

PROMOTioN:
**Demonstration of Converter
and Controller Model
Validation**

Lucy Craig
Arnhem, August 2019

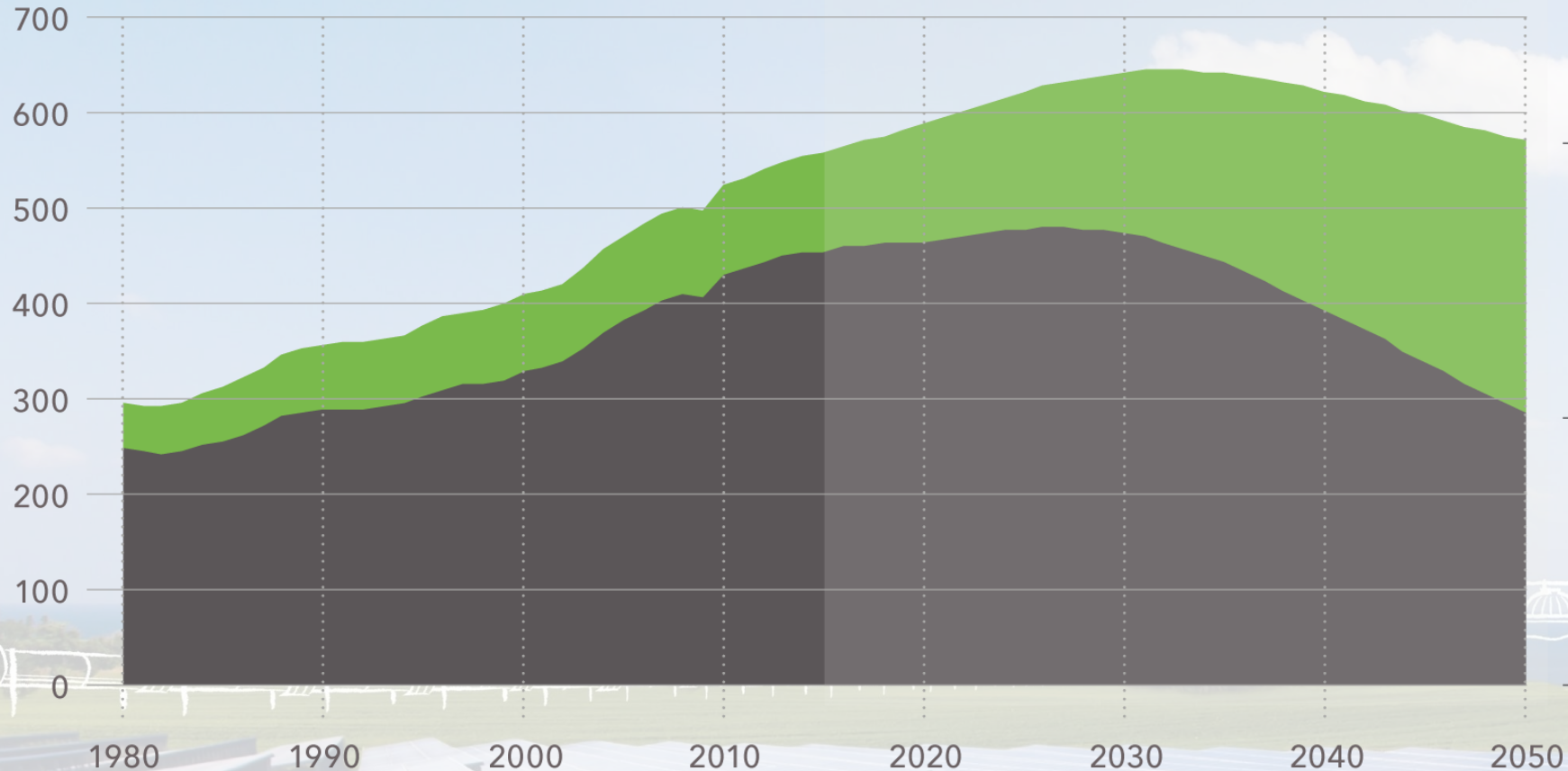


Decades of rapid and extensive change lie ahead for the world's energy systems, particularly for power generation, networks, and electricity use



