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Smart Grids and Security
Chalmers May 14, 2013

Smart Grids and Security
Agenda

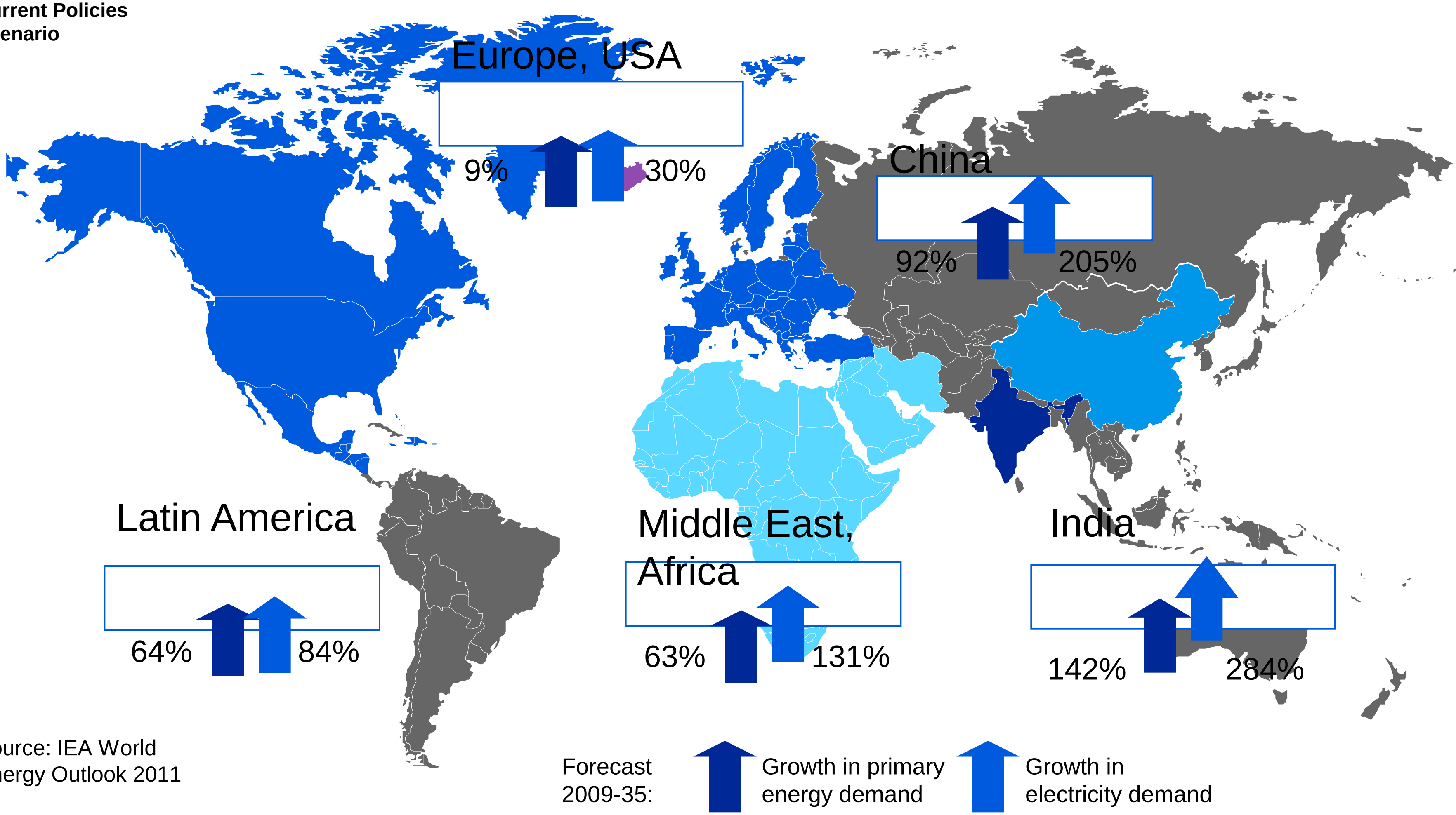
- Smart Grid Basics
- Some examples of pilot projects
- Smart Grid Security

Today's energy challenge
The evolving grid

- Electricity is the most versatile and widely used form of energy in the world, developed over the past one hundred years
- More than 5 billion people have access to electrical energy
- The electrical system ranges from power generation and transport to final consumption
- Its evolution is ongoing but we urgently need to speed up the development
- To mitigate global climate change the electrical system needs to change quickly
- **We need a much better power system**

Today's energy challenge
Soaring demand; electricity growth greater than average

Current Policies Scenario



Source: IEA World Energy Outlook 2011

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Today’s energy challenge
Global drivers

- **Growth**
  - Population
  - Economy – in particular in emerging countries
- **Sustainability**
  - Pollution – locally
  - Climate change – globally
  - Scarcity of natural resources
- **Acceptance**: Difficult to build new infrastructure
- **Substitution**: Importance of electricity still growing, outpacing all other types of energy

Development of electricity supply and application is the key to increase sustainability

Today's energy challenge
Cut link between growth, energy use and emissions

Meeting these challenges requires the world to:

