Methodology

Buildings, Energy, Manufacturing and Transport sectors research

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Table of Contents

Buildings

Methodology and approach

The buildings sector is split between residential and commercial segments. Four use cases were profiled for technology in support of lowering emissions covering smart electricity meters for households, smart electricity and smart gas meters in offices and industrial premises, and Heating Ventilation and Air Conditioning (HVAC) systems.

There was a three step process.

1. Forecasts were used from Exponential Roadmap[1] to determine the aggregate amount of CO_2 savings a given industry will need to make over the next 10 years to ensure it remains on track for net zero by 2050. For all sectors, this reduction is equivalent to 50% of 2020 CO_2 emissions

2. For each use case, residential and commercial adoption (e.g. the proliferation of a smart gas meter in office buildings) is based on GSMA Intelligence forecasts for IoT connections in the utility and buildings sectors with some adjustments. Then an average energy saving is assumed for homes and commercial premises with a given connected technology compared to those without. Combined with the electricity emission factor, this then yields an abatement factor for each technology that is extrapolated to scale by multiplying with the adoption forecasts.

3. The use case savings over a ten year period are divided into the aggregate sector reduction (from step 1) to arrive at a contribution share

[1] J. Falk, O. Gaffney, et al. Exponential Roadmap. 1.5.1 (2020) www.exponentialroadmap.org

Key assumptions

Use case	Indicator	Trajectory	Supporting data/sources
Smart meter - residential (electricity)	Smart electricity meters	Assume 80% of smart meter connections are residential. This figure is applied to GSMA Intelligence IoT forecasts for smart meters	GSMA Intelligence
Smart meter - residential (electricity)	Energy savings for smart meter households	Assume average household with smart meter uses 3% less energy per year than those without the technology. This savings is applied to each region. Various studies have estimated energy savings to range between 3-15% for smart meter households. We assume a figure of 3% to be conservative	Various
Smart buildings - commercial (electricity)	Energy savings	Assume electricity savings of approx. 10-15% in buildings fitted with smart electricity meters based on range of studies	Various
Smart buildings - commercial (gas)	Energy savings	Assume gas savings of approx. 20-25% in buildings fitted with smart gas meters based on range of studies	Various
HVAC	Energy savings	Assume energy savings of approx. 15% in buildings and other enterprise settings fitted with HVAC units. This is at the low end of studies which range from 15-30% savings	Various

Source: GSMA Intelligence & The Carbon Trust

Energy Sector

Methodology and approach

Two primary use cases for digital tech interventions in the power and energy sector were analysed, both of which are underpinned by IoT sensors and connectivity.

- ***Connected solar grids***. Connected power grids to manage and distribute solar energy. Grids are equipped with IoT sensors that, in turn, connect to a mobile network, cloud and/or end user premises (residential or commercial) through cellular or non-cellular protocols
- ***Connected wind grids***. Connected power grids to manage and distribute wind energy. Grids are equipped with IoT sensors that, in turn, connect to a mobile network, cloud and/or end user premises (residential or commercial) through cellular or non-cellular protocols

There was a three step process:

4. Forecasts were used from Exponential Roadmap[2] to determine the aggregate amount of CO_2 savings a given industry will need to make over the next 10 years to ensure it remains on track for net zero by 2050. For all sectors, this reduction is equivalent to 50% of 2020 CO_2 emissions

5. For both use cases – connected solar and wind grids – estimations were made for the share of the renewable energy grids that are IoT connected at present and over the next 30 years to 2050, drawing on our proprietary IoT forecasts and publicly available research. This translates into an overall level of avoided CO_2 emissions through the substitution with fossil fuels that would otherwise emit carbon into the atmosphere

6. The use case savings over a 10 year period are divided into the aggregate sector reduction (from step 1) to arrive at a contribution share (e.g. connected solar grids can account for 33% of the emission reductions required in the power sector over the next 10 years)

[2] J. Falk, O. Gaffney, et al. Exponential Roadmap. 1.5.1 (2020) www.exponentialroadmap.org

Key assumptions

Use case	Indicator	Trajectory	Supporting data/sources
Connected grid - solar	PV capacity growth	Annual net increase in solar PV capacity in 2020 applied for remainder of forecast period to 2030 at regional level	International Energy Agency (IEA)
Connected grid - solar	% of solar grid connected with IoT sensors	35% in 2020, rising to 75% in 2050 in straight line fashion	IEA, GSMA Intelligence
Connected grid - solar	Electricity emission factors (EEFs)	2019 base year EEFs calculated at regional level. Forward projections to 2030 for each region based on growth rate of UK EEF forecasts from UK Department of Business, Energy and Industrial Strategy (BEIS)	Carbonfootprint.com; IEA; UK BEIS
Connected grid - wind	Wind capacity growth	Wind capacity growth calculated by Global Wind Energy Council (GWEC) for 2019 and 2020. Assume annual growth of 4.5% from 2020-25 before reducing to 2% from 2025-50	GWEC
Connected grid - wind	% of wind grid connected with IoT sensors	10% in 2020, rising to 75% in 2050 in straight line fashion	GWEC, GSMA Intelligence
Connected grid - wind	Electricity emission factors (EEFs)	2019 base year EEFs calculated at regional level. Forward projections to 2030 for each region based on growth rate of UK EEF forecasts from UK Department of Business, Energy and Industrial Strategy (BEIS)	Carbonfootprint.com; IEA; UK BEIS

Source: GSMA Intelligence & The Carbon Trust

Manufacturing Sector

Methodology and approach

The manufacturing sector centres on the development of smart factories. There are several types of technologies within a smart factory that can improve productivity, lower energy consumption and reduce CO_2 emissions. Factories are fitted with connected technology and networks to improve overall productivity via automation. IoT sensors are typically fitted to machinery, which can be linked back to analytics suites to analyse very large streams of data in real time. This allows for production capacity to be shifted dynamically and faults to be repaired remotely.

