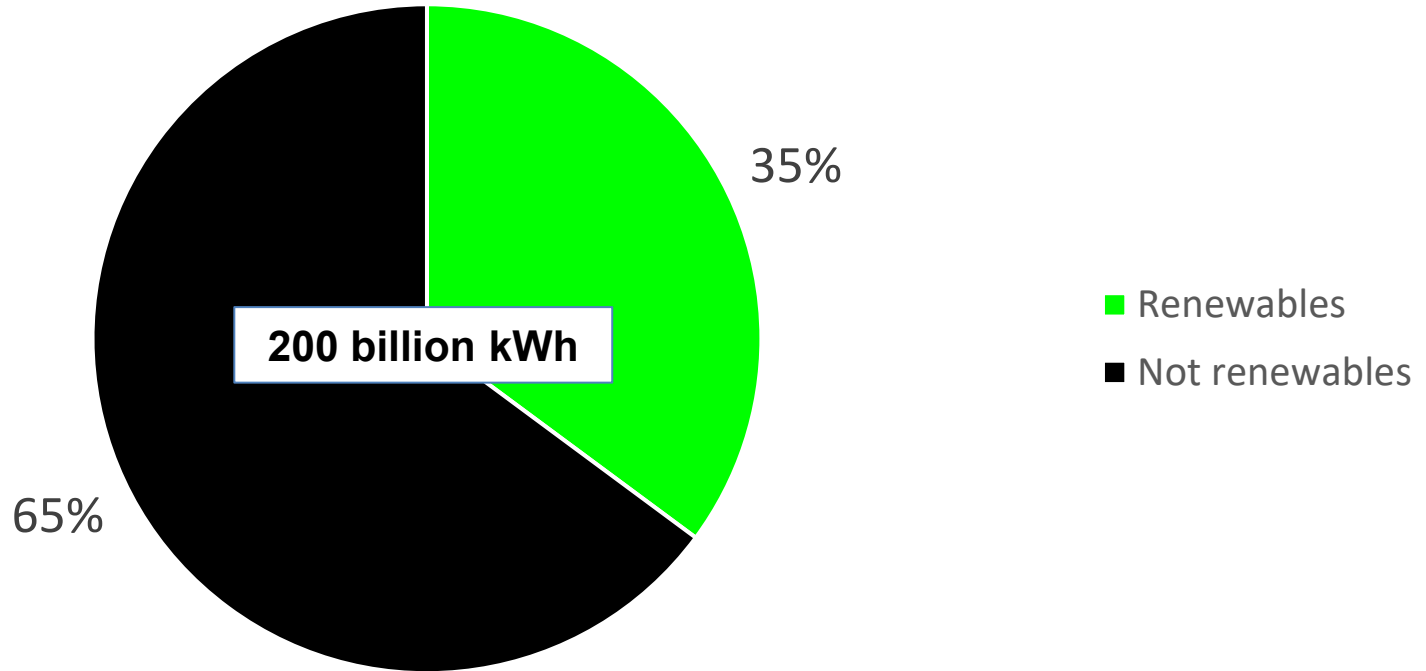


Wind Turbine Technology

