologies

There are still too many uncertain factors. And there are multiple technical solutions.

It is going to be difficult to usher all companies towards the same technology. Given the international character -> other clients may possibly opt for different technologies.

What is the best technology is not yet clear

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What are your arguments for this?

Mentimeter

There's more than one way to skin a cat.

Multiple technologies: everything is still at the preliminary stage, so how can you determine which technology will prevail?

Rijkswaterstaat can express a preference/focus. It's not the right time to impose restrictions.

high-level competition will deliver a worthy champion.

Personally, I'd look at the defects/doubts about each technology. Things like infrastructure, safety, uncertainty about how sustainable it is etc.

The Netherlands is too small to be a launching customer for a single energy carrier. If the entire EU is on board then a lot more is possible. The question then is: which technology, and do we first encourage use of a transition fuel (bio-routes) or a 'finished' solution (e-fuels)?

There are multiple technologies now, and that will always be so.

Avoid tunnel vision. At the same time, focus is also important so that change can be implemented.

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Do we aim for partnership with clients or take the lead by being a launching customer?

Mentimeter

Uniformity

being a launching customer

Uniformity versus being a launching customer

16

What are your arguments for this?

Mentimeter

Quicker alone, further together!

Ambition demands role as launching customer

Consultation/discussion with too many different clients will slow things down. Better to join a select club, be a pioneer and make big decisions quickly.

You need to work together to achieve things

Rijkswaterstaat cannot achieve this in splendid isolation. Try to get other clients on board. But make sure there's clear ambition.

With this sort of ambition you might be forced into being a launching customer

Launching customer experiences must be shared with stakeholders as well.

You want to have achieved something in terms of sustainability by 2030, so speed is of the essence. But that requires clarity

You need to be able to use the technology for other clients or else it could turn out to be a really expensive solution

17

What are your arguments for this?

Mentimeter

Rijkswaterstaat is definitely not the main client. Investments need to be worthwhile for use by many clients.

There needs to be clarity on the direction and the options for the market as a whole before investments can be made

Work together in the field of knowledge, targets, legislation and infrastructure and, in addition, being a launching customer to generate speed.

Other clients are looking for procurement methods to achieve climate goals, so share knowledge. You can move more quickly alone, but you get further together!

A good example is one to be followed, but it's important not to lose contact with followers

It is a combination of both. The transition path has no benefit if clients fail to comply with it in all tender procedures. The level of ambition offers the space for clients to take the pioneering role.

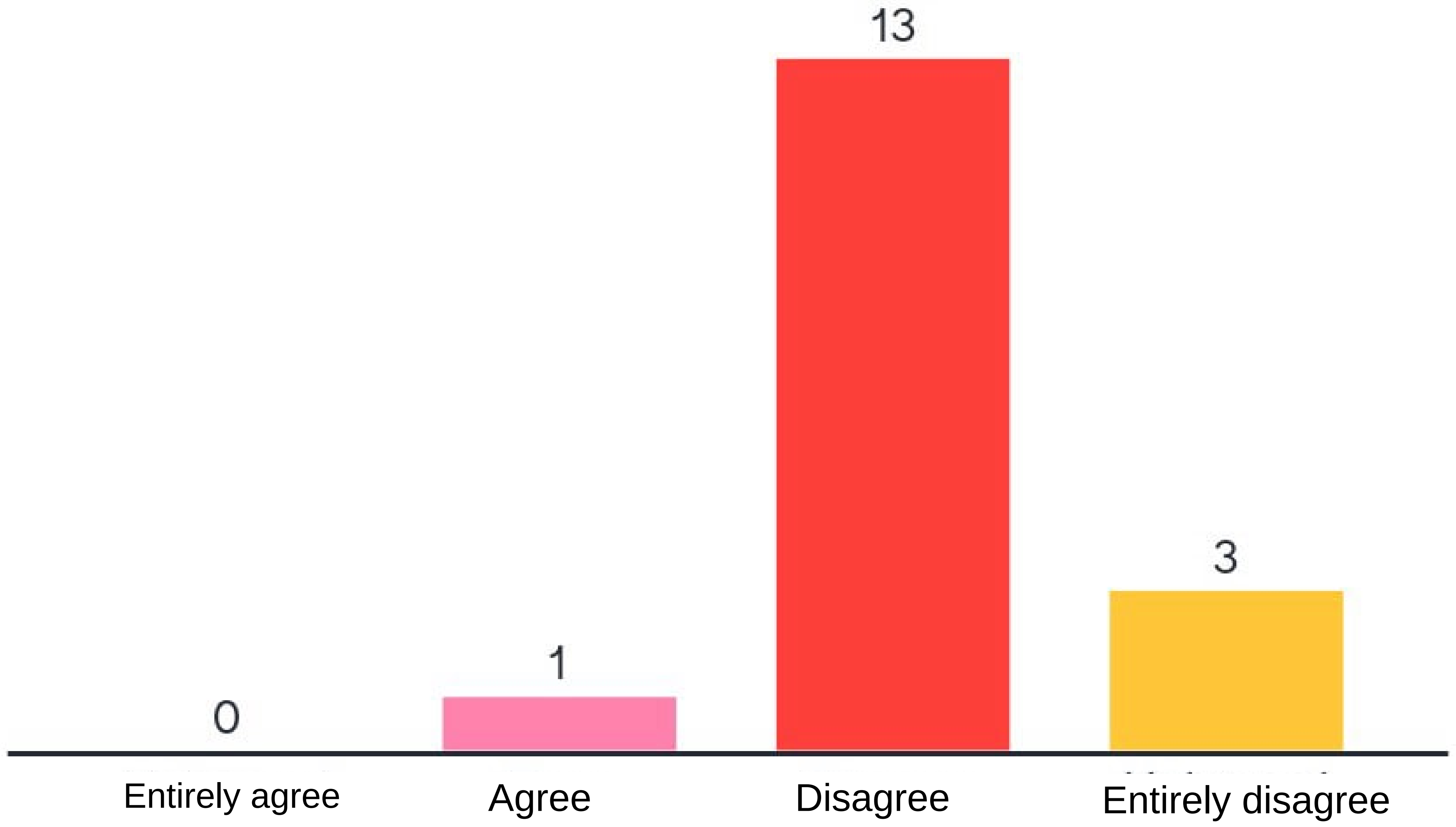
We're not going to get there on our own.

Rijkswaterstaat, the leader, pulling the EU pack.

17

Policy is clear and consistent enough in the field of emissions and as the business community we have enough certainty to invest.

Mentimeter



17

What are your arguments for this?

Mentimeter

Policy aims are (very) high on this and we need to translate them for each individual sector - something we're doing at the moment. Also demands feedback to policy.

What does the term 'zero emission' imply? We are currently discussing reduction of 75% (token entry), etc. but do we have to make investments or just go straight for a 100% reduction?

There is a lack of clarity in the extent to which sustainability in excess of the aims will be beneficial in tender procedures

The basic level is clear, but compliance is unclear. The ambition level is not yet in tune with the available financial resources. That creates uncertainty

Zero emission <=> Low-emission Together, we have work to do on investment

How firm is the EU in its policy?

The general direction is clear, but not what this implies or the speed at which we are proceeding. That makes an investment decision complicated

Zero emission v carbon neutral v renewable energy carrier

How the aims and ambitions are expressed in tender procedures and what rewards are offered is still unclear. That makes investing problematic.

15

What are your arguments for this?

Mentimeter

Translating policy for sectors/projects Only then do investments follow.

Being a client also means being able to make a choice. But a common denominator can be found in the policy (EU). Real leaders dare to make choices, rather than relying on what policy has to say

It is a broad aim, not specifically zero emission. So is it solely about the use phase?

What is clear: targets and 2% has been reserved in all maintenance projects. This gives a sense of security. In addition, from 2027 ETS will apply to marine operations. Additional certainty that sustainable options will be rewarded. But the question remains: which solution/technology?

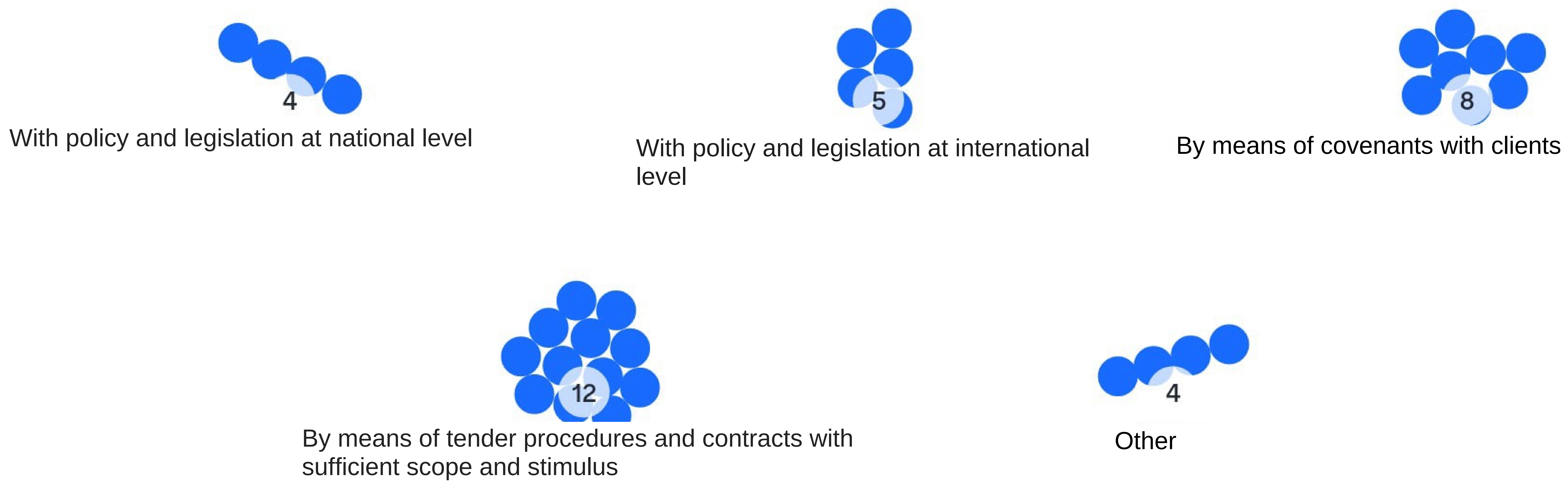
The various potential technologies are not yet sufficiently well developed to say with any certainty which investment choice will be the right one

Taking the (near) zero emissions route clearly appears to be the way to go. Speed, and rewards for it, is still unclear. So investing is risky

15

Mentimeter

How do you ultimately want to get more certainty



16

How else do you ultimately want to get (potentially) more certainty for your investment?

Mentimeter

Forward look at the ECI value of renewable energy carriers

Possibility of hitting sustainability target over the term of the contract.

The tender procedures clarify the demand and reward process.

Enforcement

Clarity about ECI scores for alternative energy carriers

Overview and opportunity to achieve objective during contract

Not just certainty on the minimum requirements, but also filtering on the basis of maximum requirements. That probably means zero emission, but that is not specified anywhere in writing.

In other words: there must be clarity about the value of energy carriers, then we can investigate a technology.

Reduction: Include targets as an entry requirement in contracts.

11

How else do you ultimately want to get (potentially) more certainty for your investment?

Mentimeter

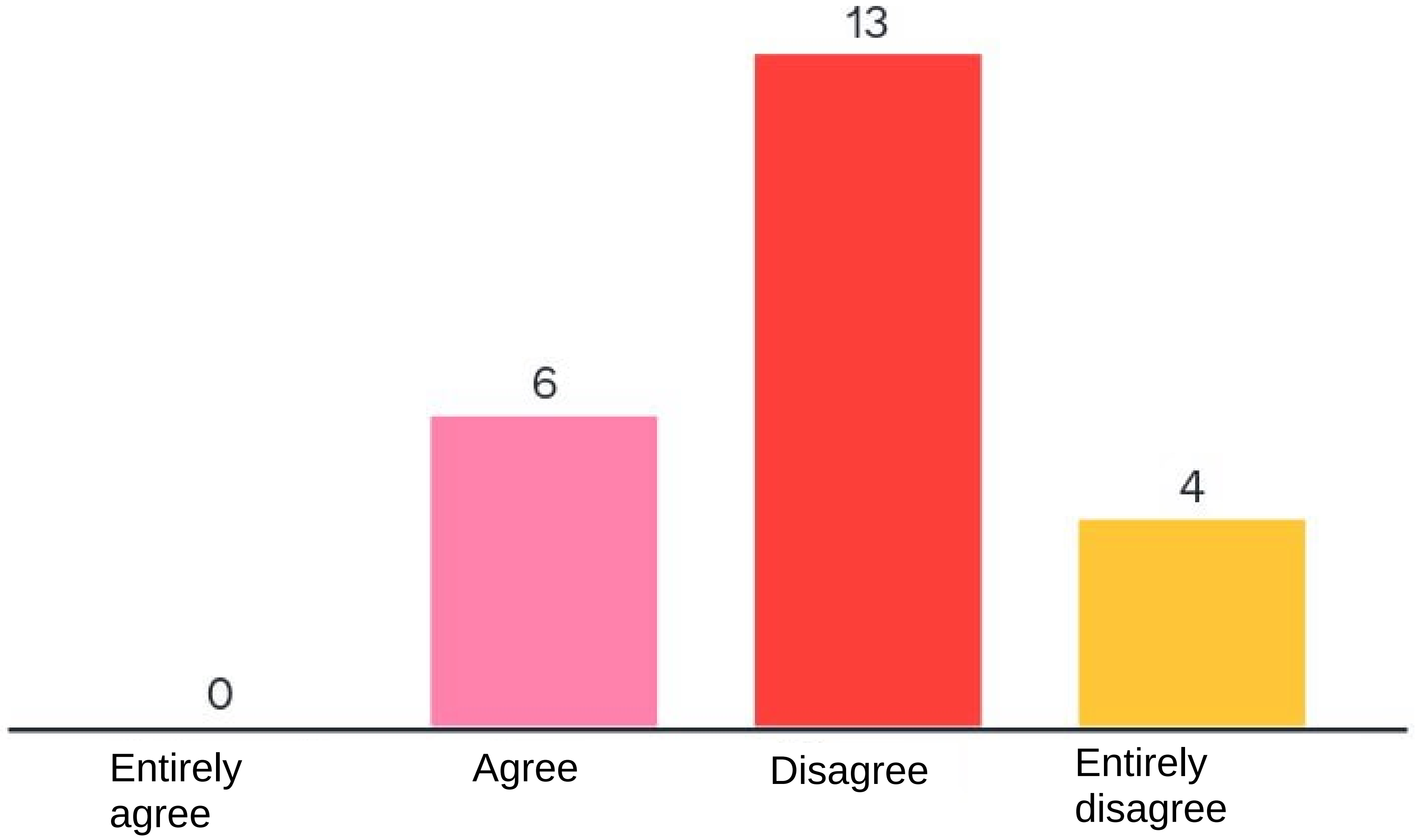
Compliance

Allow time for investment

11

Mentimeter

The risk for new sustainable dredging technologies is so great that government cannot leave this to the market alone



23

What are your arguments for this?

Mentimeter

Contractors follow developments in the marine world

Great challenge and investment, but it can be achieved with clear policy

It is not as easy as the question implies. The market can keep moving, but the situation requires clarity and government-level funding

Disagree: that restricts the development of other technologies

Clients and contractors can work together towards solutions and, in doing so, help the sector as a whole to advance

The market has shown that at a technical level a lot is possible

The risk should not be entirely with the market

Not 'left to the market', we have to do it together, using tender procedures: but how this is put into practice is an issue for the market.

A clear policy is needed to restrict the risk for the market.

19

What are your arguments for this?

Mentimeter

Clear policy helps the market to develop the innovations

If the client has extensive control (e.g. its own TSHD), there is insufficient space to explore different technologies

It is not possible for Rijkswaterstaat to acquire in-house knowledge from the dredging companies.

If the government funds (in full or in part) new dredging equipment, this will accelerate the rate at which targets are hit. Rijkswaterstaat

Technological expertise is in the market.

Most large-scale government projects are not successful.

Government is never that efficient; it is often slower than the market in terms of the learning curve and would probably hamper joint continued development of technical knowledge.

The investment risk is high for a SINGLE company, lower for a group of companies working together

Stick to what you know best

19

What are your arguments for this?

Mentimeter

Example SCR technology: Never imposed by client, yet is now spreading out over the entire dredging fleet. Good examples are often followed

19

This question has not been addressed, therefore there are also no responses

Mentimeter

Clients who invest in innovative, sustainable dredging vessels (zero emission) themselves, are setting a good example, giving technology a helping hand

Helemaal mee eens	Eens	Oneens	Helemaal mee oneens
0	0	0	0

What are your arguments for this?

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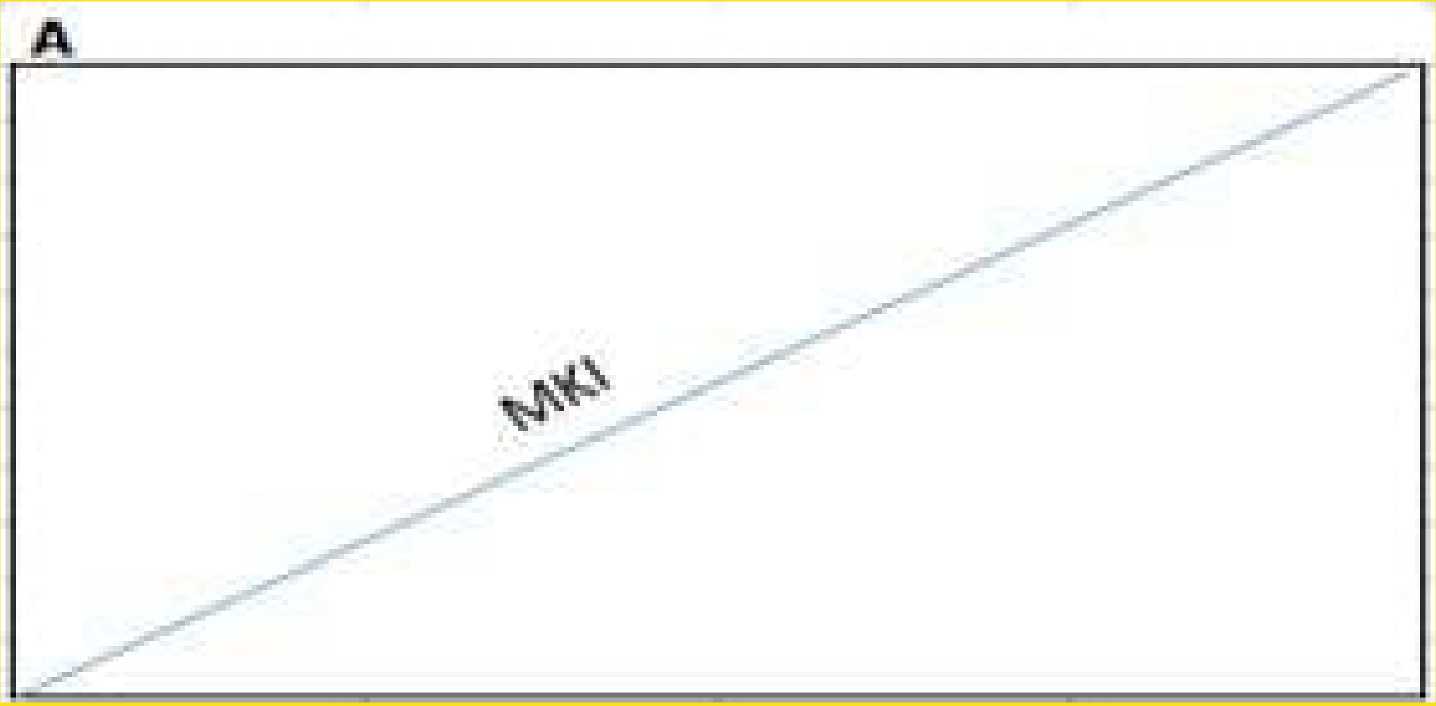
Ministerie van Infrastructuur en Waterstaat

Going through procurement scenarios

Elaboration sub-sessions

	1 Steeply rising ECI (ECI value)and sustainability requirements	2 Contractual Portfolio approach	3 Large-scale contracts	4a RWS Buying vessel	4b RWS Leasing vessel	5 Growth of zero emission
Tender Awarding Criterion	ECI value	ECI value	BPQR (no ECI)	BPQR	BPQR	BPQR (no ECI)
Minimum requirements	Ambition level growth path	Ambition level growth path	Zero emission dredging equipment	Zero emission dredging equipment	Zero emission dredging equipment	Zero emission dredging equipment
Scope contracts	No change	Aggregation in time	Up to approx. 50% of work package	Supplies and service	service	No change
Term of contracts	No change	5–10 years	About 10 years	2–5 yrs	2–5 yrs	No change
Specific feature / point of concern	% front runner projects still to be corrected	Performance management on sustainability	Tender awarding long in advance of execution	Exit strategy needed; Link works to dredging equipment	Performance management on execution; Link works to dredging equipment	Time of first and % zero emission projects still to be corrected
Change in way of working RWS-side	None	Adjust programming	Adjust programming	Management of ship + procurement of service	Procurement of service	None

Scenario 1 Steeply rising ECI (ECI value) and sustainability requirements



A MKI = ECI

Scenario 1

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Elaboration positive (+) and negative (-) properties

Format	Positive (+)	Negative (-)
Group 1 Jos	Carry on in 'familiar' way • Logical continuation • No new toolbox needed Specific steering (CO2/nitrogen) • But; deviate on possible wishes (to target reduction of a particular substance) Rijkswaterstaat 2030 target can be achieved • Dare to steer/challenge the market (links to previous point of concern)	Step to zero emission remains big: too slow • Small steps Both in mutual weighting (CO_2/nitrogen, etc.) • and in weighting as per best price/quality ratio (BPQR) • This point of concern also relates to the mutual weighting (between different emissions, as well as the weighting of ECI Value as BPQR; this is not managed strongly enough) Proper LCAs needed (including for future fuels) • Including PCR (Product Category Rule)
Group 2 Funda	• Achieve a big reduction fast: ~ 80% • Recognisable to the market	• Zero 'emission' will not be achieved
Group 3 Ronald	• Many parties can join in • High probability of follow-up at European level • Keeps up with technological developments • More efficient and cheaper • Easy to adjust Question= ECI in chain in relation to energy carriers – how to calculate it?	• Targets will not be met unless adjustments are made
Group 4 Erik	• Experience is that it works • Bonus scheme is an additional option (more money/extension) • Increasing ECI (CO_2 eq) • ROI easy to calculate (provides guidance) • Exchange between projects (ECI), learning from experience	• Fine • Not ambitious enough • Probably insufficient as a long-term solution? (but possible with ECI increase?)
Group 5 Marjolaine	• Not project dependent, but revenue dependent • At 75% front-runner, make the leap and what remains for the rest • Front-runner must be revenue-related • Rijkswaterstaat steering on market development	• Lots of organisation for Rijkswaterstaat, but retains control (as per other factor) • Feels like getting into a diesel vehicle and being stuck until 2028, while being overtaken by electric • At 2 years, you don't provoke investment • No change is not SMART • No tipping point, only steering • 1B… %-leap, with a safety net

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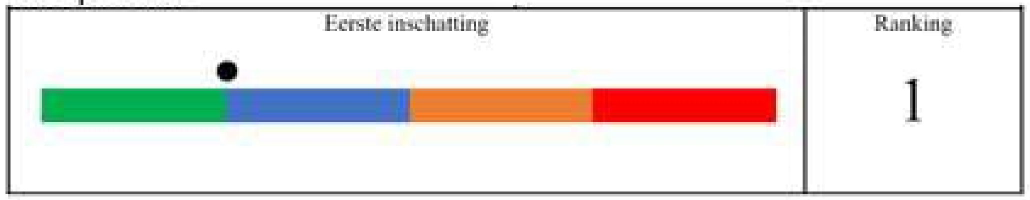
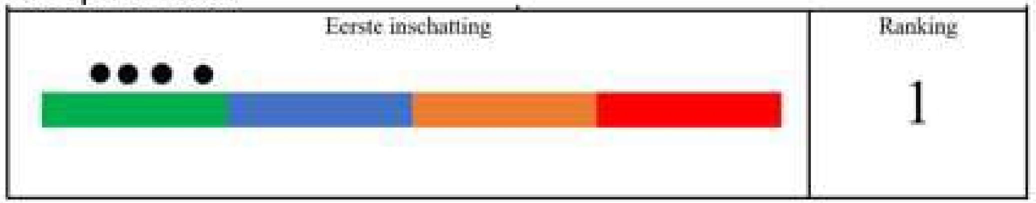
Scenario 1
Initial estimation & ranking

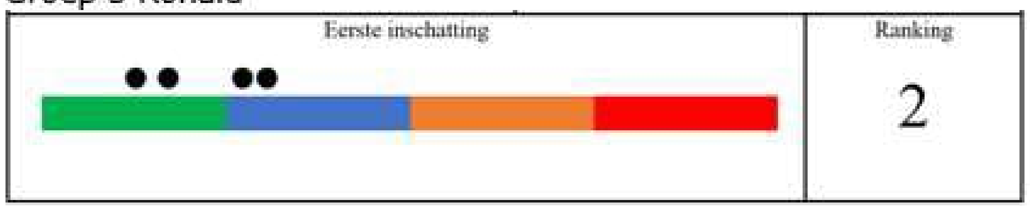
Groep 1 Jos



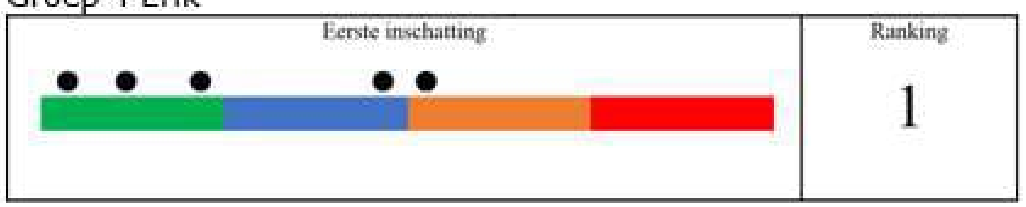
Groep 2 Funda



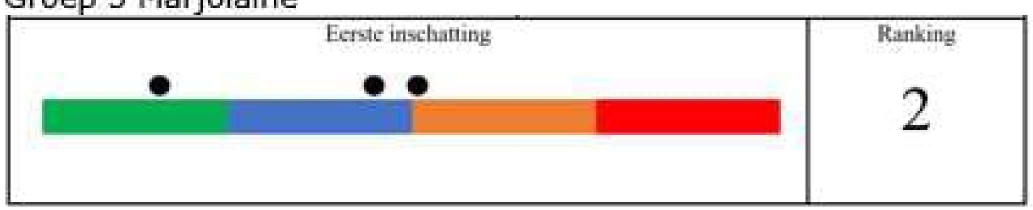
Groep 3 Ronald



Groep 4 Erik



Groep 5 Marjolaine



Initial estimation:
green= very positive, blue= positive, orange= negative and red= very negative

Ranking:
1= first place, 2= second place, 3= third place, 4= fourth place and 5= fifth place

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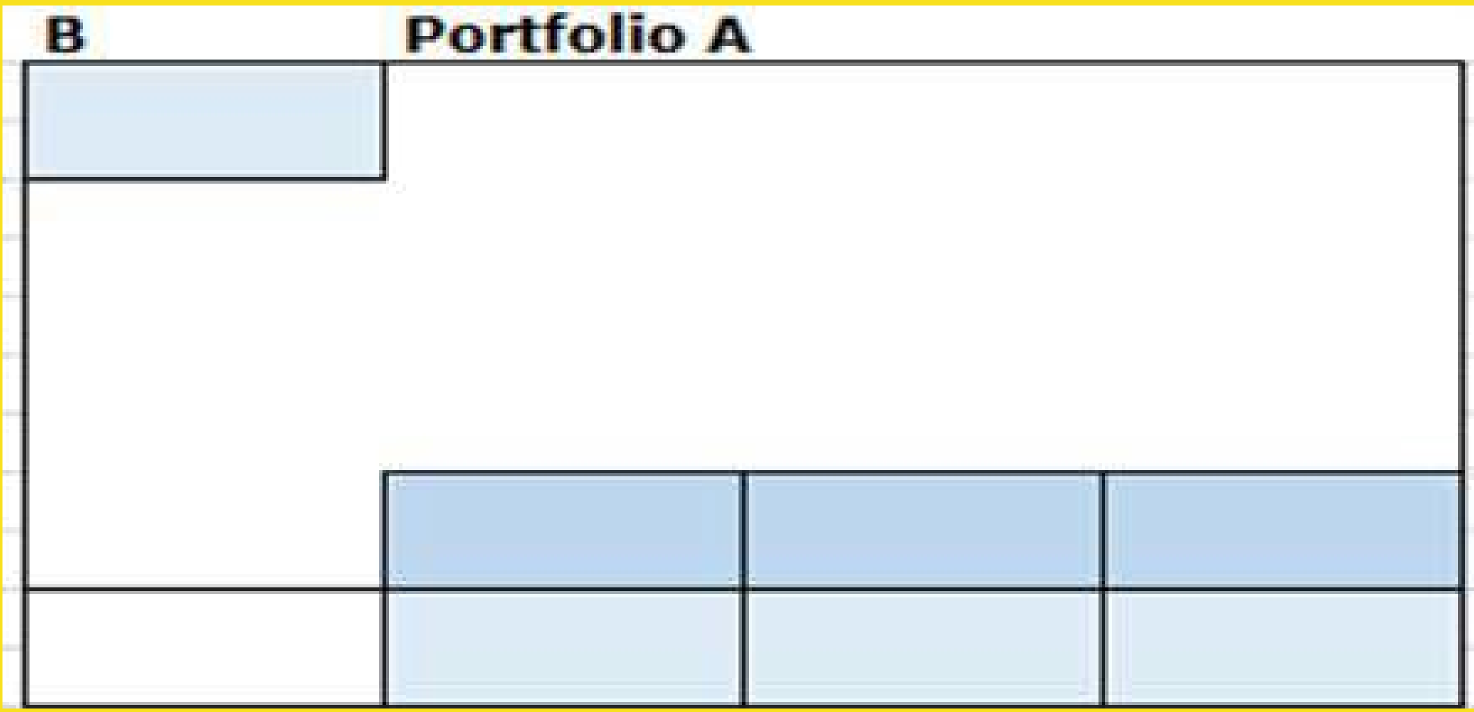
Scenario 2 Contractual Portfolio Approach



Scenario 2

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Elaboration positive (+) and negative (-) properties

Format	Positive (+)	Negative (-)
Group 1 Jos	• Greater return on investment (ROI) certainty	How much does this offer in addition? (Contractor makes small steps) • Can Rijkswaterstaat devise rules in advance For Rijkswaterstaat, the performance is not clear at the outset
Group 2 Funda	• Greater confidence of work and therefore easier to invest	• Restriction on the number of jobs (this came from examples of contracts that did not specify in advance what performance contractor had to deliver to earn the extension. The example was that something trivial was offered by contractor, which is an improvement on sustainability compared to the level originally offered, but at the same time hardly innovative/impactful/achieving the goal. Connect to the first point of concern; make it clear in tendering when an extension is earned).
Group 3 Ronald	• Opportunity to recoup investment • Technology can grow with ambition • Steering is possible Neutral= advantage for front-runner	
Group 4 Erik	• Long-term -> investment • Bonus encourages development • Precondition: requirements clear in advance	• New work less often • Inequality in the market • Uncertainty about extension
Group 5 Marjolaine	• Confidence of achieving goals • Confidence on ambition and investment	• Worst case leads to stagnation • Trapped in a group, how do you get investment from outside? • Excessive enforcement: the 'carrot' instead of the 'stick' • Feels like getting into a diesel vehicle and being stuck until 2028, while being overtaken by electric

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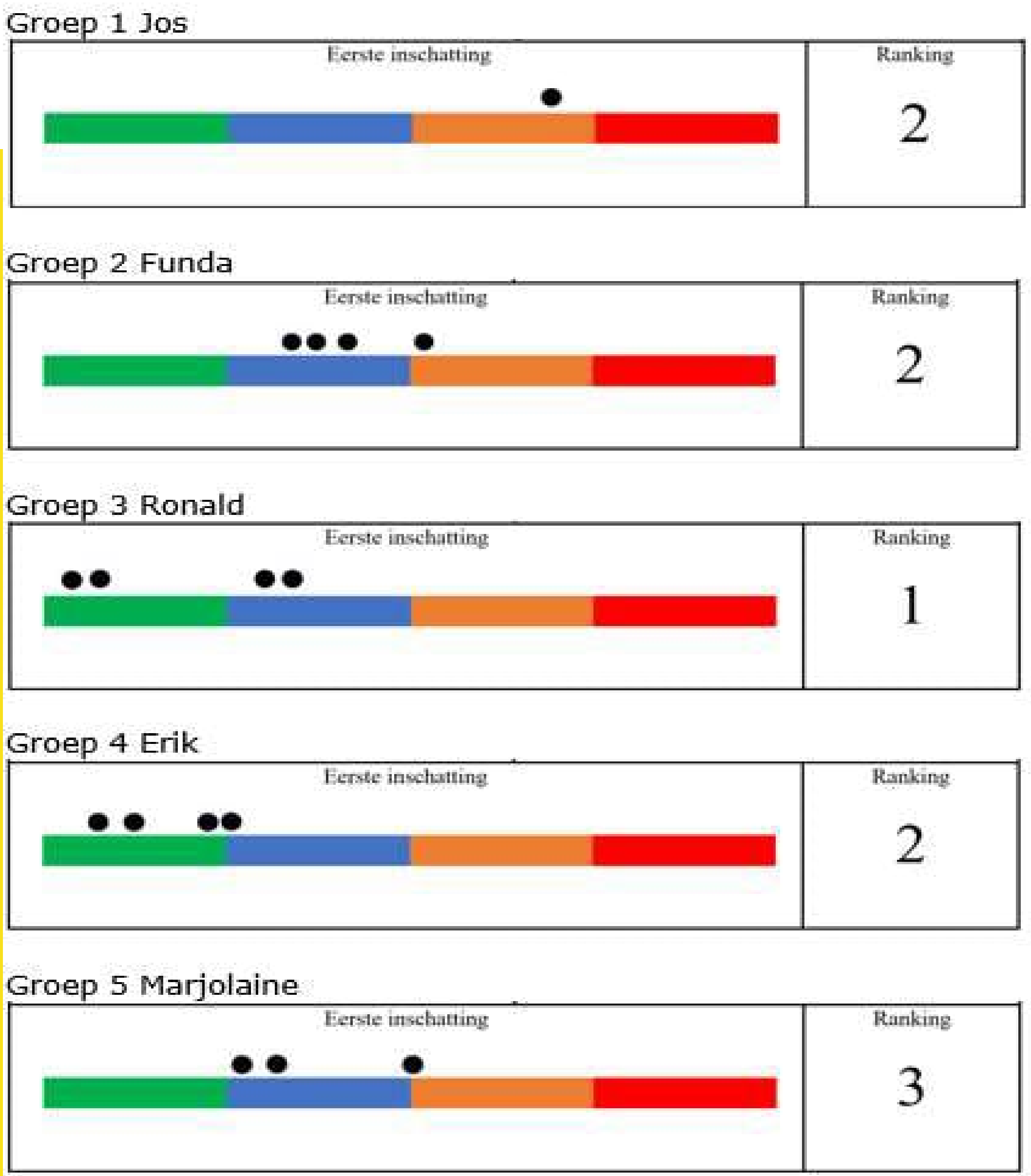

