TELECOM ITALIA GROUP

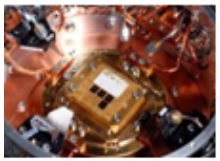
SEAD workshop on Networked Standby, Stockholm 2012/05

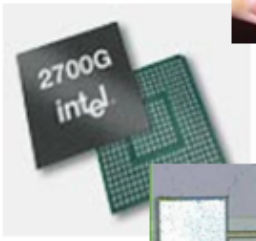
ICT related energy use
a systems perspective on trends and growth

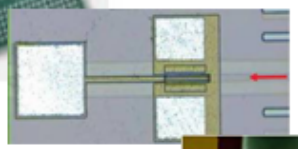
Telecom Italia – Innovation
Flavio CUCCHIETTI

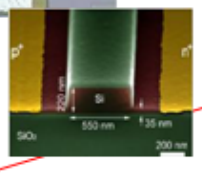
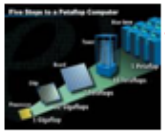
TELECOM ITALIA

Technology & Energy: Where are we going ?








2010 2020

Gbps Interc. F. → 100s' Gbps Interc. F.

WperGflop

0.2% → 0.001%

1c GFlop

100 TFlop

100s PFlop

2Tbps Interc. fabric

100 Qbit

28 Qbit

- Processing anywhere
- Low power cons/diss
- Ultra capacity
- "fibred appliances"
- Commodity
- Real time rendering
- Ambient awareness

Technology & Energy: Where are we going ?

By 2015 there will be 1 trillion sensors linking the physical and digital worlds merging to become an “Internet of Things”

(Viviane Reding 2006)

«A billion people interacting with a million e-businesses with a trillion intelligent devices inteerconnected»

(IBM chairman Lou Gerstner 1995)

List of applications is limited only by our imagination …

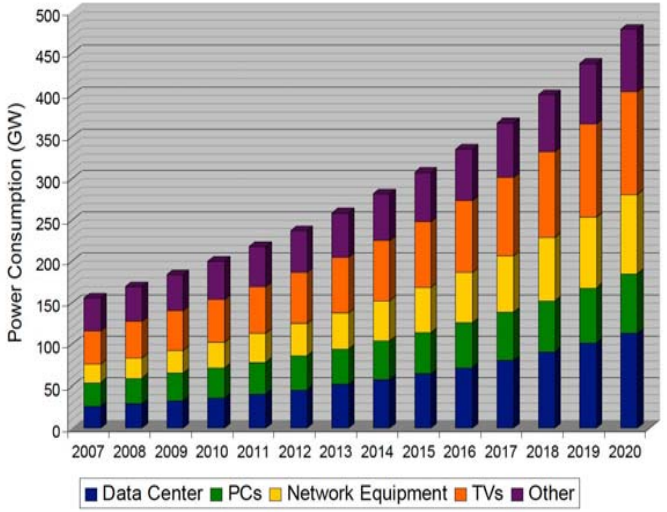
… but we can imagine the huge amount of ICT needed!

(me 2007 - 2012)

Technology & Energy: Where are we going ?

Table 1: EU wide estimates of the ICT sector electricity consumption

	2005	2020 BAU	2020 ECO
Total ICT sector electricity use in EU 25 (TWh/a)	214.5	409.7	288.2
ICT sector **without consumer electronics** in EU-25 (TWh/a)	118.6	245.1	185.2
Total ICT sector electricity use in EU-27 (TWh/a)	216.0	433.1	304.7
ICT sector **without consumer electronics** in EU-27 (TWh/a)	119.4	259.1	195.8
Share of the ICT sector electricity use over total EU-27 electricity use (%)	7.8%	10.9%	7.7%
Share of the ICT sector electricity use (**without consumer electronics**) over total EU-27 electricity use (%)	4.3%	6.5%	4.9%