RAPID RAMP-UP OF RENEWABLES

Units: EJ/ Yr

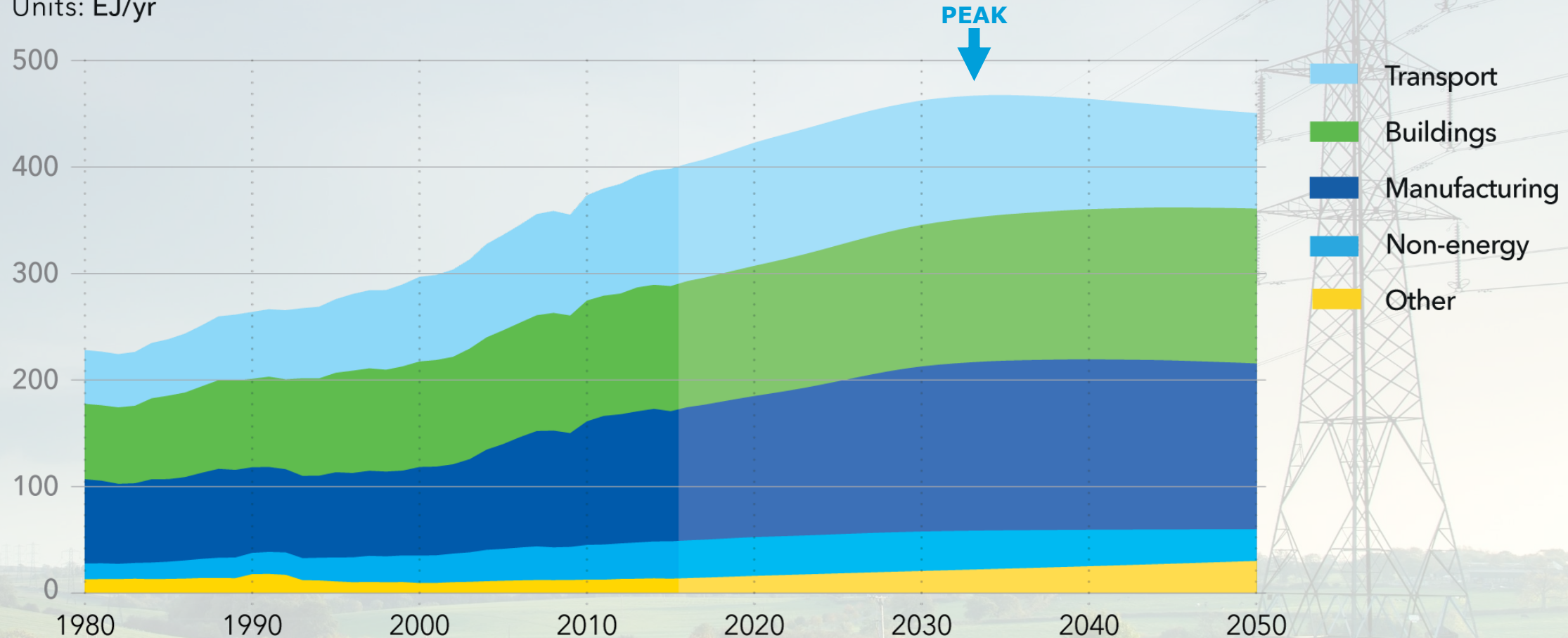


Non-fossil **50%**

Fossil **50%**

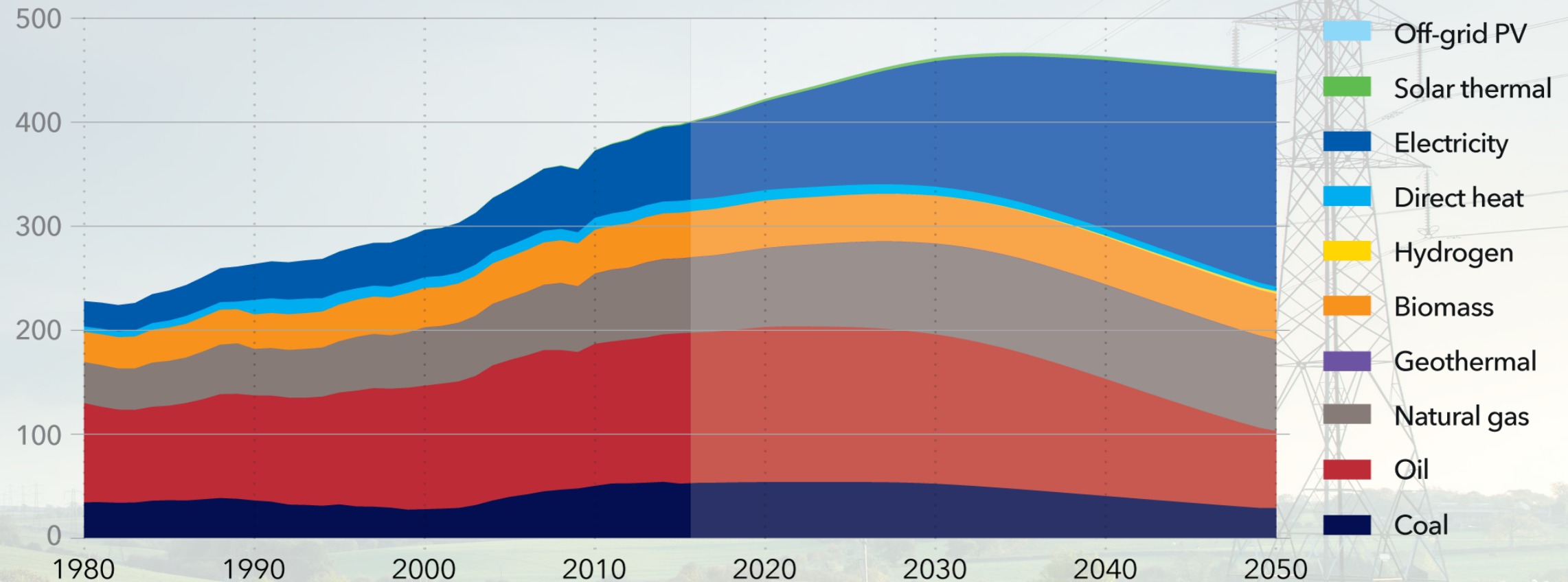
ENERGY DEMAND PEAKING IN 2035

Units: EJ/yr



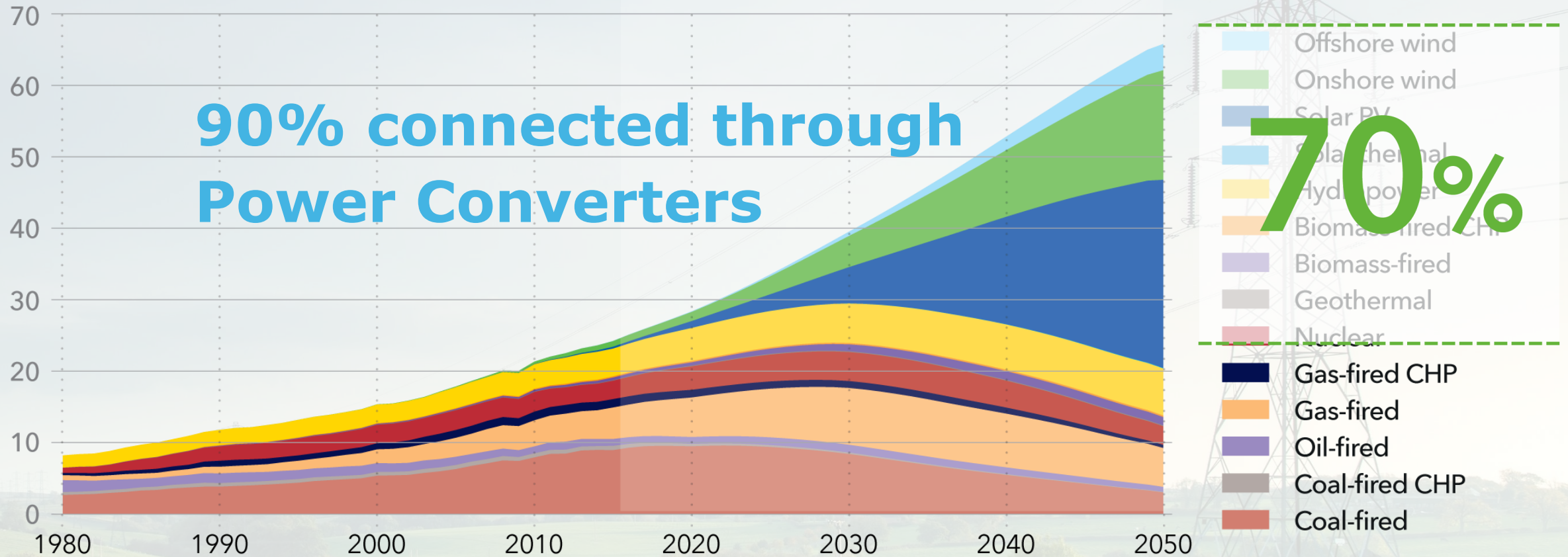
ELECTRICITY WILL MORE THAN DOUBLE

