

TRANSMISSION TO ENABLE DECARBONISATION

April 2021

John Fitzgerald

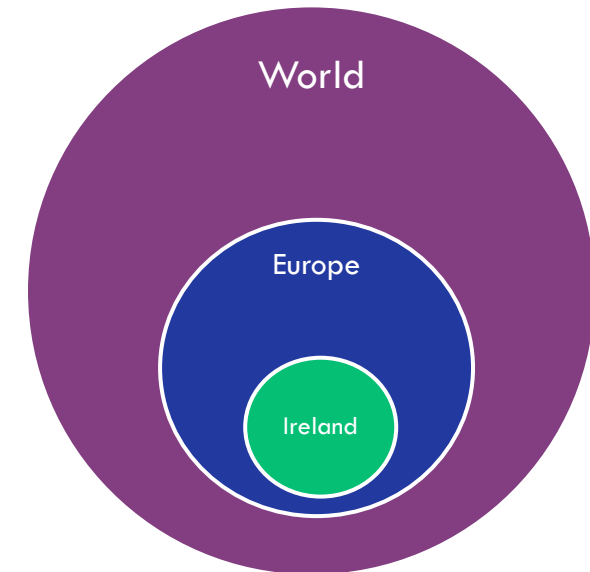


Agenda

- 1. Introduction**
- 2. Lessons Learned and a Challenge for Engineers**
- 3. Europe**
- 4. What is Possible with Transmission Technology**
- 5. Suggestions to Realise our Potential**
- 6. Conclusion**

1 Introduction

- Focus on decarbonisation of our economies by 2050.
 - “I want Europe to become the first climate-neutral continent in the world by 2050. To make this happen, we must take bold steps together” - Ursula von der Leyen
- Talk is easy, but actions need support/resources and good actions require a vision or plan to guide them.
- Electricity powered by Renewables can be the vector for decarbonising our economies competitively.
- Can Ireland, Europe and the World take such steps?



2 Learnings from our Past

Energy systems became national monopolies with increasing returns to scale by pooling all of the resources in a single network.

1. Pooling Resources with a Network gets us better cost and reliability outcomes!
2. Engineers are good at this and we have very reliable and affordable systems!

The oil crises saw oil prices increase tenfold triggering a policy response of diversification with more coal, gas and most importantly early development of renewable generation technology.

3. Some significant shock is needed to overcome business as usual inertia and trigger change!

Electricity Generation opened to competition to reduce costs and market power (Dir 96/92).

Renewables developed with subsidies as a minority share of energy to address sustainability and climate change.

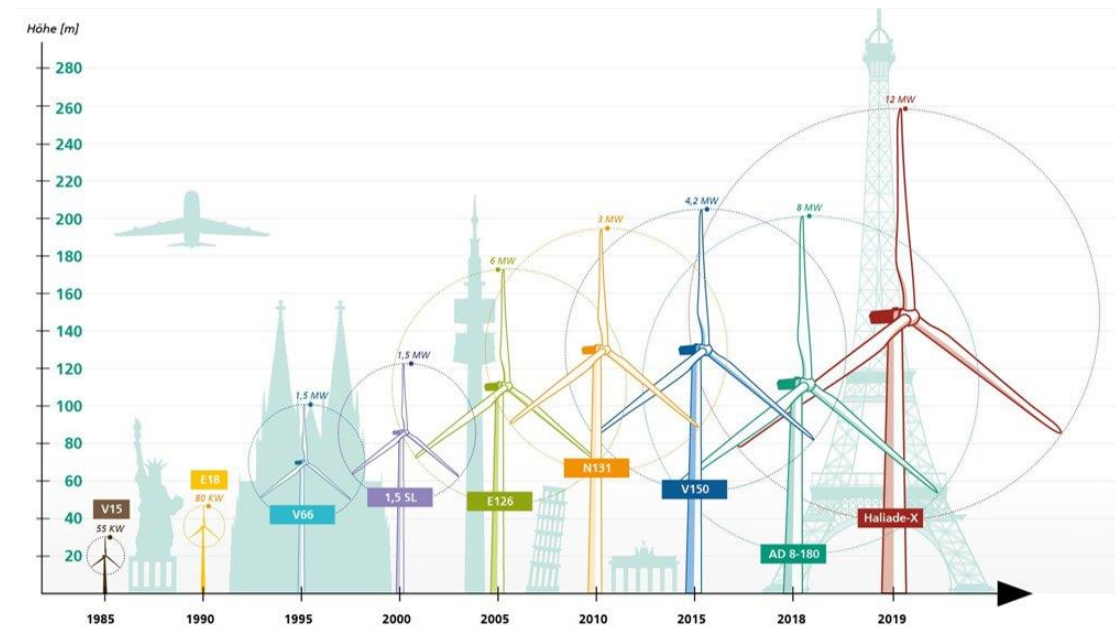
More Recent Learnings

Technical Innovation in renewable generation drives the price below fossil fuels and sees the scale of projects increase from kW to GWs.

4. Wider involvement in competition & innovation gets better results!

We have the renewable generation technology to power our global needs several times over with offshore wind and solar generation.

