DANA Elektrification Business Case

Final report **17 October 2025**

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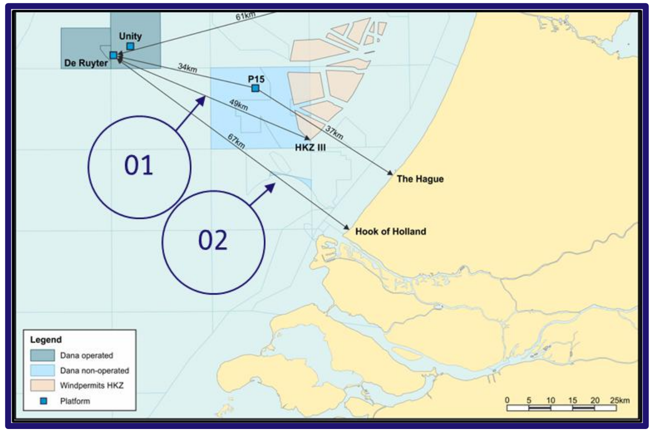
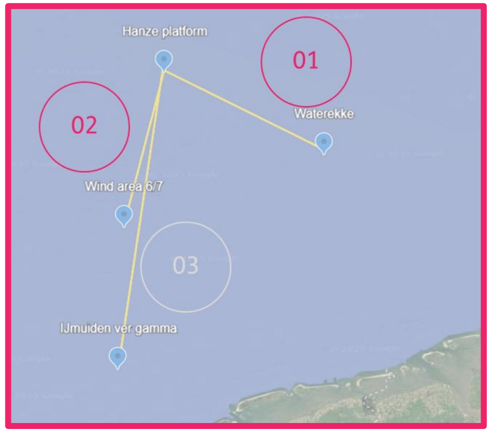
Two business cases are analysed to explore platform electrification investments

- This report presents a business case analysis for electrifying two DANA Petroleum platforms: 1) De Ruyter and 2) Hanze.
- Both platforms currently use part of their produced natural gas for power generation. Electrifying through direct coupling to the (offshore) electricity grid may provide energy efficiency benefits, significant CO_2 emissions and associated costs under the EU Emissions Trading System (EU ETS).
- The **study objective** thus was to **assess whether electrification is economically viable** under **different scenarios** encompassing potential market conditions. **Multiple cable configurations** were considered per platform: two for the Ruyter and 3 for Hanze (as visualised below), reflecting different possible design options.

De Ruyter - Cable configurations



Hanze - Cable configurations



Financial parameters

WACC: 7%

Timeframes:

- **De Ruyter**: 2028-2035
- **Hanze**: 2029-2045

Capital Expenditures (CAPEX)

- Cable purchase cost
- Cable installation costs
- Platform HV equipment
- Onshore cable connection

Operational Expenditures (OPEX)

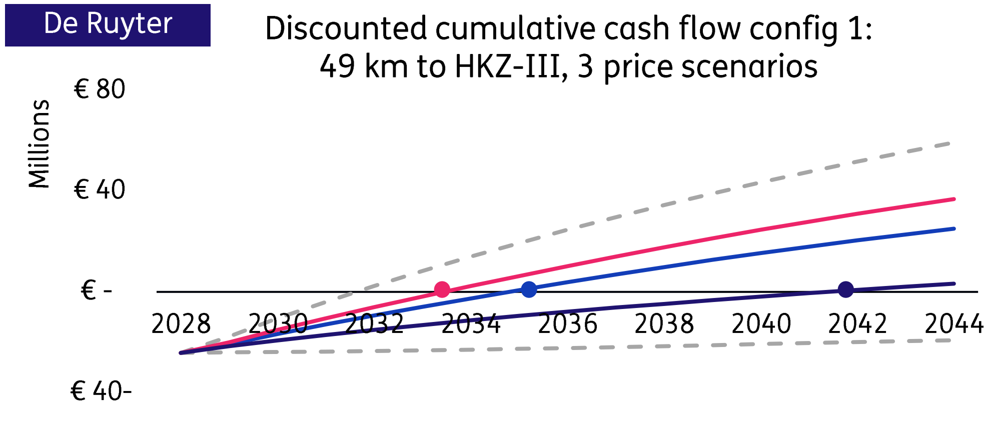
- Electricity consumption costs
- Electricity cable O&M
- Platform HV equipment O&M

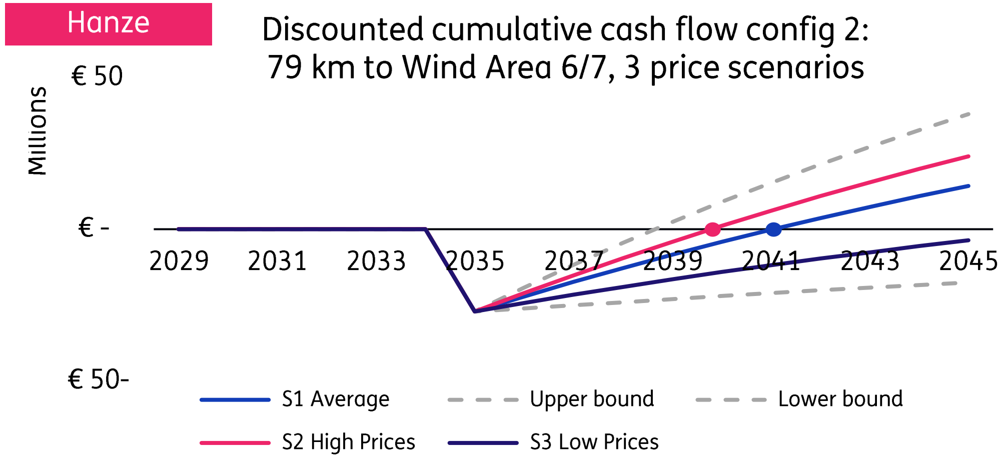
Revenues

- Additional sales of fuel gas
- Prevented CO_2 emission costs
- Prevented costs gas turbines

The payback periods of De Ruyter config. 1 (6-14 yr) and Hanze config. 2 (5-10+ yr) illustrate the uncertain factors driving the business cases

- Electrification of the De Ruyter and Hanze platforms offers a viable pathway to reduce emissions and operational costs, but economic feasibility varies significantly across configurations and scenarios.
- From the evaluated cable configurations, the options with the shortest payback period per platform are:
  - **De Ruyter**: configuration 1 (49km to HKZ-III), payback period: 6-14 yrs, across scenarios. In S1 and S2, payback occurs before 2035 which matches with the currently envisaged timeframe for De Ruyter.
  - **Hanze**: configuration 2 (79km to Wind Area 6/7), payback period: 5 yrs (in S1) to slightly beyond the business case horizon (10+ yrs) in S3
- **Sensitivity**: To realise a payback before 2035 for Configuration 1 of De Ruyter in all three price scenarios, more favourable commodity prices or lower CapEx are required. The same applies for Hanze (configuration 2) to reach payback in S3 before 2045.
- **Strategic implication**: Decision-making should consider timing of infrastructure availability, regulatory developments, and commodity price trajectories. Further refinement of cost estimates and alignment with offshore wind planning may improve feasibility.
- The analysis supports DANA Petroleum in identifying electrification options that balance technical viability, financial return, and strategic alignment with energy transition goals.





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1 Introduction

Introduction to the report

Goal

1 De Ruyter

Update of Business Case electrification of the Ruyter

2 Hanze

Drafting new Business Case electrification of Hanze platform

Context & purpose

- Electrification of offshore oil and gas platforms is a key step towards decarbonization of the energy sector.
- Aligns operations with evolving European and Dutch climate regulations.
- This report presents a business case analysis for electrifying two DANA Petroleum platforms: 1) De Ruyter and 2) Hanze.
- Both platforms currently use part of their produced natural gas for power generation:
  - Leads to significant CO_2 emissions.
  - Incurs increasing costs under the EU Emissions Trading System (EU ETS).

Scope of analysis

- Builds on a 2019 study for De Ruyter, now updated with:
  - Recent energy price trends;
  - Updated cable material and installation costs;
  - Proximity to offshore electricity infrastructure.
- Introduces a new business case for the Hanze platform.
- Enables comparative assessment of electrification feasibility and payback period
- Evaluates multiple cable configurations:
  - Direct connection to shore.
  - Shared infrastructure with nearby platforms or wind farms.
- Considers key operational and financial parameters:
  - CAPEX, OPEX, WACC.
- Revenue potential from:
  - Reduced fuel gas consumption;
  - Reduced ETS costs;
  - Avoided turbine maintenance.
- Objective: assess whether electrification is economically viable under different scenarios encompassing potential market conditions.

Independence

- This report is prepared by TNO as an independent and objective party, ensuring a transparent and technically sound foundation for strategic decision-making by DANA Petroleum.

2 Scope and assumptions

- Introduction
- Overview of the business case designs
- Platform configurations
- Price scenarios for sensitivity analysis

Introduction

This chapter outlines the scope and key assumptions underlying the business case analysis.

- The business case is set up for different configurations for De Ruyter and Hanze.
- Price scenarios are used for a sensitivity analysis.
- The business case includes the following elements: main drivers of capital expenditures (CAPEX), operational expenditure (OPEX), and revenues, as well as the financial parameters that form the basis for evaluating economic performance. These drivers are presented on the right.
- Where possible, the drivers are quantified using operational data from Dana. This holds, for example, for the electricity consumption from which the cost related to electricity consumption are calculated.
- For other factors, assumptions are made based on publicly available data and expert opinions, both from Dana and TNO.
- This chapter will provide more details on the assumptions underlying the CAPEX, OPEX and revenues.

Business case elements

Financial parameters

WACC: 7%

Timeframe:

- **De Ruyter**: 2028-2035[1]
- **Hanze**: 2029-2045

Operational Expenditures (OPEX)

- Electricity consumption costs
- Electricity cable O&M
- Platform HV equipment O&M

Capital Expenditures (CAPEX)

- Cable purchase cost
- Cable installation costs
- Platform HV equipment
- Onshore cable connection

Revenues

- Additional sales of fuel gas
- Prevented CO_2 emission costs
- Prevented costs gas turbines

[1] The timeline for de Ruyter extends until 2035 but has been projected in graphs up to 2044 to provide an outlook and observe potential developments.

Overview of the two business case designs

Platform	Configuration	Scenario 1	Scenario 2	Scenario 3	*Extreme price ranges*	
		Average Prices	**High Prices**	**Low Prices**	*Upper Bound Case Most Favourable*	*Lower Bound Case Least Favourable*
De Ruyter	01: P11b-HZKIII					
	02: P11b-Hoek van Holland					
Hanze	01: F2a-Waterekke (GER)					
	02: F2a-Wind Area 6/7					
	03: F2a-IJmuiden Ver Gamma					

CAPEX assumptions (Slides 10-14)

Commodity price assumptions and future scenarios (slides 15-17)

Example: 1 of 5 analysis

Leads to:

- Cash flow
- Cumulative discounted cash flow
- Sensitivity analysis

Business case results

- Chapter 3: De Ruyter
- Chapter 4: Hanze

Platform configurations: cable configurations for De Ruyter

The business case of each platform considers different cable configurations. These cable configurations represent a subset of potential connection points where the offshore platform could be linked to the grid.

For the Ruyter, two cable configurations are considered.

01

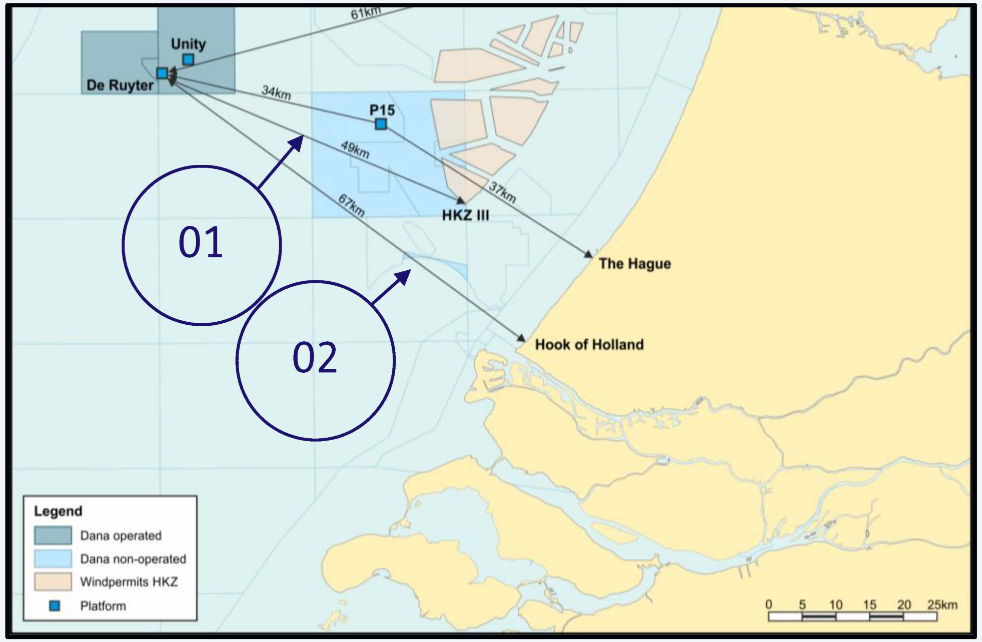
From De Ruyter to substation Hollandse Kust Zuid (HKZ) III

Distance: 49 km
Voltage: 66 kV
Note: Dutch law needs to accomodate offshore consumption of wind farm power

02

From De Ruyter to onshore grid in Hoek van Holland

Distance: 67 km
Voltage: 25 kV due onshore connection



Platform configurations: cable configurations for Hanze

For the Hanze platform, three cable configurations are considered. It is important to note that of the three connection points for Hanze, only the first and third configuration are existing substations. The second connection point, however, to a substation in offshore wind area, is a potential location for a substation to be commissioned when offshore wind farms are installed in this area. Hence, electrification for this case could only start after commissioning of the substation in 2035.

