Driving whole of system planning from the bottom up

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Centre for New Energy Technology

ESP-V webinar

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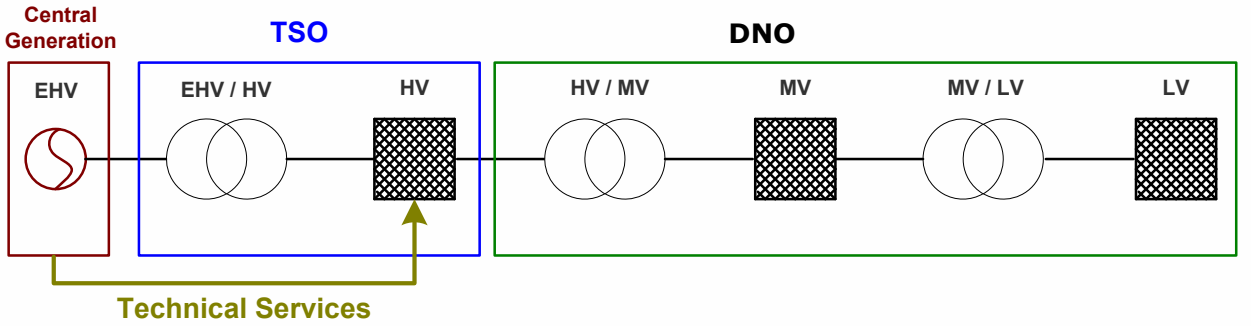
Historical system architecture and flexibility



Visible generation = "dispatchable" and "controllable"

Flexibility

Inflexible demand side

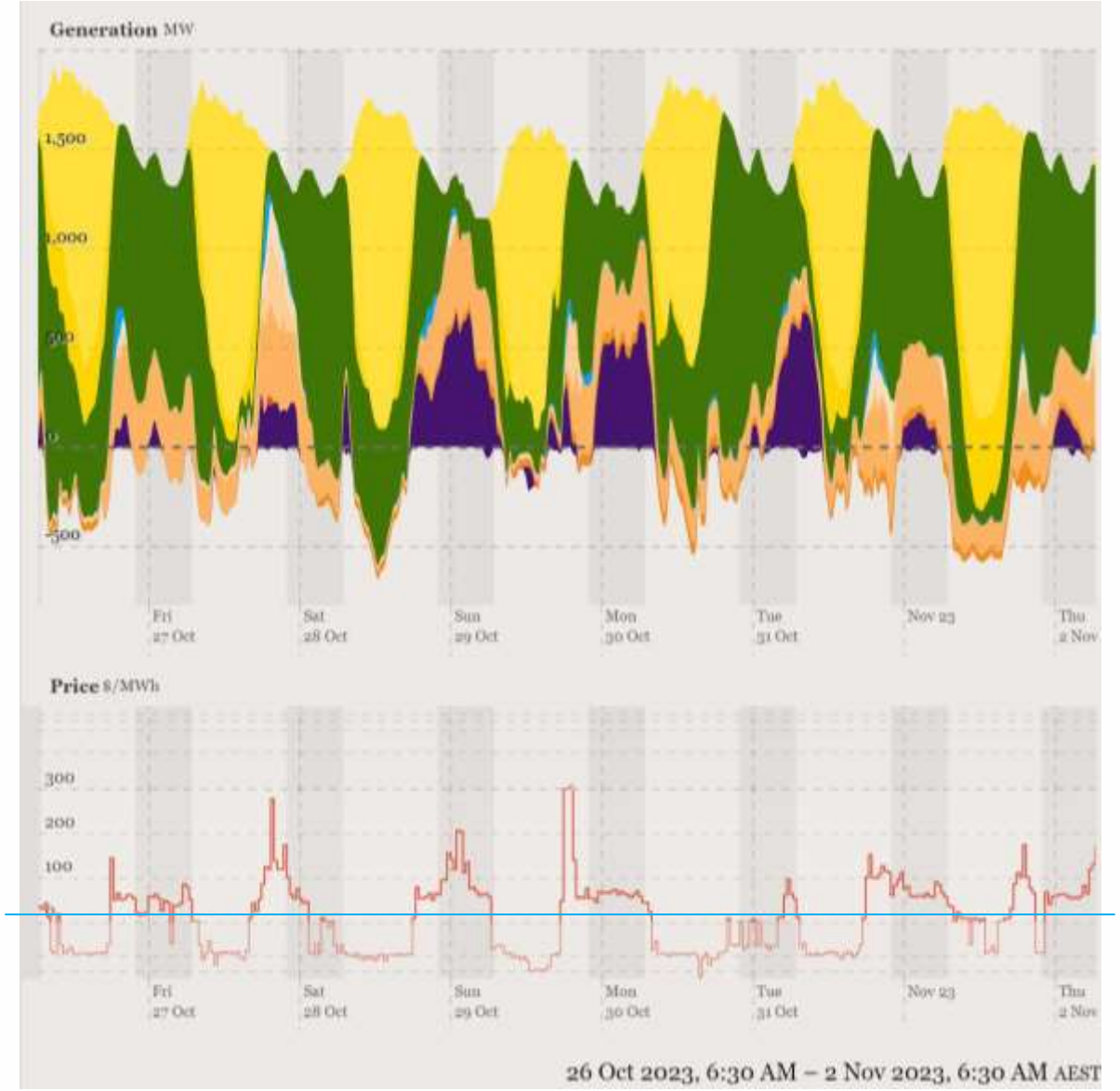
TV, microwave oven, kettle, laptop, lighting, washing machine, dishwashers, …

Invisible **embedded generation** = "non-dispatchable" and "non-controllable"

Source: More Microgrids project, 2010

Transmission vs distribution in the market

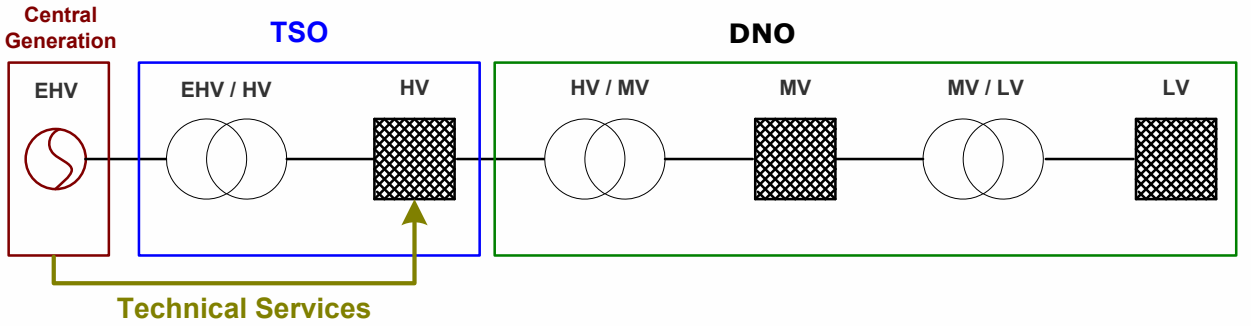
Huge rooftop PV generation



*"Utility scale solar contributed just 4.2 per cent, but that's because the bulk of its **450MW** of installed **large scale solar capacity** in the state was **curtailed** most of the time by negative prices"*

Source: OpenNEM

Historical system architecture and flexibility



Visible generation = "dispatchable" and "controllable"

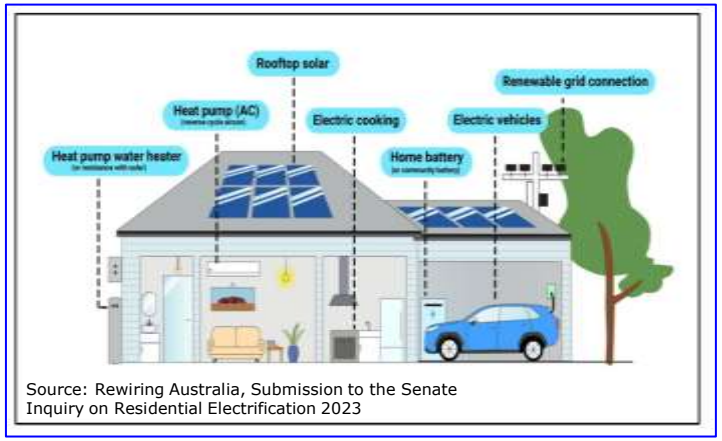
Flexibility

Inflexible

Game changer!