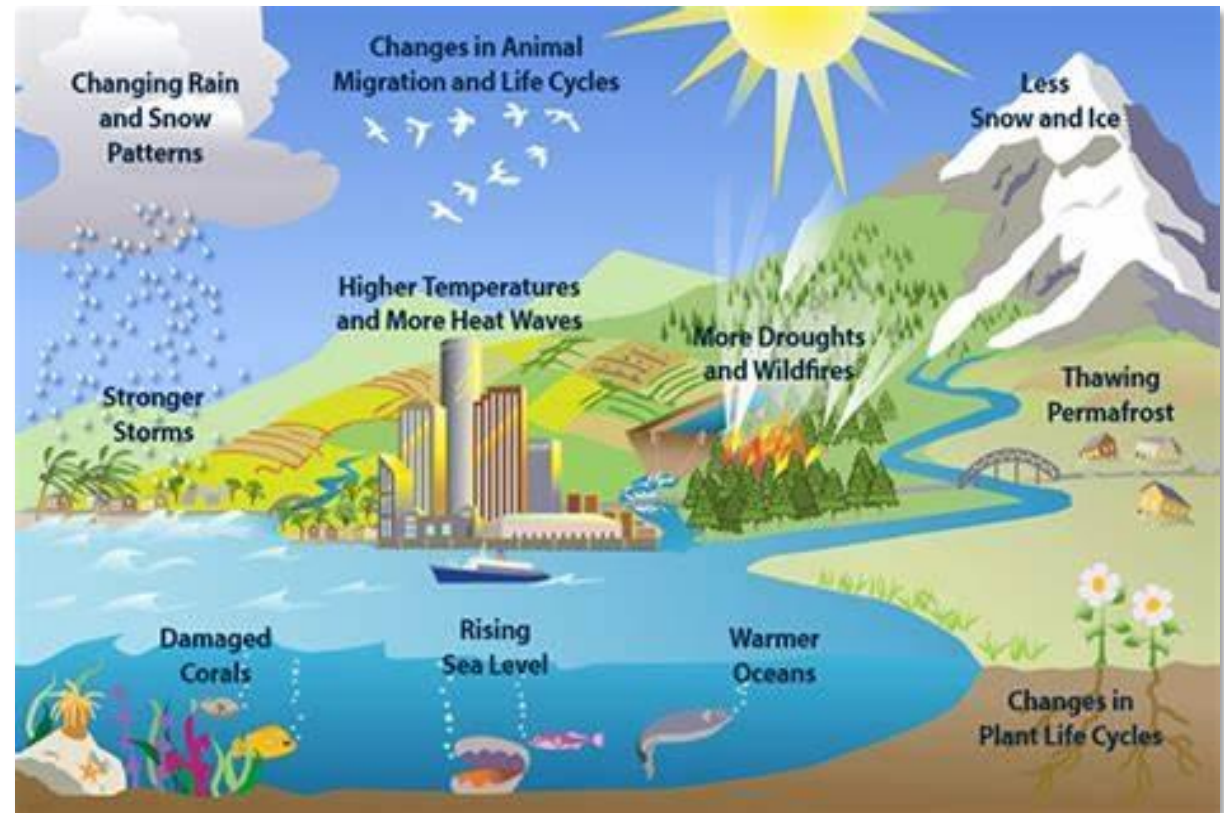
5. We have generation technology and the money we just need Systems to bring them to Market!



Climate Change – The Race of our Lives

“We all know what to do, we just don’t know how to get re-elected once we have done it.” Jean-Claude Junker

Carbon Tax!!!



Challenge for Engineers

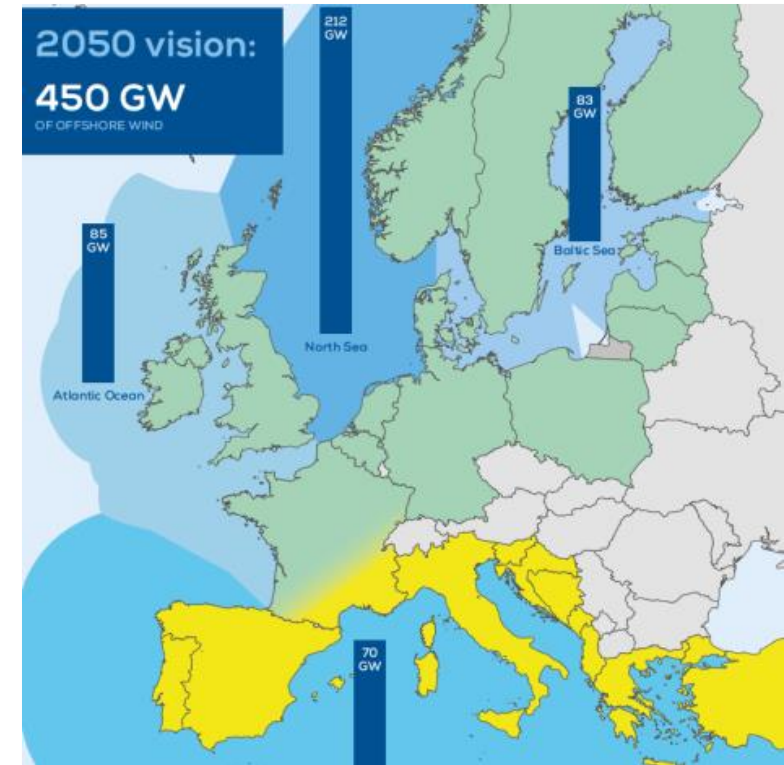
- As Engineers we are in the solutions business.
- Our predecessors designed the carbon-based systems, we operate so reliably today.
- Tweaking these systems, as we have over the last hundred years, won't get us there!
- **We have a leadership duty to society to espouse a plan for decarbonisation.**
- We need to place informed bets and to innovate in technology and process.
- Carbon abatement costs range from low (e.g. Efficiency) to high (e.g. Direct Air Capture >\$100/Ton CO₂eq)
- Our wellbeing depends upon how well we plot our escape from GHG dependency.

