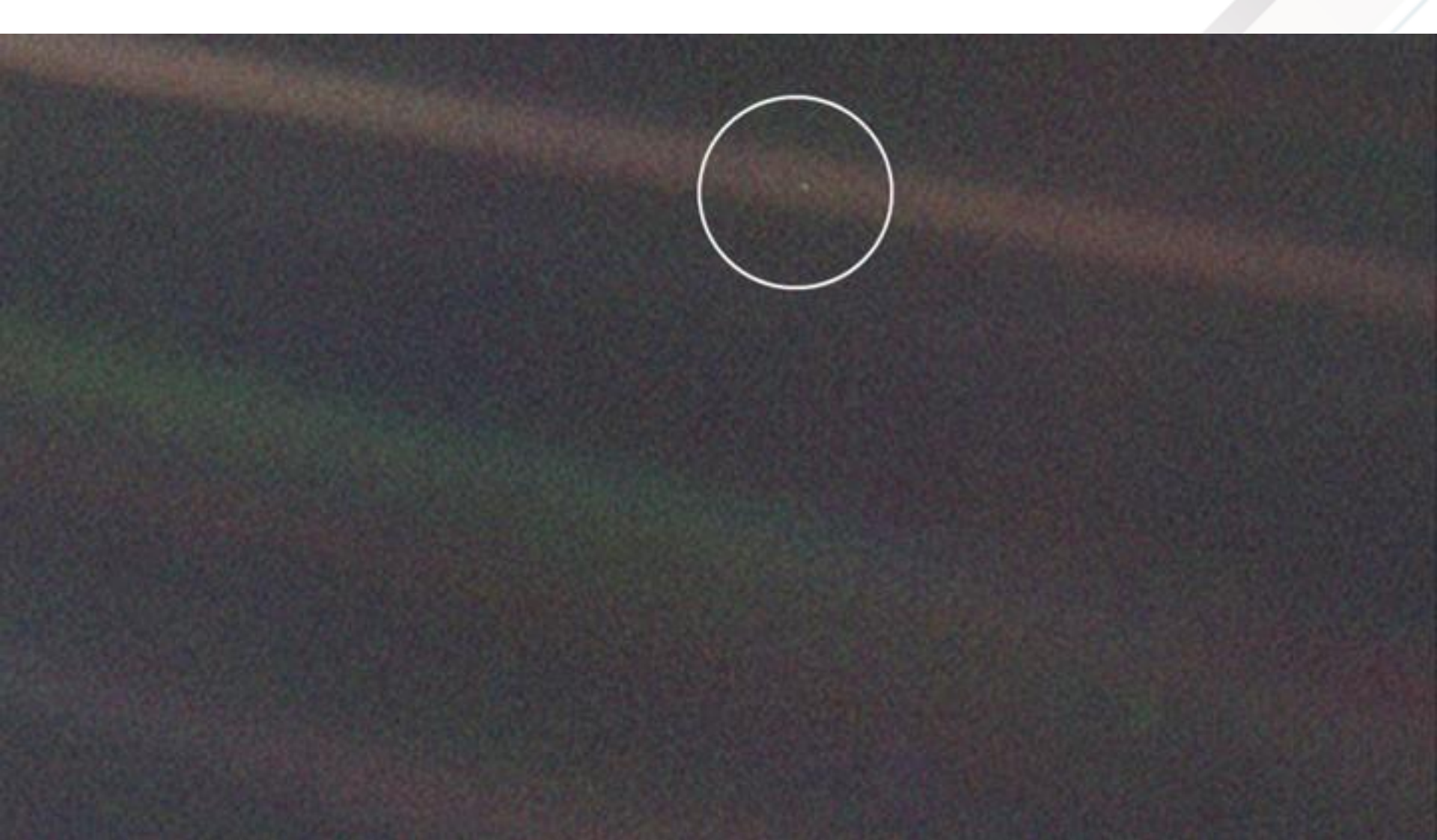


# USING THE ELECTRICITY GRID TO MAKE HYDROGEN

Power Swarm meeting  
21 February 2019  
Marcus Newborough

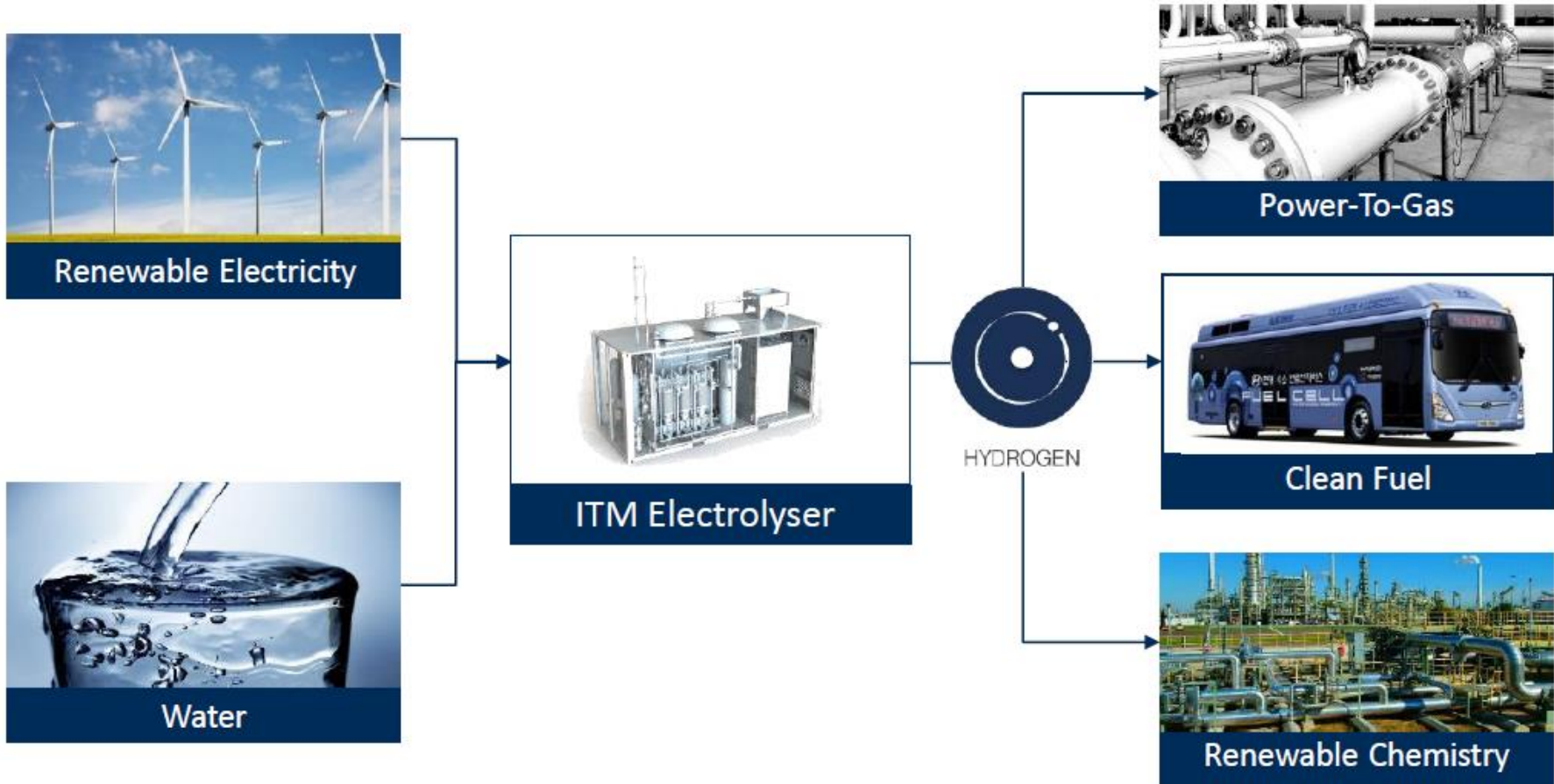




VIEW FROM VOYAGER 1 (FEB 14 1990)

# RAPID RESPONSE ELECTROLYSER

Scalable | Rapid Response | Self-Pressurising

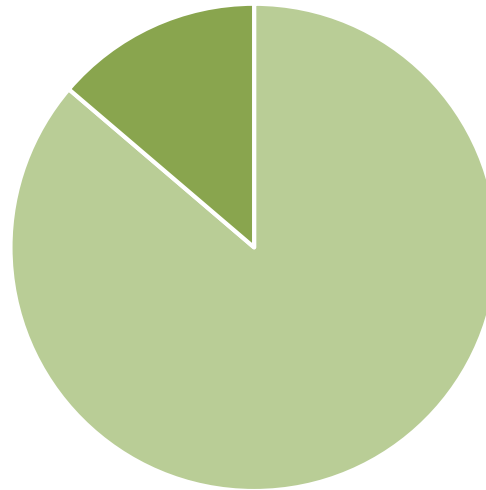


## PEM ELECTROLYSER SYSTEMS

ENERGY STORAGE | CLEAN FUEL

# WE NEED MOLECULES AS WELL AS ELECTRONS

EU-28 : Energy Consumed as Molecules and Electrons



- Primary energy consumption excluding fuel use for electricity generation (Molecules)
- Electricity consumption (Electrons)

