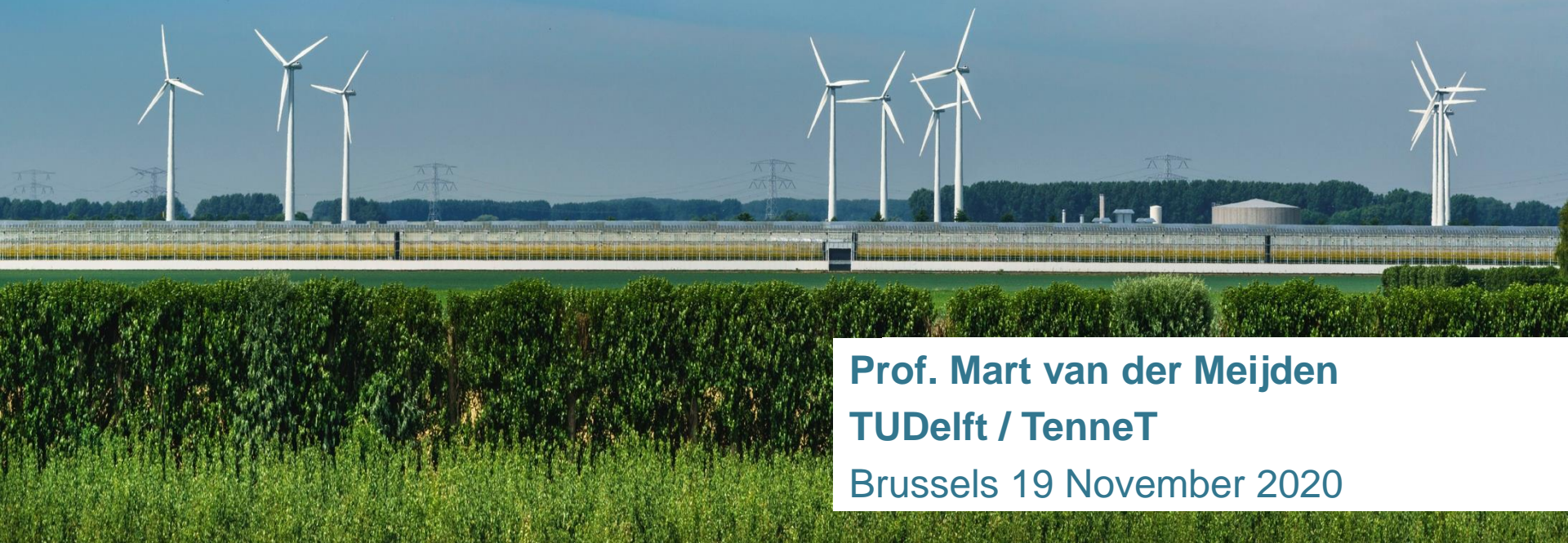


power systems of the future

hydrogen and its synergies



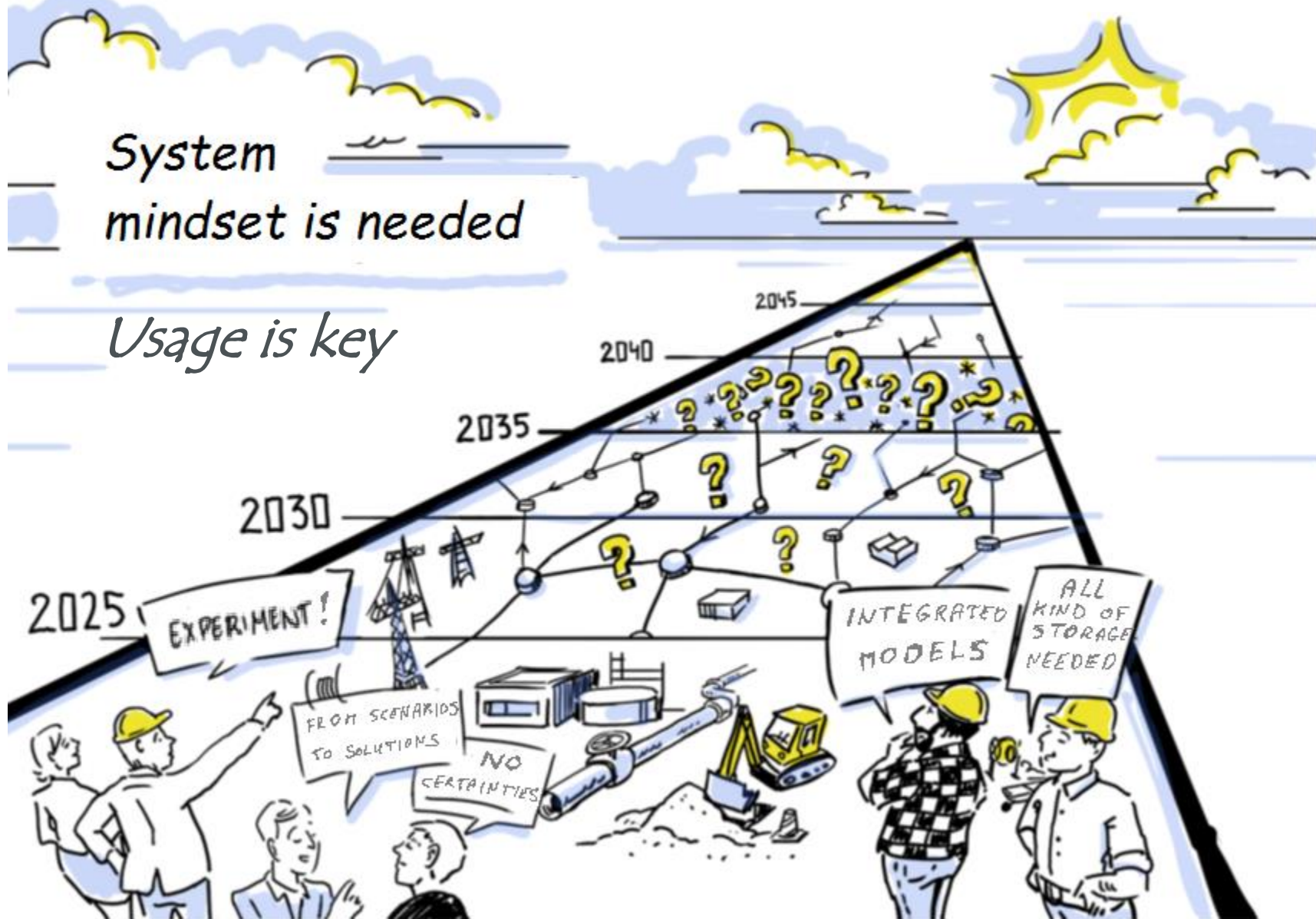
Prof. Mart van der Meijden
TU Delft / TenneT
Brussels 19 November 2020

Hydrogen and its Synergies



*System
mindset is needed*

Usage is key





Hydrogen coalition towards 2030 in NL

Electrolyser development potential:

