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The Sustainable Smart/Super Grid: Introduction to the Roundtable

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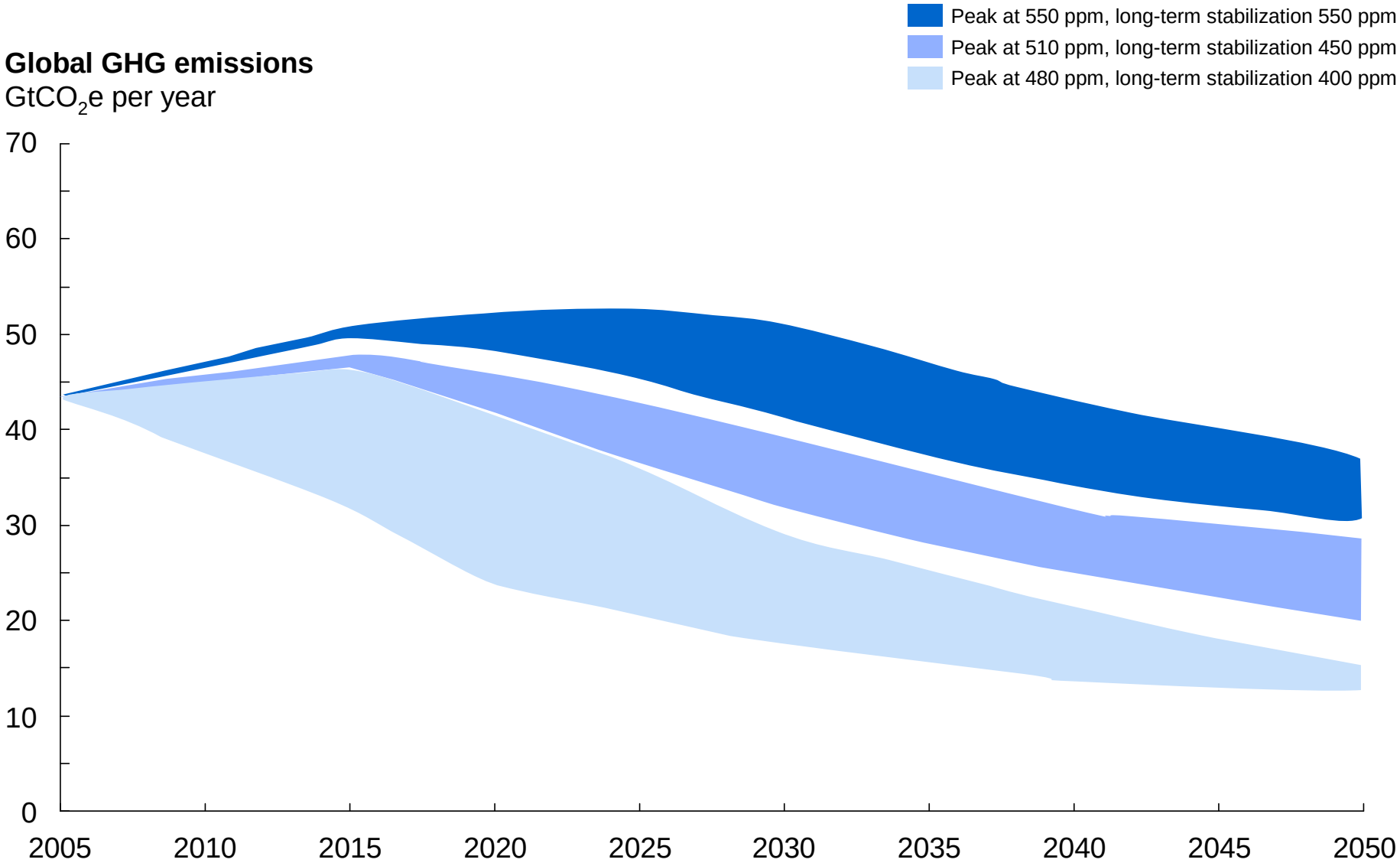
22nd Sustainability Roundtable
November 16-17, 2009

