

R&D needs for energy islands

Opening statement

Dirk Van Hertem

Professor at KU Leuven

Director at Etch EnergyVille

Chair at SET Plan IWG DC technologies

EUREC presentation 20-2-2025



The energy transition: No small feat

- Commitment net-zero by 2050
- Shift to renewables
- Shift to electrification
- New sources, at new locations
 - Far from the load (offshore)
 - At the “narrow” end of the grid: decentralized sources
- Electricity demand X 2
- Grids X 3?
- The (AC) grid is not designed to deliver this transition



FINANCIAL TIMES

IS COMPANIES TECH MARKETS CLIMATE OPINION WORK & CAREERS LIFE & ARTS HTSI

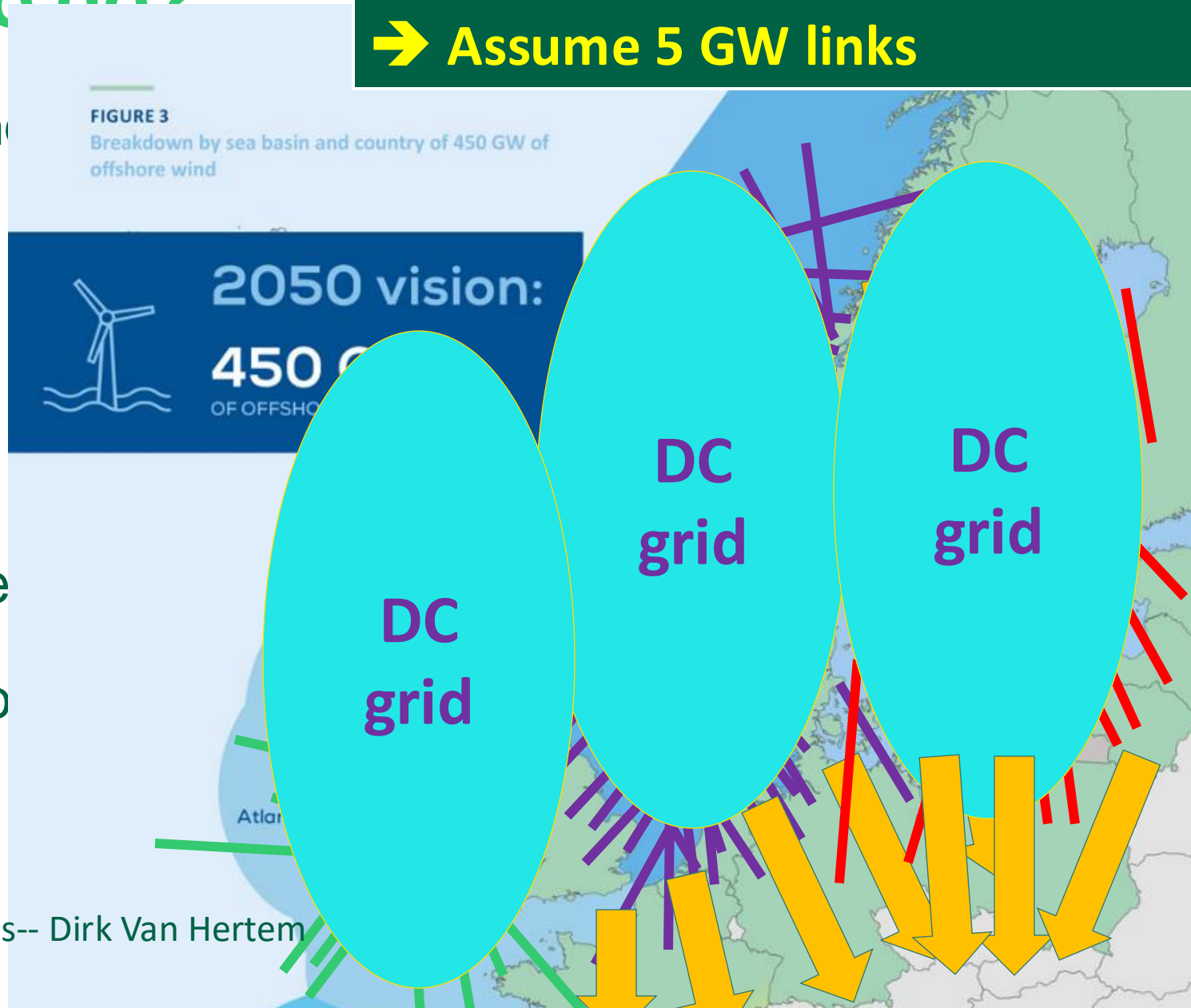
From the Draghi report:

1. ... Grid capacity could impede the spread of digital tech and transportation electrification
2. Infrastructure investment is slow and suboptimal, both for renewables and grids
3. Lengthy and uncertain permitting... for grids is a major obstacle
4. A central element in accelerating decarbonization will be unlocking the potential of clean energy through a collective focus on grids

**We need to connect 200 GW
from the north sea
→ Assume 5 GW links**

Where do we need to go?