01

From Hanze to Waterekke OWF (GER)

Distance: 93 km
Voltage: 66 kV
Commissioning: 2028

02

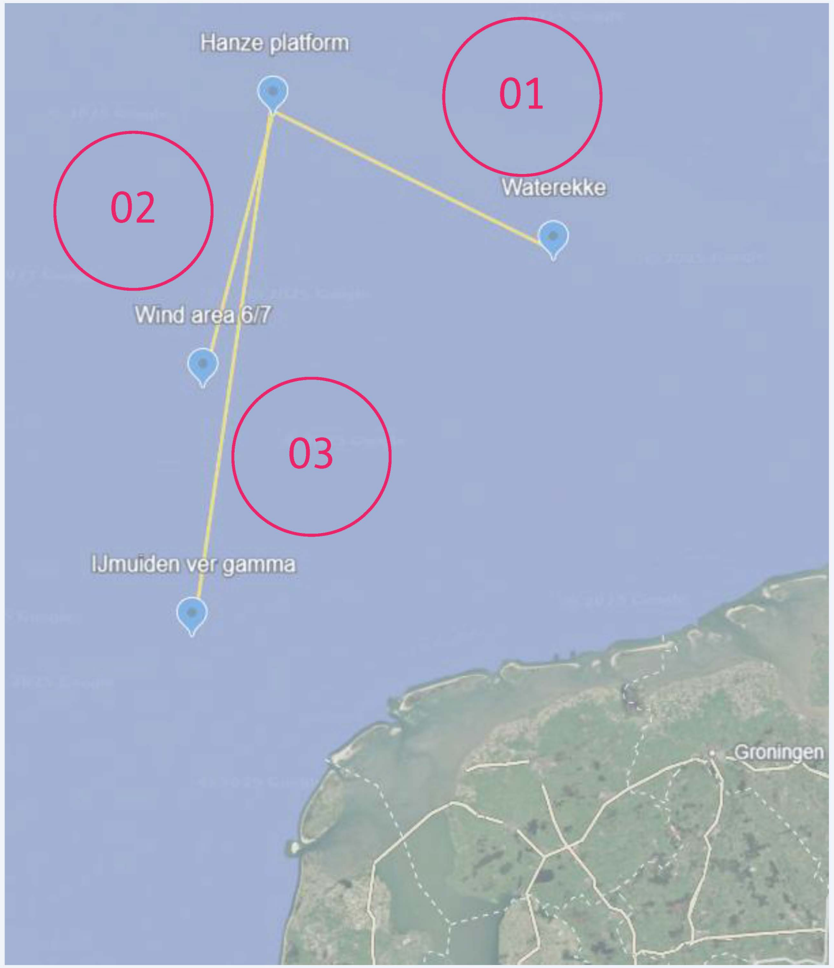
From Hanze to substation at wind area 6/7

Distance: 79 km
Voltage: 66 kV
Commissioning: 2035

03

From Hanze to substation of IJmuiden Ver Gamma

Distance: 160 km
Voltage: 66 kV
Commissioning: 2028



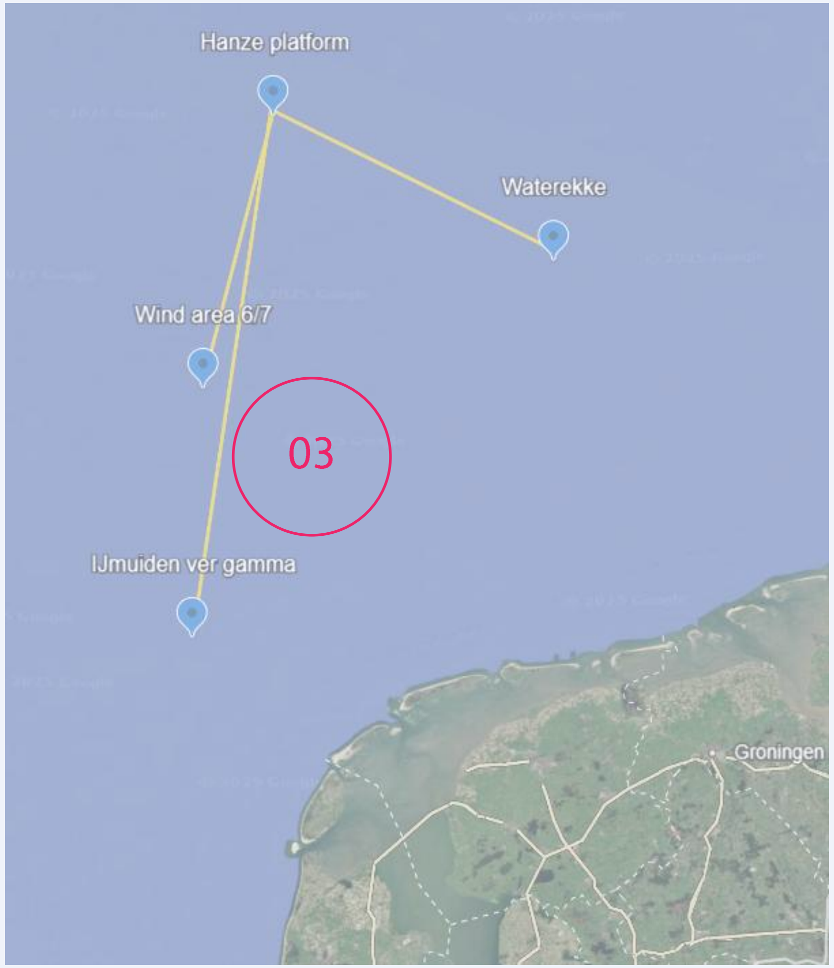
Hanze: Minimal technical performance criteria show that configuration 3 is not feasible

- Due to the relatively long distances over which electricity must be transported for both platforms, the technical feasibility of each configuration was assessed against a set of minimum performance criteria.
- These criteria are based on standard engineering parameters and user-defined thresholds:
    - **Thermal loading**: maximum of 90%
    - **Transmission losses**: maximum of 1 MW
    - **Voltage deviation**: maximum of 10% from nominal voltage
- To determine feasibility, cable diameter and material were varied to explore whether any combinations could meet all three criteria.
- For Configuration 3 of Hanze, **none** of the tested cable types or sizes met the required thresholds.
- As a result, Configuration 3 of Hanze is excluded from further business case analysis due to technical infeasibility.
- All other configurations did have sufficient performance on these minimal technical criteria.

03

From Hanze to substation of IJmuiden Ver Gamma

Distance: 160 km
Voltage: 66 kV
Commissioning: 2028



Hanze: Configuration 3 is excluded from further assessment

As a result of the technical feasibility assessment showing that configuration 3 does not meet minimal feasibility requirements, only the first two cable configurations are taken into account

01

From Hanze to Waterekke OWF (GER)

Distance: 93 km
Voltage: 66 kV
Commissioning: 2028

02

From Hanze to substation at wind area 6/7

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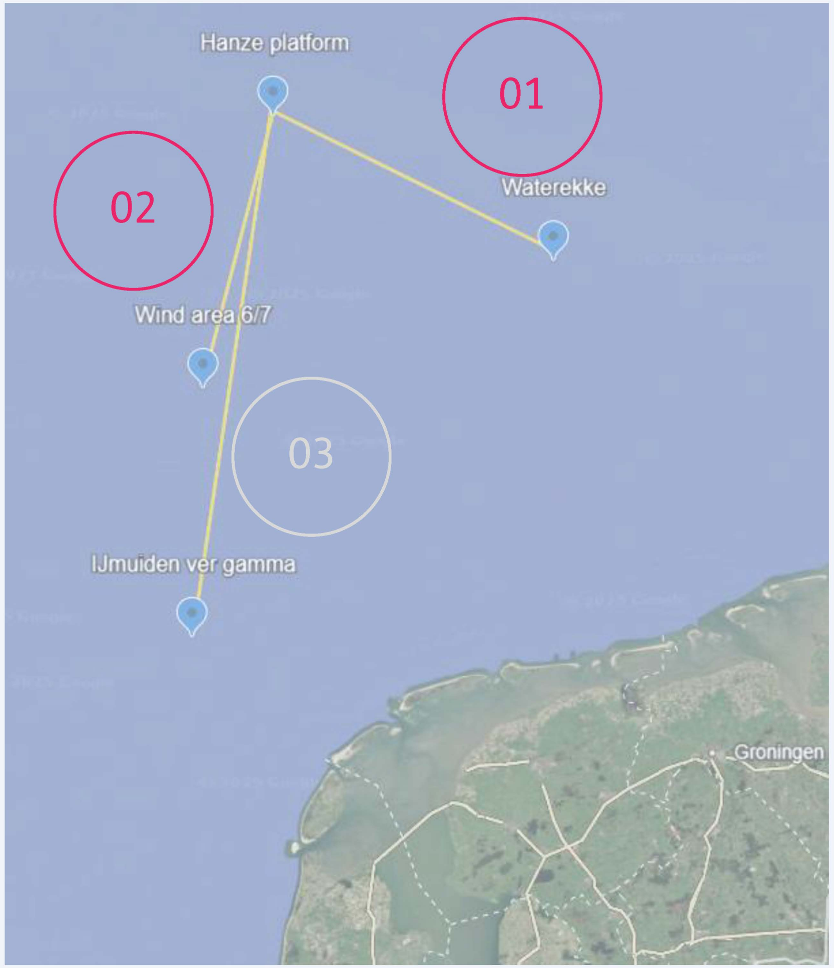


For each feasible configuration, cable material & installation CAPEX and OPEX O&M are determined

- From the feasibility assessment, the most suitable combination of cable material and diameter for each feasible configuration were determined, based on the minimal technical criteria (as described previously) :
    - **Thermal loading**: maximum of 90%
    - **Transmission losses**: maximum of 1 MW
    - **Voltage deviation**: maximum of 10% from nominal voltage
- Where technically feasible, aluminum was selected as the preferred material due to its lower cost and easier handling.
- However, for longer distances, where aluminum would lead to substantial losses, copper was chosen to ensure sufficient efficiency and compliance with the defined performance thresholds.
- This approach was applied consistently across all configurations. As previously concluded, Configuration 3 could not meet the minimum criteria with any material or diameter combination and was therefore excluded from further analysis.
- This results in the below presented specific CAPEX for cable material per configuration.
- Cable installation CAPEX, however, are very hard to estimate as they are highly dependent on availability of installation vessels, seasonal variations, seabed conditions (soil type, morphology, water depth, tidal currents, obstructions and crossings, landfall, local regulations, etc.). Based on current market conditions and comparable offshore projects, the estimate is expected to fall within a reasonable range of €200k to €300k per kilometer. A standardised CAPEX estimate of €250k per kilometer was applied across all configurations.
- OPEX for O&M (yearly inspection of the cable) is estimated at €5k per kilometer.

		Cable configuration	Length [km]	Description cable core	Cable material CAPEX [€/km]	Installation CAPEX [€/km]	OPEX O&M cable [€/km]
De Ruyter	Config 1	P11b-HZKIII	49	Al-150 mm^2	224k	250k	5k
	Config 2	P11b-Hoek van Holland	67	Al-500 mm^2	253k	250k	5k
Hanze	Config 1	F2a-Waterekke (GER)	93	Cu-300 mm^2	409k	250k	5k
	Config 2	F2a-Wind Area 6/7	79	Cu-120 mm^2	241k	250k	5k
	Config 3	F2a-IJmuiden Ver Gamma	160	Not feasible	Not feasible	Not feasible	Not feasible

Price scenarios for sensitivity analysis

- A sensitivity analysis was conducted to assess the impact of key variables on the business case, specifically:
    - EU ETS price
    - Natural gas price
    - Electricity price
    - Cable material & installation CAPEX
    - Weighted Average Cost of Capital (WACC)
- For the scenario with the longest payback period, the minimum or maximum values required for each variable to achieve a positive business case were identified for the most cost-efficient configuration per platform
- This provides insight into which parameters influence the business case and where market developments could shift economic feasibility.

