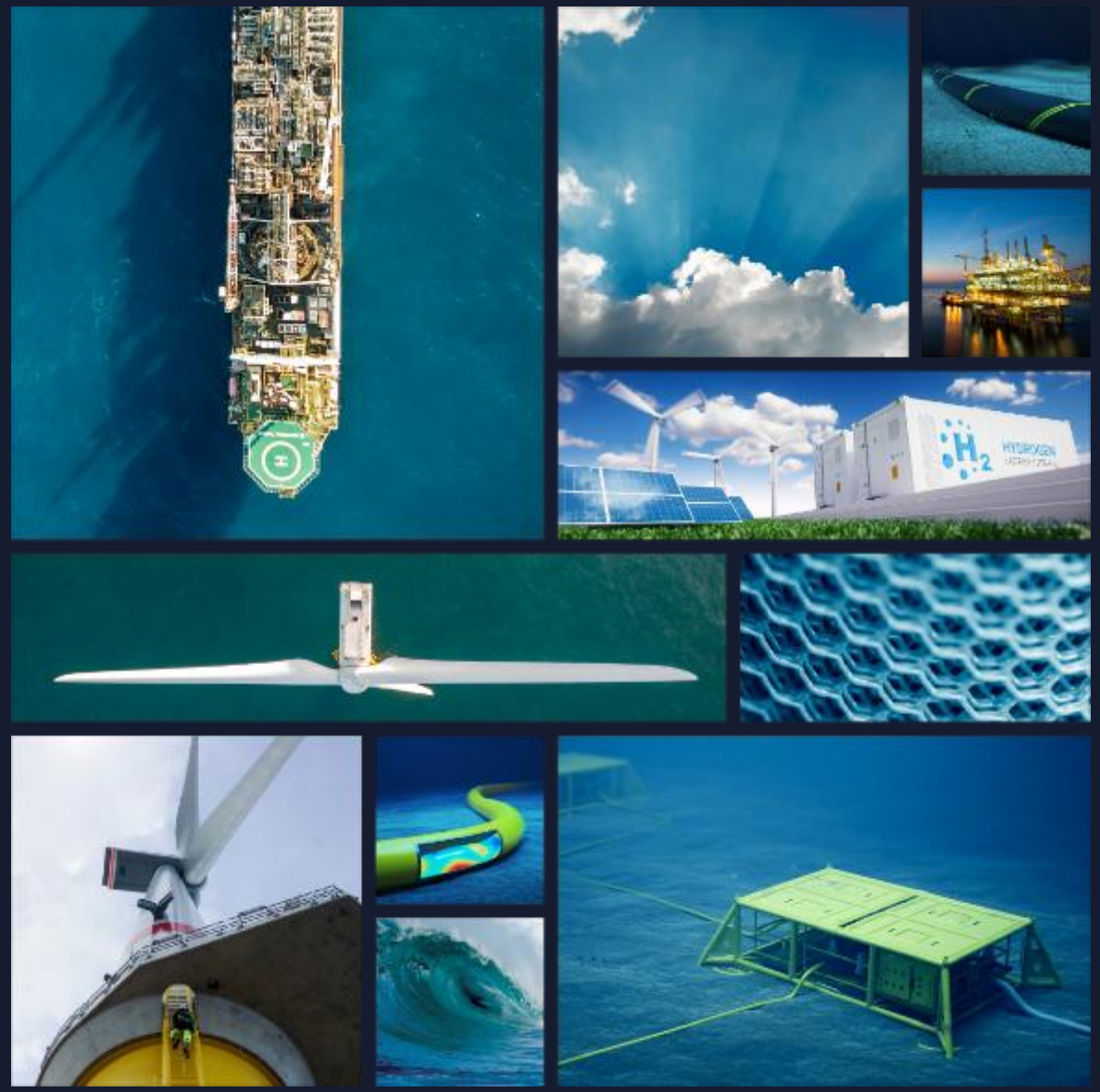
XODUS

Enabling Infrastructure for Cross-Border CO_2 Transport



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Enabling Infrastructure Study

Build on previous work to understand where and what infrastructure should be located to enable cross border CO_2 transport. Scope split into three main areas:

- Technology assessment: Assessment of the **CO_2 storage and treatment infrastructure** likely to be required for transport and port infrastructure, including a high-level understanding of capital investment requirements for that infrastructure.

- Port assessment: Assessment of the scale and suitability of existing **port infrastructure** across Europe and the UK needed to support gathering of CO_2 and transport of those emissions to ports located near to cost efficient offshore storage.