- factor 10 growth in size every 5 year
- 40 % reduction in investment every 5 year

capital cost for PEM systems	
size in MW	cost per MW
10	100%
100	60%
1000	36%

C prof van der Meijden

TenneT message: Importance of tendering

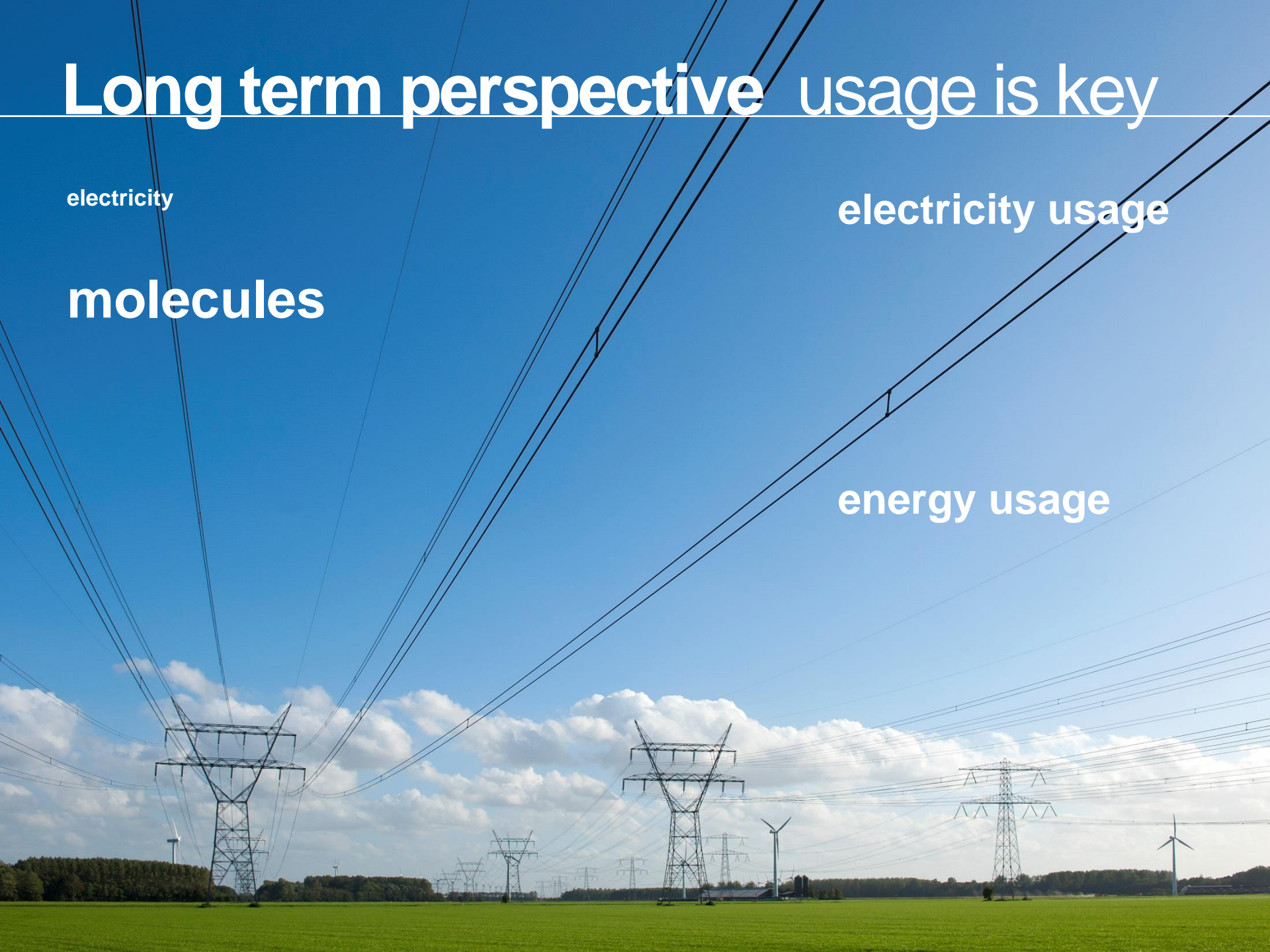
Long term perspective usage is key

electricity

electricity usage

molecules

energy usage



Long term perspective usage is key

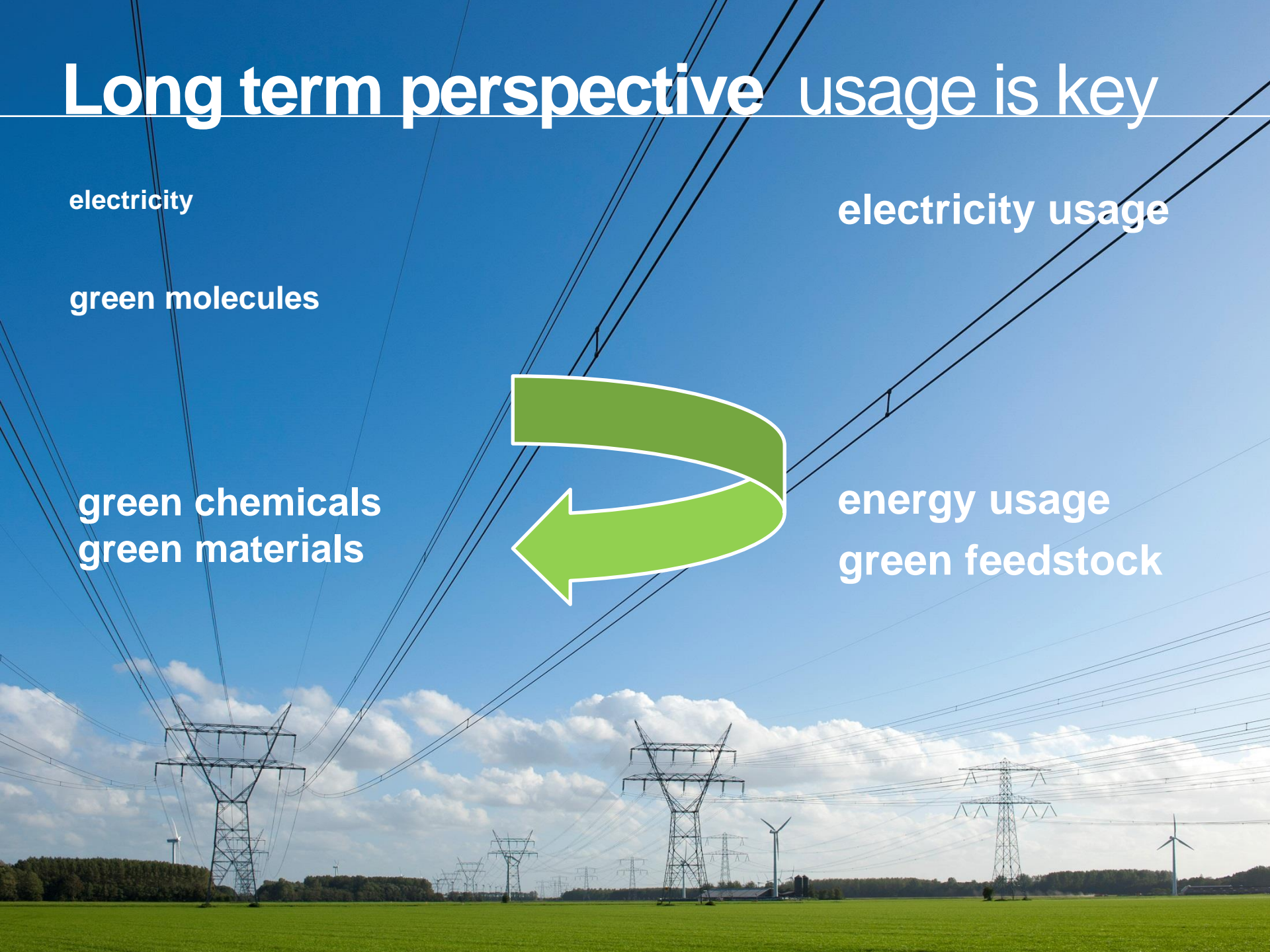