- 300-> 450 GW of offshore wind by 2050
- Offshore requires massive investments (new grid)
- Solar and onshore wind give similar needs
- High power + cable + meshes DC grid
- AC system needs reinforcement
- Meshing means nodes/substations, also offshore
- Not a north sea issue alone



Energy islands/Hubs



- Interconnecting different synchronous zones + RES → HVDC (source: Danish Energy Agency)
- Popular name for offshore substation (but multi-GW)
- But has many challenges in design, operation, protection and control...
 - Energy balance (in different time frames) (multiple markets)
 - Stiff system with badly damped harmonics and transients (multi-vendor interoperability)
 - Topology and protection
 - Hybrid design (AC or DC, wind, PV, storage, P2X,...) (multi-stakeholder, multi-technology)
 - Common mode failures
 - Operation and maintenance
 - Ownership, market integration and operational control? Likely independently managed (multiple countries)
- Might not be only electrical energy
- We need onshore multi-GW energy hubs as well...

Energy islands/Hubs



(source: Danish Energy Agency)

- Interconnecting different synchronous zones + RES → HVDC
- Popular name for offshore substation (but **multi-GW**)
- But has many challenges in design, operation, protection and control...
 - Energy balance (in different time frames) (**multiple markets**)
 - Stiff system with badly damped harmonics and transients (**multi-vendor interoperability**)
 - Topology and protection
 - Hybrid design (AC or DC, wind, PV, storage, P2X,...) (**multi-stakeholder, multi-technology**)
 - Operation and maintenance
 - Ownership, market integration and operational control? Likely independently managed (**multiple countries**)
- Might not be only electrical energy
- We need onshore multi-GW energy hubs as well...

At an unprecedented scale

- Existing grid x2 or x3 in 25 years!
- Massive investment
 - ENTSO-E ONDP: **400 BEUR** for offshore until 2050 (>85 % DC)
 - ENTSO-E: **€6 billion per year up to 2040 for cross-border will lower consumer bills by €9 billion per year.**
 - IEA: In Europe, **>€584 billion for fit for 55**
 - IEA: Grid investment x2 to **more than \$600bn a year by 2030**
 - Etch: Offshore in Europe: **600 BEUR HVDC**, onshore: similar
- How can we realise it (in time)
- What is the appropriate R&I investment level?

