

Efficiency Assessment Hollandse Kust (noord) and Hollandse Kust (west) Alpha

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Glossary

ARM	Active Risk Manager (TenneT's risk management system)
BAFO	Best And Final Offer
cPRMHB	Corporate Project Risk Management Handbook
EMV	Expected Monetary
EMVI	Most Economically Advantageous Tender
ER	Exception Report
FAT	Factory Acceptance Test
FID	Final Investment Decision
FO	Fibre optic
G2	Gate 2
HKN	Hollandse Kust Noord
HKWa	Hollandse Kust West Alpha
HKWb	Hollandse Kust West Beta
HV	High-Voltage
IBN	Commissioning
k€	One thousand euros
kV	Kilovolt
M€	Million euro
MVA	Megavolt-Ampere
NaZ	Offshore grid infrastructure
PI	Punch Item
RFC	Request For Change
PBA	Project Budget Application
PMT	Project Management Technology
PSG	Project Steering Group
RSM	Risk Sharing Model
SAT	Site Acceptance Test
SLD	Single-Line Diagram
SO	System Operations (TenneT's asset management organisation)
WaZ	Onshore grid infrastructure
W2W	Walk-to-Work
ZRO	Business Law Agreement

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1 Introduction

1.1 Background

In support of the Netherlands' energy transition, the 2013 Energy Agreement of the Social and Economic Council (SER) assigned TenneT TSO ('TenneT') the responsibility for developing and operating the offshore electricity grid—an approach aimed at ensuring efficiency and minimising costs. This role is formalised in Article 16e of the Electricity Act and further detailed in the Development Framework for Offshore Wind Energy[1], which sets out a.o. the legal, technical, and planning parameters for the realisation of offshore grid infrastructure through to 2031, during which time TenneT will establish 16 offshore grid connections.

TenneT was officially designated as the offshore grid operator by the Authority Consumer and Market (ACM) on 15 July 2016, and the Energy Agenda of 7 December 2016 confirms its obligation to connect offshore wind farms. The Development Framework outlines essential criteria for both wind farm developers and TenneT, including commissioning timelines, connection methods, expected lifespans, and capacity limits for offshore wind farms. It also mandates the use of standard offshore substations, each with a capacity of either 700 MW or 2 GW, at eight designated wind generation locations (Roadmap, April 2016).

The projects subject of this efficiency assessment, Hollandse Kust Noord (HKN) and Hollandse Kust West Alpha (HKWa), were originally planned as separate projects with independent cable routes to shore. The 2018 Routekaart Windenergie op Zee introduced the concept of a shared connection, which was formalised in the 2019 update to the Development Framework. This consolidated approach, combined with an interlink cable with Hollandse Kust West Beta (HKWb), enhances redundancy and grid reliability while reducing costs, infrastructure duplication, and environmental impact. While being part of the same wind energy area, HKWb and the interlink are part of a different project scheduled for completion in 2026 and therefore fall outside the scope of the current assessment.

Under the Electricity Act 1998, a system operator may include the costs incurred for grid-investments in the tariff proposal, provided the costs are efficient. The ACM should therefore commission an efficiency test on the costs incurred by TenneT for these offshore grid connections.

The ACM uses a policy rule[2] to assess the efficiency of investment costs. This means that the ACM must determine whether the purpose of the investment has been achieved and whether the costs sufficiently plausibly and substantiated contribute to the stated purpose. In this context, the ACM commissioned AFRY Netherlands BV ('AFRY') to carry out an investigation as described below.

[1] Appendix 1.01 Development Framework (ontwikkelkader d.d. April 2024)
[2] Policy rule ACM assessment of efficient costs of non-regular expansion investments

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1.2 Scope

The technical scope of the project is summarised in the visual below and comprises the following key components:

Offshore grid

- Two offshore platforms each accommodating 2 transformers (220/66 kV, 400 MVA), 220 kV GIS and a 66 kV GIS to connect the offshore wind farms
- HKN sea cable of approx. 2 x 34.7 km + 2x3x1.8 km land cable. HKN 1 and HKN 2 (overall approx. 70 km sea cable and 10.8 km land cable), fibre optic (FO) 3x34.7 km (sea) + 3x1.8 km (land)
- HKWa sea cable of approx. 2 x 70 km + 2x3x1.8 km land cable. HKWa 1 and HKWa 2 (overall approx. 140 km sea cable and 10.8 km land cable), FO 3x70 km (sea) + 3x1.8 km (land)
- A control and protection system
- A redundant telecommunication network between the platforms and the onshore substation

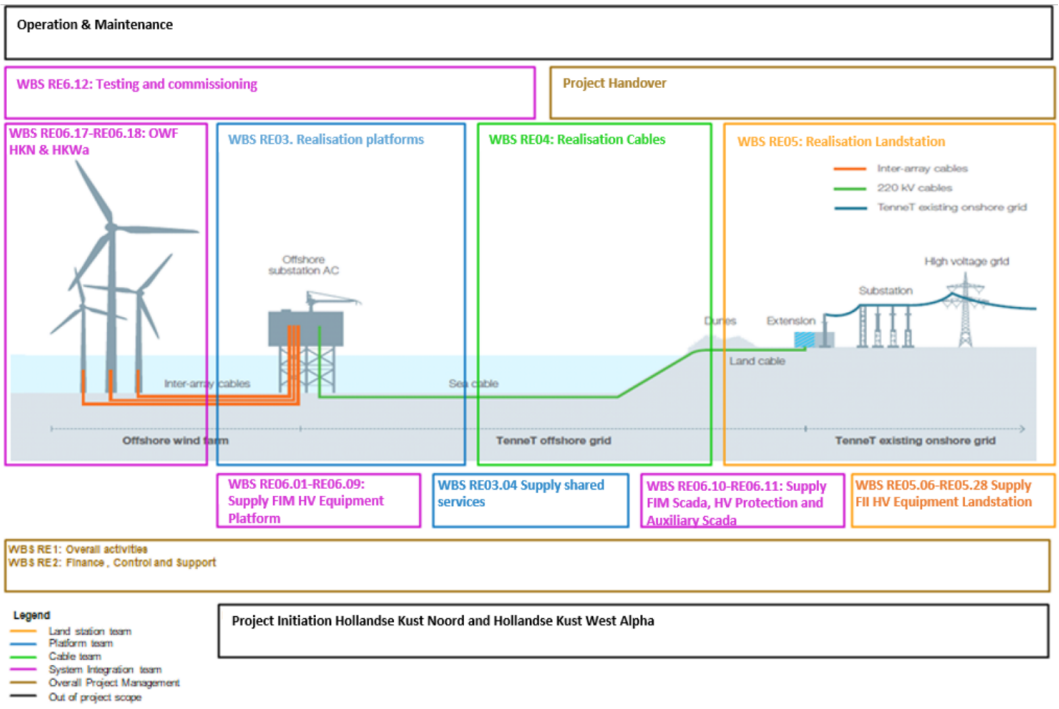


Figure 1: Technical scope offshore grid

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Onshore

The landstation scope is divided into HKWb/HKWa/HKN NoZ (offshore grid infrastructure) and WaZ (onshore grid infrastructure) as shown below.

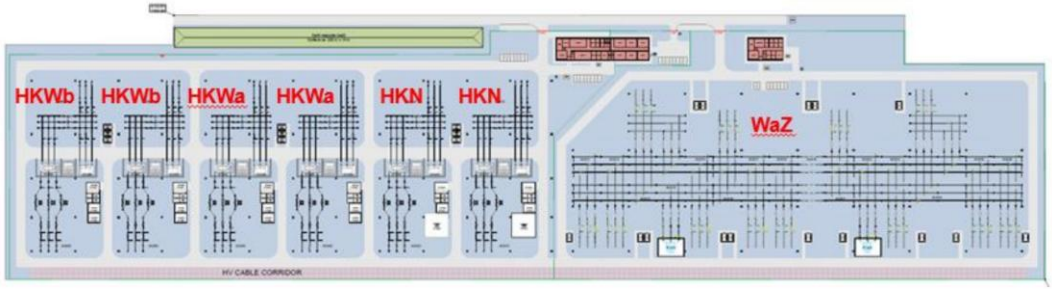


Figure 2: Technical scope onshore grid

Landstation HKN – HKW Alpha (NoZ):

- 6x 380 kV switchgear (cable bays WaZ)
- 6x 220 kV switchgear (cable bays platform)
- 6x 380/220/33 kV transformer switchgear, including 220 kV shunt reactors
- 6x 33 kV switchgear

Onshore substation (WaZ):

- 4x 380 kV cable bays (HKN/HKWa)
- 2x 380 kV reactor bays (2x 150 MVAr)
- 1x 380 kV coupling cable bay (1x BVW380)
- 2x 380 kV cable bays (2x BVW380)
- 1x 380 kV coupling bay
- 1x general bay

Cable 380 KV (onshore grid):

- 87 km 380 KV cable between substations Wijk aan Zee and Beverwijk

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2 Research questions

In this report, AFRY answers the Research questions from the table below to assess the efficiency of investments for HKN and HKWa.

	Research questions
1	Has the goal been achieved by realising the intended capacity, in the sense that it is actually and sustainably available? To determine effectiveness, sustainability was measured up to 3 months after project delivery.
2	What is the relationship between the investment budget prepared by TenneT (at the time of the final investment decision) and the most recent investment budget used by TenneT? What is the cause of any difference?
3	Is there adequate risk management by TenneT? When answering this question, consider the use of the risk budget and how TenneT uses previous experience from projects in the Netherlands or Germany.
4	Is there a difference of more than 15% between the total realised capital expenditure (including estimated capital expenditure incurred after commissioning) and a counter-budget prepared by you? If yes, what causes the difference?
5	Were formal procurement procedures followed? If not, what was the reason for this? What procedures were followed to select the contractors?
6	Do the cost items (excluding additional work) contribute to the objective? Were any costs avoidable and, if so, what proportion of the costs?
7	How does the additional work contribute to the objective? Was this additional work avoidable and, if so, what part of the additional work?
8	What amounts to efficiency? Depending on the answers to the above questions, AFRY experts will evaluate the overall efficiency of the project and this will be noted along with the reasoning.

Table 1: Overview of Research questions

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3 Approach

The approach for the efficiency assessment of the 'HKN/HKWa' project is based on answering the Research questions posed by the ACM and described in Chapter 2. This Chapter provides insight into the approach taken to answer the questions posed.

3.1 Assessment of effectiveness

Based on the Research questions, the effectiveness of the project investment is determined in terms of risk management, financial, technical and procurement. All relevant documents and data of the investment provided by TenneT, answers to questions via written Q&A and oral explanation of answers and aspects of the project during working sessions, are assessed by the AFRY experts. All documents mentioned in the assessment have been provided by TenneT and documented in the footnotes.

To answer the Research questions, AFRY distinguishes qualitative and quantitative questions:

Qualitative questions **-** These types of questions require a qualitative analysis of the plans, works, actions and processes. The answer to this type of questions is whether the performance or process has been carried out adequately or insufficiently and whether this is well substantiated based on the available documentation. Questions 1, 3 and 5 fall under this type and are scored based on the following categories:

Score	Meaning
Sufficient	A sufficient degree of efficiency and all aspects are adequately substantiated.
Insufficient	An insufficient degree of effectiveness and/or the rationale is not sufficient.

Table 2: Assessment qualitative questions

Quantitative questions **-** This type of question requires a quantitative analysis of the documents. The result is presented as a number, namely a percentage, ratio or total value of investment to be avoided. Questions 2, 4, 6, 7 and 8 fall under this type of questions.

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4 Answering research questions

4.1 Research question 1

'Has the goal been achieved by realizing the intended capacity, in the sense that it is actually and sustainably available? To determine effectiveness, sustainability was measured up to 3 months after project delivery.'

AFRY concludes that TenneT has fully met the objectives for the design, construction, and commissioning of HKN and HKWa. The intended capacity, performance targets, and operational availability (three months) have been achieved, and the requirements outlined in the Development Framework are considered fulfilled.

4.1.1 Methodology

For the evaluation of the goal of the project, AFRY will verify 3 main topics:

1. Has TenneT fulfilled the requirements as set out in the Development Framework[1]?
2. Has TenneT reached the target capacity?
3. Has TenneT reached a sustainable availability?

The assessment is done based on the documentation provided, responses to written questions and exchange of information during working sessions.