Smart Grids and Sustainability

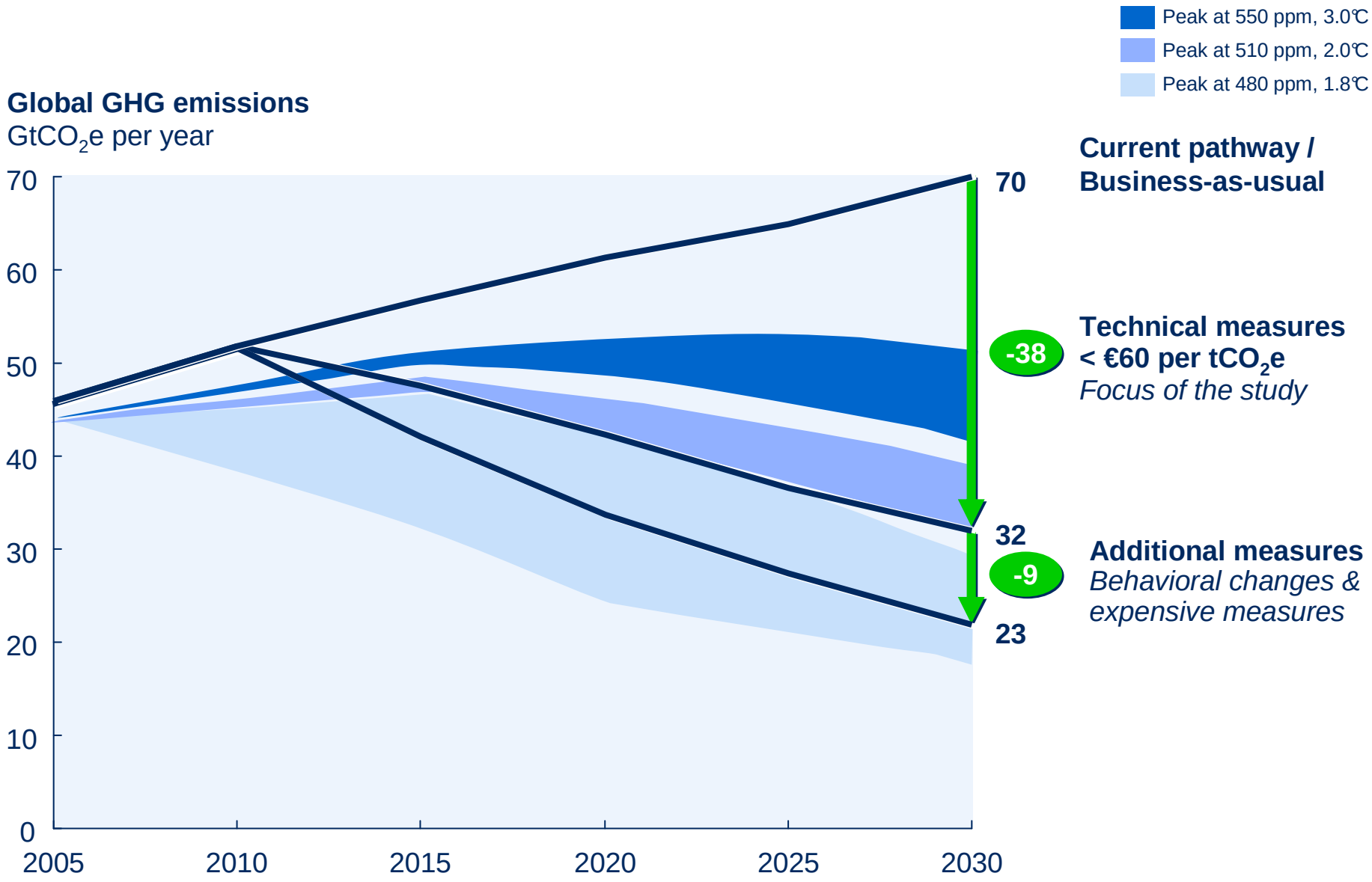
- Large role foreseen for electric power going forward in attaining sustainable energy and a low-carbon future
  - Continuing growth in Energy Consumption (IEA, 2009)
  - Energy Conservation
  - Renewable Energy Supplies
  - Electric and Hybrid transportation systems
- Many of roles intersect directly with doing things better and "smarter" (using CIT)
- At the same time, we are likely to see a continuing mix of electric power technologies (old-new, dirty-clean, …)
- Enter the Smart Grid and much else with it!