Price outlooks for CO_2, electricity, and gas form the basis for assessing business case uncertainty

Commodity prices as key drivers

- Natural gas, electricity, and CO_2 prices are key drivers of the business case.
- They strongly influence both operational costs and revenues.
- At the same time, these prices are inherently uncertain.

Approach to address uncertainty

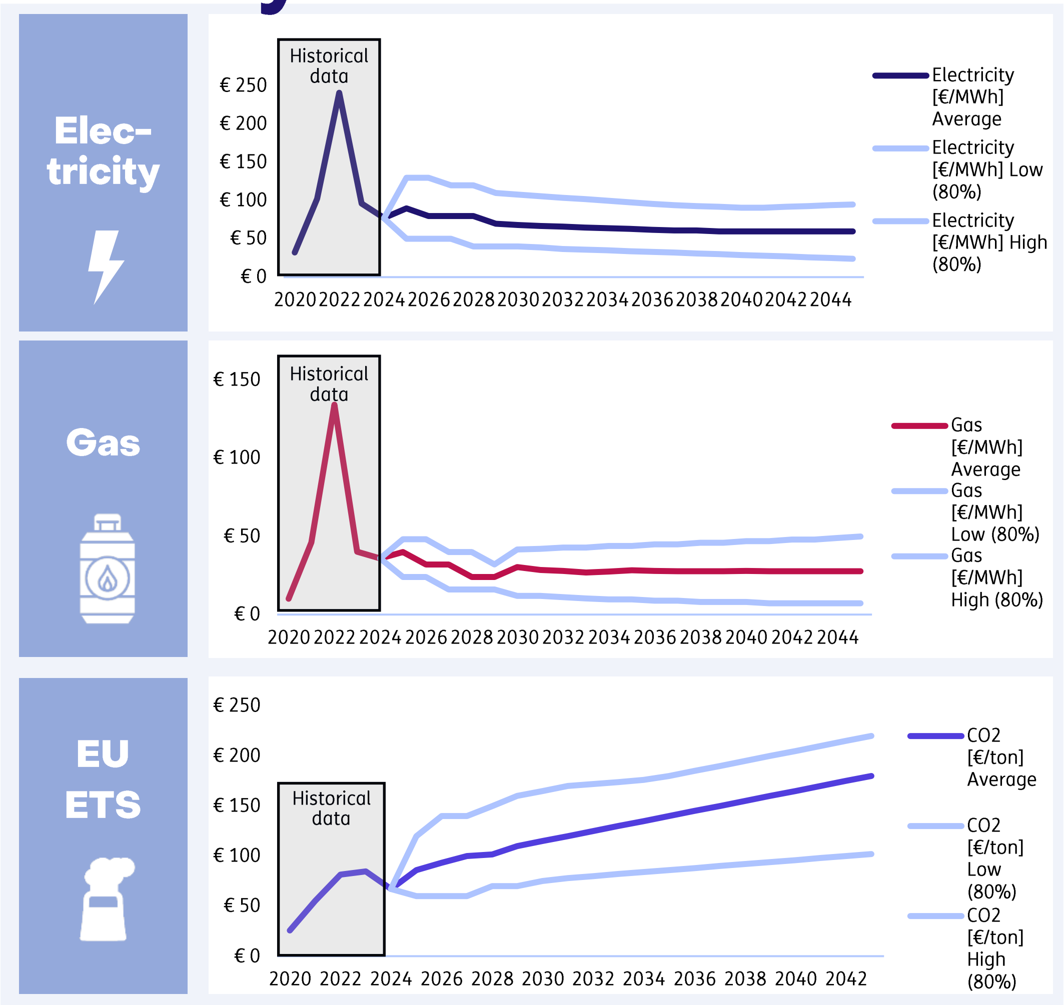
- For each commodity, three price outlooks are used: *Average*, *Low* (based on an 80% lower bound) and *High* (based on an 80% upper bound)
- The 2025-2030 outlooks are derived from the Energieprijsmonitor by TNO Vector[1]. See appendix.
- For 2030-2045 the price projections are extrapolated.
- Historical price data (2019–2024) is included for reference.

Increasing uncertainty towards future

- The further into the future, the greater the margin of uncertainty.
- While market demand patterns and consumption volumes are likely to shift, this does not directly provide insight into market clearing price levels.

About the Energieprijsmonitor

- The Energieprijsmonitor by TNO Vector is an online tool that presents quarterly updates on energy price outlooks for the Netherlands (2025–2030), based on historic price level extrapolation.
- These outlooks are based on historical price bulletins and expert assessment by TNO and merely to be considered projections.
- Drivers considered in these projections include high-level equilibrium in supply and demand, climate policy, and other structural changes. More detailed background can be found on the website[1].



[1] For more information, see https://vector.tno.nl/energieprijs-monitor/

Three scenarios are defined, based on combinations of CO_2, electricity, and gas price outlooks

Three scenarios have been selected to assess the business case:

- **S1 Average Prices:** Based on the average price outlook (see previous slide)
- **S2 High Prices:** Assumes the high price levels across all three drivers, within the 80% confidence interval
- **S3 Low Prices:** Assumes low price levels across all three drivers, within the 80% confidence interval

Reference Case – Extreme price levels
To illustrate the full potential spread of outcomes, two extreme upper and lower bound price levels are added to the *Discounted Cash Flow* graph:

- **Upper Bound Case – Most Favourable for business case[1]**
    - High CO_2 prices
    - Low electricity prices
    - High natural gas prices

- **Lower Bound Case – Least Favourable for business case[2]**
    - Low CO_2 prices
    - High electricity prices
    - Low natural gas prices

These extremes are less likely to occur and therefore show a more complete range within which the business case may fall, based on the 80% confidence interval. *Note that even more extreme price levels (up to 100% and above) may be experienced in the future but are out of scope of this study.*

PRICE SCENARIOS

S1 Average	• Average price developments • Average electricity price • Average natural gas price • Average EU ETS price
S2 High Prices	• Price developments are the high-end of the 80% interval • High electricity price • High natural gas price • High EU ETS price
S3 Low Prices	• Price developments are the low-end of the 80% interval • Low electricity price • Low natural gas price • Low EU ETS price

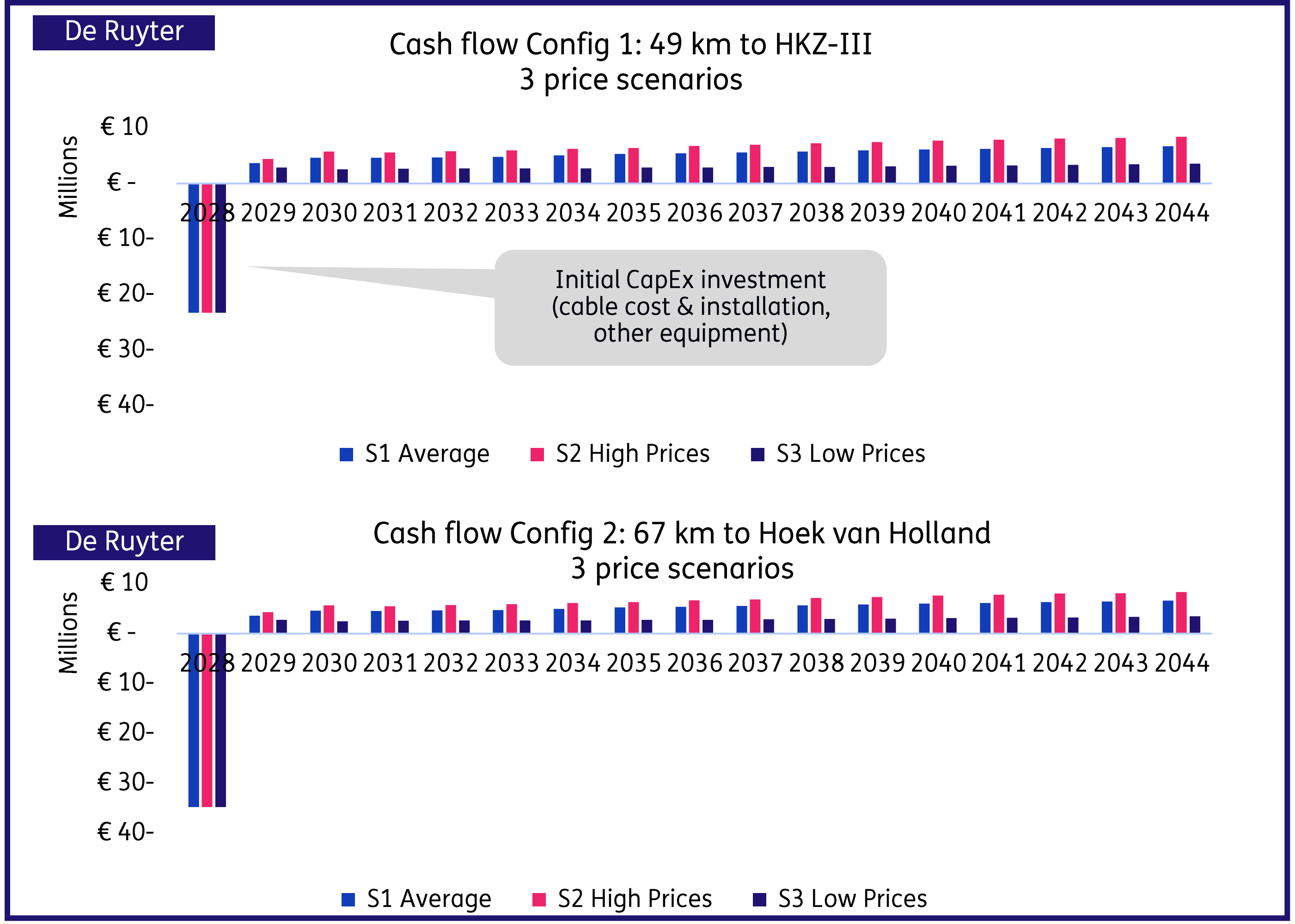
[1,2] The "most" and "least" favourable cases are defined from the perspective of the electrification business case only, not from the broader financial or operational perspective of the company.

3 Results for De Ruyter

- Cash flows
- Discounted cumulative cashflows and payback periods
- Sensitivity analysis

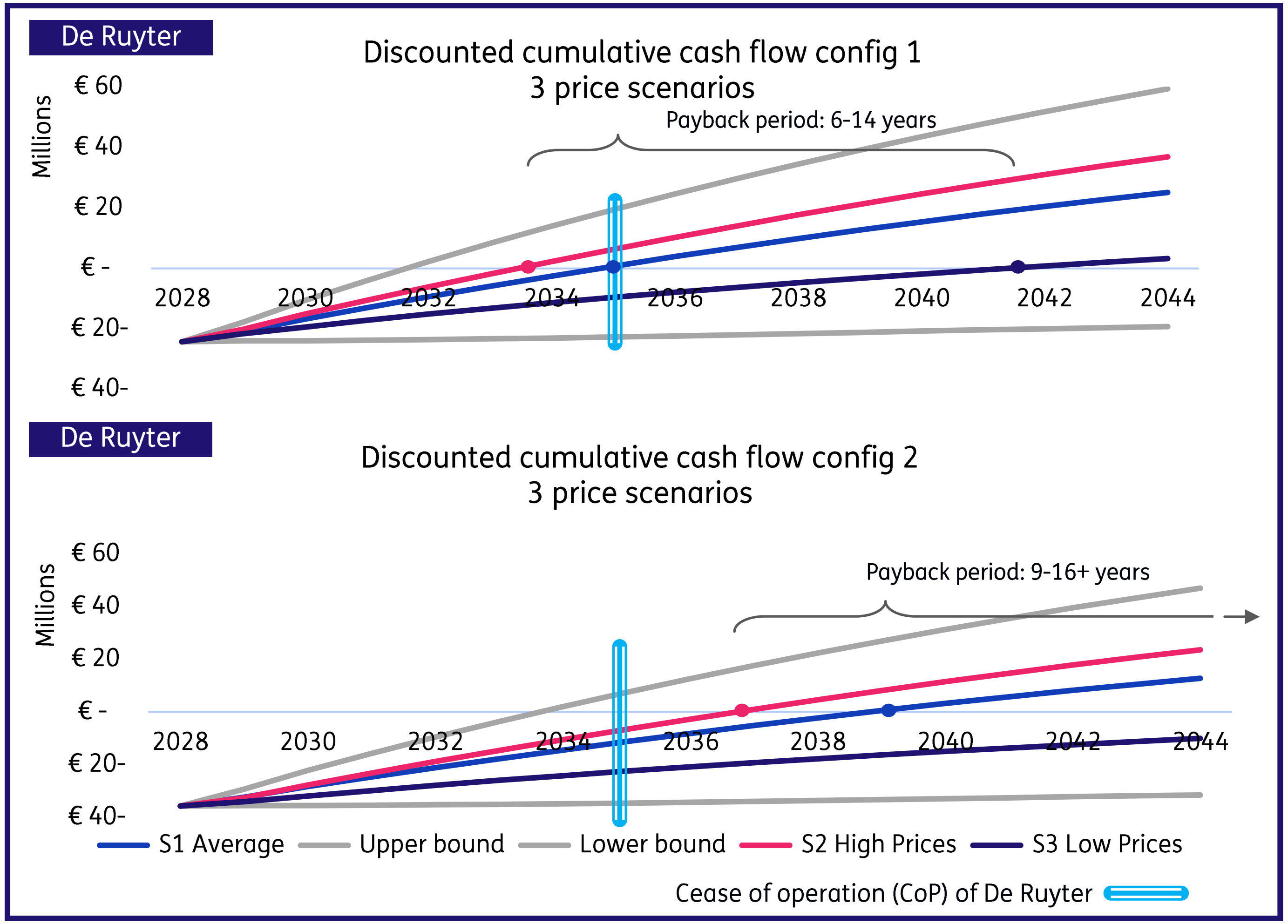
Both configurations show positive cash flow post-2028; lower CapEx makes Configuration 1 more favourable