4.1.2 Assessment

This section first verifies the requirement as per Development framework, the target capacity and finally the sustainable availability.

Development Framework

The project's planned capacity, as outlined in the Development Framework, is a minimum of 700 MW on a continuous basis. The Development Framework also states additional requirements for new connections, with the key ones being:

1. The general functional requirements and technical concept with a goal to minimize the overall costs of the project and the respective wind farms together
2. The technical assessment by an independent consultant
3. The required date of availability (HKN 31/03/23 and HKWa 31/3/24)
4. A maximum available power of 760 MW, including dynamic loading of cables

These main requirements serve as the foundation for project development and execution.

The assessment of the objective *to minimise the overall costs of offshore wind, as in the cost of the wind farms and offshore grid connection system altogether* is expected to be undertaken as part of Development Framework programme management, taking into account the resulting functional requirements and technical studies; this is not within the scope of this assessment, nor has information been provided which could substantiate fulfilling this requirement.

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TenneT has hired DNV-GL as the independent consultant to execute a complete technical assessment from the start until grid readiness. The task of assessing and evaluating the pertinent regulations, norms, and standards for power transport falls also upon this independent entity DNV-GL, which has reviewed all design documents, simulations, tender documentation, FATs, HATs and SATs.

DNV-GL has determined that grid readiness was achieved for HKN on 30/03/23 and for HKWa on 22/12/23. TenneT has reported that HKWa was preponed in respect to the original planning as to have an efficiency with executing the works in parallel with HKN. Based on the Grid Readiness Certificates, AFRY confirms that both connections were technically prepared and in compliance with functional requirements and relevant (test) standards.

The transport capability of 760 MW, as determined by dynamic loading, is primarily reliant on the 220 kV cable connections. The Single Line Diagram confirms that the other equipment can handle this 760 MW load. This specific technical requirement is an integral part of the 220 kV cable design, and thus, AFRY considers it to be compliant.

AFRY concludes that both HKN and HKWa sufficiently comply with all the main requirements outlined in the Development Framework.

Target capacity

To verify the target capacity, AFRY takes the following steps in the analysis:

1. Determination of target capacity according to TenneT
2. Verify that the target capacity is correctly incorporated in the basic design(s) and the components have been technically specified to comply
3. Verify that the supplied components that determine the capacity meet minimum requirements

The Development framework has clearly set out the transport capacity to be 700 MW minimum, while with dynamic loading the Framework states this can be increased to 760 MW. AFRY sees the above as a sound basis for verifying the target capacity.

The basic design of the complete system and technical specifications of the main components and protection systems (supported with simulations), have been verified by DNV and considered to be compliant with the target capacity according to the annex of their verification certificates item[3] #3 and #16. On this basis, AFRY concludes that the project objective can be achieved with the technical specification of the components. The requirements for cable ampacity calculations differ from the conventional conservative standard, which typically necessitates an evaluation of the maximum continuous load. TenneT, however, has opted for a dynamic approach of taking into account the gradual heating of the ground and cables deeply buried underground[4]. This approach still results in a cable design that is able to handle the required power to be transmitted without overheating the cable, while being monitored by a DTS (Distributed Temperature System). AFRY considers this approach as acceptable for the dynamic transport requirement.

The construction of the components is verified by DNV during FAT, HAT and SAT and show to have been compliant with the technical requirements as originating from the

[3] DNV Grid Readiness Verification HKN/HKWa
[4] Vraag71_CigrePaper_B1-118_2018

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design phase. On this basis, AFRY concludes that the project objective can be achieved with the built and installed components.

AFRY concludes that both HKN and HKWa comply with the three requirements related to the target capacity.

Note: Although the design and installed components appear capable of delivering the required transport power, operational verification of the contractual capacity (minimum 700 MW or dynamic 760 MW) has not been demonstrated or confirmed by TenneT. In addition, the grid readiness certificates and verification plans do not cover the additional equipment at the 380 kV Wijk aan Zee substation or the connecting cables to Beverwijk. However, AFRY reviewed selected equipment test reports and all SAT reports for the cables, and considers their readiness and status satisfactory.

Sustainable availability

Sustainably available refers to long-term availability with as few interruptions as possible from maintenance, breakdowns and disruptions (due to circumstances or by/from other connected parties). Formally, this can only be determined at the end of an asset's lifetime. To verify sustainable availability in the short period after commissioning (IBN), AFRY takes the following analysis steps:

1. Determine whether an availability target has been set for each connection that fits within the overall target availability of TenneT's network
2. Determine what the availability of each connection was for 3 months after commissioning
3. Assess whether the reasons for unavailability during that period and character of reported punch items (PI) might lead to long-term unavailability during the lifetime
4. Assess whether the operational lifetime of the grid, including any potential extensions, aligns with the Development Framework and other applicable regulatory requirements.

TenneT has not provided a target availability set out starting the design. She has calculated that the base design would arrive at an average availability of 98.7% based on the total amount of energy that could have been delivered (so not based on a percentage of the (maximum) installed transport capability, being the guaranteed 700 MW). This definition is deviating from the availability numbers for the onshore grid but can be used when checking other set-ups as future platforms / islands.
The base design in this case consists of 2 export cables with symmetrical compensation (not for HKN as being close to the shore, hence it did not require compensation on the offshore end), 2 onshore and 2 offshore transformers and no further coupling. TenneT has calculated the NPV (based on electricity lost with different electricity prices) for several other setups of the transporting grid and compared this with the additional CAPEX. This has resulted in including one adaptation: coupling of the 66 kV GIS bays offshore (as to cope with the loss of an onshore transformer, export cable or offshore transformer) providing a limited transport capability during an n-1 case. This increased the availability based on electricity lost by 0.4% leading to 99.1%. Other adaptations were considered not financially viable by TenneT.
By means of the interconnector to be realized as part of TenneT's HKWb project, in an n-2 situation (both offshore transformers on one platform not energized), platform HKWa can draw auxiliary power from its neighbouring platform HKWb (and vice

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versa). In that case all turbines connected to HKWa will have auxiliary power for preservation. This last mitigation is not implemented for HKN, being a *single* platform. Substantiation for this functionality is given in the Development Framework. AFRY regards this as a creditable design strategy for ensuring availability, which is also implemented across other platforms by TenneT.

The operational availability has been checked for the first two months after connection of the Crosswind OWF and has shown no outages. Furthermore, TenneT has confirmed that executing the last group of outstanding activities will not impact the availability. AFRY concludes that the designs and executions of project HKWa and HKN meet the self-imposed availability requirements.

As TenneT has met 100% availability during the first three months after commissioning, AFRY sees no reason to assume the presence of any unavailability-related issues that could result in long-term unavailability during the lifetime. Additionally, TenneT has provided several documents supporting the internal handover process. Here, AFRY has found that:

- The land stations were partly taken over (with a long PI list) and in a later stage completely. There were no A-punch (not able to function or safety related) items at final take-over. Other PI were considered minimal.
- The land cables showed to have many open PI in 2023 but were still accepted for hand-over as the items did not hinder safe operation. A second version of the PI list showed that most of them were closed in April 2024.
- The sea cable PI have shown to be all closed.
- For the platforms multiple PIs remained. For HKN there were 91 priority 2 items, and no priority 1 nor safety related items. On 27/3/2023, for HKWa there were 32 priority 1 and safety related PI, and 370 priority 2. In the last report of 18/12/2023, only 103 priority 2 PI remained which can be considered a large reduction by the project team. The hand-over certificate of HKWa has been shared by TenneT with minor/easy solvable PI. The Terra system shows that both platforms have been handed to the operational department.

All documents provided together on the PI and handovers show the activities were well organized (supported by an internal process flow) which is considered satisfactory for AFRY. Taking all together, AFRY considers the character of the outstanding PI such that no impact on long-term availability is expected.

Finally, to be sustainably available, the lifetime of the complete system has been assessed. In the Q&A, TenneT has given the following reasons to guarantee the availability and lifetime of the project (27 years[5]):

- Standardized 700 MW Design – The platform design follows a standardized 700 MW concept based on Ramboll's proven standard design, ensuring reliability and longevity.
- Qualified Market Inquiry – The procurement process includes a rigorous selection of qualified companies, with clear requirements for long-term operational performance. These requirements are explicitly stated and reinforced during the contracting phase.

[5] Ontwikkelkader Windenergie op Zee November 2019

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- Construction Oversight & Quality Control – Specialized auditors and inspectors monitor the construction phase, focusing on key aspects such as material durability and preservation measures (e.g., ensuring proper paint thickness for corrosion protection). This oversight helps guarantee that components meet the required offshore lifespan.

AFRY agrees with the mentioned arguments as being important to guarantee a minimum lifetime and high availability of the transport grid.

In the latest Development Framework[1], lifetime of the grid for HKWa has been extended to be at least 37 years[6]. TenneT has interpreted this as 40 years and has assessed the lifetime of the equipment in the current design, of which the main equipment groups show:

- GIS 40 years
- transformers 40 years
- reactors 40 years
- protection 15-20 years
- SCADA/Telecom 15-20 years
- AUX systems 15-20 years
- Power cables 40 years
- OSS topside 30 years
- Jacket/piles 30 years
- Onshore building 50 years

TenneT has briefly described which changes to the maintenance schedule (intensifying) will make the grid available for 40 years. For the protection / SCADA / Telecom / AUX, an exchange of equipment is foreseen.

AFRY considers this brief assessment as correct. AFRY also agrees that transformers and reactors including radiators as being *designed for 40 years as per IEC* show this lifetime capability in practice. This experience although is not yet available for offshore, as being in an (extreme) outdoor salty environment and located on a jacket which will be (minimally) vibrating with the wave frequency. This might need further consideration.

AFRY concludes that both HKN and HKWa comply with the four requirements related to the Sustainable availability.

[6] HKN has been commissioned one year earlier, and therefore does not have to follow the Ontwikkelkader windenergie op zee April 2024

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4.2 Research question 2

'What is the relationship between the investment budget prepared by TenneT (at the time of the final investment decision) and ultimately realised investment costs reported by TenneT? What is the cause of any difference?'

The investment costs realised by TenneT, as shown in the notification form and validated by Deloitte, were [redacted] or [redacted] than the budget during FID. The main reasons for the differences are:

- Not all identified risks have materialized, so the budgets reserved for the materialisation of these risks were not fully used.

- The cost overrun in the project initiation phase was mainly due to a six-month permitting delay from adding HKWa, leading to extra costs for MER and Council of State procedures.

- *Cable* costs were [redacted] than budgeted thanks to the Risk Sharing Model (RSM), which shifted major risks to the Employer, [redacted]

- *Land station* costs were [redacted] due to scope and budget reallocation from HKWb, higher tender prices, additional scope, and COVID-related expenses.

- *Project management & Engineering* costs were [redacted] higher than expected, driven mainly by the expanded land station scope requiring more Project Management Technology (PMT) resources.

All changes were adequately explained by scope changes and the materialisation of price risks. The level of final investment expenditure, including PMT costs, will be further examined in Research Question 4.

4.2.1 Methodology

On 9 March 2020, TenneT's Board of Directors approved the Gate2 (G2) document of the HKN/HKWa project. During the first phases of the project, HKN and HKWa were considered separate projects, but the processes were merged at the time of G2. According to TenneT's Investment Manual[7], this approval is considered the final investment decision (FID) of a project. At the time of G2, the estimated budget for the upgrade totalled 798.0 M€ and 88.0 M€ of identified risks, making a total of 886.0 M€. The more detailed numbers for both budget and realisation were provided by TenneT in a memorandum[8]. The budget values in this memorandum were the G3-values, but TenneT indicated that G2 and G3 were only weeks apart and the budget had not changed between the two documents.

The actual cost of the investments was provided by TenneT in the abovementioned memo and independently validated by Deloitte, resulting in a total of [redacted] including additional works. Besides these actual costs, the documentation provided by TenneT also contains a reservation of 134.6 M€ for *Asset retirement obligation*, which is a provision to account for the retirement of the assets after the lifetime of the

[7] Appendix 1A Corporate Investment Manual (Marnezijl)
[8] Appendix 2 Memorandum realisation vs budget HKN - HKWa

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project. Since this provision is required by law and is not an expense yet, AFRY has discussed with ACM, and agreed to leave this number outside the scope of this evaluation.

