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Efficiency Assessment of the Hollandse Kust (zuid) Alpha and Beta investment

Autoriteit Consument & Markt (ACM)

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Report

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List of abbreviations

AC	Alternating Current
ACM	Autoriteit Consument & Markt
ALARP	As Low As Reasonably Practicable
CAPEX	Capital Expenditures
CAR	Construction All Risk
CIV	Cable Installation Vessel
CPRMHB	Corporate Risk Management Handbook
FAT	Factory Acceptance Test
FEED	Front End Engineering and Design
FID	Final Investment Decision
FII	Free Issue Item (=TenneT nomenclature)
FIM	Free Issue Material
FPL	Financial Project Lead
FWA	Framework Agreement
G2	Gate 2
G4	Gate 4
HSE	Health, Safety & Environment
HDD	Horizontal Directional Drilling
HKZ	Hollandse Kust Zuid
HV	High-Voltage
k€	Thousand euro
M€	Million euros
MEAT	Most Economically Advantageous Tender
MFE	Mass Flow Excavation
MTBF	Mean Time Before Failure
MTTR	Mean Time To Recovery, repair, respond, or resolve
MW	Megawatt
MWS	Marine Warranty Surveyor
OPL	Operational Project Lead
OWF	Offshore wind farms
PBA	Project Budget Application
PLJR	Pre-Lay Jetting Run

PoA	Power of Attorney
PSG	Project Steering Group
PQ	Power Quality
Q&A	Question and Answer
RC	Resistor Capacitor
SLB	Simultaneous Lay and Burrier
SLD	Single-Line Diagram
T&I	Transport & Installation
TPE	Third Party Effort
UXO	Unexploded Ordnance
VKA	Voorkeursalternatief
VO	Van Oord

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1. Introduction

Background

To reach the target of the Energy Agreement, five future wind farm zones have been designated in the Roadmap of September 2014[1]. In each wind farm zone, TenneT is required to install a standard power collection platform (substation at sea), with a capacity of 700 MW. Each offshore platform will be the connection point for two offshore wind farms (OWF) of 350 MW each. Next to this, TenneT is required to connect these platforms to the onshore high voltage grid of TenneT.

In the roll out strategy (letter to Parliament, 26th September 2014[2]) of the Ministry of Economic Affairs, the wind farm zone Hollandse Kust (zuid) ('HKZ') has been indicated as the second area to be developed (second allotment(s) (Kavelbesluit) of the Ministry) as part of this roadmap. Wind area HKZ provides sufficient space for a capacity of approximately 1.400 MW. TenneT is responsible for the planning, design, construction, operation and future removal of the offshore and onshore connection of wind farm zone HKZ to the onshore high voltage grid of TenneT.

HKZ consists of a land station, sea cables and two offshore high voltage alternating current (HVAC) transformerstations, Alpha and Beta. In the context of this project, the term 'Alpha' encompasses the entirety of the scope associated with the Alpha substation, while 'Beta' includes all activities and costs arising from the work carried out on platform Beta, both connecting 700MW to the onshore grid.

The Electricity Act (1998) states that a TSO may include the costs incurred for such investments in the tariff proposal, provided the costs are efficient. The ACM therefore performs an efficiency assessment on the costs incurred by TenneT for HKZ Alpha and Beta.

The ACM uses a policy guideline[3] to assess the costs of investments in an efficiency assessment. This means that the ACM must determine whether the goal of the investment has been achieved and whether the costs contribute to the stated goal in a sufficiently plausible and substantiated way. In this context, the ACM commissioned AFRY Consultancy ('AFRY') to conduct an efficiency assessment on the investment done for HKZ.

Project Hollandse Kust (zuid)

The HKZ offshore wind farm is comprised of four areas (I, II, III & IV), all contracted to Vattenfall. It's located 18 kilometres off the coast between The Hague and Zandvoort and connected to the mainland by TSO TenneT.

[1] Offshore wind energy in the Netherlands: The roadmap from 1,000 to 4,500 MW offshore wind capacity
[2] *Kamerstukken II* 2014/15, 33561, nr. 11: https://zoek.officielebekendmakingen.nl/kst-33561-11-n1.html
[3] Beleidsregel ACM beoordeling doelmatige kosten van niet-reguliere uitbreidingsinvesteringen

In October 2016, the Minister of Economic Affairs and Climate chose the best route ('VKA' - Voorkeursalternatief) for the project, which was confirmed as the final plan in June 2018 and became official in April 2019. The route starts from the existing Maasvlakte 380kV substation, goes through the Yangtze channel and the Maasmond, and extends through the North Sea to reach the platforms.

TenneT installed two platforms, Alpha and Beta, each with a capacity of 700 MW. They're placed at sea and connected to the mainland using two 220 kV AC sea cables per platform. Onshore, there's a new transformer station connecting to the existing high voltage 'De Maasvlakte' substation. The platforms are integrated into the Randstad 380 kV Zuid Ring high-voltage connection. Platform Alpha was completed in March 2022, followed by Beta in July 2022.

By the end of July 2022, there were 36 operational wind turbines. While still in its testing phase, the first power from Platform Alpha was already delivered to the Dutch grid in early August 2022. The rest of the turbines are planned for installation in the second quarter of 2023.

Research questions

In this report, AFRY answers the research questions from the table below for the assessment of the efficiency of the investments for HKZ:

TABLE 1. OVERVIEW RESEARCH QUESTIONS

	Research questions
1	Has the objective been achieved by realizing the planned capacity, in the sense that it is truly and permanently available for the transport of electricity? For the efficiency investments the permanent availability is measured till the third month after a project has been put into use.
2	What is the ratio between the investment budget drawn up by TenneT (at the time of the final investment decision) and the most recent investment budget used by TenneT? What is the cause of the discrepancy, if any?
3	Did TenneT manage the project risks adequately? This answer will be related to the use of the project risk budget and the way TenneT uses previous experience from its Dutch or German projects.
4	Is there a difference of over 15% between the total realized investment expenditures (including the projected investment expenditures that are forecasted after the project came into operation) and an alternative budget drawn up by AFRY? If so, what causes the difference?
5	Have the official procurement procedures been followed? If not, what is the reasoning? Which procedures have been used to select the contractor?
6	Do the cost items (excluding additional work) contribute towards the objective? Were certain costs avoidable, and if so, what part of the costs?

7	How does the additional work contribute towards the objective? Was this additional work avoidable, and if so, what part of the additional work?
8	What is the overall efficiency of the project as executed by TenneT? Depending on the answers to the questions above, AFRY experts will evaluate the overall efficiency of the project and it will be noted together with the reasoning.

2. Plan of Approach

The approach for the efficiency assessment of the HKZ project is based on answering the research questions, described in Chapter 1, posed by the ACM. This chapter provides insight into the approach taken by AFRY to answer the questions posed.

Efficiency assessment

Through the research questions, the efficiency of the project investment is determined in the areas of risk management, finance, technical and procurement. All relevant documents and data of the investment provided by TenneT, along with the verbally explained aspects of the project during the kick-off, work sessions, and written explanations via Q&A's, are assessed by the AFRY experts. All the documents mentioned in the assessment, including both appendices and attachments, are provided by TenneT and documented in footnotes.

While answering the research questions, AFRY distinguishes between qualitative and quantitative research questions:

Qualitative Questions - This category of research questions necessitates a qualitative analysis of the plans, works, actions, and processes. In response to these questions, the assessment specifies whether the performance or process has been carried out adequately or inadequately, and whether this has been sufficiently substantiated based on the available documentation. Research questions 1, 3, and 5 are categorized as qualitative, and are thus evaluated according to the following criteria:

TABLE 2. EVALUATION CRITERIA

Score	Explanation
Sufficient	A sufficient degree of efficiency and all aspects are substantiated.
Insufficient	An insufficient level of efficiency and/or the substantiation is not sufficient.

Quantitative Questions - These research questions not only demand a qualitative analysis of the documentation, but also a quantitative analysis of the documents. This is done by presenting the results as numerical values,

such as percentages, ratios, or total values of avoidable investments. Research questions 2, 4, 6, and 7 are categorized as quantitative.

For research question 8, the efficiency of the investment HKZ is summarized based on the partial results of the research questions 1 till 7.

3. Answers to the research questions

Research question 1

'Has the objective been achieved by realizing the planned capacity, in the sense that it is truly ad permanently available for the transport of electricity? For the efficiency investments the permanent availability is measured till the third month after a project has been put into use.'

AFRY concludes that both the Alpha and Beta projects meet the main requirements specified in the Development Framework. However, while their designs fulfil the 700 MW transport and availability requirements, operational compliance remains inadequately substantiated.

Assessment method

AFRY has conducted a thorough analysis and assessment of the achieved target transport capacity of the HKZ project. This evaluation was based on various detailed reports provided by TenneT, among which the Development Framework[4].

The evaluation of transport capacity also encompasses the validation of the grid connection's capacity at various stages, including design (such as simulations), construction (including verification against Factory Acceptance Test (FAT) values), and operational compliance with transport capacity (including measurements).

Availability has been evaluated by comparing the planned availability with the actual realized availability.

The task of assessing and evaluating the pertinent regulations, norms, and standards for power transport falls upon the independent entity DNV-GL, which has reviewed all design documents, simulations, tender documentation, and FATs.

Assessment

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 assessment by an independent consultant;

[4] Appendix 1.01 Development Framework (ontwikkelkader d.d. 10 juni 2022)

3. The expected moment of availability (revised, 31/12/21 and 31/3/22 for Alpha and Beta);
4. A maximum available power of 760 MW, including dynamic loading of cables.

These main requirements, as described in the Development Framework, serve as the foundation for project development and execution.

Based on the Grid Readiness Certificates, AFRY has confirmed that both connections were technically prepared and in compliance with functional requirements and relevant (test) standards. It's worth noting that the assessment of the 'goal to minimize the overall costs of the project and the respective wind farms together' is expected to be carried out as part of the overall project setup, considering the resultant functional requirements and technical studies; this is not within the scope of this assessment.

As an independent consultant, DNV-GL has determined that 'grid readiness' was achieved for HKZ Alpha on 22/3/22 and for HKZ Beta on 24/6/22.

In both instances, the anticipated availability dates were not met, resulting in approximately a three-month delay. In the verification memo provided, TenneT reported that this delay did not impact the connection of the offshore wind farm significantly and only resulted in minor additional costs. These costs were substantiated by TenneT in the Q&A[5], and included claims from Vattenfall amounting to [Vertrouwelijk] k€ and VOC amounting to [Vertrouwelijk] k€.

The transport capability of 760 MW, as determined by dynamic loading, is primarily reliant on the 220kV 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 220kV cable design, and thus, AFRY considers it to be compliant.

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

Capacity

Overall, all design, tender documentation and verifiable technical capabilities of system components as well as the load-flow report review by DNV-GL show the capability of being compliant to the 700 MW transport requirement. In addition, all other grid-readiness related reports (e.g. simulations, FAT reports, commissioning tests) have been considered compliant by DNV-GL.

The requirements for cable ampacity calculations[6] differ from the conventional conservative standard, which typically necessitates an evaluation of the maximum continuous load. TenneT, however, has opted for a dynamic approach for deep sections, taking into account the gradual heating of the ground and cables deeply buried underground[7]. This approach still results in a

[5] Vraag3_Plus minus list Vattenfall_HKZ_20221026; Vraag3_EmailExchange_PlusMinus list Vattenfall_HKZ

[6] Bijlage E techniek ONL-TTB-03218-MA E3.1-220kV_Cable_design_and_manufacturing_requirements
[7] Vraag71_CigrePaper_B1-118_2018

cable design that is able to handle the required power to be transmitted without overheating the cable. AFRY considers this approach as acceptable.

