Power System’s Digital Transformation

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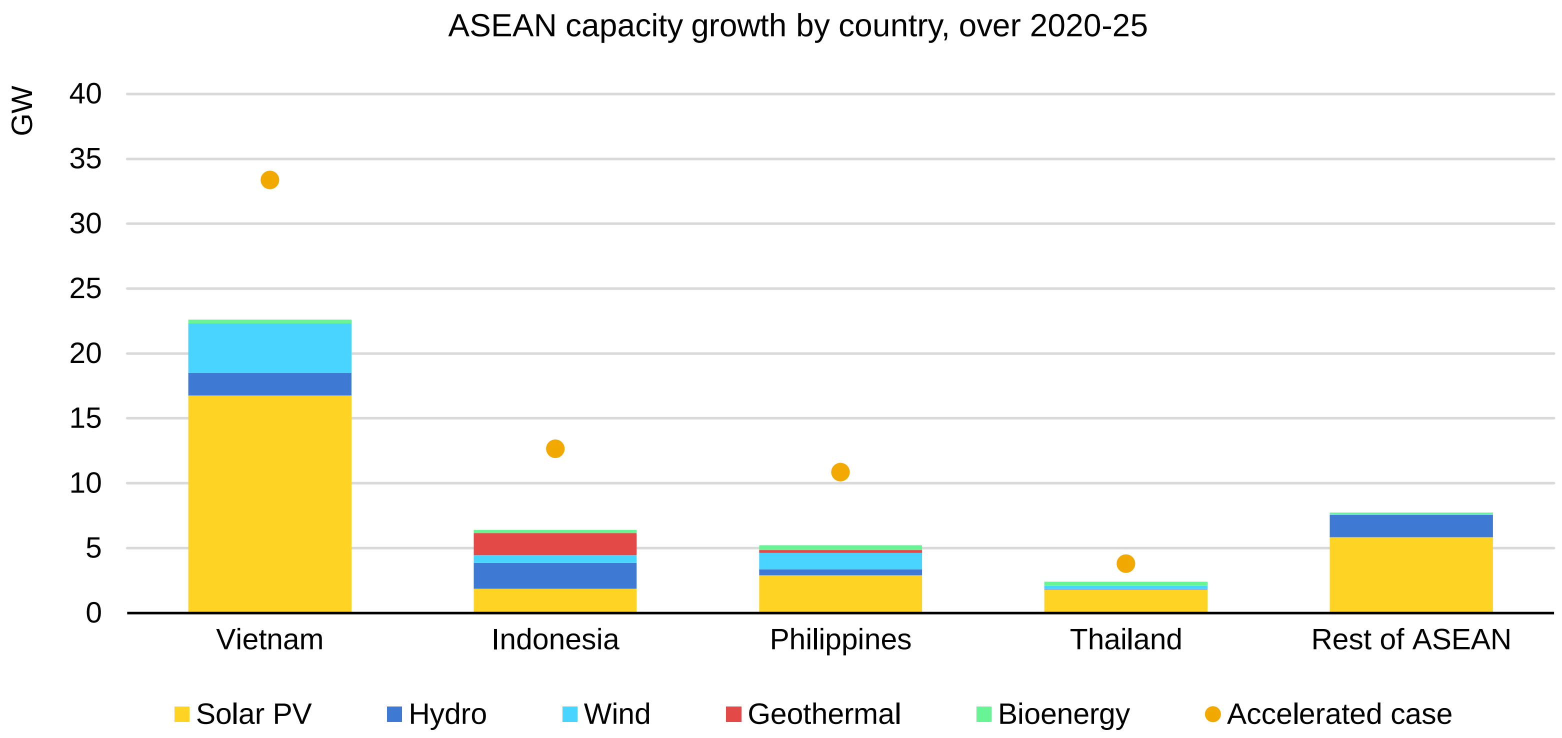
Webinar ‘*Implementation of Smart Grids in Indonesia*’, 26 February 2021

Outline

- Trends in Power Systems
  - Focus on digitalisation
- The smart grid toolkit and benefits for Indonesia
  - Generation
  - Transmission
  - Distribution and consumers
- Conclusions

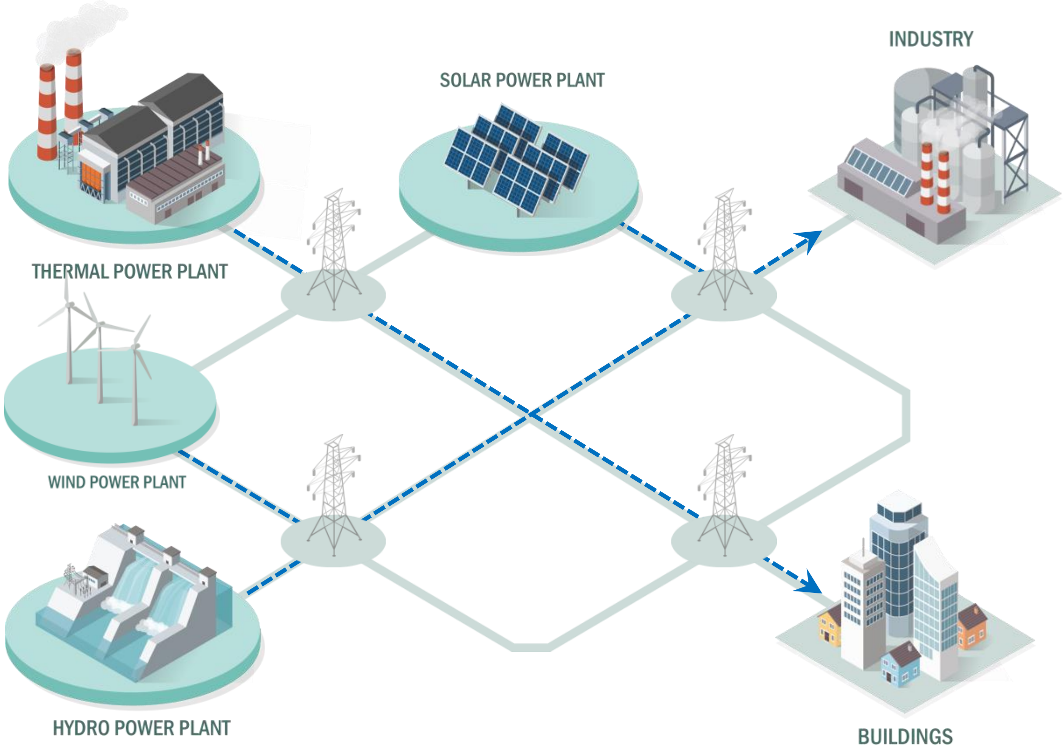
Trends in Power Systems

ASEAN is to expand renewable capacity by two-thirds in 2020-2025



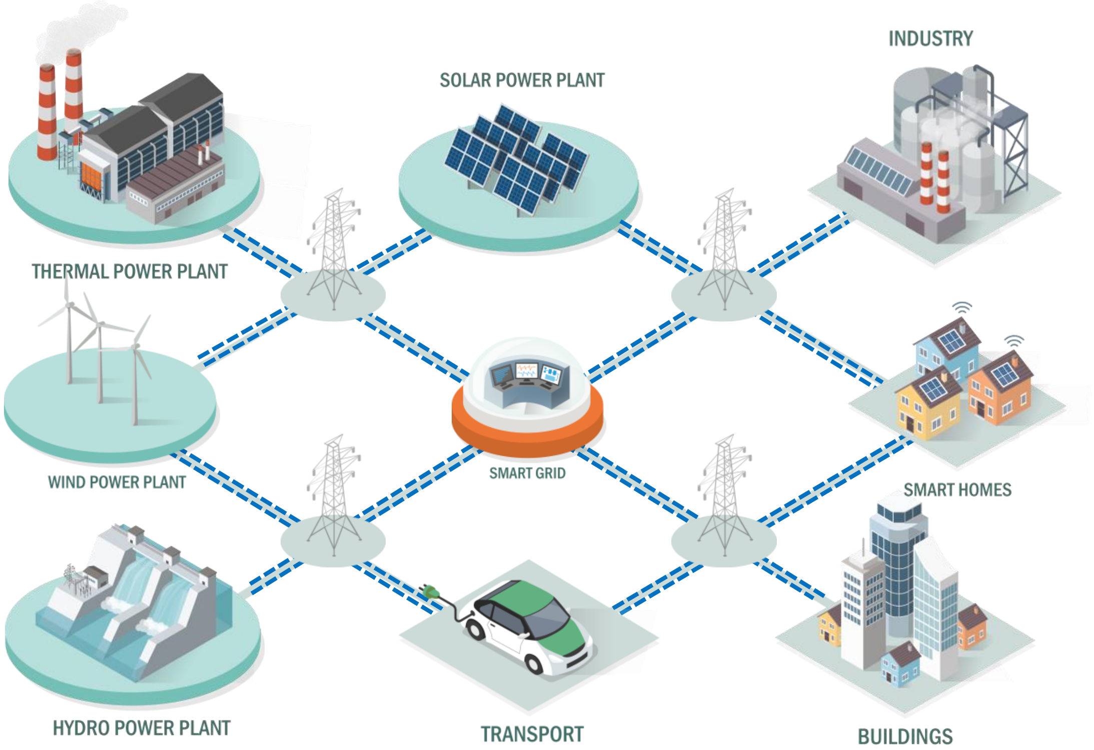
Two-thirds of ASEAN expected 45 GW renewable capacity growth will come from solar PV. Digitalization of grids will be the key to successful integration of renewables.

