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XODUS ADVISORY

PORTHOS CCS – TRANSPORT AND STORAGE (T&S) TARIFF REVIEW

The Dutch Ministry of Economic Affairs and Climate Policy





Disclaimer Notice

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01

EXECUTIVE SUMMARY



01 EXECUTIVE SUMMARY

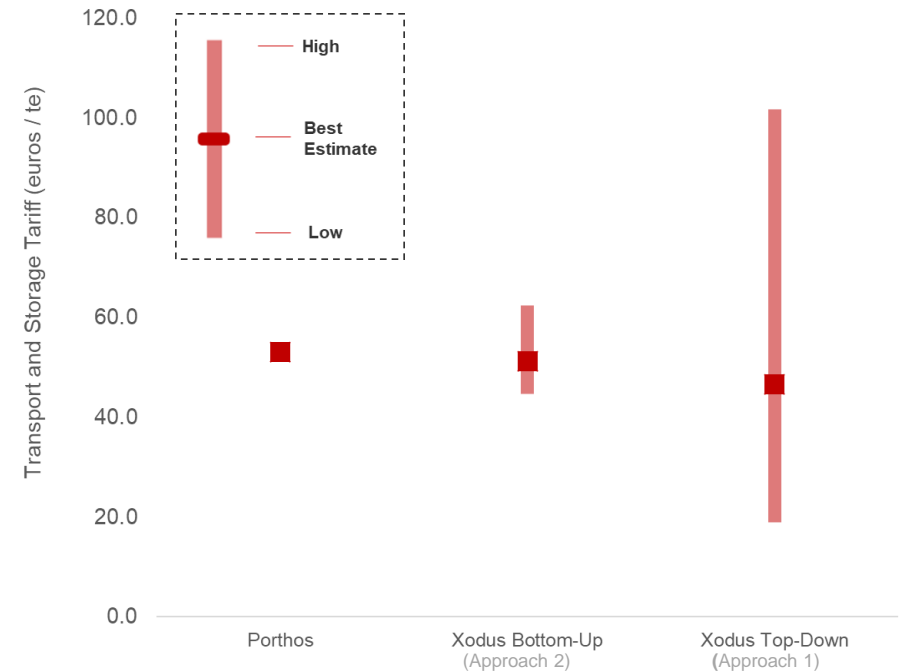
Executive Summary - Overall

Please note, throughout this document Xodus will use the terminology P90, P50 and P10. These should be understood as follows:

P90: The 90th percentile and should be understood to mean the downside case. i.e. high tariff
P50: The 50th percentile and should be understood to mean the mid or best estimate case.
P10: The 10th percentile and should be understood to mean the upside case. i.e. low tariff

Overall, the Porthos Transport and Storage required tariff estimate of 53 euros / tonne appears reasonable. The economic modelling calculation carried out is accurate and the input assumptions align well with other benchmarks.

- ▶ Xodus has reviewed the Porthos economic model along with a further data-set supplied by Porthos as well as email and phone dialogue. The main purpose of the study was to understand the 'reasonableness' of the Porthos calculated Transport & Storage (T&S) tariff. In the 'base' case this required tariff is understood to be 53 euros / tonne.
- ▶ To evaluate the 'reasonableness' of the Porthos estimated tariff, Xodus have approached the question in two different ways with the following outcomes:
 - **Approach 1** – a 'top-down' benchmarking analysis where the Porthos project is compared to other planned CCS projects globally with a focus on similar CCS backbone suppliers. **This approached yielded an average T&S tariff of 47 euros / tonne with a range of approx. 20 – 100 euros / tonne. i.e. a lower figure than Porthos, however, well within the accuracy ranges.**
 - **Approach 2** – a 'bottom-up' analysis whereby Xodus recreate the Porthos design in our cost estimating software and database to arrive at an independent tariff estimate and range. **This approached yielded an average (mid case) T&S tariff of 51 euros / tonne with a range of approx. 45 – 60 euros / tonne. i.e. corroborating approach 1.**
- ▶ The two approaches yield similar T&S 'best estimates' namely ~ 50 euros / tonne which is encouraging. These figures are also very close to the Porthos estimated figure of 53 euros / tonne.
- ▶ As highlighted by Porthos, there is a motivation to provide a conservative tariff estimate at this stage as the tariff can be further re-evaluated in the future. Reducing the tariff at the re-evaluation is possible, however as pointed out by Porthos, increasing it would prove complex. This may explain why the Porthos figure is higher.