Allowable emission pathways over time: McKinsey Study

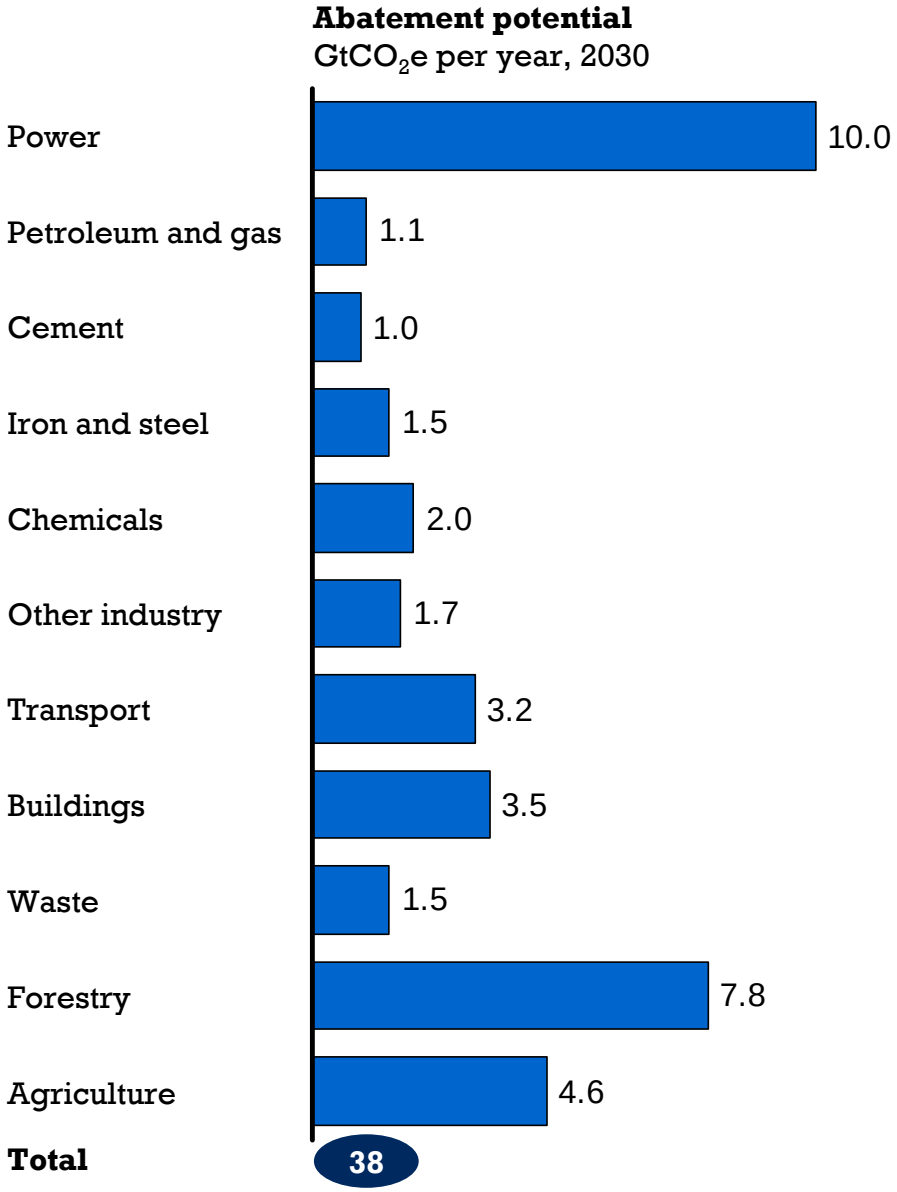


Source: den Elzen; Meinshausen; van Vuuren; Global GHG Abatement Cost Curve v2.0

Possible to contain global warming below 2℃



Abatement potential by sector and key levers



Key levers	Abatement potential
▪ Renewables (Solar, wind, biomass)	4.0
▪ Nuclear	2.0
▪ CCS	1.7
▪ CCS	0.4
▪ Energy efficiency	0.3
▪ Clinker substitution	0.5
▪ Alternative fuels	0.3
▪ Energy efficiency	0.5
▪ Co-generation	0.3
▪ CCS	0.4
▪ Motor systems	0.3
▪ ICE improvement, hybrids, EV	1.9
▪ Biofuels	0.5
▪ New build efficiency packages	0.9
▪ Lighting and lighting controls	0.7
▪ Waste recycling	0.9
▪ Land fill gas direct use	0.2
▪ Avoided deforestation	3.6
▪ Afforestation/reforestation	2.4
▪ Grassland management	1.3
▪ Organic soil restoration	1.1

Note: This is an estimate of the maximum potential of all technical GHG abatement measures below €60 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.
Source: Global GHG Abatement Cost Curve v2.0

What is the Smart Grid?

