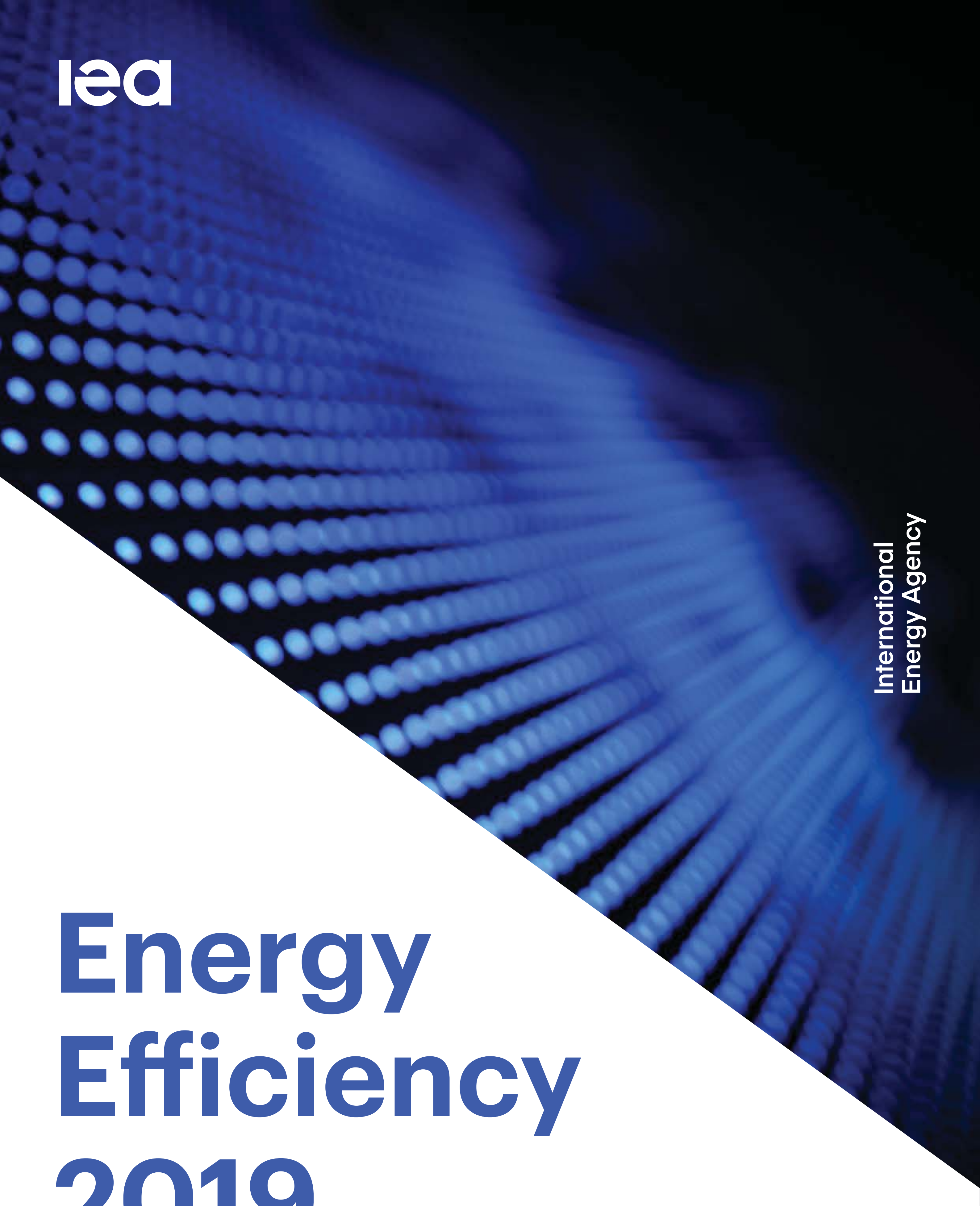


International Energy Agency

Energy Efficiency 2019

Foreword

The IEA views energy efficiency as the "first fuel" of all energy transitions. Our Efficient World Strategy, published in last year's edition of this report, provided a blueprint showing how energy efficiency alone could enable energy sector greenhouse gas emissions to peak before 2020, achieving the energy efficiency target in the Sustainable Development Goals. Unfortunately, data from 2018 reveal that the world is veering away from this pathway.

