

Cyber security and the future grid operation

Matija Naglič and Danny Klaar

10 November 2022



cigre

For power system expertise

Outline

- ❑ The future energy system
- ❑ The Swiss cheese model for cyber security
- ❑ Key questions

The future energy system

Generation ■ Consumption ■



Cooperation between TSO, DSO and the market is intensifying



More active players in the market



Greater diversity of low voltage technologies



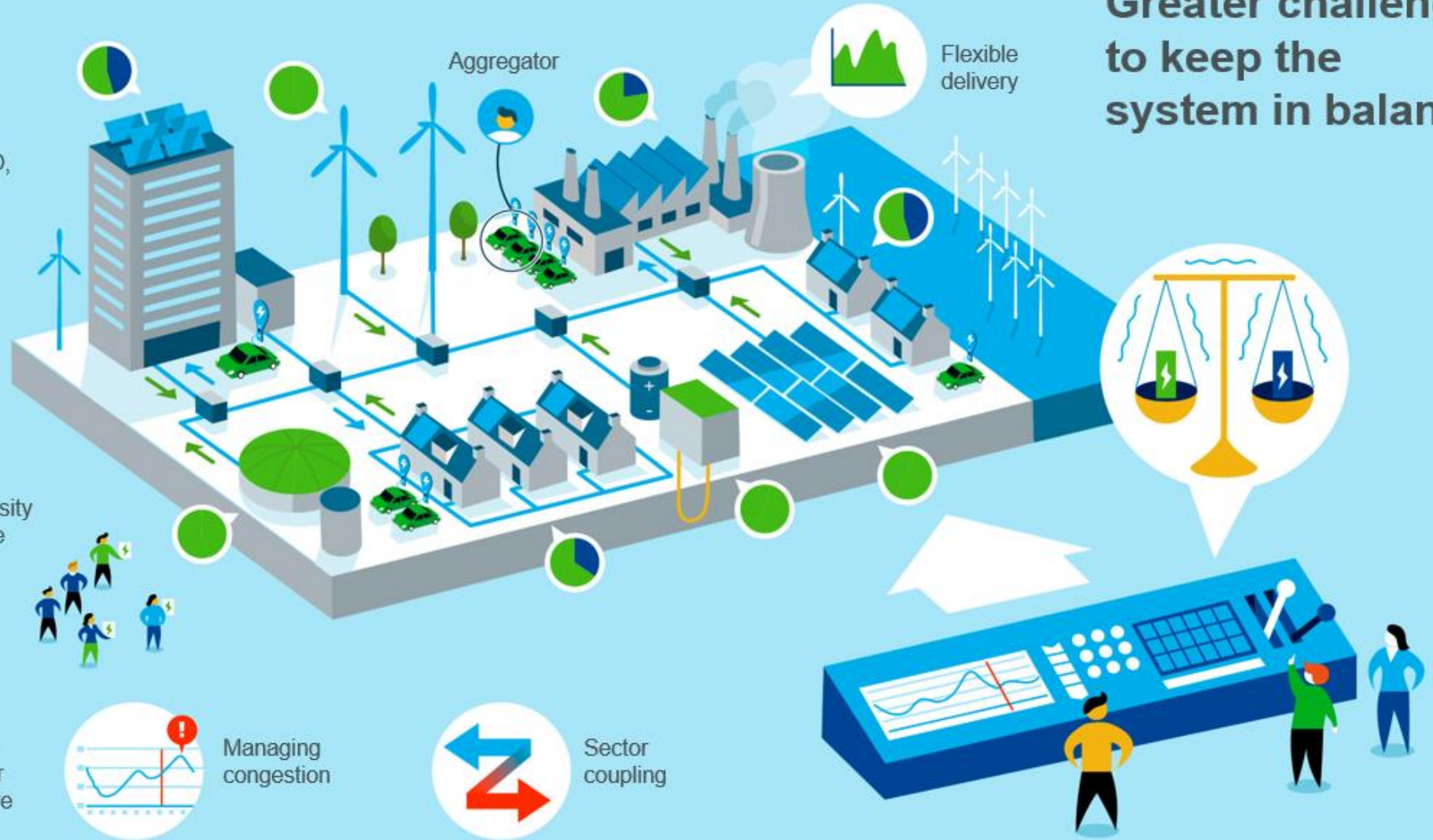
As a result, networks are coming under more pressure