The digital transformation of the energy system

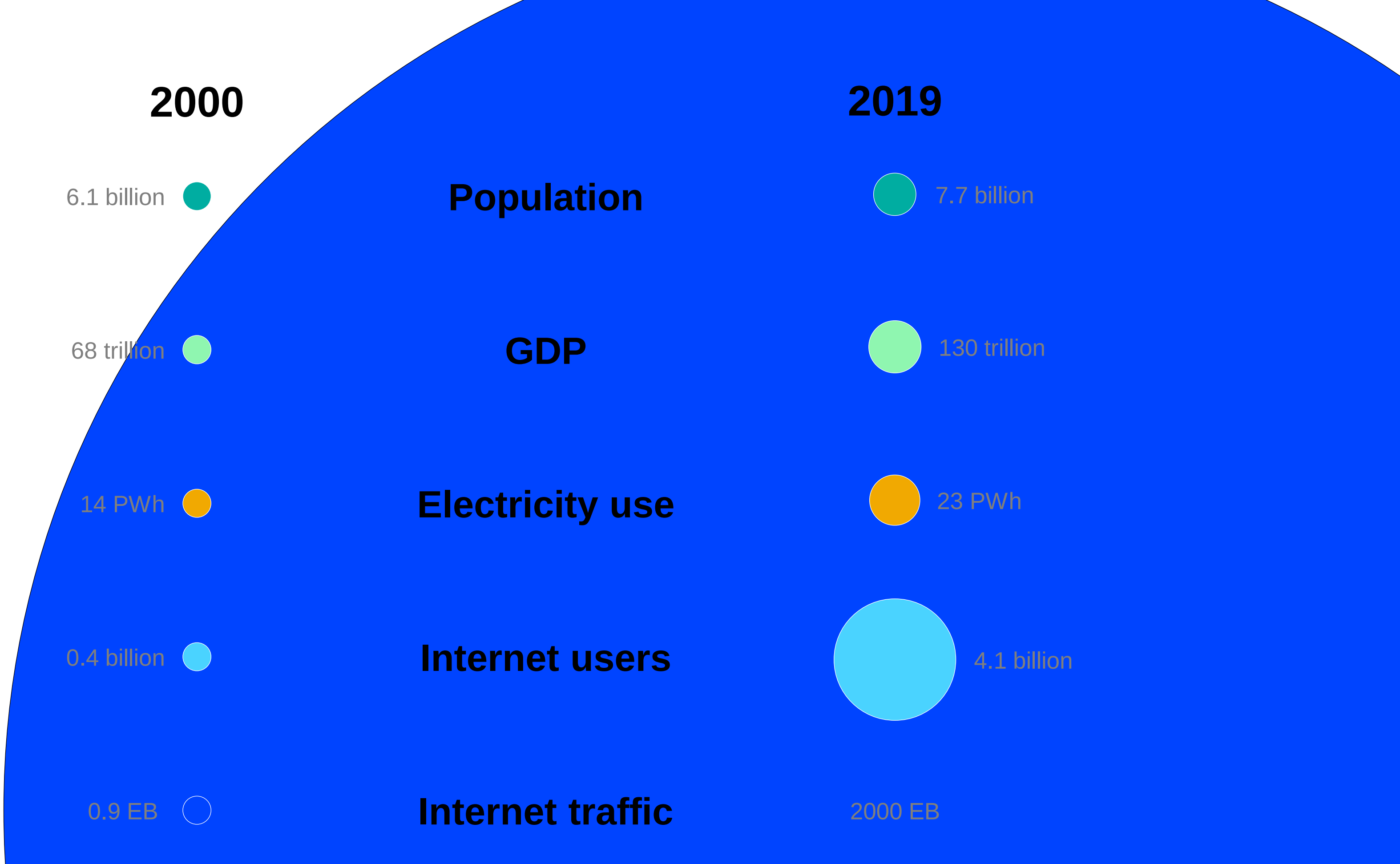


Pre-digital energy systems are defined by unidirectional flows and distinct roles

The digital transformation of the energy system

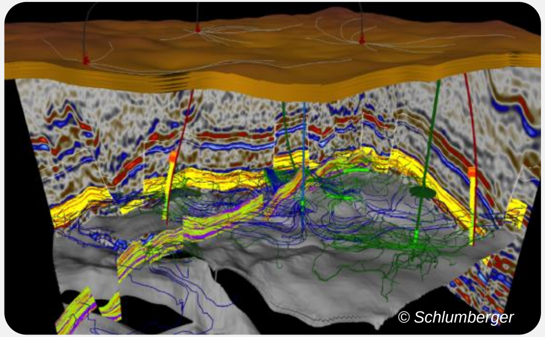


Pre-digital energy systems are defined by unidirectional flows and distinct roles, digital technologies enable a multi-directional and highly integrated energy system



Sources: UN (2019), World Population Prospects 2019; World Bank (2020), Data Bank: GDP, PPP (Constant 2017 International $); IEA (2020), Data and statistics; ITU (2020), Statistics; Cisco (2015), The History and Future of Internet Traffic; Cisco (2018), Cisco Visual Networking Index: Forecast and Trends, 2017–2022

Impacts of digital are everywhere – but digital technologies are “agnostic”



Oil and gas

- Increased productivity, improved safety and environmental performance
- Could decrease production costs by 10-20%; recovery could be enhanced by 5%.

Coal

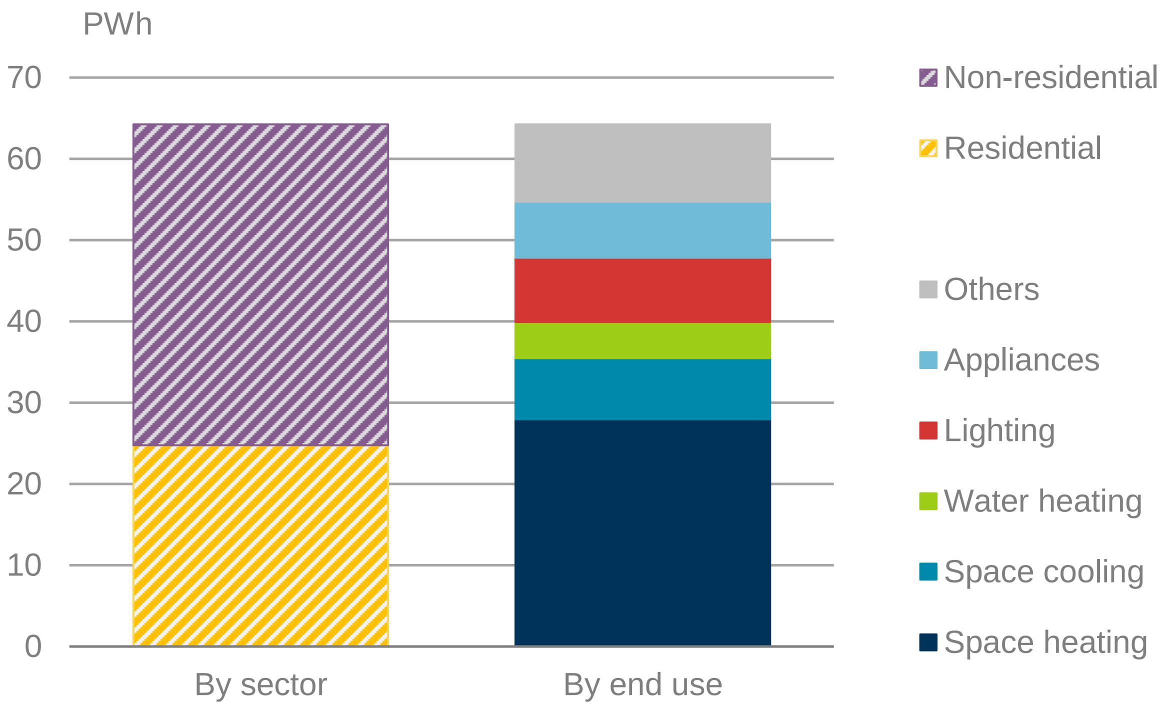
- Coal mining can expect to see improved processes and reduced costs as well as improved environmental performance

Power

- Power plants and electricity networks could see reduced O&M costs, extended life time, improved efficiencies and enhanced stability
- Savings of USD 80 billion per year