Reduce the correlation between economic growth and energy use

Reduce the correlation between energy use and emissions

Energy efficiency

Renewable sources of energy

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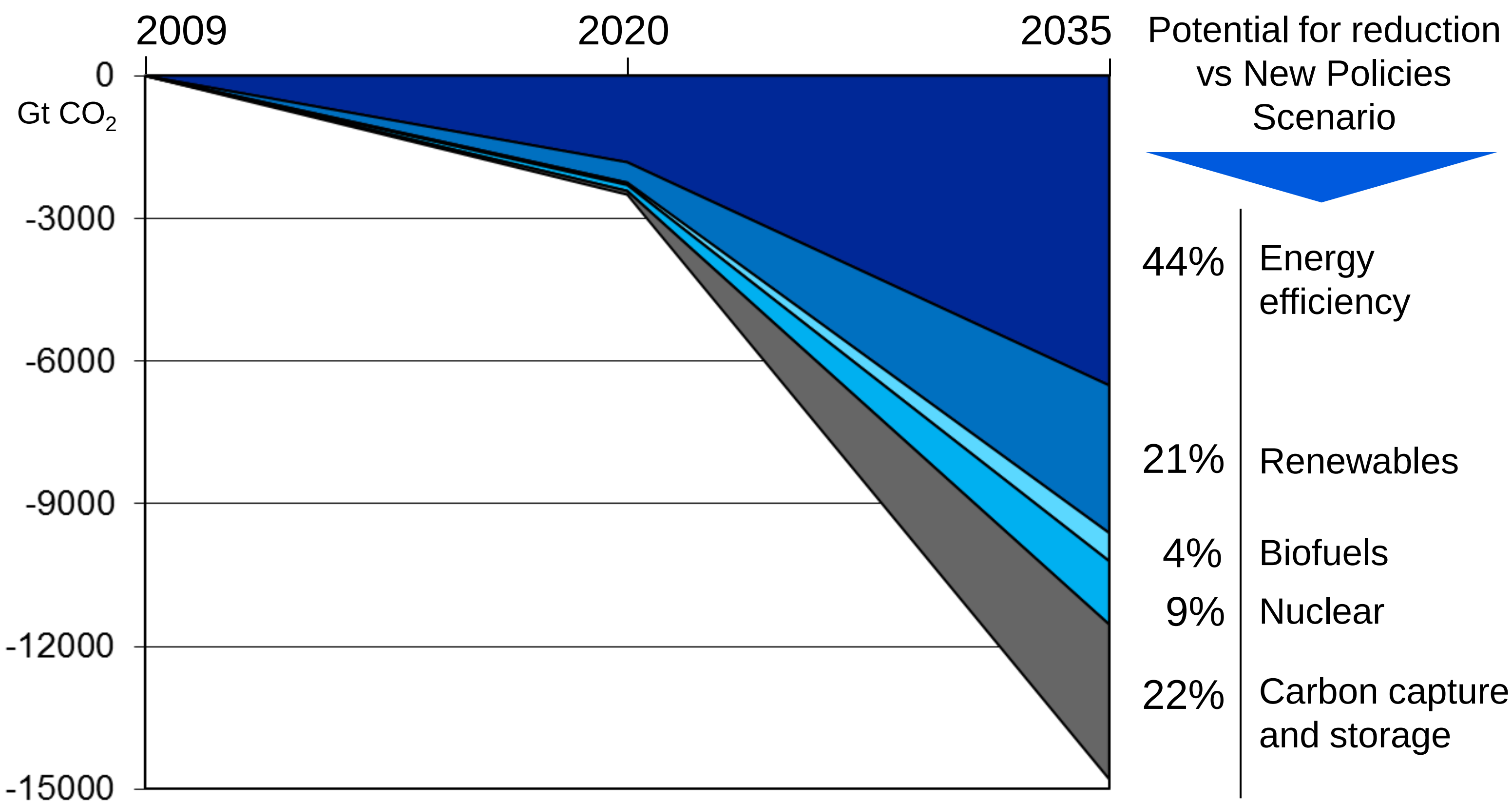
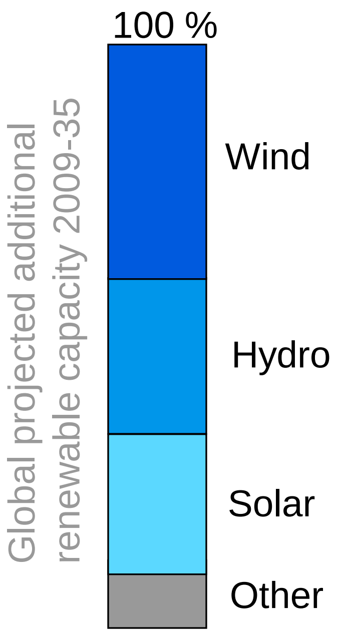
Energy efficiency and renewables
Can deliver two-thirds of emissions reductions