There was a three step process.

1. Forecasts were used from Exponential Roadmap[3] to determine the aggregate amount of CO_2 savings a given industry will need to make over the next 10 years to ensure it remains on track for net zero by 2050. For all sectors, this reduction is equivalent to 50% of 2020 CO_2 emissions

2. Assumptions were made for how much of manufacturing IoT connections are set in factories specifically. An average rate of energy savings per year is then applied to the number of smart factories and combined with the electricity emission factors to calculate a total CO_2 savings associated with smart factories in each region

3. The use case savings over a 10 year period are divided into the aggregate sector reduction (from step 1) to arrive at a contribution share

[3] J. Falk, O. Gaffney, et al. Exponential Roadmap. 1.5.1 (2020) www.exponentialroadmap.org

Key assumptions

Vertical	Use case	Indicator	Trajectory	Supporting data/sources
Manufacturing	Smart factories	Number of smart factories	Total factories in operation worldwide estimated at 9.6 million as of 2020. Using the average IoT density figures, an estimate of 130,000 smart factories were in operation as of 2020, or 1.4% of the global total	WEF, China Statistical Yearbook
Manufacturing	Smart factories	IoT proliferation	Assume approx. 420 million IoT connections in smart factories worldwide as of 2020, rising 40% per year to 2.1 billion by 2030	GSMA Intelligence
Manufacturing	Smart factories	Energy savings	Assume energy savings of 15% per year on average for smart factories	Bosch, Nokia (Oulu factory)

Source: GSMA Intelligence & The Carbon Trust

Transport Sector

Methodology and approach

Four use cases for transport-related technology were analysed that covers connected fleets (Heavy goods vehicles (HGV) and maritime), electric vehicles (EVs), and working from home – an indirect but nevertheless material carbon saving from the reduction in commuting journeys.

There was a three step process:

1. Forecasts were used from Exponential Roadmap[4] to determine the aggregate amount of CO_2 savings a given industry will need to make over the next 10 years to ensure it remains on track for net zero by 2050. For all sectors, this reduction is equivalent to 50% of 2020 CO_2 emissions

2. In each of the fleet management categories – HGVs and commercial shipping – assumptions were made on the level of telematics penetration and resulting fuel savings before extrapolating to a regional level. For EVs, a figure was estimated for current EV charging points, forecasted forward, and then fuel savings and associated CO_2 reductions were calculated based on the reduction in journeys using petrol and diesel cars. Working from home (WFH) uses estimates for the average WFH days per year per eligible worker, alongside GSMA forecasts for mobile and fixed line internet access in households as a pre-requisite for productive remote working

3. The use case savings over a 10 year period are divided into the aggregate sector reduction (from step 1) to arrive at a contribution share

[4] J. Falk, O. Gaffney, et al. Exponential Roadmap. 1.5.1 (2020) www.exponentialroadmap.org

Key assumptions

Vertical	Use case	Indicator	Trajectory	Supporting data/sources
Transport	EV's	EV charging points	Assume that EV charge points represent 1% of smart city IoT connections in 2021, rising to 10% by 2030	GSMA Intelligence, Machina
Transport	EV's	Electricity consumption	A total of approx. 3700 kWh is used per charge point per year	Various
Transport	EV's	Electricity emission factors (EEFs)	2019 base year EEFs calculated at regional level. Forward projections to 2030 for each region based on growth rate of UK EEF forecasts from UK Department of Business, Energy and Industrial Strategy (BEIS)	IEA; UK BEIS; carbonfootprint.com
Transport	Smart routing and fleet management (HGVs)	HGVs in operation	Of the approx. 360 million commercial vehicles in use, we assume that 60 million (17%) are HGVs. Of these, we assume 50% are fitted with IoT telematics sensors, equating to 30 million connected HGVs	GSMA Intelligence, Statista
Transport	Smart routing and fleet management (HGVs)	Fuel savings	Assume an average 5% fuel savings for connected HGVs based on range of studies reporting figures 5-20%	Various
Transport	Smart routing and fleet management (maritime)	Shipping emissions	An average of 17,700 kg CO_2 per ship per year is derived from estimates for total ships in operation and associated aggregate fuel consumption using data from the IMO	International Maritime Organisation
Transport	Smart routing and fleet management (maritime)	Fuel savings	Assume an average 2% fuel savings for commercial ships fitted with IoT telematics sensors	Carbon Trust

Transport	Working from home (WFH)	Workforce enabled to work from home (WFH)	Annual FTE days WFH estimated based on propensity for certain occupations to WFH, with a downward adjustment to be conservative	McKinsey
Transport	Working from home (WFH)	Employed population	Assume 70% of the working age population in each region is employed	World Bank
Transport	Working from home (WFH)	Internet connectivity	LTE and forecast 5G mobile subscribers taken as proxy for having internet access of a sufficient quality to permit WFH	GSMA Intelligence

Source: GSMA Intelligence & The Carbon Trust

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