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Session on: “Grid security and new technologies”



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Energy transformation and system digitalization: Opportunities and Challenges



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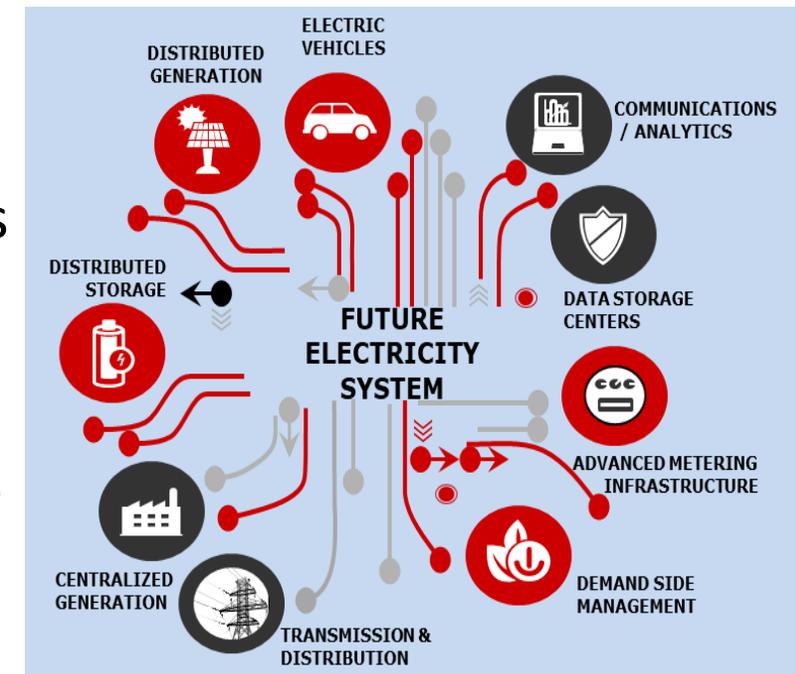
Global Energy Transformation: Trends and priorities for energy, climate and technology



The **transformation** of the energy systems is happening worldwide and all/most countries are facing **challenges** that despite the intrinsic differences in system structure and energy mix are very similar e.g., **seamless integration of high share of variable renewables (RES) to decarbonize the energy system.**

Introduction of **innovative materials and power technologies** is expected to allow the development of system infrastructures with higher performance and/or lower costs.

The **urgency** is extremely high in order to achieve the targets for decarbonisation so to limit the global temperature increase within 1.5 °C, thus mitigating the effects of climate change.



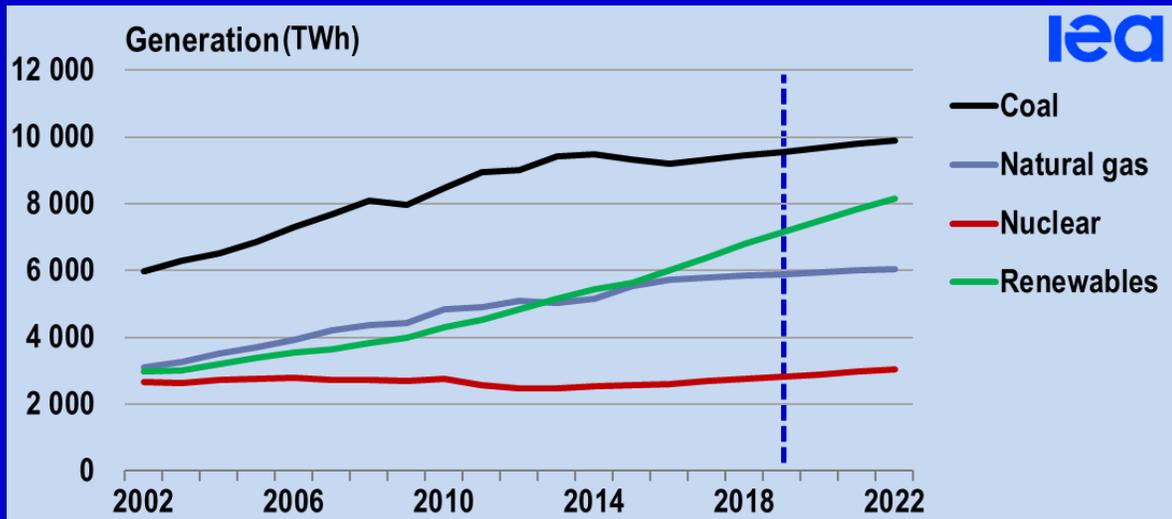
Sources: World Economic Forum (WEF)

Global Energy Transformation: Mega-trends and drivers (1/2)

