LONG ISLAND SYSTEMS, APPLICATIONS, AND TECHNOLOGY (LISAT) CONFERENCE 2013

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Smart Grid Framework & Solar PV

FARMINGDALE STATE COLLEGE
APRIL 3, 2013

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(1) GRID = "Impossibly Complex" System

- Hundreds of thousands of users
- Switches turning on & off
- Motors starting & stopping

  TRULY AMAZING THE THING ACTUALLY WORKS..!
- Few people take time to appreciate it..
- At every instant..

  SUPPLY = DEMAND
- As demand changes..
- As supply changes..

(2) System Architecture – Paradigm Shift

COMMON SUPPLY

- Baseloading (Thermal)
- Peaking generator (Gas Turbine)
- Hydro

RENEWABLE/PERPETUAL SUPPLY

- Solar PV
- Wind
- Tidal/Wave
- Hydro
- Geothermal
- Biomass (solid, gaseous, muni-waste)
- Combined Heat & Power (Co-Generation)

NON-RESPONSIVE DEMAND

- Residential
- Commercial
- Industrial

MARKET RESPONSE DEMAND (Negawatts)

- Residential – MR
- Commercial – MR
- Industrial – MR

DISPATCHED DEMAND RESPONSE RESOURCE (Negawatts)

- Residential – DR
- Commercial – DR
- Industrial – DR

BULK ENERGY STORAGE RESOURCES

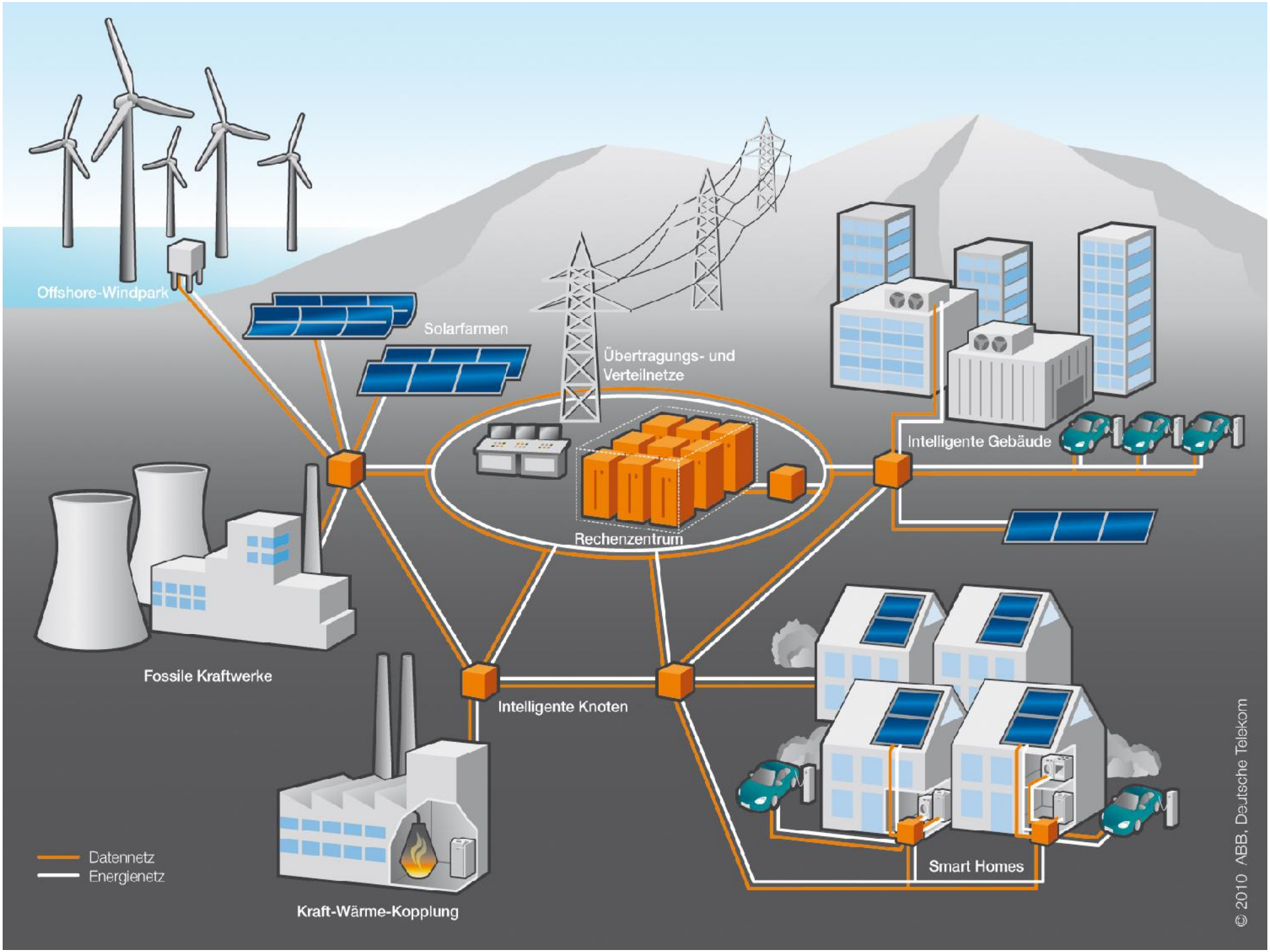
- Pumped Hydro
- Compressed Air (surface & underground)
- Flow Batteries
- Electric Vehicles, PHEV's

OPERATING / FREQUENCY RESERVES

- Inertia of spinning machines (Frequency Response Reserve)
- Flywheels, super-capacitors, batteries
- "Spinning Reserve" (additional capacity of generators already on line)
- "Peakers", "Fast-start" generators, Batts, pumped hydro
- Replacement Reserves..