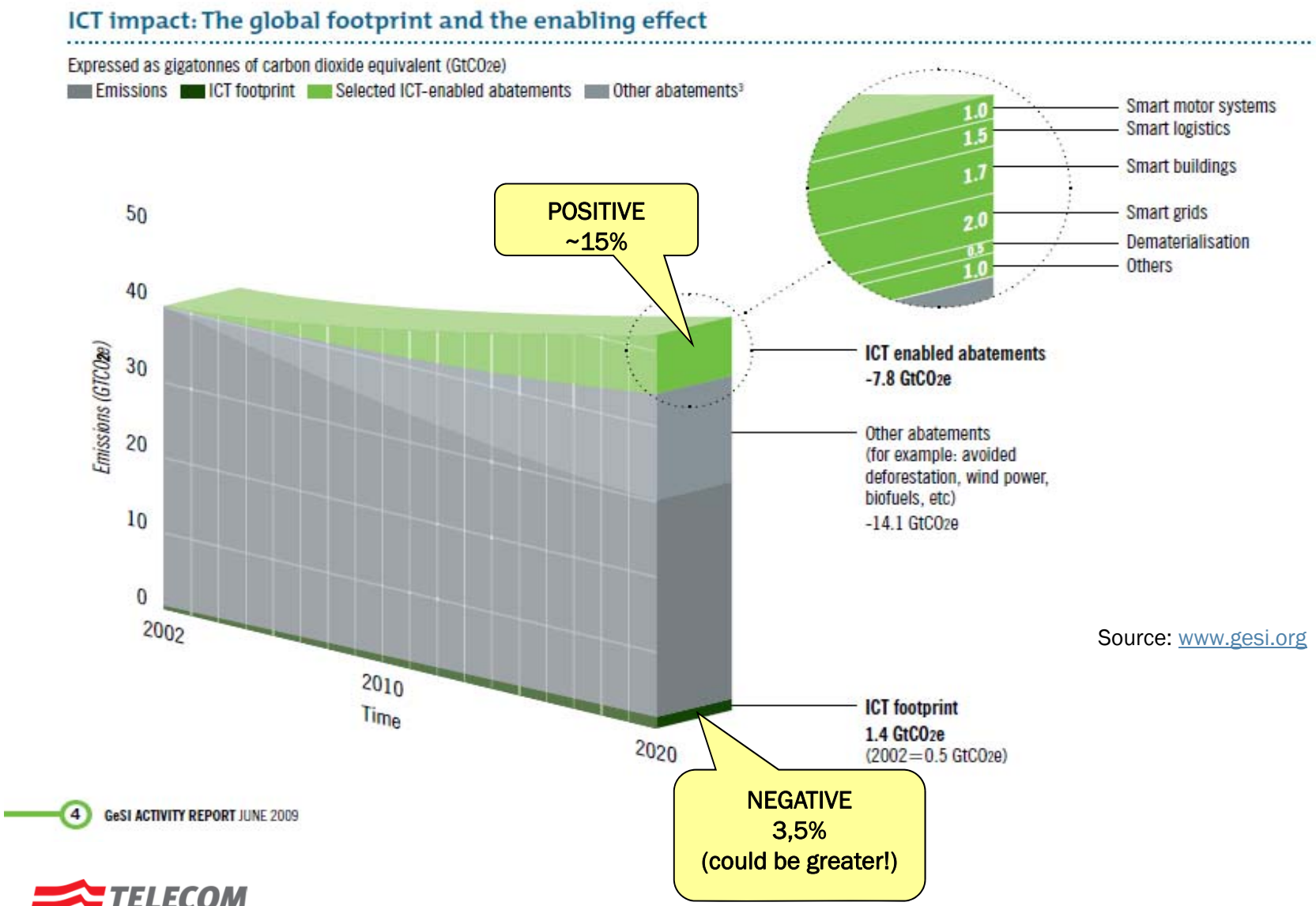
Source: http://ec.europa.eu/information_society/activities/sustainable_growth/docs/studies/2008/2008_impact-of-ict_on_ee.pdf

ICT in 2005 = about 8% of EU electicity usage

Meanwhile:

- Broadband has expanded its reach
- Everything has become «Smart» (cities, services ...)
- Smart Grids are here
- The energy load is shifting towards the home

ICT – part of the "problem" and of its "SOLUTION"



Source: www.gesi.org

Footprint of ICT elements and networks in the home

- Lots of ICT equipment in homes
- Networking elements are proliferating and more are coming
- Their energy behavior must (and can) be optimized!

Table 10: Power values for home gateway central functions plus WAN interface

Home gateway central functions plus WAN interface	Tier 2011-2012: 1.1.2011-31.12.2012		Tier 2013-2014: 1.1.2013 - 31.12.2014	
	Idle-State (W)	*On-State (W)*	*Idle-State (W)*	*On-State (W)*
ADSL2plus	2.6	3.8	2.4	3.4
VDSL2 (8, 12a, 17a, but not 30a)	3.5	6.0	3.2	4.6
VDSL2 (30a)	4.2	6.7	3.9	5.3
Fast Ethernet WAN	2.5	3.3	2.0	3.0
…				
Fibre Ptp Gigabit Ethernet WAN	3.5	6.2	3.2	5.6
GPON	4.0	6.5	3.5	5.0
…				
10/10G-EPON	5.6	8.8	5.3	7.7
DOCSIS 2.0	3.7	4.6	3.7	4.6
…				
WiMAX	7.7	10.6	3.5	6.0
3G	4.0	7.0	3.5	6.0
LTE	4.0	7.0	3.5	6.0

Table 11: Power values for home gateway LAN interfaces and additional functionality

Home gateway LAN interfaces and additional functionality	Tier 2011-2012: 1.1.2011-31.12.2012		Tier 2013-2014: 1.1.2013 - 31.12.2014	
	Idle-State (W)	*On-State (W)*	*Idle-State (W)*	*On-State (W)*
1 Fast Ethernet port				
1 Gigabit Ethernet port				
Wi-Fi interface, single band IEEE 802.11g or 11a/h radio[5] with up to 23 dB EIRP				
…				
Powerline - High speed broadband home netw (less than or equal to 5 BW)				
…				
PowerLine - Low speed smart metering and appliances control				
FXS				
ISDN S0	0.2	0.4	0.2	0.4

Table 13: Power values for USB dongles

USB dongles	Tier 2011-2012: 1.1.2011- 31.12.2012		Tier 2013-2014: 1.1.2013 - 31.12.2014	
	Idle-State (W)	*On-State (W)*	*Idle-State (W)*	*On-State (W)*
USB powered peripherals and dongles - 3G/4G	0.7	2.45	0.5	1.75