- Configuration 1 has a lower CapEx (€23 million) compared to Configuration 2 (€35 million), driven by:
  - Shorter cable length
  - Lower cable cost per kilometer
- As seen in the cash flow graphs, both configurations have initial investment in 2028
- From that point onward, both configurations generate operational profit each year as can be derived from the positive cash flow
- The magnitude of operational profit is sensitive to assumed power, gas and CO_2 prices of each scenario.
  - In the scenario S2 *High Prices*, operational profit is at least 1.5x higher than in the *Low Prices* scenario (S3).



Configuration 1 pays back faster across all scenarios due to lower CapEx — however, in S3 payback still takes 14 years

- Configuration 1 shows shorter payback periods (6–14 years) across all scenarios, driven by lower CapEx.
    - In scenarios S1 *Average* and S2 *High Prices*, the investment is paid back before 2035 (first timeframe).
- Configuration 2 pays back within the extended timeframe of the business case for two scenarios: S1 (9 yrs) and S2 (11 yrs), however only after 2035.
    - In scenario S3 *Low Prices*, Configuration 2 does **not** reach payback before 2044.
- For both configurations the investment is never paid back in the lower bound of price developments (grey dashed line in graph): operational profits remain too low due to unfavourable prices.
- **This indicates that there is a possible future in which the investment may not be recovered, increasing financial risk.**



Configuration 1 (S3): Payback before 2035 requires improved prices or lower CapEx

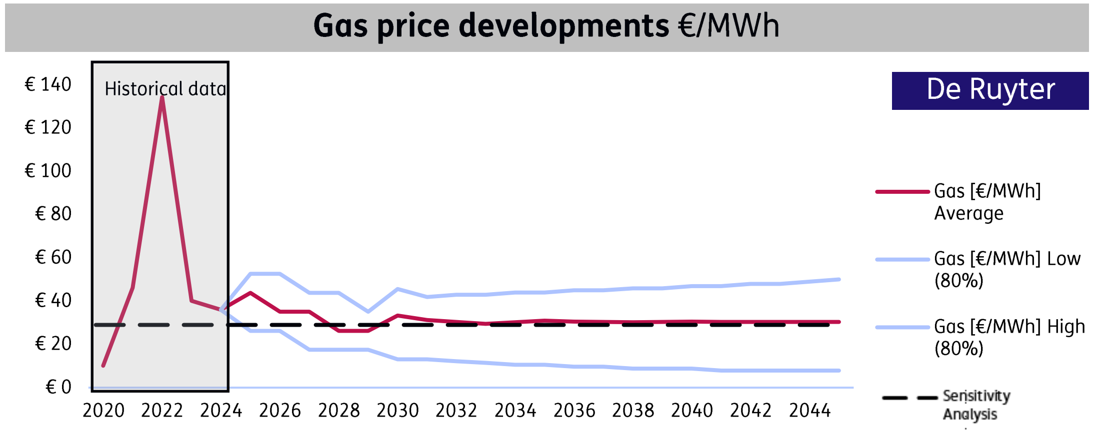
The sensitivity analysis on individual variables is performed on Configuration 1 (49 km to HKZ-III), as it is the most cost-efficient option.

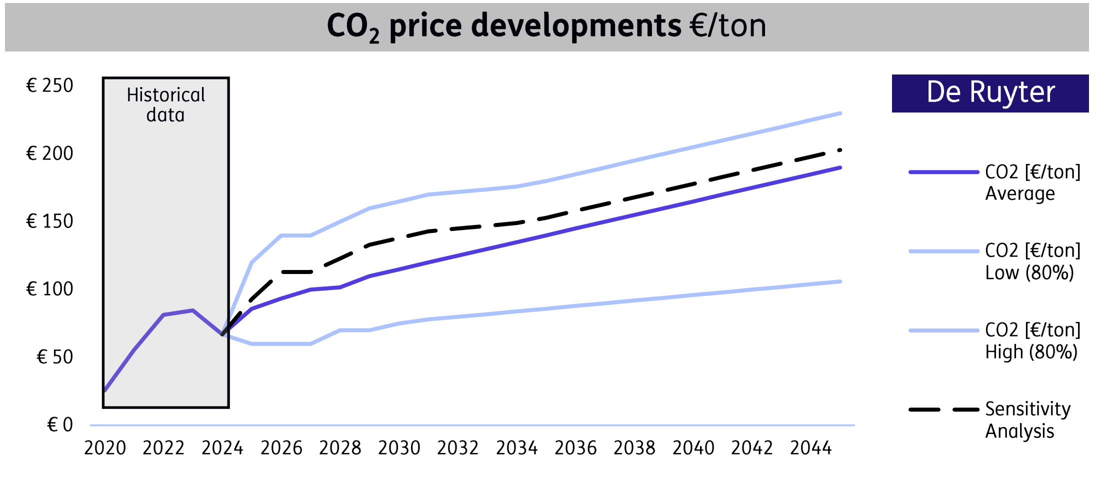
The analysis shows that outcomes across all scenarios are sensitive to changes in the selected variables.

To achieve a payback period **before 2035** in the least favorite scenario S3 *Low Prices*, the following price levels or CapEx would be required:

- Gas prices must exceed €28/MWh, or
- Electricity prices must be negative, or
- CO_2 prices must be €27/ton lower than in scenario S2 *High Prices,* or
- CapEx of cable (material & installation) must be 37% lower
- A reduction in WACC has only a limited effect on the outcome in scenario S3 *Low Prices*

- **To conclude: To realise a payback before 2035 for Configuration 1 in all three price scenarios, more favourable commodity prices or lower CapEx are required.**



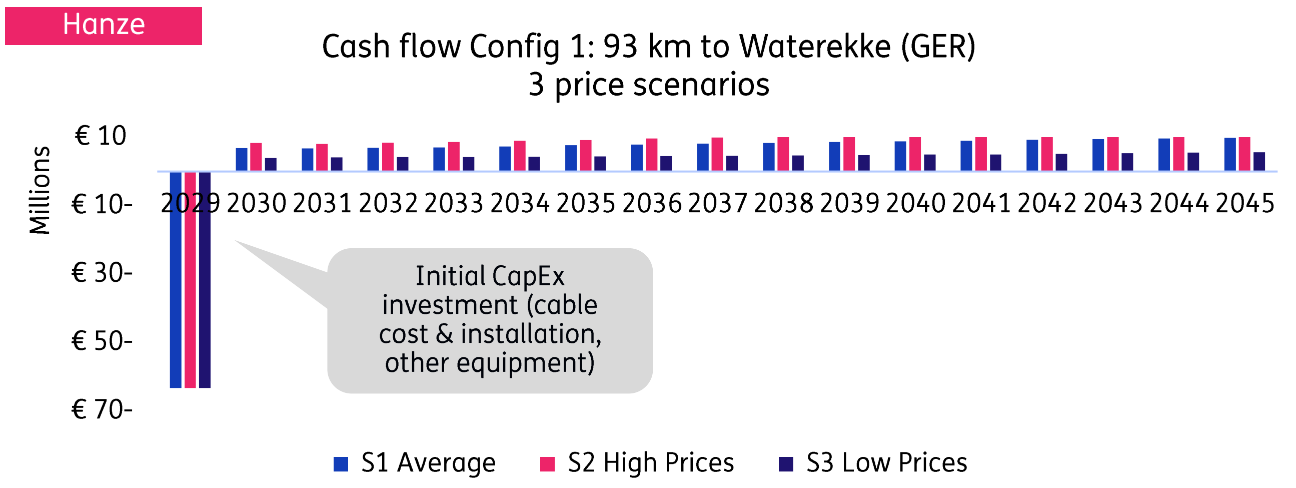


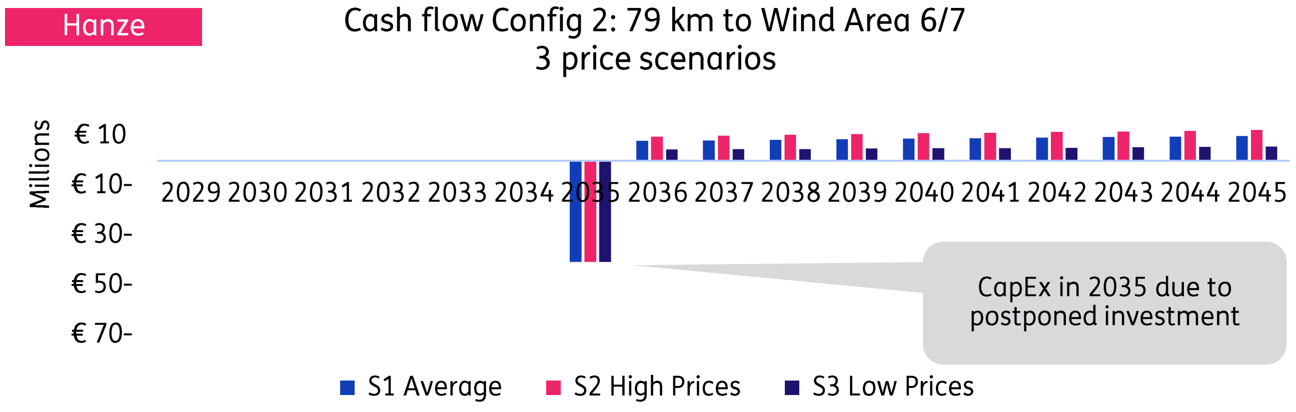
4 Results for Hanze

- Cash flows
- Discounted cumulative cashflows and payback periods
- Sensitivity analysis

