ICT and Climate Change

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14 Feb 2020, Climate Change Seminar

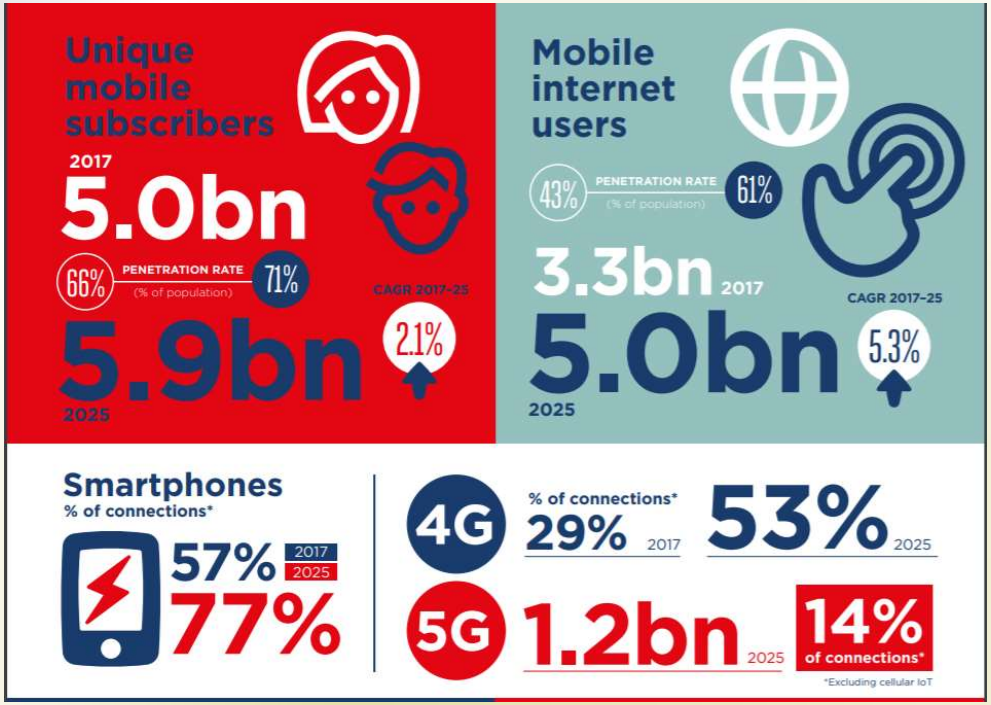
ICT's link to climate change

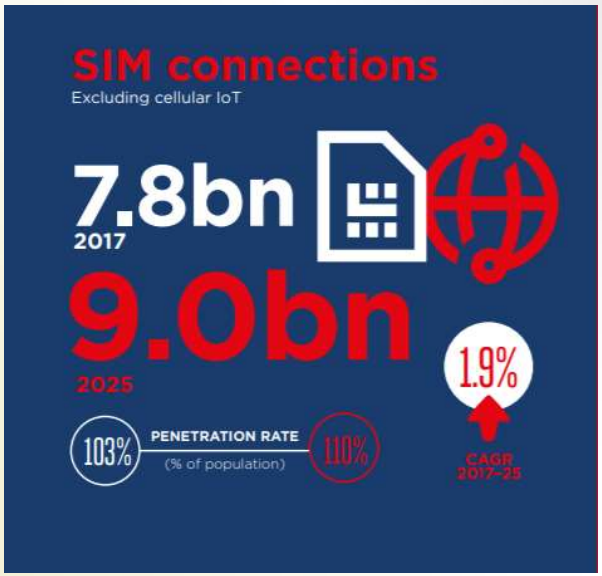
- Environmental impact of ICTs
- Supporting climate change adaptation and mitigation
- Promoting energy efficiency
- Smart cities, transport, building, water management

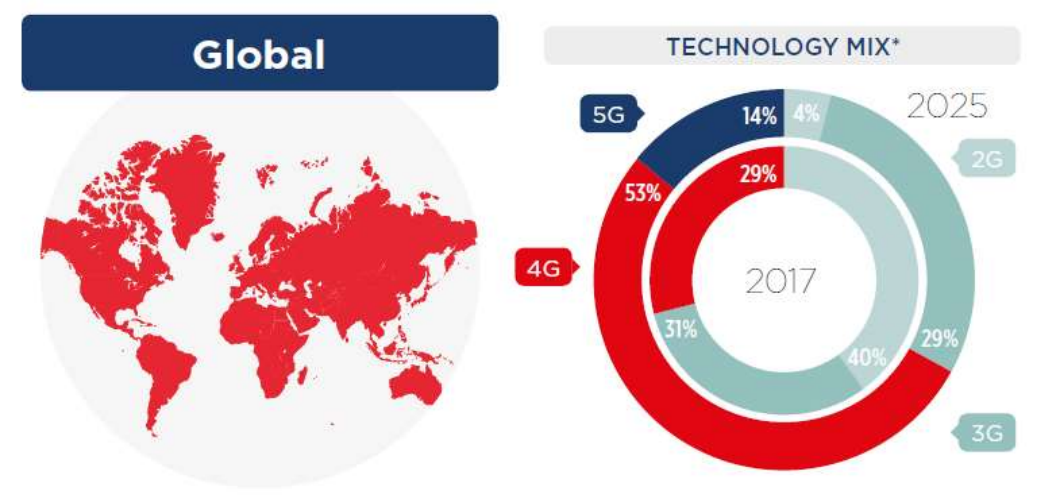
ICT is a growing contributor to global GHG emissions

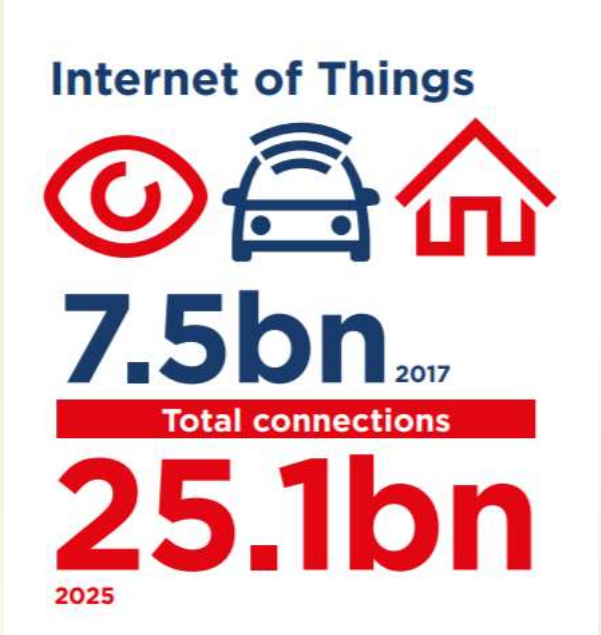
- ICT contribute to emissions through the proliferation of user devices whose use need power and also radiate heat
  - Each individual user now owning multiple devices
  - As ICT devices acquire more processing power, their requirements for energy and cooling rise (3G mobile phones operate at higher frequencies and need more power than 2G)
- GHGs are emitted for manufacturing of user devices
  - The life cycle emissions are high
  - ICT device's life cycle is shorter
- Electronic waste management is a key issues

ITU Symposium on ICTs and Climate Change, Hosted by CITIC, Quito, Ecuador, 8-10 July 2009, ITU background report