electricity

electricity usage

green molecules

green chemicals
green materials

energy usage
green feedstock



Long term perspective **synergy**

electricity

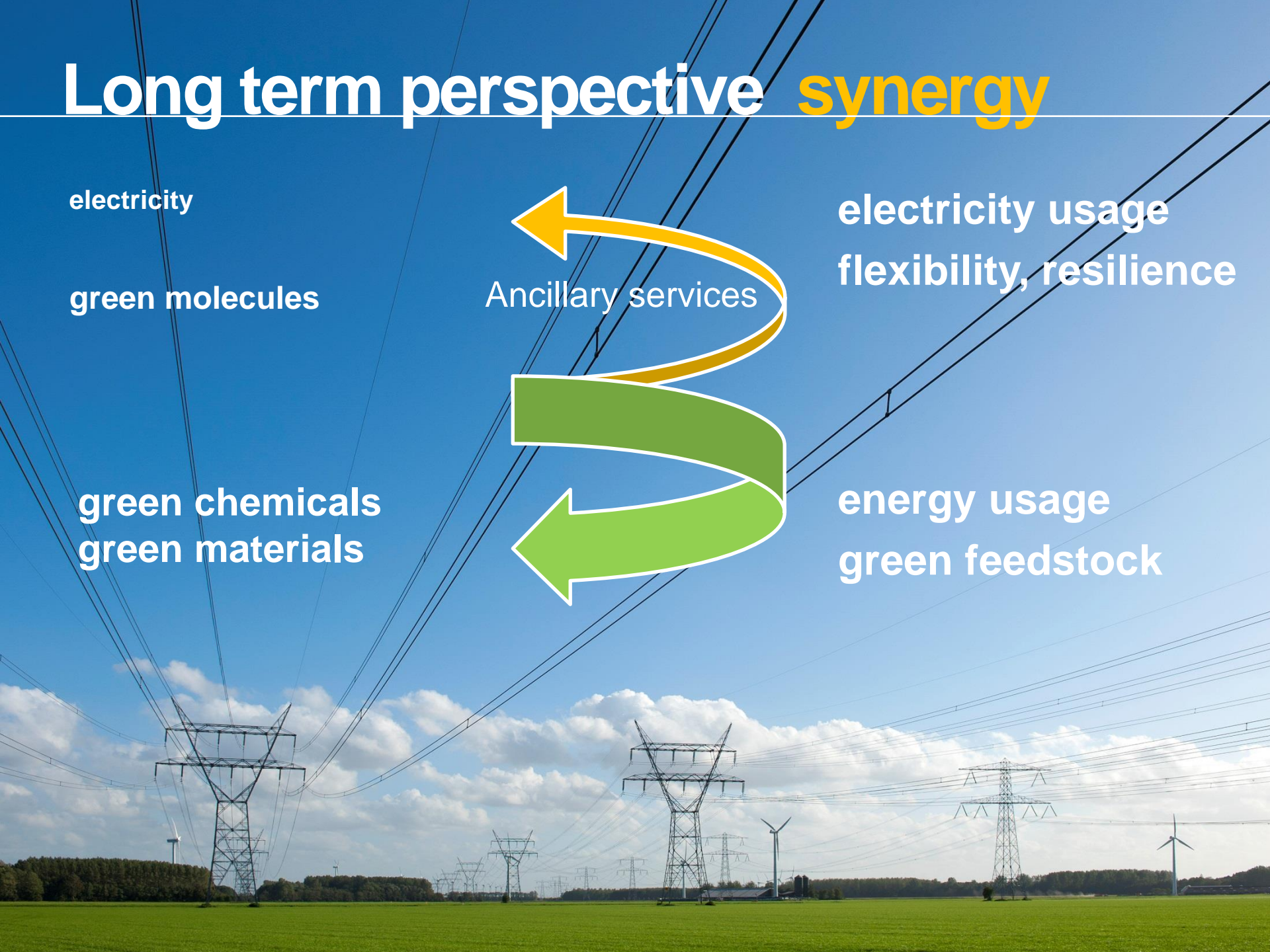
green molecules

green chemicals
green materials

Ancillary services

electricity usage
flexibility, resilience

energy usage
green feedstock



Long term perspective **synergy**

electricity

green molecules