Invisible **embedded generation** = "non-dispatchable" and "non-controllable"

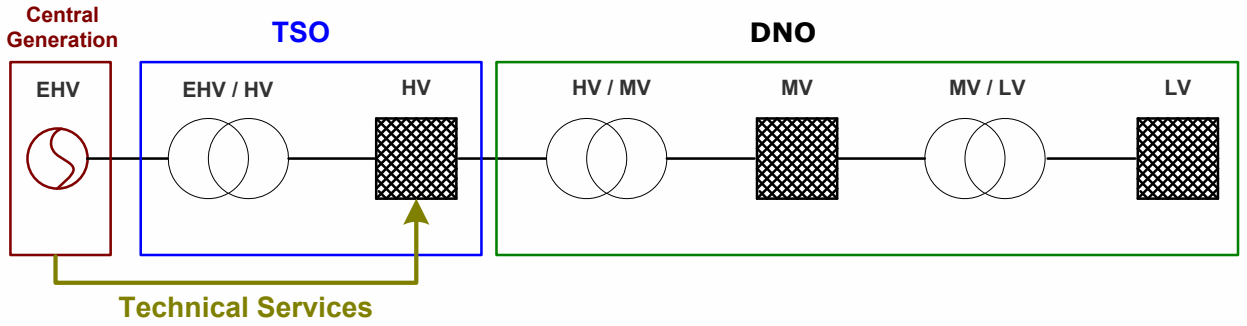
Water heater, electric heat pump, air conditioning, electric vehicle, battery



Source: Rewiring Australia, Submission to the Senate Inquiry on Residential Electrification 2023

