Mobile's Green Manifesto 2012

Contents

Introduction

In November 2009 the GSMA, together with the Climate Group, published *Mobile's Green Manifesto* which set out how the mobile industry planned to lower its greenhouse gas emissions per connection, and demonstrated the key role that mobile communications can play in lowering emissions in other sectors and industries. It also made specific policy recommendations for governments and the United Nations Climate Change Conference in Copenhagen, including the 15th Conference of the Parties (COP15), in order to realise the full potential of mobile communications' ability to enable reductions in global greenhouse gas emissions.

Shortly after the publication of *Mobile's Green Manifesto* in 2009, the GSMA set up a programme called Mobile Energy Efficiency (MEE) to help the industry measure and manage its own emissions. This document highlights the initial results from MEE as well as progress around mobile's enabling role.

As part of *Mobile's Green Manifesto* the industry stated: "the mobile industry forecasts that it will reduce its total global greenhouse gas (GHG) emissions per connection[1] by 40% by 2020 compared to 2009. This forecast covers all emissions from energy sources under the control of the mobile operators, including energy consumption from the radio network, buildings' energy consumption and emissions from transport".

Approximately 80% of the energy consumption and GHG emissions of mobile operators is from their networks, so the emphasis of this paper is on networks.

[1] Connections do not include machine-to-machine SIMs

Executive Summary

Mobile's recent energy and emissions performance

The mobile telecom industry is taking significant steps towards understanding and managing its own energy consumption and GHG emissions. Thirty-five mobile operators, accounting for over 200 networks and over 50% of mobile industry subscribers, are taking part in the GSMA's MEE Benchmarking which helps mobile operators measure and manage their network energy and emissions. Additionally many mobile operators take part in the Carbon Disclosure Project[2] and many publish their own targets around energy consumption and GHG emissions.

The increased focus by mobile operators on energy and carbon management has been making an impact. Analysis of 34 mobile networks[3] worldwide showed that, despite considerable growth in connections and traffic, their total network energy consumption increased only slightly from 2009 to 2010. The analysis also shows that the total energy per unit traffic declined by approximately 20% and energy per connection declined by 5% over this period, indicating that the industry is making strong progress towards its goal of reducing its total global greenhouse gas emissions per connection by 40% by 2020.

The data and analysis from the GSMA's MEE Benchmarking service has been used to calculate both the energy costs and the carbon dioxide equivalent (CO_2e) emissions that result from the electricity and diesel consumption of mobile networks[4] globally. Network electricity and diesel energy costs[5] have been estimated for different regions of the world and the resulting global total for 2010 is approximately $13 billion[6]. The MEE Benchmarking analysis shows that if all networks with above average energy consumption are improved to the industry average, this implies a potential energy cost saving for mobile operators of $1 billion per annum at 2010 prices. Improving to the top quartile saves potentially over $2 billion annually although not all of the potential savings will be cost-effective for mobile operators to implement.

GHG emissions of the mobile telecoms industry are low compared to other industries. Network CO_2e emissions[7] have been estimated for different regions of the world and the resulting total of approximately 70 million tonnes (Mt) for 2010 is less than 0.2% of the global total, lower than the country emissions of Austria[8], and approximately equivalent to the CO_2e emissions of seven two-gigawatt (GW) coal-fired power stations. This is the first detailed global estimate of mobile network energy consumption and CO_2e emissions. Although

[2] An independent not-for-profit organisation working to drive GHG emissions' reduction and sustainable water use by business and cities

[3] Consisting of 16 from developed countries and 18 from emerging countries

[4] Mobile networks are defined as the Radio Access Network plus the mobile elements of the Core Network. Energy consumed by IT systems (including data centres) and overheads is excluded as it is much smaller and also harder to benchmark

[5] Energy costs consist of electricity and diesel, but exclude costs associated with acquiring batteries, diesel generators and their maintenance, or up-front costs of grid connection

[6] Other estimates are higher at $20 billion. The $13 billion may underestimate local diesel prices, especially delivery costs, and this needs further investigation

[7] Scope 1 and Scope 2

[8] http://unfccc.int/ghg_data/ghg_data_unfccc/time_series_annex_i/items/3841.php

difficult to compare with the results of the *SMART 2020* report, which combines fixed and mobile networks, the GSMA's analysis suggests that the *SMART 2020* figures are too high. The GSMA intends to use the same methodology to calculate CO_2e emissions for future years, enabling performance to be tracked over time.

Mobile's enabling role

The mobile industry today is enabling significant reductions in CO_2e emissions and energy costs across a range of sectors of the economy, and the opportunity exists for mobile to enable a great deal more savings. These savings come from smart applications, often as a result of machine-to-machine (M2M) communications, and dematerialisation where travel, products and processes are substituted by virtual alternatives. The potential of smart mobile applications lies mainly in smart grids and smart meters, and smart transportation and logistics. As a whole, the mobile industry has the potential to contribute to an abatement of man-made GHG emissions that is at least four to five times its own carbon footprint.

Presently there are approximately 26 million mobile M2M connections that are enabling GHG emissions savings, estimated to be about three million tonnes (Mt) of CO_2e annually, which is just less than the emissions of Iceland[9]. The US and Canada accounts for 38% of GHG emissions savings and 50% of mobile M2M connections, Asia Pacific 30% of emissions savings and 23% of connections, and Western Europe 23% of GHG savings and 17% of connections. Global mobile M2M connections in smart grids, smart meters and fleet management are forecast to grow strongly, at 30 to 40% per annum, resulting in approximately 100 million mobile M2M connections in these areas worldwide by 2015. This translates into possible GHG savings enabled by mobile M2M connections of 18 Mt CO_2e, the equivalent of taking more than four million cars off the road[10]. Further mobile-enabled emissions savings will result from dematerialisation.

However, mobile has the potential to enable much greater emissions savings, or at least 900 Mt CO_2e in 2020, which is 1.7% of the global 2020 GHG emissions forecast by the International Energy Agency (IEA) in its "business-as-usual" scenario. Emissions savings in 2020 will result from the use of about 3.5 billion mobile M2M connections and also from mobile dematerialisation applications. This presents a significant environmental and commercial opportunity for mobile operators to help companies in other sectors and industries reduce their GHG emissions and cut energy costs.

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[9] Note that the emissions from the M2M connections themselves will be very low

[10] Assuming annual emissions per car of 4 tonnes of CO_2e

Chapter 1: Mobile's Energy Consumption and Greenhouse Gas Emissions

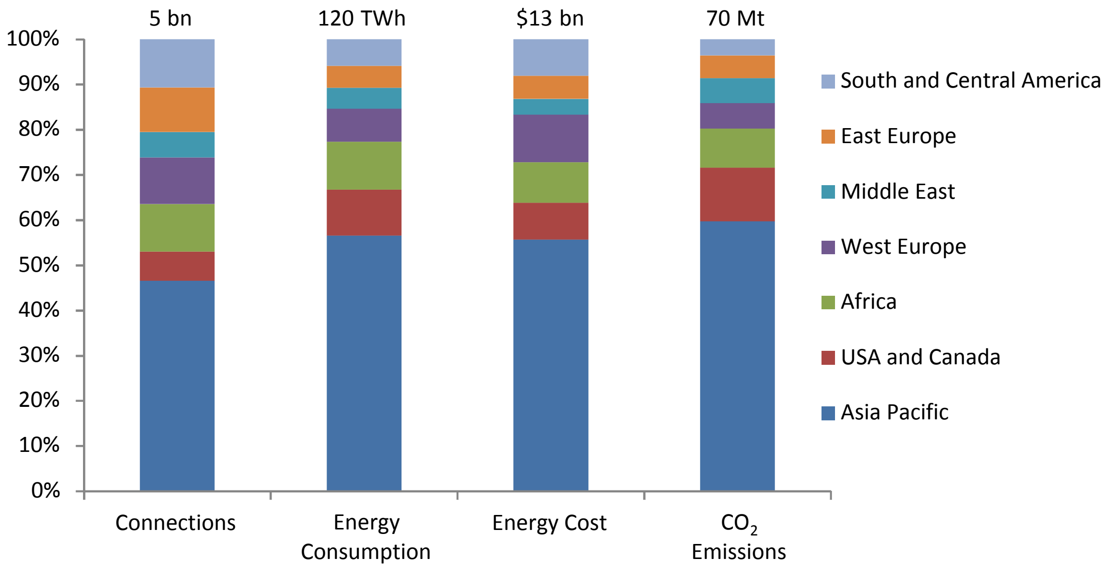
Introduction

The data and analysis from the GSMA's Mobile Energy Efficiency (MEE) Benchmarking service[11] has been used to calculate both the energy costs and the corresponding carbon dioxide equivalent (CO_2e) emissions[12] that result from the electricity and diesel consumption of mobile networks[13] globally. Actual data has been used for networks participating in the benchmarking, and estimations used for the remainder.