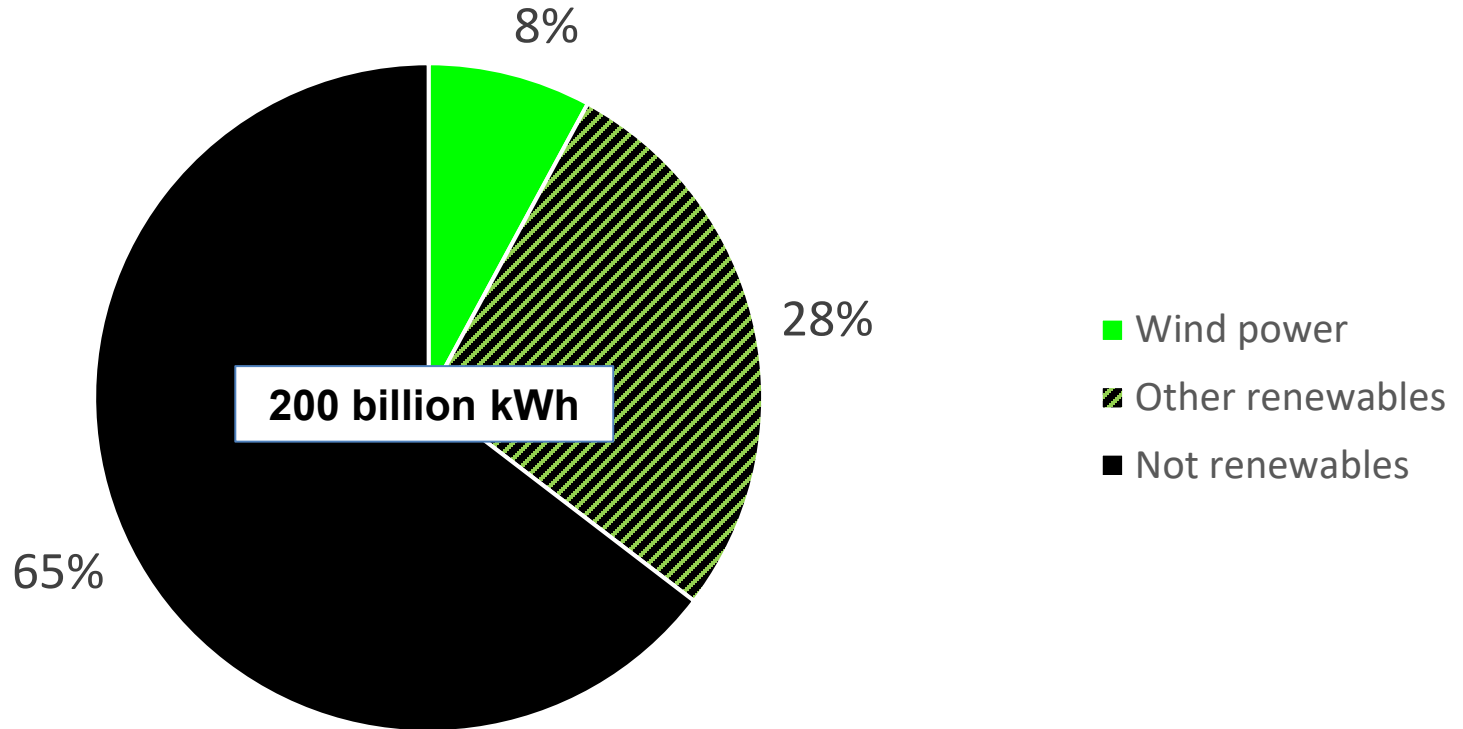
Are we designing our own death?