Source data: DG ENER, June 2017

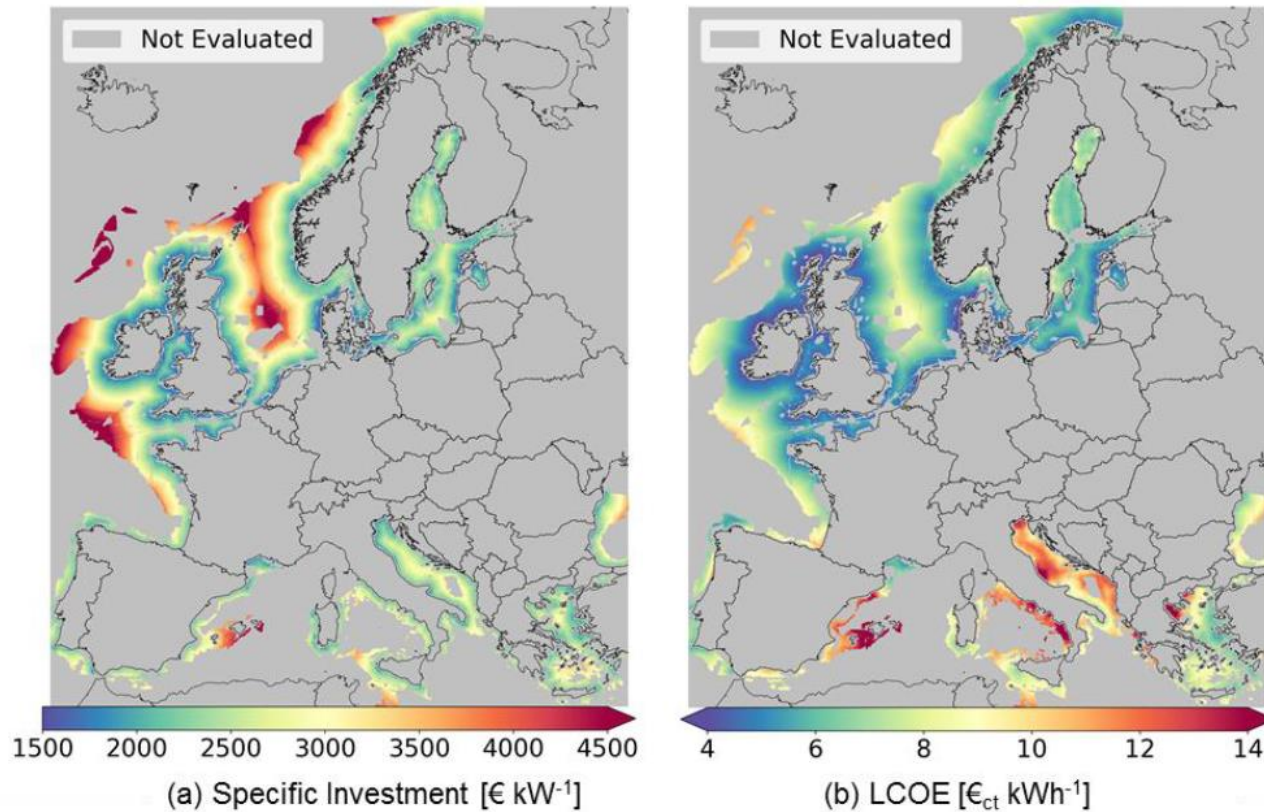
- Electrolysers convert electrons to molecules

