Danish model for OWF site investigations

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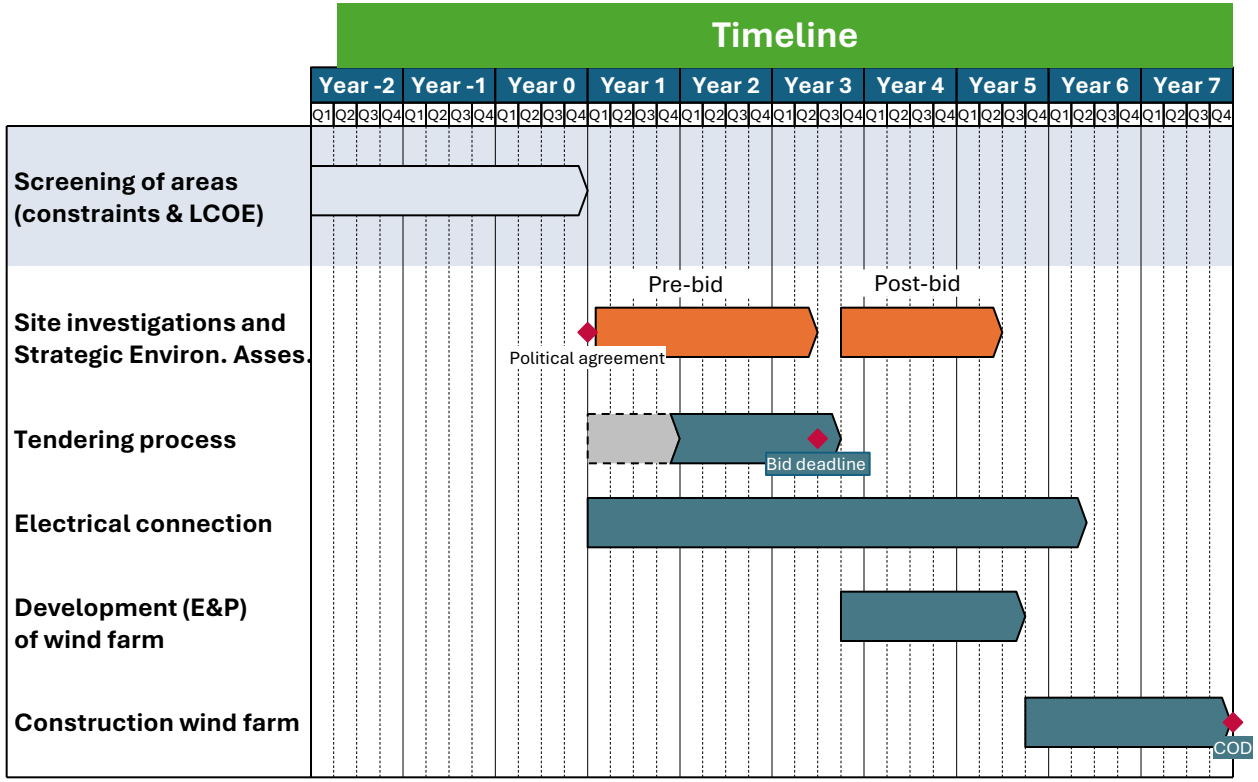
Danish Energy Agency

Site investigations (SI) as a key part of the overall offshore wind project lifecycle

Early site investigations intend to de-risk offshore wind projects and enable timely execution.

- DEA pre-identifies offshore wind sites and conducts site investigations before the final bid deadline.
- Site investigations are data on wind resources, seabed conditions, and the marine environment to inform project design and de-risk development.
- Front-loading site studies, reduces uncertainty and cost, leading to competitive bids and faster project execution.