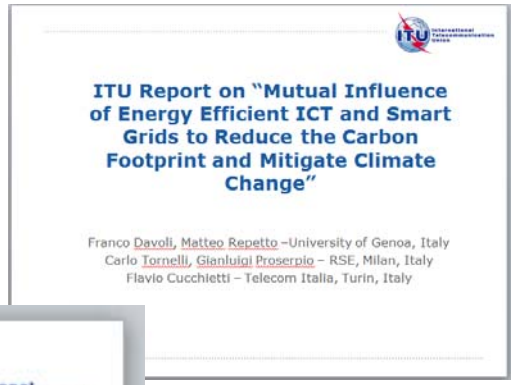
Table 14: Power targets for Home Network Infrastructure Devices (HNID)

Equipment	Tier 2011-2012: 1.1.2011- 31.12.2012		Tier 2013-2014: 1.1.2013 - 31.12.2014	
	Idle State (W)	*On-State (W)*	*Idle-State (W)*	*On-State (W)*
Wi-Fi Access Points with single band IEEE 802.11b/g or 11a	2.3	3.6	2.2	3.4
Wi-Fi Access Points with single band IEEE 802.11n radio	3.5	5.0	2.3	3.9
Alternative LAN technologies adapters (HPNA, MoCA,…)	4.5	4.5	3.5	4.0
Small hubs and non-managed 4 port Layer 2 Fast Ethernet switches without CPU (no VPN or VoIP)	1.6	2.0	1.4	2.0

Source: EC BroadBand Code of conduct
http://ie.jrc.ec.europa.eu/energyefficiency

Some insights - Smart grids

(Excerpts of the ITU report energy efficient ICT and Smart Grids)
The report will be presented at the ITU conference on ICT and Climate Change in Montreal (May 29-31th 2012)


ITU Report on "Mutual Influence of Energy Efficient ICT and Smart Grids to Reduce the Carbon Footprint and Mitigate Climate Change"

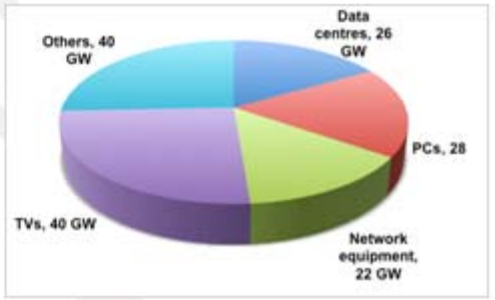
Franco Davoli, Matteo Repetto –University of Genoa, Italy
Carlo Tornelli, Gianluigi Proserpio – RSE, Milan, Italy
Flavio Cucchietti – Telecom Italia, Turin, Italy

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International Telecommunication Union

Energy footprint of ICT – 2

- Homes and Distribution grids are expected to be the most critical environments.
  - millions of such sites in the whole system.



An example: Future broadband network's Energy footprint estimation

	power consumption (Wh)	number of devices	overall consumption (GWh/year)
Home	10	17,500,000	1,533
Access	1,280	27,344	307
Metro/transport	6,000	1,750	92
Core	10,000	175	15

Sources: 1) Broadband Code of Conduct V.3 (BCoCC) and "inertial" technology improvements to 2015-2020 (home and access cons.)
2) Telecom Italia measurements and evaluations (power consumption of metro/core network and number of devices)

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Smart grids

ITU Report on "Mutual Influence of Energy Efficient ICT and Smart Grids to Reduce the Carbon Footprint and Mitigate Climate Change"

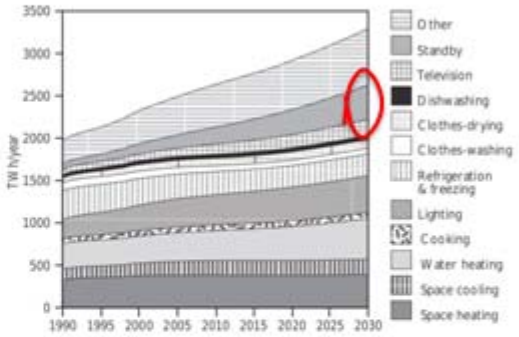
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Energy footprint of ICT – 3

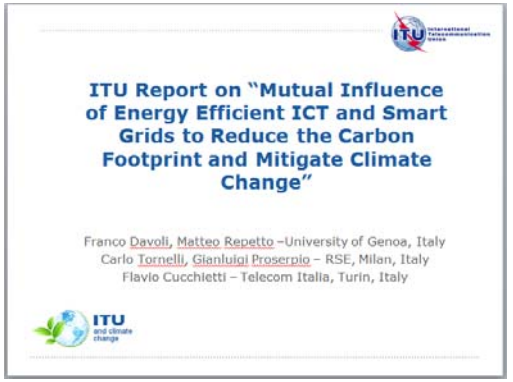
- Energy usage of ICT equipment is increasing in homes, owing to:
  - more ICT devices
    - laptops, set-top-boxes, smart phones, handhelds, tablets, … ;
  - most devices are left powered on even when not used
    - often to maintain "network presence";
  - inefficient standby states