3 Europe - Green Deal

‘Clean Planet For All’ 1.5 Tech scenario calls for 2,000 GW of renewables - mostly Wind and Solar.

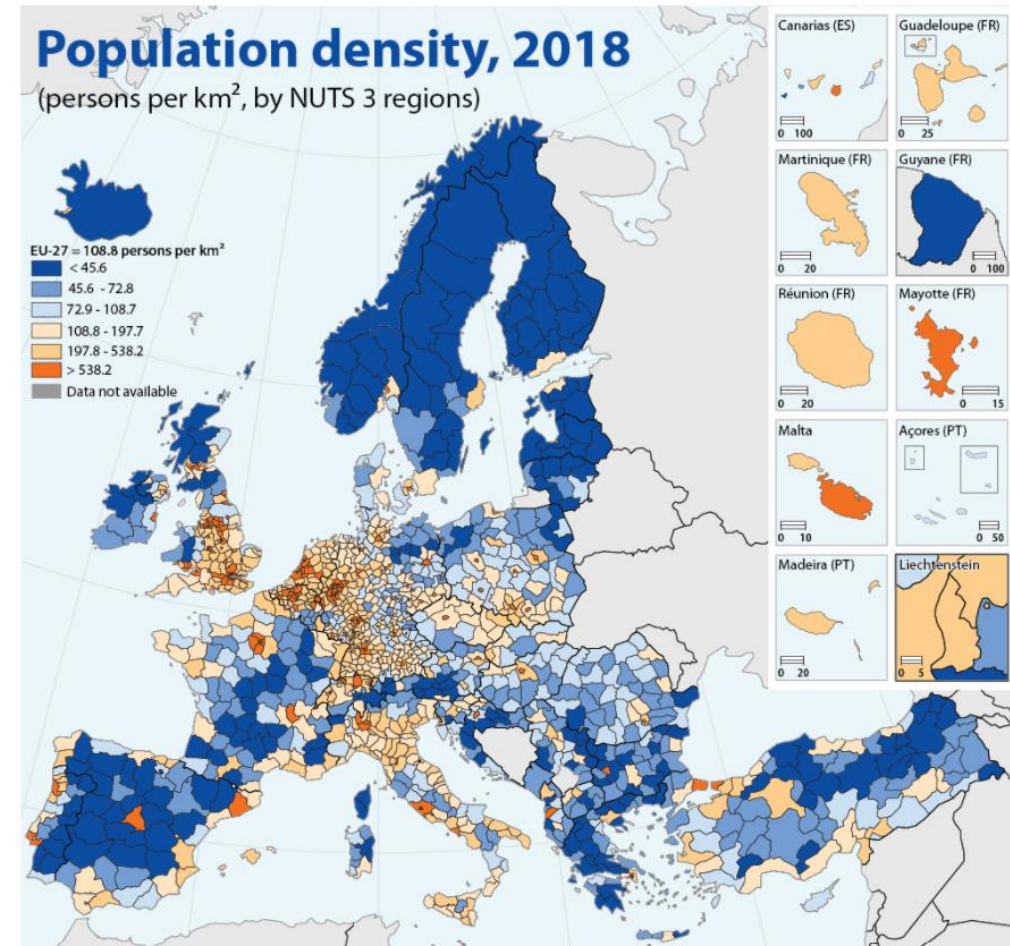
“By its very nature, renewable electricity will be cheaper than zero-carbon hydrogen (which is a vector that stores renewable electricity). In the view of the authors, this gives rise to possibly the most important conclusion from this study. Aside from energy efficiency, (...) the most important and immediate priority for the EU in ensuring a cost-effective decarbonisation of its energy system must therefore be to identify and eliminate infrastructure and other bottlenecks that are likely to constrain the cost-effective production and use of renewable electricity moving forwards.”

Florence School of Regulation - Andris Piebalgs, fmr. European Commissioner for Energy and [Christopher Jones](#), fmr. Head of Cabinet, DG Energy, European Commission

