Bulgaria's Green Energy Challenge

BULGARIAN PHOTOVOLTAIC ASSOCIATION

" Man cannot discover new oceans unless he has the courage to lose sight of the shore. "

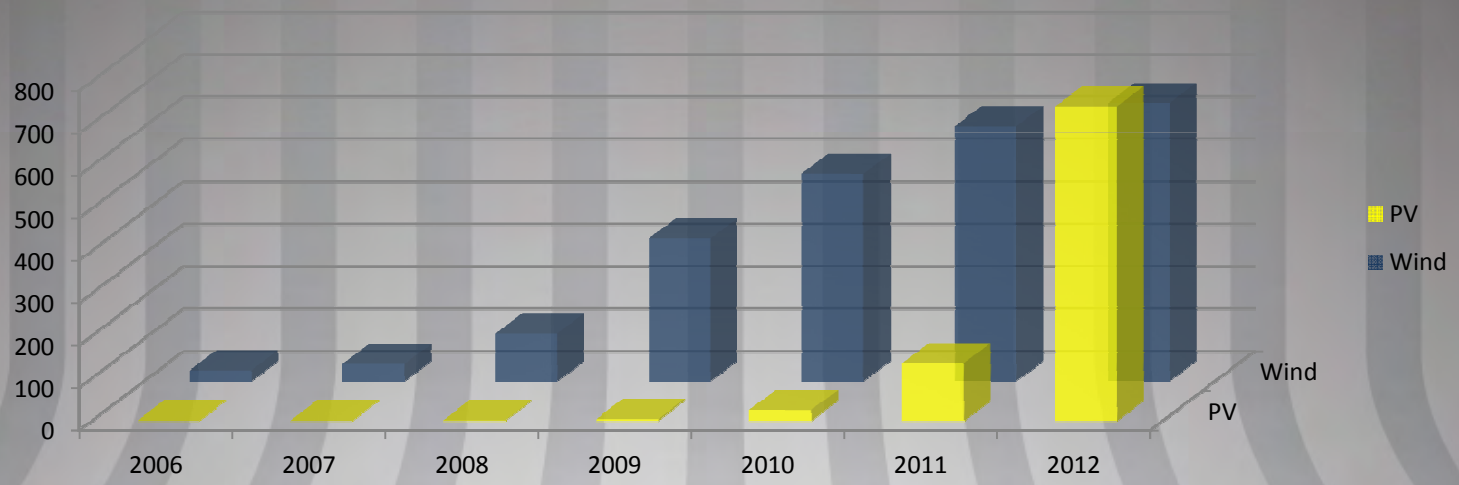
Aristophanes

Contents

- ✓ Bulgarian RE market now
- ✓ Smart grid
- ✓ Integration
- ✓ Balancing
- ✓ Operation