	On		Off		Standby	
	Average power W	operating hours per day h	Average power W	operating hours per day h	Average power W	operating hours per day h
Domestic computers and peripherals						
CRT Monitors	32,6	3,92	0,78	5,51	1,43	14,57
Desktop	119,6	5,98	0,28	8,4	36,9	9,62
Peripherals	3,32	6,38	1,29	7,2	0,42	10,42
Multi function printers	4,37	1,94	1,28	10,54	0,8	11,52
New electronic loads						
TV - Conventional	[illegible]	4,09	0,08	4,68	[illegible]	15,23
Setop box	4,5	4,5	-	-	4,51	19,5
Audio HiFi	17,92	1,35	1,25	4,14	4,39	18,51
Game/playstation consoles	2,7	1,43	0,01	10,14	0,21	12,43
DVD players and recorders	14,27	0,72	0,45	4,8	6,06	18,48
Other stand-by power						
Electronic alarm clocks	-	-	-	-	[illegible]	24
Chargers for cordless Phones and mobile phones	3,52	8,68	-	-	3,19	15,32
Microwave					0,92	

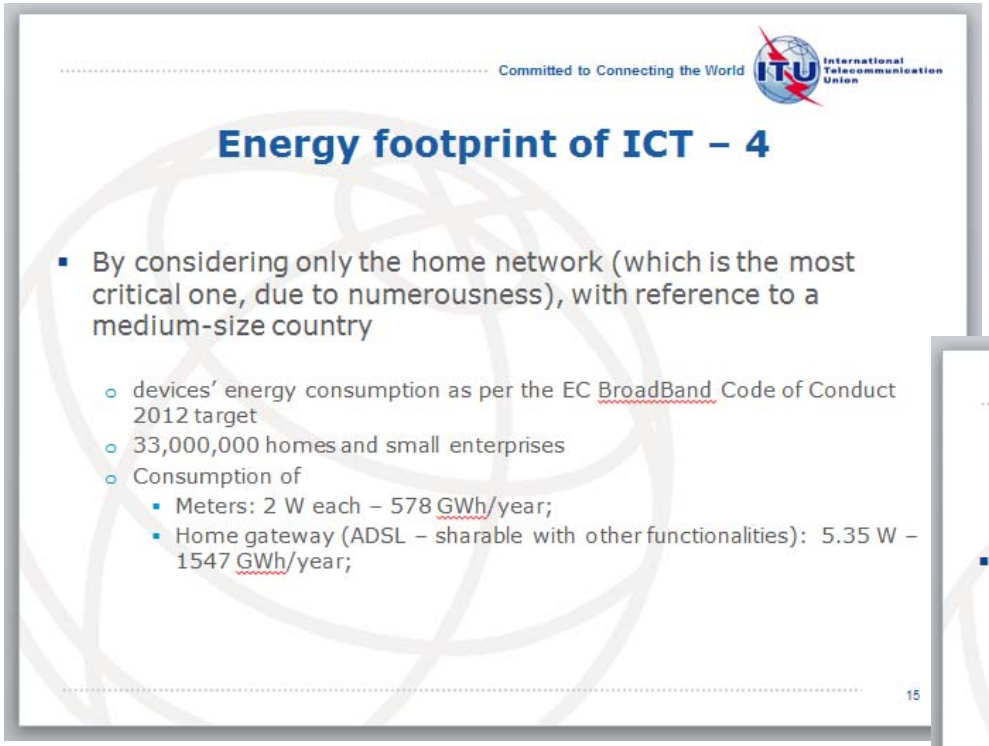
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Smart grids


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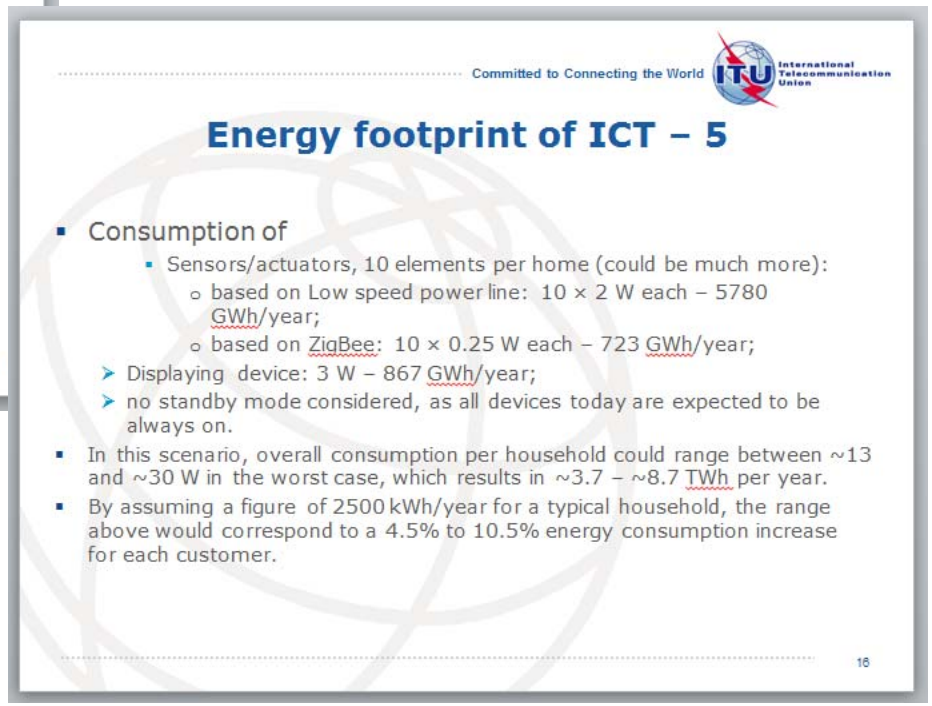
ITU and climate change