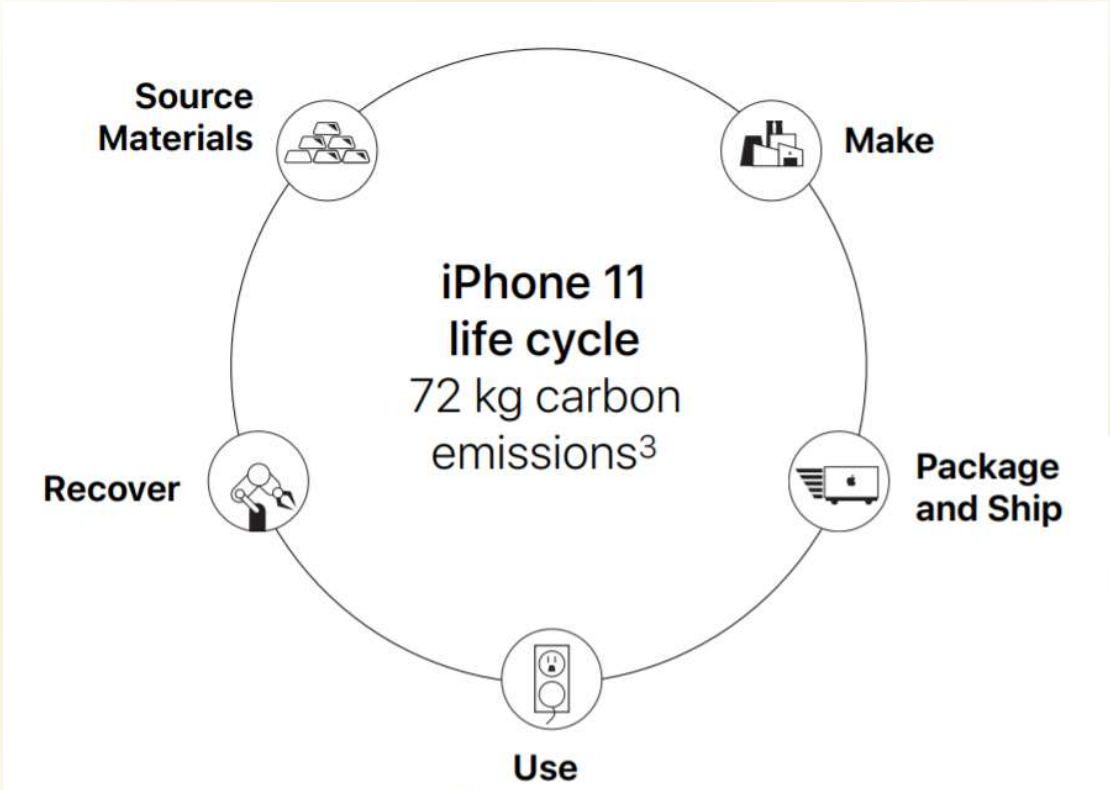




https://www.gsma.com/mobileeconomy/wp-content/uploads/2018/05/The-Mobile-Economy-2018.pdf
https://www.pewresearch.org/global/2019/02/05/smartphone-ownership-is-growing-rapidly-around-the-world-but-not-always-equally/

https://www.apple.com/environment/pdf/products/iphone/iPhone_11_PER_sept2019.pdf

iPhone 11
September 10, 2019



iPhone 11 life cycle carbon emissions

79%	Production
3%	Transport
17%	Use
<1%	End-of-life processing

[3] Greenhouse gas emissions were calculated using a life cycle assessment methodology in accordance with ISO 14040 and 14044 standards and based on the iPhone 11 64GB memory configuration.

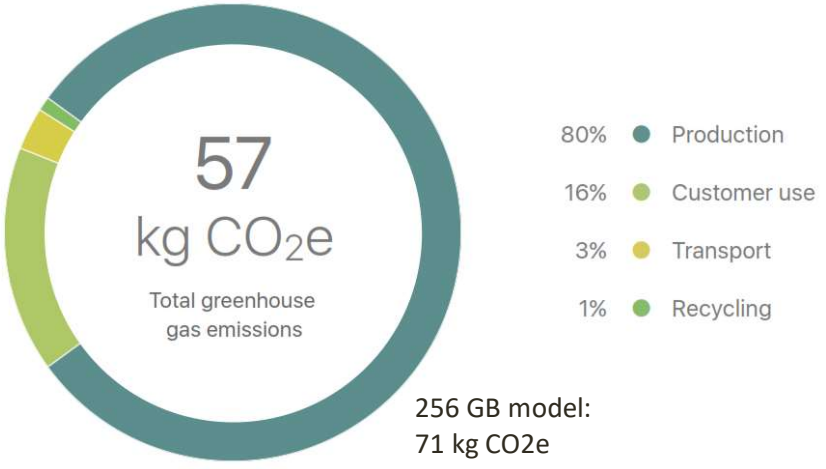
100%

All iPhone 11 final assembly suppliers have committed to 100% renewable energy for Apple production.

Configuration	iPhone 11
64GB	72 kg CO_2e
128GB	77 kg CO_2e
256GB	89 kg CO_2e

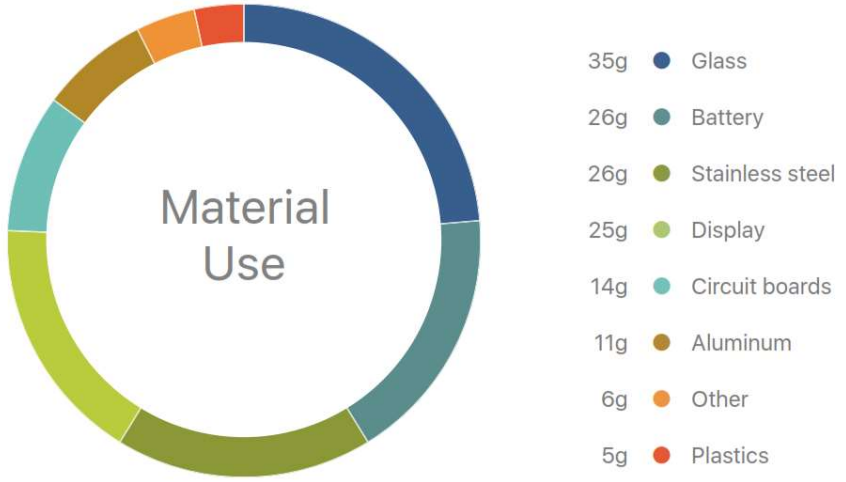
Date introduced
September 12, 2017

Greenhouse Gas Emissions for iPhone 8—64GB model



256 GB model:
71 kg CO2e

Material Use for iPhone 8



https://images.apple.com/environment/pdf/products/iphone/iPhone_8_PER_sept2017.pdf

Benchmarking mobile phones' life cycle GHG emissions

- Global electricity mix used
- Excluding accessories and network usage

Smartphone	Use Stage (%)	Production Stage (%)	Transportation Stage (%)	EoL Stage (%)	Total GWP (kg CO_2e)
Sony Xperia™ T	18	70	10	2	51
Sony Ericsson W890	20	66	13	1	17
iPhone 5	18	76	4	2	75
iPhone 4S	31	60	7	2	55
iPhone 4	26	65	7	2	55
Nokia Lumia 822	17	68	14	1	16
Nokia Asha 309	17	63	19	1	9
Nokia Lumia 620	29	55	15	1	13

Ercan, Mine. (2013), Global Warming Potential of a Smartphone: Using Life Cycle Assessment Methodology, MSc thesis report, KTH Industrial Ecology, Trita-IM-EX, 2013:01.

Sony Xperia™ T

- For Swedish electricity mix- considering a moderate usage scenario – over 3 years life
  - *Excluding accessories and network usage: 45 kg CO2e*
  - *If accessories and network included: 68 kg CO2e (network 30 %)*
- If a global electricity mix is applied
  - *Excluding accessories and network usage: 51 kg CO2e*
  - *If accessories and network included: 117 kg CO2e*

117 Kg CO2 eq means

About 40 kg CO2e per year

Equal to GHG emission from average European car for **270 km**

Ercan, Mine. (2013), Global Warming Potential of a Smartphone: Using Life Cycle Assessment Methodology, MSc thesis report, KTH Industrial Ecology, Trita-IM-EX, 2013:01.

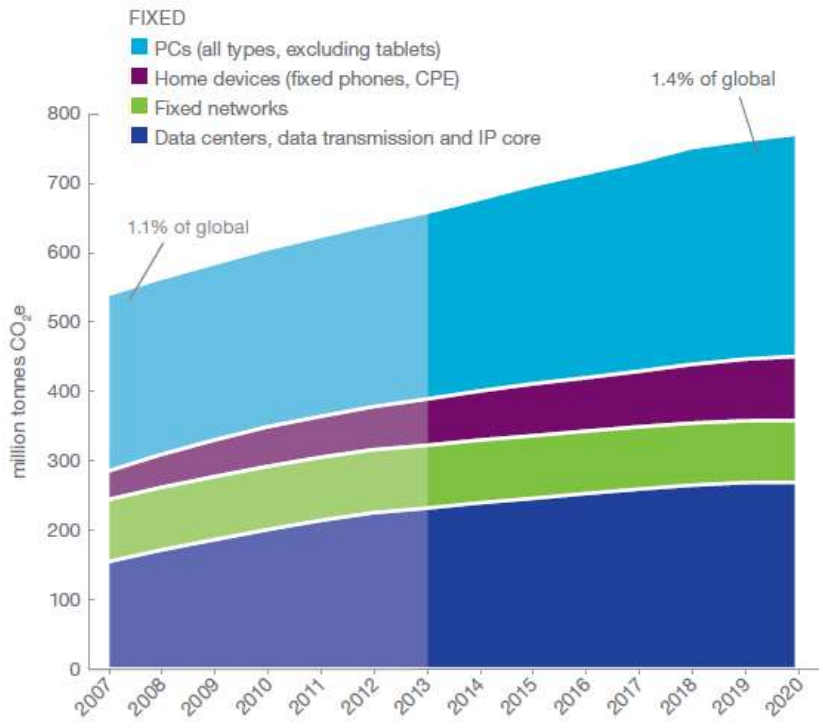
1.3% in 2007: The total ICT sector's share of the global carbon footprint (2% in 2020)

What in included in this and pervious estimation needs to be checked !!