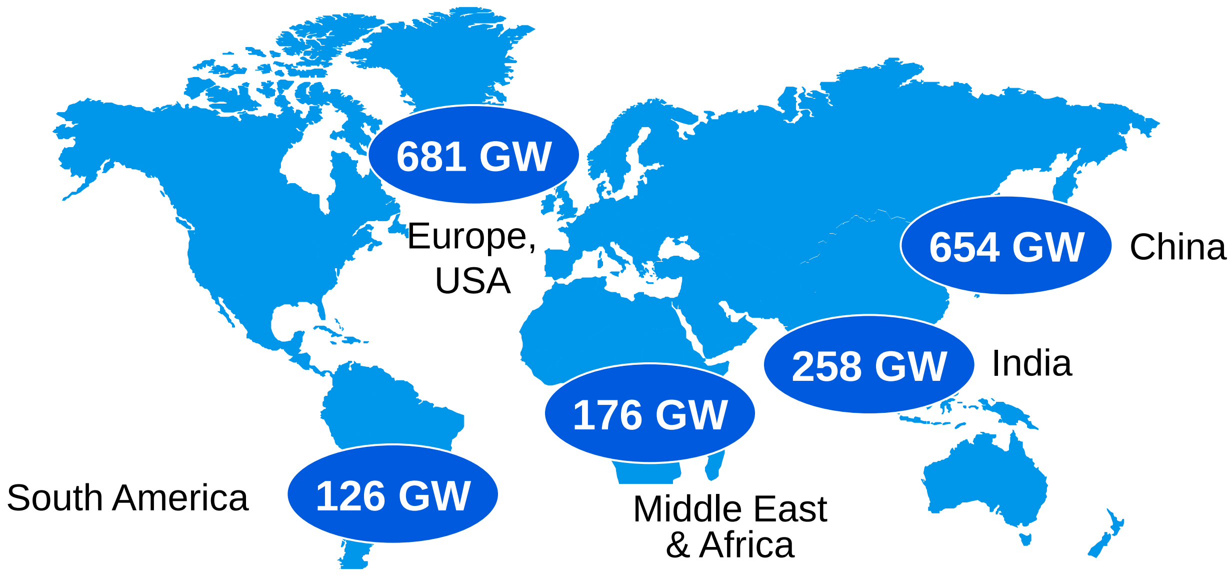
World energy-related CO_2 savings potential by policy measure under 450 Policy Scenario relative to New Policies Scenario

Source: IEA, World Energy Outlook 2010

Additions of renewables brings new growth opportunities
Wind, hydro and solar are most prevalent technologies

