

TSO views on resilience

Danny Klaar

10 November 2022



cigre

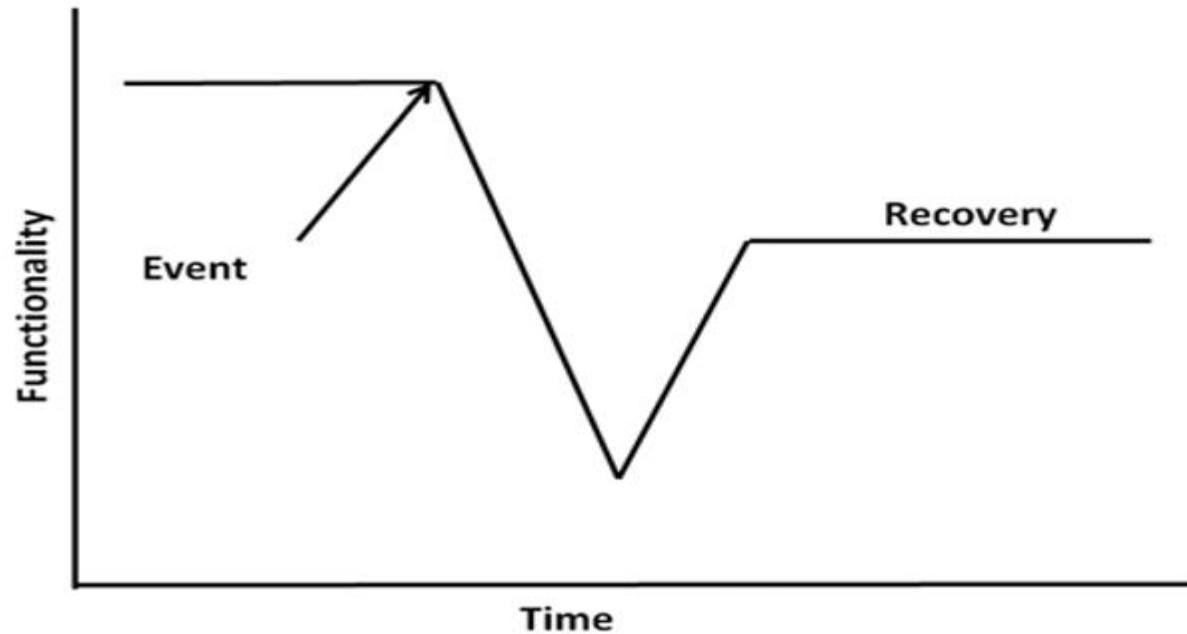
For power system expertise

Outline

- ❑ Definition of resilience
- ❑ The future energy system
- ❑ Key questions
- ❑ Concluding remarks

