GSMA™ Intelligence

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Industry pathways to net zero

Decarbonisation in energy and utilities

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GSMA Intelligence

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We would like to thank the Carbon Trust as a trusted advisor in the analysis and modelling for this research.

Carbon Trust
Established in 2001, the Carbon Trust works with businesses, governments and institutions around the world, helping them contribute to, and benefit from, a more sustainable future through carbon reduction, resource efficiency strategies, and commercialising low carbon businesses, systems and technologies.

Contents

1. Sector context and overall sustainability strategy

The energy and utilities sector is the driving source of power across the economy. It accounts for approximately 12% of CO_2 emissions worldwide,[1] with geographic variation according to differences in domestic energy supply, the rate of economic growth and political environment. As energy and utilities are the lifeblood of how we live and work, decarbonising this industry and shifting to clean fuels will play a fundamental role in a successful path to net zero.

The sector can broadly be split into two components: upstream activities, comprising fuel sourcing and production (supply side); and downstream activities, responsible for distribution across the grid to local operators and ultimately end users. The challenge to decarbonise involves a mix of large-scale migration away from fossil fuels and towards renewables; technology adoption; and behavioural change. These add up to a sustainable model for how economies and households power everyday life.

Achieving 50% reductions in emissions in each of the next three decades to reach net zero by 2050 implies removing 9.1 Gt of CO_2 from the energy and utilities market over the next 10 years (see Figure 1).

As for all the other sectors in our analysis, the 2020s are the most challenging but most important to build momentum. Commitments from COP26 provide some encouragement; India, for example, has targeted net zero by 2070 but with a more accelerated timeline on renewables (50% of domestic energy use by 2030). However, language in the final COP announcement on coal – to phase down rather than phase out – is less ambitious as it does not commit to a firm timeline.

This analysis focuses on the role that mobile and digital technology can play in helping power companies and others in the energy value chain to lower emissions and move to a more balanced model of energy transfer versus consumption. While significant gains will also be made through the shift to cleaner fuel (notably hydrogen) and reductions in methane, these are out of scope for this analysis.

A high-level quantification of CO_2 savings in the energy and utilities sector enabled by mobile and digital technology

Delivering 4.2 gigatonnes of CO_2 savings over the 10-year period to 2030 (46% of total reductions needed in the sector)

The equivalent of...

72 million
car journeys in a year

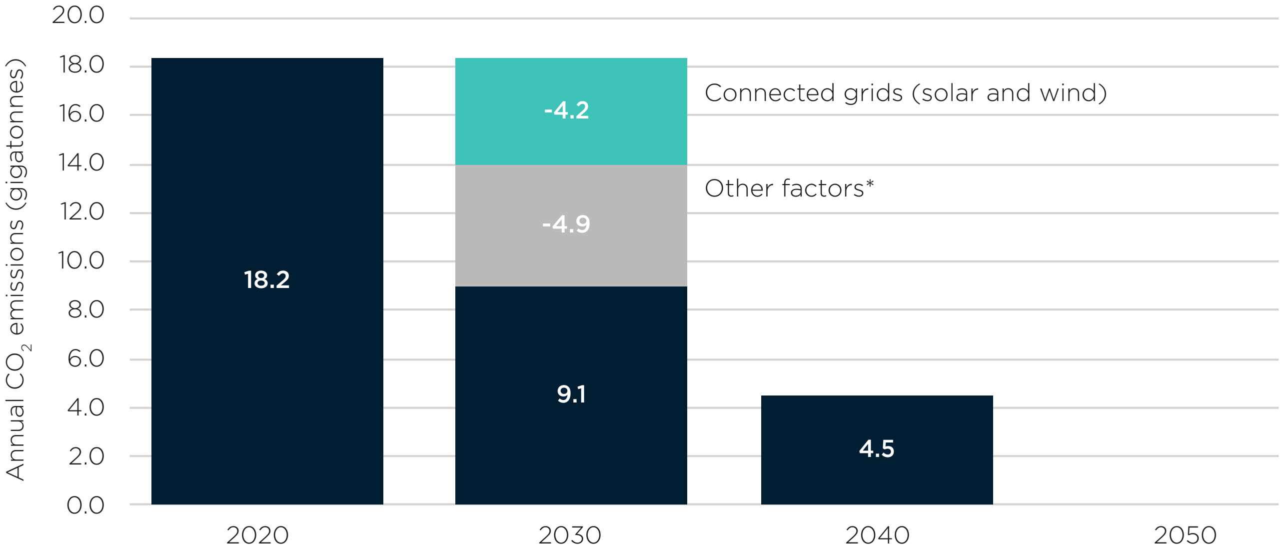
84 million
roundtrip flights from London to Los Angeles