Henrik Stiesdal, 05.10.21

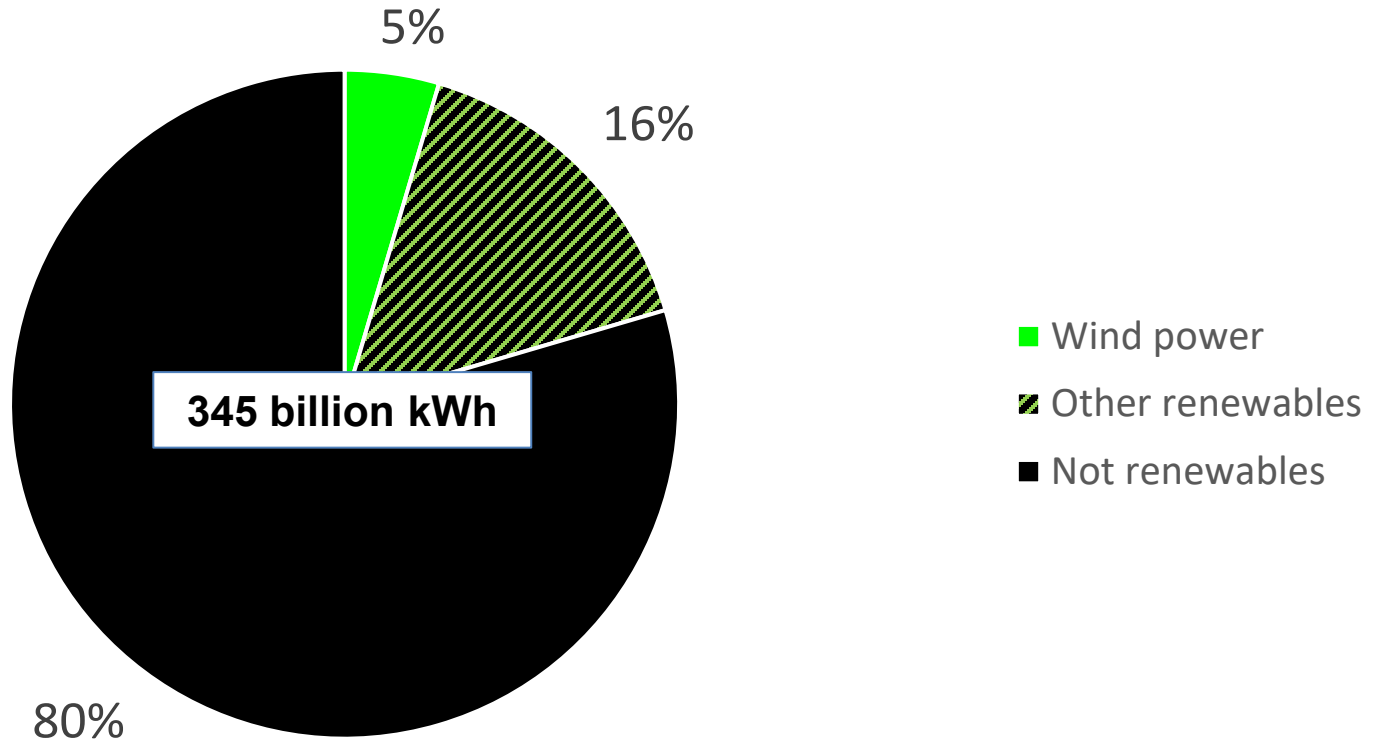
Gross energy consumption in Denmark



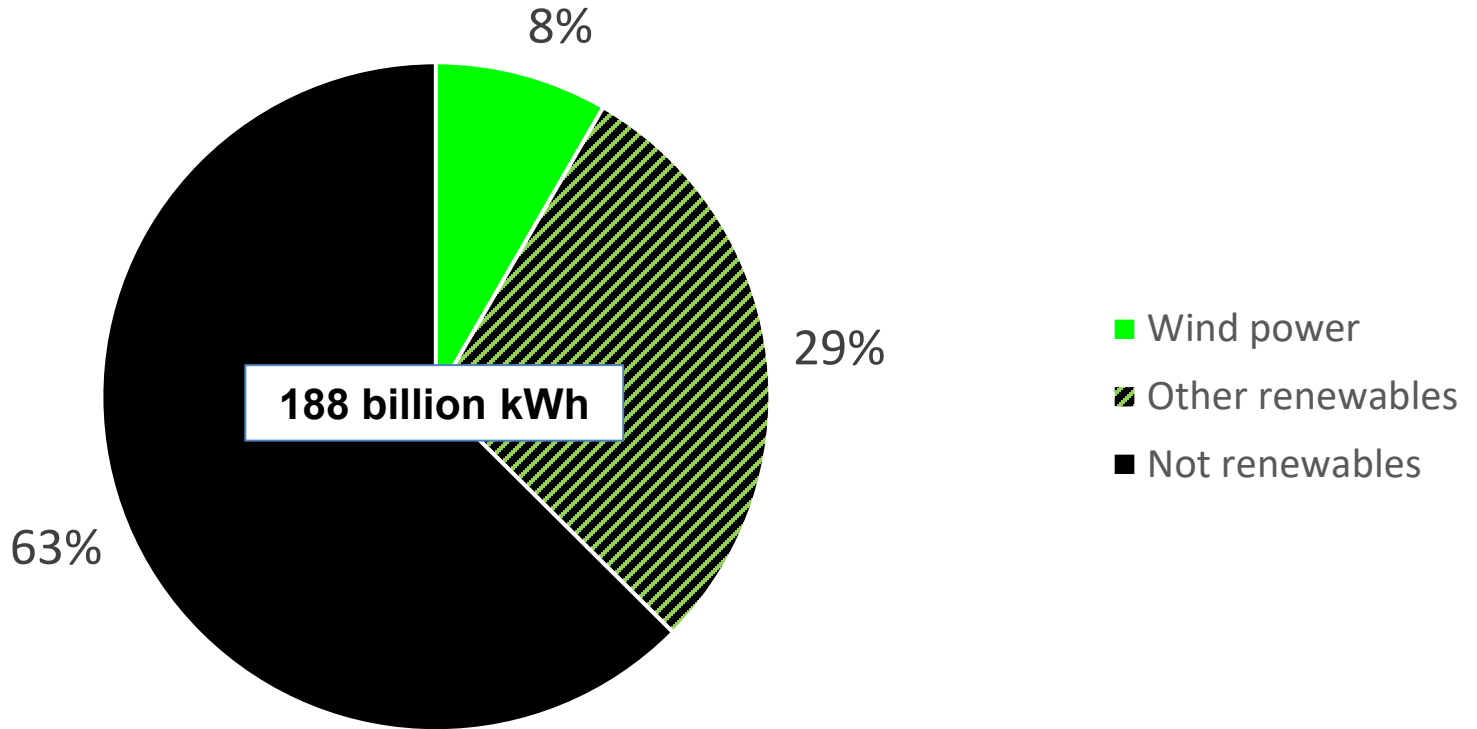
Gross energy consumption in Denmark



Gross energy consumption in Denmark, including international transport