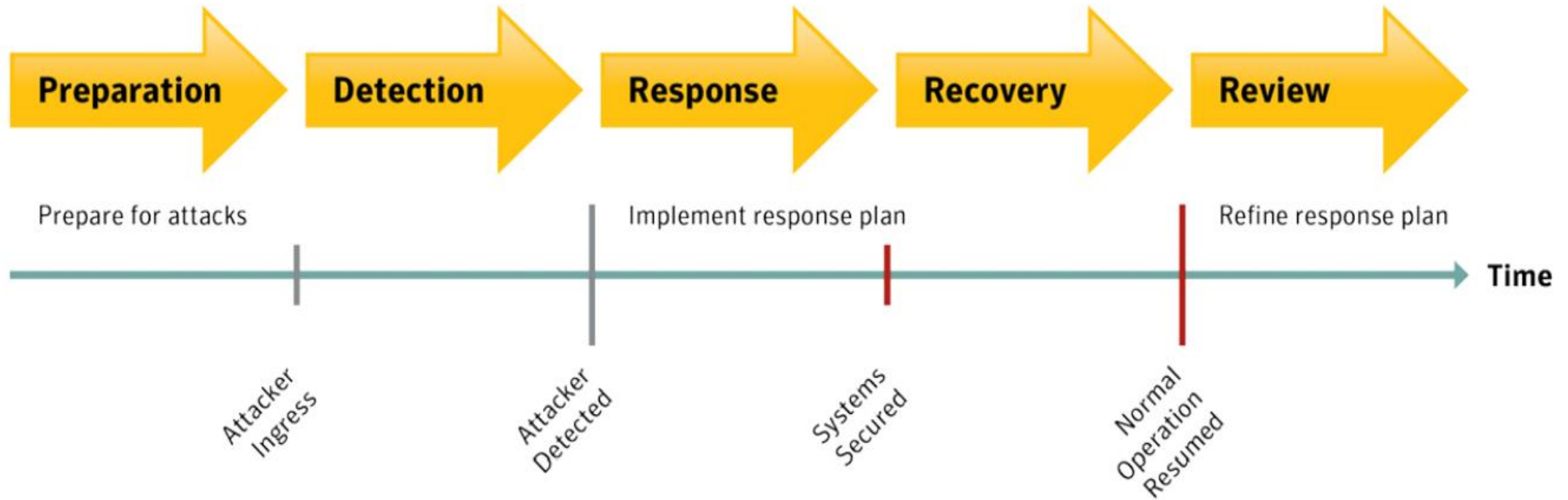
Definition of resilience

“The ability to limit the extent, severity and duration of power system degradation following an extreme event” (CIGRE WG C4.47)

