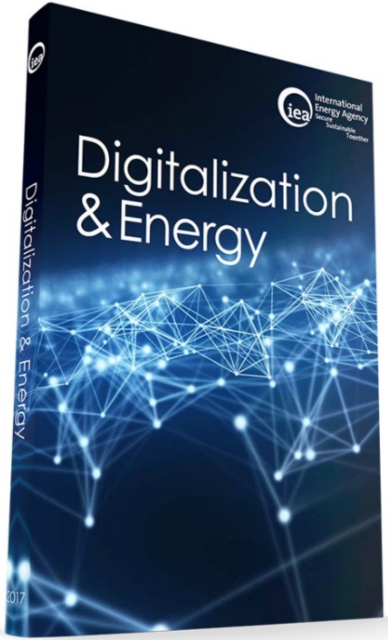
Digitalization & Energy

Louise Vickery

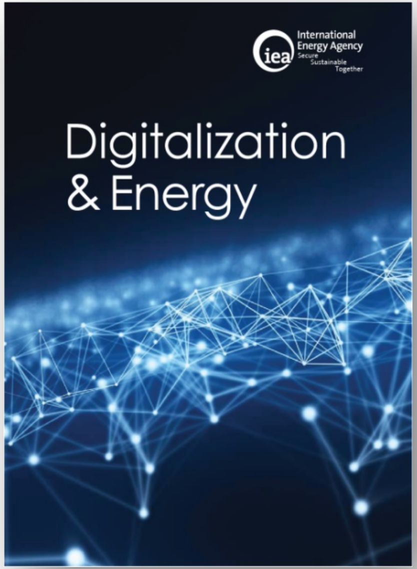
Canberra, 17 November 2017

IEA

Digitalization and Energy



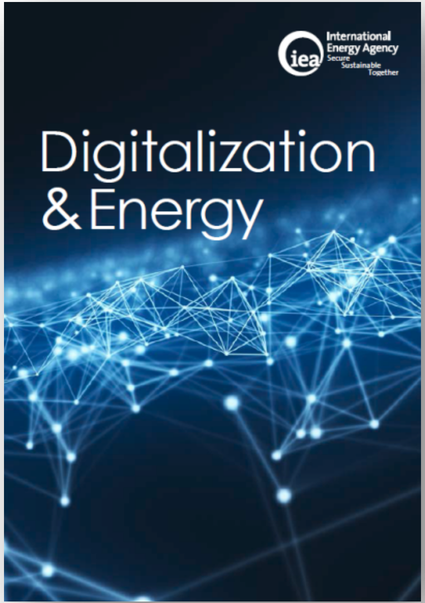
http://www.iea.org/digital/



Digitalization: A New Era in Energy?

- Digitalization is everywhere; digital and energy worlds are intersecting
- All energy demand and supply sectors are feeling the effects
- Fundamental transformation of electricity – “smart energy systems”
- Emerging risks need to be managed, including building digital resilience
- Government policy design is critical; 10 no-regrets recommendations

Digitalization & Energy



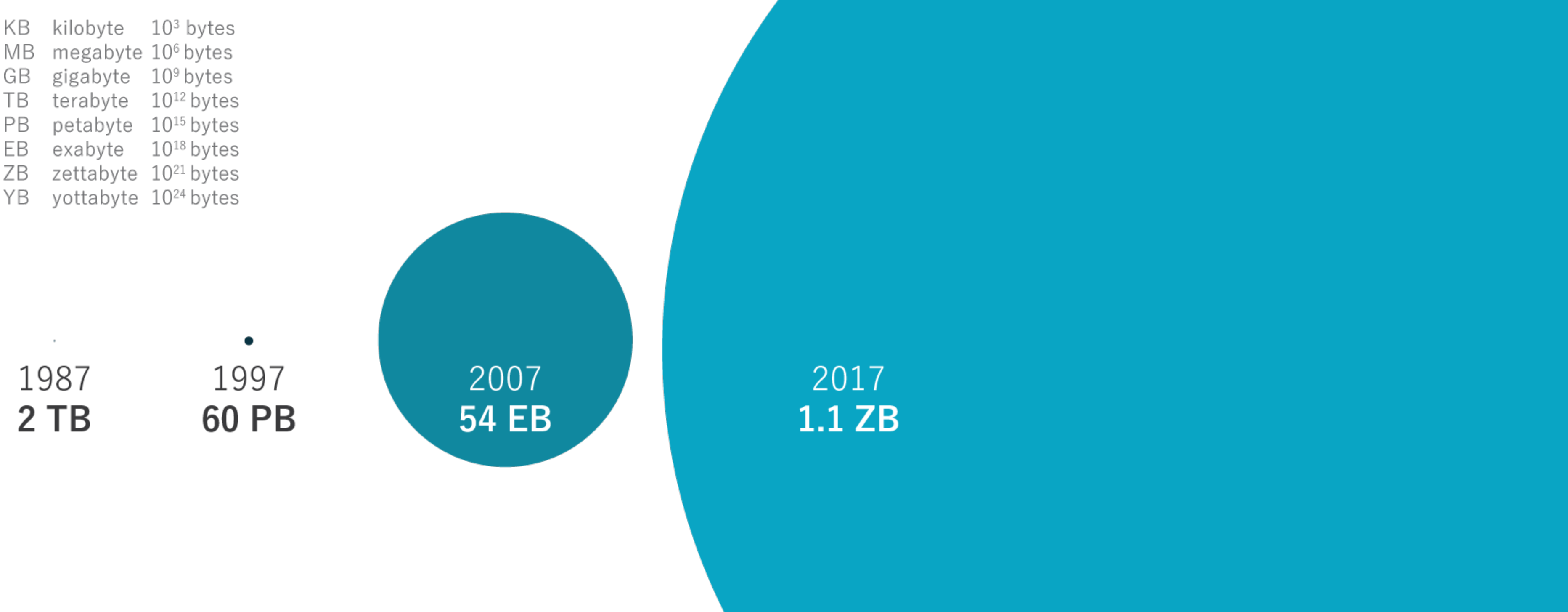
iea.org/digital

1. Introduction: A new era of digitalization in energy?
2. Energy demand: transport, buildings, and industries
3. Energy supply: oil and gas, coal, and power
4. System-wide impacts: from energy silos to digitally-interconnected systems
5. Energy use by digital technologies
6. Cross-cutting risks: cyber security, privacy, and economic disruption
7. Policy, including no-regrets recommendations

Digital technologies are everywhere….

Digitalization trends are truly astounding

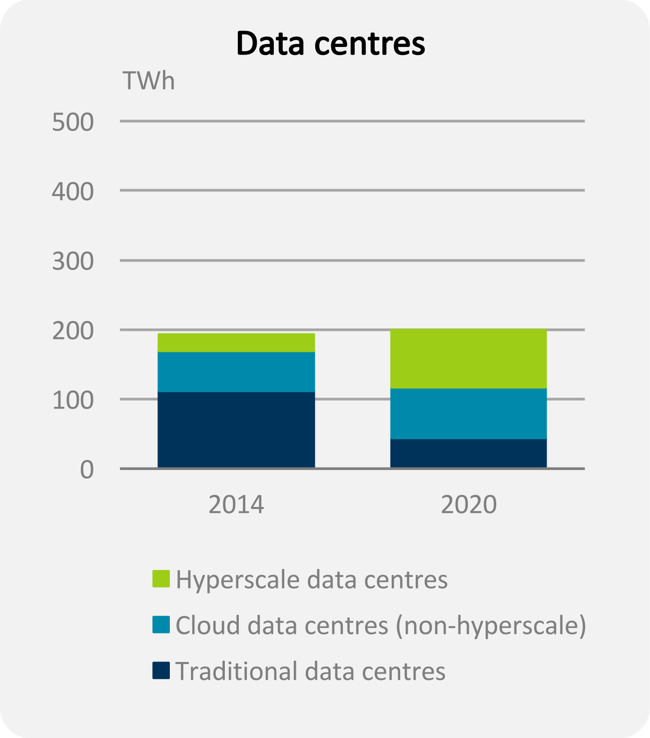
KB	kilobyte	10^3 bytes
MB	megabyte	10^6 bytes
GB	gigabyte	10^9 bytes
TB	terabyte	10^{12} bytes
PB	petabyte	10^{15} bytes
EB	exabyte	10^{18} bytes
ZB	zettabyte	10^{21} bytes
YB	yottabyte	10^{24} bytes

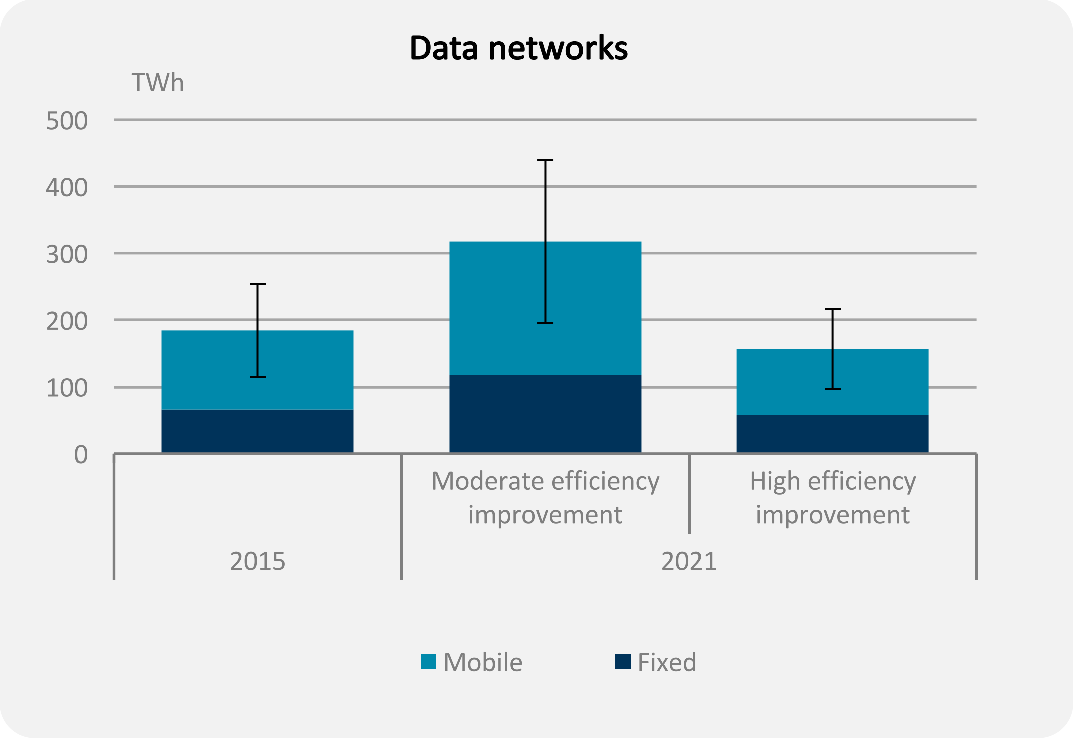


Sources: Cisco (2017). The Zettabyte Era: Trends and Analysis June 2017; Cisco (2015). The History and Future of Internet Traffic.