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Energy footprint of ICT – 4

- By considering only the home network (which is the most critical one, due to numerousness), with reference to a medium-size country
  - devices' energy consumption as per the EC BroadBand Code of Conduct 2012 target
  - 33,000,000 homes and small enterprises
  - Consumption of
    - Meters: 2 W each – 578 GWh/year;
    - Home gateway (ADSL – sharable with other functionalities): 5.35 W – 1547 GWh/year;

15

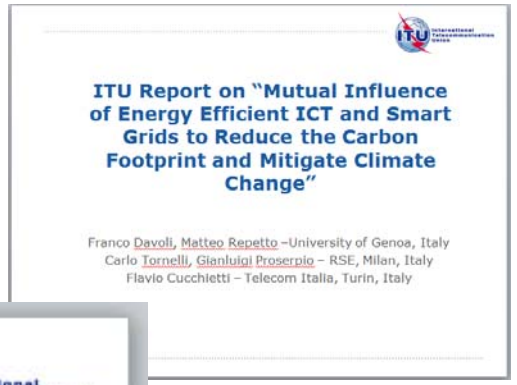

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Energy footprint of ICT – 5

- Consumption of
  - Sensors/actuators, 10 elements per home (could be much more):
    - based on Low speed power line: 10 × 2 W each – 5780 GWh/year;
    - based on ZigBee: 10 × 0.25 W each – 723 GWh/year;
  - Displaying device: 3 W – 867 GWh/year;
  - no standby mode considered, as all devices today are expected to be always on.
- In this scenario, overall consumption per household could range between ~13 and ~30 W in the worst case, which results in ~3.7 – ~8.7 TWh per year.
- By assuming a figure of 2500 kWh/year for a typical household, the range above would correspond to a 4.5% to 10.5% energy consumption increase for each customer.

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Smart grids


ITU Report on "Mutual Influence of Energy Efficient ICT and Smart Grids to Reduce the Carbon Footprint and Mitigate Climate Change"

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Energy footprint of ICT – 7

- The path towards a Green ICT includes:
  - Re-engineering of devices' hardware
    - energy-efficient silicon;
    - reduction of complexity.
  - Dynamic adaptation of performance
    - power scaling;
    - low-power idle.
  - Smart standby states
    - proxying network presence;
    - virtualization.

Both at
- device level
- whole network level (energy-aware traffic engineering)

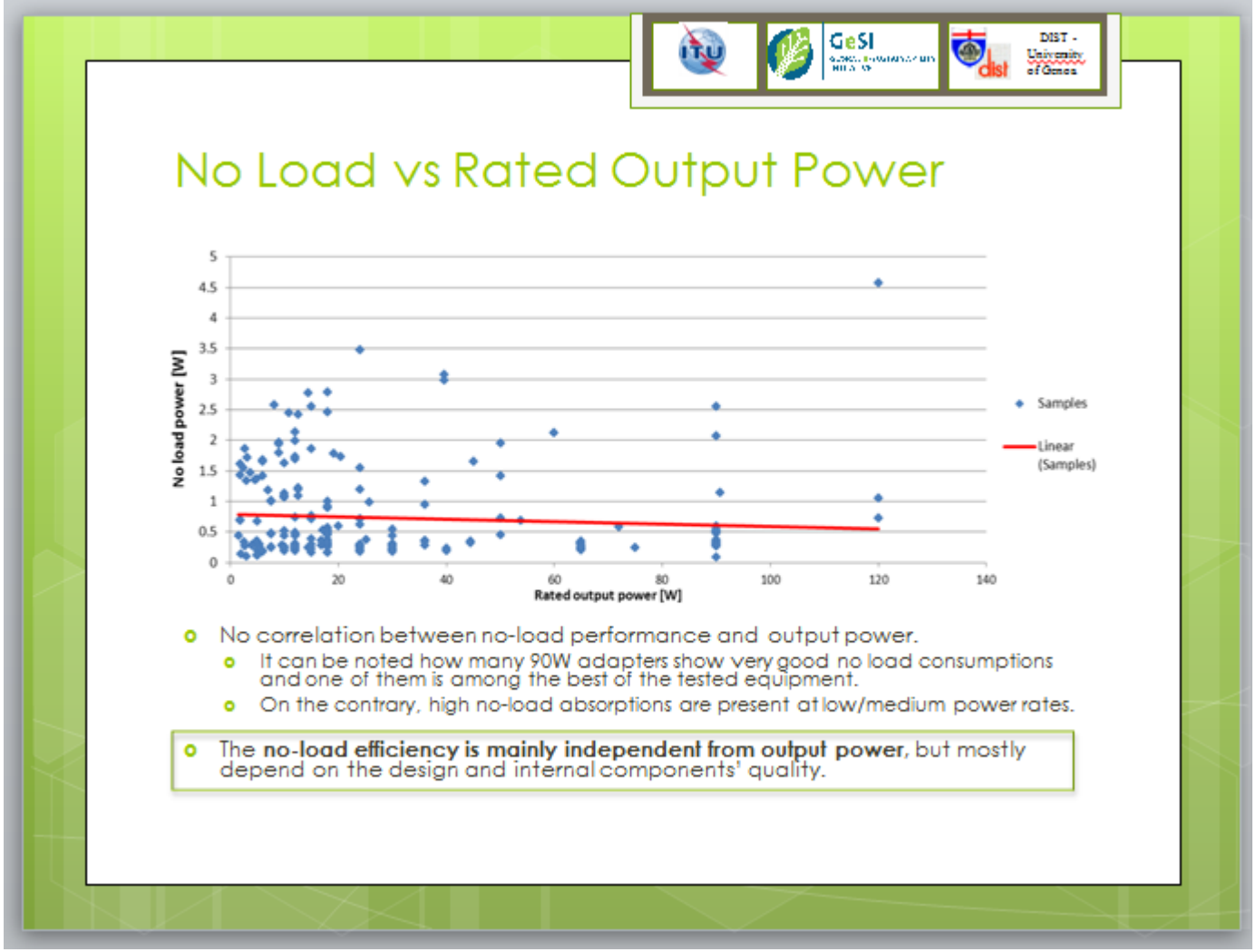
Estimated energy saving in 2015-2020 perspective telecommunication networks by the ECONET project – Telecom Italia use case.