Scenario 2 Initial estimation & ranking

Initial estimation:
green= very positive, blue= positive, orange= negative and red= very negative

Ranking:
1= first place, 2= second place, 3= third place, 4= fourth place and 5= fifth place

Scenario 3 Large-scale contracts

C Grote contracten = large scale contracts

Scenario 3

Elaboration positive (+) and negative (-) properties

Format	Positive (+)	Negative (-)
Group 1 Jos	• Even higher ROI • ROI = maximum • Target reached fast (2030) • Client needs less capacity • Good for target reach, bad for entire market	• Other contractors stand still in development • Small players get less opportunity, as they do not have the capacity • Many assumptions for budget (since the ship does not yet exist) • Uncertainty in morphology (also has to do with contractor's cost calculations; see previous point of concern)) • Fixing on technology now that will not be optimal 10 years from now • Disrupts market dynamic/level playing field • Knowledge/experience with just 1 party
Group 2 Funda	• Project investment you can ramp up in 10 years	• Risk of excluding part of the market • Risk that promises cannot be kept • Major disruption to the playing field
Group 3 Ronald	• Investment easier	• BPQR, but how? • Fewer companies (narrower) • Less sustainability of entire fleet • Steering is more difficult
Group 4 Erik	• Space for ROI • Good for Rijkswaterstaat objective (sustainability)	• Protest by small and medium-sized enterprises • Inequality (LPF) • Risk of higher tenders • But 2 parties that profit. The rest lag behind
Group 5 Marjolaine	• Trigger is in the approach • Possibility for adaptation (devised in preliminary phase) • Pilot in own fleet • Switching energy carriers while under way? Adaptive • Time is granted • Yes/no depends on work package	• Logistics (getting everything organised) • Learn fast as in 20 years everyone will be sustainable anyway • Specific operations + ambition needed to achieve this • Deliverable in 'zero-emission' context? • 10 years is too intangible • ‘Zero emission’? Rather defined in graduated steps • If there is work, there is no ship • Tendering technology difficult to organise (proportionality guide)

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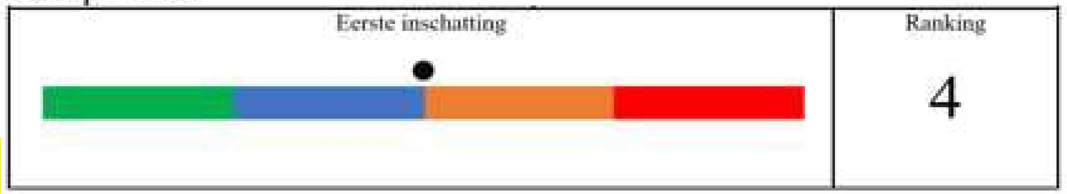
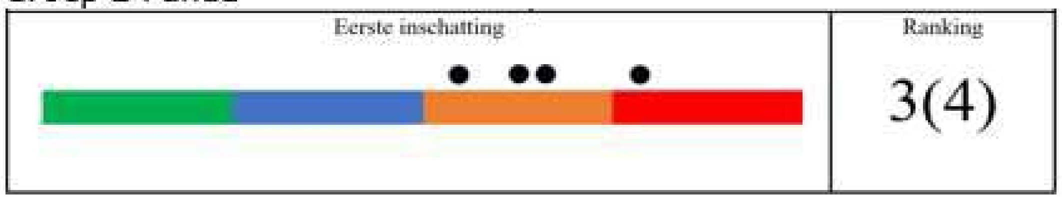
Scenario 3 Initial estimation & ranking

Groep 1 Jos

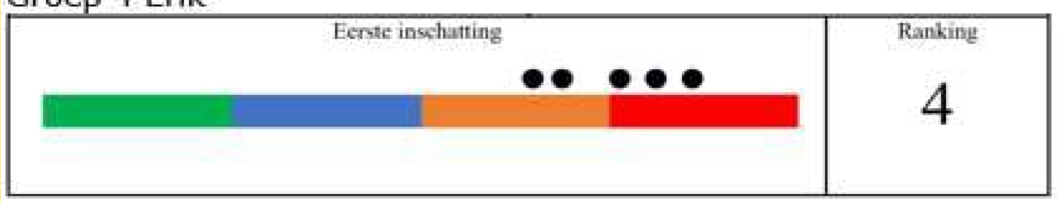


Groep 2 Funda

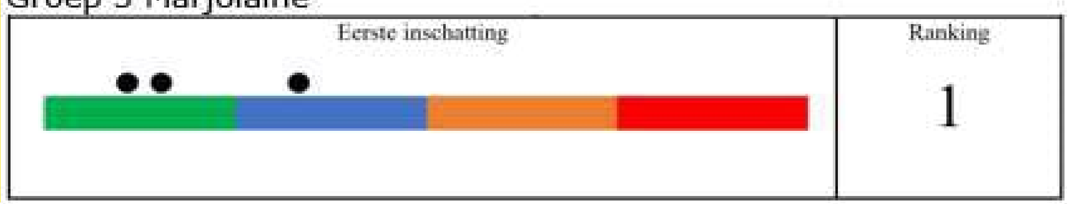


Groep 3 Ronald

Groep 4 Erik



Groep 5 Marjolaine



Initial estimation:
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Ranking:
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Scenario 4a
Rijkswaterstaat buying vessel/4b Rijkswaterstaat leasing vessel

D RWS schip

D RWS schip = Rijkswaterstaat buying/leasing vessel

Scenario 4 a+b

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Elaboration positive (+) and negative (-) properties

Format	Positive (+)	Negative (-)
Group 1 Jos	• Market runs no risk	• Contractors adopt passive attitude (do not innovate) • Difficult to ensure knowledge sharing • Target not reached quickly, market will wait and see • Not cost-effective • Market involvement marginalised
Group 2 Funda	• Limited risk to contractor • Sharing knowledge	• Limited revenue model for contractor • Obstructs further technological development • Probability of failure (other examples state fleet)
Group 3 Ronald	• 4b Lease ship + engineering development, small ship as trial	• 4b Peak power solution? • 4b Which energy carrier? • 4a Investment in the future? Worth more in time • 4a Start small and scalable
Group 4 Erik	• Commitment of Rijkswaterstaat (better than subsidy) • When goal is sacrosanct and there's no other way • Level playing field • Showcase/booster	• Market pulls out • Knowledge disappears • No innovation • More expensive • Innovation on technology only
Group 5 Marjolaine	• Pros/cons depending on operations • That's great, definitely do it • Ownership by Rijkswaterstaat, depends on party's market 'position' Rijkswaterstaat already has ships	• Non-EU parties on Rijkswaterstaat vessel • 4C -> impose how big a ship must be and what it can do (Government BE) • 4C -> Belgian model ship available to State 'French Case' (capital destruction)

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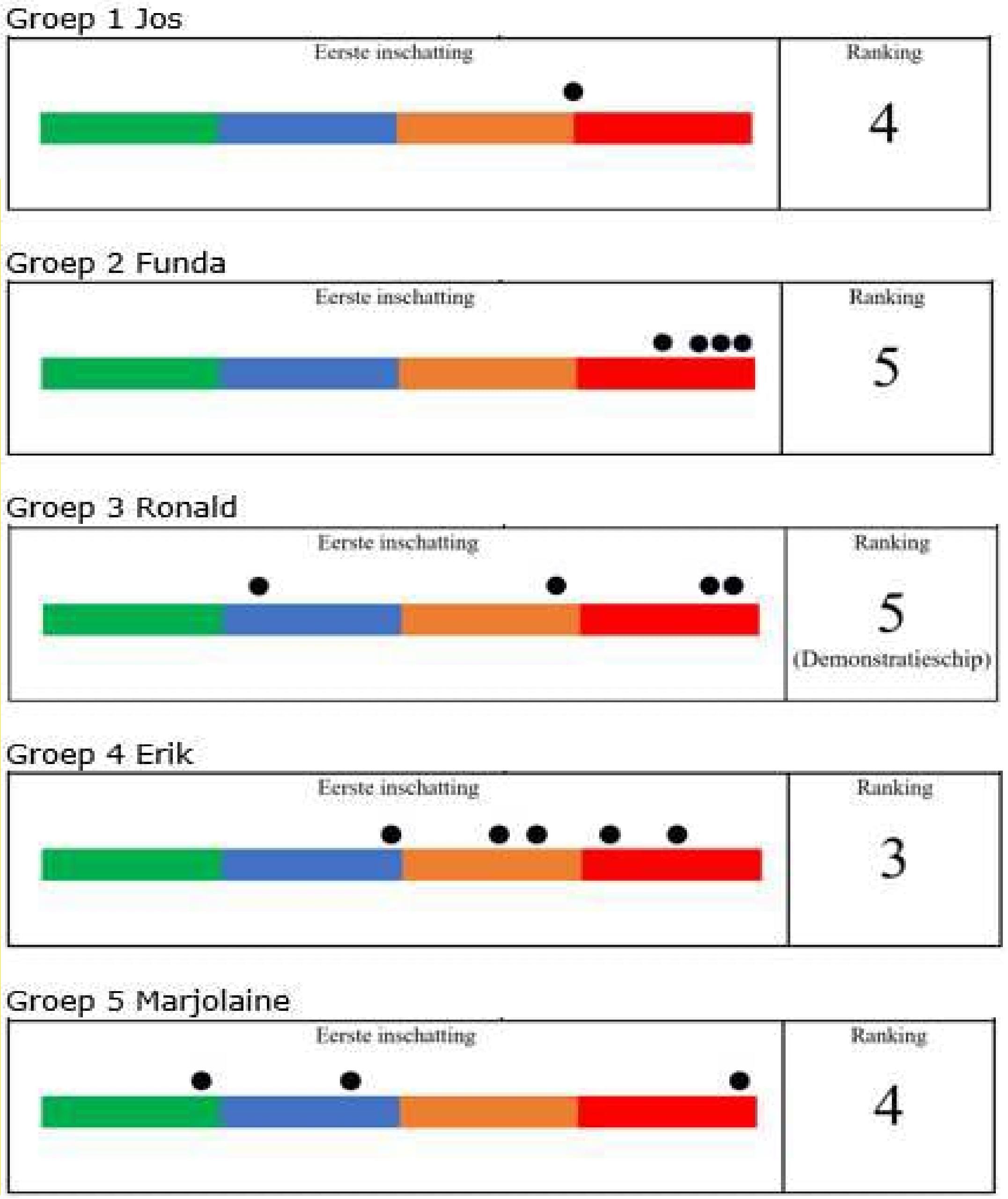
Scenario 4 a+b
Initial estimation & ranking



Initial estimation:
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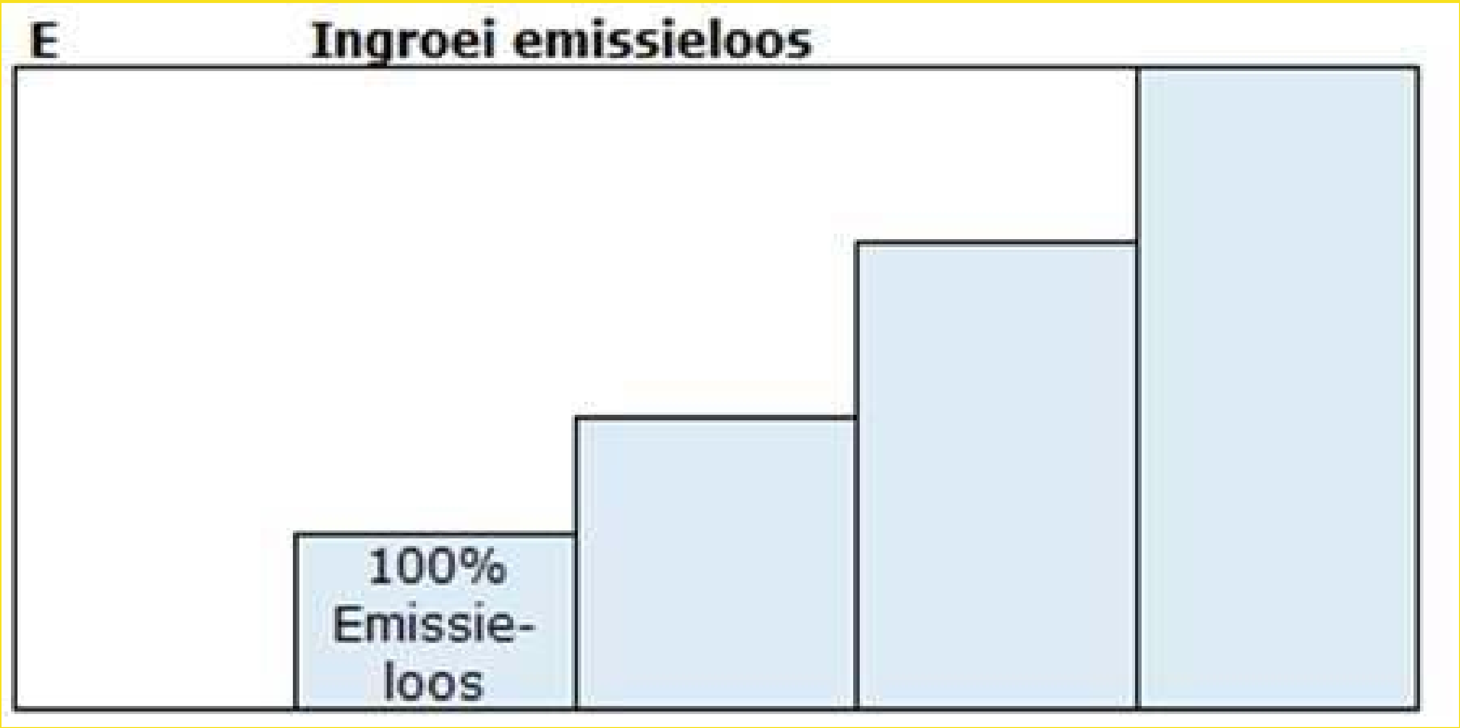
Scenario 5 Growth of zero emission



E Ingroei emissieloos = Growth of zero emission

Scenario 5

Elaboration positive (+) and negative (-) properties

Format	Positive (+)	Negative (-)
Group 1 Jos	• Dumping by coupling barge first step (start with making parts of a ship zero emission; this is where the definition of zero emission comes into play) • Good for target reach	• Market cannot deliver • Winning contractor has advantage over competition in next steps • Competition directives for European tender? (Contractor's comment; I wasn't able to ask more searching questions/ do not understand it properly) • Investment risk too great or time shortage • Risk of buying zero emission ship before tender if you don't win tender?
Group 2 Funda	• Leads ultimately to 'zero emission'	• Is it smart to tender on zero emission now?
Group 3 Ronald	• Clarity • Major positive impact • Encourages disruptive solutions	• Is there sufficient incentive? (Market volume sufficiently large?) • Advantage of 1 party that also takes follow-up work • Parties dropping out • Will the Dutch market remain interesting? • Large differences between market parties • Serves only a limited number of parties (contracts) • Investment may not be profitable (because contract is small, so little certainty) • Front-runner is in the driving seat • Zero emission – no • Zero emission – yes • Costs/TRL
Group 4 Erik	• Good option for inland navigation	• Very expensive in the short term (2030) • Invest the euros in other areas (with a greater sustainability return) • 'Zero' is too ambitious (due to the 'chain')
Group 5 Marjolaine	• Current system works competitively • Incentives for competition: "but it is zero emission!?" • 2 to 3 contracts per year for competition trigger (ECI at opening digital safe)	• Mutually dependent, excessive steering (boomerang risk) • Missed opportunity for all • Worst case: market cannot keep up

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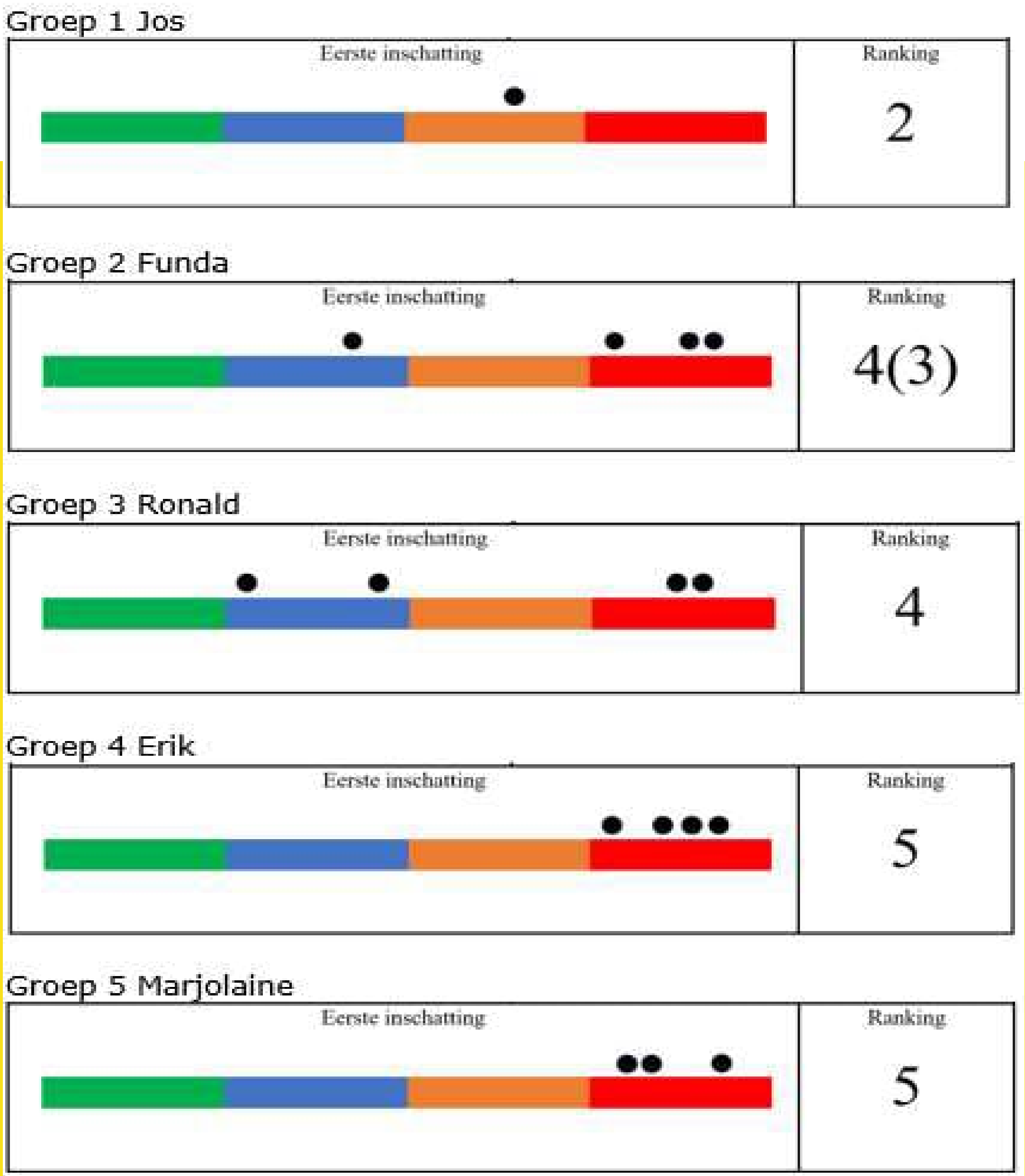

Scenario 5
Initial estimation & ranking

Initial estimation:
green= very positive, blue= positive, orange= negative and red= very negative

Ranking:
1= first place, 2= second place, 3= third place, 4= fourth place and 5= fifth place

Other findings and suggestions

Format	Other findings and suggestions
Group 1 Jos	Scenarios 3 and 4: comparable? (in the sense that a (large) part of the beach nourishment requirement is carried out by 1 party; possible misinterpretation of scenario 4) • Rijkswaterstaat implements, contractor implements Scenario 6: demonstration vessel • Joint learning/knowledge-sharing Scenario 7: 95% zero emission = most cost-effective
	Scenario 8: Rijkswaterstaat indicates what the price is/what we are prepared to pay for a tonne CO_2 eq. (and the market will know, as a result, what it has to invest in/the price that Rijkswaterstaat is prepared to pay).
	TIP: Scenarios 1, 2 & 5: combine: • reward if you operate in an extra-sustainable way • initiate ECI, if you can work in a zero emission way (extra scope)
Group 2 Funda	hybrid -> combination of scenarios or applying scenario 5 to a contract or an existing project also touches on e.g. portfolio contract scenario 2

Ranking “averaged out”

Table: ranking scores of the scenarios per group
(of group 2, the first preference taken (and not the one in brackets))

	group 1	group 2	group 3	group 4	group 5		average		median
Scenario 1	1	1	2	1	2		**1.4**		**1**
Scenario 2	2	2	1	2	3		**2**		**2**
Scenario 3	4	3	3	4	1		**3**		**3**
Scenario 4	4	5	5	3	4		**4.2**		**4**
Scenario 5	2	4	4	5	5		**4**		**4**

Rijkswaterstaat
Ministry of Infrastructure and Water Management

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Date
29 March 2023

Annex(es)
1 Overview of anonymous and summarised answers to market consultation questionnaire

Report

Description	Market consultation procurement strategy coastline and fairway maintenance transition path
Meeting date	Written questionnaires and individual interviews, 21 February - 2 March 2023
Participants	9 dredging companies
Copy	TenderNed AT-2023-01

Reading guide and context
This report forms an outline of the findings of the questionnaires and the individual interviews. The main points that we have received and heard are restated below. The more in-depth and detailed findings are included in annex 1. We are basing this on all the input contributed, including content that has been left out of this summary due to issues of confidentiality, in order to draw conclusions for the next steps. On the basis of all this input, we will go forward and process everything to formulate a draft procurement strategy. In that respect the input will be weighed on the basis of the aim, the available resources and any other considerations. Over the next few months, this will lead to a draft procurement strategy. We will provide information on this in due course.

General findings: low-emission rather than zero emission already possible
Companies have told us that there is still work to do on clarifying the aims and how much opportunity there is for solutions: is zero emission, low-emission or carbon neutral the actual target? These terms are sometimes used interchangeably in the questionnaires.
Our zero emission ambition, as formulated in the market consultation document, is not viewed as being realistic in the marine dredging market in the period leading up to 2030.
In contrast, low-emission is a target that is already possible, now, but has not yet been given as much weight in current tender procedures. The result of this is that the maximum emissions reduction that can be delivered at this point cannot be offered by the companies. To sum up: it is already possible to achieve more than the weighting would suggest.

Similarly, there are a number of elements that still need time to make the transition to zero emission in the future:
* Restricting the parameters to just emissions from operations, it is easy to forget that the current potential zero emission solutions at this point still involve plenty of emissions in the chain (sometimes even more than the existing biofuel solutions and, in any case, more than the current fossil-fuel technologies).
* The potential zero emission technologies are not yet reliably available (nor is there an obvious 'winning' technology).

General findings: start small, the importance of consistency and international demand
The companies sense the movement and direction, they can see that the current procurement instruments are a good incentive, but we do need to target the following points:
* A consistent line in relation to weighting and definitions of the rules, such as those surrounding ECI/ECI value. Consistency and predictability are important in this regard.
* The weighting for sustainability in the tender procedures must be higher in order to provide a greater incentive and, at the same time, the MEAT/BPQR sanction slows advancement. At this point in time there is no incentive to get a higher score (although there is a fine for not scoring high enough, there is no reward for better performance).
* There has been a lot of attention to the possibility of deploying dredging equipment on a wider basis and, in general, internationally. A vessel must have a long service life and must be suitable for deployment for multiple clients, different sorts of project and substrate conditions. So that also demands an international, combined approach to tackle the transition effectively. For example the partnership with other clients at home and abroad.
* To generate innovations and to gain experience in the sector by learning, it is often recommended to start small. This is because fewer financial risks are involved and because the capacities required are generally within reach for alternative energy carriers.
* Delivery times and lead times from a decision to 'launch ready' can be long, and have to be weighed up in the strategy.

Current procurement method and ECI/ECI value
Many companies have experience of working with ECI and state that they believe this to be a good method for tender procedures (objective and predictable criterion). It is also good that Rijkswaterstaat applies ECI so consistently. However, there are a number of other suggestions and points for consideration:
* Make sure there are rigorous rules for LCAs - at the moment interpretation of the rules differs too much. Use the most recent version of the databases, and ensure that the weighting factor for CO_2eq is clear and consistent.
* Think about the enforcement of the CO_2 cap in contracts; this also has disadvantages. It doesn't help LNG or the development of Bio-LNG and it gives an ambiguous picture of the strategy and aims of Rijkswaterstaat. It also raises questions such as: What is the relationship between the climate ambitions and ECI, and to what extent is the current weighting set appropriate for this?
* Companies would like a bonus scheme for a better ECI value than the one offered.
* Improve the enforcement on the ECI offered.
* Make the scope clear, for instance for (de)mobilisation of dredging equipment.

* Companies recommend using a higher ECI value factor and preferably letting it rise in line with a fixed path in years to come. New sustainable technologies are more expensive and this should equate to a higher ECI Value factor, so that they can be developed. Multiples of 3 to 6, for instance.
* Many companies want to stick to working with category 1 data. But there could be more rules on the horizon for specific aspects of the LCAs; using a PCR, for example. Think for instance of fixed values for the production phase of fuels (A1-A3).

Emissions measurements at the source (pipe)
Companies responded positively to a few pilot projects that measured emissions at the source (pipe). This gives greater insight into actual emissions rather than the assumptions in ECI, after all, the numbers tell the story. Using emissions readings for ECI contract management appears to add little of value (after all, easier alternatives are available).

Basic and ambition level growth paths
A relatively clear picture emerges in terms of the growth paths:
* The market as a whole can meet the requirements set for the dredging equipment as far as the emissions classes are concerned; everyone will still bid at the basic level. At the ambition level, this will not be possible for certain companies without investments.
* The feasibility of the requirements over the percentages for sustainable energy carriers is considered less certain. This greatly depends on (timely) availability.

General, in relation to the procurement scenarios: scenario 1 (mix with 2)
In line with the results of the plenary session, a relatively consistent preference was also expressed for scenario 1, potentially in combination with 2, in writing and in the individual interviews. The other scenarios were generally dismissed. Scenarios 3 and 4 were frequently said to disrupt the market: these were not considered viable scenarios.

Other ideas contributed:
The interviews also raised other interesting points that could make the dredging sector and the projects more sustainable.
* Suggestion: to encourage growth of biofuels and sustainable energy carriers it would be wise to think about the role of the client. Suggestions such as indexation, independently creating sustainable energy carriers and facilitating bunkering and loading infrastructure.
* In addition to focusing on the dredging equipment, think also about changes to the design/programming, such as shortening distances travelled over water.
* Furthermore, consider reusing materials from one project in another and optimising transportation.
* A few concrete ideas have filtered in relating to circular applications for released dredging material and soil, including the issue of whether a useful application could be sought within work for the Port of Rotterdam and/or Rijkswaterstaat.
* The electrification of certain types of material that are currently put to specific uses.

Testing demonstration vessel idea
Idea: Several Clients and as many Contractors as possible jointly build ademonstration dredging vessel. The purpose of this vessel is to demonstrate the

technology, acquire learning experiences and to be a demonstration vessel for the equipment of the future.

	General picture
Primary reactions	Some participants admit they agree with giving Rijkswaterstaat/Port of Rotterdam control. However, many others say: make sure there is work and a guarantee of work, as we would rather do the innovation ourselves. Recommendation: Considering a smaller vessel for inland waterways, there is less competition and the investment to be made is smaller. Start small and ensure that it can be scaled up later. Precondition: • The whole market needs to be able to learn from this. • Define SMART aims and research questions. Objections/complaints: • Don't make the group too big. This would result in too much discussion, a never-ending process. • Sharing dredging equipment is complicated, sharing knowledge is good and does happen occasionally. • Is it necessary (not for the growth path, we hear) or is the market sufficiently able to innovate by itself? • If the technology is available and there is a business case, the market will invest itself.
Number of sub-aspects that emerged:	
Type of vessel	Start small, an inland waterway hopper dredger, for instance (seagoing might be a step too far).
Energy carrier	Hydrogen and methanol have been mentioned, but not discussed widely in all talks.
Location	Wadden Sea, Western Scheldt and Rotterdam are emerging as options.
Work	Participants sense more obstacles for fairway maintenance locations than for fairway maintenance.
Research questions	• First and foremost the technology: does it work? • Research questions must be SMART and clearly formulated. • Define targets and intermediate milestones.
Which partners	This was not addressed in all interviews. Nevertheless, the perception does emerge that the whole chain is important to involve (joint clients, shipbuilders, engine manufacturers)

Are you joining us?	Yes, but primarily to share knowledge; as far as dredging equipment development is concerned, participants seem to see more benefit in leading the way themselves.

Testing front runner locations and front runner projects
Idea: In order to be able to realise the ambitions, we are looking for promising 'front runner' projects which could enable us to make the technological leap to carbon neutral.

The Port of Rotterdam is the first place that comes to mind, due to the following features:

- Good loading and bunkering infrastructure at present, and opportunities to convert this into new energy carriers.
- The operations are of sufficient scope for a good occupancy rate for a reasonably-sized suction hopper dredger.
- Collaboration between Rijkswaterstaat and the Port of Rotterdam has been good for a number of years and together they can become the leading dual client, offering sufficient quality and support to oversee new innovations.

Questions:
* In what way should we put this on the market?
* Are you interested?

	General picture
Interest	Once these starting points have been secured, the parties are interested in this assignment: • Companies say that the problem at this point is technology. • Technology must be clearly stated in the tender procedure. • The infrastructure and fuel must be available. In addition, it is important to have support from clients and the surrounding area.
Development time and contract	• The companies have a slight preference for development of the vessel within the term of the contract, plus options for extension. • If a carbon neutral hopper dredger needs to be available at the start of the contract, a lead time of around 3 years needs to be factored into calculations.

Payback period and deployment	• The term of the contract must cover several years if the investment costs are to be covered. • If the vessel can be adequately deployed elsewhere, the investment can be recouped on multiple contracts.
Innovation partnership	In that case, a tender procedure coupled with innovation partnership is something to be considered.

Finally:
An overview of the questions and an anonymised summary of all answers is shown in annex 1.

ANNEX 1 to external report: overview of anonymous and summarised answers to Market Consultation Procurement Strategy (TPKV) questionnaire. To be published via TenderNed (AT-2023-01)

Explanatory notes

It is a summary of the responses given and has been anonymized and sometimes summarised to ensure the confidentiality of what companies have answered.

10 completed questionnaires were received and explanatory interviews were subsequently conducted with 9 companies (2 companies conducted the interview together as they were presented on behalf of the same parent company; this was done by mutual agreement).

General

1)	Rijkswaterstaat's ambition is to be carbon neutral from 2030: in your opinion, which requirements must the procurement strategy meet if this target is to be met?	• The procurement strategy can ensure that short- and long-term sustainable investments are rewarded in tenders in an unambiguous, clear and fair way. • The procurement strategy should be realistic in relation to the current state of the technology. • The procurement strategy should be clear and consistent so that market players know what to invest in with a level playing field for SMEs. • Added value should be properly rewarded; value both ECI & CO_2, but at higher rates than now, otherwise fossil fuels still wins on lowest price. • Carbon neutral is not zero emission; state clearly what it is about. Clarify the sustainability (and future-proofing) of existing solutions such as biofuels and LNG. Include how to deal with capture and compensation • Tender more ambitiously, making it clearer what is already possible now and also where the limits are. If we look at low-emissions (rather than zero emission), much more is already possible today than tendered/awarded. • Think of multiple procurement strategies and room for flexibility. Create opportunities to invest even during the term of a contract. Fuel switches under the terms of a contract should also be facilitated. • Align ambition with other European clients. This will make a larger part of the European fleet sustainable and not just a couple of ships that will then do all the work for Rijkswaterstaat. So not one ship 100% zero emission while the other 19 do not innovate at all. Better that all 20 ships are 50% sustainable.
2)	How can we, the client, encourage innovation and sustainability and prevent disinvestment?	• Work in a project-oriented way. • Be reliable (consistent). • Financial incentives work. • Requirements in line with market developments. • Value sustainability in procurement, also daring to stick to this and making and keeping it concrete for years to come, also for example in the ECI value: keep and maintain a steady line. • As a client, also remove some of the risks by bearing them. • Carrying out pilots can also help drive technology. Lessons learned / 'failed pilots' prevent further disinvestment as we then know it doesn't work (yet).

		• Interestingly, some companies indicated that investment by the companies already gets sufficient attention and that clients do not have 100% influence on investment decisions.
3)	Which factors determine whether you, a company?, can recoup an investment/measure to increase sustainability? Could you state that specifically and quantitatively for the following elements? - contract scope • In m_3 per year • financial scope per year • in contract term in years	• This question is proving difficult to answer. Partly because it depends on the size of the investment and partly because there are uncertainties about technology, resulting in initial cost of training and uncertainty about depreciation and maintenance, for example. • Furthermore, it also indicated that a company's investment is never or rarely made for one specific project, so it is important for companies to keep their equipment broadly deployable and usable for multiple customers. • While the theoretical model of broad contract scope with a long duration is true for ROI, it is still not a preferred option in terms of procurement strategy, given the drawbacks also associated with this approach. (See also answers to the scenarios, especially Scenario 3).
4)	Could you describe how Rijkswaterstaat's procurement strategy could generate enough security that you would be prepared to invest in zero emission dredging equipment? Please specify the extent to which you view the following instruments as being sufficient to meet your investment appetite (explain how you see that): • Policy? • Tender/contract? • Covenants? • National laws and regulations? • International laws and regulations?	The question mentions zero emission and there are many suggestions about that. • In particular, clear definitions • Looking realistically at technical possibilities • And focusing in the short term on low-emissions solutions that are already possible. Further: • Contracts are considered more rigid than policy. • In particular, consistency and rigidity of policy are given as points of concern. • Laws and regulations in the market for seagoing vessels can only be effective if they apply internationally. • Specifically, policies and covenants can help achieve greater consistency and multi-year traction. Subsidies and knowledge and innovation paths through covenants are also mentioned. Additionally, it was noted: • In contracts and tenders, also reserve space for innovation and learning. • End fossil-fuel subsidies • Also facilitate loading and bunkering infrastructure • Facilitate certification of ships with new technologies • Demand functional, aimed at key targets and multi-year

Suggestions for current procurement method and ECI (ECI value)

5)	What do you feel are the current barriers to you, a company?, to investing (or being able to invest) in zero emission dredging equipment? Explain.	Obstacles indicated by many companies include unavailable technology and unprofitable zero-emissions solutions and lack of loading or bunkering facilities. Besides these more technical barriers, procurement barriers are also mentioned: • uncertainty about sustainability valuations in tenders • the lack of a clear, consistent line • due to price fluctuations, a solution does not outweigh the estimated added value in every tender • indexation in contracts is a risk that cannot be properly assessed by bidders.
6)	Does the current working method offer you sufficient incentives to invest in zero emission dredging equipment? Explain.	• Most parties indicate that there are now insufficient incentives to go zero emission. Key reasons for this are that the technology for this has not been sufficiently developed and the incentives in tenders are not strong enough now to start developing it. • Again, the term 'zero emission' is confusing: when are operations zero emission? For example, if that is only the case when using green hydrogen, it is going to take a long time before that fuel is available; and the technology for ships and charging infrastructure must also be available. • It is indicated that for fairway maintenance, projects can probably be carried out zero emission sooner than for coastline maintenance, partly because electricity is more readily available as a source for this.
7)	How high does the ECI value have to be for your company to offer zero emission plant and equipment? Explain.	An ECI value factor ranging between 3 and 6 is realistic with a strong preference towards a higher factor. • Contractors need the ECI value factor to be disclosed further in advance. • If the ECI value factor is scaled up, then as a client you maximize rewards on sustainable changes and as a client you actually provide a stimulus for new developments (innovations).
8)	At present, you can calculate the ECI with your own LCAs and use it as category 1 data. One drawback of this is that clients are sometimes presented with very different calculations for the same fuel category.	Many parties want to stick to working with Category 1 data. However, there could be more ground rules in certain parts of LCAs, e.g. using Product Category Rules (PCR). Consider also, for example, fixed values for the production phase of fuels (A1-A3). Furthermore, it is desirable that Rijkswaterstaat and TNO work on good ECI figures for different (scenarios) for energy carriers of the future, e.g. as is currently available for shore-based equipment.

