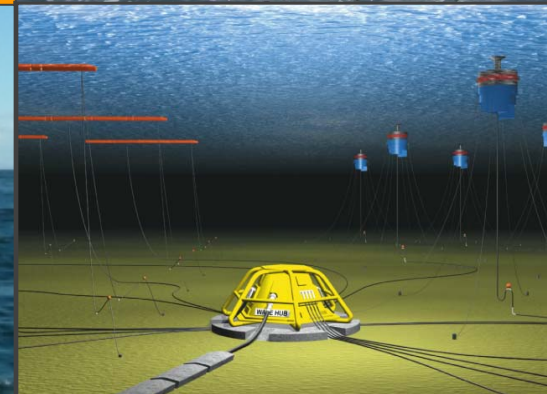


Ocean Energy Building blocks and barriers

Harvey Appelbe
Tonn Energy

Nov 2010

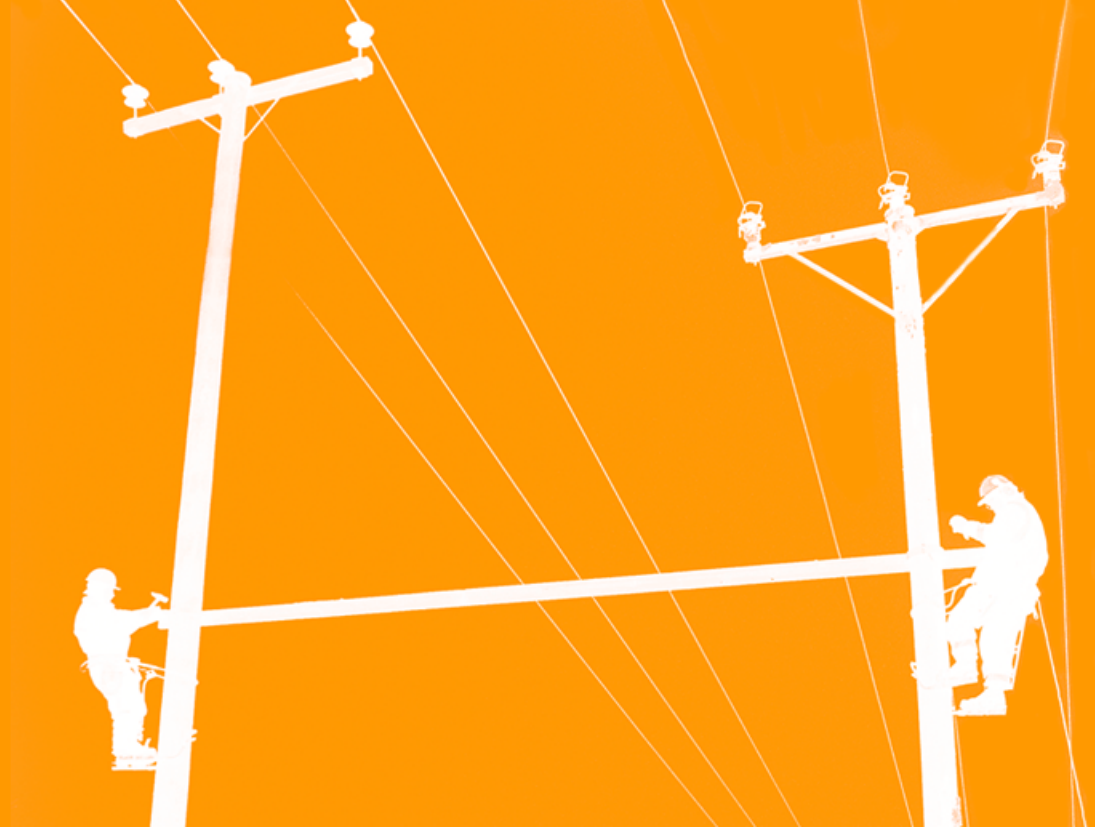
Dublin



Content

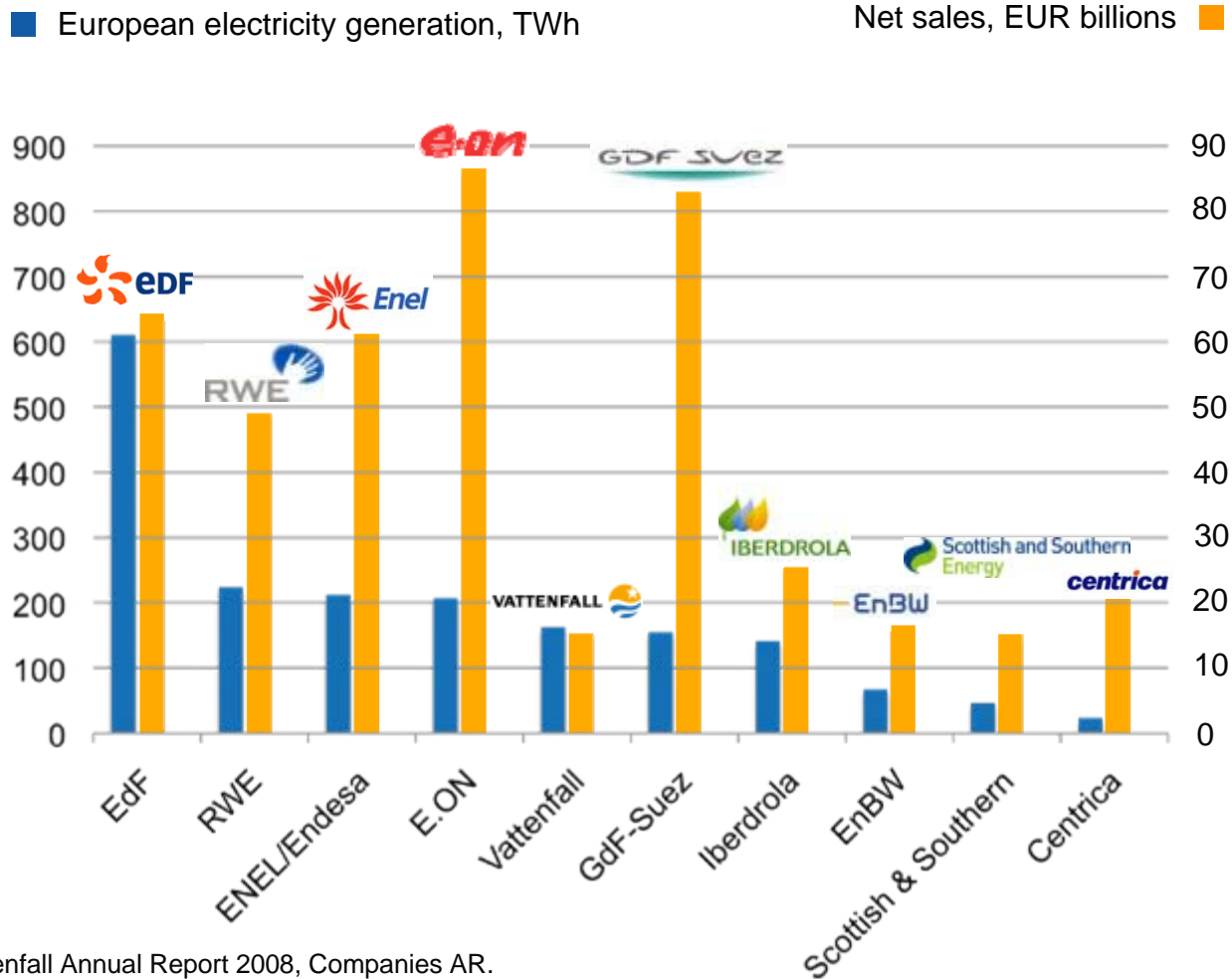
1. Who are we?
2. Why ocean energy?
3. A scenario for 2030
4. What would this mean?
5. What building blocks are required?
6. What can you do?

1. Who are Vattenfall (Tonn Energy)?



Who are Vattenfall?