It is noteworthy that the grid readiness certificates[8] and Verification plans[9], do not consider the equipment which is installed at the 380kV TenneT land station with the Connection Point. In a response to a question posed by AFRY, TenneT explains via the Q&A, that grid readiness verification can only occur upon the commissioning of a specific number of turbines. AFRY although has the opinion that grid readiness verification of the equipment can be demonstrated using the same protocols applied to other project equipment (as presented in the grid readiness report), such as FAT reports, Site Integration Tests (SIT), and 'Gebruikerstesten'. Verification of the readiness, status and tests of this equipment on the 380kV TenneT land station could therefore not be executed by AFRY.

Also, it's important to note that no documentation has been provided to demonstrate operational compliance with the minimum requirement of 700 MW transport capability.

AFRY concludes that the designs of project Alpha and Beta meet the 700 MW transport requirement, but operational compliance has not been sufficiently demonstrated.

Availability

The Single Line Diagram makes it evident that the design aims to sustain a limited transport capacity when facing an n-1 situation (such as the loss of a transformer, export cable, or a related land-station component). Moreover, in an n-2 situation, the platform can draw auxiliary power from its neighbouring platform. AFRY regards this as a creditable design strategy for ensuring availability, which is also implemented across other platforms by TenneT.

Upon AFRY's request, TenneT supplied the Terra 19 (Landstation) and Terra 20 (Offshore) documents, aimed at substantiating the current state of the project as taken over by the Operations division. These documents outline the status of punch items (no remaining A and A/B items), the extent of as-built information completeness, the aforementioned grid readiness records, and numerous other deliverables pertinent to the project. These documents although do not contain the information to verify the availability of the connections with a minimum duration of 3 months during the prior use period or after handover. The information to verify this should consist of (not complete):

- SCADA list with possible events and trips per connection
- related repair times to the beforementioned events or trips
- switching events which hinders the connectees in their operation including the possible congestion/times

[8] Appendix 1.02 Grid Readiness Certificate Alpha; Appendix 1.03 Grid Readiness Certificate Beta
[9] Appendix 1.06 Verification plan Alpha; Appendix 1.07 Verification plan Beta

- reports stating the available ampacity (if this is considered to be partial due to a switch/outage)

AFRY concludes that the designs of project Alpha and Beta meet the availability requirement, but that operational compliance has not been sufficiently demonstrated.

Research question 2

'What is the ratio between the investment budget drawn up by TenneT (at the time of the final investment decision) and the most recent investment budget used by TenneT? What is the cause of the discrepancy, if any?'

The actual investment costs of HKZ are 11% lower than the investment budget during the Final Investment Decision (FID). The main drivers for these lower actual costs are:

- The risk budget and contingency budget have not fully materialized.

- [Vertrouwelijk].

This has been partially offset by [Vertrouwelijk]

Assessment method

On April 10, 2017, the TenneT Executive Board approved the Gate2 (G2) document of the HKZ project. According to the TenneT Corporate investment manual[10], this is considered the final investment decision (FID) of a project. The budget consisted of [Vertrouwelijk] M€ project budget and [Vertrouwelijk] M€ identified risks. The actual costs of the investments have been provided by TenneT[11] and have been independently validated by Deloitte, amounting to a total of 664 M€.

AFRY has compared the G2-budget[12] (during FID) with the actual costs of the investment.

Assessment

Table 1 shows the comparison between the actual investment costs and the budgeted values during FID (because of rounding.differences, some of the calculations in the table do not fully match)

TABLE 3. COMPARISON BETWEEN THE G2-BUDGET AND THE ACTUAL COSTS OF HOLLANDSE KUST (ZUID)

Cost item	Budget on FID [M€]	Actual costs [M€]	Difference [M€]	Difference [%]
General & Finance	[Vertrouwelijk]	[Vertrouwelijk]	-[Vertrouwelijk]	[Vertrouwelijk]
Identified risks	[Vertrouwelijk]	[Vertrouwelijk]	-[Vertrouwelijk]	[Vertrouwelijk]
Platform	[Vertrouwelijk]	[Vertrouwelijk]	[Vertrouwelijk]	[Vertrouwelijk]

[10] Appendix 1A Corporate Investment Manual (Marnezijl)
[11] 2. Memo realisation versus budget.pdf
[12] Appendix 2.02 Approved FID Gate 2 (Gate 2 - ONL-TTB-04012 G2 Final Investment Decision)

Cable	[Vertrouwelijk]	[Vertrouwelijk]	-[Vertrouwelijk]	[Vertrouwelijk]
Land Station	[Vertrouwelijk]	[Vertrouwelijk]	[Vertrouwelijk]	[Vertrouwelijk]
System Integration	[Vertrouwelijk]	[Vertrouwelijk]	[Vertrouwelijk]	[Vertrouwelijk]
Project initation	[Vertrouwelijk]	[Vertrouwelijk]	-[Vertrouwelijk]	[Vertrouwelijk]
Maasvlakte 380 (onshore)	[Vertrouwelijk]	[Vertrouwelijk]	[Vertrouwelijk]	[Vertrouwelijk]
Total	746	664	-82	-11%

The actual costs of HKZ are 82 M€ (or 11%) lower than the budget during FID. The most significant differences are discussed below:

- The actual costs for General & Finance are significantly lower than the budgeted values, which is mainly caused by lower costs for internal and external resources for project management. Some of the budget has been re-allocated to account for budget overruns in the management of the platform construction.
- Budget and actuals of the platform and cable are similar; [Vertrouwelijk]
- The increased costs for the land station were mainly caused [Vertrouwelijk]. Moreover, COVID and the redesign of shard walls led to higher costs, which were released from the risk budget.
- System Integration, which consists of all primary and secondary electrical equipment and their installation on the platform, was slightly over budget. This difference was almost entirely caused by additional TenneT-resources required. These were required to manage the [Vertrouwelijk] and additional issues caused by COVID.
- [Vertrouwelijk]

Research question 3

'Did TenneT manage the project risks adequately? This answer will be related to the use of the project risk budget and the way TenneT uses previous experience from its Dutch or German projects.'

Overall, the risk management by TenneT for this project has been assessed as sufficient. The risk management process has been followed, and the financial end result is satisfactory. Several effective and significant risk mitigating actions have been implemented. Considering the 20 largest additional works, the risk management is assessed as sufficient.

Assessment method

The risk management within the HKZ project has been analyzed 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 in itself for its projects is explicitly excluded from this efficiency assessment. The assessment solely concentrates on determining whether TenneT adhered to its own processes and handbook.

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 20 largest additional works and claims?

Assessment

Risk management process

The risk management in this project was carried out based on the Corporate Project Risk Management Handbook ('CPRMHB'), developed following the ISO31000 standard for risk management.

During the kick-off meeting on April 3, 2023, TenneT explained that lessons learned from various Dutch and German TenneT projects – especially Borssele – have served as the basis of the project risk register for HKZ. Experiences from Borssele, Dolwin III, and Borwin II were incorporated to ensure that the risk register aligned with the specific project circumstances, given that these projects had a similar scope (Borssele) or involved the same subcontractors (Dolwin II and Borwin II).

In the Q&A, TenneT stated that extensive risk identification sessions were conducted within each workstream (overall & finance, platform, cable, land

station, system integration) to supplement and further specify the risk registers.

During the kick-off meeting, TenneT mentioned that the risk register is updated on a monthly basis and, at the very least, quarterly as part of accountability to the Project Steering Group (PSG) by project leaders. This quarterly reporting to the PSG includes a brief presentation, including an overview of the top 5 financial risks and the top 5 risks impacting the project's timeline. TenneT has shared multiple managerial reports[13] and related risk registers[14] from just before start of construction until the time when the project was operationally ready (Gate 4 or 'G4'), end of 2022. From these managerial reports and risk registers, it can be seen that throughout the project execution risks have evolved, and TenneT has evaluated and treated these identified risks. This is confirmed by the updates in the risk register by including the date and specific description or action where applicable.

During project execution, lessons learned were shared within TenneT's project community in so called 'Operational Project Lead/Financial Project lead' (OPL/FPL) meetings two times per year, where project management of all large projects as well as senior management were present.

Considering the frequency and distribution of these updates over time, AFRY concludes that the risk register has been adequately monitored and reviewed in terms of quantity and regularity throughout the project.

The entire process, from identifying, analyzing, and evaluating risks to executing control measures and monitoring the risk inventory, appears to have been correctly and comprehensively executed, both in preparation of the construction phase as well as throughout the project. AFRY rates the adherence to the prescribed risk process as sufficient.

FID risk budget

AFRY has compared the risk budget as part of this project's G2-budget[15] (during FID) with the prescribed guidelines. The risk budget comprises of the identified risk budget, project contingency and a general risk contingency.

At G2, HKZ's identified risk budget amounts 90 M€ equaling 12% of the net project budget, which is based on the expected risk value. This deviates from the 10% benchmark set by the cPRMHB. The increase with respect to the benchmark is explained by TenneT as a result of implementation of learnings from Borssele into the expected risk value calculation for HKZ.

The project contingency at G2 amounts [Vertrouwelijk]M€ equaling [Vertrouwelijk]% of the net project budget, which adequately aligns with the guidelines prescribed in the Corporate Investment Manual (project contingency [Vertrouwelijk]%).

The general contingency at G2 amounts [Vertrouwelijk]M€ equaling [Vertrouwelijk] % of the net project budget. The cPRMHB states that the

[13] Vraag39_MSR_18-August_Hollandse Kust Zuid_PSG-final t/m Vraag39_MSR_22-October_Hollandse Kust Zuid_PSG_final
[14] Vraag39_Risk register HKZ 14-02-2019 t/m Vraag39_Risk Registor HKZ 30-08-2018
[15] Appendix 2.02 Approved FID Gate 2 (Gate 2 - ONL-TTB-04012 G2 Final Investment Decision)

general risk contingency is a fixed buffer of [Vertrouwelijk]% of the net budget, and that the actual size of the risk budget is determined by management decision based on risk appetite and/or corporate policy. The reserved [Vertrouwelijk]% is a management decision that reflects the projects risk profile at that moment in time. AFRY assesses this as being in line with cPRMHB guidelines.

Secondly, AFRY compared the utilization of the risk budget at the time when the project was operationally ready (Gate 4 or 'G4')[16] , to the reserved risk budget at the time of FID. From the identified risk budget of 90 M at FID, a total of [Vertrouwelijk]M has been spent, which equals [Vertrouwelijk]% of the identified risk budget, or [Vertrouwelijk]% of the total budget at FID.

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

FID risk register

The risk register as part of FID documentation has been reported by TenneT on a high level[17], whereby the risks identified have been grouped into overarching risk topics. Out of the total identified risk budget with an Expected Value of [Vertrouwelijk]M€, the six largest risks identified together represent an Expected Value of [Vertrouwelijk]M€. The six largest risks are summarized below in order of magnitude:

1. Claims and variation orders,
2. Insufficient System interface management,
3. Tender result cable/platform/landstation,
4. Crossing Maasmond technically challenging,
5. Permission to use 'cable and 'kabel- en leidingenstrook' uncertain,
6. Delay in permitting process

The remaining risks identified together represent an Expected Value of 11 M€, and are grouped under "Other risks".