Typical 7-Year Development Timeline: from Political Agreement to OWF Commercial Operation Date (COD)

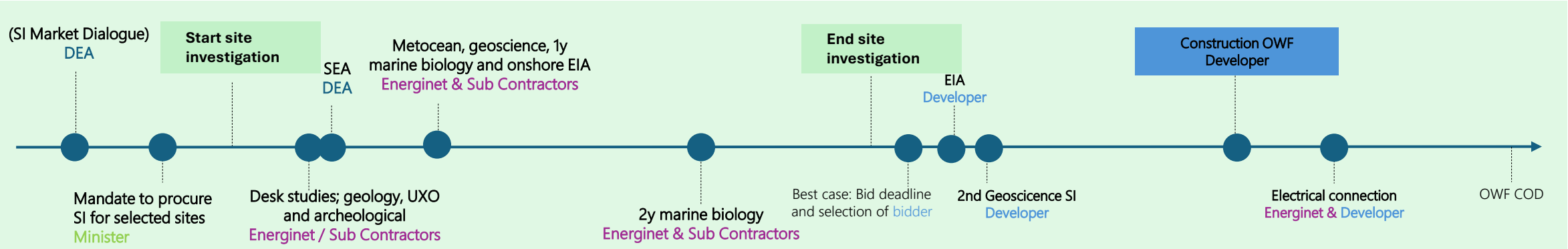


Roles and responsibilities for site investigations in Denmark

Clear public roles and defined responsibilities enable effective coordination for offshore wind site investigations (SI).

High-level timeline, main activities and responsibility for SI (pre-bid)

***Activity**
Responsibility



Climate, Energy and Utility Minister

Danish Ministry of Climate, Energy and Utilities

Political and financial insurance of pre-bid SI

Issues the legal and financial mandate for offshore wind site investigations based on the political agreement.

Mandates Energinet to procure SI for sites that DEA recommended

Danish Energy Agency (DEA)

Coordinate tender, market dialogue and pre-survey design

In charge of conducting market dialogue with tender participants prior to tendering (and SI). Ensures market alignment of execution process.

Defines task and timeline for site investigations and tender.

Energinet (TSO)

ENERGINET

System planner and management of site investigations

Procures and manages site investigations prior to tendering. Responsible for collecting and maintaining data platform, where results of completed site investigations are stored. Plans Point of Connection for off-take.

Carries out and publishes the ministers/DEAs SI

Developers (private corp.)

VATTENFALL
Ørsted
RWE
TotalEnergies

Owner, developer and operator of wind farm and export system

Carry out:
- Specific geoscience campaigns,
- EIA for OWF,
- Designing layout and EPC,
- Off-take agreements.

Own and operate the offshore wind farm

Roles

Pre-bid site investigations

Geophysical and geotechnical investigations

01.

MetOcean data

02.

Marine Environmental surveys, spatial planning, SEA, onshore EIA

03.

Survey of the seabed surface, sea-level and subsoil (sampling)

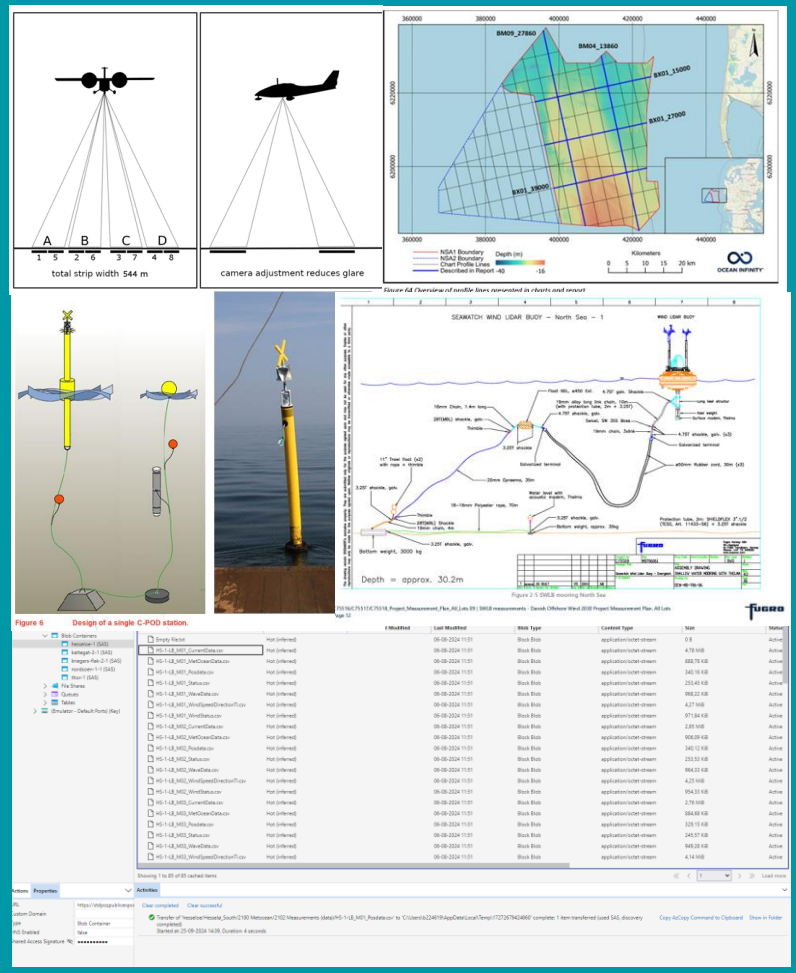
- Boreholes, CPT-campaigns, 2D UHRS surveys and 3D geomodels
- Side scan sonar, sub-bottom profiler, magnetometer

