Digitalization & Energy

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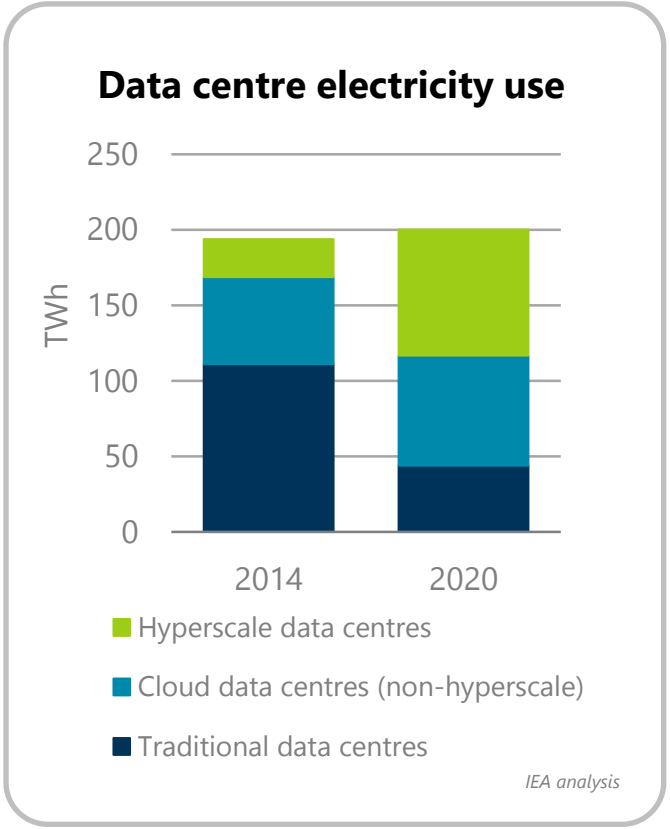
IEA

Digitalization: A New Era in Energy

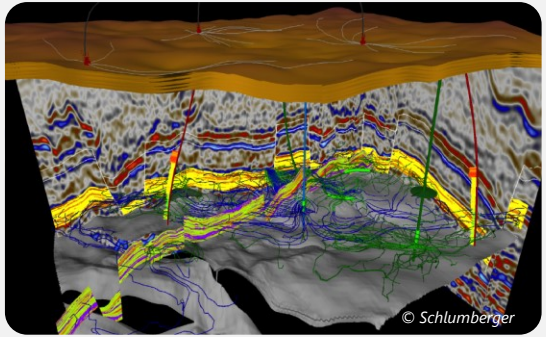
- The energy system is on the cusp of a new digital era
- This first-of-its-kind *Digitalization and Energy* report will help shine a light on digitalization's enormous potential and most pressing challenges
- But impacts are difficult to predict; uncertainty in technology, policy and behaviour
- Much 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 trends: truly astounding



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

Supply: oil and gas, coal, and power



Oil and gas

- Advanced processing seismic data, use of sensors, enhanced reservoir modelling
- Improved productivity, safety and environmental performance
- Improved recovery 5%
- Reduced production costs 10-20%

Coal mining

- Geological modelling, process optimisation, automation, predictive maintenance
- Improved processes, safety, maintenance and environmental performance
- Improved efficiency CFPP 2-3%
- Reduced CO2 emissions 5%

Electricity generation, T&D

- Digital data and analytics
- Reduced O&M costs, extended lifetime, improved efficiencies and enhanced stability
- Savings up to USD 80 billion/year (5% of total annual costs)

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

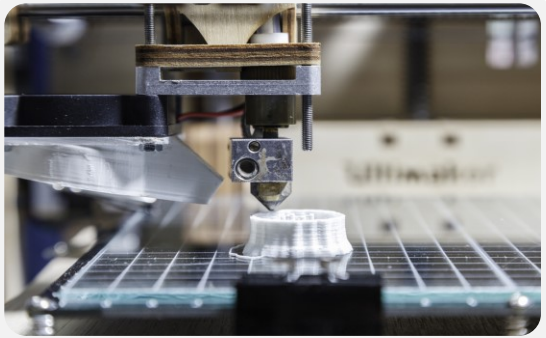
Impacts on demand sectors: transport, buildings and industry