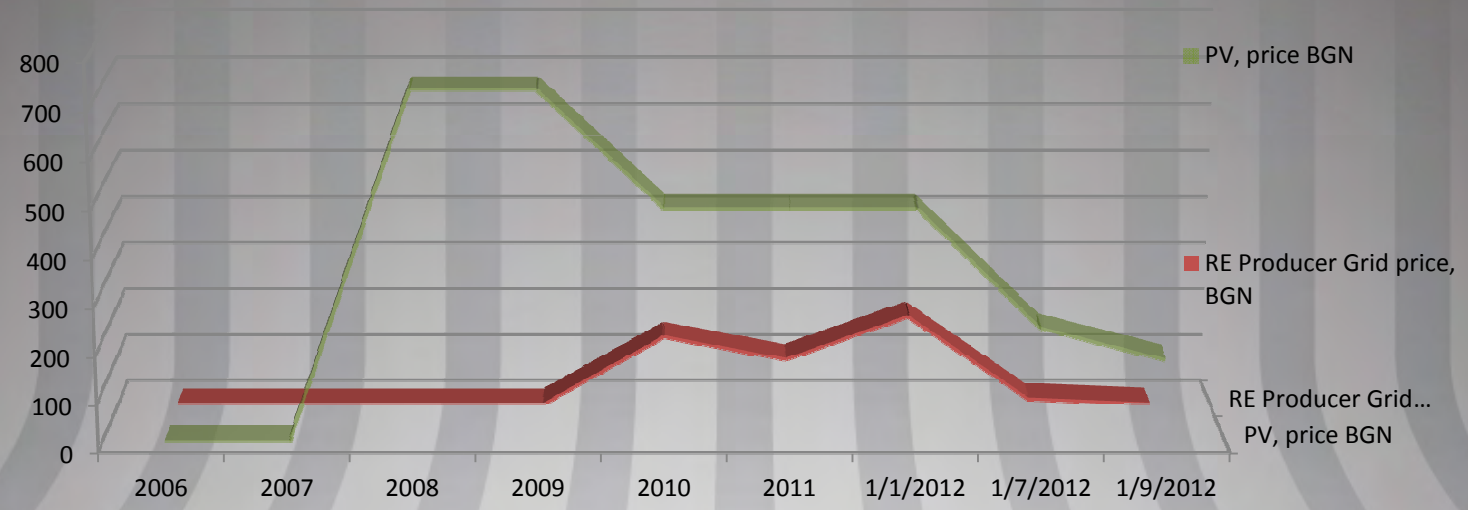
RE MARKET DEVELOPMENT IN BULGARIA

Installed capacities for PV and Wind in Bulgaria 2007 – 2012, MW



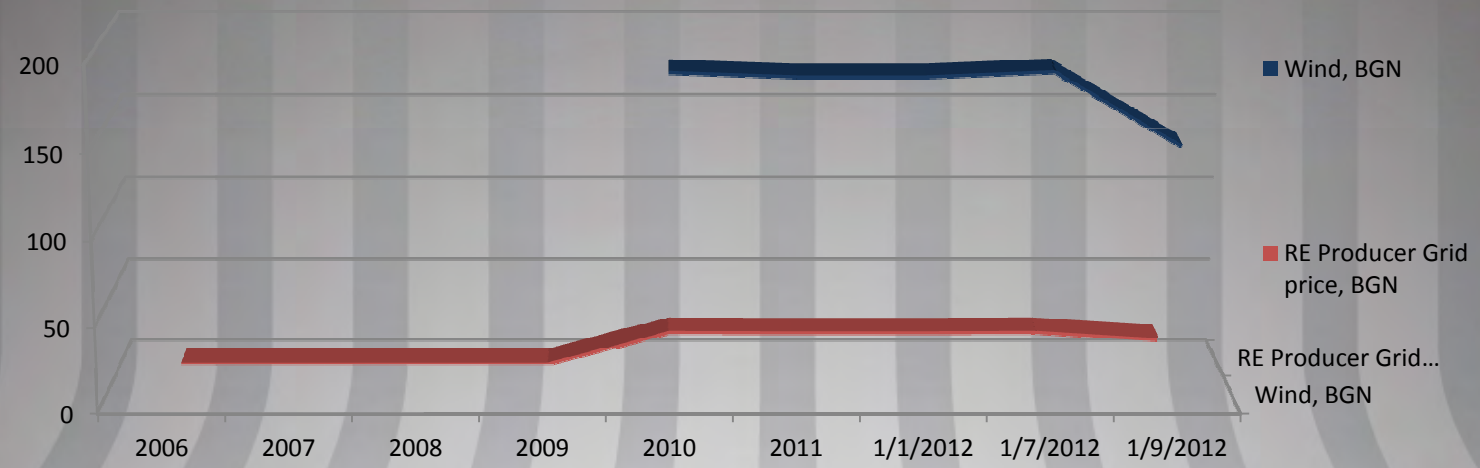
RE MARKET DEVELOPMENT IN BULGARIA

FIT for PV: 2006-2012, BGN/MWh

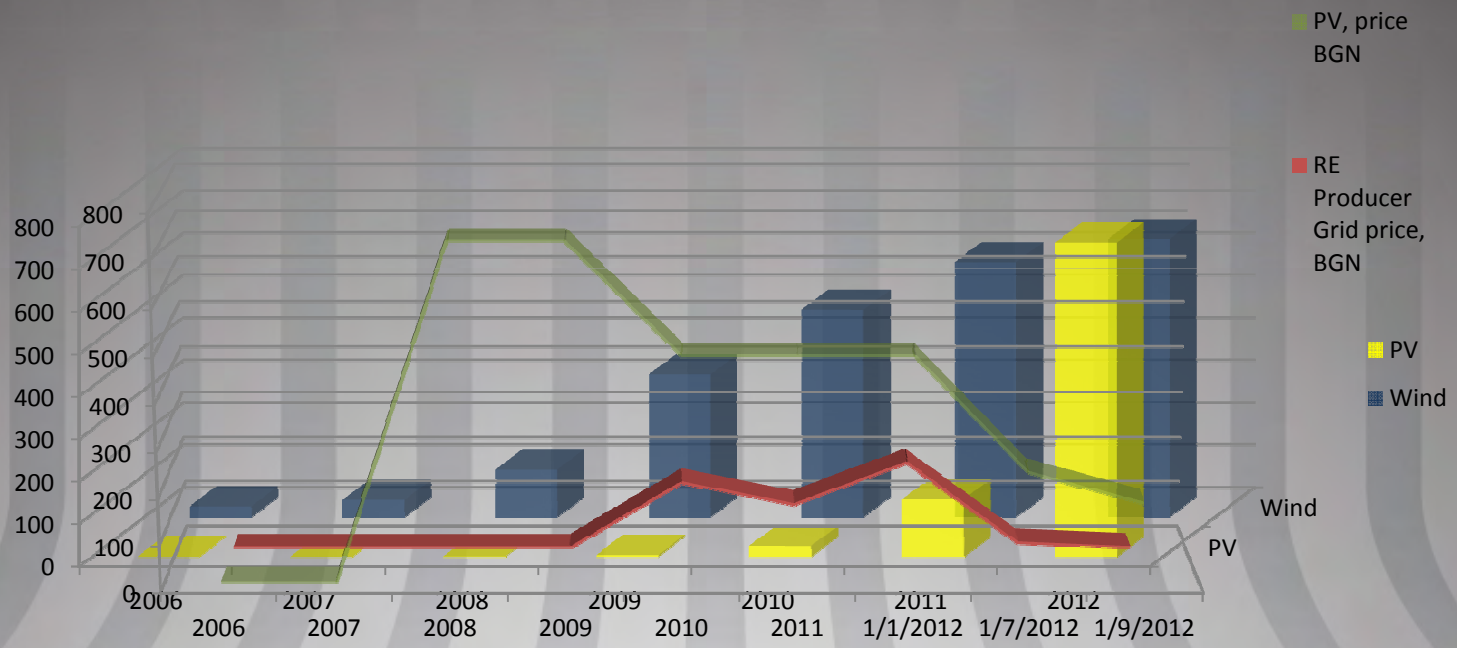


RE MARKET DEVELOPMENT IN BULGARIA