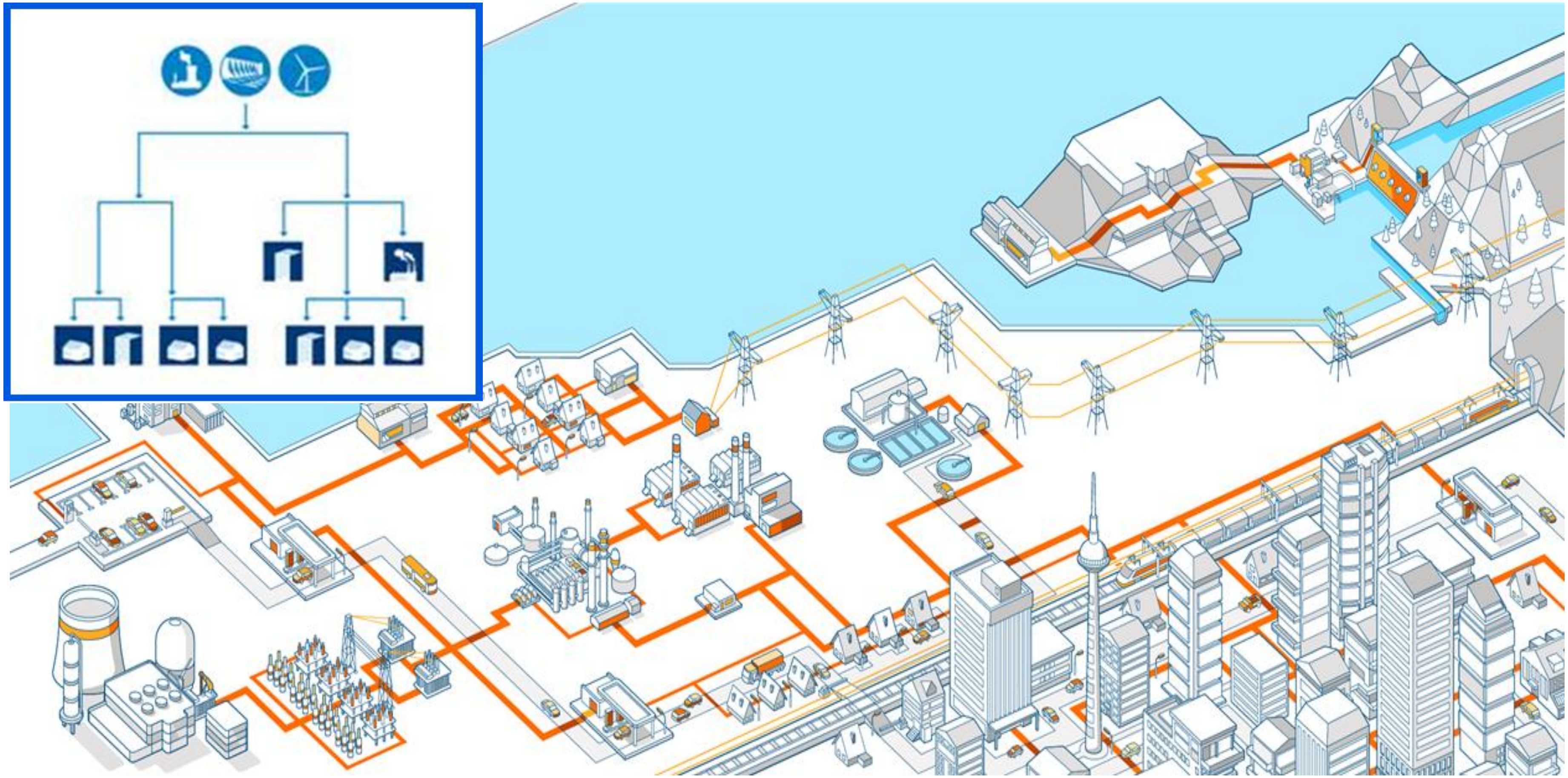


Projected Additional Renewable Capacity, 2009-2035

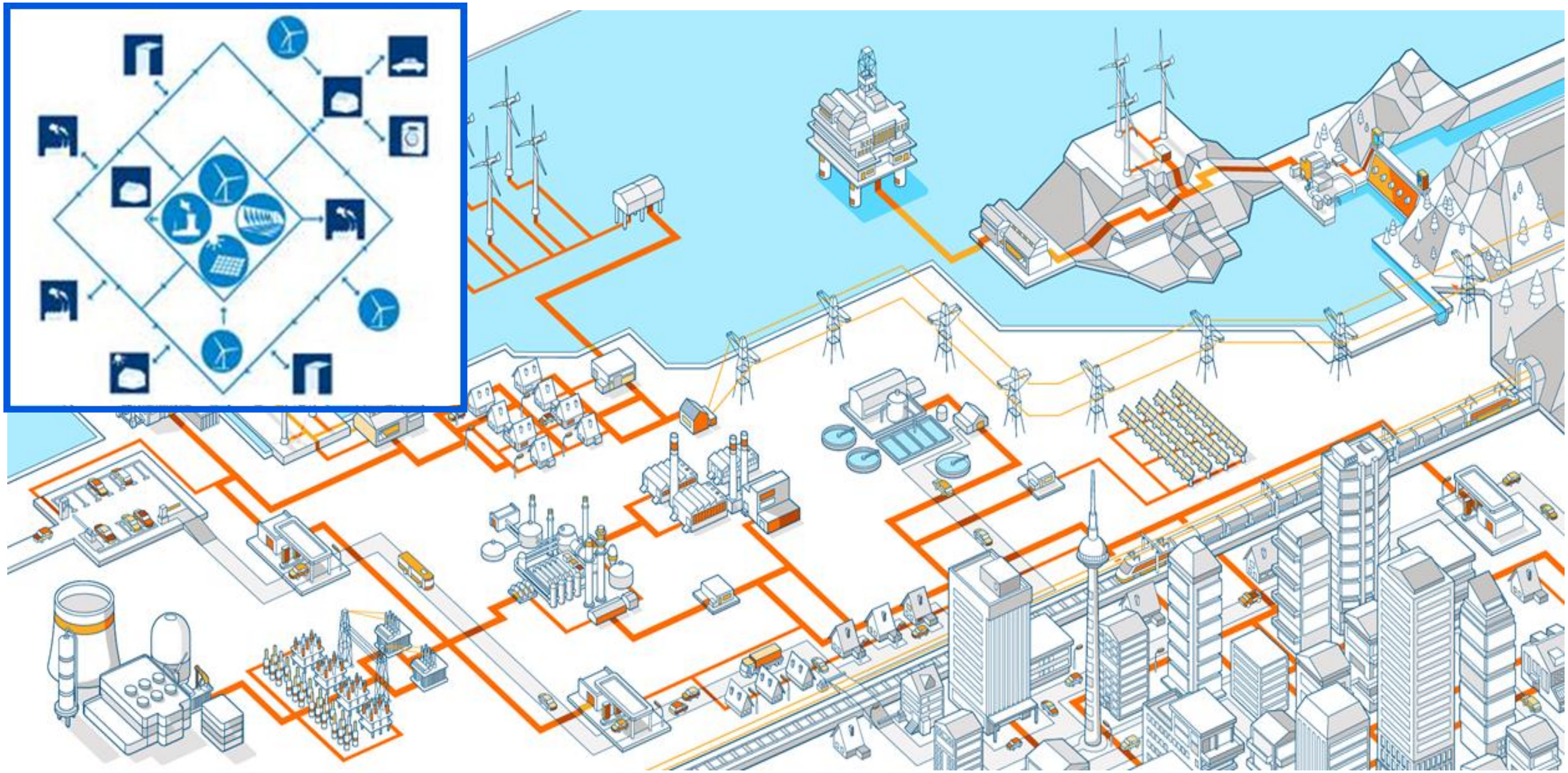


Source: IEA 2011,
New Policies Scenario

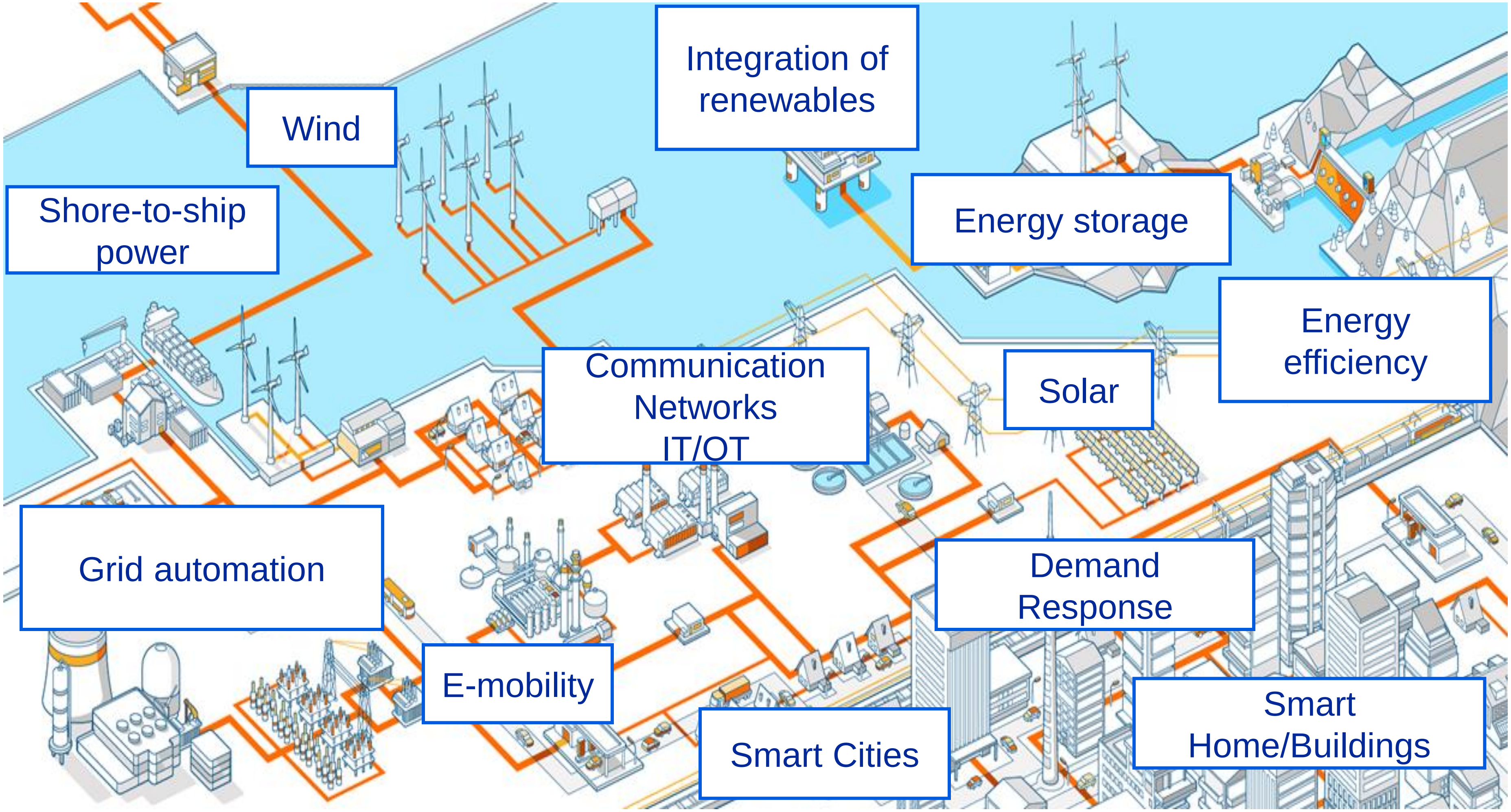
Traditional power grid
Relatively simple



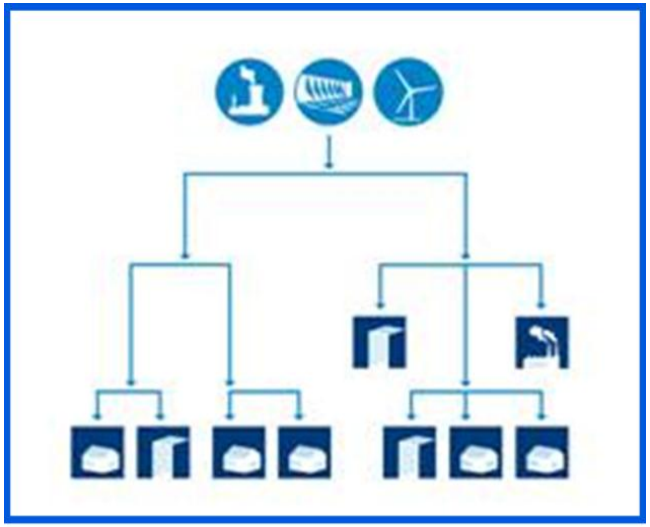
The evolving grid
New complexities



The evolving grid
New intelligence



The evolving grid
From traditional to smart grid



Traditional grid

- Centralized power generation
- One-directional power flow
- Generation follows load
- Top-down operations planning
- Operation based on historical experience

The evolving grid
From traditional to smart grid

Smart grid

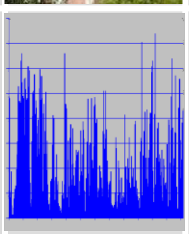
- Centralized and distributed power generation
- Intermittent renewable power generation
- Multi-directional power flow
- Consumption integrated in system operation
- Operation based on real-time data

A new generation mix
Fundamental changes

- **Remote generation** in big plants
  - Wind power – primarily offshore
  - Hydro power – in the Alps, Scandinavia
- **Distributed generation** in small units
  - Photovoltaic
  - Combined heat and power generation
- **Volatile generation**
  - Wind power
  - Solar power