Energy cost and greenhouse gas emissions of mobile networks

Total global electricity and diesel energy consumption by all mobile networks was approximately 120 terawatt hours (TWh) in 2010, resulting in energy costs of $13 billion and responsible for 70 Mt CO_2e. Almost 80 TWh of the energy consumption was from grid electricity, and just over 40 TWh was from the calorific value of the diesel used to power generators used in off-grid and unreliable grid locations. The 40 TWh from diesel corresponds to about 8 TWh of electricity generated, given a typical generator efficiency of 20%.

Figure 1: Mobile network connections[14], electricity and diesel consumption, energy cost and CO_2 emissions by region[15]



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[11] www.gsma.com/mee

[12] Note these are "use stage" carbon emissions rather than life cycle

[13] Mobile networks are defined as the Radio Access Network plus the mobile elements of the Core Network. Energy consumed by IT systems and overheads is excluded as it is much smaller and also harder to benchmark

[14] A connection is defined as the total number of SIMs or, where SIMs do not exist, a unique mobile telephone number that has access to the network for any purpose (including data only usage), except telemetric applications. SIMs that have never been activated and SIMs that have not been used for 90 days are excluded. Total number of SIMs includes wholesale and Mobile Virtual Network Operator (MVNO) SIMs but excludes mobile machine-to-machine (M2M) connections

[15] Source: GSMA's Mobile Energy Efficiency Benchmarking analysis

Just over half of the energy consumption, costs and CO_2e emissions come from networks in the Asia Pacific region (Figure 1), mainly as a result of the high number of customers there, as measured by connections. Approximately 45% of the energy costs, 50% of the energy consumption, and 55% of the CO_2e emissions from mobile networks come from three countries: China, India and the USA, which together account for 35% of global connections.

The differences between connections, energy consumption, energy cost and CO_2e emissions by region arise for a number of reasons. In particular, the USA has much higher average mobile phone usage per customer than most other countries, and this translates directly into a higher energy per connection, as shown in Figure 2. Differences between energy consumption and energy cost result mainly from two factors. First, some regions of the world lack electricity grids outside urban areas, or have unreliable electricity grids, and so diesel generators are traditionally used to power off-grid cell sites. Diesel generators typically generate electricity with only 20% efficiency, and using diesel is more expensive than using grid electricity, especially when the cost of delivering the diesel is also factored in[16]. Second, both electricity costs and diesel costs vary considerably by country primarily as a result of different generation and logistics costs, and taxation policies.

Differences between energy consumption and CO_2e emissions occur partly because the use of diesel varies by region. A further reason is the grid electricity generation mix: countries that generate electricity primarily from coal will have a higher CO_2 emission factor than those that use more nuclear fuel, natural gas or renewable energy.

Differences in energy consumption, energy cost and CO_2e emissions per connection by region, as well as regional energy cost and CO_2 emission factors can be seen in Figure 2.

Figure 2: Mobile network electricity and diesel consumption and CO_2 emissions per mobile connection, combined electricity and diesel cost factors, and CO_2 emission factors[17]

	Metrics per mobile connection[18]			*Drivers*	
Region	**Energy use kWh/ connection**	**Energy cost $/ connection**	**CO_2 emissions kg CO_2/ connection**	**Energy cost $/kWh**	**CO_2 factor t CO_2 / MWh**
Africa	24.4	2.2	11.1	0.09	0.5
South and Central America	13.3	1.9	4.6	0.15	0.3
Asia Pacific	29.3	3.0	17.6	0.10	0.6
East Europe	12.0	1.3	7.0	0.11	0.6
West Europe	17.1	2.6	7.6	0.15	0.4
Middle East	19.7	1.6	13.5	0.08	0.7
USA and Canada	38.0	3.2	25.3	0.09	0.7
Total	24.1	2.6	13.7	0.11	0.6

16 This analysis includes an estimate for logistics costs, but excludes the capital cost of diesel generators and their maintenance

17 Source: GSMA's Mobile Energy Efficiency Benchmarking analysis. The CO_2 emission factors are average emission factors for grid electricity per unit secondary energy and diesel per unit primary energy

18 Energy use is electricity and diesel consumption

The MEE Benchmarking service can also be used to estimate potential energy savings available from networks that are "under-performing" in terms of energy efficiency[19]. The MEE analysis shows that the bottom quartile of networks, ranked according to energy efficiency, could on average save 20% of their energy costs per annum if performance is improved to the sector average, and more than 35% if performance is improved to top quartile. If all networks with above average energy consumption are improved to the sector average, this implies a potential energy cost saving for mobile operators of $1 billion per annum at 2010 prices; if all are improved to the top quartile this implies a potential cost saving of over $2 billion annually. However, not all of this cost saving is likely to be cost-effective, and much of it will require investment in solutions, including:

- Cooling: increase free cooling, increase number of outdoor versus indoor sites, or use temperature resistant batteries
- Energy efficiency of network equipment: upgrade to more efficient rectifiers
- Diesel: reduction in diesel consumption, e.g. by generator-battery hybrids
- Network operation: activate more energy saving features
- Network design: technology swap, e.g. replace 2G/3G equipment with LTE only or implement "Single RAN Kits" which are LTE+3G+2G capable using the same hardware
- Site sharing: increase shared sites. However this has wider commercial implications.

These energy cost reduction initiatives will also reduce CO_2 emissions, as will the increasing use of renewable energy, especially solar, to power off-grid or intermittent grid cell sites.

To help realise these cost savings, the GSMA launched MEE Optimisation, a service which develops action plans to reduce network energy costs and GHG emissions in under-performing networks. The service is run in partnership with a third party, e.g. a vendor or systems integrator, and it identifies individual energy saving measures and assesses the business case for each. MEE Optimisation has recently completed a successful first project with Telefónica Germany, with the assistance of Nokia Siemens Networks, which identified annual energy cost savings of more than $2 million with paybacks of nine to 30 months[20].

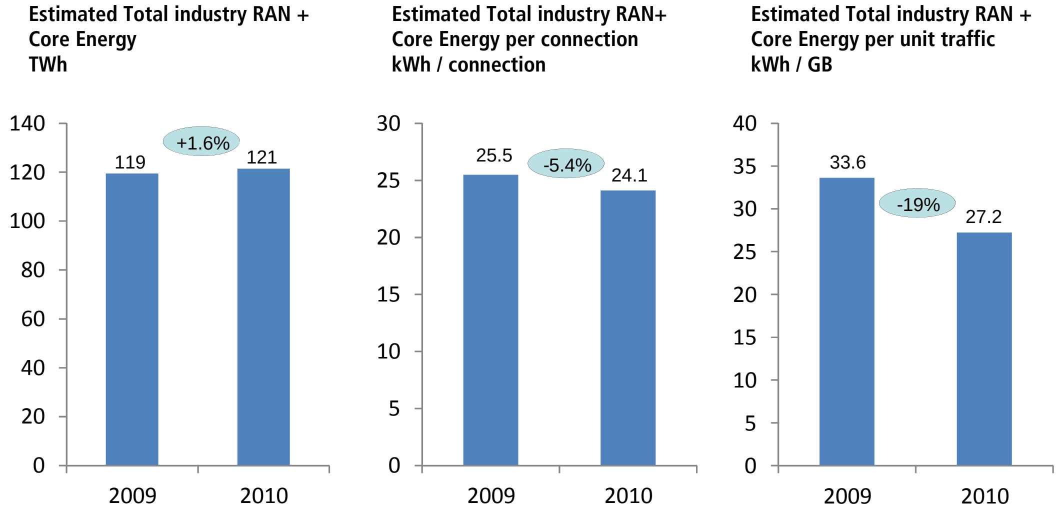
Comparison of network energy consumption and GHG emissions from 2009 to 2010

An analysis of detailed energy data of 34 networks, consisting of 16 from developed countries and 18 from emerging countries, suggests that their total network energy consumption increased slightly from 2009 to 2010 and declined significantly on a per connection and per unit traffic basis. Figure 3 shows this scaled up for the entire industry.

[19] Networks are analysed based on energy per connection, per cell site and per unit traffic. The results for each network are normalised for differences such as temperature, population density, traffic, etc., using multi-variable regression analysis. This allows high and low energy networks to be identified and their performance to be compared

[20] For more information, including a case study, see www.gsma.com/mobile-energy-efficiency-optimisation

Figure 3: Change in mobile network electricity and diesel consumption from 2009 to 2010[21]



Energy per unit traffic for this sample of 34 networks declined by approximately 20% from 2009 to 2010, despite growth in mobile connections of 7%[22]. The sample's growth in connections is less than the total industry growth of 16% so the sample may not be strictly representative, but it does indicate that growth in the mobile industry's total energy consumption is low at present and is strongly decreasing on a per unit basis.