	What is your view on the exclusion of category 1 data and the restriction to category 3 data? Or, to put it another way: What is your position in relation to the idea of working with generic aggregated data, excluding your own LCAs? And what preconditions or 'rules of engagement' are needed in that case?	
9)	In order not just to model the emissions but also to validate the ECI calculations, we could specify emissions readings. What is your position on this?	Market players are positive about some pilots for measuring emissions at the pipe. This gives greater insight into actual emissions rather than assumptions in ECI. 'Quantify to clarify'. Using emission measurements for contract management ECI seems to have little added value. There are other (cheaper and simpler) ways to do that, such as checking bunker slips for Ad Blue, and on-board fuel registration. Also, emission measurements give different units/values than the environmental impacts as contained in ECI.
10)	How do you view making a maximum performance requirement for a fixed sustainability budget a tender condition?	It turns out there was some confusion about what exactly was meant by this question. Companies indicated that if Rijkswaterstaat chooses this instrument, it should be clear how such a sustainability budget relates to the ECI BPQR criterion. Also, the budget should be high enough to make a substantial sustainable offer. Take into account, for example, the fuel price of HVO and any investments in vessel conversion. For this instrument too, Rijkswaterstaat needs to adopt a consistent and predictable approach to make investments that pay off over the long term interesting.
11)	What is your view on a maximum permitted ECI (or an emissions cap) for projects?	• Allowing a maximum emissions cap has divided views among market participants. Some find it a good tool where the client makes clear the minimum level of sustainability expected. Of course, it has to be feasible and realistic. On the other hand, there are also market players who do not see a maximum emissions cap as positive.

		• A maximum allowable ECI restricts the market player in being more sustainable than the limit or in their commitment to innovations. • A lower ECI limit ensures that market players only take measures until the lower limit is reached (at maximum discount) and not for the maximum they can get out of sustainability. • A maximum allowable ECI gives market players sufficient incentive to make sustainability improvements in steps and to keep looking for alternatives.
12)	Do you have any other requirements or suggestions for improvements to the current working method, using ECIs as an award criterion?	A number of additional suggestions are given: • Consider more uniform application of ECI in tenders • Give more weight to ECI • Besides a sanction, a reward is a much better incentive, because otherwise a market player will never try to do even better than offered. • provide a clear scope delineation: what should be included and what should not. • steer towards a more level playing field, including by making pre-procurement information easily calculable (such as subsurface data).

The growth paths

13)	If we, as a client, set the requirements of the basic level (the peloton) as the minimum for our tender procedures, would you still be able to bid in all periods? Explain.	Baseline emissions-class requirements may be met and not sustainable energy carriers; this depends on availability.
14)	If we, as a client, set the requirements of the ambition level (frontrunner) as the minimum for our tenders (or a part thereof), would you still be able to bid in all periods? Explain.	Emissions-class requirements of the ambition level can mostly be met and not sustainable energy carriers; this depends on availability. NOTE1: In answering, some companies assumed that the ambition level of the growth path assumes zero emission, but this is not the case. Discussions mostly revealed that while the emissions-class requirements from the ambition level of the seagoing growth path could be met by part of the fleet, this would exclude a large part of the market. However, there is no climate or emissions gain there overall, as those ships would be deployed elsewhere. NOTE2: The requirements of the ambition level can be met, but as a side note it was also stated that it also depends on the availability of equipment. As a company, once you deploy your equipment somewhere, it cannot be deployed elsewhere, which means that perhaps bids will be submitted with ‘older’ equipment.

15)	How many 'frontrunner' contracts per year could we put on the market? Answer in terms of m^3 per year and/or as a percentage of the total work package. Explain.	A diverse response, which was answered by 5 out of 10 respondents: Implement 100% to 20% of contracts as 'frontrunner' projects. Recommendations and comments from market participants: • Use 'frontrunner' projects as pilot projects and/or learning spaces • Link expansion rate to state of the art • Minimum level is basic level by rewarding frontrunners with ECI value benefit • This does depend on the availability of sustainable energy carriers.

The scenarios - general

16)	What do you think of the five scenarios described? What is the ideal mix as far as you are concerned?	In summary, the majority choose scenario 1 with a combination of mostly 2 and sometimes 3 or 5 as the ideal mix of scenarios. • Scenarios 1 and 2 were mentioned as the ideal mix in 5 out of 10 responses. • A response indicated that there is no ideal mix for coastline maintenance projects. • Scenarios 1 and 5 were mentioned in 1 out of 10 responses • Scenarios 1 and 3 were mentioned in 1 out of 10 responses • And finally scenarios 3, 4 and 5 in 1 out of 10 answers.
17)	Is one of them your preferred scenario? If so, which scenario and why?	In summary, scenario 1 is a preferred scenario followed by scenario 2 for the participating companies. • Scenario 1 is one of the preferred scenarios as it was mentioned in 8 out of 10 responses. • Followed by scenario 2 which was mentioned by 4 out of 10 companies (of which 3 times in combination with 1). • Scenario 3 was mentioned once as a preferred scenario. NOTE: The individual interviews revealed that the portfolio approach still needs explanation and that it could be a preferred scenario alongside scenario 1 if there are enough competition moments left and/or there is enough competition between market players.
18)	Are there any 'no go' scenarios for you, in other words, scenarios you would like to block? If so, which scenario and why?	In summary, scenarios 3 and 4 are no-go scenarios for the participating companies. • In 8 of 10 responses, scenario 4 was indicated as a no-go scenario, • Followed by scenario 3 in 8 out of 10 answers • But scenario 5 is also mentioned in 2 out of 10 responses. • One response indicated that there is no no-go scenario.

The scenarios, specifically scenario 1: ECI

19)	How do you estimate the effectiveness of this scenario in achieving carbon neutral targets? Explain.	The majority of responses (7 out of 10) are positive ('effective', 'great opportunity') about scenario 1. This includes advice such as: • ECI valuation should be adjusted/weighted more heavily (mentioned 4 times) • (Adjustments to the) ECI valuation should be communicated in a timely manner (mentioned 3 times) • ECI value can be applied directly (mentioned 5 times) • The application (incl. preconditions / rules of the game) should be clear (mentioned 2 times) In addition to the above feedback, there are responses that mention that there may not be enough dredging equipment available to meet the Rijkswaterstaat target with this scenario (mentioned 2 times).
20)	What effect does this scenario have on your investment appetite in zero emission dredging equipment?	The answers to this question are diverse. Multiple responses (5 times) mention that application of this scenario has a positive effect ('great effect', 'positive', 'boost', 'good', 'sufficient certainty') on investment appetite. Here, it stands out that there needs to be sufficient clarity and predictability to be able to weigh investments against each other (4 times). Several times (3 times) it was mentioned that application of scenario 1 does not affect the appetite to invest in zero-emissions equipment. Furthermore, responses stated that producing electricity and hydrogen without 100% green power guarantee does not yet score much lower in the current ECI than operating on e.g. HVO in combination with an SCR emissions control system. As long as this difference is not there, zero emission will not be encouraged.
21)	How do you view the consequences for extra costs for the client for this scenario compared with the other scenarios?	Most responses (5 times) to this question indicate that costs will increase (in the shorter term). It also mentions that costs are expected to be lower in the long run (2 times). Furthermore, it was mentioned that how much the cost increases depends on how fast the ECI requirements increase. One company indicates that with about 5–20% extra cost, it is possible to operate at near-zero emissions. Several times (3 times) the response stated that it is not possible to estimate the costs. One company indicates that investment is not necessary, as with HVO the ECI can be brought to a lower level.

22)	How do you view the market effects for you as a company in this scenario compared with the other scenarios?	Most responses (5 times) indicate that the market effects will not change for the respondent of the question. Here it is mentioned several times that the entire market will grow with it (4 times). There are 3 companies who indicate that application of scenario 1 is beneficial for their market position ('good', 'opportunities increase', 'frontrunner').
23)	What recommendations do you have on the use of this scenario?	Several recommendations were given: • Create clarity on the ECI valuation of future energy carriers (e.g. TNO research). • Dare to experiment with the ECI valuation. • Create clarity on growth of ECI valuation until 2050 and do not change it • Create clarity on the (future) mutual ECI weighting of emissions (nitrogen, particulate matter, etc.) • Current ECI rating does not encourage zero-emissions; increase ECI rating • When determining the ECI valuation; look at the cost of HVO • Make room for sustainability during the term of contracts • Apply ECI as a bonus, for additional incentive • Request only ECI, with CO_2 not (additionally) requested • Assess the fuel consumption and LCA calculation during the tender, and let the tenderer substantiate it. In doing this, make sure the LCA and ECI calculations are realistic, transparent and tested. • Monitor and enforce fuel consumption during execution • Repeat Innovation in Coastline Maintenance (IKZ) experiment, this time focusing on the application of ECI (calculate scenarios for the application of energy carriers versus costs) • Implement scenario 1 quickly and ambitiously • Steer not only towards climate improvement, but also for particulate matter and nitrogen reduction • Requirement in all contracts 100% HVO (without application of ECI) • Requirement to use no more than 80% HVO, leaving margin to absorb setbacks.
24)	Which of the revenue models for frontrunners is included in this scenario/possible solution and where is there room for improvement, if any?	Most responses (5 times) indicate that the frontrunners can achieve a low ECV score, giving these frontrunners a greater chance of winning the tender. This also motivates the peloton to achieve low ECI value scores. Here, one company indicated that it is currently a limited earnings model, but that this can be adjusted by valuing ECV more in the MEAT-BPQR weighting. Other responses (2 times) seem to be in line with this; these indicate that if enough notional discount is given, fairer prices for sustainable solutions will emerge.

		Another company indicates that support for the application of this scenario is high, and that ECV is already being applied. One company advises applying an ECI bonus at the end of implementation, instead of an ECI fine / MEAT-BPQR sanction.

The scenarios, specifically scenario 2: contractual portfolio approach

25)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.	Overall, a realistic, motivating and implementable scenario. Provided the right innovations are encouraged, it could have a big effect, even in combination with scenario 1. Provides opportunities at project level and in improvements during the term of the contract, the pitfall being in the longer contracts (sticking to one project for too long and missing out on innovation).
26)	What effect does this scenario have on your investment appetite in zero emission dredging equipment?	On average a high investment appetite is seen as a great business opportunity and sustainability initiative.
27)	How do you view the consequences for extra costs for the client for this scenario compared with the other scenarios?	Ranging from no additional cost to high additional cost, the emphasis being on estimation complexity and the higher the durability, the higher the cost.
28)	How do you view the market effects for you as a company in this scenarios?	Ranging from market-distorting to no high impact. Depending on the size of the work packages, market disruption occurs (rest of the market is left behind). Accelerating sustainability.
29)	What recommendations do you have on the use of this scenario?	Start small, include clear/unambiguous conditions for extension in tender, include unambiguous requirements in tender. Award based on sustainability performance. Keeping an eye on SMEs.
30)	Which of the revenue models for frontrunners is included in this scenario/possible solution and where is there room for improvement, if any?	Investment and effective innovations can be recouped/rewarded.

The scenarios, specifically scenario 3: Large-scale contracts

31)	How do you estimate the effectiveness of this scenario in achieving carbon neutral targets? Explain.	The responses to this question paint a diverse picture. One positive aspect mentioned about this scenario is that the long lead time prior to implementation may encourage contractors to invest (3 times). At the same time, the answer is that the contractor of this scenario builds a big lead over the other market players (2 times). It is therefore advised that the contracts should not have a long duration, thus providing for sufficient competition moments (2 times). This also helps the client: shorter contracts avoid working too long with old techniques It is also stated that it is better to incentivise all market players, rather than just the winner of the big contract. This is expected to yield more across the board (3 times). Finally, several responses were given that it is currently unclear which techniques should be invested in (3 times).
32)	What effect does this scenario have on your investment appetite in zero emission dredging equipment?	The responses to this question paint a two-fold picture. On the one hand, the answer is that applying this scenario is likely to lead to faster and greater investment (6 times). At the same time, it was also indicated that this scenario is likely to lead to a single winner of this large contract, negatively affecting market relations (2 times). Finally, there are 2 responses that indicate that using this scenario will not affect investment in zero-emissions equipment.
33)	How do you view the consequences for extra costs for the client for this scenario compared with the other scenarios?	The additional costs for the client are variously estimated in the responses. It was most often indicated that the additional costs could not be estimated (5 times). Three times it was indicated that this scenario involves higher costs, both in the medium and long term (3 times). Finally, one party indicates that no additional costs are expected.
34)	How do you view the market effects for you as a company in this scenario?	The answers to this question are largely negative. By applying this scenario, a major disruption in the market is expected, with a few (wealthy) parties remaining (3 times). It was also indicated that SMEs cannot make the necessary investments in really large-scale contracts (3 times). On the other hand, it was mentioned twice that the investment appetite is increased because the investment can be (partly) recouped with this large contract. Two answers indicate that no estimate can be made. Finally, one company mentioned the risk that the company that wins this contract may not innovate further, and the other

		companies may not be able to compete for this work for an extended period of time and therefore not innovate.
35)	What recommendations do you have on the use of this scenario?	The following recommendations/comments were submitted: • The time between contract start date and work execution is positively rated by one company. This allows the necessary time to make the investments for zero-emissions implementation, and certainty of the equipment to be deployed. • One company indicates that the investment appetite depends on whether they are the winner of the contract. • Three companies indicate they have no recommendations for this scenario • One company indicates that a large contract fits well with multi-year maintenance of channels/seaports. • One company indicates that this scenario should be introduced quickly and ambitiously. • One company indicates that this scenario requires further exploration. This should require the exploration of the extent to which an investment can be recovered within the contract period. • One company advises against implementing this scenario. • One company indicates that SMEs would be sidelined under this scenario, and that a mix of larger and smaller contracts would be wiser.
36)	Which of the revenue models for frontrunners is included in this scenario/possible solution and where is there room for improvement, if any?	One picture regularly emerges from the responses; that an earnings model only exists for the frontrunner ('very strong market position', 'select part', 'rest of the companies will lose a lot of market share') in this scenario (6 times). Furthermore, two companies indicated that the large contract provides security (for the winner). One company indicates that bold investments are rewarded; that frontrunners are rewarded, and that in this way the peloton is motivated to do as well / quickly follow.

The scenarios, specifically scenario 4: Rijkswaterstaat buying and/or leasing of vessel

37)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.	A diverse response from 'high', to 'non-existent', to 'very limited'. There is no effectiveness for this scenario; once market players can complete the business case, they will develop and build ships themselves as there is enough knowledge and expertise among them. Rijkswaterstaat will be dependent on 1 vessel to achieve its stated goals because companies have no incentive to invest in their own equipment in this scenario. Other companies further indicate that the effectiveness will be high in the beginning but there is also a dependence on how the equipment is developed further and this affects the effectiveness as time goes on.
38)	What effect does this scenario have on your investment appetite in zero emission dredging equipment?	The responses range from: 'it does not fit the company's earnings model', 'none', 'bad effect' to '(big) negative effect'. By not rewarding investment in proprietary equipment, it will have no impact for market players and this scenario will cause market players to adopt a wait-and-see attitude. Also, the overall scope of dredging activities is becoming less and this will affect the investment appetite of market players.
39)	How do you view the consequences for extra costs for the client for this scenario compared with the other scenarios?	The responses range from: • It does not fit the company's earnings model. • With the purchase of 1 ship, not all sustainability ambitions and goals will be achieved because contractors will now sit back / not invest in more sustainable equipment. • And that it cannot be estimated with current knowledge. A number of market participants estimate the impact on extra costs as follows: • The extra costs will be higher; this is closely related to how the ship is used among other things in relation to productivity, OPEX, execution, procurement, application of sustainability measures and legal costs. Owning a ship is not part of the government's core business, unlike that of the various market players.
40)	How do you view the market effects for you as a company in this	The responses range from: no effect; zero impact; serious disruption of market operations; it does not fit the company's earnings model; to it not being seen as a realistic scenario.

	scenario compared with the other scenarios?	This scenario ensures that market players will be less likely to implement sustainability by adopting a wait-and-see attitude. It is only 1 ship that is being made more sustainable, while in the other scenarios there are multiple contracts for greater sustainability. Due to this scenario, there will be fewer personnel available to market players, there will be less tendering and this in turn will affect the work packages of dredging work to be marketed.
41)	What recommendations do you have on the use of this scenario?	The response ranges from: ‘no recommendations’, ‘it does not fit the company’s earnings model’ to ‘not applying it because it will not be successful’. While other market players still give the recommendations below: • That it will not be effective and is not necessary to achieve reduction targets by way of this route; • That it will stall the development of sustainable technologies by market players and it will not help the market move forward.
42)	Which of the revenue models for frontrunners is included in this scenario/possible solution and where is there room for improvement, if any?	The response varies from: ‘difficult to estimate’, ‘no earnings model’ to ‘very limited earnings model because only crew is provided’. In summary, this scenario offers a ‘zero’ to ‘very limited’ earnings model for market players and there is no frontrunner for this scenario.
43)	Would you be interested in bidding to become an operator on a Rijkswaterstaat vessel?	Two market players have indicated their interest in becoming operators. One more market player would consider it only to stay involved in the market; however, this company does not believe in scenario 4. In 8 out of 10 cases, market players are not interested in becoming operators; people are not positive about it and it does not fit the company’s earnings model. Scenario 4 is not seen as a realistic scenario.
44)	How could the experiences of what you have learnt about purchase or lease of this vessel become accessible for the sector?	In 3 out of 10 responses, market players are not positive about it, as it does not fit into the company’s earnings model. The other market players do make some suggestions to unlock knowledge by: • Organising open days on the ship to sail along and allow questions to be submitted in advance;

		• Share accumulated knowledge and improvements with the industry (periodically); • Have different crews from as many companies as possible on the ship; • Share and publish learning experiences widely; • Open and transparent communication about data that follows from the equipment installed on the ship.
45)	What is a good exit strategy for this scenario?	In 2 out of 10 responses, market players indicated that the vessel could be sold after x number of years. In 6 out of 10 answers, market players do not see a good exit strategy because people are not interested in it, they are not positive about it, it does not fit into the company's earnings model. Scenario 4 is not seen as a realistic scenario.

The scenarios, specifically scenario 5: growth of zero emission

46)	How effective do you think this scenario is in terms of hitting carbon neutral targets? Explain.	• Overall negative due to estimated infeasibility in the remaining time to 2030 (6 years and 9 months left). • Terminology should be clear (everyone on the same page). • For longer-term positive / more positive if Rijkswaterstaat provides further/clearer definitions. • Market players see a sustainability push (positive), just not in set time frame.
47)	What effect does this scenario have on your investment appetite in zero emission dredging equipment?	• Divergent investment appetite, especially if this is in operations. • Dissenting voices about unavailable technology, energy carriers and excessively high ambitions that could lead to poor/wrong choices, among other things.
48)	How do you view the consequences for extra costs for the client for this scenario compared with the other scenarios?	High, on average.
49)	How do you view the market effects for you as a company in this scenario?	Limited to high, depending on investment appetite and sustainable operations.

50)	What recommendations do you have on the use of this scenario?	Define zero emission, moving with the development of technology over time and not aiming for zero emission by 2030.
51)	Which of the revenue models for frontrunners is included in this scenario/possible solution and where is there room for improvement, if any?	Strongly increasing for companies that can do it quickly, harder to achieve for companies that still need to invest.

Technology/Knowledge and Innovation

52)	How do you, a company, view the imposition of measures to reduce nitrogen, particulate matter and a combination of nitrogen/particulate matter?	Almost all companies are neutral to positive about prescribing NOx and PM10 and NOx/PM10 reduction measures. No supplier is adverse to this but a few question whether this is necessary as these indicators are already included in the ECI, so there is no reason to do this separately. Adjusting the weighting of these indicators within the ECI is more in line with the systematics. It did not address whether the requirements for NOx/PM10 should be done together or separately other than that they are already integral to the ECI.
53)	What do you expect will happen in relation to the availability of the biofuels specified in RED II, annex IXa, in years to come?	The market has widely varying perceptions and expectations regarding the availability of REDII annex IXa. This question also notes that as per RED II, Annex IXa, biofuels are not supplied as a physical ‘product that can be bunkered but are included as a percentage in the biodiesel supplied. Should this be prescribed anyway, mass balance or guarantees of origin will have to be used.
54)	We view biofuels as transition fuels on the way to REDII, category 4. the so-called RFNBOs. What is your view of this in the period from now until 2030? And for the years after that?	Biofuels (IXa and IXb) are expected to still have an important role and share as an energy carrier for the salt-water dredging sector in mid-2030 and beyond, and will continue to develop. RFNBOs (Renewable Fuels of Non-Biological Origin) themselves and availability will certainly start to evolve and develop, increasing their share in total supply/demand by mid-2030 but still a relatively small share due to cost.

		At present, there are no powertrains available that can run entirely on RFNBOs, and no statement can be made at this time as to whether RFNBOs are a future solution and/or which ones that might be.
55)	Which energy carriers, possibilities in fuel and technology should Rijkswaterstaat be encouraging with its procurement strategy?	There is a very varied picture as to which energy carriers and techniques Rijkswaterstaat should promote. Almost all current and new-generation energy carriers such as biodiesels, methanol, hydrogen, electric and technologies (ICE, fuel cell and nuclear) were mentioned. NB1: It is noted that energy carriers will follow the development of engines and powertrains, not the other way around. NB2: It is also notable that end-of-pipe technologies such as SCR, particulate filters are not named to stimulate their use, but all answers are about energy carriers in relation to propulsion technology.
56)	When will it be possible for you, a company, to work without emissions?	Besides various preconditions, 2050 is mentioned several times as the time when zero-emissions operation becomes available for seagoing equipment. For fresh-water equipment, this is already possible. A number of times it is mentioned that zero-emissions is very ambitious and that low-emissions is already possible now. Preconditions for zero emission operation are mentioned: • Availability of techniques • Purchase guarantees • Subsidies
57)	Where do you have knowledge gaps in relation to carbon neutrality, circular economy and zero emission working and how could these gaps be closed?	Suppliers do not lack existing knowledge or forums and platforms, but the energy carrier of the future is simply not concrete enough to stake so much on carbon neutral and zero emission operations.
58)	How can we optimise the development and sharing of knowledge? What preconditions are necessary for this?	Several methods are mentioned for knowledge development and especially sharing: • Organising demonstration projects, • That Rijkswaterstaat should gather knowledge from producers of equipment and energy carriers is explicitly mentioned several times. • The TNO reports on LCA energy carriers are cited several times as examples. • Furthermore, a healthy market, an effective (knowledge) infrastructure and international cooperation are seen as important preconditions.

Risks, planning and financing

59)	What indexation for alternative energy carriers can we, the client, use?	Platts price indices are available for MGO and LNG. For biofuels, indexation is not yet common. Settlement can then take place on the basis of substantiated bid at tender, with actual price in execution based on bunker slips and demonstrated price.
60)	How can we, the client, mitigate/keep manageable the price and productivity risks for both companies and clients?	• Effective infrastructure for energy carriers. • Align sustainability ambitions with the state of the technology.
61)	What is the expected effect on costs of zero emission working on (<u>give quantitative answers</u>):	This is currently difficult to quantify
	a) CAPEX: in % vs traditional diesel ships?	Hard to quantify, possibly 25–40% more expensive.
	b) OPEX: in % compared with traditional diesel vessels for the following aspects:	Hard to quantify, possibly 60–100% more expensive.
	c) -% Productivity gain (-) or loss (+) per m3-hopper-hour	Hard to quantify.
	d) –% fuel costs more expensive (+) or cheaper (-)	Hard to quantify.
	e) –% maintenance more expensive (+) or cheaper (-)	Hard to quantify.
	f) –% crew costs more expensive (+) or cheaper (-)	Hard to quantify.
	g) –% depreciation more expensive (+) or cheaper (-)	Hard to quantify.

	h) In total: CAPEX + OPEX in % expected price per m3-hopper-hour more expensive(+) or cheaper (-)	zero emission will be more expensive.
62)	How should the risks and/or costs be distributed between companies and clients in relation to sustainability?	• Distinction between CAPEX and OPEX is specifically mentioned a number of times. • CAPEX: Some of the risk on the investment can be left with the company, although there are also many answers that point to integrally calculating and placing all costs and risks with the client. • OPEX: According to all companies (who replied), the client should bear the risk for the operational extra costs.

Your starting position

63)	How are sustainability and investment intertwined and organised in your business?	For almost all companies, investing is a means for ensuring operational continuity, and sustainability plays an important role in this (partly because it is mandated/expected as a future requirement, partly because it fits with company policy). Here, the precondition of continuity remains a concern: investments must be able to be earned back and generate revenues and returns.
64)	Which investment programmes do you, a company, expect to engage in?	Replacement and/or expansion investments are continuously considered. Several potential investments are mentioned in different segments (inland to marine), ranging from engine management, SCR, LNG, electric, methanol to hydrogen.
65)	As a company, how do you view your position if competitiveness on sustainability becomes the most important criterion in tender procedures?	Many companies see themselves as frontrunners, although some point to an older fleet and international deployability: competing on sustainability here, can be detrimental to competing on lowest price elsewhere.
66)	For which other clients do you, a company, work in coastal and waterway maintenance? Are these clients moving in the same direction and have they already asked you similar questions	Various, but still relatively little interaction on this topic.

	in a market consultation?	
67)	How do you, a company, view the speed of emissions requirements all around us (from the IMO, EU and other customers)?	Many companies indicate that awarding tenders on sustainability is still hardly done in neighbouring countries. Rijkswaterstaat's ambitious pace seems out of step with the overall playing field and is judged by some to be unrealistic.

Finally

68)	What other ideas do you, as a company, have about making water-borne dredging equipment more sustainable in relation to coastline and fairway maintenance?	Several ideas are put forward: • Shorten sailing distances. • Reuse materials from one project in another. • Alternative dredging methods can sometimes also be a solution, such as deploying a WID during fairway maintenance, for example. • Optimising emissions reductions often requires a specific ship design (with operational profile), which is a mismatch with the broad deployability of many companies. • Consistent policy, addressing: 1) long depreciation periods; 2) dependence on technology, loading and bunkering facilities; and 3) dependence on laws and regulations. • Make sure sufficient competition moments remain.
69)	What else would you like to say in relation to the establishment of a procurement strategy for coastline maintenance and saltwater/freshwater fairways?	Several comments and suggestions are posted: • Look carefully at the international playing field, both on the client side (do not get too out of step and look at the internationally agreed targets in e.g. the Paris Agreement), and on the policy-maker side (ETS, Carbon Border Adjustment Mechanism, RED II, RED III, etc.). • Keep an eye on distinction between small and large companies. • The entire LCA must be considered (e.g. hydrogen is beneficial in the realisation phase but not in the development phase). • Engaging with the market and producers. Include the market in good time. Also consider engine and fuel suppliers (and factor in availability). • Allowing interim achievable emissions improvement targets seems to be a viable strategy for freshwater fairways. • The focus is on the equipment to be deployed but other methods of replenishment/implementation are not included here. • Also consider surplus sand, this can be used for foreshore replenishment. • For coastline maintenance: work packages should be put together based on most suitable equipment, rather than location. This will probably be more efficient. and better optimised in terms of sustainability.

		• For estimating hopper loading, the in-situ density of the material to be dredged is an important parameter. This information is missing from many tenders. Optimisation of fuel use works better if the in-situ density is determined in advance and included in the tender. • Furthermore, the client's ambition is to protect its stocks of dredged material/soil and preserve its value as of 2030. It is important that these ambitions are integrated as carbon neutral operations, as they also contribute to the carbon neutral ambition. Looking only at type of equipment is not the only option.
70)	What else would you like to say about this market consultation?	Too many questions! (often mentioned), but also: • Good to be aware of each other's worlds and have open dialogue. • But do ensure sufficient technical knowledge, including at the client's and make sure requirements and ambitions are balanced and realistic.
71)	If you were to rate this market consultation (1-10), what grade would you give it? Explain.	The figures vary slightly. On average, a 7.7 was given during the written round, with a few times a 9 and once a 4. During individual interviews, the possibility of still revising the grade was pointed out. One company has taken advantage of that so far (the 4 became a 6).

Market developments Coastline Management and Fairway Maintenance

Analysis for Roadmap Transition to Carbon Neutral and Circular Infrastructure

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Economisch Instituut voor de Bouw

September 2022

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Analysis for Roadmap: Transition to Carbon Neutral and Circular Infrastructure

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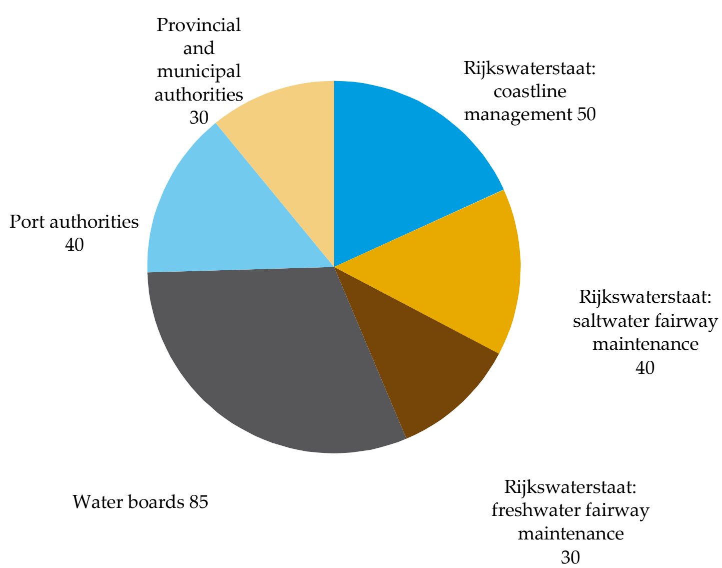
General conclusions

The government aims to achieve a Carbon Neutral and Circular Infrastructure (KCI in Dutch) by 2030. Rijkswaterstaat is developing transition paths for four policy areas to achieve these goals. As part of the ‘Coastline Management and Fairway Maintenance’ (KLZ/VGO in Dutch) Transition Path, the EIB is further surveying the market on behalf of Rijkswaterstaat, on both demand and supply sides.

Rijkswaterstaat is dominant client for saltwater dredging work
Within the Netherlands, Rijkswaterstaat is the only client in the coastline management domain. The tendered volume here is around €50 million per year. Additionally, Rijkswaterstaat tenders saltwater fairway maintenance and this is estimated at €40 million. Some of this work is tendered in cooperation with port authorities, as work in the ports is related to the adjacent fairways.

In freshwater fairway maintenance, Rijkswaterstaat is less dominant. Rijkswaterstaat’s average investment in this domain is around €30 million per year. Water boards play a much bigger role in the domestic dredging market. The water boards’ annual cost of dredging is about €85 million per year.[1] Port authorities, particularly Rotterdam, invest around €40 million a year in dredging. Additionally, provincial and municipal authorities also play a role in this market. For them, it is estimated that several tens of millions of euros per year are involved. The total domestic volume of coastal, offshore and inland dredging reached €275 million in 2020 (Figure 1).

Figure 1 KLZ/VGO market volume indication in 2020 by type of client (and activity for Rijkswaterstaat), million euros



Source: UVW, Rijkswaterstaat, interviews, EIB

[1] Dutch Association of Water Boards. WAVES databank.

The dredging market is defined here in a narrow sense. In practice, dredging is sometimes combined with other activities such as structural hydraulic engineering, bank-protection works or sand extraction. For this additional work, similar equipment to that for dredging is regularly used. This also largely involves the same companies that are active in dredging itself. The market volume in these 'adjacent' markets has not been explicitly mapped, but indicatively it may be as large as the dredging market in the narrow sense.

CO_2 emissions not yet fully mapped
In previous research, TNO mapped the CO_2 emissions of the entire freshwater hydraulic engineering fleet. It is estimated that this part of the fleet emits about 77 Ktonnes of CO_2 per year. However, this is broader than just dredging as other work is also carried out with this fleet. The focus of these emissions is on four types of dredging equipment, namely suction dredgers, grab (hopper) dredgers, hopper barges and suction hopper dredgers. CO_2 emissions from coastline management, at 37.9 Ktonnes, are estimated by Rijkswaterstaat to be about half as much as the total emissions of the freshwater fleet. CO_2 emissions from other saltwater activities have not yet been mapped.

Market development towards 2030 depends, among other things, on speed of sustainability and budgets
Towards 2030, a number of developments are important for production in the dredging market. First, due to climate change, relatively more frequent high water plays an important role. This has potential implications for the dredging market, although these implications have not been identified in this study. While sea levels will gradually rise, the impact on other waters such as rivers are more uncertain. Additionally, spatial developments may also play a role. One example is the relocation of businesses within the Rotterdam port to newer sites requiring the construction of harbour basins. Potential delays due to PFAS issues also play a role. Finally, in the field of asset management and digitalisation, there are apparent innovations for smarter dredging that reduce dredging volumes or perform dredging with fewer emissions.

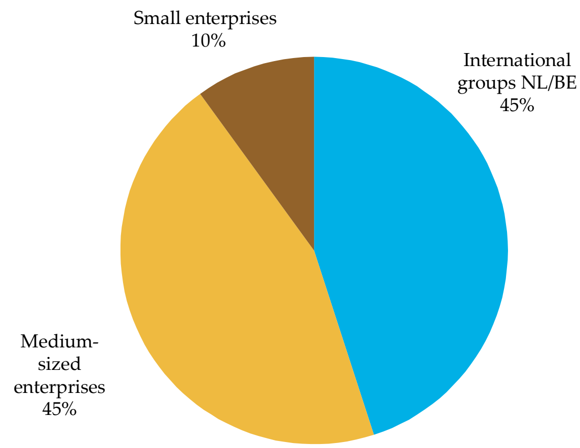
Another important factor for development up to 2030 is the energy transition. Making dredging equipment more sustainable may lead to higher costs through investment in new, more expensive dredging equipment and to accelerated depreciation of old dredging equipment. However, there is still a lot of uncertainty here regarding the development of fuel prices, of both diesel and renewable alternatives. Currently, many renewable fuels still seem to be more expensive than diesel, although with current price dynamics, it is uncertain to what extent and for how long this will remain the case. But the scope for sustainability depends heavily on the clients' available budgets and the importance given to it during tenders. With fixed budgets, sustainability may imply that physically less dredging volume can be processed.

