Digitalization & Energy

Webinar – 7 February 2018

IEA

Speakers

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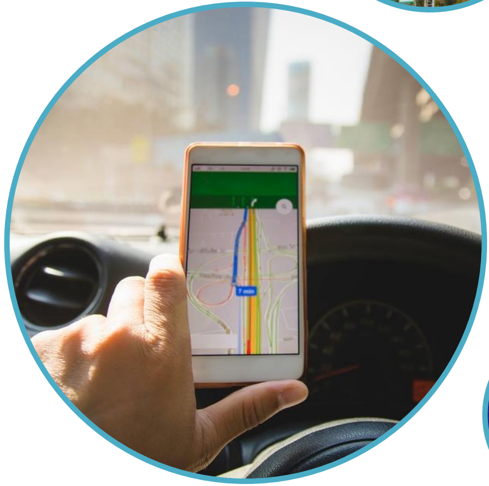
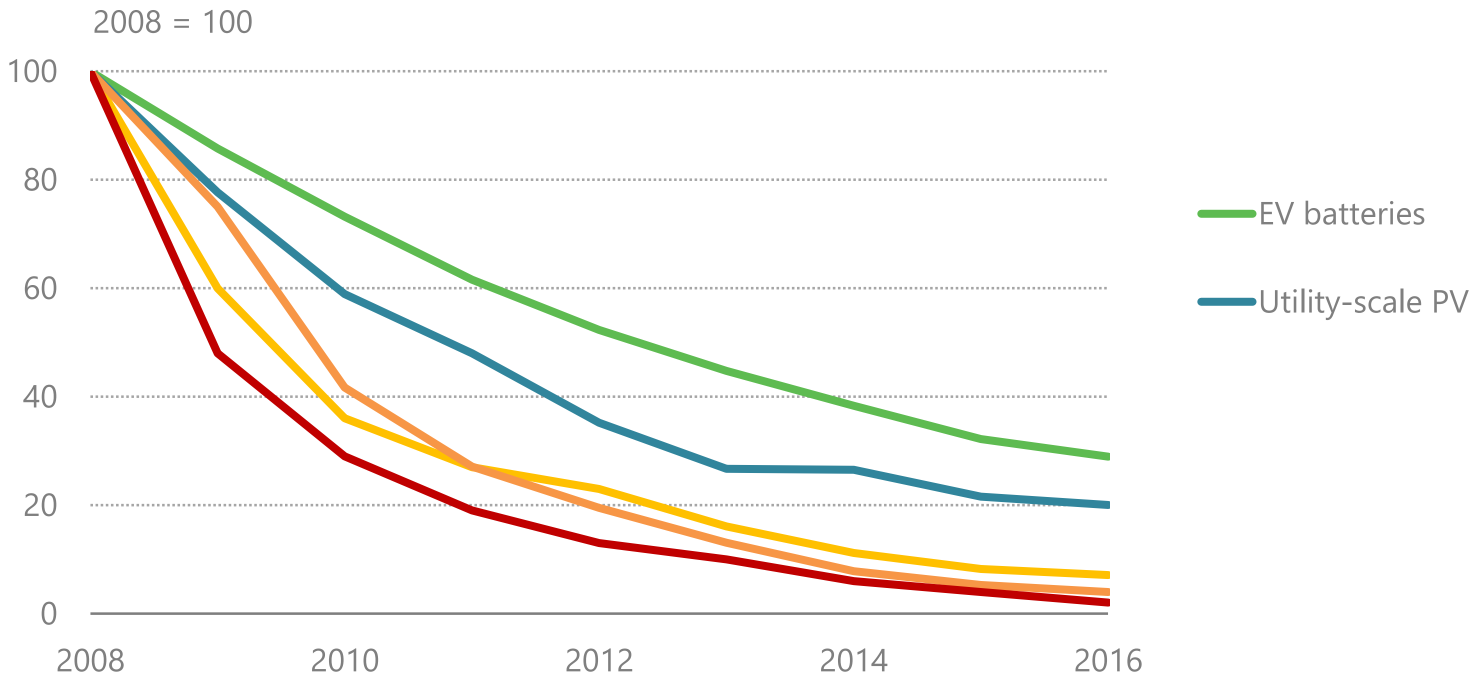
Kira West	Energy Demand Outlook Division
Christophe McGlade	Energy Supply Outlook Division
Carlos Fernández Alvarez	Gas, Coal & Power Markets Division
Brent Wanner	Energy Demand Outlook Division
Luis Munuera	Energy Technology Policy Division
Jan Bartoš	Energy Policy and Security Division

Digital technologies are everywhere….



Drivers of digitalization: data, analytics, and connectivity

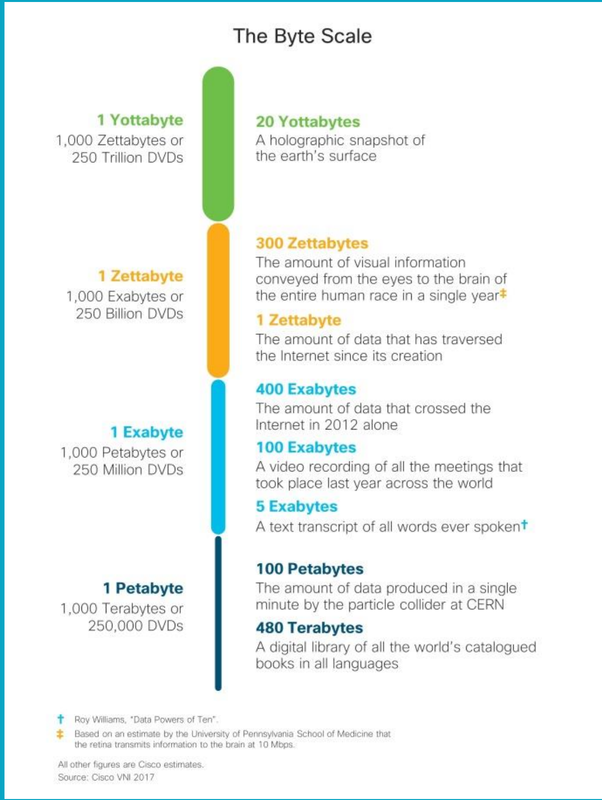


Sources: Based on BNEF (2017), Utilities, Smart Thermostats and the Connected Home Opportunity; Holdowsky et al. (2015), Inside the Internet of Things; IEA (2017), Renewables; Tracking Clean Energy Progress; World Energy Investment; Navigant Research (2017), Market data: Demand Response. Global Capacity,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

Since 2008, data collection, storage, and transmission costs have declined by over 90%

Entering the zettabyte era

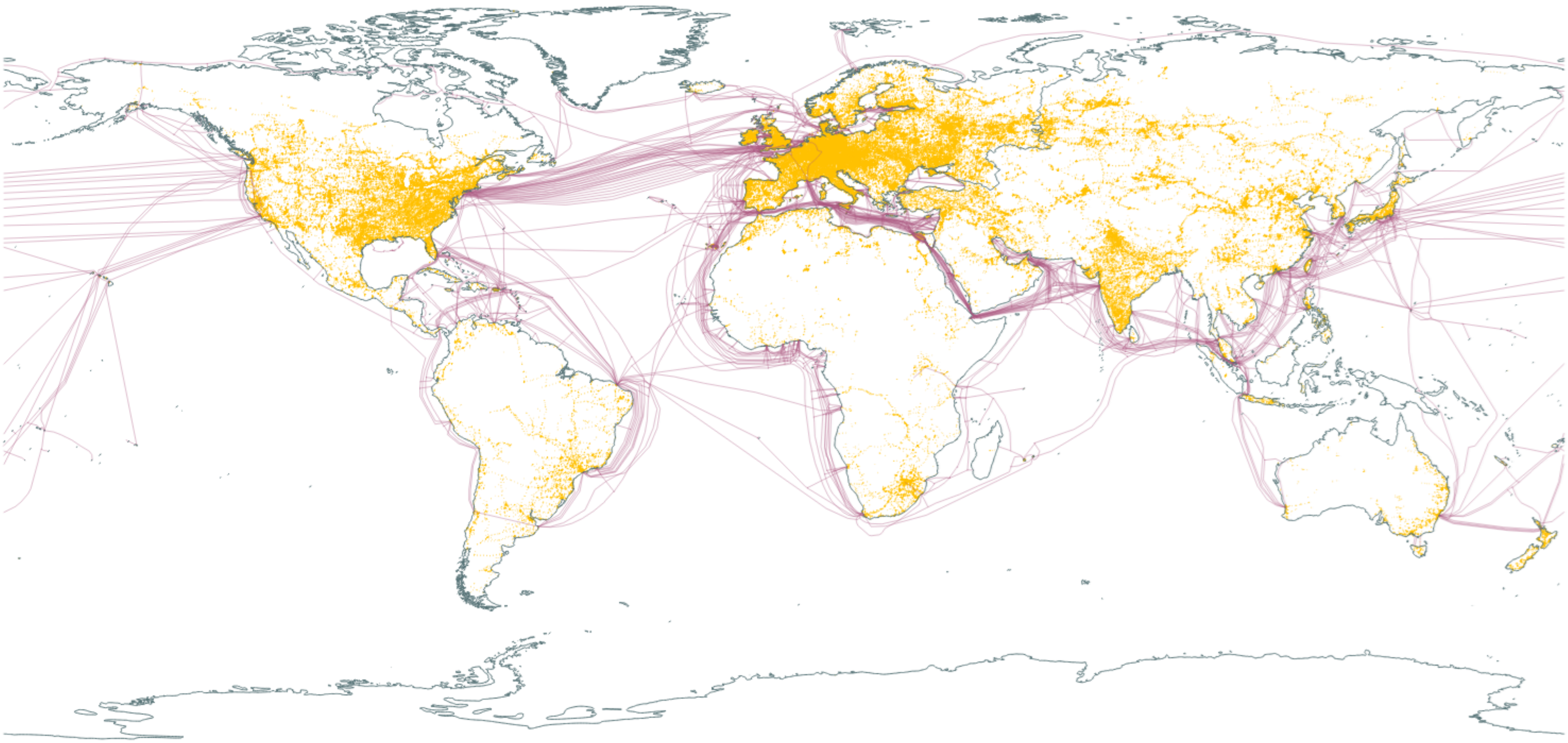
KB	kilobyte	10^3 bytes
MB	megabyte	10^6 bytes
GB	gigabyte	10^9 bytes
TB	terabyte	10^{12} bytes
PB	petabyte	10^{15} bytes
EB	exabyte	10^{18} bytes
ZB	zettabyte	10^{21} bytes
YB	yottabyte	10^{24} bytes



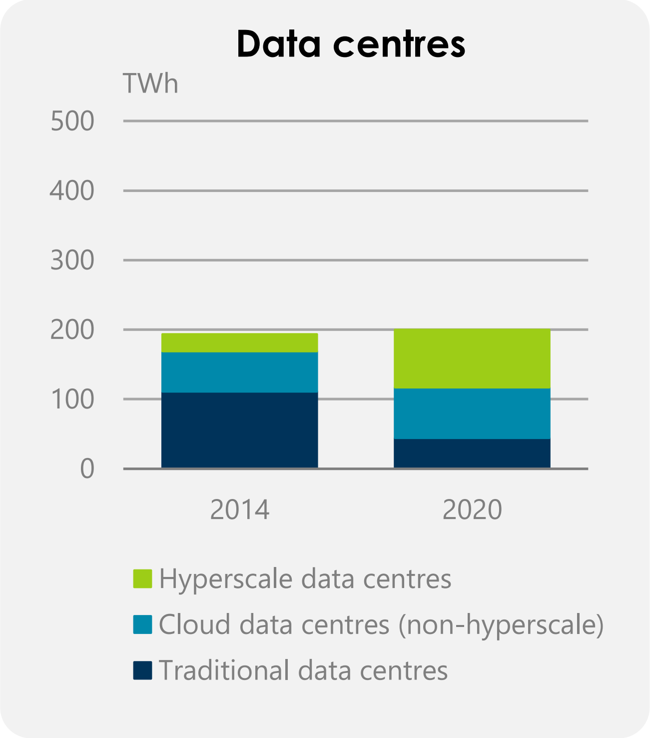
Sources: Cisco (2017). The Zettabyte Era: Trends and Analysis June 2017; Cisco (2015). The History and Future of Internet Traffic.