MetOcean by fLiDAR (1 year)

- Wind, wave, currents, visibility, rainfall, humidity, salinity, water temperature, air pressure, (ice)
- Third-party certified for FEED.

Maritime environmental surveys (2 years coverage) for *EIA usage* – BAT and compatibility with National programmes

- Marine mammals, birds, bats, benthic flora and fauna and "*fish and fishery*"
  - Flight surveillance, PAM, Soundtraps, National monitoring programs, grabs
- Radar-analysis for civil and military radars
- Desktop studies of UXO, marine archeology, underwater noise-modelling, geology, marine traffic and safety assessments
- Onshore EIA-permit and spatial planning
- SEA

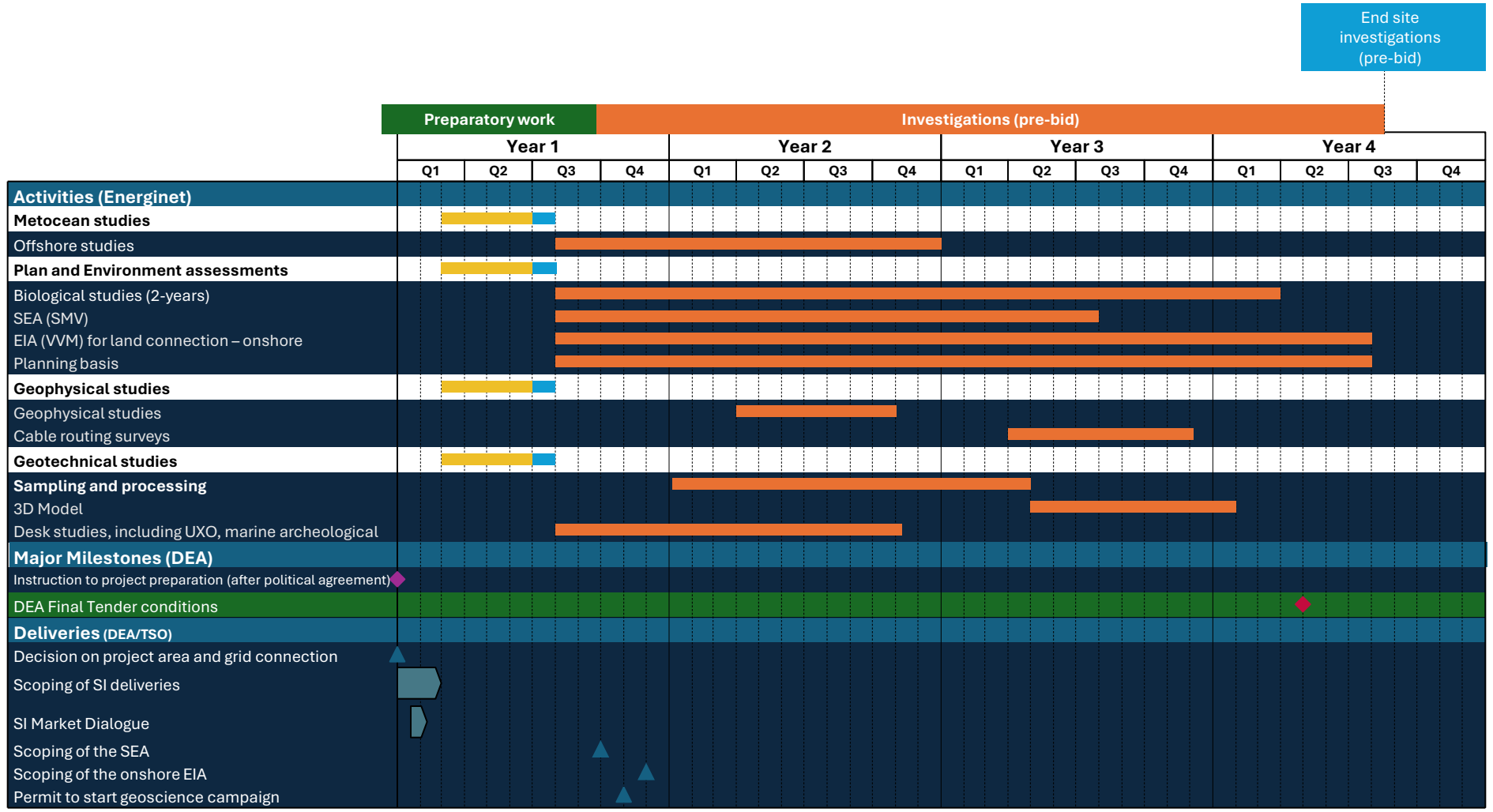


Publicly available at Azure platform. Tendered at EU Supply

Site investigations within a 3-4-year planning window

Broad example of approach for investigation activities (pre-bid)

- Close cooperation between the DEA and Energinet is the main driver for optimizing the process.
- Timely decisions are essential



Post-Award, developers are responsible for all necessary investigations for the execution of a project

Once the tender winner is decided, the responsibility of site investigations shifts to the developer.

Specific geotechnical and physical investigations

- **Layout specific samples**
- **UXO survey, boulder clearance**
- **Revised 3D model**

1b

Extended MetOcean measurements

- **Wind, wave and currents**

2b

Final Environmental Impact Assessment of Wind Farm

- **Additional biological sampling if necessary**

3b

While core activities like geotechnical surveys, geomodelling, and UXO clearance are generally mandatory for engineering design, others—such as further metocean measurements or supplementary environmental studies—may be required based on initial findings or specific insurance/financial conditions.

The duration of these investigations usually ranges from a few months up to one year, depending on site complexity, seasonal constraints, and permitting requirements.

Not all investigation types are always necessary; the specific scope is determined by regulatory bodies, project needs, and initial site knowledge. For example, if challenging soil conditions are found, further investigation would be needed.

The developer must apply for a preliminary investigation license. This license includes conditions to mitigate underwater noise, protect marine life, and ensure environmental monitoring.