Managing congestion



Sector coupling

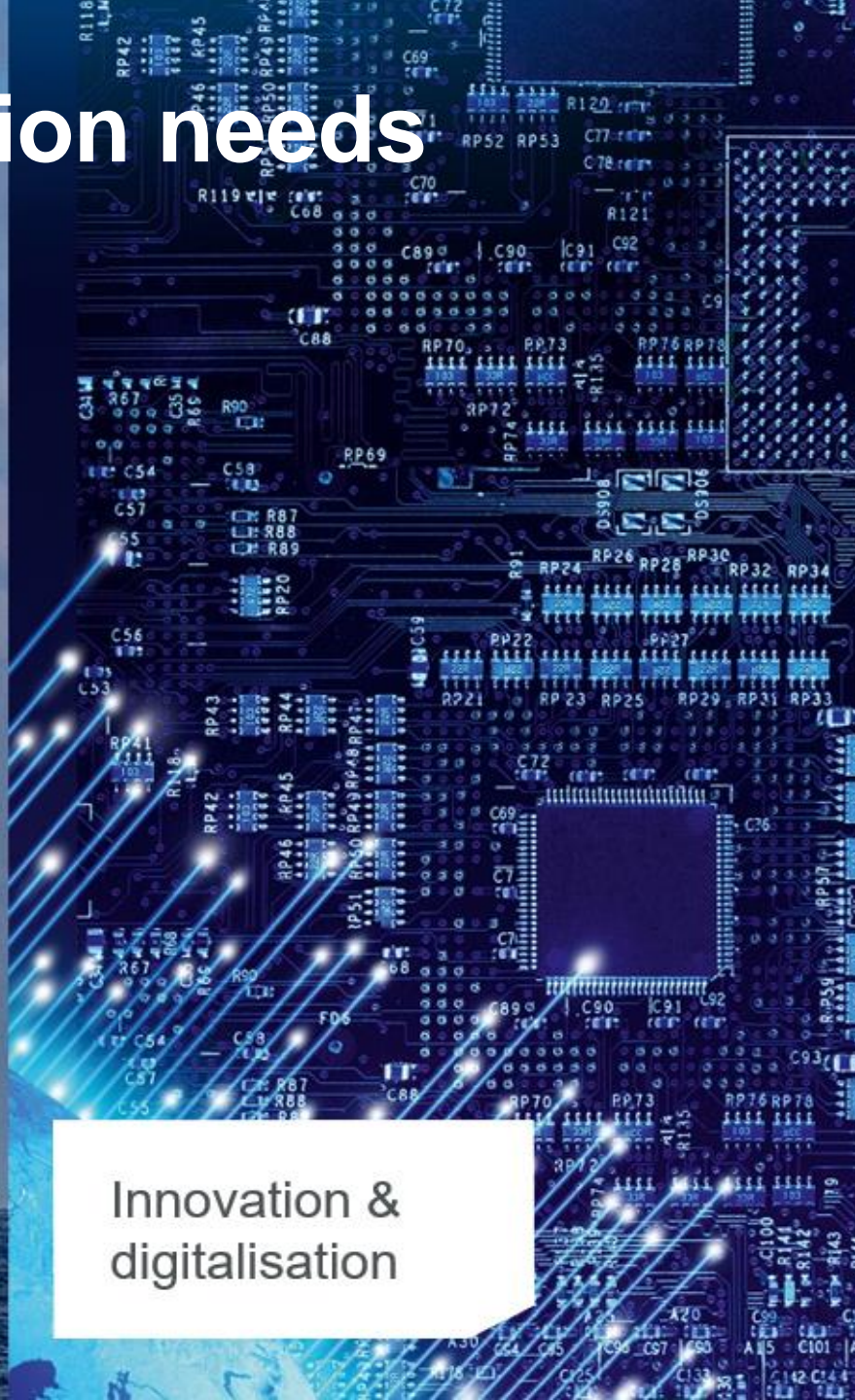


Greater challenge to keep the system in balance

Future operation needs



Large scale
grid expansion

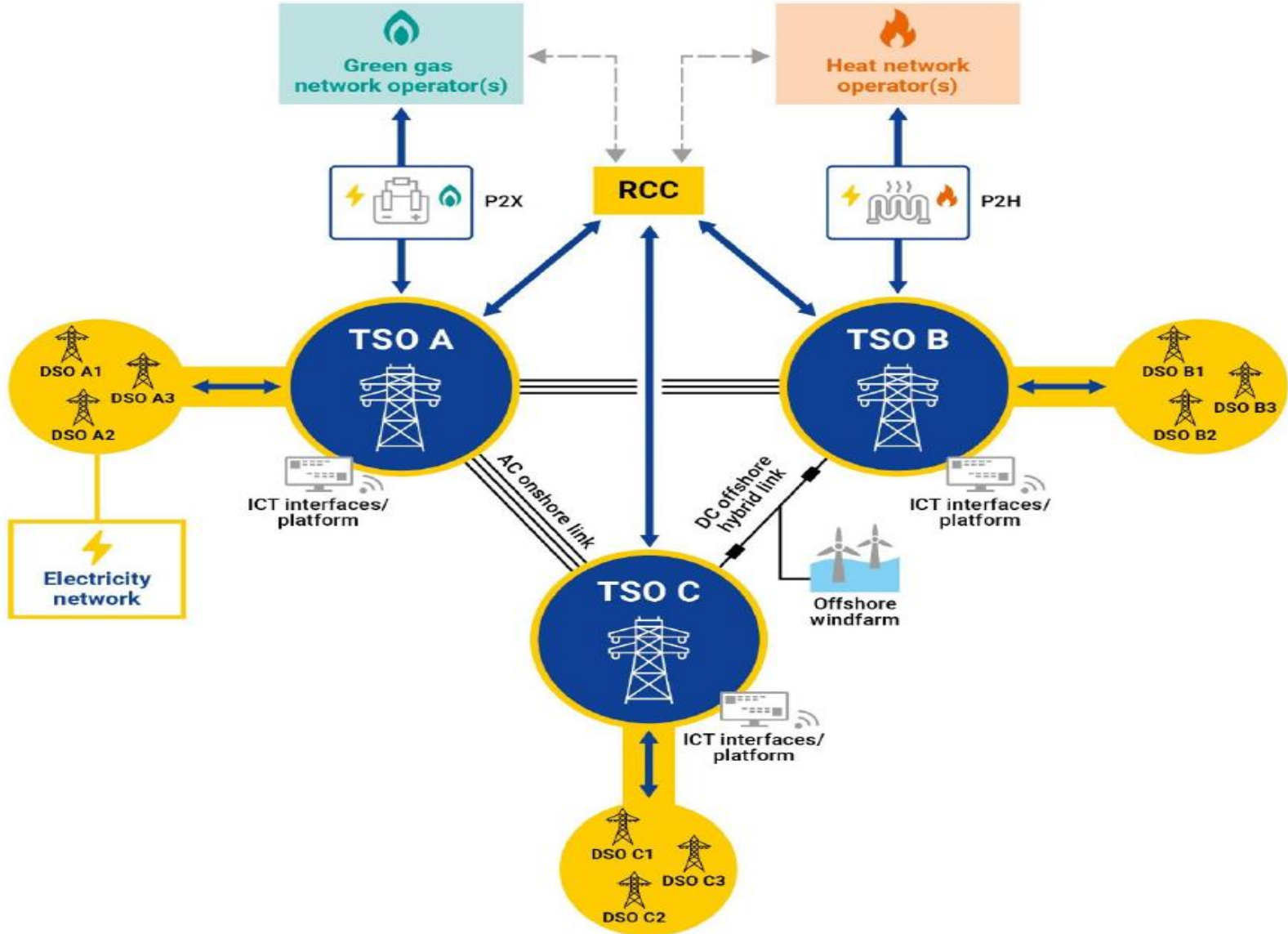


Innovation &
digitalisation



System
integration

Operation of a weather-dependent System of Systems



Source:
ENTSO-E

Flexibility will be essential

	Need	Periods of vRES shortage	Balancing/ congestion management	Stability/ inertia	Voltage control	Reliability/ restoration
	Source					
Generation	Fossil thermal generation	↓	↓	↓	↓	↓
	Hydrogen power generation	●				○
	Dispatchable RES (hydro, bio)	●	○	○	○	●
	Variable generation		●	●	●	○
Demand	Smart charging EVs/small DSR	○	●	●	○	○
	Large DSR	○	●	●	○	●
Storage	Chemical batteries/V2G		●	●	●	●
	Supercapacitors			○		
	Hydro pumping storage	○	●	●	●	●
	Flywheels			○		
Coupling	LAES/CAES, thermal storage	○	○	○		
	Power-to-hydrogen		●	○	○	
Grid	Power-to-heat		○	○		
	Interconnections (incl. HVDC & conversion stations)	●	●	○	●	○
	Grid flexibilities (power flow, voltage control)		●	●	●	●