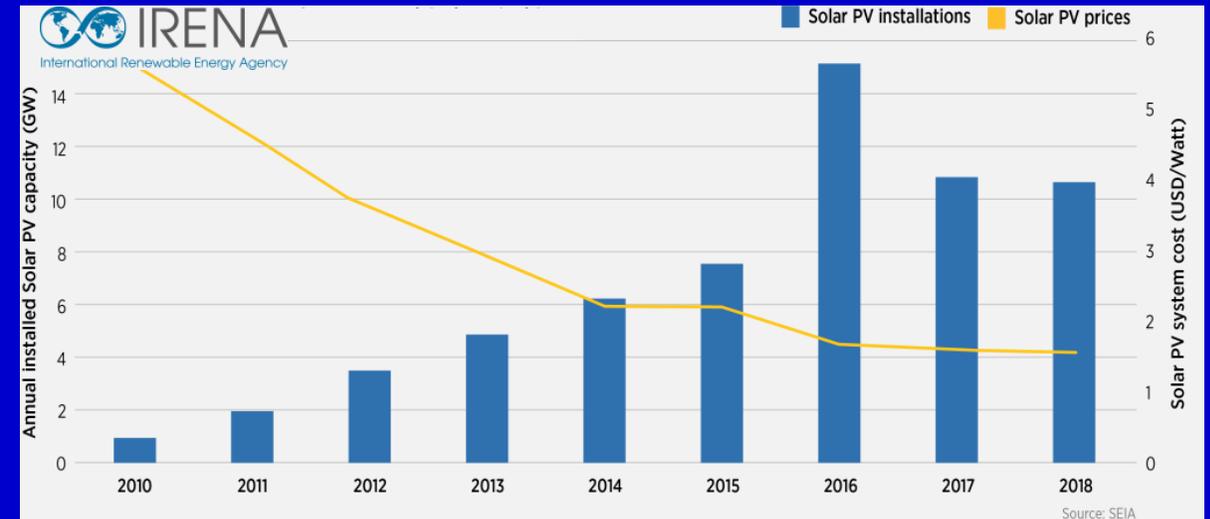


- **Decarbonization** - global energy markets are changing rapidly: costs of renewable energy sources (RES) continue to decline rapidly and wind and solar PV lead the power capacity expansion *driven by policy support & cost reductions*
- **Digitalization** is having profound impacts both at system operation level and as customer empowerment, but also raising growing cyber security concerns
- **Decentralization** - Distributed Generation especially by RES, such as rooftop PV, enables the progressive evolution of passive electricity **consumers** towards active prosumers that will increasingly produce, consume, store, and sell electricity
- **Electrification** - expanding electricity use in all sectors can be the main driver for accelerating the energy transformation e.g. *Electric car sales are growing exponentially*
- **System integration** – storage integration at all levels and sector coupling between the electricity system and other energy vectors (e.g. gas, water, heating & cooling) has the potential to dramatically expand the flexibility of the entire energy sector

Global Energy Transformation: Mega-trends and drivers (2/2)