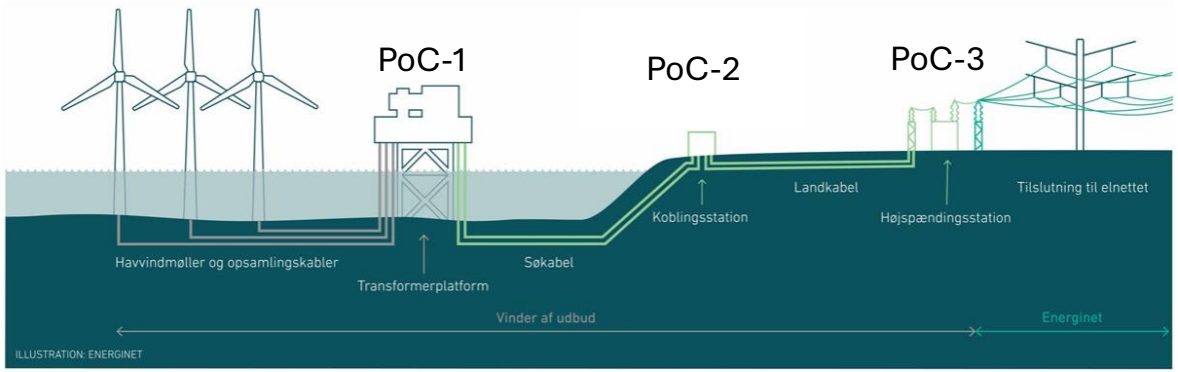
Demarcation of the project

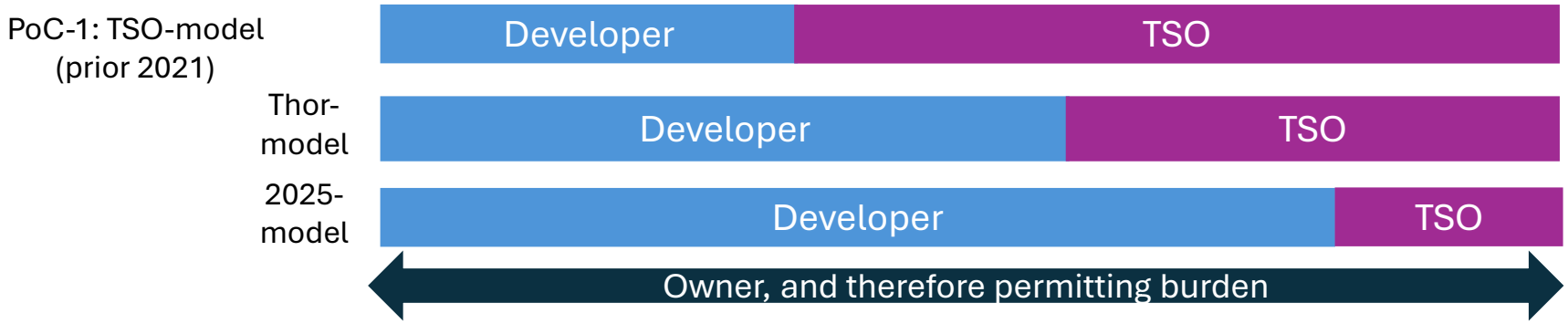
Danish experiences on clarification of ownership, construction and operation of the project(s)

TSO-Thor models; Transmission System Operator (TSO/Energinet) provides Point of Connection (PoC-1/2) by constructing, operating and owning the grid connection from the platform/nearshore (PoC) to the existing transmission grid.

2025-model; Concession winner constructs, operates and owns OWF and export system to the existing (or ext.) transmission grid (POC-3).

Offshore Wind Farm with HVAC-transmission system





Why is this relevant?
Shifts execution burden and the amount of relevant site investigations

Going onshore increases the need of permits drastically in DK (up to 5 times as many)[1]