	Full load power consumption [W]	*Number of devices [#]*	*Overall full consumption [GWh/year]*	*Percentage Gains [%]*	*Energy Gains [GWh/year]*
Home	10	17,500,000	1,533	70	1,060
Access	1,280	27,344	307	70	213
Metro/transport	6,000	1,750	92	54	49
Core	10,000	175	15	58	9
Total [GWh / year]			**1947**	**68**	**1,331**

18

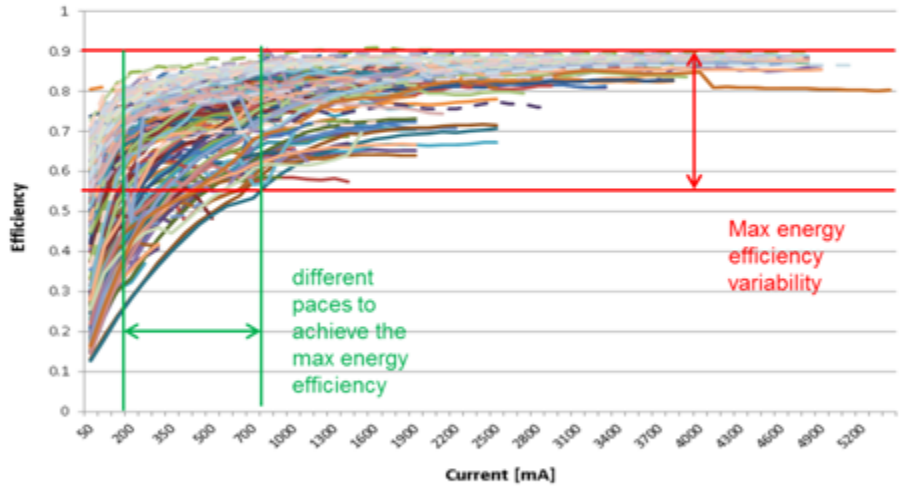
Some insights – External Power Supplies

(Excerpts of the ITU-GeSI report External Power Supplies)
The report will be soon available in the ITU and GeSI web sites)



Some insights – External Power Supplies

Energy Efficiency at Variable Loads

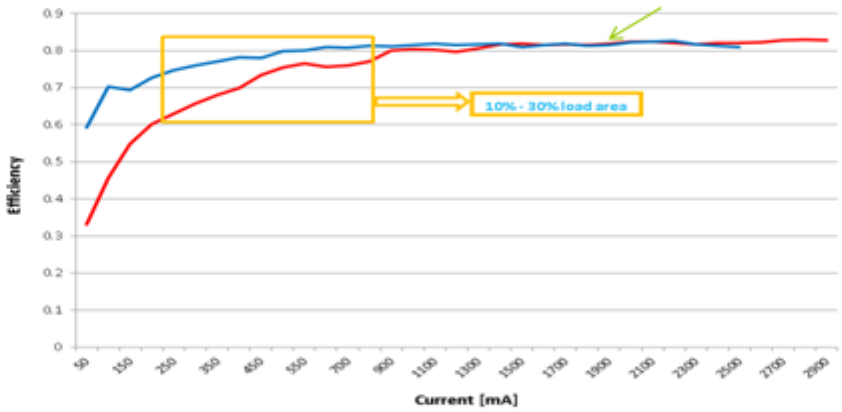


- Energy efficiency curves with variable loads for all the analyzed adapters.
- Each power supply has been tested up to its declared maximum value of DC current.