Transport

- Automation, sharing, route optimisation, platooning, data sharing
- Passenger cars: Reduced energy use, cost/journey BUT expected increase in trips
- Trucking/logistics: Energy reduced by 20-25%

Buildings

- Smart controls and sensors (lighting, heating/cooling)
- Improved comfort, building energy management
- Reduced energy use 10% by 2040
- Rebound effects are uncertain



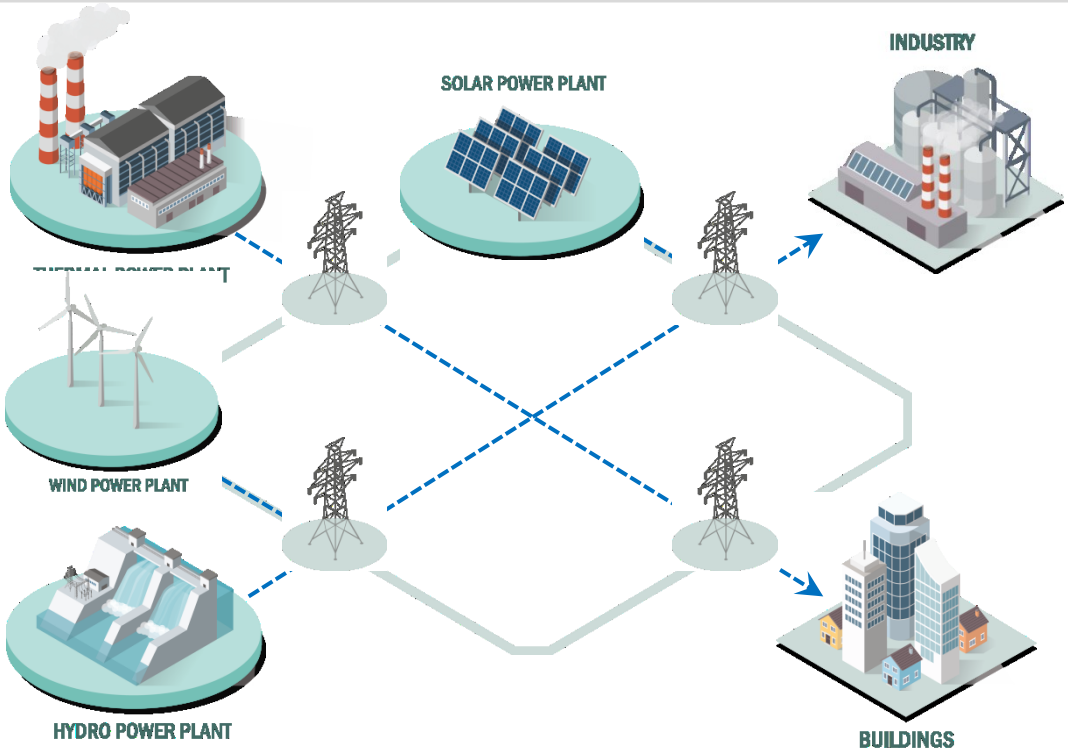
Industry

- Advanced process controls, data analytics, combined smart sensors, 3D printing, machine learning
- Increased productivity, reduced costs and improved safety
- Lower costs at plant level but broader impacts remain uncertain