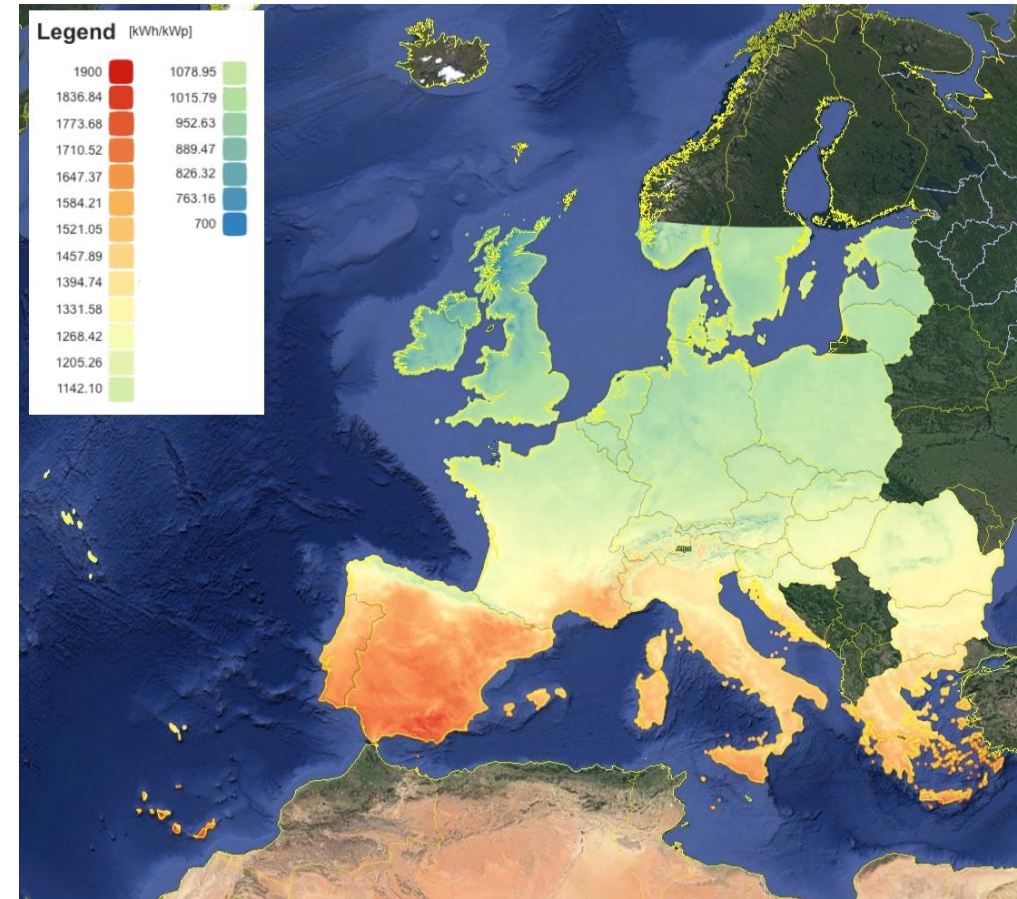
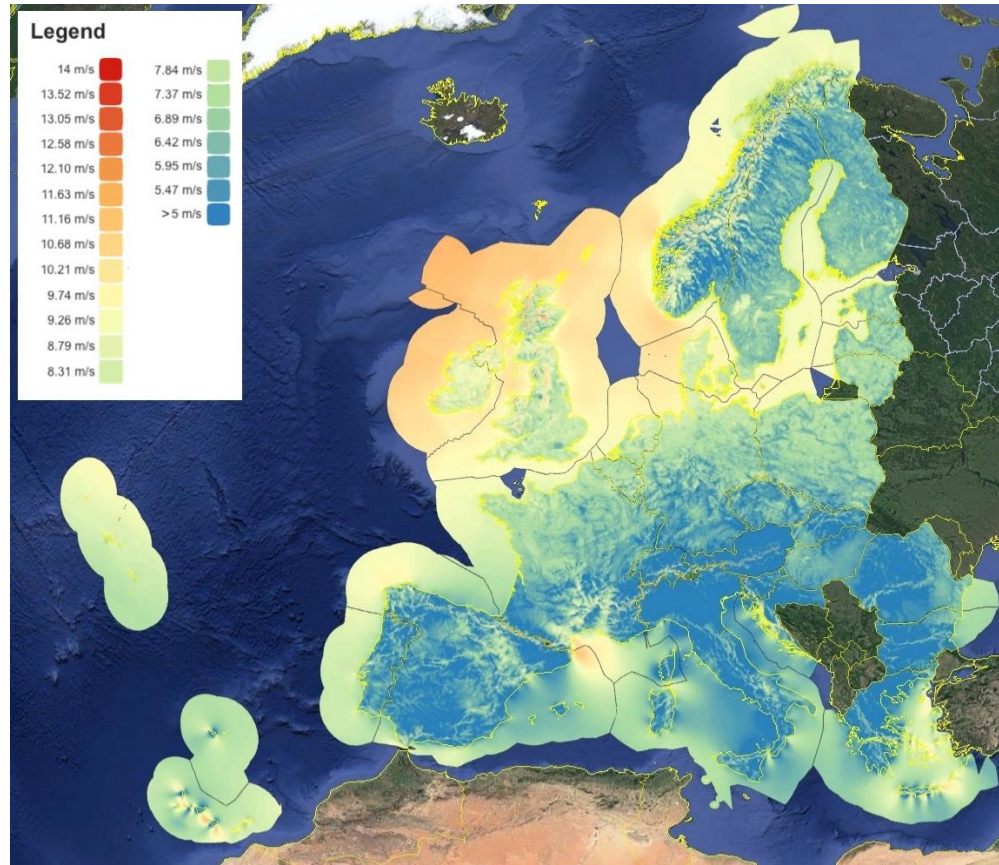


European Population Density

- Central Europe clearly seen to be the most densely populated region of Europe.
- Electricity demand is also highest in Central Europe.