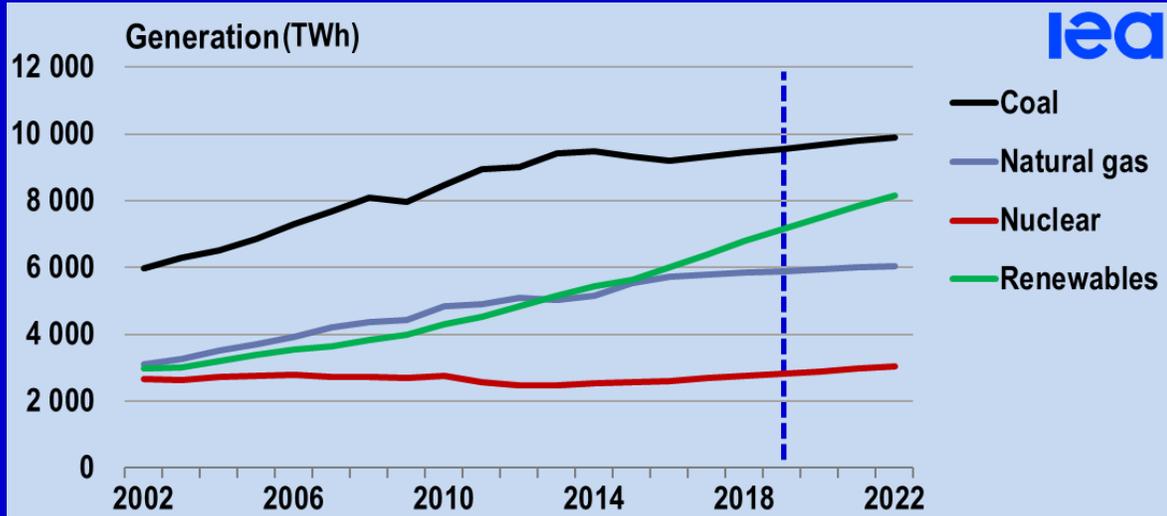


Sources: IEA

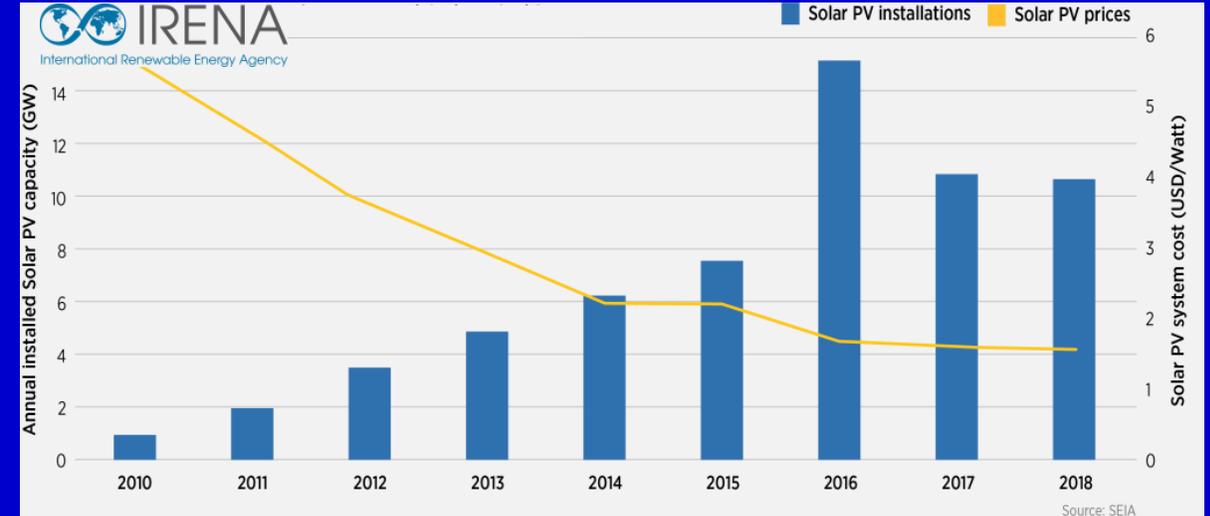


Sources: IRENA

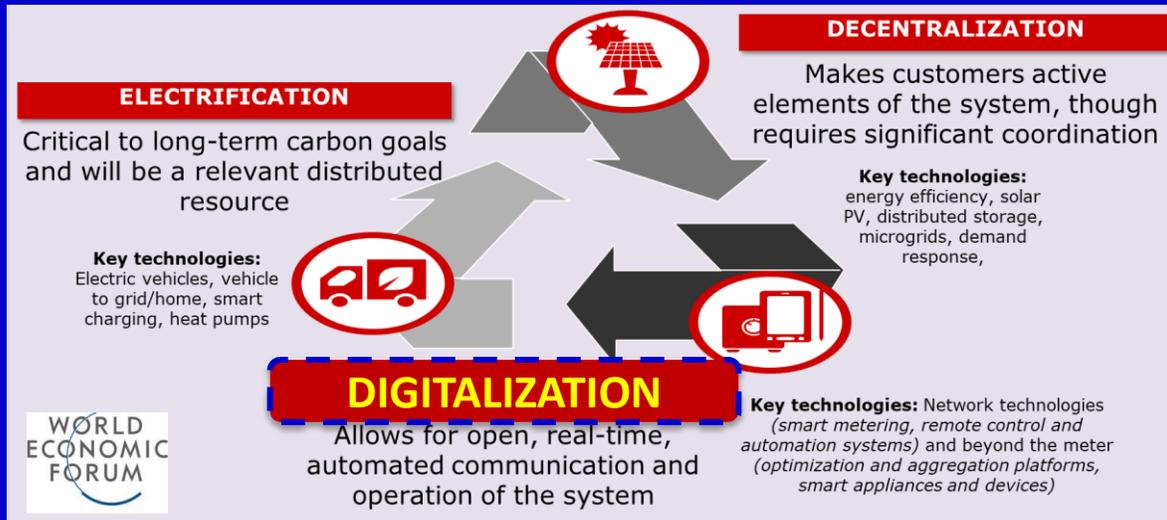
Global Energy Transformation: Mega-trends and drivers (2/2)