At the time of G4, [Vertrouwelijk]M€ has materialized in relation to the six largest risks and has been paid from the applicable risk budget. A further [Vertrouwelijk]M€ has been paid from the "Other risks" budget of [Vertrouwelijk]M€[18].

AFRY concludes that the high-level risk identification process followed by the project team sufficiently identified the most significant risks.

Additional works

The top 20 additional works amount to a total of 58.420 k€[19]. A significant part of these 20 additional works is the sum of multiple claims and/or works,

[16] Vraag14_Ontwikkeling_IdentifiedRisks_G2toG4
[17] Appendix 2.02 Approved FID Gate 2 (Gate 2 - ONL-TTB-04012 G2 Final Investment Decision)
[18] Vraag14_Ontwikkeling_IdentifiedRisks_G2toG4.pdf
[19] 5. Explanation on additional work HKZ

see referenced document[19]. In assessing the risk management related to these top 20 additional works, all variations and all claims larger than 250.000 € have been assessed. This results in 36 variations and claims with a total amount of 58.3 M€. For each of these claims and variations, it was determined whether it was accounted for in the risk register at FID or shortly before the start of construction in September 2018 (based on the risk register of August 30, 2018). For the materialized risks, AFRY has assessed whether initial classification was in proportion to the materialized value, and whether mitigating measures have been taken. The assessment of whether additional works were avoidable is further addressed in research question 7.

Seven claims with a total value of 17.5 M€ were not paid from the risk budget because they resulted from an increased scope of work. Two claims by Petrofac with a value of [Vertrouwelijk]M€ are for "contribution to completion of offshore phase", it remains unclear why this has been paid from the risk budget. These nine claims have not been taken into account in this analysis.

Seven claims with a total value of [Vertrouwelijk]M€ resulted from the unforeseen circumstances of COVID-19, and were therefore assessed as unavoidable due to risk management. Three claims with a combined value of [Vertrouwelijk]M€ (related to the updated design of the crossings and the sinkhole at the landfall) are considered unforeseen circumstances and were not concretely accounted for in a specific Risk ID, but considered to be covered by the risk reservation made for G3 (Risk ID 28168) and/or the project risk contingency of [Vertrouwelijk]% of the net budget.

Four claims with a total value of [Vertrouwelijk]M€ were the result of TenneT's risk mitigation measures, such as the pre-trenching of the entire nearshore route, and the de-risking measures implemented for Beta based on lessons learned of Alpha executed by Van Oord Cable V.O.F.

The remaining thirteen claims with a total value of 9.9 M€ were identified in the risk register before start of construction.

These thirteen claims are covered by 10 risks, which have been classified sufficiently in proportion to the materialized value of the related claims. Only Petrofac's claims related to "additional survey works for identification of positive UXO", LMR Drilling GmbH's variation "casing removal" and BAM Infra B.V.'s "reinforcement shard walls" surpass the expected maximum costs, but these are still in the same order of magnitude.

Seven of the ten risks were attempted to be mitigated. Two of the ten risks involve soil uncertainties and survey uncertainties. It is commonly accepted that these works are planned based on information available, aiming for a risk level that is As Low As Reasonably Practicable (ALARP), without the need for further risk mitigation. The last of the ten risks is related to topside delay, where float was planned but turned out to be insufficient. Overall, AFRY considers the mitigation measures as sufficient.

Considering the top 20 additional works, AFRY concludes the risks have been managed sufficient, given the overall adequate classification, the [Vertrouwelijk] M€ worth of claims spent on mitigating actions, and risk

register showing TenneT has planned mitigating actions were deemed possible.

Research question 4

'Is there a difference of over 15% between the total realized investment expenditures (including the projected investment expenditures that are forecast after the project came into operation) and an alternative budget drawn up by AFRY? If so, what causes the difference?'

The realised investments costs incurred by TenneT are 11% lower than the counter budget, prepared by AFRY. The main driver for this cost difference [Vertrouwelijk]. Two realized investment cost items are significantly higher than the counter budget, namely:

Land station, which has been caused by difficulties in construction and increases in material prices and labor shortage, which was not taken into account in the cost database of AFRY.

Project management, which can be explained by the multi-contracting strategy followed by TenneT. However, this strategy has paid off in significant lower realized investment costs for platform and cable.

Assessment method

To answer research question 4, a counter budget is prepared by AFRY, based on a catalogue of cost values from previous projects and studies in which AFRY has participated. This cost catalogue is regularly updated with data from the latest international projects and the latest innovations and technologies available on the market. As a preparation to this assessment, TenneT has provided a high-level cost breakdown of the project into six different categories. The categories are further broken down into actual contracts, TenneT resources, third party effort and miscellaneous. The cost breakdown has been discussed during the kick-off and the work session of May 8, 2023.

To evaluate the validity of the investments, the counter budget has been created using the following approach:

1. The contracts of the four main cost items have been compared with AFRY counter budget values. These counter budget values are based on typicals in the AFRY reference project list. To control possible Additional Works, the AFRY counter budget values have been increased with 10%.
2. Insurance costs have been budgeted separately and valued at 2% of the contract value.
3. 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. For the specific components, the following reasons apply:
- The platform is expected to require additional project management given the multi-contracting strategy
- The cables were procured from a remote location and are require significant interface management between production, transport and installation
- The land station and adjustments for MV380 are also specialized investments that face significant site-specific challenges.

4. The TenneT-items "Third Party Effort", "Initiation" and "Project Management" were all considered part of this 10-15%.
   - Project initiation is the first phase of project management and the cutoff point between the two is arbitrary and differs throughout companies. Moreover, many commercial developers group both Initiation and Project Management together.
   - Third Party Effort (TPE) are project management and support services that are performed by third parties and are therefore also included in this category.

Assessment

Table 4 contains an overview of the actual costs of the investment as incurred by TenneT and the AFRY counter-budget, constructed using the steps provided above.

TABLE 4. COUNTER BUDGET

#	Cost Item	Actual costs HKZ [M€]	Counter budget [M€]	Difference [M€]	Percentage difference actuals vs counter budget [%]
1	Platform + transformer	[Vertrouwelijk]	294	[Vertrouwelijk]	[Vertrouwelijk]
2	Cables (Sea-, land cables, HDD, UXO)	[Vertrouwelijk]	279	[Vertrouwelijk]	[Vertrouwelijk]
3	Land Station	[Vertrouwelijk]	53	[Vertrouwelijk]	[Vertrouwelijk]
4	Maasvlakte 380 changes	[Vertrouwelijk]	12	[Vertrouwelijk]	[Vertrouwelijk]

5	Insurance	[Vertrouwelijk]	13	[Vertrouwelijk]	[Vertrouwelijk]
6	Project Management and TPE	[Vertrouwelijk]	96	[Vertrouwelijk]	[Vertrouwelijk]
7	Project initiation	[Vertrouwelijk]			
	Total	**664**	**745**	**-81**	**-11%**

The actual investment cost of TenneT is 81 M€ (corresponding to 11%) lower than the AFRY counter budget. On a cost item level, the results vary; the largest differences are described below:

1. [Vertrouwelijk] Moreover, TenneT has chosen a multi-contracting strategy, which can lead to lower realised costs if managed effectively. Contracts for platform and cables have all been awarded before COVID and the rapid rise in construction prices of 2020 - 2022, so this effect is not seen in this cost item. The costs for horizontal directional drilling (HDD) and Unexploded ordnance (UXO) surveys and removal were similar between the actuals and counter budget.
2. The land station is significantly more expensive than the counter budget. A main driver for this, is that the contracts have partially been awarded during COVID and the resulting rapid rise in construction prices of 2020 - 2022. These price increases were not yet included into the AFRY-database of reference projects.
3. Project management costs are significantly higher than the industry standard. This can be explained by the multi-contracting strategy (instead of turn-key) that TenneT employed on many lots, [Vertrouwelijk] The difference between the tender results and the counter budget by AFRY of 'platform' and 'cables' is much higher than the higher project management costs, which can be seen as a justification that these costs are in line with expectations.

Concluding, since the counter budget is higher than the actual costs by TenneT, the realized investment costs are not more than 15% higher than the counter budget. Some cost items, most notably the land station and project management costs, are significantly higher than the counter budget. This difference will be further discussed in research question 6.

Research question 5

'Have the official procurement procedures been followed? If not, what is the reasoning? Which procedures have been used to select the contractor?'

TenneT has demonstrated adherence to the relevant procedures in the tendering and procurement of the primary erection and equipment delivery contracts for the project. Additionally, TenneT has effectively demonstrated the robust governance process overseeing these procedures.

Overall assessment is that adherence to applicable procurement procedures is deemed sufficient.

Assessment method

The assessment of the compliance to procurement procedures has been performed through assessment of the provided documentation, the responses to questions and the further clarifications received during the procurement work session. Based on the schematic overview of what was assessed below, the following sub-questions can be conducted:

1. What was the contracting strategy and its justification basis in policies and other considerations?
2. What processes govern the execution of the strategy in individual tenders?
3. What governance structure is in place to ensure that the tenders are performed in accordance with the processes and to endorse the tender results?

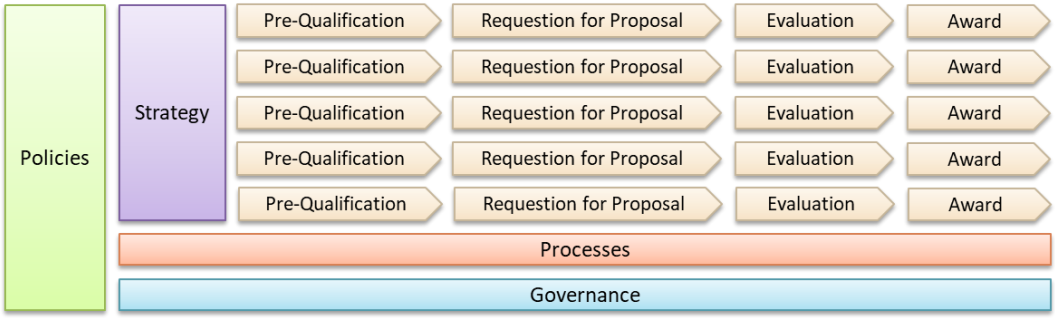

FIGURE 1: GOVERNANCE STRUCTURE TENDER PROCESSES

Though the project contracting strategy and tender documentation contained some clear references to existing policies, the policies themselves and verification of their full implementation were outside of the scope of the assessment.

At the start of the efficiency assessment AFRY received an extensive documentation package, including a general description of the tender procedures and some sample documents from the main tenders. In response to questions by AFRY this documentation was completed with further documentation about contracting strategy, individual tenders, and governance processes.

There has been one work session in relation to the procurement processes. In this work session, the assessment method and follow-up questions with regard to the provided documentation were discussed. The Negometrix platform was also demonstrated for one of the main tenders (selected at random).

The focus of the assessment was on the main execution contracts listed as item 2-6 in Table 6, these represented more than 90% of total contract value of all contracts above 1% of total investment and as such were deemed sufficient for the purpose of the assessment. The Free Issue Materials (FIMS), item 1 in Table 6, were ordered under existing framework agreements, so the majority of the tendering for these FIMS were considered to be outside of scope of the assessment. Still, it was decided to do a sample of the FIM tendering and to include this in the assessment.

Assessment

Governance

Within TenneT the Power of Attorney with regard to external commitments (such as erection contracts) is arranged in the *Corporate Policy External Power Of Attorney And Internal Authorisation Rules*[20].