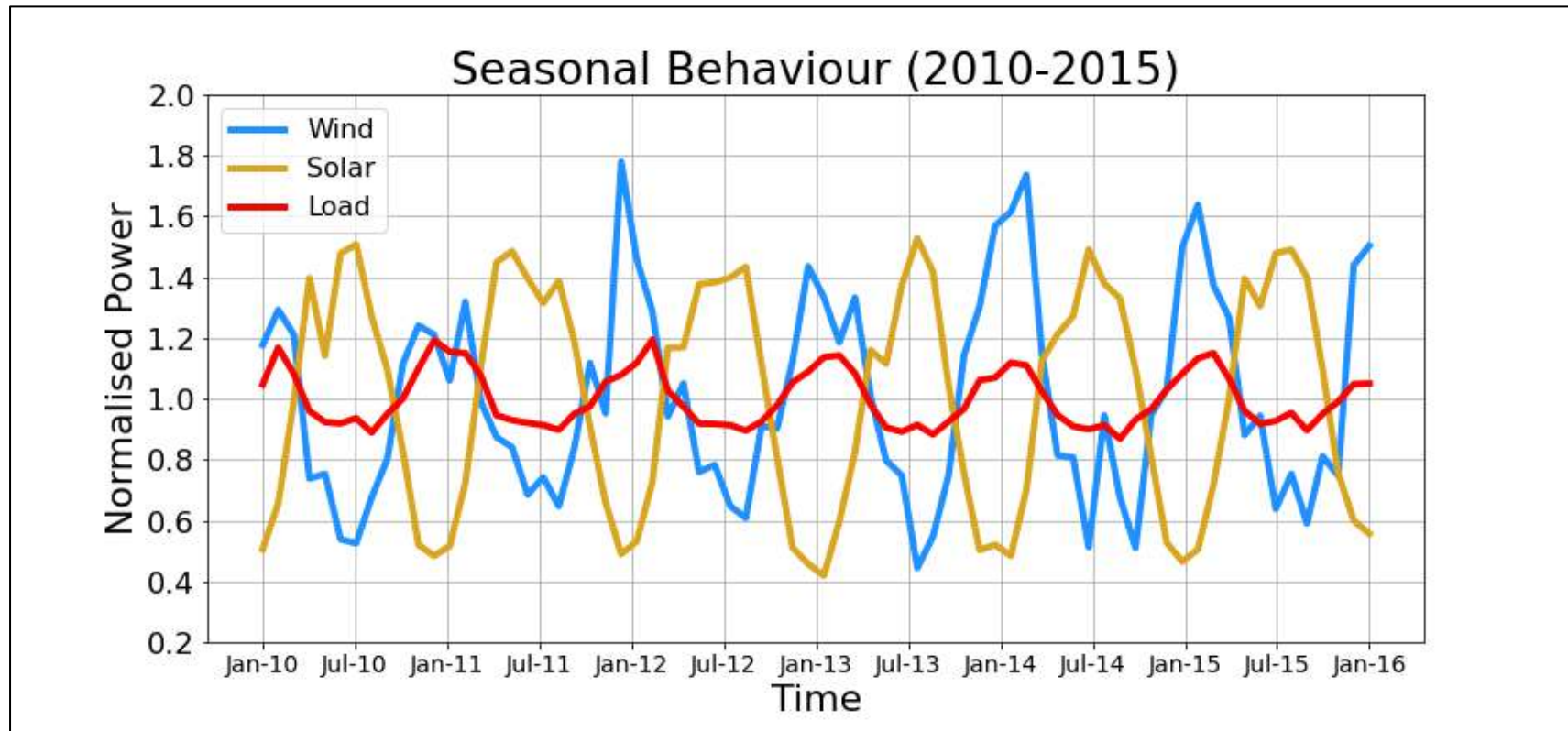


Renewable Generation Potential



Seasonal Share of Wind and Solar PV

- Normalised wind and solar power generation and load time series in Europe.
- Each plot is shown in one-month resolution and normalised to its 5-year average.



European Decarbonisation

- The most efficient way to decarbonise our economies is with electricity which could increase from **25%** to more than **75%** of our total energy usage.
- In an era of free fuel 'Merit order based CBAs to develop grids' is no longer appropriate.
- Variability of generation is a regional phenomena so more interregional energy transmission capacity is required than in a carbon dispatch based system.
- A regional plan to recover renewables will result in a suboptimal grid design with more generation capacity needed, more curtailment and ergo higher costs for consumers.
- It will fail to provide secure decarbonised supplies based upon renewable electricity.

Challenges

- Most renewable resources are not connected to markets; the markets are not sufficiently interconnected; and we do not have a Single Energy Market in Europe.
- Some countries are long in variable renewables but cannot use them while others have insufficient domestic renewable resources and cannot access those abroad.
- Energy is a devolved national competency but few countries can decarbonise by themselves.
- A point-to-point or patchwork approach will become unworkable well before we reach our 2050 2,000 GW of renewables required.