Digitalization is an enabler that accelerates the achievement of policy objectives: it can increase productivity, safety or accelerate the pace of innovation in whichever direction framework policy points it towards

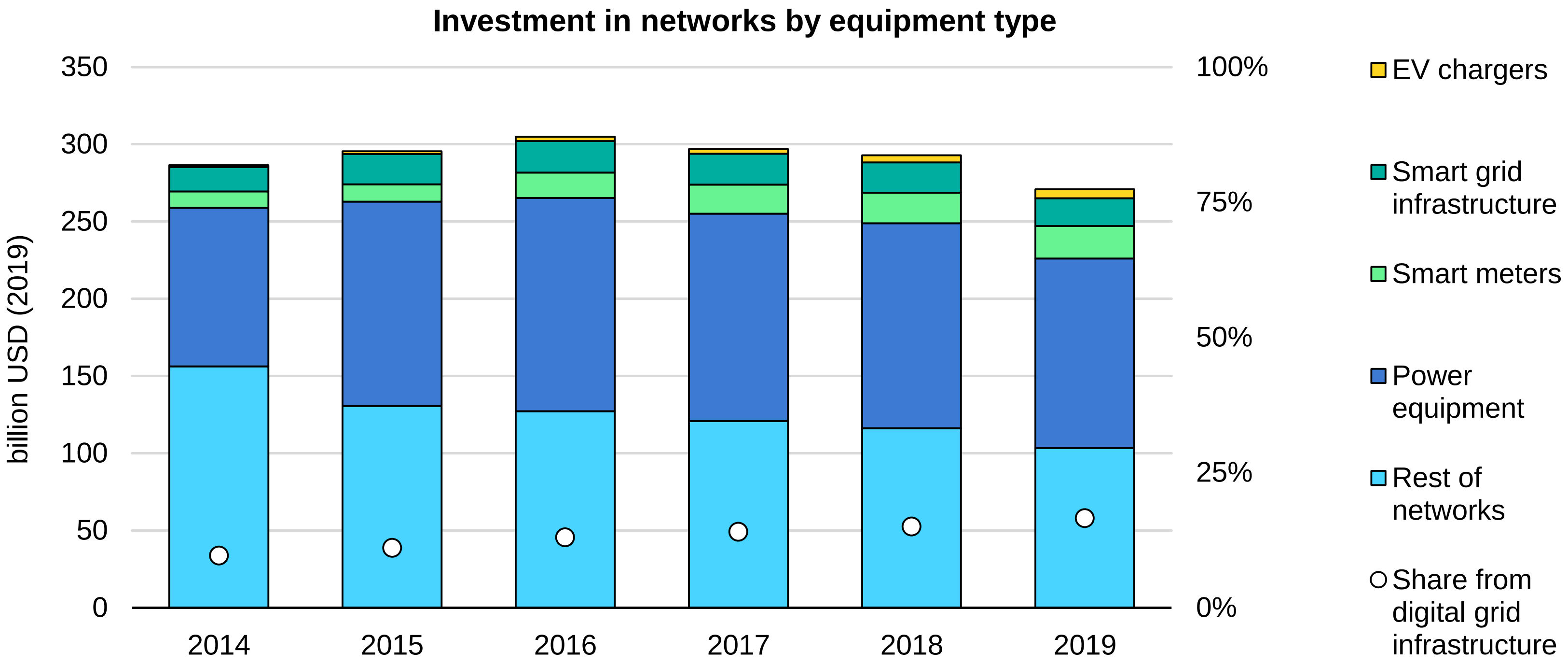
Smarter buildings can unlock deeper energy savings while providing connectivity



IEA analysis

Widespread deployment of smart building controls could reduce energy use by 10% to 2040

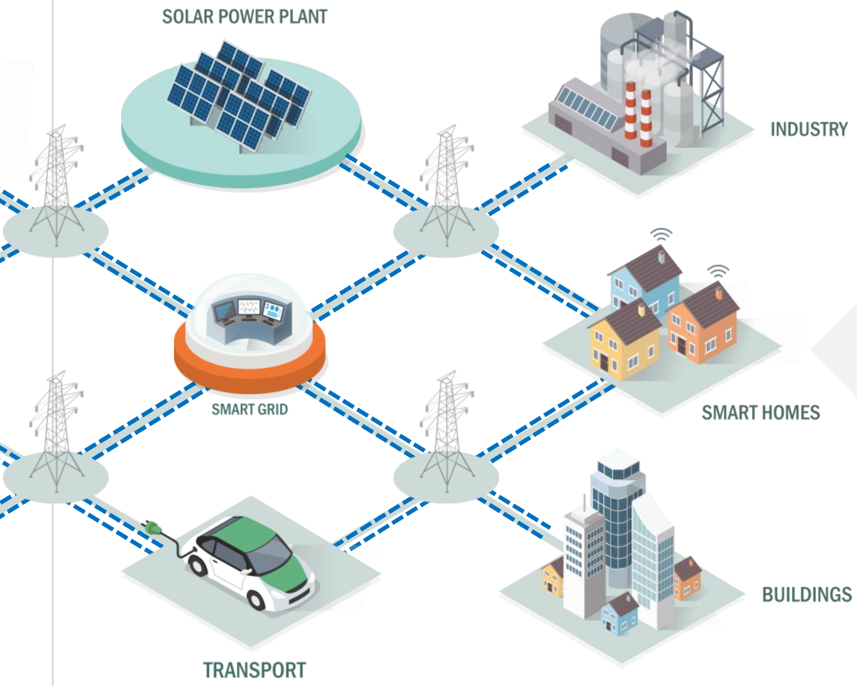
Grids transform slowly – but digital is accelerating in many regions



Overall grid investment declines… : In 2019, investment in electricity grids declined by 7% compared with 2018 levels, falling under USD 280 billion.

… but technology becomes smarter : Smart meters, utility automation and EV charging infrastructure, at USD 40 billion, now make up more than 15% of total spending.

Smart demand response

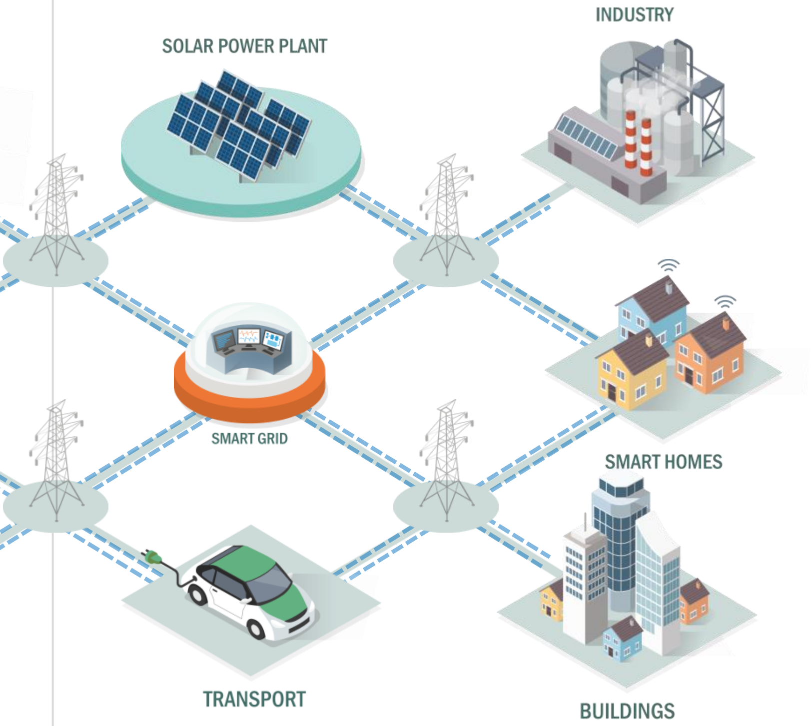


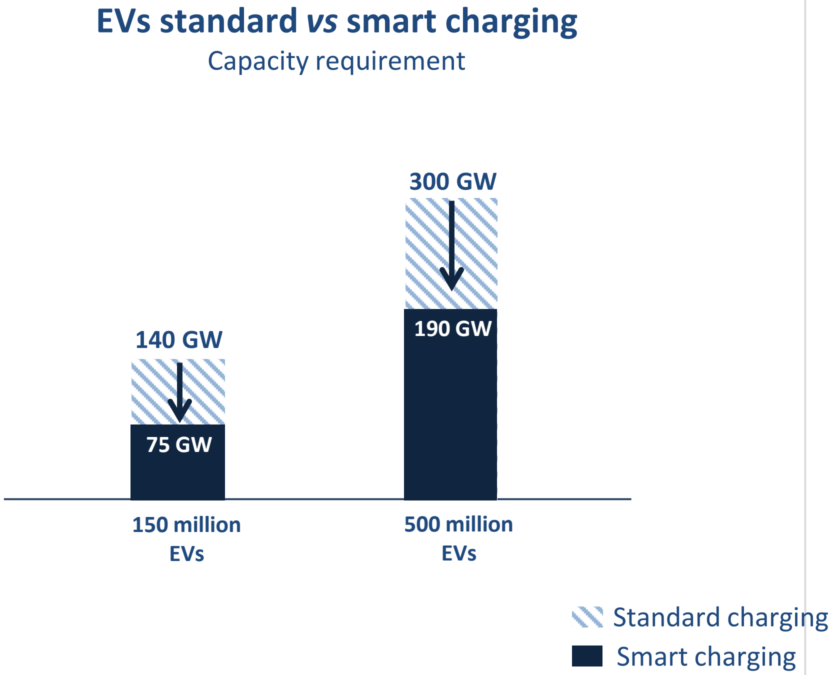
Residential sector

1 billion households and **11 billion smart appliances** could actively participate in interconnected electricity systems