Some insights – External Power Supplies

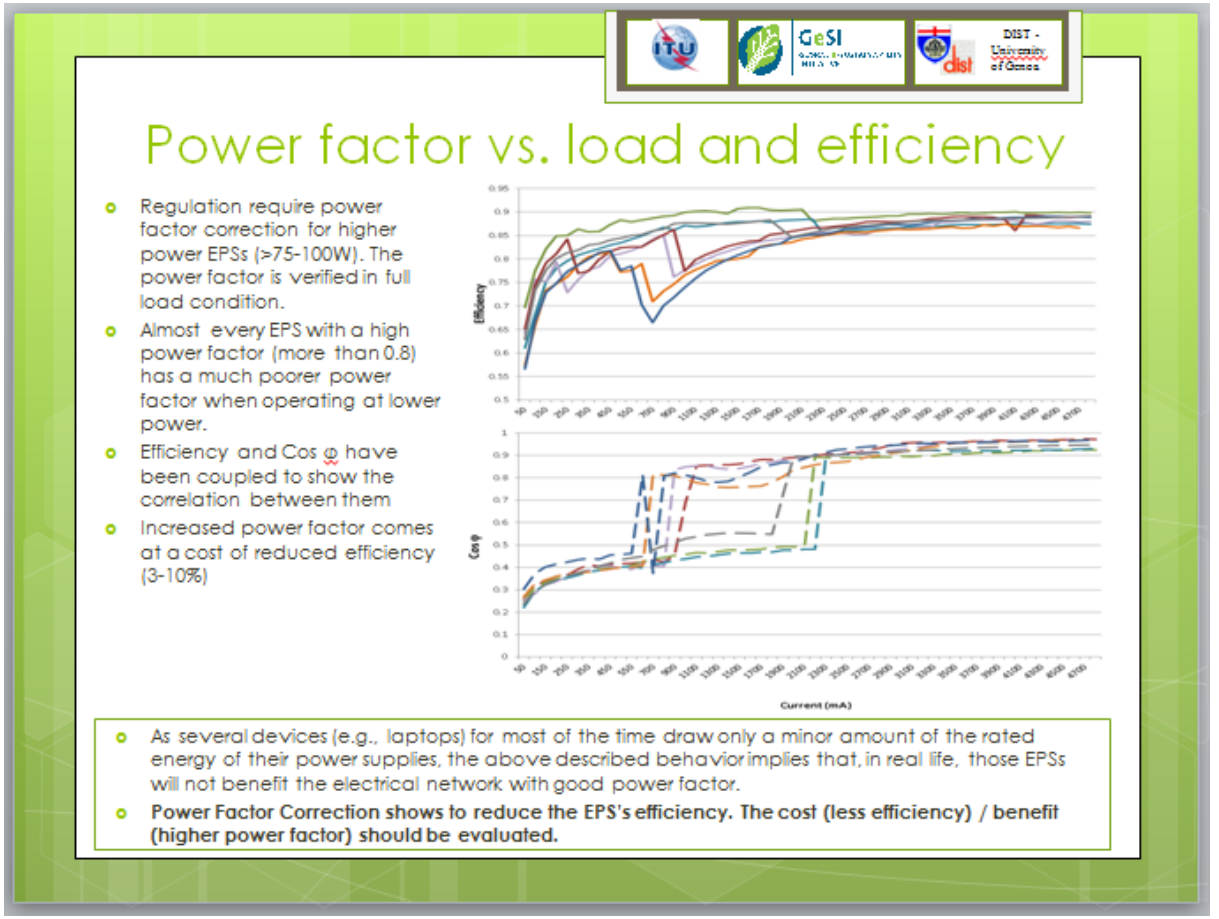
Comparison among equivalent equipment

Two EPSs with the same average ES consumption



- Even if the Energy Star calculation of the average energy efficiencies (mean of the efficiencies at 25%, 50%, 75% and 100% of the rated load) gives very similar results, the differences in the efficiency behavior are often clearly noticeable.
- **The gap in the range up to the 20-30% of the maximum load can be quite noticeable (5%-15%).** This results in a significant increase in the overall energy consumption as several devices draw only a limited amount of energy for most of their operating time.

Some insights – External Power Supplies



Work in progress on EPS:

- Within Standardization
- In DoE (BCEPS)
- In Europe CoC on EPS

Defining more efficient equipment and architectures

Do we want results soon?



..... Go Standard!

..... Connect STD with public and private research!