The Smart Grid is the tight coupling of:

- The Power Delivery System AND
- Advanced information technology and command-control-monitoring (CCM) capabilities AND
- Supporting regulations, policies, market rules and business processes

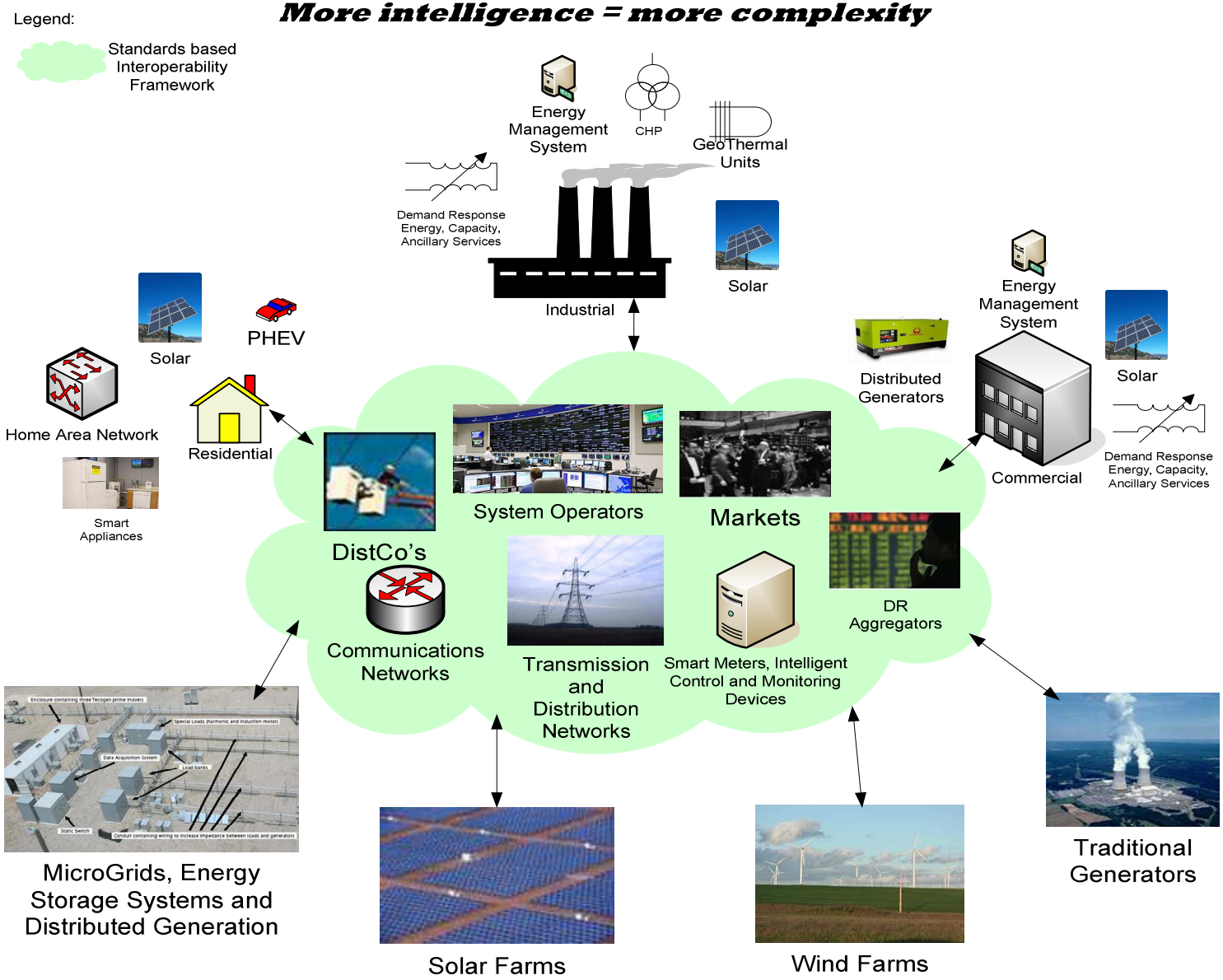
that will improve the overall efficiency of electricity production, delivery and consumption, evolving from the existing grid infrastructure while maintaining high reliability and strong security

Objectives of implementing the Smart Grid?