A Project Steering Group (PSG) is instated which, amongst others, is tasked with the endorsement of contract strategies and award recommendations.

Process

TenneT is a contracting entity *('speciale-sector bedrijf'*) subject to the Public Procurement Act. As a consequence, tenders are published in the Supplement to the Official Journal of the European Union and on TenderNed[21]. Furthermore, evaluation criteria to determine the most economically advantageous tender (MEAT) are described in the *Instruction to Tenderers* in a transparent manner. The EU tender rules specify the tendering process to be followed. TenneT uses the electronic tendering platform Negometrix where all tender communication is securely stored.

As a part of the assessment, AFRY aimed to determine the applicable processes that dictate the way the contracting and procurement is performed within TenneT. Information was provided about the TenneT power of attorney policy, but no overarching procurement and contracting processes were provided. This was subsequently discussed in the procurement work session. Here, it was highlighted that there is a management process system in place within TenneT, called ADONIS. However, the project team relied on the process dictated by the power of attorney (PoA) policy and adherence to the EU tender rules for the procurement and contracting process. Though a more thorough TenneT-specific process description for contracting and procurement would have been helpful for the assessment, we agree with the assessment by the TenneT project team that the PoA and EU tender rules would be leading in any case. The PoA in combination with EU tender rules actually provide enough guidance on the process to be followed and the governance

[20] Vraag17_Corporate Policy External Power of Attorney and Internal Authorization Rules
[21] http://ted.europa.eu, http://www.tenderned.nl

over this process, therefore the assessment focused on proper performance of the tenders in accordance with these guidelines.

Contracting Strategy

In 2015 the overall contracting strategy for the projects Borssele Alpha & Beta, HKZ Alpha & Beta and Hollandse Kust Noord Alpha was established and approved by the PSG in March 2015[22]. Later that year the contracting strategy was developed further, in line with this overall strategy, and captured in a PSG decision document. In this document the justification for selection of the contract formats FIDIC Yellow Book for the offshore works and UAV contracts (UAV-GC 2005) was presented[23].

The contracting strategy for HKZ Alpha and Beta, in line with the overall strategy, including selected contract types, was as follows:

TABLE 5. SELECTED CONTRACT TYPES AND CONTRACTING STRATEGY

No.	Scope	Tender	HKZ Alpha / HKZ Beta
0	FEED	-	In-house engineering / Ramboll
1	Free issued materials	FWA	Framework agreements
2	Platforms including T&I	EU Tender	FIDIC Yellow Book
3	Sea cable supply and installation	EU Tender	FIDIC Yellow Book
4	Land cable supply and installation	EU Tender	FIDIC Yellow Book
5	Land station civil works	EU-202	UAV 2012
6	Land station installation works	EU-203	UAV 2012
7	Services (surveys)	-	TenneT contract

The first step of cost-effective procurement is the selection of an effective contracting strategy. From the documentation provided, and subsequent discussion in the procurement work session, it is evident that TenneT had a clear vision of what they aimed to achieve. In our opinion, the selected contracting strategy balances risk (and its allocation) and cost effectiveness.

Free issue materials, mainly consisting of high voltage equipment, were ordered under existing TenneT framework agreements with the suppliers of these free issue materials. In general, use of free issue materials introduces an interface risk with the main erection contracts, as the employer delivers materials that are to become an integral part of the finished erection contract work. The reasoning behind the choice of free issued materials as part of the contracting strategy was thoroughly discussed in the procurement work

[22] Vraag19_DP002 ONL 15-156 Procurement Strategy all projects
[23] Vraag 59 17092015 Decision Proposal PSG - WoZ Contracting V8 0 final

session and more justification was provided in a memorandum[24]. AFRY concludes that the choice for free issued materials was justifiable for reasons of standardization, TenneT control over HV (component) design and quality control. Besides that, this resulted in a lower component cost due to increased volume over projects, due to portfolio approach, and standardization. The introduced interface face risk was clearly addressed within TenneT's risk management, with late delivery of FIMs being flagged as a possible cause for claims and variation orders as well as a general risk in relation to insufficient system interface management. Risk budgets were allocated to cater for these risks. Please refer to the chapter on research question 3 for further details.

Documentation has been made available to clarify the reasoning behind the selected contracting strategy. Also, the management (PSG) endorsement of the strategy was demonstrated.

Tenders

For all the tenders within the scope of our assessment, AFRY received key tender documentation. This included pre-qualification documents, award criteria documentation, award recommendation reports and award decisions. From the documentation provided it can be concluded that the tenders were performed in line with the (endorsed) contracting strategy and in line with the applicable processes (as defined by EU tender rules). Also, the governance over the process was well documented including the endorsement of the award recommendations.

[24] Vraag21_ONL-TTB-03063 Free Issued items, demarcation of components between TenneT and Contractor

Research question 6

'Do the cost items (excluding additional work) contribute towards the objective? Were certain costs avoidable, and if so, what part of the costs?'

AFRY has analyzed the different cost items that were supplied by TenneT, focusing on the actual costs. The avoidability of the additional work has not been considered in this research question and will be further discussed in research question 7. The costs have been divided into the same categories as for research question 4 (counter budget). Based on its assessment, AFRY concludes that all cost items are not avoidable.

Assessment method

AFRY conducted its evaluation by utilizing the data and documentation furnished by TenneT. TenneT provided several financial statements, which were thoroughly analyzed and discussed during the work session on May 8, 2023. With this input, AFRY assessed the cost items to determine if any of them could have been partially or entirely avoided. It is essential to note that TenneT holds responsibility for the accuracy of this information.

Given AFRY's positive assessment of the procurement process (see research question 5), where TenneT demonstrated compliance with all procurement requirements, it can be concluded that TenneT achieved the best value for money for the tendered items. Therefore, in this chapter, all components and services contracted through the most economically advantageous tender (MEAT) are considered unavoidable.

In this paragraph, the realized cost items are considered excluding the additional works. The avoidability of additional work has been assessed separately in research question 7.

Assessment

The results from the assessment of each category are summarized in the table below, and further detailed in the following sections. As shown in the table, all cost items are not avoidable.

TABLE 6. AVOIDABILITY OF COST ITEMS

#	Cost item	(Partially) avoidable
1	Platform + transformer	No
2	Cables (Sea-, land cables, HDD, UXO)	No
3	Land station	No
4	Maasvlakte 380 adjustments	No
5	Insurance	No

6	Project management and TPE	No
7	Project initiation	No

Platform and transformer

This cost item includes the construction and installation of the platforms, the purchase of the electrical equipment and their installation on the platform.

The platform itself has been tendered under best value procurement for [Vertrouwelijk]M€, [Vertrouwelijk] lower than the counter budget created by AFRY. The transformers and secondary components were procured under multi-year framework agreements with suppliers for [Vertrouwelijk]M€. These framework agreements have also been tendered.

Overall, none of the costs that fall under the cost item platform and transformer are deemed avoidable.

Cables & UXO

The cost item labeled as 'cables' encompasses the UXO campaign and all costs associated with producing and installing both onshore ([Vertrouwelijk]M€) and offshore ([Vertrouwelijk]M€) cables, and includes a small HDD section to cross the Rotterdam harbor. This section ([Vertrouwelijk]M€), albeit expensive, was deemed unavoidable to prevent significant disruption and risk materialization in the harbor area. The UXO campaign ([Vertrouwelijk]M€) was expensive compared to other projects, but this can be well explained, since the surveyed area is both a high-risk area for UXO and a busy port area, which leads to many false positives.

All tasks were awarded through a competitive bidding process, specifically through full competition based on MEAT criteria. The tender results for the cables and their installation were in line but slightly lower than the counter budget created by AFRY.

To conclude, none of the costs that fall under the cost item 'cables' are deemed avoidable.

Land station

This cost item consists of the civil works, installation works, primary and secondary electrical equipment and site supervision. The civil works ([Vertrouwelijk] M€) and installation works ([Vertrouwelijk]M€) have been executed under existing framework agreements with contractors. The electrical equipment ([Vertrouwelijk]M€) 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 ([Vertrouwelijk]M€) 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 item 'land station' are deemed avoidable.

Maasvlakte 380 adjustments

To connect HKZ to the national 380kV grid, the 380kV station Maasvlakte needed to be adapted and expanded, the costs of which fall under this category. The costs ([Vertrouwelijk]M€) are incurred under framework agreements with contractors and suppliers and are in line with expectations.

In conclusion, none of the costs that fall under the cost item 'Maasvlakte 380 adjustments' are considered avoidable.

Insurance

Insurance costs for large infrastructural projects are in line with international best practices and the insurance premium is in line with similar projects. Therefore, insurance costs are considered not avoidable.

Project management & third-party effort

The project management cost item encompasses all expenses related to (internal and external) TenneT employees during the construction phase, including post-construction support. Alongside overall project management, each specific workstream (cable, platform, land station, and system integration) had its dedicated project management team. The general project management team consisted of various roles such as project managers, project support staff, work preparation specialists, project controllers, risk managers, quality managers, project control experts, document managers, contract managers, and procurement professionals. The project management for the other workstreams primarily involved project managers and engineers. Even though the costs for project management (when including the initiation phase, see for additional explanation research question 4) were higher than the industry standard of 15% of the CAPEX, this can be well explained by the multi-contracting strategy that TenneT chose, which led to cost savings in other lots (see also research question 4).

The category 'third party effort' consists of smaller subcontracting of activities like inspections, progress monitoring and studies. For all workstreams combined, the costs accrued to [Vertrouwelijk]M€. AFRY has requested a deeper substantiation of these costs and after reviewing, all cost items appeared reasonable and unavoidable.

To conclude, none of the costs that fall under the cost item 'Project Management & TPE' are deemed avoidable.

Project initiation

Project initiation activities include things like developing a comprehensive project plan and obtaining necessary licenses and permits., evaluating soil

quality and assessing environmental conditions, conducting engineering design and feasibility studies and procuring necessary materials, equipment, and services. These activities form the foundation for a successful project by organizing the team, planning, assessing environmental factors, securing land, addressing technical considerations, and procuring resources.

The cost items mentioned under Project Initiation were expected. When comparing to the counter-budget, the costs for Initiation were added to Project Management & TPE and even though the combination of Initiation and Project management was higher dan 15% of the CAPEX, this can be explained by the multicontracting strategy (see above). To conclude, none of the costs that fall under the cost item 'project initiation' are deemed avoidable.

Research question 7

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

AFRY has conducted an analysis of the top-20 additional works (variations and claims) and determined whether they were (partially) unavoidable. The analysis revealed that none of the additional works were avoidable.