Supply side of dredging market highly differentiated
On the supply side of the Dutch market, we distinguish between three types of dredging companies:

- Major international enterprises from the Netherlands and Belgium.
  This concerns four enterprises that depend on the global market for a large part of their sales. In the Netherlands, they are mainly active in the larger projects, such as coastline management, and only carry out limited work on fresh waters. They achieve an estimated 25% of their turnover in the Dutch market.
- Medium-sized enterprises.
  For these enterprises, the focus is on the Netherlands (an estimated average of 75% of revenues), but they also operate to widely varying degrees in a number of surrounding countries.
- Small, regional dredging enterprises.
  This concerns a relatively high number of enterprises that primarily focus on smaller projects, such as from water boards and provinces and municipalities. Their turnover is almost entirely generated on the Dutch market.

The distribution of the dredging market in 2020 by these three types of companies is shown indicatively in Figure 2.

Figure 2 Indicative market breakdown KLZ/VGO by company type, 2020



Source: Annual reports, edited EIB

The Netherlands leads the way in sustainable dredging
The total global dredging market in 2019 and 2020 was around €5 billion per year and the European market was around €1.4 billion in these years. This excludes closed markets and concerns only international tenders.[2]The pace of development in other countries is particularly important for the saltwater dredging market and also for the larger enterprises. Dredging equipment from these enterprises usually needs to be deployable in multiple countries.

Interviews with clients and dredging companies suggest that the Netherlands is ahead of other European countries in promoting sustainable dredging. The Netherlands is moving forward with sustainability ambitions and Dutch clients, for example, already tender relatively frequently on the basis of an Environmental Cost Indicator (ECI). Within the Netherlands, Rijkswaterstaat, together with other organisations such as port authorities and some water boards, plays an important role with regard to sustainable dredging. In other European countries there is increasing focus on sustainable dredging, partly in line with policy developments from the European Commission. The pace of this represents a major factor of uncertainty. Outside Europe, this focus is still very limited.

Long lifespan complicates investment decisions
A feature of much of the dredging equipment is that it has a relatively long lifespan. The technical lifetime is 25 to 30 years on average. Interviews show that especially in smaller enterprises, dredging equipment is often used for longer periods of time. This long lifespan makes investment decisions in combination with the uncertainties surrounding long-term opportunities for sustainability difficult.

[2] Tenders below the international procurement threshold are not part of this estimated market size.

Enterprises handle this differently. On the one hand, small enterprises have a smaller fleet and it is a challenge to make the right choices now for 30 years in the future. Larger enterprises have ships built more frequently and it may be easier for them to swap these ships globally. On the other hand, these ships should not only be deployable in the Netherlands but should also be competitive in other countries and/or continents.

Industry plays a key role in sustainability developments
Besides clients and dredging enterprises, key players for making the sector more sustainable are shipyards and engine manufacturers. These two types of industry players do not operate exclusively for the dredging market but also for sectors such as container shipping and offshore, especially in regions outside the Netherlands. Given the large difference in the (peak) power requirements of dredging equipment, specific innovations for sustainability are needed here. However, dredging equipment is only a very small market for the industry. Dredging enterprises indicate that they tend to cooperate with shipyards and manufacturers in developments towards sustainability. But dredging equipment development, from design to realisation, takes a relatively large number of years.

Highly divergent routes to sustainability of seagoing and inland dredging equipment
Trends towards cleaner blends of fuels are visible across the dredging fleet. However, for further sustainability, there is an important distinction between the possibilities for seagoing and inland dredging equipment. Given the differences between the two domains, it makes sense to pursue different routes towards sustainability. These differences relate not only to sustainability options and costs, but also to the speed at which sustainability can be achieved. Finally, it is also important to take into account the different actors active within the domains. Below are the main differences for sustainability options.

The seagoing dredging equipment requires larger (peak) capacities and full electrification therefore does not seem to be an option. Here, developments towards bio-LNG, methanol, ammonia and hydrogen are apparent. A key issue in this regard is the uncertainty about the availability of these sustainable energy carriers in the near future. Dredging equipment that regularly returns to the same place or port is easier to make sustainable than equipment that spends weeks at sea. Given the size of seagoing equipment, large investments are needed to achieve sustainability. According to contractors, the scale of these investments and the associated risks make it difficult to bear them entirely by themselves. Pilots are therefore needed in the early stages to gain experience. In the seagoing market, international developments are also important because this equipment is also used in an international setting.

For inland dredging equipment, there are developments towards electrification, including for stationary vessels. However, this often still faces significant challenges as the electricity supply required for this is often not yet available in rural areas where dredging takes place. Inland dredging equipment is smaller and requires less investment. This makes it relatively easier to apply innovations. However, there are also uncertainties and risks here. The high degree of fragmentation among both clients and contractors, for instance, hinders the pace of sustainability. Due to the many clients in this domain, there are many differences in tendering methodology and the extent to which sustainability is given a role in awarding tenders. As a result, the level at which dredging equipment can be used elsewhere is not always clear in advance.

Intensive cooperation between actors needed to achieve sustainability
To achieve sustainability in dredging activities, different actors are important for the saltwater and freshwater domains. Primarily, in the case of saltwater dredging, this involves the clients in this domain, namely Rijkswaterstaat and the major port authorities. Further, the larger international concerns play an important role in this field and, finally, cooperation with industry is important. Together, pilots will have to be launched to ensure sustainability within this domain. It makes sense to expand this cooperation with the governments of our neighbouring countries, which have a similar task with saltwater dredging and call on the same capacity in the market. Policy-making at the European level provides further support for these developments.

Freshwater dredging involves a larger number of clients. Through partnerships such as the Buyer Group Sustainable Dredging, experiences can be exchanged, increasing the probability of realising greater uniformity in requirements. Greater uniformity gives companies a better understanding of the overall policy and provides guidance for investing in sustainability. These companies could also be more involved in this to indicate what they are and are not capable of and in what time frame.

Issues to consider when tendering and drafting contracts
From discussions with various companies a number of concerns emerge about the choices faced when drafting a contract and tendering. For instance, there is a desire from dredging companies for consistent policies and a clear direction for the future. The roadmap can play an important role here. Additionally, the ECI appears to be a useful tool and is generally recognised as such by the market. However, market participants do question whether the current design always achieves the intended goal. Further, the degree of distinctiveness is a point of concern so tenders are not just awarded on the basis of lowest price. At the water boards, it is also important that multi-year contracts are put out to tender and fewer separate specifications are used. This gives dredging companies a clearer view of continuity. Finally, parties are positive about constructions where extensions are given on a contract when more sustainability is applied during the contract period.

Matching supply and demand
In the coming period, there is clearly a transition phase and it will not be possible to make all dredging equipment fully sustainable in the short term. If all clients increase their requirements sharply at the same time, it will be economically difficult to still make good use of the old dredging equipment. Additionally, the technical capacity, for example in the industry, seems insufficient to make all current dredging equipment sustainable at once. In the saltwater dredging market, there are a limited number of players operating in the Dutch market and these players are very active internationally. These players will not be able to make all their dredging equipment sustainable over the short term and at the same time use their dredging equipment efficiently abroad. Since Rijkswaterstaat wants to tender as sustainably as possible, it is important to ensure that sufficient sustainable dredging equipment is available. This is possible by informing the market in good time what type of work will be tendered and when, combined with indicating sustainability requirements. In that way, parties in the market can estimate their required commitment, although here companies still depend on the outcome of the tender. Keeping the market well informed helps to prevent the number of companies with dredging equipment available from being very limited.

Further research needed to assess impact of transition
This study identified the key players and some of the trade-offs. An interesting next step would be to identify the impact of the transition based on technical capabilities. Two aspects come to mind here:

- **Impact on investments for companies and costs for clients**
  Depending on technical developments and trends in dredging equipment and fuel costs, the implications for necessary investments by companies can be identified. This could include looking at the composition of the dredging equipment fleet and the remaining lifespan. This analysis establishes a link to the amount of CO_2 avoided and provides insight into the cost-effectiveness of sustainability measures. For freshwater hydraulic engineering, this has been taken a step forward by TNO on behalf of the Vereniging van Waterbouwers (Association of Hydraulic Engineers).[3]

[3] TNO (2022). Exploring sustainability options of freshwater hydraulic engineering fleet. Delft / The Hague.

- **Impact of cooperation in policy, both national and international**

  What effect does policy coordination at the national level – such as between Rijkswaterstaat and water boards – have on the pace of sustainability and cost development? This route is interesting for making domestic dredging equipment more sustainable. Similarly, cooperation at the international level may affect the pace and cost of the transition. This is especially true for seagoing dredging equipment.

1 Introduction and background

1.1 Motivation

The government aims to achieve Carbon Neutral and Circular Infrastructure (KCI) by 2030. Rijkswaterstaat is developing transition paths for four policy areas to achieve this objective in the coming period. One of the transition paths concerns 'Coastline Management and Fairway Maintenance' (KLZ/VGO). The aim of the transition is for coastline management and fairway maintenance to be carbon neutral and circular by 2030 in the networks Rijkswaterstaat manages.

Rijkswaterstaat is currently working on a roadmap for this transition. Rijkswaterstaat approached the EIB with a request to provide insight into the market size of KLZ/VGO work. This involves dredging activities on both open water and inland water. Rijkswaterstaat is keen to understand its stake in the various areas of the hydraulic-engineering market and how this position compares with that of other major clients, including decentralised authorities and port authorities. Additionally, Rijkswaterstaat is keen to understand the factors important to achieving sustainability in the sector.

1.2 Formulating the question

Rijkswaterstaat's information needs concern three aspects:

1. In euro terms, what are the revenues of Rijkswaterstaat in the key domains and what volume of greenhouse gases are emitted in the process? This concerns both the state of play in 2020 and an exploration of the development until 2030.

2. What are the dredging market's revenues in the Netherlands/Europe/worldwide and what volume of greenhouse gases are emitted in the process? In the Netherlands, in addition to Rijkswaterstaat, this includes other clients for this type of works, such as water boards and port authorities, as well as possibly provincial and municipal authorities. Again, this concerns the current situation and developments up to 2030.

3. What is the market share of the Netherlands in the revenues of companies operating in the Netherlands?

1.3 Delineation and classification by domains

Dredging involves several types of activities. We distinguish three main categories:
- Coastline management
- Saltwater fairway maintenance and ports
- Freshwater fairway maintenance

Apart from this, other types of activities such as environmental dredging exist but generally this often seems to be of a limited extent or is not seen as a separate category. Other hydraulic-engineering activities, such as structural work and sand extraction, are not included.

1.4 Actors in the market

We distinguish four main types of actors in the market, each of which has its own role in developments. Each of these types is characterised by a relatively high diversity, both in size and numbers and regional coverage. In different domains, the weight of the different actors may vary. These are the following types of actors:

- Clients[4]
    - Rijkswaterstaat
    - Water boards
    - Municipal and provincial authorities
    - Port authorities
    - Private sector / project development
- Hydraulic engineering enterprises
    - Major international groups
    - Medium-sized enterprises, partly international
    - Small, regional enterprises
- Industry and energy
    - Shipyards
    - Manufacturers
    - Energy suppliers
- Governmental authorities
    - European government
    - National government
    - Regional government

[4] Activities such as sea sand extraction and inland raw material extraction are not within the domain of this roadmap. Some market parties also carry out this type of activity (as project developers) in addition to KLZ/VGO, and interesting developments with regard to the energy transition may also occur here.

2 Investments in the Netherlands

2.1 Introduction

In this section, we look at the scale of investment in 2020 and trends up to 2030. The dredging market is defined here in a narrow sense. In practice, dredging is sometimes combined with other activities such as structural hydraulic engineering, shore-based bank protection works or sand extraction. For this additional work, similar dredging equipment to that used for dredging is regularly deployed. This also largely involves the same companies that are active in dredging itself. The market volume in these 'adjacent' markets has not been explicitly mapped, but indicatively it may be as large as the dredging market in the narrow sense.

The focus of this section is on the main clients for dredging activities, namely Rijkswaterstaat and the water boards. We also briefly discuss other asset managers such as provincial and municipal level authorities and port authorities. In Section 2.2, we describe the market situation in 2020, the base year for our analysis. Section 2.3 summarises the main policy issues with potential impacts on dredging expenditure in the period to 2030.

2.2 Current situation 2020

2.2.1 Rijkswaterstaat

Rijkswaterstaat is dominant client for saltwater dredging work
Within the Netherlands, Rijkswaterstaat is the only client in the coastline management domain. This work involves, for example, beach replenishment and foreshore replenishment both around the Wadden Islands and along the rest of the coastline. An average of 12 million m^3 of sand is being replenished.[5] The tendered volume is around €50 million per year.

Additionally, Rijkswaterstaat tenders saltwater fairway maintenance. Some of this work is tendered in cooperation with port authorities, as work in the port is related to the adjacent fairways. The working scope of these costs is estimated at €40 million a year.

Rijkswaterstaat less dominant client in freshwater fairway maintenance
Finally, Rijkswaterstaat is active in freshwater dredging, where it is responsible for maintaining the profile of the larger canals, rivers and waterways. The average investment is around €30 million per year.

This brings Rijkswaterstaat's total expenditure on dredging to around €120 million a year.

2.2.2 Water boards

Water boards' responsibilities include managing regional water systems. This includes maintenance of the freshwater waterways. The Dutch Association of Water Boards' Waves Database maintains data on the work of water boards.[6] This includes costs for dredging watercourses and remediating water beds. In 2020, the total cost of water boards for this work was around €85 million. These costs should be seen bearing in mind that not all dredging is carried out from the water but partly from the shore. However, this distinction has not been further mapped.

[5] Rijkswaterstaat. Referenced at: https://www.rijkswaterstaat.nl/water/waterbeheer/bescherming-tegen-het- water/maatregelen-om-overstromingen-te-voorkomen/kustonderhoud/doelen-en-resultaten.

[6] Dutch Association of Water Boards. WAVES databank.

Among water boards, a slight downward trend seems to be visible: in the period 2011–2015, these costs ranged between €90 million and €105 million per year. In this regard, there are large differences in the extent of dredging activities between water boards. For most water boards, dredging costs a maximum of several million euros a year. Some water boards have a larger management area, such as Hollandse Delta, Rijnland and Rivierenland, and therefore also have larger investments in dredging.

2.2.3 Other authorities

For other authorities, no comprehensive survey of the annual size of the dredging market has taken place. The following are some indications.

Port authorities
Besides Rijkswaterstaat and the water boards, port authorities are key players in the dredging market. We estimate the size of this dredging market at €35 million a year. The most important port in this is Rotterdam. The Port of Rotterdam authority tends to work together with Rijkswaterstaat for fairway maintenance. Other ports include Delfzijl and Amsterdam. The size of this market involves both maintenance and investment. According to the Port of Rotterdam authority, annual investments can fluctuate widely and depend on specific projects around port relocation, expansion or deepening. Maintenance expenditure has a more continuous trend.

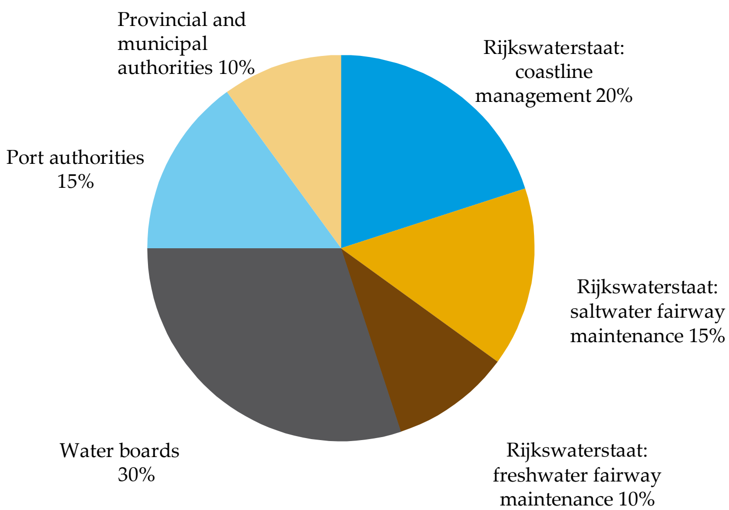
Provincial and municipal authorities
Additionally, provincial and municipal authorities also play a role in this market. The size of the dredging market of provinces and municipalities cannot be accurately indicated on the basis of public data. The distinction between dredging and other work is not always delineated specifically. Besides that, it is difficult to make such an inventory given the large number of municipalities.

We estimate the size of this market similar to that of the port authorities, possibly slightly smaller. It should be borne in mind that for smaller fairways, work is not always carried out with vessels but from shore. This work is not part of the target group of the relevant roadmap.

2.2.4 Estimate of total dredging market

The total size of the dredging market is estimated at €275 million for 2020 based on the above amounts among the various clients. Figure 2.1 gives an indication of the market breakdown. Rijkswaterstaat's share of the total dredging market is around 45%. In the saltwater dredging market, this share is relatively large and ports are active as well; in the freshwater dredging market the Rijkswaterstaat share is around 15%. The role of Rijkswaterstaat in the two different sub-markets is therefore very different.

Figure 2.1 **Indicative market breakdown KLZ/VGO in 2020 by type of client (and activity for Rijkswaterstaat)**



Source: UVW, Rijkswaterstaat, interviews, EIB

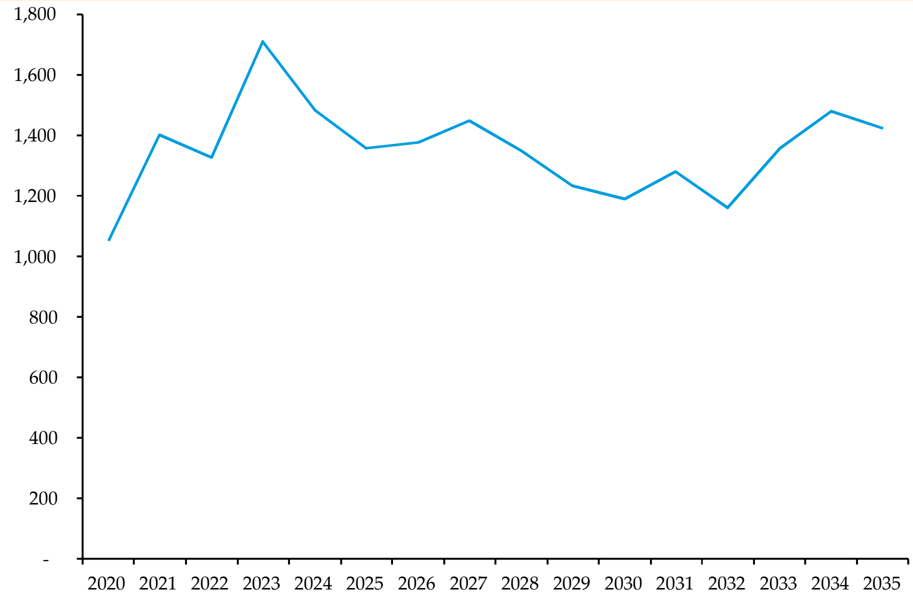
2.3 Developments in the dredging market until 2030

More frequent high water due to climate change
Towards 2030, a number of developments are important for production in the dredging market. First, due to climate change, relatively more frequent high water plays an important role. This has potential implications for the dredging market, although these implications have not been identified in this study. While sea levels will gradually rise, the impact on other waters such as rivers are more uncertain. Figure 2.2 shows the resources of the Delta Programme. Although this programme covers the whole spectrum of hydraulic engineering activities and thus includes more than just dredging, the figure indicates that the available budgets are fairly constant.

Offshore a key market
Another key driver is offshore energy production, such as wind farms. Companies indicated during interviews that this sector has become more important in recent years and that this will continue in the future.

Global developments in trade, tourism and urbanisation important
First, the global market for hydraulic engineering is linked to developments in global trade. In recent years, increasingly larger vessels have been used, requiring not only maintenance of waterways but also capacity increases such as deepening. Urbanisation and tourism are also drivers. Expanding tourist facilities and urban infrastructure is running into spatial limits in some countries in Asia, for example. However, the financial scale of these developments towards 2030 is currently difficult to pinpoint, also given the uncertain geopolitical situation.

Figure 2.2 Annual budgets available for the Delta Programme, 2020–2035 (mln euros)



Source: Deltafonds

Important role for speed of sustainability and budgets

Another important factor for development up to 2030 is the energy transition. Making dredging equipment more sustainable may lead to higher costs through investment in new, more expensive dredging equipment and to compensate for accelerated depreciation of old equipment. Additionally, there is a lot of uncertainty regarding the development of fuel prices, of both diesel and renewable alternatives. Currently, many renewable fuels still seem to be more expensive than diesel. However, the scope for sustainability depends heavily on the clients' available budgets and the importance given to it during tenders. With fixed budgets, sustainability may imply that physically less dredging volume can be processed.

Furthermore, spatial development may also play a role. One example is the relocation of businesses within the Port of Rotterdam to newer sites requiring the construction of harbour basins. Potential delays due to PFAS issues also play a role. Finally, in terms of asset management and digitalisation, smarter dredging innovations are becoming more visible.

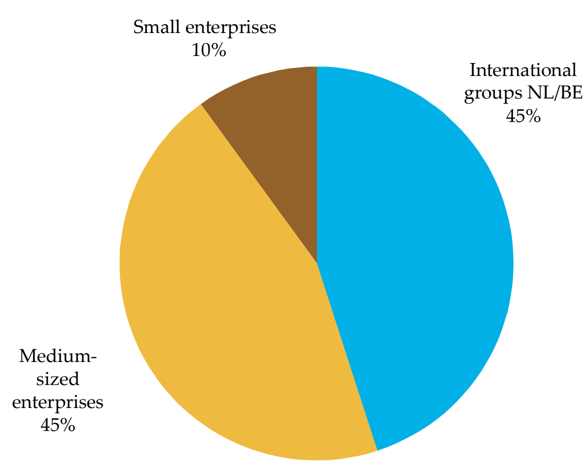
3 Hydraulic engineering fleet and emissions

In this section, we look at the market side of the dredging sector. First, we describe the supply structure of dredging companies. We then discuss the fleet used in dredging operations and, finally, the CO_2 emissions released during these operations.

3.1 Supply structure hydraulic engineering companies

Supply side of dredging companies highly differentiated
Firstly, the supply side of dredging companies in the Dutch market has four major international players. These companies depend on the global market for much of their sales. Furthermore, the supply side has a relatively high number of small, regional dredging companies. These companies are more focused on smaller projects, such as from water boards and provincial and municipal authorities. Finally, a number of medium-sized companies are active with a focus on the Netherlands but that are also active in a number of surrounding countries. The distribution of the dredging market by these three types of companies is shown indicatively in Figure 3.1.

Figure 3.1 Indicative market breakdown KLZ/VGO by company type, 2020



Source: Annual reports, edited EIB

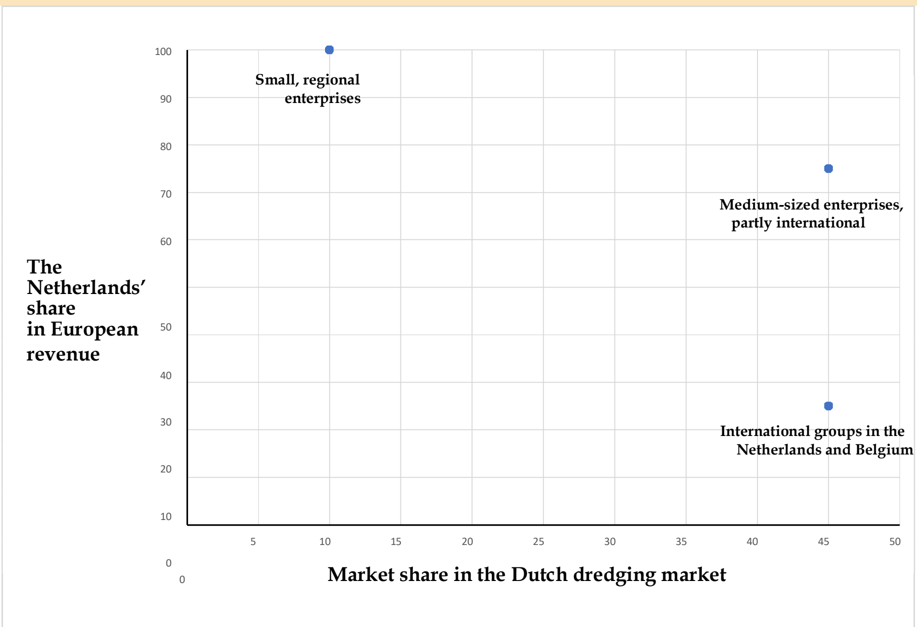
Four big concerns get most of their sales from abroad
The four major groups are Dutch companies Boskalis and Van Oord, and Belgian companies Jan de Nul and DEME. In the Netherlands, these enterprises are mainly active in the larger projects such as coastline management, ports and large saltwater fairways, and thus mainly work for Rijkswaterstaat and port authorities. They carry out dredging on fresh waters to a lesser extent. They do have shore-based activities but these involve dredging to a lesser extent and rather include tasks like dyke reinforcement. Although the big groups dominate the Dutch market, the Dutch market

constitutes a relatively small part of their total European revenues. This is shown in Figure 3.2 where the horizontal axis shows the market share in the Dutch dredging market and the vertical axis shows the proportion of the company's revenues achieved in the Netherlands compared to European revenues.

Among major companies, however, the importance of the Dutch market still varies significantly. Among major Dutch enterprises, shares are substantial. Among foreign enterprises, the Netherlands' share is harder to estimate, but it will be significantly lower. Furthermore, these shares seem to change over time due to dependencies on projects being tendered and the course of these tenders.

Medium and small enterprises focus on the Netherlands
Medium-sized hydraulic engineering enterprises derive an estimated 75% of their turnover from operations in Europe. The focus of enterprises in this segment changes and depends on their fleet. Some enterprises mainly operate within the larger Dutch works relating to coastline management or ports. Other enterprises have smaller dredging equipment as well with which they also carry out more inland work. These enterprises do not operate exclusively in the Netherlands but to varying degrees also work in Germany and other European countries. The smaller enterprises operate almost exclusively in the Netherlands. They mainly work for water boards and also carry out works for municipal authorities, for example.

Figure 3.2 The Netherlands' share in European revenues of dredging companies, 2020



Source: Annual reports, edited EIB

3.2 Fleet

When deploying by type of dredging equipment, it is important to distinguish between the type of work. Below, we describe the deployment of dredging equipment for saltwater hydraulic engineering and for freshwater hydraulic engineering.

3.2.1 Saltwater hydraulic engineering

In coastline management and saltwater fairway maintenance, relatively large dredging equipment is active. Important types of dredging equipment include (trailing) suction hopper dredgers, cutter suction dredgers, grab (hopper) dredgers and water-injection dredgers. Vessels deployed mainly for ports, coastline management and large saltwater fairways are often too large for inland work.

Uncertainty regarding best technology for sustainability
Interviews show that there is still uncertainty about the 'best' solution for making large ships more sustainable. Potential solutions include bio-LNG, hydrogen, methanol and ammonia. This involves several trade-offs. First, with the alternative fuel, the ship must still have sufficient power. Dredgers also distinguish themselves in this regard from other large vessels such as container ships. Container ships require more constant power while dredging operations require high peak power. Safety is also important, for example in the area of toxicity, explosiveness or in working with high pressure. Furthermore, it is important to look at the implications for ship design. Some fuels have a low energy density or need to be stored very cold, making this less attractive. Finally, the availability of fuel in sufficient locations is important. With seagoing dredging equipment, alternative energy supply is difficult because ships sometimes do not come ashore for several weeks.

3.2.2 Freshwater hydraulic engineering

TNO has mapped the freshwater hydraulic engineering fleet in previous research (Table 3.1).[7] In terms of numbers, push vessels are the most important dredging equipment. It should be noted that not all freshwater dredging is carried out from the water. In narrow ditches, managed by water boards for example, cranes sometimes work from the shore. This dredging equipment is beyond the scope of this transition path.

Table 3.1 Freshwater hydraulic engineering fleet

Type	Quantity	Ktonnes CO_2-eq per year	Tonnes NO_x emissions per year	Tonnes PM_{10} per year
Suction dredger (stationary)	46	21	162	5.1
Cutter suction dredger stationary/mobile	23	4	35	1.0
Suction hopper dredger	10	9	89	2.4
Bucket suction dredger	6	2	22	0.5
Grab (hopper) dredger	41	17	135	3.6
Silt pusher	14	0	1	0.0
Piling barge	19	7	32	0.9
Auxiliary equipment (support)	32	2	22	0.7
Hopper barge	34	13	116	3.1
Push vessel	269	1	6	0.2
Other vessels	120	1	15	0.5
Total	**614**	**76**	**634**	**18**

Source: TNO

[7] TNO (2022). Exploring sustainability options of freshwater hydraulic engineering fleet. Delft / The Hague.

First electric dredging equipment available
For inland dredging equipment, there are developments towards electrification, including for stationary vessels. This often still has significant challenges as the electricity supply required for this is often not yet available in rural areas where dredging takes place. If this facility is not available, it means working with a (diesel) generator, for example, or regularly transporting batteries to an electricity supply.

Inland dredging equipment is smaller and requires less investment. This makes it relatively easier to apply innovations. However, there is also a financial mark-up for electrical dredging equipment and uncertainties and risks exist here too. Due to the many clients in this domain, there are many differences in tendering methodology and the extent to which sustainability is given a role in awarding tenders. As a result, the level at which dredging equipment can be used elsewhere is not always clear in advance. Additionally, there seems to be a challenge for the very small dredging equipment. These ships are so small that no battery will actually fit on them. This requires working with power connectors that are not always available. Finally, power requirements are also a bottleneck for certain types of equipment.

3.3 CO_2 emissions

CO_2 emissions from freshwater hydraulic engineering fleet estimated at 76 Ktonnes CO_2 per year
In previous research, TNO mapped the CO_2 emissions of the entire freshwater hydraulic engineering fleet (Table 3.1). It is estimated that this part of the fleet emits about 76 Ktonnes of CO_2 per year. However, this comprises more than just dredging as other work is also carried out with this fleet. The focus of these emissions is on four types of equipment, namely suction dredgers, grab (hopper) dredgers, hopper barges and hopper dredgers.

According to the Waves database, CO_2 emissions from outsourced water system maintenance by water boards was 38 Ktonnes CO_2 in 2020.[8] This covers part of the work where the freshwater hydraulic engineering fleet operates and therefore overlaps with TNO's estimate. Furthermore, these CO_2 emissions are also broader than just dredging because it involves the entire water system. Finally, there are also water boards that carry out work themselves, placing it outside the scope of CO_2 emissions from outsourced maintenance.

CO_2 emissions from saltwater fleet not yet fully mapped
CO_2 emissions from coastline management are estimated by Rijkswaterstaat to be about half as much as the total emissions of the freshwater fleet, at 37.9 Ktonnes. CO_2 emissions from other saltwater activities have not yet been mapped.

3.4 Considerations for sustainability

Large proportion of particulate matter and nitrogen emissions avoidable
Enterprises indicate that much of the particulate matter and nitrogen emissions can be reduced by currently available systems. For nitrogen, an SCR system can be installed and filters exist for particulate matter. This does require additional investment.

Choices in tendering and contracting important for sustainability
Companies indicate that the tendering process and the choices made in contracts are of great importance. For example, the higher investments are difficult to make for a short-term contract because it is often uncertain whether this dredging equipment can be used elsewhere. However, the payback period also depends on equipment utilisation rates.

It is also important that, if the ECI is used, it creates a sufficient distinction. Parties in the market indicate that sometimes scores are so close that the lowest price is still awarded. Also, according to market participants, the notional discount is not always proportional to the project.

[8] Dutch Association of Water Boards. WAVES databank.

Acquisition costs of sustainable dredging equipment are significantly higher but operational costs are also higher. An alternative would be to prescribe a certain level of sustainability as a client.

It is also important that tenders are announced on time. If dredging equipment needs to be converted or purchased, there should be sufficient time to do so. If the timing of the tender is too close to implementation, there is insufficient time to have the sustainable equipment readied for deployment.

Enterprises are generally positive about extending a contract when there is a concrete sustainability plan. This also seems like an opportunity to create sufficient time between tendering and implementation. In this case, the contract can be designed so that sustainability requirements are tightened over the years, encouraging the use of more sustainable dredging equipment later in the contract.

Long lifespan complicates investment decisions

A feature of much of the dredging equipment is that it has a relatively long lifespan. The technical lifetime is 25 to 30 years on average. Interviews show that especially in smaller enterprises, dredging equipment is used for longer periods of time. On the other hand, sections of ships are often replaced in the meantime. Combined with the uncertainties surrounding long-term opportunities for sustainability, this long lifespan makes investment decisions difficult. This means, for example, that if an investment is made in an intermediate solution now, it will not be written off in 2030.

Companies handle this differently. On the one hand, small enterprises have a smaller fleet and it is a challenge to make the right choices now for 30 years in the future. Depending on the type of equipment, for example, an intermediate solution is chosen. This may achieve a good score in tenders now but may put the enterprise behind again in a few years.

Larger enterprises have ships built more frequently and it may be easier for them to swap these ships globally. They may also have greater investment capacity. On the other hand, these ships should not only be deployable in the Netherlands but should also be competitive in other countries and/or continents.

Difference in short- and long-term opportunities

In the short term, running ships entirely on alternative fuels may not yet seem possible. This depends on developments in engines from industry and the availability of alternative fuels. For example, to deal with uncertainty about fuel availability, dual-fuel engines can be chosen. These can run on bio-LNG as well as conventional fuels. There also seems to be some kind of modular option. This takes into account converting a ship, during its construction, for alternative fuel in the future. In this respect it is already necessary, for example, to make space for pipes needed at a later date.

Industry plays a key role in sustainability developments

Besides clients and dredging companies, key players for making the sector more sustainable are shipyards and engine manufacturers. These two types of industry players do not operate exclusively for the dredging market but also for sectors such as container shipping and offshore, especially in regions outside the Netherlands. Container ships require more constant and lower power while dredgers require higher (peak) power. Given the vast difference in this, specific innovations for sustainability are needed.

However, dredging equipment is only a very small market for the industry. Dredging companies indicate that they tend to cooperate with shipyards and manufacturers in developments towards sustainability. For example, in an innovation partnership with Rijkswaterstaat, IHC is developing a

LEAF (low energy adaptive fuel) hopper that will be powered by hydrogen[9] and collaborates in MENENS (methanol as an energy step towards zero-emission shipping) with 22 companies from the Dutch maritime sector.[10] Dredging equipment development, from design to realisation, takes a relatively large number of years.

Given the size of seagoing dredging equipment, large investments are needed to achieve sustainability. In the early stages, pilot projects are needed to gain experience. Given the scale of these investments, contractors say it is difficult to bear these investments and risks themselves.