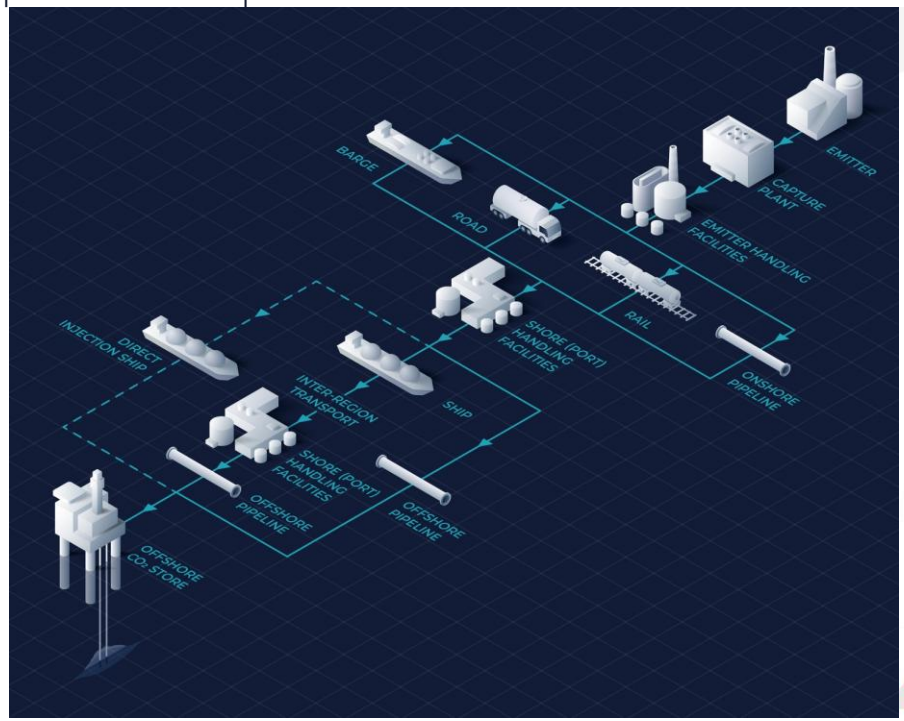
- CO_2 volume assessment: Assessment of the potential volumes of CO_2 emissions that may be transported between countries within Europe and UK **via ship** at 10-year time intervals from 2030 to 2050.

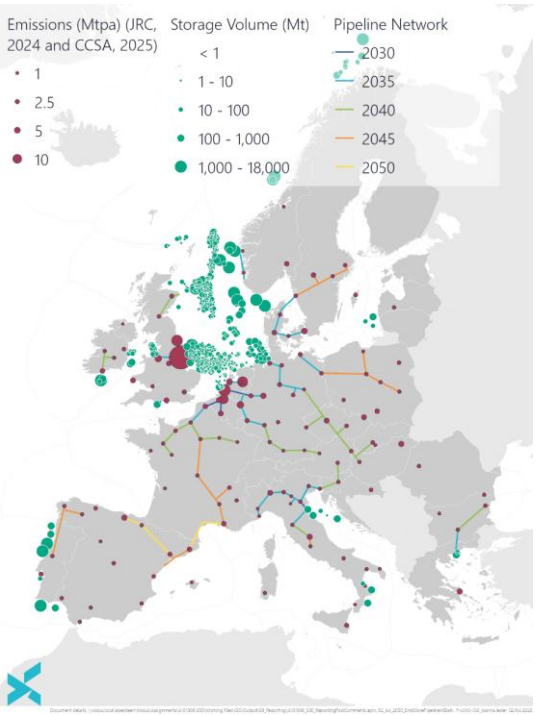
Technology Assessment

Assessment of the technology for four main areas to transport captured CO_2 from source to store:

- Transport method from source to gathering point (e.g. road tanker, rail tanker, barge, pipeline).
- “Emitter port” to enable buffer storage and export between emitters and export transport method
- Transport method from emitter port to store port (e.g. pipeline, ship).
- “Store port” to enable buffer storage and export to store (pipeline).

High level capability of transport methods and technology requirements for ports examined. Indicative CAPEX for a typical “store port” developed.