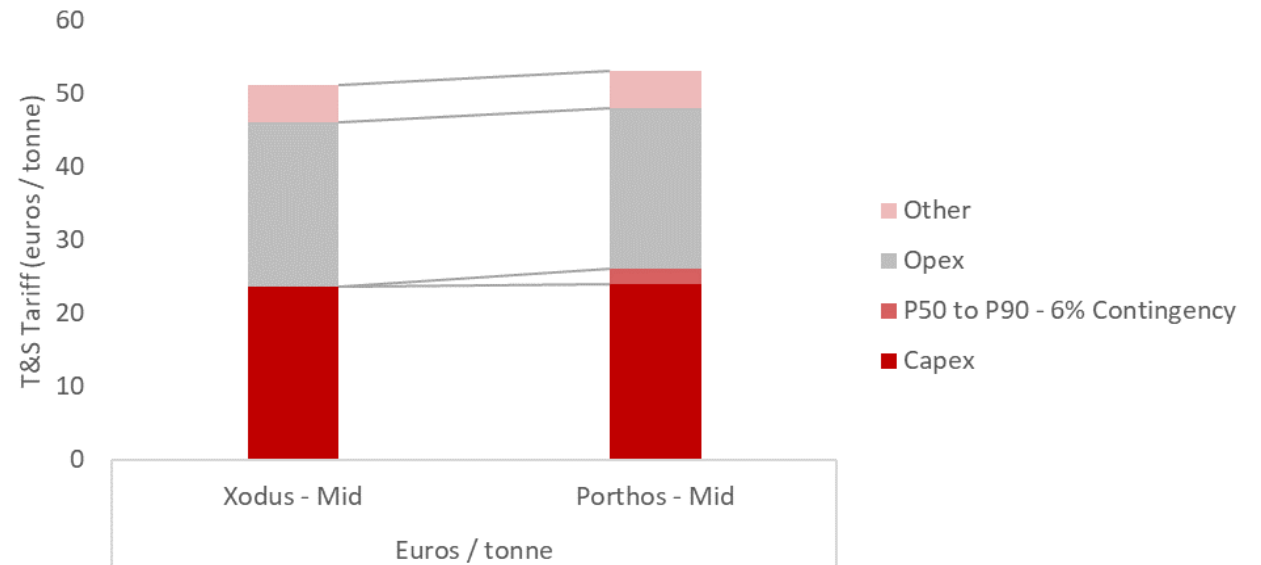
- ▶ Please note, as CCS is both complex and in its infancy as a 'low carbon' solution, this will inevitably mean uncertainty and risks are substantially higher than other low carbon solutions e.g. wind and solar. As a result, appreciation for the risks involved and subsequent requirement from investors for higher returns should be expected. As the solution matures in the coming decade, cost and uncertainty will reduce which will together lead to lower tariff requirements.



01 EXECUTIVE SUMMARY

Executive Summary – The main difference between the Xodus and Porthos tariffs is due to the inclusion of a 6% further contingency in the Porthos case

- ▶ The Xodus P50 Capex base is marginally lower than the Porthos P50 Capex figure due to the Xodus lower Offshore Pipeline estimate
- ▶ Xodus Opex is marginally higher than Porthos estimate
- ▶ Both Xodus and Porthos include contingency in their cost estimates, however, Porthos' base / mid case allows for a further 6% contingency. This aims to capture some P90 risking.
- ▶ Xodus have also provided a P90 estimate, however, it is not considered the 'base / mid case'.
- ▶ Xodus estimates;
 - ▶ P90 : 62.4 euros / tonne
 - ▶ P50 : 51.3 euros / tonne
 - ▶ P10 : 44.7 euros / tonne
- ▶ Compared with the Porthos figure of 53.1 euros / tonne
- ▶ **Overall, Xodus is comfortable with the Porthos approach and tariff figure and view the small differences as acceptable at this stage in the project.**



	Euros / tonne		
	Xodus - Mid	Porthos - Mid	Difference
Capex	23.7	24.0	0.3
P50 to P90 - 6% Contingency	0	2.1	2.1
Opex	22.3	21.9	-0.4
Other	5.1	5.1	0.0
Total	51.1	53.1	2.0