Configuration 2 has lower CapEx, but can only be operational from 2035 onwards

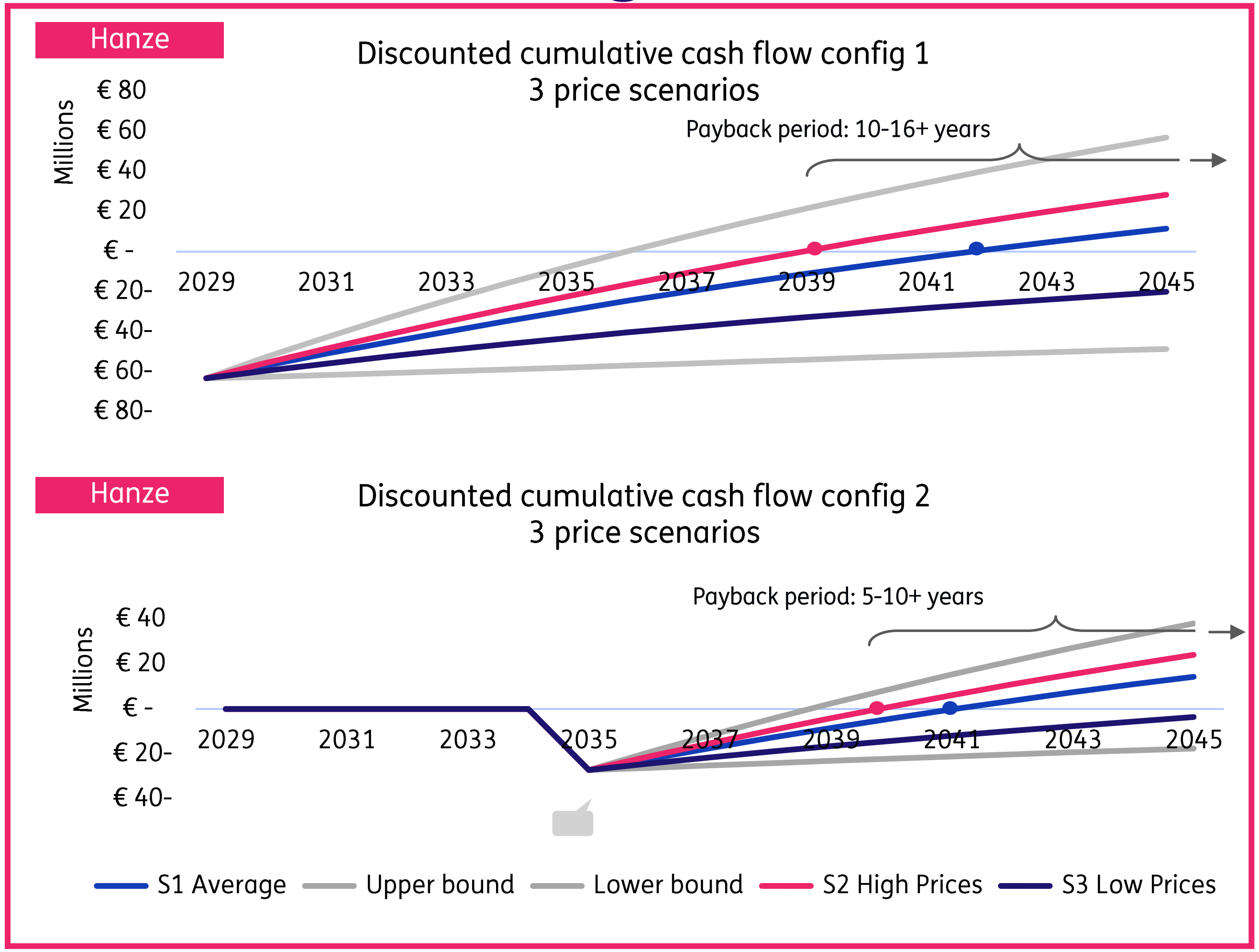
- Configuration 2 has a lower CapEx (€41 million) than Configuration 1 (€63 million), driven by:
  - Shorter cable length
  - Lower cable cost per kilometer
- The year of initial investment differs per configuration due to commissioning of the substation:
  - Configuration 1: 2029
  - Configuration 2: 2035 (substation commissioned later)
- From the moment of investment, both configurations generate annual operational profit – as shown by positive cash flows.
- Operational profit is sensitive to assumed commodity prices per scenario.
- In scenario S2 High Prices, operational profit is at least 2x higher than in scenario S3 Low Prices.





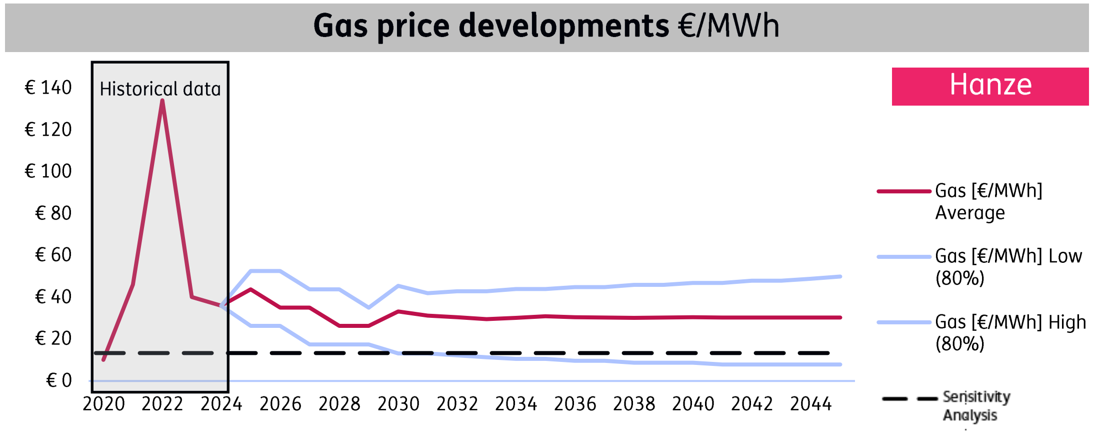
Configuration 2 has shorter payback periods, but postponed investment enhances impact of discounting

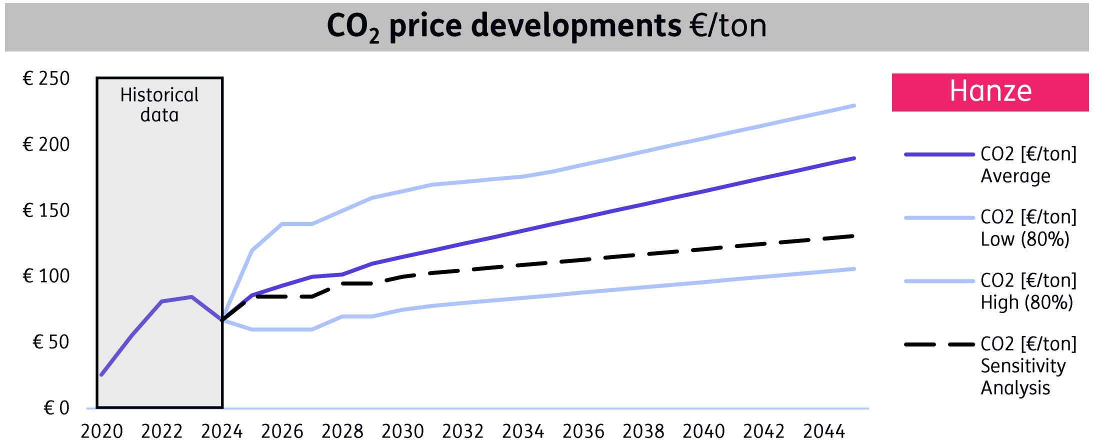
- Configuration 1 generally has longer payback periods than configuration 2 due to higher CapEx.
    - Still, scenarios S1 and S2 reach payback before 2045.
    - In scenario S3, Configuration 1 does not reach payback within the timeframe.
- Configuration 2 shows shorter payback periods in all three scenarios, compared to configuration 1.
    - Due to discounting, the CapEx (€27M) in 2035 is lower than the absolute CapEx (€41M).
    - The payback time in S3 is exceeding the timeframe of the business case.
- For both configurations, the investment is never paid back in the lower bound of price developments (grey bottom line in graph): operational profits remain too low due to unfavourable prices.
- **This indicates that there is a possible future in which the investment may not be recovered, increasing financial risk.**



Configuration 2 (S3): Payback before 2045 requires improved prices, lower CapEx or WACC

- The sensitivity analysis on <u>individual variables</u> is performed on Configuration 2 (79 km to Wind Area 6/7), as it is the most cost-efficient option.
- The analysis shows that outcomes across all scenarios are sensitive to changes in the selected variables.
- To achieve a payback period **before <u>2045</u>** in the scenario S3 *Low Prices*, the following adjustments are required:
    - Gas prices must exceed €15/MWh, or
    - Electricity prices must be €47/MWh lower than in scenario S1 *Average*, or
    - CO_2 prices must be €25/ton higher than in scenario S3 *Low Prices*, or
    - CAPEX of cable (material & installation) must be 15% lower, or
    - The WACC must be lower than 4%
- Due to postponed investment to 2035, the WACC has a stronger impact, as costs and benefits are shifted further into the future. This increases sensitivity to discounting effects.

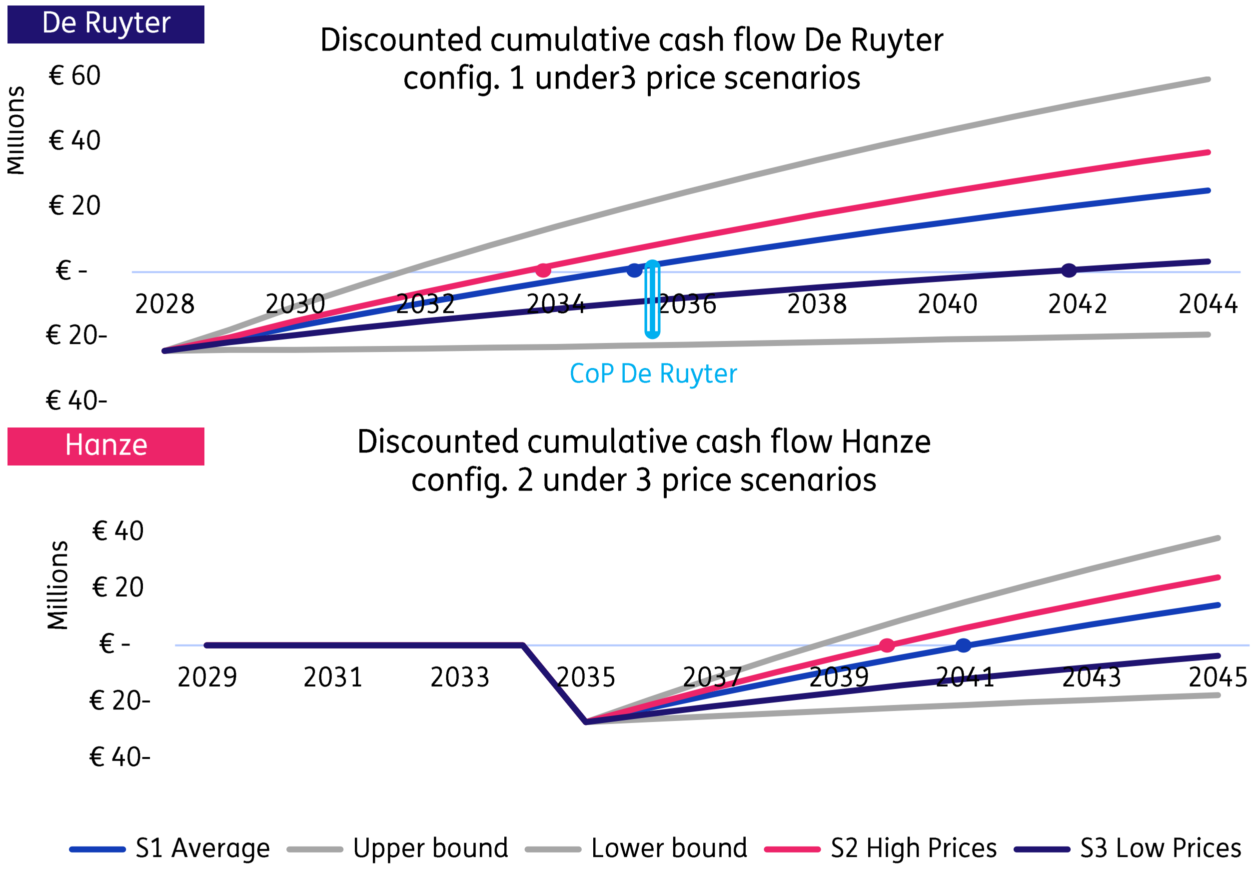




5 Conclusions

Conclusion (I/II): The payback periods of De Ruyter config. 1 (6–14 yr) and Hanze config. 2 (5–10+ yr) illustrate the uncertain factors driving the business cases.

- Electrification of the De Ruyter and Hanze platforms offers a viable pathway to reduce emissions and operational costs, but economic feasibility varies significantly across configurations and scenarios.
- From the evaluated cable configurations, the options with the shortest payback period per platform are:
  - **De Ruyter**: configuration 1 (49km to HKZ-III), payback period: 6-14 yrs, across scenarios. In S1 and S2, payback occurs before 2035 which matches with the currently envisaged timeframe for De Ruyter.
  - **Hanze**: configuration 2 (79km to Wind Area 6/7), payback period: 5 yrs (in S1) to slightly beyond the business case horizon (10+ yrs) in S3
- **Sensitivity**: For De Ruyter configuration 1 to realise a payback before 2035 in all three price scenarios, more favourable commodity prices or lower CAPEX are required. The same applies for Hanze (configuration 2) to reach payback in S3 before 2045.



Conclusion (II/II): The economic feasibility of electrification varies significantly across configurations and scenarios.

- **Strategic implication**: Decision-making should consider timing of infrastructure availability, regulatory developments, and commodity price trajectories. Further refinement of cost estimates and alignment with offshore wind planning may improve feasibility.
- The analysis supports DANA Petroleum in identifying electrification options that balance technical viability, financial return, and strategic alignment with energy transition goals.