- ***"The goal is to use advanced, information-based technologies to increase power grid efficiency, reliability, and flexibility, and reduce the rate at which additional electric utility infrastructure needs to be built."*** **[CRS, 2007]**
- *Deployment and integration of* ***distributed resources and generation****, and especially large-scale increments of* ***renewable resources****.*
- *Development and* ***incorporation of demand response, demand-side resources, and energy-efficiency*** *resources.*
- *Deployment of* ***"smart" technologies*** *(real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices)* ***for metering, communications concerning grid operations*** *and status, and distribution automation.*
- ***Integration of "smart" appliances and consumer devices****.*
- *Deployment and* ***integration of advanced electricity storage and peak-shaving technologies****, including* ***plug-in electric and hybrid electric vehicles****, and thermal-storage air conditioning.*
- ***Provision to consumers of timely information and control options to communicate scarcity values of electric power resources.***

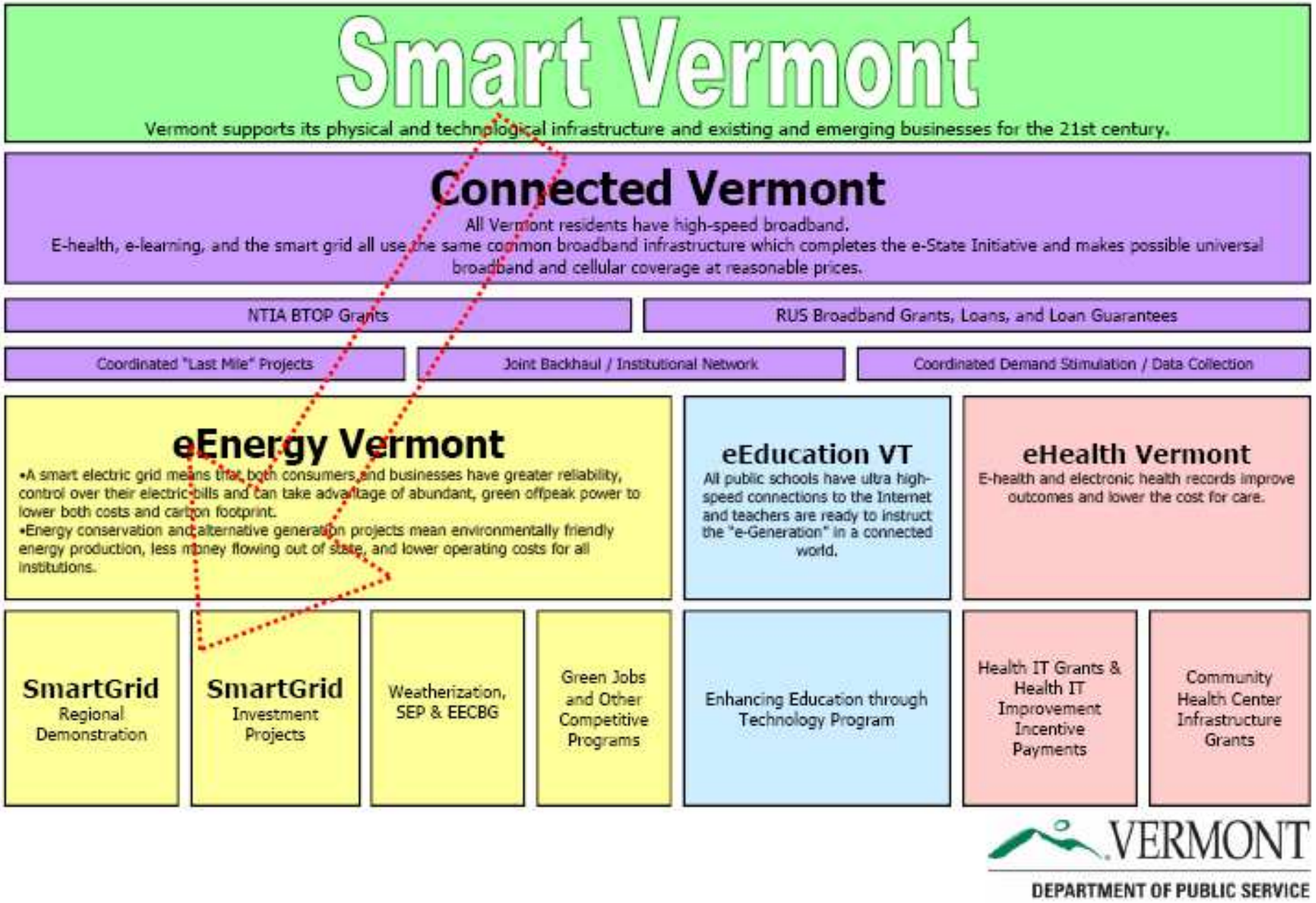
The Smart Grid

More intelligence = more complexity



Significant Shifts are Underway, many of which are connected to the Smart Grid

• Construction of new facilities	More efficient use of existing system
• Static Operating Parameters	Dynamic calculations
• Large Supply Resources	Small Supply Resources
• Fossil Fuels	Renewable Resources
• Centralized Control	Distributed Control
• Passive Customer Participation	Active Customer Participation
• Gasoline & Diesel	Electricity
• Limited operator visibility	Sub-second visibility
• Manual operations	Automation