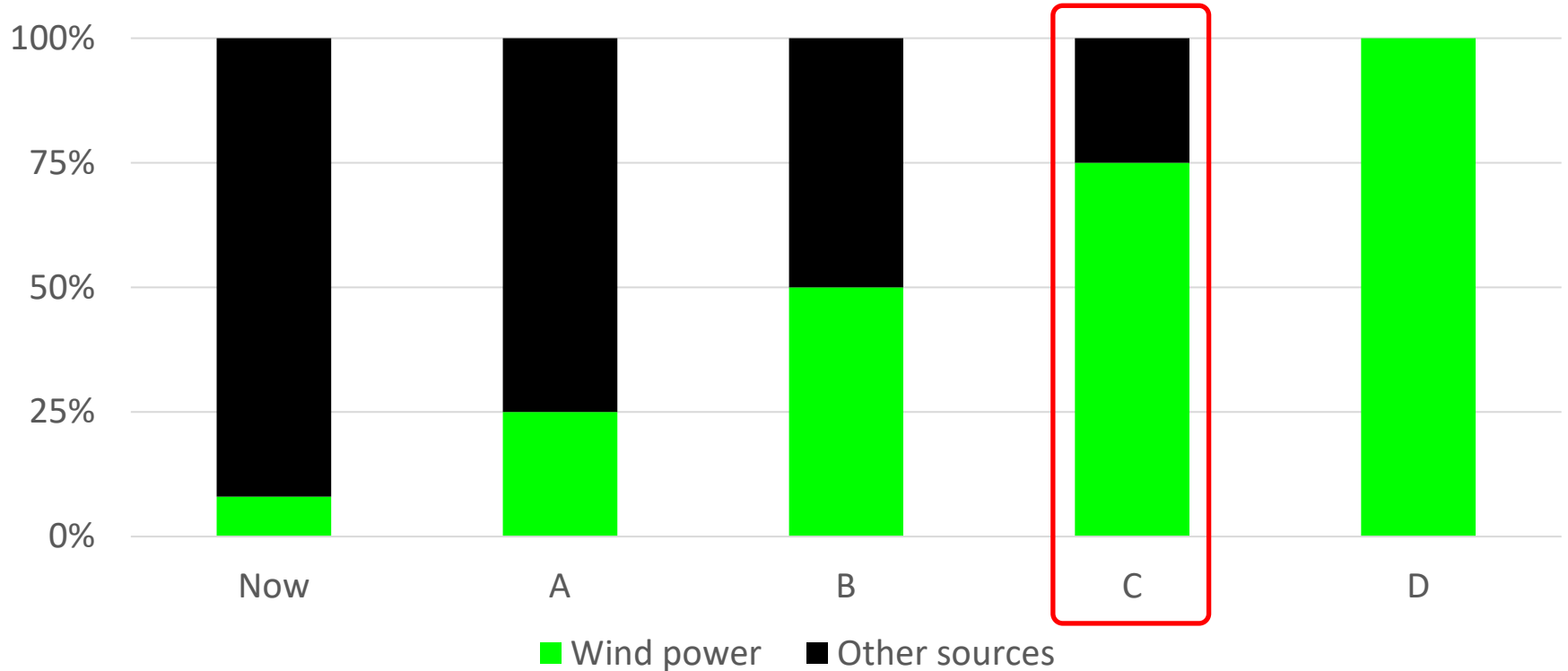
Net energy consumption in Denmark, including international transport



Source: Danmarks Statistik, adjustment by Stiesdal

© Stiesdal A/S 2021, All Rights Reserved

How much wind power do we want?