In 2018, global primary energy intensity improved by only 1.2%, the slowest rate since the start of the decade and the third consecutive year that energy intensity improvements have weakened. This trend is worrying in a world where there is a growing disconnect between political statements and global energy-related greenhouse gas emissions, which, in 2018, grew at their fastest rate since 2013.

As *Energy Efficiency 2019* highlights, the rate at which technologies and processes are becoming more energy efficient is slowing, while structural factors are curbing the power of these technological gains to improve energy intensity. If these trends continue, energy efficiency will need to increase much more quickly to achieve a level of energy intensity improvement consistent with meeting global climate change and sustainability goals.

These findings should trigger immediate action by energy efficiency policy makers and investors. We know that the technologies exist to raise the energy intensity improvement rate to 3%, more than double today's level, and that these technologies are commercially available and cost-effective. To drive their uptake, ambitious policies are required to drive a scale-up in investment.

One area where policy makers could start is digitalisation. *Energy Efficiency 2019* shows how a range of digital technologies accompanied by the right policies could improve energy efficiency in industry, buildings and transport. To harness the power of digital technologies to deliver further gains in energy efficiency, energy policy makers will need to engage with a range of challenging issues.

The IEA will be an active partner, helping all countries to meet the challenge of ramping up efficiency and realising the benefits of digitalisation. I am very proud that in the last year alone we have trained almost 500 policy makers from 100 countries, connecting policy makers all over the world to exchange experience and knowledge.

Other responses to the need for urgent action are emerging. In September, 15 leading countries formed the Three Percent Club, signalling their commitment to help ensure that global energy intensity improves by at least 3% per year. In addition, a group of global leaders have been convened to form the Global Commission for Urgent Action on Energy Efficiency to influence policy at the highest levels. They will work together to identify ways to achieve breakthroughs in energy efficiency policy that are commensurate with the scale of urgency. I will be following these initiatives closely and look forward to them bearing fruit in the near future.

Dr. Fatih Birol
Executive Director
International Energy Agency

IV. Emerging trends:

Highlights

- Digitalisation is reshaping the entire energy system. This transformation is being driven by advances in three fields: volumes of data are increasing thanks to the declining costs of sensors and data storage, rapid progress is being made in advanced analytics and computing capabilities, and connectivity is being boosted by faster and cheaper data transmission.

- At a time of deep change in the energy system, with growing shares of intermittent generation from renewable energy sources, digitalisation is making demand-side energy efficiency a more valuable resource. As well as improving end-use efficiency, many digital technologies provide other services, such as flexible load, that increase the efficiency of the entire system. While end-use efficiency has always had system benefits, digitalisation allows for these benefits to be measured and valued faster and more accurately.

- Digital technologies could benefit all sectors and end-uses. Digitalisation could reduce global buildings sector demand by up to 10% by 2040. Digitalisation could also increase demand response capacity more than ten-fold, from 40 GW today to 450 GW in 2040. However, the exact scale of these impacts is uncertain, and depends on policy responses, which also need to consider the risk of increased energy demand from the growth of digital devices. More evidence is needed on how digital technologies could combine to deliver system-wide improvements, and how rebound effects might curtail their benefits if the spread of digital devices increases energy use.

- Policies explicitly focused on digital technologies for efficiency are rare but starting to emerge. Technology deployment can be accelerated by policies that recognise the energy system benefits of digital technologies and help overcome barriers to implementation.

- The IEA has created the Readiness for Digital Energy Efficiency policy framework, a set of critical policy considerations for harnessing digital technologies for energy efficiency. The framework is designed to ensure that the benefits of digital energy efficiency are realised through policies that address a range of issues: from balancing data accessibility with data privacy, to helping remove regulatory barriers to innovation.

Introduction

Digitalisation is the growing application of information and communications technology (ICT) across the economy, including energy systems. The process of digitalisation involves increasing interaction and convergence between the digital and physical worlds. Three elements are fundamental to the process of digitalisation:

- **Data**: digital information.
- **Analytics**: computing vast amounts of data to produce actionable insights.
- **Connectivity**: exchange of data between machines or humans and machines, through digital communications networks.

People have been using digital technologies for decades. What is new today is the scale and pace of digitalisation, and its increasing focus on connectivity. The trend toward greater digitalisation is enabled by advances in all three of these areas: volumes of data are increasing thanks to the declining costs of sensors and data storage, advanced analytics and computing capabilities are making rapid progress, and connectivity is increasing as transmission becomes faster and cheaper.