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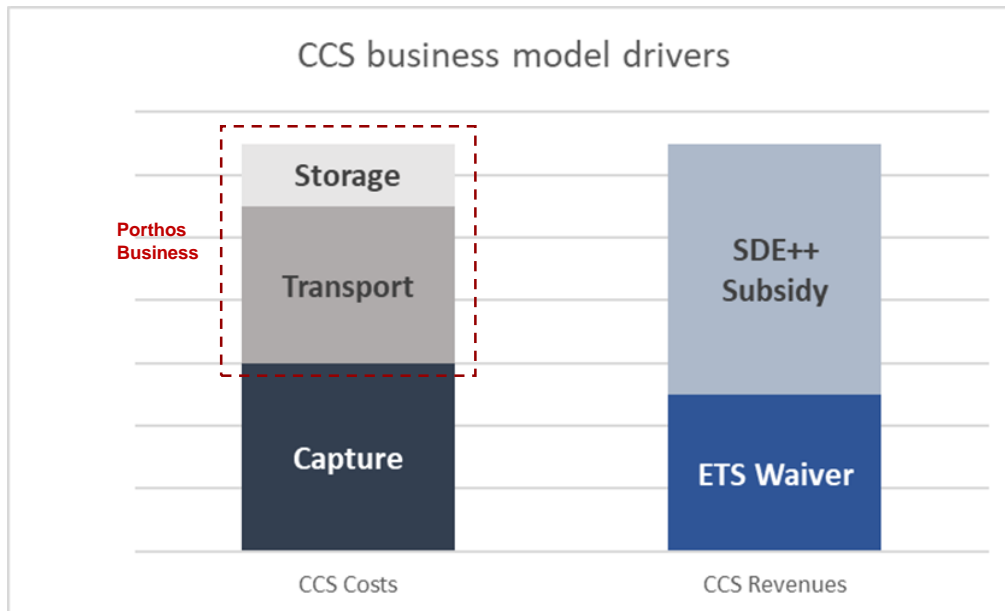
INTRODUCTION