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

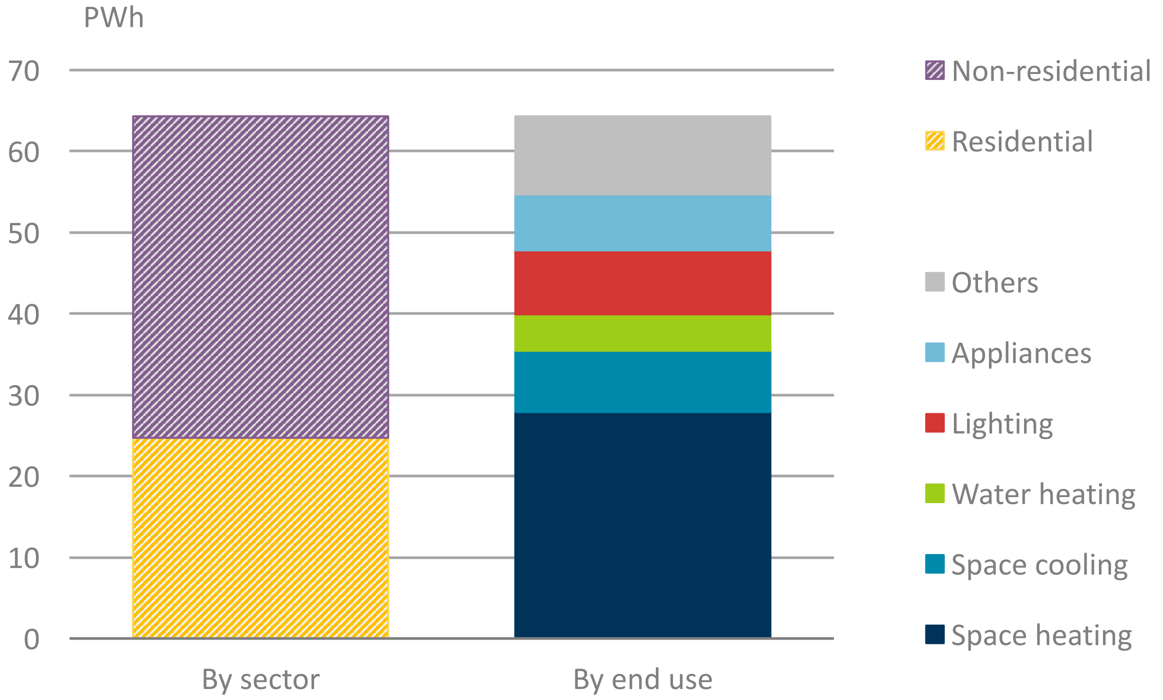
Electricity use by data centres and networks





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

Buildings



IEA analysis

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

Transport

Road freight

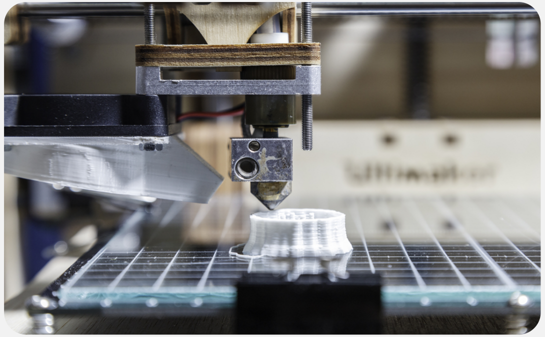
- Digital solutions for trucks and logistics could reduce energy use for road freight by 20-25%.
- Digital solutions include platooning, route optimisation, and data sharing across the supply chain

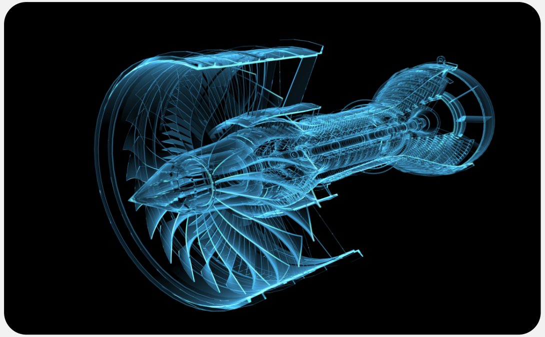
Road passenger

- Automation, connectivity, sharing, and electrification (ACES) to dramatically reshape road transport
- Impacts on energy demand difficult to predict
- Automation and connectivity could halve or double energy demand, depending on how technology, behavior, and policy evolve

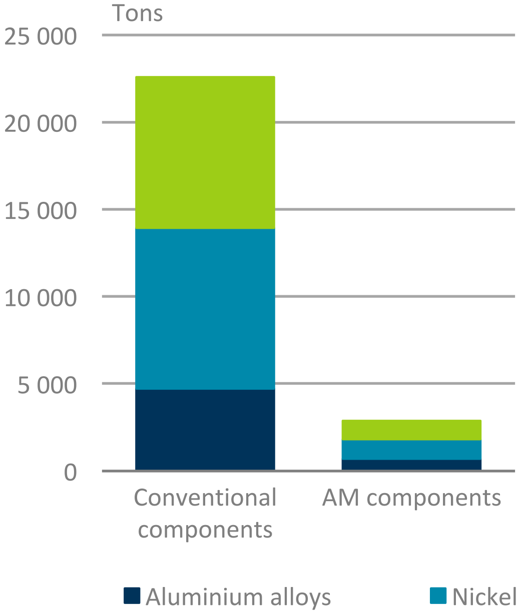
Intelligent transport systems are improving safety and efficiency of all modes, with the most transformative impacts expected in road transport

Industry

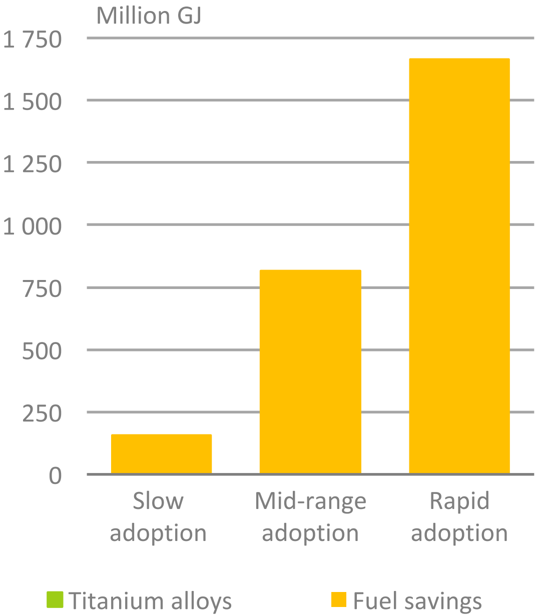




Metal demand in 2050



Cumulative aircraft fuel savings to 2050

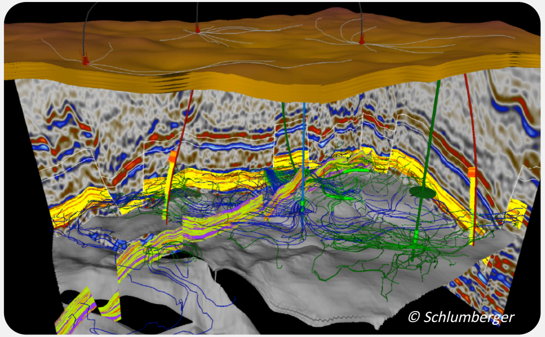


Source: Huang et al. (2016)

Energy use can be incrementally reduced at the plant level

but widespread use of 3D printing, AI and robotics could herald transformative changes

Supply: oil and gas, coal, and power



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

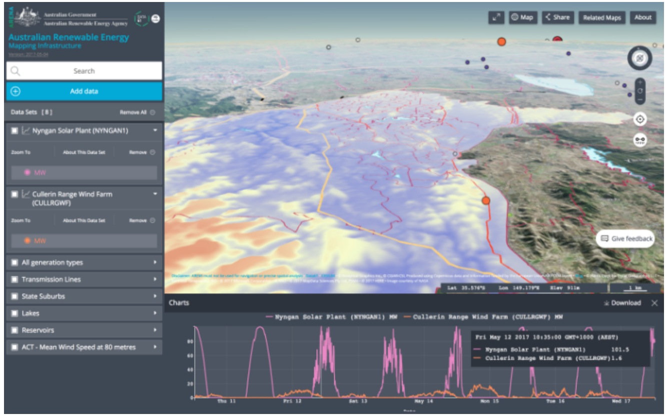
Power

- 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

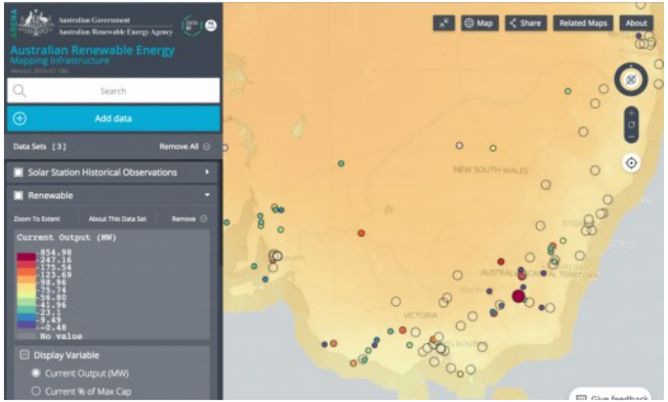
Energy companies have been adopting digital technologies for years, to increase productivity, reduce costs, improve safety and environmental performance

Australian Renewable Energy Mapping Infrastructure

- Accessible online map - 650 layers of information about:
  - Energy resources – solar, wind, marine, biomass, geothermal
  - Grid & Substation Infrastructure - Constraints and Capacity
  - Generation performance – real time
  - Environmental information, land tenure, topography
  - Demographics and Household Energy Demand
  - In future - ARENA projects – LCOE and performance
  - In future - Heat maps of large energy users energy demand



- Supported by ARENA funding and available at: www.nationalmap.gov.au/renewables



- Part of Australian Government national policy commitment to Open Data – as source of business and policy innovation

Energy use data model to be developed over 3 years, 5 work streams

1

Deep and ongoing stakeholder engagement

Working with energy sector stakeholders to determine the critical facets of a fit-for-purpose national energy use data model.

2

Data sampling and collection

Addressing high-priority gaps and developing statistically and ethically robust sampling methodologies for the collection of new primary energy data.

3

Fusion of data sets

Bringing together high-quality pre-existing datasets to provide a comprehensive view of the key energy data domains.