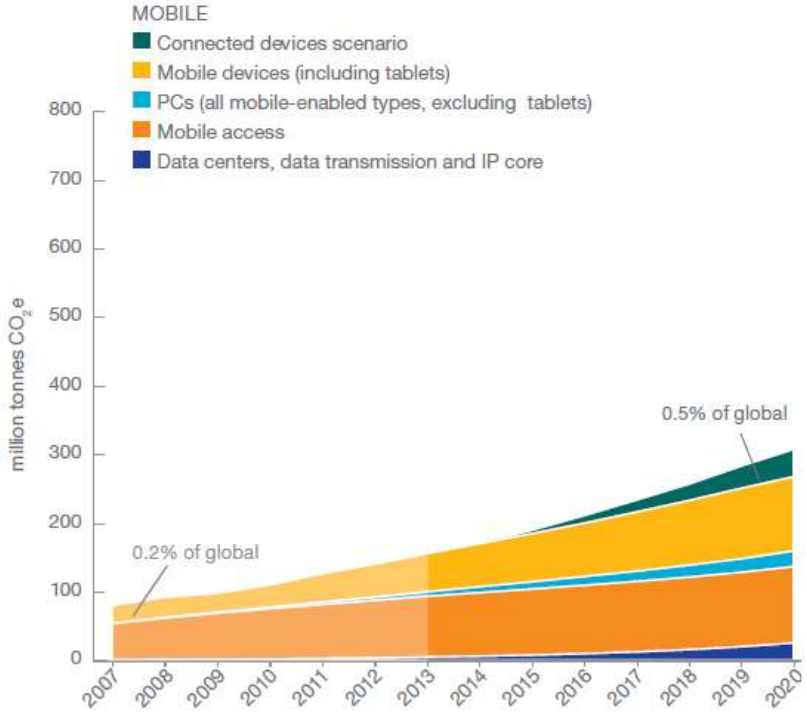
FIXED ICT **1.4%** OF GLOBAL GHG EMISSIONS IN 2020

MOBILE ICT **0.5%** OF GLOBAL GHG EMISSIONS IN 2020

Total GHG emissions from fixed ICT networks



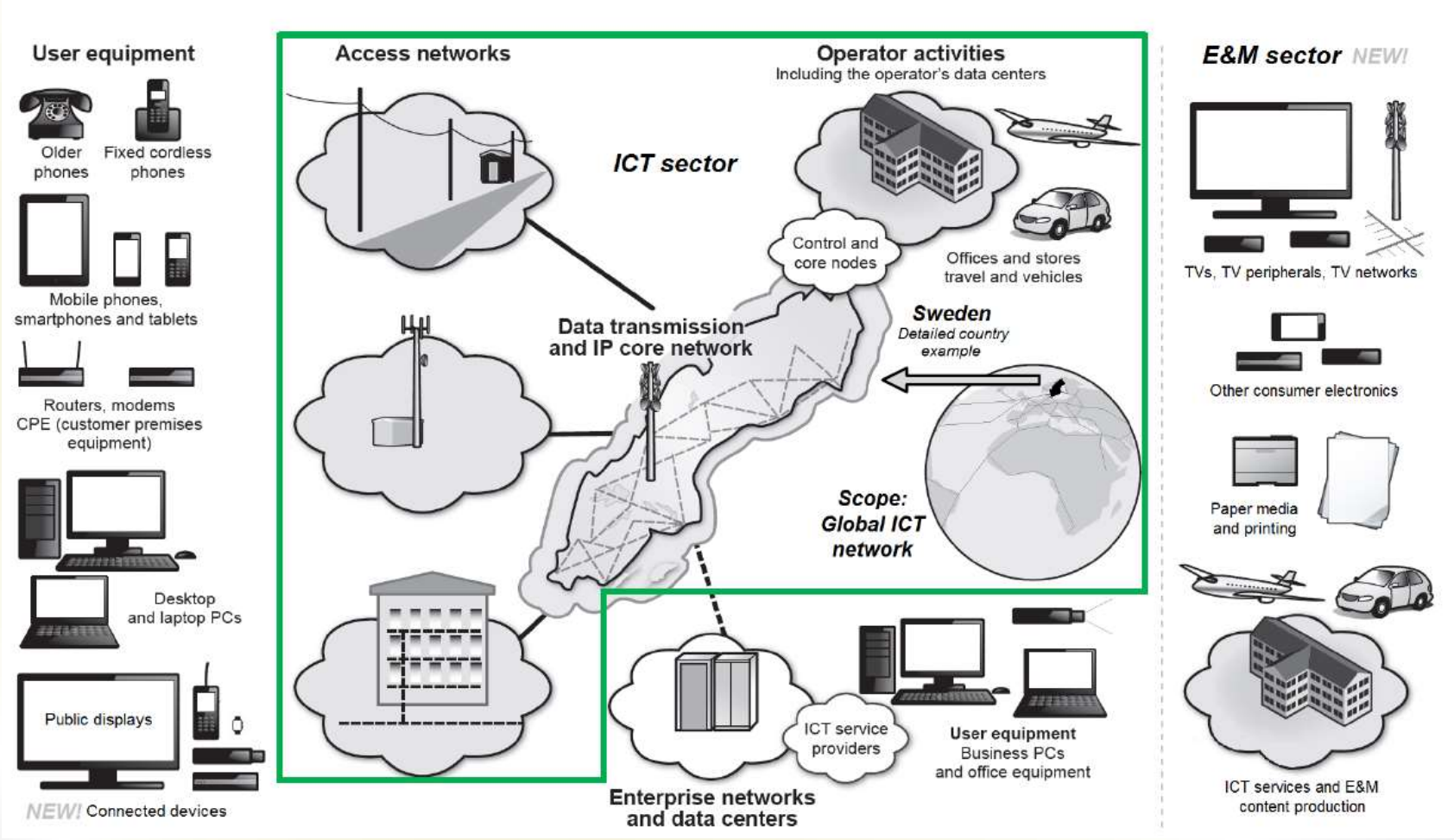
Total GHG emissions from mobile ICT networks



Ericsson Energy and Carbon Report, 2014

https://www.ericsson.com/res/docs/2014/ericsson-energy-and-carbon-report.pdf

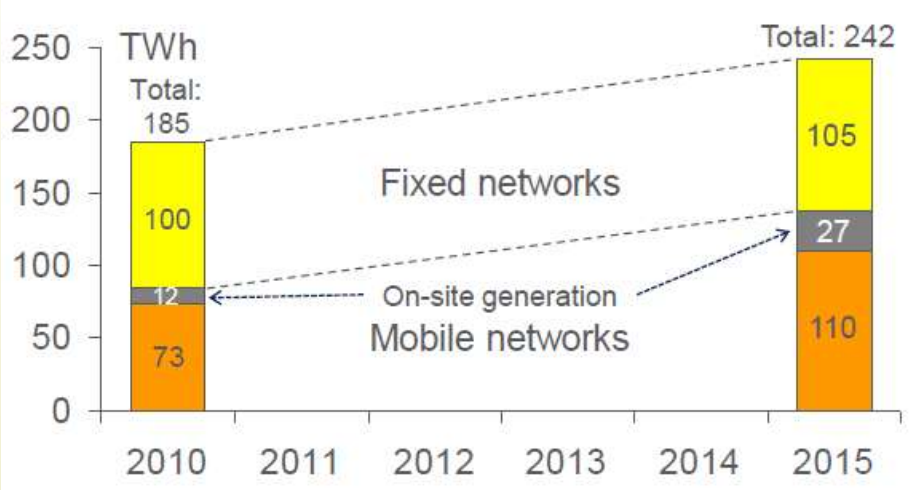
The scope of new estimation (inside the green outline) compared to the wider scope (full picture) of the ICT sector and the E&M (Entertainment and Media) sector



Jens Malmodin and Dag Lundén (2018), The electricity consumption and operational carbon emissions of ICT network operators 2010-2015, Report from the KTH Centre for Sustainable Communications, Stockholm, Sweden 2018 (ISBN: 978-91-7729-679-9; TRITA-EECS-RP-2018:1)