Source: More Microgrids project, 2010

A changing paradigm for flexibility provision

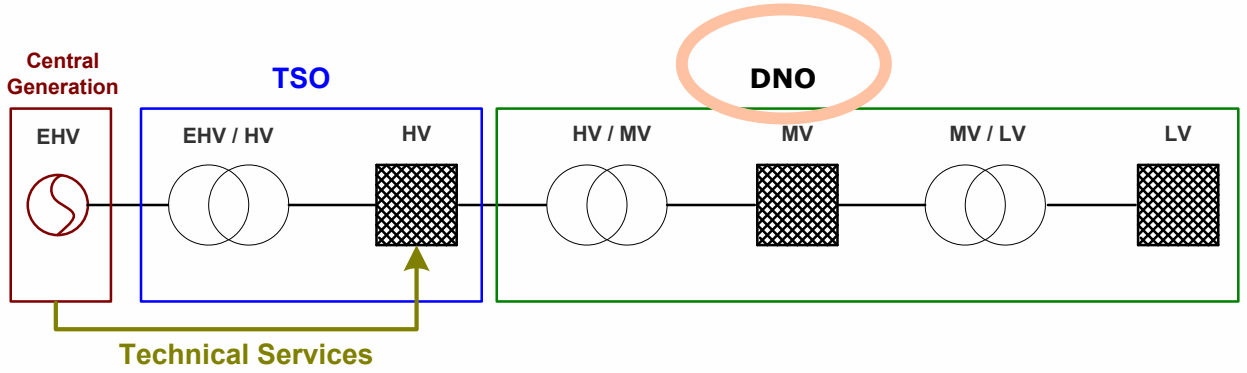


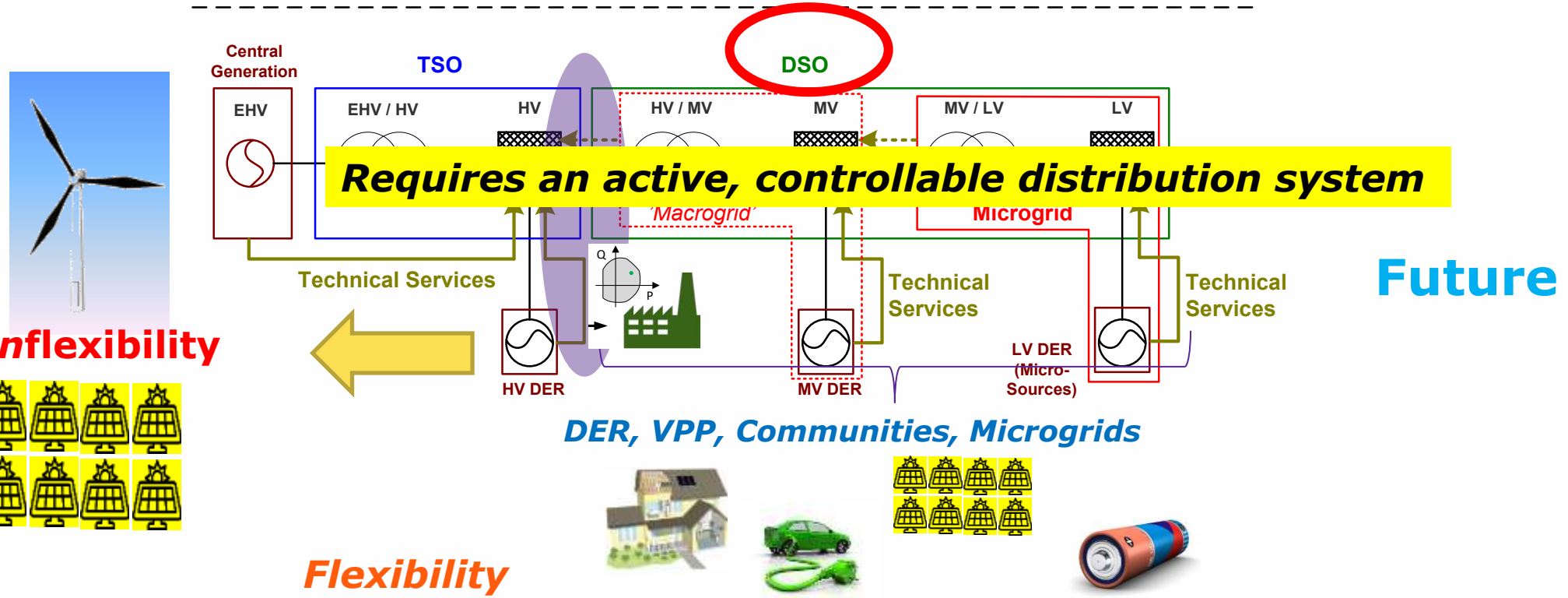
Past

Flexibility → **Inflexibility**

Source: More Microgrids project, 2010

A changing paradigm for flexibility provision

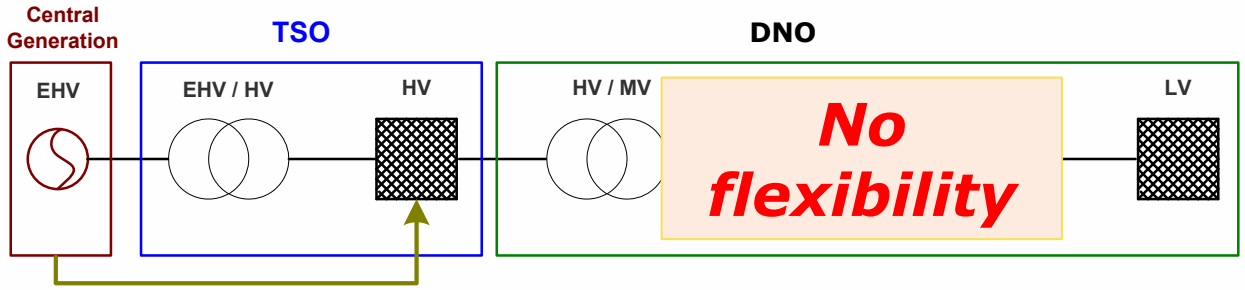




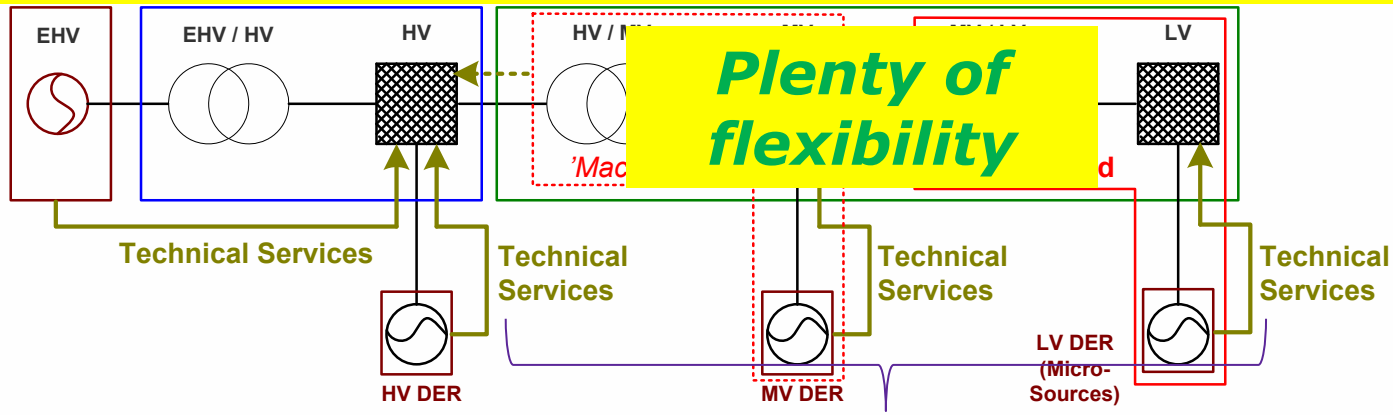
Source: More Microgrids project, 2010

(Images sourced from the internet)

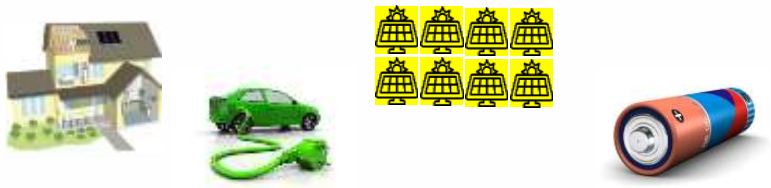
A changing paradigm for flexibility provision



How much network redundancy do we need in the two systems? And where should it be?



DER, VPP, Communities, Microgrids

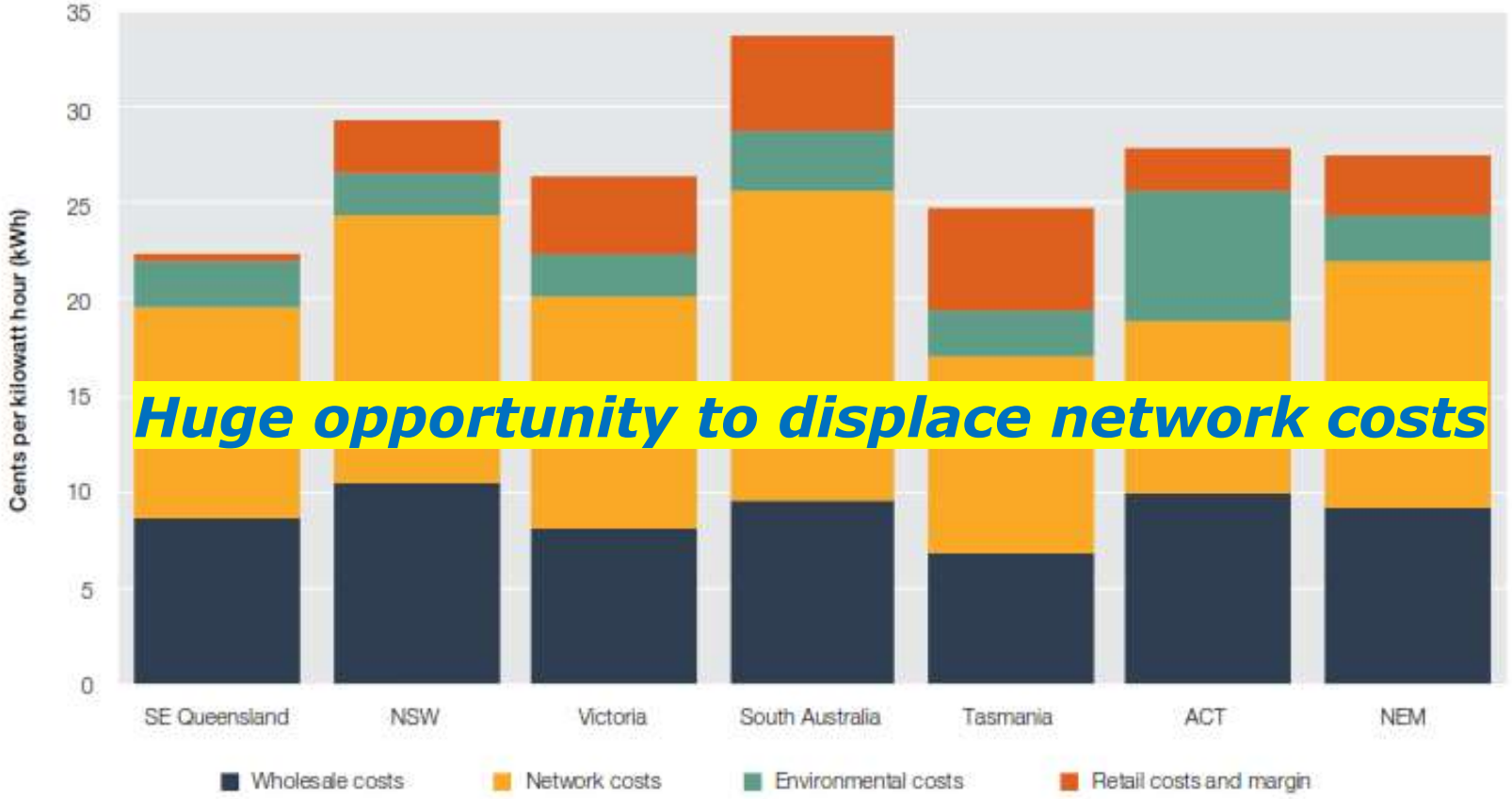


Source: More Microgrids project, 2010

(Images sourced from the internet)