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

policies are needed to maximise benefits and reap energy saving opportunities

The digital transformation of the energy system



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

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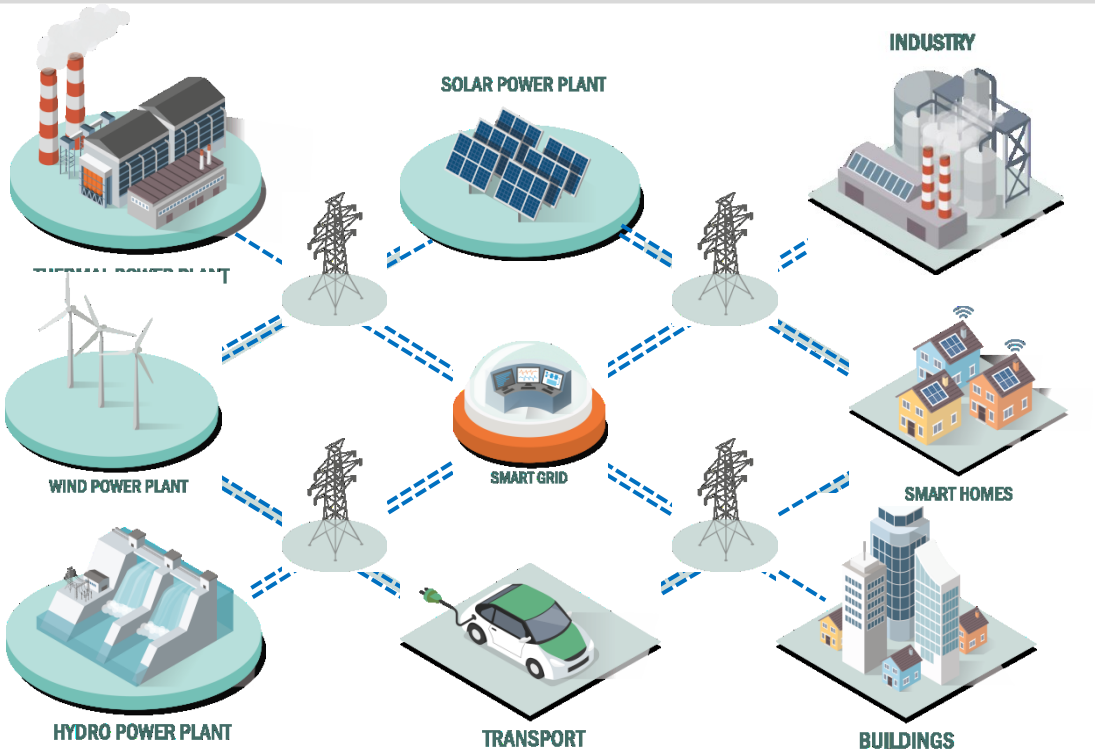
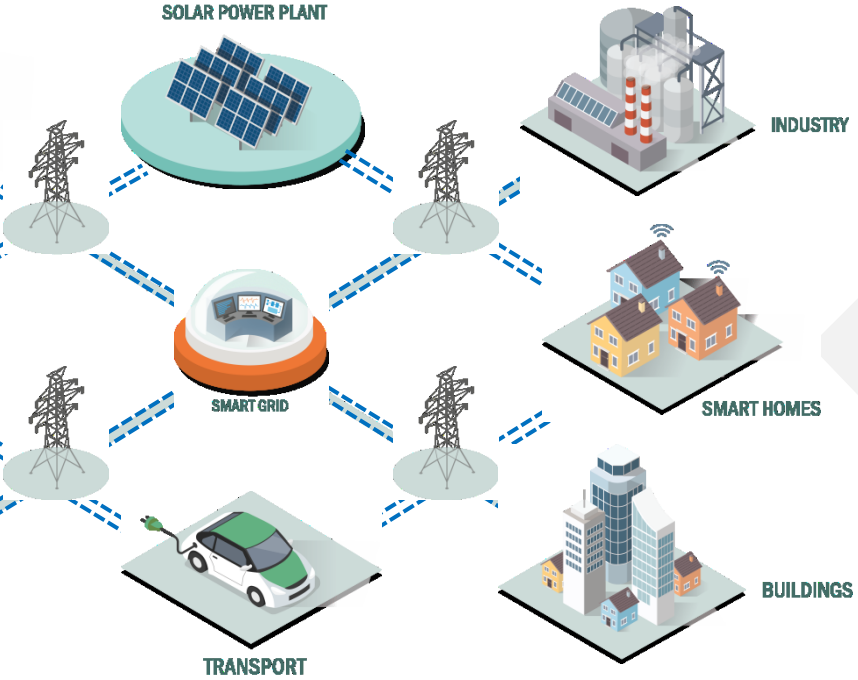
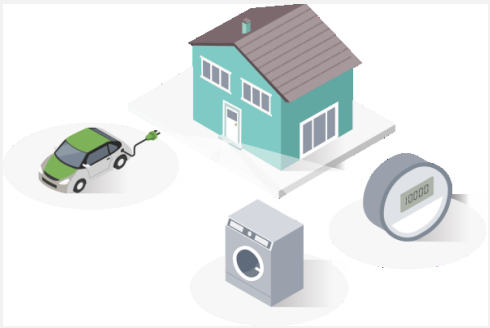