Seagoing dredging equipment also deployed abroad
The large, seagoing dredging equipment is often used by the big companies not only in the Netherlands but also in other countries. As a result, developments are also important at an international scale. If these developments lag behind Dutch developments, this constitutes a bottleneck: a sustainable ship is often uncompetitive if this aspect is not taken into consideration when tenders are awarded. These international developments are described in greater detail in the next section.

Additionally, dredging equipment that regularly returns to the same place or port is easier to make sustainable than equipment that spends weeks at sea. This is due to the fact that most alternative fuels have a lower energy density. And that has an impact on ship design: either more frequent refuelling is required or a larger part of the ship must be reserved for fuel storage.

Highly divergent routes to sustainability of seagoing and inland dredging equipment
Trends towards cleaner blends of fuels are visible across the dredging fleet. However, for further sustainability, there is an important distinction between opportunities for seagoing and inland dredging equipment as also described in earlier sections.

Given the differences between the two domains, it seems sensible to pursue different routes. These differences relate not only to sustainability options and costs, but also to the speed at which greater sustainability can be achieved. Finally, it is also important to be aware of the different actors operating within the domains. Various forms of development and cooperation will have to be found for the seagoing and inland fleets, respectively.

9 Royal IHC (March 2021). Referenced at https://www.royalihc.com/news/royal-ihc-receives-approval-principle- hydrogen-fuelled-tshd.

10 Martiemmedia (December 2021). Referenced at https://maritiemmedia.nl/miljoenen-voor-project-menens-vanuit-rd-mobiliteitsfonds/.

4 Policy developments related to emissions

In this section, we discuss policy developments related to emissions. First, we describe what key developments we see among clients in terms of procurement policy. This includes, for example, national policies such as the Climate Agreement. We then describe the importance of the international market and describe policy developments at the international level, such as the Fit-for-55 package.

4.1 Domestic developments, requirements of clients

Carbon neutral and energy neutral as objectives
The Climate Agreement states that governments aim to ensure as much carbon neutral and circular procurement as possible by 2030.[11] The Ministry of Infrastructure and Water Management therefore asked Rijkswaterstaat to come up with a roadmap to become carbon neutral and circular.

Not only is Rijkswaterstaat working towards these goals, but water boards too are committed to achieving sustainability. In 2019, for instance, the water boards were already 40% self-sufficient in sustainable energy production and the goal is to continue this further to energy neutrality by 2025.[12]

Other targets within the Climate Agreement include the package of measures to reduce emissions from mobile tools by 30% (0.4 Mtonnes). It was also included within the Green Deal for shipping, inland navigation and ports that the inland navigation sector aims to achieve a 0.4 Mtonnes reduction by 2030.

Buyer Group Sustainable Dredging to share experiences between clients
The Buyer Group has been established specifically in the context of dredging. Since January 2022, public clients have been working together in this to make dredging more sustainable. Current participants include Rijkswaterstaat along with a number of water boards and provincial authorities. The aim is also to organise a market dialogue and, in time, share knowledge and experience gained with other companies.

Targets and policies on nitrogen and particulate matter as well
Besides policies and measures to reduce CO_2 emissions, there are also targets to reduce other emissions, including nitrogen and particulate matter. The Clean Air Agreement, for instance, agreed to reduce emissions of pollutants from inland navigation by at least 35% by 2035 compared to 2015.[13] For the mobile machinery sub-sector, the target is to reduce the negative health impacts of NO_2 and particulate matter from mobile machinery by at least 75% by 2030 compared to 2016. The latter is relevant for both the dry and mobile equipment of hydraulic engineers.

Smarter dredging is also being investigated
Besides developments to dredge more sustainably, there are also developments to dredge less and/or smarter. For example, the water-injection technique can be used to move dredged material to deeper sections of fairways. This requires less capacity. However, it is not possible everywhere. Additionally, the use of natural currents for sediment dispersal is being investigated, as are ways to reduce silting-up. The potential of these developments is not yet clear. It makes sense to monitor the applicability of these alternatives as they have a direct impact on emissions.

11 Rijksoverheid (2019). Climate Agreement.

12 Association of Water Boards (2021). Referenced at https://unievanwaterschappen.nl/10-jaar-klimaatmonitor-waterschappen-succesvol-verduurzamen/.

13 Rijksoverheid (2020). Clean Air Agreement.

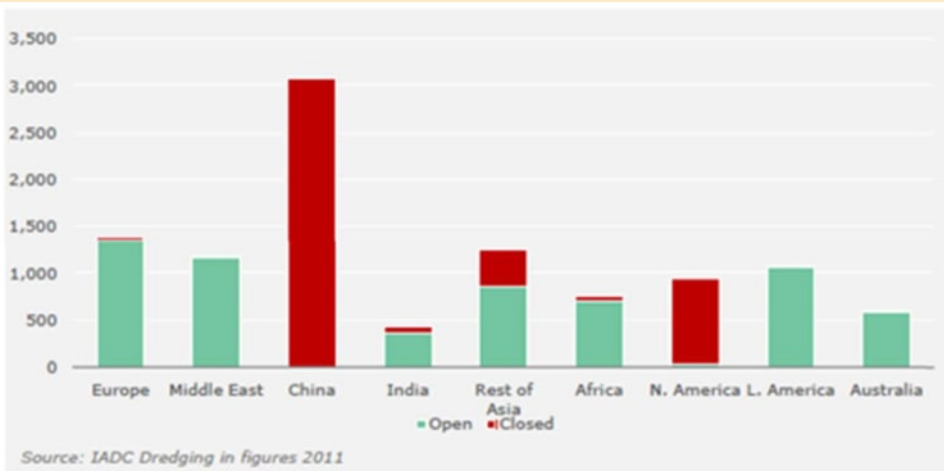
Companies see ambitious targets in the Netherlands
Companies indicate that Rijkswaterstaat is leading the way with ambitious targets. The big port authorities often work closely with Rijkswaterstaat and also often follow a similar route. There are also many positive developments among water boards, according to companies. Here, tenders are increasingly being put out with a focus on sustainability, for example through an ECI or through a possible extension of the contract in case of a concrete plan for sustainability. However, differences still exist between water boards.

4.2 Investments in Europe / globally

Total open dredging market about €5 billion in recent years
The International Association of Dredging Companies (IADC) estimated the dredging market's revenues for 2020 at €4.86 billion.[14] This is slightly lower than in 2019 when sales were around €5.2 billion. However, the IADC does not publish information on closed markets such as China and the US. It also excludes projects that are not internationally tendered.

In 2013, a study of the dredging market by Rabobank included an indication of the size of the global dredging market (Figure 4.1).[15] The total dredging market in 2011 was estimated at €10.7 billion at the time. This includes closed markets such as China and North America. Overall, the open market covered about 57% of the total market, amounting to about €6.1 billion.

Figure 4.1 Geographic distribution of dredging market, 2011 (mln euros)



Source: Rabobank

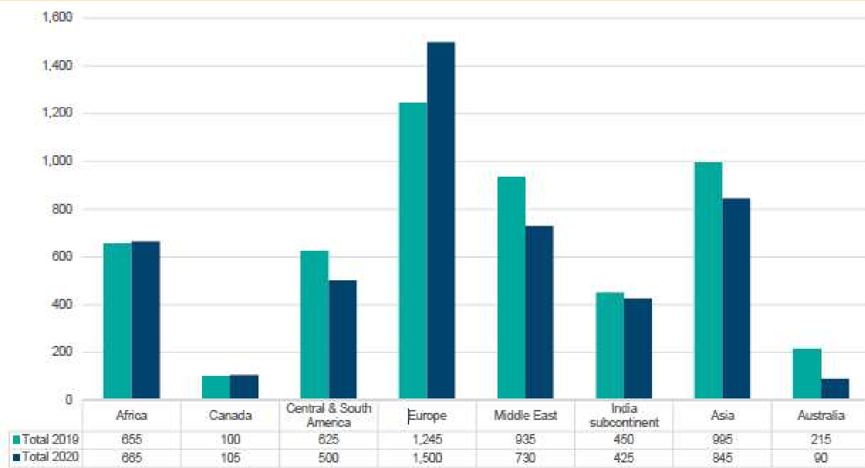
14 IADC (2021). Dredging in figures 2020.

15 Rabobank (September 2013). Dredging.

European market about €1.4 billion
Both in 2011 and averaged over 2019 and 2020, revenues of the European dredging market were around €1.4 billion. This makes Europe an important market with about 23% of the global market in 2019 and 30% of the global market in 2020 (Figure 4.2).

International market also affects investment decisions
The major players operating in the saltwater market not only operate in the Netherlands but also in other parts of Europe and the world. The above analysis suggests that the Dutch market represents only a limited part of total demand. As a result, developments at the international level also influence investment decisions of large dredging companies. This also affects the phasing of sustainability in the Netherlands.

Figure 4.2 Annual revenues of dredging market, 2019 and 2020 (mln euros)



A comparison of annual turnover from 2019 and 2020 according to geographical area.
Source: IADC member companies

Source: IADC

4.3 International policy developments

The Netherlands leads the way in sustainable dredging policy
Discussions with clients and infrastructure companies suggest that the Netherlands is ahead of other European countries in sustainable dredging. The Netherlands exceeds sustainability ambitions and Dutch clients, for example, tender relatively frequently on the basis of an ECI. Other European countries are seeing an increasing focus on sustainable dredging, partly in line with policy developments from the European Commission. Outside Europe, this focus is still very limited.

Emissions from European dredging companies fall sharply between 2008 and 2018

Emissions from European dredging companies (EuDA members) in 2008 were about 3.4 Mtonnes CO_2. Emissions from European dredgers fell to 2.7 Mtonnes in 2014. In 2015, these emissions increased again to 3 Mtonnes, mainly due to an increase in activities that can be linked to the expansion of the Panama and Suez Canal.

After this, emissions fell again to around 2.1 Mtonnes in 2018.[16] This involves total emissions and does not yet provide insight into emissions per work carried out.

Below, we describe the main developments for European and global dredging policy in the coming years.

IMO

In 2018, the International Maritime Organisation (IMO) has set itself three targets on reducing greenhouse gas emissions for the international shipping industry:

1. At least 40% reduction in CO_2 emissions by 2030 and further efforts for a 70% reduction by 2050, both compared to 2008 levels.
2. Reduce peak greenhouse gas emissions from international shipping by at least 50% compared to 2008.
3. Reducing CO_2 emissions by implementing further phases of the 'Energy Efficiency Design Index' (EEDI) for new ships.[17]

An example of measures IMO is taking to achieve this is, for example, the obligation since 2019 to monitor data on fuel use. This data should help member states make further decisions on improving energy efficiency.

Fit-for-55 accelerates greater sustainability within Europe, but implications for dredging sector not entirely clear

The European Commission introduced a 'Fit-for-55' package in 2021. The objective here is to reduce greenhouse gases by 55% compared to 1990. The package consists of strengthening existing legislation and new initiatives. Examples of measures include extending the Emissions Trading System (ETS) to the maritime sector. This means a cap on the total amount of emissions for which rights are tradeable. Furthermore, the package includes proposed regulations to set mandatory targets for the deployment of alternative fuel infrastructure and to adjust energy taxes so that the most polluting types of energy are also taxed the most.

It is important to note here that the dredging sector is not always explicitly mentioned and sometimes not (yet) included. For instance, the ETS builds on a monitoring system (Monitoring, Reporting and Verification (MRV)) that has been in place since 2015, which at the time chose to exclude the dredging sector. The reason was that regulations in the dredging sector can be better used on the project than on ships as these ships are used on different projects with many different conditions and requirements affecting energy efficiency. As a result, the workload of the vessel and the expected CO_2 emissions involved could be better estimated when tendering for projects than at the equipment level.[18]

[16] EuDA (November 2020). Policy paper on dredging decarbonisation.

[17] IMO (2018). Note by the International Maritime Organization to the UNFCCC Talanoa Dialogue.

[18] EUDA (November 2020). Position paper on decarbonisation of dredging projects.

5 Starting point for policy actions

In this chapter, we outline policy actions and the role that different companies may have in them. These policy actions are aimed at developing an action perspective based on the roadmap. A key point is that the routes towards greater sustainability vary widely between seagoing and inland dredging equipment. The involvement of key actors also varies in this respect. Importantly, intensive cooperation between actors is needed to achieve sustainability.

Cooperation in the Netherlands for freshwater dredging
Freshwater dredging involves the following types of actors:

- Clients: water boards, Rijkswaterstaat, municipal, provincial and port authorities;
- Hydraulic-engineering companies: mostly small, regional companies and some medium-sized enterprises;
- Industry: shipbuilders, manufacturers and energy suppliers.

In freshwater dredging, market parties are relatively often smaller and often operate exclusively in the Dutch market. As a result, the role of Dutch clients is significant. Through partnerships such as the Buyer Group Sustainable Dredging, experiences can be exchanged, increasing the probability of realising greater uniformity in requirements. Greater uniformity gives market parties a better understanding of the overall policy and provides guidance for investing in sustainability. The companies could also be more involved in this to indicate what they are and are not capable of and in what time frame.

Cooperation with international players also key to saltwater dredging market
Saltwater dredging involves the following types of actors:

- Clients: Rijkswaterstaat, port authorities and foreign coastal authorities;
- Hydraulic-engineering companies: mainly a small number of large, international players, and some medium-sized players;
- Industry: shipbuilders, manufacturers and energy suppliers.

Initial pilot projects exist within the Netherlands to kick-start innovations for seagoing dredging equipment. Industry plays a major role here. Pilots seem useful given the large investments, long depreciation periods and uncertainty about being able to use equipment elsewhere.

Given the international activities of companies, however, it is not only Dutch clients that are affected in the saltwater dredging market. Companies indicate that sustainable dredging equipment is often not yet competitive abroad. So this is also where international coastal and port authorities have a role to play in bringing about greater sustainability. It makes sense to expand this cooperation with the governments of our neighbouring countries, which have a similar task with saltwater dredging and call on the same capacity in the market.

Issues to consider when tendering and drafting contracts
From discussions with various companies, a number of concerns emerge about the choices faced when drafting a contract and tendering:

- There is a desire for consistent policy. Methods of tendering still vary relatively widely, making it difficult to make investment decisions on this basis.
- A clear direction for the transition to future sustainability is desired. The roadmap can play an important role here.
- At the water boards, it is important that multi-year contracts are put out to tender and fewer separate specifications are used. This gives dredging companies a clearer view of continuity.

- The ECI appears to be a useful tool and this is generally recognised as such by the market. However, there do seem to be questions as to whether the current design always achieves its intended purpose. Further, the degree of distinctiveness is a point of concern so tenders are still too often awarded on the basis of lowest price. An alternative would be to prescribe certain sustainability requirements. However, this will first require insight into the techniques available in practice.
- A number of companies indicate that there are constructions where there is a reward for applying greater sustainability during implementation, for example by extending maintenance contracts. Companies are positive about this. This offers further opportunities to deploy dredging equipment and gives more time to commission a sustainable vessel or convert existing ones.
- Several pilot projects are running to bring about innovations around sustainability. The desire from the market seems to be for pilot projects to share the risks fairly between client and contractor(s).

Matching supply and demand
In the coming period, there is clearly a transition phase and it will not be possible to make all dredging equipment fully sustainable in the short term. If all clients increase their requirements sharply at the same time, it will be economically difficult to still make good use of the old equipment. In addition, the technical capacity seems insufficient to make all dredging equipment sustainable in one single effort. In the saltwater dredging market, there are a limited number of players operating in the Dutch market and these players are very active internationally. These players cannot / will not be able to make all their dredging equipment sustainable over the short term at the same time as using their equipment efficiently abroad. Since Rijkswaterstaat wants to tender as sustainably as possible, it is important to ensure that sufficient sustainable dredging equipment is available. This is possible by informing the market in good time what type of work will be tendered and when. In that way, companies can estimate their required commitment, although here companies still depend on the outcome of the tender. Keeping the market well informed helps to prevent the number of companies with dredging equipment available from being very limited.

Further research needed to assess impact of transition
This study identified the key players and some of the trade-offs. An interesting next step would be to identify the impact of the transition based on technical capabilities. Two aspects come to mind here:

- **Impact on investments for companies and costs for clients**
  Depending on technical developments and trends in dredging equipment and fuel costs, the implications for necessary investments by companies can be identified. This could include looking at the composition of the equipment fleet and the remaining lifespan. This analysis establishes a link to the amount of CO_2 avoided and provides insight into the cost-effectiveness of sustainability measures.

- **Effects of cooperation in policy, both national and international**
  What effect does policy coordination at the national level – such as between Rijkswaterstaat and water boards – have on the pace of sustainability and cost development? This route is interesting for making domestic dredging equipment more sustainable. Similarly, cooperation at the international level may affect the pace and cost of the transition. This is especially true for seagoing equipment.

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Ministerie van Infrastructuur en Waterstaat

Report

Coastline and Fairway Maintenance Transition Path

Contents

1 Introduction

1.1 Trigger for the transition path

Dredging is second nature in the Netherlands. For centuries the Netherlands has been battling against water, with the result that the country occupies a leading position in the dredging industry. The Netherlands is always busy keeping the sea at arm's length, reclaiming land and making sure its shipping channels and rivers are navigable. Yet this battle, centuries in the making, is facing a new social challenge In addition to keeping our feet dry and keeping the waterways navigable to facilitate transportation, we are confronting the issue of how to do this in the most sustainable way possible.

That's only logical, as vessels in the dredging sector produce emissions that are damaging to nature (from nitrogen), the climate (from CO_2) and health (from particulate matter and nitrogen dioxide). That's why the transition to a zero emission, clean living and working environment also has a bearing on how the dredging sector can be made more sustainable in the future. In addition to the current developments in the field of climate change we are also seeing increasing exhaustion of raw materials. Over the past few years there has been more attention to aims in relation to circularity. How are we to reduce our use of primary raw materials? And how can we use them in the highest value way? For the dredging sector, this means that it is increasingly necessary to gain insight into various applications for dredged material (and soil) and how they can be utilised within the circular economy.

To really tackle these sustainability challenges, the Ministry of Infrastructure and Water Management, Rijkswaterstaat and ProRail are busy implementing the Carbon Neutral and Circular Infrastructure (KCI in Dutch) programme. This is done via transition paths that represent the work sites with the greatest climate impact. Together with stakeholders from the market, public authorities (clients) and research institutes we are developing a roadmap for each transition path, in which we define the most realistic route to 2030. The dredging sector has its own transition path, called Coastline and Fairway Maintenance (TPKV in Dutch), with an accompanying roadmap. You see before you the in-depth underlying document for this roadmap. The transition path addresses the process of making all coastline and domestic/inland dredging projects more sustainable. Together with companies and other clients, we are exploring which innovations can actually be used to realise the change to sustainability in practice.

The TPKV also puts into effect the Clean and Zero Emission Construction (SEB in Dutch) programme. This programme was set up by the government (including government agencies) in cooperation with provincial and municipal authorities, water boards, companies and research institutes. The SEB programme combines and jointly addresses the various aims from the structural approach to nitrogen, the Climate Agreement and the Clean Air Agreement, where they touch on making mobile machinery, vehicles and vessels used in construction more sustainable.

The process of making the dredging sector more sustainable is a complex task that may have an impact on its continuity. Making the sector more sustainable is not only imperative because of climate change, but also because stricter requirements are being set in laws and regulations (on the environmental impact of work carried out) to protect the living and working environment. For instance, it has recently become necessary to take into account the presence of per- and polyfluoralkyl substances (PFASs) in dredged material and soil. As a result, projects are increasingly being restricted in the extent to which they are able to use or transport soil containing PFASs. Shipping companies must also increasingly take into account stricter rules for new vessels imposed by authorities including the International Maritime Organisation (IMO), aimed at fulfilling the targets outlined in the Paris Agreement. This is not restricted to reducing emissions such as nitrogen dioxide and particulate matter, but it also relates to gaining insight into energy consumption and emissions of greenhouse gases. Finally, we see that the problems with nitrogen have forced the postponement or deferment of thousands of construction plans and planning permission applications due to excessive nitrogen deposition that could be carried to natural areas in the vicinity. So it is high time to give greater priority to the topics of carbon neutrality and circularity within the dredging sector.

1.2 Aims and ambitions of the SEB and KCI programmes

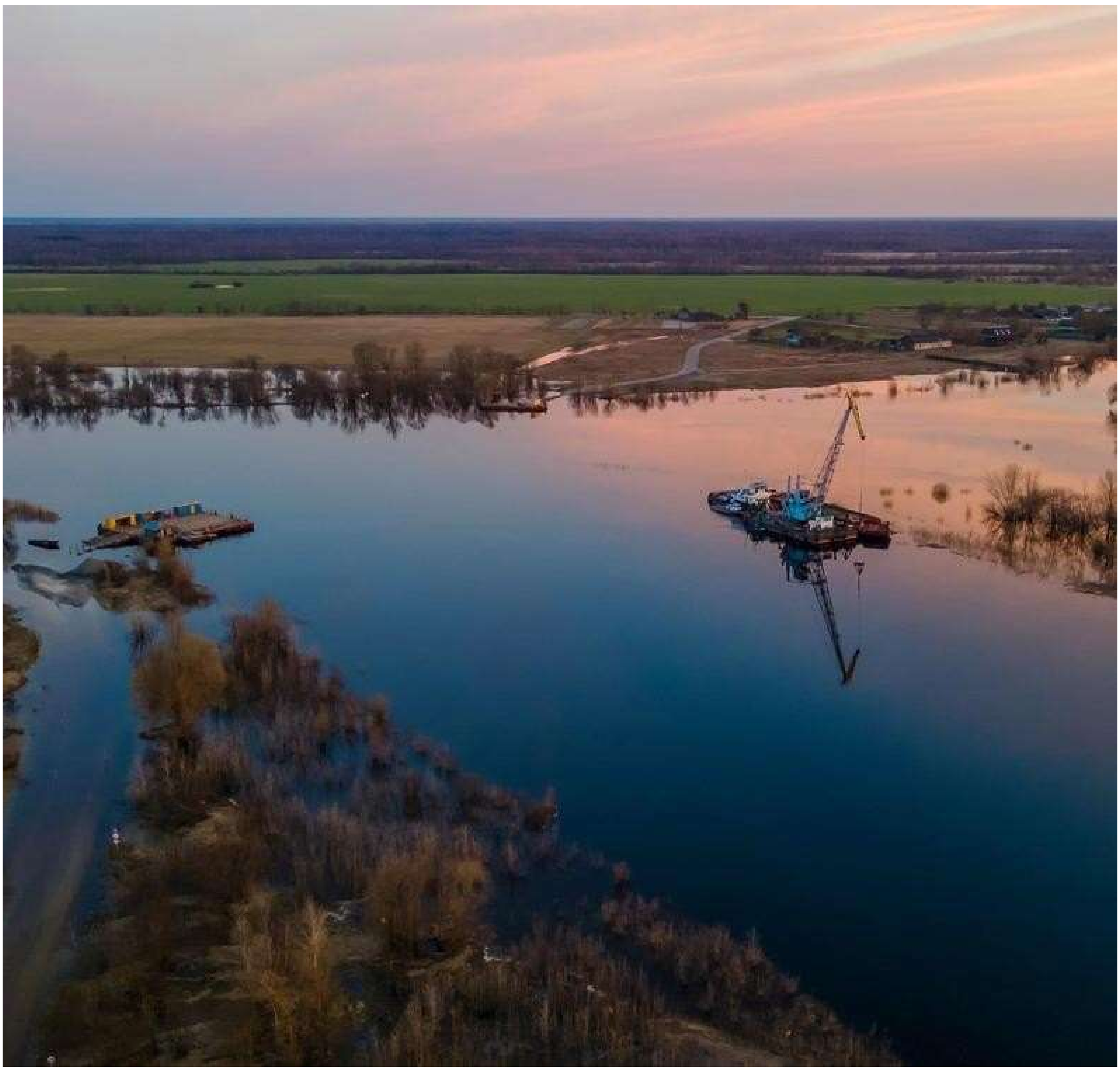
The aim of the SEB programme is to improve conditions for nature, the climate and public health by reducing the emissions produced by tools, vehicles and vessels used in construction and, in so doing, to meet the aims and ambitions from the structural approach to nitrogen, the Climate Agreement, the Carbon Neutral and Circular Infrastructure projects strategy and the Clean Air Agreement. So the SEB programme also has a bearing on fairway and coastline maintenance. The aims must have been attained in 2030.

The 'Government Strategy for Carbon Neutral and Circular Infrastructure Projects' contains the ambition for working in a way that is fully carbon neutral and circular on civil engineering projects in 2030. In this way, the KCI programme puts the terms of both the climate agreement and the raw materials agreement into practice, and makes a contribution to attaining the SEB aims. The table below shows the aims and ambitions of both programmes.

Figure 1. Table of SEB aims and KCI ambitions

Clean and Zero Emission Construction (SEB) (Goals)			Carbon Neutral and Circular Infrastructure (Ambitions)	
Nature recovery (NOx)	Health (PM10)	Climate ($CO_{2\,eq}$)	Climate ($CO_{2\,eq}$)	Raw materials
Structural approach to nitrogen	Clean Air Agreement	Climate Agreement	Climate Agreement	Raw materials agreement
60% reduction in nitrogen compared with 2018	75% reduction in damage to health compared with 2016	0,4 Mtonnes CO_2 reduction compared with 2019	No net CO_2 equivalent emissions	50% reduction in use of raw materials and high-value use of products and materials
2030	**2030**	**2030**	**2030**	**2030**

What can be seen here is that there is some overlap, but also differences, between the two programmes. The starting point for KCI is a focus on reducing CO_2 equivalents and primary raw materials. There are no aims for SEB in relation to raw materials; in contrast, there are indeed firm aims in relation to nitrogen, particulate matter and carbon dioxide. In relation to the transition path we are well aware of the differences and similarities, and we are using this integrated roadmap to make a contribution to each of these ambitions and aims.



1.3 Aims of the Coastline and Fairway Maintenance transition path

But what do the ambitions and aims referred to above actually mean for the TKPV? In terms of the transition path we aim to achieve the following ambitions and aims in 2030.

By being committed to the ambitions and aims referred to above, the extraction, transportation and use of dredged material must be carried out with a significant reduction in greenhouse gas emissions in 2030. Vessels are powered by ‘clean’ energy through the use of different renewable energy carriers. Emissions of nitrogen and particulate matter will also be reduced in the short term.

In addition, a coherent policy for dealing with dredged material will be in place in 2030 so that the material released by the dredging process can be used again or upcycled. Also, the security of supply for the use of soil and dredged material is guaranteed government-wide, the stock of soil and dredged material in the substrate is protected and there is sufficient space to extract sand for beach nourishment. Lastly, there is clarity about the conditions under which materials from other cycles/streams can be used to replace soil or dredged material.

Figure 2. Overview of ambitions & aims, Coastline and Fairway Maintenance transition path (TPKV)

Emissions from vessels	**Aim no. 1** We will reduce emissions of nitrogen (NOx) when extracting, transporting and using dredged material by 60% compared with 2018.
	Ambition no. 2 We will not emit any more CO_2 equivalents when extracting, transporting and using dredged material.
	Aim no. 3 We will reduce emissions of particulate matter (PM_{10}) when extracting, transporting and using dredged material in (freshwater or saltwater) fairway maintenance by 75% compared with 2016.
Use of soil and dredged material	**Ambition no. 4** We will maintain the value of soil and dredging material by reusing it in a high-quality way.
	Ambition no. 5 We protect resources of dredged material and soil by safeguarding its quality and by using it sparingly.

1.4 Alignment with other agreements, legislation and policy

Together with the other transition paths, TPKV puts the aims of the Climate Agreement, Clean Air Agreement, Raw Materials Agreement and the structural approach to nitrogen into practice. The preconditions surrounding these different policy guidelines will have to be incorporated into the project implementation (Coastline and Fairway Maintenance) via the transition path. In addition to these agreements other (related) agreements and legislation, plus (underlying) policy are also relevant. The TPKV must take this into account, although it might also be used to the transition path's advantage. An initial overview of relevant underlying policy is included in table 1.

Table 1. Overview of underlying initiatives and policy

Category	Initiative	Year
Policy	Fit-for-55 package	2020
	The Netherlands 'Circular in 2050'	2021
	Central Commission for the Navigation of the Rhine roadmap	2016
	EU Water Framework Directive	2018
	EU Marine Strategy Framework Directive	2008
	EU Waste Framework Directive	2008
	EU Soil Strategy	2021
Legislation	European Union Emissions Trading System	2005
	Dutch Climate Act	2019
	EU regulation 2016/1628	2018
	Renewable Energy Directive (RED)	2016
	IMO legislation 2020	2020
Agreements	Maritime, Inland Navigation and Ports Green Deal	2019
	Clean Air Agreement	2018
	SPP (Sustainable Public Procurement) Manifesto	2016

1.5. Reading guide

Chapter 2 describes the transition path. We explore in greater depth the scope and scale of the transition path. Chapter 3 describes where we are now in relation to making the sector more sustainable and sets a baseline measurement for the aim in section 1.3. In the subsequent chapters (nos. 4, 5 and 6) we consider the growth and reduction paths that form part of the transition path. These chapters outline the measures for making the sector more sustainable in years to come, and the expected impact of these measures (on the target range). Chapter 7 is a thematic representation of the actions that are going to be carried out over the next few years to implement the measures and, consequently, to achieve the aims. In the last chapters (nos. 8 and 9), we consider the monitoring, evaluation and the hierarchy of the programme.

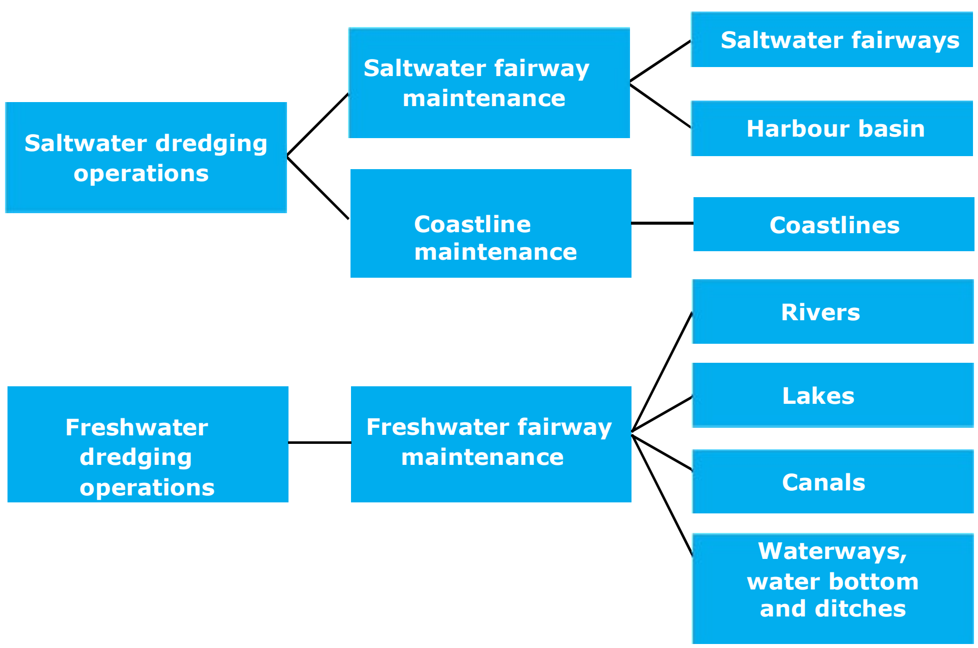
2. Description of the transition path

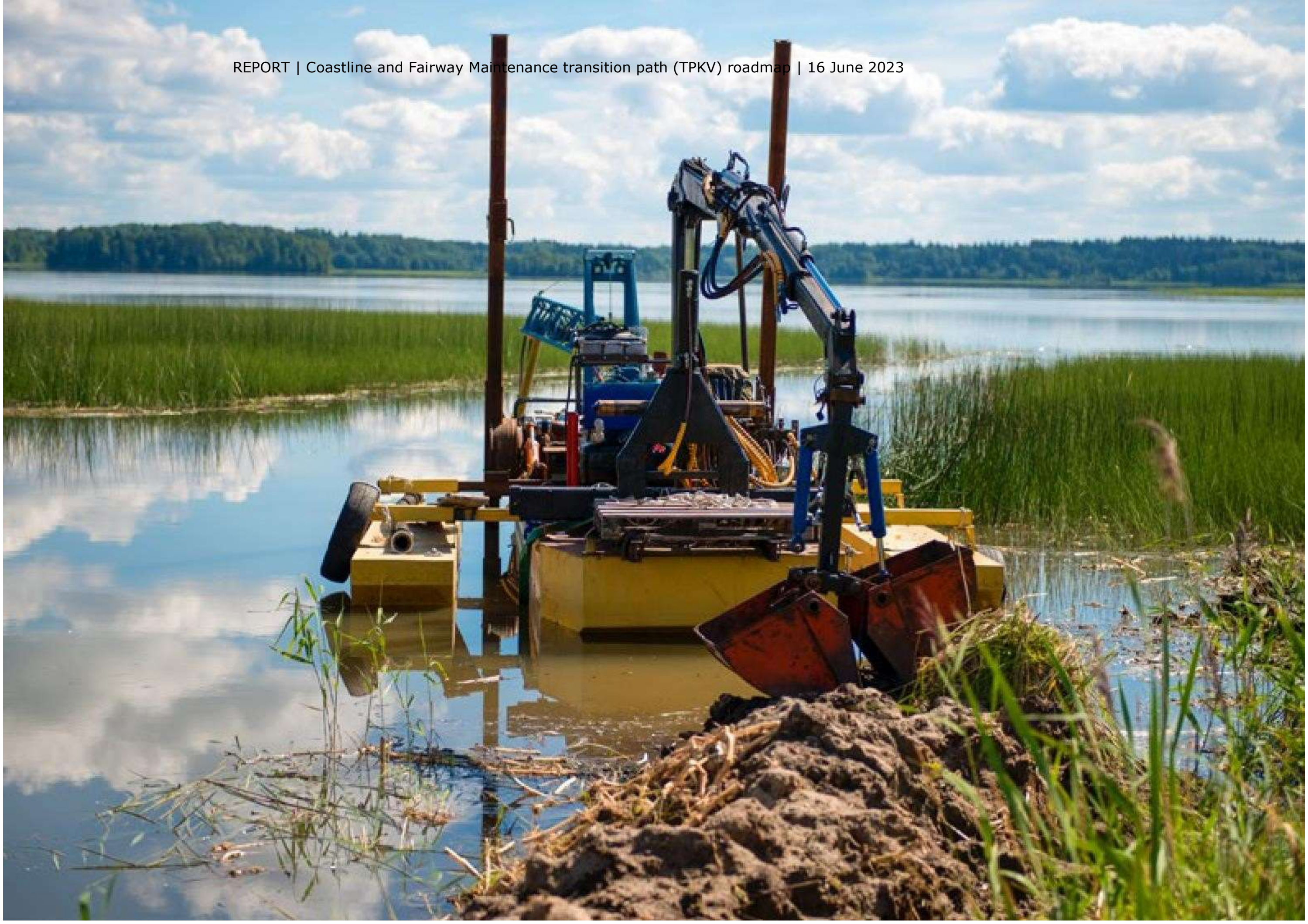
In this chapter, we describe the scope and scale of the transition path. In addition, we consider the market by describing the market dynamics and the most important players. We have used analyses and data from the "Market Developments in Coastline and Fairway Maintenance" (*marktontwikkelingen kustlijnzorg en vaargeulonderhoud*) report by the Economic Institute of Construction (*Economisch Instituut voor de Bouw*, EIB).