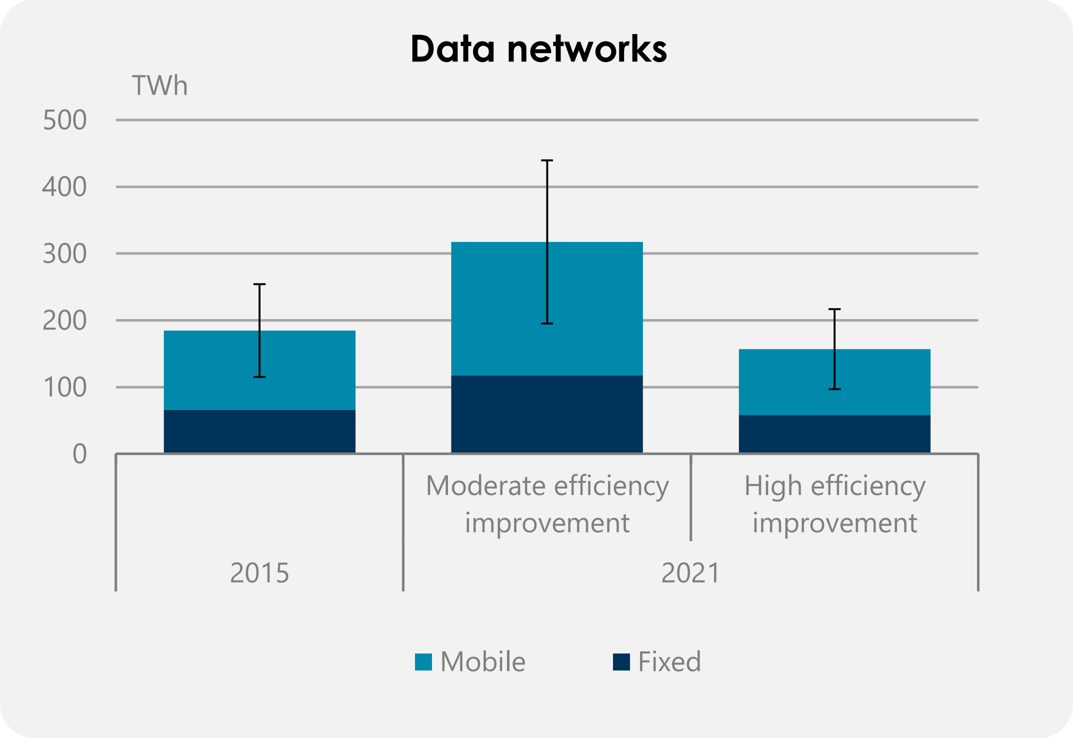
Internet data traffic is growing exponentially, tripling over the past five years

World electricity and backbone internet infrastructure



Electricity use by data centres and networks





Sustained efficiency gains could keep ICT electricity demand largely in check over the next five years, despite exponential growth in demand for data centre and network services

Poll Q1

Which sector do you think will be most impacted / transformed by digitalization over the next 5-10 years?

a) Buildings

b) Transport

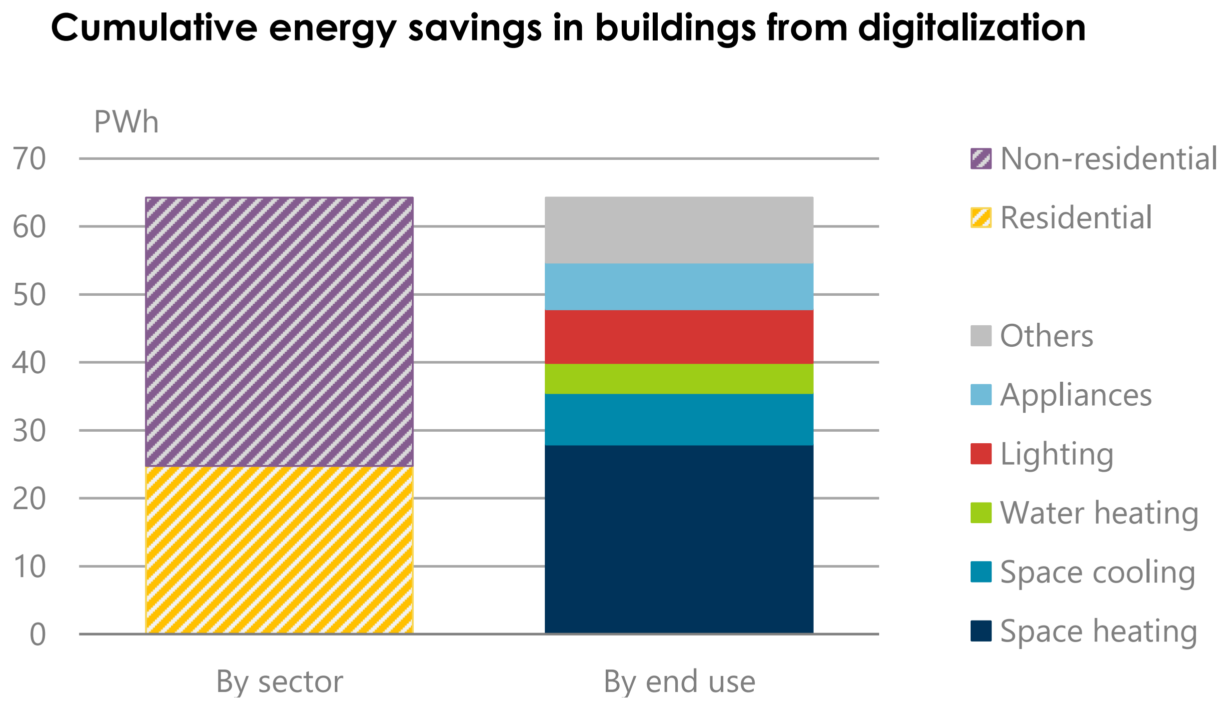
c) Industry

d) Oil & gas

e) Coal

f) Power

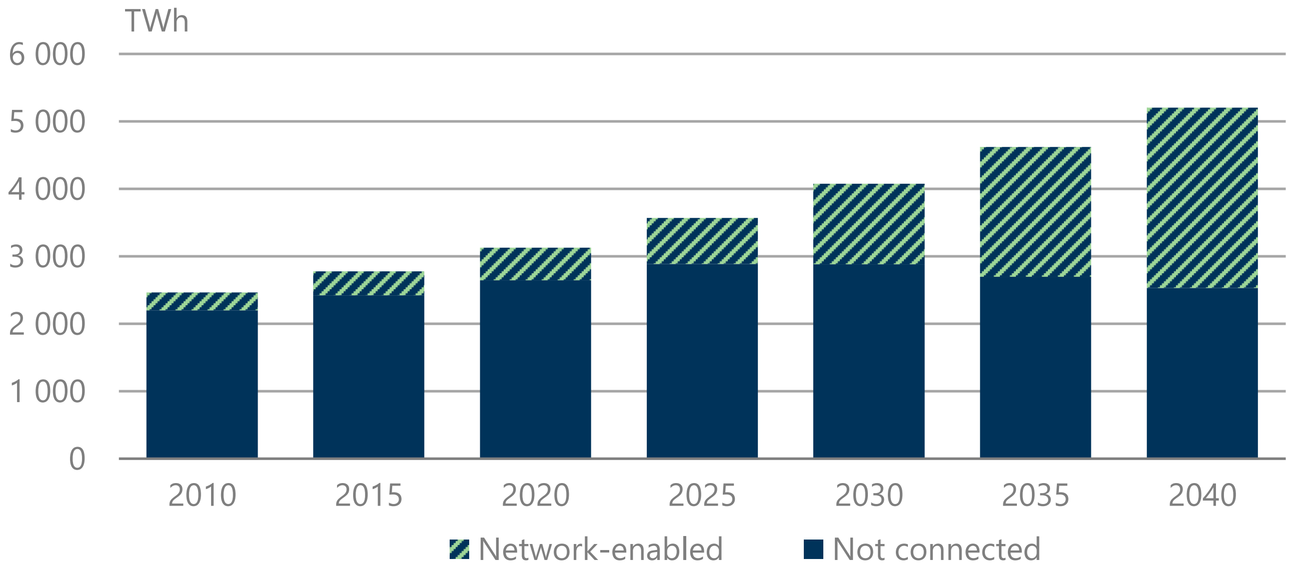
Buildings: reducing global energy demand



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

Buildings: enabling demand-side response

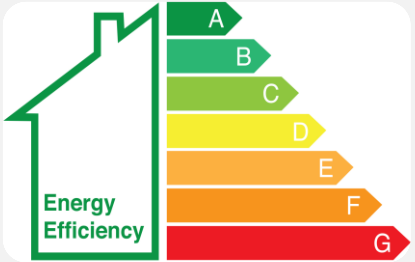
Household electricity consumption of appliances and other small plug loads



The growth in network-enabled devices presents opportunities for smart demand response but also increases needs for standby power control