Units: EJ/yr



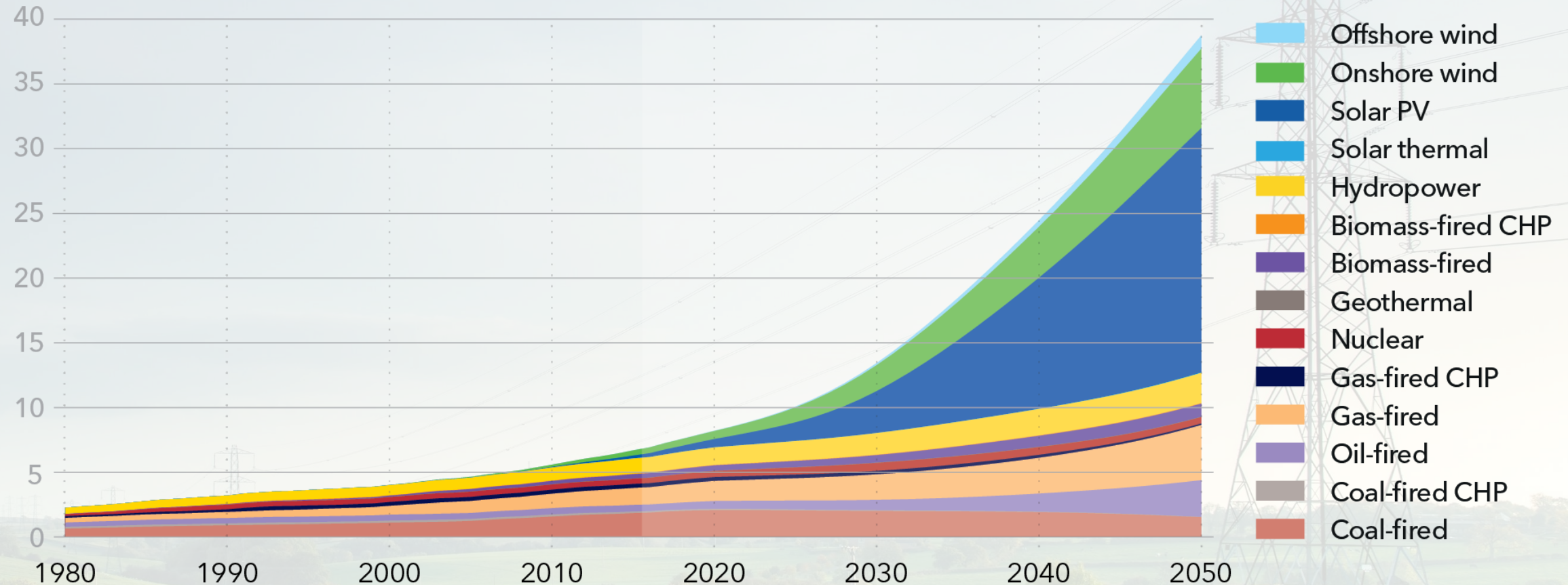
DRAMATIC RISE IN SOLAR PV AND WIND

Units: PWh/yr



MORE THAN 5x NEW INSTALLED CAPACITY

Units: TW



30 TRILLION USD FOR GRIDS



The energy transition is already here: and setting new challenges for power grids

UK to probe world's largest offshore wind farm's role in blackout

Lost generation from Hornsea 1, which will total 1.2GW when fully commissioned, and a gas plant were pinpointed as the twin causes of a blackout that hit a huge swathe of Britain late on Friday afternoon, sparking travel chaos at peak commuter time.