AFRY compared the G2 budget (during FID) with the actual cost of the investment. This was done by analysing the abovementioned, which provided explanations for a number of cost item changes. During a working session on 24 March, cost developments not (sufficiently) explained in the memo have been clarified.

4.2.2 Assessment

The table below shows the comparison between actual investment costs and budgeted values during FID.

Cost category	Budget at the time of G2 (FID) [M€]	Realised investment costs [M€]	Difference [M€]	Difference [%]
1. Project management & engineering	[redacted]			
2a. Overall & finance - General				
2b. Overall & finance - Identified risks				
3. Project initiation				
4. Platform				
5. Cable				
6. Land station				
7. System integration				
8. Grid connection existing 380 kV				
Total	**886.0**	[redacted]	[redacted]	[redacted]

Table 3: Comparison between actual investment costs and budget at the time of G2 - due to rounding differences, some calculations in the table do not fully match

The actual cost of HKN/HKWa were [redacted] than the budget during FID. The main reason for this significant underspending is the fact that a significant portion of the Identified Risks had not materialized. [redacted]

Overall & Finance

Besides the [redacted], only a small increase in costs remains, which almost exclusively is caused by higher insurance costs.

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Project initiation

The overrun in the project initiation was mainly due to the extended permitting phase caused by the addition of HKWa, which required a six-month delay. As a result, extra costs were incurred for the Environmental Impact Assessment (in Dutch: MER) and Council of State (in Dutch: Raad van State) procedures.

Platform

The realised investment costs for the platform were higher than budgeted. This overrun was largely driven by a [redacted] settlement related to delays and operational costs on the HKN platform, caused by adjusted milestones, extended use of the Jack-Up Barge, and reliance on temporary diesel generators. Additionally, [redacted] was allocated for a customer connection, such as the electrification of offshore oil and gas platforms, as mandated by the Ministry of Economic Affairs and Climate Policy after FID to support the 2020 Offshore Wind Energy Development Framework, aimed at reducing emissions and improving grid efficiency.

Cable

The [redacted] actual costs compared to the Gate 2 budget are mainly due to the lower tender price using the RSM, which shifted risks like soil and weather to the Employer. Some risks, such as compacted peat and adverse weather, did materialize, leading to cost adjustments. These were settled based on actual conditions under the RSM.

Land station

At the land station, realised investment costs were in total [redacted] than budgeted during FID (G2). TenneT explained that during the project execution, 25.5 M€ was transferred from the scope and budget for the land station of HKWb to manage the construction of all three land stations at Wijk aan Zee within one project. The additional roughly [redacted] was the result of unfavorable tender results, additional scope and additional expenses resulting from COVID-19.

Grid connection existing 380 kV

The grid connection to the existing 380 kV infrastructure was [redacted] more expensive than budgeted. This was solely due to the inclusion of a fourth circuit into the scope. The necessity of this scope item will be further discussed in Research Question 6.

Project management & Engineering

This category contains all the internal and external resources needed to initiate and manage the project. These budget items were distilled from TenneT's budget and put into a separate category. The realized cost for this cost category was [redacted] higher than during G2. The main reasons for this item were the increased scope of the land station (see above), which led to additional PMT costs. The level of PMT costs will be further explored in Research Question 4.

Conclusion

The realized investment costs are [redacted] lower than the investment budget originally prepared by TenneT. The main reason for this significant underspending is the fact that a significant portion of the Identified Risks had not materialized. Significant cost increases were observed in the category *Land station* and *Grid connection existing 380*

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kV, while category *Cable* showed a significant underrun. All changes were adequately explained by scope changes and the materialization of price risks. The level of final investment expenditure, including PMT costs, will be further examined in Research Question 4.

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4.3 Research question 3

'Is there adequate risk management by TenneT? In answering this question, consider the use of the risk budget and how TenneT uses previous experience from projects in the Netherlands or Germany.'

AFRY assesses the implementation of the prescribed risk management activities in the preparatory, implementation and closure phases, including the application of lessons learned from previous projects, as sufficient. The risk budget reserved at FID has proved sufficient, and the risks register is sufficient in content. Considering the 15 largest additional works, AFRY rates risk management as sufficient. Overall, AFRY therefore assesses TenneT's risk management as sufficient.

4.3.1 Methodology

The risk management within the HKN/HKWa project has been analysed and evaluated by AFRY based on the applicable risk management handbook as provided by TenneT, the project-specific risk register, and information obtained from various work sessions. The evaluation of TenneT's risk management process itself is explicitly excluded from this efficiency assessment. The assessment solely concentrates on determining whether TenneT adhered to its own processes and handbook in this project.

The research question has been assessed using the following sub-questions:

1. Has TenneT followed the process as per the prescribed risk management handbook, in preparation of and throughout the project's execution?
2. Is the risk budget reserved at the start of the project (FID) sufficient?
3. Is the risk register at the beginning of the project (FID) sufficient in content?
4. Have the risks been adequately managed, considering the 15 largest additional works and claims?

4.3.2 Assessment

Risk management processes

Risk management in this project was carried out on the basis of the Corporate Project Risk Management Handbook (cPRMHB), developed by TenneT using the ISO31000 standard for risk management. The purpose of the handbook is to describe the principles, methodological framework and shared vocabulary for project risk management within TenneT. It describes the risk management activities existing within TenneT for the preparatory, executive and final project phases. AFRY tests whether these activities have been sufficiently followed.

The project specific risk management plan for HKN/HKWa is embedded in its project management plan[9]. The risk management plan describes the process including main actions and responsibilities and the output. AFRY assesses it is sufficiently in line with the main principles and guidelines outlined in the cPRMHB.

Populating the project risk register, TenneT has identified risks based on lessons learned from previous offshore projects Borssele and HKZ, from TenneT's project wide risk register, and through risk sessions with and/or reports from project team

[9] Question 5b. HKN HKWa Realisation Project Management Plan

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members and contractors involved. Multiple examples of implemented lessons learned have been shared by TenneT during the kick-off presentation on the 11th of February 2025[10].

In the FID report and ER report, the key risks are reflected including their probability, impact, associated mitigation measures, and contingency plan[11]. From the monthly Project Steer Group reports[12] and risk registers provided by TenneT[13], it can be seen TenneT has identified and registered risks in line with the prescribed format. The risk register has been further detailed during the project, as can be seen from the various updates in the risk register. Based on the frequency of the reporting and on the regular status updates of the risks & risk mitigations in the documentation provided, AFRY concludes that TenneT has sufficiently and regularly analysed, evaluated, treated, monitored, reviewed and communicated risks from the early initiation phase through to project closure.

TenneT has managed the risks in procurement of the different scopes of this project, by registering and allocating (interface) risks regarding both process and product. TenneT has for example addressed tender risks through market consultation and a suitable tender strategy, a.o. by implementing its RSM in the cable installation tender. The RSM provides transparency in installation speed and costs, enabling comparison between contractors with different burial tools. It also helps assess potential claims and prevents double invoicing of risk materialisations. AFRY assesses risk management in procurement as sufficient.

To manage interface risks across the HKN and HKWa projects, TenneT has applied a structured system integration approach. Through the Q&A, TenneT has explained she has used a detailed SI flowchart to map all workstreams and interdependencies, a dedicated planner and project leads monitored progress and alignment across parties. TenneT included time buffers between key activities to absorb delays, and discussed interfaces in weekly team meetings. Furthermore, TenneT managed interfaces with contractors in quarterly quality assurance reviews. TenneT has shared the SI flowchart, and on AFRYs request also the agenda of the quarterly meetings held in collaboration with the contractor of the offshore platform. AFRY assesses the interface risk management as sufficient.

For the FID (gate 2), the risk budget was prepared on the basis of Borssele and HKZ budgets, where the RSM had also been applied. During project execution, TenneT's cPRMHB prescribes the risk budget approval procedure depending on size. For the larger risk approvals, TenneT has provided two examples: a Change Request covering the tender result of the land station civil contract[14], and the ER of November 2021[15], to realise the opportunity to include the installation of the fourth cable circuit and expansion of BVW and WAZ substations within the HKN/HKWa project. AFRY assesses the risk budget preparation process and risk budget management as sufficient.

Evaluation of the risk management process and sharing of lessons learned is a continuous activity within TenneT's *Business Guidance Nederland Offshore Risk*

[10] Kickoff ACM audit HKN en HKWa
[11] 2.03. Gate 2 HKN_HKWa
[12] Question 6b. MSR_20-March_Hollandse Kust Noord_PRM, Question 6c. MSR_21-December_Hollandse Kust Noord_PRM, Question 7. MSR_22-July_Hollandse Kust Noord_PRM
[13] Question 6a. Copy of HKN - Risk Registor NL Complete v2 SQL
[14] 4.05. Budget Release Approval HKN identified risk tender result
[15] 4.04. Exception report 4th cable circuit

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Management team. The HKN/HKWa project team has been involved in continuous improvement by participating in lessons learned sessions, evaluating the risk management process and sharing lessons learned. Furthermore, risk managers of TenneT's large offshore projects have held discussions about notable situations whenever they occurred, and distilled lessons learned where possible. TenneT confirms key lessons have been implemented in the risk management process for HKN/HKWa, as well as in updates for the cPRMHB.

Finally, outstanding risks have been transferred to TenneT's asset management department System Operations (SO) as part of TenneT's *Terra20 process*[16].

AFRY concludes that TenneT has implemented a comprehensive and structured risk management approach in accordance with the principles and guidelines outlined in the Corporate Project Risk Management Handbook across all phases of the project.

FID Risk budget

The initial FID of this project was taken in March 2020, with a net budget of 798.0 M€, and risk budgets as described in the table below.

Type	Prescribed according to cPRMHB [%]	M€	
Identified risk budget	P50 of risks identified, expectation around ~10% of net budget	[redacted]	
Project contingency	0-5% of net budget		
General risk contingency	[redacted] of net budget		
Total			351

Table 4: Risk budget (ex. RSM budget) as prescribed in cPRMHB and in the approved FID report[17]

TenneT has calculated the *Identified risk budget* based on the expected outcome of the identified risks, taking into account of the experience of Borssele and HKZ. The size of HKN/HKWa identified risk budgets is in line with the guideline described in the cPRMHB, and comparable to the identified risk budget of HKZ (12% of the net budget).

The *Project contingency* is significantly larger than what is prescribed in cPRMHB. This is because of positive tender outcomes and a clearer risk profile progressing from Gate 1.3 to FID, which allowed budget to be transferred from net and identified risk budget to the project contingency budget, as per TenneT procedure.

The *General contingency* is significantly higher than what is prescribed in the cPRMHB, namely [redacted] of the net budget vs. a prescribed [redacted] of net budget. This is because at the time of FID, for HKN there were still 5 route alternatives, with a maximum cost difference of ~100 M€. At FID, the net budget corresponded to the cheapest alternative, the project budget application (PBA) included all contingencies based on the most expensive alternative. In the end the cheapest alternative has been executed.

In addition to the risk budgets described above, [redacted] of the net budget was reserved to cover outcomes of the RSM. This *RSM budget* was applied on the

[16] Question 82. HNA TERRA-20 OFF Handover to Operations - sign off (part 1) - signed
[17] 2.03. Gate 2 HKN_HKWa

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cable installation scope, whereby the size of the RSM budget was based on the expected outcome, incorporating experience from Borssele and HKZ. TenneT's cPRMHB does not provide a guideline to what size the RSM should be. AFRY assesses the process of defining the RSM budget as correct.

AFRY has compared the utilization of the risk budget at the time when the project was operationally ready (Gate 4 or 'G4'), to the reserved risk budget at the time of FID. The total materialization of risks amounts 105.8 M€, of which 21.9 M€ is an outcome of the RSM. This means [redacted] of the RSM budget was used. The remaining 84.0 M€ of risk materialization equals [redacted] of the identified risk budget, or [redacted] of the total risk budget excluding RSM budget.

AFRY concludes that the risk budget at G2 has been set up sufficiently in line with prescribed guidelines, that both the Identified risk budget and RSM budget at G2 are in proportion to utilized risk budget at G4, and therefore rates this as sufficient.

FID risk register

To determine whether the content of the risk register is complete at the start of the project (G2 moment), the risk registration regarding the increase in project costs was examined based on Gate and/or Exception Reports and on the top 15 additional works. For both components, it was examined whether the risk register covers the content sufficiently, whether the pre-estimated impact matches sufficiently, and whether sufficient mitigating measures have been recorded.