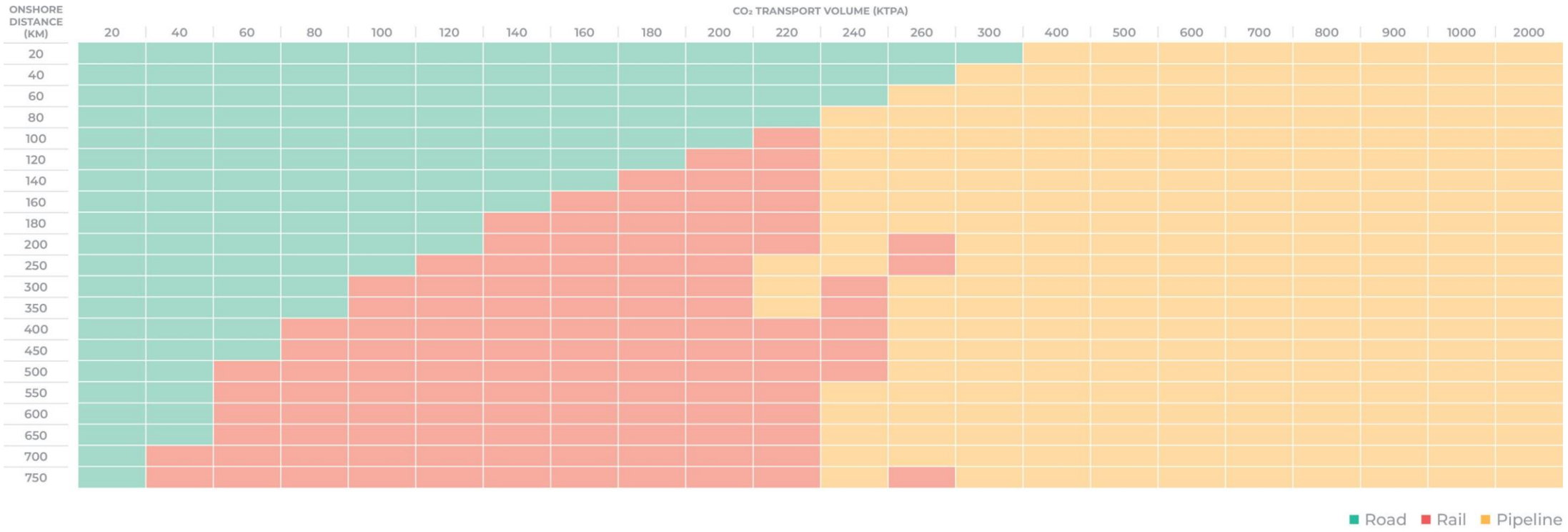




Technology Assessment

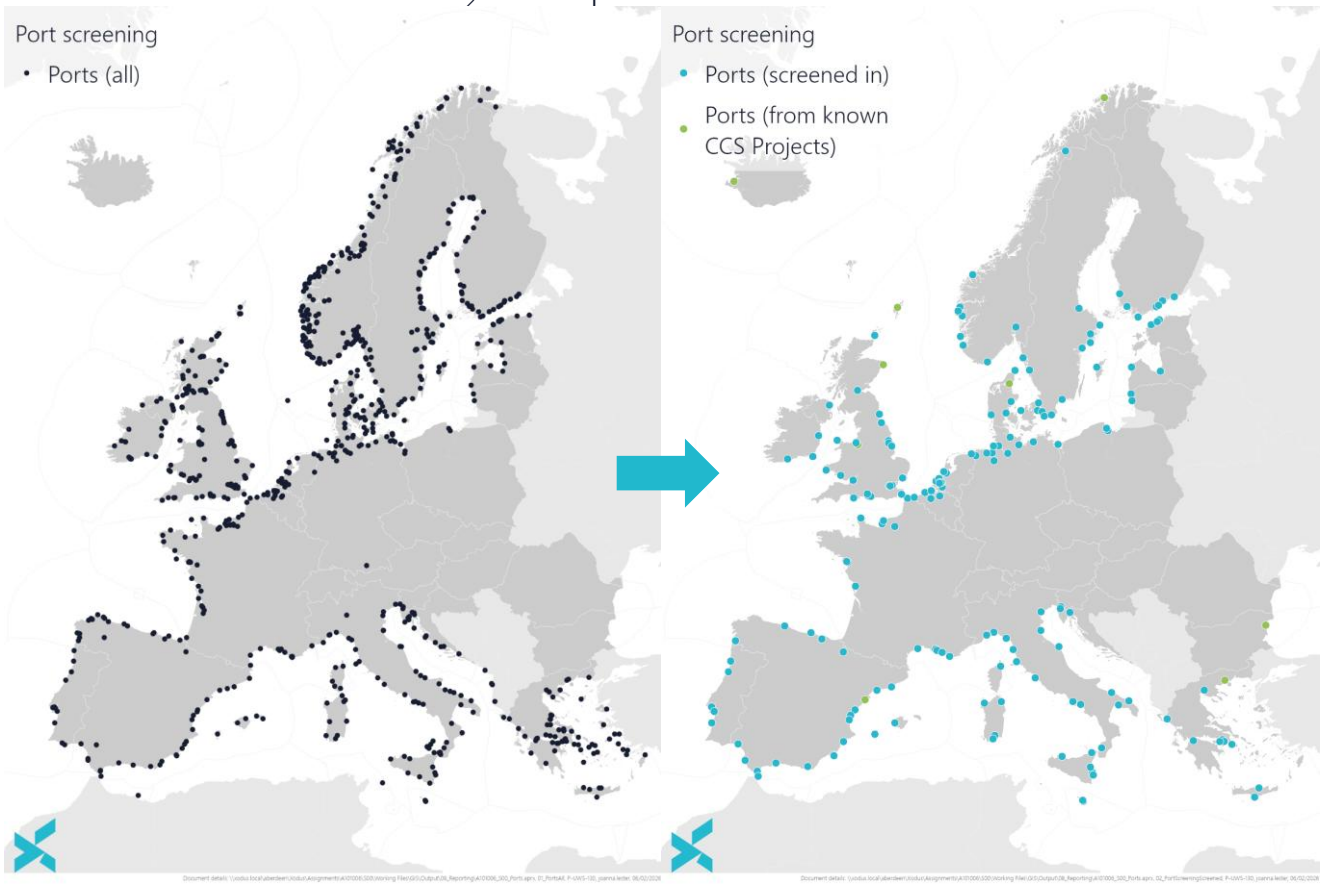
- The majority of technologies required to enable Europe wide CCUS transport are established and proven.
- A need exists to evolve technology to reduce over cost and expand scale but not a revolution.
- Pipeline transport is the most efficient method of transporting large volumes of CO_2 over long distances.
- Non-pipeline transport is a realistic alternative to pipeline transport:
  -  Road tankers: Existing technology suitable for small emitters remote from CO_2 gathering infrastructure.
  -  Rail cars: Evolution of existing technology suitable for transporting from small/medium emitters but challenged by high utilisation of rail network.
  -  Barge transport: Evolution of existing technology limited to emitters adjacent to major rivers but opportunity to service multiple emitters with common barges.
  -  Ship transport: Existing technology already being scaled up, suitable for bulk transport between regions.
- Challenges around trace non-condensable gases and metering are the main recommended focus areas for non-pipeline transport.