Issues with our Present

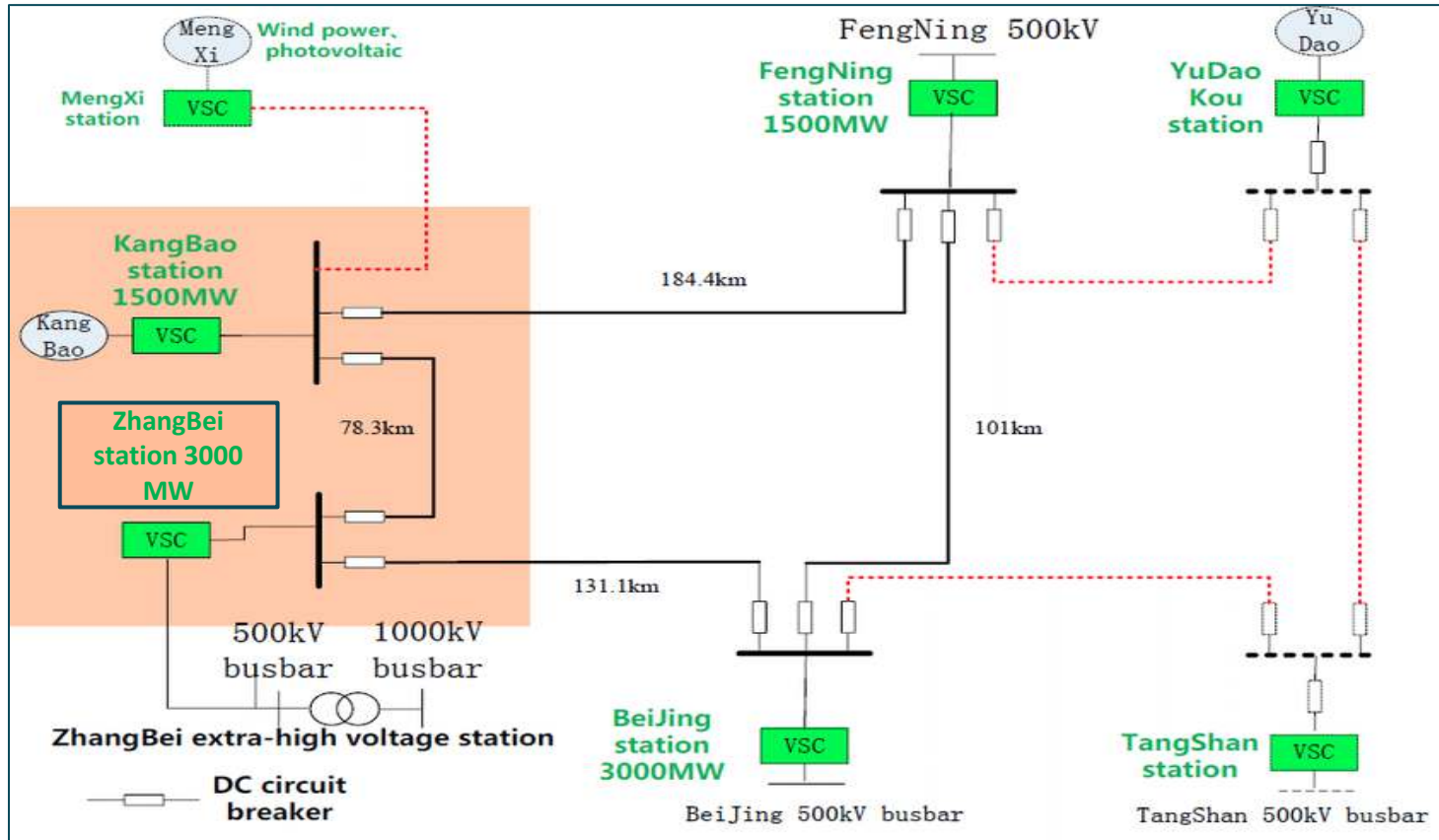
- Electricity T&D is slow moving, insular and nationalised where innovation is seen as more of a threat than an opportunity.
- Our existing and planned Grids are not Fit for Purpose.
- We have transmission technology R&D but it is not coming through to demonstration.
- We need to work together to develop the networks needed to power our economies cleanly, securely and competitively.



4 WHAT IS POSSIBLE

I think we should look at China

China have a real-sized demo in Zhangbei



Phase I (4-terminal system)	Key dates
Construction commenced	Feb. 2018
First energization the four-terminal ring grid	June 2020
Commercial operation	June 29, 2020
Phase II (extend to 7-terminal system)	
To be commissioned	2021

Transmission Technology - China

- Multi Terminal HVDC networks are operated in China Today.
- They use the HVDC breakers which we fretted about for a decade or two in Europe.
- Their DC circuits are operated like autobahns moving power of circa 10GW over long distances while the AC system below carries local traffic.
- Their scale enables interregional transmission at a scale never seen before.
- They appear to see their network as something evolving to meet their needs and not as an immovable fixture.
- The largest single circuit has a capacity of 12GW and is 3,324km in length or 40,000GW.km.