Buildings: broadening horizons

Other opportunities

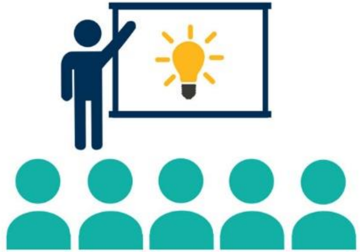


Measuring, reporting and monitoring

Enhanced energy services

Other barriers

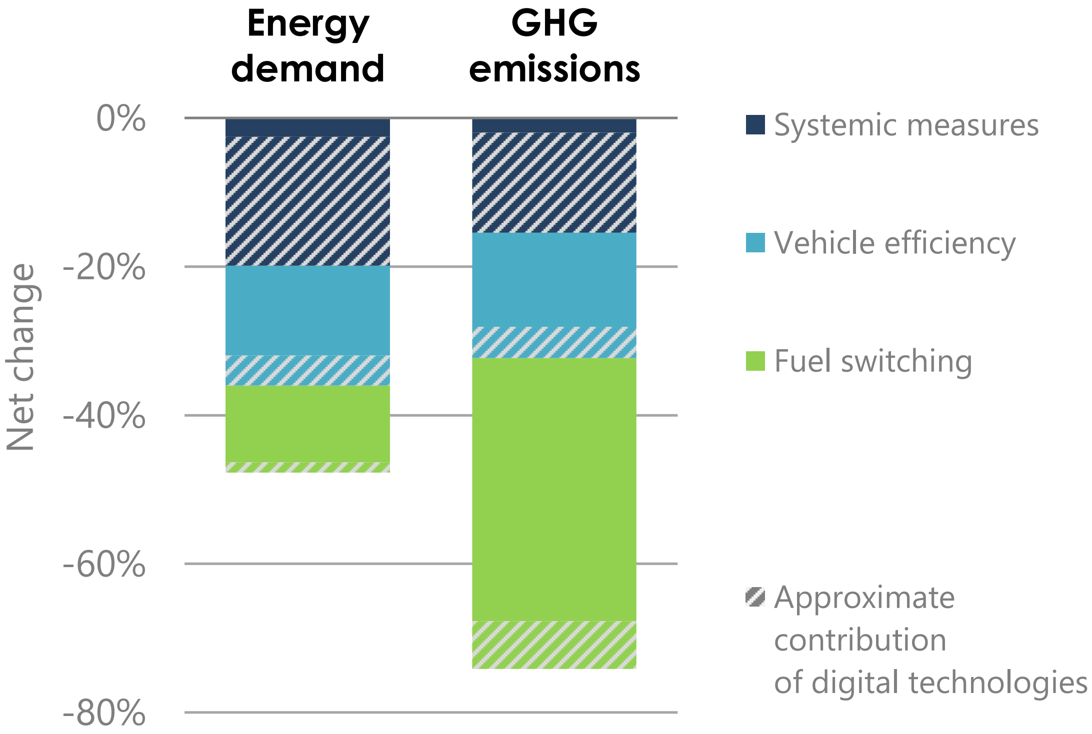
Interoperability



Education
Training
Communication

New business models for enhanced energy services could help overcome technical and economic barriers to digitalization in buildings.

Digitalization and transport

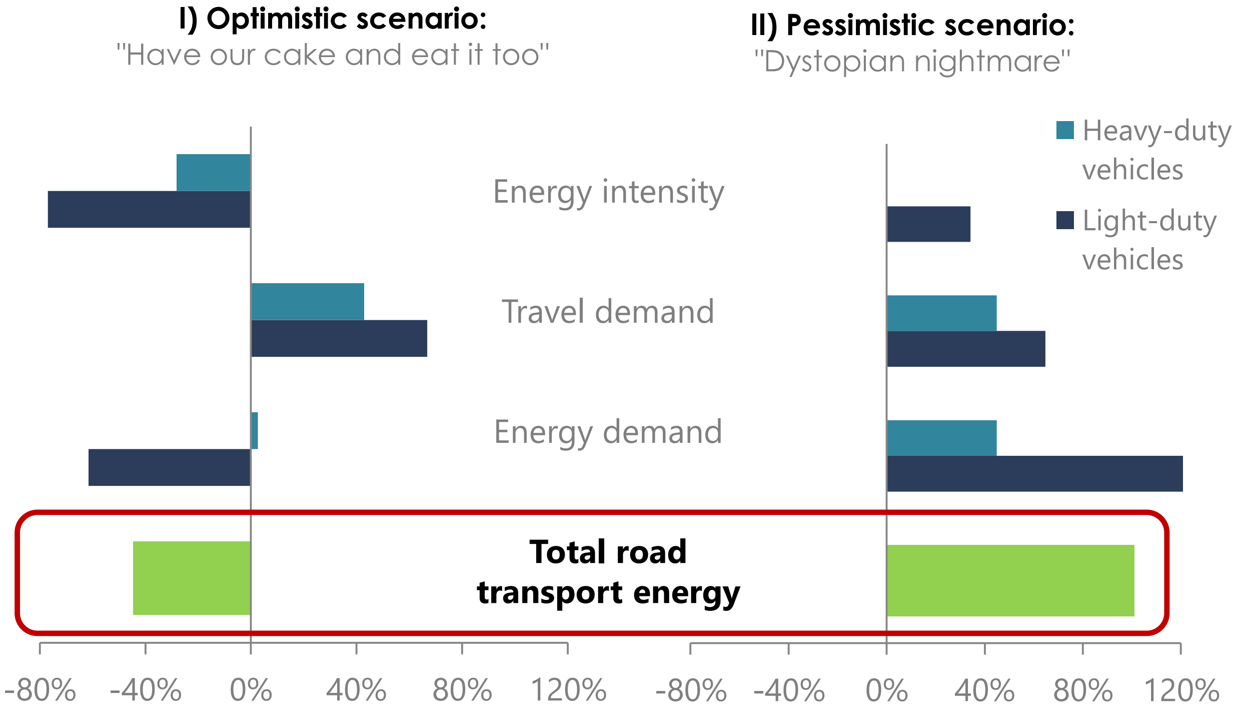


Source: IEA (2017). The Future of Trucks: Implications for energy and the environment.

Digital solutions for trucks and logistics could reduce energy use for road freight by 20-25%

Impacts on road transport energy demand

- Automation, connectivity, sharing, and electrification (ACES) to dramatically reshape mobility
- Impacts on energy demand difficult to predict

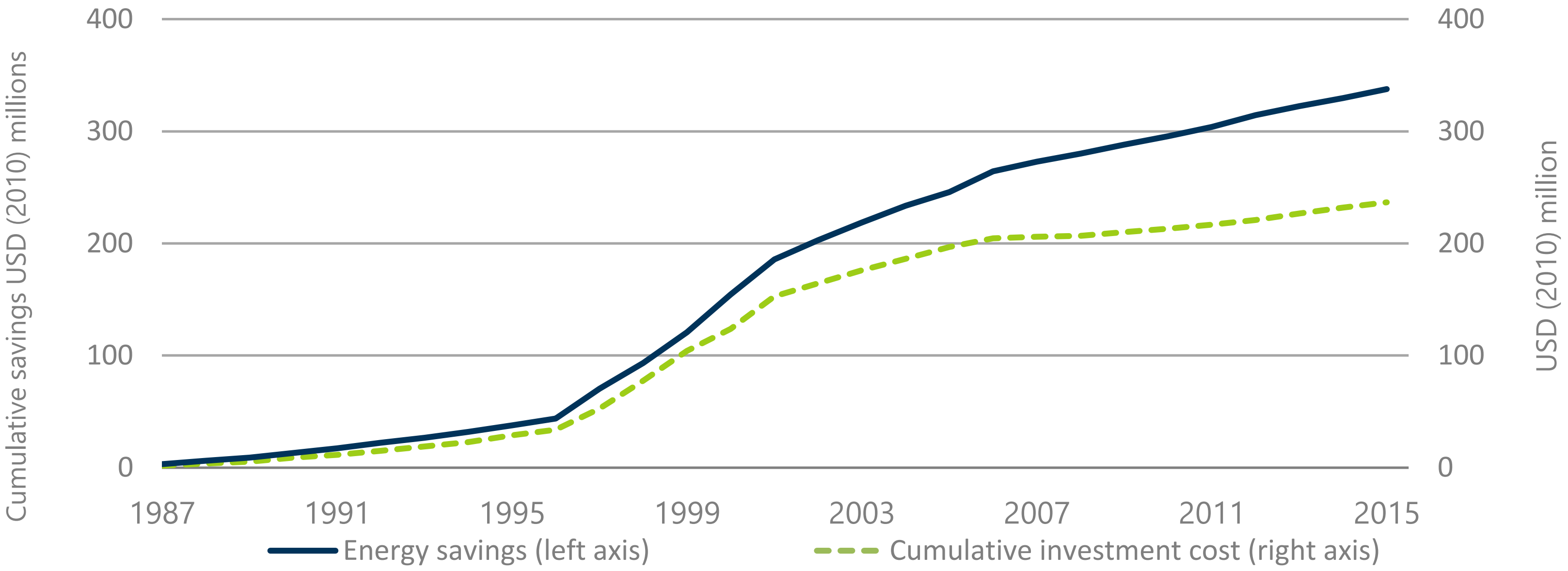


Source: Wadud, MacKenzie and Leiby (2016), "Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles".

Road transport energy demand could <u>halve or double</u> from automation and connectivity depending on how technology, behavior, and policy evolve

Energy savings from improvement to industrial process controls

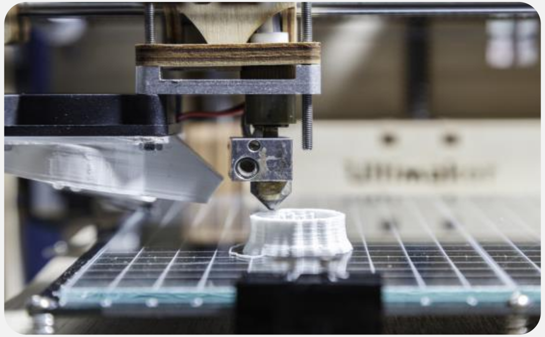
Energy efficiency measures relating to improved process control in small to medium US manufacturers

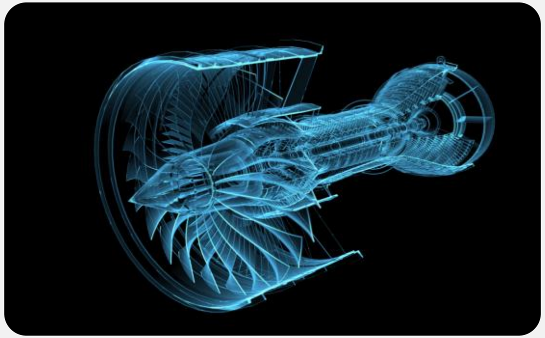


Source: IAC database

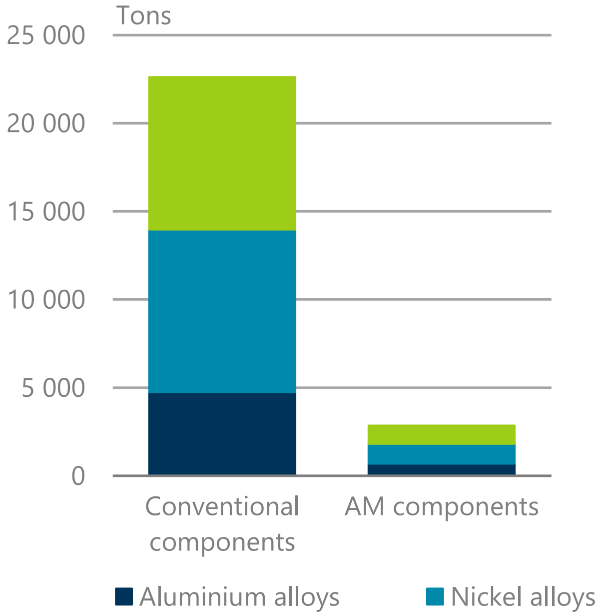
Improvements to industrial process controls produce substantial energy and associated cost savings