Assessment method

TenneT provided the top 20 Additional Works for the purpose of this research question. AFRY believes that by assessing these top 20, the majority of the expenditures resulting from additional works can be assessed. The financial range of the top 20 Additional Works ranges from [Vertrouwelijk]k€ to [Vertrouwelijk] k€ and the total adds up to 58.420 k€. An overview of the Additional Works categorized per party can be found below:

TABLE 7. OVERVIEW ADDITIONAL WORK [VERTROUWELIJK]

Additional Work	Claim #	Topic	Site	Amount [k€]	Avoidable
A. Claims Alpha (total)		**Total of 17 claims**	**Alpha**	**[Vertrouwelijk]**	**No**
A. Claims Alpha	CLD-025, 26, 27	COVID-19 settlement value	Alpha	[Vertrouwelijk]	No
A. Claims Alpha	CLD-018, 024	PLJR	Alpha	[Vertrouwelijk]	No
A. Claims Alpha	CLD-022/23	Engineer's instruction to complete PLJR	Alpha	[Vertrouwelijk]	No
A. Claims Alpha	CLD-028	Transpooling Alpha 2	Alpha	[Vertrouwelijk]	No
A. Claims Alpha		Claims not assessed25	Alpha	[Vertrouwelijk]	n/a
A. PS Alpha		**Provisionary Sum**	**Alpha**	**[Vertrouwelijk]**	**n/a**
B. Claims Beta (total)		**Total of 10 claims**	**Beta**	**[Vertrouwelijk]**	**No**
B. Claims Beta	VP-022, 023	Maasmond dredging	Beta	[Vertrouwelijk]	No
B. Claims Beta	CLD-016	Covid-19 settlement value	Beta	[Vertrouwelijk]	No
B. Claims Beta	CLD-017	Remedial cable burial	Beta	[Vertrouwelijk]	No
B. Claims Beta	CLD-013	Topside delay	Beta	[Vertrouwelijk]	No
B. Claims Beta	CLD-008	UXO removal	Beta	[Vertrouwelijk]	No
B. Claims Beta		Claims not assessed[26]	Beta	[Vertrouwelijk]	n/a

[25] AFRY assessed the claims on a sample basis by reviewing in detail all claims with a settlement value > 250 k€.
[26] AFRY assessed the claims on a sample basis by reviewing in detail all claims with a settlement value > 250 k€.

B. PS Beta		**Provisionary Sum**	**Beta**	**[Vertrouwelijk]**	**n/a**
C. Variation derisking measures Beta (total)		**Total of several variations**	**Beta**	**[Vertrouwelijk]**	**No**
C. Variation derisking measures Beta	VP-011	Float before SLB	Beta	[Vertrouwelijk]	No
C. Variation derisking measures Beta	VP-008	PLJR nearshore section	Beta	[Vertrouwelijk]	No
C. Variation derisking measures Beta	VP-010	Dredging at dispersion	Beta	[Vertrouwelijk]	No
C. Variation derisking measures Beta		Claims not assessed[26]	Beta	[Vertrouwelijk]	n/a
D. Variation pre-lay jetting run to remove potential obstacles		**D**	**Alpha**	[Vertrouwelijk]	**No**
E. Crossing design change (total)		**Total crossing design change**		[Vertrouwelijk]	**No**
E. Crossing design change		E	Alpha	[Vertrouwelijk]	No
E. Crossing design change		E	Beta	[Vertrouwelijk]	No

TABLE 8. OVERVIEW ADDITIONAL WORK PETROFAC

Additional Work	Claim #	Topic	Site	Amount [k€]	Avoidable
A. Claims Alpha + Beta (total)		**Total of several claims**	**Alpha + Beta**	[Vertrouwelijk]	**No**
A. Claims Alpha + Beta (total)	CL-01	Engineer's delay and disruption to contractor engineering works	Alpha	[Vertrouwelijk]	No
A. Claims Alpha + Beta (total)	CL-03	Impact of preferential inspection	Alpha	[Vertrouwelijk]	No
A. Claims Alpha + Beta (total)	CL-05	Delay caused by Covid-19 affecting milestone M12	Alpha	[Vertrouwelijk]	No
A. Claims Alpha + Beta (total)	CL-07 (A + B)	Delay due to COVID-19 affecting Contractor's ability to achieve milestones M14b and M15 disruption part	Alpha	[Vertrouwelijk]	No

A. Claims Alpha + Beta (total)	CL-08	Additional survey works for the identification of UXO	Alpha	[Vertrouwelijk]	No
A. Claims Alpha + Beta (total)	CL-03	Additional survey works for the identification of UXO	Beta	[Vertrouwelijk]	No
A. Claims Alpha + Beta (total)	CL-05 (A + B)	Delay caused by Covid-19 affecting milestone M14b + M15	Beta	[Vertrouwelijk]	No
A. Claims Alpha + Beta (total)	Settle	Contribution to competing the offshore works up and until 7th of October 2022	Alpha + Beta	[Vertrouwelijk]	No
B. Main transformer exchange				[Vertrouwelijk]	**No**
C. Change of jacket Beta sail away				[Vertrouwelijk]	**No**

TABLE 9. OVERVIEW ADDITIONAL WORK FUGRO

Additional Work	Amount [k€]	Avoidable
A. Variation increases quantities	[Vertrouwelijk]	No
B. Contract amendment	[Vertrouwelijk]	No

TABLE 10. OVERVIEW ADDITIONAL WORK SIEMENS NL

Additional Work	Amount [k€]	Avoidable
A. Rebaselining agreement	[Vertrouwelijk]	No
B. Variation in HVSS starting point	[Vertrouwelijk]	No

TABLE 11. OVERVIEW ADDITIONAL WORK LMR DRILLING

Additional Work	Amount [k€]	Avoidable
A. Claim settlement	[Vertrouwelijk]	No
B. Variation casing removal	[Vertrouwelijk]	No

TABLE 12. OVERVIEW ADDITIONAL WORK BAM

Additional Work	Amount [k€]	Avoidable
A. Reinforcement shart walls	[Vertrouwelijk]	No

TABLE 13. OVERVIEW ADDITIONAL WORK SIEMENS AG

Additional Work	Amount [k€]	Avoidable
A. LS Power transformers price adjustment	[Vertrouwelijk]	No

With respect to each additional work, it was determined whether it was (partially) avoidable. When assessing the degree of avoidability, subjective factors naturally come into play, such as the availability of complete information, the existence of unforeseen circumstances, the assessor's experience, and their viewpoint. Consequently, the justifications behind a particular judgment are well-founded.

An Additional Work encompasses a wide range of data, including observed facts, the underlying cause, potential solutions with their respective impact on budget, schedule, and quality, as well as alternative options. While all these aspects are taken into consideration during the evaluation process, the reporting primarily focuses on the financial aspect and the level of avoidability. This reporting approach aims to best support the overarching evaluation of the goal of achieving 'efficiency'.

Assessment

Additional works related to VO Cable V.O.F.

A	Claims Alpha
Costs	[Vertrouwelijk]k€
Avoidable	no

VOC has submitted 17 claims with a total value of [Vertrouwelijk]k€, which were negotiated and finally settled with TenneT for an amount of [Vertrouwelijk] k€.

AFRY assessed these claims on a sample basis by reviewing in detail all claims with a settlement value > 250 k€. These claims were discussed during two work sessions with TenneT for clarification. The results of this assessment are presented below:

3 claims relate to COVID-19 amounting to settlement value of [Vertrouwelijk] k€ (CL 25-27)

Additional work

The additional costs include among others the time impact, quarantine requirements, extended, re-routed and cancelled travel of employees, housing and hotels, additional health examination, etc.

Assessment by AFRY

Due to the unforeseen and widespread nature of the pandemic, AFRY concludes that these costs could not have been avoided.

2 claims relate to Pre-Lay Jetting Run (PLJR) with a total settlement value of [Vertrouwelijk]k€ (CL 018, 024)

Additional work

Two different methods were used for installing the cable at depth across the route. This is due to the different requirements in the Water Permit for the burial depth in the nearshore and offshore area. To maximize the probability of achieving the correct burial depth where burial depth requirements are

high, laying and burial should be performed in one combined Simultaneous Lay and Burial (SLB) operation.

In the nearshore area, SLB is executed with a cable laying vessel (CLV) in conjunction with the 'Deep Dig-It' trencher, a newly built underwater tracked vehicle that can jettison or mill a narrow trench in the seabed and buries the cable directly at the required depth. The trencher is a very heavy machine, equipped with tracks that allow it to move under its own power. The seabed over which the trencher travels must have sufficient bearing capacity to prevent sinking. In addition, the ground must be sufficiently compact to generate traction to enable the forward motion of the trencher.

However, when VOC conducted pre-sweeping surveys prior to the cable laying works, these showed that over a width of about 800m in the Maasmond there is a layer of silt or clay with insufficient bearing capacity and/or traction for the trencher. Before crossing with the trencher, the top layer of silt had to be removed (blown away sideways) using Mass Flow Excavation (MFE). Initially, an attempt was made to resolve the situation through additional dredging, which would have been the cheapest solution, but proved unsatisfactory. The claims includes the costs incurred for: the additional dredging conducted on August 18, 19, 20, 21, and 31, as well as September 1, 2020, the subsequent soil survey works, and the additional engineering required to address the issue. Reaching the depth of burial with a MFE and/or backfilling spread is removed from this claim, which is further discussed in VP 022 (Maasmond dredging).

TenneT explained during one of the work sessions and via the Q&A that soil surveys were carried out on multiple occasions before, during, and after the cable installation campaign. Results from surveys, including Cone Penetration Testing (CPT), conducted pre-tender and shared with the tenderers, showed no indication of a problematic silt layer, so no problems were anticipated by both TenneT and the contractor during the tender phase.

[Vertrouwelijk]As the pre-tender surveys did not reveal any inconsistencies either, the silk layer could have not been foreseen. [Vertrouwelijk] Time impact of this claim is addressed in CL 022 and CL 023 (Engineer's instruction to complete PLJR).

Assessment by AFRY

AFRY concludes that the costs of these two claims could not have been avoided, as the soil conditions were not reasonably foreseeable at the submission date of the tender.

2 claims related to Engineer's Instruction to complete PLJR with a total settlement value of [Vertrouwelijk]k€ (CL 022,023)

Additional work

The Maasmond is vital for accessing the Port of Rotterdam, making it a crucial part of the port infrastructure. To ensure a smooth implementation of the project while considering each other's interests, TenneT and the State Harbour Master ('Rijkshavenmeester') established a close cooperation and

developed a set of nautical preconditions for VOC to follow when crossing the Maasmond with the cable installation equipment.

One of the nautical preconditions set by the Harbour Master involves conducting a test trench across the fairway using the Deep Dig-It trencher to prove operational readiness prior to cable installation. This test evaluates the trencher's speed and suitability for the local subsurface, as well as the communication protocol between the executing contractor and the Harbour Master. VOC conducted an initial test run on August 1st 2020 and encountered soft soil conditions on two locations, which caused the Deep Dig-It trencher track pads to slip, slowing down the trencher until the trencher eventually became immobilized in the seabed.

As the first test run failed due to immobilization of the trencher, TenneT instructed VOC to perform an additional test trench on August 18, 2020. This included the instruction to complete the PLJR for the remainder of the route, see also claim CL 018 and 024 (PLJR).

As the additional PLJR was not part of the contract scope, the time impact resulting from keeping the Deep Dig-It trencher and the remaining spread on stand-by, as well as the instructed PLJR at the soil dispersion location are included in this claim.

Assessment by AFRY

Following the same line of reasoning as CL 018 and CL 024, AFRY concludes that these costs were not avoidable.

Claim related to Transspooling Alpha 2 with a total settlement value of [Vertrouwelijk]k€ (CL 028)

Additional work

During the load-out of the Alpha 2 cable in September 2020, an occurrence of cable irregularity was observed. Such anomalies are commonly encountered during this stage and do not indicate any actual cable damage at this point. To ensure the cable's safety and prevent potential damage, the Marine Warranty Surveyor (MWS) made the decision to slow down the cable spooling process as a precautionary measure. TenneT explained they supported this cautious approach to prioritize cable protection.

The MWS acts on behalf of the Construction All Risk (CAR) insurer, overseeing and monitoring the work to determine if it falls within the scope of the CAR insurance coverage. Compliance with the MWS's instructions is crucial to maintain insurance coverage for the work, and consequently, disregarding the MWS's guidance would annul the work's insurance.