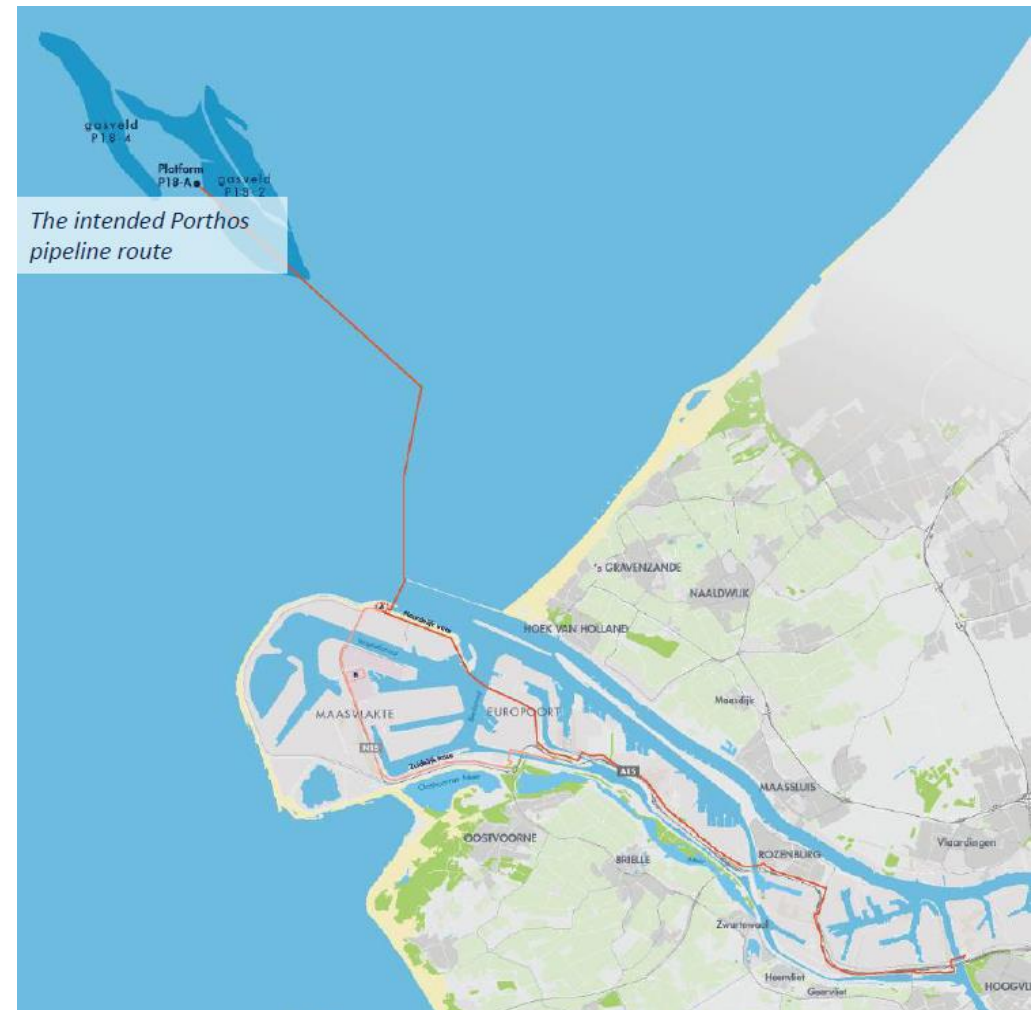
02 INTRODUCTION

Background

- ▶ The Ministry of Economic Affairs and Climate Policy of the Government of the Netherlands have requested Xodus provide a proposal for reviewing the possible levels of CCS Subsidy for current and future CCS projects. In particular, the subsidy evaluated by the PBL Netherlands Environmental Assessment Agency for the Porthos project.
- ▶ Multiple different CCS business models exist with different stakeholders. The focus of Porthos is on the transport and storage part of the CCS chain. As such all costs related to the Capture element are not covered. Moreover, due to a lack of completed CCS-projects in the Netherlands, there are minimal references to build on. The agency has indicated that, as a consequence, there exists considerable uncertainty with regards to the estimated transportation and storage fee for CCS. For this reason, this review has been carried out.



Porthos Model Drivers (Diagram by Porthos – Xodus have not verified the basis)



Porthos Project Proposal



03

CCS PROJECT COMPARISON (APPROACH 1)



03 CCS PROJECT COMPARISON

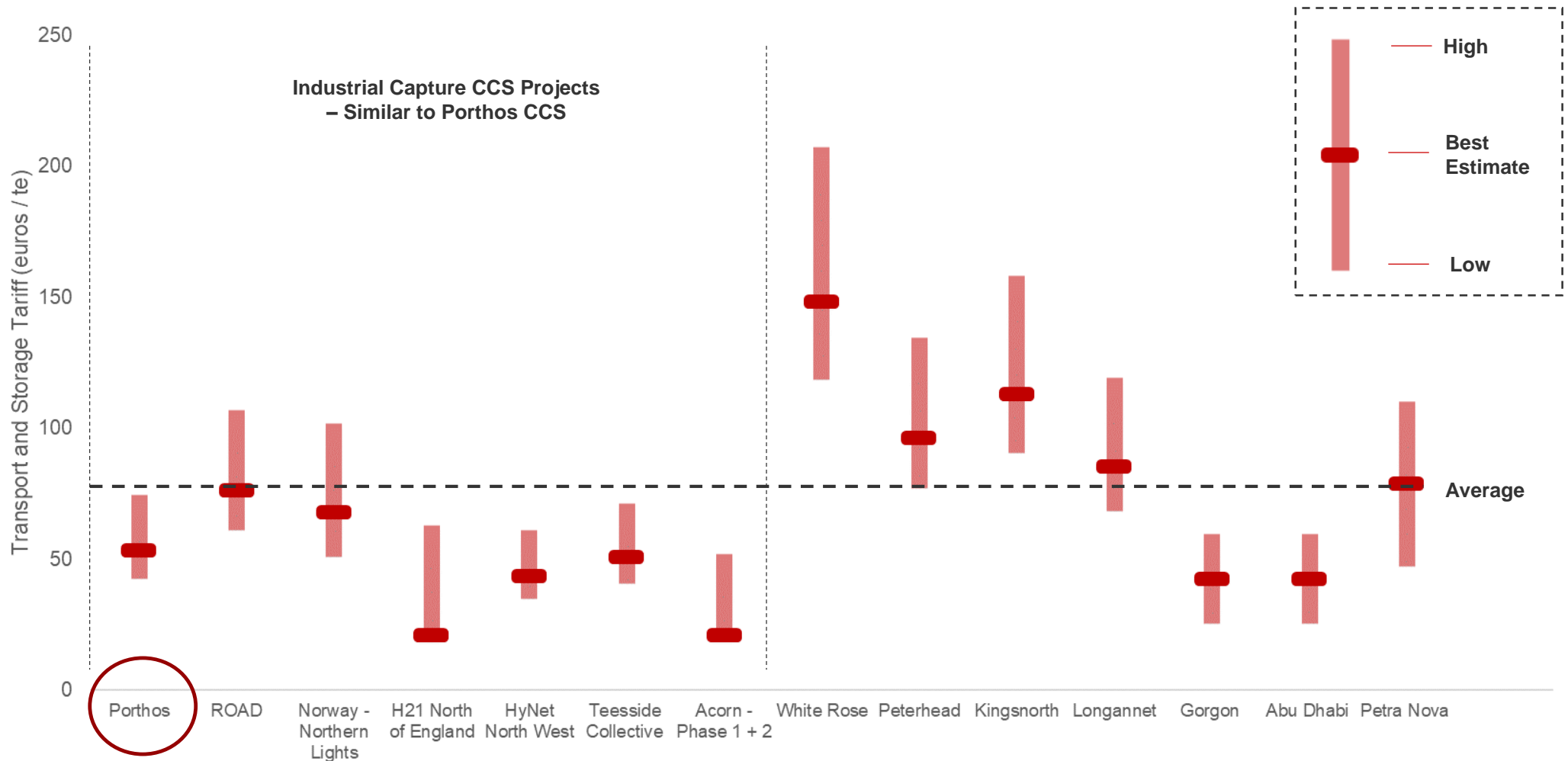
Basis for generating comparable CCS Projects