Illustrative case study: aircraft component light-weighting

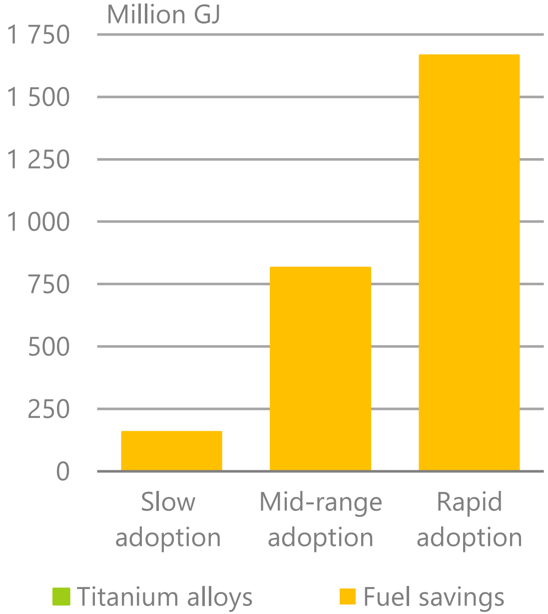




Metal demand in 2050



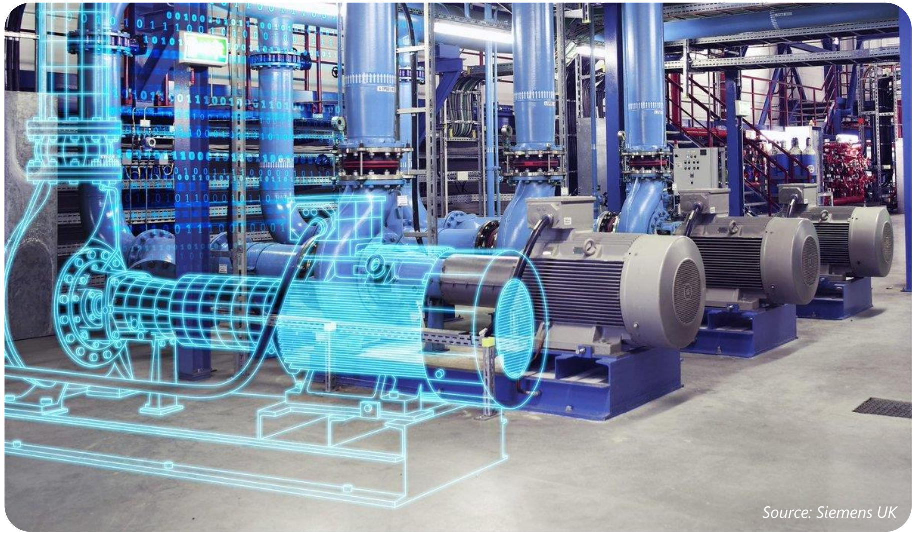
Cumulative aircraft fuel savings to 2050

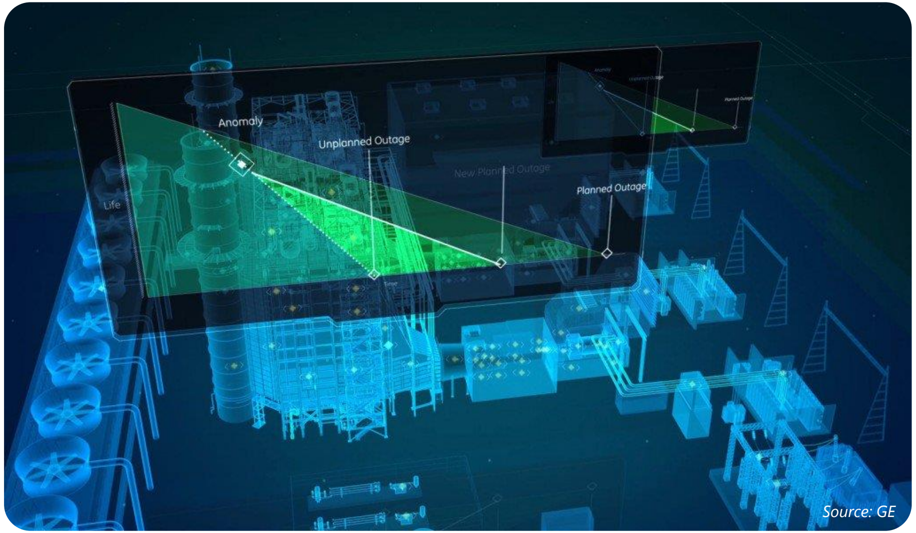


Source: Huang et al. (2016)

The use of 3D printed components in commercial aircraft could lead to significant material demand and fuel savings

Digital plant twins


Source: Siemens UK

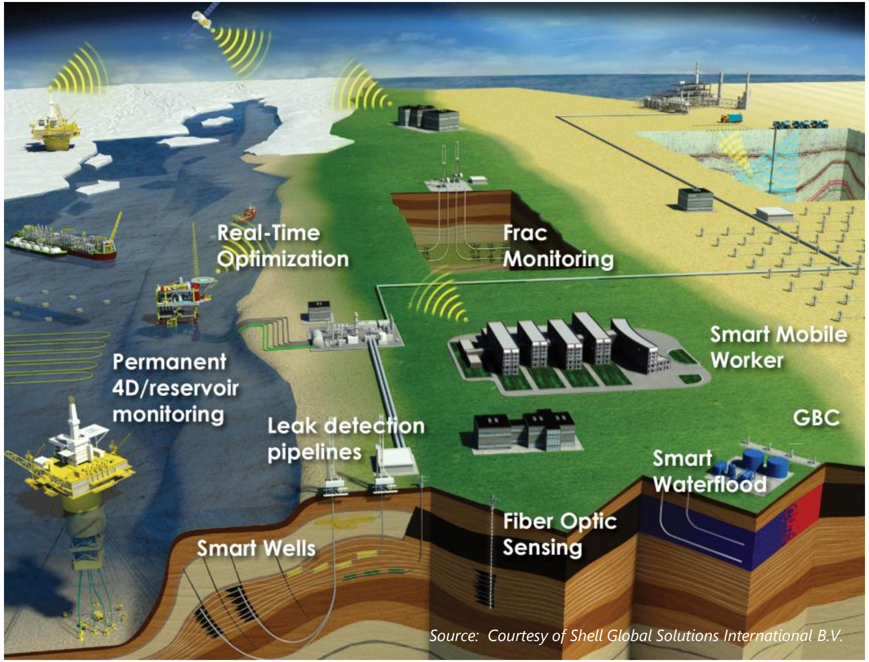


Source: GE

Virtual feasibility and durability testing of real process plants can accelerate the innovation cycle by saving time and resources

Digitalization and oil and gas supply

Examples of digital oil and gas supply technologies

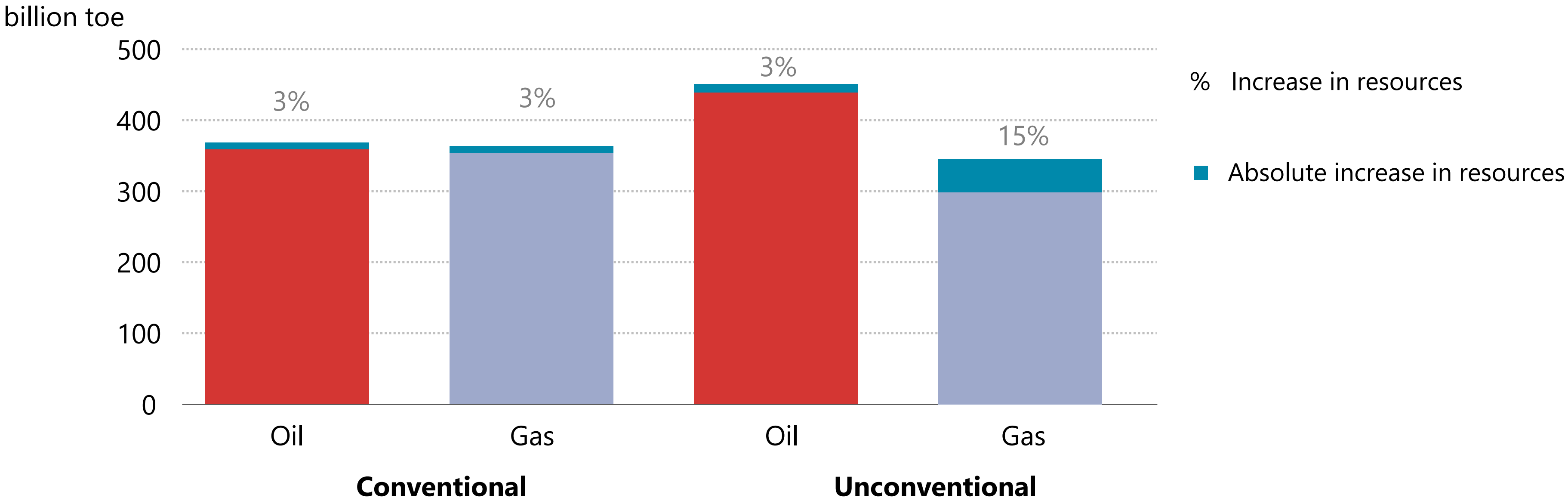


Source: Courtesy of Shell Global Solutions International B.V.