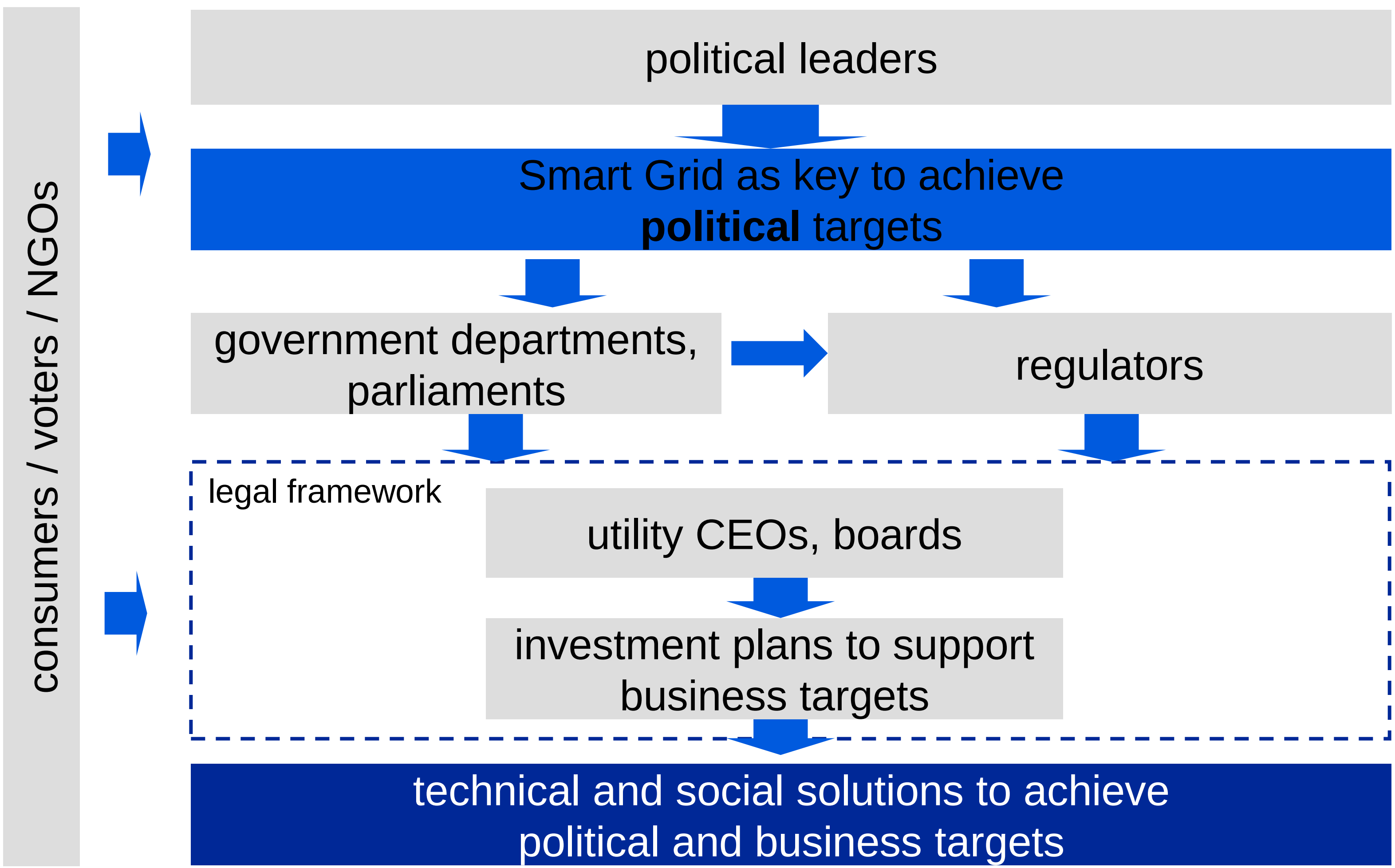
Consequences for the whole power generation system -
transmission, distribution and consumption -
Requires a new system design

Strong drivers towards a new type of power system
Technical consequences

Driver		Conventional generation	Transmission	Distribution	System operation	Application
Remote, bulk generation			▪ Long dist. transmission ▪ Overlay grid/HVDC			
Distributed generation				▪ Automation ▪ Voltage regulation	▪ Communi-cation ▪ Control ▪ VPPs[1]	
Volatile generation		▪ High efficiency all over the output range ▪ Flexibility	▪ Trans-regional leveling ▪ Overlay grid/HVDC ▪ Bulk storage	▪ Distributed storage	▪ Demand response ▪ VPPs[1]	▪ Storage (in applications) ▪ Demand response
Cost pressure, aging infrastructure			▪ Asset health management	▪ Automation ▪ Asset health management		▪ Demand response
New loads (E-mobility)				▪ Charging infrastructure	▪ Demand response	

[1] VPP: Virtual Power Plant

Smart Grid is also a political issue
Many players need to be informed consistently



Pilot projects enable smart grids understanding
Shaping the future of power systems

- ABB is currently at work on projects in all regions of the world covering various requirements and examining all aspects of smart grids, from e-mobility and energy storage to network management, metering and communication, distribution automation and home automation systems.

- We have smart grid research and commercial projects in one or more of these areas which will give our customers and suppliers a more in-depth understanding of this emerging business.

- Collaboration and open innovation between companies, universities and research institutions enhance the development of new ideas and knowledge. We believe in and boost the power of collaboration.

Pilot projects enable smart grids understanding
On-going development in all relevant areas

Pilot projects help customers and suppliers understand the relationship of technology, economics and regulation

Diverse players planning projects

Smart grid projects address these areas

- Distributed generation
- e-Mobility
- Demand response
- Distribution grid automation
- Meters and communication
- Network management
- Energy storage
- Zone concept
- Substation automation
- Shore-to-ship power
- Projects covering all areas

GRID4EU
A European Smart Grid Project under EC FP7 Research Program

Carried by 6 Distribution System Operators (DSOs) cover more than 50% of the metered electricity customers in Europe
27 partners (Utilities, Energy Suppliers, Manufacturers, Research Institutes
Duration: 4 years (November 2011 - December 2015)

Key objectives:

- Develop and test innovative technologies
- Define standards through the set up of demonstrators
- Guarantee the scalability of these new technologies
- Guarantee the replicability over Europe
- Analyze Smart Grid Cost-benefits (Business Case)

ABB's involvement:

ABB will participate in three pilots working with RWE in Germany, Vattenfall in Sweden and CEZ in Czech Republic, which objectives are:

- Demonstrate that existing distribution networks having smart metering and CHP units can be upgraded to allow automatic islanding while ensuring enough power supply. Location: Vrchlabi, Czech Republic
- Validate that the control of Low Voltage distribution networks using AMR events allows for more distributed generation while improving customer power quality. Location: Uppsala, Sweden
- Demonstrate that European Medium Voltage networks can use the concept of autonomous, self-organizing nodes to serve the need of both the DOSs and the served clients. Location: municipality of Reken, North-Rhine Westphalia, Germany

Stockholm Royal Seaport project – Sweden (1)
Shaping the future of the Swedish capital

Fortum is a leading energy company focusing on the Nordic countries, Russia and the Baltic Rim area with about 1,6 million electricity distribution customers.