The risk register as part of FID documentation has been reported by TenneT on a high level[18], whereby the risks identified have been grouped into overarching risk topics. TenneT has summarized the risk as per below in order of magnitude:

- Claims and variation orders
- TenneT is asked to take additional Co2/NOx restriction or compensation measures
- Council of state procedure leads to delay of 12 months
- Tender results land-station and land cable
- UXO requirements exceed normal key figures
- Other

Whereby *Other* is a relatively small part (6 M€ or 7%) of the total identified risk budget.

Completeness regarding the Gate and/or exception reports

Between G2 and G4, there has been an increase in project costs of [redacted]. The increase is mainly related to the following three changes.

The first is a scope transfer with a budget of 25.5 M€ from HKwB to HKN/HKWa, where the 380 KV connection WaZ to Beverwijk was transferred to the contractors of HKN/HKWa to achieve scope optimisation.[19]

The second concerns a scope change to accommodate growing grid demands, described in Exception Report (ER) TTB-07503 of November 2021, to accommodate for a customer power connection to add a 4th cable circuit, along with two additional 380

[18] 2.03. Gate 2 HKN_HKWa
[19] 2. Memorandum realisation versus budget (FINAL)

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kV bays and a sectionizer. Because of positive tender results, no additional budget was requested.[20]

The third considers the [redacted] tender result of the landstation civil contract, as described in the budget release approval of January 2021[21]. The proposed offer [redacted] (original estimation of [redacted] vs. offered [redacted]).[22] Of the [redacted] exceedance, [redacted] was due to scope increase, specifically related to a larger CDG, the addition of 33 kV filters, and the associated building. The remaining [redacted] reflects the actual risk materialisation of the tender result and falls within risk *Tender results land-station and land cable* with an Expected Monetary Value (EMV) of [redacted] M€.[23]

AFRY does not expect (the above) scope transfers and changes to be covered by the risk register. As the risk materialisation of the tender result falls within risk EMV, AFRY concludes the FID risk register was sufficient in content regarding Gate and/or exception reports.

Completeness regarding the Top 15 additional works

The top 15 additional works represent 57.7 M€ (55%) of the projects additional works totalling 105.8 M€. Of this top 15, 21.9 M€ is an outcome of the RSM, [redacted] concerns a scope change to accommodate for a customer power connection along with two additional 380 kV bays and a sectionizer, to accommodate growing for a customer connection (also covered in the section above). [redacted] concerns additional costs related to the Ukraine war, which AFRY deems unforeseeable.

The remaining 20.8 M€ of risk materialization is covered by risks *Claims and variation orders* ([redacted] materialization vs [redacted] EMV), *UXO requirements exceed normal key figures* ([redacted] materialization vs [redacted] EMV) and *Other* ([redacted]materialization vs 6 M€ EMV). AFRY concludes the projects top 15 additional works are covered within their specific risks EMV, and therefore that the project team sufficiently identified and assessed the most significant risks. Also, the mitigation measures described for the high-level risks are deemed sufficient.

AFRY concludes the FID risk register was sufficient in content regarding the top 15 additional works, and sufficient in content overall.

Risk management looking at top 15 additional works

No items emerged from the additional work analysis where better risk management could have potentially prevented additional costs, and therefore this component was assessed as sufficient.

[20] 4.04. Exception report 4th cable circuit
[21] 4.05. Budget Release Approval HKN identified risk tender result
[22] 4. Memo Internal project procedures HKN HKWa (FINAL)
[23] Q&A question 108

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4.4 Research question 4

'Is there a difference of more than 15% between the total realised capital expenditure (including estimated capital expenditure incurred after commissioning) and a counter-budget prepared by you? If yes, what causes the difference?'

The realised investment costs incurred by TenneT are 10.5% lower (or -96.4 M€) than the counter budget prepared by AFRY. In this respect, the *Project management & Engineering* category comes out significantly lower, with a [redacted]% difference [redacted]). Category *System integration* also presented a difference of more than [redacted], being [redacted]% lower [redacted] compared to the counter-budget. *Project initiation* was the only category in which the actual costs incurred by TenneT are higher than our estimations, but remains within the 15%. The largest differences are caused by:

- *Project management & Engineering* costs were significantly lower than in AFRY's counter-budget, due partially to the higher investment costs budgeted by AFRY but also due to our calculation method to estimate these costs (10-15% of the total investment costs excl. project management and engineering). The costs incurred by TenneT were circa 10% of their investment costs, which is within the expected range.

- *Platform* costs are significantly lower than AFRY's counter-budget [redacted] and represents the biggest difference in absolute numbers after project management. This can be attributed to the fact that TenneT awarded 3 platforms at once, potentially reducing the individual prices, and the fact that the 700 MW platforms from TenneT are standardized platforms, which further reduces the prices compared to our benchmarks.

- The free issue items for the HV Platform were significantly less expensive than in the AFRY counter-budget [redacted]€). This difference can be explained by the fact that TenneT has framework agreements on the electrical components as part of the 700 MW standardized rollout strategy, reducing the costs for individual cases.

The avoidability of the costs will be discussed further in Research Question 6.

4.4.1 Methodology

To answer research question 4, AFRY has prepared a counter budget based on cost values from previous projects and studies in which AFRY has participated, combined with publicly available information from reports and news articles. AFRY's cost catalogue is regularly updated with data from the latest international projects and the latest innovations and technologies available on the market. In preparation for this assessment, TenneT provided a detailed cost breakdown of the project, divided into seven main categories: *Overall & finance*, *Project initiation*, *Platform*, *Cable*, *Land station*, *System integration* and *Grid connection existing 380 kV*. In addition, AFRY has added two additional categories for comparison purposes: *Project management & Engineering,* which includes all items labelled as project management and/or engineering, procurement, and third-party effort, and *ARO*, which includes TenneT's cost estimations for the Asset Retirement Obligation. As already mentioned in Research Question 2, AFRY will not include the ARO into this efficiency assessment since it is a provision for future decommissioning costs. The cost breakdown was discussed during the kick-off meeting and all subsequent working sessions.

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To evaluate the validity of the investments, the counter-budget was made using the following approach:

1. AFRY has adhered as much as possible to the cost categories used by TenneT in the cost breakdown. However, some of these TenneT cost categories include project management or engineering-related hours in addition to (framework) contracts. These have been removed from the cost categories and added up to the *Project management & Engineering* category.
2. The contracts and external costs of the cost categories were compared with AFRY's counter-budget values. These counter-budget values are based on typical values in AFRY's reference projects. To compensate for the materialisation of unforeseen risks, leading to additional works or other extra costs, AFRY's reference values have been increased by 10%. Some small (about 3% of the total investment) cost items have been taken directly from the TenneT actuals, as the impact on the counter-budget is negligible.
3. The costs for Land management, under category *Project initiation*, have also been taken directly from the TenneT actuals. These costs include primarily the costs for the land acquisition for the land station and Wijk aan Zee substation from Tata Steel, plus licensing and compensations. These costs rely heavily on customized agreements for which a counter-budget cannot be prepared.
4. An industry standard for overall project management costs for a large offshore wind electrical infrastructure is between 10-15% of the contract value of the main cost items. AFRY assesses that these numbers are applicable to this case and has chosen to use 10% for all components that were supplied under a framework contract (in this case the HV components), since framework agreement have been managed beforehand and generally require significantly less interface management and procurement costs. The project management for all other investments were considered as 15%, since they are not procured under a standardized and low risk approach. This counter budget was then compared with TenneT's realised investment costs.

4.4.2 Assessment

The table below summarises the actual cost of the investment as incurred by TenneT and AFRY's counter budget, constructed using the above steps

Cost category	Realised investment costs [M€]	Counter-budget AFRY [M€]	Differ-ence [M€]	Differ-ence [%]
1. PM & engineering	[redacted]	116.1	[redacted]	[redacted]
2. Overall & finance		16.6		
3. Project initiation		36.3		
4. Platform		257.8		
5. Cable		312.2		
6. Land station		117.3		
7. System integration		50.1		
8. Grid connection existing 380 kV		16.5		

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Cost category	Realised investment costs [M€]	Counter-budget AFRY [M€]	Difference [M€]	Difference [%]
Total	**825.4**	**921.8**	**-96.4**	**-10.5%**

Table 5: AFRY Contra budget set against TenneT's realised investment costs (notification form) - due to rounding differences, some calculations in the table do not fully match

TenneT's actual investment cost is 825.4 M€, which is 10.5% lower than AFRY's counter budget. At the cost item level, the results vary; the differences are described below.

TenneT's actual expenditure for the Engineering, Procuring, Construction and Installation (EPCI) of the two offshore platforms is [redacted] lower than the counter-budget. This difference can be partly explained by the standardization of TenneT's 700 MW platforms, which were developed in-house up to the level of basic design and awarded as part of the same tender process (3 platforms: HKN, HKWa and HKWb, which was included as an optional platform).

The cost category *Cable* contains a subcategory Horizontal Directional Drilling (HDD), for which the counter-budget is approximately [redacted] lower than the actuals incurred by TenneT. The relatively high costs can be explained by both project-specific and market-driven factors. Tight market conditions during tendering, limited contractor availability, and a narrow rural corridor increased complexity and reduced flexibility. Only one bidder remained after the initial round. A challenging drill near the 'sandcastle' added [redacted] and even excluding this, the remaining costs still reflect above-average complexity and risk compared to AFRY's 2015–2020 benchmarks. However, since the other subcategories were higher in the counterbudget, the overall category cable shows a negligible difference.

TenneT's actuals for the Civil works at the *Land station*, which also includes the civil works at substation WaZ, are approximately [redacted] higher than AFRY's counter-budget. This can be explained by the fact that the AFRY counter-budget numbers are from a period before 2020, while the tender for the civil works was held in mid-2020, with execution beginning in 2021. Market conditions at that time were more constrained than during the 2017–2019 period. This was evident as several invited companies declined to submit offers due to limited capacity. Among the four bids received, three were considerably more expensive than the winning bid from BAM Infra.

TenneT's actuals for the free issue items on the HV Platform, as part of the *System Integration* cost, were [redacted] lower than the counterbudget by AFRY. This difference can be explained by the framework agreements for the electrical components as part of the 700 MW standardized rollout strategy, reducing the costs for individual cases.

AFRY concludes that the difference between counter-budget and realisation is within 15%, with the realisation being cheaper. The higher cost items will be discussed further in Research Question 6.

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4.5 Research question 5

'Were the formal procurement procedures followed? If not, what was the reason for this? What procedures were followed to select the contractors?'

TenneT has sufficiently demonstrated that the relevant procurement procedures have been followed. In doing so, it was demonstrated that internal controls and management approval on the procurement procedures followed were in place.

The procurement plan has been determined and affirmed as per TenneT governance and relevant documents have been signed off accordingly.

In summary, it can be concluded that adherence to the formal procurement procedures and their controls has been sufficient.

4.5.1 Methodology

The assessment of compliance with the applicable procurement procedures was carried out by checking the relevant documentation provided by TenneT, answers to written questions and further explanations as given during the working session on 24 March 2025 and hereafter. Based on the schematic representation of the procurement process and its controls, the following questions can be derived:

1. What was the chosen procurement strategy and its justification based on policy, (market) conditions or other considerations?
2. Which processes describe how the procurement strategy should be implemented?
3. What controls are in place to ensure tenders are executed in line with strategy and to validate results?



Figure 3: Governance structure tender processes

At the beginning of this efficiency assessment AFRY received a comprehensive package of information, including an explanation of the procurement approach containing a description of the procurement procedures followed for each lot, the procurement strategy for the lots and various tender documentation. This package was supplemented with additional tender documentation consisting of tender rules and award decisions for the specific lots. Furthermore, justifications and further substantiation was provided by TenneT to answer detailed questions on the documents provided, including the explanation of the approval of the procurement plan and executed tenders.

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A working session on the procurement procedures took place on 24 March 2025. In this working session, the tendering and evaluation methodology were explained by TenneT and questions on the documentation provided were discussed. Hereafter TenneT also provided additional documentation on the approval of relevant documents.

For materiality purposes, the focus of the assessment has been the main contracts, each having a value of more than 1% of the total investment amount. The tenders assessed are shown in Table 6.