Payback period (in years) for each cable configuration in the three energy and CO_2 ETS price scenarios (S1-3):

Platform	Cable configuration:	S2 High	S1 Average	S3 Low
De Ruyter	01: P11b-HZKIII	6	7	14
	02: P11b-Hoek van Holland	9	11	16+
Hanze	01: F2a-Waterekke (GER)	10	13	16+
	02: F2a-Wind Area 6/7	5	7	10+
	03: F2a-IJmuiden Ver Gamma	n/a	n/a	n/a

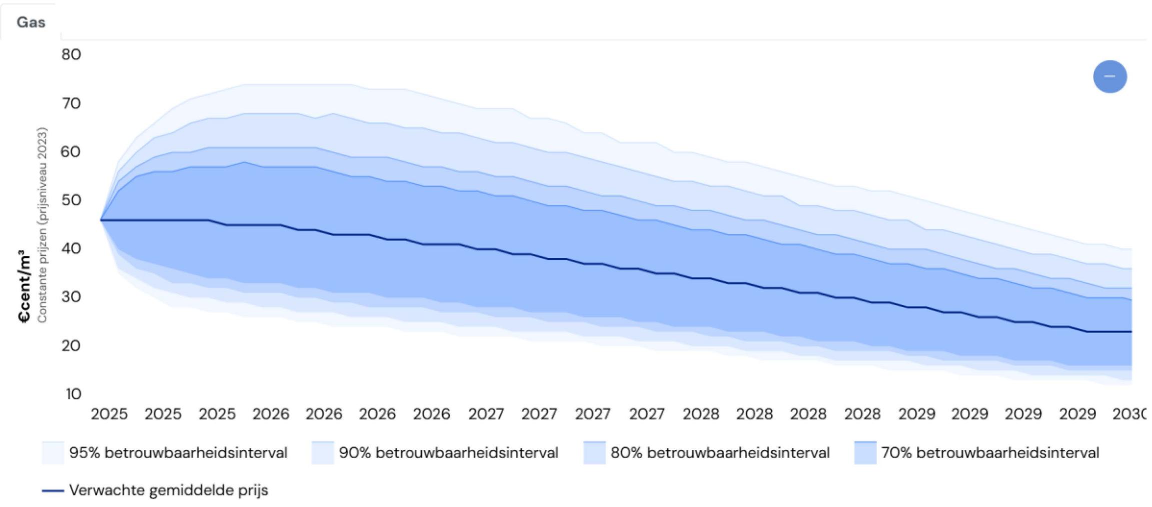
Appendix

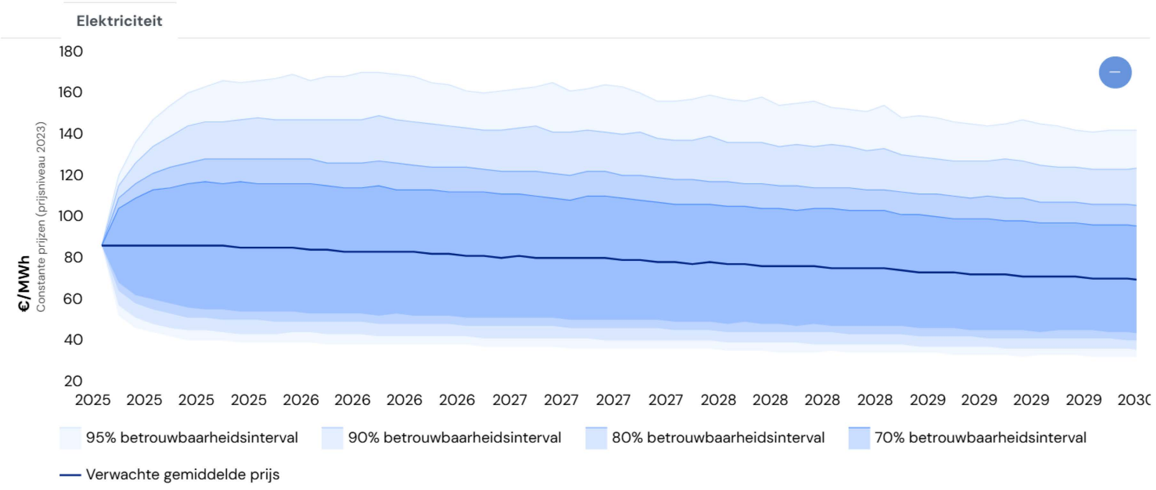
Appendix

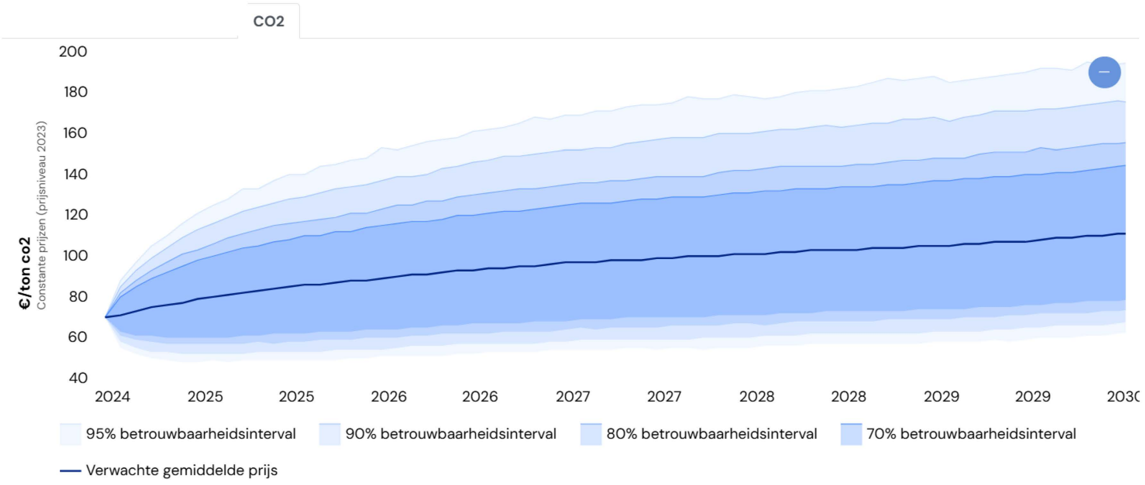
The business case model will be provided separately in an Excel.

TNO Vector energieprijsmonitor

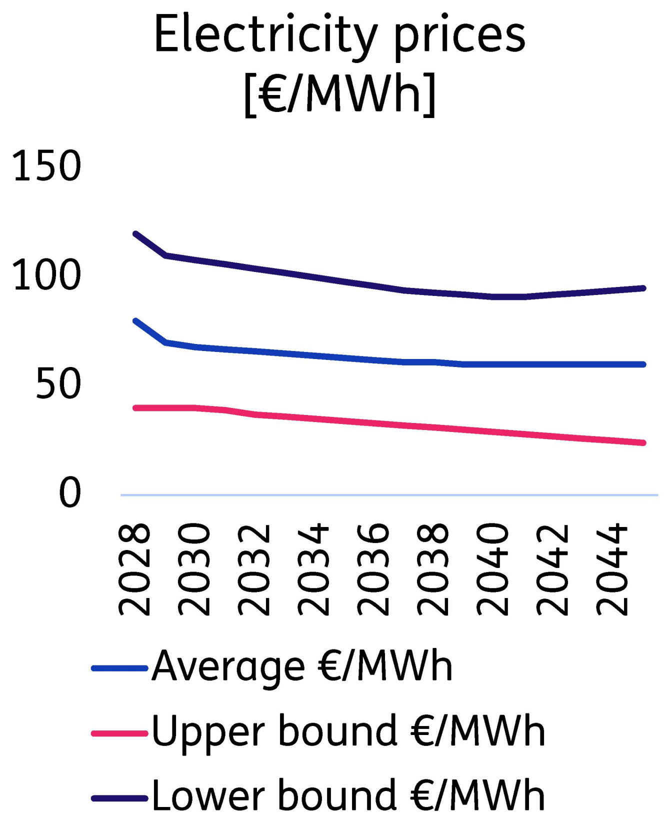
Method description of the Energieprijsmonitor

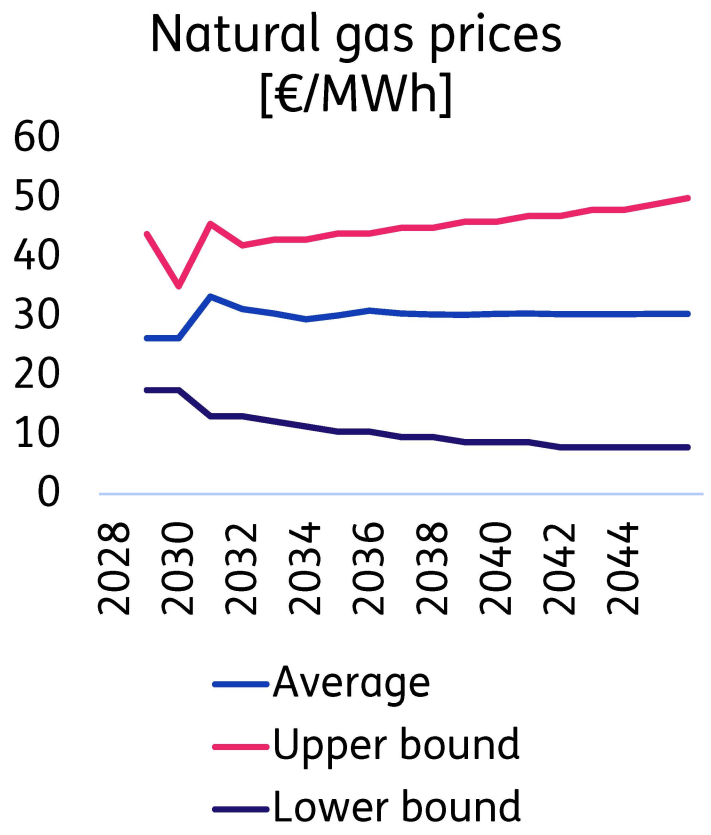


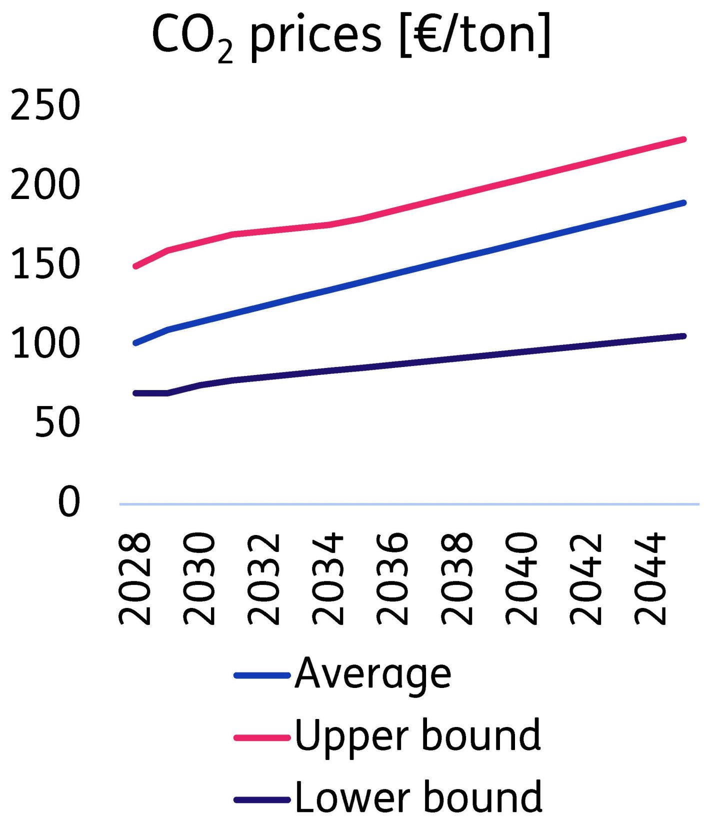




De Ruyter & Hanze – Price scenarios 1, 2, 3







High level cable cost exploration by TNO

High level offshore cable cost exploration by TNO based on public sources and available internal expertise