420
coal-fired power plants taken offline over the next five years

[1] Exponential Roadmap. See the main report, Industry pathways to net zero: mobile and digital technology in support of industry decarbonisation

Figure 1

The energy and utilities sector's path to net zero



*Outlined below in *Decarbonisation drivers – non-digital*
Source: Exponential Roadmap, GSMA Intelligence

Decarbonisation drivers: digital

Several options are available for deploying digital technology in the energy sector. Collectively, the technologies are increasingly becoming part of remodelled grids – smart energy systems (SESs) – embedded with connectivity and analytics. An SES in its full sense also includes reformed heating systems, replacing gas and oil-fired boiling systems with low-carbon heat pumps. This will have a significant impact on CO_2 reductions from energy use but is out of scope for this research. The modelling and quantification here focus on renewable energy grids fitted with IoT sensors: connected solar and wind grids.

To distribute and manage these two renewable sources of energy, the grids are equipped with IoT sensors that in turn connect to a mobile network, the cloud and/or end-user premises (residential or commercial) through cellular or non-cellular protocols.

Beyond connected grids, battery storage and excess resale solutions, smart meters (residential, business and grid), private networks, electric vehicle (EV) charging and vehicle-to-grid (V2G) links all have a potential impact on lowering emissions. These are discussed in *Digital technology impact.*

Decarbonisation drivers: non-digital

The phasing out of coal-fired power plants and replacement with renewables and cleaner hydrogen-based fuel ('clean coal') is the largest potential driver of CO_2 reductions in the energy sector. This addresses the main sources of fossil fuel emissions from extraction, refinement and onward use by other industries. Reductions are also needed from reducing methane emissions, which arise mostly from leakages in oil, gas and coal operations.

Fortum, a power operator in the Nordics, also asserts that carbon capture and storage (CCS) is important in sequestering emissions in the upstream portion of electricity production. However, costs are a limiting factor in widescale deployment of CCS, with intense efforts underway to demonstrate viability and consequently increase production volumes.

2. Digital technology impact

With an SES, a digitised network of energy production, distribution and end-customer use is interlinked through IoT sensors, connectivity and analytics. Reductions in carbon emissions come from substitution to wind and solar energy (as well as other renewables), efficiencies in distribution, reduced leakage, and more efficient use of energy by customers with smart meters. Connected solar and wind grids are therefore an integral part of SES that will scale considerably over the coming 10 years. Several other digital technologies are also available. To help understand how these can lead to efficiency and emissions savings, Table 1 provides a selection of use cases.