4.5.2 Assessment

Governance

The Asset Chain Framework, as pictured below, outlines TenneT's investment approval process, progressing through five gates from initiation to project closing. Governance levels escalate decisions based on thresholds, involving the Shareholder, Supervisory Board, Executive Board, Asset Committee, and PSG/BSG. Key teams and Project Leads oversee specific project phases, ensuring alignment with technical and financial requirements. This structure ensures transparency, accountability, and compliance with financial mandates[24]

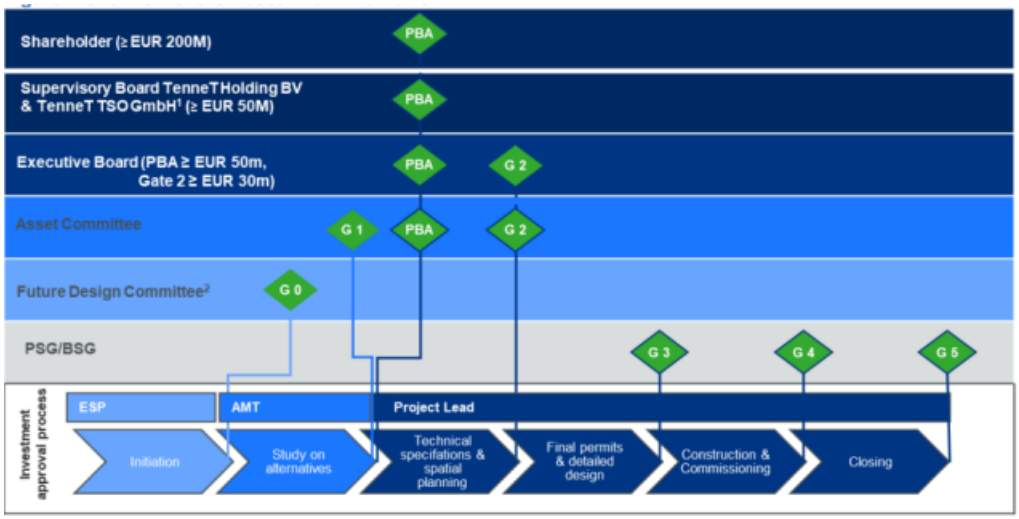


Figure 4: TenneT's Asset Chain Framework

Process

As a public organisation, TenneT follows the Procurement Act. Tenders are published in the *Supplement to the Official Journal of the European Union* (the official EU website for tenders) and on TenderNed. European procurement rules dictate the procurement process, which means that, among other things, award criteria (MEAT) are defined in the award guidelines of the various tenders and a transparent process is run. For the relevant tenders, TenneT used the tender platform Negometrix for process assurance and management of all tender documentation.

[24] 3. Tender Procedures HKN HKWa (FINAL), 2.5 d).

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The defined governance combined with the Procurement Act and European procurement rules dictate the processes to be followed for the various tenders.

Procurement plan

The project has an overarching strategic procurement plan that was determined in 2014/2015 and concluded and implemented in 2016.

Hereafter, the lessons learned from the period 2016 to early 2018 have been determined by TenneT in a workshop in January 2018. Examples of these lessons learned were:

- Only one contract with one platform 66 kV/220 kV power transformer supplier can give rise to serious time risk if the contractor is not able to deliver on time or within specification. For these platform power transformers it was decided to procure an alternative source to mitigate this risk whereby the design (both functionally and technically from a construction point of view) has to be standard hence that the transformers from other suppliers are exchangeable.
- In the platform contract the right of intellectual property of the design shall be with TenneT, so lessons learned with respect to the (detailed) design can (and will) be used for the next platforms.
- All 220 kV land cables in the same corridor are to be installed at the same time to save mobilisation costs and to decrease the impact for the environment and land owners.
- Regarding the land station, an important issue when working under UAV is the split in engineering between the engineering contractor and the construction contractor. The split has proven to be more (cost) effective if the detailed construction drawings of building and equipment components are performed by the construction contractor.

The outcome of the workshop was incorporated in a position paper reflecting the procurement strategy[25] which describes and explains, amongst others, the division of the lots, the number of contracts and the applicable tender procedures.

For each tender, TenneT selected the appropriate tender procedure and criteria based on for example estimated contract value, available time for tendering, complexity of the scope (for instance, the introduction of the RSM for the installation of the sea cables for delays caused by weather or soil conditions) and if a qualification system / framework agreement was already in place.[26]

In determining the procurement strategy the main objective[27] as identified by TenneT was to achieve a well-managed risk balance, taking into account:

- The division of responsibilities between the contractors and TenneT;
- The interfaces to be managed by TenneT;
- Supply market developments;
- Required flexibility with respect to amongst others external and internal stakeholders;
- TenneT's own ability and experience.

[25] Position Paper Procurement strategy Offshore Grid NL: HKN, HKW alpha, HKW beta and TNW, 27-07-2018
[26] 3. Tender Procedures HKN HKWa (FINAL), 2.5a.
[27] 3.01 Procurement Strategy HKN HKWa, 2.1

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In line with these objectives, TenneT introduced the RSM as a strategic response to one of its core project drivers: achieving a well-managed and balanced distribution of risks. TenneT's procurement strategy emphasizes selecting procedures and criteria based on factors such as contract value, project complexity, and risk exposure. The RSM was introduced specifically for offshore cable installation, where delays due to weather or soil conditions could be significant and unpredictable. The procurement objective was to ensure a well-managed risk balance by assigning risks to the party best positioned to manage them, contractors for known risks, and TenneT for unforeseen ones.

The updated 2018 procurement plan was aligned and agreed as a Gate 3 document and affirmed in the PSG meeting. This was documented in the signed off monthly status report wherein the finalization of the procurement plan was approved.[28].

Later, TenneT decided upon adding the option of a third platform to the lot HKN & HKWa platforms. This was approved in the Project Management Team meeting and reported in the minutes of meeting[29]

Table 6 shows the distribution of lots with which the project was implemented. These are in line with the procurement plan as provided.

Contractor	Scope	Contract type	Procedure	Value EUR
Jan de Nul Luxembourg - LS Cable VOF	Installation of Sea Cables HKWa	FIDIC Yellow Book	Negotiated procedure Procurement Act 2012	[redacted]
JV HKWa (Joint Venture Hollandse Kust)	HKWa Platform	FIDIC Yellow Book	Negotiated procedure	
JV HKN (Joint Venture Hollandse Kust)	HKN Platform	FIDIC Yellow Book	Negotiated procedure	
Jan de Nul Luxembourg - LS Cable VOF	Installation of Sea Cables HKN	FIDIC Yellow Book	Negotiated procedure	
BAM Infra Regio Zuid Civiel	Substation WaZ – Civil works	UAV 2012	Tender framework agreement EU-255	
SC&M Integrated Substations VOF	Substation WAZ – Electrical	UAV 2012	Tender framework agreement EU-303	
NRG VOF	Landcable Civil works &	UAV-GC 2005	Tender framework	

[28] Question 13. MSR_18-September_Hollandse Kust Noord_PRM
[29] Question 15: Email optie 3e platform 20-12-2018

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	HDD – Perceel 2		agreement EU-202	
NRG VOF	Landcable Civil works & HDD – Perceel 1	UAV-GC 2005	Tender framework agreement EU-202	[redacted]
Taihan Electric Wire Co. LTD	Supply 380 kV land Cables	UAV-GC 2005	Tender framework agreement EU-375	

Table 6: Tenders assessed

Tenders under framework agreements

For the tenders in the scope of this assessment as described above in Table 6, AFRY received key tender documentation. This included tender guides with the Most Economically Advantageous Tender (EMVI) criteria, award guides and signed-off award decisions. These documents included an overview of the tender and the evaluation of the various bids including EMVI assessments.

Example: Substation Civil Works – Bouwteam Contract

The Bouwteam contract was a two-phase contract, whereby the first part consisted of engineering, (the design that this Bouwteam contract covered would also be done for HKWb) following by a first right to submit bid[30]. This was benchmarked by TenneT to check competitiveness by both an internal calculation reviewed by a cost engineer and comparing the bid with a suitable alternative from a similar project that has been recently tendered by TenneT[31].

The actual execution was awarded after the Bouwteam contract[32] was completed. A separate signed off award recommendation document was provided for the execution of the Works in January 2021.[33]

For all reviewed lots, the applicable tender documents and signed award decisions have been provided.

AFRY concludes that TenneT has sufficiently demonstrated that relevant procurement procedures have been followed, with internal controls and management approval.

[30] Question 21, Answer working session 24-03-2025
[31] Question 21a. Award recommendation report Hollandse Kust Noord Landstations 24-12-2020
[32] Question 21b. Bouwteam Overeenkomst ten behoeve van het ontwerp van de civiele werken voor het landstation Hollandse Kust, 22-09-2020
[33] Question 1i. PRC20-0636 Award recommendation report Hollandse Kust Noord Civil Works Landstation, 26-08-2020, p.8.

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4.6 Research question 6

'Do the cost items (excluding additional work) contribute to the objective? Were any costs avoidable and, if so, what proportion of the costs?'

AFRY analysed the various cost items provided by TenneT, focusing on the actual costs. The avoidability of additional works is not included in this Research question and will be discussed further in Research Question 7. The costs are divided into the same categories as for Research Question 2 (budget development). All cost items have been assessed by AFRY as unavoidable.

4.6.1 Methodology

AFRY conducted an assessment based on the data and documentation provided by TenneT. The results of the assessment are shown in the table below.

Cost category	Investment Costs excluding additional Work [M€]	Additional work [M€]	Avoidability of costs excluding additional work
1. PM & engineering	[redacted]	[redacted]	No
2. Overall & finance			No
3. Project initiation			No
4. Platform			No
5. Cable			No
6. Land station			No
7. System integration			No
8. Grid connection to existing 380 kV			No
Total	**719.5**	**105.8**	

Table 7: Avoidability of cost items of HKN & HKWa - due to rounding differences, some calculations in the table do not fully match

TenneT provided several financial statements, which were then analysed and discussed during the working sessions. With this input, AFRY assessed the cost items to determine whether some or all of them could have been avoided. It is important to note that TenneT bears responsibility for the accuracy of this information.

Within each cost category, the extent to which the cost item itself is necessary for the implementation of the project, and therefore unavoidable as a cost item, was considered for each cost item. AFRY then analyses whether a cost item is partly avoidable, e.g. because the purchase price is too high.

This section considers the realised cost items excluding additional works. This has been done by subtracting the additional works per cost category, as requested from TenneT, from the corresponding cost categories. The avoidability of the top 15 additional works has been assessed separately in Research Question 7.

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Since all major components were procured through tender or framework agreement, it was concluded in these cases that the level of the cost of the procured goods was entirely unavoidable.

Furthermore, the level of general project costs (*Project Management & Engineering*) has already been analysed in Research Question 4, and assessed as within the range of the industry standard, and even on the positive side. Based on this, AFRY sees no need to investigate this cost item further and considers this cost as not avoidable

4.6.2 Assessment

An overview of the level of costs and their (degree of) avoidability was drawn up for each item in the main budget. The avoidability of the additional work costs is assessed separately under Research Question 7.

Overall & Finance

The [redacted] cost category *Overall & Finance* includes [redacted] of contracts and planned costs and [redacted] of additional work. Most of the cost items within this category, as provided by TenneT, were actually Project Management Costs and have been allocated and evaluated accordingly.

The main constituent of the category is the CAR insurance needed for such projects. Moreover, the category includes permitting costs, licensing costs, and land management. All costs are deemed necessary for the project, and the cost levels are low related to the overall project size, and are therefore not considered avoidable.

Project Initiation

The [redacted] cost category *Project Initiation* contains [redacted]of contracts to contractors and [redacted]of additional work. The cost items within this group, as reported by TenneT, largely consisted of Project Management Costs, which have been classified and assessed as such. The remaining cost items were Soil Assessment, Land Management, and Licencing, all of which were necessary for the project and therefore considered unavoidable.

Platform

The [redacted] cost category *Platform* consists of investments related to the construction of the platform. The procurement and installation of the electrical equipment can be found in the category *System Integration*. The category contains [redacted] in investments and [redacted] of additional work. The platform itself has been tendered under best value procurement, which in line with the amount budgeted by TenneT and lower than the counter budget created by AFRY. Therefore, none of the cost items that fall under cost category *Platform* are deemed avoidable.