Residential electricity bill cost components

Figure 6.2 Composition of a residential bill – electricity



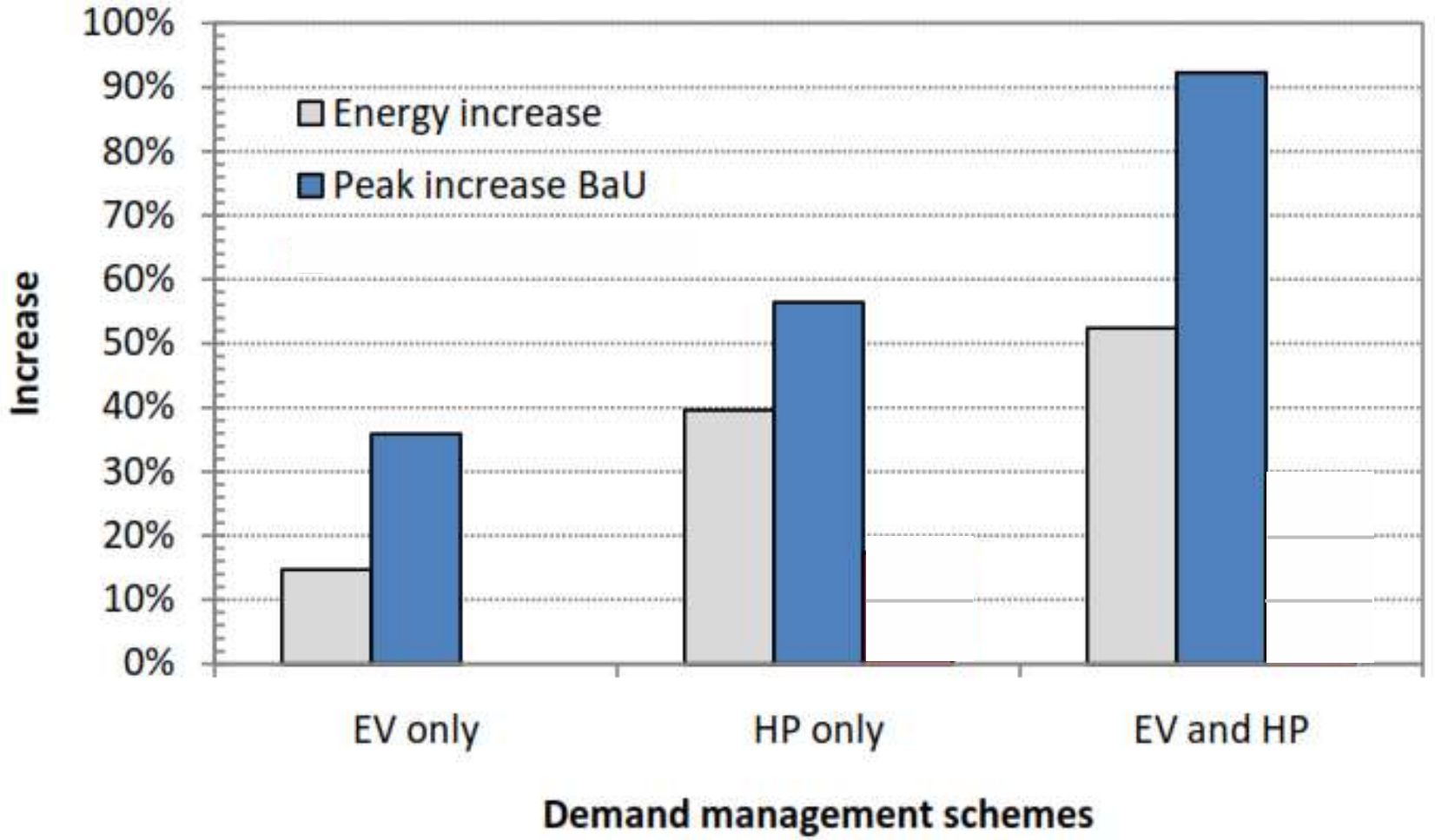
Huge opportunity to displace network costs

Note: Cost components for the average residential customer in 2021–22, excluding GST Calculated using tends in supply chain components for each jurisdiction and national trends.

Source: AEMC, *Residential electricity price trends 2021*, 25 November 2021 (using data from Energy Made Easy and Victorian Energy Compare on 17 September 2021).

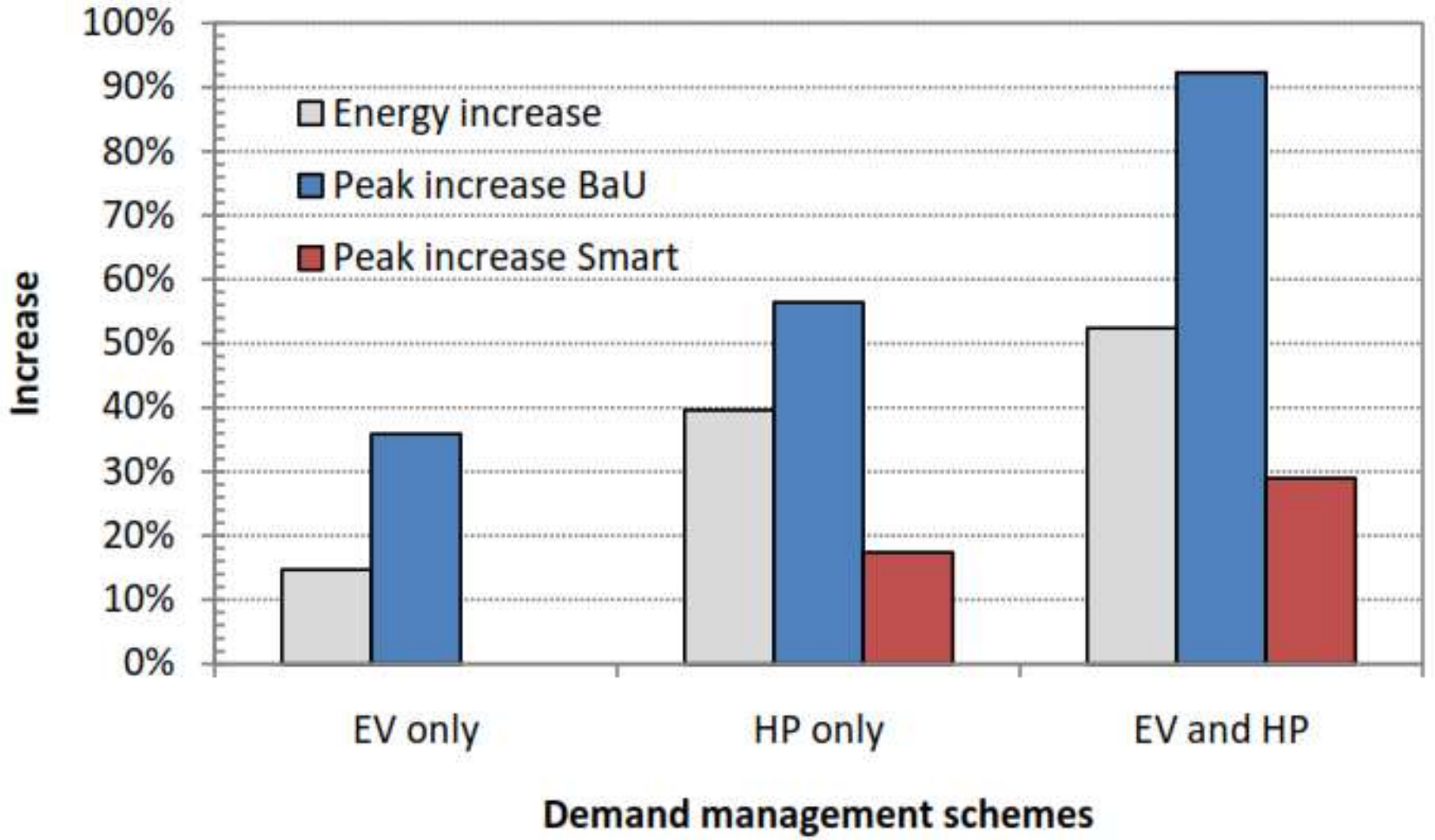
Source: https://www.aer.gov.au/publications/reports/performance/state-energy-market-2022