Table 1

How technology deployment flows through to energy savings

Technology family	Product or service	Mechanism for CO_2 reductions
IoT	Sensors embedded on solar photovoltaic (PV) installations (e.g. a micro grid run by a smallholder or large-scale solar farm) to monitor production and distribution	Avoids fossil fuel-derived emissions (mostly coal) Optimises power consumption at residential and industrial premises by using stored energy (rather than relying on the grid)
	Sensors at grid switching points (could also use LTE or 5G connectivity)	Part of broader SES in which transmission, consumption and redistribution of energy are monitored through a network of sensors and dashboards managed by the grid operator Reduces energy wastage and associated emissions in national or state-level grids through predictive analytics to pre-empt grid supply or capacity crunches
	Management of smallholder or commercial premises battery installations for energy storage and flexibility	Allows for a smoother pattern of consumption at end-user premises (reducing wastage) and the sale of excess power to the grid operator at peak periods
Cellular connectivity (LTE and 5G)	Private networks (or slices)	Service solar grids (could combine with massive IoT deployments), linking back to remote terminal units (RTUs) and the main dashboard to optimise electricity loads and reduce risk of outages Automates power plant operations Full grid network to enable distribution automation. Reduces outages and truck rolls.
	Connected drones	Used to inspect solar/wind farms and power lines to identify defective components or risk factors such as overheating (so-called 'hotspots' on solar panels that lead to leakage) and turbine chinks. Reduces the need for call-outs of engineering teams, often to remote locations.
	Behind-the-meter (BTM) energy management	Increasingly popular model of renewable generation, especially where national supply is low (e.g. India). LTE or 5G connectivity underpins data transfers between renewable generation assets, smart meters and the grid to shift or store excess energy for later use on the grid.
Cloud and analytics	Automated grid function	Connectivity underpins analytics to monitor electricity grid functioning and predictive maintenance on a local or national scale. Reduces truck rolls and associated emissions.
	Forecasting and management of peak demand response	Sensor data from connected assets across a national or local grid and smart meters is processed by AI algorithms in the cloud to enable dynamic shifting of capacity to even out supply This extends to forecasting energy production and consumption, which helps lower the risk of supply and price volatility (as seen in global wholesale gas markets in 2021, for example)
	Asset monitoring and predictive maintenance	The processing of sensor data attached to grid assets (exchange points, solar PV, wind farms) through algorithms to pre-empt repairs and outages, reducing truck rolls and associated emissions

Note: use cases are non-exhaustive to illustrate how technology investments work in parallel with renewable energy to lower energy consumption and emissions

Source: GSMA Intelligence

To help convey practical benefits, below we have expanded on some of the use cases and provided examples of real-world deployments.

IoT sensors

We estimate that around 35% of solar PV grids have IoT connectivity, with the corresponding figure for wind at 10%. These will scale to 75% by 2050, driven by cost reductions from scale economies and proof points of efficiency savings. The examples below illustrate the impact mechanisms in action.

Smart grids

Connected grids rely on sensors fitted to distribution assets and switching points (which could also use LTE or 5G private cellular networks) that underpin data collection and analytics. Renewable grids were historically small in scale (an industrial property or smallholder agricultural installation, for example), but embedded cellular connectivity means these can be scaled to connect across wider areas and ultimately into the national grid.

- Europe (particularly Scandinavia) is the leading region for renewable deployments. **Enel,** the national grid operator in Italy, is retrofitting grids with sensors interconnected with consumer premises and electric vehicles. This offers more efficient electricity distribution and turns consumers and vehicle owners into 'prosumers' – consumers that actively become producers or sellers of a good – who can financially benefit from smarter energy use.
- Wind is slightly less mature than solar, with 10% of wind farms fitted with IoT sensors (turbines or processing). **Siemens** has, for example, integrated IoT sensors on wind turbines from design to enable the monitoring of energy production and digital twins that can be used to pre-empt repairs, saving on call-outs and optimising generation capacity.

Smart meters

Connected meters at end-user premises and grid points are foundational to the working of an SES. Energy consumption for end users can be reduced by accurately tracking daily usage (British Gas reports 5% lower usage for customers with smart meters, for example). Connectivity with the grid also enables the sale of excess energy from residential or commercial premises (such as solar panels on an industrial campus) back to the grid to mitigate peak demand periods and outages.

- **Enexis,** a power group in the Netherlands, can monitor energy usage and distribution in real time for a network of connected residential premises equipped with smart meters (eSIM, upgradable over the air). It passed 2.8 million smart meters in 2020 (around 36% of Dutch households). This leads to reduced energy consumption at the household level and rapidly identifies electricity outages at substations (reducing downtime).

Battery storage and distribution

Batteries are a key means of regulating supply/demand in the grid and provide a cost-effective energy source for commercial premises. Enterprise and residential customers can utilise energy stored during down periods (e.g. wind installations charged overnight) for daylight hours, allowing resale of excess power to the grid, provided the home meter is fitted with connectivity (usually cellular IoT modules running LTE or in some cases GSM).