green chemicals
green materials

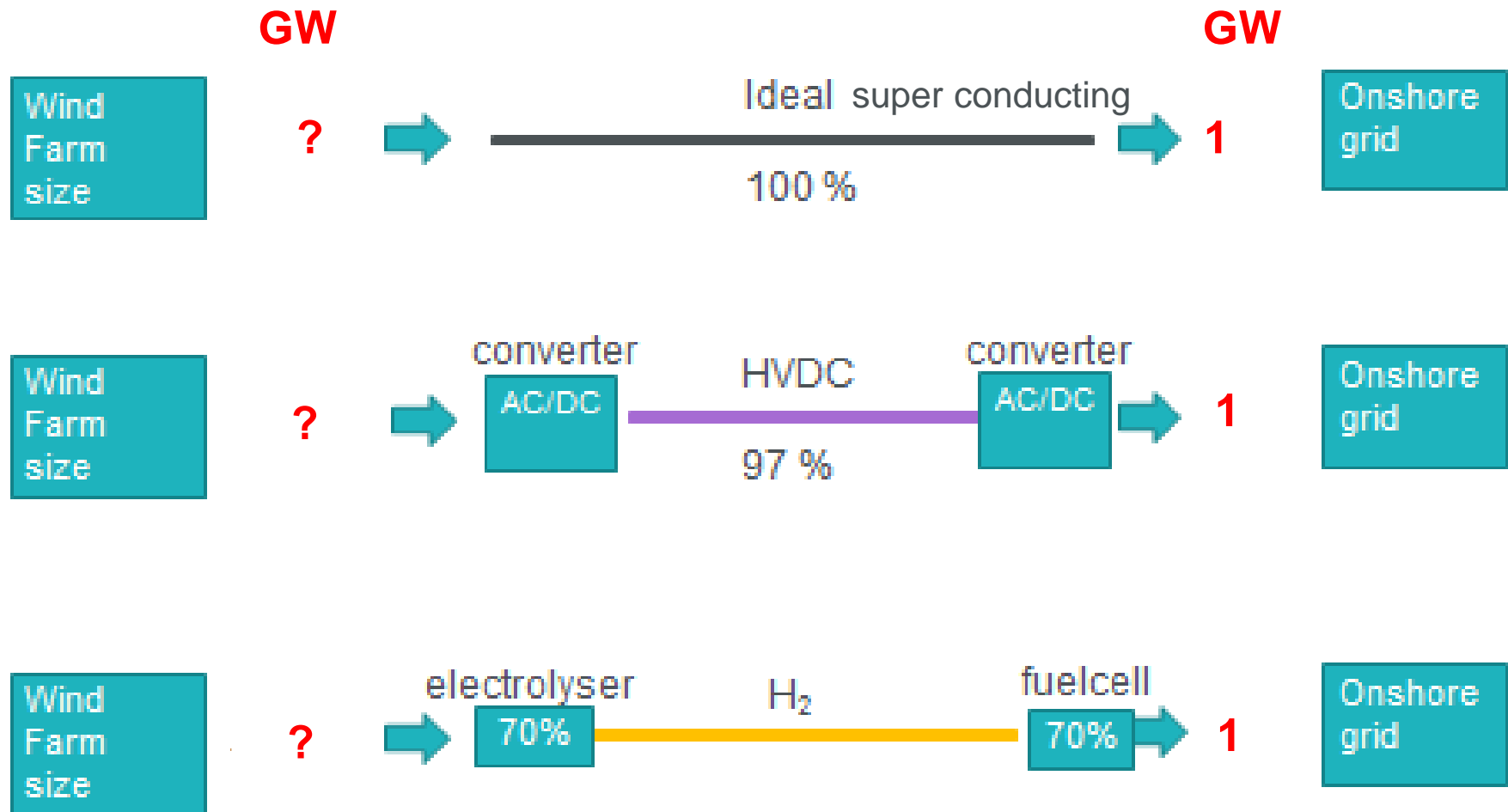
Ancillary services

electricity usage
flexibility, resilience

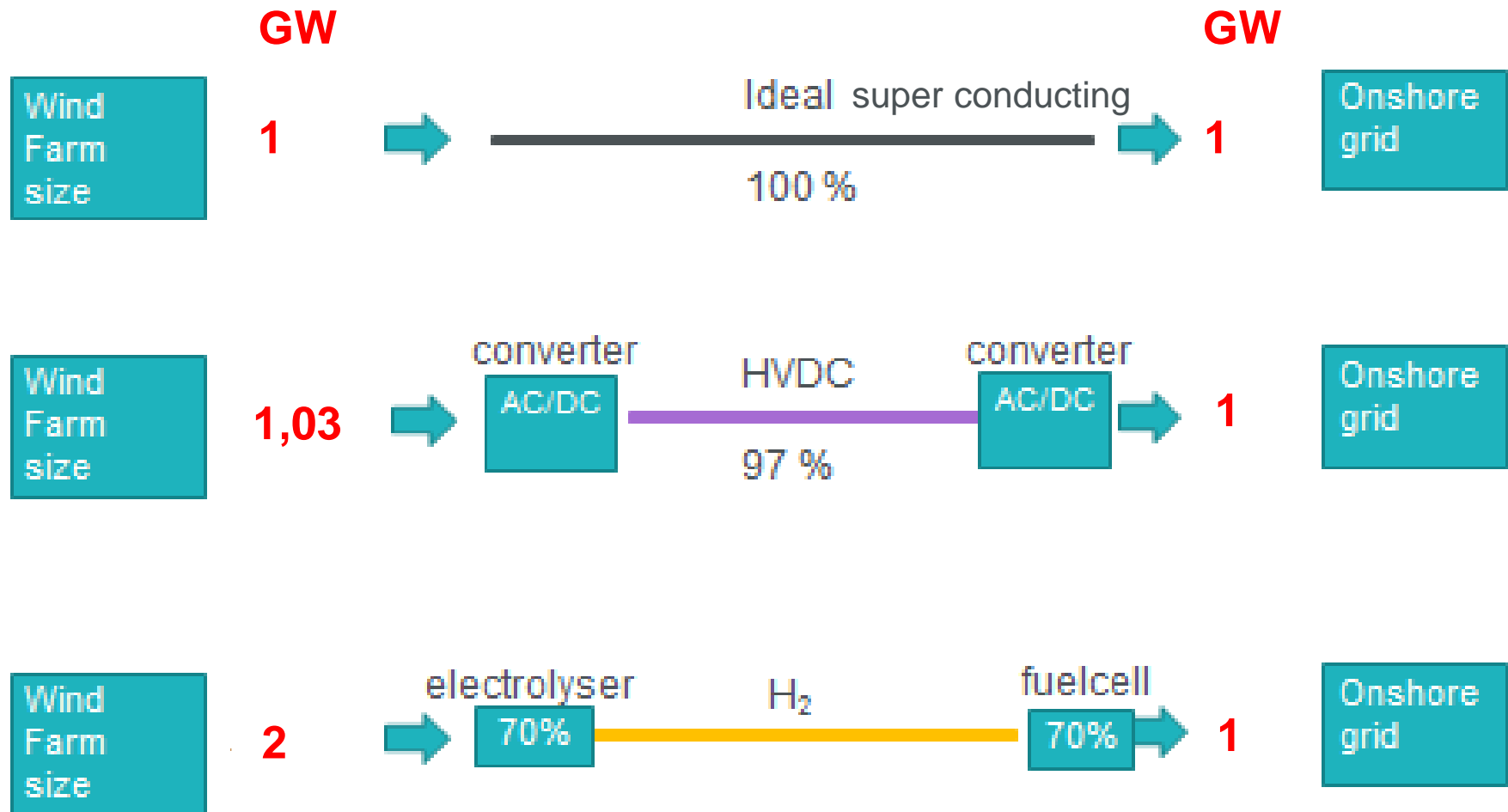
energy usage
green feedstock

Green hydrogen is important for future integration of sustainable energy sources in the power system (storage capability, bulk transmission, ancillary services, frequency support, congestion mitigation, resilience)