4

Data innovation

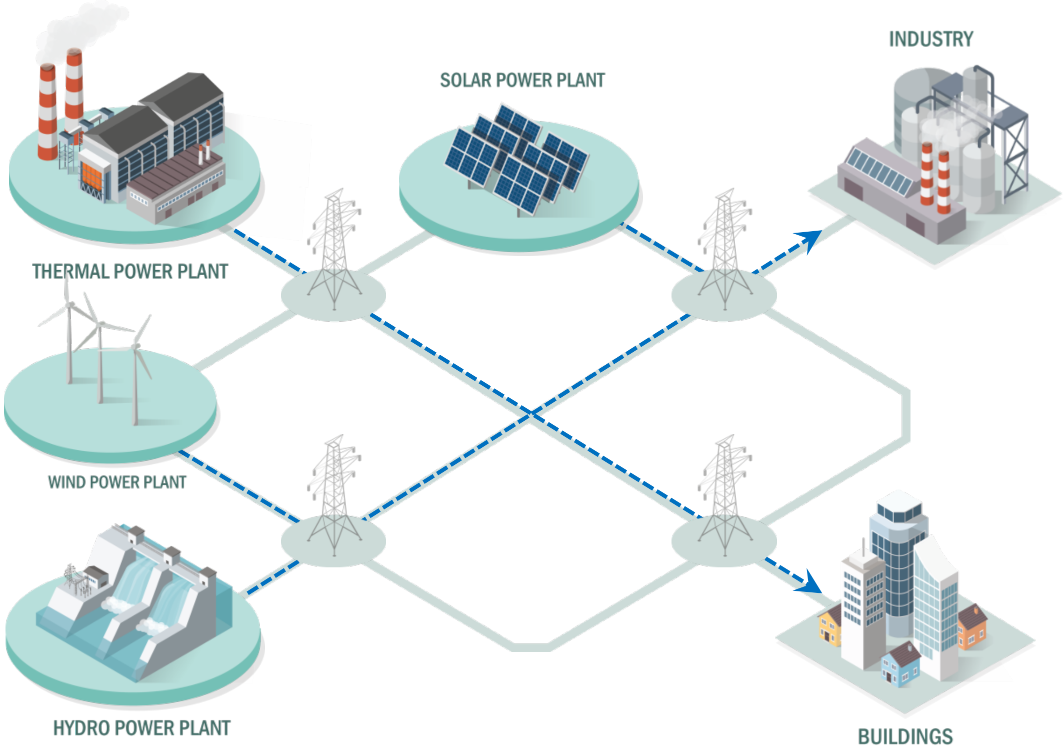
Leveraging cutting-edge science and research to proactively manage data privacy and delivering new insight and value for energy sector stakeholders.

5

Interactive data

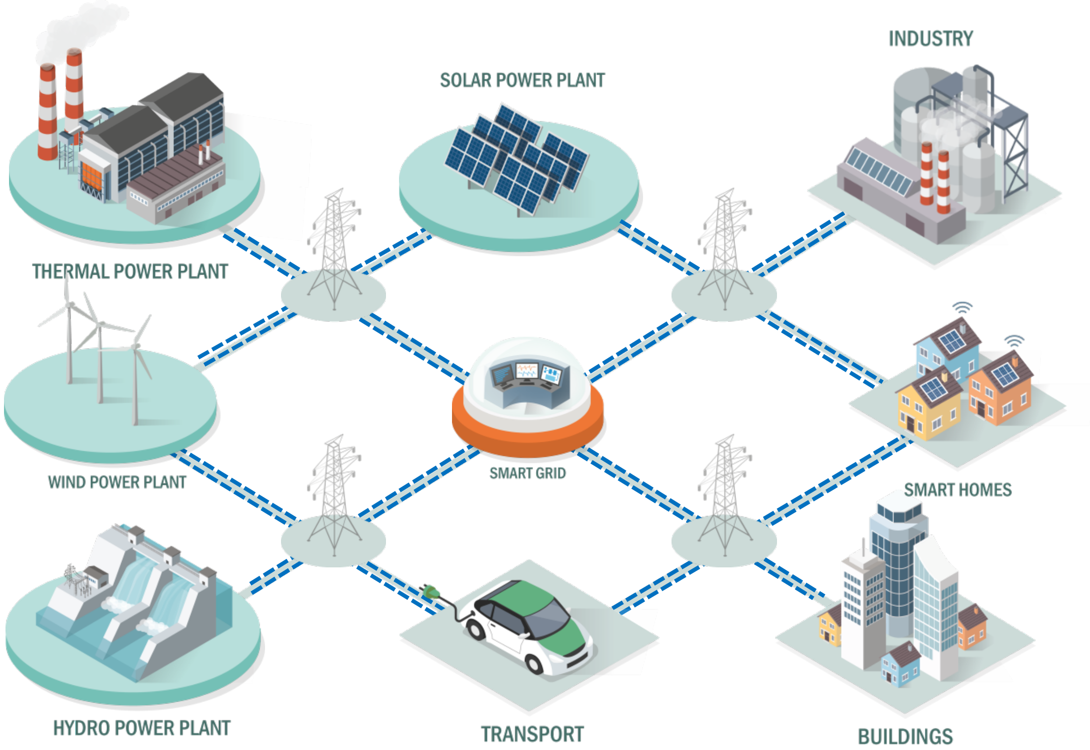
Develop a robust, user-friendly and visually appealing method for accessing all elements of the final energy use data model.

The digital transformation of the energy system



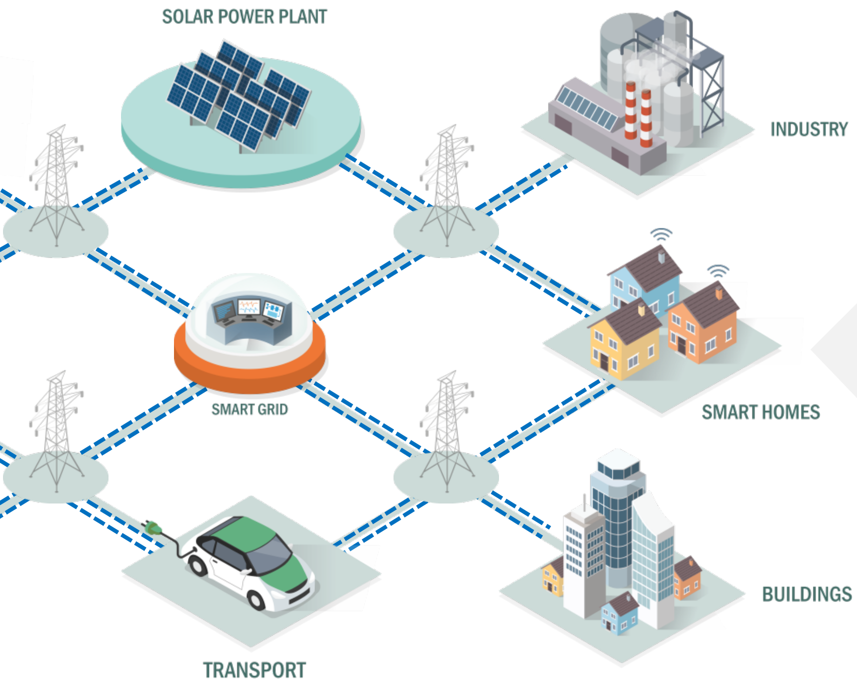
Pre-digital energy systems are defined by unidirectional flows and distinct roles