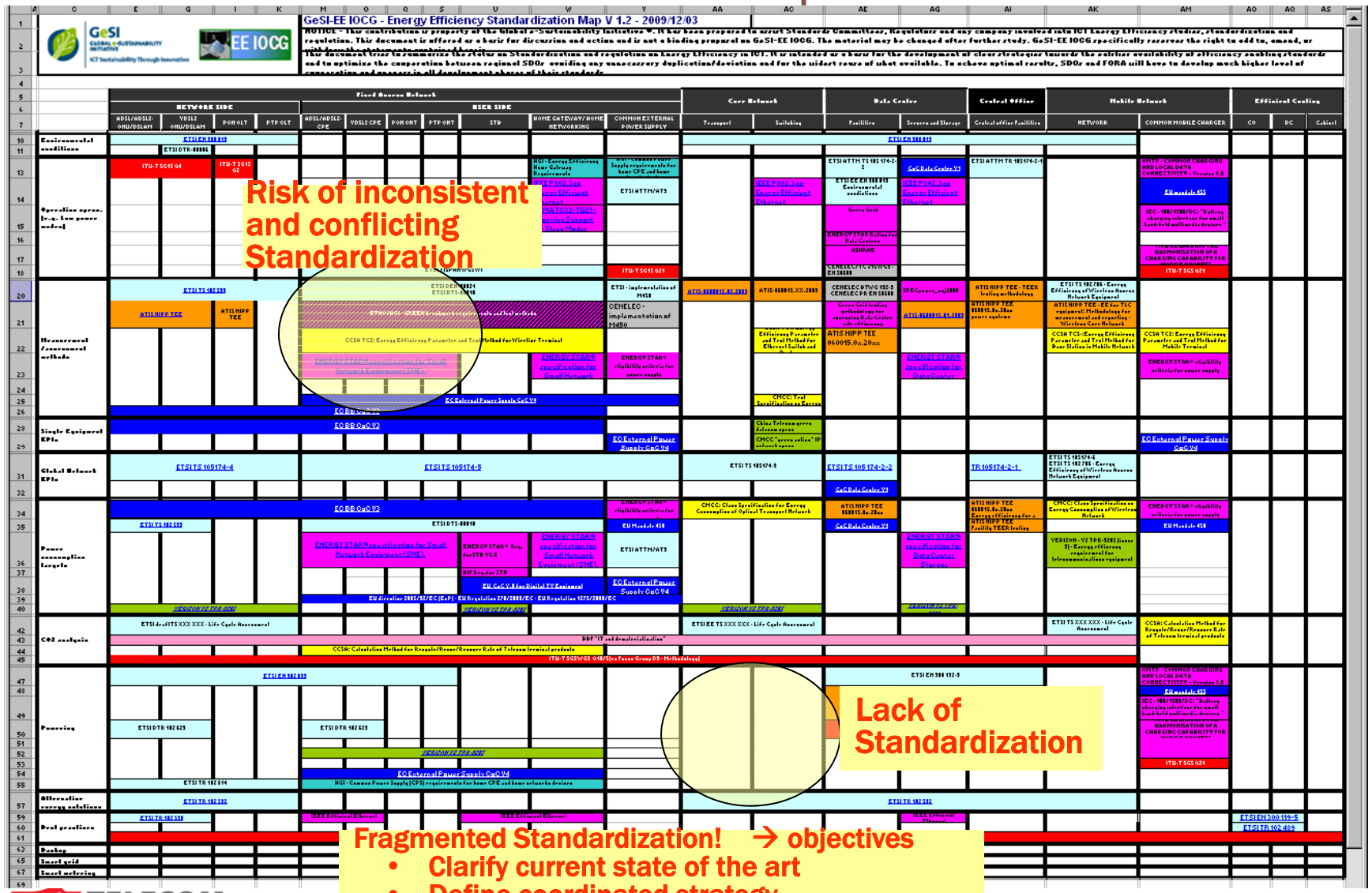
- Products are global and need huge investments
- Standardization is the key to guarantee:
  earlier availability, quality and affordable costs

... but is the Standardization arena ready for this challenge?

- Strong need for coordinated action within and among STD Bodies
- To reach the 2020 objectives it is urgent to obtain results now
- Regulators/Governments need to play an active role

Standardization's fragmentation and lack of coverage

GeSI EE IOCG Standardization Map – December 2009



Fragmented Standardization! → objectives

- Clarify current state of the art
- Define coordinated strategy

Source: http://gesi.org/LinkClick.aspx?fileticket=Lmkk%2fMfiZ9Q%3d&tabid=72

Many activities in progress in and outside Europe

ECO net

Trend

greenet

GreenTouch™



University research
Public research
Private research

STRONGEST

eARTH
Energy Aware Radio and neTwork tecHnologies

Many other .....

Step 2b → Coordinating objectives and actions

Do we want results soon?



..... Go Standard!

..... Connect STD with public and private research!

... too often research results do not become products

- **Promote** linking and cross fertilization among Research, Academia and Standardization
- **Do it systematically**, starting from the EC funded projects
- Review procedures and rules **of the Standardization organizations** to enable such contributions

Let's move all together!

- **Showing that the ICT can contribute within its own sector**

Let's not be shy

Energy Efficiency is worth re-thinking architectures, protocols, standards …

- **Coordinating actions to accelerate the availability of more efficient ICT**
- **Enabling important and measurable savings now**
- **Paving the way for future technologies and services that will deliver even more**
- **… then ICT will be more credible towards the "98%"**

It is URGENT to develop an energy efficient and low carbon society

It can be reached through coordination,

cooperation and standardization

Let's make it happen!

See also https://itunews.itu.int/En/1942-Time-for-coordinated-action.note.aspx

Thank you

flavio.cucchietti@telecomitalia.it

See you and let's progress at the 2nd ITU Green Standards Week
17-21 September 2012, Paris, France
http://www.itu.int/ITU-T/worksem/climatechange/