Pre-digital energy systems are defined by unidirectional flows and distinct roles, digital technologies enable a multi-directional and highly integrated energy system

Smart demand response



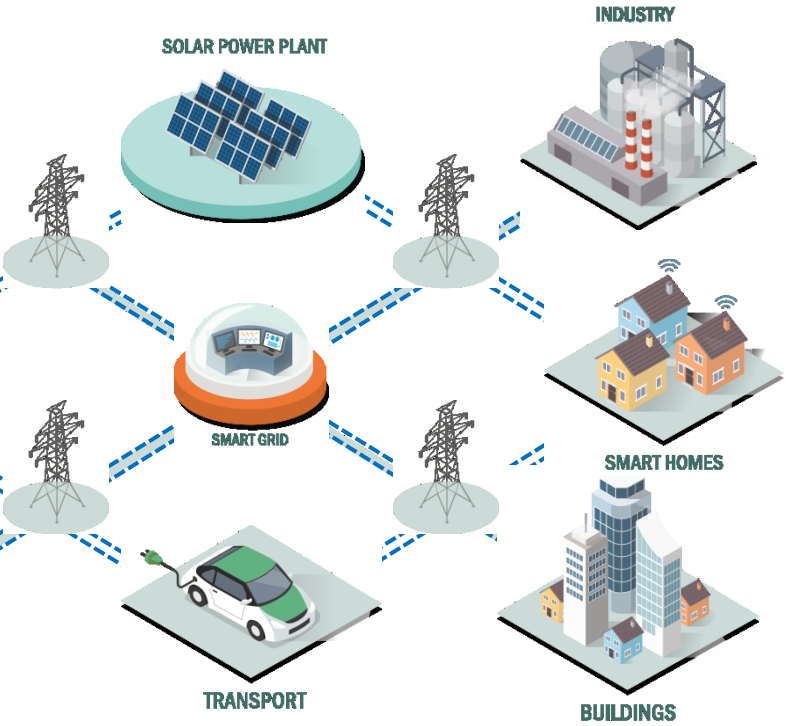
Residential sector

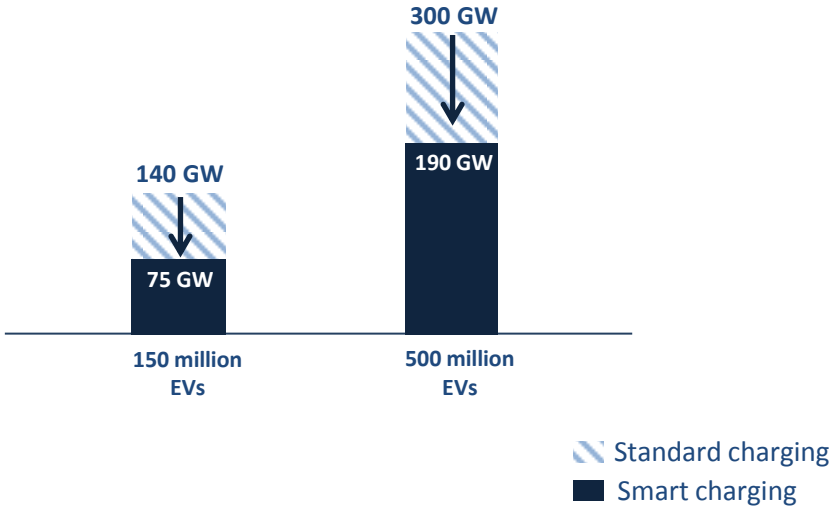


1 billion households and **11 billion smart appliances** could actively participate in interconnected electricity systems

Demand response programs in end-use sectors could provide 185 GW of flexibility, avoiding investment in new electricity infrastructure of USD 270 billion