Role of ICT in global energy and CO2 emissions, 2015

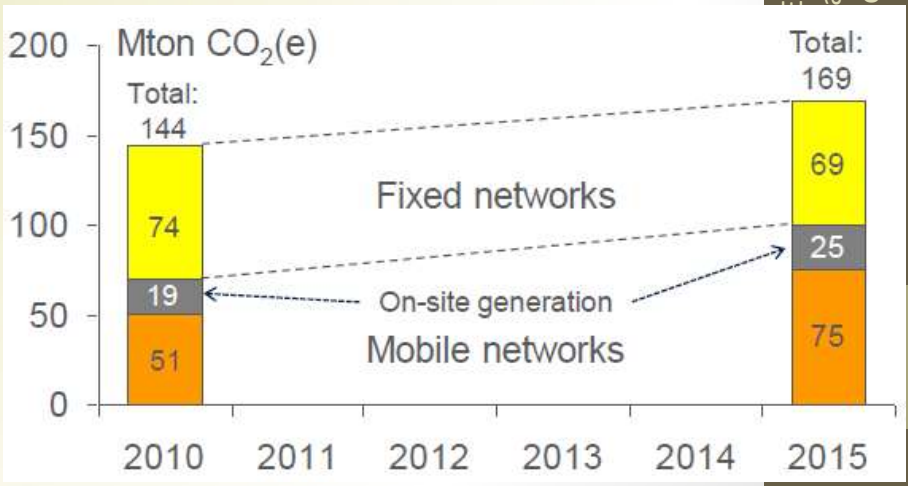
- The total annual operational electricity consumption of the overall ICT networks globally is estimated to 242 TWh for 2015
  - Grid (215 TWh) and on-site generated electricity (27 TWh)
  - This makes 1.15% of the total global electricity grid supply
- The total annual operational carbon emissions of the ICT networks are estimated to 169 Mtonnes CO2e for 2015.
  - This is 0.53% of the global carbon emissions related to energy (about 32 Gtonnes), or 0.34% of all carbon emissions (about 50 Gtonnes)



Total electricity consumption of the ICT networks operations

Change 2010-2015	Fixed	Mobile	Total
Total grid electricity consumption.	+5%	+51%	+24%
…with additional on-site generated electricity consumption.	n.a.	+61%	+31%

[1] Mainly from diesel
[2] Per mid-year according to subscription numbers from ITU



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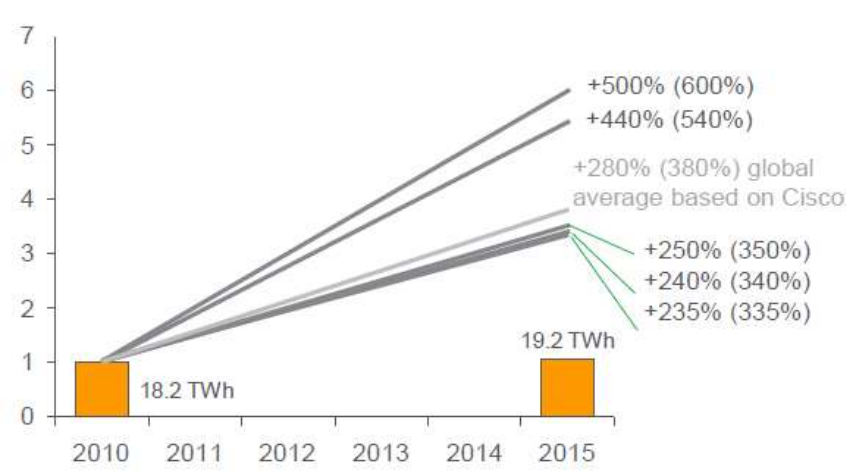
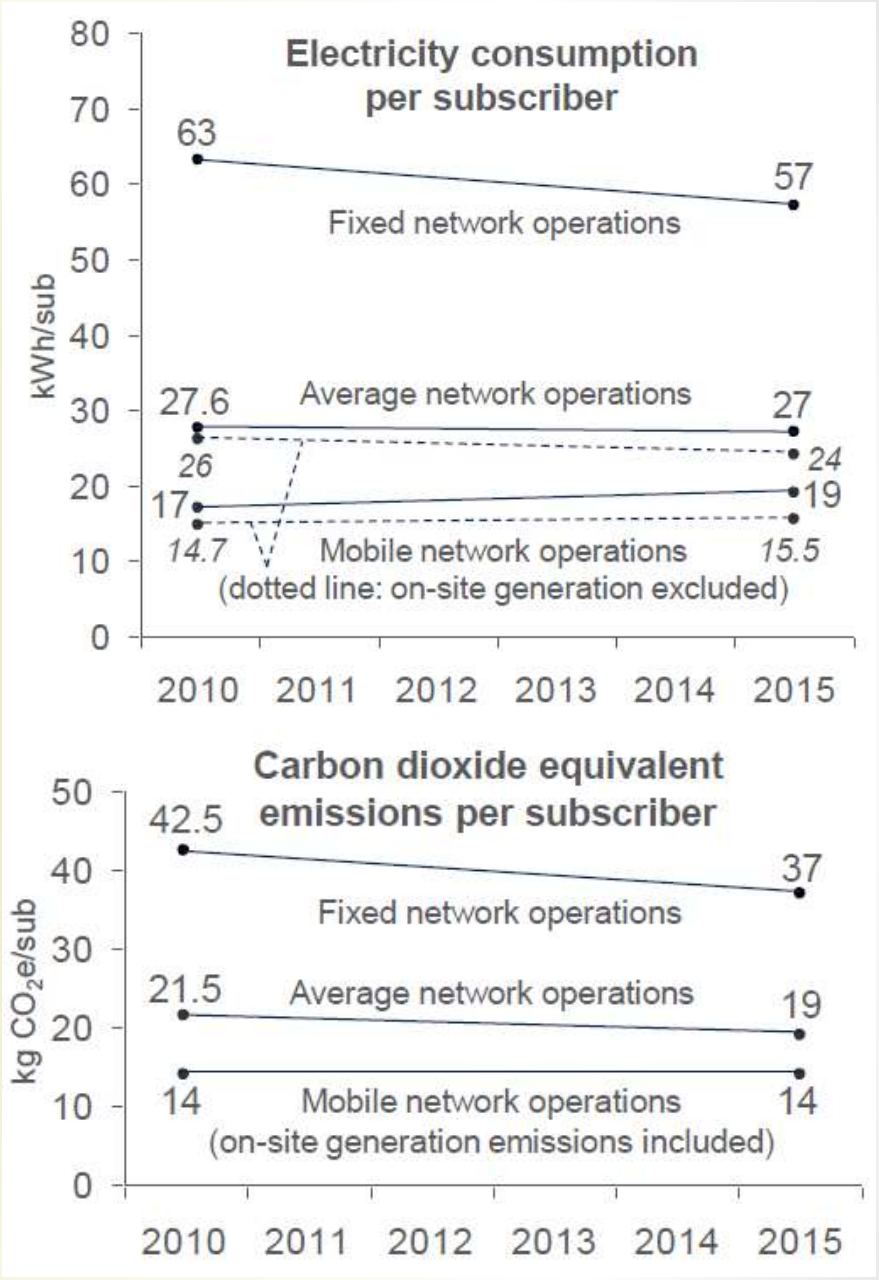
Are we doing better over time?



Electricity consumption and data traffic (indexed, 2010 level equals 1) for five operators that have measured data traffic 2010-2015.

Energy demand increase is modest but data traffic increased several times !!



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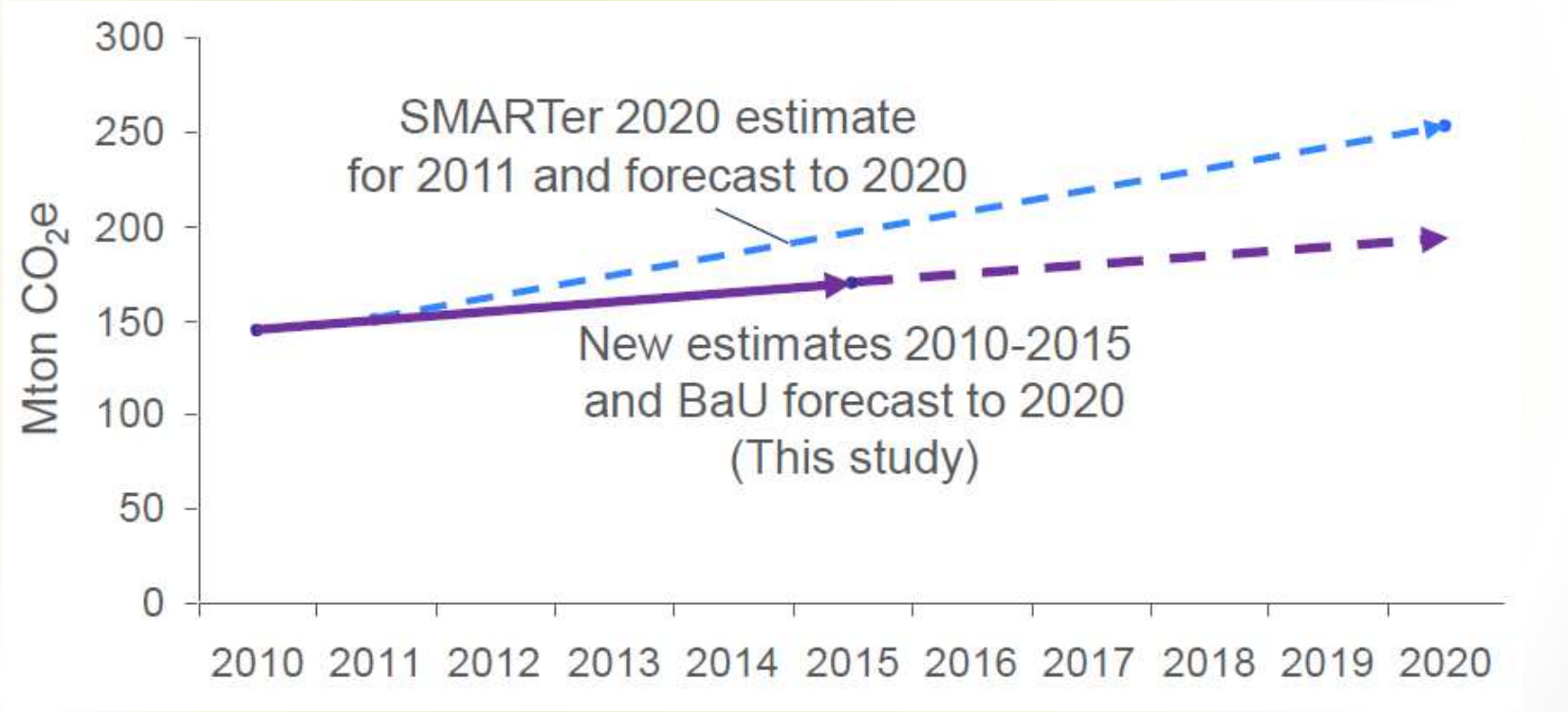
Role of ICT in global energy and CO2 emissions