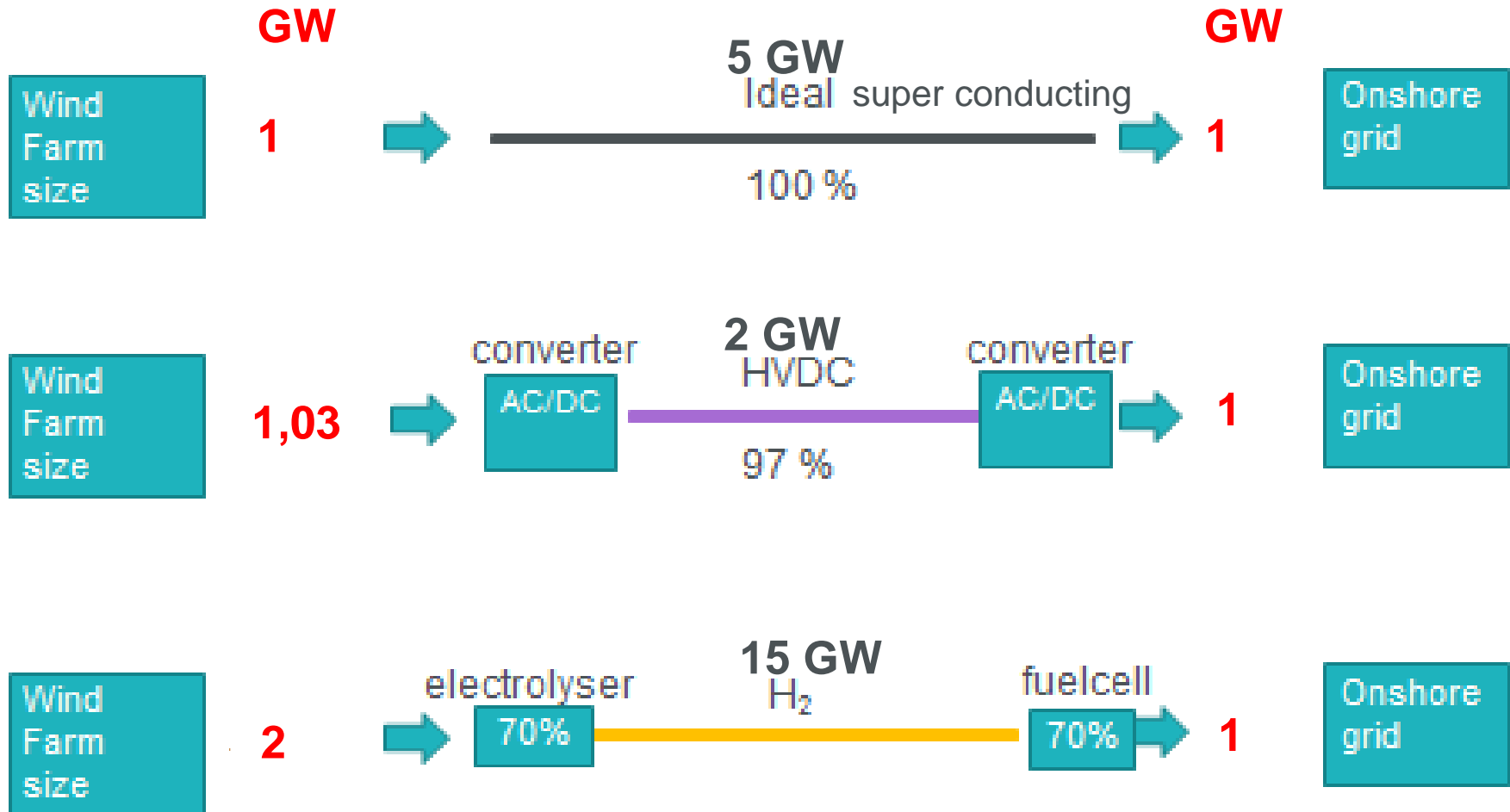
Gas meets electricity



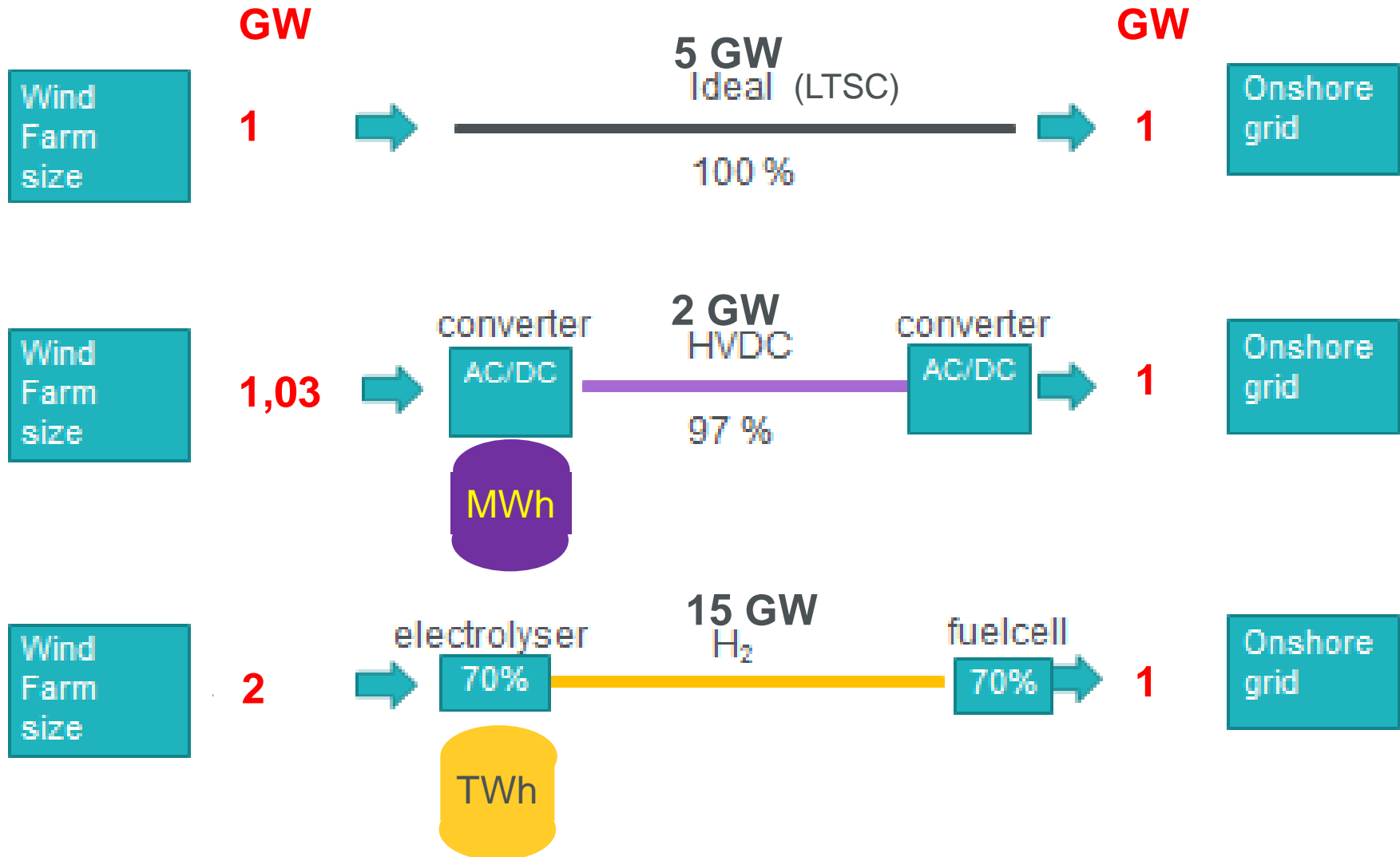
Gas meets electricity



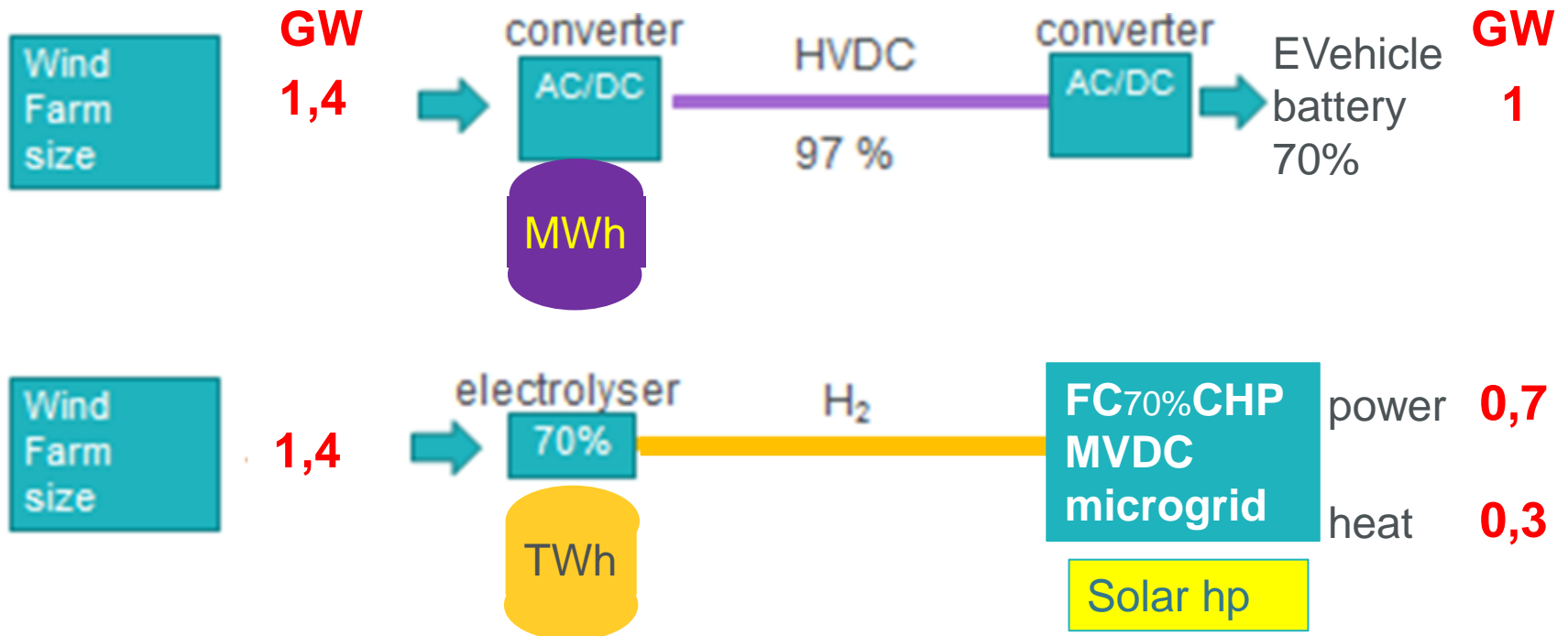
Gas meets electricity



Gas meets electricity