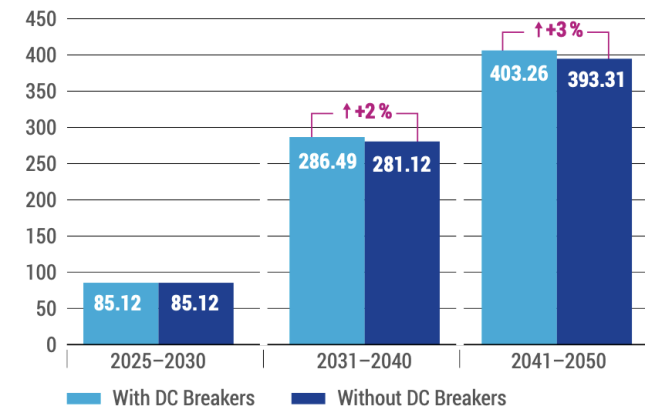
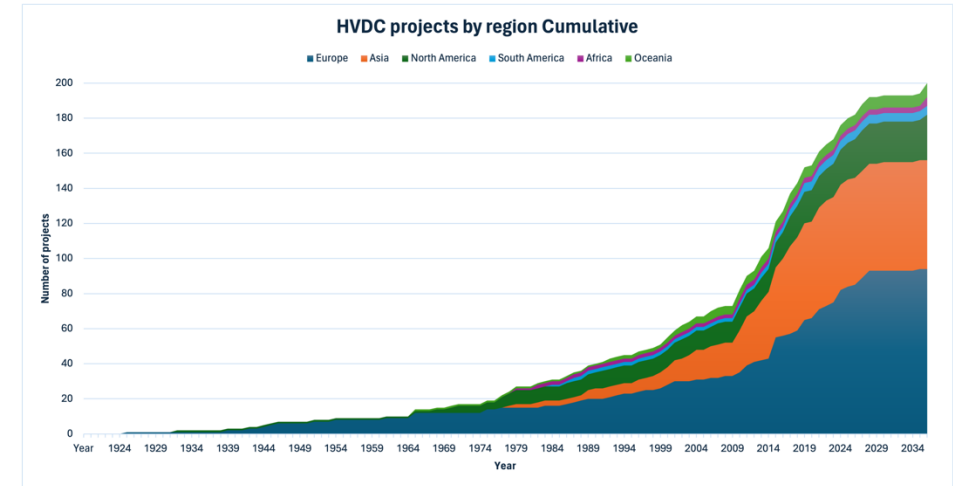
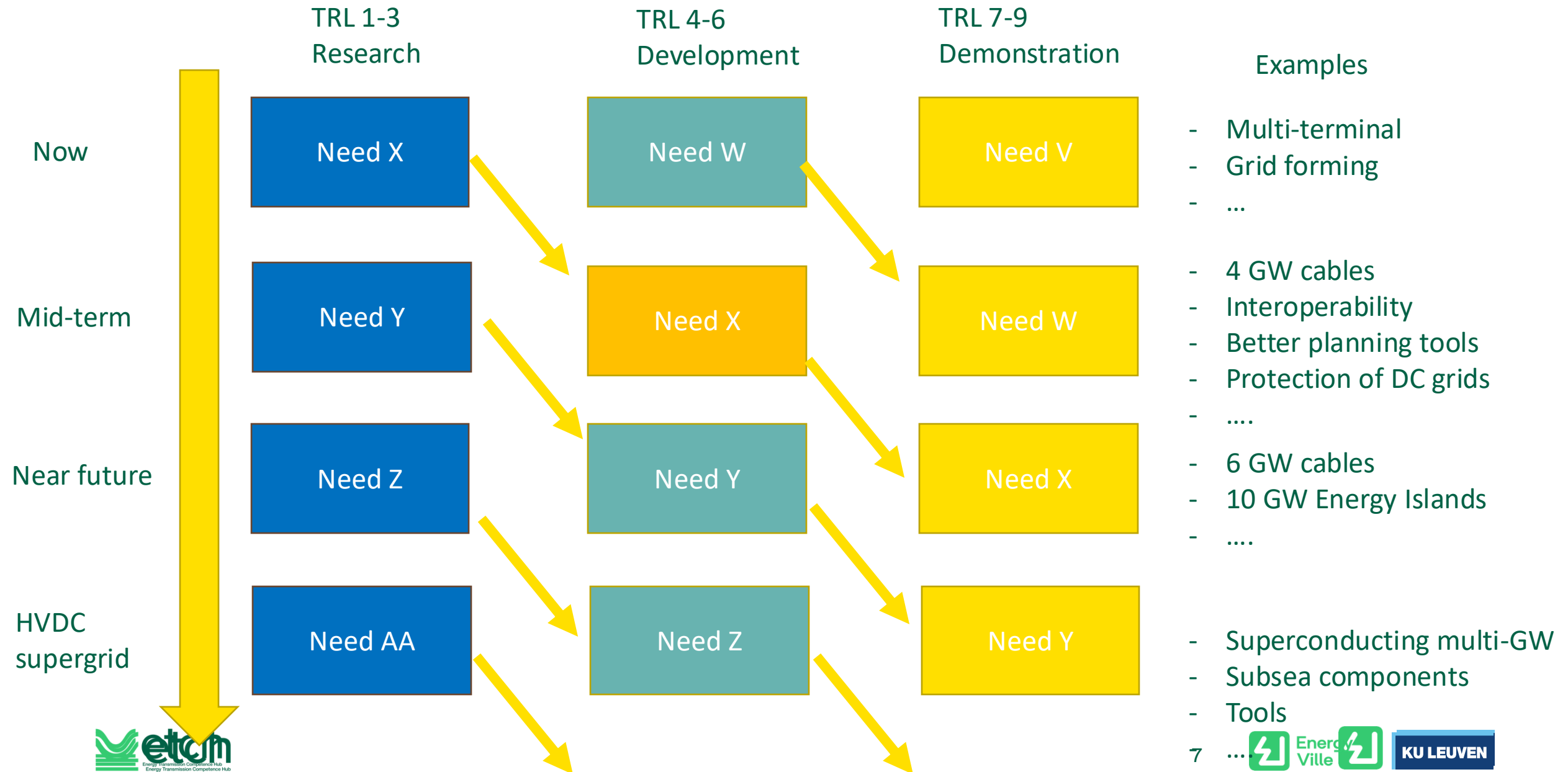


Figure 6 – Needed CAPEX [bn €] for investments in transmission network infrastructure (cumulative values) to connect the ENTSO-E countries' RES capacities considered in the ONDP. The costs do not include the radial capacities in UK.

Research & skills of the future





SET Plan Implementation Working Group
on Direct current technologies

DC FOR
EEU

Developing the next implementation plan DC technologies with the SET plan

Industrialization, scale-up and competitiveness

- Supply chain, production techniques, asset management,...

DC Technology development

- Converters, DC breakers, Cable systems, offshore substations (islands)...

DC System integration

- Planning, Operation, Interoperability,...

Sustainability and circularity

- LCA, SF6 replacement, PFAs,...

Skills, acceptability

- European skill development, centres of excellence





With the support of:



DEPARTMENT OF
ECONOMY
SCIENCE &
INNOVATION



Energy
Ville



#SETPlan



Funded by
the European Union



With the support of the Belgian energy transition funds project directions