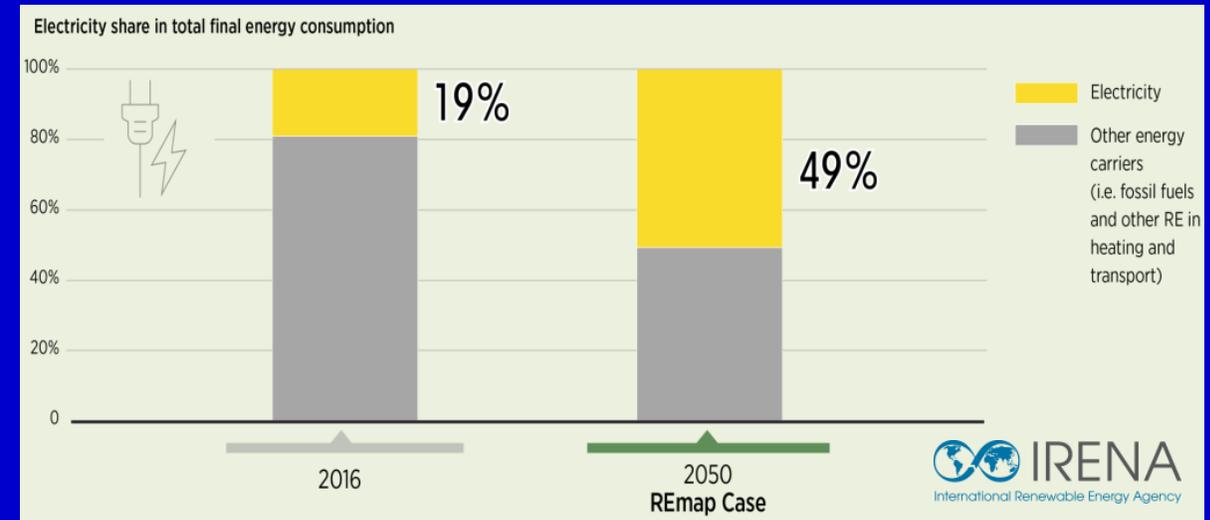
Sources: IEA



Sources: IRENA



Sources: World Economic Forum (WEF)



Sources: IRENA

Digitalization trends are truly astonishing

Data traffic is increasing exponentially

KB kilobyte 10^3 bytes
MB megabyte 10^6 bytes
GB gigabyte 10^9 bytes
TB terabyte 10^{12} bytes
PB petabyte 10^{15} bytes
EB exabyte 10^{18} bytes
ZB zettabyte 10^{21} bytes
YB yottabyte 10^{24} bytes