Changji Converter Station

Mongolia

3324 km

40,000GW.km

China

Beijing
北京

North Korea

Seoul
서울

South Korea

Yellow Sea

Sea of Japan

Nagoya
名古屋
Osaka
大阪

Shanghai
上海

East China Sea

Guquan converter station

Taipei
台北

Taiwan

Hong Kong
香港

Philippine Sea

India

Nepal

Bhutan

Bangladesh

Myanmar
(Burma)

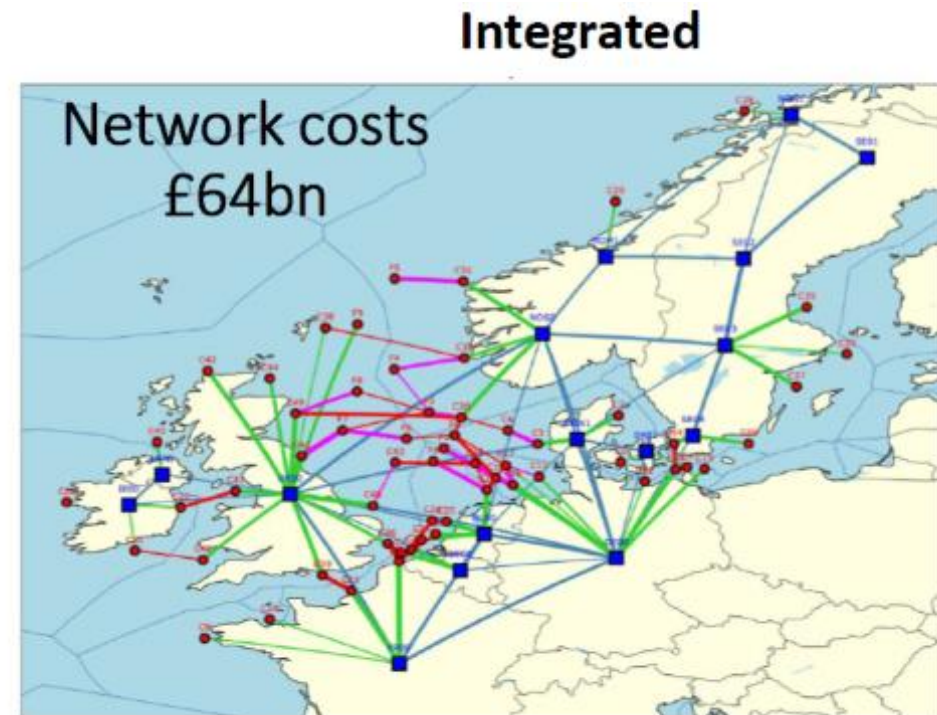
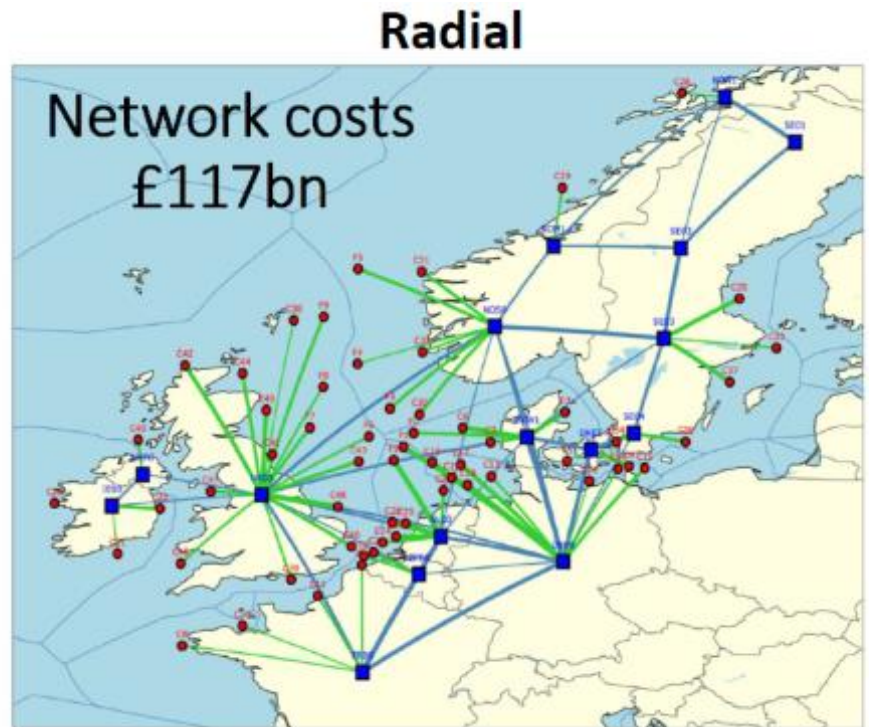
Laos
Google



Transmission Technology for Europe

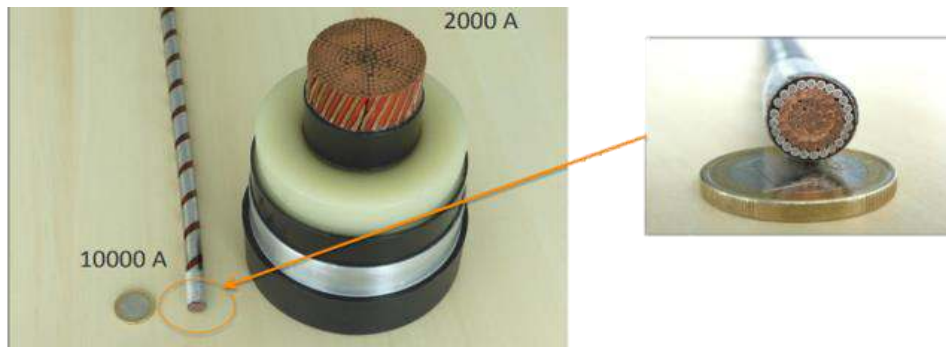
- Europe needs similar scale of Bulk Power Transfer.
- Europe cannot adopt the exact same approach but can draw inspiration from the examples of what is possible.
- For Europe we need underground transmission technology that is publicly acceptable and deployable in a marine setting.
- Integrated or Meshed DC Grids are the future for integrating Renewables at the scale required.
- This requires a plan and international cooperation for a Pan-European Grid.
- These are the bold steps we need to take!