Vattenfall fifth largest electricity generator



Source: Vattenfall Annual Report 2008, Companies AR.

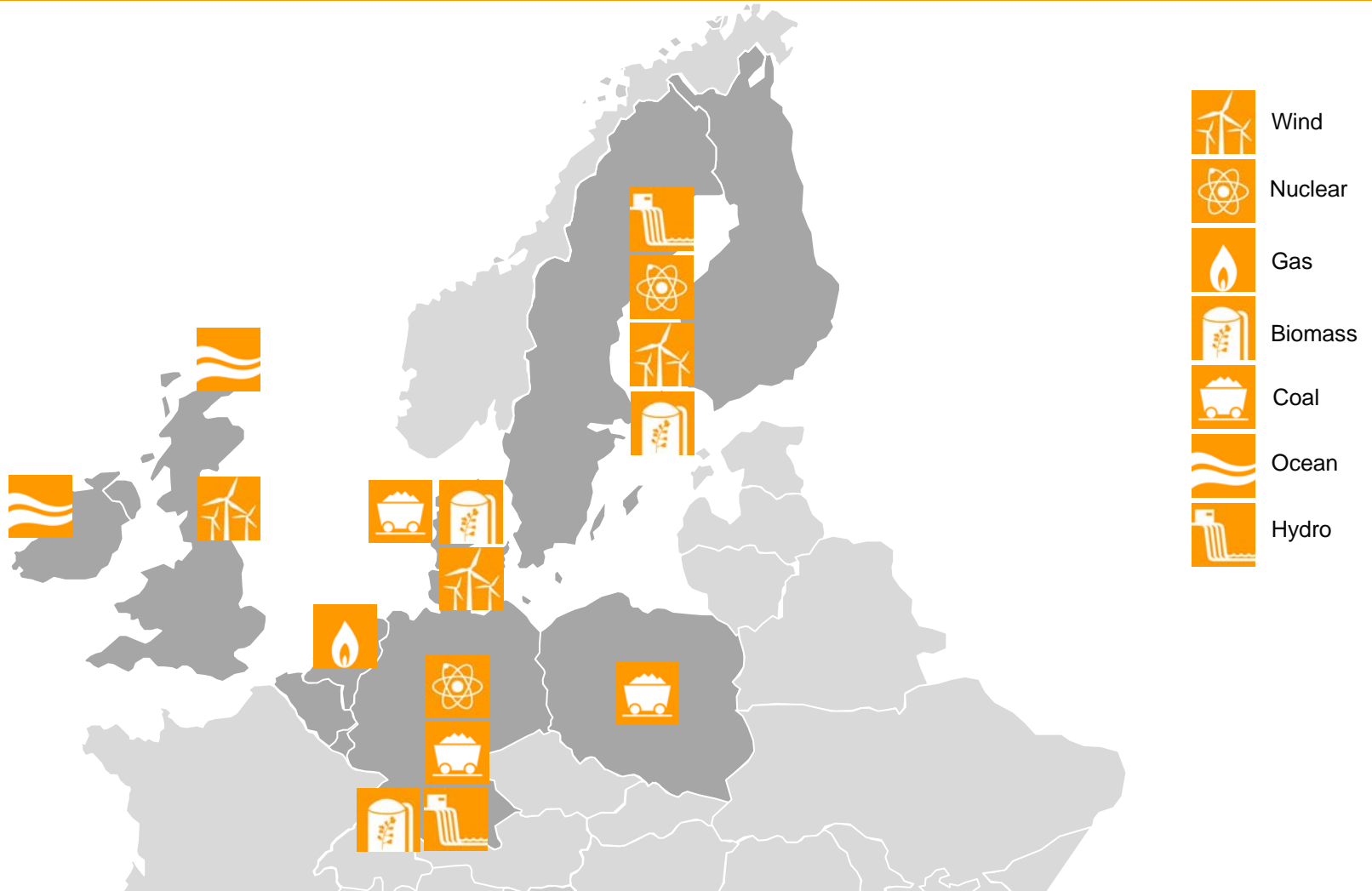
Who are Vattenfall?

At a glance...

- Europe's fifth largest generator of electricity and the largest producer of heat
- Net sales 2009: app. £ 18 b
- Vision: To be a leading European energy company
- Operations in Sweden, Finland, Denmark, Germany, Poland, Netherlands, Belgium and the UK.
- Electricity: generation, distribution and sales
- Heat: production, distribution and sales
- Gas: production and sales
- Mining and sales of lignite
- Energy trading in electricity, gas and coal
- Consulting and contracting operations in the energy sector
- 40,000 employees
- Vattenfall AB is wholly owned by the Swedish state

Who are Vattenfall?

Our main energy sources



Mini-utility in Ireland



- Started with Wavebob in 2008
- Collaboration with Irish Govmnt, 2009
- Collaboration with Irish utility, ESB, 2010
- Collaboration with Pelamis, APL, OE, 2010
- Shareholder with Irish utility, Bord Gáis, 2010

Utility Partners:



Technology:



2. Why Ocean Energy?



Why Ocean Energy?

Less environmental impact – greater competitiveness

Our business strategy

Investing in low-emitting energy production for improved competitiveness and long-term profitable growth

Our commitment

Operations climate-neutral by 2050

Initiatives in two main areas:

Low-emitting energy production:

Renewables

Nuclear Power

Coal with CCS

New applications for electricity:

Energy Efficiency Services

Sustainable Cities

E-mobility

Why Ocean Energy?

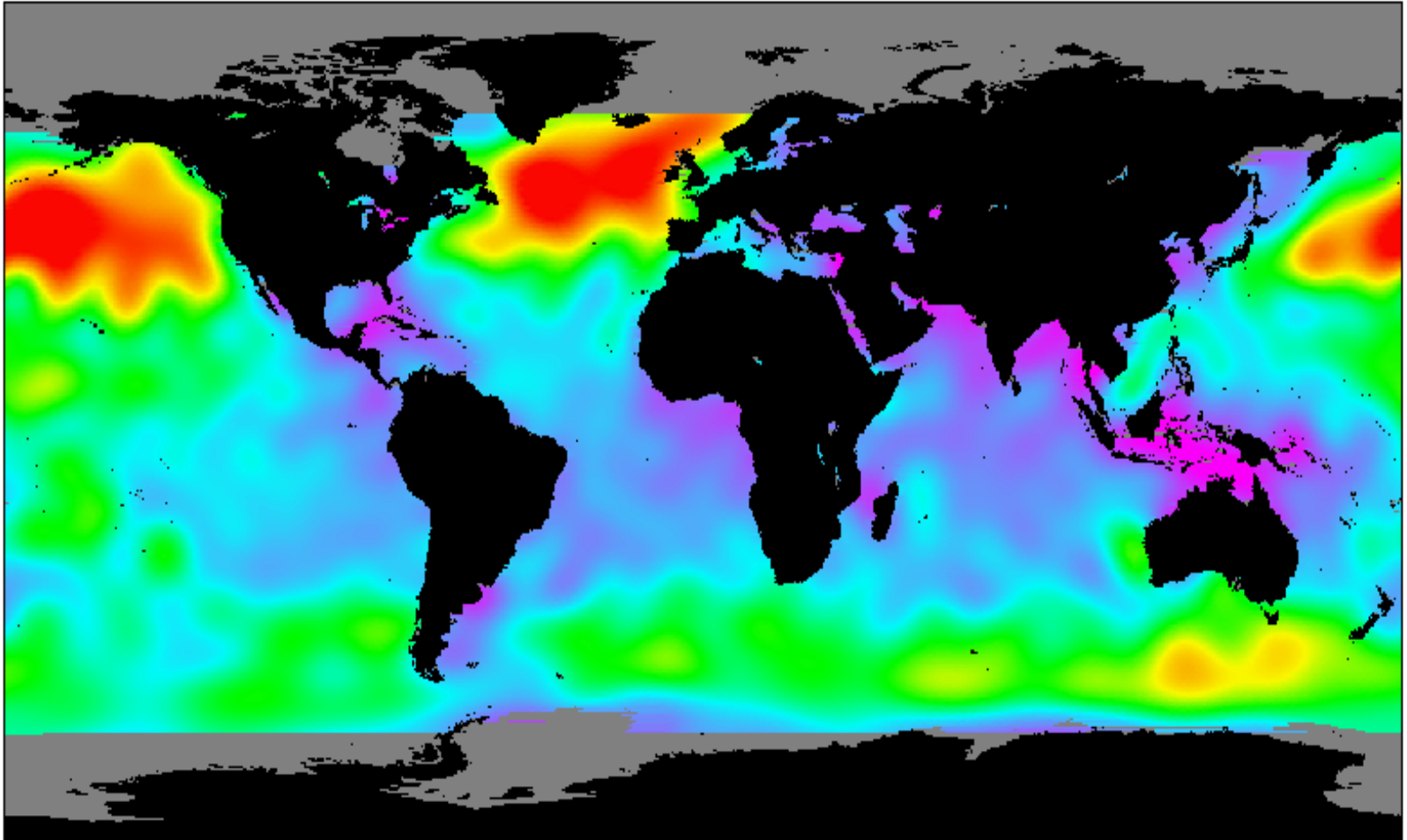
Tough climate demands within the EU for 2020