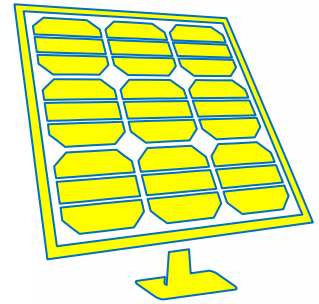
Electrification and network benefits of DER management schemes



G. Strbac et al., "Benefits of Advanced Smart Metering for Demand Response based Control of Distribution Networks", Imperial College London, 2010

Electrification and network benefits of DER management schemes





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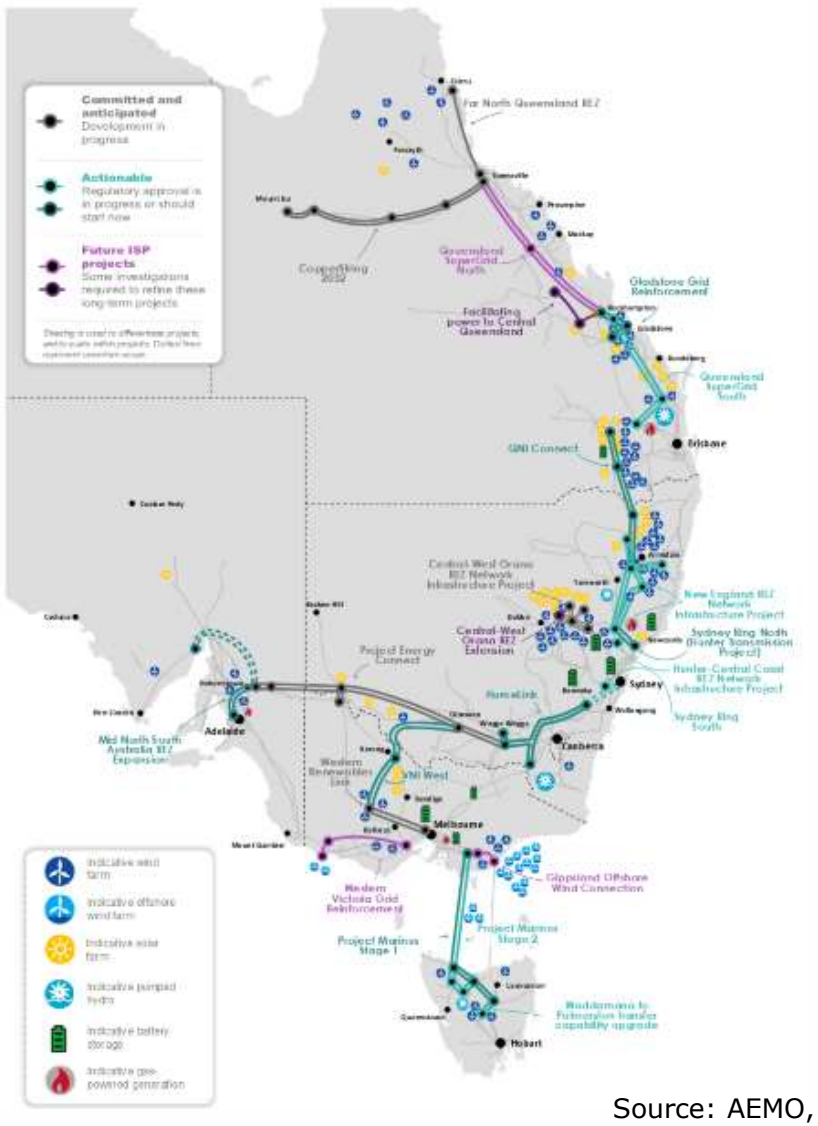
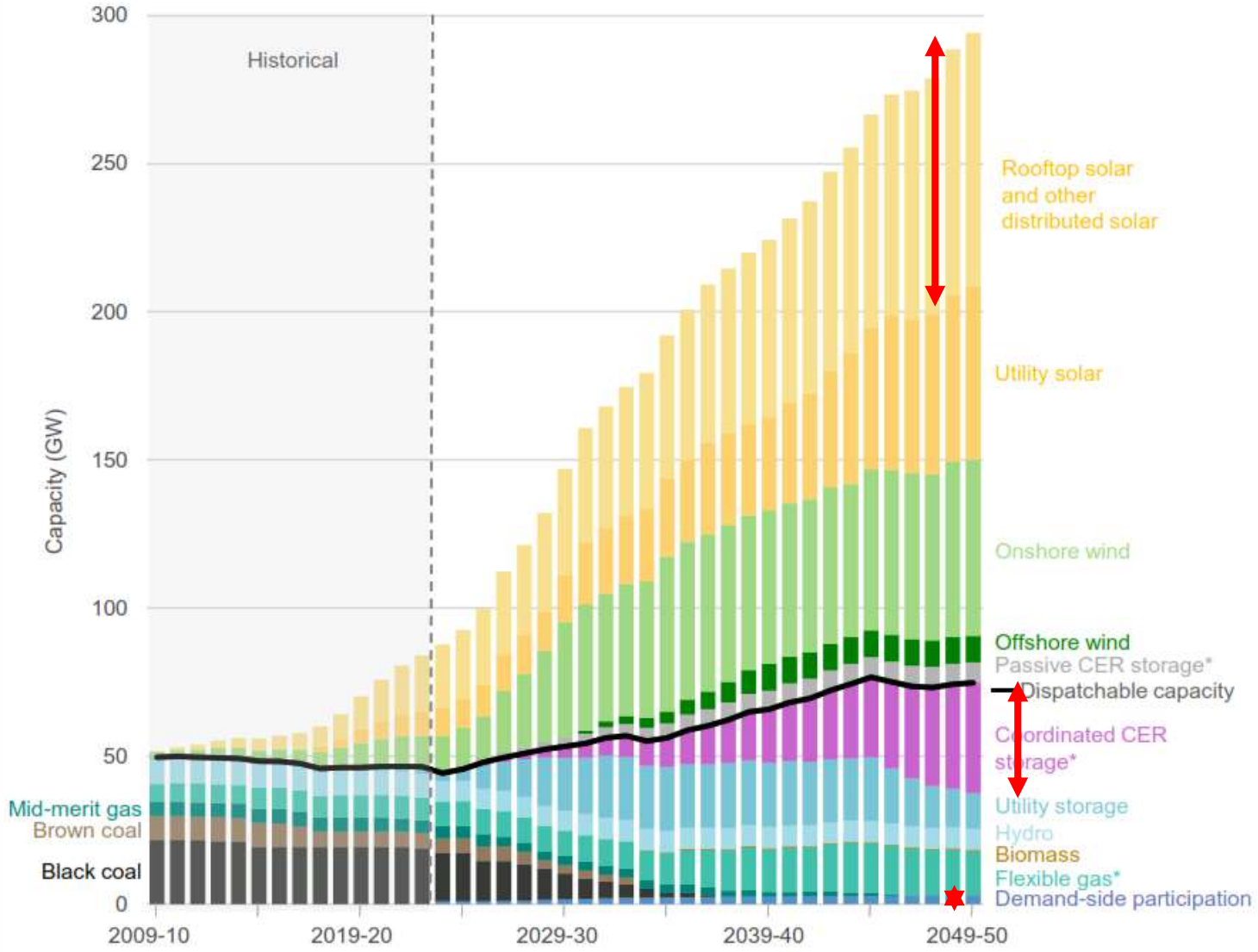
What is the role of the demand side in the future?