Cable

The [redacted] cost category *Cables* encompasses the UXO campaign and all costs associated with producing and installing both onshore and offshore cables, and includes a small HDD section. This category, albeit expensive, was deemed unavoidable to allow for an effective crossing. The UXO campaign was more expensive compared to the average UXO-campaign in the AFRY-database, but this can be well explained, since the surveyed area is both a high-risk area for UXO and a busy area, which could lead to many (false) positives.

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The cost category contains [redacted] in contracts and costs and [redacted] in additional work All tasks were awarded through a competitive bidding process, specifically through full competition based on MEAT criteria. TenneT chose to use a RSM for the cable tender, which has led to attractive tender results, much lower than in the budget and also than in the counter-budget by AFRY. On the other side, RSM has been the cause of a significant amount of additional work. Since, even when adding all additional work to the bare cable contracts, the total value is still lower than the counter-budget, RSM was deemed a cost-effective strategy that did not lead to any avoidable costs. To conclude, none of the costs items that fall under cost category *Cables* are deemed avoidable.

Land Station

The *Land Station* cost category includes investments in the land stations totalling [redacted] consisting of [redacted] of orders to contractors, and [redacted] of additional work. It consists of the civil works, installation works, primary and secondary electrical equipment and site supervision for HKN and HKWa. Since the land station for HKWb was located at the same site, this scope was added to the project to manage the project as one. The civil works and installation works have been executed under existing framework agreements with contractors. The electrical equipment has been procured under framework agreements with suppliers. The costs for site supervision have not been shown to be awarded under framework agreements or public tender but were minor and in line with expectations.

The costs for the civil and installation works were higher than the counter budget created by AFRY. This can be explained (as already briefly discussed in Research question 4) by increased prices for construction materials and labour shortages at the time of execution. AFRY has based the counter budget on works and offers that were completed earlier, so these price increases were not yet included here. Since the works were tendered under MEAT and a strong reason exists for the slightly higher actual costs, the costs associated with civil and installation works are not considered avoidable. To conclude, none of the costs that fall under the cost category *Land station* are deemed avoidable.

System Integration

The *System Integration* cost category of [redacted] includes investments in the procurement of the electrical equipment on the platform and its installation, and consists of [redacted] of contracts, and [redacted] of additional work. The transformers and secondary components were procured under multi-year framework agreements with suppliers. These framework agreements have also been tendered. Therefore, all costs associated with category *System Integration* are considered unavoidable

Grid connection to existing 380 kV

This *Grid connection to existing 380 kV* onshore grid totals [redacted] As already discussed in Research Question 2, the actual costs for this category have surpassed the budget by [redacted] or [redacted] as a result of a scope change during the project, since it was decided to also install a 4th circuit. TenneT has described the rationale for this decision in an Exception Report and made a convincing case why this was needed.

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Since the height of the full scope (including the 4th circuit) was also below the counter-budget by AFRY, the costs under this category have been deemed unavoidable[34].

In conclusion, no cost items in the realisation (excluding additional work) were found to be avoidable; the additional work costs will be addressed in Research Question 7. As all significant cost items were obtained through tendering, the level of costs is also realistic, and therefore not avoidable.

[34] It has to be noted that though TenneT considers the scope change of the 4th cable circuit as part of the analysis of cost items *without* the additional work. However, the top-15 additional work does include 3 RFC's relating this matter. This can be attributed to different interpretations of the term 'additional work'.

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4.7 Research question 7

'How does the additional work contribute to the goal? Was this additional work avoidable and, if so, what part of the additional work?'

AFRY conducted an analysis of the 15 largest additional works (variations and claims) to assess whether they were (partially) unavoidable. These additional works ranged in value from €[redacted] million to €[redacted] million. Among them, two were related to the discovery of an unexpected peat layer and were managed under the RSM. Three others stemmed from the integration of a fourth cable circuit, while two were linked to the impact of the war in Ukraine on contracts and procurement. The remaining eight variations had diverse causes.

The total value of these top 15 additional works amounted to 57.7 M€. AFRY considers only one of them to be partially avoidable, with the avoidable portion estimated at 349.340 k€.

4.7.1 Methodology

A total of 105.8 M€ of RFCs have been approved on HKN and HKWa. For the purpose of answering this Research question, TenneT provided the top 15 RFCs (Requests for Change). These top 15 total 57.7 M€ (or 54,5% of the total value of all RFCs), with the financial range of these top 15 additional works ranging from [redacted] to [redacted] AFRY believes that the top 15 additional works provide sufficient basis to determine whether the additional works contribute to the project goal and whether the costs were (partially) avoidable. Determining the degree of avoidability naturally involves subjective aspects such as: information not fully made available, a reality that turned out to be different from what was recorded, experience and viewpoint of the assessor, etc. Therefore, careful justification was given as to why a particular judgement was reached. The assessment of avoidability was carried out by AFRY through analysis of the available documentation, Q&A exchanges, and worksessions with active discussions. If certain RFCs are found to be partly avoidable, the unavoidable part or alternative is deducted from the total RFC; in this way, the avoidable part of the RFC is determined.

4.7.2 Assessment

VAR-00011-001	Risk Sharing Model Settlement for Jan de Nul & LS Cables: Unforeseen Soil and Weather Impact Hollandse Kust West Alpha.
Contractor	Jan de Nul Luxembourg – LS Cable VO
Amount:	[redacted]
Avoidable:	No

As part of the tender strategy, TenneT adopted a RSM in which it assumed responsibility for certain risks, specifically those related to soil conditions and weather. This approach, previously applied in similar projects such as Borssele and HKZ, proved effective in reducing the tendered prices received during the Best and Final Offer

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(BAFO) stage, as contractors excluded these risk premiums from their pricing. The estimated difference between the fixed sum and the projected tender outcome amounts to [redacted] which has been set aside as a provisional sum for the project. AFRY has reviewed TenneT's procurement strategy in Research question 5 and considers the use of the RSM to be appropriate. Therefore, this section does not question the choice of the RSM itself; rather, it takes the RSM as a given and focuses on evaluating whether the costs incurred under this model were adequately controlled and minimized.

During offshore installation, the project faced unforeseen challenges, including the discovery of a compacted peat layer that caused delays and equipment damage. These issues were compounded by adverse weather conditions. In the Q&A, TenneT explains that soil investigations were conducted in line with expert recommendations and industry standards. The findings did not indicate any soil conditions that would obstruct cable burial using a jet trencher. Moreover, the peat layer turned out to be very narrow (approximately 50 meters), making it difficult to detect in advance. TenneT also states that there was no indication to doubt these results. Soil fragments first appeared during the burial of the HKN1 export cable but were initially considered isolated and not indicative of a broader issue.

To ensure transparency and accurate cost tracking under the RSM, TenneT deployed representatives on-site and on the installation vessel to monitor conditions and actions taken. Daily Progress Reports (DPR) and surveyor observations helped verify actual soil and weather impacts. To minimize further delays and costs, TenneT implemented several mitigation measures: the cable installation sequence was adjusted, hard layers in the beach were broken up using sheet piles, cable positioning was modified to allow more flexible vessel movement during jointing, burial depth requirements were relaxed to permit multiple burial tools, and, with input from the Marine Warranty Surveyor, contractor, and TenneT, weather limitations were expanded and required weather windows shortened.

The final settlements amounted to [redacted] for HKWa and [redacted] for HKN, totalling [redacted] which could fully be covered by the original [redacted] risk provision. Of this [redacted] approximately half of the costs are related to weather, and the other half to delays resulting from the peat layer. The additional work did not impact the project's timeline or quality and was resolved within the contractual framework.

AFRY concludes that TenneT took all reasonable steps to limit the financial and schedule impact of the unexpected conditions and deems the resulting costs unavoidable.

VAR-00034-001	Risk Sharing Model Settlement for Jan de Nul & LS Cables: Unforeseen Soil and Weather Impact Hollandse Kust Noord.
Contractor	Jan de Nul Luxembourg – LS Cable VO
Amount:	[redacted]
Avoidable:	No

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This additional work entails the same risk materialisation as outlined in RFC VAR-00011-001 but applies to HKN rather than HKWa. Following the same rationale and justification, AFRY assesses these costs as unavoidable.

RFC004B	HDD Modifications: Adjusting Beach Construction Work for Hollandse Kust Noord and Hollandse Kust West Alpha.
Contractor	NRG vof
Amount:	[redacted]
Avoidable:	No

This additional work concerns a modification to the original plan for installing land cables across the beach area at Velsen, as the HDD drilling faced technical challenges. The primary issue involved a height difference of approximately six meters between the drill entry and exit points, creating a risk of collapse in the borehole due to the levelling of drilling fluids over a 100-meter horizontal span. To mitigate this, a temporary 'sandcastle' structure was constructed on the beach to raise the exit points, enabling safe and stable drilling operations. This solution ensured that all four drillings could proceed safely and without incident. These challenges were already flagged during the tender process, with contractors indicating that further geotechnical investigation would be needed. However, due to tight timelines, this research was carried out after contract award to avoid delays in project execution.

Through the Q&A process, TenneT clarified that delaying the tender to conduct further geotechnical investigation was not a viable option, as the project schedule had no available float due to dependencies with other workstreams. During the worksession of 24-03-2025, TenneT further explained that including this risk in the tender would have complicated bid comparisons and likely increased overall costs. Conducting the necessary investigations prior to tender was not feasible within the timeframe and would have imposed significant, non-reimbursable costs on bidders.

To maintain transparency and fairness, TenneT published the proposed solution on the project portal, giving other contractors the opportunity to object. No contractor objected. TenneT ensured competitive pricing by engaging its internal cost engineers, who thoroughly reviewed the RFC, developed counter estimates, and validated the reasonableness of the proposed costs.

AFRY has requested further clarification on the process involving the cost engineers, as this process is referenced and appears to apply to several other additional work items (e.g., RFC-007, RFC-055) in this assessment. In response, TenneT has provided a flowchart outlining the process, which details the roles of the involved parties (Project Manager, Contract Manager, Cost Engineer) and the various assessment stages, including efficiency verification and the preparation of a counter budget.

Designed in accordance with Deltares assessments, the structure was engineered to withstand storm conditions with a 1-in-20-year frequency, providing both operational safety and environmental protection. The total cost of this modification was [redacted], covering the increased complexity of the drilling works, additional safety

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provisions for beachgoers, and the logistical demands of working in a dynamic coastal environment. The modification was fully paid from the general contingency budget.

According to AFRY's assessment, the decision to address this issue post-contract award was justified by time constraints, tender practicality, and the low-cost impact relative to the full scope. Moreover, taking no action could have led to a drilling blowout, requiring a full restart of the HDD operation, an option deemed unfeasible due to spatial limitations. Therefore, this additional work is assessed as necessary and unavoidable.

RFC-007	4th Cable Circuit HKN to support additional customer connection.
Contractor	Taihan Electric Wire
Amount:	[redacted]
Avoidable:	No

This additional work concerns the installation of a fourth cable circuit between the Wijk aan Zee (WaZ) and Beverwijk (BVW) substations to facilitate a new customer connection to the WaZ substation. While space for such a connection was reserved in the initial design, TenneT's policy prohibits investment in fundamental assets without a signed customer agreement. As a result, budgets and permits could only be secured after formalization, making earlier implementation unfeasible.

The fourth circuit was required to meet the stricter redundancy (N-1) requirements introduced under the Voortgangs Energie Transitie (VET) legislation for electricity networks exceeding 1 GW. It ensures service continuity during maintenance or low offshore wind generation, thus supporting grid reliability. This requirement was not part of the original scope, since the regulatory regime for this route changed from offshore to onshore due to the (future) TATA customer connection.

The scope included procurement, cable installation, cross-bonding joints, earthing boxes, transport, testing, and integration with the existing infrastructure. By utilizing pre-installed ducts from the basic design and integrating this scope into the ongoing contract with the SC&M consortium, TenneT avoided the higher costs and disruptions of a stand-alone project. Such a stand-alone project would have been significantly more expensive and practically unfeasible due to spatial limitations along the cable route: once the existing cables are in place, adding a new circuit in the same corridor would not be possible due to safety distances and limited space, likely requiring a completely new, complex route.

By integrating the fourth circuit into the current project, TenneT avoids these future complications. The favorable tender result provided budgetary space, allowing the extra scope to be included without increasing the overall project budget. The change is formally processed as an RFC, driven by the VET legislation, and aligns with discussions with EZK to ensure a future-proof design.