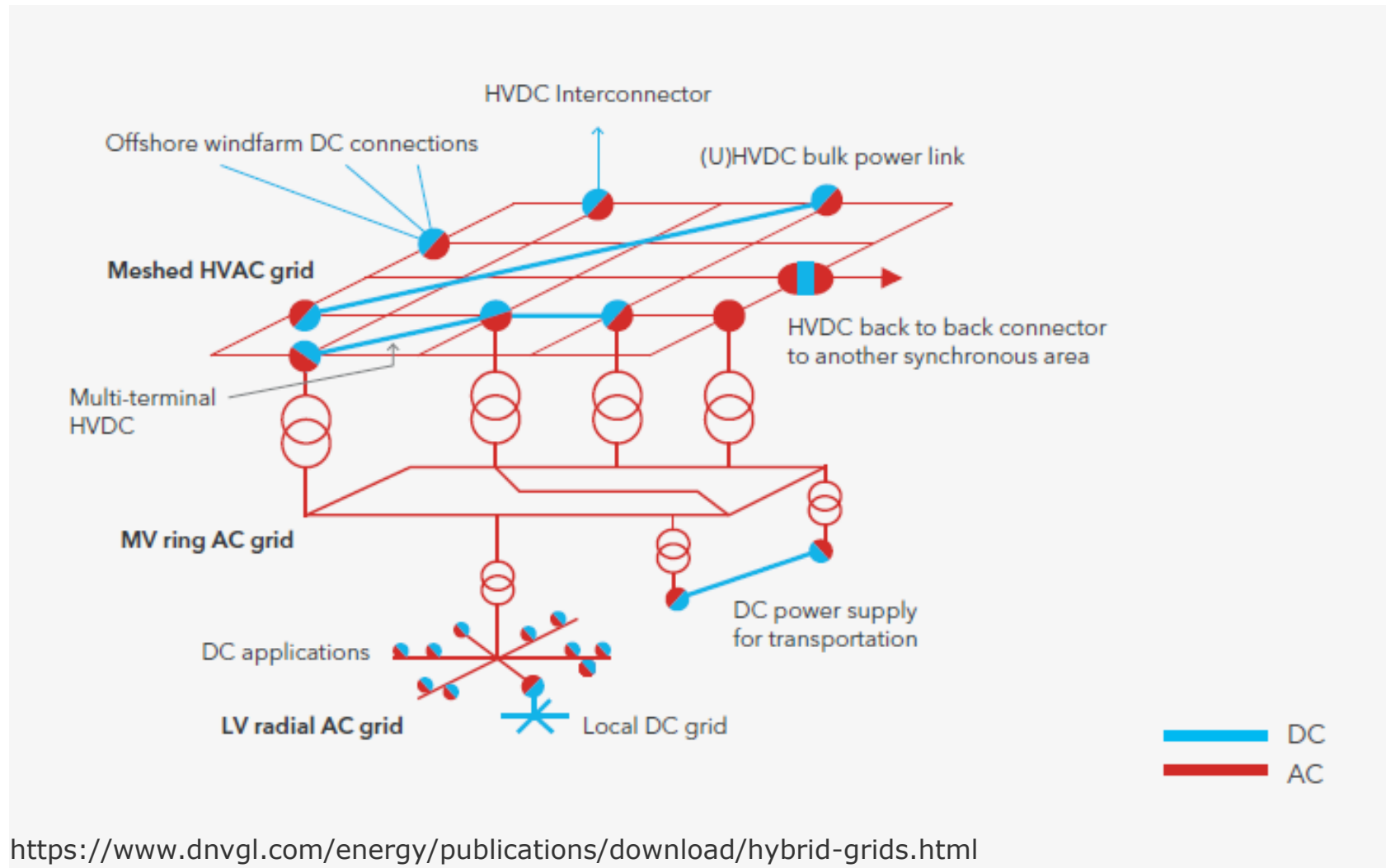


WIND FARM OWNERS TAKEN TO COURT OVER 2016 AUSTRALIA BLACKOUT

Four wind farm operators are being taken to court by the Australian Energy Regulator (AER) over a statewide blackout in South Australia during a major storm in September 2016. Subsidiaries of AGL, Neoen, Pacific Hydro and Tilt Renewables are accused of failing to comply with performance requirements to “ride through” major disruptions and disturbances, in breach of national electricity rules, and now face financial penalties, if found guilty.

Source: Recharge

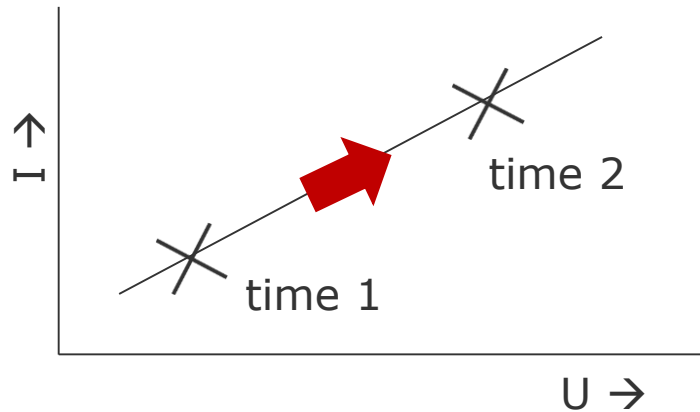
HVDC becomes part of the solution