FIT for Wind: 2006-2012, BGN/MWh

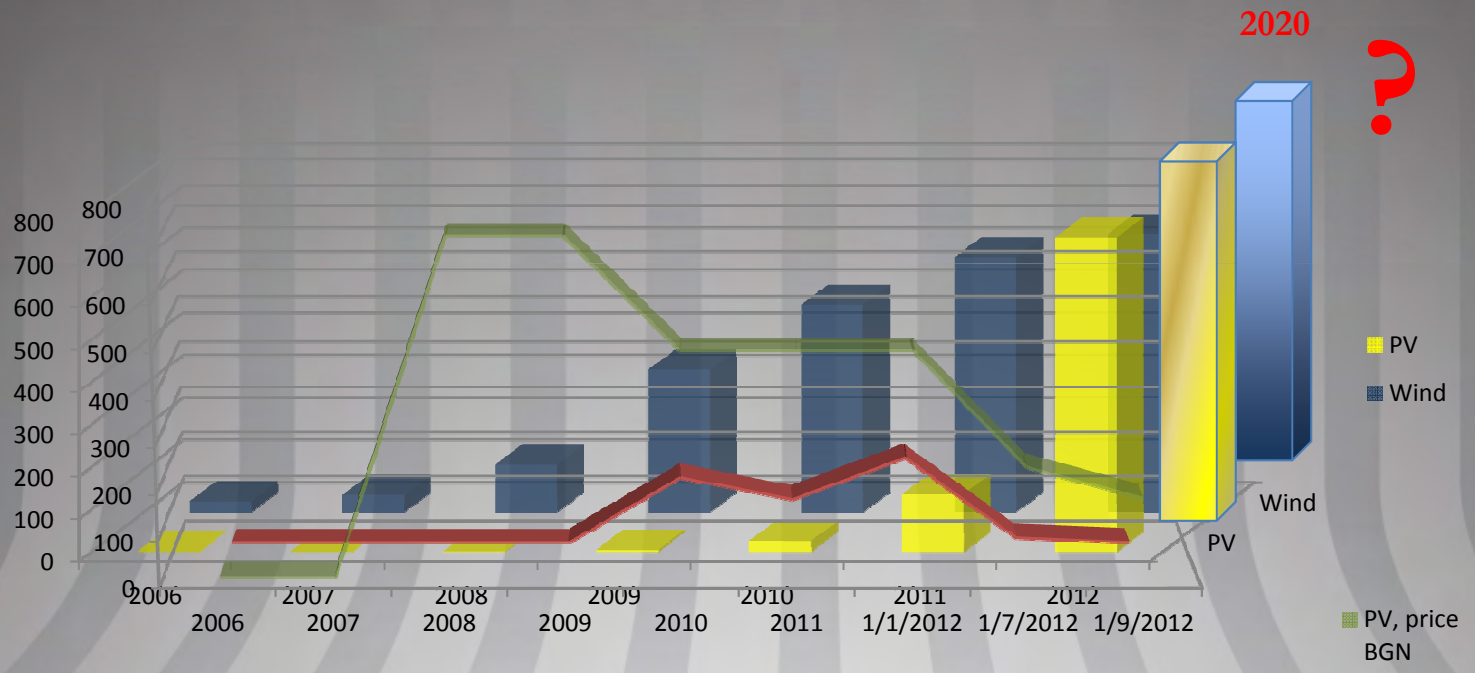


RE MARKET DEVELOPMENT IN BULGARIA



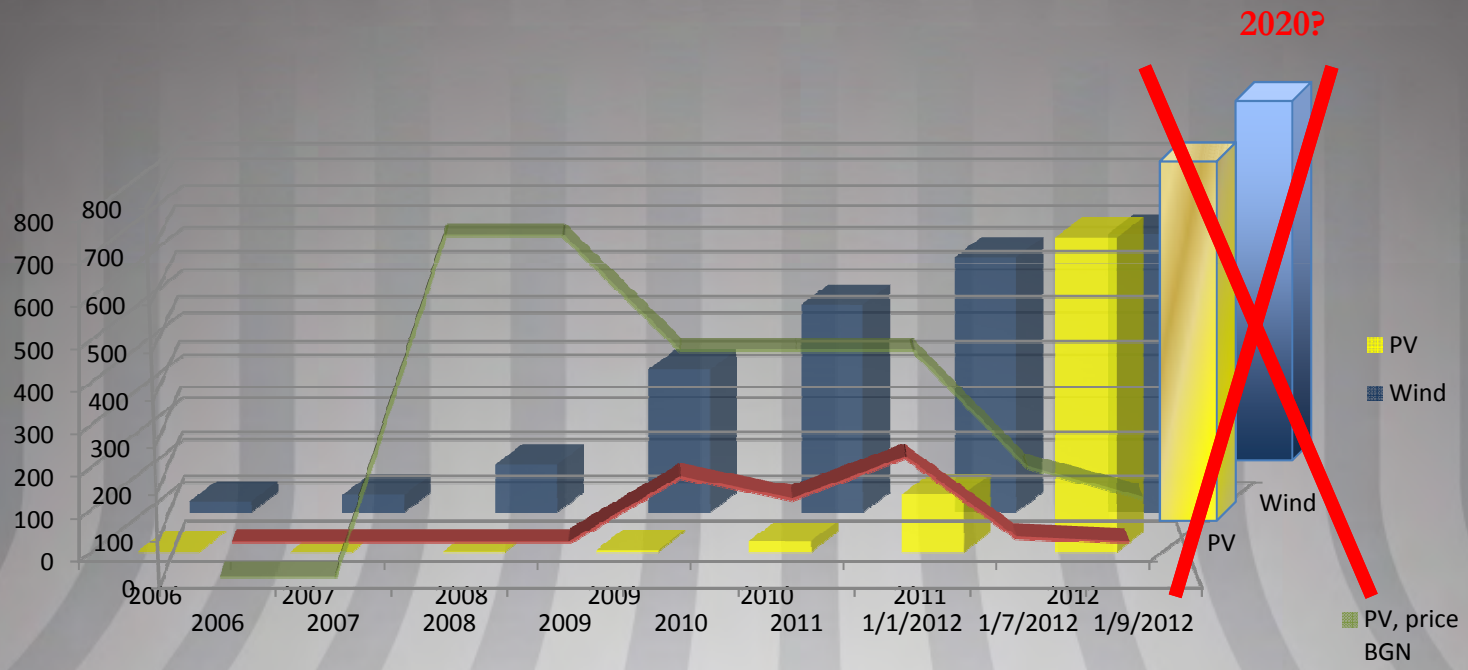
RE MARKET DEVELOPMENT IN BULGARIA

Installed capacities for PV and Wind in Bulgaria 2007 – 2020, MW



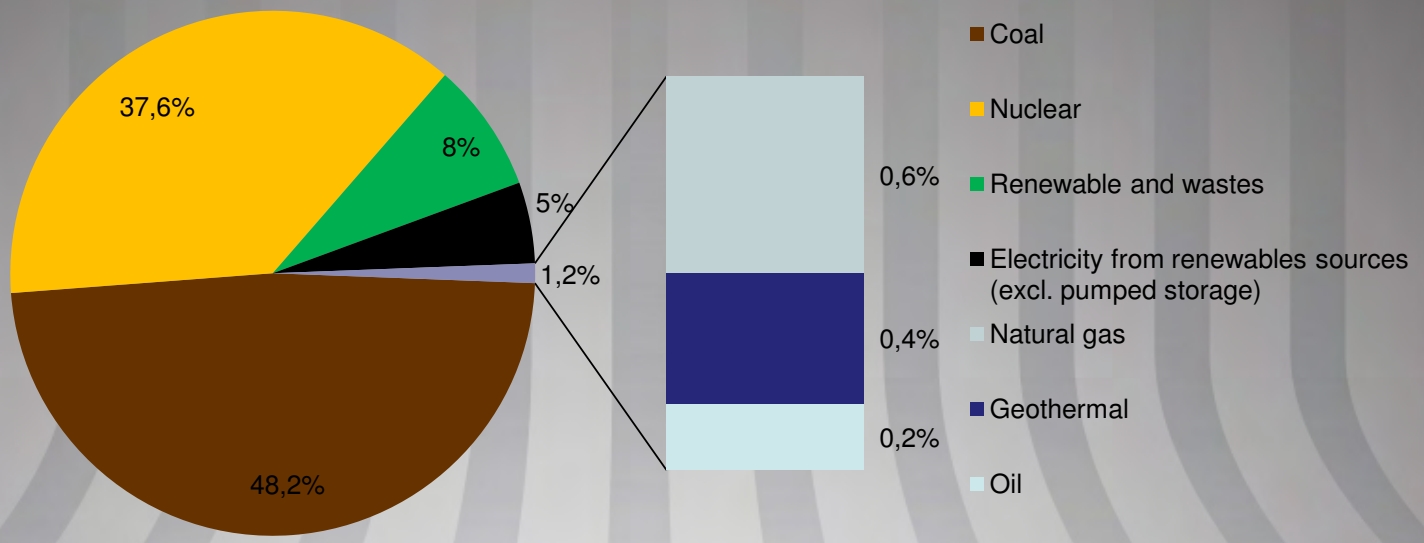
RE MARKET DEVELOPMENT IN BULGARIA