Methodology

The GSMA's calculations of carbon intensity[23] of mobile telecommunication networks used for the MEE service have passed independent review by the Carbon Trust[24]. The estimated CO_2e emissions by region calculated using this methodology are likely to be accurate to within 10%, although the accuracy is slightly less in the USA and India[25]. Certain operators publish CO_2e emissions data by network and this has been used to cross-check the results.

Detailed in-use mobile network energy consumption data has been gathered for approximately 100 of the mobile networks owned by 35 mobile operators. This information, combined with the MEE normalisation methodology, is used to estimate the energy consumption, split between electricity and diesel, globally for all other operators. The MEE normalisation methodology uses regression analysis and involves estimating operators' network energy consumption[26] as a function of their number of connections, temperature

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[21] Source: GSMA's Mobile Energy Efficiency Benchmarking analysis

[22] GSMA's Wireless Intelligence

[23] Note that this refers to carbon emissions for the "use stage", rather than full life cycle

[24] The Carbon Trust is a not-for-profit company with the mission to accelerate the move to a low carbon economy. See www.carbontrust.co.uk

[25] No US operators participate in MEE Benchmarking so estimates are used; the split between electricity and diesel in India needs further refining

[26] Mobile network energy consumption is defined as energy consumed by the Radio Access Network plus the mobile elements of the Core Network. Energy used by IT systems (including data centres) and overheads is excluded as it is much smaller and also harder to benchmark

(measured by cooling degree days), the amount of voice traffic, the percentage of connections that are 3G (used as a proxy for data traffic), the geographic area covered, and the extent to which customers are prepaid or contract. This is the first detailed global estimate of mobile network energy consumption and CO_2e emissions. The GSMA's MEE Benchmarking methodology has been included in a global standard by the International Telecommunication Union (ITU), namely Recommendation ITU-T L.1410 'Methodology for Environmental Impact Assessment of Information and Communication Technologies (ICT) Goods, Networks and Services'.

The network energy consumption of all the operators is then converted to CO_2e emissions by using standard grid electricity emission factors for each country (sourced from the Carbon Trust), power losses from transmission and distribution (sourced from the World Bank), average diesel generator efficiency (agreed by operators participating in MEE Benchmarking)[27] and a diesel emission factor (also sourced from the Carbon Trust).

Electricity and diesel cost data has been provided by many of the 100 networks. This, combined with databases of electricity and diesel costs by country[28], has been used to translate the energy consumption into an estimate of energy cost.

Comparison with previous publications

The GSMA's calculation of energy consumption of mobile networks is difficult to compare with the results of the *SMART 2020*[29] report published by the Global e-Sustainability Initiative (GeSI) and the Climate Group in 2008, which combines fixed and mobile networks. The GSMA's analysis suggests that the *SMART 2020* figures are too high. The *SMART 2020* report makes the simple assumption that annual network energy consumed per telecom subscriber is 50 kWh[30] for both mobile and fixed, sourced by averaging eight mobile and fixed operators' data. This is considerably higher than the 24 kWh calculated by the GSMA for mobile, indicating that the *SMART 2020* mobile footprint calculation was over-stated.

Next steps

As more operators join the GSMA's MEE benchmarking service, the accuracy of the estimations of total mobile network energy consumption, energy cost and CO_2e emissions can be improved and the results used to track industry performance over time.

The GSMA will continue to collaborate with regulators and standards bodies to ensure MEE Benchmarking methodology, already included in a global standard by the ITU, fits with other methodologies developed by the global ICT industry. Future development may include life cycle assessment of energy and carbon emissions based on an approach agreed by operators and manufacturers.

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[27] The MEE Benchmarking analysis assumes an average diesel generator efficiency of 20%

[28] Various sources including International Energy Agency (IEA), Eurostat and Deutsche Gesellschaft für Internationale Zusammenarbeit

[29] *SMART 2020 – Enabling the low carbon economy in the information age*, GeSI and the Climate Group, 2008

[30] See note 42 on page 25 of the *SMART 2020* report. The difference with the GSMA's figure is actually even higher as *SMART 2020*'s figure is only for electricity and excludes diesel

Chapter 2: Enabling Impact of Mobile

Introduction

Smartphones, tablets, consumer electronics and machine-to-machine (M2M) devices are beginning to connect everything from cars to health services and even entire cities[31], which will have a positive impact on many industries. Through some of these developments, the mobile industry today is enabling significant reductions in GHG emissions and energy costs across a range of sectors of the economy, and the opportunity exists for mobile to enable a great deal more savings. These savings come from smart applications, often as a result of mobile M2M communications, and dematerialisation where travel, products and processes are substituted by virtual alternatives. The potential of smart applications lies mainly in smart grids and smart meters, and smart transportation and logistics. As a whole, the mobile industry has the potential to enable a reduction in man-made GHG emissions that is much greater than its own direct emissions.

The areas where the mobile industry has the greatest potential to enable the reduction of GHG emissions and energy costs are in smart grids and smart meters, smart transportation and logistics, smart buildings, and dematerialisation[32].

Smart grids and smart meters

Mobile M2M-connected devices can help utilities reduce network transmission losses by monitoring the transportation and distribution elements of the electricity network. Smart meters can help with micro-generation for buildings by enabling renewable electricity generated by consumers and small businesses to be sold back to utility companies for local distribution. Smart metering can also help optimise loading of the electricity grid, simply through provision of information which enables end users to better manage their consumption[33].

There is a reasonable degree of dependence of smart meters on mobile connections as approximately 20%[34] of smart meters are connected directly to a central system via a mobile network[35]. Indirectly, mobile is also crucial to smart metering as it is a typical element in the support of alternative connection technologies such as power line communication.

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[31] See the GSMA's Connected Living programme at www.gsma.com/connectedliving for more detail

[32] Source: *Mobile's Green Manifesto*, 2009. Smart manufacturing has been omitted because its carbon abatement potential is forecast by Vodafone's *Carbon Connections: Quantifying mobile's role in tackling climate change*, July 2009, to be less than 2% in EU25. It is also likely to be small in other parts of the world.

[33] Note: much of the same ICT infrastructure can be used for peak shaving in district heating and cooling systems. This is not considered in this report

[34] Source: Machina Research

[35] Excludes data concentrators

Smart transportation and logistics

Wireless tracking devices fitted to vehicles can enable fleet logistic operations to be run more efficiently, reducing energy consumption and GHG emissions. These tracking devices can feed data to centralised fleet management software or to other vehicles in the fleet. They can also be used to remotely monitor loading capacities in addition to location, enabling loading optimisation. Further benefits can arise in "smart cities" where wireless devices can be used in applications such as traffic volume monitoring, connected road signs and traffic light synchronisation.

Smart buildings

Mobile connections, including M2M, can enable the optimisation of building technologies such as building management systems, heating, ventilation and air-conditioning (HVAC) systems, and lighting. Building occupiers and facility managers are able to control building HVAC, lighting and other building technologies remotely, using mobile devices, e.g. heating can be switched off remotely with a mobile device should the plans of the occupier change and he or she returns home later than expected.

Dematerialisation

Mobile technology can enable the substitution of physical products and activities with virtual alternatives. The main energy and GHG savings here arise from wireless technology facilitating remote or smart working, which both reduces travel and cuts office infrastructure requirements. Also, near field communications may result in GHG savings through increased growth in electronic payments, reduced cash processing and card manufacturing; and decreased use of paper for tickets, coupons and receipts.

Current mobile enabled emissions reductions and 2015 forecast

Mobile enabled emissions reductions are starting to take off and are forecast to grow 30 to 40% per annum until 2015[36]. The M2M market as a whole has shown rapid growth recently, although from a small base. Global mobile M2M connections grew by 45% from 2010 to 2011 for the top nine mobile operators, according to Machina Research.