		Cu-core [mm2]	Al-core [mm2]	CAPEX Cu-core [M€]	Capex Alu-core [M€]	Distance [km]	CAPEX/km Cu	Capex/km Alu	Installation costs
Platform 1	Conf 1	95	240	10	11	49	204.082	224.490	12.250.000
	Conf 2	240	500	17	17	67	253.731	253.731	16.750.000
Platform 2	Conf 1	300	Not feasible	38	No feasible config.	93	408.602		23.250.000
	Conf 2	Not feasible	Not feasible	No feasible config.	No feasible config.	160			40.000.000
	Conf 3	150	800	19	43	79	240.506	544.304	19.750.000

selected & implemented

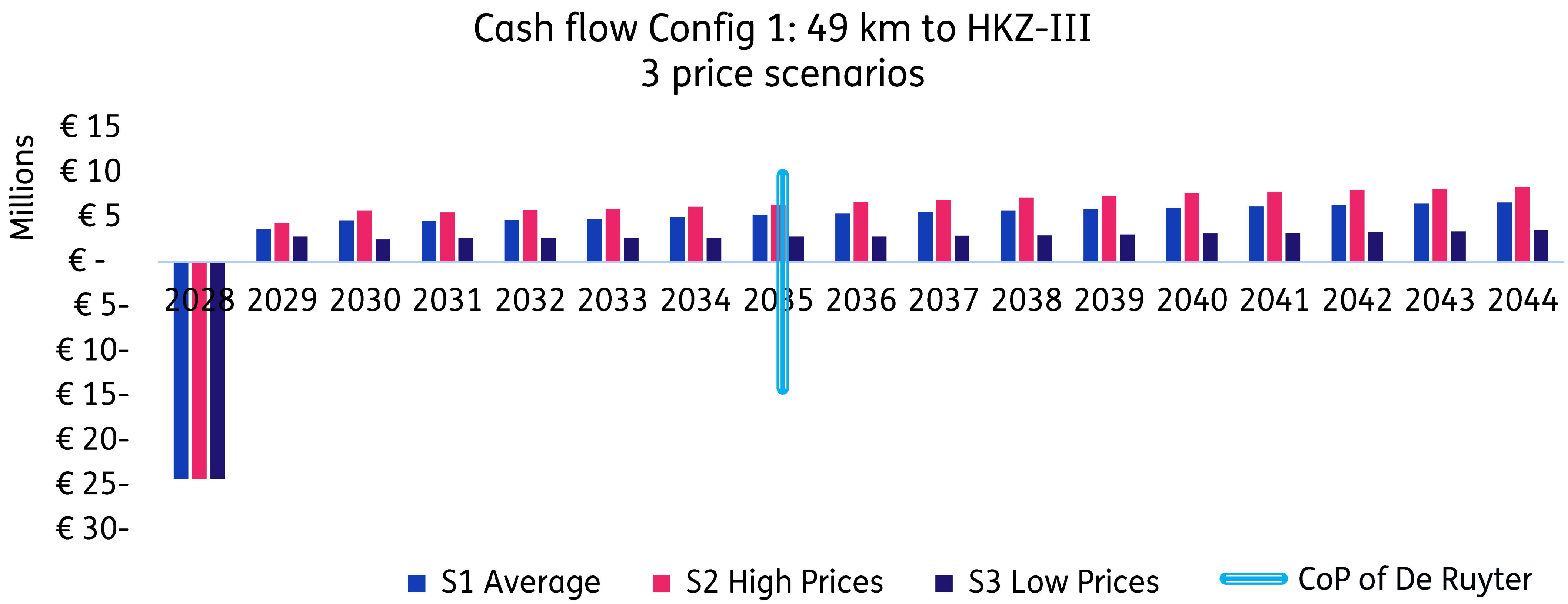
Danish Energy Agency - cable array costs

source: technology_catalogue_offshore_wind_march_2022_-_annex_to_prediction_of_performance_and_cost.pdf

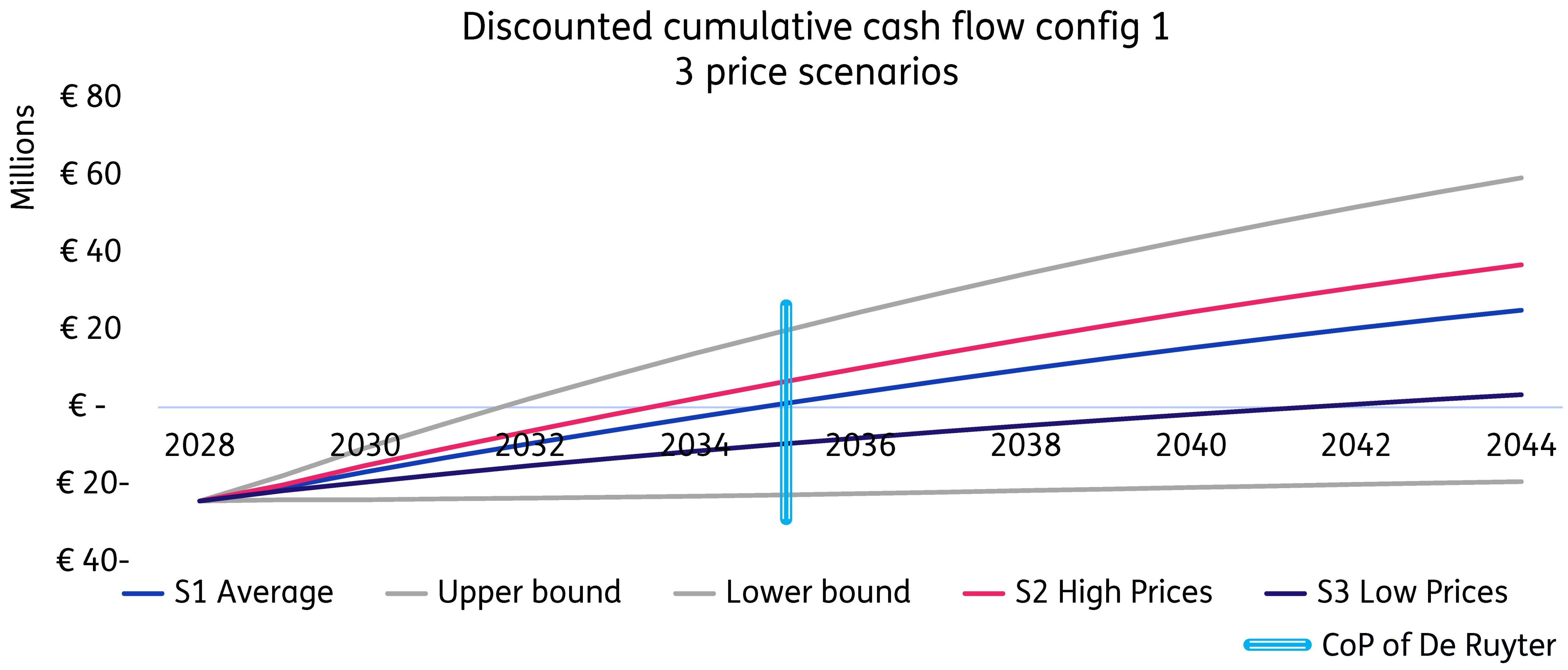
500.000 euro/km
33% equipment cost
67% installation cost

		Distance [km]	CAPEX equipment c	CAPEX installation c	Total CAPEX	Comparison	
Platform 1	Conf 1	49	8.085.000	16.415.000	24.500.000	0,81	0,75
	Conf 2	67	11.055.000	22.445.000	33.500.000	0,65	0,75
Platform 2	Conf 1	93	15.345.000	31.155.000	46.500.000	0,40	0,75
	Conf 2	160	26.400.000	53.600.000	80.000.000	#VALUE!	0,75
	Config 3	79	13.035.000	26.465.000	39.500.000	0,69	0,75

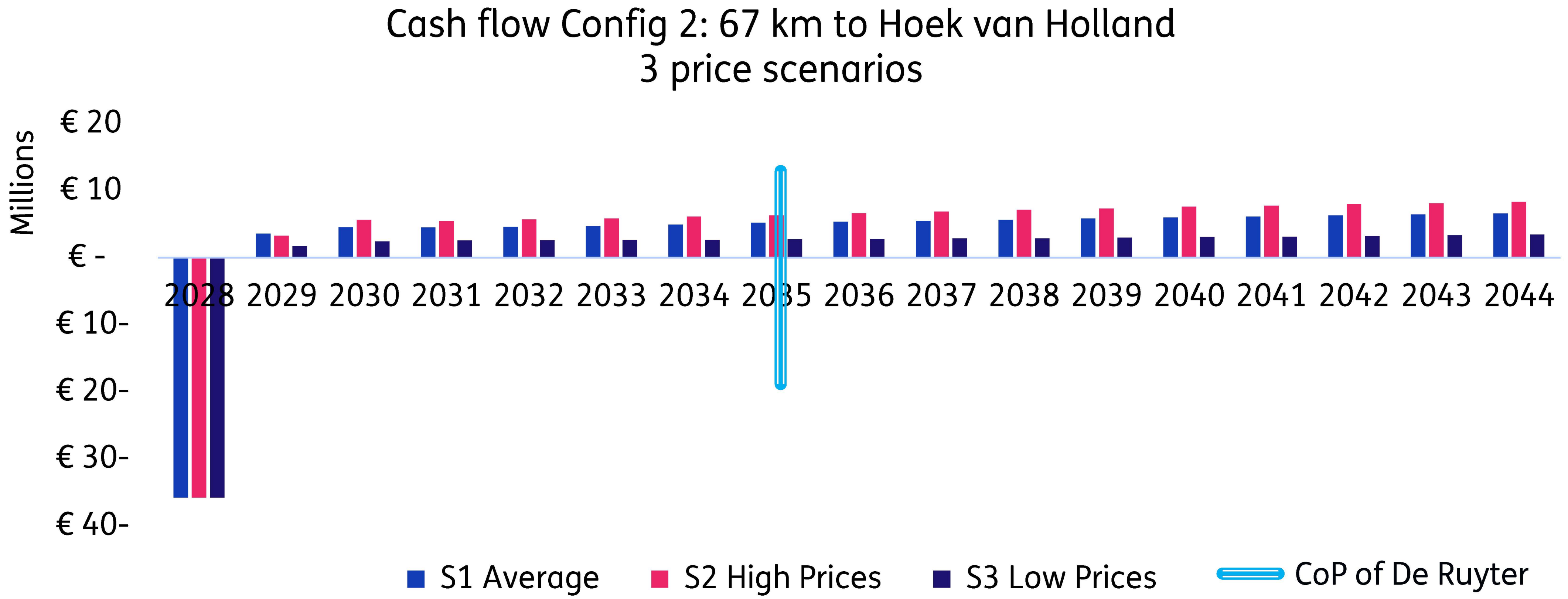
De Ruyter – Cashflow – Configuration 01



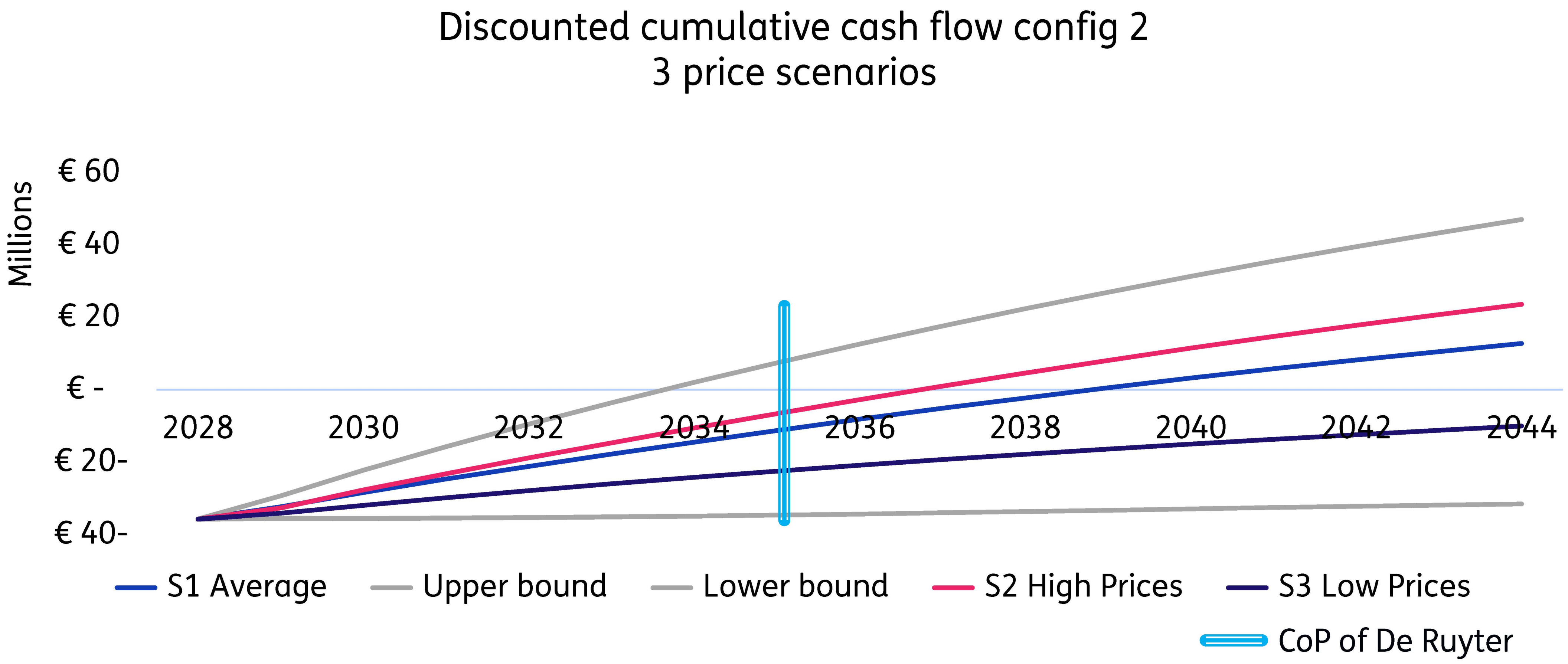
De Ruyter – Disc Cum Cashflow – Configuration 01