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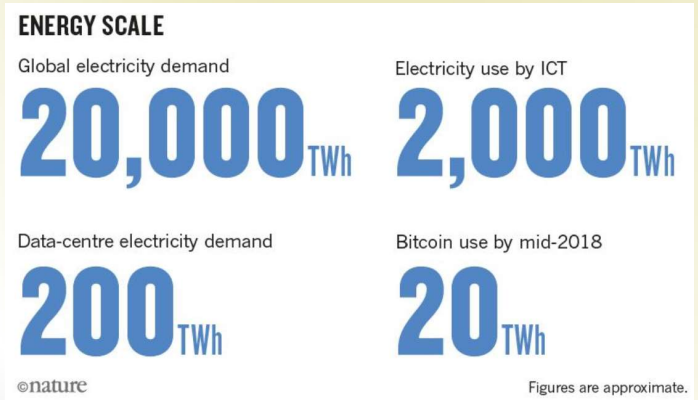
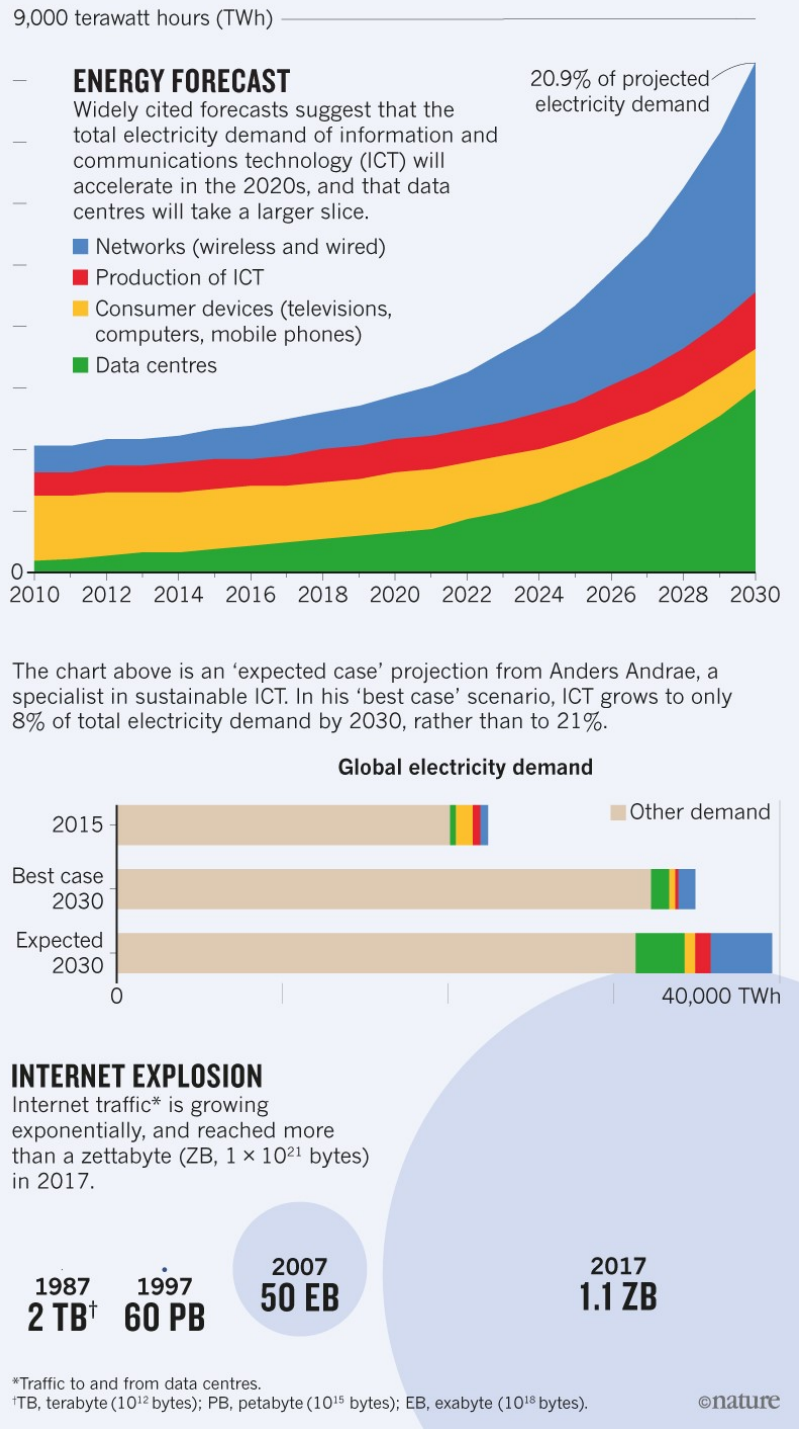
GeSI, "SMARTer 2020: The role of ICT in driving a sustainable future", 2013.

ICT and energy

- Data centres use about 200 TWh/yr in 2017; 1% of global electricity demand; 0.3% of global CO2 emissions
- ICT ecosystem as a whole — under a sweeping definition that encompasses personal digital devices, mobile-phone networks and televisions — accounts for more than 2% of global emissions
- Most worrying models predicts that electricity use by ICT could exceed 20% of the global by 2030 and data centres using more than one-third of that



https://www.nature.com/articles/d41586-018-06610-y



How ICTs can mitigating GHGs?

- A. Directly, by reducing the ICT sector's own energy requirements
  - Energy efficient ICT equipment's use and promotion
  - Next-Generation Networks (NGN) are expected to reduce energy consumption by 40 % compared to today's PSTN
  - Development and introduction of modern radio technologies (digital modulation in combination with the digital video broadcasting standards and effective compression algorithms) that reduce energy consumption by powerful broadcasting transmitters ~10 times
- B. Indirectly, using ICTs for carbon abatement for avoiding travel
  - Using and promoting email, phone calls, text messaging, video conferences, instead of physically travelling
  - Flexible work arrangement (telecommuting, nomadic working)

ITU Symposium on ICTs and Climate Change, Hosted by CITIC, Quito, Ecuador, 8-10 July 2009, ITU background report

How ICTs can mitigating GHGs?

- C. In a systemic way, by using ICTs to reduce emission in other sectors
  - Smart Transportation Systems, Smart logistics, Smart buildings or the Smart energy grid to increase energy efficiency
  - Demand-supply optimization in power sector utilizing 'energy storage' effectively and load levelling- e.g. EV to Grid, appliance use at energy low demand period
  - *Dematerialization*: Shifting away from physical distribution (DVD, CDs) to online delivery; paper-based to online publishing; e-offices

ITU Symposium on ICTs and Climate Change, Hosted by CITIC, Quito, Ecuador, 8-10 July 2009, ITU background report

A. Reducing the ICT sector's own energy requirements

Google Data Centers

- Google's first reported carbon footprint in 2011 was about same as Laos's annual emissions
- Google claims that its data centres improved and they get 3.5 times the computing power for the same amount of energy now
- Google claims it has cut its vast data centres' energy use by 15% by applying artificial intelligence
- Google's data Centre at The Dalles (1.2 b US$ investment):

Water vapor rises above the cooling towers in The Dalles data center in Oregon. These plumes of water vapor create a quiet mist at dusk.