The oil and gas sector has a complicated relationship with digital technologies but multiple opportunities are available

Digitalization and oil and gas supply

Impact of digitalization on global technically recoverable oil and gas resources



Digitalization could increase recoverable resources, decrease production costs, improve health and safety, and reduce the environmental impact of production

Coal: Multiple opportunities to improve efficiency throughout the supply chain

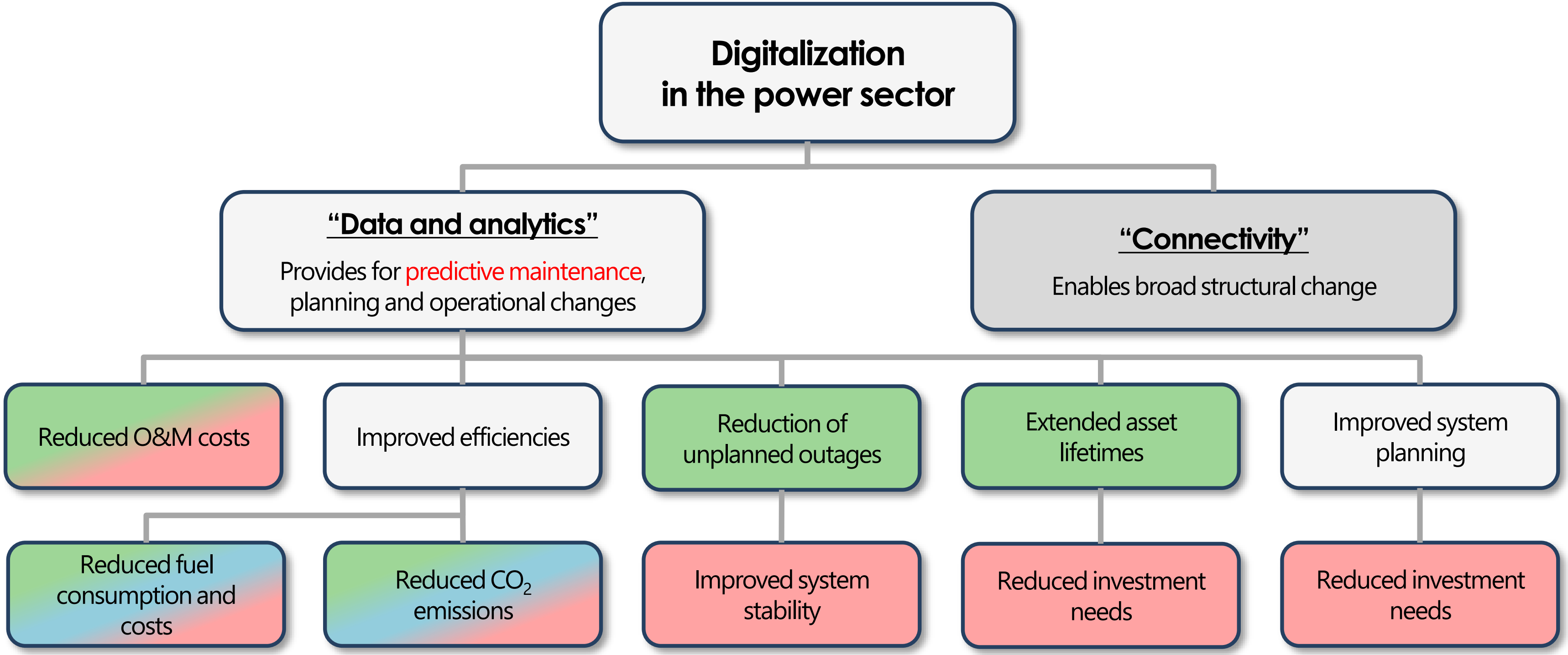
Increasing performance step by step

Drones, data processing and remote operation may optimize the use of big and expensive machinery

Safety will be the main benefit of digitalization

Mechanization of underground mine and use of super-giant machinery in surface mines removed most of the mining jobs. Driverless trucks and shovels and remote longwalls will reduce further

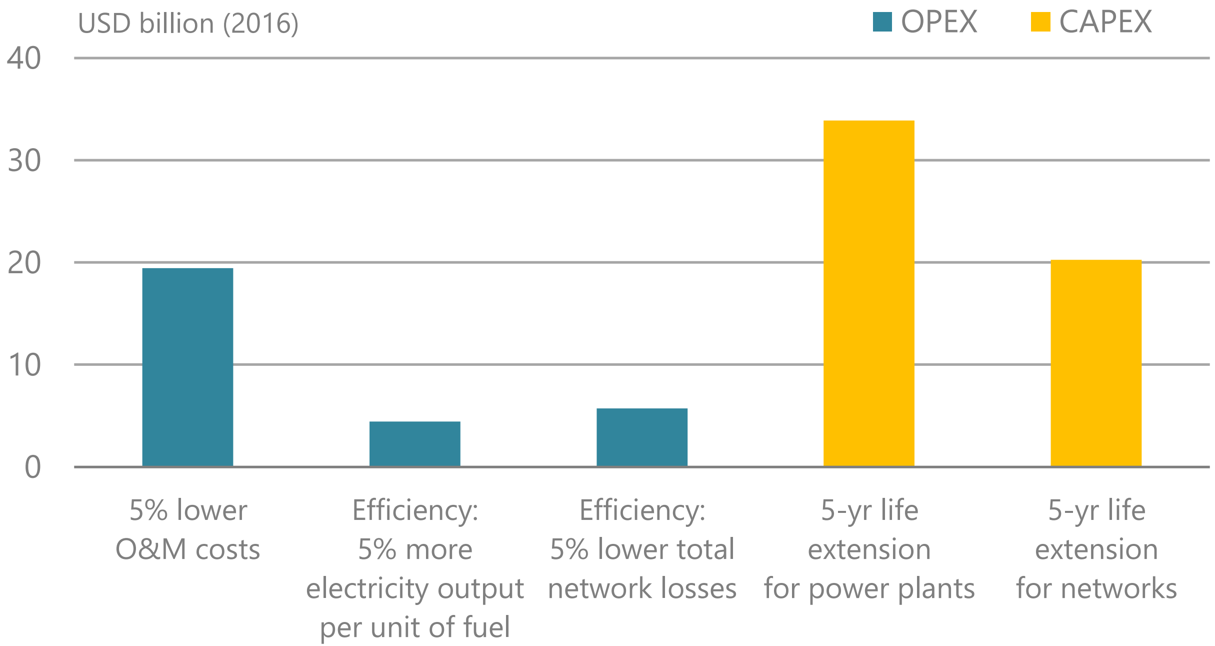
Electricity generation and networks



*Green = benefit to asset owner, red = system benefits and consumers, blue = global environmental benefits

Digital data and analytics in existing systems can deliver benefits to the owners of power sector assets, the wider electricity system, consumers and the environment

Electricity generation and networks



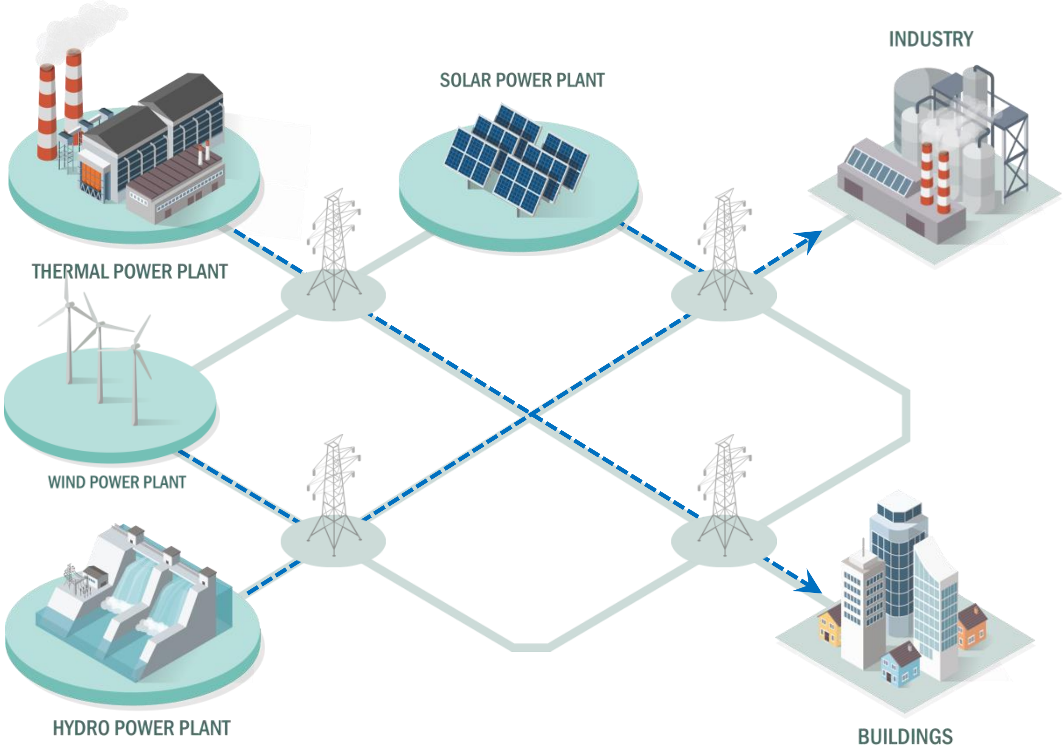
Digitalization could save around USD 80 billion per year, or about 5% of total annual power generation costs

If every car today was an EV, how much would…

- Electricity demand increase?
  A. 110%
  B. 55%
  C. 12%

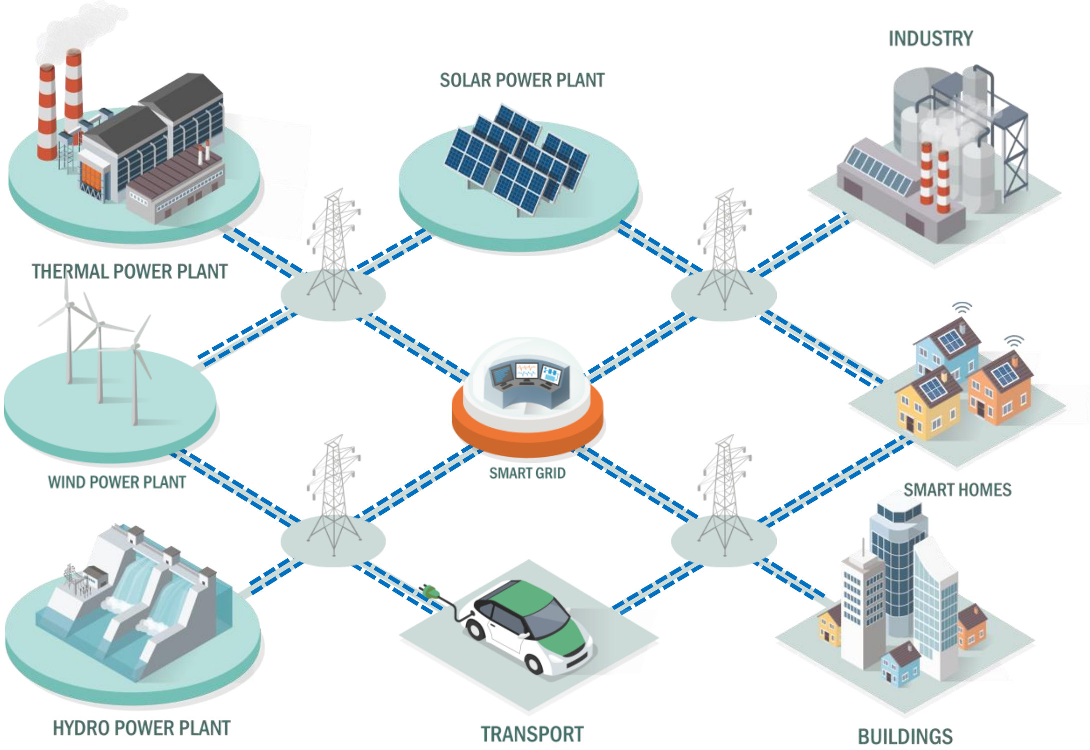
- Generation capacity increase, if everyone charged when it was best for them?
  A. 12%
  B. 40%
  C. 20%