(3) Grid Transformation, a 30 Year Plan

Timeframe	Phase Definition	Defined by.. (Key Characteristics)	Key Functions / Technologies	RE Penetration
0 - 10 Year Grid	**1. Communications & Measurement**	*Laying the foundation for future technologies through communications. 'Tidying' up our usage.*	- Energy efficiency - Demand Response	5% (by capacity)
10 - 20 Year Grid	**2. Advanced Components & Dynamic Control**	*Physical Restructuring of the Grid. Overcoming initial supply & demand variability.*	- Network Adaption & Reconfiguration - Islanding	15% (by capacity)
20 - 30 Year Grid	**3. Large Scale Pervasive Renewables**	*Mass adoption of Renewable Energy resources enabled through Storage & fast supply &demand balancing control.*	- Distributed Generation, Storage, Electric Vehicles	40+% (by energy)


Offshore-Windpark
Solarfarmen
Übertragungs- und Verteilnetze
Intelligente Gebäude
Rechenzentrum
Fossile Kraftwerke
Intelligente Knoten
Smart Homes
Kraft-Wärme-Kopplung
Datennetz
Energienetz
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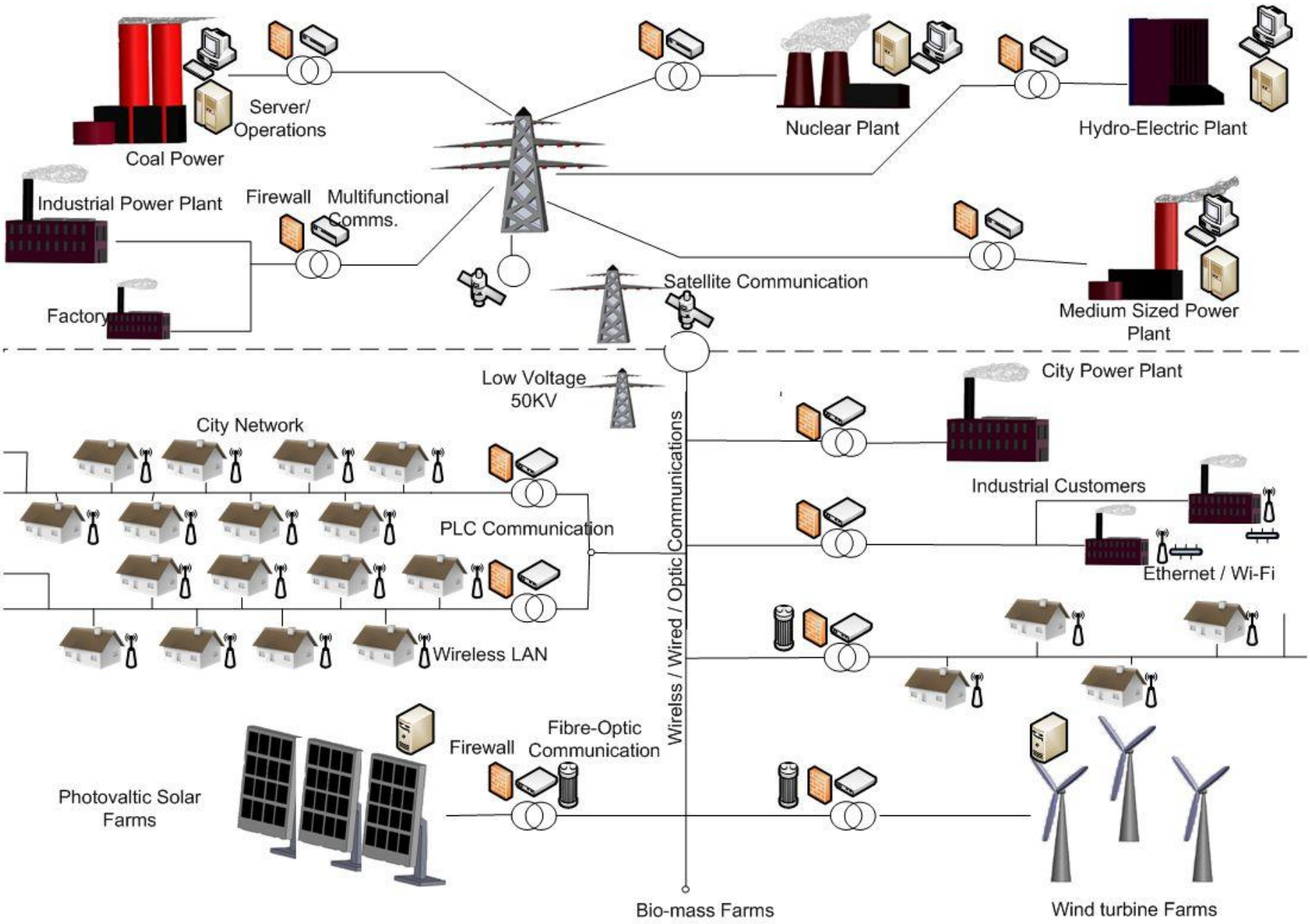

And as if it wasn't complex enough already..!