The total global market for mobile M2M connections in 2011 is approximately 100 million[37]. Of these, 74 million are in applications which are unlikely to reduce GHG emissions, such as consumer telematics in vehicles[38]. However, approximately 26 million mobile M2M connections (Figure 4) are in smart grids and smart meters, and smart transportation and

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[36] Yankee Group 2011 and Machina Research. Disagreement between data sources for 2011 figures mean that a more closely defined growth rate forecast is not possible

[37] The Yankee Group estimates approximately 100 million mobile M2M connections in 2011, excluding connected consumer electronic devices (e.g., tablets, e-readers, connected TVs) and connections used for military purposes. Pyramid Research estimates that there were 72 million mobile M2M connections in 2010, it forecasts 280 million in 2016, which at a Compound Annual Growth Rate (CAGR) of 26% gives 90 million in 2011, so approximately the same as Yankee

[38] These provide benefits which are unlikely to save GHG emissions, including faster delivery of medical care and recovery of vehicles in the event of an accident; real-time navigation, road and weather information; early warning of potential mechanical or electrical problems; ability to locate missing and stolen vehicles; easy access to information on local amenities; and on-demand videos, television, music, social networking and Internet access

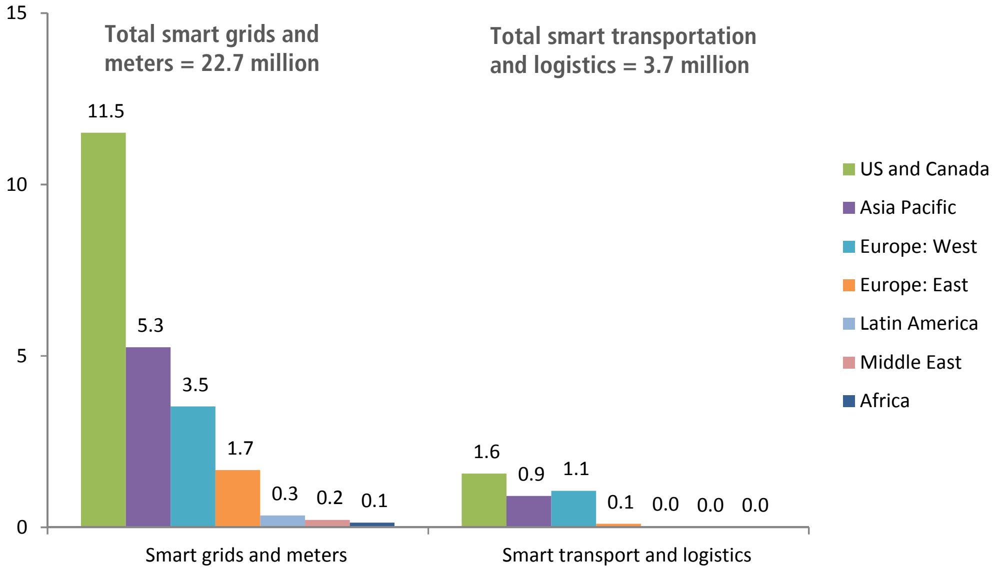
logistics where GHG emission reductions are enabled. The enabled emissions reductions are estimated at 3 Mt CO_2e globally in 2011 (Figure 5). As far as the GSMA is aware, this is the first attempt to quantify current global mobile-enabled GHG emissions reductions. We believe that mobile enabled reductions in smart buildings are small in 2011. Data for dematerialisation is not available but we believe that this is also small at present.

Figures 4 and 5 show that a much greater GHG saving per mobile M2M connection may be achieved from smart transportation and logistics compared to smart grids and smart meters. The ratios are 0.5 and 0.05 t CO_2e per mobile M2M connection respectively which are based on estimates from Vodafone's *Carbon Connections*[39] report applied to 2011.

The largest market is the US and Canada with 38% of GHG emissions savings, accounting for 50% of M2M connections, followed by Asia Pacific with 30% of emissions savings, accounting for 23% of connections.

The emissions from mobile networks' use globally were approximately 70 Mt CO_2e in 2010 and the total in use emissions from mobile operators 90 Mt CO_2e, according to GSMA estimates. Therefore, the mobile industry is currently enabling GHG savings in other sectors of approximately 5% of its own absolute direct network emissions. Although this is a small number, mobile enabled GHG savings in other sectors and industries are forecast to grow rapidly and take significant steps towards realising mobile's full potential.

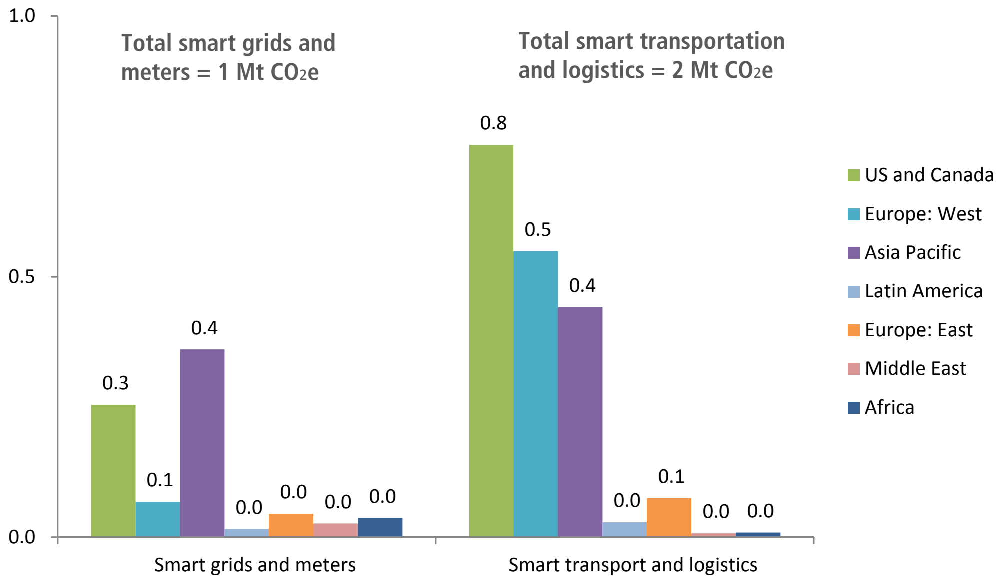
Figure 4 – Estimated mobile M2M connections in smart grids and smart meters, and smart transportation and logistics, million connections, 2011[40]



[39] Vodafone, *Carbon Connections: Quantifying mobile's role in tackling climate change*, July 2009

[40] Source: Machina Research. Note: smart metering connections only includes mobile enabled M2M connections and excludes data concentrators

Figure 5 – Estimated GHG savings in smart transportation and logistics, and smart grids and smart meters, Mt CO_2e, 2011[41]



Global mobile M2M connections will grow by approximately 25% per annum to reach 245 million connections by 2015, according to Yankee Group. Smart grids and smart meters are forecast to grow at 30 to 40% per annum to reach 85 million connections worldwide by 2015, and fleet management, the major driver of emissions reductions in smart transportation and logistics, is expected to grow at the same rate to reach 15 million[42]. This equates to an upper estimate of 18 Mt CO_2e of mobile-enabled emissions reductions in 2015, up from 3 Mt CO_2e in 2011.

Green mobile apps can be an important tool to help promote a low carbon economy, and there have been recent efforts to increase development of these apps, e.g. the Green ICT Hackathon at Mobile World Congress 2012 and the 2nd Green ICT Application Challenge, both supporting sustainable energy use[43].

Mobile enabled emissions reductions in 2020

Much of the published quantification of enabled emissions savings, e.g. in the *SMART 2020* reports and SK Telecom's Social GHG Abatement report, focuses on ICT rather than just

[41] Source: IEA and GSMA analysis. Note: the 3 Mt CO_2e total emission savings figure and its components are estimates. For smart grids and meters, the GHG figures by region are calculated using the ratios of CO_2e emissions reductions to required M2M connections, as per the EU25 focused Vodafone *Carbon Connections* report, by sub-sector (fleet management; traffic volume monitoring, connected road signs and traffic lights) in 2020, adjusted for differing regional carbon emission factors (for Asia Pacific, North America, etc. – source: IEA, 2009). The GHG emission factors are assumed not to change from 2009 to 2011, and to 2020. For smart transportation and logistics, the *Carbon Connections* ratios are also used, but no adjustment to the ratios is made, because diesel/gasoline is assumed to have a constant emissions factor globally. These ratios are multiplied by the number of mobile M2M connections required in 2011 by sub-sector for each global region (from Machina Research), and then aggregated. It is assumed that the ratios of GHG emissions reductions to connections broadly do not change from 2011 to 2020. Note: smart meter GHG savings only include mobile enabled GHG savings

[42] Yankee Group 2011 and Machina Research. Disagreement between data sources for the 2011 figures mean that a more closely defined growth rate forecast is not possible

[43] Source: ITU and Telefónica

mobile. These reports typically show that by 2020 ICT has the potential to enable carbon emissions reductions between five and eight times the direct emissions of the ICT sector itself:

Report	Date	Direct ICT emissions 2020 (Mt CO_2e)	ICT-enabled emission reductions 2020 (Mt CO_2e)	ICT enablement factor
SMART 2020 (Global)	2008	26	194	7
SMART 2020 (US)	2008	1,430	7,800	5
SMART 2020 (Germany)	2009	180	810 - 1,410	5 - 8
SKT Social GHG Abatement	2012	20	118	6

Other reports such as those by Telstra, World Wide Fund for Nature (WWF), European Telecommunications Network Operators' Association (ETNO) and AT&T have also highlighted the potential for ICT to enable emissions reductions.