Some quick mental arithmetic

Wind power has to deliver

- 75% of 188 billion kWh = 141 billion kWh

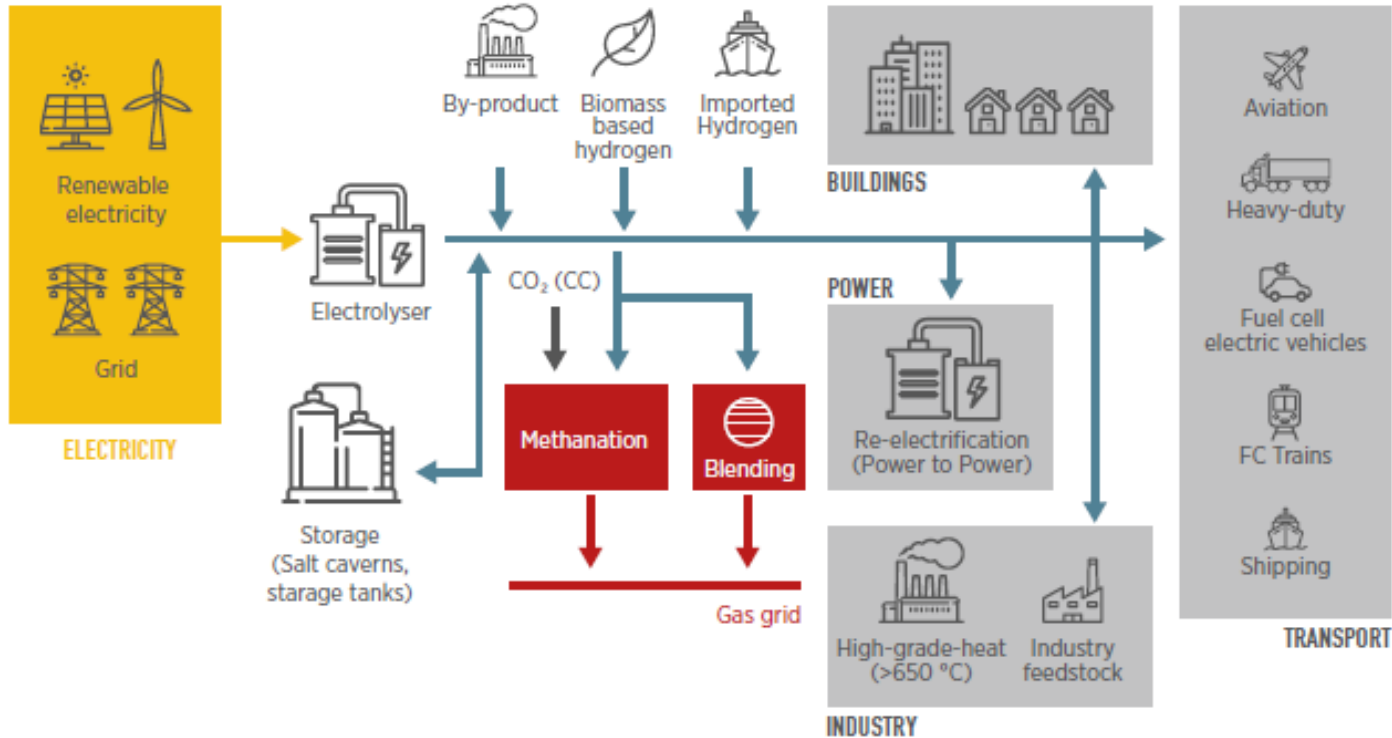
We need to expand our wind power deliveries by

- 141 billion kWh – 16 billion kWh (2019) = 125 billion kWh

Relying on offshore wind, we need to expand the capacity by

- $125 \text{ billion kWh} / (8760 \text{ h} * 55\%) = 26 \text{ GW}$

A large part of the electricity generated has to go through PtX



Net electrical energy is not enough!