  - Power consumption: Equivalent electricity to power a town of 200,000 inhabitants in USA
  - Google chose to locate this data center next to the Columbia River, in Dalles, Oregon USA, to make use of cheaper and less polluting hydro-electricity
- Other opportunities: Savings possible by addressing the way that data centres are structured, by using fewer but more powerful processors, and by changing the way that servers are cooled and networked together

https://www.google.com/about/datacenters/inside/locations/the-dalles/

- ITU Symposium on ICTs and Climate Change, Hosted by CITIC, Quito, Ecuador, 8-10 July 2009, ITU background report
- https://www.theguardian.com/environment/2016/jul/20/google-ai-cut-data-centre-energy-use-15-per-cent

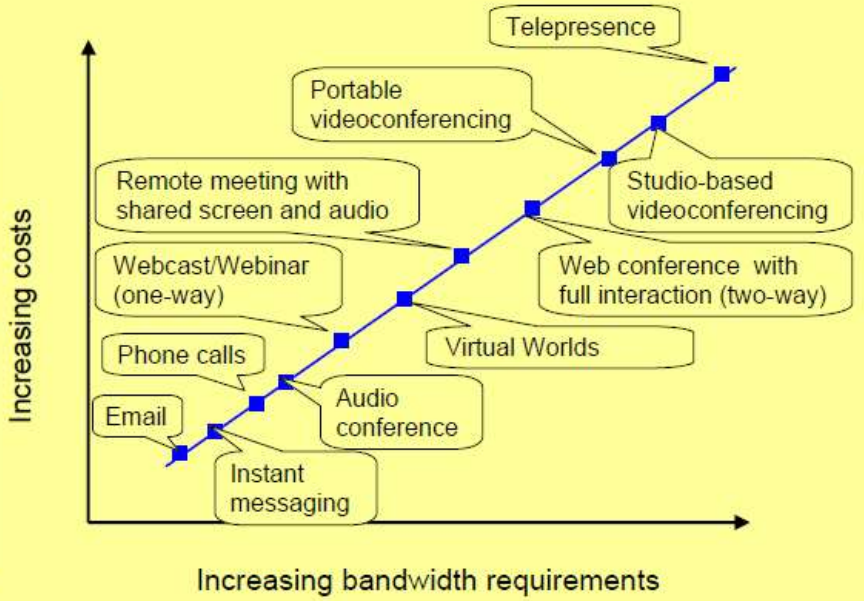
NTT, Japan

- "Total Power Revolution" (TPR) campaign
  - Promoting energy management schemes for 4,000 buildings that NTT occupy throughout Japan
  - Deploying energy efficient electrical devices and air conditioning equipment
  - Switching to the use of energy-saving DC power supply for broadband equipment such as servers and routers
  - Call for the use of clean energy systems such as solar and wind power
- Saved 133 million kWh of electricity throughout the entire NTT Group in 2008 compared with 2007

B. Indirectly, using ICTs for carbon abatement for avoiding travel

Remote collaboration tools

	Same time *synchronous*	Different time *asynchronous*
Same place *co-located*	***Face-to-face meetings*** meeting rooms, projection systems, tabletop computer, flip charts etc	***Ongoing collaboration*** project management tools, e-calendars, wall charts, shift-work groupware etc
Different place *remote*	***Remote meetings*** remote collaboration tools, audio/video conferencing, IM/chat, telepresence, webcasts, virtual worlds etc	***Time-shift remote collaboration*** websites, forums, email, e-calendars, sharepoints, wikis, version control etc



Note: Segmented by time and place (left chart) and by bandwidth / cost (right chart).

Source: ITU-T Technology Watch Report: "Remote Collaboration Tools." March 2008.
http://www.itu.int/oth/T2301000005/en.

Remote collaboration tools

- Communication-Coordination-Collaboration capabilities are key
- Collaboration in virtual worlds: Virtual worlds can provide a online collaboration plate form and are quickly moving from the entertainment world to the business world of meetings and presentations
- A combination of groupware: Combines the functions of software for communication, collaboration and coordination in one solution. Some examples, and related standards, are shown →

Type of groupware >>	**Audio and video conferencing**	**Instant messaging**	**Multi-user editors, whiteboards, version control**
Examples	• Wengo • Skype • Gizmo • Sipgate	• IRC • ICQ • AIM • Jabber	• Google Docs • Zoho • MediaWiki • ACE • SVN
Standards and protocols involved	H.320, H.323, SIP, H.264, others	XMPP, SIMPLE, others	HTTP, ODF, XML, WebDAV, others

	Remote collaboration tools (vendor)
Examples	Acrobat Connect (Adobe) GoToMeeting (Citrix) Lotus Sametime (IBM) Office Live Meeting (Microsoft) one2meet (Netviewer) OpenMeetings (Open Source project) Marratech (acquired by Google) WebEx Meeting Center (Cisco) etc.
Standards and protocols involved	H.323, T.120, SIP, SIMPLE, XML, XMPP, SSL, TLS, AES, HTTP, LDAP, etc.

Remote Collaboration Tools, ITU-T Technology Watch Report 5 March 2008

C. In a systemic way, by using ICTs to reduce emission in other sectors

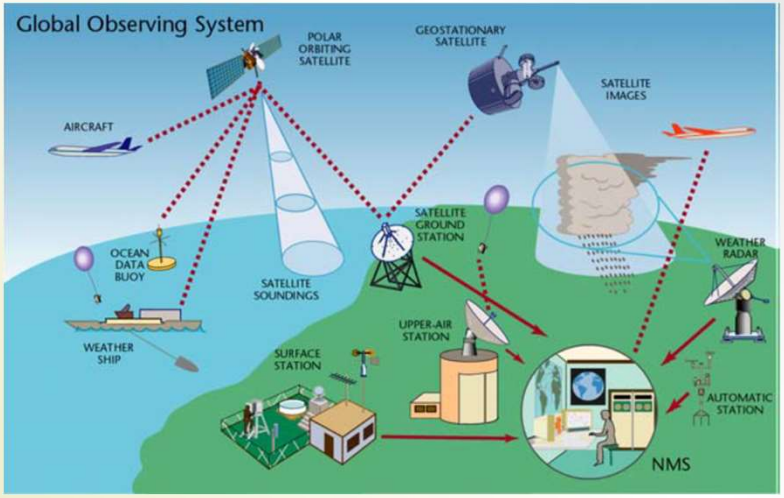
ICT and Intelligent Transport Systems

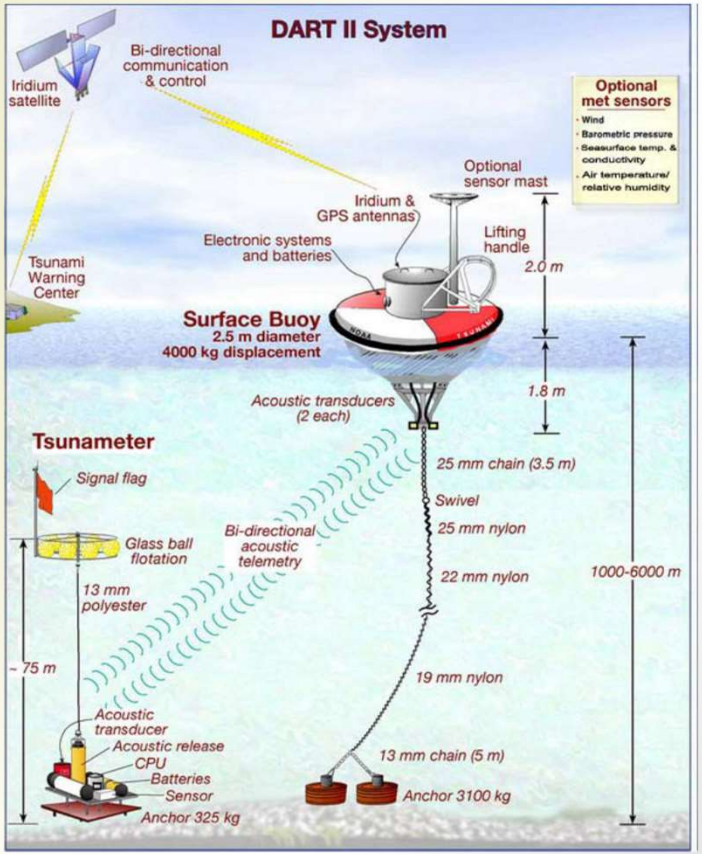
- Parking guidance systems can lead motorists to the most appropriate parking space, and thereby reduce engine time
- GPS use for navigation or vehicle dispatch can reduce journey time
- Road pricing schemes, such as the congestion charge in Singapore and London can encourage greater use of public transport, reduce congestion, thereby reducing journey times
- Using cars as an environment monitoring tool, Feeding real-time data collected from vehicle on average speed, climatic conditions, hold ups etc into satellite navigation systems→ give other vehicles real-time picture of road conditions and suggest alternatives as appropriate

http://statestimesreview.com/2016/02/25/singapores-road-usage-tax-erp-goes-gps-by-2020/