Installed capacities for PV and Wind in Bulgaria 2007 – 2020, MW



PV MARKET DEVELOPMENT IN BULGARIA

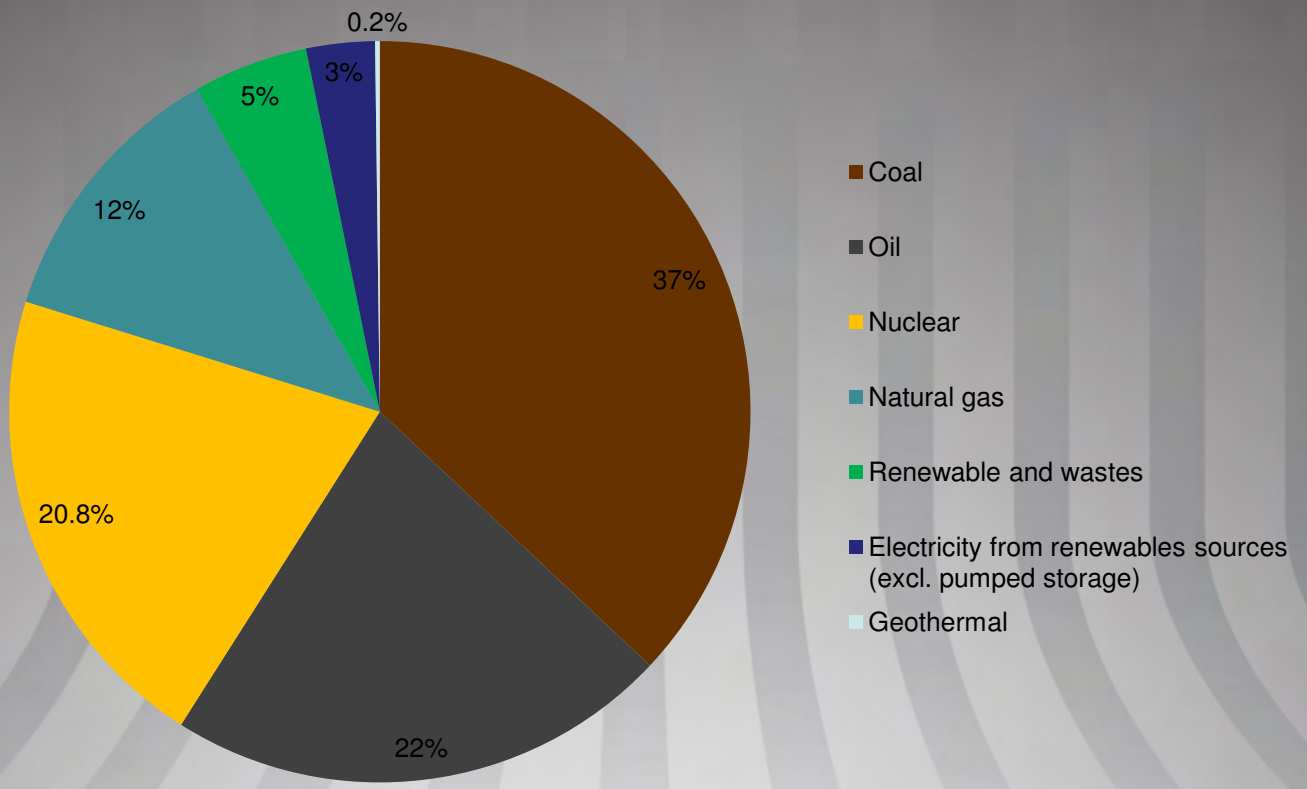
Bulgaria Energy Production Mix 2010



Source: Overall Energy Balance Sheet 2010, NSI

PV MARKET DEVELOPMENT IN BULGARIA

Energy Consumption Mix Bulgaria 2010



Comprehensive energy management, now what?!