Following discussions between VOC and TenneT, a mutual decision was reached to share the costs associated with the event, considering the circumstances and respective responsibilities; there was no actual damage of the cable indicated and the decision to slow down by MWS was on behalf of TenneT.

Assessment by AFRY

AFRY concludes that these costs could not have been avoided by TenneT.

A	Provisory Sums statement Alpha
Costs	[Vertrouwelijk]k€
Avoidable	n/a

Additional work

TenneT has made an estimation of the provisions to be included in the budget, taking into account the scope of work and associated execution risks. The weather delays and additional rock dump are the primary elements in the Provisory Sum statements. This estimated amount was not pre-included in a purchase order as it does not represent a fixed obligation. The actual commissions were treated as additional work and assigned a separate purchase order, which is why they are listed among the top-20 variations.

Assessment by AFRY

As these costs were anticipated and accounted for, and part of the risk budget, AFRY does not treat this as an additional work.

B	Claims Beta
Costs	[Vertrouwelijk]k€
Avoidable	no

VOC has submitted 10 claims with a total value of [Vertrouwelijk]k€, which were negotiated and finally settled with TenneT for an amount of [Vertrouwelijk] k€.

AFRY assessed these claims on a sample basis by reviewing in detail all claims with a settlement value > 250 k€. These claims were discussed during two work sessions with TenneT for clarification. The results of this assessment are presented below:

2 claims concern Maasmond dredging which amount to a settlement value of [Vertrouwelijk]k€ (CL 22-23)

Additional work

At a number of locations on the north and south sides of the Maasmond, the embankment slope was steeper than the maximum slope that the trencher could cross. In addition, within the Maasmond near the north and south slope, it is essential to consider the Nautical Guaranteed Depth (NGD) for shipping, which is set at LAT -23,2m. With a dredging margin of 1,5m and a necessary ground cover of 3m, this yields a minimum installation depth of -27,7m. This burial depth requirement was greater than the maximum burial depth that the trencher could achieve. To this end, local dredging was carried out to smoothen or lower the seabed.

The initial local dredging at the cable route Alpha was not sufficient, which resulted in the trencher getting stuck during the simultaneous lay and burial (SLB) of the Alpha 2 cables, because the south slope collapsed onto the trencher.

As a de-risking measure to prevent a similar incident to what occurred at the Alpha cable routes, for Beta, the Maasmond underwent additional dredging, albeit with a less steep south slope. TenneT covered the cost of dredging beyond the standard depth of 27 meters, i.e. the extra meter beyond VOC's scope, required in this case.

Assessment by AFRY

As previously explained, the unexpected soil conditions in Maasmond had an effect on the progress of the works conducted for Alpha. Therefore, AFRY views the dredging in Maasmond for Beta as a suitable risk mitigation measure and concludes that these costs were not avoidable.

Claim relating to COVID-19 with a settlement value of [Vertrouwelijk]k€ (CL 16)

Additional work

The additional costs include among others the time impact, quarantine requirements, extended, re-routed and cancelled travel of employees, housing and hotels, additional health examination, etc.

Assessment by AFRY

Due to the unforeseen and widespread nature of the pandemic, AFRY concludes that these costs could not have been avoided.

Claim involving backfill along Beta 1 cable route as result of mass flow excavation with a settlement value of [Vertrouwelijk]k€ (CL 17)

Additional work

In a specific segment of the cable route, the trencher was unable to perform a second pass of work to achieve the required burial depth of the sea cables. As a result, VOC had to conduct additional excavation using Mass Flow Excavation (MFE) in an effort to reach the required depth for the cables. MFE creates a trench which, as explained by TenneT during one of the work sessions and confirmed in the Q&A, had to be filled to comply with permit requirements (commissioned by Rijkswaterstaat). As these backfilling activities were not expected in the tender phase, they were also not included in the contract. The expenses associated with MFE were covered by VOC, while the cost of backfilling was born by TenneT.

Assessment by AFRY

As the trench created by MFE activities was unforeseen by TenneT, and permit requirements need to be fulfilled, these costs were not avoidable.

Claim Topside Delay Beta with a settlement value of 334 k€ (CL 13)

Additional work

The delivery delay of the Beta Topside by Petrofac has resulted in a significant setback of ~150 days for VOC's project schedule and the completion of the Beta contract.

These costs related to the delay have not yet been considered in the settlement reached with Petrofac. [Vertrouwelijk] However, at the time of settlement, the offshore phase of the project had already been ongoing for nine months and had also experienced its own delays. [Vertrouwelijk]

Assessment by AFRY

AFRY concludes that the costs for VOC are not avoidable.

Claim for Identified objects removal with a settlement value of [Vertrouwelijk] k€ (CL 8)

Additional work

Fugro anticipated the presence of more unexploded ordnance (UXO) objects and a greater impact than initially expected at the cable laying route (see Additional Work Fugro *A* (*Variation increases quantities*) and B (*Contract amendment*). In an effort to mitigate project risks and avoid encountering potential obstacles that could hinder the trencher's operations, VOC made attempts to remove these higher-risk targets.

Assessment by AFRY

AFRY concludes that these costs are not avoidable.

B	Provisory Sums statement Beta
Costs	[Vertrouwelijk] k€
Avoidable	n/a

Additional work

TenneT has made an estimation of the provisions to be included in the budget, taking into account the scope of work and associated execution risks. The weather delays and additional rock dump are the primary elements in the Provisory Sum statements.

This estimated amount was not pre-included in a purchase order as it does not represent a fixed obligation. The actual commissions were treated as additional work and assigned a separate purchase order, which is why they are listed among the top-20 variations. As these costs were anticipated and accounted for, and part of the risk budget, AFRY does not treat this as an additional work.

C	De-risking measures Beta HKZB-VOC-00547-002 VP-011
Costs	[Vertrouwelijk] k€

Avoidable	no

Additional work

VOC has proposed several variations to address and minimize the risks that arose during the analysis and clarification of the Alpha scope. These variations have been thoroughly examined, clarified, and ultimately agreed upon by TenneT, resulting in a settlement amount of [Vertrouwelijk] k€.

AFRY assessed these variations on a sample basis by reviewing the variations with a settlement value > 500 k€. These claims were discussed during two work sessions with TenneT for clarification. TenneT stated that the de-risking variations for the Beta contract primarily resulted from the lessons learned during the execution of the Alpha contract. These de-risking measures include actions taken to address Maasmond test trenches with the Deep Dig-It trencher, a Pre-Lay Jetting Run at the nearshore section (further explained in the next section: D Pre-lay jetting run to remove potential obstacles), dredging at the soil dispersions and adding float before SLB.

A more thorough investigation was performed on the latter (VP 011, Float before Simultaneous Lay and Burial (SLB)). The planning of VOC for Beta was tight with limited slack to handle breakdowns. In the work plan for the construction and maintenance of sea cables for HKZ, it is stipulated that lessons learned will be gathered with all relevant stakeholders and implemented for the upcoming activities. After each crossing of the shipping lane with the trencher, upon completion of the test-trench, and following the installation of the Alpha export cables, a lessons learned session has been conducted for the subsequent tasks. Based on lessons from the Alpha campaign, it was concluded that including float in the planning for Beta would be beneficial. This addition of float aimed to achieve several objectives: enhance the predictability of the planning, meet the expectations of stakeholders (especially the Port of Rotterdam), ensure preparedness for the SLB campaign, and reduce the risk of claims related to the SLB campaign. [Vertrouwelijk]

Assessment by AFRY

AFRY supports the decision of TenneT to de-risk the Beta project with respect to the variations mentioned above. Therefore, AFRY concludes that these costs were not avoidable.

D	Pre-lay jetting run to remove potential obstacles
Costs	[Vertrouwelijk] k€
Avoidable	no

Additional work

Identified and unidentified obstacles laying in the seabed deeper than 1,2 m pose a risk to the trencher and the cable lay operation. Delay risk due to unforeseen circumstances may lead to significant costs [Vertrouwelijk] when

the entire spread is involved and may lead to cable damage or undesirable repair actions.

As a de-risking measure the entire nearshore route (first 10 km) can be pre-trenched, via a so-called PLJR, at which all objects are either broken, fluidized to below 5 m or identified as non-passable. In Germany pre-trenching is standard practice but in NL it was not and depended on the actual situation. Therefore, TenneT already requested a PLJR in the contract but it was not yet priced. Underlying reason for this decision was that at that time, marine engineers in the Netherlands were not convinced that a PLJR would be necessary.

During the preliminary work, it was found that there were many obstacles on the route (UXOs, cables, etc), and more than anticipated in the tender stage, that could result in significant damage to the trencher and delay of the project. As a de-risking measure it was agreed between TenneT and contractor to conduct pre-trenching at both the Alpha and Beta cable route. The costs for this PLJR were born by TenneT.

Assessment by AFRY

These additional costs are not avoidable.

Note: As a result of these lessons learned, a PLJR has now been adopted by TenneT as standard practice in the Netherlands.

E	Crossing design change Alpha and Beta
Costs	[Vertrouwelijk]k€
Avoidable	no

Additional work

TenneT, in collaboration with the pipeline owner [Vertrouwelijk], conducted a comprehensive risk analysis for the installation, management, maintenance, and removal of the crossing structures. This analysis played a crucial role in determining the type of crossing structures to be constructed. The primary criterion for the selection was to minimize risks to the crossing itself and other maritime users throughout the lifespan of the structures. The procedural guidelines for this selection process are outlined in the crossing agreement between TenneT and [Vertrouwelijk]. Accordingly, the crossings with the existing infrastructure will adhere to the specifications stated in the crossing agreement.

At the pipeline locations, the cables will be laid over the existing infrastructure instead of being buried. A separator and protective measures will be installed around the cable at the crossing site. The crossing agreement stipulate that no soil-penetrating tools may be used within a 50-meter radius on either side of the crossing, which was also adopted as the new design standard within TenneT. Within the 50-meter zone, the burial depth is set to zero and the cable, along with the separator and protection, are laid over the relevant gas pipeline.

The initial crossing designs in the contract with VOC were aligned with the former design standard of TenneT, indicating that no soil penetrating tools would be used within 25 meters of the crossing. Due to the revised requirements, a modification was made to the crossing design. The modified crossing, referred to as type B, was agreed upon within the crossing agreement established with [Vertrouwelijk], ensuring adherence to their specific requirements.

Negotiations for the adjusted crossing designs with VOC took place during the project's execution phase. As a result of the design changes, a variation payment of [Vertrouwelijk]k€ was made for the Alpha crossing, while the Beta crossing incurred a variation payment of [Vertrouwelijk]k€. These payments reflect the additional costs associated with the design modifications.

Assessment by AFRY

AFRY concludes that these costs resulting from modified design insights are not avoidable.

Additional works related to Petrofac

A	Claims Alpha and Beta
Costs	[Vertrouwelijk] k€
Avoidable	No

Petrofac reported delays in the sail-out of the Alpha jacket in December 2019, followed by a six-month delay in the sail-out of the Alpha topside in March 2020. [Vertrouwelijk], which later translated into a claim from Petrofac against TenneT. It became evident that also the T&I slots for both the Alpha and Beta topsides would be missed.