Climate demands

- 20% reduction of carbon dioxide emissions
- 20% renewable energy (currently just over 8.5%)
- 20% higher efficiency in energy use

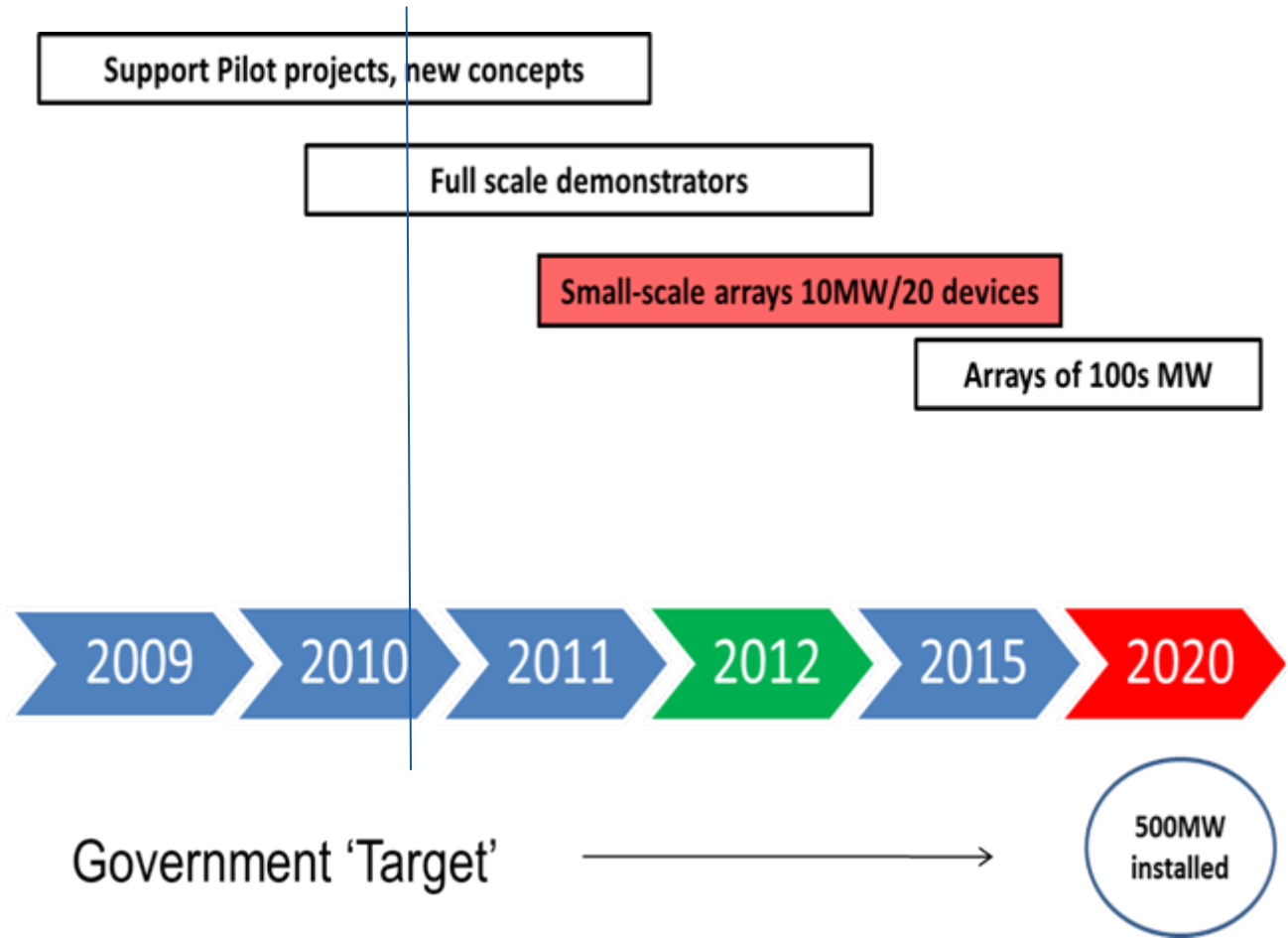
Why Ocean Energy?

Wave Energy Resource (winter)



Why Ocean Energy?