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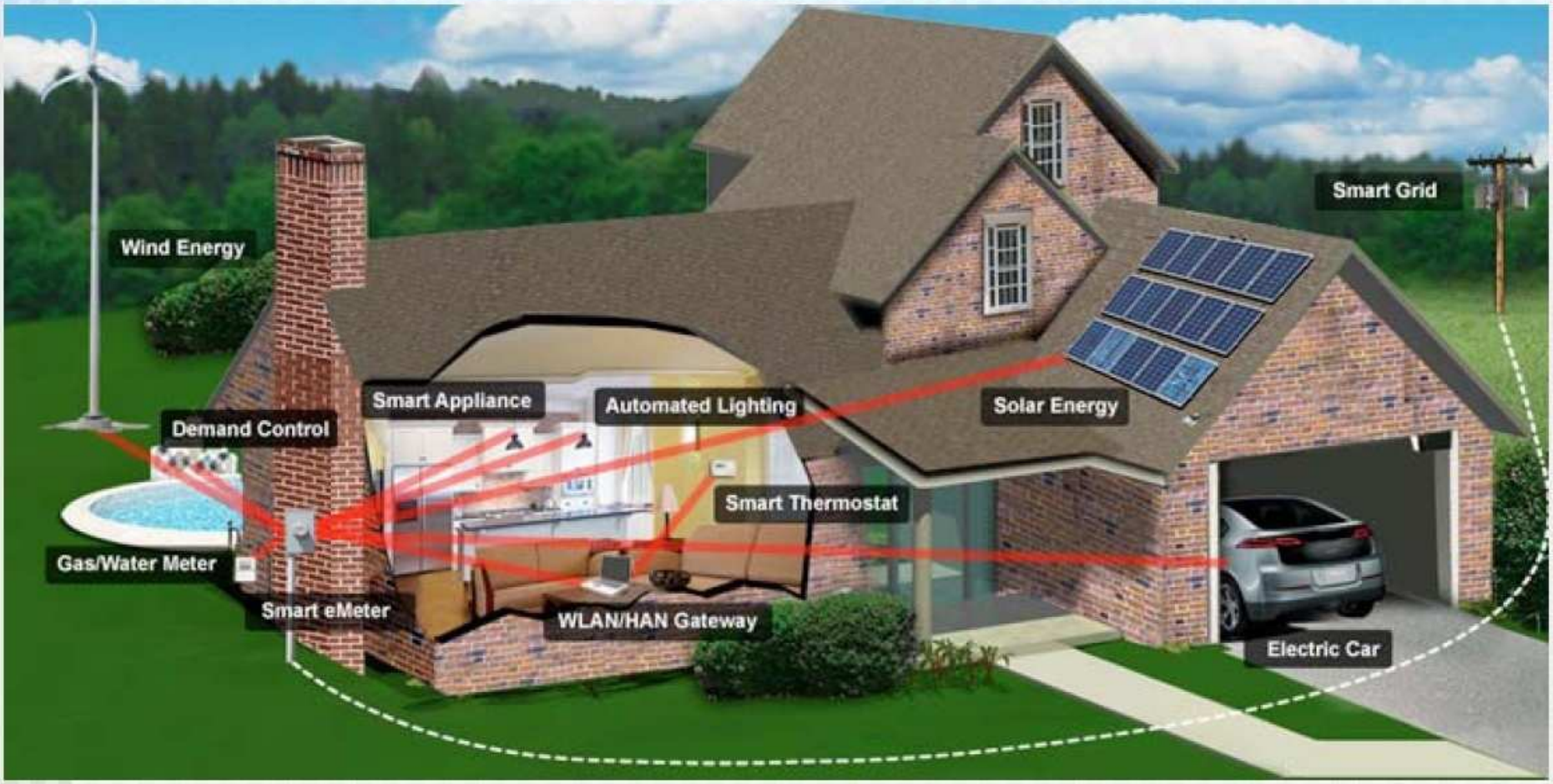