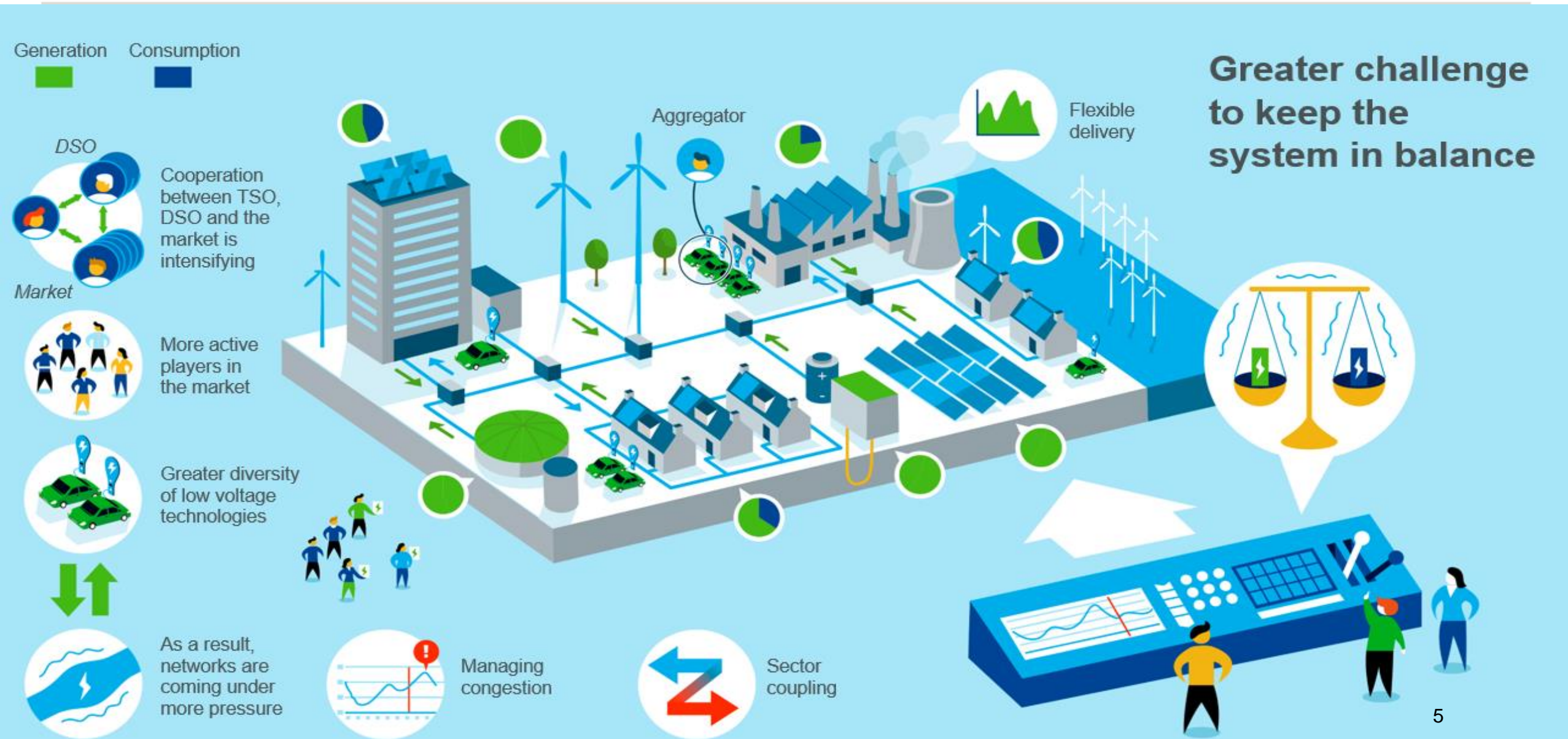


Disruption Model for Survivability or Resilience Engineering

Five Elements of a Resilience Framework



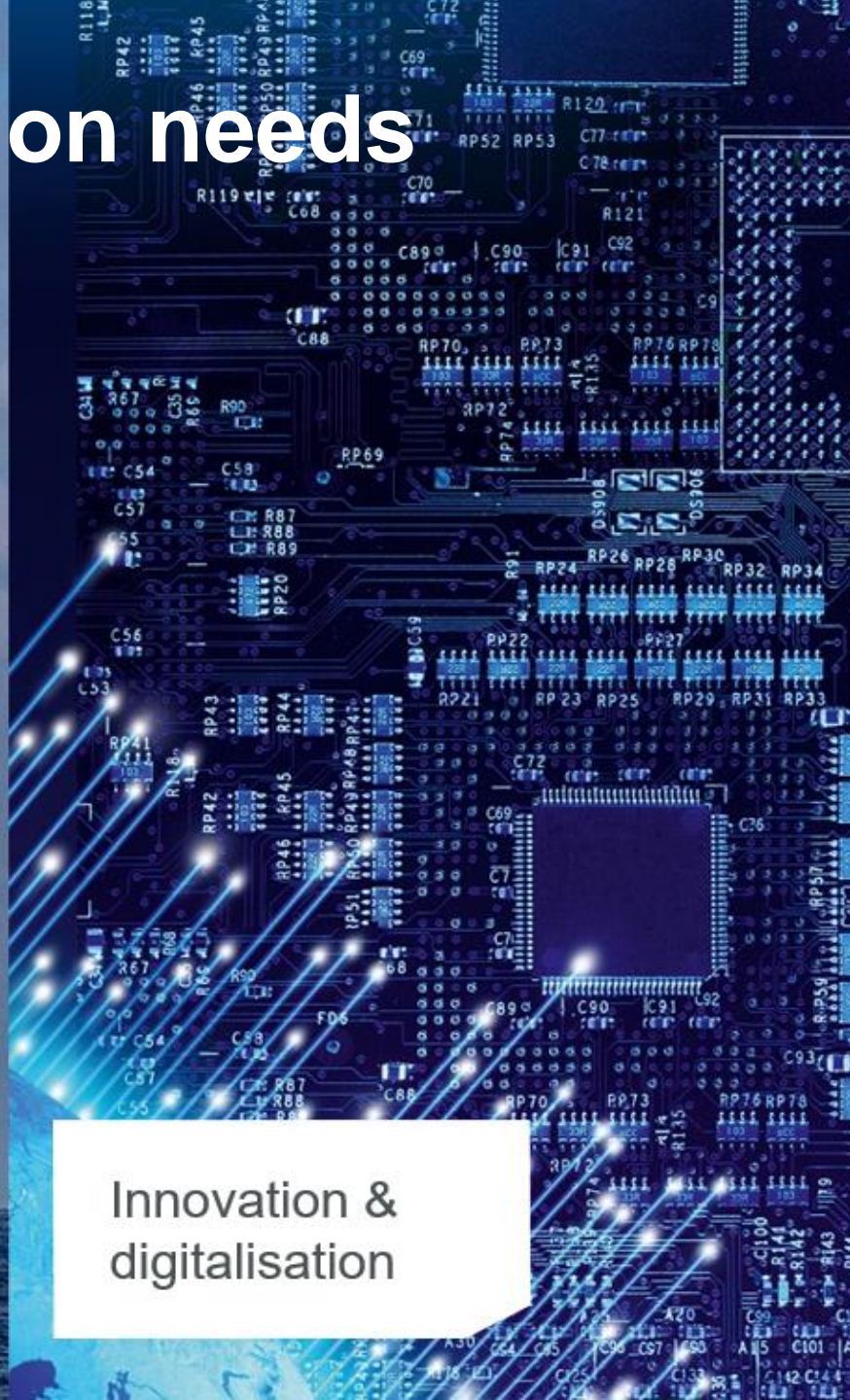
The future energy system



Future operation needs



Large scale
grid expansion

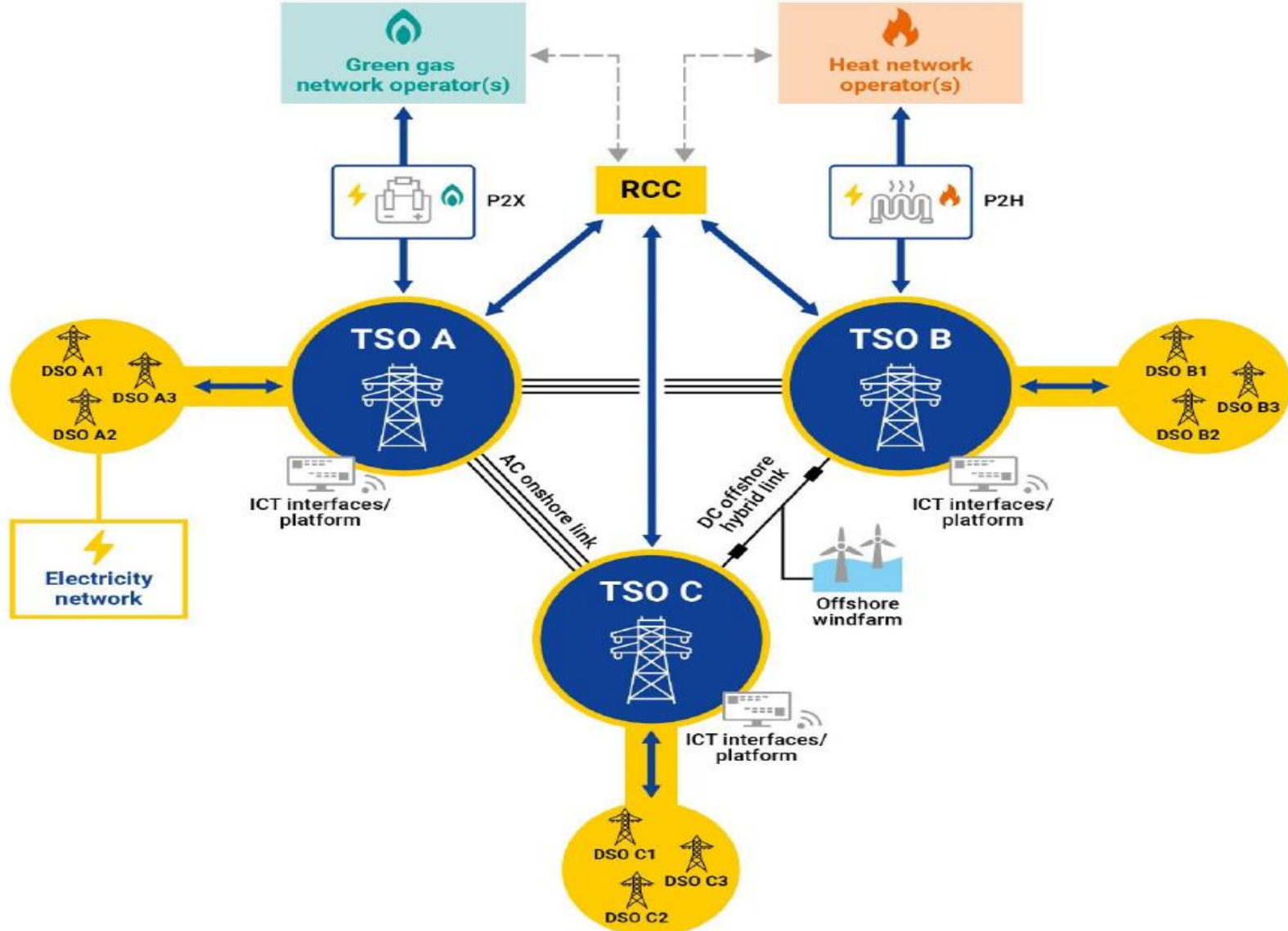


Innovation &
digitalisation



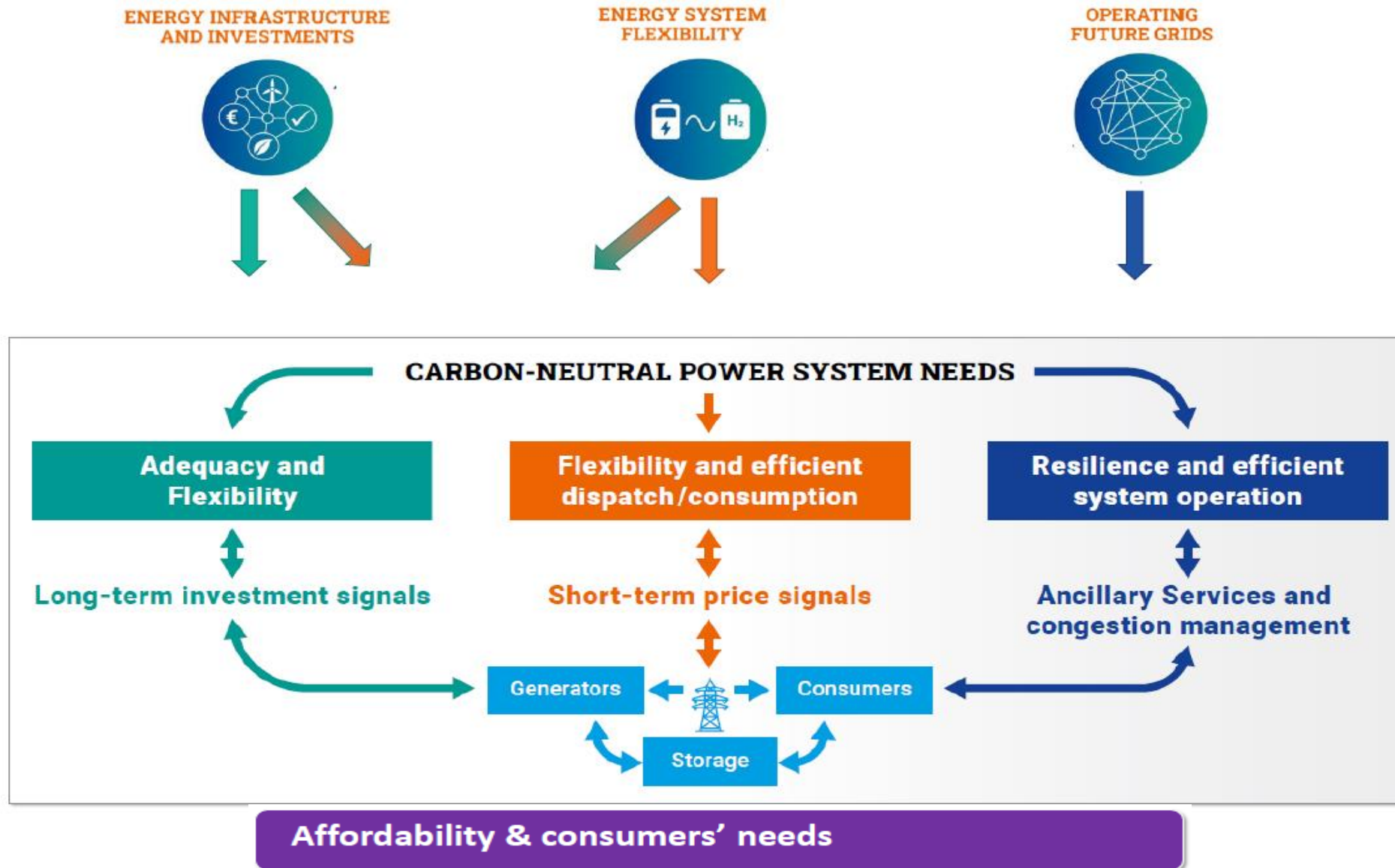
System
integration

Operation of a weather-dependent System of Systems



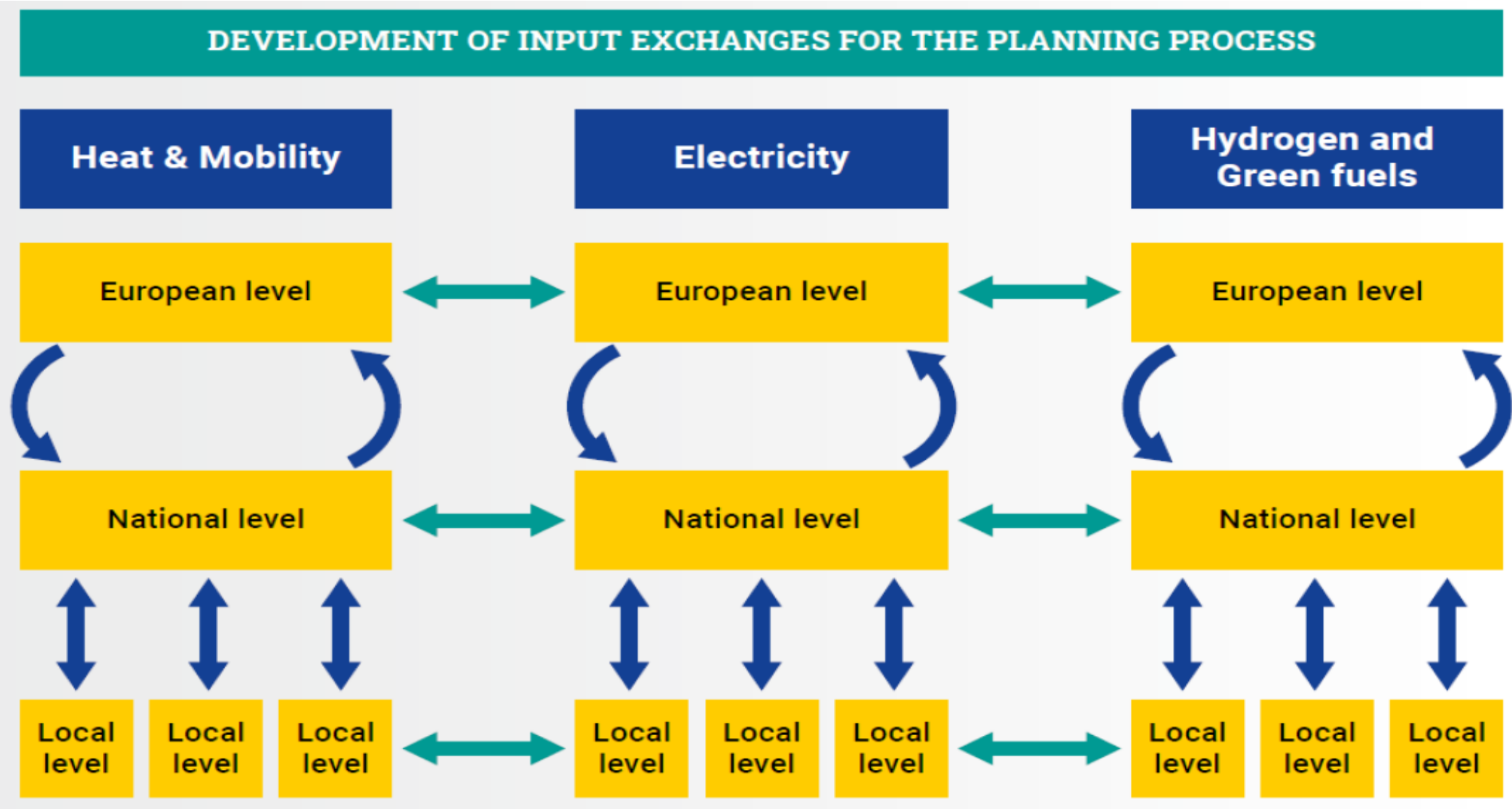
Source:
ENTSO-E

Market design challenges



Source: ENTSO-E

Energy infrastructure planning (source: ENTSO-E)



Factors impacting resilience (source: ENTSO-E)

Extreme weather
conditions

Digitalization &
automation

Interoperability

Design of power
system controls

Design of
protection devices

Cyber security

Measures to enhance resilience (source: ENTSO-E)

Enhanced weather
forecasting

Robust
infrastructure
across sectors

Cross-sector
cooperation

Multi-sector
risk awareness

New modelling
techniques

Training

Key questions

- 1) How to guarantee and maintain an adequate level of resilience for the System of Systems?
- 2) How can we target for a “resilience by design” concept?
- 3) How can we share responsibility among stakeholders for cyber-physical incidents in the System of Systems?
- 4) What role do governments have in the governance and enforcement of cyber security?

Concluding remarks

- ❑ There is an increasing resilience risk in the more complex energy system
- ❑ Understanding the behavior and controlling the System of Systems under abnormal conditions is key
- ❑ There is a need for new resilience strategies, skills and tools for operators, cyber specialists and field engineers
- ❑ A lot of research and innovation is needed
- ❑ An adequate governance including audit/validation bodies is needed to guarantee and maintain an adequate level of cyber hygiene at individual stakeholder level. Enforced coordination among stakeholders is crucial.

Thank you for your attention!



cigre

For power system expertise