The budget estimate of the fourth circuit was [redacted] (including additional cable, PQ measurements, sectionizer, 4th Bay Beverwijk 380 kV and 4th Bay Wijk aan Zee). The

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execution of the fourth cable circuit progressed without major unforeseen events or significant cost increases.

The cost-control process followed standard TenneT procedures, as described in the assessment of RFC0004B. All estimates were reviewed and verified by internal cost engineers. In the Q&A, TenneT confirms that the applied tariffs were competitively offered, ensuring market-aligned pricing.

Executing this as a stand-alone scope after 2026 would have substantially increased total connection costs. AFRY therefore supports TenneT's decision to integrate the additional scope and associated costs into the existing HKN/HKWa contracts. The work was competitively tendered, delivered near budget, and faced no major unforeseen issues. AFRY considers the decision to proceed within the current project framework sound, with the associated costs both justified and unavoidable.

VAR-00011-IDC	pUXO and Debris Clearance in Beach and Tidal Areas
Contractor	NRG vof
Amount:	[redacted]
Avoidable:	No

At the time of tendering, the UXO identification and clearance (ID&C) scope was defined to a depth of 2 meters, aligning with available market capabilities and ensuring a fair and competitive tender. However, to secure long-term operational reliability of the cable system in the dynamic nearshore environment, deeper burial depths of up to 8 meters were required by the permit conditions from Rijkswaterstaat, which were driven by seabed mobility and the need to avoid future remedial burial. While the risk of deeper UXO clearance was identified during the tender phase, it was not feasible to incorporate it as a hard requirement as no suitable equipment was widely available in the market to clear UXOs effectively beyond 2 meters in the harsh nearshore conditions, and enforcing such a requirement would have resulted in unfeasible or non-competitive bids. Therefore, the approach was to manage this risk post-award through variations, if necessary, while ensuring a level playing field during tendering.

During execution, the need arose to clear potential UXO targets in the tidal nearshore zone at depths beyond 2 meters to achieve the ALARP safety level required for cable installation to proceed without delays. The initially contracted party, NGS, was unable to perform this work in the tidal zone due to environmental and technical constraints, despite being capable elsewhere along the route. Multiple alternatives were explored, including the Boskalis Herris system, which was unavailable, and the use of the Sea Auk system with a smaller vessel, which offered limited workability and would have delayed the project while increasing costs due to the need for pre-dredging. The option of using the ABEKO Server vessel was also considered, but its operation would have required a significantly higher number of standby days under challenging weather conditions, introducing greater safety and schedule risks. The chosen solution, using Fugro's Sea Auk system on the WaveWalker 2 platform subcontracted via JLC, provided the best operational stability, safety, and workability in the harsh tidal conditions, reducing standby time while ensuring that the UXO clearance could be

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completed before cable installation began. While the WaveWalker 2 came with a higher day rate than the ABEKO Server, the reduced standby days and improved safety and schedule certainty justified the additional cost, as potential knock-on costs of project delays would have been significantly higher.

AFRY considers the costs of this additional work unavoidable. The need for deeper clearance in specific tidal locations was driven by a combination of regulatory burial requirements, dynamic seabed conditions, and safety obligations. Despite early recognition of the risk, it was neither technically nor commercially feasible to address the issue fully during the initial tender phase. TenneT's choice to proceed with Fugro's advanced equipment on the WaveWalker 2 was the most efficient, safe, and schedule-resilient solution available, ultimately avoiding greater risks and higher costs that would have resulted from alternative approaches or project delays.

VAR-00090091	Cost Escalation Claim Settlement for Jan de Nul & LS Cables: Post-COVID and Ukraine War Impact on Hollandse Kust West Alpha.
Contractor	Jan de Nul Luxembourg – LS Cable VO
Amount:	[redacted]
Avoidable:	No

Following the COVID-19 pandemic and the Ukraine war, global labour and consumer costs rose sharply, leading to significant inflation. Jan De Nul & LS Cables submitted a cost escalation claim for labour and consumer price indexation, which was not covered under the original contract. In response, TenneT applied its SCM guideline to assess the claim based on reasonable pre-pandemic cost trends. This resulted in a claim of [redacted] and a final settlement of [redacted]

During the work session on 22 May 2025, TenneT explained that the tender was issued in 2019, a period characterized by market stability and low inflation (around 1.5%). Contractors were expected to incorporate indexation into their pricing based on historical market conditions. Major disruptions such as the COVID-19 pandemic and the war in Ukraine were not anticipated. While the contracts included indexation mechanisms for certain materials like copper and steel, they did not cover others, such as wood and plastic, which were not expected to require such provisions. At the time, TenneT did not have a standardized policy for handling these situations, which were addressed on a case-by-case basis. In response to the emerging challenges, TenneT introduced the SCM Guideline for Dealing with the Ukraine War'.

According to the SCM Guideline, force majeure does not entitle contractors to cost compensation by default. However, the guideline also states that *TenneT does not exclude in advance that the Ukraine war could establish unforeseen circumstances* and *Each case should be substantiated and handled on a case-by-case basis*. This case-by-case principle was applied to variation items HKWA-TTB-JLC-VAR-00009-001 and HKWA-TTB-JLC-VAR-00008-001 from the additional works memorandum, where contractors submitted substantiated claims showing the impact of Ukraine-related inflation. In the Q&A, TenneT explains that these claims were assessed in line with the SCM Guideline's emphasis on (1) *the good merchant principle*, which allows for

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reasonable adjustments based on exceptional market conditions, and (2) TenneT's responsibility to ensure continuity of critical infrastructure, in partnership with suppliers.

In conclusion, TenneT did not provide general or automatic compensation. Costs were only reimbursed after:

- Validation against objective market data
- Exclusion of unjustified elements (e.g. idle time, dock time)
- Documentation of decisions in line with SCM procedures.

TenneT also confirmed that the settlement was in line with accepted market conditions and did not affect project timelines or quality.

AFRY acknowledges that TenneT followed the appropriate procedure and agrees that the market circumstances at the time of tendering were indeed unforeseeable. Consequently, the costs are assessed as unavoidable.

VAR-00052	Settlement Agreement for Hollandse Kust Noord Platform: Addressing Delays and Final Cost Adjustments.
Contractor	JV HK (Joint Venture Hollandse Kust)
Amount:	[redacted]
Avoidable:	No

This additional work relates to a settlement agreement between TenneT and contractor JV-HK, addressing delays and related cost impacts on the HKN offshore platform. The primary issue was the postponed Taking Over Date, caused by the need to synchronize timelines between interdependent sub-projects. This delay temporarily prevented grid power from being supplied to the platform, requiring the use of diesel generators. To avoid the higher costs and operational risks of demobilizing and later remobilizing the Jack-Up Barge (JUB), it was kept on-site throughout the delay period.

From the work session on 22 May 2025, AFRY understands that delays arose due to interface risks between different workstreams, particularly because of delays regarding the onshore substation. All workstreams had a contractual end date of 31 December 2022, with the overall project end date set at 31 March 2023, providing a three-month buffer to absorb potential delays. The onshore substation was the only workstream that required use of this buffer, primarily due to delays related to the connection of the Tata Steel customer and the associated integration works. As a result, the energization could not take place within the initial timeframe. Given the complexity and scale of the project, it was challenging to align the timelines of the different workstreams. The interface risk associated with this coordination lay with TenneT, meaning that delays in one workstream—such as the onshore substation—had direct impact on the others.

According to TenneT, mitigating the delays was not feasible. Asking the platform contractor to delay their work wasn't a viable option either, as this would have incurred even higher costs. Additionally, vessel availability in alternative time windows was most likely limited. An alternative approach involving remote generator operation

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and weekly refuelling was also considered but rejected due to minimal savings and increased operational risks.

AFRY considers this additional work unavoidable due to the complexity of fully aligning interfaces in a project of this scale. TenneT explored alternatives, but delaying other workstreams or weekly refuelling would have led to higher costs and risks. Using diesel generators and keeping the JUB on-site was the most practical and cost-efficient solution under the circumstances.

RFC046	Scope Expansion: 4th Cable circuit (WAZ - BVW), installation HGIS
Contractor	SC&M Integrated Substations vof
Amount:	[redacted]
Avoidable:	No

This variation, also related to the 4th cable circuit, involved the installation of a Hybrid Gas Insulated System (HGIS), primary and secondary components, a cable field, and the relocation of the power metering point from Beverwijk 380 kV to WaZ 380 kV.

To meet Netcode requirements, secondary systems such as kWh meters and primary equipment including RC dividers and PQ meters were installed at the new transfer point for accurate energy and power quality measurements. These are essential for both regulatory compliance and tariff calculations for the new customer connection at WaZ 380 kV. Additionally, a HGIS was installed in ACA19 to maintain N-1 redundancy, and a new cable field (ACA24) was constructed to support the expanded system configuration.

As explained in RFC-007, executing this as a stand-alone scope would have significantly increased the total connection costs. Given this, AFRY supports TenneT's decision to incorporate the additional scope and associated costs within the existing HKN/HKWa contracts. The work was competitively priced, executed close to budget estimates, and encountered no significant additional works. AFRY therefore acknowledges the decision to proceed within the project framework in place and considers the associated costs justified and unavoidable.

RFC-P2-055	Horizontal Directional Drilling (HDD) and Sewer Crossing Adjustment for Hollandse Kust Noord at Station Beverwijk
Contractor	NRG vof
Amount:	[redacted]
Avoidable:	Yes, €349.340

During the HKN project, a conflict was discovered between the planned high-voltage cable installation at Station Beverwijk and an existing sewer owned by Hoogheemraadschap Hollands Noorder Kwartier (HHNK). The original design included a

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cable route that crossed the sewer, which was not permitted under an existing agreement with HHNK. This restriction was initially overlooked, as the land is owned by TenneT and no limitations were anticipated.

From the work session on 22 May 2025, AFRY understands that while the presence of the pipeline was known, the restriction on crossing it was not communicated to the project team. Route alignment is managed by a multidisciplinary team, including Land Affairs, which in this case overlooked the crossing restriction stated in the ZRO. AFRY understands that the omission was a mistake by TenneT's Land Affairs team, which had a direct impact on the project's progress. The oversight is considered exceptional, as the land in question was owned by TenneT itself, whereas standard legal reviews typically focus on third-party land.

The restriction only became apparent during execution. Although ZRO agreements are standard practice for managing third-party infrastructure, they contain asset-specific conditions. In this instance, the ZRO was not identified earlier because it was not integrated into the usual documentation systems and was not flagged in the KLIC notification (the standard Dutch process for mapping underground utilities). TenneT considers this an isolated case and has shared the lessons learned internally to avoid similar issues in the future.

To resolve the issue, TenneT and contractor NRG implemented a revised solution, involving horizontal directional drilling (HDD) beneath the sewer. This required removal of part of the already installed cables and additional drilling activities. Although this design adjustment led to an extra cost of [redacted] it was a significantly faster and more cost-efficient alternative to relocating the sewer, which would have required a complete reroute around the high-voltage station and delayed the project's energization schedule.

From a cost perspective, the revised design solution was managed through the regular RFC process. Quantities and unit prices were reviewed and validated by TenneT cost engineers, as described for RFC0004B, and the rates were competitively sourced during the initial tender. The missed identification of the ZRO represents an inefficiency on TenneT's part. While the costs of the HDD itself are considered unavoidable, as the same procedure would have applied even with earlier knowledge of the restriction, the costs related to installing and removing already-installed cables could have been avoided if the ZRO had been identified and addressed upfront. According to TenneT, the removal of these cables cost 199.340 €, while the initial installation costs of the same cables amounted to 150 k€. Since the cables were reused in the final design, the material value of the cables being removed accounted for 0 k€. AFRY therefore considers 349.340 € of the total [redacted] in additional work to be avoidable.

20200520	Additional Customer Connection Fields to Support Offshore Electrification
Contractor	JV HK (Joint Venture Hollandse Kust)
Amount:	[redacted]

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Avoidable: No

As part of the government's strategy to support the electrification and decarbonization of offshore oil and gas platforms, the Ministry of Economic Affairs and Climate Policy (EZK) has formally instructed the addition of customer connection fields to the offshore grid. This measure enables these platforms to draw electricity from offshore wind farms, reducing emissions and enhancing the efficiency of the offshore grid. The instruction is in line with the Offshore Wind Energy Development Framework (spring 2020), which outlines provisions for adapting the HKN platform to support this objective.