- ▶ In order to benchmark the Porthos base case tariff figure, Xodus have reviewed other CCS projects both planned and in operation.
- ▶ We have focussed ideally on projects that a.) are multi-party 'industrial backbone' type developments and b.) have accessible reports detailing project specifications, plans and estimated costs. However, a range of projects are included.
- ▶ Not all of the other CCS projects adopt the same business model approach as Porthos and even if they have, the T&S tariff element is not always explicit in the documentation.
- ▶ Xodus have therefore modelled the other CCS projects using the Porthos economic model creating 'pseudo T&S tariffs' for each of the projects, enabling a direct comparison to Porthos.
- ▶ We have gathered the following information from the other CCS projects:
 - ▶ Peak CO₂ rate and duration
 - ▶ Capex for Transport and Storage elements. Where only a total figure is given which includes Capture, we have assumed the same Capex splits for Transport and Storage as Porthos
 - ▶ Opex (where available). Where no Opex is provided, the % factors used by Porthos to estimate Opex from Capex have been adopted.
 - ▶ Abex (where available). As Abex costs are incurred late in project life, the impact on the tariff is small, therefore in most cases, the Porthos project Abex is assumed.
 - ▶ Relevant country tax rate.
- ▶ The remaining input variables in the Porthos model remain fixed, e.g. WACC, inflation rate etc.
- ▶ Based on the above, the 'pseudo T&S tariffs' created are largely a reflection of the project's T&S Capex per tonne of CO₂. Opex, schedule and tax are less significant drivers than Capex due to the discount factor applied to future years. Capex is expensed at the start.
- ▶ The following slides indicate Xodus' estimated low, best estimate and high T&S tariffs. The low and high ranges aim to provide an indication of uncertainty relating to:
 - ▶ Level of project definition and maturity
 - ▶ Timing of project start date
 - ▶ Amount and type of data available
 - ▶ Extent of assumptions required to generate 'best estimate'. For example, if transport and storage cost are not explicitly broken out and an estimate is required, these would lead to a larger range.
- ▶ Please note, there are currently (2020) no operational CCS projects with multiple suppliers and a shared backbone. All of the projects that are comparable in scope and size are less developed than the Porthos development is, which makes it challenging to compare these projects to Porthos on a like-for-like basis.