Stockholm Municipality is an administrative body and the largest one in Sweden.

Customers

- Fortum
- Stockholm Municipality

Key objectives

- Develop a world class sustainable city district
- Reduce CO_2 emissions to a level below 1.5 tonnes per inhabitant by 2020
- Become fossil fuel free by 2030
- Adapt to climate change

Focus areas

- Efficient energy use
- Environmentally efficient transports
- Local ecocycles
- Environmental life styles
- Regulatory framework

Stockholm Royal Seaport project - Sweden (2)
Shaping the future of the Swedish capital

Fortum is a leading energy company focusing on the Nordic countries, Russia and the Baltic Rim area with about 1,6 million electricity distribution customers.

Stockholm Municipality is an administrative body and the largest one in Sweden.

Partners

Partners

- A total of 16 partners are involved in the project

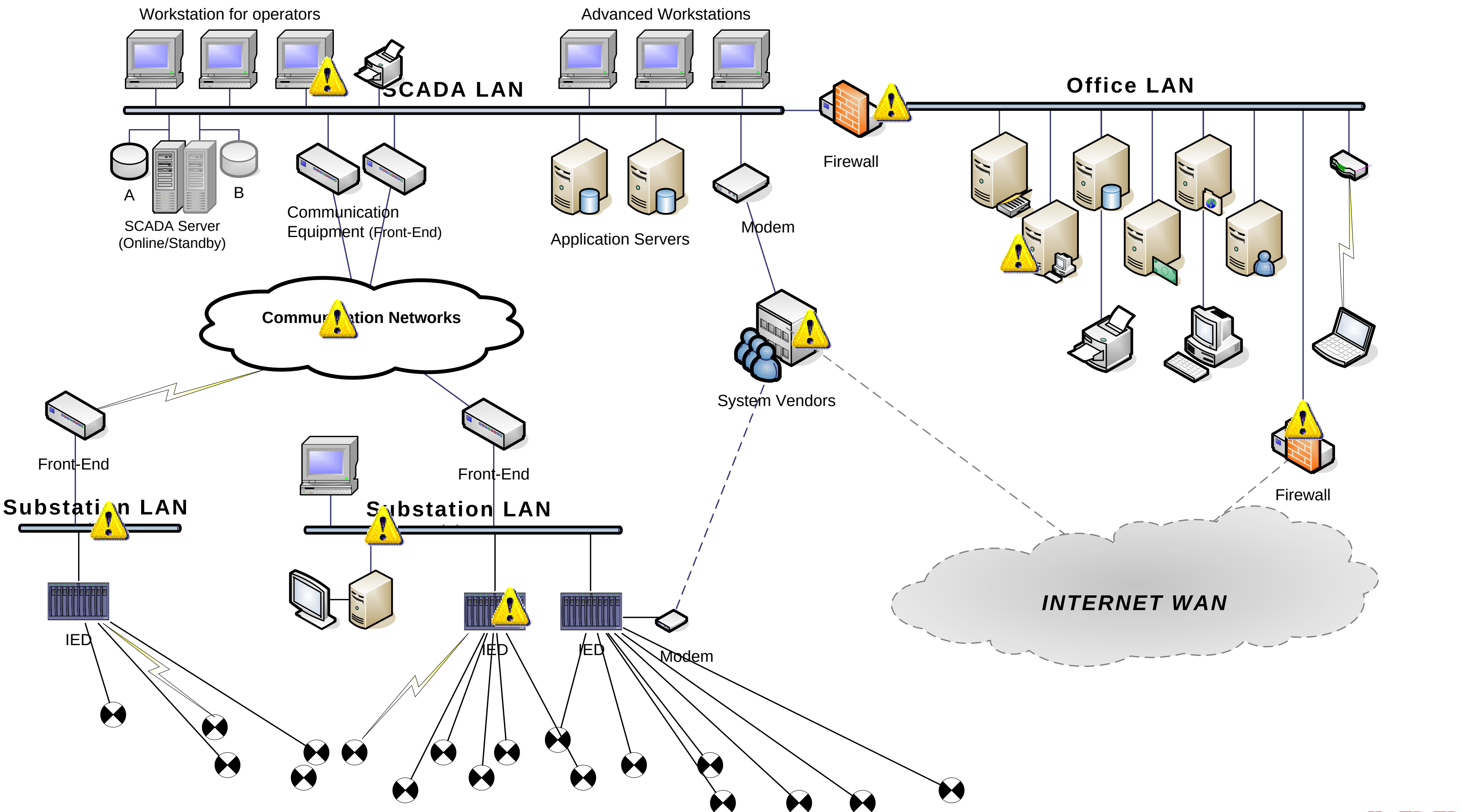
ABB's response – Smart grid scope

- Automated intelligent urban distribution grid
- Demand Response Management
- Integration of renewable energy
- Integration of electric vehicles
- Energy storage
- Electrification of harbor – Ship to shore
- House and building automation