Demand response programs – in buildings, industry and transport - could provide 185 GW of flexibility, and avoid USD 270 billion of investment in new electricity infrastructure

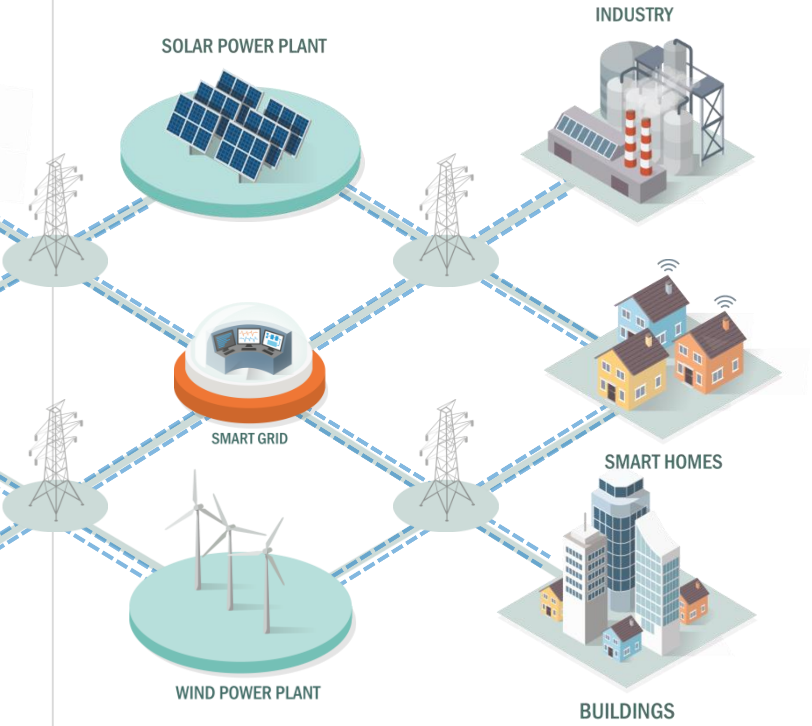
Smart charging of electric vehicles

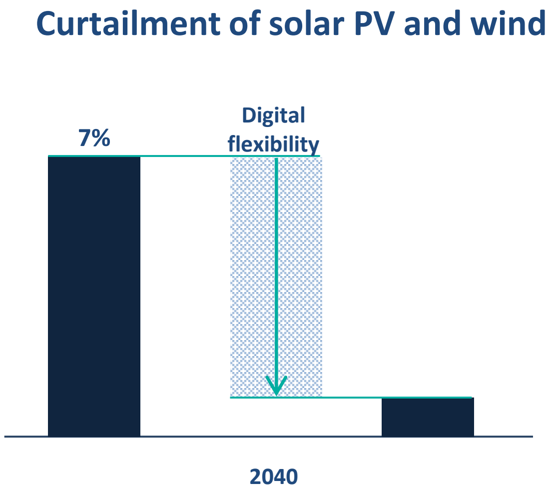




EVs smart charging would provide further flexibility to the grid saving between USD 100-280 billion investment in new electricity infrastructure

Integration of variable renewables





Digitalization can help integrate variable renewables by enabling grids to better match energy demand to times when the sun is shining and the wind is blowing.

The smart grid toolkit

Opportunities for Indonesia

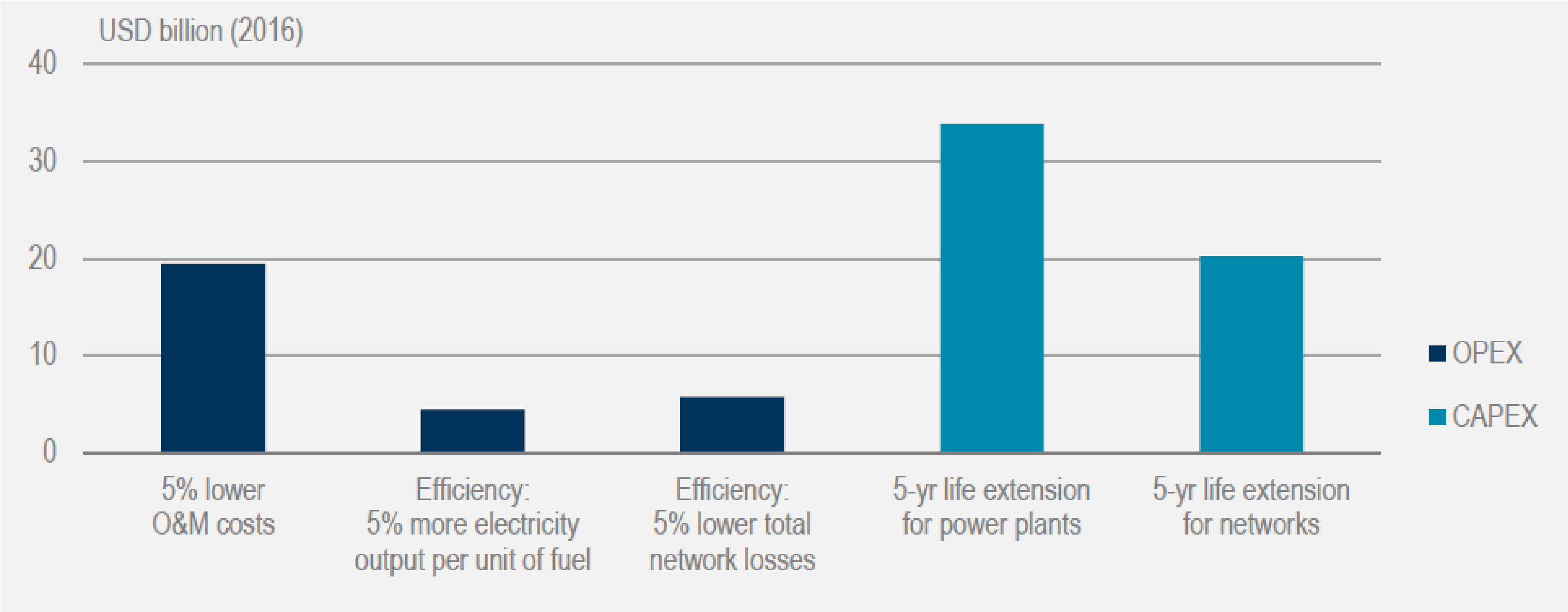
A smart grid toolkit?

*"A smart grid is an electricity network that can **intelligently** integrate the actions of **all users** connected to it – generators, consumers and those that do both – in order to **efficiently** deliver sustainable, economic and secure electricity supplies."*