2.1 Scope of the transition path

Coastline and Fairway maintenance refers to the Dutch dredging operations aimed at maintaining coastal defences at delta height, and maintaining fairways at sufficient depth (vessel draught). We can differentiate between two types of dredging operation in this respect. Seagoing 'saltwater' dredging operations and domestic inland 'freshwater' dredging operations, each with their own features. Saltwater dredging operations relate to maintaining the coastline of the Netherlands, saltwater fairways and harbour basins. Freshwater dredging work relates to dredging operations in the creation, deepening and widening of rivers, lakes and canals. In addition, freshwater dredging includes smaller dredging operations, such as maintenance of waterways and drainage ditches.

Figure 3. Scope of the Coastline and Fairway Maintenance transition path





The scope of the roadmap, within both freshwater and saltwater dredging operations, has two components and relates to both the dredging equipment, and the material.

1. **The dredging equipment:** Reduction of emissions (nitrogen, carbon dioxide and particulate matter) produced by the use of vessels that are deployed to maintain the coastline and fairways of the Netherlands. This relates to aims 1 - 3 inclusive, as explained in section 1.3.
2. **The material:** High-value reuse and protection of reserves of dredged material/soil brought to the surface during coastline and fairway maintenance in the Netherlands. This relates to aims 4 and 5 as explained in section 1.3.

For the sake of completeness, it is important to note that this document does not (currently) address the mining of aggregates, such as gravel, sand and clay for use in composite products such as glass, concrete, ceramics or asphalt. Sand extraction for use in beach nourishment does fall within the scope.

2.2 Scale of the transition path

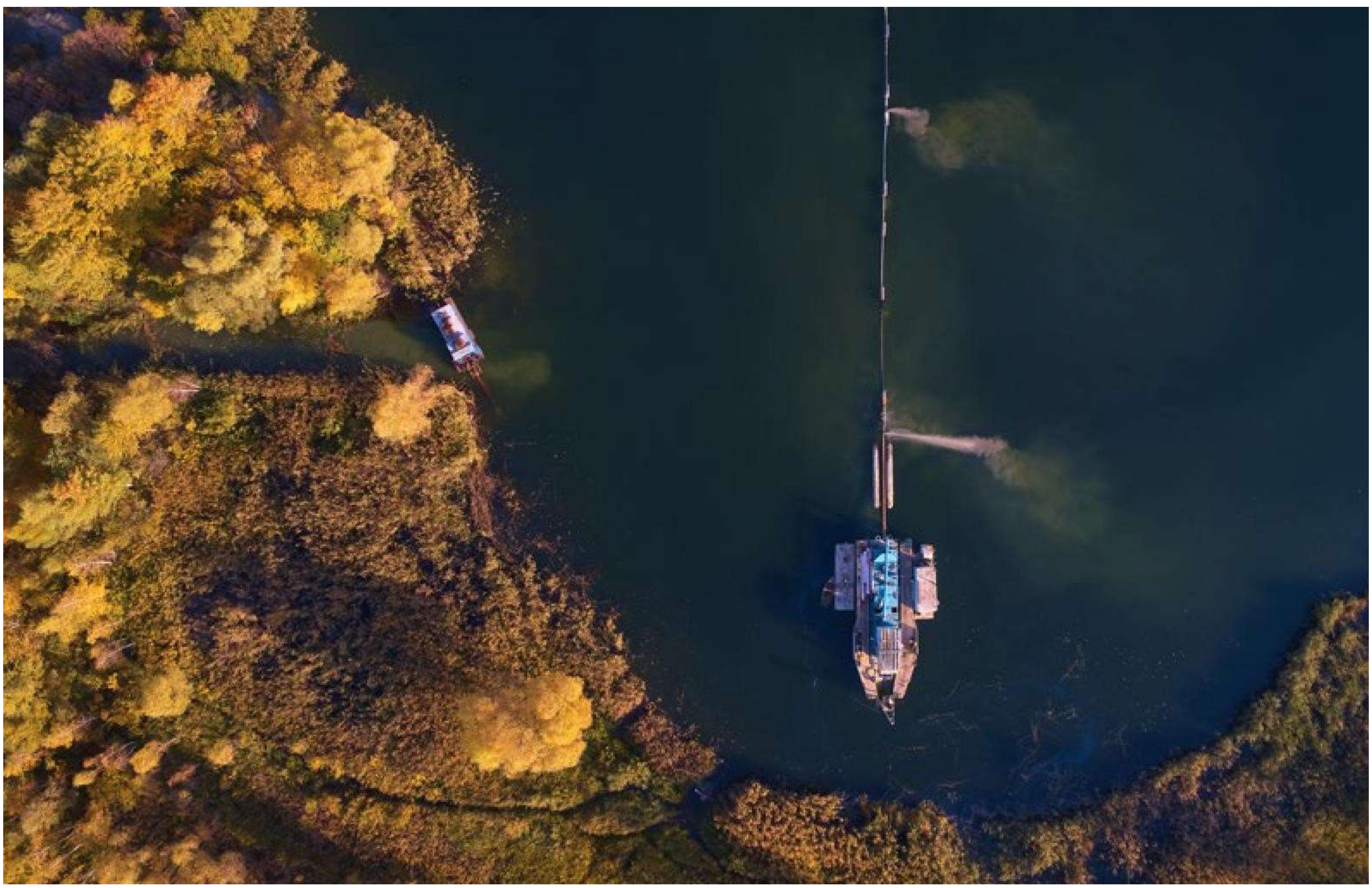
Scale of the dredging equipment

The scale of the equipment relates to the deployment of the vessels used for saltwater and freshwater dredging operations. Within the vessels modality two categories can be distinguished.

1. The saltwater hydraulic engineering fleet, which is deployed for coastline and saltwater fairway maintenance.
2. The freshwater hydraulic engineering fleet for deployment in freshwater fairway maintenance.

Saltwater hydraulic engineering fleet - saltwater dredging operations

Within the saltwater hydraulic engineering fleet, in total between 15 and 30 different vessels per year spend a period working in the Netherlands on saltwater coastline and fairway maintenance. These vessels are not exclusively deployed in the Netherlands. The companies involved operate world-wide and the specific deployment of vessels for the Netherlands is based on availability and tender specifications. If we assume absolute figures, this distorts the picture of the actual task at hand. For that reason, we would rather talk here about the number of cubic metres of dredged material in situ. In total, each year approximately 23 million tonnes of material are dredged. This annual amount is relatively stable. To be able to dredge up this 23 million tonnes of material, we need to deploy a range of different vessels. Trailing suction hopper dredgers are generally used to perform the work for coastline and large-scale sea channel maintenance. In addition, various vessels are deployed for saltwater fairway maintenance, including grab (hopper barges), hopper barges and suction hopper dredgers.



Freshwater hydraulic engineering fleet - freshwater dredging operations
Freshwater fairway maintenance is performed on behalf of municipal and provincial authorities, water boards and Rijkswaterstaat. If we consider the freshwater hydraulic engineering fleet in the Netherlands, we note that around 600 freshwater hydraulic engineering ships and push vessels are active (TNO). The fleet consists of around 345 freshwater hydraulic engineering ships and a further 269 push vessels with a very small auxiliary motor on board, for hydraulics. The composition of the freshwater hydraulic engineering fleet comprises a large variety for the different primary tasks (for example vessels deployed for dredging operations or for example for the construction and maintenance of quay walls and locks). The technical characteristics and operational deployment of these vessels varies widely.

The table below (table 2) is an overview of the number of vessels that are deployed per vessel type. The figures presented below are the results of the questionnaire held among members of the *Vereniging van Waterbouwers* (Association of Hydraulic Engineers). The results were collated by TNO and processed in the '*verkenning duurzaamheidsopties zoete waterbouwvlootverkenning*' report (Freshwater Hydraulic Engineering Fleet Sustainability Options Exploration). As a consequence of the fact that the questionnaire was held solely among members of the Association of Hydraulic Engineers, the figures presented under-represent the total freshwater hydraulic engineering fleet that is active in the Netherlands. This applies in particular to the smaller and 'other' vessels, such as mowing boats, silt pushers and small support vessels.

Table 2. Overview of number of vessels, freshwater hydraulic engineering fleet

	Number
Sand dredger (stationary)	46
Cutter suction dredger - stationary/mobile	23
Suction hopper dredger	10
Bucket suction dredger	6
Grab (hopper) bargel	41
Silt pusher	14
Piling barge	19
Auxiliary equipment (support)	32
Hopper Barge	34
Push vessel	269
Other vessels	120
Total	**614**

Scale of the material
As referred to in the scope description (section 2.1), we understand 'material' to mean both soil and dredged material. Both types of material are, after all, a by-product of dredging or are used in operations within the Coastline and Fairway Maintenance transition path. To differentiate and define these two concepts, we follow the Soil Quality Decree (*besluit bodemkwaliteit*). This instrument defines the terms as follows:

'Excavated soil: solid material that consists of mineral parts with a maximum granule size of 2 millimetres and organic substance in a ratio and with a structure that occur naturally in the soil, as well as shells and gravel naturally occurring in the soil with a granule size of 2 to 63 millimetres, not being dredged material.

Dredged material: material that has come from the soil via the surface water or the space intended for that water and that consists of mineral parts with a maximum granule size of 2 millimetres and organic substance in a ratio and with a structure that occur naturally in the soil, as well as shells and gravel naturally occurring in the soil with a granule size of 2 to 63 millimetres.

Although the Soil Quality Decree classifies soil and dredged material differently, both material streams are interchangeable. Dredged material, for instance, can be used on and in the ground, while soil can be used in water systems.

Table 3 shows that this involves moving c. 24 million cubic metres of material per year for Fairway and Coastline Maintenance.

The data for the saltwater dredging operations comes from the Rijkswaterstaat Monitoring and Registration System (MARS). MARS is a measurement and registration system developed by Rijkswaterstaat for saltwater dredging operations. This system, certified by the Government Audit Department (*Accountantsdienst Rijk*), allows Rijkswaterstaat to monitor the quantities of dredged material. This forms part of the contract management process. The system measures and calculates how many cubic metres of sand or tonnes of dry matter (TDS) have been dredged up during each dredging operation, and shows the locations to which dredged material is transported. Rijkswaterstaat is responsible for 90% of the dredging operations in saltwater fairway and coastline maintenance. So the total volume of dredged material as presented in table 3 has been measured accurately, but may vary (significantly) from year to year due to the dynamics of/in the system.

There are many different clients and activities carried out in relation to freshwater dredging operations. So it is difficult to establish exactly how many cubic metres are dredged up annually and how much earth is excavated or moved per year. It is advisable to monitor this more closely in the future. In that way, after all, we can monitor the extent to which soil and dredged material are reused in a high-quality way. Nonetheless, the amount of dredged material released per year can certainly be estimated by means of 'expert judgement'. This is estimated to be around 20 million cubic metres of dredged material per year in total.

Table 3. Overview of number of cubic metres of dredged material.

		Millions of M^3
Saltwater dredging operations[1]		
Coastline maintenance - foreshore (sand)		6.6 m^3
Coastline maintenance - beach (sand)		4.4 m^3
Fairway maintenance - saltwater (dredged material & sand)		13.0 m^3
	Total - saltwater	**24.0 m^3**
Freshwater dredging operations[2]		
Fairway maintenance - freshwater (dredged material)		10.0 m^3
Fairway maintenance - freshwater (earth movement)		10.0 m^3
	Total - freshwater	**20.0 m^3**
Total - saltwater & freshwater		**44.0 m^3**

Source: TNO 2022 R11048: Identification and categorisation of current and future range of sustainable mobile machinery, building-logistics vehicles, rail equipment and vessels deployed for hydraulic engineering.

1. Information obtained from MARS-data, Rijkswaterstaat

2. Information obtained on the basis of 'expert judgement'

2.3 Features and dynamics of the market

There are three different markets within the scope of this roadmap:
1. The saltwater dredging market (deployment of equipment for projects).
2. The freshwater dredging market (deployment of equipment for projects).
3. The market for dredged material (and soil).

The first two markets relate to the deployment of equipment. The equipment is used to move dredged material (and soil) in order to achieve project aims. Equipment is thus used as it were to trade the dredged material. That is the third market that is the subject of this roadmap.

The saltwater dredging market

The saltwater dredging market refers to the deployment of dredging equipment for coastline dredging operations and saltwater fairway maintenance. The companies that perform coastline and saltwater fairway maintenance generally operate on the international market and generate more than 80% of their turnover abroad. Around the world there are several hundred hopper dredgers active, which are often specifically designed for particular types of operation. The total saltwater dredging market in the Netherlands represents around 1-2% of the world-wide saltwater dredging market. A feature of the sector that stands out is that it is energy- and capital-intensive. The market uses a lot of energy when carrying out the operations, notably through the use of Marine Diesel Oil (MDO). However, in the past few years we have seen an increase in the use of HVO and LNG. In addition, the equipment has both a long economic life and product lifespan; generally between 25 and 30 years. In conclusion, we could suggest that the key features of the saltwater dredging market are that it is:

- An international market with merely a few large-scale players, plus some smaller parties.
- A capital-intensive market with long depreciation periods.
- A niche market for the construction of vessels and dredging equipment. This is a small market with a handful of players and specialist customers.
- Just a few clients (Rijkswaterstaat and the Port of Rotterdam Authority are responsible for almost the entire market demand in the Netherlands).

Figure 4. Saltwater dredging market value chain The freshwater dredging market

The freshwater dredging market relates to the deployment of dredging equipment for freshwater fairway maintenance dredging operations. The freshwater dredging market has a more domestic character than that for saltwater and has many players in the SME sector.
Like the saltwater dredging market, the freshwater market is also capital-intensive. New vessels are expensive to procure and have long-term depreciation periods. The vessels are, in many cases, expected to have a product lifespan of 30 years or more in order to recover the purchase costs. The high purchase costs mean that the freshwater hydraulic engineering fleet is well maintained. For the same reason, the freshwater hydraulic engineering fleet is showing its age in some cases. In conclusion, we could suggest that the key features of the freshwater dredging market are that it is:

- A domestic market with many (small-scale) players.
- A capital-intensive market with long depreciation periods.
- A market dominated by two clients (Rijkswaterstaat and water boards). Rijkswaterstaat and the water boards are responsible for 60% of the demand for freshwater dredging.

Figure 5. Freshwater dredging market value chain

The market for dredged material and soil
The market for dredged material itself is also important. Where dredged material is in the way, it must be removed. That can be done only if the dredged material to be removed can be put to use elsewhere. The supply of dredged material in one place must therefore be balanced by a demand for dredged material in another place. How the market of supply and demand for dredged material works is intensively regulated and so has become a key determining factor for the feasibility (in terms of costs and time) of dredging projects and the deployment of equipment to do so. The provisional legislation in response to PFASs in dredged material, for instance, has made it impossible for a short period to give a different purpose to dredged material contaminated with PFASs. The logical conclusion (at that time) was that dredging projects could not be carried out.

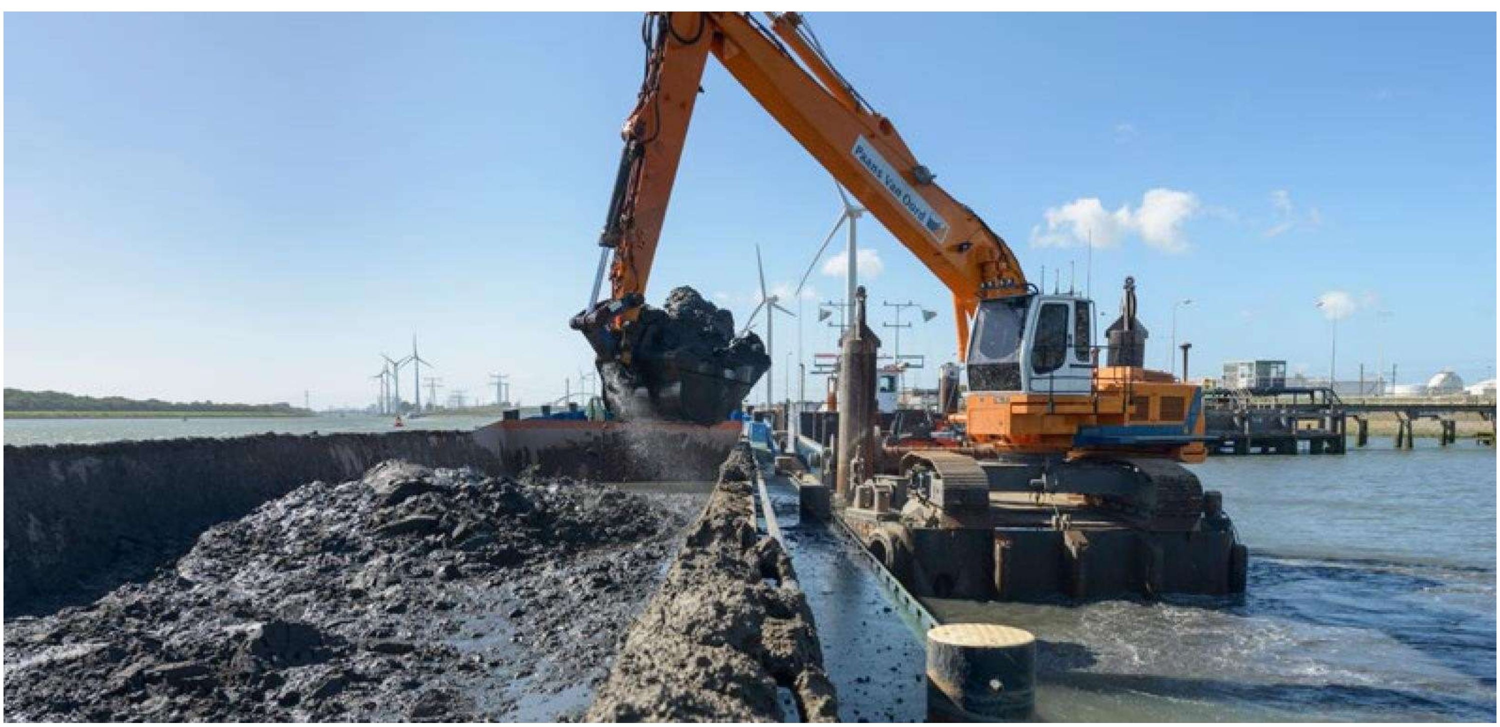
The legislation that drives the market for dredged material also includes other materials (and waste), such as soil and (secondary) construction materials. These materials are often interchangeable. Dredged material can, for instance, be used as soil. So, in the wake of this roadmap, the materials soil and secondary construction materials are also taken into consideration. This is done in collaboration with the other transition paths and the CE programme.

The CE programme focuses on raw materials for construction. It is important to use these sparingly. The CE programme has specific reduction targets for the use of materials, that also apply to dredged material/soil. The reduction target for dredged material/soil is not deemed to be feasible and, moreover, regarded as not suited as dredged material/soil is completely different in nature to the raw materials for which the CE programme has specified reduction targets. Dredged material/soil that is released during fairway maintenance and civil engineering projects can often not be said to be a raw material for another product; in most cases it is reused as dredged material/soil. In that way it remains part of the resources. The use of dredged material and soil in the Netherlands is becoming ever more important for keeping our feet dry, by adapting to a changing climate. Using less dredged material/soil does not, therefore, appear feasible and, given the nature of the material and the uses to which it is put, is not deemed sensible, either.

Rijkswaterstaat and the water boards are the largest suppliers in the market, supplying around 90% of the dredged material. In line with EU legislation, dredged material is most frequently viewed as waste which is to be processed in line with waste legislation. In principle, there is a level playing field in the EU for waste. In part, the Netherlands can be said to be a front runner in the European market for waste handling. Companies import various sorts of ground/soil for cleaning/processing here. The demand for dredged material/soil could be reduced by using residual materials from other chains as replacements for dredged material/soil. However, the scale of these residual streams is not large enough to fully satisfy the demand for dredged material/soil. Finally, we see that resources of soil (supply) are becoming scarce in the market due to a lack of space for extraction and pollution of the reserves of dredged material/soil in the ground and water system due to the discharge of contaminants. In conclusion, we could suggest that the key features of the market for dredged material/soil are that it is:

- A market that is, in principle, domestic but based on European rules and regulations (level playing field).
- A market in which the use of dredged material/soil is becoming increasingly important due to climate adaptation.
- The supply of dredged material is dominated by two clients (Rijkswaterstaat and the water boards). Rijkswaterstaat and the water boards are responsible for 90% of the dredged material (and a large portion of the soil) brought to the surface. Scarcity is an issue.
- An international market in which the Netherlands is, in many respects, a front runner.

Figure 6. Value chain market for dredged material and soil



2.4 Players in the market

The dredging market is a market in which many different types of player are active. To make things easier we have gathered together these players and separated them out into clients, contractors, industry and government agencies (see table 4). A brief explanation of these categories follows.

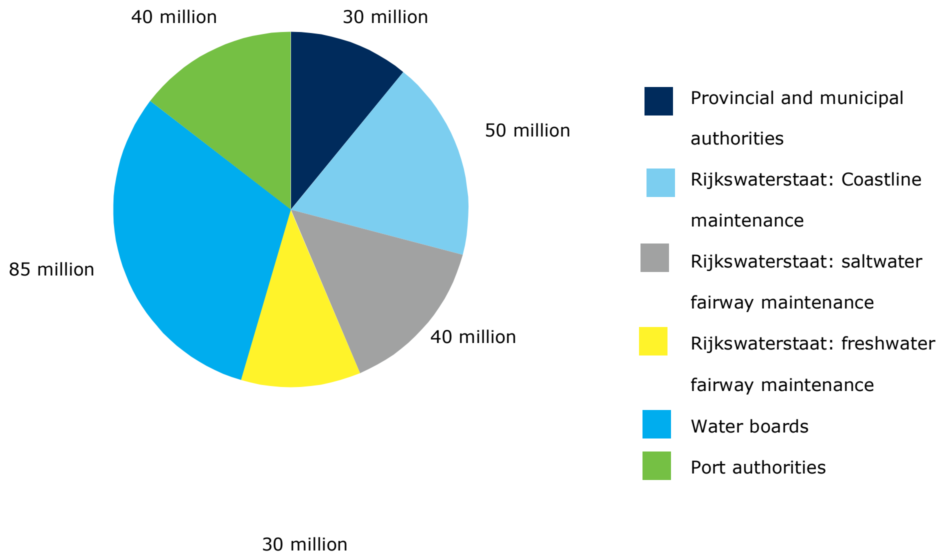
Table 4. Overview of the most important players in the dredging market

Clients	Contractors	Industry and energy	Governme
Rijkswaterstaat	Large-scale multinationals	Shipyards	European governmental authorities
Water boards	Medium-sized enterprises some operating internationally	Manufacturers	National government
Municipal authorities	small-scale regional enterprises	Energy suppliers	Regional authorities
Provincial authorities			
Port authorities			

Clients

Within the Netherlands, Rijkswaterstaat is the sole client in the coastline maintenance domain. The volume of contracts subject to a tender procedure is around EUR 50m per year. In addition, Rijkswaterstaat has tender procedures for saltwater fairway maintenance; this is estimated at EUR 40m. Some of this work is tendered in cooperation with port authorities, as work in the ports is related to the adjacent fairways. The most important port authorities in the Netherlands are the Port of Amsterdam Authority, the Port of Rotterdam Authority, North Sea Port and Groningen Seaports. Freshwater fairway maintenance is carried out on behalf of Rijkswaterstaat, the provincial and municipal authorities and water boards. Rijkswaterstaat has a less dominant position in freshwater fairway maintenance. The average Rijkswaterstaat spend in this domain is around EUR 30m per year. Water boards play a more significant role on the market for freshwater fairway maintenance. The annual costs to the water boards for dredging operations amount to around EUR 85m per year. The port authorities, particularly the Port of Rotterdam, spend around EUR 40m per year on dredging operations. Additionally, provincial and municipal authorities also play a role in this market. For them, it is estimated that several tens of millions of euros per year are involved. The total domestic volume spent on dredging operations along the coastline, at sea and in the inland/domestic was an estimated EUR 275m in 2020 (source: *Economisch Instituut voor de Bouw*).

Figure 7. Market volume per client.



Source: Economic Institute of Construction (Economisch Instituut voor de Bouw, EIB) 'Market Developments in Coastline and Fairway Maintenance' (marktontwikkelingen kustlijnzorg en vaargeulonderhoud)

In addition to these clients and contractors there are also other important stakeholders in the dredging sector: what about the following, for example:

Research institutes and platforms:
- Baggernet (a knowledge-sharing platform)
- Netherlands Maritime Technology (NMT) (research institute)

Lobbying and advocacy bod(y)(ies):
- VNO-NCW
- World Organization of Dredging Associations (WODA)
  - Central Dredging Association (CEDA)
  - Western Dredging Association (WEDA)
  - Eastern Dredging Association (EADA)
- European Dredging Association (EUDA)
- *Nederland Maritiem Land* (The Dutch Maritime Network)
- *Koninklijke Vereniging van Nederlandse Reders* (Royal Association of Dutch Shipowners)
- International Maritime Organization (IMO)
- Association of Hydraulic Engineers (VvW)
- *Bouwend Nederland* (Trade association for construction and civil engineering companies)

Network organisation(s):
- *Stichting Maritiem Nederland* (Dutch Maritime Foundation)

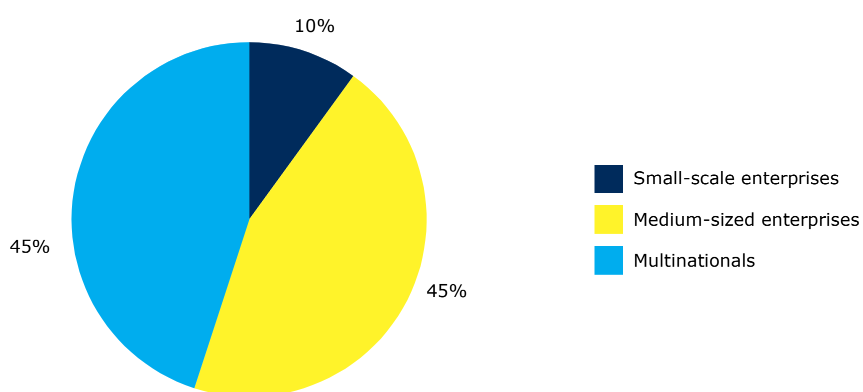
Other:
- Foreign authorities

Contractors
We understand 'contractors' to mean the dredging companies that carry out the dredging operations. The dredging sector in the Netherlands has around 75 such companies. In total, about 6,300 people are employed in the sector. Some companies are small, work in the Netherlands only or are specialised in a particular branch. Other companies cover a broad working area and also operate abroad. The two largest dredging companies are Boskalis and Van Oord. Together with the Belgian competitors Jan de Nul and DEME, they form the worldwide top four on the free market. For their turnover, these companies depend to a great deal on the world market.

As these companies carry out a wide range of operations, it is not easy to say how much of their sales are directly related to dredging. Large-scale dredging companies are also, for instance, involved in offshore activities such as depositing stone and other material required for creating oil and gas installations. Turnover in the dredging industry in the Netherlands is estimated to be EUR 1.83bn. Figure 8 shows each type of company's share of this EUR 1.83bn. Of course, the dredgers are, to a great extent, reliant on work that government authorities and companies want them to carry out. They are not in a position to determine the size of their market themselves.

Figure 8 shows that the market in the Netherlands is made up of small- and medium-sized enterprises, and multinationals. The market in the Netherlands is, firstly, home to four large-scale international players. These companies are largely dependent on the world market for their turnover. In addition, the supply side has a relatively high number of small, regional dredging companies. These companies are more focused on smaller projects, such as from water boards and provincial and municipal authorities. Finally, a number of medium-sized enterprises are active with a focus on the Netherlands but that are also active in a number of surrounding countries.

Figure 8. Market share in terms of type of enterprise



Source: 'Market Developments in Coastline and Fairway Maintenance' (Marktontwikkelingen kustlijnzorg en vaargeulonderhoud, EIB).

Industry and energy
Besides clients and dredging companies, key players for making the sector more sustainable are shipyards and engine manufacturers. These two types of industry players do not operate exclusively for the dredging market but also for sectors such as container shipping and offshore, especially in regions outside the Netherlands. Given the large difference in the (peak) power requirements of dredging equipment, specific innovations for sustainability are needed here.
However, dredging equipment is a very small market in terms of heavy industry as a whole. In respect of efforts to make the sector more sustainable, dredging companies often work together with shipyards and manufacturers. Dredging equipment development, from design to realisation, takes a relatively large number of years.

Governmental authorities
Lastly, the European, national and regional authorities are the most important players on the market. Dredging operations must, after all, be compatible with the applicable laws and regulations. Dredging maintenance must meet the rules and regulations imposed by Europe, by the state and the province. The currently applicable laws and regulations are summarised in section 1.4.

3. Where are we now?

3.1 Developments to date

An estimated 85% of vessels worldwide are still sailing on low-quality bunker oil (source: "Visie schone scheepvaart" (Vision on Clean Maritime Transport) - Port of Amsterdam). It is cheap and readily available everywhere. A vessel has a product lifespan of around 25 years. During its service life, the rules for fuel will change appreciably. Many ship owners therefore make adjustments to their fleet in advance, to make them 'future-proof'. With stricter legislation on fuel (International Maritime Organization (IMO) and the European Commission) on the horizon, they are increasingly considering alternative fuels. This achieves a substantial reduction in emissions. It is expected that electricity, e-fuels and hydrogen will not make a substantial impact until after 2030.

In addition to low-quality bunker oil, outdated engines also mean high emissions. Technological developments are making engines cleaner and more efficient. Over the past few decades, dredging vessels have become substantially more efficient than their counterparts made in the ten years before that were. This applies to all types of vessel. We expect that stricter legislation and further technological developments will make dredging vessels increasingly cleaner, producing less in the way of emissions.

The Dutch maritime sector is working, not least, towards procuring cleaner engines, using (blending) environmentally-friendly fuels, developing a 'blue shipping zero emission' label and developing sustainable maritime solutions for zero-emission maritime transport. One of the pre-conditions in the fight against hazardous emissions from seagoing and inland/domestic shipping is that alternative fuelling and loading infrastructure (including shore-side electricity, charging points for renewable energy carriers and battery changing locations) is available in good time.

Besides developments to dredge more sustainably, there are also developments to dredge less and/or smarter. For example, the water-injection technique can be used to move dredged material to deeper sections of fairways and other channels. This requires less capacity. However, it is not possible everywhere. Also under investigation is the use of natural currents for the distribution of sediment, plus methods for reducing deposition of silt. The potential of these developments is not yet clear. It would be useful to gain more knowledge on the applicability of these alternatives, given that they have direct consequences for the emission of substances.

3.2 Baseline measurement

In this section we consider the baseline measurement for both the dredging equipment, and the material. Where the baseline measurement for the equipment is concerned, we look to the emissions including carbon dioxide, nitrogen and particulate matter. This baseline measurement relates to aims 1 - 3 inclusive (section 1.3) For the baseline measurement for the dredging equipment, we use the TNO data (2022) from the report '*Inventarisatie and categorisatie huidige en toekomstige aanbod duurzame vaartuigen*' (Inventory and Categorisation of the Current and Future Range of Sustainable Vessels). This was carried out on behalf of the Ministry of Infrastructure & Water Management. For the baseline measurement in relation to material, we assess the high-value reuse and protection of the reserves of soil and dredged material. This relates to targets 4 & 5 (section 1.3).

Baseline measurement, dredging equipment

To determine the emissions caused by saltwater dredging operations we use the total amount of fuel used in coastline maintenance projects. This total amount of fuel is a known quantity, taken from the '*Bepaling milieu-impact Kustlijnzorg-projecten*' (Determining the Environmental Impact of Coastline Maintenance Projects) study (TNO 2020). To calculate this, it is first necessary to calculate average fuel consumption per m^3 of dredged material. This average fuel consumption per m^3 is then used to reveal the total annual fuel consumption, so that it is possible to calculate the quantity of CO_2 emissions.

Nitrogen and particulate matter could not be calculated in the same way, as the estimate of total NOx and PM emissions demands a detailed approach based on the specifications of the engines of the vessels. These emissions do depend on the emissions class of the engines, the engine capacity, the presence of an emission control device (SCR catalytic converter and/or diesel particulate filter), the fuel used and the deployment profiles and load per engine. TNO collects data on these features from the hydraulic engineers. This data on the vessels from the hydraulic engineers is then used to make an estimation of the NOx and PM emissions from operations of the fleet as it is at present. These emissions are expressed in the mass of NOx and PM per litre of fuel, before an estimate of the total emissions is made based on the total fuel consumption. See table 5 for the results.

Table 5: Annual emissions for saltwater dredging operations (2021)

Activity	Millions of m^3	CO_2 eq Mtnnes)		NOx (Ktonnes)		PM_{10} (Tonnes)	
Coastline maintenance foreshore	6.6	0.01	0.03	0.2	0.3	4.7	7.5
Coastline maintenance beach	4.4	0.01	0.03	0.2	0.3	4.2	7.9
Saltwater fairway maintenance	13.0	0.05	0.10	0.6	1.3	15.9	31.2
Total	**24.0**	**0.07**	**0.16**	**1.0**	**1.9**	**24.7**	**46.6**

Source: Operational data from hydraulic engineers, 'Bepaling milieu-impact Kustlijnzorg- projecten' (TNO, 2020), 'Methods for calculating the emissions of transport in the Netherlands' (Geilenkirchen et al, 2021).

As can be seen in table 5, a margin applies to this calculation. Fuel consumption per m^3 may vary considerably between the various types of work carried out (the use of different types of vessel, for instance, or the type of material dredged up or the distance travelled over water to the site of the work). The margin applied is greater for saltwater fairway maintenance than for coastline maintenance, as it involves a greater degree of uncertainty. This is partly due to the variation in type of work and the equipment used.

TNO has also made an estimation of the emissions for the freshwater hydraulic engineering fleet. The calculation of the emissions of CO_2 was made on the basis of an estimation of the fuel consumption and the number of engine service hours. At company level, engine service hours and distribution over power/engine capacity classes and age classes are available. The estimation of fuel consumption is made on the basis of average engine load, number of engine service hours and total engine capacity. It is assumed that an engine has an average capacity from its capacity class.

The calculations of NOx and PM are made on the basis of the number of engine service hours, number of litres used, engine age class and total engine capacity. These are multiplied on the basis of the emission factors based on emission measurements in practice. For more background information on the calculation methods used, see '*eindrapport verkenning duurzaamheidsopties zoete waterbouwvloot*' (Final Report on Investigation of Sustainability Options, Freshwater Hydraulic Engineering Fleet) by TNO. The calculations for CO_2, NOx and PM show that the total freshwater fleet emitted approx. 76 ktonnes of CO_2, 634 tonnes of NOx and 18 tonnes of PM emissions (see table 6).