The digital transformation of the energy system



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

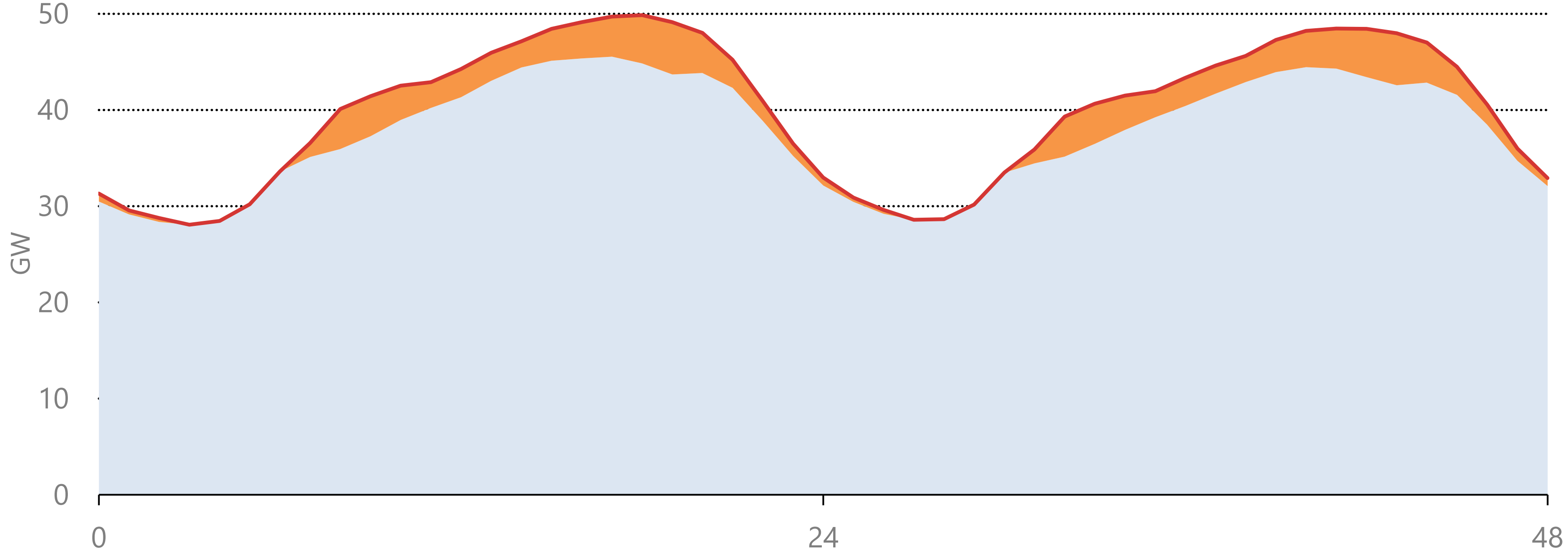
The digital transformation of the energy system



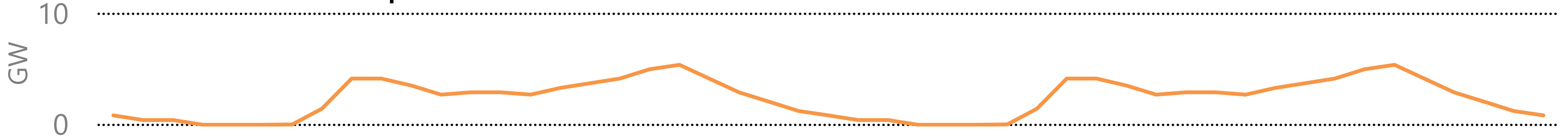
Pre-digital energy systems are defined by unidirectional flows and distinct roles, digital technologies enable a multi-directional and highly integrated energy system

Providing system flexibility from the demand side

Uncontrolled demand process, no system optimisation



Uncontrolled demand profile



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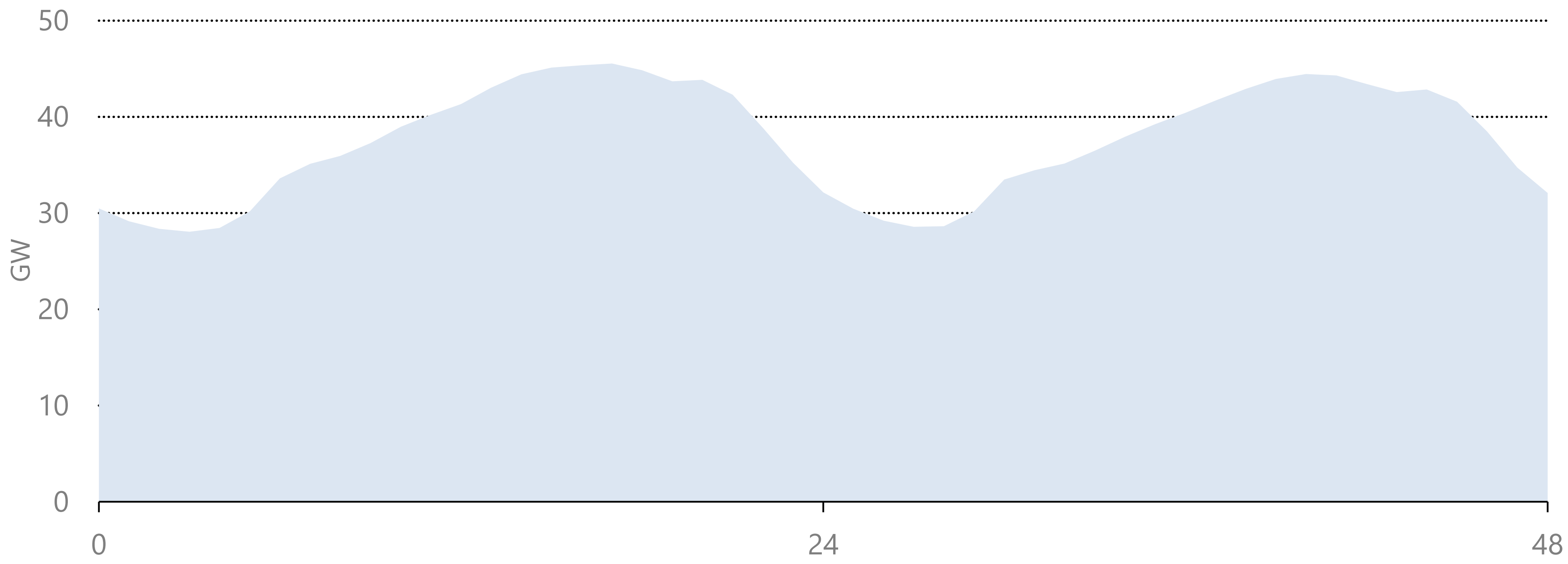
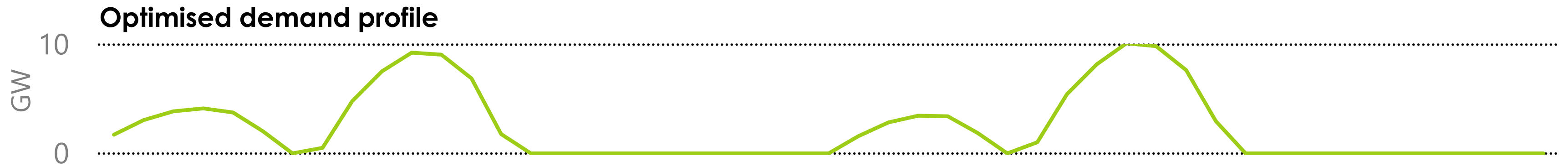
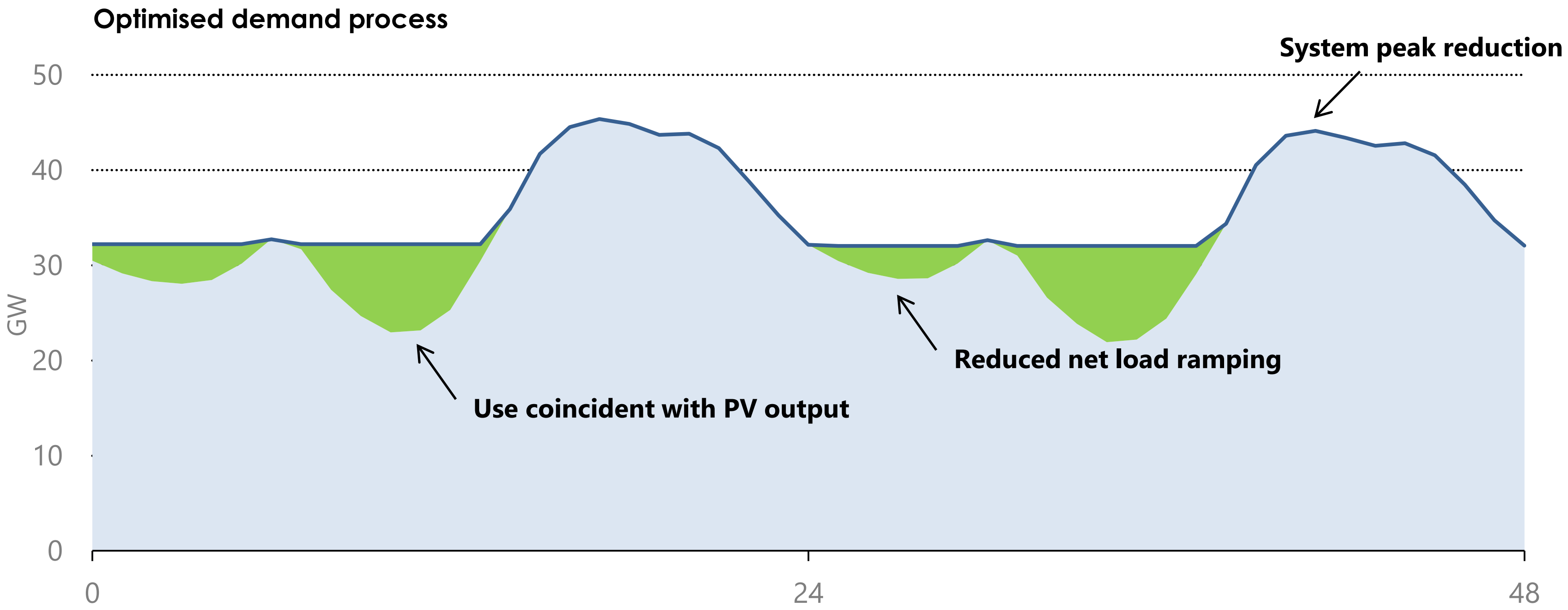
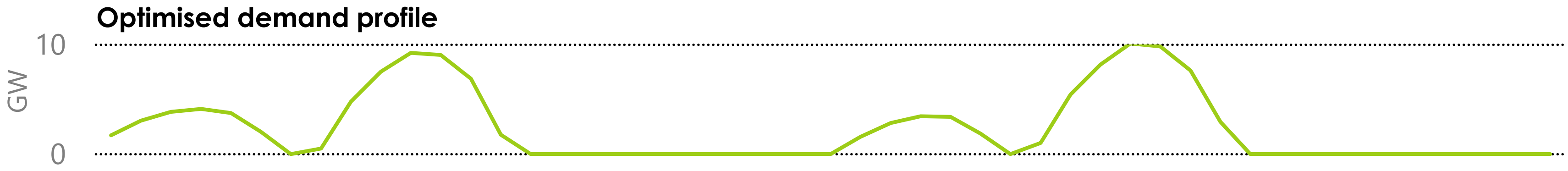