(4) A Fundamentally New Mindset..

ECONOMIC

- Tariff Related
- FIT Rates
- REC's
- Dynamic-Pricing
- Demand Response Incentives

TECHNICAL

- Interconnection
- Evaluation processes
- Control Requirements
- Communication Rqmts.
- Metering

(5) Technical / Operational "Toolbox"

Sample Assets / Enabling Equipment	Function
*Fault Current Limiters (**FCL's**)*	**Fault Current Limiting**
*phasor measurement units (**PMU's**), data concentrators, and advanced software*	**Wide Area Monitoring, Visualization and Control**
*sensors, information processing and **communications***	Dynamic Capability Rating (AKA, **Ampacity Determination**)
*Phase angle **regulating transformers** (PARs) or Flexible AC Transmission System (FACTS) devices*. Solutions are being explored using *superconducting cables or very low impedance (VLI) cable with a phase angle regulator*	**Flow Control**
Set points adjustment for the ***relays and switching** devices* would be done by *algorithms* running within *software* programs and systems.	Adaptive Protection (AKA, Adaptive **Fault Protection**)
*sensors, controls, switches, and **communications** systems*	Automated **Feeder Switching** (AKA, Automated Feeder **Switch Actuation**)
Islanding is enabled through various *sensors, controls, switches, and communications systems, **inverters**, controllers and distributed energy resources*	Automated Islanding and Reconnection (AKA, Enabling **"Islanding"**)

Sample Assets / Enabling Equipment	Function
Control systems could determine when to operate these devices (Ie, *generator voltage regulators*), and do so automatically.	**Automated Voltage and VAR Control**
***SCADA** systems including sensing / monitoring devices, communications networks and analysis software*	**Diagnosis & Notification** of **Equipment Condition**
*High resolution sensors, algorithms detecting fault signatures, high speed digital communications and computing, line differential protection, **adaptive relaying** and System Integrity Protection systems (**SIPS**)*.	Enhanced **Fault Protection**
*Smart meters and appliance controllers, **Advanced Metering** Infrastructure (AMI) systems (smart meters, two-way communications) and embedded appliance controllers, real-time price signals, time-of-use (TOU) rates, and service options*	Real-Time **Load Measurement & Management**
Control systems, actuating equipment, etc.	Real-Time **Load Transfer**
*sensing and reporting equipment, interactive **software**, appliances which respond to signals, an on-line marketplace, etc*	Customer **Electricity Use Optimization**

(6) Driving Factors Final Rqmts.

Regulatory / Policy Environs

- Inver Manufacturer Testing & Acceptance
- NYS-SIR, PSC
- UL & IEEE Standards
- Industry Precedent
- EPRI & other reputable reports

Physical System Conditions

- Type of injection (IE. PV)
- Size (capacity) of installation
- Location of connection on feeder circuit
- Available fault current
- Type of equipment on feeder already (ie Substation, protection equipment, etc)

(6) Common Issues / Challenges

Operational Considerations

- Direct Transfer Trip (**DTT**)
- Supervisory Control & Data Acquisition (**SCADA**)
- "Leaselines" Alternative

Fees

- Application Fee
- Ongoing Operational
- Utility Upgrades
- Transformer Purchases

Fault Analysis Clarifications

- Redundant Relaying
- Grounding Transformers
- High Voltage Excursions
- Redundant Relaying

Process

- Screening process
- Timeframes
- Staffing & Resources


277V/480V

(7) Thank You LIPA..

LIPA & Industry

- Power & Asset Mgt
- Solar Pioneer/Entrepreneur
- LISEIA / IEEE
- Often a struggle, but one worth pursuing
- Genuine spirit of collaboration

JUST the beginning..

- Time to dig in.
- This program is Rev 1.
- Under 1% penetration... Opportunity is major for all

(8) Appeal for SMART implementation.

MANY CHALLENGES!

- Reliability & Power Quality
- Safe Operation
- Cost Effective / Electricity Savings
- Minimal Environmental Impact
- Energy Security

MINDSET SHIFT..

- Genuine desire to WANT to make it work... (as opposed to a negative default position)
- REALISTIC balance of risk
- Old assumptions revisited..
- Transparency
- Looking beyond supposed "utility mentality"
- Inspired leadership

Contact, Reference

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MIT Thesis – Defining, Modeling & Designing Smart Grid Systems

http://www.empower-solar.com/blog/2010/09/03/empower-coo-greg-sachs-graduates-mit-publishes-smart-grid-design-evolution-thesis/