Technology Assessment

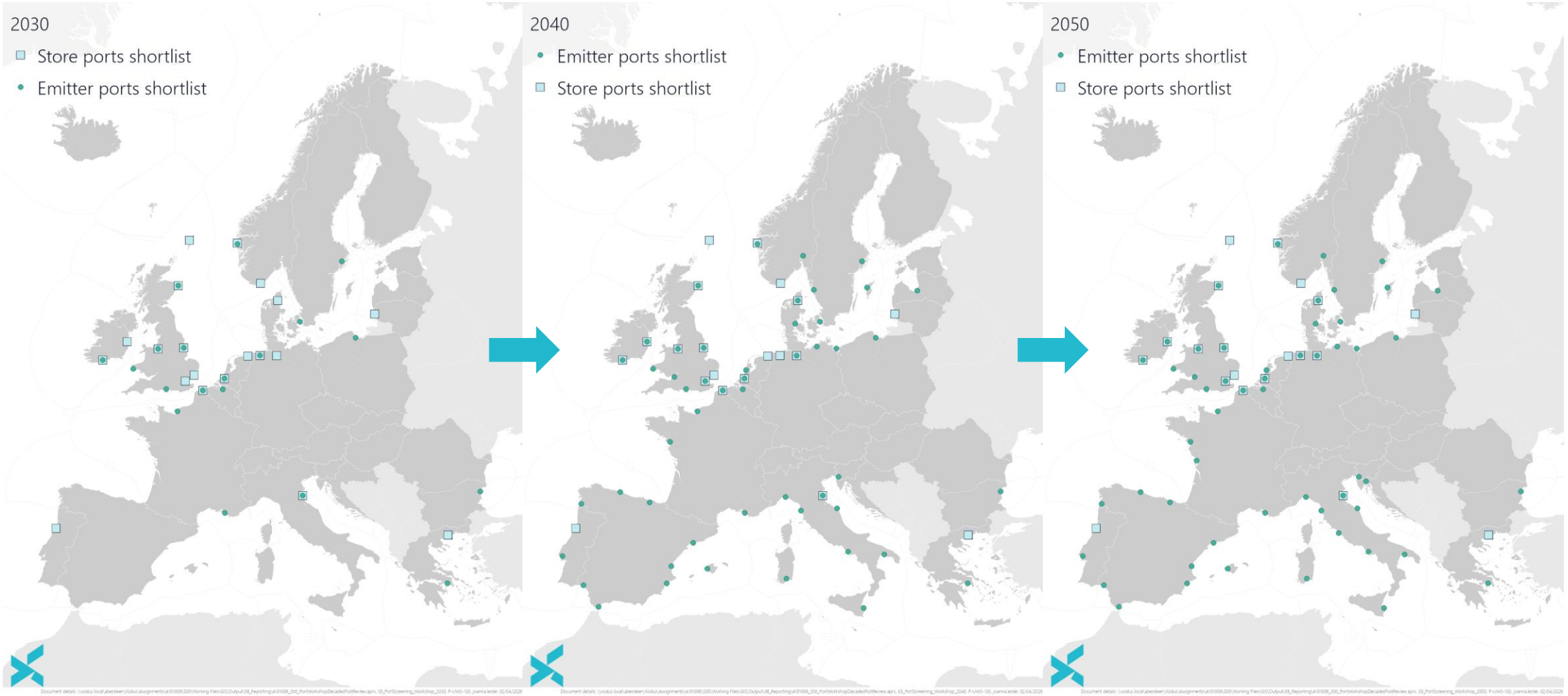


Port Assessment

- Reviewed every port across Europe and UK for CO_2 ship suitability by using historic ship movement data, and whether they are part of an “active” CCUS project.
- 1.3 million activities across approximately 850 ports reviewed to screen ports not suitable for handling frequent visits from likely size of CO_2 ships.
- Circa 200 ports assessed as being potentially suitable, screened down to circa 50 key ports across Europe and the UK that can enable cross-border CO_2 transport.