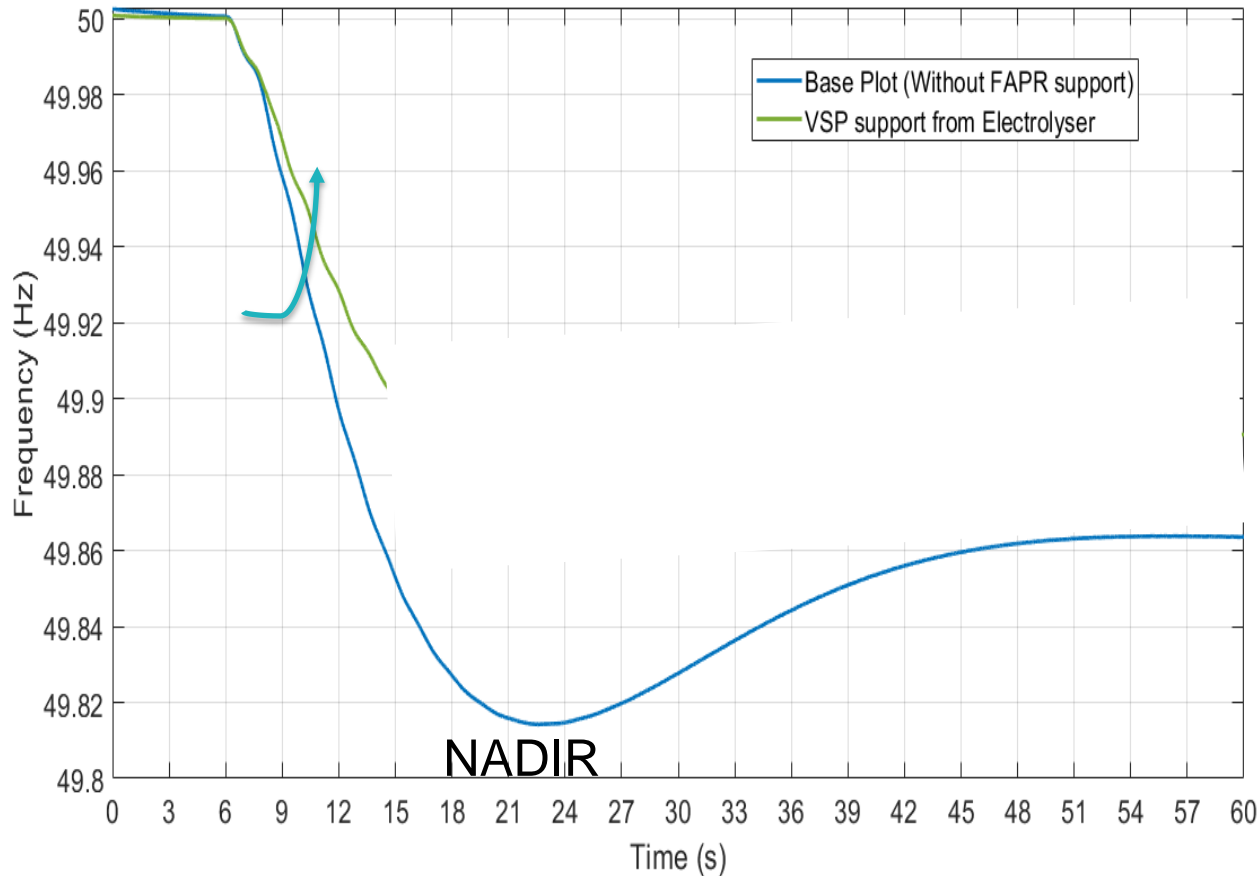
Hydrogen and its Synergies



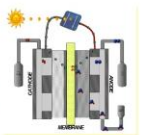
hydrogen and its synergies with wind, heat, power and solar bring affordable, sustainable and resilient solutions for 2050