Future grid stability will be more complex

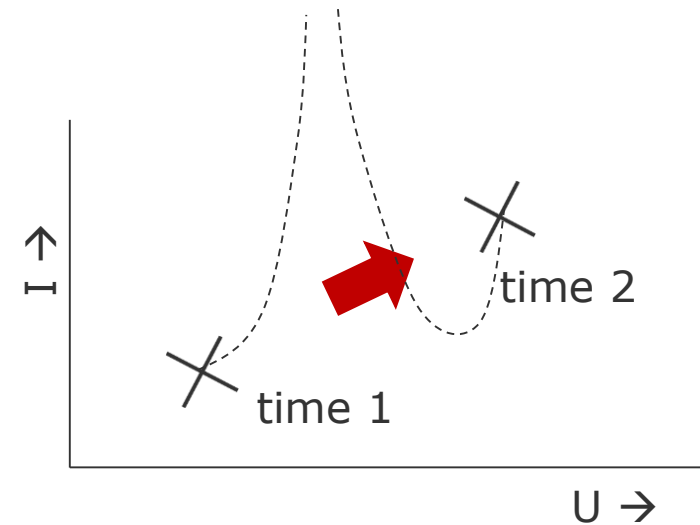
- Past / Current situation:

- $I = U/R$
- Smooth continuous transition from operation modes



- Future situation

- Governed by discrete algorithm:
 $I_{k+1} = U_k/R + \alpha(U_k)^2$



From (simple) physics to complex active non-linear control system

The future of validation

HIL technique enables flexibility and allows for innovative development, it mitigates the introduction of new and unforeseen error-modes and most importantly prevents proliferation of rogue control software, that over time might jeopardize the entire power system.

WELCOME!