Ireland's Ocean Energy Strategy

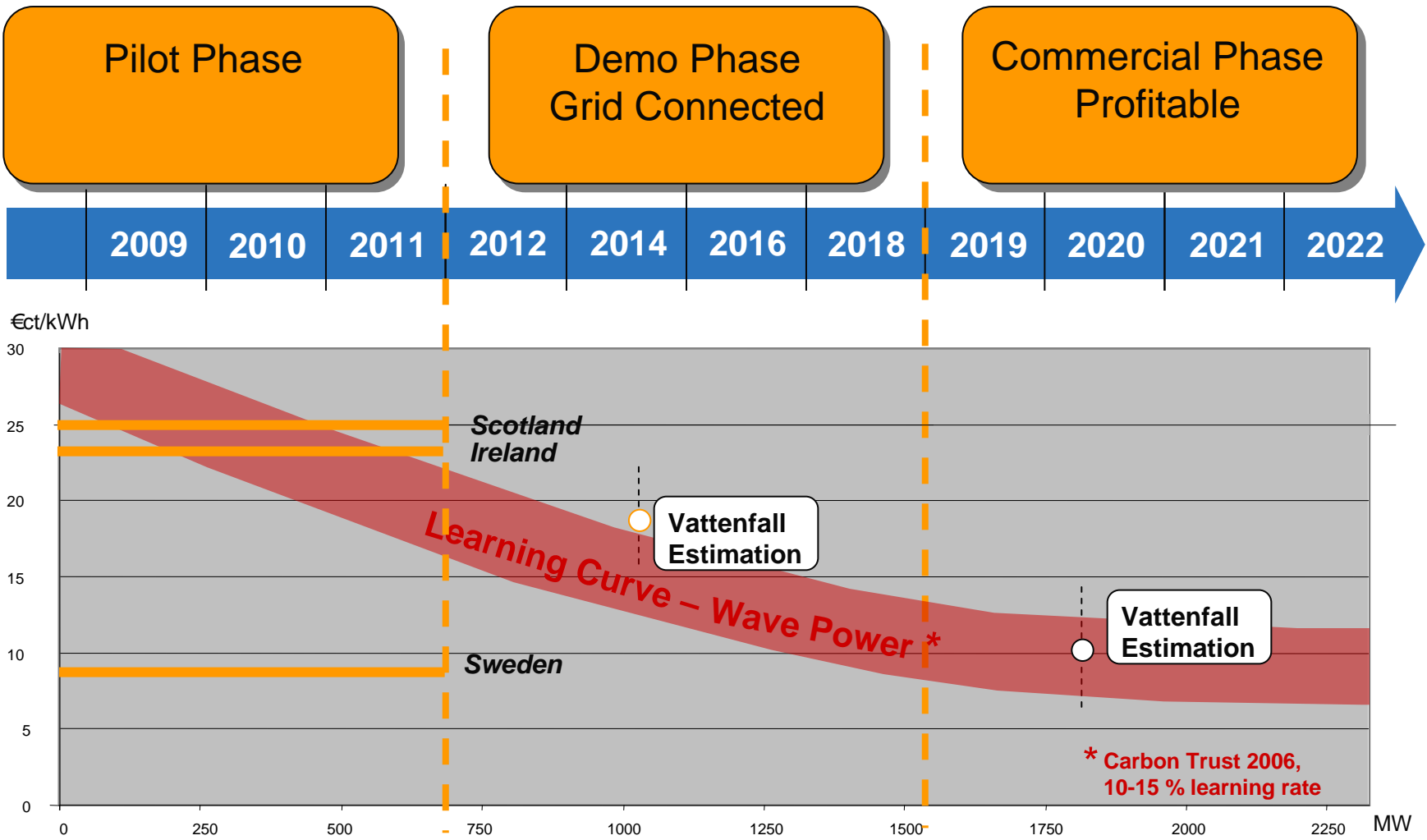


3. A scenario for 2030



A Scenario for 2030

In 2010 we are (late) pursuing a learning curve



A Scenario for 2030

In 2015 ...

In 2015...

- Is the war against climate change won?
- Does Ireland have energy security?
- Are the renewable energy targets all met?
- Is society sustainable?

A Scenario for 2030

No? Then in 2015 ...

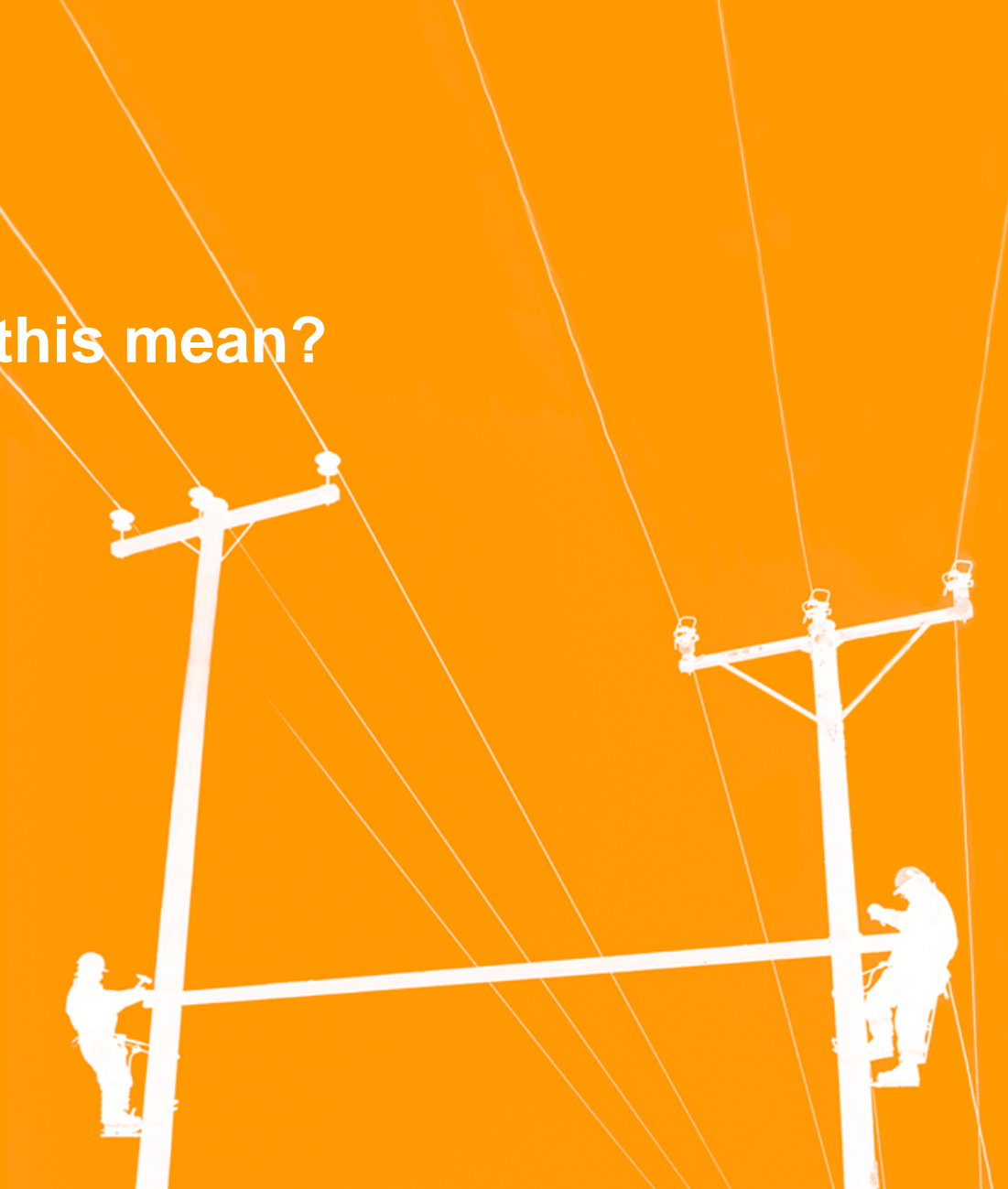
Utilities like Vattenfall, E-On & SSE will probably be developing wave farms of utility scale.

Vattenfall, on its own, have ambitions for some 30 TWh for 2030+.

This could be organised as follows...

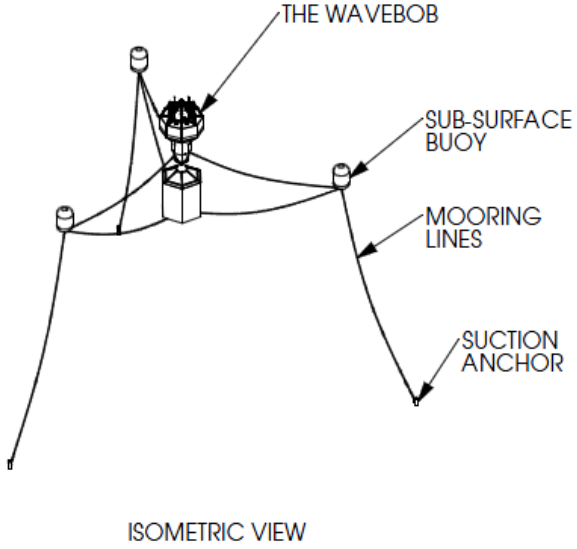
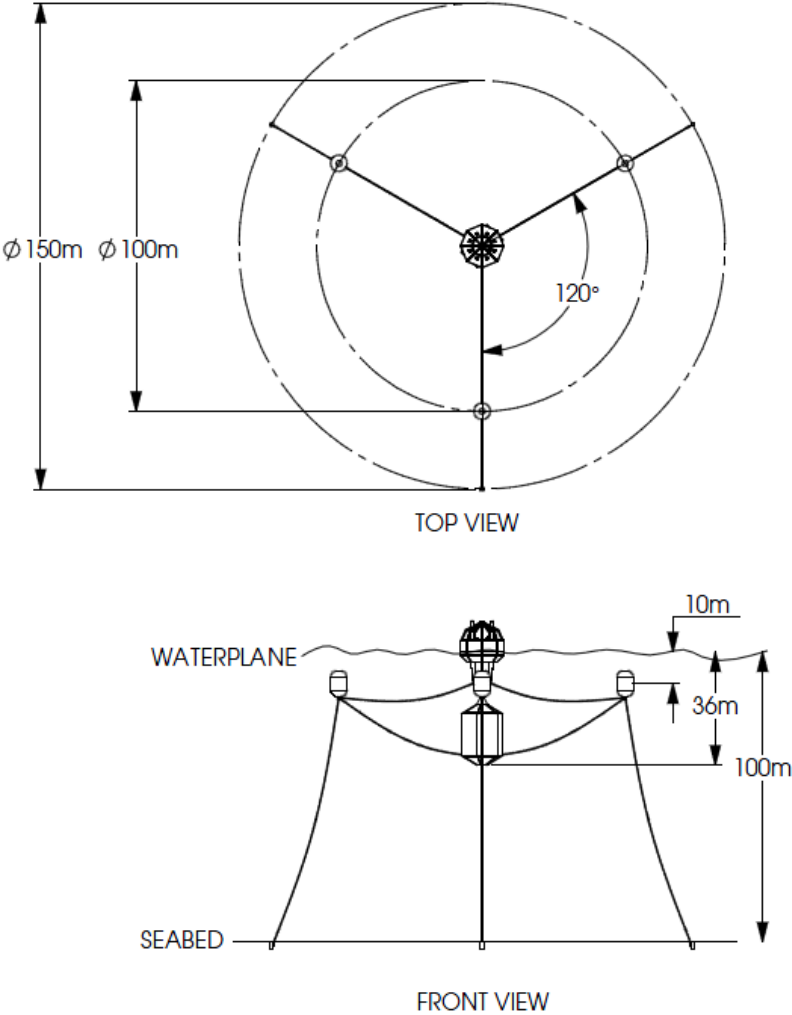
| Country | Capacity [GW] | Capacity [TWh] | Theoretical Pot [TWh] | Technical Pot [TWh] | Mean W-E Level [kW/m] |
|--------------|---------------|----------------|-----------------------|---------------------|-----------------------|
| Ireland | 2 | 6,1 | 525 | 20 | 50 |
| UK | 5 | 15,3 | 840 | 80 | 30-60 |
| Norway | 2,8 | 8,6 | 600 | 12-30 | 40 |
| Total | 9,8 | 30 | - | - | - |