Aside from the GSMA's original *Mobile's Green Manifesto*, the main published study to examine the potential of the mobile industry's potential to enable significant emissions reduction is Vodafone's *Carbon Connections* report. Its calculations also show a similar result to those from the broader ICT sector, i.e. mobile has the potential also to enable emissions reductions much greater than its own emissions. *Carbon Connections* showed that there is considerable potential for mobile to enable carbon savings, requiring millions of additional M2M connections by 2020. The report focused on Europe and showed that, for EU25, 113 Mt CO_2e of GHG emissions could be saved by 2020 through opportunities in dematerialisation, smart transportation and logistics, smart grids and smart meters, and smart manufacturing. This would require over 900 million mobile M2M connections and save a potential €43 billion in energy costs. By comparison, the network emissions of the mobile industry in the EU25 were only 5 Mt CO_2e in 2010 and any increase in these network emissions by 2020 is expected to be small. Since network emissions typically account for 70 to 80% of the emissions of mobile operators, the potential for mobile operators to reduce GHG emissions is many times their own direct emissions.

The growth rates needed to achieve this potential are high, although they start from a low base, and sectors such as smart grids and smart meters are expected to grow rapidly. To achieve the carbon potential of 46 Mt CO_2e identified by *Carbon Connections* in smart transportation and logistics, mobile M2M connections would need to grow at about 60% per year in the EU25 from the 2011 figure of 0.6 Mt CO_2e. To achieve the 43 Mt CO_2e of potential in smart grids and smart meters, mobile M2M connections required by smart meters to enable micro-generation for buildings would need to grow at over 200% per year from 2011 to 2020, and connections for electricity network monitoring 100% per year over the same period. The required connections growth rate for dematerialisation is also likely to be high, although the dematerialisation applications require mobile and tablet connections rather than mobile M2M connections.

Growth rates in other parts of the world are likely to be of a similar magnitude to maximise mobile's potential to save emissions. Assuming these growth rates worldwide[44], then the global GHG emissions saving potential in 2020 is at least 900 Mt CO_2e, similar today to the annual emissions of Germany[45]. This is split as follows:

- Approximately 690 Mt CO_2e is from smart transportation and logistics, and smart grids and smart meters, requiring 3.5 billion mobile M2M connections[46] (Figures 6 and 7)
- An estimated 160 Mt CO_2e is from dematerialisation[47]
- Smart buildings' contribution is now believed to be relatively small and in the region of 30 Mt CO_2e, requiring 170 million mobile and tablet connections (Figure 8)[48]
- The remaining 20 Mt CO_2e is accounted for by smart motors[49].

As far as the GSMA is aware, this is the first attempt to forecast global mobile-enabled GHG emissions reduction potential, a market that presents a significant opportunity for mobile operators and other industry participants.

[44] Note that the growth rate for smart transportation and logistics has been increased from 60% to 80% CAGR as the EU25 market is expected to be relatively more advanced than developing markets and so has correspondingly less growth potential

[45] http://unfccc.int/ghg_data/ghg_data_unfccc/time_series_annex_i/items/3841.php

[46] As before, the GHG figures by region are estimates. For smart grids and meters, the GHG figures by region are calculated using the ratios of CO_2e emissions reductions to required M2M connections, as per the EU25 focused *Carbon Connections* report, by sub-sector (fleet management; traffic volume monitoring, connected road signs and traffic lights,) in 2020, adjusted for differing regional carbon emission factors (for Asia Pacific, North America, etc. – source: IEA, 2009). For smart transportation and logistics, the *Carbon Connections* ratios are also used, but no adjustment to the ratios is made, because diesel/gasoline is assumed to have a constant emissions factor globally. These adjusted ratios are multiplied by the number of M2M connections required in 2020 by sub-sector for each global region, and then aggregated. The required mobile M2M connections for 2020 to achieve full potential are based on 2011 Machina Research data and have growth rates applied to them by sub-sector. These growth rates are calculated by sub-sector, using the EU25 2011 M2M connections figures from Machina Research and the potential 2020 figures from the *Carbon Connections* report. The growth rates are assumed to be the same across all regions

[47] Source: *Mobile's Green Manifesto*, 2009

[48] The 30 Mt CO_2e is estimated using *SMART 2020* figures for ICT-enabled GHG emissions savings in Building Management Systems, HVAC and lighting of 660 Mt CO_2e adjusted for the telecoms-enabled component, assumed to be 20%, and the mobile-enabled component of telecoms, assumed to be 25%

[49] Smart motors are ICT technologies that reduce energy consumption at the level of the motor, the factory or across the business. Source: *Mobile's Green Manifesto*, 2009

Figure 6 – Potential mobile M2M connections in smart grids and smart meters, and smart transportation and logistics, million connections, 2020[50]

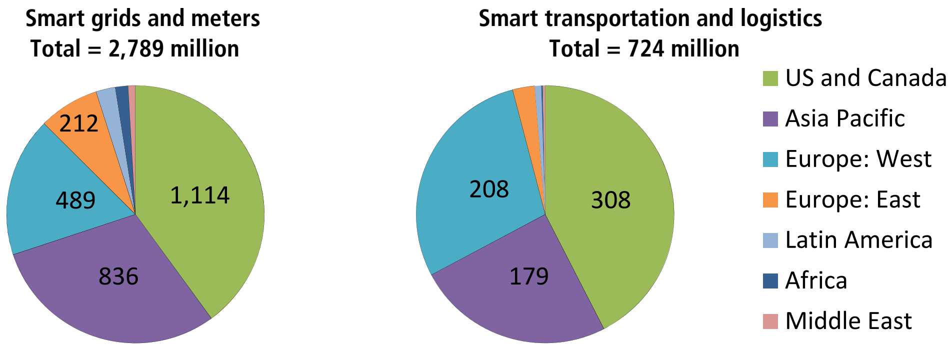
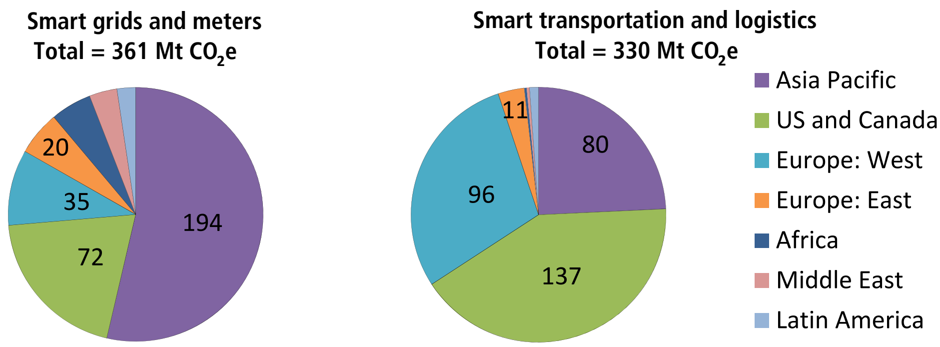


Figure 7 – Potential GHG savings in smart grids and smart meters, and smart transportation and logistics, Mt CO_2e, 2020[51]



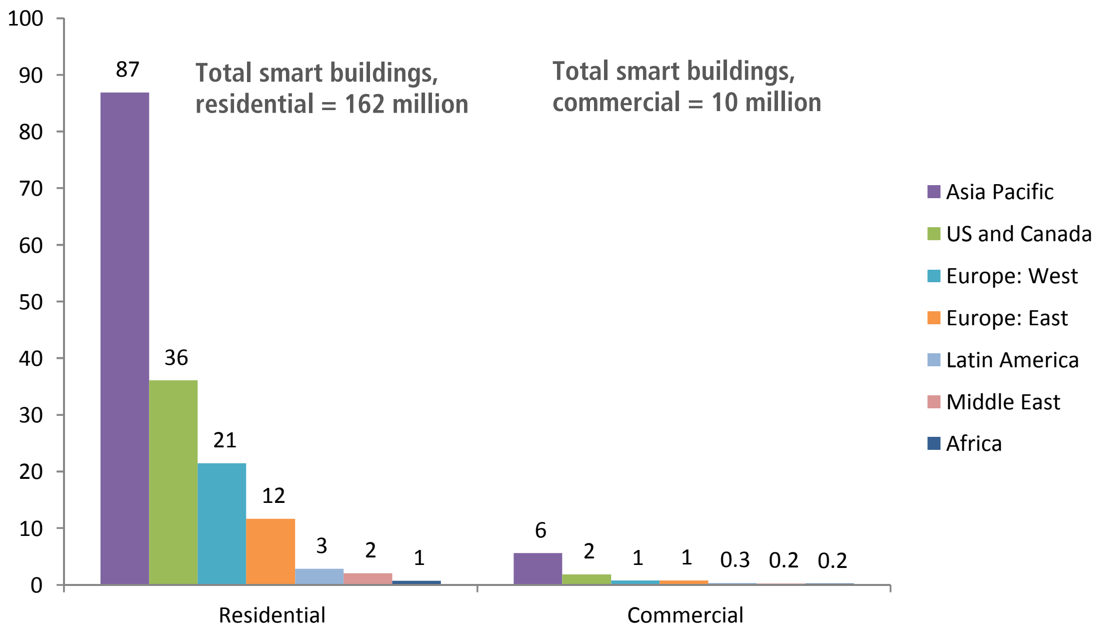
Asia Pacific is projected to have the largest potential for GHG emissions reductions in 2020 for smart transportation and logistics, and smart grids and smart meters, with a 40% share of emissions followed by the US and Canada with 30% and Western Europe with 19%. In terms of required connections to achieve this potential, the US and Canada is forecast to be the largest with 40% followed by Asia Pacific with 29% and Western Europe with 20% (Figures 6 and 7). The reason why emissions shares are quite different in some cases to mobile M2M connection shares is due to differing GHG savings potential in the sub-sectors (Figures 12 and 14).