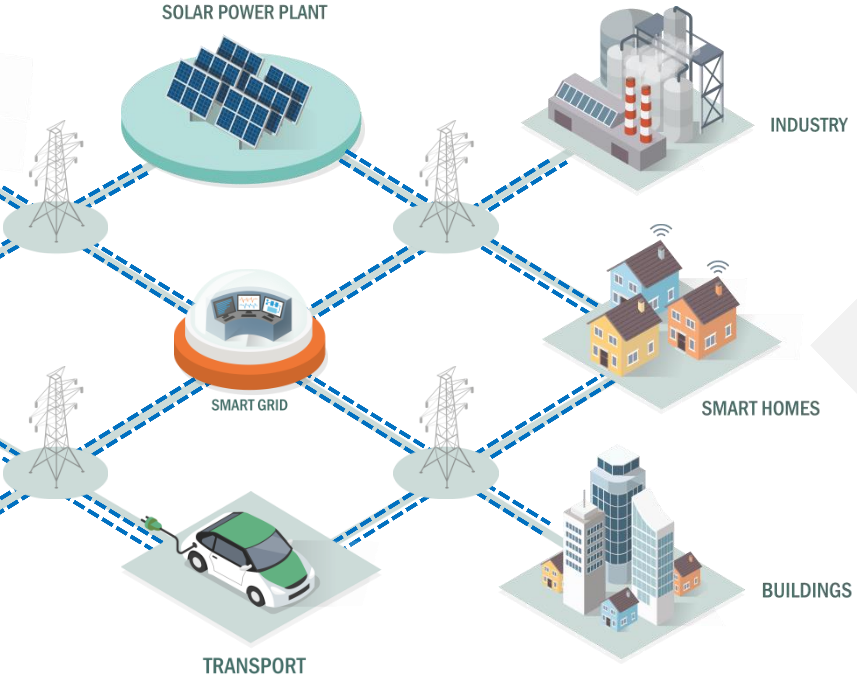


Providing system flexibility from the demand side





Smart demand response

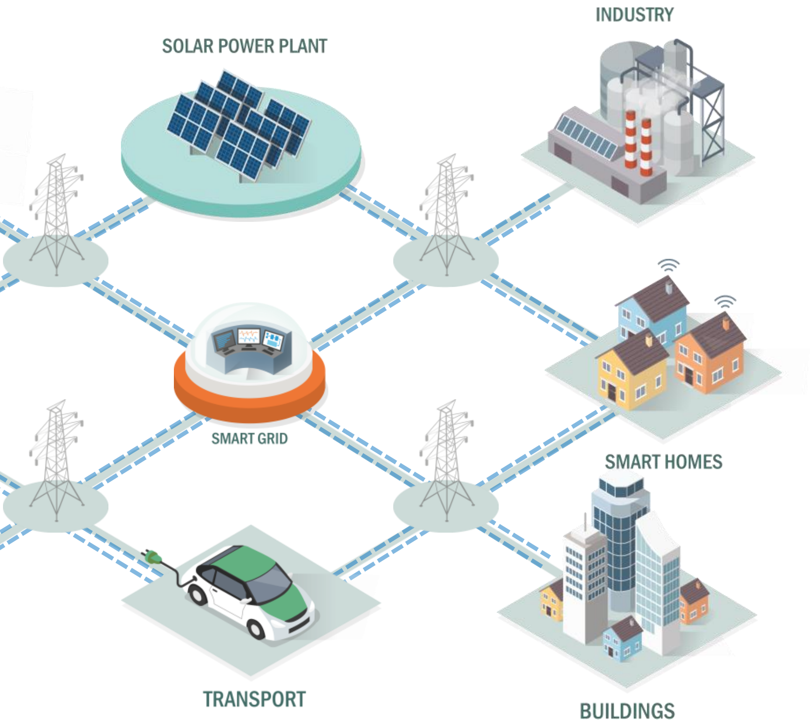


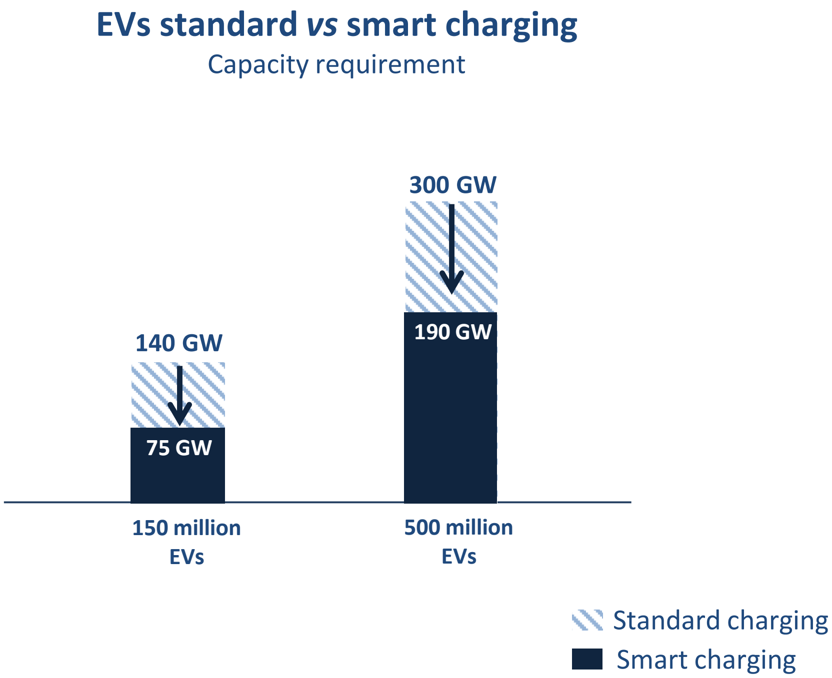
Residential sector

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

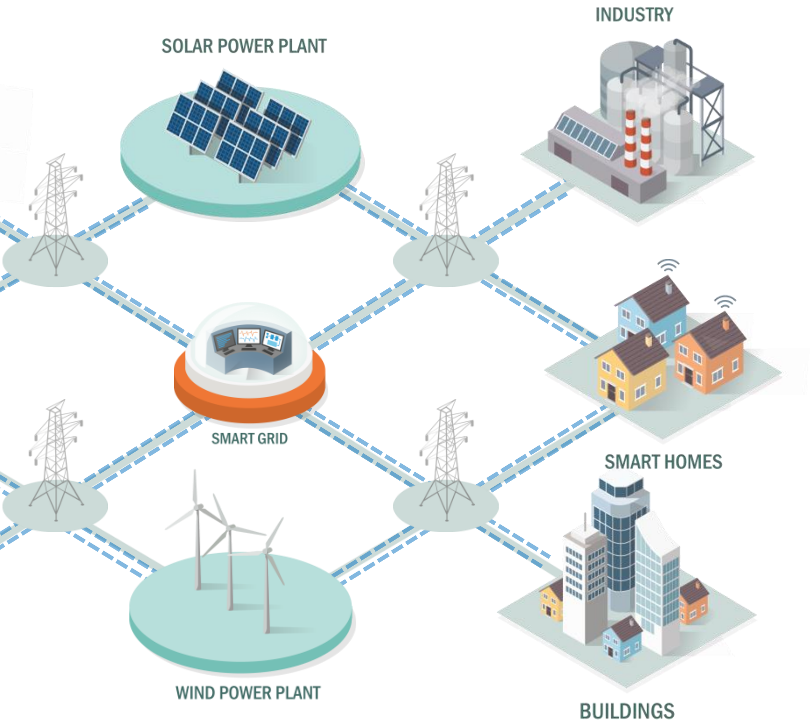
Smart charging of electric vehicles

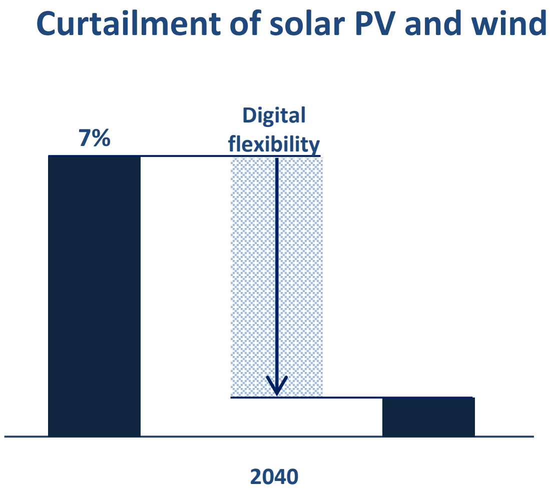




EVs smart charging would provide further flexibility to the grid saving between USD 100-280 billion investment in new electricity infrastructure