Frequency support by electrolyzers

Fast active power-frequency regulation

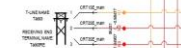
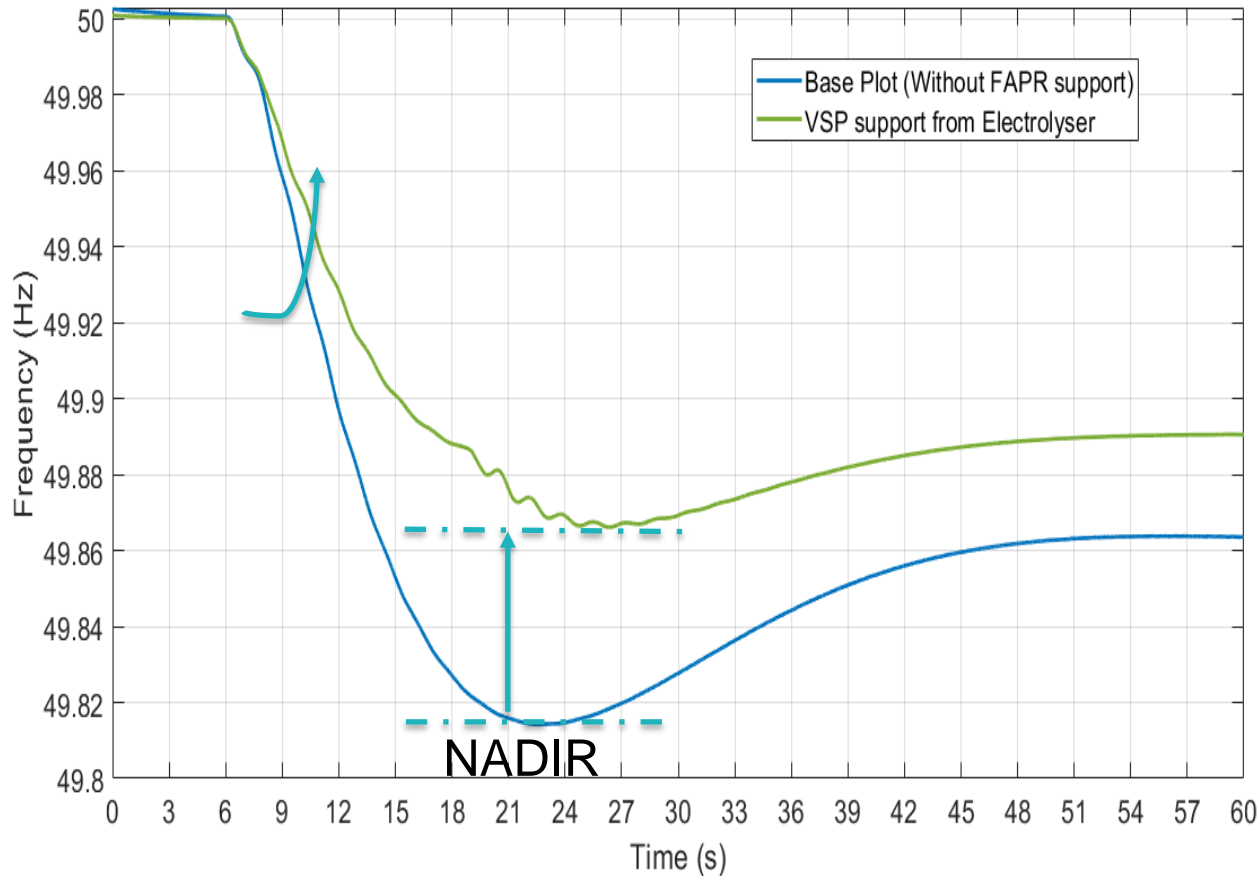