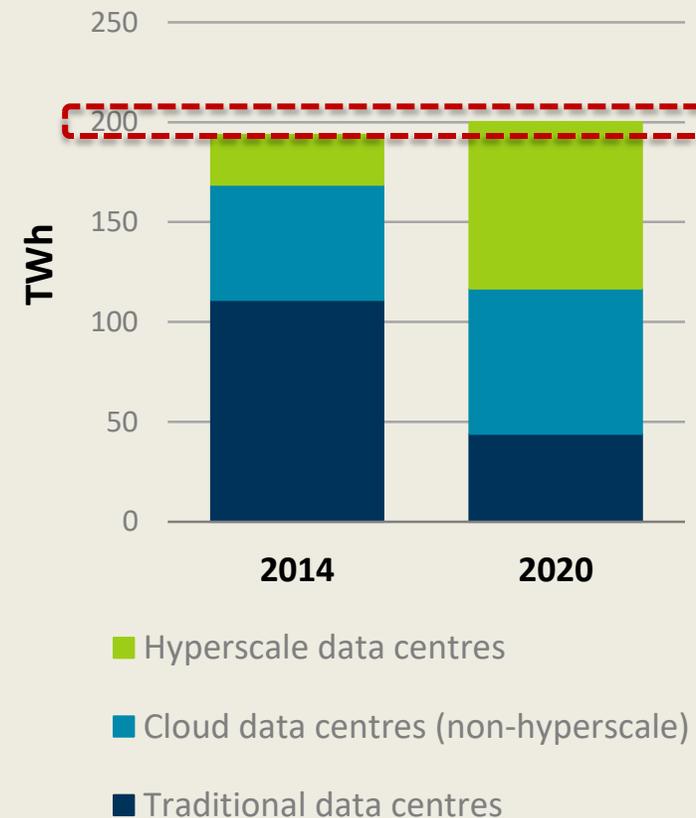
1987
2 TB

1997
60 PB

2007
54 EB

2017
1.1 ZB

Data centre electricity use



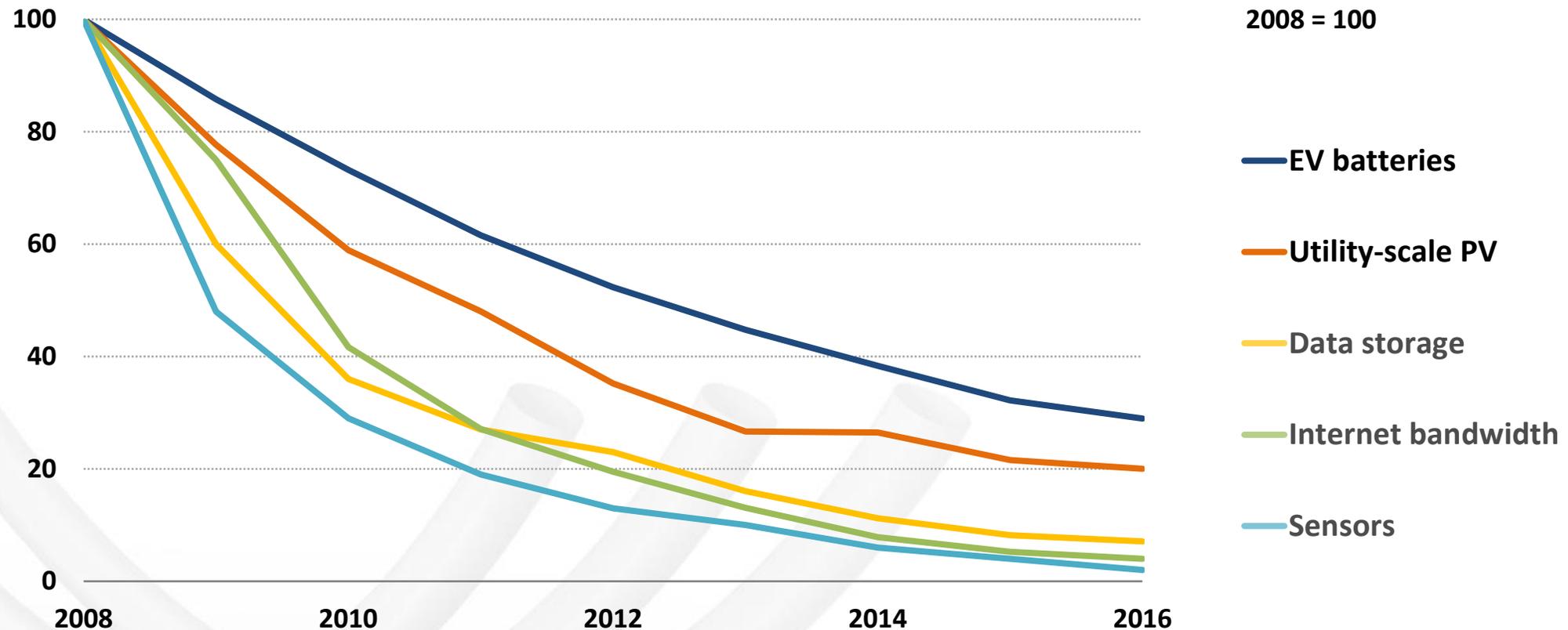
Sources: Cisco (2017). The Zettabyte Era: Trends and Analysis June 2017; Cisco (2015). The History and Future of Internet Traffic.

Digitalization: A New Era in Energy

- Digitalization is everywhere: digital and energy worlds are intersecting
- The energy system is on the cusp of a new digital era and all energy demand and supply sectors are feeling the effects
- Fundamental transformation of electricity towards “smart energy systems”
- But impacts are difficult to predict due to uncertainty in technology, policy and behavior →
 - emerging risks need to be managed, including ensuring digital resilience
- Present steps to focus on high impact, high uncertainty areas:
 - Automation, connectivity, and electrification of transport
 - Electricity and smart energy systems
 - Decentralization and decarbonisation



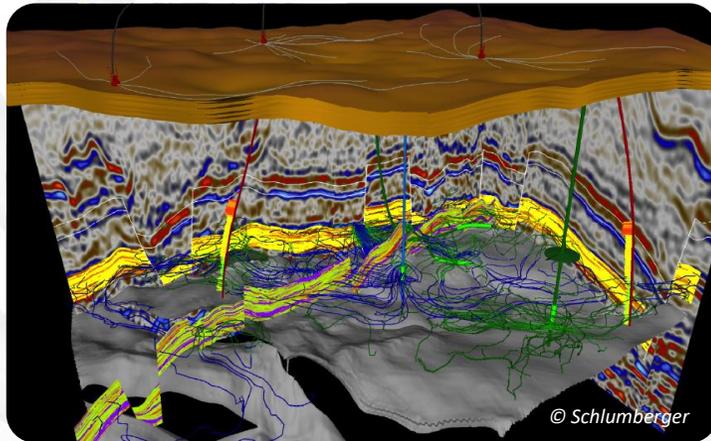
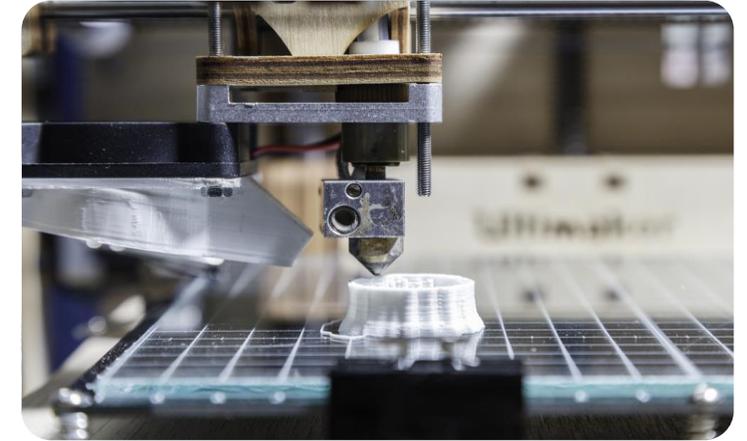
Drivers of digitalization: Data, analytics, and connectivity



Sources: Based on BNEF (2017), Utilities, Smart Thermostats and the Connected Home Opportunity; Holdowsky et al. (2015), Inside the Internet of Things; IEA (2017), Renewables; Tracking Clean Energy Progress; World Energy Investment; Navigant Research (2017), Market data: Demand Response. Global Capacity, Sites, Spending and Revenue Forecasts.

Data collection, storage, and transmission costs have declined by over 90% since 2008

Digitalization is impacting all energy demand and supply sectors ...