TenneT engaged in discussions with Petrofac to clarify subcontractor positions, obtain accurate sail-out dates, and secure revised T&I slots. Petrofac terminated its existing T&I contract with [Vertrouwelijk] and entered into new contracts for heavy transport vessels. Subsequent claims were made against TenneT, [Vertrouwelijk]

[Vertrouwelijk]

For the assessment of each of the claims that were part of the negotiations, AFRY performed two separate analyses for Alpha and Beta, see below.

Alpha

Cost arising from Engineer’s delay and disruption to Contractor engineering works (CL-01)

Additional work

[Vertrouwelijk]

Assessment by AFRY

AFRY holds the opinion that this working method of TenneT was necessary to achieve the required quality of the documents and that TenneT could not have avoided these additional works.

Impact of preferential inspection and testing requirements by Employer (CL-03)

Additional work

[Vertrouwelijk]

Assessment by AFRY

AFRY is of the opinion that additional work resulting from necessary modified inspection test procedures cannot be avoided.

Delay caused by COVID-10 affecting Contractor's ability to achieve milestone M12 (CL-05)

Additional work

Petrofac filed a claim for delay caused by COVID-19 affecting Petrofac's ability to achieve milestone M-12 'Jacket Installation Complete' (CL-05) for an amount of [Vertrouwelijk] k€. The impact of COVID-19 had caused severe delays and disruption to Petrofac's procurement, fabrication and construction works due to enforced closures of manufacturing plants and other workplaces, and travel restrictions in place, preventing the transportation of materials and people. [Vertrouwelijk]

Assessment by AFRY

AFRY's assessment of CL-05 is taken into account in the assessment of CL-07A & B

Delay due to COVID-19 affecting Contractor's ability to achieve milestones M14b and M15 prolongation & disruption part (CL-07A & B)

Additional work

Petrofac filed a claim (CL-07A & B) for four events causing delay that affected Petrofac's ability to achieve milestone M-14b 'Topside Installation and offshore pre- energization commissioning complete' and M-15 'System Take Over Certificate (Taking Over Platform)', namely:

1. Extended FIM Suppliers' Onshore Installation and Commissioning works duration (for the supply of 66kV GIS, 220kV GIS, Main Transformer and Earthing/Auxiliary transformer, 220kV Platform Cable, Power Quality Metering System, Protection & Control relays including SCADA, Backup Generator Sets)
2. Additional Works – Design for Alternative Aux Transformer, Swapping of Array Cable Strings 3, 4 & 5
3. Additional Works – Replacement of faulty Main Transformers
4. COVID-19 Delay Event

[Vertrouwelijk]

Assessment by AFRY

AFRY acknowledges TenneT's decision to partially compensate Petrofac for the T&I window, encompassing delays attributed to COVID. After a thorough

review, AFRY concluded that all four instances of delay were either the result of unavoidable circumstances or deemed as sensible and beneficial risk-mitigating decisions.

Additional survey works for the identification of positive UXO (CL-08)

Additional work

Petrofac filed a claim for additional survey works for the identification of positive UXO for an amount of [Vertrouwelijk] k€. During the execution of the works, Petrofac, [Vertrouwelijk] carried out a detailed survey at the offshore location for identification of positive UXOs in compliance with the Employer's Requirements and approved procedures. Fugro anticipated the presence of more unexploded ordnance (UXO) objects and a greater impact than initially expected at the cable laying route (see RFC 'A + B Variation increases quantities + Contract amendment'). Therefore, on request of TenneT, [Vertrouwelijk] undertook additional investigation of suspected UXOs in order to identify positive UXOs. [Vertrouwelijk] performed these additional surveys as a variation to the contract. [Vertrouwelijk]

Assessment by AFRY

AFRY concludes that TenneT could not have avoided these additional works.

Additional contributions of [Vertrouwelijk] k€ each were made for both Alpha and Beta, to complete the offshore phase and reach an agreement between TenneT and Petrofac.

In summary, AFRY concludes that none of the claims related to Alpha are avoidable, and the decision of TenneT to pay for one additional T&I window is appropriate considered all aforementioned events.

Beta

Additional survey works for the identification of positive UXO (CL-03)

Petrofac filed a claim for additional survey works for the identification of positive UXO for an amount of [Vertrouwelijk] k€. [Vertrouwelijk] AFRY concludes that TenneT could not have avoided these additional works.

Delay due to COVID-19 affecting Contractor's ability to achieve milestones M14b and M15 prolongation & disruption part (CL-05A & B)

Additional work

Petrofac filed a claim for three events causing delay that affected Petrofac's ability to achieve milestone M-14b 'Topside Installation and offshore pre-energization commissioning complete' and M-15 'System Take Over Certificate (Taking Over Platform)', namely:

1. Extended FIM Suppliers' Onshore Installation and Commissioning works duration
2. COVID-19 Delay Event
3. FAT rejection

[Vertrouwelijk] settlement negotiations from July 2022 resulted in TenneT deciding to pay Petrofac for Beta an additional amount proportionate to the disruption costs of the T&I claim, [Vertrouwelijk] Two main reasons supported this decision: Petrofac's proactive efforts to reset the T&I window to protect the project timeline, and the [Vertrouwelijk] indicated difficulty to determine the correct amount of the compensation based on the claim details.

Asessment by AFRY

AFRY understands TenneT's decision to compensate Petrofac based on the costs for the rescheduling of the T&I window.

In addition, there are extra contributions totaling [Vertrouwelijk]k€ to finalize the offshore phase and facilitate an agreement between TenneT and Petrofac, similar to Alpha.

In summary, AFRY concludes that none of the related claims to Beta are avoidable.

B	Main transformer exchange
Costs	[Vertrouwelijk]k€
Avoidable	no

Situation

TenneT placed an order for six transformers from Royal Smit [Vertrouwelijk]. Two of these transformers were ordered for Borssele, the four others for HKZ. Following consultation with the ACM, it was decided to focus this efficiency assessment exclusively on events occurred during the HKZ project, disregarding decisions made related to the procurement process of the transformers before gate 2 of the HKZ project[27].

In July 2019, Kema conducted a short-circuit test on the first transformer for HKZ, and it failed. While awaiting the outcome of the investigation on the short circuit-test failure of the transformer, TenneT decided to ship the two already fabricated transformers for HKZ Alpha to the fabrication yard in the United Arabian Emirates (UAE). Later, it was discovered that the failed short-circuit test was due to a serious manufacturing flaw in the transformer's mechanical properties. This concerned all four transformers for HKZ.

Based on the second short circuit test performed during the period of 25-30 March 2020, TenneT confirmed that Royal Smit had adequately demonstrated the short circuit requirements of the modified design[28].

During the kick-off meeting on April 3rd, 2023, TenneT explained to AFRY that they decided to install and commission the faulty transformers as a de-risking measure. This decision is confirmed by the Change Request form, in which TenneT states that "*the decision allowed them to continue working on the platform and already test the HV cables*"[29]. According to TenneT, "*this has*

[27] 4. Memo Internal project procedures
[28] Vraag112_20200813 Settlement Agreement TenneT_vs4 Final - Singed TenneT Smit
[29] 5. Explanation on additional work HKZ

proven to be valuable, since a problem was discovered with the Pfisterer plug, which TenneT was able to replace".

Additional reasons mentioned for the decision to proceed with the defective transformers were given by TenneT via the Q&A (on July 5th, 2023): "*to comply with contractual delivery dates of Free Issued Material to Petrofac and prevent claims, to protect the project timeline and to continue the fabrication and commissioning process in the UAE*".

For the assessment by AFRY, the timeline for the replacement of the faulty main transformers is summarized below:

[Vertrouwelijk]

Additional work

Since TenneT had decided to transport and install the faulty transformers, Petrofac was informed to arrange and execute the replacement of the faulty transformers, which had already been installed in the platform in July 2020, with new transformers arriving at the fabrication yard end of January 2021.

To perform the transformer exchange, Petrofac had to access the soft patch. The soft patch is an area in the roof deck specifically designed to allow for a possible transformer exchange without any structural impact. This means that they had to cut open the roof deck, exchange the transformers and seal off the roof deck again. The variation proposal from Petrofac was accepted for an amount of [Vertrouwelijk] k€[30]. This included the costs to exchange the transformers for Alpha by Petrofac in Dubai, and the transportation costs to send the faulty transformers back to the Netherlands.

[Vertrouwelijk] As it was TenneT's decision to ship and install the faulty transformers for HKZ Alpha, they had to born the costs made by Petrofac for the transportation and exchange of the faulty transformers of HKZ Alpha.

Assessment by AFRY

During kick-off meeting on April 3rd, 2023, TenneT explained their de-risking decision to ship transformers to the UAE while awaiting investigation results from a failed short circuit test. In light of the circumstances, AFRY expressed support for this decision, recognizing its potential to prevent substantial costs and delays if the investigation revealed a readily solvable issue.

AFRY also affirms that the decision to install the faulty transformers was an appropriate de-risking measure [Vertrouwelijk]. Subsequent to the installation of new transformers, a high-voltage cables test was conducted. Despite the increased costs for TenneT resulting directly from the decision to install and commission defective transformers, AFRY aligns with TenneT's justification. They emphasize the primary goal of preventing disruptions to the manufacturing process, as the faulty transformers facilitated crucial connections and links to other equipment, allowing the smooth progress of commissioning activities and planned tests. AFRY also recognizes the

[30] 5. Explanation on additional work HKZ

identification of an issue with the Pfisterer plug as a positive outcome of installing the transformers.

Additional reasons provided by TenneT during a Q&A session on July 5th, 2023, for proceeding with the defective transformers include compliance with contractual delivery dates of Free Issued Material to Petrofac, [Vertrouwelijk], protecting the project timeline, and ensuring the continuation of the fabrication and commissioning process in the UAE. [Vertrouwelijk]

Taking all circumstances into account, AFRY supports TenneT's choice to transport the faulty transformers to the UAE while awaiting the results of the short-circuit test failure. Furthermore, AFRY understands the decision to install the faulty transformers, leading to the conclusion that the additional costs related to the main transformer exchange are unavoidable.

C	Change of jacket Beta sail away
Costs	[Vertrouwelijk]k€
Avoidable	no, see Petrofac additional work 'Claim A + B'

Additional work

In January 2021, TenneT realized that the sail out slot for the Beta jacket needed to be changed, as they anticipated project delays.

[Vertrouwelijk]

Assessment by AFRY

In a work session, TenneT clarified that the consideration of paying this claim is integrated into the ongoing negotiations with Petrofac, forming part of the comprehensive claim settlement process totaling [Vertrouwelijk] k€, as outlined in Petrofac additional work A (Claims Alpha + Beta). AFRY therefore considers there costs as unavoidable.

Additional works related to Fugro

A + B	Variation increases quantities + Contract amendment
Costs	[Vertrouwelijk] k€
Avoidable	no

Additional work

As part of the construction of HKZ, Fugro conducted a complete cable route survey, interpreted these targets and then further investigated the potential UXO with their identification vessel.

During the tender stage, an initial estimate of 300 potentially unexploded ordnance (pUXO) targets were considered for identification in order to achieve a safe working environment (ALARP).

However, during the magnetometer survey, a significantly higher number of metallic objects was encountered in the cable corridors, resulting in the revision of the estimate to approximately 1000 pUXO targets. As a result,

TenneT reached an agreement to adjust the contract based on the additional targets, resulting in a variation amounting to [Vertrouwelijk] k€.

Assessment by AFRY

AFRY concludes that these costs were not avoidable.