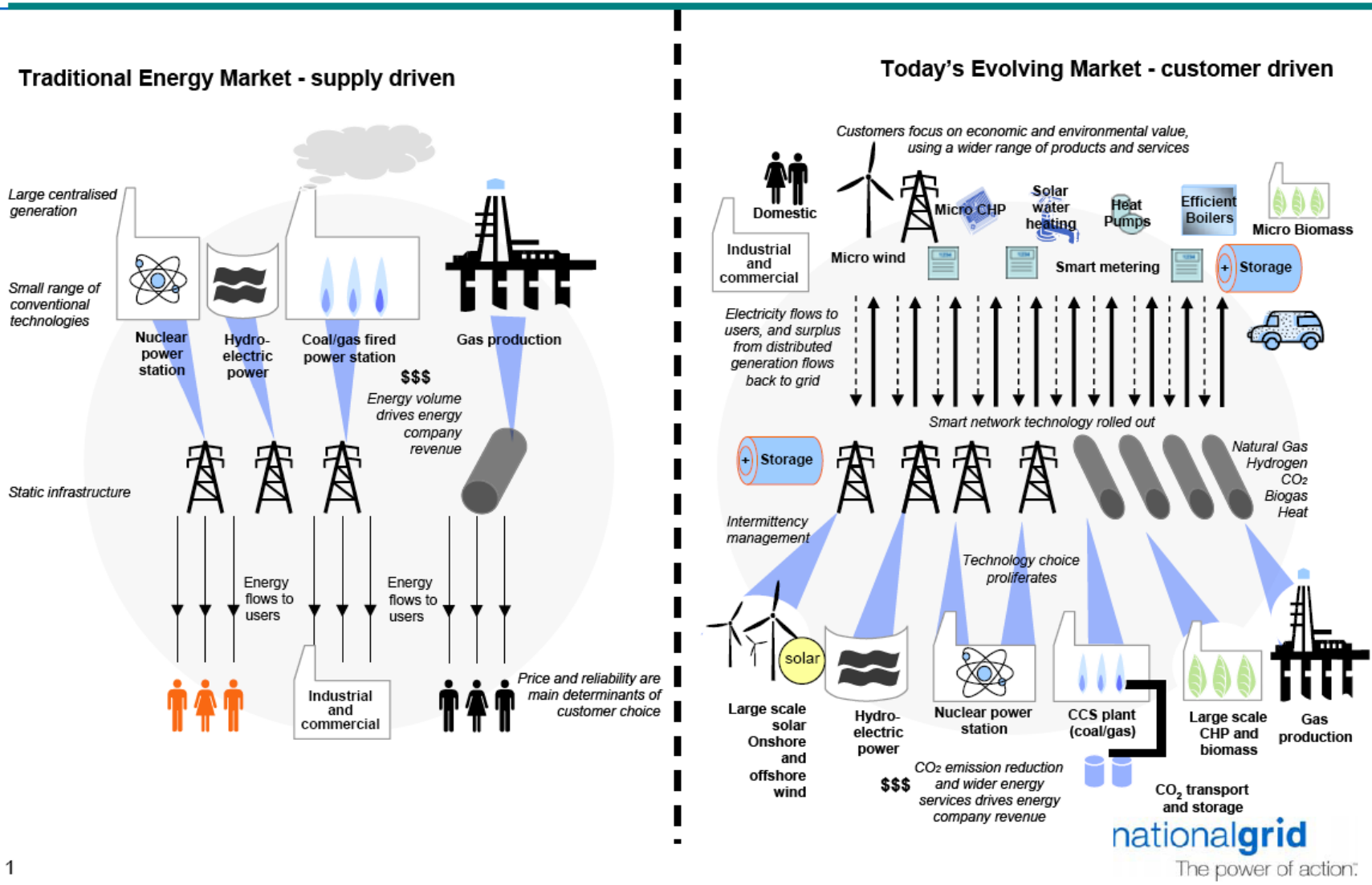
Bangor Hydro
ELECTRIC COMPANY