Radial vs Integrated Approach: E3G Study



Superconductors

- Material that can conduct electricity with **zero resistance** so there are **no losses**.
- In order, for the material to be superconductive it must be at or below its “critical temperature”.

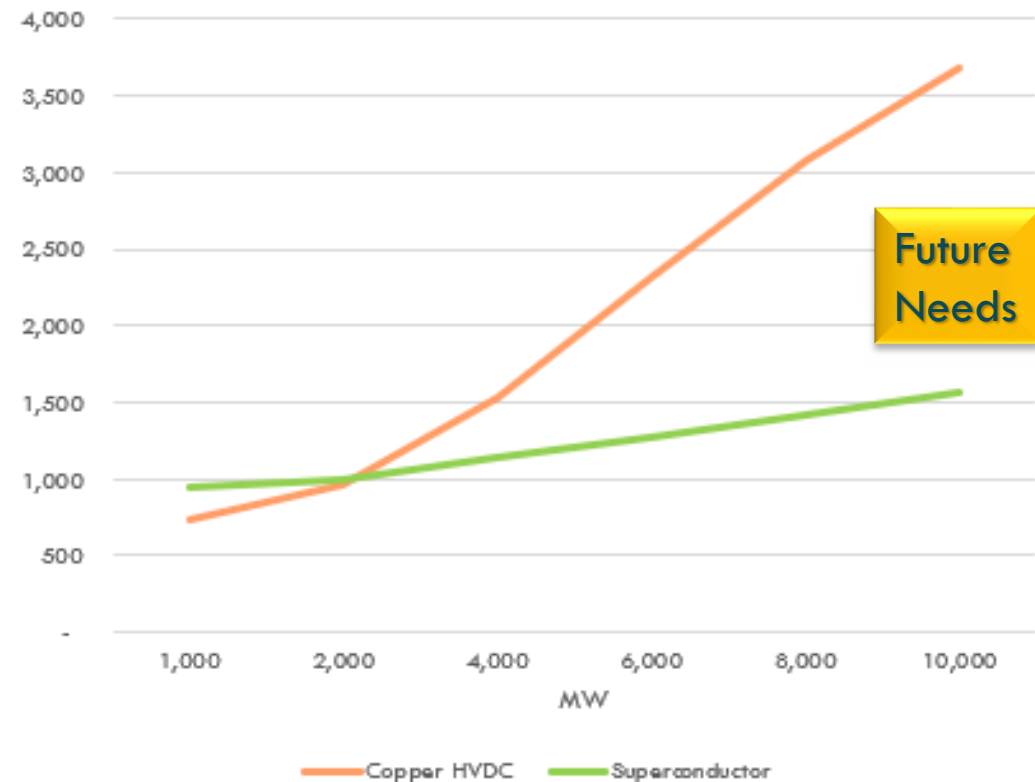


“Gigawatt-scale superconducting cables have been investigated and shown to be technologically mature and cost-competitive for the transmission of large amounts of electricity. Thanks to their high efficiency, compact size, and reduced environmental impact, superconducting cables are more likely to find higher public acceptance than overhead lines and conventional cables.”

EU Horizon Project Best Paths, Advancing Superconducting links for very high-power transmission” 2018

Bulk Power Transfer

- Superconducting technology is deployed in urban settings where space is at a premium and traditional Cu/Al technology cannot meet the need.
- This cost is largely fixed so as scale increases so does the cost advantage of using Superconductors.
- For 6-12GW links in Europe per China there is no realistic alternative to HVDC Superconductors.



Superconductors for Europe

- Much of Europe's Renewable resources are in the marine environment.
- SuperNode are developing technology to improve the thermal performance and to extend the use case for superconductors.
- DNV GL has awarded SuperNode with a Statement of Feasibility for its Subsea Superconducting Cable System.
- Superconducting cables, among other innovative technologies, will play a vital role in connecting the amounts of offshore wind required for decarbonisation.



5 Suggestions to Realise our Potential

- Work back from 2050 to see what it will take!
- Establish a Single European entity for new (offshore) energy infrastructure – an ISO/Architect without assets.
- Reverse the trend in Member States of trying to find national solutions to European problems.
- Facilitate ‘Market Shaping Grid Innovation’ and avoid closed shop innovation in Transmission.
- Start funding and supporting transmission innovation as we did with generation.
- See our existing systems as a springboard not an immovable feast.

6 Conclusion

We need to be more ambitious in terms of what electricity can do for us.

- Renewable Generation Technology is available to competitively power our economies.
- Electrification is the most efficient and economic way to decarbonise.
- Electricity Networks are a growing constraint and not on track to do this job for us.
- We need an engineer's mindset, to lead the way in finding new technologies and an openness to new ways and new technologies - work back from 2050.
- We need international cooperation, a single energy market with an ISO and an integrated Pan European Grid based upon DC technology.
- Superconducting technology can be the building block for such a Grid.