Boosting Energy Efficiency through Smart Grids

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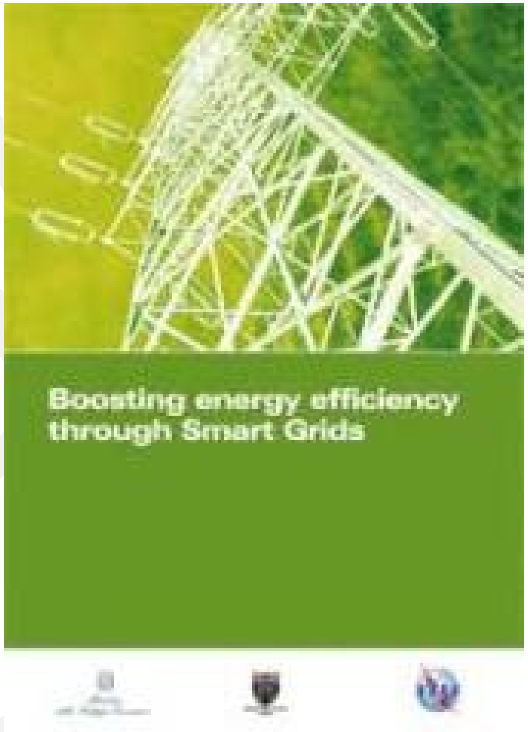
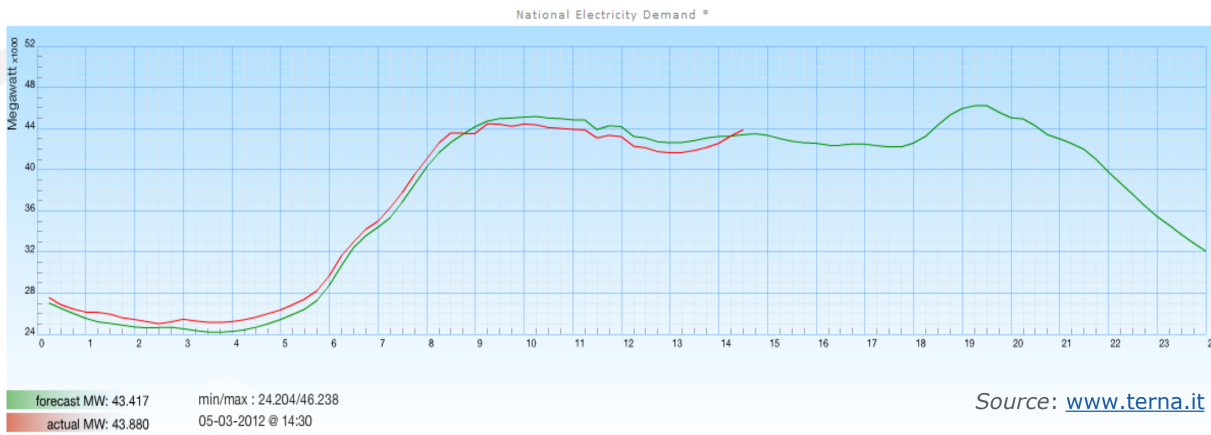
Outline

- Responsibility of the electrical system in GHG emissions
- The need for Smart Grids
- The role of ICT in reducing GHG emissions
- ICT and the Smart Grid
- Energy footprint of ICT infrastructures
- Smart Grids and Smart Cities