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

Smart demand response

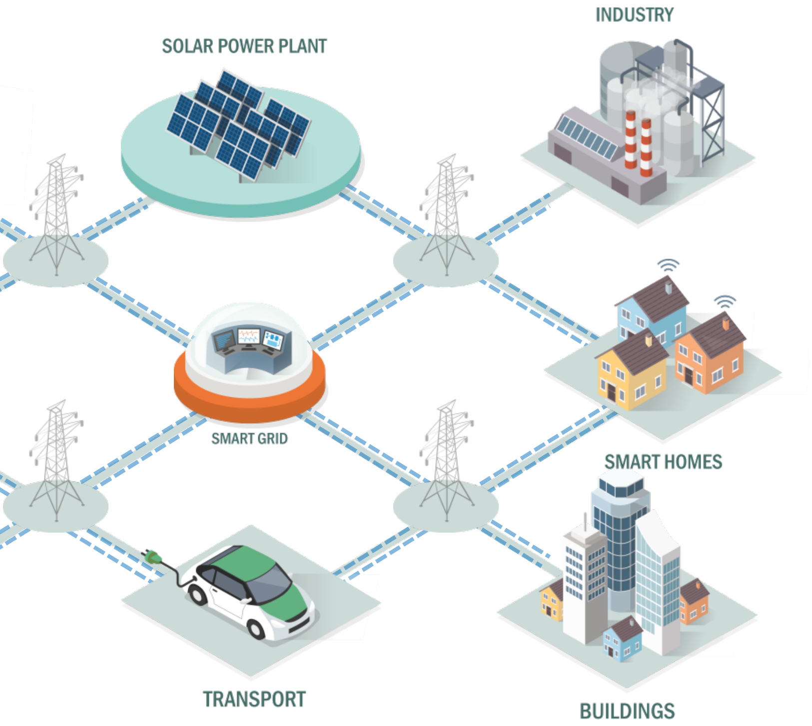


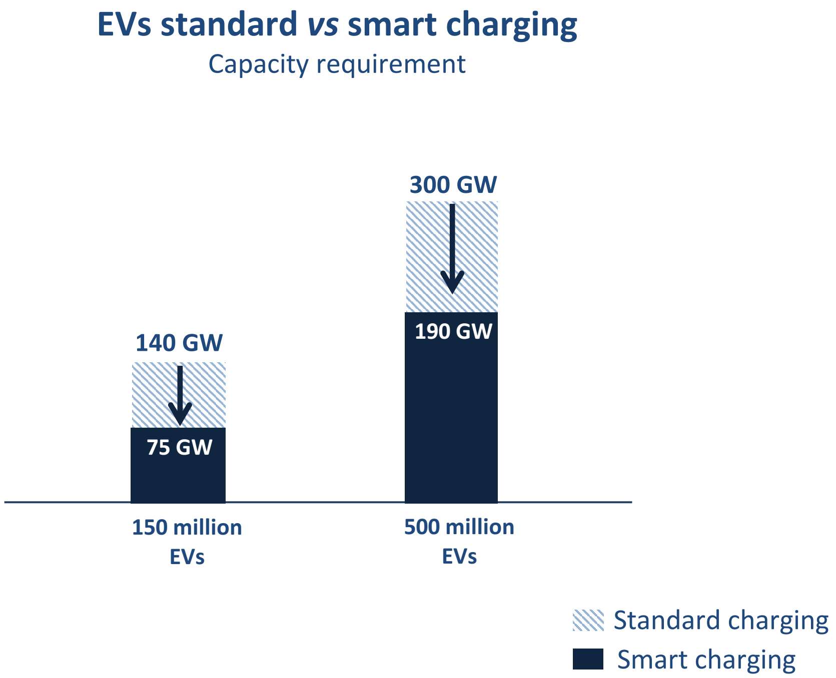
Residential sector

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

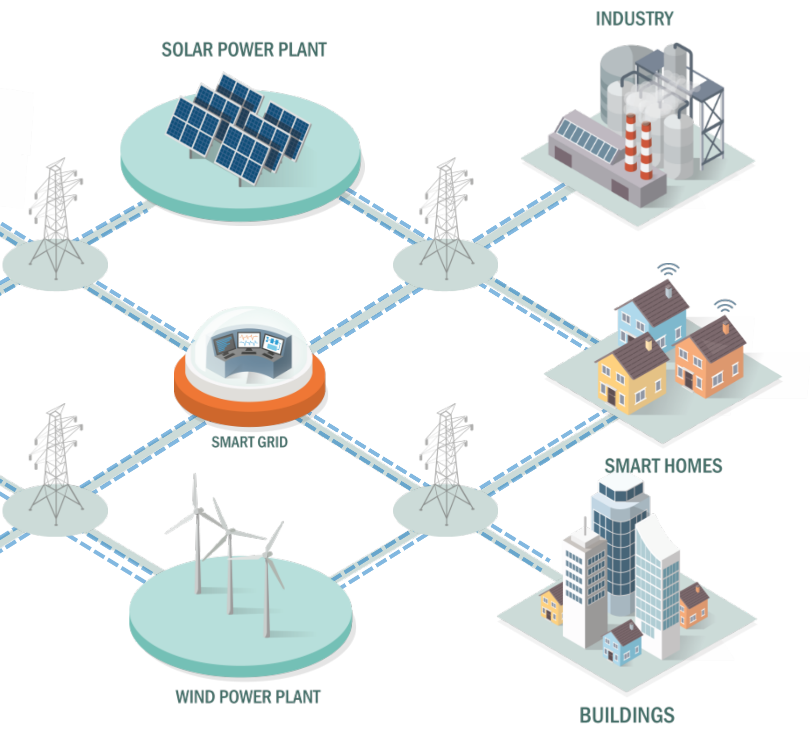
Smart charging of electric vehicles

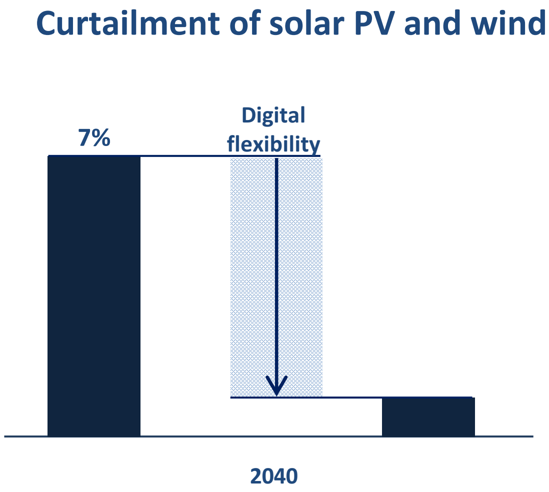




EVs smart charging would provide further flexibility to the grid saving between USD 100-280 billion investment in new electricity infrastructure

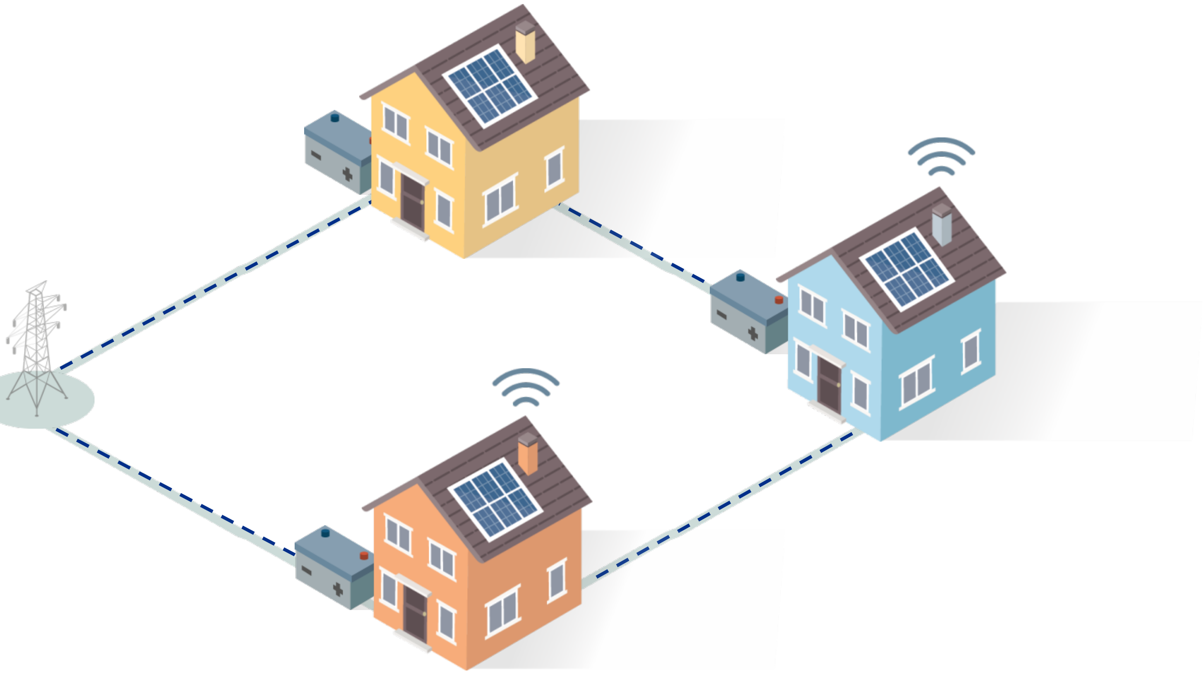
Integration of variable renewables





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

Energy use by digital technologies - overview

Cloud
(data centres)

Network Infrastructure

Traditional Network Connected Devices

- **Mobile devices** (smartphones, tablets)
- **Computers** (PCs, laptops)
- **Mobile devices** (e.g. smart TVs, set-top boxes, etc.)

IoT Devices

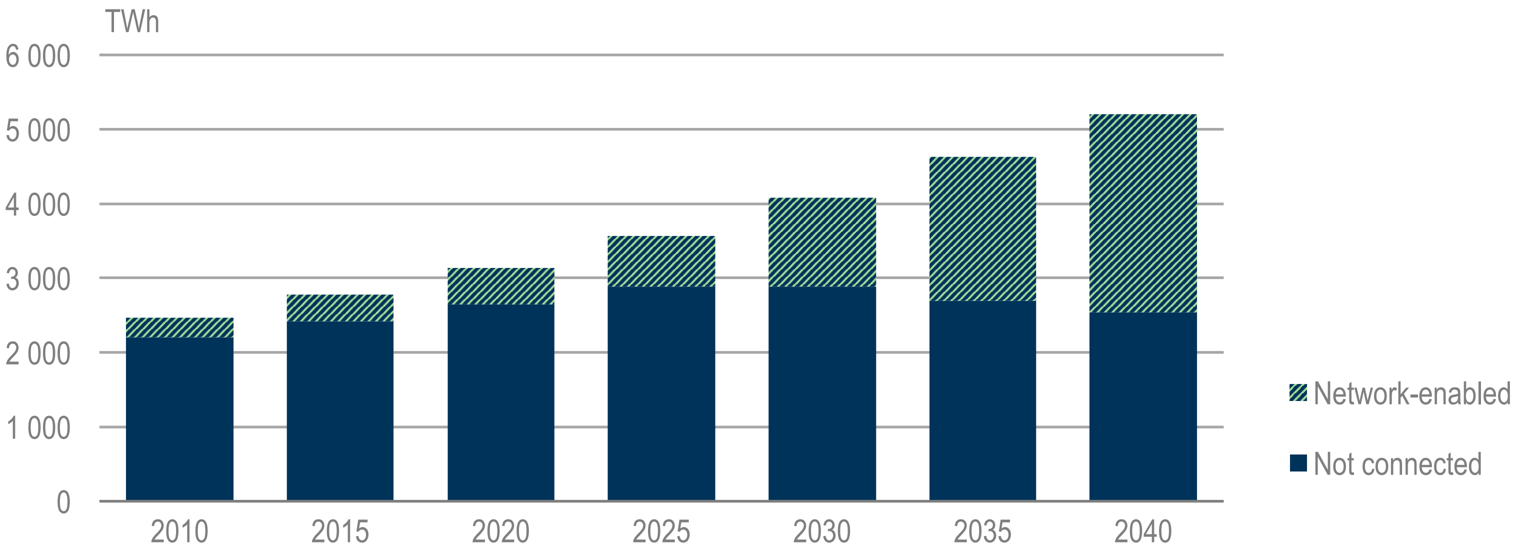
Smart home
Smart health
Smart factory
Smart mobility
…

- **Battery/self-powered**
- **Mains-connected** (e.g. smart lighting, smart appliances, etc.)

Source: 4E TCP (2016) Energy Efficiency of the Internet of Things

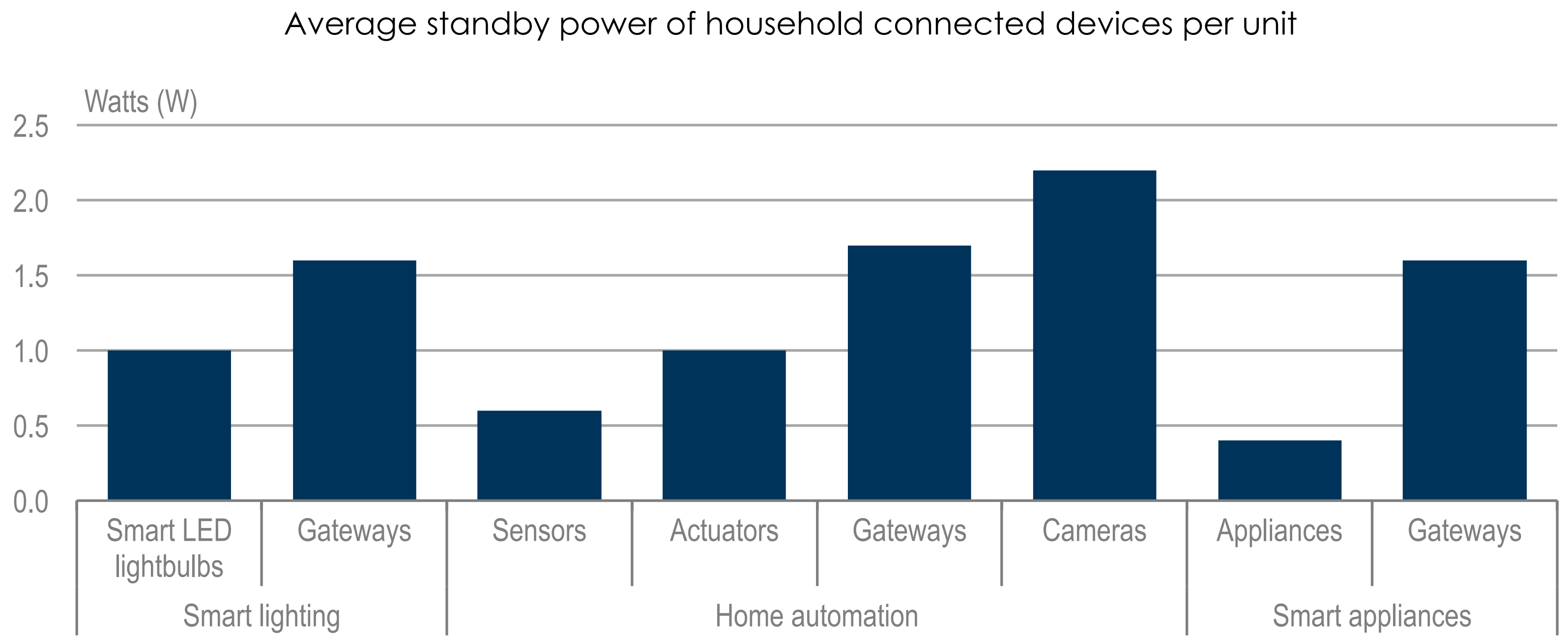
A greater share of appliance electricity use is network-enabled