- **KPN** (Netherlands) has reconfigured some network exchange sites to utilise nickel batteries. Excess power can be distributed as a supplement to, or replacement for, the main grid when capacity is stressed or power outages occur. Battery power is sourced from mains grid and renewable sources (wind and solar farms). Mobile network connectivity underpins data transfer and IoT analytics (such as the prevailing purchase price paid for grid rates or actual transmission load volumes), which can help more accurately forecast future peaks and troughs.

Cellular network connectivity

Cellular connectivity has an array of applications in energy and utility networks. We outline below the key focus areas of private cellular networks, behind-the-meter energy management, and EVs and associated charging infrastructure.

Private networks

Private networks provide high-grade connectivity with guaranteed, or ring-fenced, quality of service (QoS). Private LTE or 5G networks work at point locations as well as distributed grids across a larger range (over 50,000 sq km). The benefits come from monitoring electricity distribution, pre-empting faults and automating grid operations that can be managed from a control centre.

- **Western Power Generation** (WPG), a regional power operator in the UK, partnered with Nokia to deploy a 4.9G private LTE network for grid monitoring via SCADA and voice/data communications across its field footprint, enabling fault identification and more balanced grid distribution.

- **Fortum,** a power plant group in the Nordics, uses sensors and analytics in its power plants to improve operational efficiency. AI allows for massive data ingestion and analytics, improving power plant operational efficiency. The company is also exploring the potential use of 5G.

Behind-the-meter (BTM) energy management
BTM installations produce energy for consumption on a local or industrial premises (such as a factory, campus or farm), usually using solar, wind or other renewable source. This ensures supply for producer operations without full reliance on the grid. Where regulations allow, producers can sell excess power back to the grid (sometimes to a pre-defined limit), helping to manage peak demand response and even out consumption. Coordination between BTM installations and the grid requires assets (e.g. solar PV, smart meter, grid exchange points) to be connected, which can use LTE or 5G connectivity.

- **Verizon** is expanding its Grid Wide product in the US, using LTE connectivity. Smart meters at the residential premises of customers of local or state-level energy suppliers or co-operatives are connected to the grid.

- **Hawaiian Electric Company (HECO)** is using Verizon's Grid Wide as part of its customer grid supply programme. Residential customers with solar PV or battery storage on-site distribute excess energy to the grid. HECO requires a level of control to orchestrate redistribution, which in turn depends on connectivity to monitor consumption levels for each household and the grid in real time.

EVs and charging (vehicle-to-grid; not shown in table)
EVs will be the largest factor in lowering transport-related CO_2 emissions (1 Gt globally or approximately 24% of the reductions needed in the sector over the 10 years to 2030). This depends on the availability of EV charge points and them being linked with EVs and the grid through sensors and connectivity, either LTE or 5G. IoT-enabled telematics in EVs optimise routing and power consumption, notify drivers when in close proximity to charging points and, critically, enable the sale of excess energy back to the grid through vehicle-to-grid connectivity.

- **Tesla,** the world's largest EV maker, has a network of 25,000 charging stations connected to the grid and accessible via a smartphone app. These have always been available to Tesla vehicle owners, but the company is now expanding access to owners of EVs from other automakers that utilise Combined Charging System (CCS) ports, such as Mercedes, Ford and Volkswagen.

- **BP** has developed a charging scheme called Pulse (UK), which facilitates data transfer between EVs and charging stations in close proximity based on when vehicle needs to be recharged, while also allowing vehicle owners to sell excess electricity to the grid.

3. Go to market: opportunities and challenges

Decarbonising global energy production, transmission and consumption is paramount in the global fight against climate change and the transition to a sustainable green economy. While this will require a widescale shift away from fossil fuels to renewables and clean production/refinement processes, the role of connectivity and digital technology is foundational in orchestrating SES.

The main challenges lie in inertia, technical integrations, and reconciling investment costs with payback periods. National utilities are infrastructure-heavy businesses, which take time to integrate new technology into legacy systems – regardless of will or impetus. This can be compounded if the prevailing political environment favours a gradual transition to renewables, particularly where utilities are government owned, or where regulatory systems deter investment. Proof points in the public domain from real-world deployments of digital technology – whether lower energy use or higher distribution efficiency – are crucial but currently lacking. Our analysis indicates that real change can happen with the installation of connected grids, together with other innovations in battery storage, V2G and smart meters. But it requires investment now, even if the time taken to implement means payback periods may be five to 10 years away.