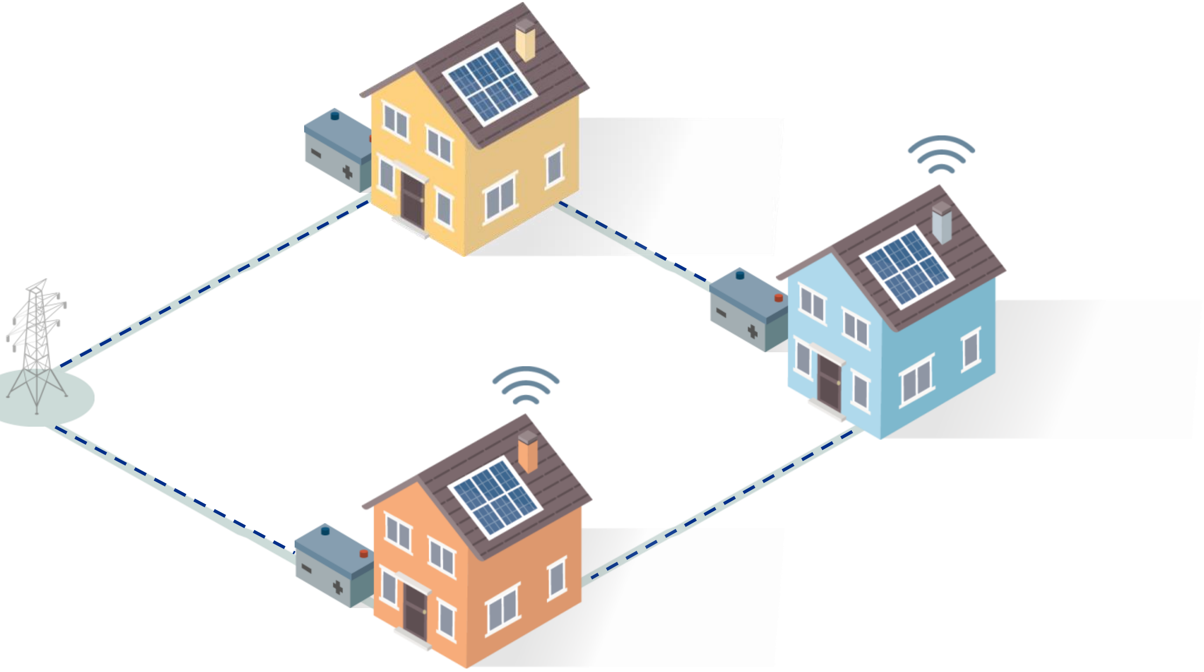
Integration of variable renewables





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.

Distributed energy resources



Blockchain could help to facilitate peer-to-peer electricity trade within local energy communities

Digitalization can facilitate the deployment of residential solar PV and storage, making it easier to store and sell surplus electricity to the grid or locally

Poll Q2

What will be the biggest barrier to achieving the benefits of digitalization?

a) Data ownership / data privacy

b) Cybersecurity

c) Economic disruption and transformation (e.g. job losses)

d) Market design challenges (e.g. ensuring accurate price signals)

e) Lack of public acceptance / trust with new technologies

Building digital resilience

- To date, cyber disruptions to energy have been small
- But cyber-attacks are become easier and cheaper – malware, ransomware, phishing / whaling, botnets
- Digitalization also increases the “cyber attack surface” of energy systems
- Full prevention is impossible, but impact can be limited:
  - Raised awareness, cyber hygiene, standard setting and staff training
  - Coordinated and proactive preparation by companies and governments
  - Design digital resilience in technologies and systems
- International efforts can help raise awareness and share best practices

Industroyer / Crash Override

Cybersecurity:

The ability to protect or defend the use of cyberspace from cyber-attacks and cyber incidents, preserving the availability and integrity of networks and infrastructure and the confidentiality of the information these contain.

Commonly also refers to the safeguards and actions available to do this.

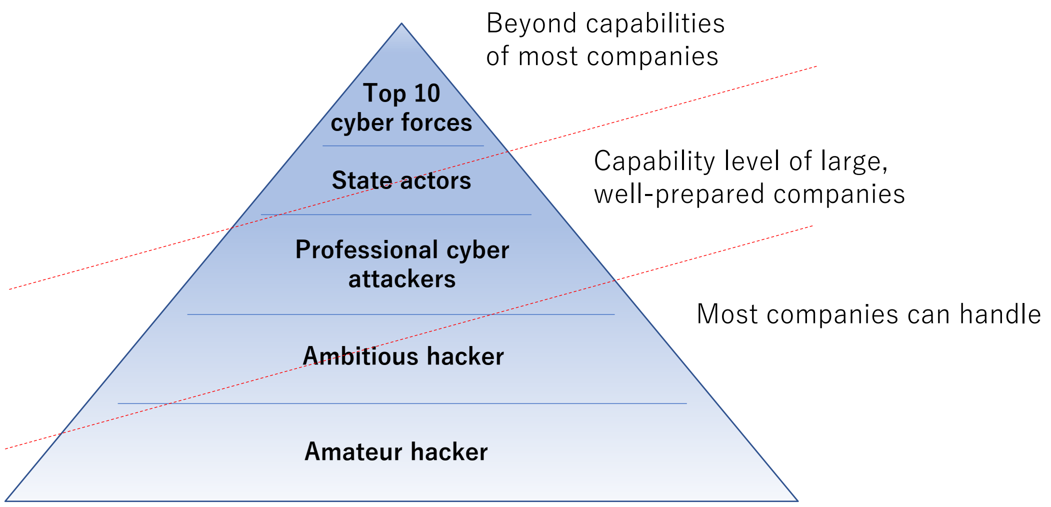
Ukraine, December 2016 (reported May 2017)

- A second brief but significant attack on the Ukrainian electricity system.
- Thought to have been a test run for malware "Industroyer" (also known as "Crash Override"): a versatile malware enabling attackers to view, block, control or destroy grid control equipment, including circuit breakers.
- Malware design suggested expert knowledge of several standardised industrial communication protocols widely used to control infrastructure – not only electricity grids – throughout Europe, Asia and the Middle East.
- This was an example of a cyber intrusion into the control systems of critical infrastructure.

Preparedness

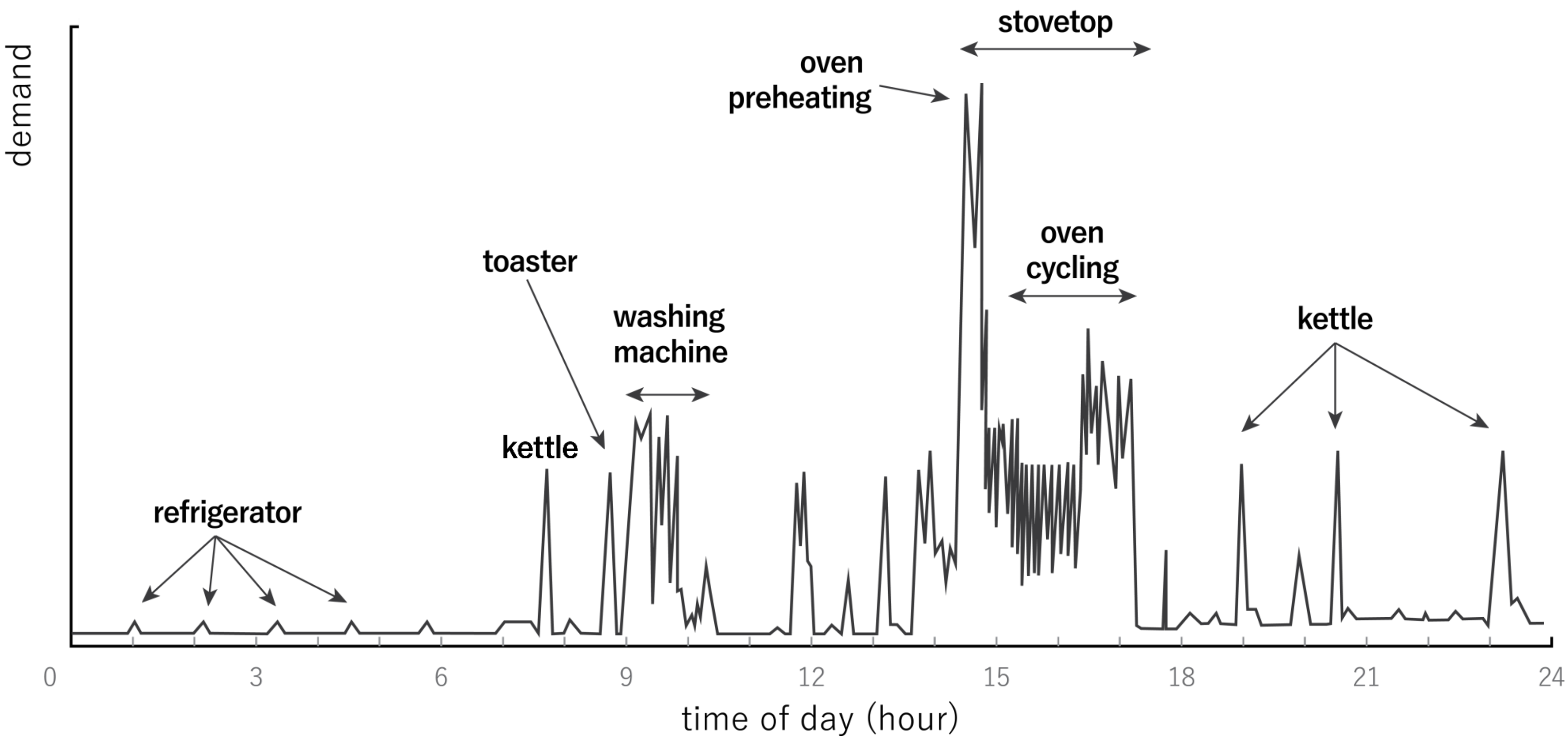
Limiting impact (resilience) is particularly important for **critical infrastructure**: the physical and institutional assets that are essential for an economy to function, such as large-scale energy systems.

- Mexico: identified 3 000 "strategic installations", half of them owned by the national oil company PEMEX and another 13% by the Federal Electricity Commission.
- Germany: any infrastructure on which more than 500 000 people (1/160th of population) depend is considered critical. This includes all gas power plants and electricity transmission grids.



Key message: The handling of some attacks falls within the capability of companies themselves, while larger-scale attacks by sophisticated actors may require more active government responses.

Managing privacy concerns



Source: *Newborough and Augood (1999), "Demand-side management opportunities for the UK domestic sector" (reproduced courtesy of the Institution of Engineering and Technology).*

No-regrets policy recommendations

1. Build digital expertise within their staff.
2. Ensure appropriate access to timely, robust, and verifiable data.
3. Build flexibility into policies to accommodate new technologies and developments.
4. Experiment, including through "learning by doing" pilot projects.
5. Participate in broader inter-agency discussions on digitalization.
6. Focus on the broader, overall system benefits.
7. Monitor the energy impacts of digitalization on overall energy demand.
8. Incorporate digital resilience by design into research, development and product manufacturing.
9. Provide a level playing field to allow a variety of companies to compete and serve consumers better.
10. **Learn from others, including both positive case studies as well as more cautionary tales**.

Digitalization: A New Era in Energy

- The energy system is on the cusp of a new digital era
- This first-of-its-kind “Digitalization and Energy” report will help shine a light on digitalization's enormous potential and most pressing challenges
- But impacts are difficult to predict; uncertainty in technology, policy and behaviour
- Much more work needs to be done…
- Next steps for IEA, especially to focus on high impact, high uncertainty areas:
  - Automation, connectivity, and electrification of transport
  - Digitalization, electricity, and smart energy systems

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