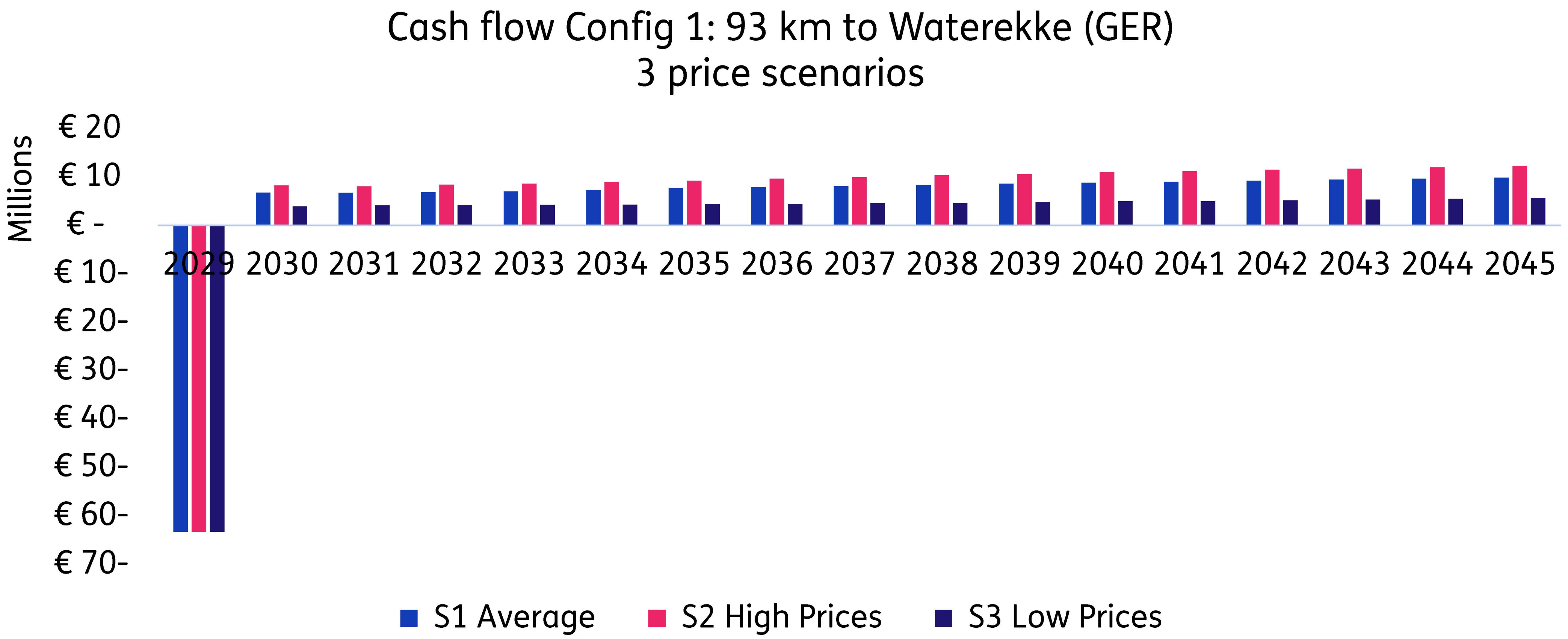
De Ruyter – Cashflow – Configuration 02



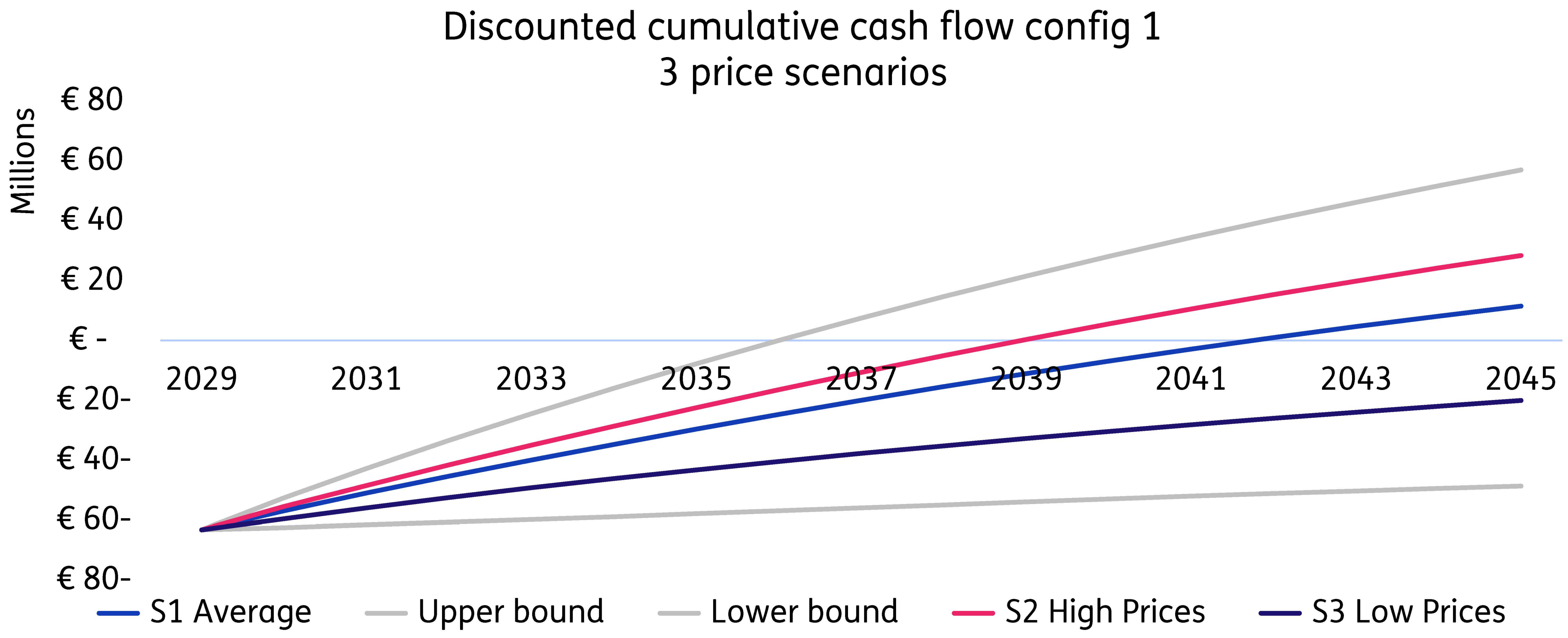
De Ruyter – Disc Cum Cashflow – Configuration 02



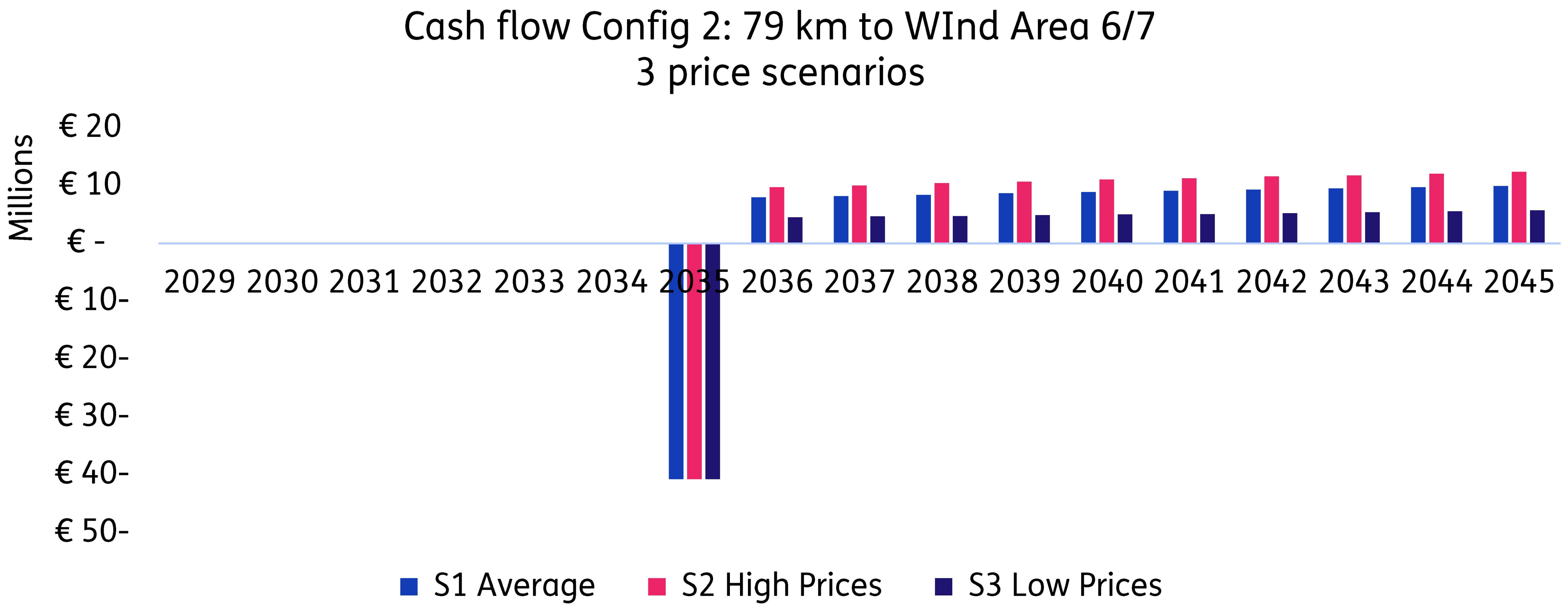
Hanze – Cashflow – Configuration 01



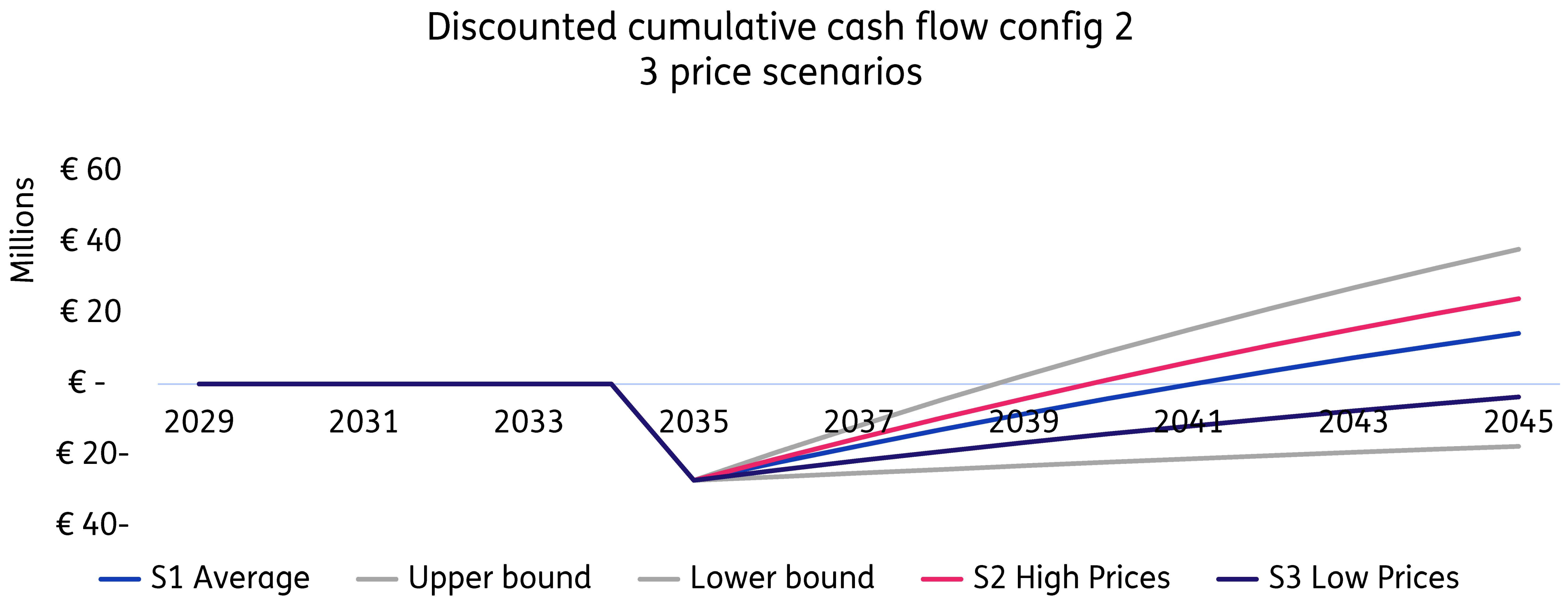
Hanze – Disc Cum Cashflow – Configuration 01



Hanze – Cashflow – Configuration 02



Hanze – Disc Cum Cashflow – Configuration 02



Point of contact:

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