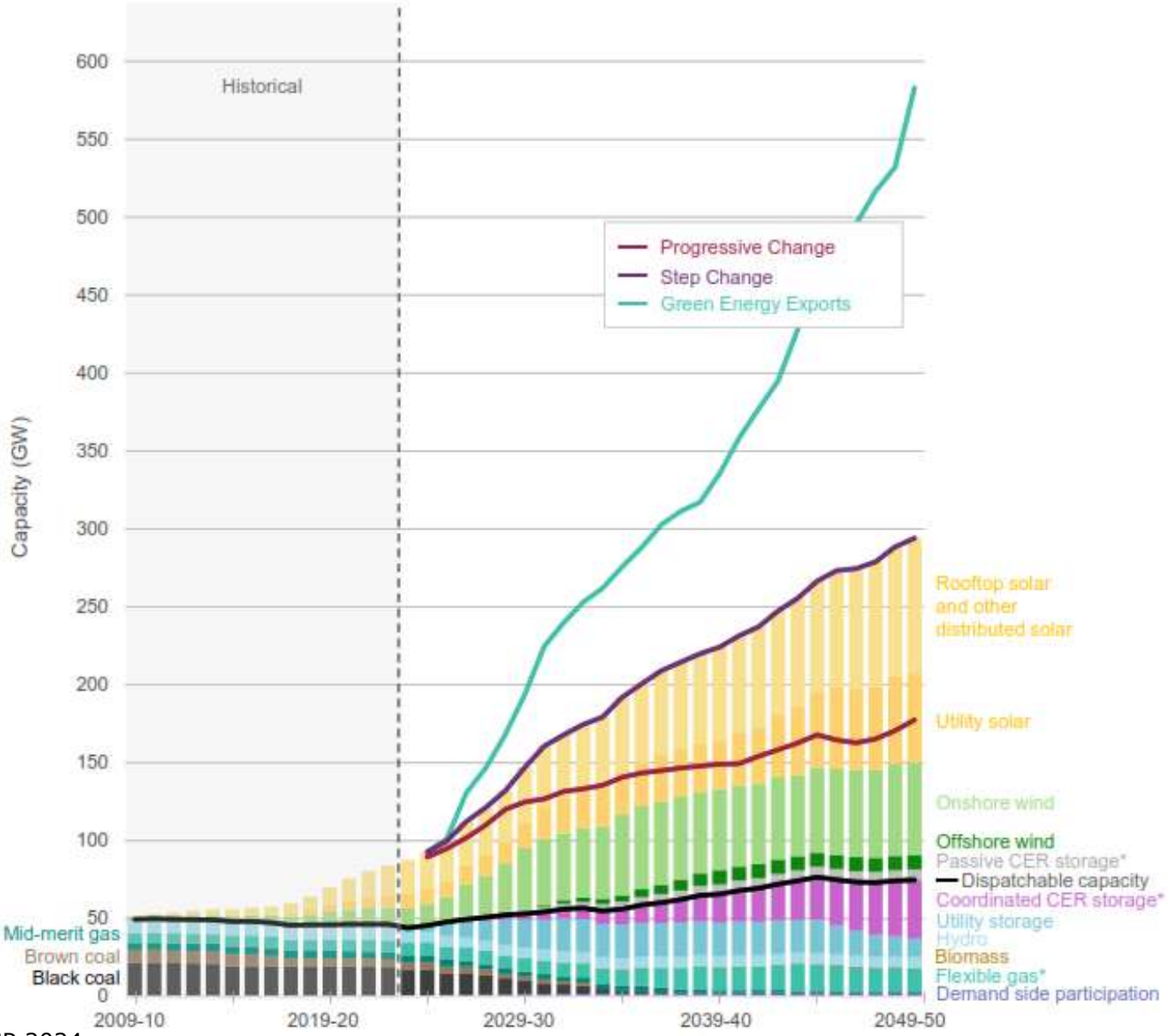
Installed generation capacity, "Step change" scenario





Source: AEMO, ISP 2024

But what future do we plan for?