4. What would this mean?



What would this mean?

1MW per Wavebob

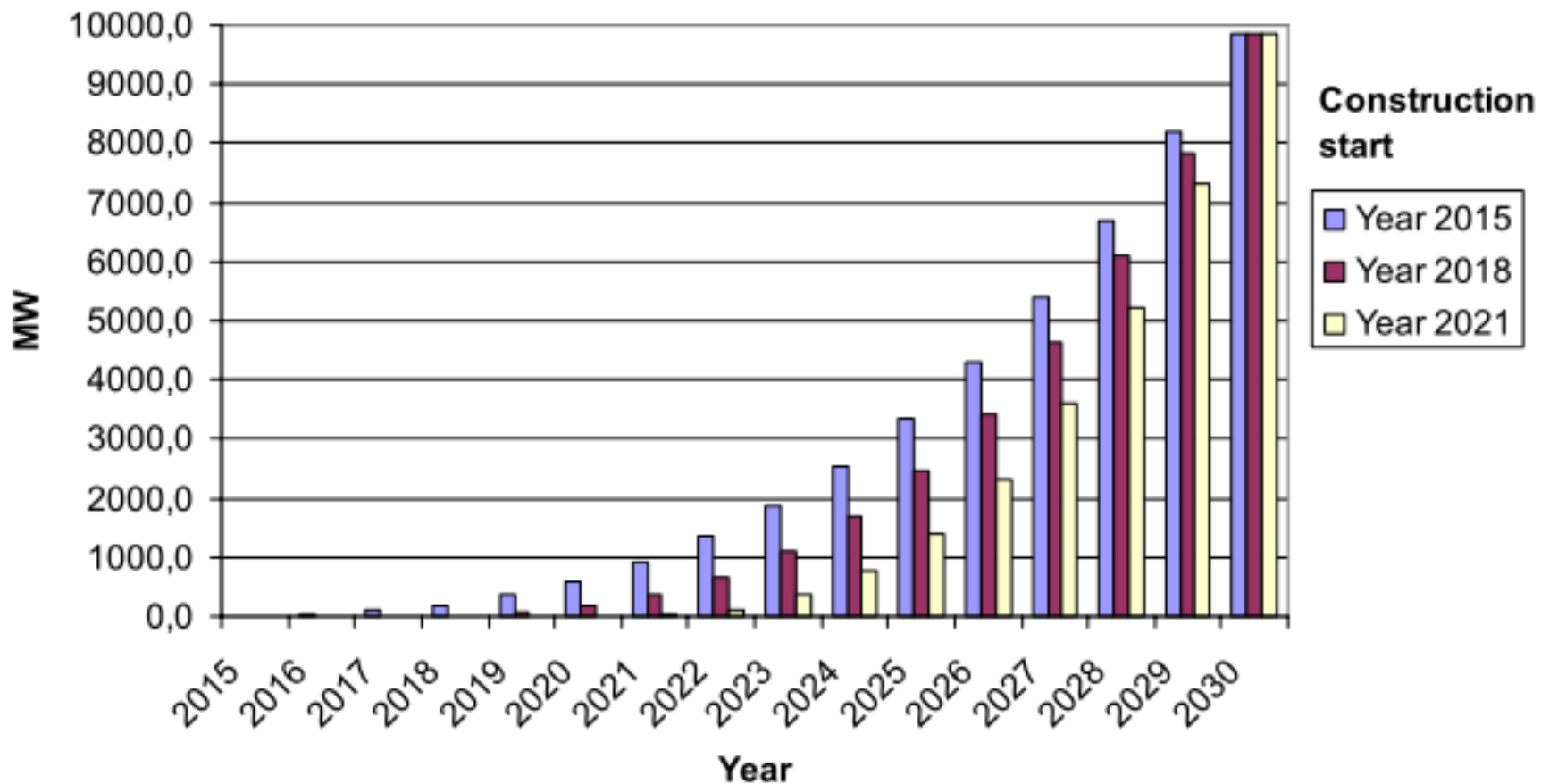


Power = c.1MW

What would this mean?

Depends on when you start: 2015, 2018, 20?