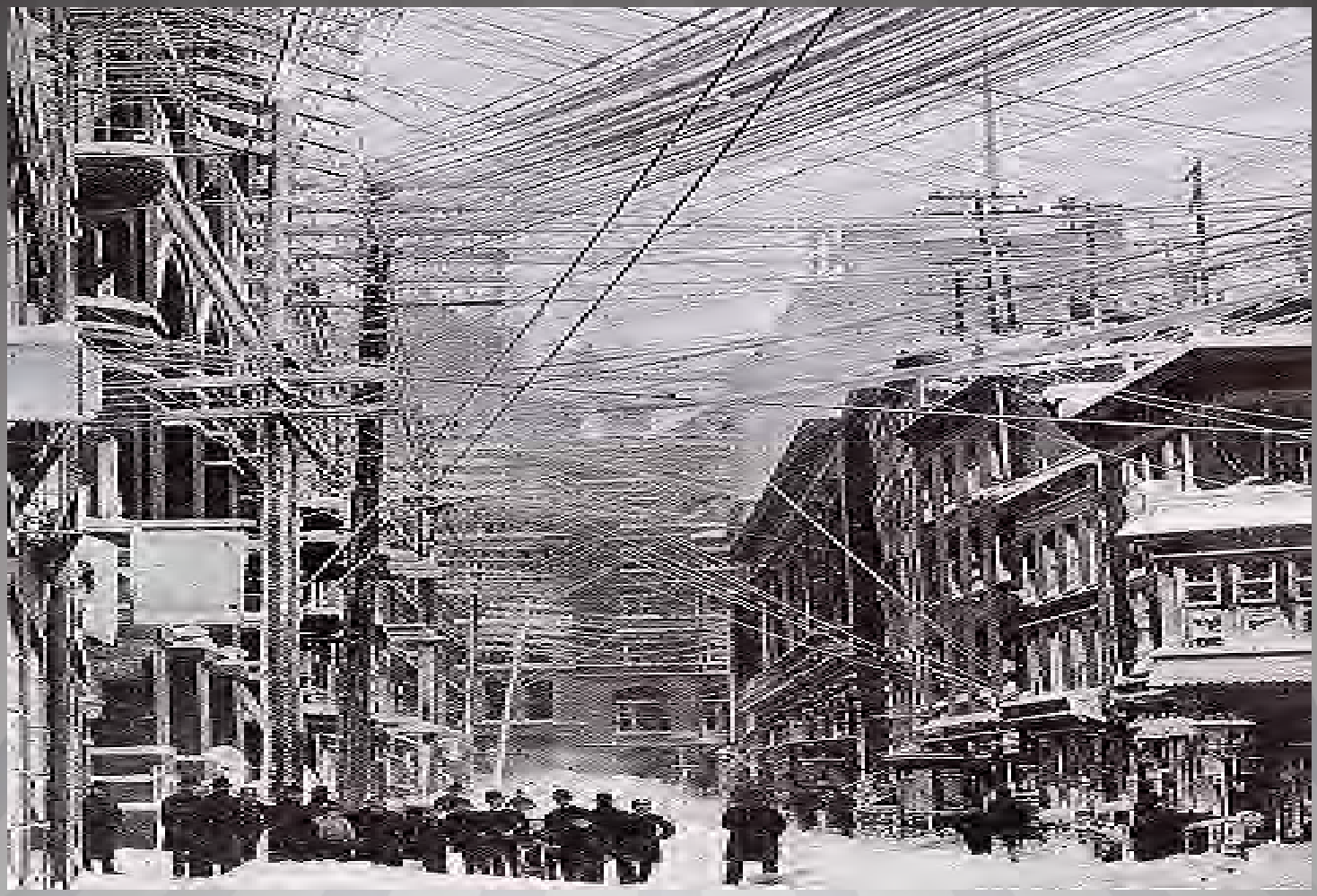
Bulgaria's Green Energy Challenge, Sofia, October 10th , 2012

Comprehensive energy management, now what?!

Diversity of new services:

- ✓Huge data volumes analysis
- ✓Нарастващ обмен и предоставяне на данни
- ✓IT/EMS/ERP/CRM/SCADA/… implamentationa & integration
- ✓Data integration
- ✓Multilevel & bidirectional customer relationship management – prosumers
- ✓Guarantees
- ✓Financial / legal services
- ✓ net-metering,
- ✓Green certificates, CO2, subsidies, green loans
- ✓load flow control and power quality improvement
- ✓…….