SECTORAL INTEGRATION

ENERGY STORAGE | CLEAN FUEL



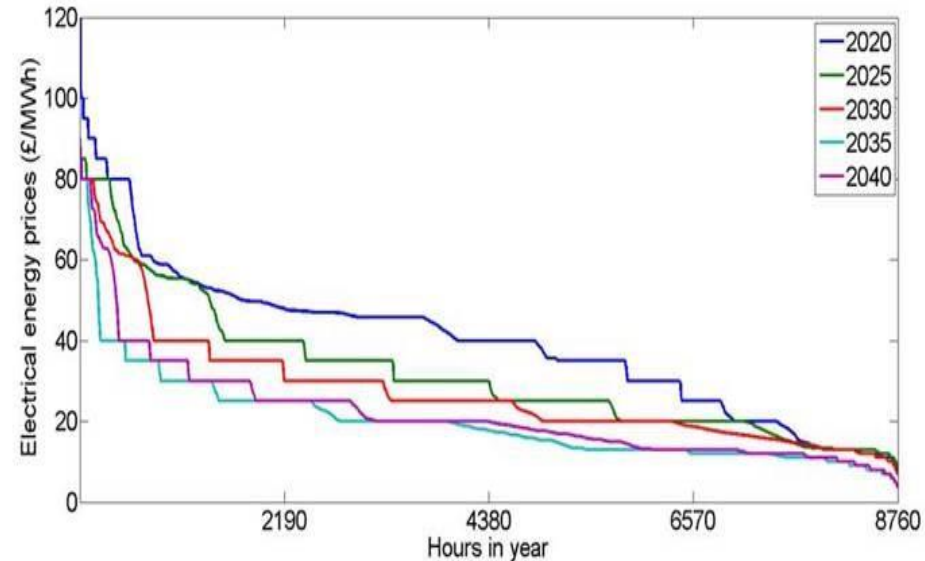
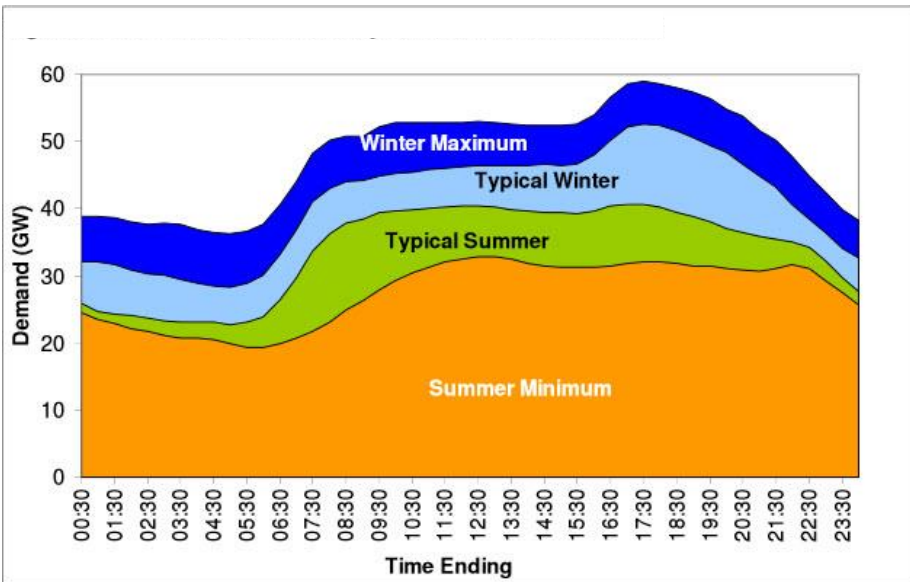
# OFFSHORE RENEWABLES



The overall potential for offshore wind energy across Europe will constitute nearly 8.6 TW and 40,000 TWh at roughly 7 €cents/kWh average LCOE by 2050 [Caglayan et al, 2019]. (EU28 gross inland energy consumption  $\sim$  19,000 TWh)

# ELECTROLYSER DEPLOYMENT

- On-grid and off-grid
- Rapid response electrolyser technology for grid balancing:
  - frequency response
  - negative reserve ('valley filling' electricity demand profiles)



# RELEVANT ELECTRICITY GRID TRENDS

- 373TWh in 2007, 302 TWh in 2017.
  - Annual load factor ~ 60%.
  - Transformers and power lines running at <40% capacity for much of the year.
  - Variability in all power grids is increasing due to renewables integration.
  - Minimum load on transmission grid is falling.
  - Negative reserve requirement increasing markedly.
  - Curtailment is increasing.
  - Need for flexibility services is increasing – electrolyzers can provide up/down response CO<sub>2</sub>-free.
  - Electricity price duration curves are changing, marginal costs of power generation decreasing off-peak.
  - Uncertain economic case for sustained renewables deployment.
- Electricity grid is an under-utilised asset with untapped potential for producing hydrogen.
- Use the electricity grid to generate hydrogen when and where required to increase grid utilisation without requiring its expansion and thereby produce ≥100 TWh of hydrogen.