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

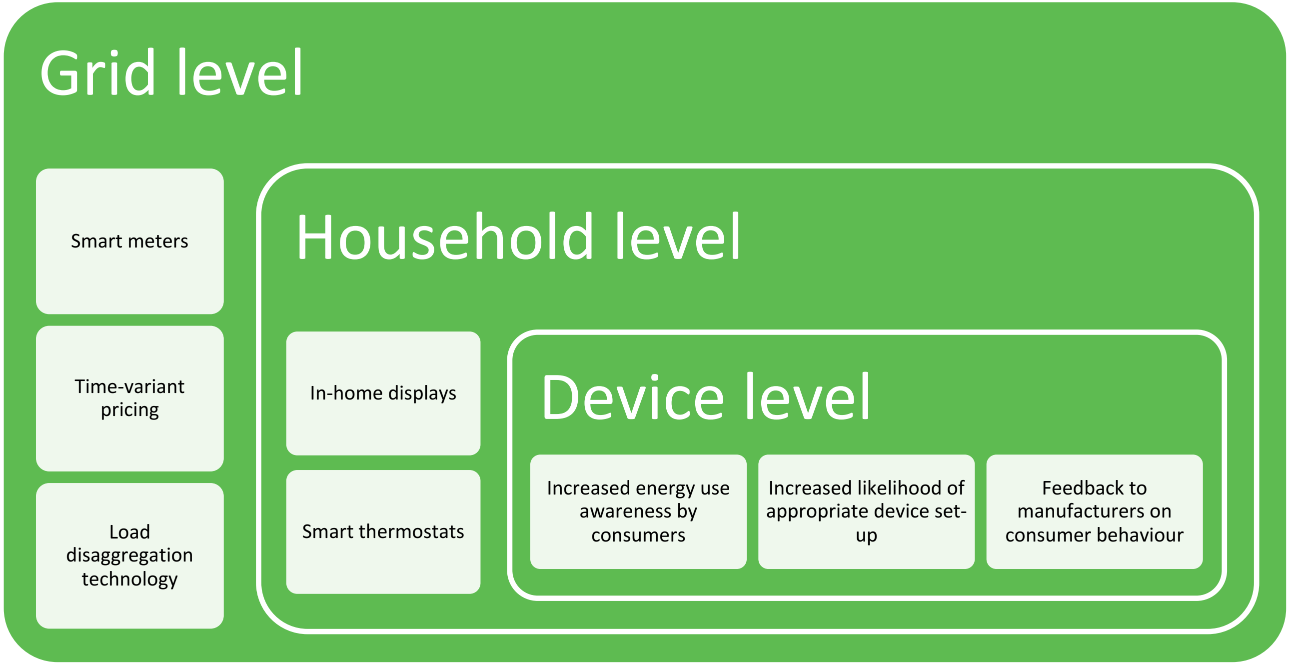
Connected devices comes with a hidden energy price tag



Networked standby, the energy used to maintain the device's connection to the wider network, is also often a connected device's biggest draw on power.

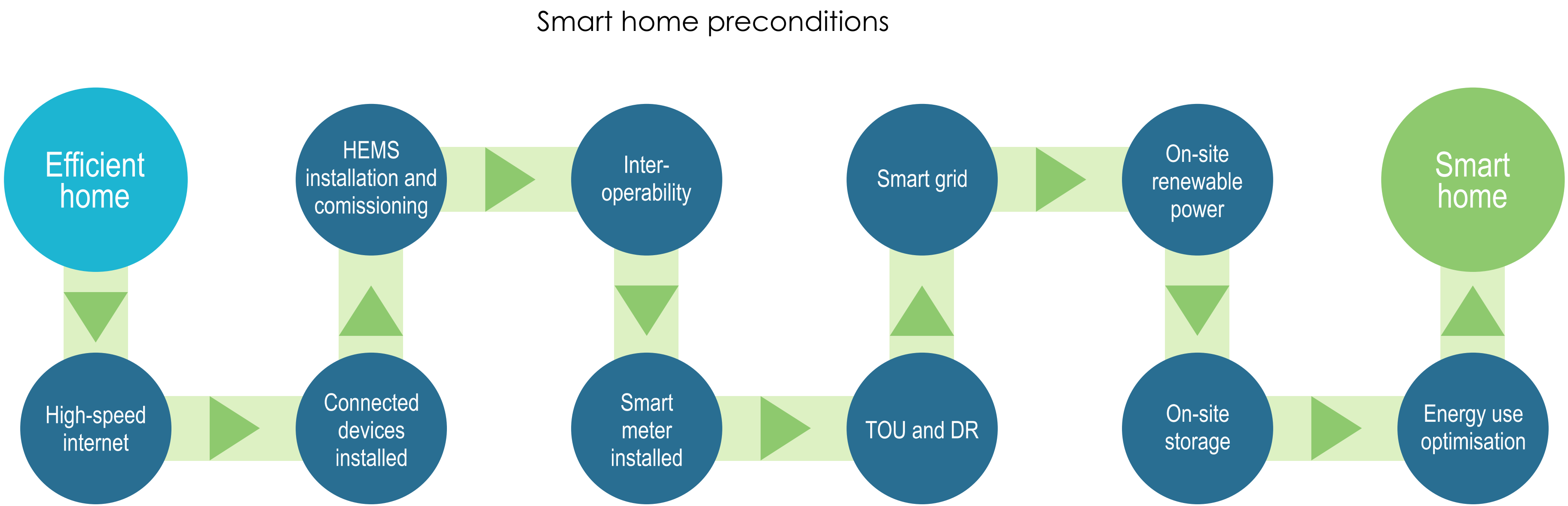
Smart devices enable new efficiency opportunities

Examples of energy efficiency enabled by household connected devices



But many of these opportunities are driven by customer behaviour, which is not always efficient.

Smart home technology exists but there are many barriers to market growth



There are at least 11 preconditions for a smart home, starting with an efficient home with high-speed Internet access.

Design & Policy Principles for Energy Efficient Connected Devices

- Developed by the **G20 Networked Devices Task Group**, consisting of **industry and government representatives**. The **Principles** have two focuses:
  - The CDA Voluntary Design Principles provide **guidance on the key features** of energy efficient connected devices, networks and communications protocols - for use by designers, manufacturers and protocols authors
  - The CDA Policy Principles encourage a **common global framework** for the development of government policies and measures - for use by policy makers
- Available at: **http://cda.iea-4e.org/cda-principles**

connected devices ALLIANCE

International Energy Agency

KOREA ENERGY AGENCY

ACEEE

ITI

Swedish Energy Agency

Danish Energy Agency

Sony Interactive Entertainment Inc

Department for Business, Energy & Industrial Strategy

CISCO

intel

hp

NEDO

eceee

Consumer Technology Association

Netherlands Enterprise Agency

Among other things, the principles address networked standby power use.

Using digitalization for compliance and evaluation

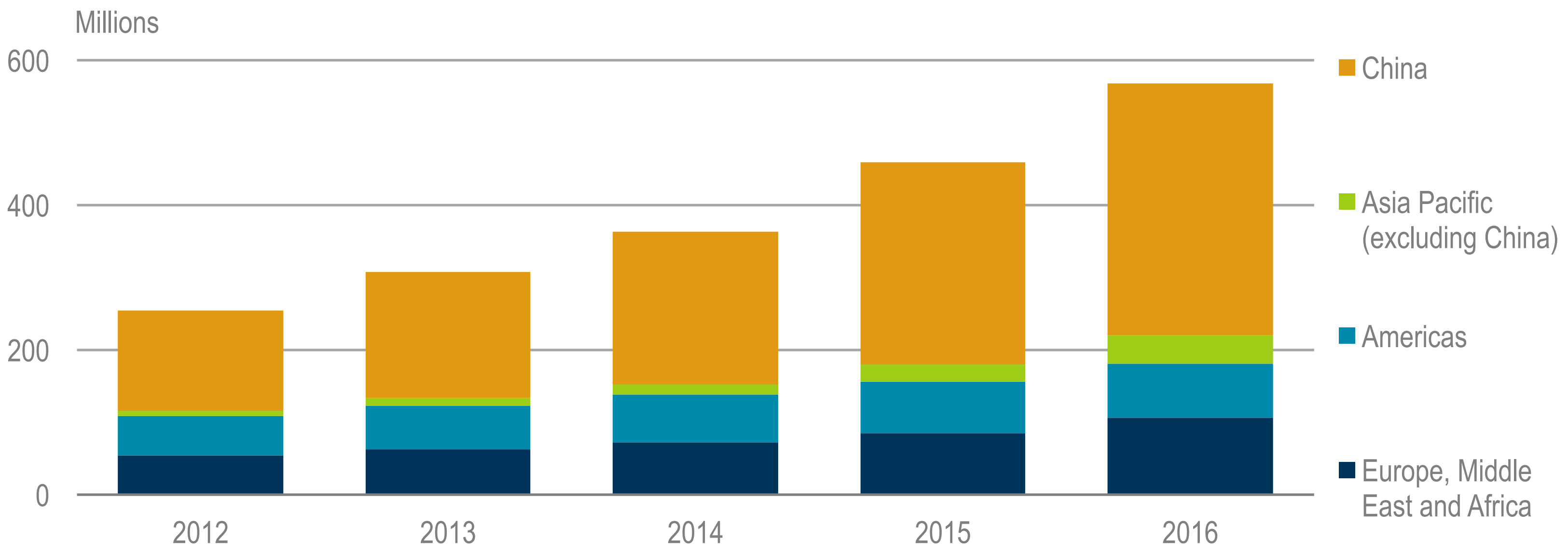
- **China** is at the forefront of using new technologies for managing their standards and labelling programme