Definition by the European Technology Platform Smart Grid

Beyond Generation and Grids Automation : data and advanced analytics

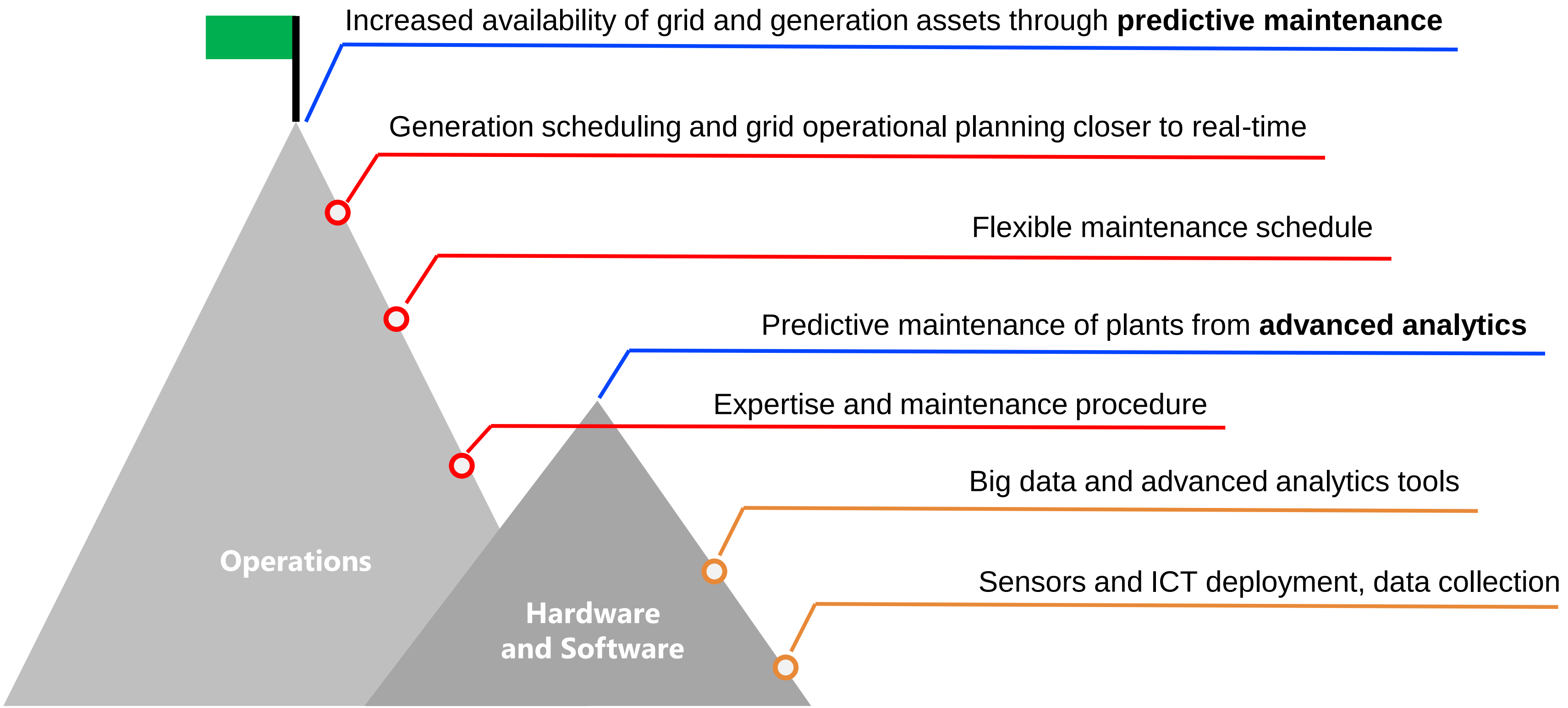
Potential worldwide cost savings from enhanced digitalization in power plants and electricity networks to 2040



Cumulative savings from the widespread use of **digital data and analytics in power plants and electricity networks** could average around **USD 80 billion per year**

For CAPEX alone: **USD 1.3 trillion** of cumulative investment could be **deferred** until 2040

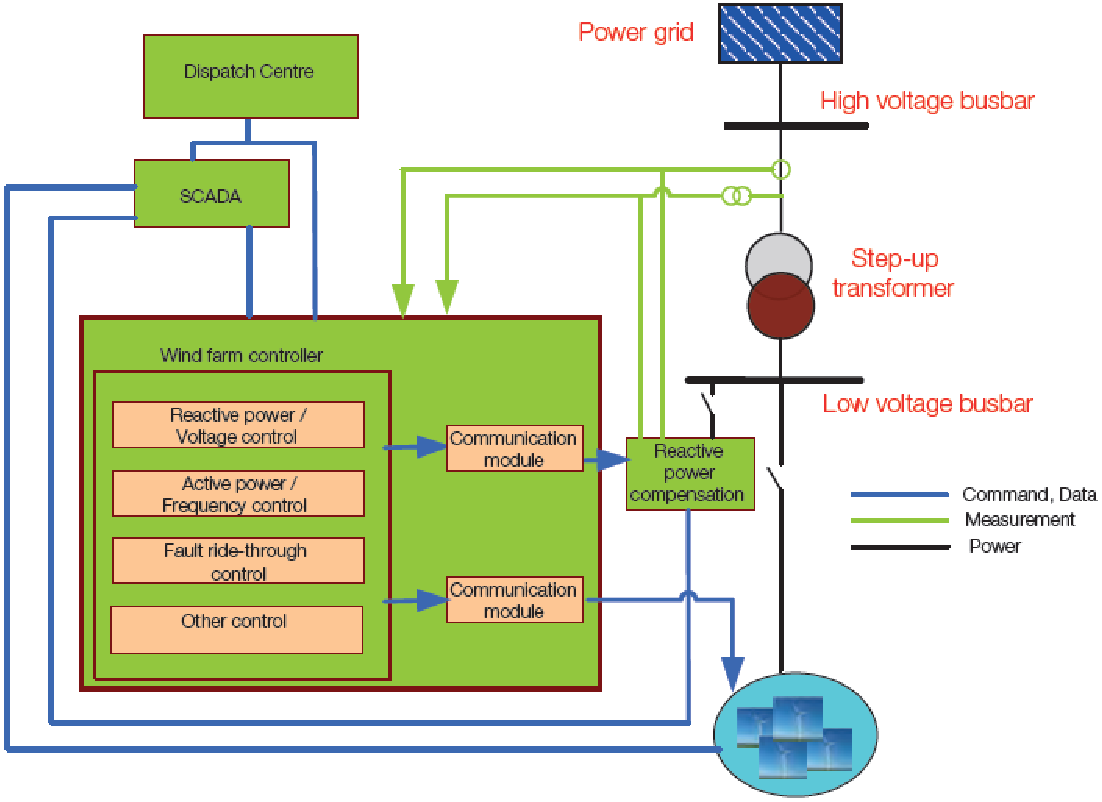
Capturing the benefits of Assets Management



The Digital Grid-friendly Power Plant

Modern wind or solar PV farms with advanced sensors and controls

- Predictive maintenance
- Short-term generation forecasts
- Local controls to remain connected and support grid local f- and V-control (grid-code enabled)
- Centralised controls to manage grid congestions and contribute to system flexibility



Case study: Iberdrola CORE

- In Toledo (Spain)
- CORE **Control Centre for Renewable generation** units
  - 7 GW installed capacity
  - Over 200 wind farms (over 6000 turbines) and 70 mini hydro power plants across 9 countries
  - 2 million sensors
- Assets management
- Grid interface

Source: Iberdrola

The central role of the Transmission grid

Digital substation	Planning and Operations	Control Room New Generation SCADA
Fault detection Remote controls Asset Management	Short-term weather forecast Close-to-real time operational planning Remote control of generation to optimise VRE infeed Dynamic Line Rating (DLR)	Dynamic Security Assessment (DSA) Wide area monitoring and control (WAMS, WAMPAC) Grid flows prediction

Digitalisation contributes to power system efficiency, resilience and flexibility

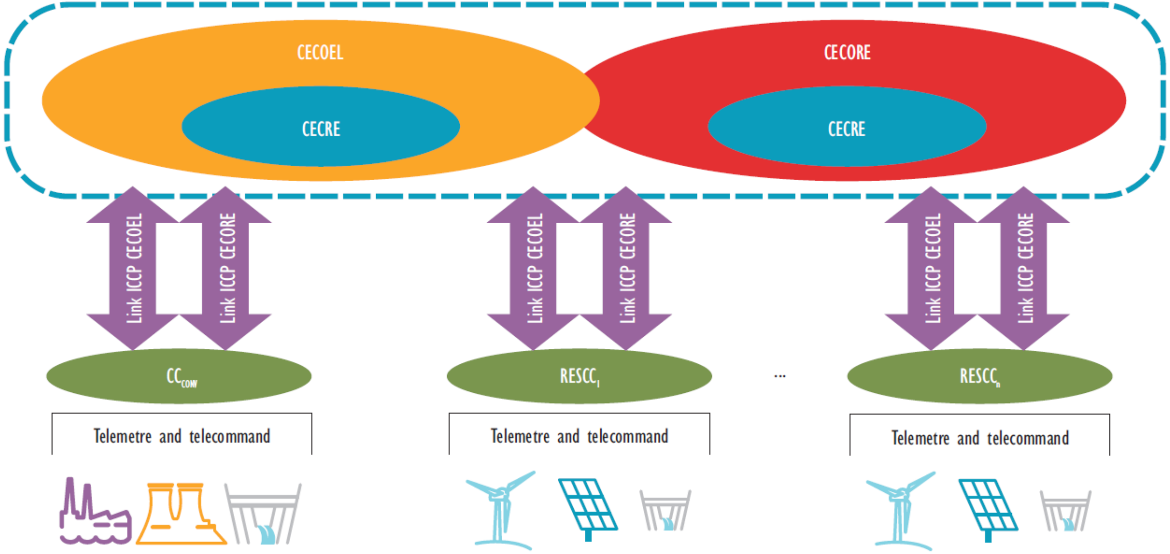
Case Study: Red Eléctrica de España CECRE (Spain)

CECOEL: Electricity Transmission CC
CECORE: Local Network CC

CC: Control Centre

CECRE: Renewable CC
RESCC: Generation Company Renewable Energy Source CC
CCconv: Generation Company Conventional Generation CC