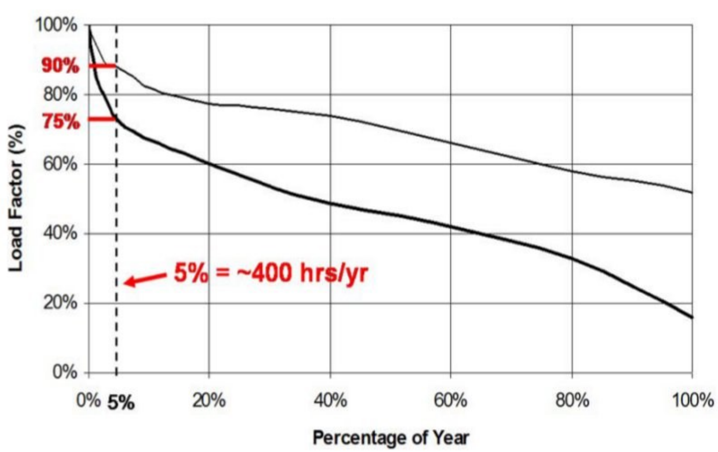


Responsibility of the electrical system in GHG emissions

Large fluctuations in electricity demand …



Source: www.terna.it



… require overprovisioning plants and grid and lead to inefficient generation

Oil and coal fired power plants are mainly responsible for GHG emissions of electricity production

Source: E. M. Lightner, S. E. Widergren, "An orderly transition to a transformed electricity system", IEEE Transactions on Smart Grid, vol. 1, no. 1, pp. 3-10, June 2010.

The need for Smart Grids (SG)

- **To aim at a more sustainable electrical system**
  - higher efficiency and full integration of renewables will strongly cut down GHG emissions.
- **To enable optimal use of resources, new services and economic saving**
  - Through: Load management, Distributed Generation, Microgrids, Energy Storage, Grid Management, Market operations, Electrical Vehicles, …
- **To link up all elements:**
  - To make grid management automatic, reliable, resilient, safe and secure.

The role of ICT in reducing GHG emissions

The ICT sector can enable emission reductions in a number of ways:

- **Standardizing**: ICT standards are the keys for optimizing the management of the electrical grid and the ICT's own energy footprint;
- **Monitoring**: ICT can incorporate monitoring information into the design and control of energy use;
- **Accounting**: ICT can provide the capabilities and platforms to improve accountability of energy and GHG;
- **Rethinking**: ICT can offer innovations that capture energy efficiency opportunities across buildings/homes, transport, power, manufacturing and other infrastructures, and provide alternatives to current ways of operating, learning, living, working and travelling;
- **Transforming**: ICT can apply smart and integrated approaches to energy management of systems and processes, including benefits from both automation and behavioural change and develop alternatives to high carbon activities, across all sectors of the economy.

ICT and the Smart Grid

- Information should be easily available to any legitimate participant at any location;
- Delivery should account for different levels of quality of service, according to the specific application;
- Most important parameters are bandwidth, delay, reliability, resilience;
- Information needs to be protected against illegitimate use, and participants must be enabled to trust each other and the data exchanged;
- Commands/activations are vital to guarantee safety, interworking and service stability. They will have to be particularly protected.

Designing communication facilities in smart grids involves dealing with several aspects:

- software infrastructures to build distributed services and applications;
- syntax and semantics of information exchange;
- transport of information and networking;
- communication media and technologies.

ICT and the Smart Grid

However…

- SG has different meanings for different players and uses
- ICT supplies the pillars for the development of the Smart Grid, but there is a great risk of fragmentation
- Issues
  - too many contexts
  - system of systems
    - heterogeneous communication technologies
    - integration and interoperability