Smart Grid Projects
Other ongoing Smart Grid pilots

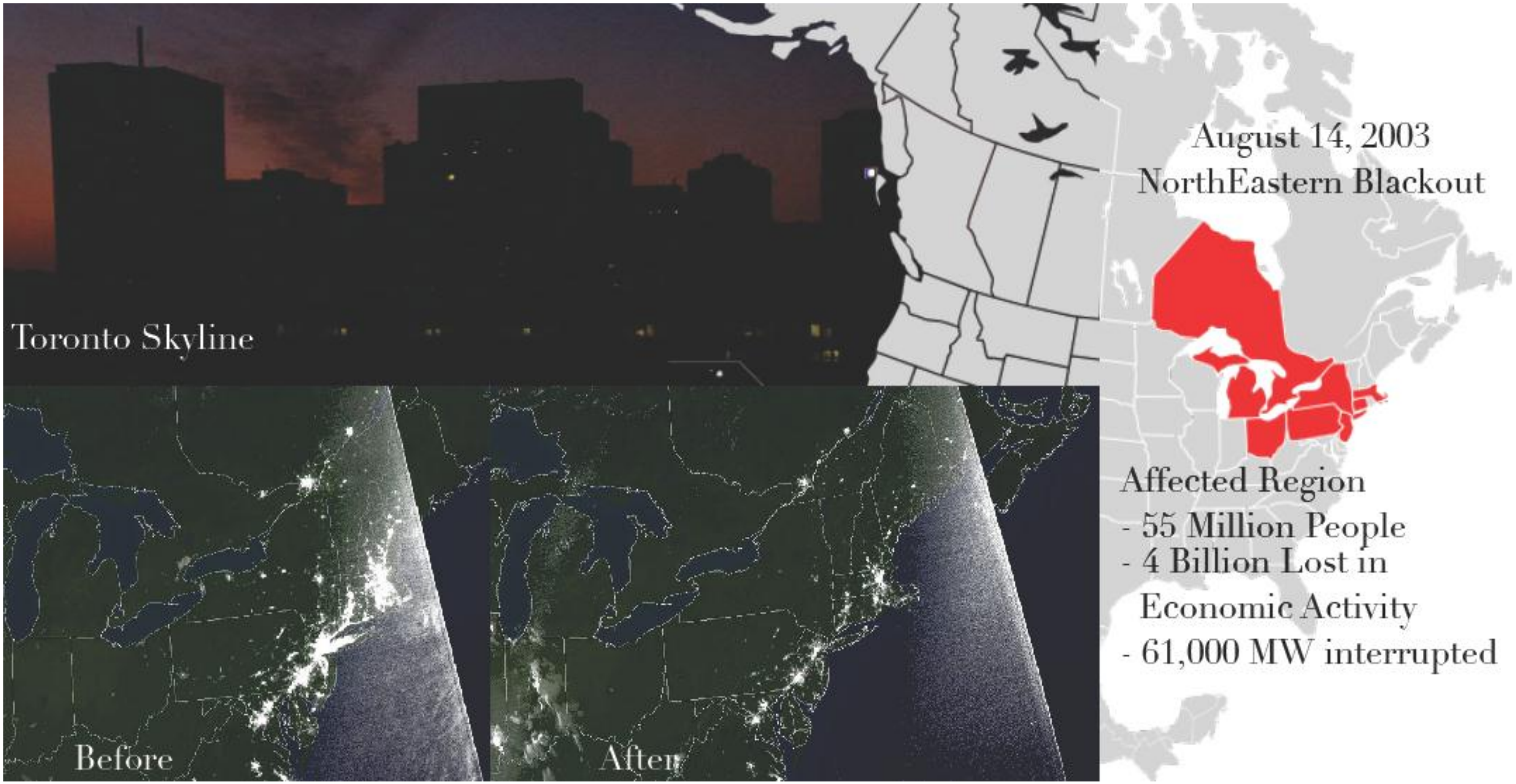
- Smart Grid CenterPoint - US
  Improving power reliability in Houston, Texas
- MEREGIO – Minimum Emission REGIOn - Germany
  Creating a more energy conscious life
  (www.meregio.de)
- Smart Grid Gotland - Sweden
  Full-scale distribution system on the island of Gotland
  (www.smartgridgotland.com)
- Deutsche Telekom (T-Systems) – Germany
  Converging power technologies and ICT: T-City
- Kalasatama Smart Grid – Finland
  Building a smart city in the heart of Helsinki
- „RiesLing“ (**Ries** - **L**eittechnik **in**telligent **g**emacht)
  Distribution automation & intelligent network control

SCADA Security
Potential attack points



SCADA Security
This is what we want to avoid

SCADA Security
North-east American blackout Aug. 14, 2003



Other Black-outs:
WECC 1996 Break-up, European Blackout (4-Nov.-2006), London (28-Aug.-2003), Italy (28-Sep.-2003), Denmark/Sweden (23-Sep.-03), . . .

SCADA Security
Smart Grid Challenges

- The number of installed, IP enabled equipment will grow dramatically, e.g. smart meters
- Automatic control functions will increase and will be moved to lower voltage levels. Medium and low voltage networks are much bigger than transmission networks
- Increased automatic control requires that primary equipment, e.g. breakers, need to communicate with each other
- The need for communication can most probably not be met with utility owned communication. The need to use public network will increase
- **Conclusion:**
  - The attack surface for cyber attacks on the electrical infrastructure will increase radically with the introduction of Smart Grids
  - Security is not easliy added afterwards. Security, as well as availability, must be considered at system design

Summary
Sustainability in the power sector

- Efficiency is the key to a sustainable energy future
- Integration of renewables and reliability improvements are increasingly important
- Smart transmission and distribution grids is necessity to support efficiency and renewable energy.
- Managing and optimizing two-way flow of power and information becomes vital
- Security is an vital aspect when designing the new grid

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