FAPR



Frequency support by electrolyzers

Fast active power-frequency regulation



FAPR

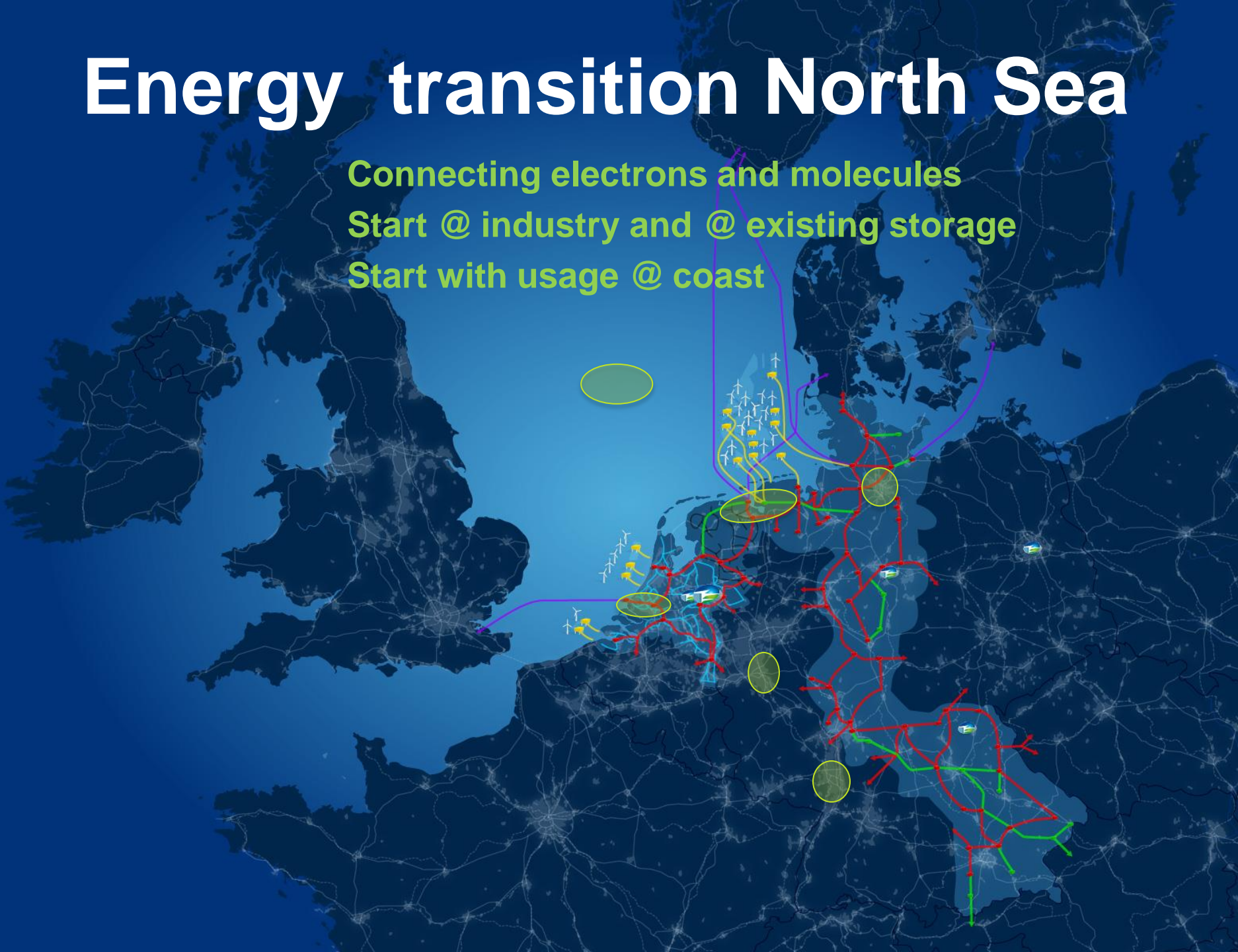


Energy transition North Sea

Connecting electrons and molecules

Start @ industry and @ existing storage

Start with usage @ coast

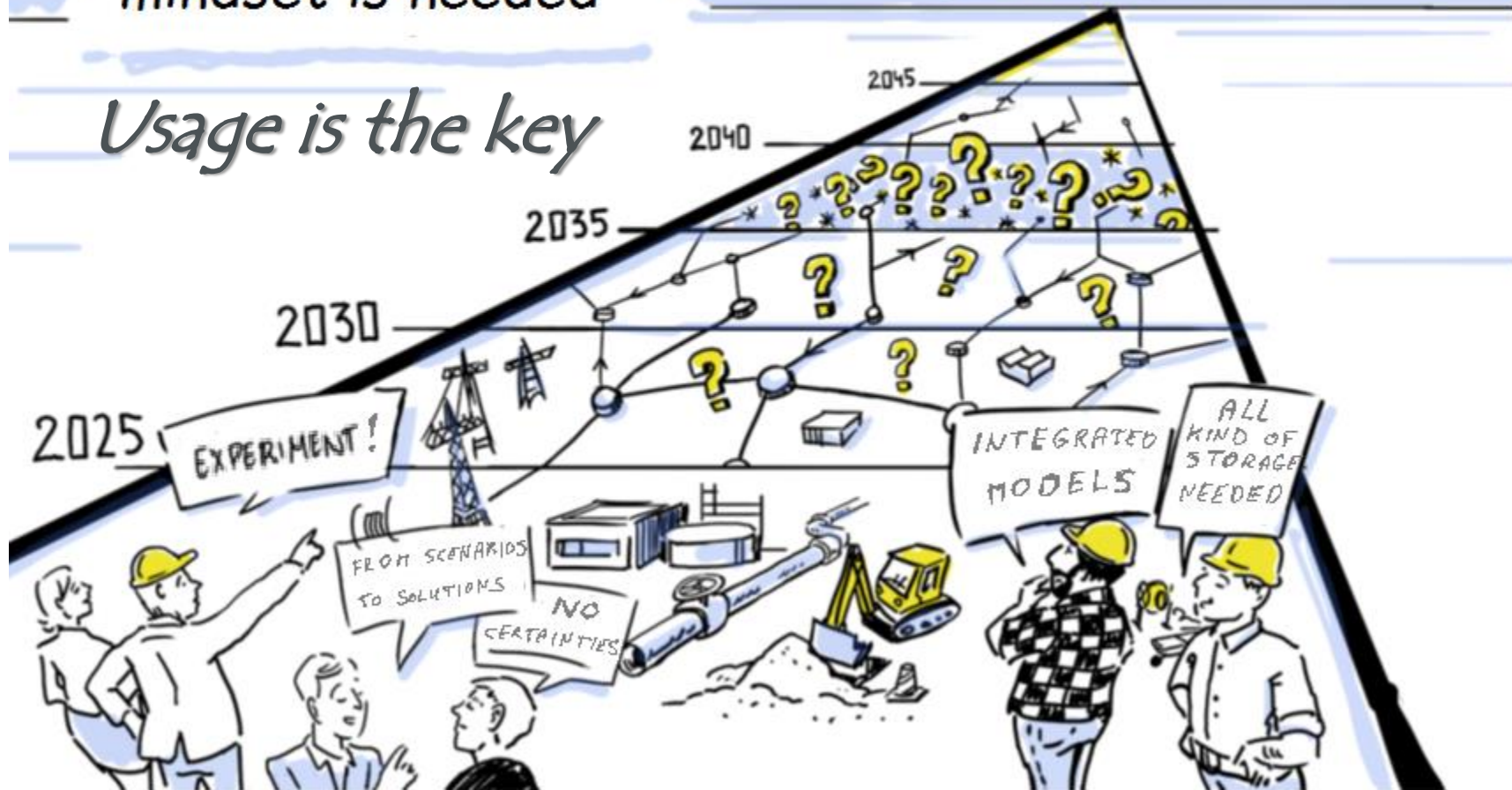



Hydrogen and its Synergies



System
mindset is needed

Usage is the key



A wide-angle photograph of an offshore wind farm at sunset. The sky is a deep blue with scattered white clouds. The sun is low on the horizon, casting a warm, golden glow across the water and the sky. Several wind turbines are visible, their white towers and three-bladed rotors standing out against the colorful background. The water is dark with some ripples. A small boat is visible in the distance on the left, and another larger vessel is in the foreground on the right.

Thank you for your attention

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RTDS hardware in the loop @TU Delft



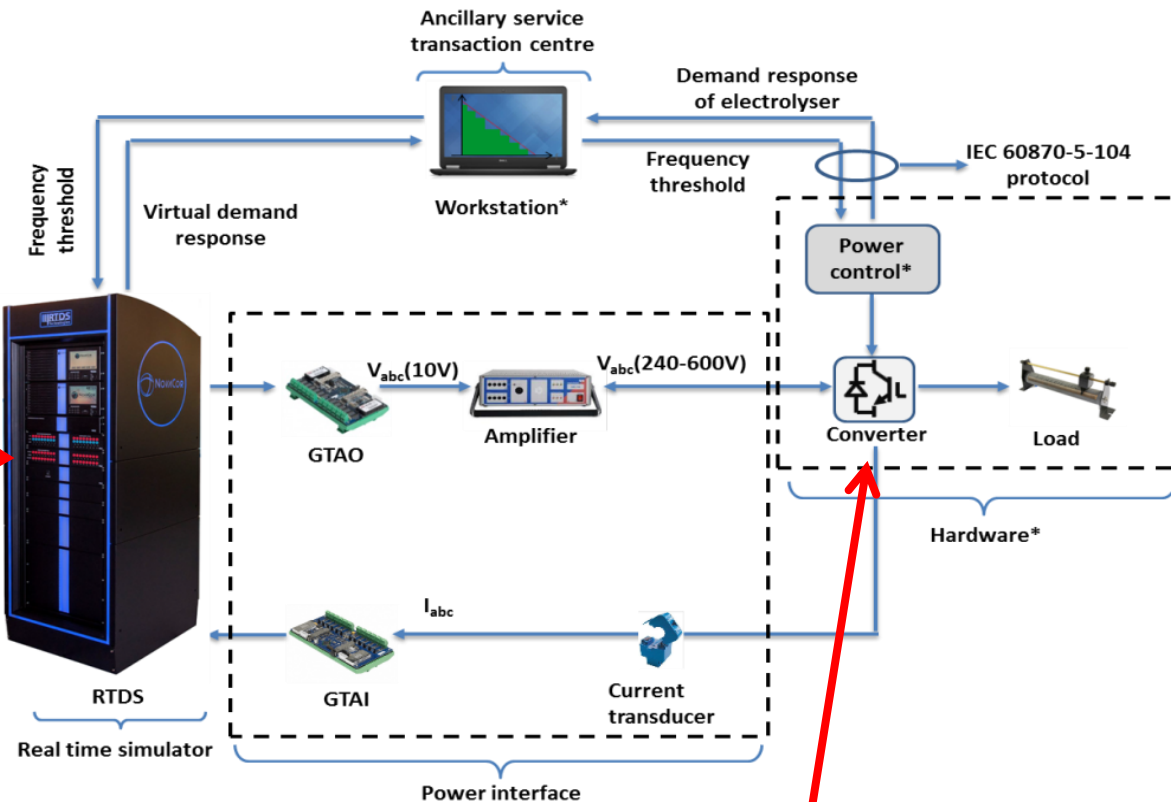
RTDS

Novacore

<--> Lehrte

<--> Bayreuth

<--> Arnhem



1,25 MW PEM electrolyser