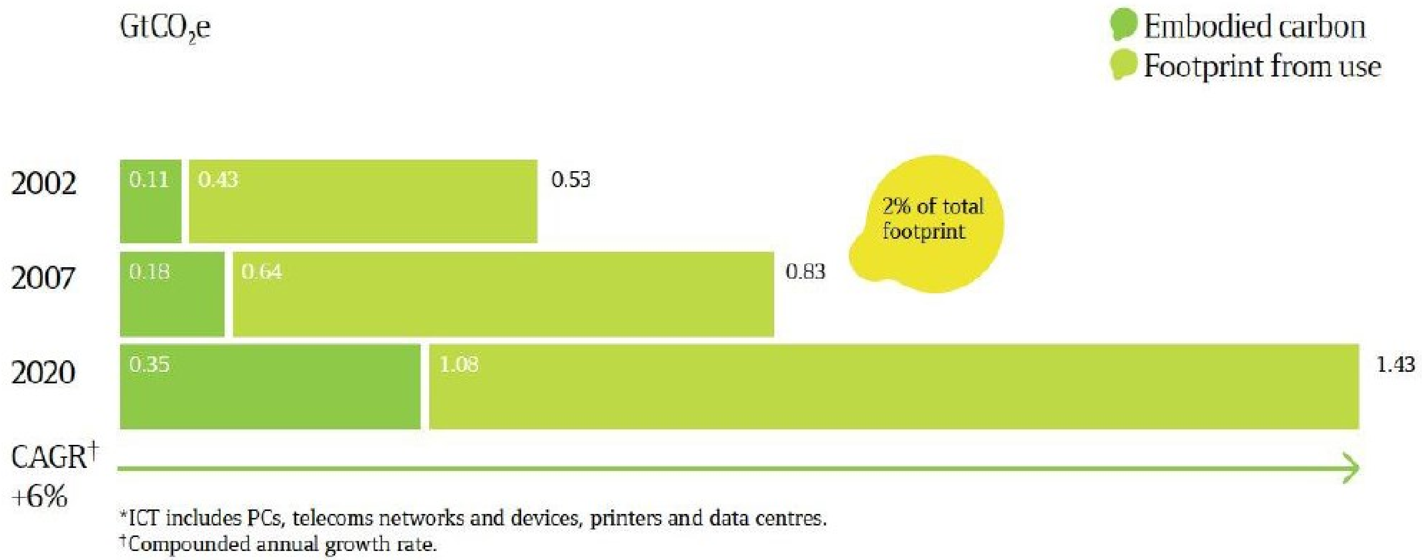
Distributed services and applications

Data models and information exchange
CIM, IEC61850, DLMS/COSEM

Networking
SN, LAN/HAN, NAN/MAN, WAN

Communication media and technologies
Wired (Ethernet, xDSL, optical fibre), Power-Line (HomePlug, HomePNA, HomeGrid), Wireless (ZigBee, Z-wave, WiFi, WiMax, GSM, UMTS/LTE) …

Energy footprint of ICT - 1



- Energy footprint of ICT is continuously increasing … mainly at the user side
  (Due to: more ICT devices; most devices are left powered on even when they are not used; standby mode is inefficient)
- Full implementation of Smart Grids will further raise current forecasts!

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 (EC-JRC) 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)
[see R. Bolla, R. Bruschi, K. Christensen, F. Cucchietti, F. Davoli, S. Singh, "The potential impact of green technologies in next-generation wireline networks: Is there room for energy saving optimization?" IEEE Communications Magazine, vol. 49, no. 8, pp. 80-86, Aug. 2011]

Energy footprint of ICT – 2

- Consumption of SG elements will not be negligible!
- There is definitely the need for:
  - Improvement of equipment, networks and services
  - Development of SG with a holistic perspective
  - Involvement of all stakeholders

  More STANDARDIZATION and cooperation is needed!
- Without strong improvement on technologies and careful choice among solutions:
  - The additional consumption of ICT in homes (home networks, sensors, actuators, meters, displays …) could add as much as 10% to end users' energy bill
  - At national level, the global energy footprint of ICT for SG could be measurable as many percentage points of additional energy load

Energy footprint of ICT - 3

- The path towards Green ICT includes:
  - Careful evaluation of the technical solutions chosen
    - There is definitely not a single solution able to fit all needs, World’s regions, cities, rural areas …
    - Base decisions also on their energy consumption
  - Re-engineering of devices’ hardware
    - energy-efficient silicon and reduction of complexity.
  - Dynamic adaptation of performance/consumption
    - power scaling (Adaptive Rate, AR) and low-power idle (LPI).
  - Smart standby states
    - proxying network presence and virtualization.
  - Device and network level optimization
    - energy-aware traffic engineering