There are opportunities for telcos and vendors from a competitive standpoint. The required scaling up of renewables and consequent decline in cost is at least partly dependent on connectivity to link solar PV and wind farms with the grid, which would supplement existing fibre. While we estimate 35% of solar grids are currently fitted with IoT sensors, this is heavily skewed towards Europe and parts of the US. China, India and other large electricity-consuming nations in Asia have far less renewable capacity.

This will change over the next decade as infrastructure and interconnection expand, helped by a wave of government and private sector investment, higher liquidity in wholesale markets, and availability of forward purchase contracts to mitigate price fluctuations. Almost 75% of the CO_2 savings in energy and utilities by 2030 will come from Asia. This regional pivot is a strategic gap to exploit by telcos in partnership with national grids, regional power operators, and EV makers. Addressing challenges head-on is key; in the case of private networks, these include power autonomy, maintenance scheduling and investment models.

A connected energy grid provides consumers with the opportunity to monetise excess energy, either from their home or EV. This wave of 'prosumers' is likely to be engaged and sticky, providing service upsell for telecoms operators at the residential level and new revenues in the automotive vertical in facilitating V2G connectivity.

Ultimately, the shift to a green economy requires digital technologies and is the key paradigm of this century. The time to act is now.

> "
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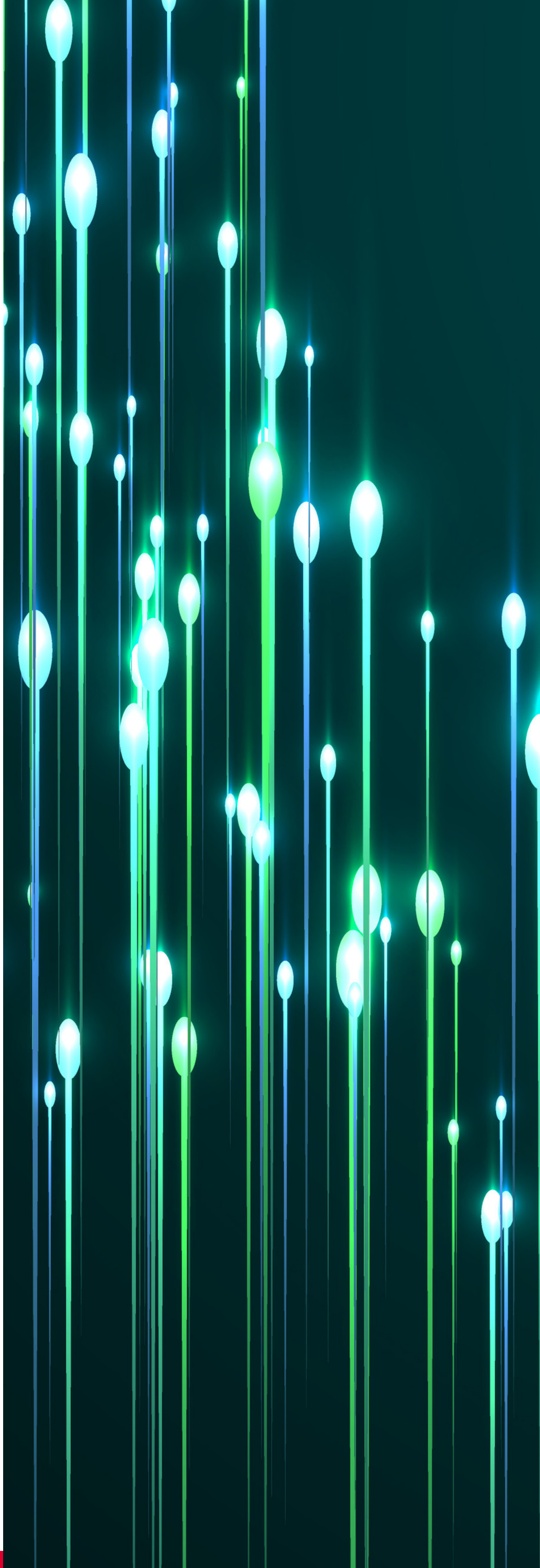

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