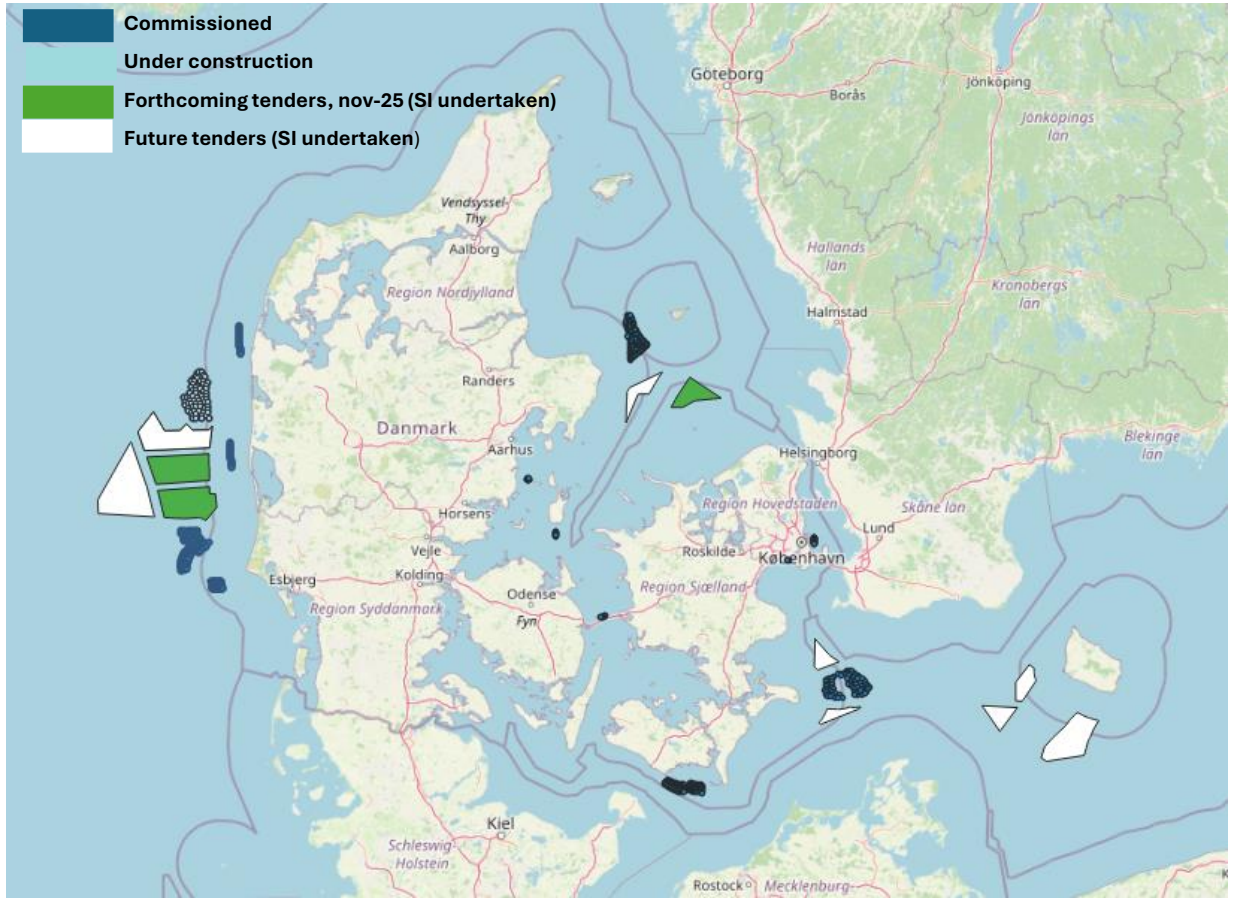
[1] https://www.kefm.dk/Media/638687206136506042/Nekst_Hurtigere%20udbygning%20af%20elnettet.pdf

Cost analysis of Danish OWF site investigations

Danish Energy Agency

Sites with varying characteristics have implications to SI costs

- North Sea 1
  - Large area
  - Shallow waters
  - Relatively rough sea conditions, high wind speeds, strong waves and currents
- Hesselø and Kattegat:
  - Calmer sea conditions, lower average wind speeds compared to the North Sea.
- Kriegers Flak II
  - Moderate water depths, relatively moderate sea states, seasonal sea ice risk.