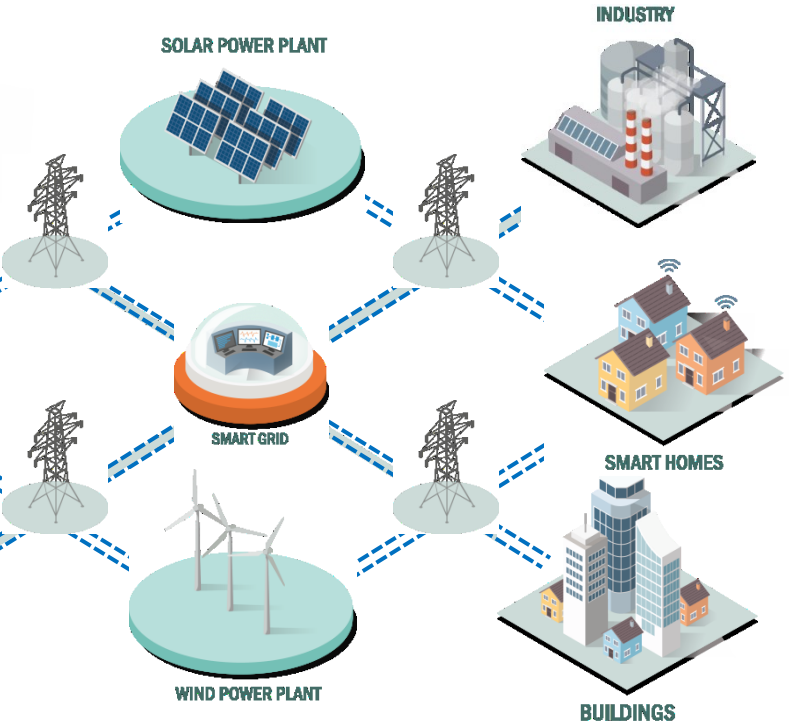
Smart charging of electric vehicles



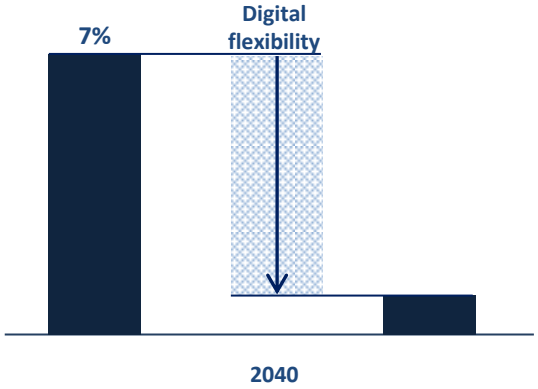


EVs smart charging would provide further flexibility to the grid saving between USD 100-280 billion investment in new electricity infrastructure