Table 6. Annual emissions for freshwater dredging operations (2021)

	Number	CO_2-eq ktonnes	NOx (tonnes)	PM_{10} (tonnes)
Sand dredger (stationary)	46	21	162	5.1
Cutter-suction dredger - stationary/mobile	23	4	35	1.0
Suction hopper dredger	10	9	89	2.4
Bucket suction dredger	6	2	22	0.5
Grab (hopper) dredger	41	17	135	3.6
Silt pusher	14	0	1	0.0
Piling barge	19	7	32	0.9
Auxiliary equipment (support)	32	2	22	0.7
Hopper Barge	34	13	116	3.1
Push vessel	269	1	6	0.2
Other vessels	120	1	15	0.5
Total	**614**	**76**	**634**	**18**

Source: Eindrapport verkenning duurzaamheidsopties zoete waterbouwvloot (TNO 2022)

Material baseline measurement
If we look at the extent to which dredged material is 'upcycled' and reserves are protected, it is unclear what the current state of affairs is for these two targets in a quantitative sense. The aim of the transition path is to identify this over the next few years to improve monitoring and, as a result, to actively manage more on these two targets.

Rijkswaterstaat did, indeed, commission a survey into the circularity of earth movement operations in the Netherlands in 2018 (*Verkenning naar de betekenis van circulaire economie voor de grondketen* (Exploration of What Circularity Means for the Soil Supply Chain), 2018)). This survey makes findings, including that the largest proportion of the 'use' of dredged material and soil for civil-engineering (GWW) applications/work remains available within the reserves (of soil). So the survey shows that earth movement in the Netherlands is already putting into practice its interpretation of two of the transition path's circular economy targets. The greatest proportion of the dredged material/soil reserves can be reused. Only a relatively small amount may not be reused but must be processed as waste (discarded/removed from the reserves).

So all in all it's going pretty well, but things could always be better. And improvement is something we need (and will continue to do so). For instance, where protection of the reserves against new pollutants is concerned. Improvement is also necessary because support (from society) for the use of contaminated dredged material/soil (in line with the Soil Quality Decree *normenbouwhuis* (substantiation of standardisation)), or dredged material/soil replacement materials from other material supply chains (thermally-cleaned soil, granulate, bottom ash) appears to be reducing. And the duty of care that has to be taken into account during earth movement operations in relation to PFASs has led to a situation where reserves of usable and reusable dredged material/soil has dropped, compared with 2018.

4. Growth path for dredging equipment

The growth paths describe the route that the sector should follow to achieve the targets on the basis of the requirements to be made of floating dredging equipment that are divided into four time periods. The growth paths were created on the basis of the target range for nitrogen, particulate matter, CO_2, technical feasibility and costs. The starting point in this regard is that the measures must be realistic and feasible on the one hand, and challenging enough on the other to realise the ambitions and hit the targets. Autonomous development alone does not deliver enough of a result in this respect. The section below shows the relevant growth paths for both coastline and fairway maintenance.
There are two levels for each growth path. The basic level, for the 'peloton', and the ambition level, for the 'front runners'.

1. Basic level seagoing dredging equipment: contains all requirements included in the contracts of the public clients. The requirements within this level are made up of a combination of emission standards (tier-requirements and/or CCR standards) and a percentage of the work that should be carried out with renewable energy carriers.
2. Ambition level seagoing dredging equipment: contains the more ambitious requirements for further reducing emissions. Front runners among clients must translate these requirements in their contracts for the (front runner) projects. They can also impose requirements that go beyond the requirements in the table. The requirements within this level are made up of a combination of emission standards (tier requirements or CCR standards) and a percentage of the work that should be carried out with renewable energy carriers.

So for each period there are minimum requirements in relation to the dredging equipment to be deployed in a project (the basic level). These minimum requirements will be gradually tightened up. The requirements must be applied in contracts and permits. The requirements do not apply retroactively to current contracts or already awarded projects. In long-term contracts, the turning points are specified. As well as including minimum requirements, clients can also further challenge and encourage the market, for example via an awarding criterion focused on the deployment of zero emission vessels (the ambition level).

The growth path shows what is expected of stakeholders from the sector. This is done by indicating the speed at which measures will be taken up by means of procurement and underlying policy. The effect that this growth of measures has over time on the target range of SEB and KCI is reflected in the reduction path (chapter 5). As far as KCI is concerned, the ambition is to be 100% carbon neutral and to have called for tenders in relation to fully circular coastline and fairway maintenance projects by 2030. For SEB, there are aims in relation reference years: 60% reduction in nitrogen in relation to 2019 levels and 75% reduction in particulate matter (PM10) in relation to 2018 (Clean Air Agreement, SLA in Dutch).

It is important that there is support among the stakeholders for the proposed growth path. Work has been done on this recently by returning the growth path to the interdisciplinary Roadmap Working Group. This working group includes a range of contractors, industry associations and public authorities. The growth path referred to in this chapter is one of the results of that.

4.1. Measure and indicator types

We use various types of measures and indicators in the growth path. We do this to determine which minimum requirements should be set for each period. The table below (4.1) shows the measures that are used in the growth path. A further explanation of these measures is given in the subsequent sub-sections (4.1.1 & 4.1.2).

Table 4.1 Overview of type of measures and indicators

Measures	Indicators
1. Cleaner engines a. Tier emission requirements b. CCR emission standards	Tier emissions requirement Tier I - III CCR0 - Stage V – IWP/IWA/NRE
2. Use of renewable energy carriers a. Conventional biofuels b. Biofuels in accordance with RED annex IXa and IXb c. Renewable Fuels of Non-biological Origin (RFNBO) d. Renewable electricity	% renewable energy carriers

4.1.1 *Cleaner engines*

Measure one relates to cleaner propulsion, operating and auxiliary engines/motors of vessels. Dredging equipment newly introduced to the market must comply with the emissions requirements under the terms of legislation (European and otherwise). This is divided into two different categories. Propulsion of saltwater vessels is indicated by Tier emission standards. Propulsion of freshwater vessels is represented by the CCR standards. Each of these categories is explained in brief below.

Table 4.2 Overview of CCR standards and Tier emission standards

IMO emission standards tiers for seagoing vessels	CCR emission standards for inland/domestic vessels
Tier I (2000 – 2010)	CCRI (2003 – 2006)
Tier II (2011 – 2020)	CCRII (2007 – 2018)
Tier III (2021)	Stage V – IWP – IWA – NRE (2019)

The IMO Tier emission standards for seagoing vessels

Saltwater propulsion is classified on the basis of three Tier emission standards. Depending on the year of construction of the vessels, there may still be differences within a vessel type and vessel size classification. IMO MARPOL Annex VI Regulation 13, sets requirements relating to NOx emissions from diesel engines on board vessels (IMO, 2005). In that respect, either Tier I, Tier II or Tier III NOx standards are set for the engine depending on the year of construction of a vessel and the routes it travels.

Engines of vessels that came on the market between 2000 and 2011 must comply with the least strict Tier I standards. Engines of vessels that came on the market from 2011 onwards, by contrast, must comply with the Tier II standards. Tier III standards apply from year of construction 2021.

CCR emission standards for inland waterway vessels
In 2003, the Central Commission for Navigation on the Rhine (CCR) implemented the CCR phase 1 (CCR1) emission standards. The CCR1 standards show threshold values for the emission of nitrogen oxides, carbon dioxide, hydrocarbons and particulate matter. This standard was replaced in 2007 with the CCR phase 2 (CCR2) emission standards. The threshold values are reduced in comparison with CCR1 in these standards. The CCR2 standards were valid for newly installed engines in inland waterway vessels until 1 January 2019. From 1 January 2019, the NRMM stage V emission standard was introduced in a step-by-step process. The Stage V standard imposes considerably lower emission limit values. The EU stage V engines for shipping on inland waterways are sub-divided into three categories: IWP, IWA and NRE. See table 4.3 for an explanation of these categories.

Table 4.3 Overview of engine categories for EU stage V engines

Engine categories for NRMM stage V emission standards
Engine category IWP This category includes engines of 19 kW or more, exclusively used on inland navigation vessels for direct or indirect propulsion or intended for that purpose.
Engine category IWA Auxiliary engines with an output equal to or in excess of 19 KW used exclusively on inland shipping vessels are covered by category IWA.
Engine category NRE Engine category NRE relates to engines that although not directly intended for use on inland navigation vessels may nonetheless be used for that purpose. This specifically relates to engines with a capacity of less than 560 kW that are used in place of the engines of categories IWP or IWA.

4.1.2 Renewable energy carriers
The second measure of the growth path is the use of renewable energy carriers. We use the European Renewable Energy Directive (RED) to define renewable energy carriers. The entire European Directive can be found here.

Europe has set targets for the use of renewable fuels. The Directive obliges member states to deploy a minimum % of renewable energy in transportation. Consequently, member states must demonstrate that they have complied with the obligation.[1] In the Netherlands, this is a task of the National Emissions authority (NEa). The use of renewable energy carriers is regulated in the RED Directive. RED makes a distinction between different types of renewable energy carriers. We use the RED to classify the term renewable energy carriers:

1. Biofuels from residual and waste streams without processing by advanced technology (RED Annex IXb).
2. Biofuels from residual and waste streams processed by advanced technology (RED Annex IXa).
3. Food and crop based conventional biofuels
4. Renewable Fuels of Non-Biological Origin (RFNBO).
5. Renewable electricity.

[1] Air and maritime transportation are exempt from this obligation up to 1 January 2025.

The various energy carriers referred to above have large differences in Technology Readiness Level (TRL). This means that energy carriers will be deployed at different points in time.

Biofuels from residual and waste streams (RED Annex IX a and b)
There are two sorts of biofuel from residual and waste streams; biofuels obtained from raw materials in accordance with Annex IXa and IXb respectively.
Biofuels made from waste and residual matter, included in list B of annex IX, are made up of animal fat categories 1 and 2, and use frying fat, which is usually made from vegetable oils. Biofuels included in list A of Annex IX are fuels based on raw materials such as waste materials and agricultural residues, non-food crops, algae or ligno-cellulose. Annex I includes an overview of the fuels that currently (June 2023) fall under list a and list b.

As with conventional biofuels, biofuels from Annex IXb are regulated under the European Directives. The Netherlands limits these sorts of biofuels and targets the growth of advanced biofuels (Annex IXa). In respect of supplies for shipping in particular, there is a rapid increase (as of 2022) in the use of advanced biofuels aimed at shipping. Innovation and production of the advanced biofuels must continue to be stimulated in order to achieve our growth ambitions in other sectors, too. It is expected that the proportion of advanced biofuels will continue to grow in the future.

Although the quantity of biofuel continues to grow in the Netherlands, the availability of raw materials may become critical if the shipping and aviation sectors are going to use these in substantial quantities. So the availability of sustainable biofuels is something to be aware of and will be addressed by EU legislation and the Dutch Sustainability Framework for Biomaterials.

Powertrains using biofuels from Annex IXa and b are not carbon neutral under the terms of the RED. On paper, these give around 80 - 90% CO_2 reduction (heat reduction), depending on the feedstock. The powertrain will not be zero emission with an SCR and DPF, either.

These emission control devices can filter out a large part of the NOx and PM, sufficient to meet the limits of the most ambitious Tier III/stage V standards, but not a 100% reduction.

Conventional biofuels
Conventional biofuels are biofuels that are made from common crops such as oilseed rape, sugar cane and maize. This category is officially called 'food and crop based biofuels', but the term 'conventional biofuels' is often used.

The Netherlands is primarily targeting waste materials and residues, rather than food and crops. In the Netherlands, the use of conventional raw materials is limited to the level of 2020 (1.7%). That is a lot lower than the limit that Europe demands (7%). The European Directive also leaves space for a more stringent limit. In the Netherlands, crops are mainly used in ethanol for fuel mixtures.

Renewable Fuels of Non-Biological Origin (RFNBO)
In addition to (advanced) biofuels, we also recognise RFNBOs as renewable energy carriers. The category RFNBO includes energy carriers such as (green) hydrogen and E-fuels. E-fuels are an emerging class of carbon neutral combustion fuels. They are synthetic fuels, made from renewable electricity and CO_2 that is recovered from the air. Examples are methanol, ethanol, dimethylether (DME), ammonia, formic acid, metal hydrides, sodium borohydride or LOHC. E-fuels are not yet technologically highly developed, and it is expected that they will have only a small role to play until 2030.

Renewable electricity
In addition to RFNBOs, we have renewable (green) electricity as a renewable energy carrier up to and including 2030 (and beyond). Renewable electricity differs from grey electricity as it is not generated from fossil fuels.

RED III
The energy transportation policy is to be updated shortly under a European revision of the RED II (RED III) and other European (Fit for 55: FuelEU, ReFuel, ETS) and national (Coalition Agreement) developments. The aim is that amended legislation will come into effect on 1/1/2025. When the roadmap is evaluated, it is necessary to stay in line with and take into account the revision of this policy. This is important, for instance, to prevent offering excessive incentives, as it is reasonable to assume that this policy will already demand blends with a higher proportion of ethanol (in line with the transition paths) from 2025, to replace diesel.

Growth paths, basic v ambition level
In the basic path we define sustainable energy carriers as all renewable energy carriers specified in the RED. So this includes biofuels from residues and waste streams (Annex IXa & b), conventional biofuels, RFNBOs and renewable electricity. The starting point is that the deployment of feedstocks is regulated in the annual obligation and that biofuels from Annex IXa/b will be targeted.

For the ambition level we will, in addition to biofuels, focus on the use of RFNBOs and renewable electricity. This is to emphasise the point that ambitious clients want to encourage zero emission energy carriers for a limited percentage of their order portfolio. That is why a separate objective has been included. Although RFNBOs are not yet completely zero emission, their low TRL level does give them the potential to become fully zero emission (or get very close to this level).

Growth opportunities of sustainable energy carriers

As far as the transition path is concerned, we see limited growth opportunities for conventional biofuels and Annex IXb biofuels. There are a number of reasons for this which are explained in brief below:

Conventional biofuels

- As specified earlier, the use of conventional biofuels is regulated in the European Directives. For the Netherlands, there is a 1.4% limit on food and crop based fuels. This has been fixed for the period 2022 - 2030.
- The lifecycle emissions of crop based biofuels differ per raw material, but these fuels generally deliver a lower emissions reduction than Annex IXa and b biofuels or RFNBOs.
- There are worries about crop based biofuels (often conventional fuels) due to indirect emissions from changes in land use (ILUC), an increasing risk of deforestation and loss of biodiversity.
- In the shipping sector, the opportunities to use crop based biofuels are usually rejected. This category has not been included as a sustainable biofuel in the Fit-for-55 plans in order to prevent competition with the road transportation sector.

Biofuels, Annex IXb

- As mentioned above, the use of biofuels from Annex IXb and conventional biofuels is regulated in the European Directives. For the Netherlands, there is a limit on Annex IXb raw materials (oils and fats) of 10.0% including duplication. This will be fixed for the period 2022 - 2030. This regulation does not apply to shipping. Seagoing equipment is therefore exempt from this limitation.
- There are limits on the availability of the raw materials in Annex IXb. That is, even now, a strongly limiting factor that will only increase in the future. After all, there is great demand for these raw materials for the production of other transportation biofuels.
- Chain emissions from Annex IXb are (at the moment) comparable with Annex IXa, but often lower than conventional biofuels. However, the emission reduction potential is limited, given the limited volume for this category of biofuels
- Over the coming years, the potential production capacity for biofuels from Annex IXb will, it is expected, increase slightly, albeit at a very slow rate. The reason for this is that biofuels from Annex IXb are the most highly developed from a commercial point of view, and the cheapest to produce. Limitations caused by shortages of raw materials will, however, continue to form a barrier.

So growth in the deployment of renewable energy carriers in the basic and ambition growth path must, in the long term, be achieved from advanced biofuels (Annex IXa), RFNBOs or renewable electricity. In line with inland/domestic and European

Demonstrability of biofuels

Demonstrability of the use of specific biofuels is currently problematic for the end user. Biofuels at the fuel pump are a mixture of all possible biofuel categories from the RED (Conventional, Annex IXa and b). For this reason, it is impossible to determine exactly what sort of biofuel is actually filling the fuel tank. For that reason, it is not easy at this point to target the use of specific biofuels, because it is difficult to demonstrate that the biofuel is completely made up of a single specific biofuel. To be able to target the consumption of individual biofuels in future, it is important to keep working on the 'individual' demonstrability of the various sorts of biofuels in years to come. In that way, it will be possible in the future to better target the use of specific biofuels. Until that time, there is no separate objective included for the different types of biofuels from the RED for this transition path, but we view this as a collective objective (for the classification of biofuels, see 4.1.2).

4.1.3 Powertrains

The sustainable energy carriers can be used via a range of powertrains. We can differentiate between conventional piston engines (LNG/diesel), hybrid, fuel cell and battery/plug-in electric powertrains. The vast majority of the freshwater and saltwater fleet is powered by a combustion engine for direct drive. This means that the screw or other equipment driving the vessel is directly linked (via the transmission) to a single combustion engine.

A hybrid powertrain uses a hybrid configuration. This combines a combustion engine on the prop shaft with an electric motor, mounted in series on the same prop shaft. A modular powertrain has a modular construction of power generated by a diesel engine and power consumed by an electric motor. The advantage of a hybrid powertrain is that the conventional piston engine can, in theory, be replaced by a fuel cell or battery. This demands extra space in the vessel, as alternative sustainable energy carriers (e-fuels) have a significantly lower energy density than diesel or LNG. A "modular hybrid powertrain" provides that extra space and functionality in the modular design of the vessel.

A battery-powered powertrain often uses battery packs. They are charged with green energy and the electric powertrain on board the vessel ensures that no CO_2, nitrogen or particulate matter is emitted. A fuel cell powertrain is a powertrain in which hydrogen or methanol is converted into energy. Conversion of hydrogen in a fuel cell generates electricity, water and a little heat. So the sole emission that you have is water. To be really emission-free, you need green hydrogen as the input source, i.e. directly or indirectly produced with green energy.

When making investment decisions on sustainable powertrains, the following aspects appear to be important: operational costs of use (now and in the future), physical availability & infrastructure (now and in the future), safety and, obviously, reduction potential. We know from an initial analysis that suitable motors are not yet available for all types of energy carriers. Expectations in relation to when they become commercially available differ for each energy carrier.

Most of these energy carriers can be used in both a combustion engine and a fuel cell. Where used in a combustion engine there will always (regardless of after treatment) be a certain level of emission of NOx and particulate matter (PM). The extent of this depends on the energy carrier and the exact combustion technology of the engine. As yet relatively little known, although not unimportant, is the fact that aldehydes are released in some energy carriers (formaldehyde being the most well-known and frequently occurring of these); this is not yet covered by legislation, even though it is harmful.

A few (but not all) suppliers are able to reduce emissions of harmful substances to untraceable, basically zero emission levels by using 100% hydrogen in a combustion engine. Where these energy carriers are used in a fuel cell, zero emission levels are indeed reached. The most significant disadvantage of this is that such powertrains are much more expensive to purchase, some 2 - 5 times as expensive, depending on the size and application. So the question is how much you are willing to pay to go completely carbon neutral.

4.2. Growth path tables

The growth path can be divided into two different categories. Saltwater dredged material (coastline and saltwater fairway maintenance) and freshwater dredged material (freshwater fairway maintenance). See below for the growth paths for both categories.

Coastline and saltwater fairway maintenance (seagoing dredging equipment) - Basic level
Rijkswaterstaat - Port Authority

Vessel type		Period 1 2022 through to 2024	Period 2 2025 through to 2027	Period 3 2028 through to 2029	Period 4 From 2030
"Trailing suction hopper dredgers, Grab hopper dredger, grab dredger, cutter suction dredger, suction hopper dredger, water injection dredger"	Engines	Minimum emissions in compliance with Tier class I*/**	Minimum emissions in compliance with Tier class I*/**	Minimum emissions in compliance with Tier class II*/**	Minimum emissions in compliance with Tier class III*/**
	Energy carriers	At least 10% renewable energy carriers	At least 20% renewable energy carriers	At least 40% renewable energy carriers	At least 60% renewable energy carriers

** Certified tier I to III or retrofit compliant with emission standards in compliance with Tier I to III*

*** With the exception of vessels with a hopper capacity >15,000 m3 that can be demonstrated necessary for performance of the work*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Fairway maintenance freshwater - Basic level
Rijkswaterstaat - Provinces - Municipalities - Water boards

Vessel type		Period 1 2022 through to 2024	Period 2 2025 through to 2027	Period 3 2028 through to 2029	Period 4 From 2030
Hopper barge, silt pushers, auxiliary equipment (survey vessels, tugs and push boats), small cutter suction dredgers** other small waterborne dredging equipment	Engines	No requirement	No requirement	Minimum emissions in accordance with CCR II*	Minimum emissions in accordance with CCR II*
	Energy carriers	At least 20% renewable energy carriers	At least 35% renewable energy carriers	At least 60% renewable energy carriers	At least 75% renewable energy carriers
"Grab hopper dredger, grab dredger, cutter suction dredger, bucket wheel suction dredgers, hopper barges, piling barges, support vessels, suction hopper dredger"	Engines	No requirement	No requirement	Minimum emissions in accordance with CCR II*	Minimum emissions in accordance with stage V (IWP-IWA)*
	Energy carriers	At least 20% renewable energy carriers	At least 35% renewable energy carriers	At least 60% renewable energy carriers	At least 75% renewable energy carriers

** Certified CCR I to stage V (IWP-IWA) inclusive or retrofit compliant with the emission standards in accordance with CCRI to stage V (IWP-IWA)*

*** Small cutter suction dredgers are suction dredgers deployed solely on zone 4 waters.*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Coastline and saltwater fairway maintenance (seagoing dredging equipment) - Ambition Rijkswaterstaat - Port Authority

Vessel type		Period 1 2022 through to 2024	Period 2 2025 through to 2027	Period 3 2028 through to 2029	Period 4 From 2030
"Trailing suction hopper dredgers, Grab hopper dredger, grab dredger, cutter suction dredger, suction hopper dredger, water injection dredger"	Engines	Ambition 20% Tier class III*	Ambition 50% Tier class III*	Emissions in accordance with Tier class III*	Emissions in accordance with Tier class III*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 90% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or RE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 10% RFNBOs or RE

** Certified Tier I to III or retrofit compliant with the emission standards in accordance with Tier I to III*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Explanatory note 5: RE stands for renewable electricity & RFNBOs stands for renewable fuels of non-biological origin

Fairway maintenance freshwater - Ambition level
Rijkswaterstaat - Provinces - Municipalities - Water boards

Vessel type		Period 1 2022 through to 2024	Period 2 2025 through to 2027	Period 3 2028 through to 2029	Period 4 From 2030
Hopper barge, silt pushers, auxiliary equipment (survey vessels, tugs and push boats), small cutter suction dredgers** other small waterborne dredging equipment	Engines	No requirement	Ambition 10% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 40% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 70% emissions in accordance with stage V (IWP-IWA- NRE)*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 85% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or HE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 15% RFNBOs or RE
"Grab hopper dredger, grab dredger, cutter suction dredger, bucket wheel suction dredgers, hopper barges, piling barges, support vessels, suction hopper dredger"	Engines	No requirement	Ambition 25% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 60% emissions in accordance with stage V (IWP-IWA- NRE)*	Ambition 100% emissions in accordance with stage V (IWP-IWA- NRE)*
	Energy carriers	Ambition 20% biofuels	Ambition 40% biofuels	Ambition 60% biofuels	Ambition 85% biofuels
	RFNBOs + RE	Ambition 1% RFNBOs or HE	Ambition 2% RFNBOs or RE	Ambition 5% RFNBOs or RE	Ambition 15% RFNBOs or RE

** Certified CCR I to stage V (IWP-IWA) inclusive or retrofit compliant with the emission standards in accordance with CCRI to stage V (IWP-IWA)*

*** Small cutter suction dredgers are suction dredgers deployed solely on zone 4 waters.*

Explanatory note 1: Non-installed mobile equipment on vessels falls under the transition path road, dike and rail equipment (WDSM)

Explanatory note 2: xy% renewable energy carriers: at least xy% renewable energy carriers in accordance with RED in the contract portfolio of the client

Explanatory note 3: Emission class standards relate to the weighted average of the installed capacity on the vessel as a whole, including all main, auxiliary and work engines.

Explanatory note 4: For classification of renewable energy carriers, see section 4.1.2. of the roadmap

Explanatory note 5: RE stands for renewable electricity & RFNBOs stands for renewable fuels of non-biological origin

4.2.1. *General starting points*

The growth paths referred to above have been validated in consultation with the sector and TNO. This was done in two workshops. A number of general starting points for the growth paths emerged from these workshops. We will explain them briefly below:

1. The pace and scale of the measures reproduced in the growth path are based on the technical maturity of cleaner options, the economic feasibility and support/continued effect of the measures by the stakeholders involved. The pace and scale of the measures have also been validated in consultation with the sector and TNO.

2. We follow the Renewable Energy Directive (RED, European directive on renewable energy) for defining the sustainable energy carriers. The sources of energy below are defined as being sustainable:
   a. Biofuels that fall under RED Annex IXa and Annex IXb.
   b. Conventional biofuels
   c. Renewable Fuel of Non-biological Origin (RFNBO).
   d. Renewable electricity.

3. Whether or not the emission standards for a specific emissions class have been met can be indicated by direct certification for the relevant standard for a new ship to be built or by means of a retrofit that complies with the emission standards that apply to the emissions class in question.

4. The decision has been taken to not distinguish between different output classes in the categorisation of floating dredging equipment, in order to prevent so-called ‘avoidance behaviour’.

5. To continue investing in making engines more sustainable in a way that is cost-effective, it has been decided that emission class standards (Tier standards and CCR standards) should relate to the weighted average of the installed power on the vessel as a whole. This includes all main, auxiliary and working engines.

6. The starting point is that the percentage of sustainable energy carriers is measured on the contract portfolio of the client. This is done to offer space to individual projects in which the use of sustainable energy carriers is troublesome (or more challenging).

7. Non-installed mobile machinery on vessels falls under the transition path road, dike and rail equipment (WDSM). This category includes mobile pumps, booster stations, crawler and mobile cranes, and bulldozers. This non-fixed installed mobile machinery correspondingly falls under the regime of the WDSM growth path.

4.2.2. Growth path, basic level

Coastline and saltwater fairway maintenance

Minimum requirements for engines

Looking at the basic level growth path for coastline and saltwater fairway maintenance we see the following. For saltwater dredging operations, cleaner engines does not focus on requirements any stricter than the Tier I standards for period 3. The primary reason for this is that TNO calculations have revealed that under those conditions, 50% of the available fleet would be rendered obsolete. It does not appear realistic to replace 50% of the saltwater fleet within 3 years. It would also seem logical, when replacing vessels, to acquire Tier III-compliant vessels immediately. Whereas this sounds logical, the choice is nonetheless to take a transitional step and to go for a minimum requirement of Tier II in period 3. The consideration in this respect was to give the market more time to issue tenders for Tier III as a minimum requirement in period 4.

Finally, there is an exception for vessels with a hopper capacity in excess of 15,000 m^3 It is both economically and technologically unrealistic to set minimum requirements for vessels with a hopper capacity in excess of 15,000 m^3. For that reason, the basic level of the growth path makes an exception for seagoing vessels in excess of 15,000 m^3. Vessels with a capacity in excess of 15,000 m^3 are hardly ever used for dredging work as part of coastline and saltwater fairway maintenance. As a result, the expectation is that the impact on the ultimate target range of the growth path will be slight.

Minimum requirements for sustainable energy carriers

The minimum requirements relating to the use of sustainable fuels are also going to be built up slowly over the next few years. As stated previously, efforts to increase the use of sustainable fuels will particularly have to be sought in the advanced biofuels in Annex IXa and RFNBOs. Due to the limited availability of these fuels, the minimum requirements in the first two periods will be low, before rising sharply. Where coastline maintenance is concerned, from period 3 using a hydrogen- or methanol-powered trailing suction hopper dredger may be taken into account. Together with companies, Rijkswaterstaat is busy researching the situation and developing a trailing suction hopper dredger of this type. This means that the use of sustainable fuels will continue to rise. It is expected that from period 4 RFNBOs will be so technologically advanced from period 4 onwards that they will be introduced in practice. This will ensure that the use of sustainable fuels rises even further.

Freshwater fairway maintenance

Minimum requirements for engines

If we look at the basic level growth path for freshwater fairway maintenance, what is noticeable is that there are no minimum requirements in respect of the CCR standards in the first two periods. The reason for this is that there are relatively many 'old' cutter suction dredgers, hopper barges, piling barges and support vessels in the fleet. TNO research shows that more than 80% of the current fleet is CCRI-compliant, or even lower. It is not realistic to aim for replacement of all this within the first two periods.

What is also noticeable is that no requirements have been set for the category 'hopper barges and other vessels' higher than CCRII in period 4. For small cutter-suction dredgers and silt pushers, requirements in excess of CCRII are not actually physically possible. The Stage V engines for this category are larger than the current engines; in other words, they do not fit in the hull of these vessels. Of course, it would be possible to install a larger hull, but the vessels would then not be able to pass under certain older bridges. This will particularly be a problem for the water boards. This group solely concerns vessels that operate in category-4 waters. The category grab (hopper) dredgers, cutter-suction dredgers and suction hopper dredgers does not have this limitation and, furthermore, is also relatively new (2013 - 2016) compared with the category of barges and other vessels. That is why the basic level for the CCR standards has been approached from a 'stricter' angle for this category (Stage V IWP/IWA).

Finally, it is well to mention that the minimum requirements for Stage V engines for the category crane vessels, cutter-suction dredgers and hopper dredgers relate solely to IWP and IWA engines. This has been decided because the requirements made for NRE engines appear to be infeasible for a large part of the fleet. See the table below for the relevant exhaust emissions in g/kWh.

Table 4.4 Stage V emission standards for IWP & IWA

Category	Net Power	Date	CO	HC_a	NOx	PM	PN
	kW			*g/kWh*			*1/kWh*
IWP/IWA-v/c-1	19 ≤ < 75	2019	5.00	4.70_b		0.30	-
IWP/IWA-v/c-2	75 ≤ P < 130	2019	5.00	5.40_b		0.14	-
IWP/IWA-v/c-3	130 ≤ P < 300	2019	3.50	1.00	2.10	0.10	-
IWP/IWA-v/c-4	P ≥ 300	2020	3.50	0.19	1.80	0.015	1×10^{12}

$_a$ A = 6.00 for gas engines
$_b$ HC + NOx

Minimum requirements for sustainable energy carriers
No distinction is made between the various vessel types for sustainable energy carriers in relation to freshwater fairway maintenance. This is to create a level playing field for the use of the various power classes and vessel types. The minimum requirement of 75% sustainable energy carriers in period 4 is solely possible if biofuels are procured on a large scale.

4.2.3. Growth path, ambition level

Coastline and saltwater fairway maintenance

Ambition for engines
The ambition is to focus as quickly as possible on engines that comply with the Tier III emission standards. So the aim is to make sure that half of the vessels to be deployed already comply with this by the end of period 2. It is expected that this will be possible in respect of coastline maintenance. This is due to the limited number of trailing suction hopper dredgers (7 - 9 vessels per year) that is needed to carry out the work. Rijkswaterstaat is also the sole client in the sector, so it is easier to control the situation. Many of the trailing suction hopper dredgers deployed in coastline maintenance already comply with the Tier II standards; it is merely a small step up to Tier III. However, this does not mean that the entire 'trailing suction hopper dredger fleet' in the Netherlands meets these standards; just the vessels that work on behalf of Rijkswaterstaat will have to comply with the standards. As far as saltwater fairway maintenance is concerned, it is expected that attaining the ambition will be a lot more challenging. Because in this respect, we have to deal with multiple clients and a diverse fleet of vessels that also vary greatly in the emission standards with which they have to comply.

Ambition for sustainable energy carriers
For sustainable energy carriers, the ambition is to hit the 100% sustainable energy carrier mark in period 4. This relates to a combination of both biofuels and RFNBOs and renewable electricity. In respect of biofuels from Annex IXa, RFNBOs and renewable electricity, the availability in the short term will be restricted. For that reason, it is expected that conventional biofuels and biofuels in Annex IXb in particular will be used in the first periods. In the medium to long term (period 2/3), availability of biofuels from Annex IXa will increase and technological developments will advance accordingly. As a result, the proportion of the use of these advanced biofuels will increase. In addition, it is expected that the first pilot projects and work with RFNBOs will be possible. In the longer term, RFNBOs (such as e-fuels and hydrogen), but also renewable electricity, in combination with the accompanying powertrain, will be so technologically advanced that this becomes a feasible option for renewable energy carriers. However, it is not realistic to expect this before period 4. This means that we can conclude that carbon neutrality, i.e. no net emissions of carbon, nitrogen and particulate matter, is not feasible for the transition path in 2030.

In this respect, it is also important to note that there is still uncertainty surrounding the availability of RFNBOs in this period. RFNBOs can, in addition to renewable electricity, make the decisive difference for our aims of 100% carbon neutrality in the period following 2030. To ensure that these developments are put in motion at the earliest possible stage, the task for the clients is to target the use of RFNBOs at an early stage (periods 1 and 2). This was also an important reason to opt for the ambition level for a separate objective for this category of energy carriers.

Freshwater fairway maintenance

Ambition for engines
The minimum requirements set in relation to the Tier emission standards for freshwater fairway maintenance in the first two periods are limited. To accommodate this, there is an incentive for getting vessel types cleaner by focusing on an ambition in relation to stage V (IWA - IWP - NRE). Ultimately, this should ensure that at least 70% of the fleet is made up of stage V (IWA - IWP - NRE) in period 4, due to new procurement, updates and retrofitting. It will be a challenge to achieve this ambition, given the age of the fleet and limitations arising from the environment in which the work takes place. So achieving this ambition will only be possible if there is large-scale conversion of engines with a targeted retrofitting campaign.

Ambition for sustainable energy carriers
The aim is to apply 100% sustainable energy carriers (categories 3 & 4) at the end of period 4. To create a level playing field here, too, it has been chosen not to make a distinction between the various power classes and vessel types. The considerations that apply to coastline and saltwater fairway maintenance in respect of sustainable energy carriers also apply to freshwater fairway maintenance.

5. Reduction path for dredging equipment

The reduction path outlines the expected fall in harmful emissions, broken down into emissions of CO_2, NOx and PM10 (particulate matter) for the sector. In this way, the reduction path shows the expected effect of the growth path. The reduction path is expressed in two different scenarios: an autonomous scenario and a challenging & feasible scenario. The starting point for the reduction path is determined in chapter 3, with a description of the baseline measurement. A short description of the meaning of the scenarios is shown below:

- Autonomous scenario: this scenario is based on not adopting additional measures, as a result of which there is no acceleration in the reduction of emissions. It is expected that emissions will gradually fall over the years through technological developments, but that this reduction will be limited.
- Challenging and feasible scenario: the reduction path for the challenging & feasible scenario was drafted on the basis of the 'Basic level floating dredging equipment' growth path. These are the minimum requirements that are set.

The starting points for the Climate and Energy Outlook (PBL, 2021) form the framework for autonomous development. The reduction paths are calculated by TNO on the basis of available, up-to-date information from the registers, and models for vessels. These models are also used for the national emissions figures.