↓ Phase-out by 2050 ● Most promising ○ Contributing

Source:
ENTSO-E

Possible game changers (source: ENTSO-E)

Nuclear renaissance




Fusion reaching commercial viability or wide deployment of new generation Fission plants

Superconductivity



Technology becoming very widely applied for new lines

Slower uptake of Hydrogen




High present expectations materialise only partially

Carbon Capture & Storage




Achieving cheap & wide application to fossil plants

Supergrid



Deploying continental overlaying HVDC grid, including neighboring countries

Prosumers, Microgrids



High uptake of local systems, complementing present top-down grid architecture

Cheap short & long storage



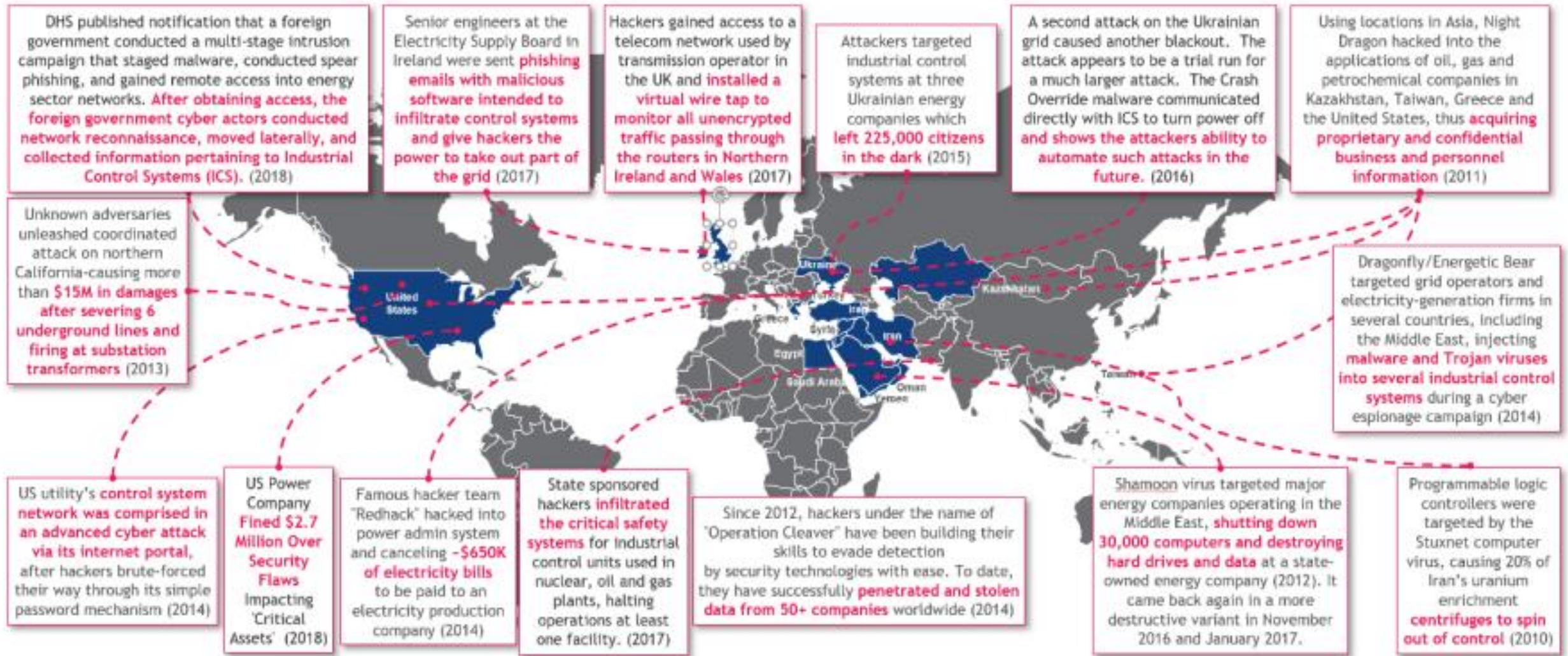
Becoming widespread in all use cases as prominent provider of flexibility