- Why a Quick Response (QR) code?
  - Half the Chinese population uses smart phone apps
  - Not patented, low cost and easy to use on existing energy label for appliances

- Benefits:
  - Guides consumers to make better informed decisions
  - Supports local compliance authorities, reducing compliance costs and simplifying data collection
  - Helps in the monitoring and evaluation of the effectiveness of the programme

Smart meters installations are quickly accelerating

Global contracted installations of electricity smart meters

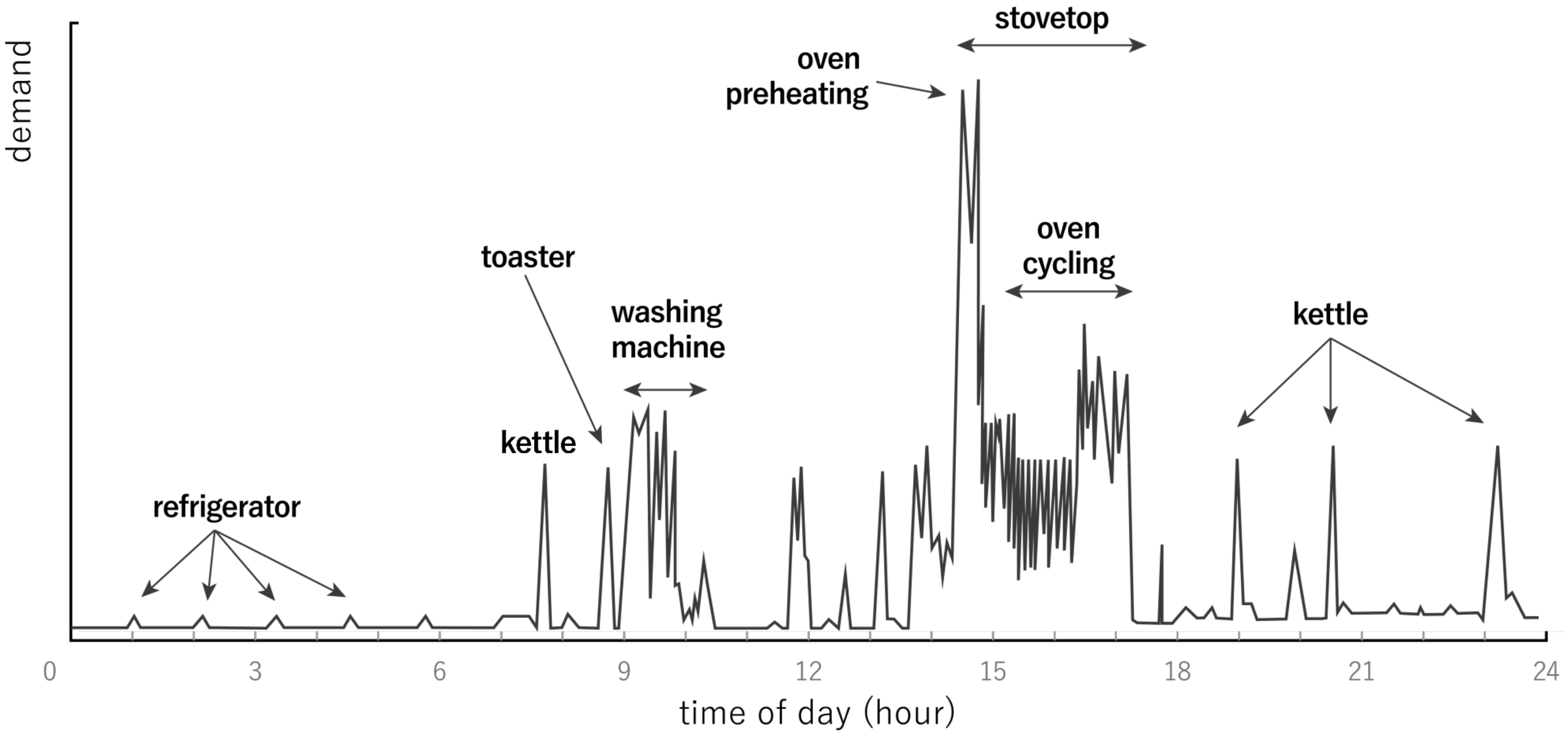


Smart meters do not directly result in energy savings but enhance or enable other savings opportunities by measuring household electricity use frequently enough for household occupants (or devices) to respond in real time.

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

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
  - Electricity and smart energy systems
  - Digitalization and decarbonisation

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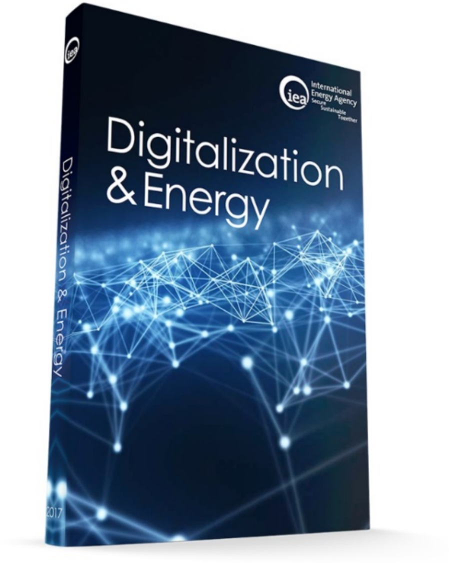
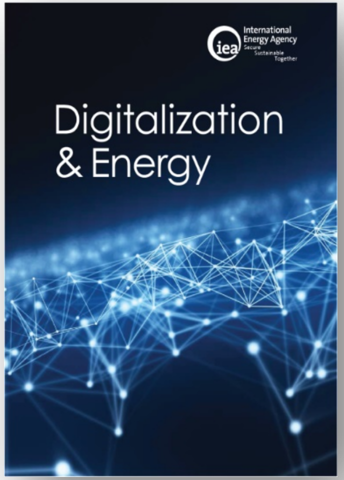
Extras


International Energy Agency
Secure Sustainable Together
Digitalization & Energy
Digitalization & Energy
2017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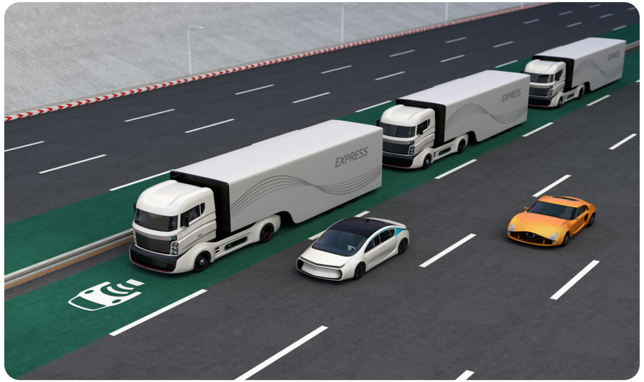
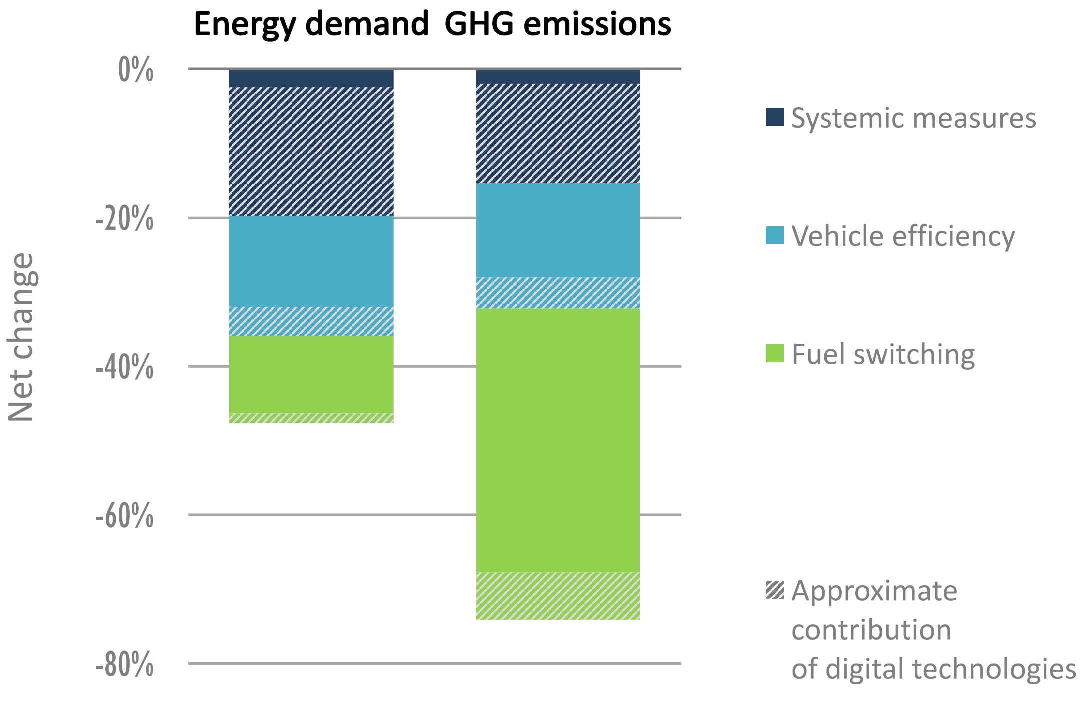
Digitalization and trucks



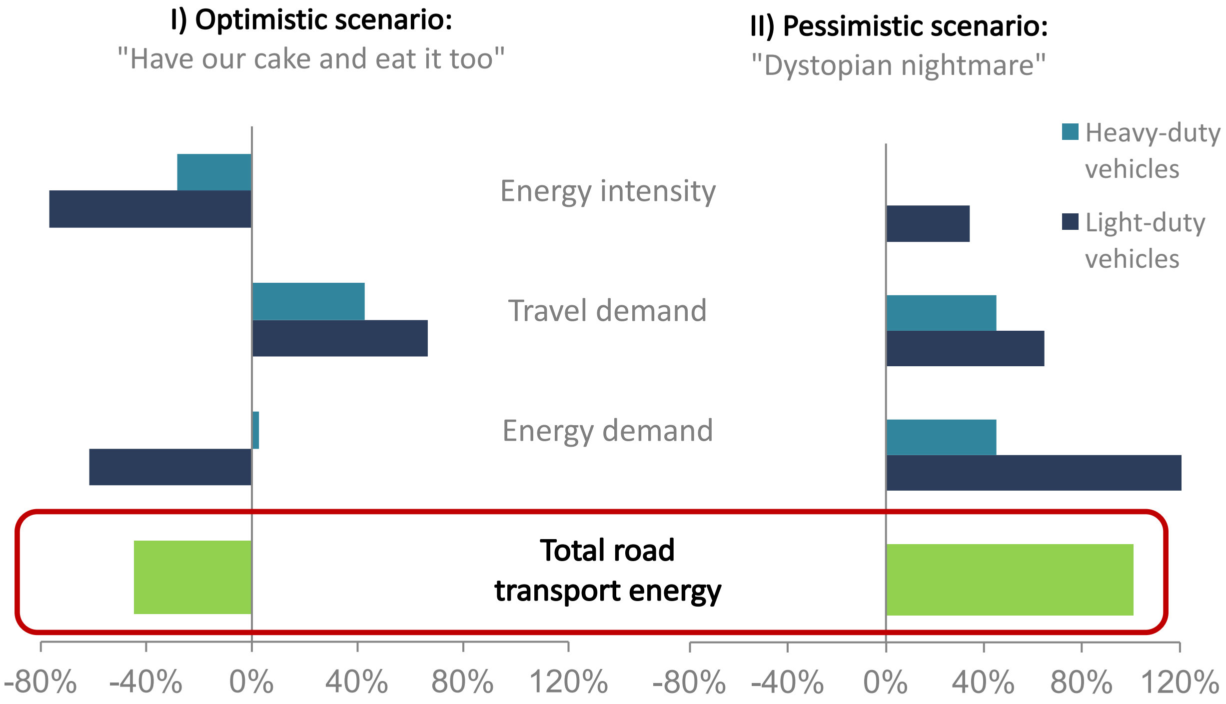


Source: IEA (2017). The Future of Trucks: Implications for energy and the environment.