ICT at work for climate change and impacts monitoring

- WMO World Weather Watch, incorporate:
  - Global Observing system
  - Global Telecom System
  - Global Data Processing system
- Remote sensing
- Environmental monitoring
  - Tsunami early-warning system
- Digital climate forecasting models
- GPS-enabled telemetry
- Ubiquitous sensor networks

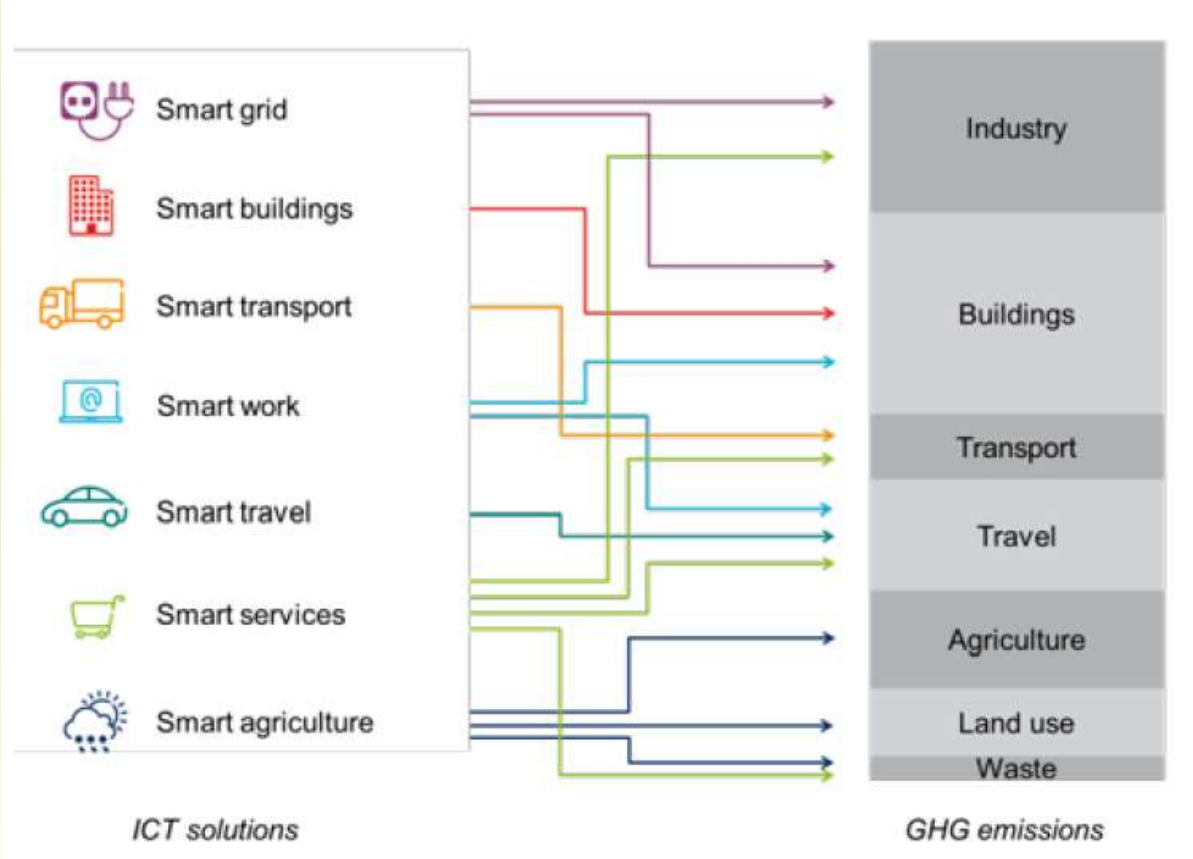




2008Tim Kelly, Head, Standardization Policy Division International Telecommunication Union (ITU), C7 eEnvironment, WSIS action line facilitation meeting, Geneva, 21 May 2008

ICT solutions' Global GHG mitigation potential in 2030

ICT is expected to have large potentials to reduce the GHG emissions across society → How?



Jens Malmodin and Pernilla Bergmark (2015). Exploring the effect of ICT solutions on GHG emissions in 2030. 29th International Conference on Informatics for nvironmental Protection (EnviroInfo 2015) and Third International Conference on ICT for Sustainability (ICT4S 2015), Proceedings pp 37- 46, Published by Atlantis Press.

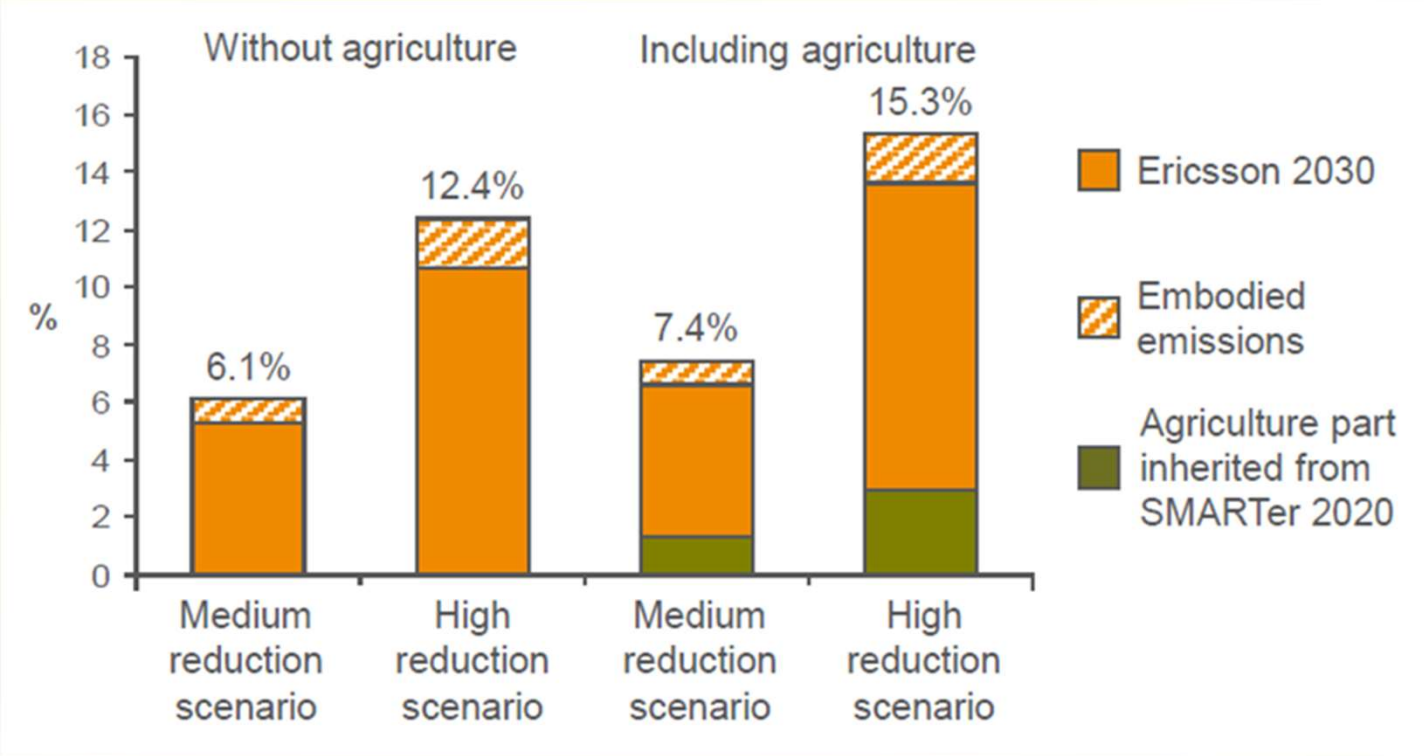
ICT Solutions considered in this study

Enabling ICT solutions	Ref. high %	MRPS/ HRPS %*	Addressable emissions % of emissions from (sub)sector
Smart grids: Smart metering	10	5 / 10	Residential buildings energy: 57% of Buildings sector
Power grid optimization	60	15 / 30	Transmission and distribution electricity losses: 8% of electricity, 2% of global emissions
Facilitating renewable energy sources	9	2 / 7	Electricity production: 25% of global emissions
Smart buildings: Smart building solutions for offices, stores, hotels, schools, etc.	40	10 / 15	Energy consumption in offices, stores, hotels, schools, etc.: 31% of Buildings sector
Smart building solutions for healthcare, food stores and services, etc.	17	3 / 5	Energy consumption in healthcare, food stores and services, etc.: 9% of Buildings sector
Smart transports: Route optimization, fleet management	23	10 / 20	All road transport: 58% of Transport sector
Facilitating the choice of transport mode with help of ICT	50	5 / 10	Shift from air to train/ship, 10% of Transport sector
Smart work: Telemeetings, etc.	60	20 / 30	Air business travel: 7% of Travel sector
Telemeetings, etc.	50	10 / 20	Car business travel: 12% of Travel sector
Telemeetings, etc.	-	12.5 / 25	Hotels used for business, 1.6% of Building sector
Reduced office space, due to ICT	25	10 / 20	Office buildings: 7% of Buildings sector
Teleworking	50	15 / 30	25% of private car travel is allocated to employees who could work from home to some extent: 17.5% of Travel sector
Smart travel: Smart public travel	10	5 / 10	Private car travel: 35% of Travel sector
Fleet car management	23	8 / 15	Commercial car travel: 12% of Travel sector
Route optimization	17	5 / 10	All road travel: 82% of Travel sector
Smart services: e-commerce solutions, products-to- services	10	5 / 10	All transports and industry: 100% of Transport sector 100% of Industry sector
Smart agriculture incl. land use:	13	7 / 13	Agriculture incl land use: 100% of Agriculture sector