03 CCS PROJECT COMPARISON

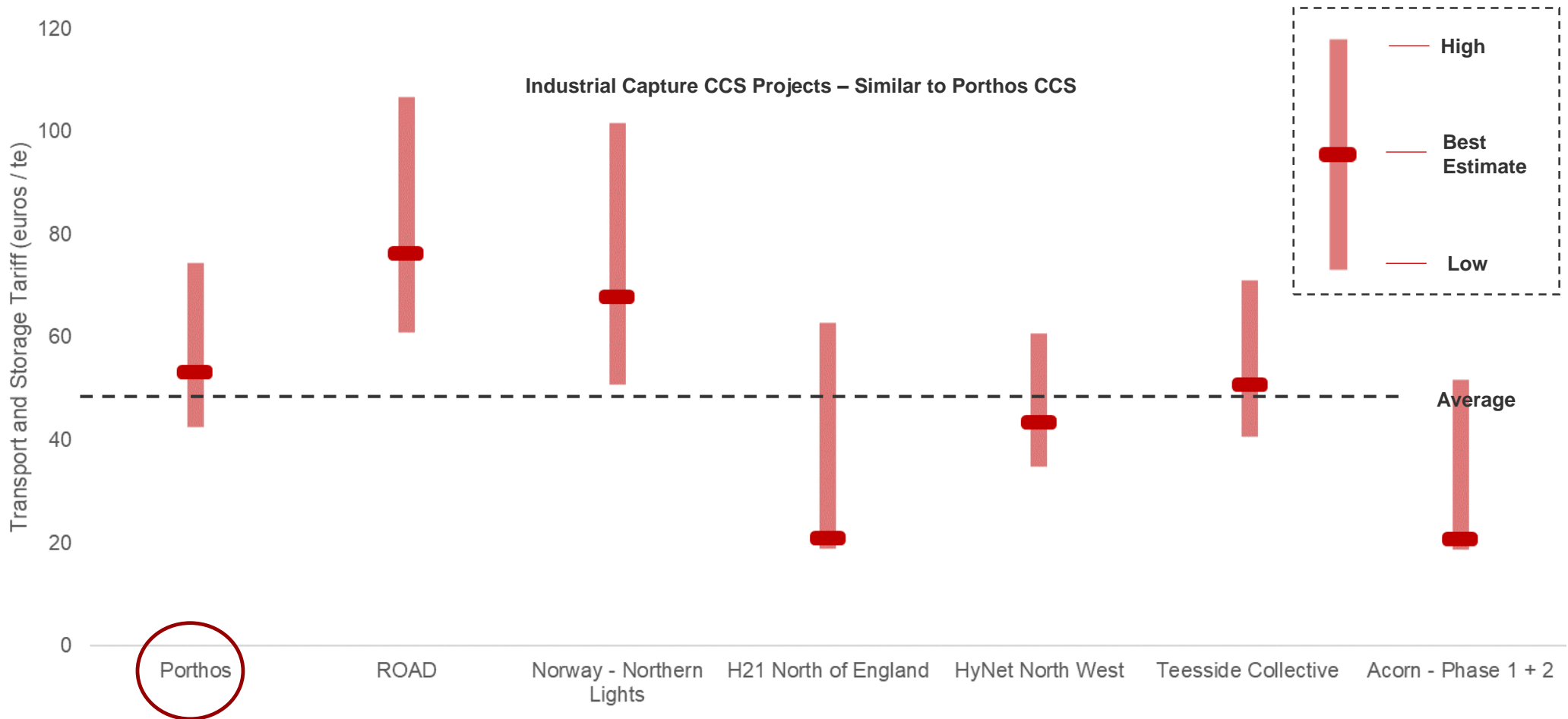
'Industrial Capture CCS' projects typically would require lower T&S tariffs compared to all projects





03 CCS PROJECT COMPARISON

Of the 'Industrial Capture CCS' Projects only, Porthos' required tariff is average *



* Please note, the Porthos development is at a significantly more advanced stage than all of the other examples shown and therefore the tariff calculated is based on input parameters with much greater levels of certainty than the other projects with far greater levels of assurances in, for example, volume levels. In the public data available for the other projects, figures quoted are often 'aspirational' and target capacities rather than firm agreements.