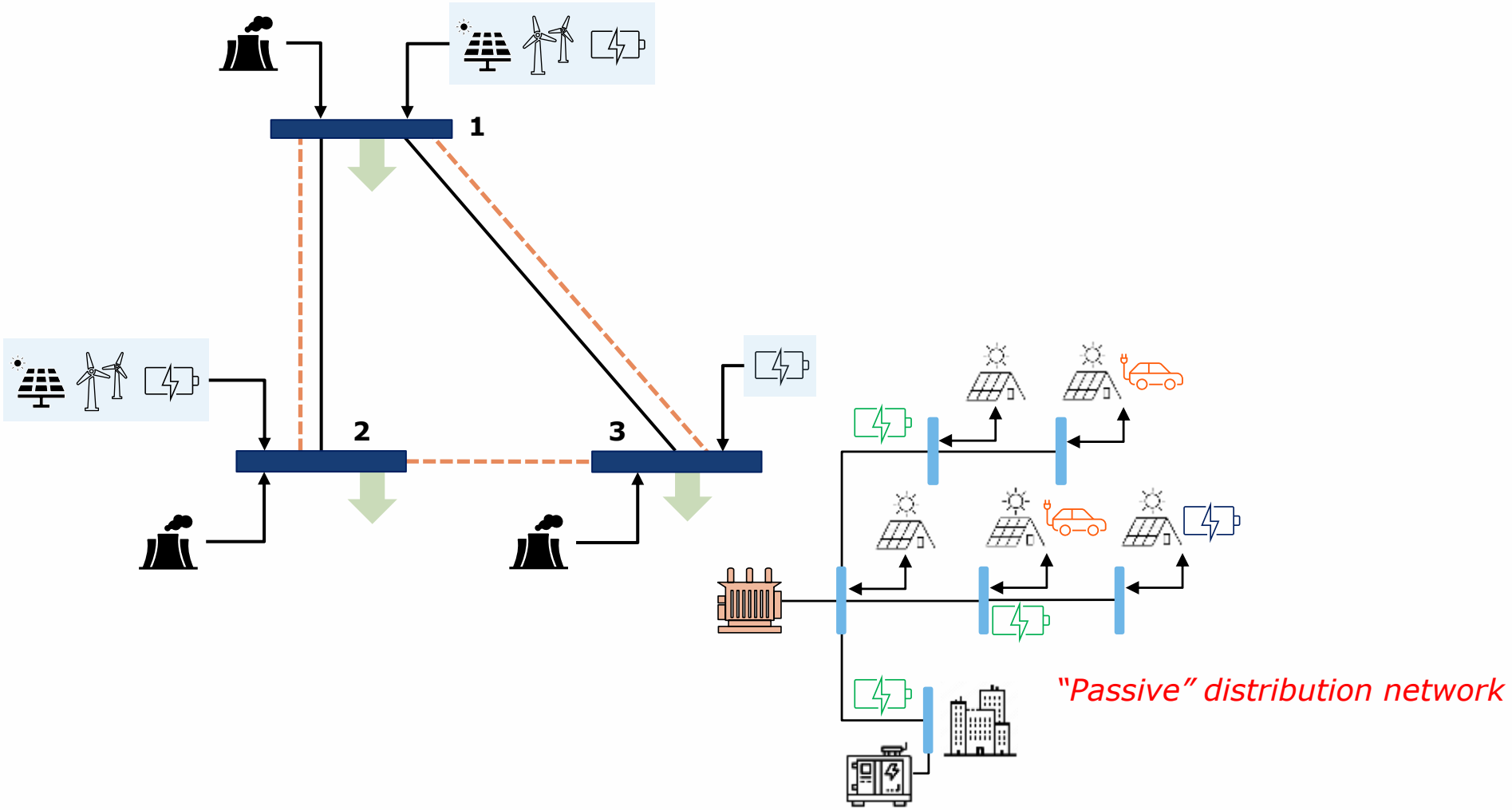


Source: AEMO, ISP 2024

- **DER with orchestration** and **transmission-level investment** exhibit **complementarity and synergy**
- Benefits from DER orchestration better captured when considered **planning uncertainty** and network **investment risk**
- ***DER orchestration*** may systematically **reduce** transmission-level:
  - **investment** requirements
  - **investment uncertainty** → *risk-hedge value*

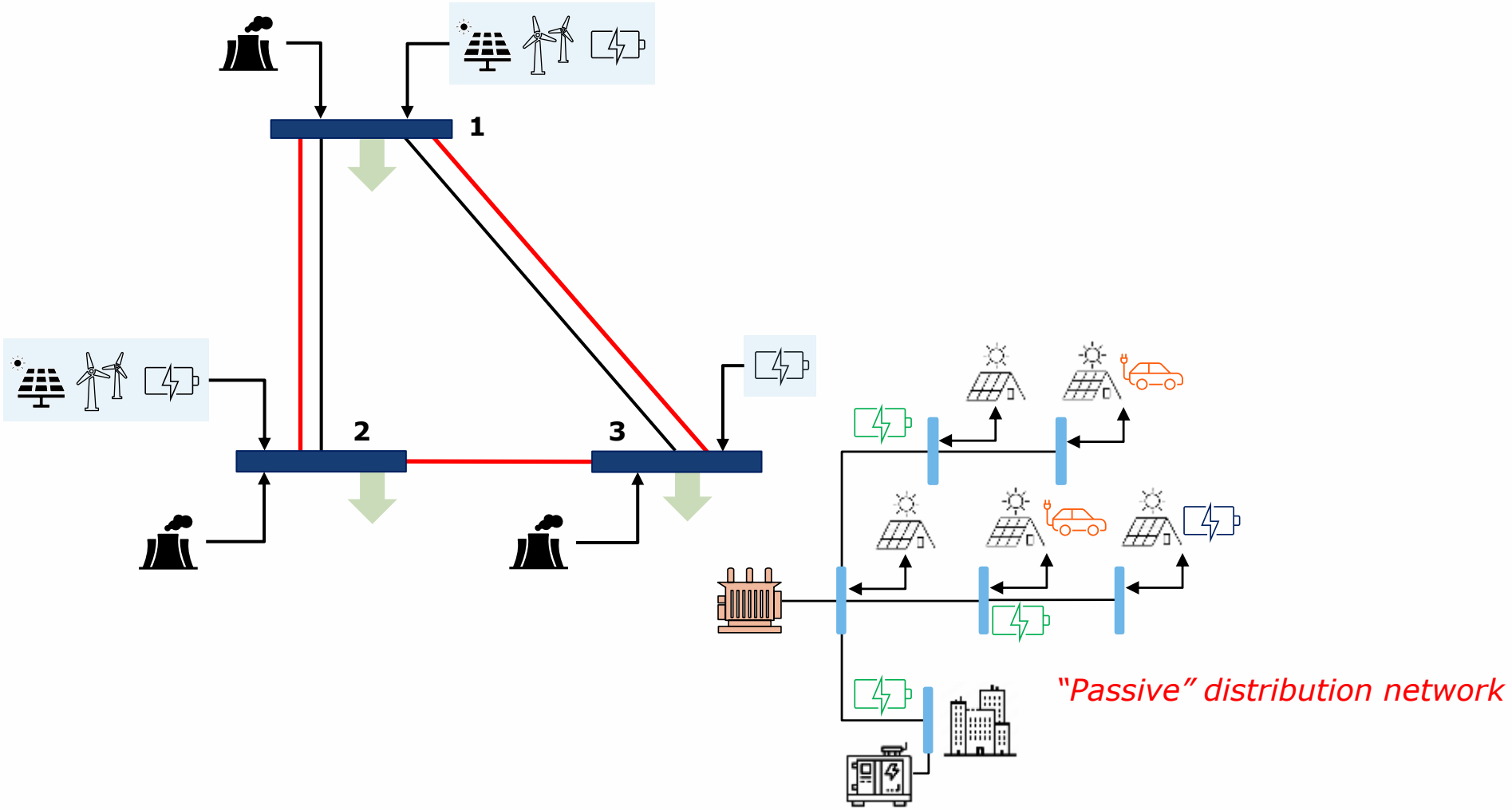
P. Apablaza *et al.*, "Assessing the Impact of DER in the Expansion of Low-Carbon Power Systems Under Deep Uncertainty*", Electric Power System Research*, 2024

Integrated planning of transmission and distribution



C. Alcarruz *et al.*, "Integrated transmission and distribution expansion planning: A critical overview", 2024, *under preparation*