Digital technologies can help improve safety, productivity, and efficiency of energy systems

Impacts on supply sector:

Electricity generation and networks



Power

- Power plants and electricity networks could see reduced O&M costs, extended life time, improved efficiencies and enhanced stability

The digital transformation of the energy system is enabling:

- About 5% of total annual power generation **costs saving**
- Smart **Demand Response** programs in buildings, power system, industry and transport
- EVs **smart charging** that can provide further flexibility to the grid
- Grid **integration** of higher shares of variable renewables (VRES) by better matching energy demand to times when VRES are available
- Deployment of residential solar **PV and storage**

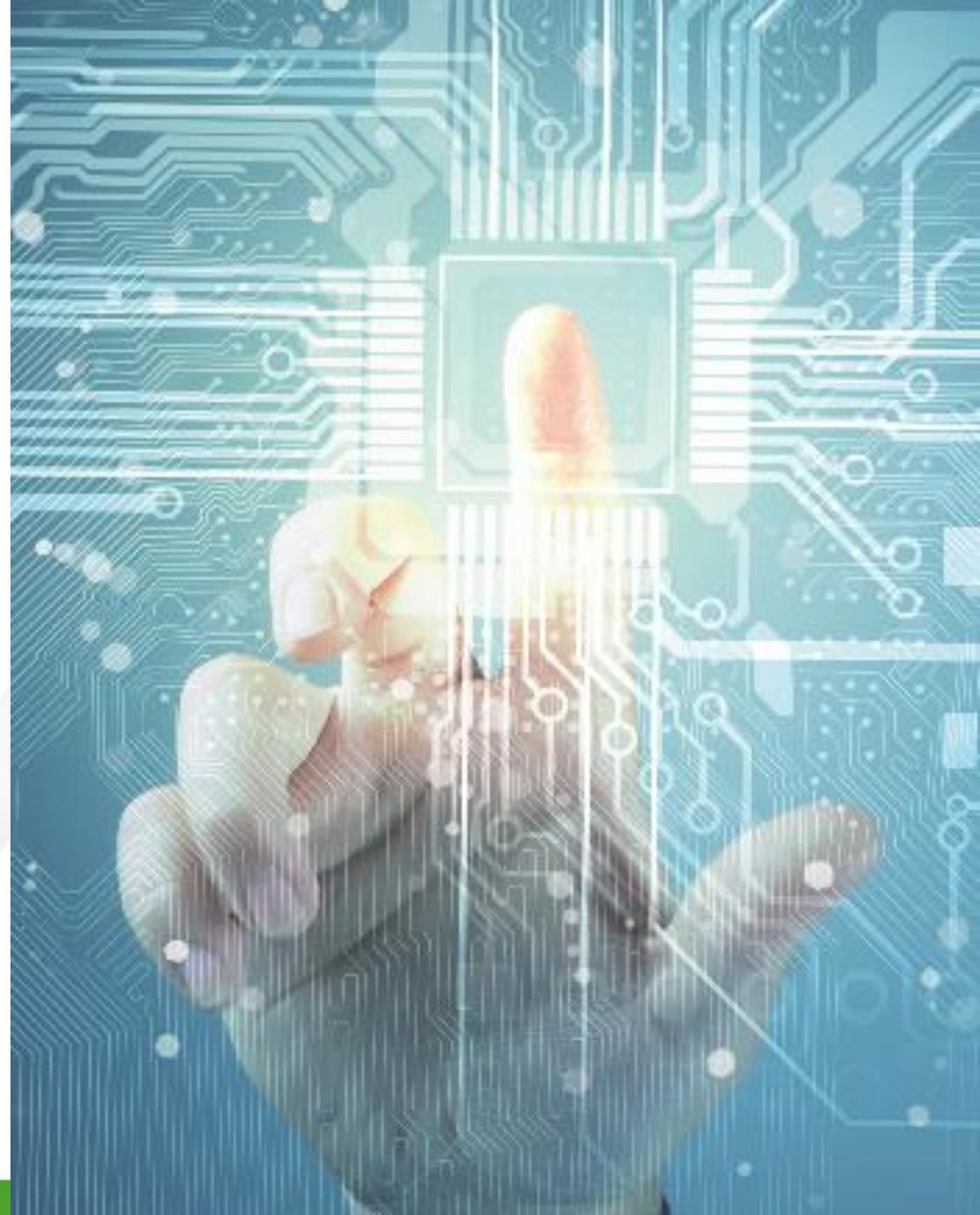
The IoT & Big data Lab

Collect, manage and exploit system DATA

Promoting the energy system

Digital Transformation

- Big Data analytics
- Artificial Intelligence and Machine learning
- Cloud, edge and fog computing
- Internet of Things (IoT)
- Monitoring and Control of Smart Grids, Smart Homes and Smart Mobility
- Blockchain