The need for the additional customer connection fields could not have been anticipated during the initial project planning phase, as this was the first time such a directive was issued. Although the instruction came after the project had commenced, the costs were covered under the original platform contract within the existing project budget.

The claimed costs relate to engineering & design, procurement of the components, installation works, testing & commissioning. The main components required for the additional customer connection are additional cabling, and additional protection/control cabinets.

AFRY considers this additional work unavoidable, as the government's instruction to add customer connection fields to support offshore electrification was issued after project initiation and could not have been foreseen during initial planning. The directive aligns with national decarbonization policy and implementing it under the existing contract was the most efficient way to enable future offshore platform electrification while minimizing cost and schedule impacts.

RFC043 4th circuit cable pulling

Contractor NRG vof

Amount: [redacted]

Avoidable: No

As part of the fourth cable circuit installation, NRG was instructed to carry out additional land cable works. This included all related civil works, cable pulling, and the setup of temporary facilities and storage. A key element was the secure storage and protection of 18 cable reels and associated 380

kV system accessories for the subcontractor.

Assessment of this additional work follows the same reasoning as RFC-007 and RFC-046 about the 4th circuit. Similarly, executing this scope after 2026 would have significantly increased the total connection costs. Given this, AFRY supports TenneT's decision to incorporate the additional scope and associated costs within the existing HKN/HKWa contracts. The work was competitively priced, executed close to budget estimates, and encountered no significant additional works. In line with RFC-007 and RFC-046 regarding 4th circuit, AFRY considers this RFC to be unavoidable.

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ICR008	Extension of time compensation for NRG due to project delays
Contractor	NRG vof
Amount:	[redacted]
Avoidable:	No

This additional work concerns delays during the Land Cable and HDD works, caused by the late availability of several work sites. These delays were mainly the result of extended finalization of legal agreements and construction arrangements with external stakeholders, including NS Vastgoed and the Municipality of Velsen. Although TenneT engaged early with these parties, unforeseen legal complexities regarding land rights, as well as last-minute changes, such as revised access routes and the unexpected presence of a protected species (a kingfisher), led to access restrictions and required alternative planning. The total cost of this variation amounted to [redacted]

The presence of the kingfisher and its impact on access to the construction site were not foreseen in the environmental assessments, due to the dynamic nature of wildlife behaviour. While general environmental assessments take known protected species and their habitats into account, the specific presence of the kingfisher at the planned access route only became apparent after planning was completed. Once discovered, construction had to be adapted in line with environmental regulations. This required negotiations for an alternative access route and contributed to additional delays. This delay was not caused by a lack of assessment, but by the obligation to respond in a legally compliant way to unforeseen ecological constraints.

- Several mitigating measures were implemented to minimize the impact of delays caused by the late availability of work sites. Key mitigation actions by TenneT included:
- Resequencing of activities: The original construction logic was adjusted to allow cable-pulling operations to run in parallel with ongoing drilling works, regaining critical time in the schedule.
- Deployment of temporary work sites and rerouting: When access to certain areas was blocked (e.g. WKT6a due to ecological restrictions), alternative routes and sites (e.g. WKT6b) were arranged to maintain progress.
- Temporary storage solutions: NRG arranged off-site storage for key materials such as HDPE ducts to avoid on-site bottlenecks while awaiting land access.
- Prevention of idle time: Drilling and pulling equipment was temporarily deployed on other projects to avoid downtime. Simultaneously, project capacity was retained so activities could immediately resume once access was granted.
- Formal change management: TenneT issued formal change requests to adjust the schedule and scope where needed, enabling more flexible and efficient planning within project constraints.

AFRY agrees that the causes of the delays, namely, discussions with municipalities and the presence of the kingfisher, were unforeseeable. Furthermore, TenneT took

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proactive measures to minimize the impact of these delays. As a result, AFRY considers the associated costs to be unavoidable.

VAR-00008-001	Fuel Price Escalation Claim Settlement for Hollandse Kust West Alpha
Contractor	Jan de Nul Luxembourg – LS Cable VO
Amount:	[redacted]
Avoidable:	No

The contractor, Jan de Nul & LS Cables (JLC), submitted a fuel price escalation claim due to sharp fuel cost increases during transport and installation of the HKWa export cables, driven by post-COVID inflation and the Ukraine war. A final settlement of [redacted] was agreed, with deductions for idle time, docking, and repairs. The settlement followed TenneT's Ukraine SCM policy, which allows compensation for justified cost increases due to geopolitical inflation.

The assessment of this additional work follows the same reasoning as VAR-00009-001. AFRY acknowledges that TenneT followed the appropriate procedure and agrees that the market circumstances at the time were indeed unforeseeable. Consequently, the costs are assessed as unavoidable.

VAR-00013	Walk-to-Work Platforms HKN
Contractor	JV HK (Joint Venture Hollandse Kust)
Amount:	[redacted]
Avoidable:	No

This variation order covers the installation of four additional Walk-to-Work (W2W) platforms on HKN. Positioned on all four sides of the platform, the W2W platforms enhance safe and flexible crew access under varying sea conditions.

The decision to install lower-altitude walk-to-work (W2W) access platforms on all four sides of the platform was based on lessons learned from the Borssele and HKZ projects. The aim was to enhance safety, improve accessibility, and increase cost-efficiency. During the work session on 22 May 2025, TenneT explained that the additional platforms would help reduce weather-related delays by improving access to the platform. This approach is also more cost-effective than relying on additional vessel deployment, previously estimated at approximately 20 additional uses per year.

This issue had already been observed during the Borssele project. However, by the time the lessons became clear, the HKN contracts (awarded in 2023) had already been finalized, several years after the installation at Borssele in 2019, leaving no opportunity to incorporate these changes into the tender specifications.

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Alternative solutions, such as helicopter access or crew transfer vessels (CTVs), were considered but rejected due to either higher costs (helidecks) or reduced safety and operability (CTVs). While the variation adds [redacted] in upfront cost, it is expected to generate annual operational savings of approximately [redacted] per platform by enabling the use of smaller, more cost-efficient vessels. The payback period is estimated at 5–6 years, excluding the additional safety benefits.

While this requirement could have potentially been incorporated into the original scope if identified earlier, the change is justified by evolving operational insights during vessel contracting and a growing focus on safety. Therefore, AFRY concludes that the associated costs are justified and deems them unavoidable.

RFC04	Shifting of joint location at Leeghwaterweg
Contractor	Taihan Electric Wire Co., LTD
Amount:	[redacted]
Avoidable:	No

During the detailed engineering phase, it became evident that the original location for Joint Pit 7, situated near Leeghwaterweg and Wijkeroogpark, was unworkable due to space constraints and unforeseen elevation differences between the road and an adjacent ditch. These spatial limitations, combined with the additional of a fourth cable system, left insufficient room for both the joint bay and the required expansion loops. As a result, the joint location had to be shifted into Wijkeroogpark, requiring a revision of the *Inpassingsplan*.

The relocation caused HDD8 to become longer and HDD9 shorter, necessitating recalculations of cable lengths and the procurement of nine additional sections of 3000AlMil cable. While this solution introduced extra costs, it was technically necessary to maintain the project timeline and ensure safe construction conditions.

This issue originated from the early planning stage, where the corridor appeared sufficient on topographic maps but proved too narrow in practice due to overlapping constraints, elevation changes, road and ditch proximity, safety margins, and underground infrastructure. Although safety buffers were incorporated into the corridor design, the corridor was not significantly wider than strictly required, leaving little room for unforeseen obstacles.

TenneT clarified in the work session of 22 May 2025 that route definition involves a tension between providing construction flexibility and limiting spatial impact. In this case, the route passed over a road, ditch, and verge, based on the assumption of technical feasibility. However, the contractor later identified that the location was unbuildable without substantial modifications. This misalignment only became apparent during detailed engineering. The need for relocation was formally acknowledged in the revised *Inpassingsplan*, which concluded that execution within the original corridor was not feasible. Although elevation differences were considered during planning, the severity of the spatial limitations was underestimated. In summary, this additional work stems from unforeseen physical constraints not

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captured in early-stage maps and route assumptions. Given that the design was developed within standard planning tolerances and that alternative solutions would have been equally or more costly, AFRY assesses the resulting cost as unavoidable.

4.8 Research question 8

'What amounts to efficiency? Depending on the answers to the above questions, AFRY experts will evaluate the overall efficiency of the project and this will be noted along with the reasoning.'

AFRY considers 349.340 k€ of the total investment for the HKN/HKWa project to be avoidable, as the missed identification of the ZRO, resulting in the removal and reinstallation of already installed cables, reflects an inefficiency on TenneT's part. All other costs are deemed unavoidable.

AFRY conducted a final assessment of the effectiveness of the investments in project HKN/HKWa. This assessment was based on the answers to research questions 1 to 7, using information provided by TenneT in the form of shared documentation, working sessions and written answers to questions posed by AFRY. AFRY gained insight into the achievement of the set objectives and carried out an analysis of the financial and technical aspects, the procurement process and risk management within the project.

1. AFRY concludes that TenneT has designed a system that meets the predetermined project requirements in terms of capacity and sustainable availability. The realisation of the target capacity has been plausibly demonstrated based on the analysis of the supplied documents. AFRY rates the availability of the systems after IBN as sufficient.
2. The investment costs realised by TenneT, as shown in the notification form and validated by Deloitte, are [redacted] lower than the budget at the time of FID. The main reasons for the difference are that not all identified risks materialized and cable costs were significantly lower due to the use of the RSM. All changes were adequately explained by scope changes and the materialisation of price risks.
3. AFRY rated TenneT's risk management in all project phases, including the application of lessons learned from previous projects, as satisfactory overall.
4. The realised investment costs incurred by TenneT are 10.5% lower (or -96.4 M€) than the counter budget prepared by AFRY. In this regard, the *Project management & engineering* and *system integration* categories are significantly lower than the 15% margin. *Project initiation* was the only category in which the actual costs incurred by TenneT are higher than AFRY estimations, but remains within the 15%.
5. TenneT has sufficiently demonstrated that the relevant procurement procedures have been followed and that internal controls and management approval on the procurement procedures followed have been in place.
6. The actual costs of the various cost items, excluding additional works, have been assessed as unavoidable.
7. AFRY analysed the 15 largest additional works, totalling 57.7 M€, to assess their avoidability. These included issues such as an unexpected peat layer, integration of a fourth cable circuit, and impacts from the war in Ukraine. AFRY

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concluded that only one item was partially avoidable, estimating the avoidable cost at 349.340 k€.

Based on the findings from Research Questions 1 to 7, AFRY concludes that 349.340 € of the HKN/HKWa project costs are avoidable.

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5 TenneT feedback

As part of the efficiency assessment process, TenneT was given the opportunity to provide feedback on the draft report written by AFRY. TenneT provided two comments to the content of the draft report. This chapter addresses TenneT's comments and explains whether, and if so, what changes have been made to finalise the report.

Research question 1, paragraph Sustainable availability, p. 12

In the draft report, AFRY had written: *HKN showed an A-punch (not able to function or safety related) item at final take-over.*

TenneT's feedback to this finding was: *The A-punch items had been completed at the time of commissioning [of the project red.]. This is indeed not immediately apparent from the documentation provided. If any A-punch items were still open, the project would not have been able to be commissioned.*

To ensure formal confirmation that no A-punch items were still open, AFRY has requested evidence. In response, TenneT has provided the formal and signed commissioning documentation, where TenneT's operational asset management department confirms the asset is safe and fit for operation and no A-punch items remain.

AFRY has changed the text to: *There were no A-punch (not able to function or safety related) items at final take-over*.

The conclusion of research question 1 has not changed.

Research question 6, paragraph Cable, p. 33

In the draft report, AFRY had written: *The UXO campaign was expensive, but this can be well explained, since the surveyed area is both a high-risk area for UXO and a busy area, which could lead to many (false) positives.*

TenneT's feedback to this statement was: *This is incorrect, price per km of HKZ and Borssele are higher compared to HKN/HKWa* [red.].

AFRY has compared the UXO campaign costs to projects included in her own data base, which are not all in a high risk area such as the North Sea, and therefore less expensive. AFRY has added text to clarify this, the text was changed to: *The UXO campaign was more expensive compared to the average UXO-campaign in the AFRY-database, but this can be well explained, since the surveyed area is both a high-risk area for UXO and a busy area, which could lead to many (false) positives.*

The conclusion of research question 6 has not changed.

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