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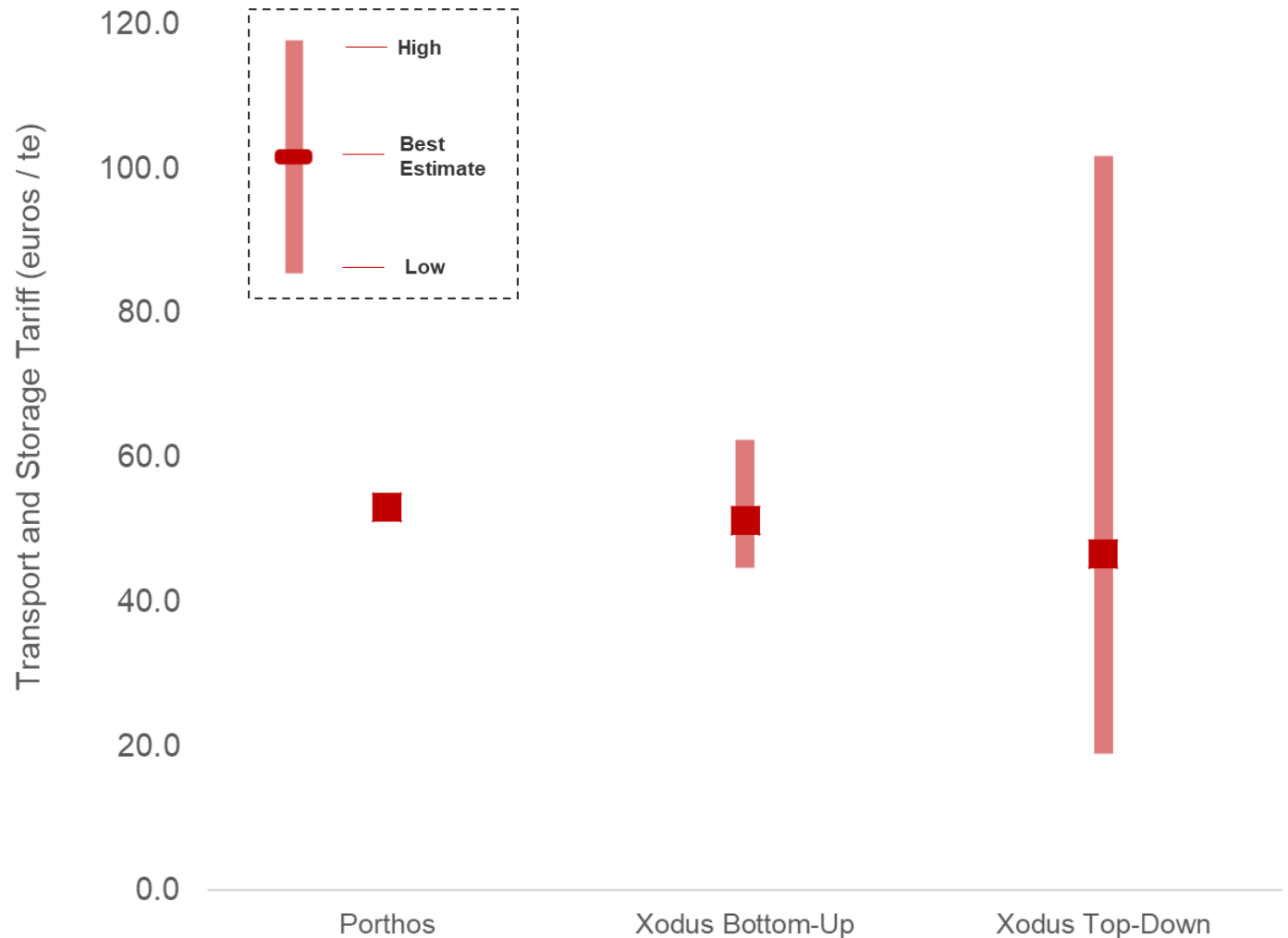
XODUS TARIFF ESTIMATES (APPROACH 2) AND CONCLUSIONS



04 XODUS TARIFF ESTIMATES

Overall, the two approaches corroborate Porthos' methodology and provide comparable figures

- ▶ Tariff estimates have been produced using the Porthos economic model with the following adjustments:
 - ▶ Xodus inputs of P90, P50, and P10 Capex and Opex (shown to the right and discussed in the previous section)
- ▶ Based on the above Xodus arrive at the following 'Bottom-up' (Approach 2) tariff estimates:
 - ▶ **P90 : 62.4 euros / tonne**
 - ▶ **P50 : 51.3 euros / tonne**
 - ▶ **P10 : 44.7 euros / tonne**
- ▶ Compared with the Porthos figures of 53.1 euros / tonne
- ▶ Looking back at the Approach 1 (top-down – section 4) and 2 (bottom-up) estimate, we see that the two approaches yield similar T&S 'best estimates',
- ▶ Both approaches are marginally lower than the Porthos figure of 53 euros / tonne, however, well within the estimated P90 (90th percentile) and P10 (10th percentile) accuracy ranges.
- ▶ As highlighted by Porthos, there is a motivation to provide a conservative tariff estimate at this stage as the tariff can be further re-evaluated in the future. Reducing the tariff at the re-evaluation is possible, however, increasing it would prove complex.