Vision of the Future



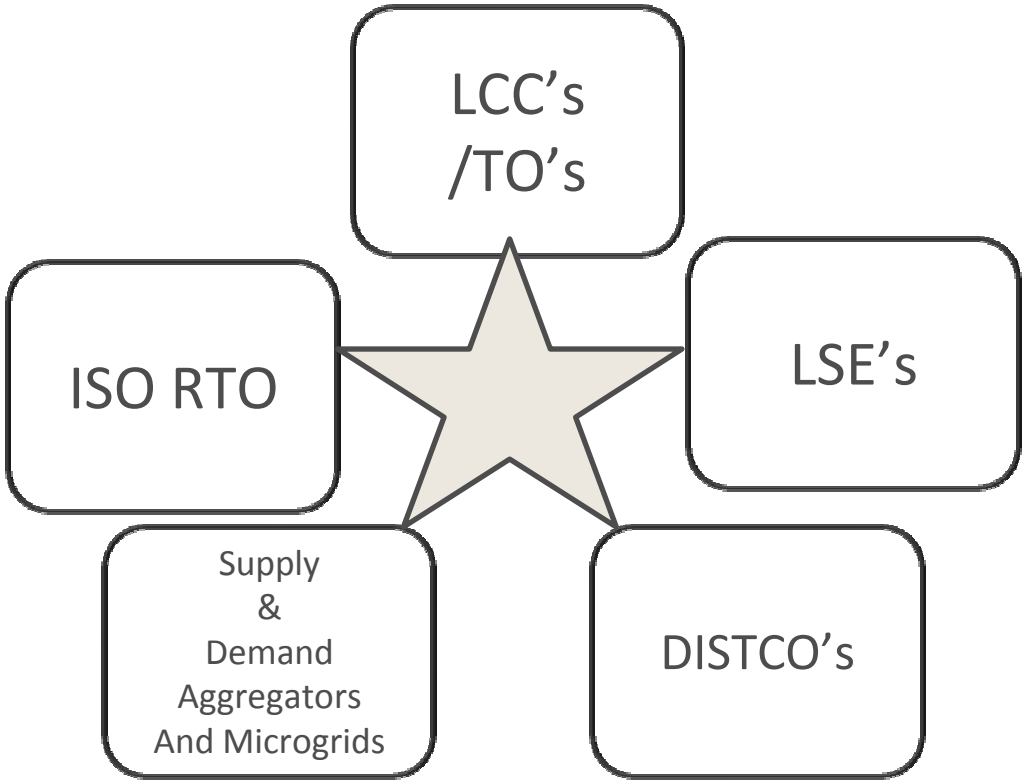
The Smart Grid is an Essential Part of the Evolution of the Energy Industry



The lines between Transmission and Distribution are blurring

- Increasing number of generating resources located on the distribution network (e.g. wind turbines, solar arrays, microgrids, CHP)
- Demand resources playing larger role in traditional "transmission level functions" (e.g. energy, reserves and emergency response)
- Regional Power System Control entities need more granular locational and capacity information for both demand and supply resources located on the distribution network
- Reliable operations capacity analysis requires situational awareness of supply resources located within a region, regardless of the network to which they are connected

Smart Grid System Control Entities



These are within specific control area; Regional and super-regional grids present additional interactions.

Super Grids and Smart Grids

- For reasons of pooling, shared reserves and demand response, across regions and countries, interconnectedness and interoperability between grid control regions is very desirable
- Integration of Smart Grids will make this problem even more important and complex in the future.
- Super Grids (basically integrated grids across multiple regions and countries) offer interesting new possibilities for accessing non-local power sources, but this will require new standards and new approaches to investment and to payment for grid resources. For private infrastructure, let the market reign. For shared infrastructure, there are many complexities.

Why do we need a Smart Grid?

- Difficulty in building new generation and transmission facilities where they're needed most (NIMBY)
- Construction of new generating facilities is not keeping pace with increased demand – need greater reliance on demand response and value alignment
- Public pressure to lower electricity costs
- New, more sophisticated sense and respond (S&R) and generation devices coming on to the grid require more sophisticated capabilities
- Intermittent resources, such as Wind Power, require more sophisticated tools and capabilities to manage/control
- The existing grid control tools are incapable of managing the complex components and relationships that are beginning to appear on the grid (e.g. V2G and compound offers such as cooperating Wind Power/Demand Response resources)

Topics for Discussion at the 22nd SRT

- What's ahead in Europe in electric power?
- Current INSEAD research on sustainable energy
- System stability and reserve problems in the "New Era"
- Investment challenges & Smart Grid operations
- The Mediterranean Super Grid
- Policy and Strategy Challenges
- Along the way: Discussion, Research, Education