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



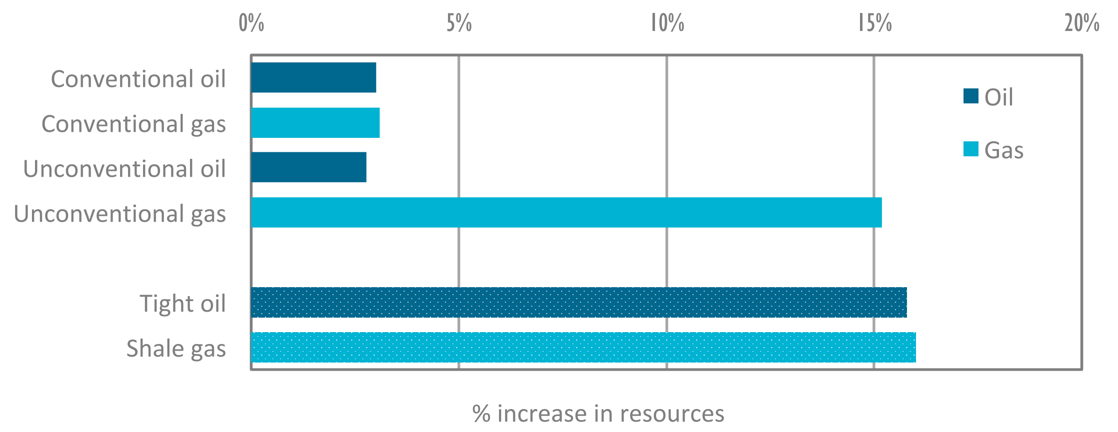
Source: Wadud, MacKenzie and Leiby (2016), "Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles".

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

Supply: Fossil fuels

Oil and gas

- Increased productivity, improved safety and environmental performance
- Production costs reduced 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 and safety

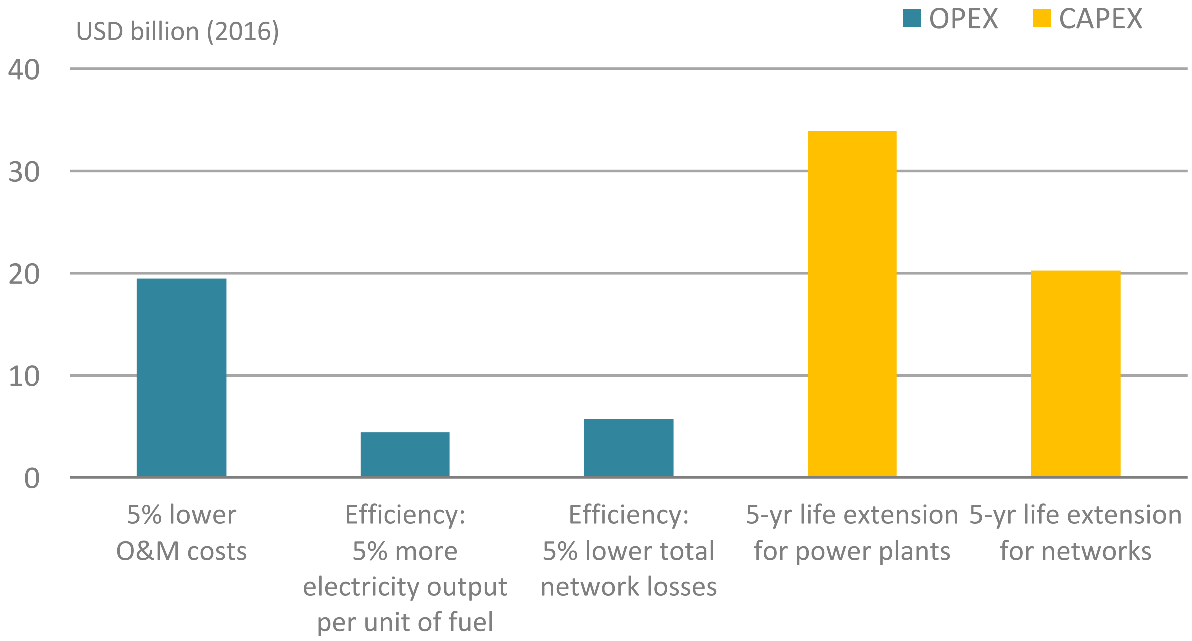
Energy companies have been adopting digital technologies for years.

Digitalization helps to increase productivity, reduce costs, improve safety and environmental performance.

Supply: Electricity generation and networks

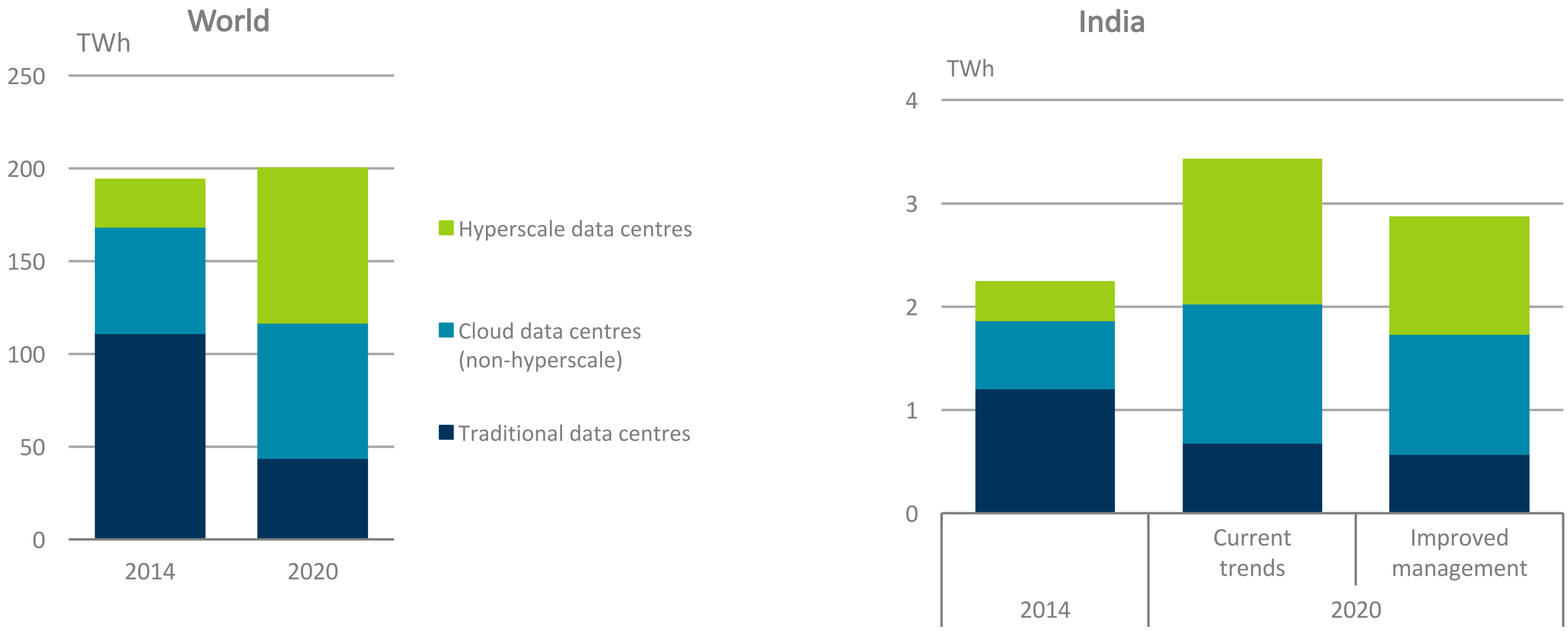
Power

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



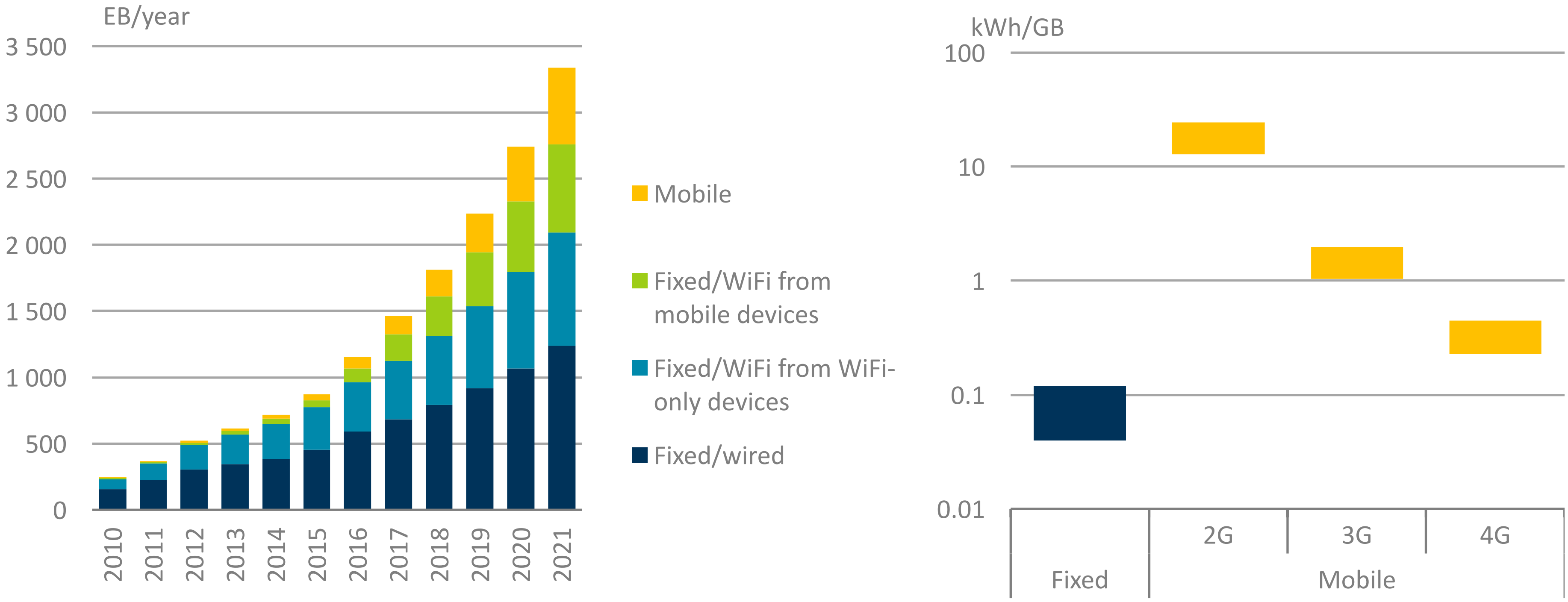
Digitalization could save around USD 80 billion per year, or about 5% of total annual power generation costs