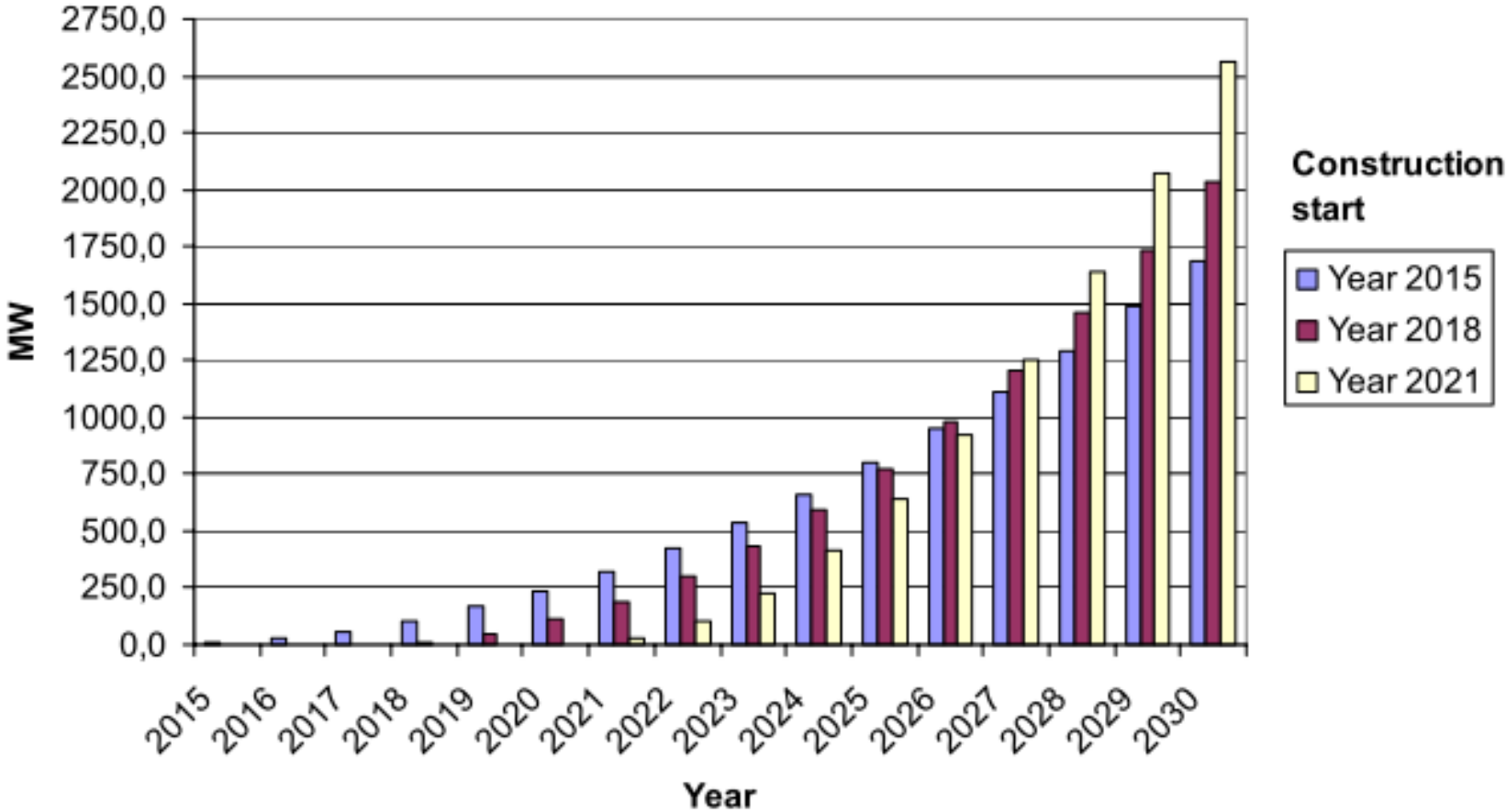
Cumulative installed capacity



What would this mean?

Logistics: 2.3GW installed per annum in 2030

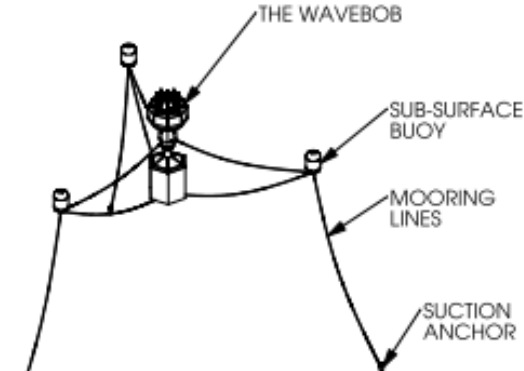
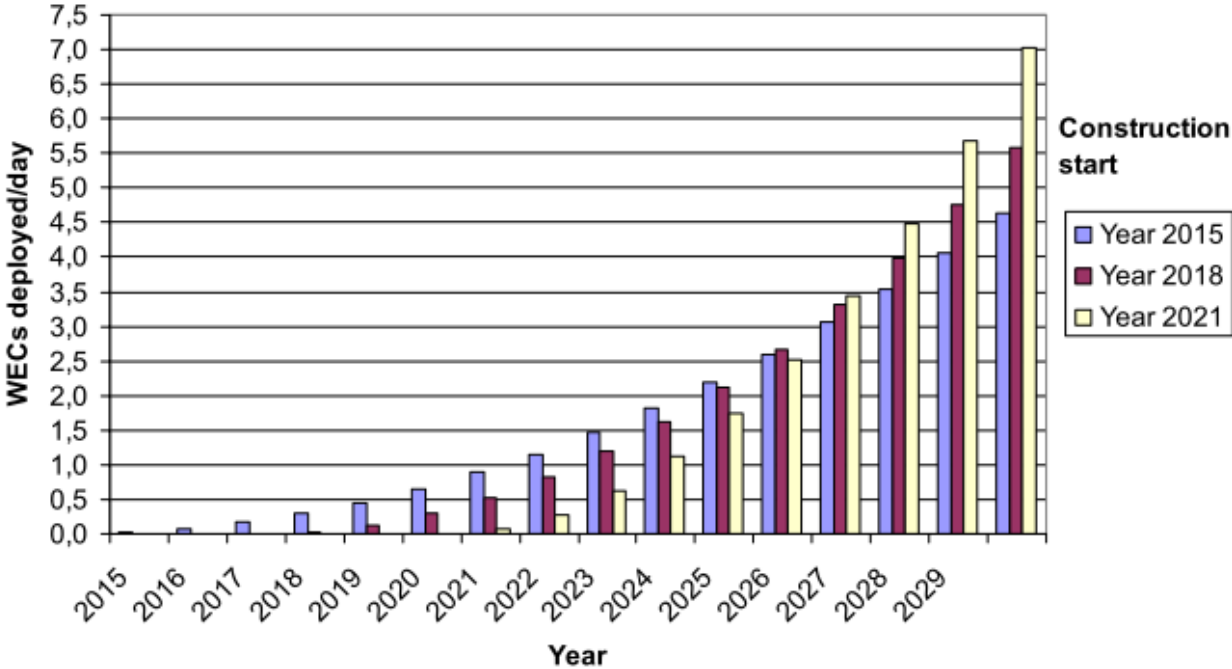
Annually installed capacity



What would this mean?

Logistics: 5 WECs per day in 2030.