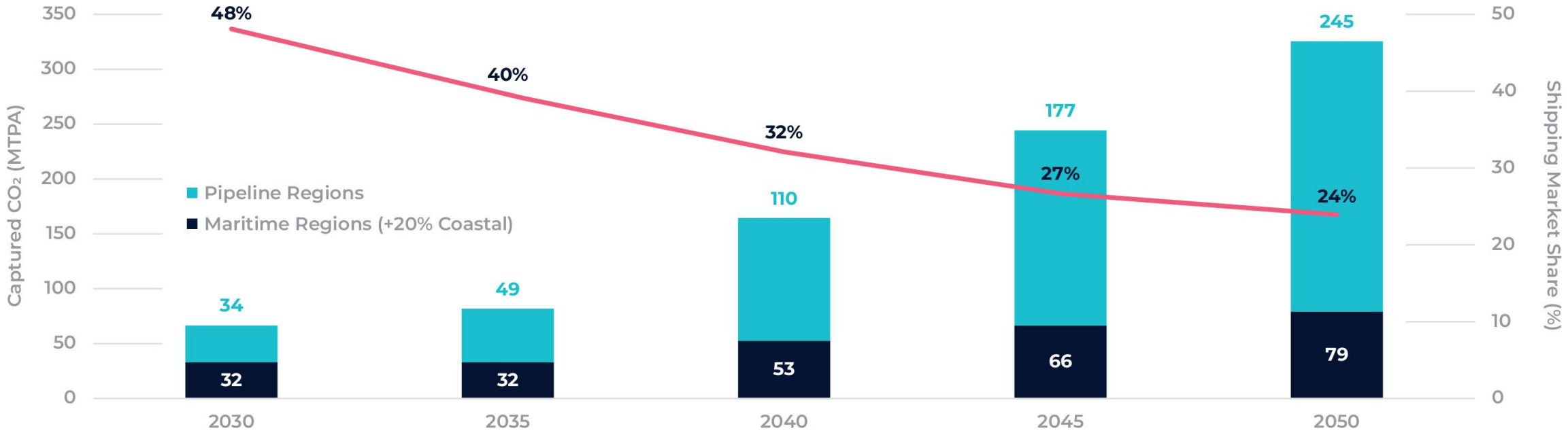


Port Assessment

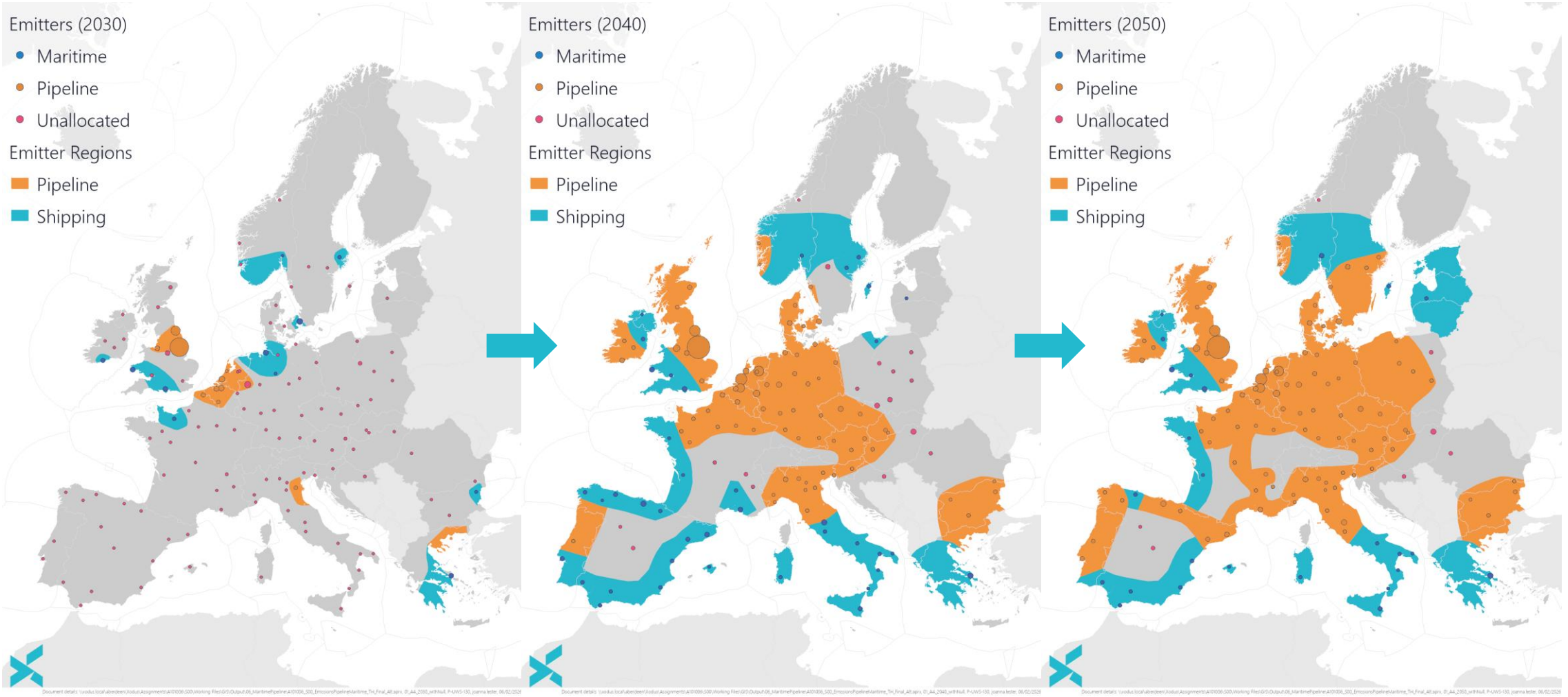


CO_2 Volume Assessment

- Assessed the potential scale of CO_2 that could be transported between emissions gathering and storage ports at 2030, 2040, and 2050 based on JRC emissions predictions.
- Analysis allocated volumes to pipelines or shipping depending on least-cost access to storage.
- Market growth over time likely to support expansion of onshore CO_2 pipeline network in areas with concentrated emissions.
- Shipping volume predicted to stabilise at 35-40MTPA after initial growth with an upside of circa 80MTPA., providing additional resilience and flexibility in the overall CO_2 transport system.