If growth to 2015 is as predicted then M2M connections would need to grow at just over 100% per year from 2015 to 2020. Whether mobile's enabling potential is fully realised by 2020 will depend, in particular, on government policies towards smart meter roll-out, smart grid investment and the demand growth for fleet management solutions.

[50] Source: GSMA analysis extrapolating from Vodafone's *Carbon Connections*

[51] Source: GSMA analysis extrapolating from Vodafone's *Carbon Connections*

Figure 8 – Potential mobile handset and tablet connections in smart buildings, million connections, 2020[52]



Extrapolating from the results of the *Carbon Connections* and *SMART 2020* reports shows that the mobile industry has the potential to enable GHG savings in the region of 900 Mt CO_2e in 2020, or 1.7% of the global 2020 GHG emissions in the International Energy Agency's (IEA) "business-as-usual" scenario, provided the initiatives are rolled out worldwide. The *SMART 2020* report estimated the total carbon footprint of the mobile industry in 2020 to be 245 Mt CO_2e in the "business-as-usual" case. However, as mentioned earlier, the GSMA believes the *SMART 2020* figures for the network part of the footprint are too high[53]. Adjusting for this implies that the mobile industry has the potential to reduce GHG emissions by at least four to five times its own footprint.

Further work is required to improve the life cycle analysis of mobile emissions but this will not change the overall conclusion as GHG emissions from handset manufacture, use and end of life, and from network equipment manufacture and end of life, are unlikely to be significantly higher in total than the 70 Mt CO_2e GHG emissions from mobile networks in use.

Projected global GHG emissions in 2020, by sector

A "business-as-usual" scenario would see global emissions associated with human activities rise from 40 Gt CO_2e emitted in 2002 to nearly 52 Gt CO_2e in 2020, according to the IEA, see Figures 9 and 10. These emissions arise from six major sources: transportation, power,

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[52] Source: Machina Research. Note: excludes dual use applications where devices are used to control both residential and commercial systems. Mobile M2M connections will be relatively small and will be mostly deployed in building technologies as back-up to short-range M2M connections

[53] Note that this also means the carbon footprint for mobile documented in the original *Mobile's Green Manifesto* is also too high as it was based on *SMART 2020* calculations

buildings, industry, agriculture, and forestry and land use. These emissions clearly dwarf those of the mobile networks.

Figure 9 – GHG emissions by geography, Gt CO_2e, 2020, Global[54]

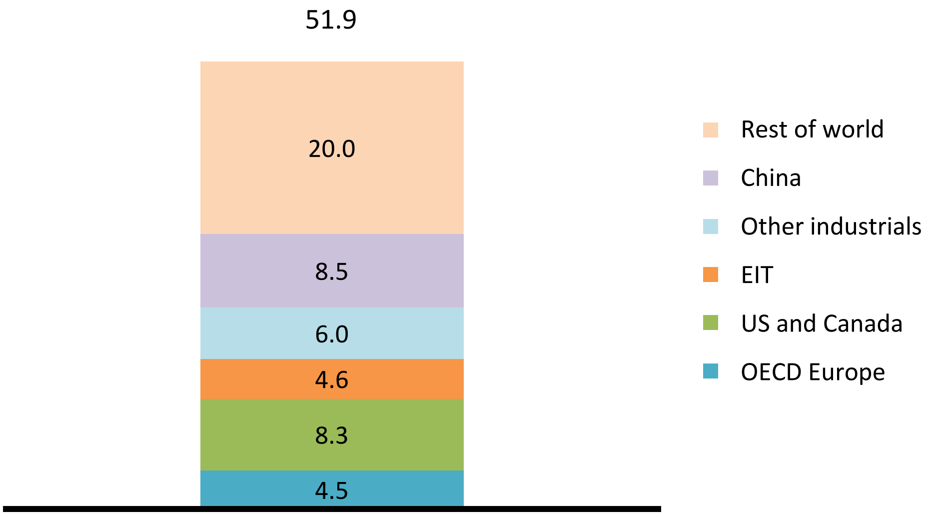
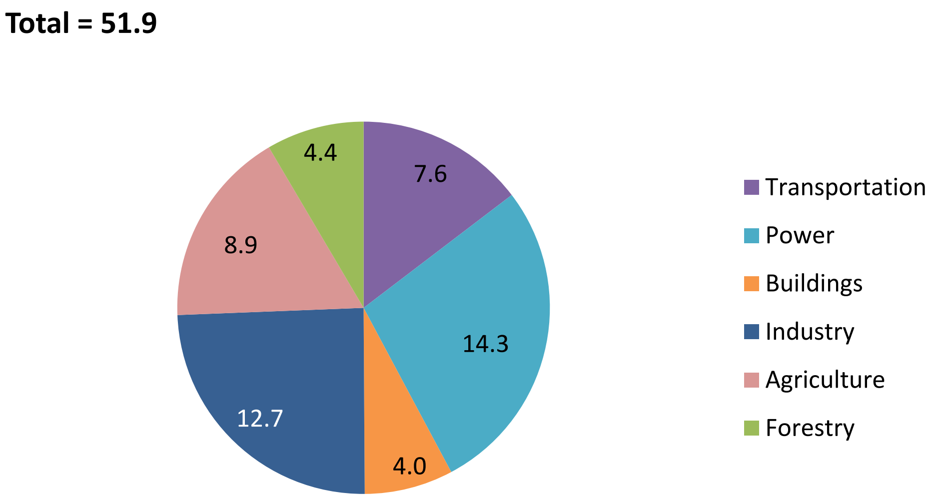


Figure 10 – Direct emissions by sector, Gt CO_2e, 2020, Global[55]



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[54] IEA, *World Energy Outlook*, 2002

Note: Other industrials: Australia, New Zealand, Japan, Singapore, South Korea, Taiwan, UAE, Saudi Arabia, Qatar, Oman, Kuwait, Israel, Bahrain and Mexico

EIT = Economies In Transition: Eastern Europe and Russia

Rest of the World: Africa; South and Central America excluding Mexico; Asia excluding China and countries included in "Other Industrials"

[55] IEA, *World Energy Outlook*, 2002

Smart transportation and logistics

Transport-related GHG emissions accounted for 14% of global GHG emissions in 2002, and GHG emissions from transport are expected to grow 42% over the period from 2002 to 2020 to reach 7.6 Gt CO_2e or 15% of global GHG emissions in 2020, according to the IEA (Figure 10).

GHG emissions savings enabled by mobile come from fleet management, where mobile M2M connections can help to improve efficiency by, for example, cutting journey times, reducing vehicle miles, optimising vehicle loading and reducing the number of trucks required in a fleet. Secondly they can result from improvements to traffic flow and reductions in road congestion.

Of the estimated 2 Mt CO_2e global mobile-enabled emissions savings in smart transportation and logistics in 2011, 1.5 Mt CO_2e is in road fleet management with North America and Western Europe the major markets. The remainder is in traffic volume monitoring, connected road signs (including variable speed limits and variable lanes) and traffic light synchronisation[56] (Figure 11). Road fleet management requires an estimated 3.6 million mobile M2M connections and traffic volume monitoring, connected road signs and traffic light synchronisation the remaining 0.1 million.

The potential emissions reduction enabled by mobile by 2020 is forecast to be 300 Mt CO_2e in road fleet management and 30 Mt CO_2e in traffic volume monitoring, connected road signs and traffic light synchronisation. North America, Western Europe and Asia Pacific are the major markets, see Figure 12. Mobile connections required to achieve this potential are forecast to be 720 million and 10 million respectively.