Strong cooperation between Research – Standardization – Industry - Providers - Users is needed

Smart Grids and Smart Cities 1/2

- Most consumers located in cities!
- Density of users and limited distances make cities the ideal site for early SG developments (optimal cost-benefit)
  - Large-scale grid monitoring network
    - Also allows conceiving shared use by multiplexed applications that base on user data from public and home networks
  - Infrastructure sharing among applications (verticals)
    - Vital to enable early and cost-effective SG deployment
    - Metropolitan area networks for data collection
      - Using existing public and private networks
      - Best and earliest environment for fixed and mobile ultraBB
    - ICT consumes a huge lot of energy too → opportunity to act on the energy consumption "through ICT" and "of the ICT"
      - E.g. demand/response, telcos' backup battery pools in urban areas, …)

Smart Grids and Smart Cities 2/2

- Density of users and limited distances …
  - Users are becoming small producers
    - Adopting renewable energy solutions (e.g., solar) – impact on urban architecture, need to coordinate w/ eco-city-planning
  - Incremental optimization of the electric transport network in urban areas
    - Electric vehicles
      - Positive impact on traffic and pollution,
      - Positive/negative impact on the electric system,
      - Deployment of charging points
      - …
  - "Smoothing" distribution through increased awareness of demand and supply

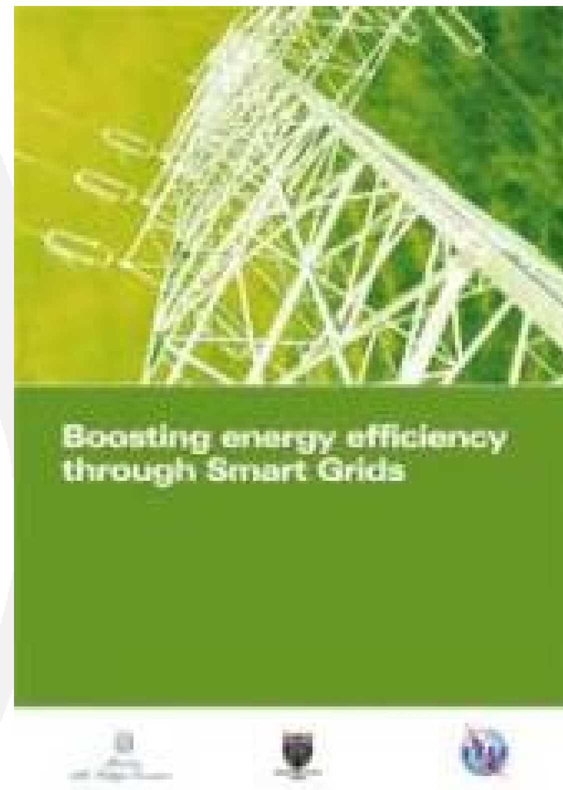
Key issues, challenges and opportunities for ICT

- Modern paradigms often rely on rich and flexible data description
  - Risk of transmission delays, network overload and unacceptable performance for time-critical applications.
- Coexistence of multiple technologies – no "one fits all" solution
  - wireline = higher performance, but with higher deployment costs (remote areas)
  - wireless = cost-effective solutions, but performance limits and reach limitations; interferences are likely for unlicensed technologies
- Survivability of the telecommunication network to blackouts
- ICT for SG has to be carefully designed and standardized to:
  - Maximize SG benefits
  - Guarantee a stable energy system
  - Avoid ICT to become an unacceptable energy burden itself

ICT is the enabler of a more efficient electrical system and for the electrification of developing countries

More information

- Contact: Cristina Bueti (greenstandard@itu.int)
- http://www.itu.int/ITU-T/climatechange/
- Report: http://www.itu.int/ITU-T/climatechange/report-smartgrids.html



Thank YOU