Integration of variable renewables



Curtailment of solar PV and wind



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

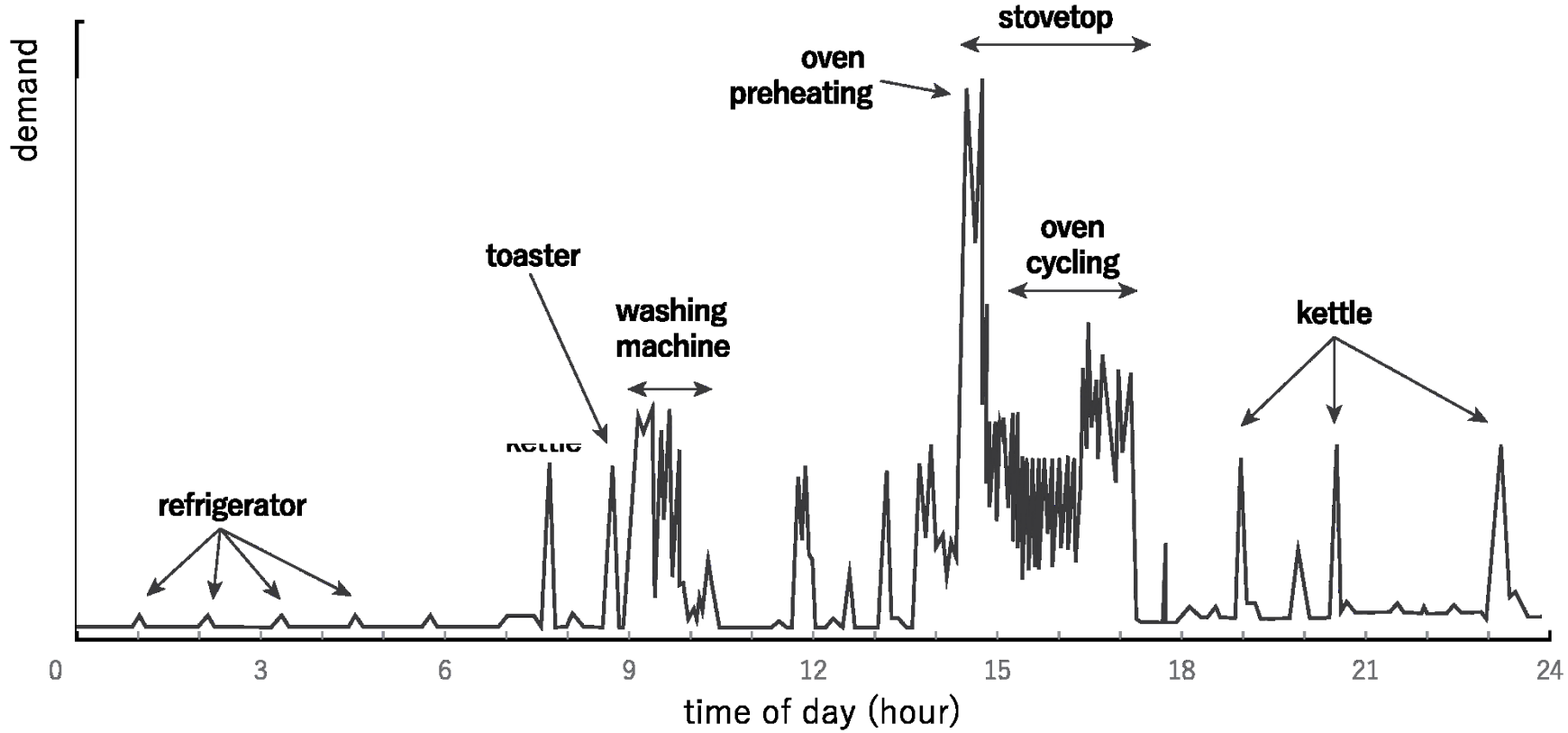
Blockchain could help to facilitate peer-to-peer electricity trade within local energy communities

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

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.

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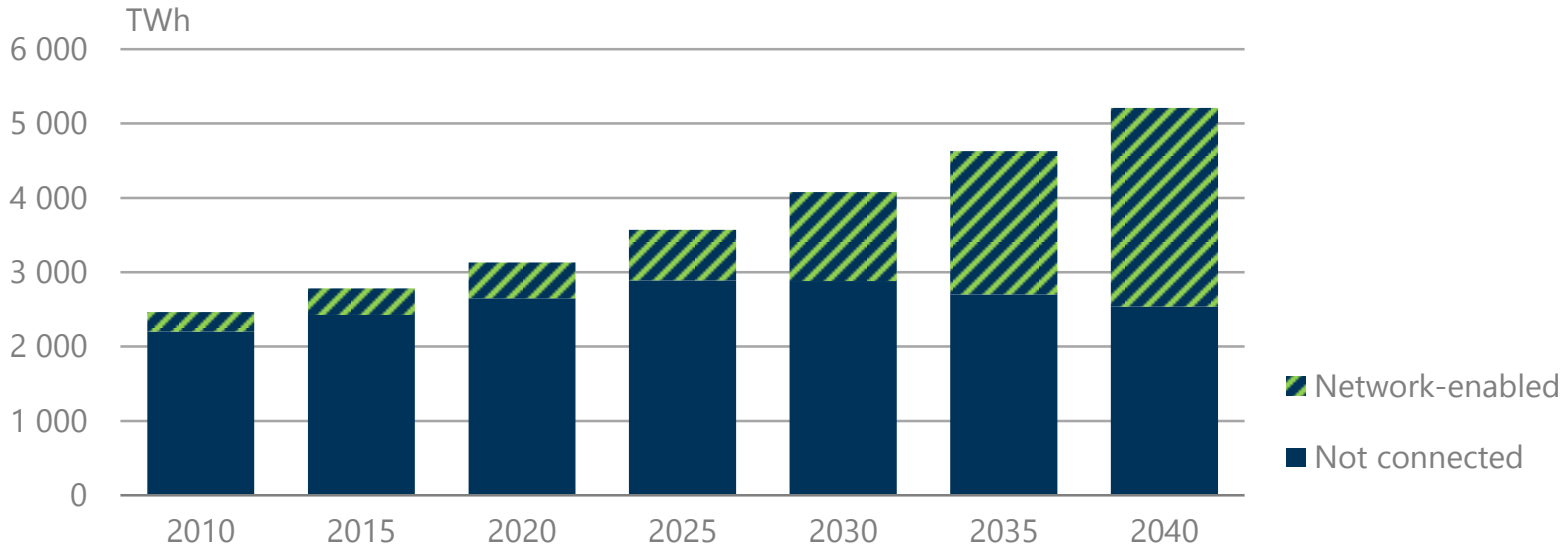
Digital technologies are everywhere….