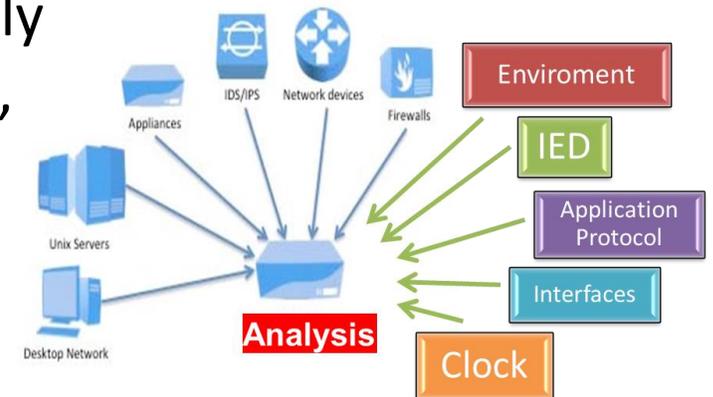


Cyber challenges to the energy transition

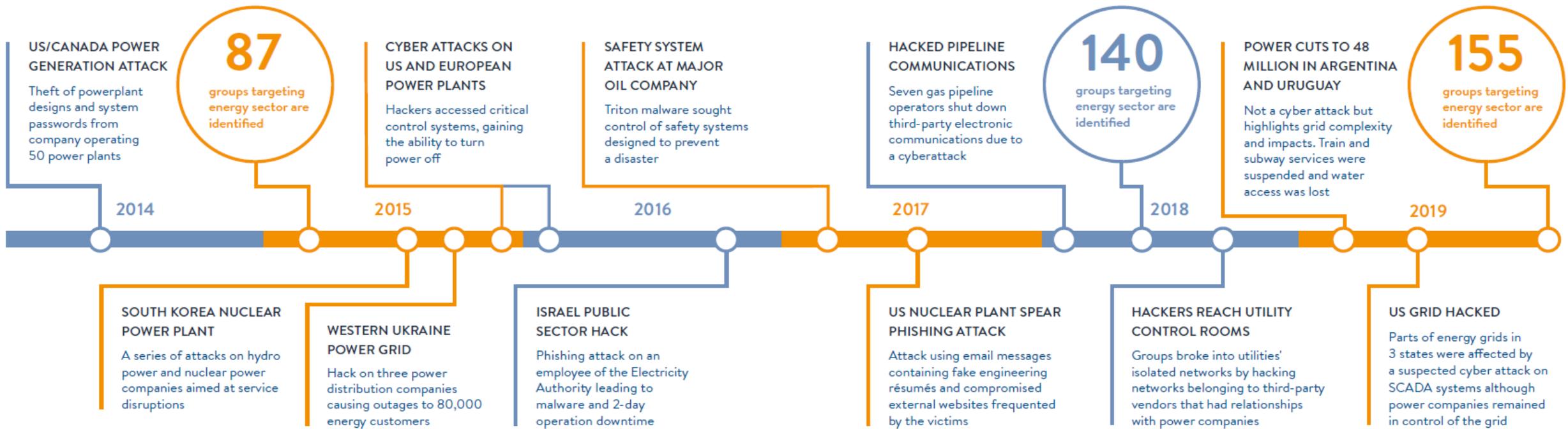
In many aspects, the **resilience** of the energy sector is greatly increased by **digitalisation** as it enables the use of a complex and widening array of decentralised resources, improved efficiency, and enhanced abilities to detect threats, thereby increasing operational accessibility, productivity, sustainability, and safety.

At the same time, **digitalisation presents new challenges**. For example, cyber or digital disruption risk can affect every operation within a power plant especially with the increased use of connected industrial devices and automated controls.

The pace of digitalisation in the energy sector may potentially outpace **cyber defence** and digital management capabilities, resulting in greater exposure to risk.