As with the growth path, the reduction path is a model that points in a particular direction without making a precise prediction of the future (the data and model are a representation of reality). It is an ambition that we determine together on the basis of a challenging & feasible scenario, underpinned quantitatively by TNO in the "Identification and categorisation of current and future range of sustainable mobile machinery, building-logistics vehicles, rail equipment and vessels deployed for hydraulic engineering 2022" report (in Dutch). The expected fall in CO_2, NOx and particulate matter is determined by the measures that are referred to in the growth path. Each measure has a different effect. To give an idea of the emissions (CO_2, NOx and particulate matter) on which the measures have an impact, see below for a qualitative analysis. We use the labels below:

+ = positive impact on emission reduction
+/- = no impact
- = negative impact on emission reduction

Table 5.1. Overview of the impact of the measures

Measures for the growth path	Carbon dioxide (CO_2-eq)	Nitrogen (NOx)	Particulate matter (PM)
1. Measure design			
1.1 Tier classes	+/-	+	+/-
1.2 CCR emission standards	+/-	+	+
2. Sustainable energy carriers			
2.1 Cat.1 conventional biofuels	+/-	+/-	-
2.2 Cat. 2 biofuels from waste streams	+	+/-	-
2.3 Cat. 3 advanced biofuels	+	+/-	-
2.4 Cat. 4 Renewable Fuels of Non Biological Origin	+	+	+

In addition to a description of the qualitative impact that the measures have, TNO has assessed the quantitative impact that the measures elicit. This quantitative impact is included in the tables below. A distinction is made here between the autonomous and challenging & feasible scenarios.

5.1. Reduction path tables

The table below shows what the reduction in the saltwater and freshwater dredging operations is on the basis of an autonomous scenario. As far as the trend in the run-up to 2030 is concerned, it is expected that the scope of the fleet and the work for both components will remain stable. The autonomous scenario assumes not having to take any additional measures. So public clients will offer no 'extra' incentives for further reduction of CO_2, NOx and PM.

Table 5.2. Impact of the Autonomous reduction path, Source TNO 2022 R11048

		2021	2025	2030	2021 - 2030
Saltwater	CO_2-eq - Mtonnes	0.12	0.11	0.11	-5%
	NOx – Ktonnes	1.50	1.34	1.10	-27%
	PM – tonnes	35.7	35.7	35.7	0%
Freshwater	CO_2-eq - Mtonnes	0.055	0.051	0.045	-18%
	NOx – Ktonnes	0.47	0.46	0.43	-10%
	PM – tonnes	13	12	11	-17%

The results show that the average reduction is c. 15% for saltwater dredging operations. This is particularly the consequence of a (small-scale) rejuvenation of the fleet: as a result, emissions will fall over years to come. This fall will be steeper for NOx in the saltwater fleet (-27%) than in the freshwater fleet (-10%). This is because tender procedures for the saltwater fleet include emissions under the environmental cost indicator (ECI). This gives companies an incentive to rejuvenate their fleet or implement retrofitting solutions. It is expected that the emissions will fall within the foreseeable future as a result. This incentive is not present for all tasks/contracts for the freshwater fleet. The result of this is that the fleet is, on average, a little older, although there is wide variation between vessel types. In terms of CO_2 emissions the effect is reversed; the fall in the freshwater fleet (-18%) will be more rapid than in the saltwater fleet (-5%). The cause of this is the blending mandate for biofuels in inland shipping fuels.

So without having to take additional measures, we can see that there is an ongoing fall in emissions. This fall will continue under the challenging & feasible scenario. The table below shows the effects of the challenging & feasible scenario for saltwater dredging operations.

Table 5.3 Autonomous versus challenging & feasible scenario for saltwater dredging operations. Source TNO 2022 R11048

	2021	2030 autonomous	% in relation to 2021	2030 challenging	% in relation to 2021
CO_2-eq - Mtonnes	0.12	0.11	-5%	0.06	-45%
NOx – Ktonnes	1.50	1.10	-27%	0.42	-70%
PM – tonnes	0.04	0.04	0%	0.04	0%

The results show that the greatest reduction is in emissions of nitrogen (70%). This is to do with the tightening of the Tier emission requirements towards Tier III in 2030. The effect on CO_2 is less spectacular, but there will still be a reduction of around 50%. This is primarily caused by the growth of advanced biofuels (category 3) and the phasing out of conventional biofuels (category 1) plus biofuels from waste streams (category 2).
RFNBOs will have a limited role before 2030, so this will have hardly any effect on CO_2 and NOx reduction. There will be no reduction in particulate matter as the Tier emission standards have no bearing on particulate matter. A conscious choice has been made not to achieve this via other measures as the impact of particulate matter emissions on open sea in terms of health-related complaints is low.

In terms of freshwater dredging operations, we also see that there will be a sharp fall in emissions in the challenging and feasible scenario. The table below shows the effects of this feasible scenario on freshwater dredging.

Table 5.4 Autonomous v challenging & feasible scenario for freshwater dredging operations. Source TNO 2022 R11048

	2021	**2030 autonomous**	**% in relation to 2021**	**2030 challenging**	**% in relation to 2021**
CO_2-eq - Mtonnes	0.055	0.045	-18%	0.021	-61%
NOx – Ktonnes	0.47	0.43	-10%	0.16	-67%
PM – tonnes	0.013	0.011	-17%	0.002	-85%

The reduction path shows a steep fall in the emissions. As with saltwater dredging operations, this fall in CO_2 can be attributed to the use of biofuels. The starting point for the calculation of this fall is the use of advanced biofuels (category 3) with a heat recovery reduction of 70%. The reduction for NOx and PM runs parallel to the gradual uptake of the CCR emission standards. In contrast to saltwater dredging operations, we do see a sharp drop in particulate matter emissions here. This is because the CCR emission standards also relate to the reduction of particulate matter. It is also necessary, in contrast to saltwater dredging operations, to limit particulate matter emissions. This is because freshwater dredging operations are often conducted in places where particulate matter emissions could have an adverse impact on health in the surrounding area.

The reduction paths show that where the ambitious & feasible scenario is applied throughout the sector, the ambitions and targets enshrined in the Approach to Nitrogen, the Clean Air Agreement and the Climate Agreement can be hit. This is not the case for the KCI aims. They do assume 100% carbon neutral status in 2030. By choosing to target RFNBOs and electricity after 2030 as well, this would only be feasible after 2030.

5.2. Costs

To ensure effective and efficient implementation of the transition it is important to get a better understanding of the expected costs and yields. The costs associated with the Coastline and Fairway Maintenance transition path have been mapped out by TNO (Estimate of additional costs, Clean and Zero emission Construction for Mobile Dredging Equipment, Construction Transport, and Coastline and Fairway Maintenance, 2023). In the sections below, we discuss the results of this study.

The costs for the Coastline and Fairway Maintenance transition path have been calculated for two scenarios.

Scenario 1: in the first scenario, existing powertrains with an internal combustion engine are retained and retrofitted with an SCR catalytic converter and diesel particulate filter (DPF) for seagoing vessels, or engine upgrade to a Stage V engine for the freshwater fleet.

Scenario 2: in the second scenario, an estimate of the cost of changing the powertrains is included for the freshwater fleet. This is an estimate based on current cost prognoses for alternative powertrains using electricity[3].

Before we present the costs of both scenarios, we should pause to consider the starting points used to make the calculations.

1. For the first scenario the estimate is based on the costs for installation of DPFs (€315,000) and SCR catalytic converters (€420,000) for all engines of an average seagoing hydraulic engineering vessel.
2. A term of 15 years leaving no residual value on the investment is used to calculate the depreciation on said investment.
3. The installation of the SCR and DPF account for extra operation and maintenance costs. For that reason, a 10% margin is built into the annual costs in addition to depreciation.
4. Other than additional costs for the technological investment in the vessel, additional costs for sustainable fuels are also included. This calculation assumes that B100 fuel is 42% more expensive than conventional MGO (based on EICB and TNO, 2021).

An estimate of the costs has been made for both saltwater and freshwater dredging operations. For each of these categories an estimation has been made of the total costs of investment and the extra annual operational costs for the fleet as a whole.

Costs - saltwater

The costs of saltwater dredging operations are made up of costs for the conversion to Tier III in order to hit the NOx target, in combination with use of advanced fuels to hit the CO_2 target. The costs have been calculated on the basis of the numbers of vessels in the saltwater fleet requiring investment in clean technology to meet the requirements. The costs for conversion to electric powertrains or fuel cells has not been included for the saltwater hydraulic engineering fleet in this study. However it is expected that this will be considerably higher than the costs that are presented here.

3. A note of caution in this respect is that for a number of hydraulic engineering vessels, new powertrain technology is not yet suitable for operations at sufficient power with the required uptime. For vessels for which this is not considered to be technically feasible it has been assumed that a Stage V internal combustion engine can be used.

Table 5.5 Additional costs, saltwater dredging operations

		Total investment	Costs per year in 2030	Cumulative costs, 2022 - 2030
Investment and depreciation	Basic	€ 38,200,000	€ 2,400,000	€ 17,900,000
	Basic and ambitious	€ 38,200,000	€ 2,400,000	€ 17,900,000
Additional costs, sustainable energy carriers	Basic	-	€ 12,300,000	€ 44,500,000
	Basic and ambitious	-	€ 20,500,000	€ 91,600,000
Total extra costs	Basic	**€ 38,200,000**	**€ 14,600,000**	**€ 62,400,000**
	Basic and ambitious	**€ 38,200,000**	**€ 22,900,000**	**€ 95,000,000**

The table shows that the most sizeable costs for the sector are accounted for by the increasing use of category 3 biofuels. The higher costs of the ambitious level relative to the basic level are due to the increasing use of these sustainable energy carriers. In 2030, this concerns additional costs of EUR 8.2m per year. The cumulative amount for the whole period up to and including 2030 amounts to additional costs of EUR 32.5m for the ambitious level over and above the basic level.

Costs - freshwater

The cost estimation for the freshwater hydraulic engineering fleet is based on cleaner existing technology using after treatment methods. This estimation does not take into account new technology and alternative powertrains, such as battery power or hydrogen. That sort of technology is considerably more pricey than the existing internal combustion engines. TNO has estimated that alternative, sustainable powertrains could add up to an investment of around EUR 500m. This would mean around EUR 26m per year for depreciation and sustainable fuels. The table below presents the costs for reduction of NOx and PM emissions and cleaner engines with Stage V.

Table 5.6. Additional costs, freshwater dredging operations

		Total investment	Costs per year in 2030	Cumulative costs, 2022 - 2030
Investment, stage V, SCR + DPF	Basic	€ 50,000,000	€ 3,300,000	€ 11,300,000
	Basic and ambitious	€ 50,000,000	€ 3,300,000	€ 11,700,000
Additional costs energy carriers	Basic	-	€ 3,500,000	€ 17,000,000
	Basic and ambitious	-	€ 4,700,000	€ 22,500,000
Total extra costs	Basic	**€ 50,000,000**	**€ 6,800,000**	**€ 28,300,000**
	Basic and ambitious	**€ 50,000,000**	**€ 8,000,000**	**€ 34,200,000**

The total investment costs (EUR 50m) are considerably higher than the investment costs that are needed for the saltwater dredging operations (EUR 38m). More will have to be invested to reach the minimum requirements and ambition relating to the CCR emission standards. The primary reason for this is the relatively old age of the freshwater dredging fleet compared with the saltwater dredging fleet. The freshwater dredging sector will thus have to invest more to meet the requirements that have been set. The annual costs for sustainable energy carriers are, indeed, considerably lower than for the saltwater dredging fleet, as a relatively smaller amount needs to be invested to convert to advanced biofuels.

Conclusion

The table below shows the additional costs for the floating dredging equipment used in Coastline and Fairway Maintenance. A large proportion of the additional costs is taken up by the share of sustainable fuels (EUR 61.5m - 99.5m). This also includes a large factor for uncertainty, as how the prices for these fuels may move in future is, as yet, uncertain. The total investment in new technology to meet the emissions requirements is lower, but still significantly large (EUR 88.2m). Before ship owners are prepared to make these investments, they will need a measure of certainty to be able to recover the investment in subsequent years.

Table 5.7 Total additional costs, Coastline and Fairway Maintenance (saltwater and freshwater)

		Total investment	Cumulative costs, 2022 - 2030
New dredging equipment	Basic	€ 88,200,000	€ 29,200,000
	Basic and ambitious	€ 88,200,000	€ 29,600,000
Additional costs, sustainable energy carriers	Basic	-	€ 61,500,000
	Basic and ambitious	-	€ 99,500,000
Total extra costs	Basic	**€ 88,200,000**	**€ 90,700,000**
	Basic and ambitious	**€ 88,200,000**	**€ 129,100,000**

6. Growth and reduction path for material

In addition to the growth and reduction path for dredging equipment, we will also consider the growth and reduction path for material in this chapter. We will briefly discuss the feasibility of a growth and reduction path and also assess the available measures for hitting the targets formulated in section 1.3 (Targets 4 & 5).

6.1 Growth and reduction path feasibility

It is a fact that enforcement of a reduction target for dredged material/soil is not realistic. Volumes of dredged material and earth streams have been inventoried in outline only. So it is not possible to measure (and control) the progress and yield of measures for the dredged material/soil, in the same way that it is done for the emissions of dredging equipment, with an independent reduction and growth path. The roadmap for the dredged material/soil may have an impact on the growth and reduction paths for the (use of) the dredging equipment. Use of this, along with the implementation logistics (transportation) is strongly influenced by the preconditions that legislation (environmental and other) makes of the use of the dredged material/soil. So the preconditions for working with dredged material/soil in a circular way have an impact on (are decisive for) the footprint of dredging/excavation work.

6.2 'Stock protection' type measures

There are two reasons to protect stock. First and foremost, it is important to protect the quality of the 'dredged material/soil stock' or, alternatively, to protect water systems and the substrate. If dredged material/soil becomes polluted with substances from other material chains (e.g. PFASs) this can have the result that stocks shrink, as polluted dredged material/soil can no longer be used. In such cases, the value of the stock declines. So it is important to focus on prevention of substrate and water pollution in order to maintain and protect the quality of the dredged material/soil. In this respect there are already legal instruments in force, such as the Soil Protection Act (*Wet bodembescherming*), the Water Act (*Waterwet*), the Nature Protection Act (*Wet milieubeheer*) and the Soil Quality Decree (BBK) and soon, potentially, the Environment and Planning Act (*Omgevingswet*). An EU soil strategy is currently being developed.

The stock can also be protected by using it efficiently. Asset managers, such as Rijkswaterstaat, are unable to control this effectively. This is because the usefulness and necessity of dredging depends on decision-making relating to the building and design of infrastructure in the Netherlands. However, conditions are set in advance in relation to actual use/reuse of (extracted) dredged material/soil in order to protect stock. It is important to ensure that the quality of the stock is not affected by the use or reuse of dredged material/soil and building materials on or in the stock in question (substrate/water system). There is already a (legal) framework in effect in the Netherlands to this end (including the Soil Quality Decree). This national-level (legal) framework includes standards that aim to ensure that the 'leaching' of pollutants from 'works' made out of dredged material/soil, or of other materials that replace the substrate, do not pose a threat to the quality of the stock/soil/ groundwater/water. So this framework prevents loss of the value of soil/dredged material that is available in the stock.

It is expected that the need for civil engineering projects and, as a consequence, the use of dredged material/soil will increase in the future. This is, in part, due to the necessity of climate adaptation. Aiming to use 50% less dredged material/soil is not assumed to be realistic and has little relevance to the targets outlined here relating to circular economy.
Use of stock can be limited by using other materials in place of soil. So-called soil replacement materials. These are materials obtained from other material chains. They may, for instance, be residual products from rubble production (granulite), or ash from waste incineration. These materials may have properties that make use in earthworks functional. The scope of these material streams is, however, nowhere near large enough to make use of soil superfluous. It may be able to help to minimise the use of soil.

The (legal) framework in the Netherlands and the standards this covers are, at present, the subject of social debate. The framework/the standard for use of soil (granulite) and dredged material in deep lakes is being questioned.
Another area of debate is use of thermally-cleaned soil, while there are concerns about other secondary construction materials. A further point is the lack of standards relating to PFASs. This situation means that there is a lack of clarity and that project implementation is associated with risks. The improvement of support for the substantiation of standardisation (normenbouwhuis) for contaminated substrates, soil, dredged material and construction substances is thus of great importance for circular operations with dredged material/soil.

6.3 'High-value reuse' type measures

High-value reuse/upcycling has direct relevance to the use of dredged material/soil. When it is used, it is important that dredged material/soil retains its value. This may mean that, once it has been used, the properties of the dredged material/soil have not changed. However, dredged material/soil is a collective term. The properties of dredged material/soil can be very different. Sand, for instance, has completely different properties to silt from a (small) watercourse and, consequently, both materials have different values. The suitability for a particular use depends on these properties. One example is the suitability of clay for dykes and embankments, which depends on the specific properties of the clay. Clay which has these properties has a high value. When it is used for this, it is important that the value is harnessed (and retained). From the point of view of the circular economy aims, it is important to use the dredged material/soil in as high-value a way as possible.

It is relevant to note that substrates and water systems have, in the past, become contaminated with many pollutants (at the same time). And even today known and unknown contaminants are released into the environment. For example PFASs. Discharges of this kind ultimately affect the value of dredged material/soil. As referred to under the protection of stock, the Soil Quality Decree applies to earth moving. This decree sets conditions for the use of contaminated dredged material/soil and, as a result, also specifies when contaminated dredging material/soil may not be used. The Soil Quality Decree, or the extent of contamination, is thus another factor determining the value of dredged material/soil. A balance has been found between, on the one hand, the use of contaminated dredged material/soil from stock and, on the other, the protection of the stock itself, although only for standardised substances. The precautionary principle must be applied to non-standardised substances that have contaminated the substrate or water systems (such as PFASs and other substances of very high concern). The PFAS Operating Framework makes it clear that the use of a 'precautionary approach' to an 'end-of-pipe problem' makes stocks of reusable soil a lot smaller. Since mid-2019, stocks of reusable dredged material/soil in the Netherlands have become a lot smaller. And, as stated, there is little support from society at large for the use of 'soil replacement materials'. High-value dredged materials/soil have become more scarce.

At this point, the legal framework for the use of dredged material/soil offers little or no manoeuvring room for contractors to seek (tailor-made) solutions for the use of contaminated dredged material/soil[3]. That is an obstacle to high-quality use of dredged material/soil. The Soil Quality Decree views the use of dredged material/soil as useful if this is functional (and proportional). This Decree does not include a ranking for use of dredged material/soil or soil replacement materials. So there is some room available for optimisation of the interpretation/effect by the asset managers.

3. The legislation (the system) for earth moving is wide-ranging and complex (many definitions) and, as such, is a structure that is difficult to explain and allows ample opportunity to make mistakes. An Infrastructure & Water Management (Ministry) task force is working on improving the system. More to the point, the meaning in relation to product quality (functional properties of earth works) is contested (quality of substantiation of standardisation) There is a desire to improve (and broaden) substantiation of standardisation.

7. KCI Action Programme

In order to create the growth path and thus also the reduction path, it is necessary to jointly formulate actions that are preconditions for this. There are conceivable interventions along various courses of action:

- **Policy course of action:** The policy course considers the policy measures that can be taken to reduce the emissions of floating dredging equipment. In addition, this course of action addresses a number of management measures surrounding the organisation of initiatives from the roadmap.

- **Market and procurement course of action:** The market and procurement course considers the procurement instruments that can be used to achieve the continued reduction of emissions. These include, for example, the use of ECI, additional BPQR criteria or the standardisation of the tender process. All these elements must, together, be combined into a single procurement strategy that is ideally coordinated with various government agencies, so as to create uniformity.

- **Knowledge and innovation course of action:** The knowledge and innovation course of action is about innovation, standardisation and production (I-U-P in Dutch). The Coastline and Fairway Maintenance transition path is not itself a framework for carrying out research or pilot projects; the focus is, after all, on realising the transition by means of execution of projects, or 'the production'. Nevertheless, precisely thanks to this focus, specific research questions from this production environment can be addressed. In addition, it is also possible to take part in the introduction and launch of promising innovations that can be scaled up in practice. So starting with the transition path, we differentiate the phases of innovation (developing knowledge, applying it, trying it out and evaluating it), standardisation (making it suitable for standardisation/scaling up) and production (making knowledge/innovation profitable for the best price/quality ratio). For all of these phases, knowledge and experience is needed that as far as possible we will develop with our partners and combine for the ambitions and targets of the transition path. Knowledge and/or innovation development is necessary for sustainable measures and production processes that:
  - can already be used now in standard contracts for production (Production TRL 9);
  - are ready to be scaled up by the launching customer (Standardise TRL 7-8);
  - are yet to be developed in innovation and knowledge programmes etc. (Innovation TRL 5-8).

  Furthermore, there is a range of research, developments and pilot projects relating to the transition paths and Rijkswaterstaat's partners in which new knowledge is being developed or to which contributions are being made that could be used successfully in Rijkswaterstaat projects.

- **Finance course of action:** This course of action describes the financial incentives that can be deployed by the government to further encourage the transition. This relates both to ‘pricing up’ or making polluting activities more expensive and ‘rewarding’ activities that reduce emissions.

- **Material (dredged material and soil) course of action:** This course of action is based on the actions needed to realise the ambitions set for dredged material and soil. Broadly speaking, within this course of action three categories of action are regarded as necessary:
  - improvements on policy (legislation, framing the (EU) playing field).
  - knowledge development and innovation.
  - implementation-related improvements.

- **Miscellaneous courses of action:** The actions in this topic generally apply to information management, the configuration of the governance and the creation of programme management.

To give an outline idea of the different actions, the section below includes an overview of the sub-topics for each course of action, with a short explanation per topic.

Policy course of action

Topics	
Formulating policy	These actions relate to which policy needs to be formulated in order to achieve the aims. An example of this is the drafting of policy in relation to biofuels.
Partnership	These actions relate to working together with several parties in order to learn from one another and to formulate a coherent policy to present to companies. For example, this includes the coordination of the procurement strategy by public-sector clients in the dredging Buyer Group, and getting the sector as a whole on board for the transition strategy. And joint initiatives, such as the 'Zero Emission Dredging Hub' are also taken up.

Market and procurement course of action

Topics	
Strategy	The actions with the 'strategy' topic under market and procurement concern the development and shaping of an appropriate procurement strategy to achieve the ambitions as agreed in this transition path.
Procurement instruments	These actions are related to the instruments that can be used to implement the conceived strategies. Possible examples are ECI requirements on the dredging equipment or an emission performance label.

Knowledge and innovation course of action

Topics	
Research	The actions in the 'research' course of action are related to outsourcing or following-up relevant research/studies with a low TRL level that may be able to make a sizeable contribution to hitting the sustainability targets in the future. An example of this is the TU Delft study into dredging with low peak output levels.
Demonstrations	The actions in the field of demonstrations are more concrete and relate to innovations that have a somewhat higher TRL level. 'Demonstrations' teaches what works and what doesn't, for example the 'Sailing through mud' (*varen door slib*) demonstration. The aim is to go from research to demonstrations, and to implementation.
Implementation	The actions in the 'implementation' course of action are linked to actions that are needed to put innovations really into operation.

Finance course of action

Topics	
Stimulation	The actions in this topic relate to what is needed to stimulate the right developments (and to reward front runners).
Innovation	The actions within this topic relate to which initiatives and innovations need to be deployed and how these should be financed.

Material (dredged material and soil) course of action

Topics	
Policy-based improvements	These actions are focused on formulating/reformulating policy relating to dredged material and soil. Changing the policy frameworks and regulations (the playing field) is a powerful instrument. Policy-related actions can have a greater impact than those in respect of project implementation. In terms of policy, there is already an action agenda for improving the legislation on how to deal with dredged material and soil. This should, in part, be dedicated to achieving the ambitions in this transition path.
Knowledge development and innovation	Knowledge development should be focused on supporting the achievement of the ambitions relating to dredged material and soil. Knowledge development is aimed at improving the policy, the dredged material and soil itself, and improving the actual use of that material. Actions in this category can be developed by many parties, both by government agencies (Ministries such as Infrastructure and Water Management), and by the market and research institutes.
Implementation -related improvements	An important subject for this theme is the value of reuse. A number of ideas are currently being explored (clay from dredged material, stones from dredged material, dykes from 'native' soil, dredged material as a soil improver etc.). Except for the implementation of the work itself, this category of actions may also concern the procurement or tendering policy of clients in the civil engineering. In that case, it may be a matter of knowledge sharing or further development of collaborative working methods.

Miscellaneous courses of action

Topics	
Miscellaneous	The actions in this topic generally apply to information management, the configuration of governance and the creation of programme management.

8. Monitoring and evaluation

Exactly what the monitoring system will look like is not yet certain, and is one of the outstanding actions. More work will be carried out on the precise structuring of the monitoring system, over the coming year. In this chapter, we do consider the different levels of monitoring that exist within the transition path. As with the SEB roadmap, the effects of the Coastline and Fairway Maintenance roadmap are monitored on three levels. At an overarching level, to assess the impact of the approach on the total emissions of the sector. At the level of Rijkswaterstaat, to see how the roadmap is implemented. And at project level, to see what the influence of the agreements is on implementation of actual projects. This chapter gives a description of the monitoring at sector, organisation and project level. In addition, we briefly consider the evaluation of the programme.

Level 1: Monitoring effects in the sector
To be able to monitor the effects at sector level, use is made of the monitoring system that will be established for the SEB roadmap. As with the Coastline and Fairway Maintenance transition path, the system will be filled in further in the coming year, so we cannot yet explain this in greater detail. What is important is that the starting points from the baseline measurement, on which the growth paths in the Coastline and Fairway Maintenance roadmap are based, will be fixed. In that way it is possible to prevent situations in which dissimilar things are nonetheless compared. If there is a departure from the starting points, it is important to specify where this is the case so that any differences can be explained. The most recent baseline measurement for both the dredging equipment and the material is described in section 3.2.

As described in section 3.2, it is unclear what the current position is for the extent to which dredged material is being upcycled/given high-value reuse and resources are being protected. The transition path aims to get a picture of this in years to come to improve monitoring and thus to get a better focus on these two ambitions. One of the points that call for attention in this respect is the registration of released quantities of dredged material and soil in projects. In addition, the specification of indicators we wish to monitor is something we have to consider to be able to make progress on the ambitions surrounding dredging equipment clear.

Level 2: Monitoring of the effects within Rijkswaterstaat
In addition to monitoring at sector level, it is important that Rijkswaterstaat monitors the emission and reductions achieved by its own organisation. Unfortunately, it is not yet certain what form this will take within Rijkswaterstaat. For that reason, work will be carried out on a monitoring system in 2023. Doing so, we will consider the issue of how we at Rijkswaterstaat will monitor the progress and which indicators we will use, but also which data would be needed in that case, and whether this data is already available.

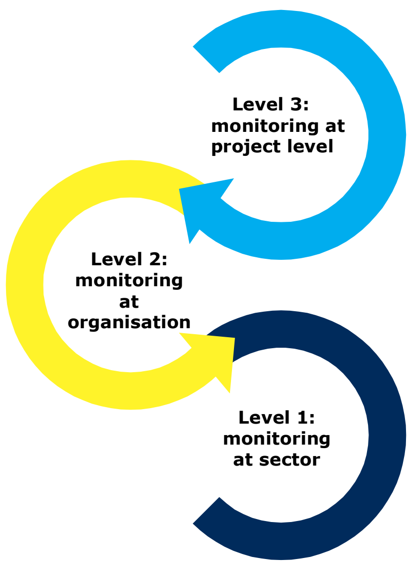
We do see a number of potential options. For example, it is possible to monitor the reduction achieved in relation to a reference year. If, as part of the monitoring system, a choice is made to measure the reduction, it would be important to make a baseline measurement at organisation level in advance.

Another option is not to carry out a baseline measurement, but to regularly monitor what the situation is surrounding emissions and achieving the set ambitions. As a result, it is not necessary any more to work with a reference year; rather, you can opt to monitor absolute annual emissions. With the configuration of the monitoring system, this choice will be filled in further.

Regardless of the fact that the configuration of the system is still unclear, we can still say that monitoring the progress at organisation level is important. On the one hand to be able to monitor the effects of measures and, on the other, because the terms of the SEB imply that information on the progress of implementation of the roadmap will be supplied annually. SEB uses this information to monitor at sector level. Parties are expected to give an insight into the reduction in emissions achieved. Monitoring at organisation level is essential to achieve this.

Level 3: Monitoring of the effects at project level
Clients can monitor the expected emission reductions from the projects on which they impose additional requirements on sustainability. A variety of methods can be used for this purpose. For example the 'Sustainable public procurement' report and the 'Emissions tool'.
Agreements made in this context between clients and contractors can also serve as the basis for monitoring and enforcement for the term of the project. In addition, the monitoring data at project level can in turn serve as input for monitoring at organisation level (see figure 8.1).

Figure 8.1 Different monitoring levels



Evaluation
New developments, insights and information may lead to adjustments to the roadmap. Evaluations will be carried out in 2024, 2027 and 2030. Participating parties will be closely involved in these evaluations. The information gathered via the monitoring levels described above will form the basis for the evaluation process. During the evaluation, aspects looked at will include whether targets in the field of nitrogen, CO_2 and particulate matter have been hit as efficiently and effectively as possible. Whether or not the roadmap is having the effect envisaged in the original starting points will also be assessed.

9. Cooperation in the chain

To make the market transformation successful, it is important to understand which stakeholders need to make interventions, what sort of interventions these are and in which phase they need to be performed to improve key processes, accelerate the emerging system and put the old system under pressure.
Every party in the chain must grasp his or her role; it is essential to work together. Below is a summary of collaborative roles in the chain that are required to implement the Coastline and Fairway Maintenance roadmap.

Role of the clients
The roadmaps and structural inclusion of the ambitions in the awarding and contract of contracts in projects for clients such as Rijkswaterstaat and the water boards is essential to the implementation of the KCI strategy.

The clients' role is on a number of different levels:
Demand aggregation: Investigating the possibility of demand aggregation at European level to kick-start production of large-scale zero emission dredging equipment (e.g. via EU Big Buyers Group).
Demand stability: Stable demand from clients means that entrepreneurs' investment risk will reduce.
Communication of vision and future demand: It is important to communicate aims and future demand clearly to reduce perceived risks (to manufacturers of dredging equipment, but also to buyers of large-scale dredging equipment in the Netherlands).
Reward front runners: Rewarding front runners may, particularly in chain links with many companies as is the case with contractors, provide an extra acceleration.
Cooperation with front runners at policy level: Dutch companies in hydraulic engineering are in demand for their expertise around the world. So pushing the boundaries and innovating are in the sector's DNA. Working together with front-runners will help clients to come up with challenging, yet feasible policy.

Rijkswaterstaat is also exploring whether it is possible to make a paradigm shift in the market for seagoing vessels. That is why the 'Innovation in Coastline Mainteance' (Innovaties in de kustlijnzorg, IKZ) programme was started. This is a programme with which Rijkswaterstaat, together with companies, aims to develop one or more sustainable, cost-effective innovation(s) with the ambition of achieving coastline maintenance that is free from emissions of greenhouse gases. Together with the market, we have opted for the innovation partnership (IPS) instrument, in which Rijkswaterstaat supports market parties with the development of their innovation. This development lasts a number of years and has a number of points at which progress is contingent on a go-ahead being given. The IKZ programme is an important link in the Coastline and Fairway Maintenance transition path.

Role of the contractors
The coastline and fairway maintenance roadmap demands a lot of the sector, not least in terms of creative and innovative solutions. The ambition expressed in this roadmap is challenging and, as such, cannot be attained without the help of all parties. Everyone is agreed about the necessity of increased sustainability, but the sector is characterised by a number of specific features that make this especially challenging. An example of this is the atypical fleet with its wide range of support vessels: from mowing boats to giant dredging vessels that are deployed for various sorts of project, each with its own challenges in terms of CO_2 reduction. Furthermore, it is a very capital-intensive market. So it is important that contractors have actively assisted in the process of drawing up the growth and reduction path for the roadmap. In addition, the role of the contractors is very specifically to implement contracts in the most sustainable way possible and, in so doing, meeting at least minimum environmental requirements. They are further expected to invest in sustainable innovation projects.

Role of manufacturers and suppliers
The switch to and target range of the roadmap depends on availability/accessibility of the required dredging equipment in good time. Important actors in this respect are the shipyards and engine manufacturers. These two types of industry players do not operate exclusively for the dredging market but also for sectors such as container shipping and offshore, especially in regions outside the Netherlands. Given the large difference in the (peak) power requirements of dredging equipment, specific innovations for sustainability are needed here. However, dredging equipment is a very small market in terms of heavy industry as a whole. In respect of efforts to make the sector more sustainable, dredging companies often work together with shipyards and manufacturers.

Solutions aimed at acceleration and upscaling are conceivable due to joint procurement and a shared equipment pool. This goes hand-in-hand with a growing trend for companies to lease or rent dredging equipment and is one way to create greater flexibility and purchasing power for the (as yet relatively) high purchase prices of zero emissions equipment.

Role of research institutes, umbrella organisations and industry associations The transition to clean, zero emission equipment demands a lot of knowledge from the clients and contractors concerned. Research institutes, industry associations and umbrella organisations form an essential link in the design, coordination, and development and distribution of information and knowledge. This may include current agreements in relation to the SEB roadmap, legislation on dredging equipment, safety requirements (in relation to the use of dredging equipment with batteries or hydrogen) besides requirements relating to emissions, the possibilities of obtaining grants, knowledge on fuelling and loading infrastructure, the environmental impact of the industry etc.

Annex I

Part A. Raw materials for the production of biogas for transportation, and advanced biofuels, for which it may be assumed that their contribution to attaining the minimum shares referred to in article 25(1), paragraphs 1 and 4, is twice their energy content

a) Algae, where cultivated on land, in ponds or in photobioreactors.

b) The biomass fraction of mixed municipal waste, but not separately collected household waste, to which recycling targets apply in accordance with article 11(2)a of Directive 2008/98/EC.

c) Bio-waste as defined in article 3, point 4 of Directive 2008/98/EC (for private households), to which separate collection as defined in article 3, point 11 of said directive applies.

d) The bio-mass fraction of industrial waste unsuitable for use in the fodder or food chain, including material from wholesale and retail, the agro-feed industry and the fisheries/aquaculture sector, with the exception of the raw materials referred to in part B of this annex.

e) Straw.

f) Livestock manure and sewage sludge.

g) Palm oil mill effluent and palm bunches.

h) Tall oil pitch.

i) Crude glycerine.

j) Sugarcane bagasse.

k) Grape marc and lees.

l) Nutshells.

m) Husks.

n) Cobs from which the maize has been degermed.

o) Bio-mass fraction of waste materials and residues from forestry and forestry-based industry, such as bark, branches, pre-commercial thinnings, leaves, needles, canopies, sawdust, wood shavings/chips, black liquor, brown liquor, fibre sludge, lignin and tall oil.

p) Other non-food cellulose material.

q) Other ligno-cellulose material, except trunks or blocks suitable for sawing and veneer.

Part B. Raw materials for the production of biofuels and biogas for transportation of which the contribution to attaining the minimum share defined in article 25(1), paragraph 1 is restricted, and for which it may be assumed that this is twice their energy content.

a) Used cooking oil.

b) Animal fat, in either category 1 or 2, in accordance with Regulation (EU) no. 1069/2009.

Rijkswaterst

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