Medium Reduction Potential Scenario; High Reduction Potential Scenario
Ref. High → highest reported

Jens Malmodin and Pernilla Bergmark (2015). Exploring the effect of ICT solutions on GHG emissions in 2030. 29th International Conference on Informatics for nvironmental Protection (EnviroInfo 2015) and Third International Conference on ICT for Sustainability (ICT4S 2015), Proceedings pp 37- 46, Published by Atlantis Press

Effect of ICT solutions on Global GHG mitigation in 2030



Total GHG emission reduction potential due to the studied ICT solutions:

- @ 10 GtCO2e or 15% of the global GHG emissions in 2030 (high reduction potential scenario)

Jens Malmodin and Pernilla Bergmark (2015). Exploring the effect of ICT solutions on GHG emissions in 2030. 29th International Conference on Informatics for Environmental Protection (EnviroInfo 2015) and Third International Conference on ICT for Sustainability (ICT4S 2015), Proceedings pp 37- 46, Published by Atlantis Press

Thank you

New Trends to Mitigate GHG Emissions

Behavioral change and collaborative consumption

Collaborative consumption

- Collaborative consumption— This is the systems of organized sharing, bartering, lending, trading, renting, gifting, and swapping
- Booming digital ‘Networking’ technology
- Through networking you can do more with less
- We are already sharing products on a scale never before possible

Collaborative consumption

- http://www.zipcar.com/

what's zipcar?

Glad you asked. It's a smarter way to get around the city.

- Drive cars by the hour or day. Gas & insurance included.
- In neighborhoods, cities and airports across the globe.
- Save hundreds over car ownership.
- Choose from sedans, hybrids, vans and more.
- Membership starts as low as $7/month.

http://www.zipcar.com/

how it works

4 simple steps to Zipcar freedom.

JOIN

Apply in the app and drive in minutes. Or apply online. Once approved, we'll send you a Zipcard to access vehicles worldwide.

RESERVE

Book a Zipcar for as little as 1 hour or as long as 7 days.

TAP

Hold your Zipcard to the car's windshield—or tap the app—to unlock. Voila! It's all yours.

DRIVE

Hit the road. When you're done, park the car in its reserved spot and use your Zipcard or the app to lock up.

Harvard Business Review

BUSINESS MODELS

Beyond Zipcar: Collaborative Consumption

by Rachel Botsman and Roo Rogers

Companies to offer goods as a service rather than sell them as products

Used or preowned goods are moved from somewhere they are not needed to somewhere they are, either free or with price

People with similar needs or interests band together to share and exchange less-tangible assets

	THE PROBLEM	THE SOLUTION
PRODUCT SERVICE SYSTEMS	Half of U.S. households own power drills, but most of them are used for only 6 to 13 minutes during their lifetime.	Zilok.com offers peer-to-peer daily rental of tools, camcorders, and other goods.
REDISTRIBUTION MARKETS	Americans discard 7 million tons of cardboard annually.	UsedCardboardBoxes.com "rescues" and resells boxes to movers.
COLLABORATIVE LIFESTYLES	Millions of houses and spare rooms around the world are sitting empty and have "idling capacity."	Airbnb.com, the "Match.com for travel," allows anyone from private residents to commercial property owners to rent out their extra space.

https://hbr.org/2010/10/beyond-zipcar-collaborative-consumption

https://www.airbnb.com/

Why host on Airbnb?

No matter what kind of home or room you have to share, Airbnb makes it simple and secure to earn money and reach millions of travelers looking for unique places to stay, just like yours.

You're in control

With Airbnb, you're in full control of your availability, prices, house rules, and how you interact with guests. You can set check-in times and handle the process however you like.

We're there at every step

Airbnb offers tools, hospitality tips, 24/7 support, and an online community of experienced hosts for questions and sharing ideas for success.

1 Create your listing

It's free and easy to create a listing on Airbnb. Describe your space, how many guests you can accommodate, and add photos and details.

Our pricing tool can recommend competitive rates, but what you charge is always up to you.

2 Welcome guests

Get to know guests before arrival by messaging them on our platform.

Most hosts clean the spaces guests can use, and provide essentials like clean sheets, towels, and toilet paper.

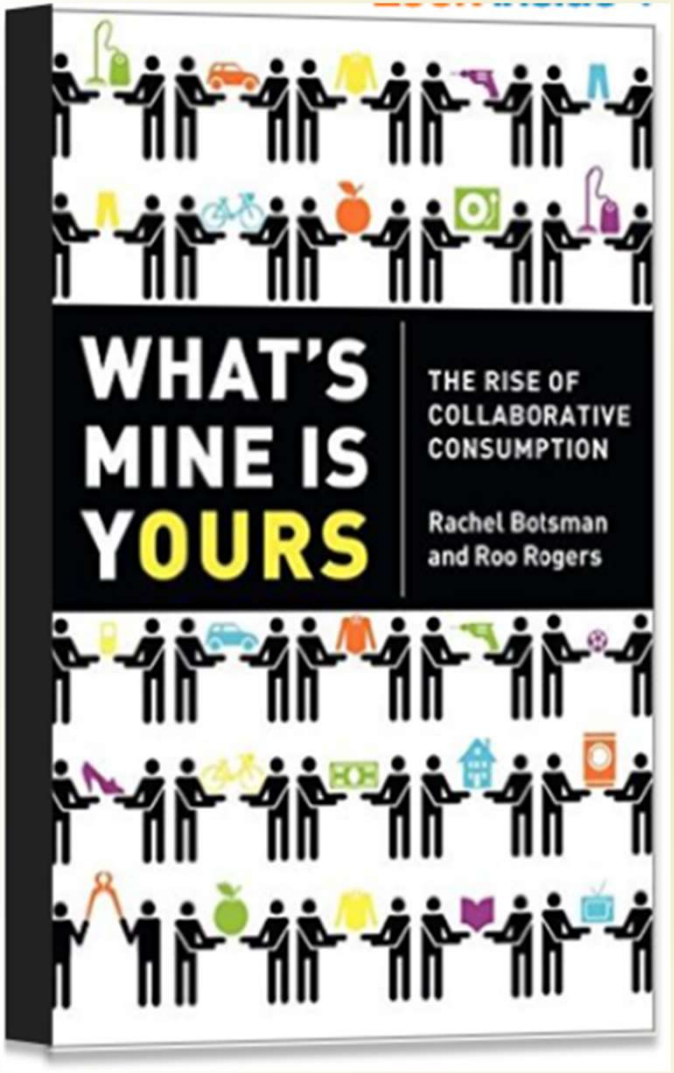
You can greet guests in person with a key or just send them a door code.

3 Get paid

Airbnb's secure payment system means you never have to deal with money directly.

Guests are charged before arrival, and you are paid automatically after check in, minus a 3% service fee.

You can be paid via PayPal, direct deposit, or international money wire, among other ways.



TIME

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Today's Smart Choice: Don't Own. Share

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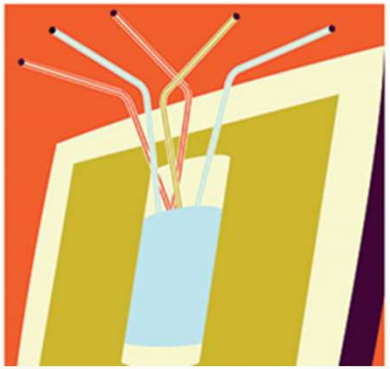
By Bryan Walsh | Thursday, Mar. 17, 2011



Someday we'll look back on the 20th century and wonder why we owned so much stuff. Not that it wasn't great at first. After thousands of years during which most human beings lived hand to mouth, in the 20th century the industrial economies of the West and eventually much of the rest of the world began churning out consumer goods — refrigerators, cars, TVs, telephones, computers. George W. Bush won re-election as President in 2004 in part by proclaiming an "ownership society": "The more ownership there is in America, the more vitality there is in America."

Even as Bush was announcing its birth though, the ownership society was rotting from the inside out. Its demise began with