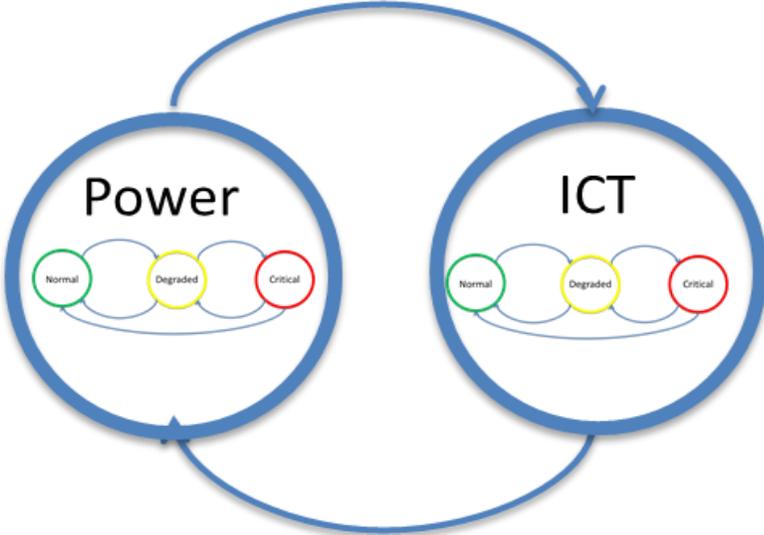
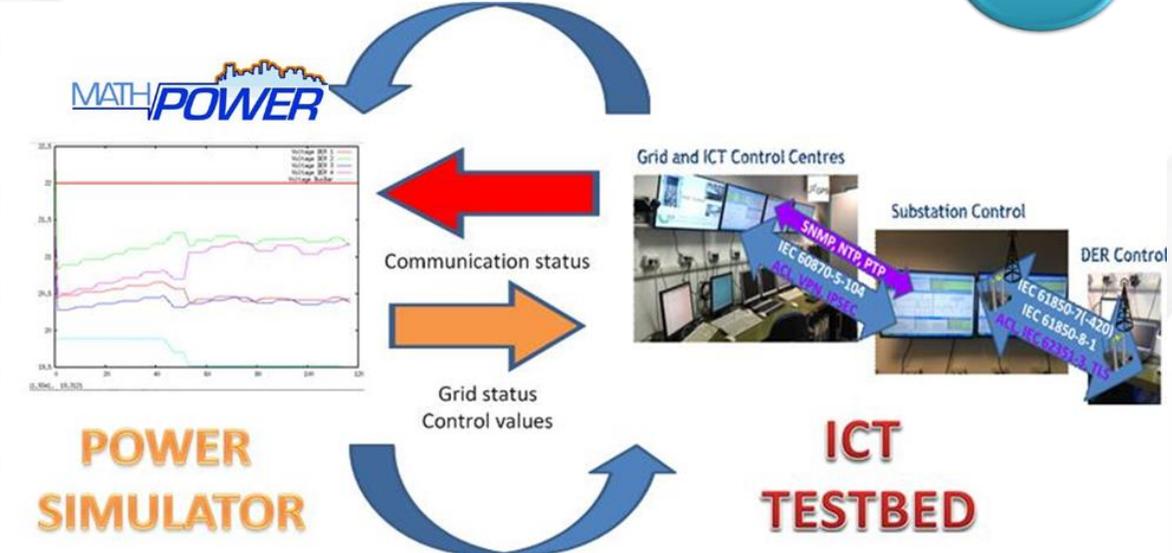
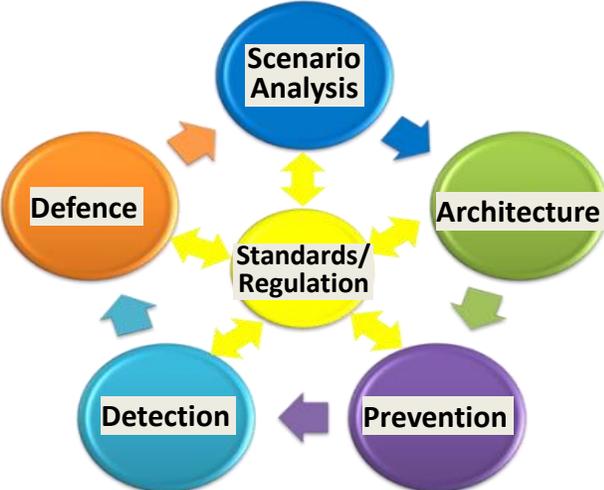


Cyber challenges to the energy transition by WEC



Cyber incidents increasing in both frequency and impact
The number of known attack groups increases

Research Framework for Cyber Resilience of Digital Energy infrastructures



**Thank
you!**

for your kind attention



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Impacts on demand sectors: Transport, buildings, and industry



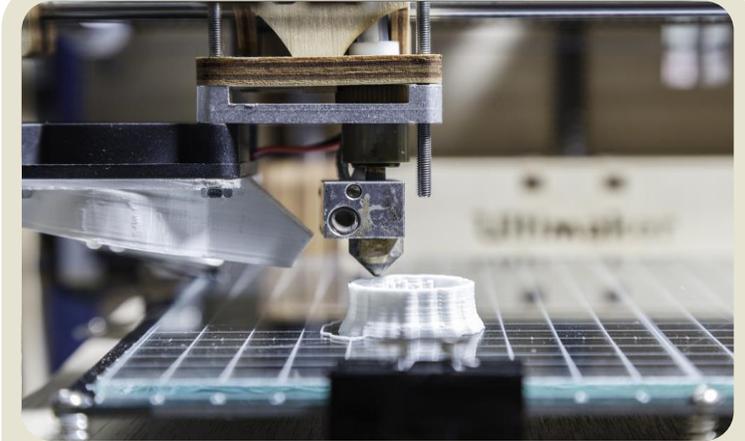
Transport

- Key digital trends across all modes: connectivity, sharing, and automation
- Digital solutions for trucks and logistics could reduce energy use for road freight by 20-25%



Buildings

- Smart building controls will improve comfort and transform building energy use
- Energy use could be reduced by 10% to 2040, but rebound effects are uncertain



Industry

- Industry will witness increased productivity, reduced costs and improved safety
- Energy use can be incrementally reduced at plant level but broader impacts remain uncertain

Digitalization has the potential to reshape, modernize, transform demand-side sectors