Additional works related to Siemens Netherlands

A + B	Variation in HVSS engineering starting point and supply scope + Rebaselining agreement
Costs	[Vertrouwelijk]k€
Avoidable	no

Additional work

Two contractors, Siemens Netherlands and [Vertrouwelijk], participated in the tender for the delivery of the HVSS (High Voltage Secondary Systems) to monitor, operate and safeguard the high voltage equipment of the Borssele, HKZ and HKN projects. For 5 projects, Siemens offered an amount of approximately EUR [Vertrouwelijk]k€, while [Vertrouwelijk]offered around EUR [Vertrouwelijk]k€. TenneT's own assessment of the scope was approximately EUR [Vertrouwelijk]k€ and therefore, Siemens' offer was not considered too low and was accepted.

However, during the execution of the Borssele project, it became evident that the initial tender for this project had incomplete scope, and that the actual amount of hours spent to achieve the scope far exceeded the amount of hours Siemens Netherlands (SNN) could expect based on the tender information.

Several program level and project specific variations in the HVSS engineering starting points and supply scope were implemented, with an amount of [Vertrouwelijk]k€ for the HKZ project.

In addition, HKZ encountered project specific complexities such as: technical differences in interfaces, the inclusion of a 33kV filter necessitating software and HVSS system changes, challenges in platform construction in Dubai affecting transport and coordination, and differing requirements in the delivery contract.

[Vertrouwelijk]

The total additional works sum up to an amount of [Vertrouwelijk]k€.

Assessment by AFRY

AFRY assesses that the additional scope and the associated costs can be considered as not avoidable. If the entire scope had been tendered at once, it might have potentially resulted in a lower outcome. However, the agreed cap on the reimbursable estimated amount effectively mitigates the primary risk of high costs for TenneT.

Additional works related to LMR Drilling GmbH

A + B	Variation casing removal + Claim settlement
Costs	[Vertrouwelijk] k€
Avoidable	no

Two additional works related to LMR Drilling GmbH have been assessed, as described below:

Variation casing removal

Additional work

In October 2018, TenneT awarded LMR Drilling GmbH with ta contract to carry out the HDD sea defense for for the HKZ offshore grid. LMR's proposal incorporated the use of steel casing on the landside as an additional risk mitigation measure to address specific concerns: 1) protection against soil washout in the entry area, particularly to prevent cable subsidence, 2) support the borehole, especially after emerging onto the seabed when the borehole's fluid level equates with sea level.

The proposal accounted for the casing's installation but not its removal, assuming that it could remain in the ground. However, the presence of the casing had an adverse impact on cable performance, specifically related to heat, which was deemed unacceptable by both TenneT and the sea cable contractor (VOC).

Consequently, the decision was made to remove the casing. This additional work of removing the casing is now assigned to LMR and comes at an additional cost of [Vertrouwelijk] k€.

Assessment by AFRY

As TenneT could not foresee the removal of the casing, AFRY concludes that these costs are unavoidable.

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Additional work

On May 7th, 2019, the borehole of HDD1 experienced an unexpected collapse due to destabilization caused by the groundwater level. LMR Drilling had taken precautions as instructed by TenneT to prevent instability, but the sinkhole incident was unexpected. To address the issue, LMR was tasked with developing a mitigation plan, mainly involving lowering the groundwater level. During dewatering attempts, it became evident that the ground in the drilling trajectory area, particularly the first 10 meters, had a higher clay content, indicating a complex hydrogeological situation. As dewatering couldn't resolve the issue with the sinkhole, TenneT's instructed LMR to elongate the casing.

TenneT and LMR Drilling GmbH worked together to implement essential risk mitigation measures, adjust the method statement, and obtain the necessary approvals from local authorities. However, despite these efforts, project execution encountered delays due to the unexpected sinkhole incident, the

challenging hydrogeological condition of the soil which avoided effective dewatering and the long response time of the authorities. This claim from LMR Drilling to TenneT have been resolved and settled for an amount of [Vertrouwelijk] k€.

Assessment by AFRY

AFRY concludes that this additional work could not have been foreseen and avoided by TenneT.

Additional works related to BAM Infra B.V.

A	Reinforcements shard walls
Costs	[Vertrouwelijk] k€
Avoidable	no

Additional work

During the reinforcement process of the 33kV- and 380kV buildings, it was discovered that the stirrup reinforcement was insufficient, leading to a halt in the concrete works. TenneT found that the wind form factors [Vertrouwelijk] for the shard walls were too low, necessitating adjustments to the cellar beam reinforcements. Also, the calculation model failed to account for external moments from the shard walls, requiring increased quantities of cuttings and braces. Assessing delay damages was challenging, but the matter was addressed at the project management level, with prompt action by BAM Infra B.V. to mitigate the impact of delays. The total costs for the additional work performed by BAM Infra B.V. amounted to [Vertrouwelijk]k€. [Vertrouwelijk].

Assessment by AFRY

AFRY believes that this incident could not have been foreseen by TenneT and therefore, the costs could not have been avoided.

Additional works related to Siemens AG

A + B	LS Power transformers + price adjustment
Costs	[Vertrouwelijk]k€
Avoidable	no

Additional work

This additional work is related to the price adjustment (indexation) determined according to the terms outlined in paragraph 7 of the framework agreement with Siemens AG.

Assessment by AFRY

AFRY concludes that this additional work could not have been avoided by TenneT.

Research question 8

'What is the overall efficiency of the project as executed by TenneT? Depending on the answers to the questions above, AFRY experts will evaluate the overall efficiency of the project and it will be noted together with the reasoning.'

AFRY assesses the total investment sum of project HKZ as unavoidable.

The final assessment of cost-effectiveness for the investments in project HKZ was conducted by AFRY. This assessment was based on the answers to research questions 1 to 7, utilizing information provided by TenneT in the form of shared documentation, work sessions, and written responses to inquiries posed by AFRY.

AFRY has gained an understanding of the achievement of set objectives and performed an analysis of financial and technical aspects, the procurement process, and risk management within the project.

1. Alpha and Beta projects align with the primary criteria in the Development Framework. However, while their designs meet the 700 MW transport and availability requirement, substantial proof of operational compliance is missing.
2. The most recent investment budget is 11% lower than the budget at the time of FID (Final Investment Decision), primarily due to a reduction in risk and contingency budgets and a [Vertrouwelijk]
3. Overall, risks have been adequately managed throughout the project. The risk management process has been followed, and the financial end result is satisfactory.
4. The difference between the budget prepared by AFRY and the actual investment expenditures by TenneT is less than 15%, specifically 13%. For the land station, Maasvlakte 380 changes and project management, actual costs are higher than the counter budget.
5. The execution of the procurement process is rated as 'sufficient' by AFRY.
6. AFRY conducted an analysis of 7 distinct cost items provided by TenneT, focusing on the actual expenses. The findings revealed that all of these cost items were deemed unavoidable.
7. Upon a thorough examination of the top 20 additional works, it was established that all costs resulting from additional works were unavoidable. All additional expenses were either a result of justified de-risking measures or unforeseen events.

4. Hearing and counter-hearing

As part of the efficiency assessment process, a hearing and counter-hearing process with TenneT was conducted based on the concept report. TenneT has received the concept report drafted by AFRY, and provided feedback through a memorandum addressing some conclusions related to research questions 1 and 7 in the report. This section elaborates on TenneT's response and explains whether, and if so, to what changes in the report and/or conclusions their response has led.

Operational Compliance

AFRY concludes that TenneT has not adequately substantiated that the investment is operationally and sustainably available. AFRY argues that the 'grid readiness certificates' and 'verification plans' do not take into account components at the substation, such as connection fields and shunt. In response, TenneT has indicated that these components could only be tested later when a sufficient number of turbines must be installed. AFRY notes that sustainable availability could also have been demonstrated with a Fabrication Acceptance Test (FAT), Site Integration Test, and user tests.

Regarding AFRY's conclusion on research question 1, TenneT has made some comments. Below, these comments are discussed, adjusted, or contested by AFRY.

Argument TenneT

TenneT observes that more documentation has been provided in the efficiency test of HKZ than, for example, at Borssele, to demonstrate sustainable availability. In addition to the documents from the start dossier (basic) designs, FATs, and various studies have now been provided. The start dossier of Borssele was comparable to that of HKZ, and that did not give rise to doubt the sustainable availability of the connection at that time.

In addition, TenneT states that the offshore grid connections are standardized in design, and Borssele has been in operation without interruptions at full capacity for several years. For HKZ, the generated energy has also been transported without interruptions.

The connection fields and the shunt of the substation constitute a limited part of the entire offshore grid connection. There is sufficient substantiation for all other components. TenneT finds AFRY's general conclusion on research question one too strong. Additionally, testing of these components will always take place relatively late because, in accordance with the COD data in the offshore wind energy development framework, the offshore grid connection will be delivered first before the realization of the wind farm to be connected.

Counterargument AFRY

Firstly, AFRY has no knowledge of the precise delivery time of documents to the other verifying party. Additionally, according to AFRY, it is not sufficient for another party (in this case, DNV-GL) to be satisfied with the provided

documents; this is not automatic proof of their adequacy. Contrary to TenneT's claim, no Fabrication Acceptance Test (FAT) reports have been provided, only DNV-GL's verification documents.

Secondly, AFRY acknowledges the standardization of the design and did not mention in the report that this design was insufficient. However, AFRY makes a note about the use of the term '*standardization*,' as there was a slight difference between HKZ and Borssele, both onshore and in the connection to the 380kV station (connection with a filter at 220kV, number of cables to 380kV station).

Thirdly, *'several years without interruptions at full capacity'* does not necessarily mean that the system is operated at full capacity (700 MW or even more, as allowed by the temperature of the export cables). AFRY understands from TenneT's response that both connections were 100% available (without any limitations from components taken out of service) from COD to 3 months after COD ('For HKZ, the generated energy has also been transported without interruptions.'). This confirms the operational availability, according to AFRY, and this has also been adjusted in the answer to research question 1.

Finally, AFRY has stated that the verification, as performed by DNV-GL on the offshore grid, could have been conducted by TenneT or DNV-GL for a longer time and had nothing to do with the number of turbines that would be connected/operational. AFRY agrees with TenneT's comment about the 'harshness' of this part in the report and has made adjustments accordingly in the answer to research question 1.

However, AFRY still has not seen documents proving operational ampacity, so this remains unchanged in the report.

Main transformer exchange

TenneT's decision to install faulty transformers for HKZ Alpha led Petrofac to replace them in July 2020, with new ones arriving in January 2021. Petrofac's accepted variation proposal, costing [Vertrouwelijk] k€, covered the exchange and transportation of the faulty transformers. Following a settlement agreement with Royal Smit, TenneT had to bore the expenses incurred by Petrofac due to their decision to use the defective transformers for HKZ Alpha.

In AFRY' analysis, the additional costs related to the main transformer exchange consisted of two aspects: the costs related to the exchange of the faulty transformer for HKZ Alpha, and the costs of disruption and prolongation associated with the transformer exchange. In the initial assessment of additional works for research question 7, AFRY was missing justification for why the installation and commissioning of the defective transformers was deemed necessary, especially given the fact that transport for the new transformers was already scheduled and the significant costs associated with replacing the defective transformers with new ones.

Upon obtaining further clarifications from TenneT, as well as the Expert Review Board report and TenneT's vision on this review, AFRY revised its opinion and all costs are categorized as unavoidable. The decision to install the (defective) transformers was primarily driven by the need to avoid disrupting the manufacturing process. This allowed for the establishment of crucial connections and facilitated the smooth progress of commissioning activities and planned tests. [Vertrouwelijk]