Efficiencies

- Electricity to hydrogen: ~80%
- Hydrogen to ammonia or methanol: ~85%

Gross energy consumption at conversion

- $100\% / (80\% * 85\%) = \sim 150\%$

Expansion needs at conversion of 2/3 of electricity

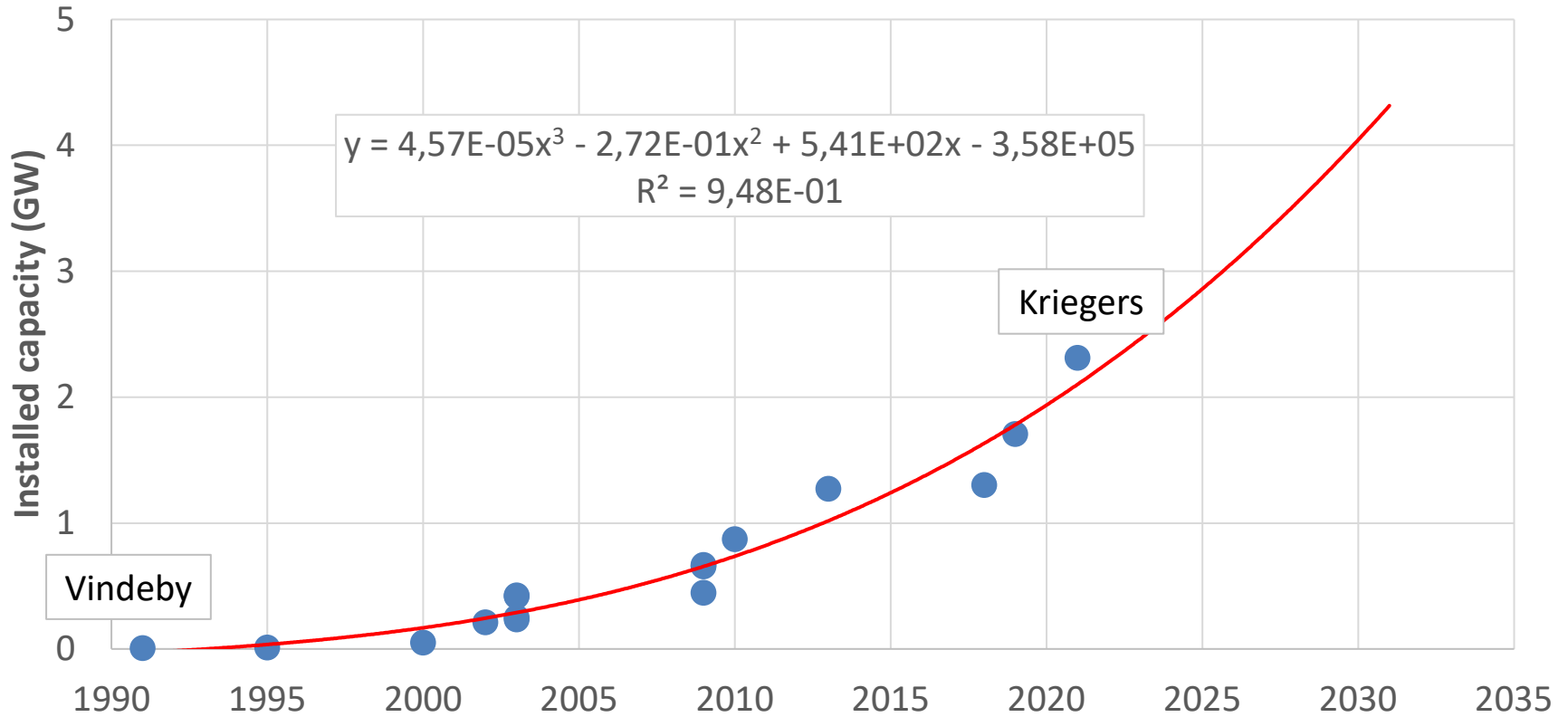
- $26 \text{ GW} * (1/3 * 100\% + 2/3 * 150\%) = 35 \text{ GW}$