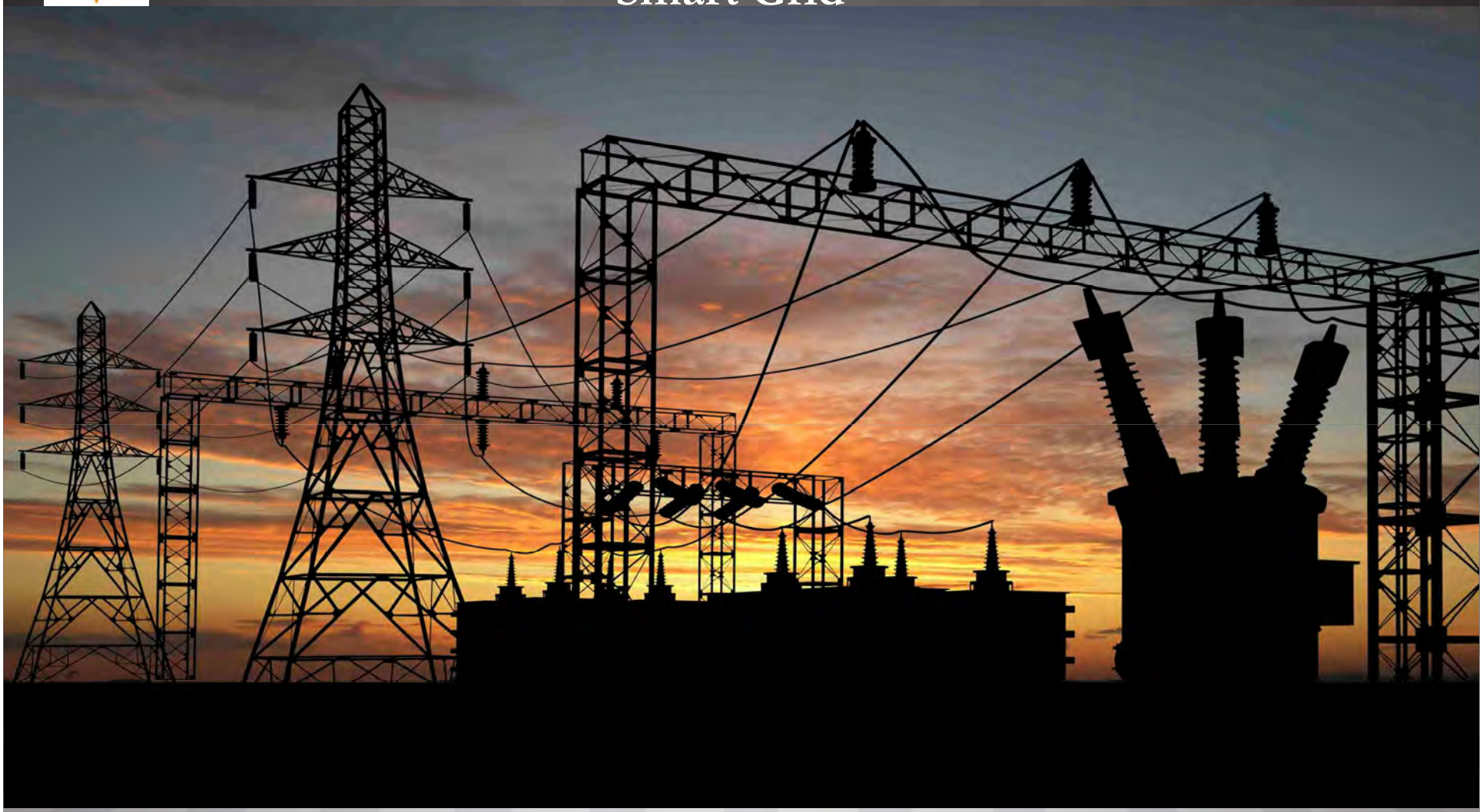
Smart Grid



New York, 1888

Bulgaria's Green Energy Challenge, Sofia, October 10th , 2012

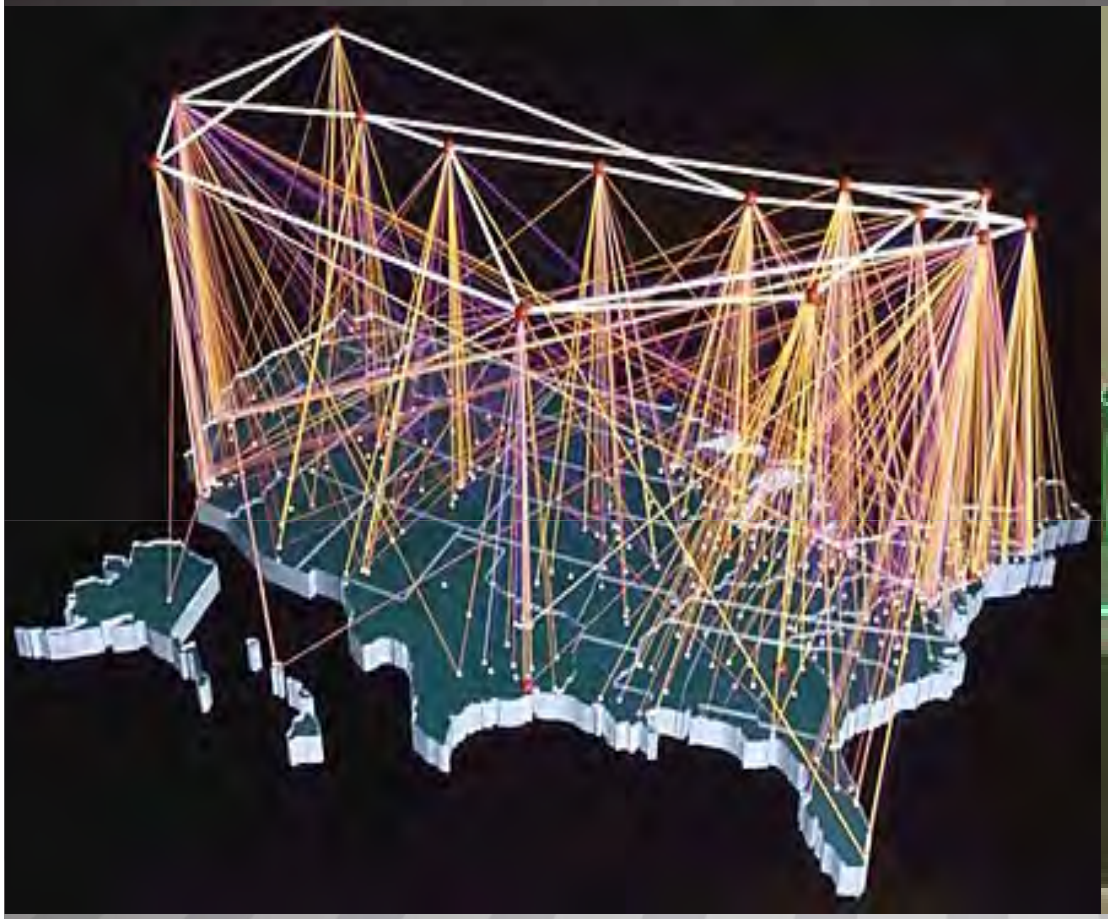