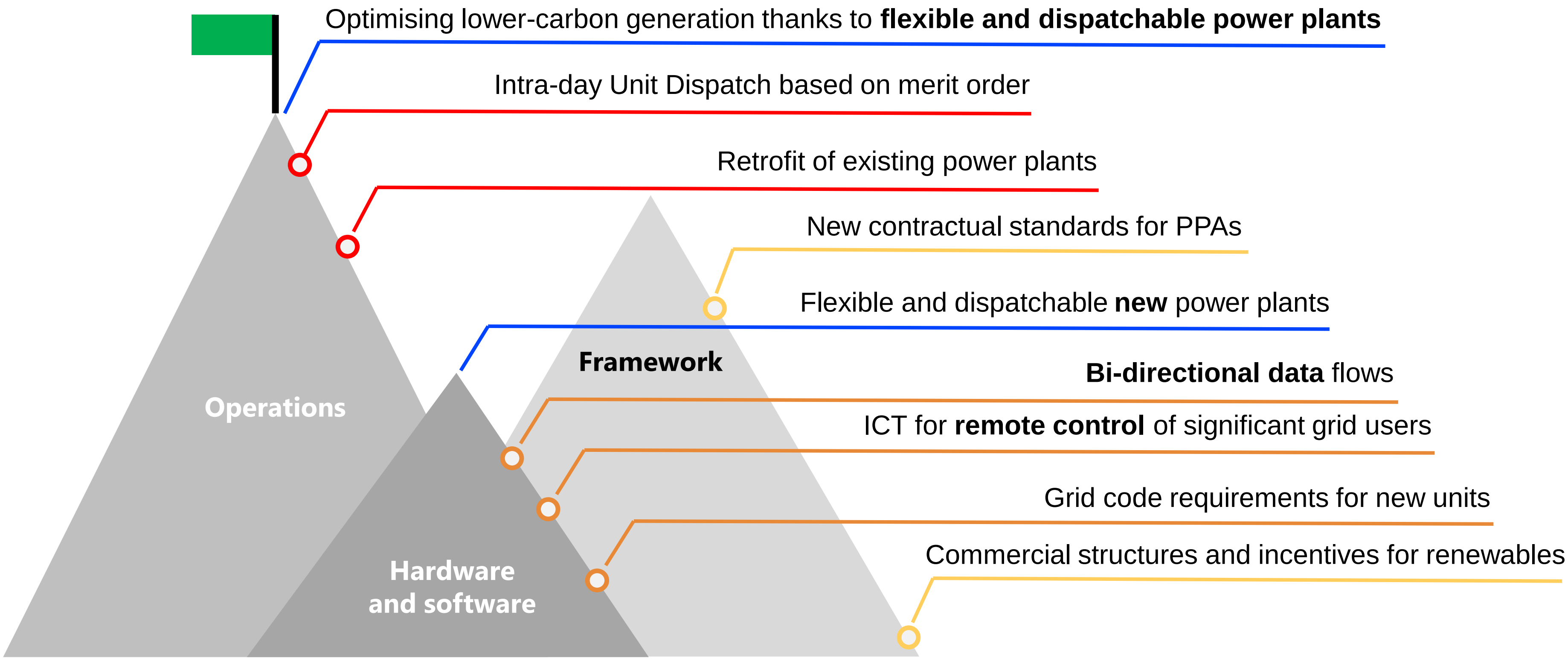
Source: REE



- In Madrid
- Forecasts wind and solar over Spain
- Pre-calculates effects of grid faults on VRE
- Remote control of significant plants

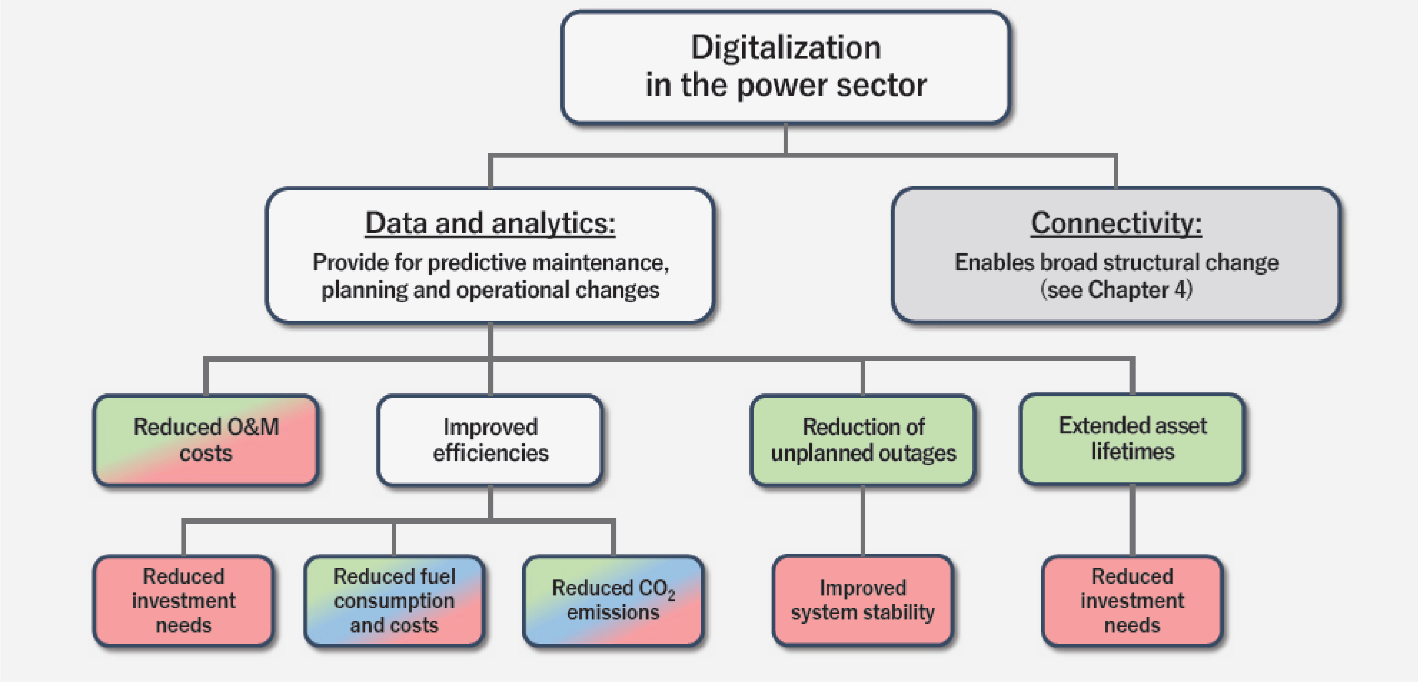
The combination of CORE and CECRE is an important factor in the successful integration of wind power in Spain

Capturing the benefits of Flexible Generation



Assets digitalisation benefits all players in the power system

Impact of digitalization on electricity sector assets



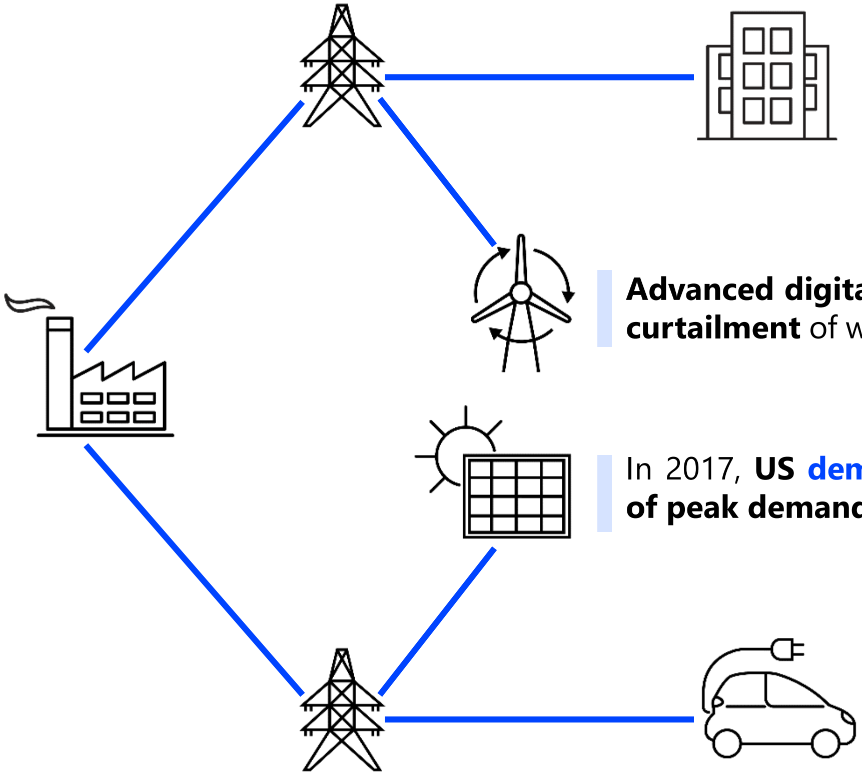
Green: financial benefits for asset owner

Red: system benefit, consumer benefit

Blue: global environmental benefits

Digitalization in the power sector has the **potential** to bring **benefits** to the owners of power sector assets, the wider electricity system, consumers and the environment

Digitalisation benefits: from source to consumption



Real-time communication through **smart meters** in buildings can **lower the peak demand** by up to **8.9%**.