Digitalisation's impact on energy demand is multi-faceted. Digital devices offer large improvements in energy efficiency for the transport, buildings and industry sectors. If not managed carefully, however, they could contribute to increases in energy use, as devices become more prevalent (including Internet-connected devices that consume energy constantly to remain connected) and more transmission networks and data centres are required to transmit, house and process the data they produce.

One risk of increased digitalisation is that by offering a better quality of service, digital technologies may result in a rebound effect, whereby energy users consume more energy services than they would have without digital technologies. Estimates of the potential for rebound effects stemming from digital technologies vary between sectors, ranging from less than 10% to nearly 30% more energy consumed for some technologies and end uses (Global e-Sustainability Initiative and Accenture, 2015).

This rest of this chapter is structured as follows:

First, information is presented on how digital technologies can combine to improve energy efficiency. Technological change has been rapid since the IEA published *Digitalisation and Energy* (IEA, 2017) so this section provides examples of recent applications of digital technologies on the demand side.

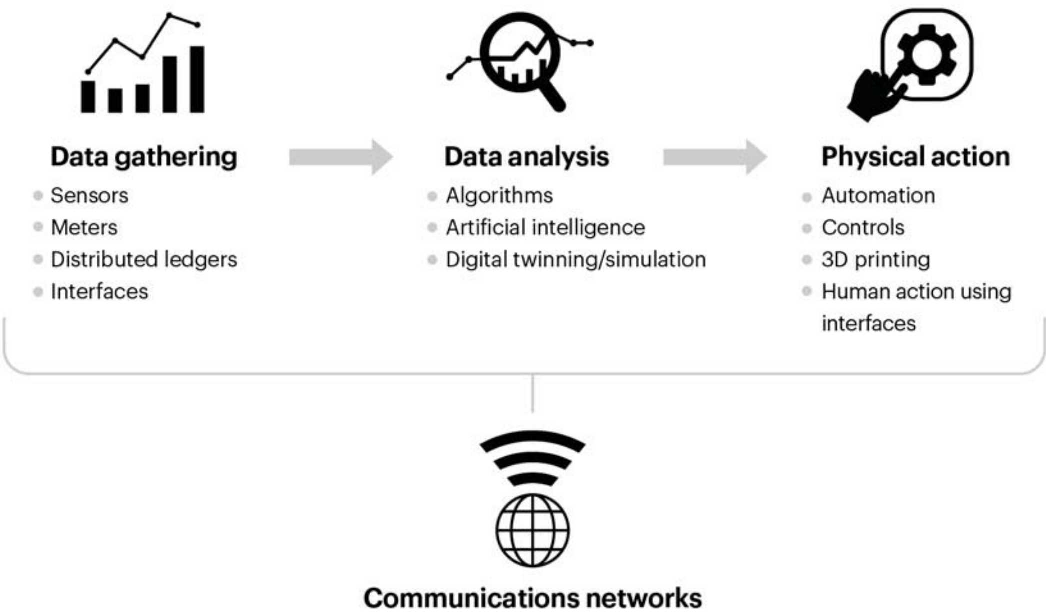
Second, some recent estimates of digitalisation's impacts at a global level are provided for buildings, industry and transport, from the IEA and other sources. Estimated impacts of digitalisation on individual energy-using components in each sector are also presented. This section explains how digitalisation is modernising energy efficiency, extending its benefits from individual end-uses to the energy system as a whole and allowing these benefits to be measured and valued faster and more accurately.

Third, the chapter investigates policy settings necessary to harness digital technologies for energy efficiency, and overcome barriers that exist in all sectors. It then outlines the IEA Readiness for Digital Energy Efficiency policy framework, a set of policy principles for harnessing digital technologies for energy efficiency.

How can digital technologies combine to improve energy efficiency?

Digitalisation offers the potential to increase energy efficiency through technologies that gather and analyse data, then use it to make changes to the physical environment (either automatically, or through human intervention). All of these processes are underpinned by digital communications networks, both wired and wireless, which allow people and machines to send and receive data and analysis to one another in larger volumes and faster than ever (Figure 4.1).