Overview of the costs for site investigations in Denmark

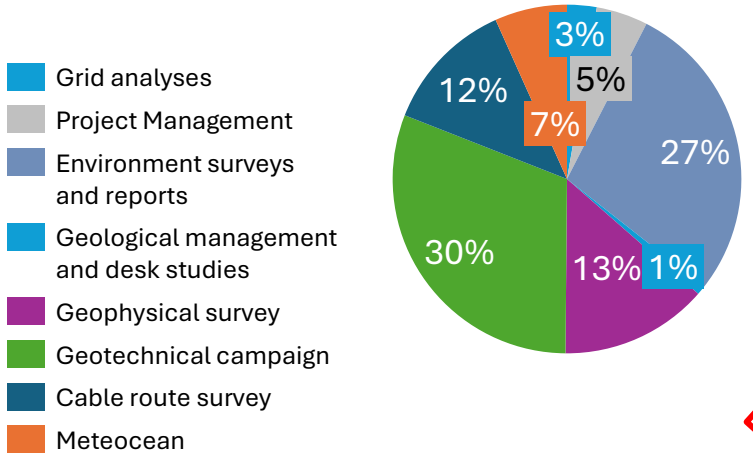
Recent SI for upcoming tender (nov-25)

Site investigation element	Mill. DKK	Mill. USD
Project Management	5-7	0.8-1.1
Environmental surveys and reports	38-68	5.9-10.0
Geological management and desk studies	1-2	0.2-0.4
Geophysical survey	20-70	3.1-10.9
Geotechnical campaign	45-170	7.0-26.4
Cable Route survey	20-30	3.1 – 4.6
Metocean	5-18	0.8-2.8
Total	150 – 295	23.3-45.7
Grid analyses	4-5	0.6-0.8

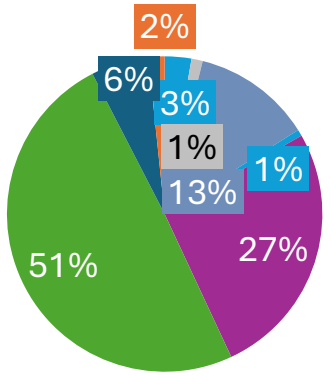
Kattegat, Hesselø, Kriegers Flak II and Northsea 1 Mid site investigations , 2023 – 2025
Trend: large increase in number of projects in Europe => ”sellers market”