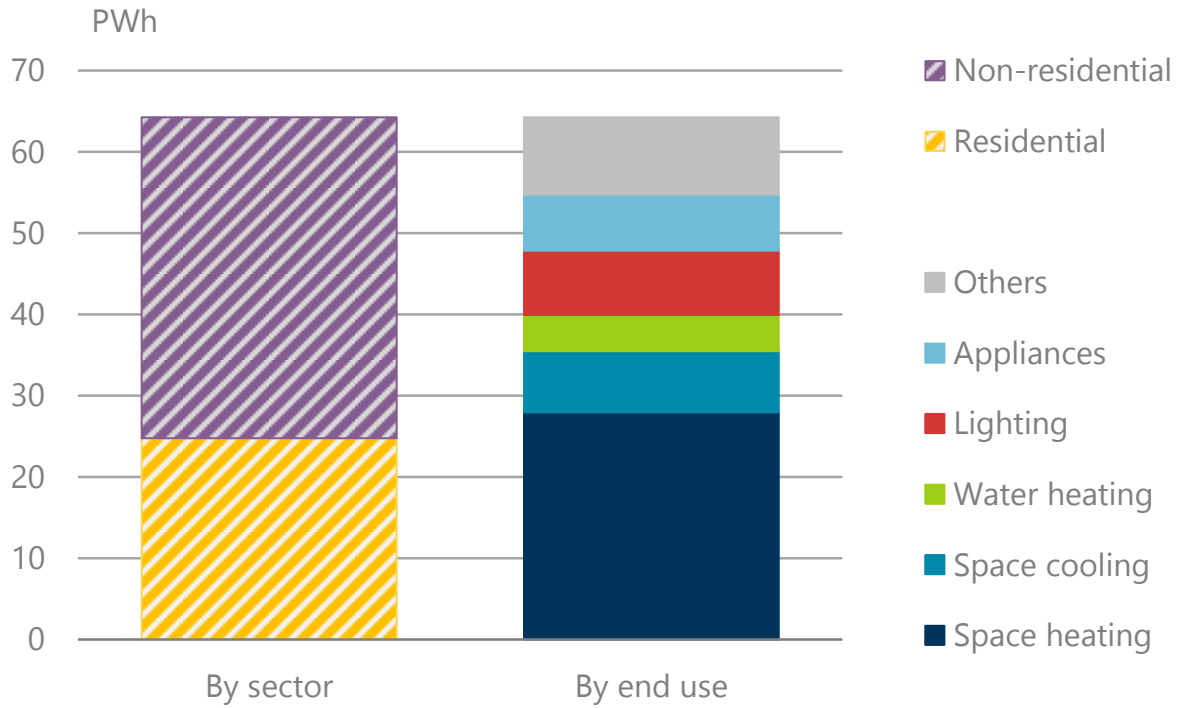
Growth of IoT and connected devices

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

Buildings



IEA analysis

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

Transport

Road freight

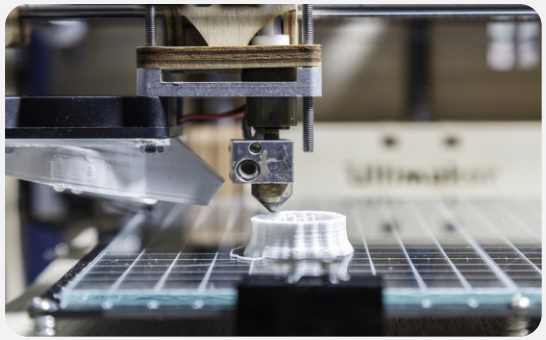
- Digital solutions for trucks and logistics could reduce energy use for road freight by 20-25%.
- Digital solutions include platooning, route optimisation, and data sharing across the supply chain