Figure 4.1. How digital technologies, when combined, could boost energy efficiency



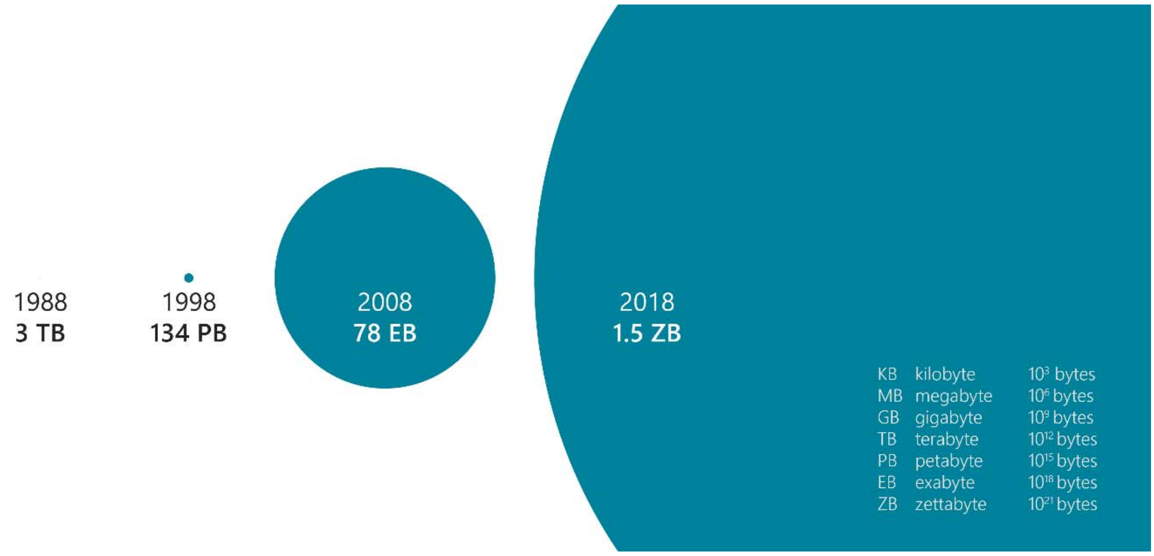
Data gathering

One of the biggest changes brought about by the digital era is the proliferation of data. For example, global Internet traffic generated 1.5 zettabytes of data in 2018, 19 times more than a decade ago (Figure 4.2).

A wide range of data are created every second, that are directly relevant to energy efficiency. These include not only data on energy consumption but also data *related* to energy consumption, such as weather conditions, consumer purchasing decisions and behaviour. Examples of such data include smart meter data; data on commuter movements; data gathered from mobile telephone networks; and data on changing consumer preferences, gathered through online shopping sites and social media channels.

High-level technology types that can generate and collect data relevant to energy efficiency include sensors, meters, distributed ledgers, interfaces and many more.

Figure 4.2. Global annual Internet traffic



Sources: Based on Barnett et al.(2019), *Cisco Visual Networking Index: Forecast and Trends, 2017–2022*; Cisco (2016), *The Zettabyte Era: Trends and Analysis, July 2016*; and Sumits, A. (2015), *The History and Future of Internet Traffic.*

Sensors

Sensors detect or measure input from the physical environment, such as daylight, temperature, motion or pressure. While sensors are not new, they have proliferated thanks to reductions in cost, improvements in performance, and size reductions. Policy has also boosted sensor deployment in the buildings sector, particularly in the EU and US markets, where building codes have helped drive change over the last 15 years (Walker, 2013).

Box 4.1. Sensors, connectivity, and automation for energy-efficient freight transport

One application of sensors, in combination with other technologies, that promises possible future gains in transport energy efficiency is "platooning". Platooning refers to operating two or more vehicles at high speeds with a small enough gap between them to reduce drag losses. In road freight, trucks that are equipped with state-of-the-art driving support systems can form a "platoon", guided by smart vehicle communication and automation technologies. Pilots suggest platooning of freight trucks could improve highway fuel economy by up to 10-25% (Wadud, MacKenzie and Leiby, 2016).

As well as the sensors found on most modern vehicles, additional types of sensors are crucial for platooning. Radar-based collision mitigation systems precisely detect the distance from one truck to another as well as other objects and obstacles on the road. These sensors can track everything around the vehicle simultaneously, 50 times per second (Peloton, 2018). GPS sensors are also used to track the location of individual vehicles within the platoon. They also provide information about the platoon's location relative to hazards or obstacles that might slow the journey or increase fuel consumption, such as traffic congestion.

Source: Wadud et al. (2016), *Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles*; Peloton (2018), *Platooning combines advanced technologies to improve safety and fuel efficiency*, https://peloton-tech.com/how-it-works/.