Smart Grid



Somewhere in “the developed world”, 1988

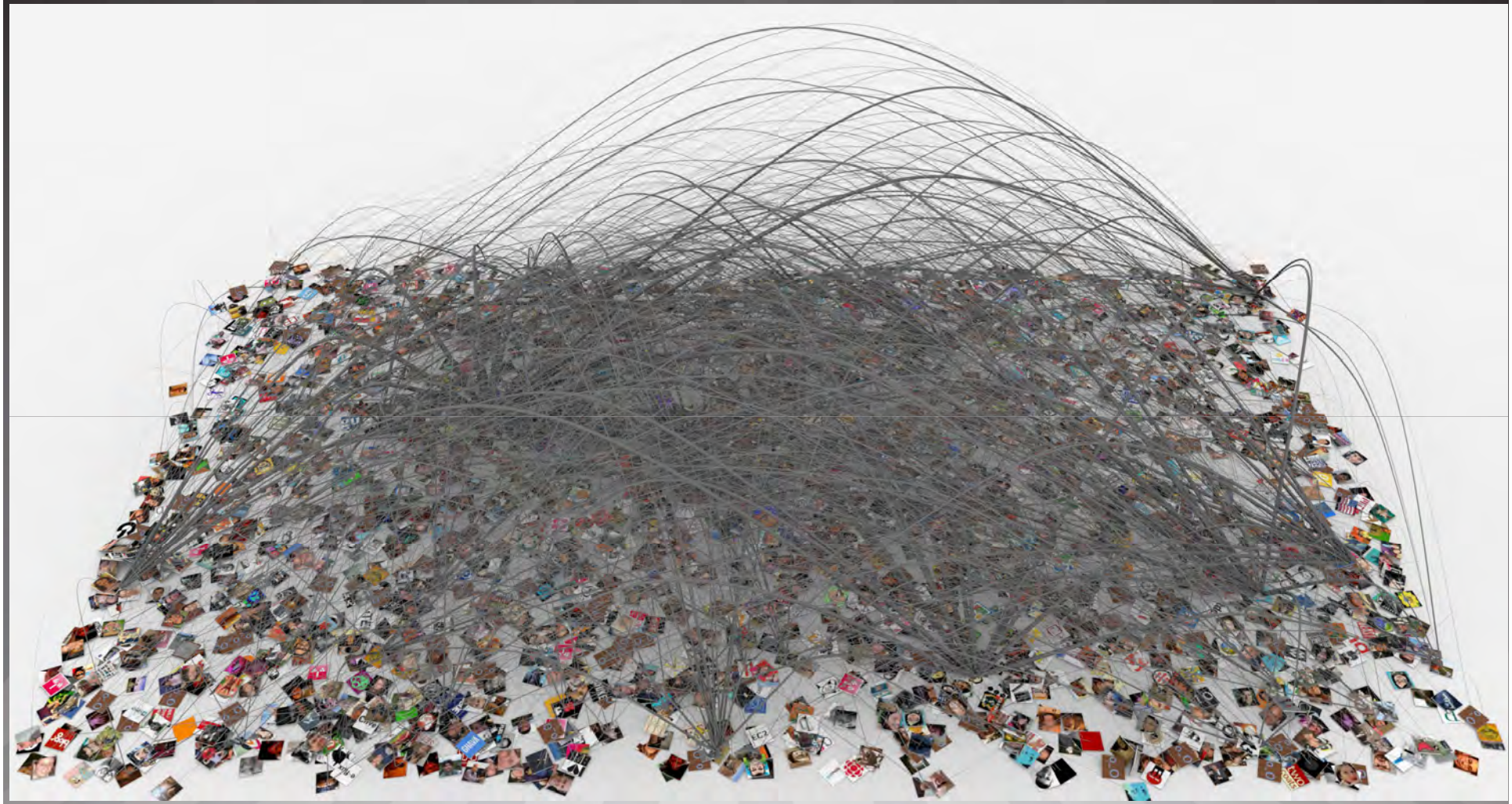
Bulgaria’s Green Energy Challenge, Sofia, October 10th , 2012

Smart Grid



2012 ?