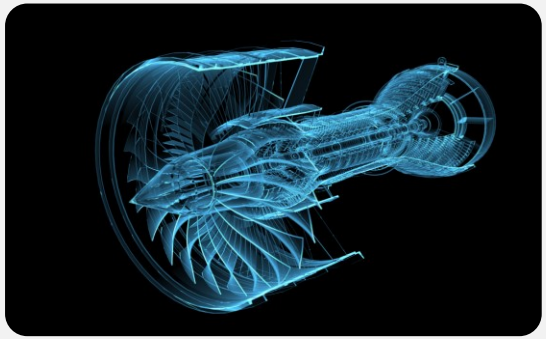
Road passenger

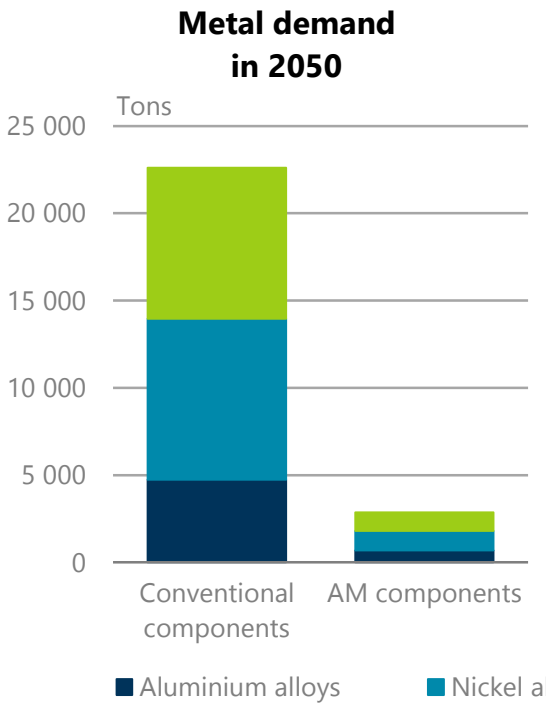
- Automation, connectivity, sharing, and electrification (ACES) to dramatically reshape road transport
- Impacts on energy demand difficult to predict
- Automation and connectivity could halve or double energy demand, depending on how technology, behavior, and policy evolve

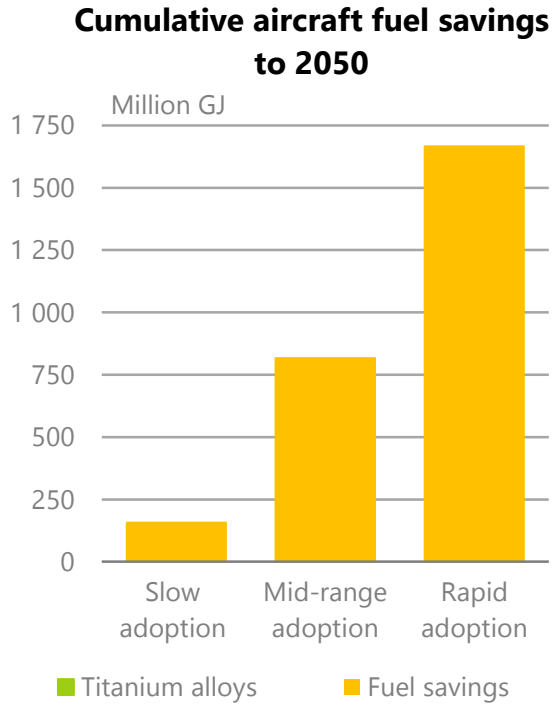
Intelligent transport systems are improving safety and efficiency of all modes, with the most transformative impacts expected in road transport

Industry









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