Advanced digitalized weather forecasting can reduce curtailment of wind generation by **10%**.

In 2017, **US demand response program** saved **1-4% of peak demand** across each balancing authority.

150 million EV would require **75GW with smart charging, and 140GW without**

Harnessing the load flexibility potential

To meet the challenge of increased VRE integration, while maintaining affordable costs, the power system will need to better harness flexibility, including from the demand-side.

Demand Response Potential

6400 TWh

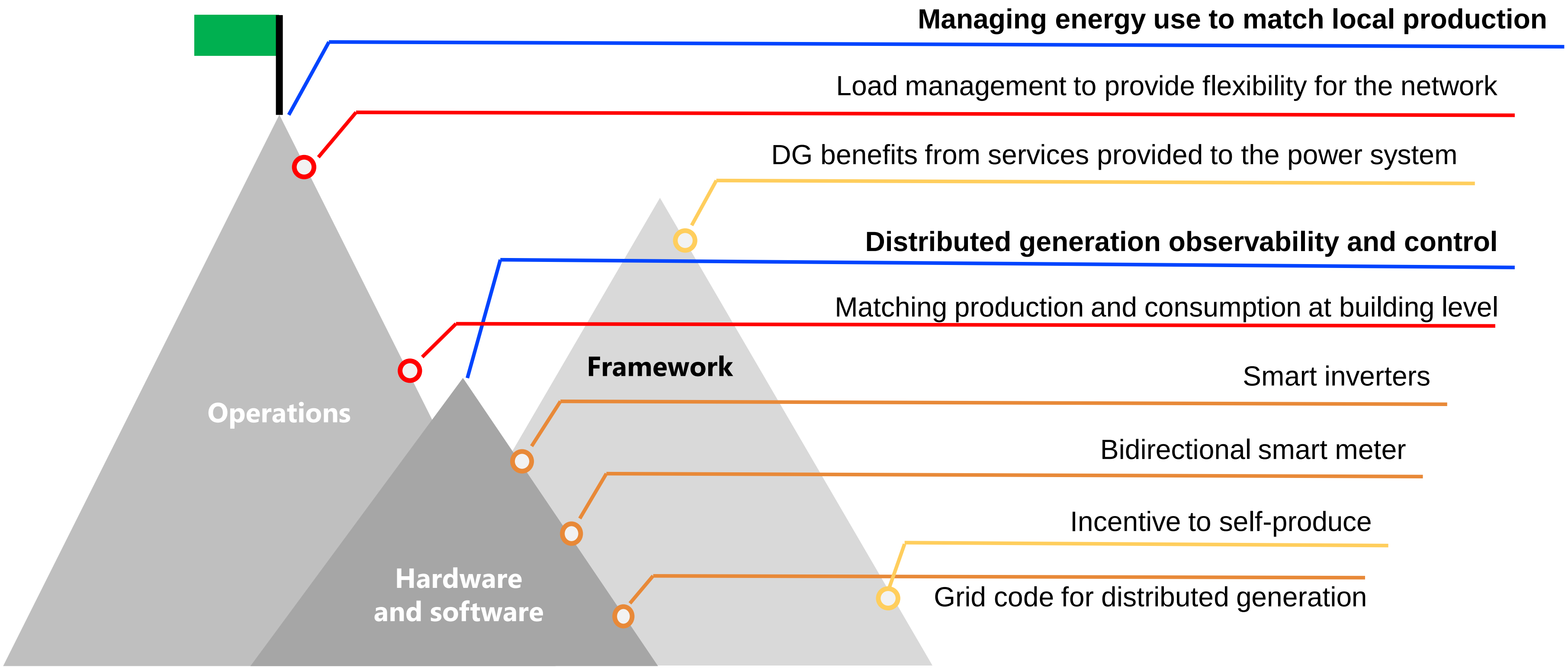
Theoretical potential in 2040

15%

of today's potential is tapped

Digitalization & Energy 2017
https://webstore.iea.org/download/direct/269

Application : Capturing flexibility for distributed generation



Application : Capturing the benefits for DSO operations

Data collection

- Smart meter
- sensors

Data processing

- Reduced non metered energy
- Better grid observability

Enhanced operations and investments

- Increased billability / reduced non-technical losses
- Reduced SAIDI/SAIFI

- Enel Italy reduced the System Average Interruption Duration Index (SAIDI, an indicator of grid quality) by 65%, and it is currently spending nearly one-third of its investment budget on digital technology
- **Reduced commercial losses are key in smart metering roll-out cost-benefit analysis**. However, this can cause backlash from consumers supporting increased bills.

Data at the core of smart grid

As digitalisation spreads, data will become widespread. The issues will be to harness it to benefit the power system and its users

Data collection

- Smart meters
- Grid sensors
- IoT data

Data processing

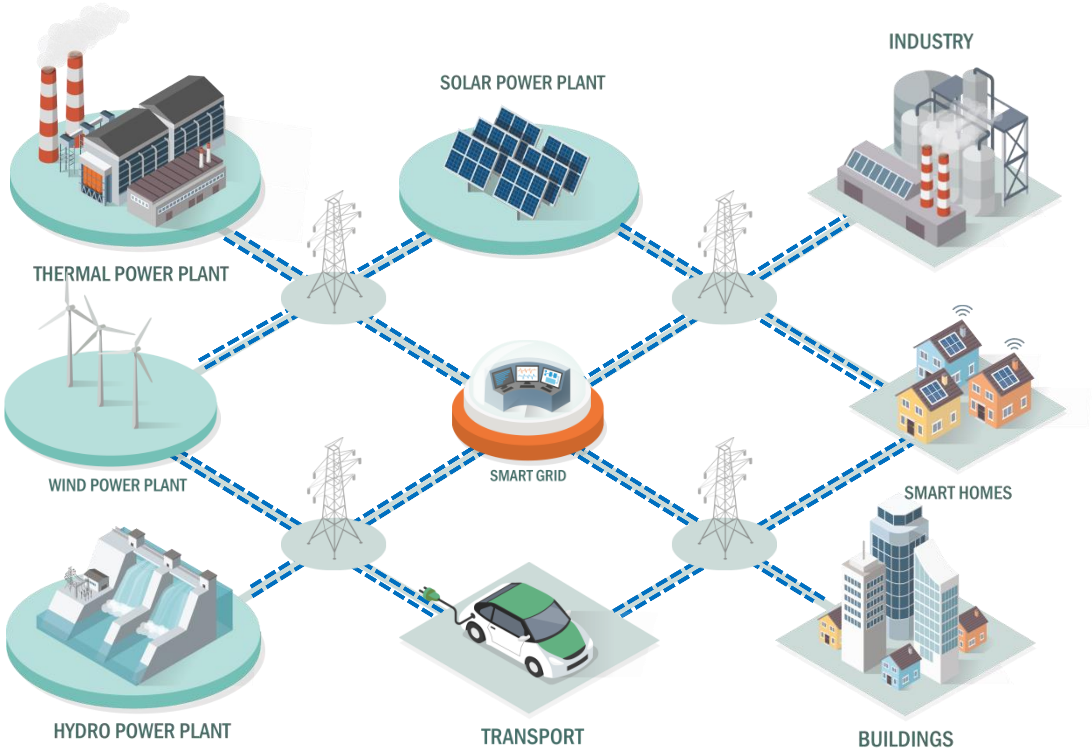
- Digital twin of distribution network
- forecast of consumption and generation
- Measuring flexibility

Enhanced operations and investments

- Less outages though predictive maintenance
- Better targeted investments
- Flexibility allows delayed investment
- Reduced (technical and non technical) losses

Conclusion

The power sector landscape is changing dramatically



Traditional system

Centralised / dispatchable

High inertia and stability

Central planning

One way flows of energy and communication

Closed networks, few devices

New system

Decentralised / variable generation

Low system inertia from rotating machines

Multiple actors / competitive markets

Two way flows of energy and communication

Open networks and many devices

Changing climate patterns

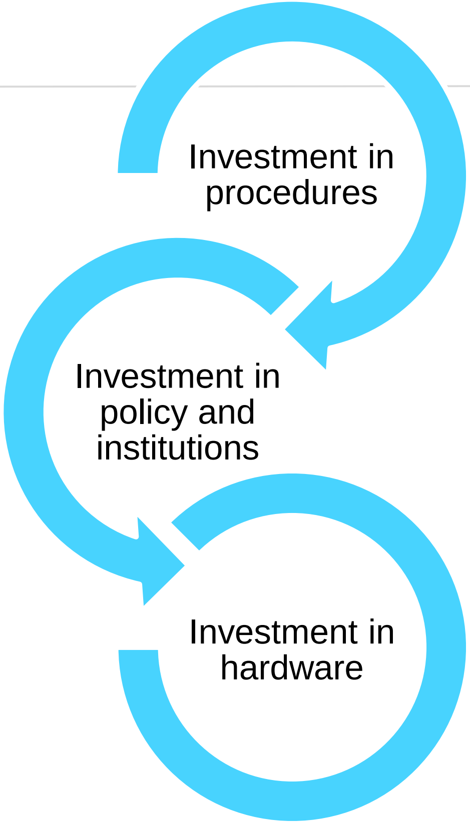
Digitalisation is at the core of the power system transformation