Conclusion:

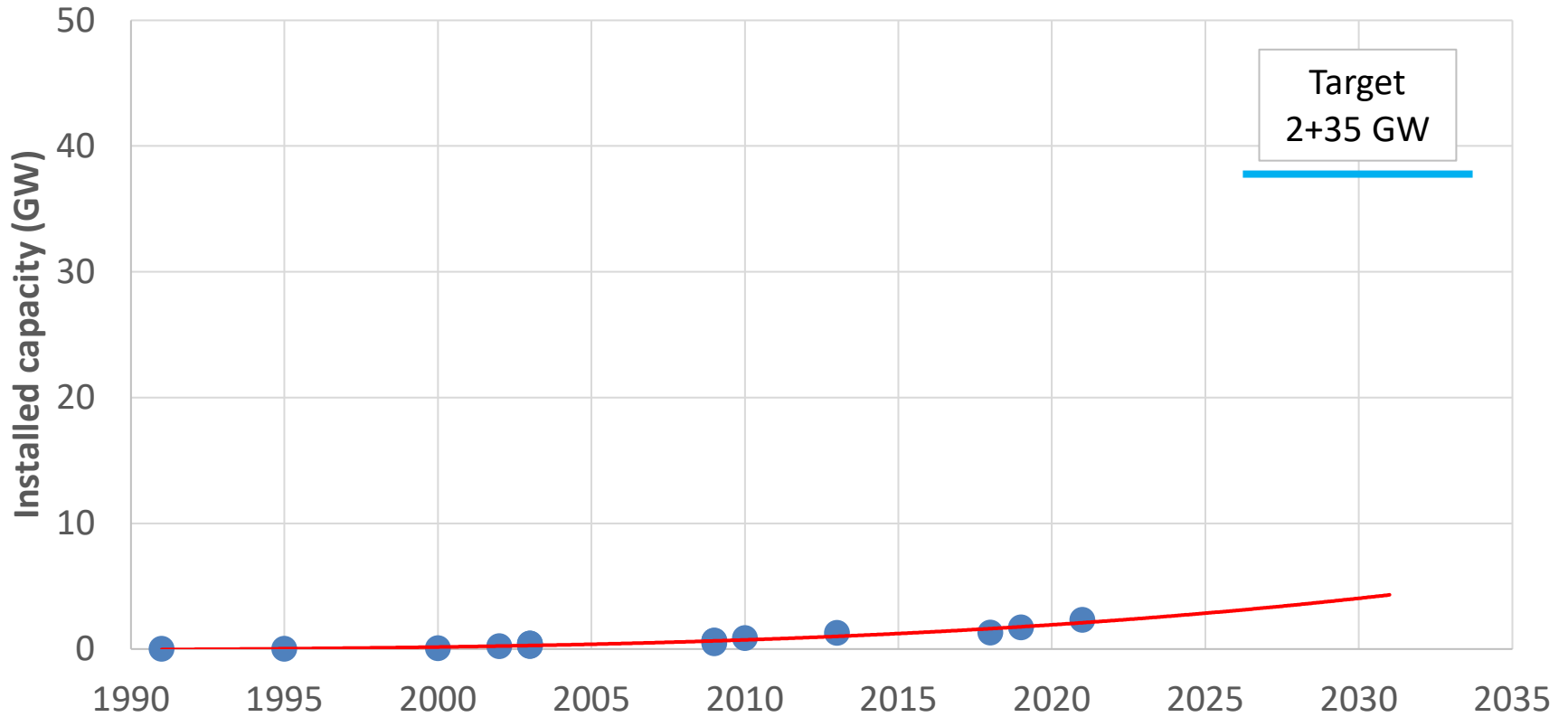
For Denmark alone we need 35 GW more of offshore wind power