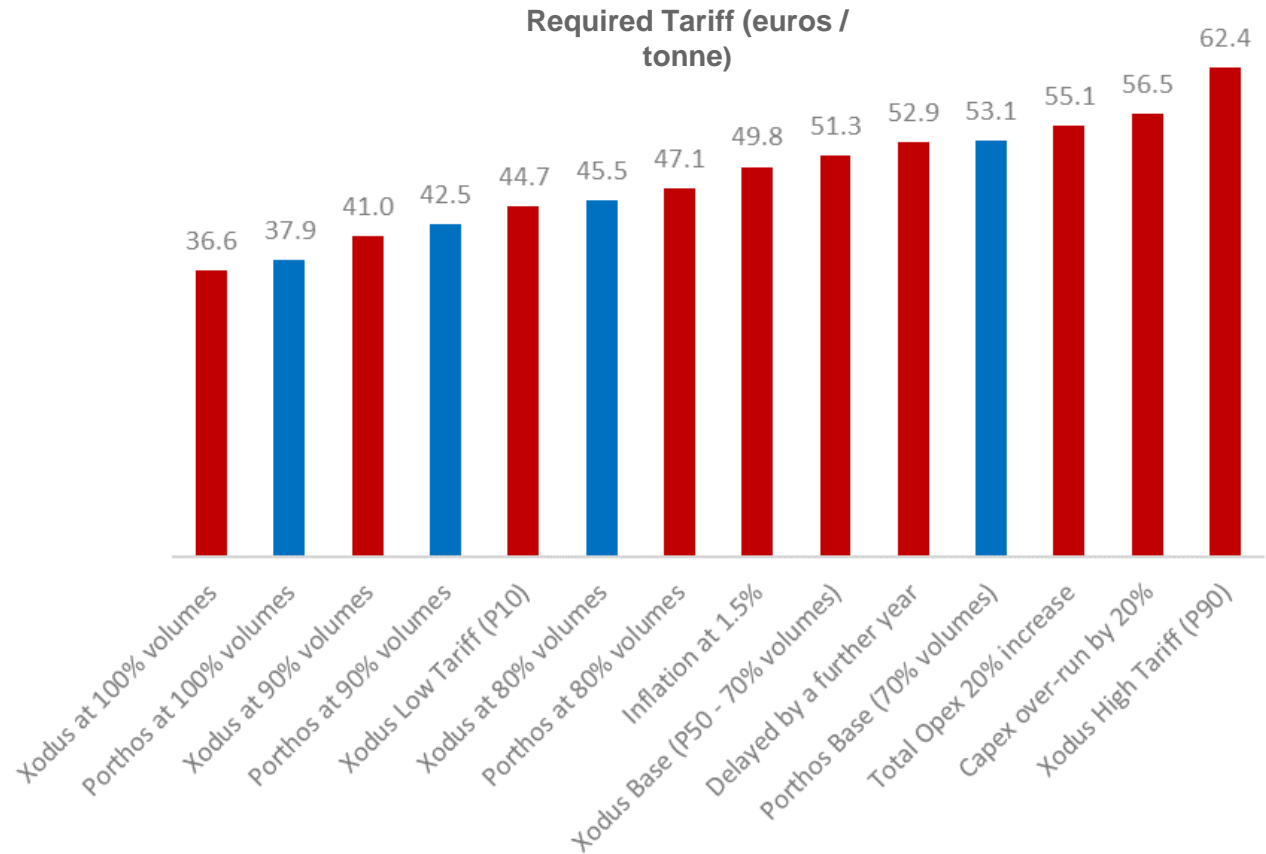




04 XODUS TARIFF ESTIMATES

Sensitivities

- ▶ A number of other sensitivities around the Xodus P50 were run to understand the impact on the required tariff. The Xodus P90 and P10 are also shown for reference. Xodus cases shown in **red**.
- ▶ Three volume cases (70%, 80%, 90% and 100%) are also shown in **blue** based on the Porthos base case (method). (See previous sections in the report to understand differences between Xodus and Porthos base case)
- ▶ The largest impact on tariff is the ability to run the system at 100% of the 2.5 Mton/year capacity (as opposed to the base case of 70%). This would result in a required tariff of 37.9 euros / tonne, significantly lower.
- ▶ The sensitivities shown are:
 - ▶ Volumetrics at 100% and 90% as opposed to the 70% rate of 1.75 Mton / yr.
 - ▶ Inflation at 1.5% - base cost inflation used in the model is 2%. Given low inflation rates currently, a sensitivity at 1.5% was carried out. The impact on tariff is small at 1.5 euro / tonne
 - ▶ Delayed by a further year – Capex and ‘first gas’ is delayed by a year, this further reduces revenue on a ‘time value of money’ basis and therefore requires a higher tariff
 - ▶ Total Opex 20% increase – All Opex e.g. M&O, insurance, energy, etc. is increased by 20%.
 - ▶ Capex over-run by 20% - All Capex costs are increased by 20%.





05

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05 REFERENCES

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NORCEM HEIDELBERG CEMENT Group	2017	Norwegian CCS Demonstration Project Norcem Concept and Preproject
Equinor	2019	Northern Lights Project Concept report
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Poyry Teesside Collective	2017	A Business Case for a UK Industrial CCS Support Mechanism
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IOGP	2019	The potential for CCS and CCU in Europe
Planbureau voor de Leefomgeving	2019	Conceptadvies Sde++ CO ₂ -1 Reducerende Opties