Data centres

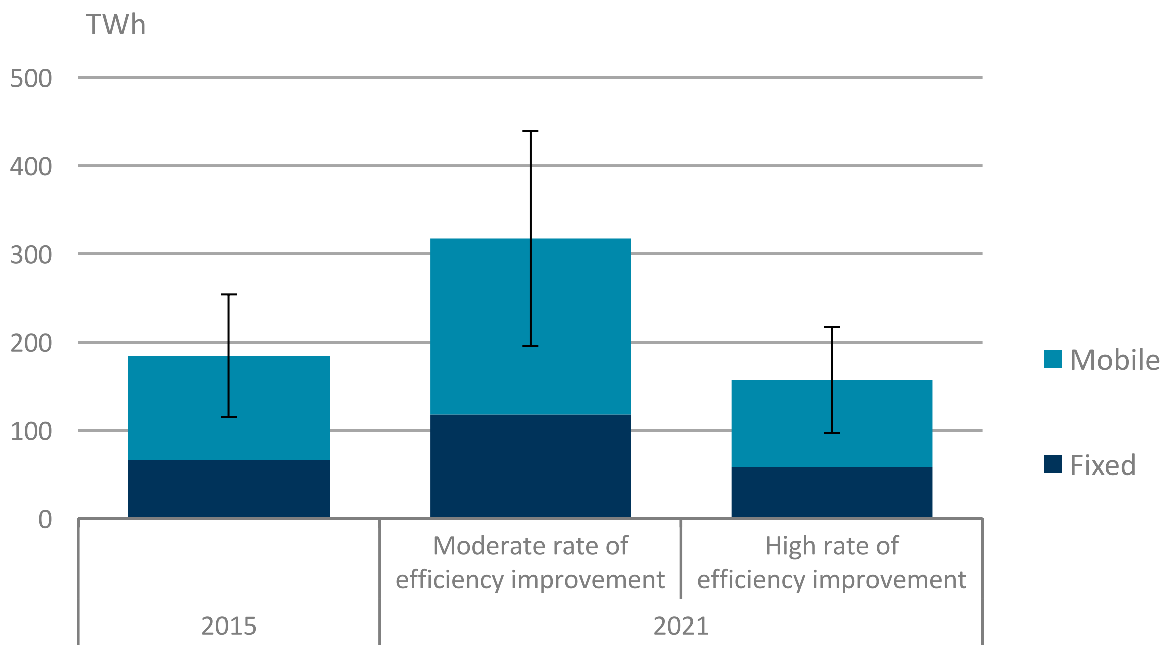


Continued gains in efficiency can keep energy use by data centres and networks largely in check over the next five years.

Data transmission networks



Data transmission networks



Louise

IEA-4E will be interested to see how we have handled the stand-by energy issue, given that this is a pressing concern for regulators and policy makers (the audience). You should mention that we point to the Connected Devices Alliance voluntary principles for appliance manufacturers and policy makers (p.117) in this context.

But at the same time, they will want to see how we have covered the broader topic of digitalisation and energy in buildings (and transport), and the coverage of cross-cutting themes such as privacy and security, as this will be the context within which they will design new policy interventions. I added transport in parentheses as EV chargers is one of the appliance groups that 4E are looking at in terms of their efficiency.

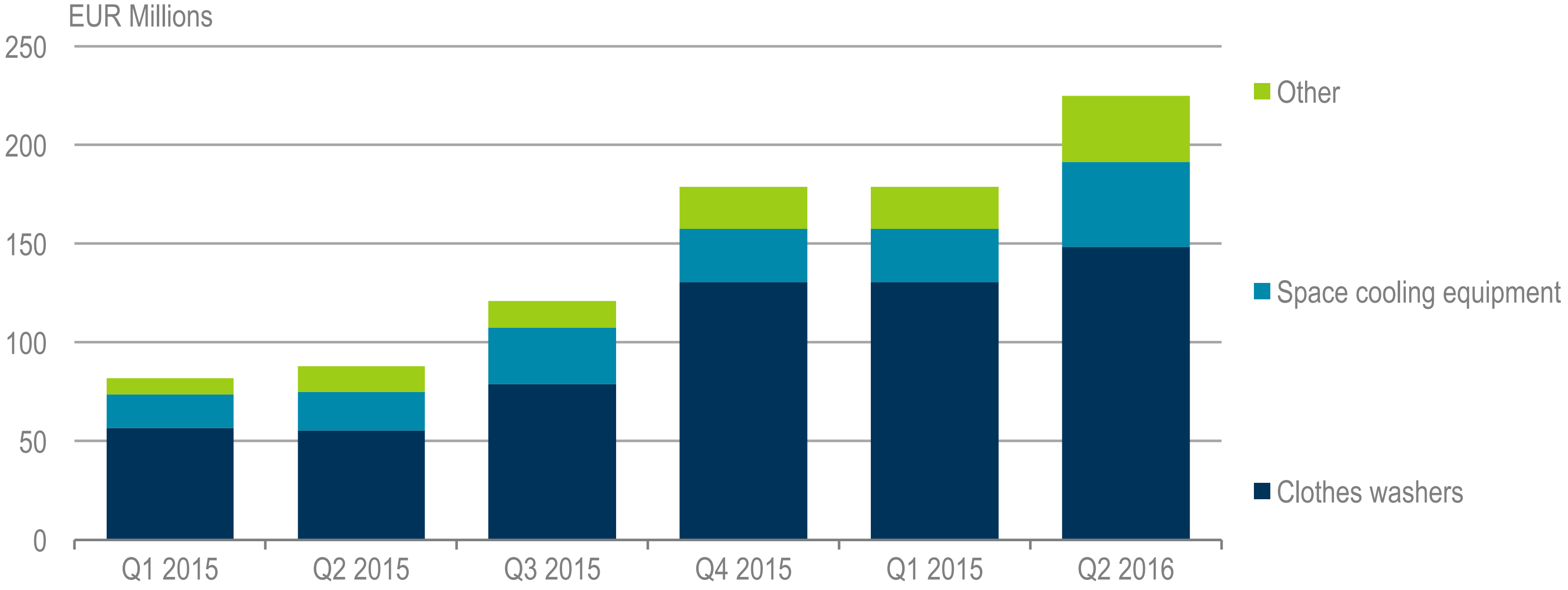
They will be less interested in Chapter 3, but the rest of what is a great report will be of interest, so I would give a broad overview of the whole report and then dig deeper on the end-use side.

Lastly, they will be wondering how they can leverage the report to pursue new work in their Electronic Devices and Networks Annex (EDNA). It will be interesting to hear their ideas and it would be great if you could report back.

Thanks
Sam

The popularity of smart appliances is quickly growing

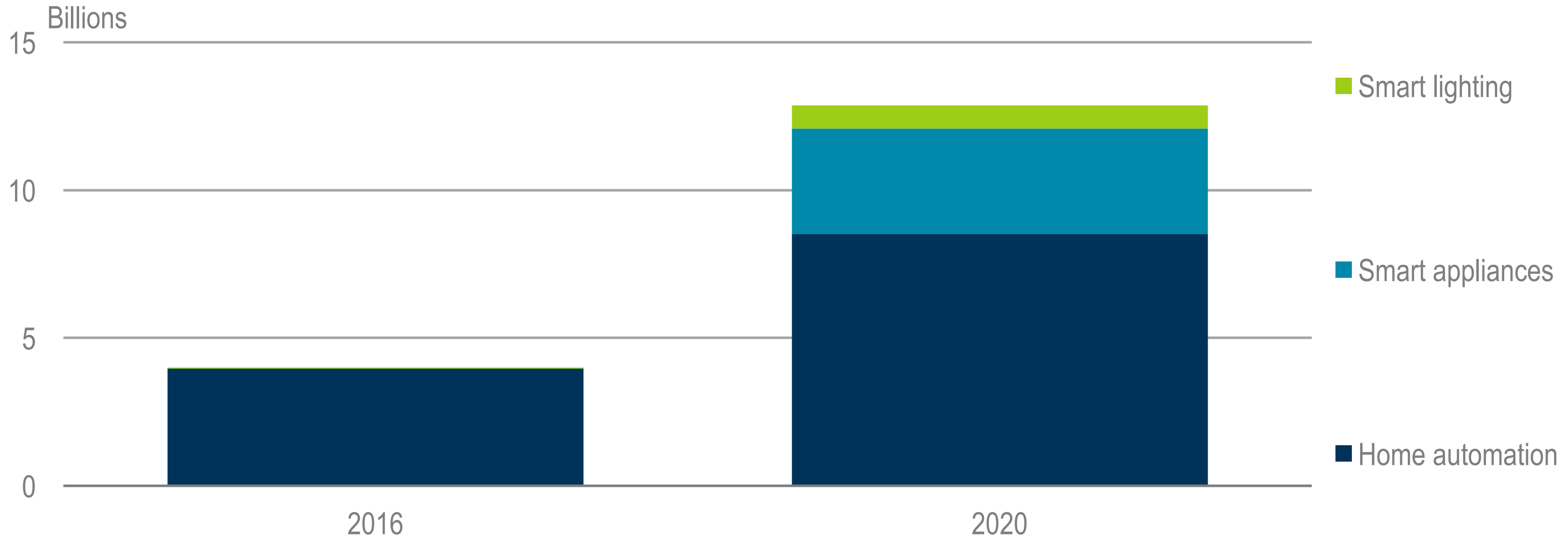
Sales value of large smart home appliances in the European Union, 2015-16



Sales value in the EU grew by two-and-half between 2015 and 2016.

The number of installed connected devices may triple by 2020

Global household connected devices installed by the end of 2016 and forecasted for 2020



4 billion devices were installed worldwide in total by the end of 2016. These devices are enabling new services that may enhance quality of life, but smart devices are not necessarily energy-efficient.