Number of WECs deployed per day

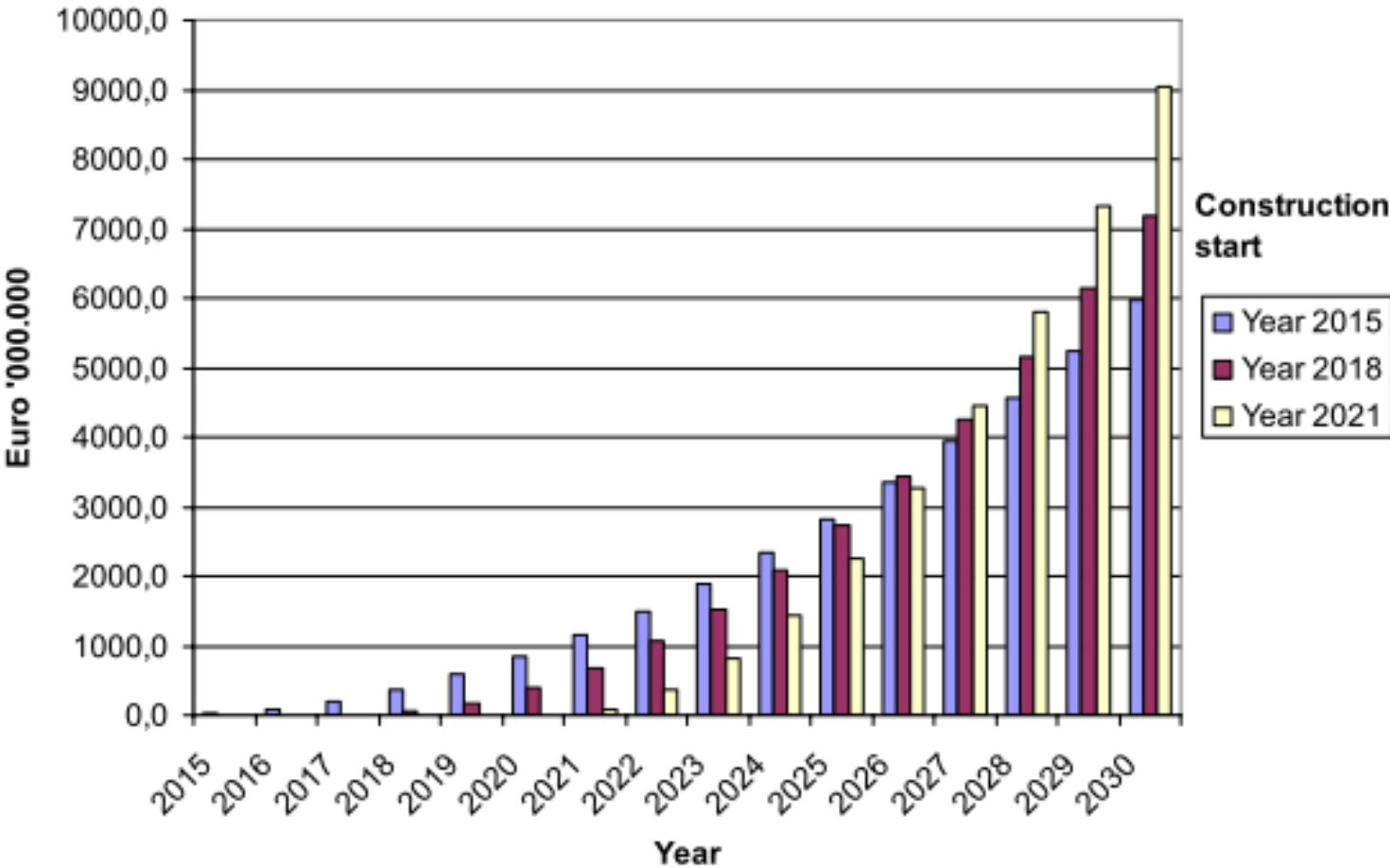


x 5 every day

What would this mean?

CAPEX: €7B per annum, in 2030

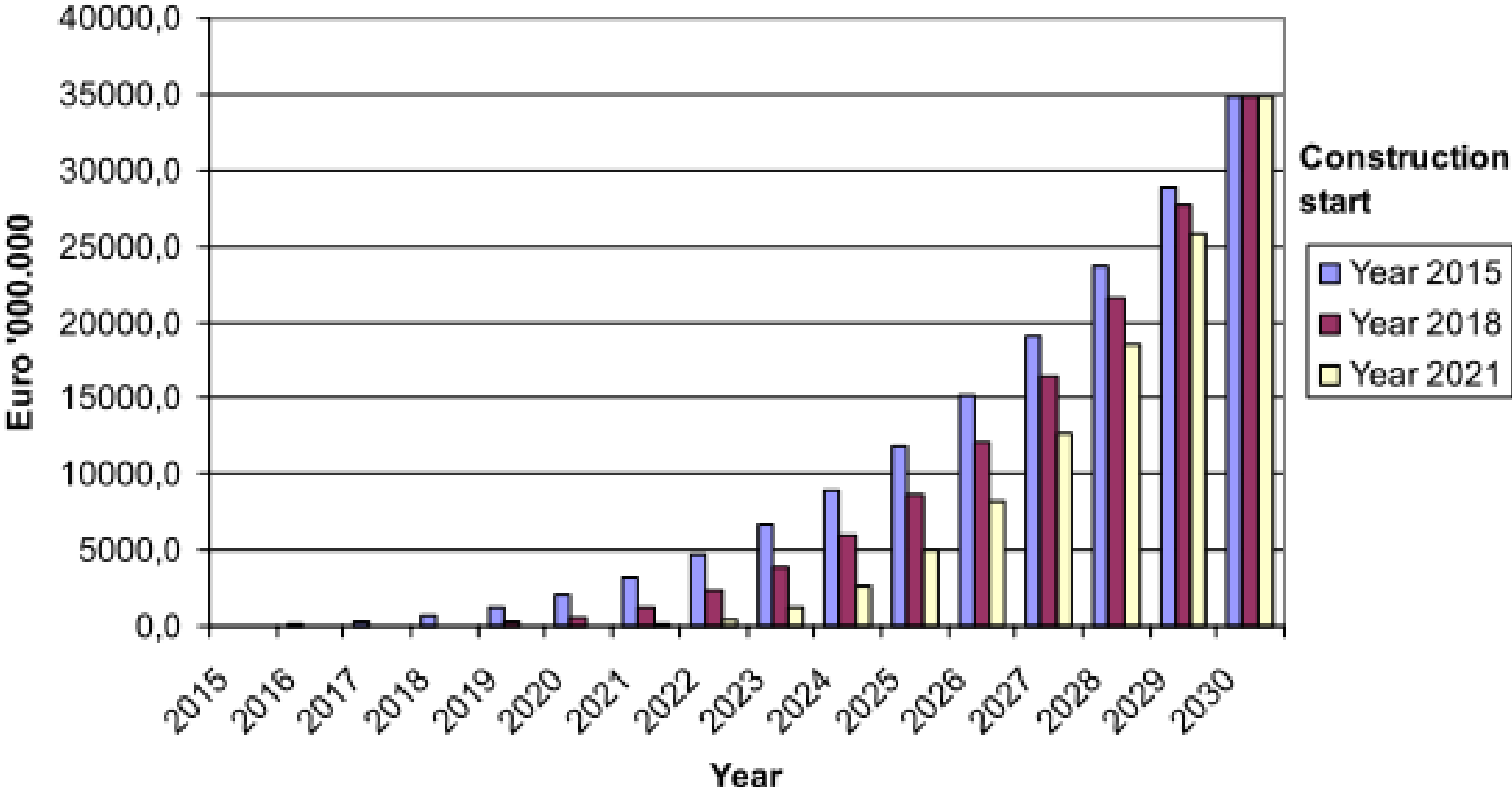
Annual Investments



What would this mean?

CAPEX: c.€30B by 2030

Total Investments



What would this mean?

Space: c.500km by 2030

| Region | Array length (40 %) [km] | Array length (100 %) [km] | Wave climate | Installed [GW] |
|----------------|-----------------------------|------------------------------|-----------------|-------------------|
| Ireland | 100 | 40 | (50 kW/m) | 2 |
| UK - Scotland | 175 | 70 | (60 kW/m) | 3,5 |
| UK - Southwest | 75 | 30 | (30 kW/m) | 1,5 |
| Norway | 140 | 56 | (40 kW/m) | 2,8 |
| Total | 490 | 196 | | 9,8 |

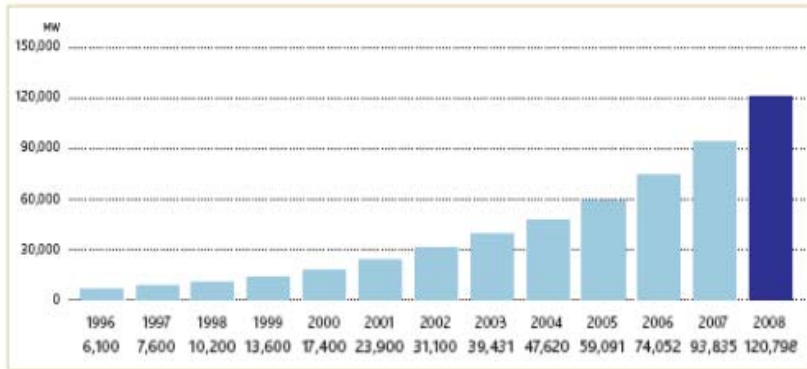


What would this mean?