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[56] In *Carbon Connections* this sub-sector is called synchronised traffic and alert systems. It is often regarded as part of Smart Cities

Figure 11 – Estimated GHG emissions savings in smart transportation and logistics, by sub-sector, Kt CO_2e, 2011[57]

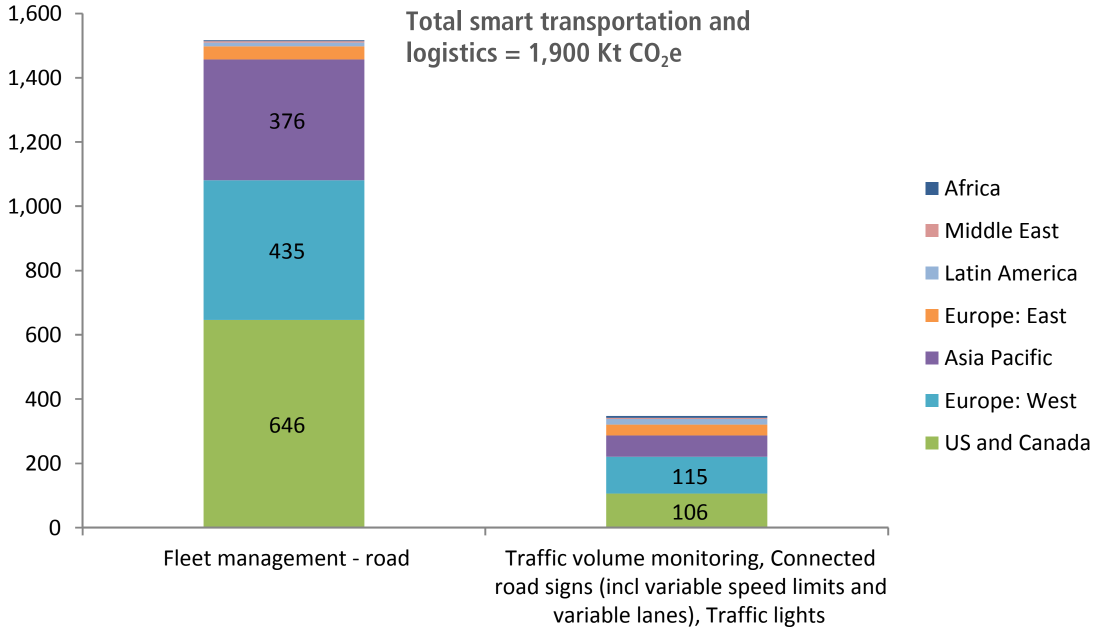
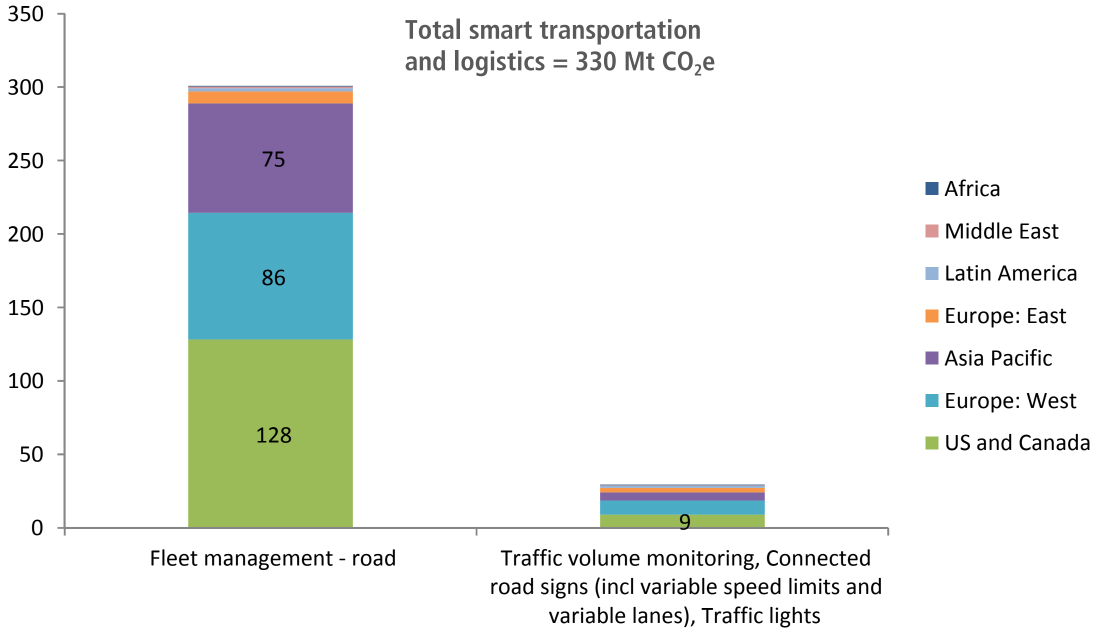


Figure 12 – Potential GHG emissions savings in smart transportation and logistics, by sub-sector, Mt CO_2e, 2020[58]



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[57] Source: Machina Research, GSMA analysis

[58] Source: Machina Research, GSMA analysis

Case study 1 – Smart logistics in Groningen, Netherlands

Municipal authorities collect and remove waste using teams of refuse collectors that typically undertake fixed collection rounds to empty bins. This can lead to waste bins being emptied when they are not full or being emptied too infrequently. The smart solution is provided by a Vodafone GPRS-enabled ICT device attached to the waste bins which detects how full the bins are. The devices, developed by Mic-o-data, communicate through a mobile M2M connection to a central server at the authority. When a pre-determined filling level is reached, the bin is included in a collection round.

This system maximises collection efficiency in time and cost terms, decreases fuel use and GHG emissions, and delivers a social benefit from reduced complaints about litter. Furthermore, in the medium term, fewer additional waste collection vehicles need to be procured.

The results from the Groningen municipal authority showed a net saving of almost 30 t CO_2 per year comparing the business-as-usual scenario to the ICT-enabled scenario after implementation, an 18% saving in CO_2 emitted by the collection fleet. The analysis considered the use and manufacturing phases of the life cycle. This saving is equivalent to the amount of CO_2 emitted in 373 car trips from Groningen in the north of the Netherlands to Maastricht in the south. Since its implementation, the municipality has saved an estimated €92 000 in capital and operational costs.

Smart grids and smart meters

Power-related GHG emissions are a major contributor to overall global emissions, accounting for 24% of global GHG emissions in 2002, with a forecast 51% growth from 2002 to 2020 to reach an expected 14.3 Gt CO_2e or 27% of global GHG emissions in 2020, according to the IEA (Figure 10).

GHG emissions savings enabled by mobile come from grid loading optimisation, where energy providers are able to optimise grid loading because smart meters encourage end users to adjust daily electricity use and smooth consumption peaks. Secondly they arise from electricity network monitoring, where wireless devices monitor losses and the load capacity of the electricity transmission and distribution network, helping to locate network losses and minimise energy shortages and power outages. Thirdly they result from micro-power generation, where, for example, smart meters enable two-way electricity flow in urban grids, increasing the uptake of small-scale renewable generators and reducing centrally generated power and transmission losses[59].

Of the estimated 0.8 Mt CO_2e mobile-enabled emissions savings in 2011, just over half is in the sub-sector grid loading optimisation and the remainder is in electricity network monitoring. North America and Asia Pacific are the largest markets for grid loading optimisation while Asia Pacific dominates electricity network monitoring (Figure 13).

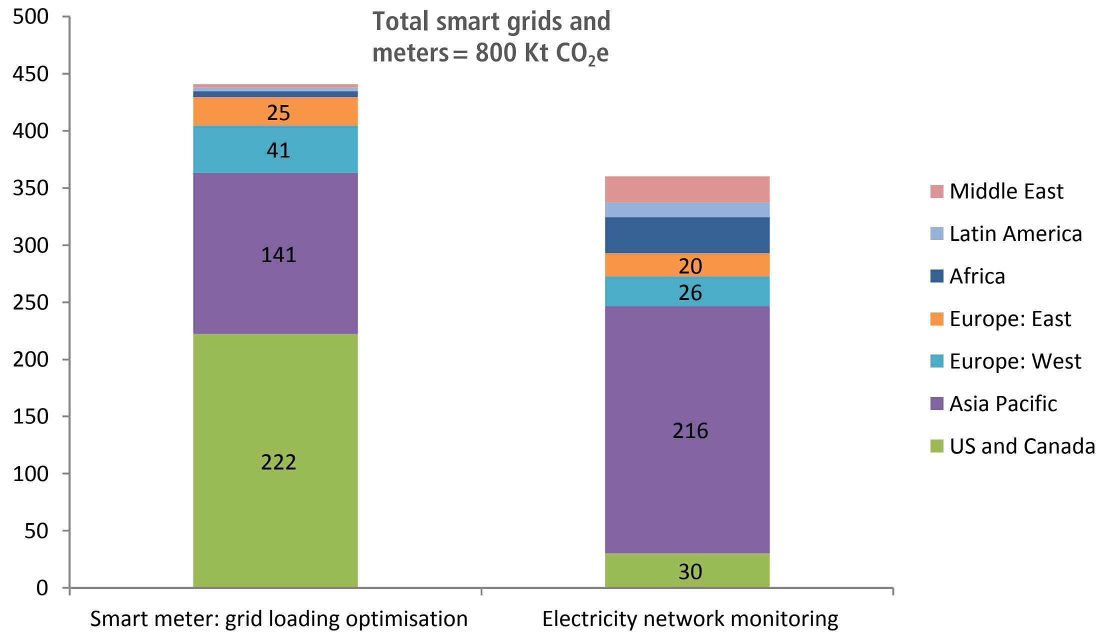
Of the 22.7 million mobile connections estimated by Machina Research in smart grids and smart meters in 2011, grid loading optimisation accounts for 22.1 million. The latter figure,

[59] Rather than being connected through smart meters, some micro-power generation systems may have an integrated connection, i.e. they do not need external Central Processing Units (CPU) or software in order to function

which consists of smart meters connected directly via a mobile network, is approximately the same as figures estimated by other specialist market research companies.