Mean cost distribution

Kattegat - 122 km²
Per km²: 1.2 mill. DKK



North Sea 1 Mid - 396 km²
Per km²: **0.71 mill. DKK**

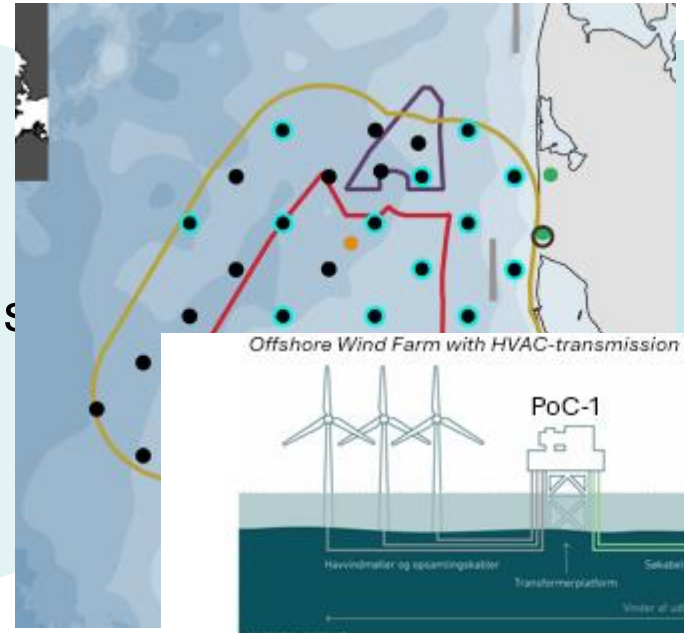


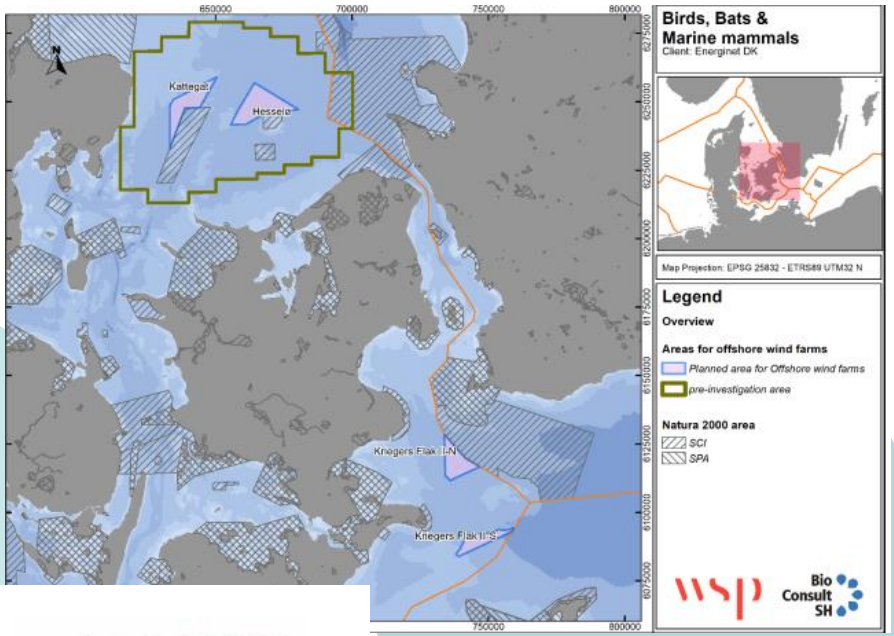
Economies of scale

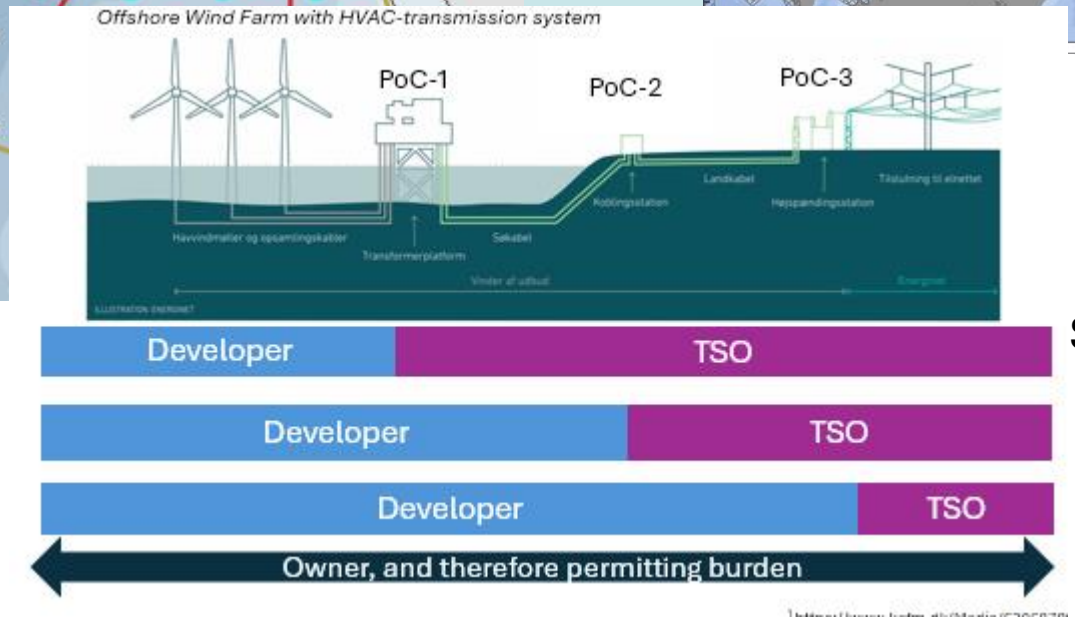
Considerations

Size of area

Project(s







What risk does the developer carry?

At what time?

Standardized deliveries vs. best-available-technology with focus on output

Considerations

Project(s)

What burden has the developer?

At what time?

Size of area

Scale matters

Try to combine multiple areas and ensure efficient tendering of area

Data

Standardized deliveries vs. best-available-technology with focus on output

Thank you

Questions?

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