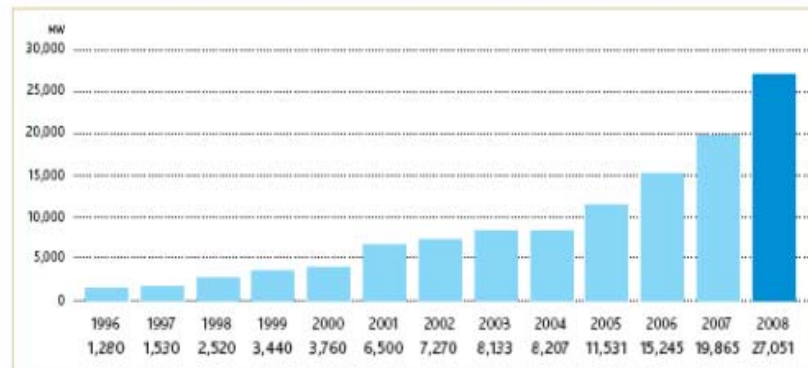
Similar to the wind industry growth

Global wind installation

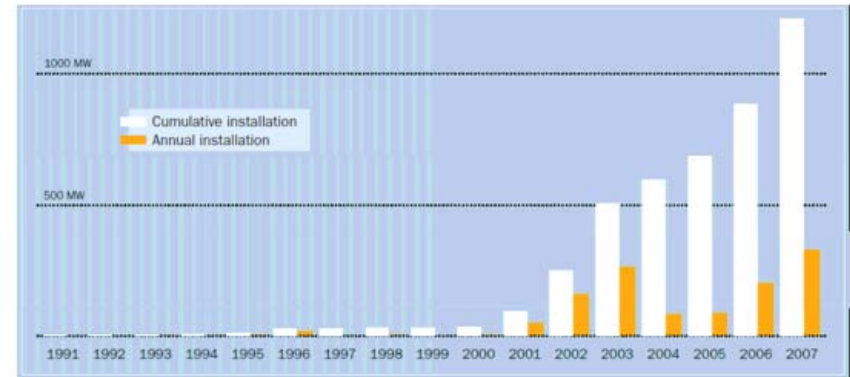
GLOBAL CUMULATIVE INSTALLED CAPACITY 1996-2008



GLOBAL ANNUAL INSTALLED CAPACITY 1996-2008



Global offshore wind



...but the wind industry is global, not just Ireland, UK and Norway.

5. To put this in context



To put this in context

If in 2026 we want to build 1000MW of OE

Vattenfall built the Lillgrund offshore wind farm in 2008.

- Sweden's largest farm.
- 48 turbines
- 110MW



To put this in context

If in 2026 we want to build 1000MW of OE

This is equivalent to 9 x Lillgrund in 2026, >€3B FDI

110MW



6. Building Blocks



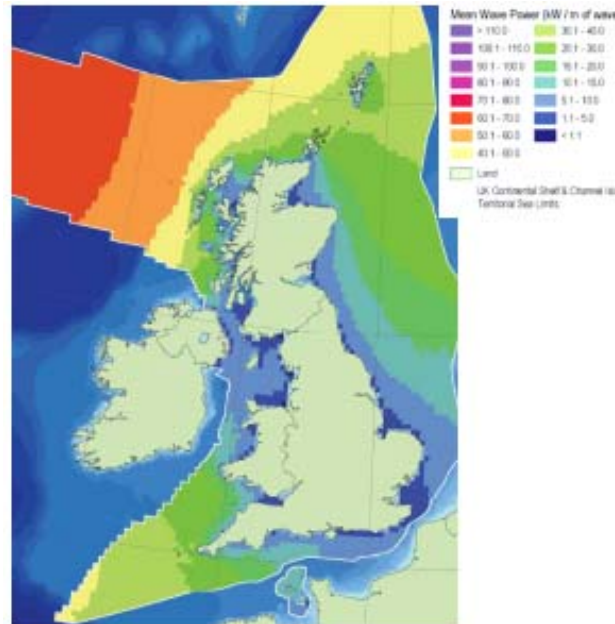
Building Blocks

Energy Resource

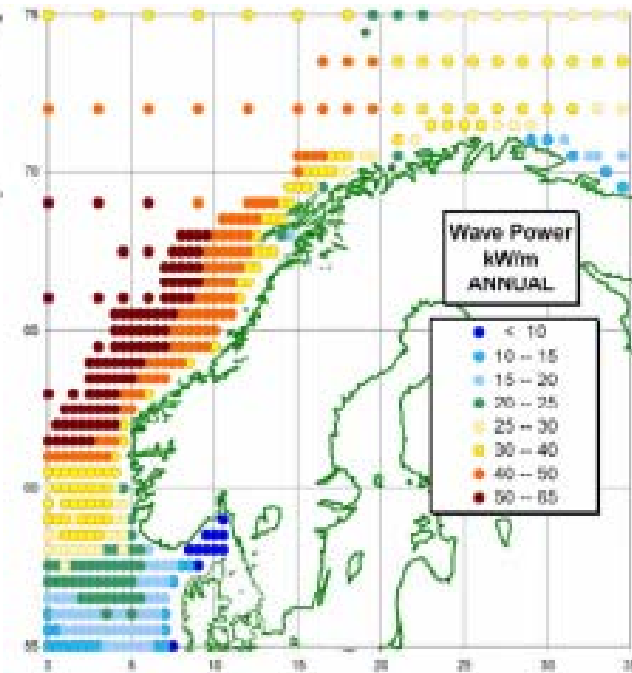
Ireland = Great



UK = Great



Norway = OK



Consent Regime

Ocean Renewable Energy Development Plan (OREDPlan)

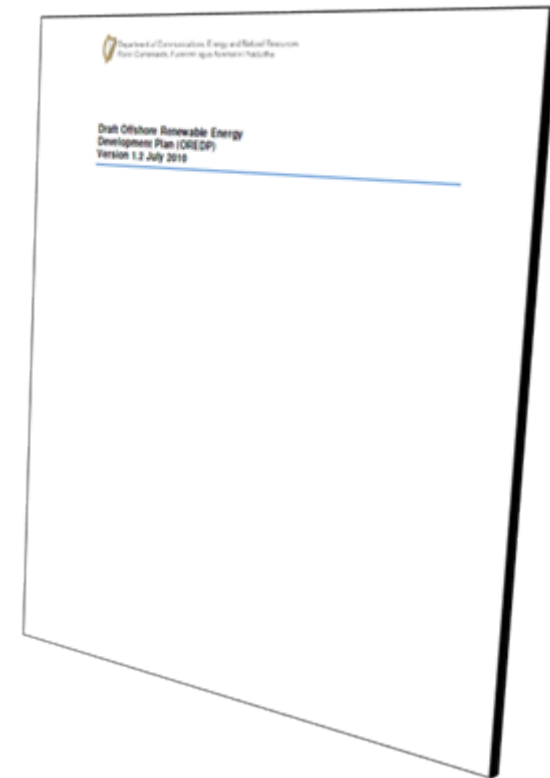
Strategic Environmental Assessment (SEA)

Draft actions...

- A forum to drive the agenda for OE.
- Address the data gaps.
- Allow scaling up over time (deploy & monitor).
- Prepare 'locational guidance' for zones of development.

Foreshore Licensing/Lease (DoEHLG)

Marine Spatial Planning



Subsea Grid Interconnection

Ireland & UK = Okay



Norway = Great



Building Blocks

Economics

| Markets | Energy intensity kW/m wave | Incentives €/kWh | Attractiveness | |
|---------------|-------------------------------|---------------------|----------------|---------------|
| UK (Scotland) | 50 | 0,4 | 20 | Break Even |
| Ireland | 70 | 0,22 | 14 | |
| Norway | 40 | 0,05 – 0,1 | 4 | |
| Denmark | 15 | 0,1 | 2 | |
| Germany | 10 | 0,1 | 1 | |
| Netherland | 10 | 0,1 | 1 | |
| Sweden | 5 | 0,1 | 1 | |

7. What could Ireland do now?



What could Ireland do now?

Plan led approach

Coordinated spatial plan led approach...

- Grid access
- Environmental sensitivity
- Seabed Suitability
- Users interaction
- Supply chain



What could you do now?

Remove some of the road blocks

Answer the unknowns that block the way...

- Seabed conditions; cable routes, mooring locations
- Coastal process; ADCP, beach formation, scouring
- Geotechnical; sediment depth/type,
- Resource; scatter diagrams, time series, measurement

We will need your help if we are to do this!

Thank you

Harvey Appelbe
Project Director
Tonn Energy

in collaboration with
Vattenfall