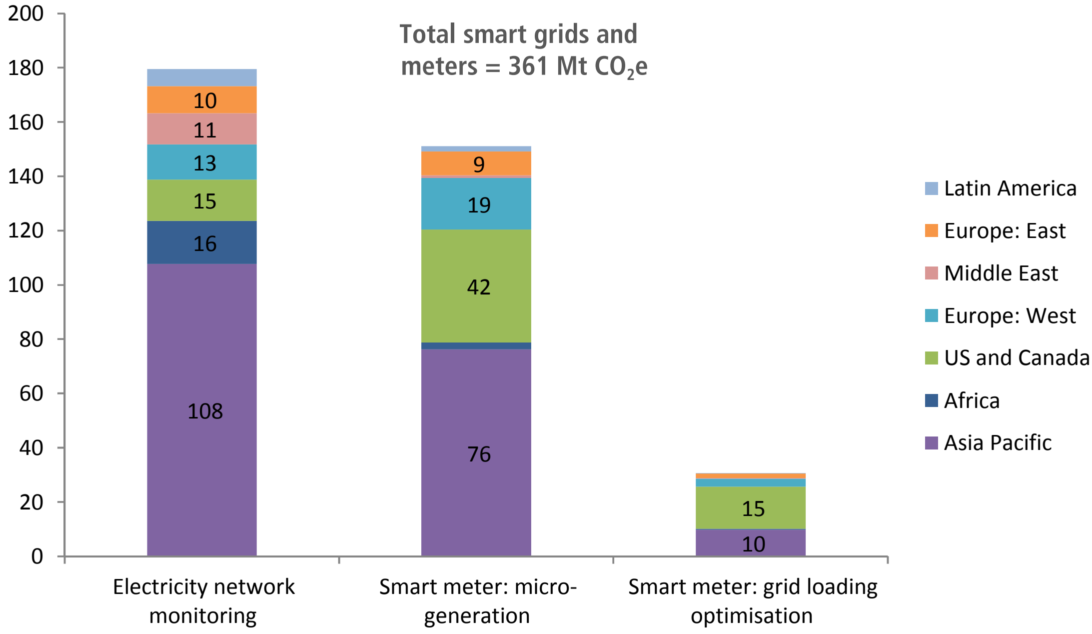
By 2020, electricity network monitoring has the potential to save the most GHG emissions within smart grids and smart meters, with approximately 180 Mt CO_2e, followed by smart meter enabled micro-generation with 150 Mt CO_2e and grid loading optimisation with 30 Mt CO_2e (Figure 14). Connections to achieve this potential are forecast to be 0.25 billion, 1 billion and 1.5 billion respectively. Asia Pacific accounts for 55% of the emissions savings.

Figure 13 – Estimated GHG emissions savings in smart grids and smart meters, by sub-sector, Kt CO_2e, 2011[60]



60 Note: Smart metering for micro-generation has been omitted because it is very small (5 Kt CO_2e in 2011). Source: Machina Research, GSMA analysis

Figure 14 – Potential GHG emissions savings in smart grids and smart meters, by sub-sector, Mt CO_2e, 2020[61]



Case study 2 – Smart metering at ASB Bank, New Zealand

The ASB Bank in New Zealand installed smart meters across their estate of 167 branches, offices and data suites to accurately monitor and measure energy consumption. In order to make the data more readily accessible for analysis across the dispersed geography of New Zealand, the meters were remotely connected using Vodafone SIM cards with GPRS connectivity. These send the collected energy consumption data using mobile M2M connections to a central server. The accurate energy consumption data enables ASB to understand its energy use, and therefore to reduce consumption and GHG emissions. This case study is an example of energy reduction, which at larger scale would result in grid loading optimisation opportunities.

Using this data, ASB improved the efficiency and optimisation of its heating, cooling and lighting equipment, and installed motion and light sensors to reduce lighting demand. Staff were trained on energy efficiency. The data from the meters allowed ASB to realise and quantify considerable energy and cost savings and therefore also build the business case for further energy efficiency improvements.

The results showed a net saving of 2.2 Kt CO_2 per year comparing the business-as-usual scenario to the ICT-enabled scenario after implementation, a 27% saving in the energy used and CO_2 emitted in running the buildings. The analysis considered the use and manufacturing phases of the life cycle. Putting this into perspective, this saving is equivalent to the CO_2 emitted from a person flying from Auckland, New Zealand, to Sydney, Australia, and back over four thousand times.

[61] Source: Machina Research, GSMA analysis

Smart buildings

Mobile connectivity can enable emissions reductions in buildings by increasing building automation and control, for example in building management systems, heating, ventilation and air conditioning (HVAC), and lighting. Mobile technology can enable users to control building technologies remotely, for example by adjusting HVAC settings from a mobile device. Mobile M2M devices can be embedded in HVAC, lighting and other appliances across a building, either as the main means of communication with access points or as a back-up facility to short-range M2M communication in the case of critical systems.

Mobile-enabled smart buildings were not included in *Carbon Connections* but were part of *SMART 2020*. Possible reductions in GHG emissions from smart buildings are now thought to be in the region of 30 Mt CO_2e in 2020. This downward adjustment has been made because in most applications the emissions savings will be driven by non-cellular M2M connections. Rebound effects must be also taken into account, see below.

Dematerialisation

Dematerialisation offers the potential to substitute high carbon products and activities with low carbon alternatives. *Carbon Connections* estimates that 22 Mt CO_2e in 2020 can be saved from applying a small number of dematerialisation solutions in the EU25, requiring an extra 140 million connections and saving a potential €14 billion in energy costs. These savings are predominantly achieved by remote or smart working. However, it was not made clear how much of this saving could be attributed to mobile telecoms, as mobile communication is not the only enabler of remote working. Fixed-line technologies also play a key role. In addition, rebound effects must be taken into account, see below.

The 2009 *Mobile's Green Manifesto* report extrapolated the *Carbon Connections* estimate of dematerialisation emissions reduction in the EU25 to a worldwide estimate, suggesting that GHG emissions have the potential to be reduced by 160 Mt CO_2e in 2020.

Mobile-enabled dematerialisation is small currently but there should be potential for this market to grow substantially.

Rebound effects and other caveats

The calculation of enabled emissions savings requires a high degree of estimation and there are several complexities that theoretically need to be addressed such as double counting and rebound effects.

Double-counting could arise in the case of another industry claiming the same emissions savings. For instance, by enabling emissions reductions in fleet logistics through M2M technology, the savings might also be claimed by industry segments such as the truck manufacturers, or logistics software companies. This report has only considered areas where we believe the emissions reductions could not happen without mobile technology. We also note that the potential emissions savings are many times greater than mobile's direct emissions, so even if the enabled emissions savings need to be shared with other industries the overall impact is still positive.

Rebound effects are more complicated and are hard to quantify. They refer to the second-order behavioural or other responses to the introduction of new technologies that reduce energy consumption and associated GHG emissions. Typically, rebound effects tend to offset the beneficial effects of the new technology and there is considerable uncertainty as to their size and importance in different situations. For instance, in the example of dematerialisation, where mobile technology enables more home-working and thereby saves on emissions associated with travel, the home-workers may use the time saved to indulge in other GHG emitting activities instead, such as using the car to go shopping or to go out for lunch. Another example would be in smart buildings where an occupier might switch their heating on an hour before returning from work to warm up their house, thereby increasing energy consumption and GHG emissions.

* * *

Since the publication of *Mobile's Green Manifesto* in 2009, the mobile industry has made considerable progress. The GSMA has set up a programme called Mobile Energy Efficiency (MEE) to help the industry measure and manage its own emissions and, as at June 2012, this service is working with 35 mobile operators, accounting for over 200 networks and over 50% of mobile industry subscribers. Energy consumption, energy cost and GHG emissions are being measured and actively managed. Network energy consumption increased only slightly from 2009 to 2010 and total energy per unit traffic declined by approximately 20%.

The mobile industry today is also enabling significant reductions in GHG emissions and energy costs across a range of sectors of the economy, and the opportunity exists for mobile to enable a great deal more savings. As a whole, the mobile industry has the potential to contribute to an abatement of man-made GHG emissions that is at least four to five times its own carbon footprint. This presents a significant environmental and commercial opportunity for mobile operators to help companies in other sectors and industries reduce their GHG emissions and cut energy costs.

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