CO_2 Volume Assessment



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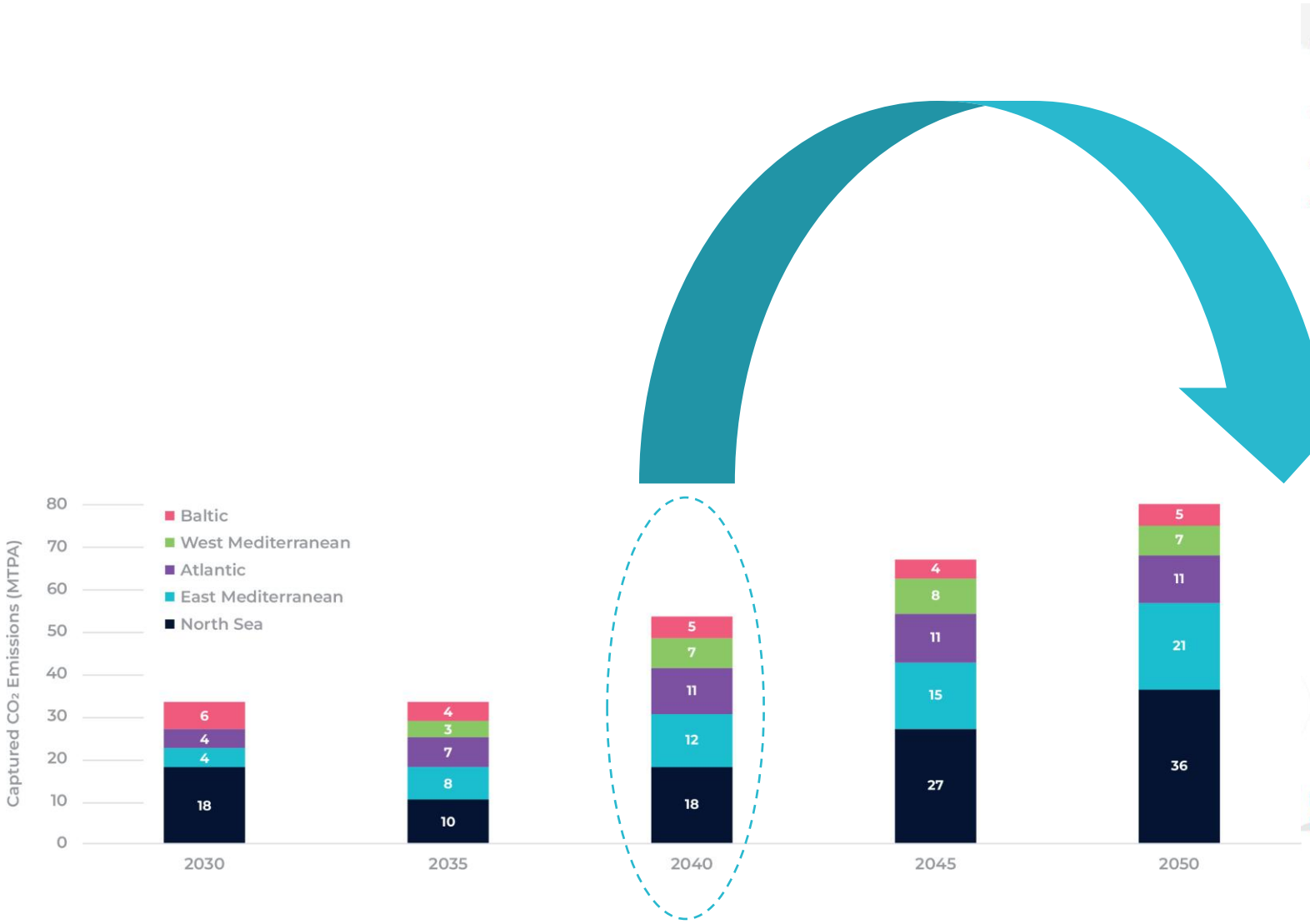
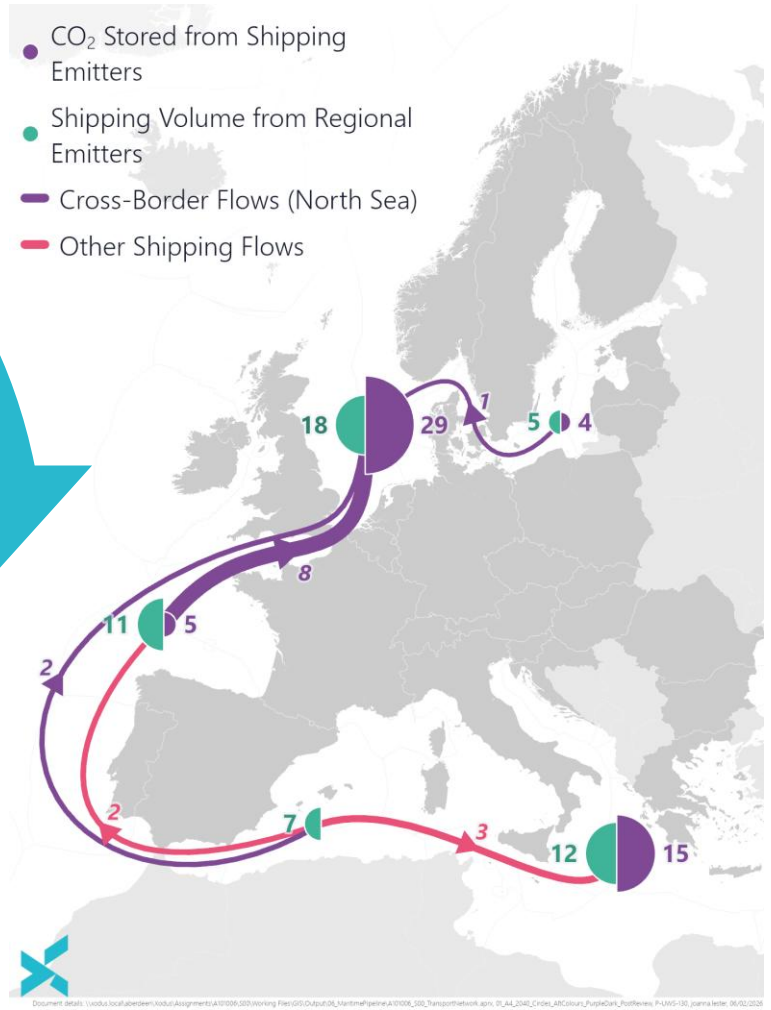