- The Power System Transformation
  - Decarbonization
  - Decentralisation
  - *Digitalisation*

- Digitalisation is a game-changer for our ability to **track and to control the energy system**
  - Improve performance
  - Increase Stakeholders participation at all levels
    - Design
    - Investments
    - Operations

Towards smarter grids

- Investments in operational procedures
  - Updating current practises (including software enhancement)
  - Use existing technology
  - Updating procedures for new technology
- Investments in policy and institutions
  - Incentivising uptake
  - Tracking of uptake and utilisation (including software)
  - Requirements for new investments
- Investment in hardware: *smart-ready* infrastructure
  - Sensors and Meters
  - Retrofits in generation



To yield the benefits of digitalisation,
procedures, policy and institutions must support hardware

The IEA is committed to support Indonesia

For the IEA:

Smart grids in Indonesia is a holistic effort

to digitalise and enhance technology,

processes and institutions

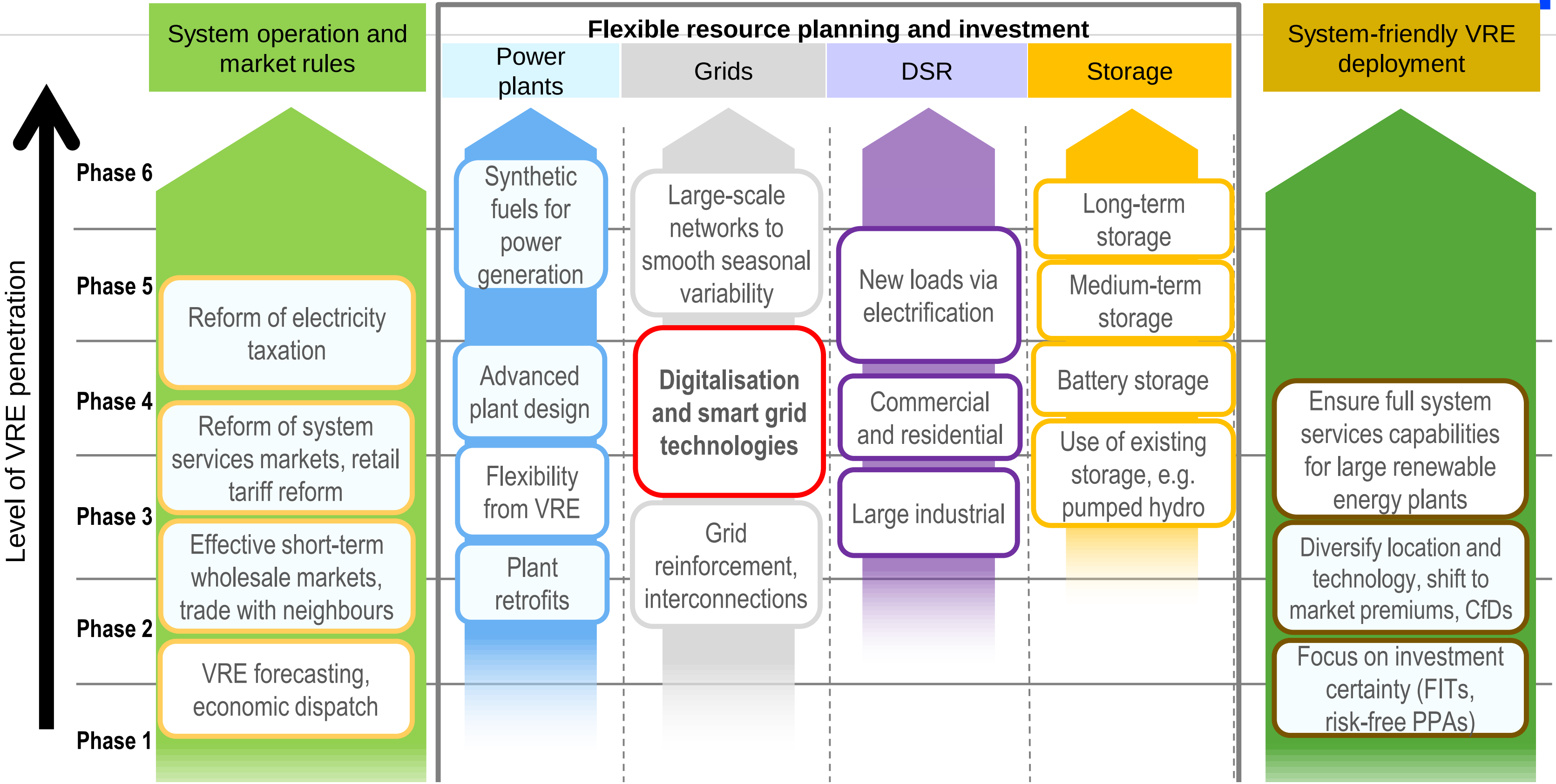
in order to enable

a clean and secure electricity system of the future

The IEA's participation in this event was made possible through the Clean Energy Transitions in Emerging Economies programme has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952363.

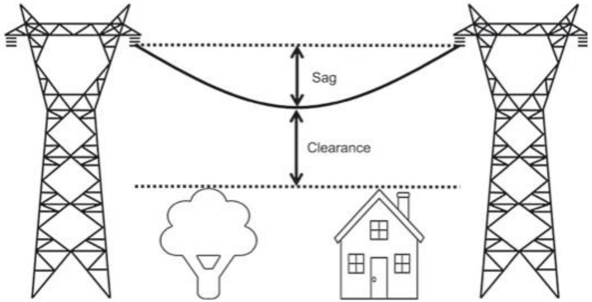
Backup slides

Digital transformation is a step-wise, system-wide process involving many sectors and technologies

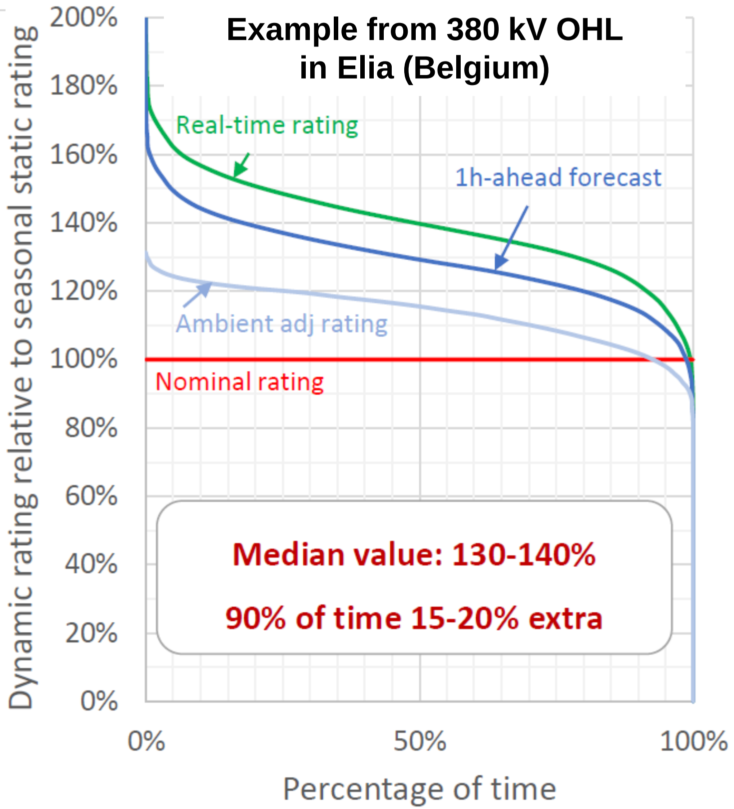


Digitalisation is at the heart of the power system transformation but requires progressive investments.
This includes improving enabling conditions, like grid practices and by creating a favourable investment environment.

Application: Dynamic Line Rating (DLR) for Transmission Lines



Source: Elia / Ampacimon



- **Ampacity** (Ampere + Capacity): maximum current a conductor can carry without exceeding its temperature rating
- Ampacity is a function of ambient weather (temp, wind speed)
- Enabling factors

Algorithms	Calculate ampacity
Digitalisation	Real-time monitoring, communication and control
Legal and regulatory framework	Incentives for cost-efficient grid operation
Operations	Short-term operational planning

DLR reduces congestions and enables a more cost-effective generation dispatch
Capturing the DLR benefits requires flexible operating practices to be incentivised by the legal framework