Deep digitalisation



Pervasive modifications of most devices, systems and processes

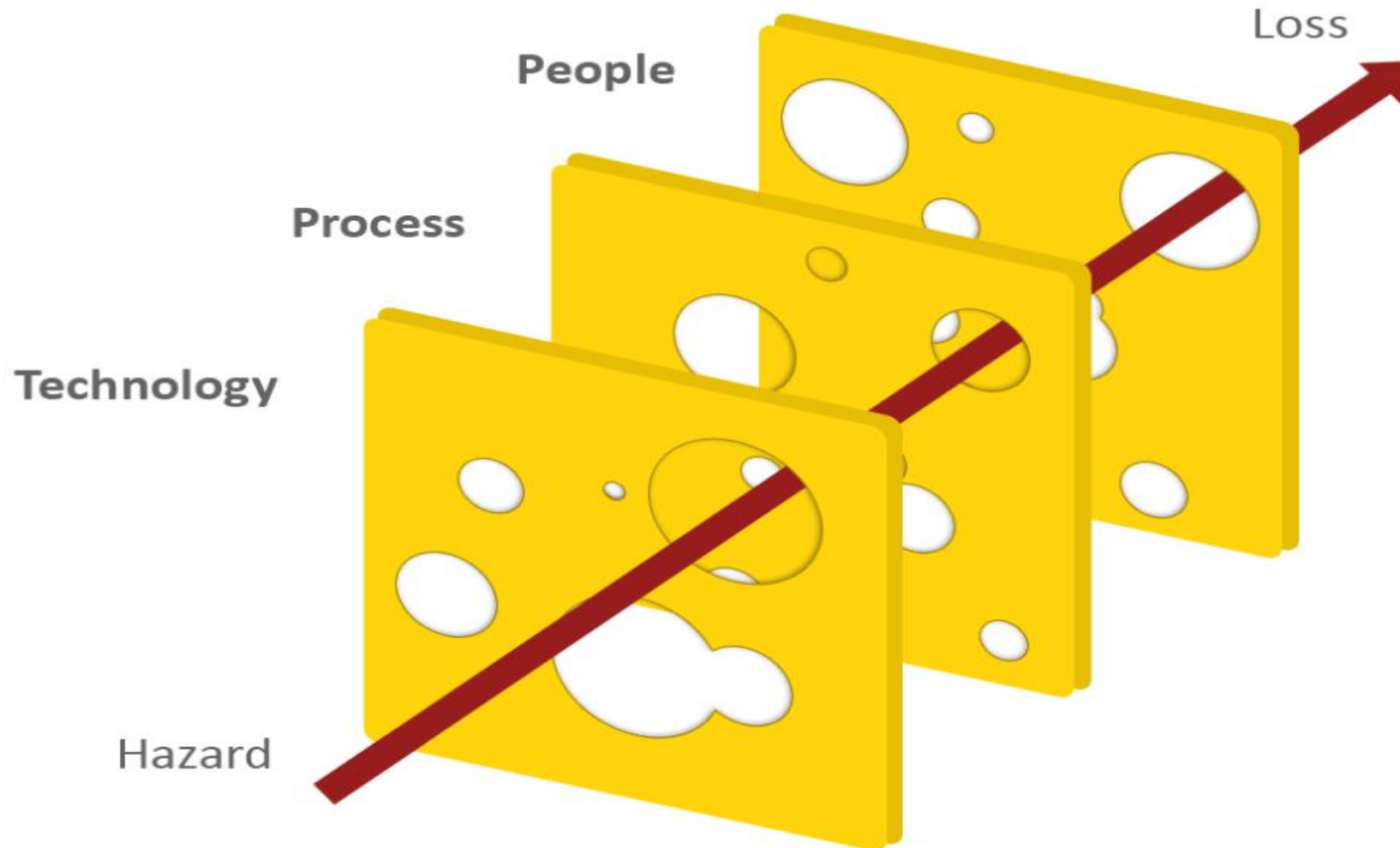
Overview of cyber attacks (period 2010-2018)



Source: World Economic Forum 2019

Disclaimer: overview of events according to our best knowledge, it may not be complete

The Swiss cheese model for cyber security



The Swiss Cheese model, adapted for cyber security. Illustration based on Dante Orlandella and James Reason.

Key questions

- 1) What should be our focusing areas concerning cyber security?
- 2) How to assure cyber security for all connected intelligent assets to the grid?
- 3) How to assure cyber security for the cross-sector interfaces?
- 4) How to develop quick recovery strategies after an impactful cyber incident?

Thank you for your attention!



cigre

For power system expertise