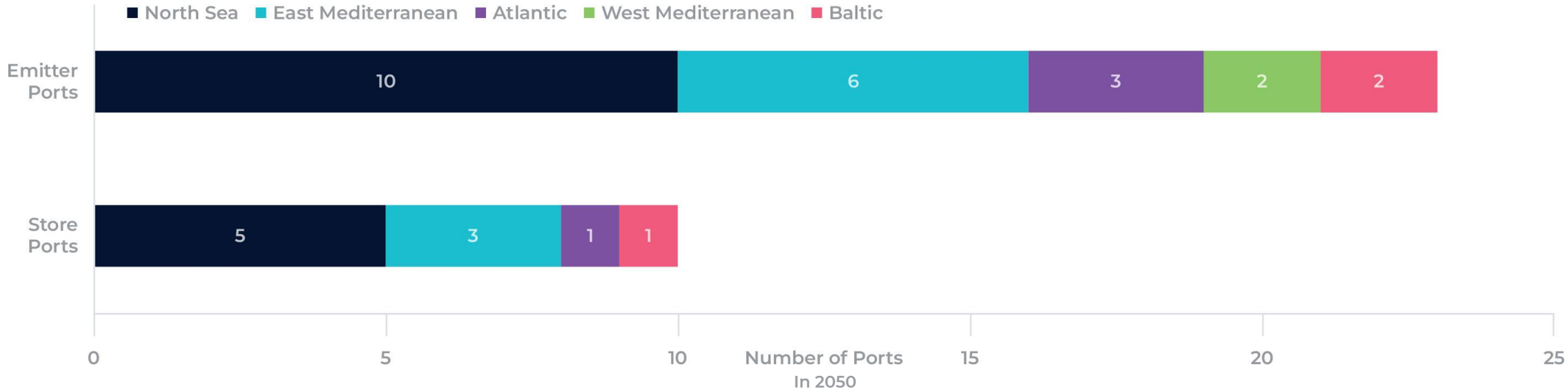
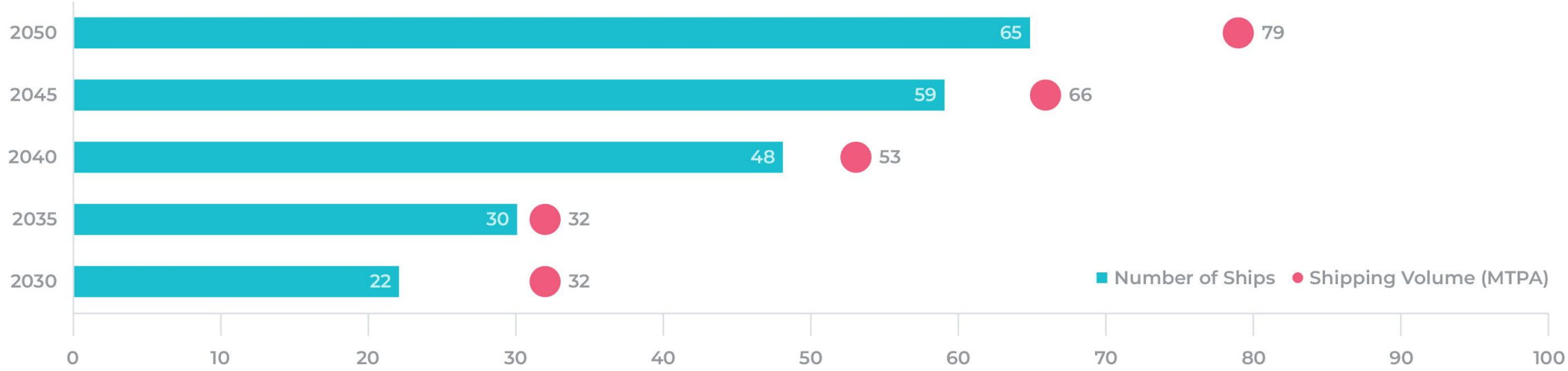




CO_2 Volume Assessment





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