Our target date to reach this objective could be end of 2030

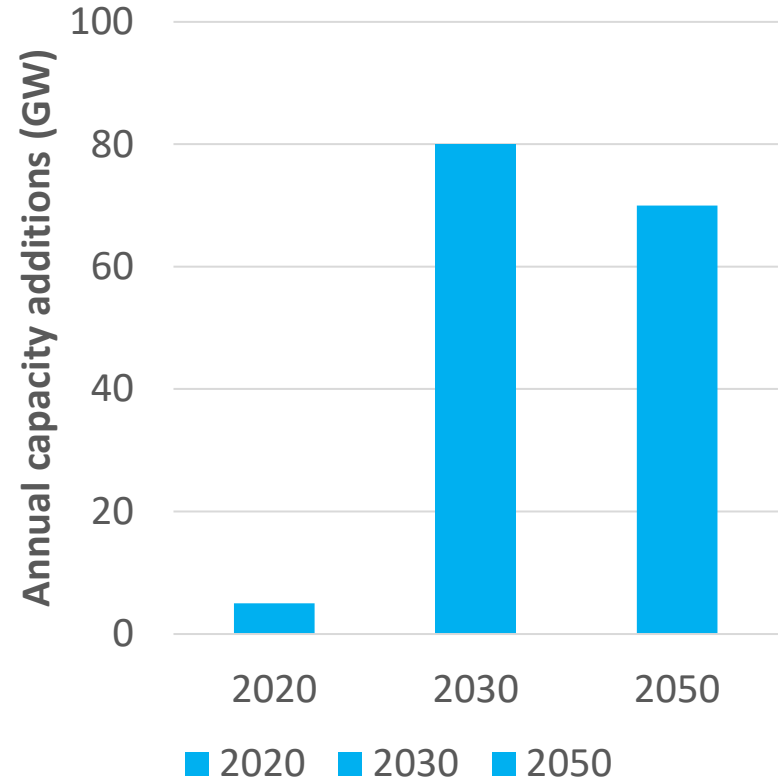
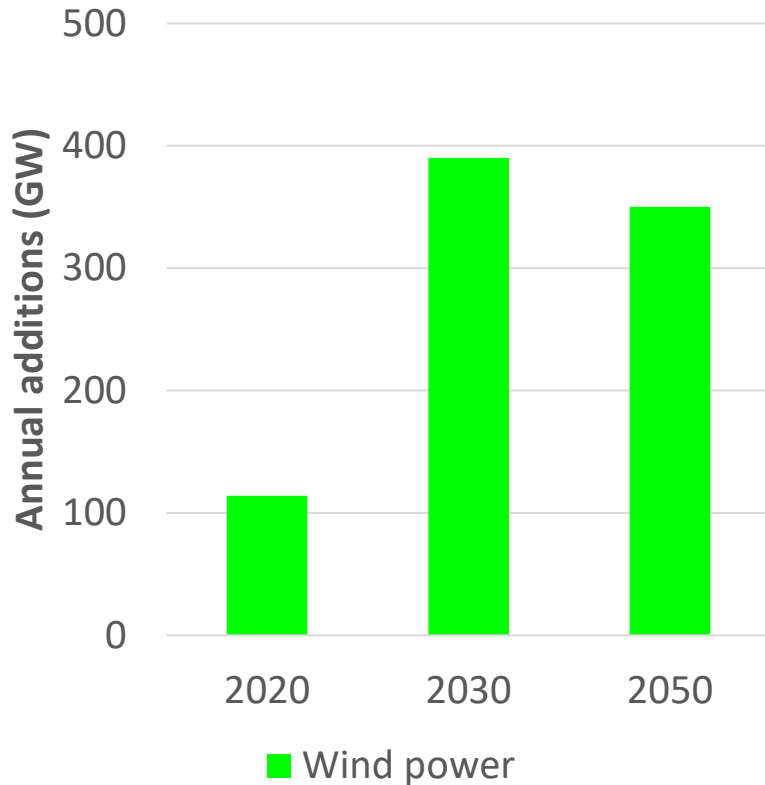
So – how are we doing in Denmark?



To assess how we are doing we need the proper y-axis!



The IEA assessment of the whole world's expansion needs



The good questions

Necessary total expansion in Denmark by 2030 relative to predicted level

- Offshore wind power: 9 x

Necessary annual expansion rates by 2030 relative to 2020, at global level

- Wind power total: 3.5 x
- Offshore wind power: 16 x

So ...

- Is this possible?
- Do we want our (manufacturers', developers') market share to remain, grow or decline?
- Are we tackling the challenge in the right way?

Thanks for your attention

Henrik Stiesdal
hst@stiesdal.com