Integrated planning of transmission and distribution



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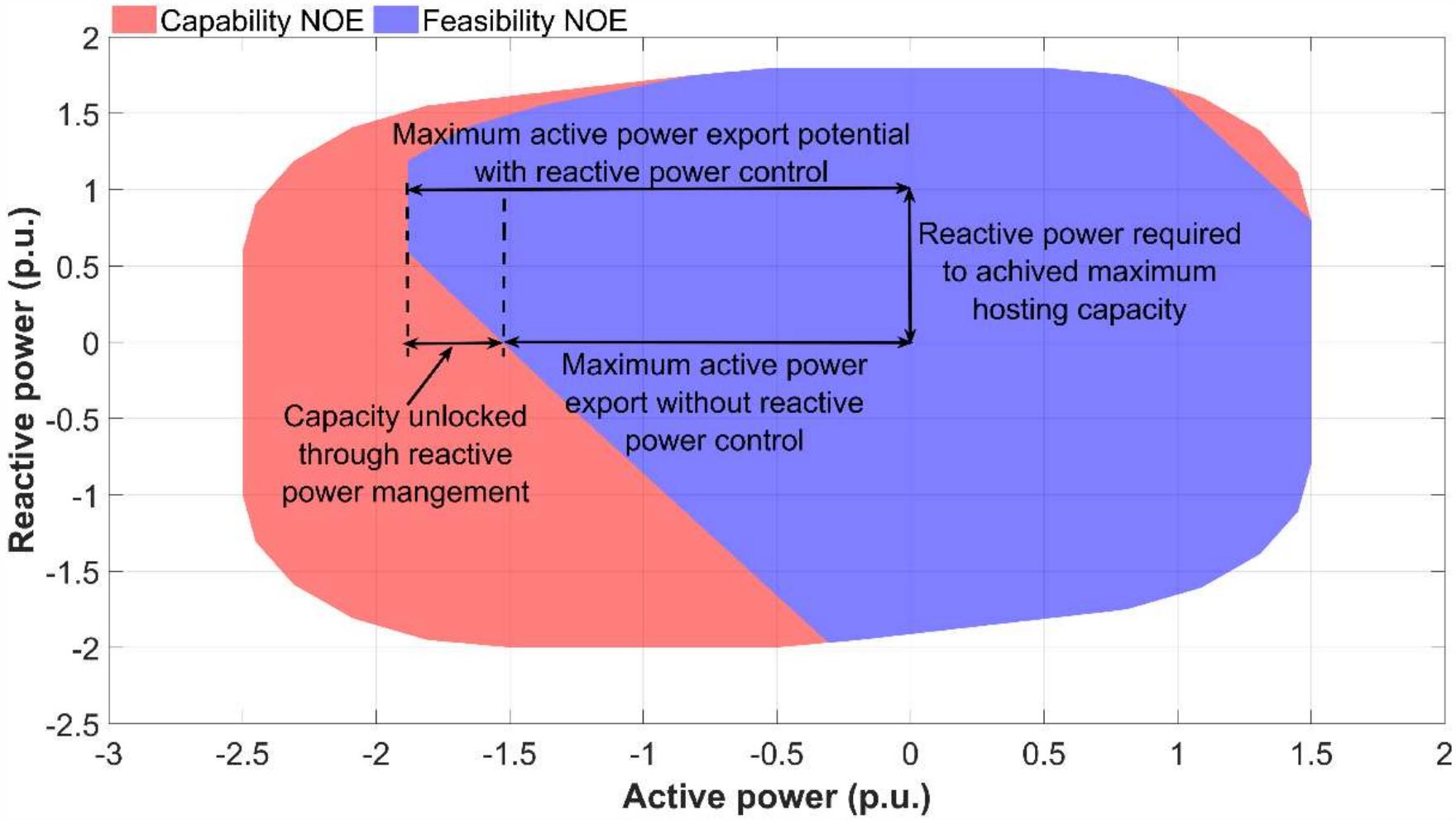
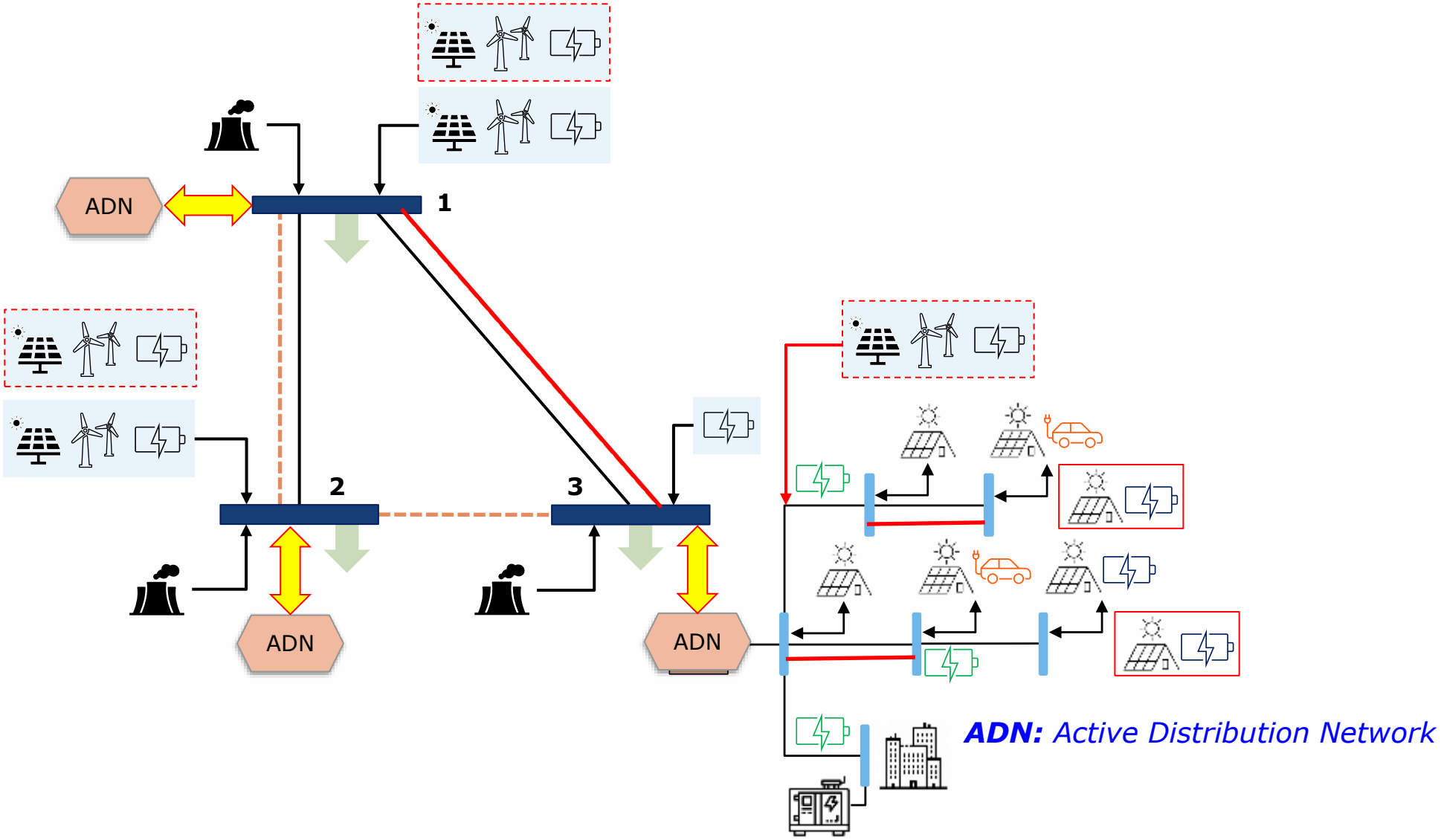
From passive to active distribution networks



Source: M. Liu *et al.*, "Grid and market services from the edge", *IEEE Power and Energy Magazine*, July/August 2021

Integrated planning of transmission and distribution



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Acknowledgements

- C4NET for the *"ESP-V"* project
- CSIRO and AEMO for the ongoing support on the topic of "*Planning*" as part of the GPST consortium
- The incredible work of my incredible team!

Thank you!
Any question?

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