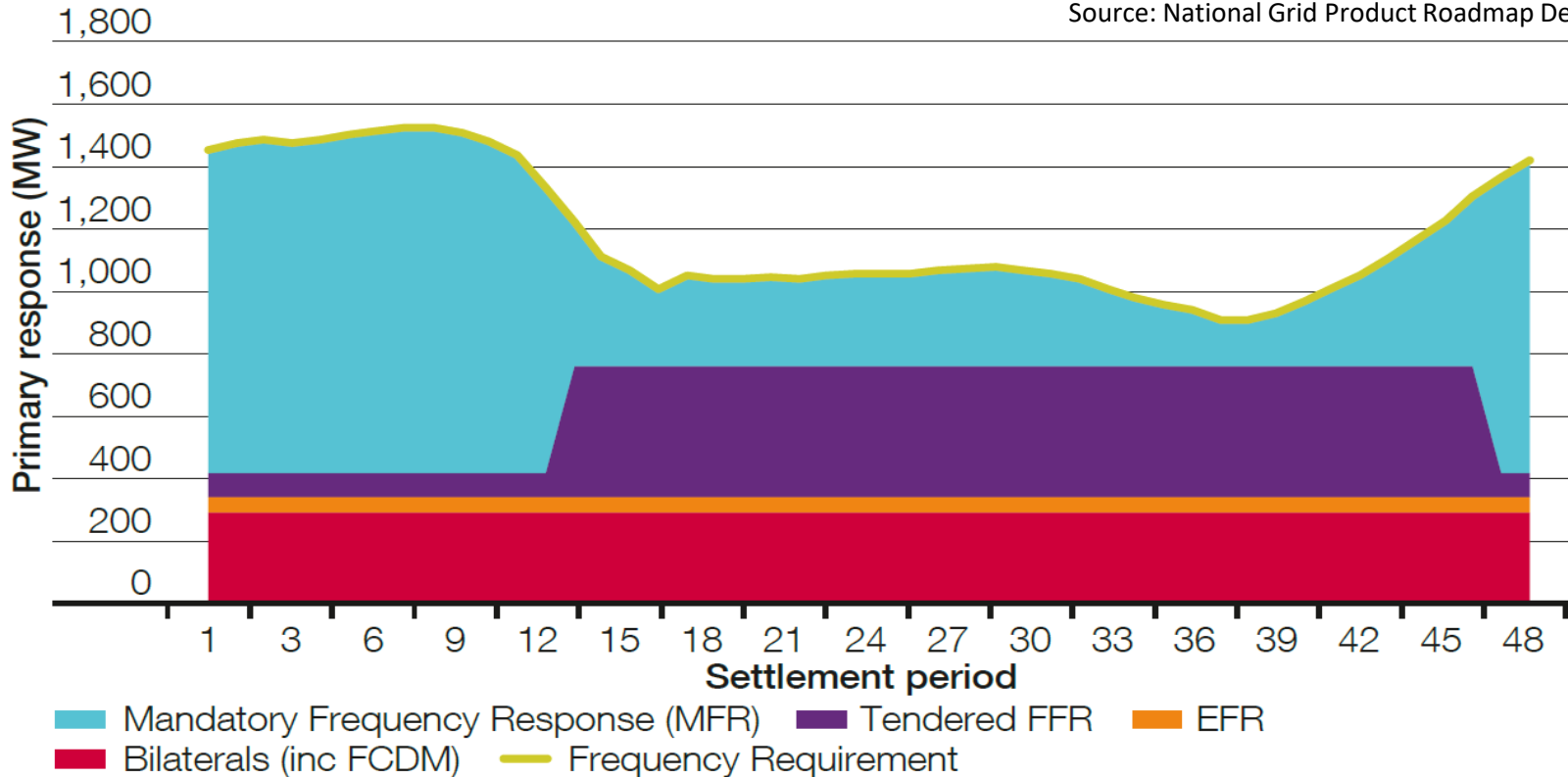
# BACKUP SLIDES



# TREND IN FREQUENCY RESPONSE REQUIREMENT

*Illustration of typical frequency response requirement components*

Source: National Grid Product Roadmap Dec 2017



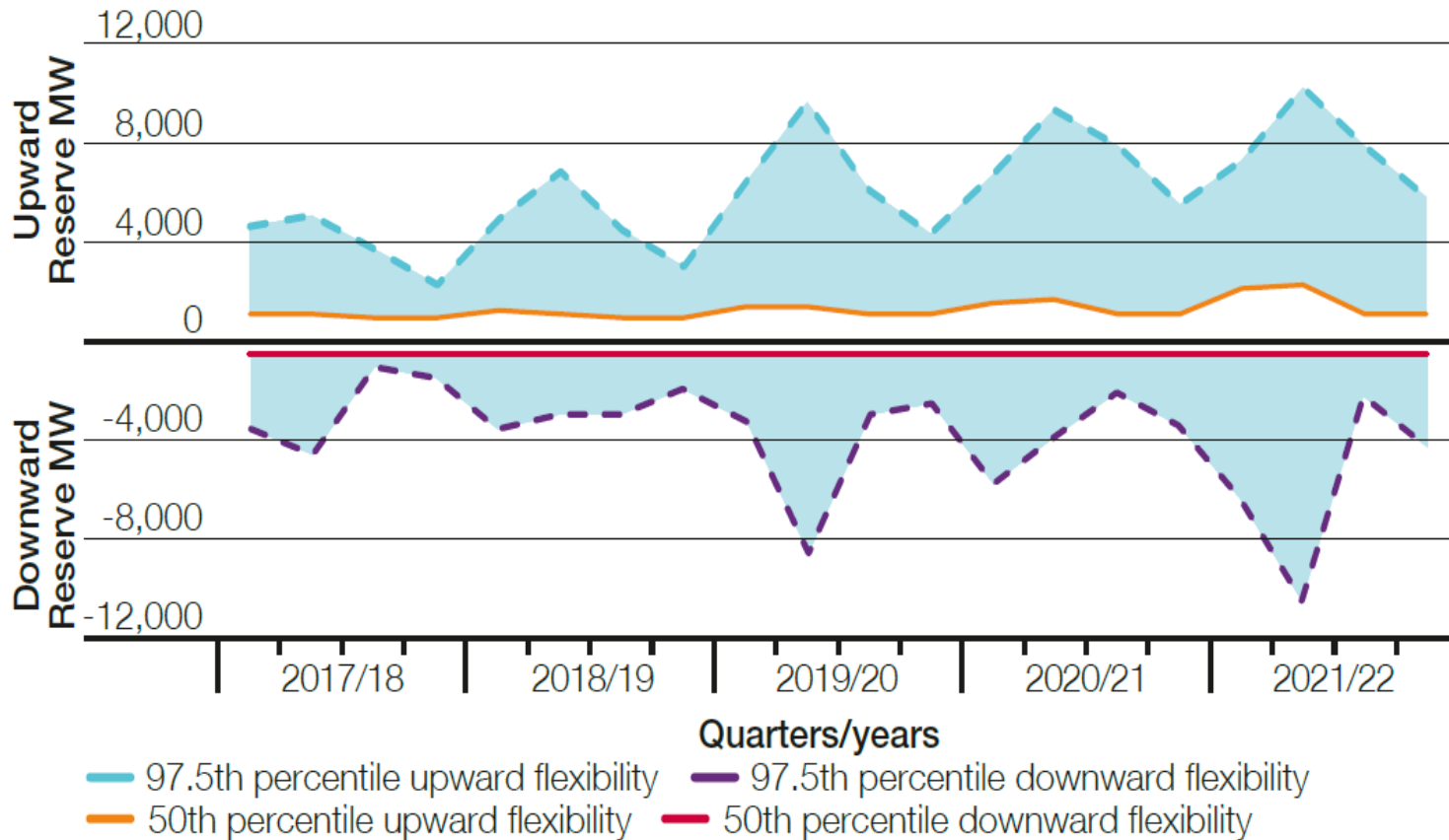
Entire Frequency Response market equates to on average ~ 0.5% H<sub>2</sub> concentration in gas grid

## FREQUENCY RESPONSE SERVICES

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# TREND IN RESERVE REQUIREMENT

*Range of upward and downward flexibility required (Consumer Power)*



Source: National Grid System Needs and Product Strategy, June 2017

RESERVE SERVICES

ENERGY STORAGE | CLEAN FUEL