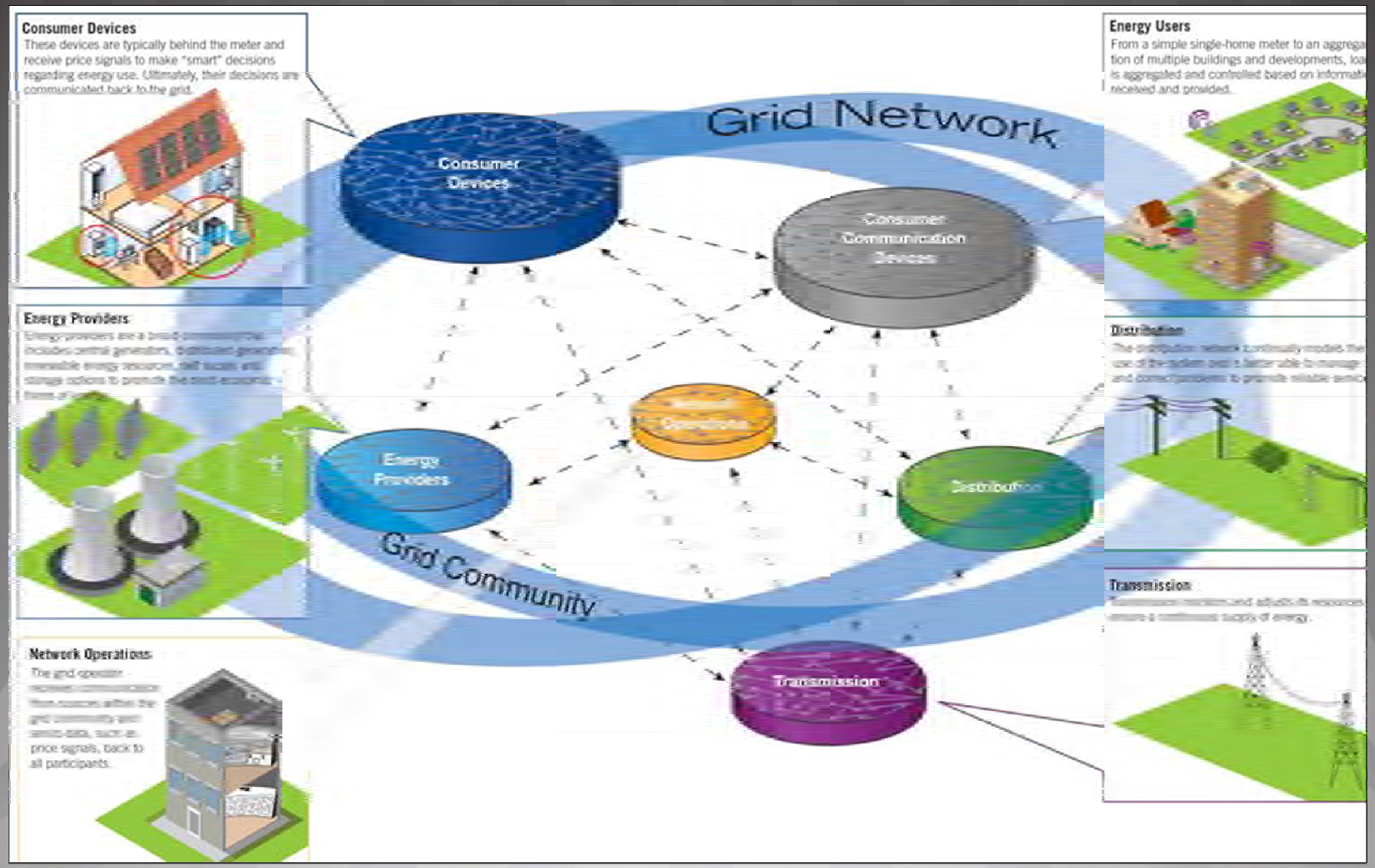
Smart Grid



21.12.2012…

Bulgaria's Green Energy Challenge, Sofia, October 10th , 2012

Smart Grid

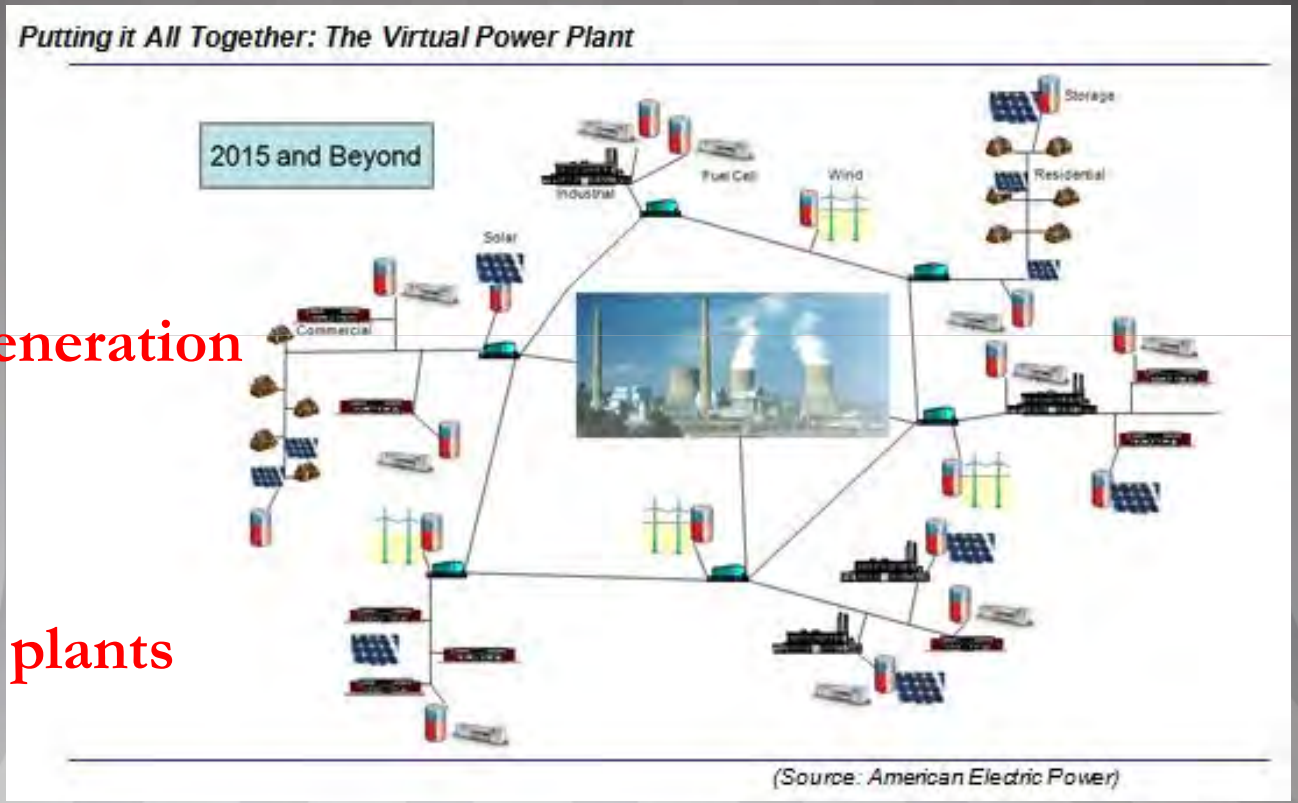

Consumer Devices
These devices are typically behind the meter and receive price signals to make "smart" decisions regarding energy use. Ultimately, their decisions are communicated back to the grid.
Energy Providers
Network Operations
The grid operator
price signals, back to all participants.
Grid Network
Consumer Devices
Energy Providers
Transmission
Grid Community
Energy Users
From a simple single-home meter to an aggrega
tion of multiple buildings and developments, loa
is aggregated and controlled based on informati
received and provided.
Transmission

Smart Grid

Prosumers = producers/consumers

Distributed generation

Virtual power plants



Smart Grid

Source:

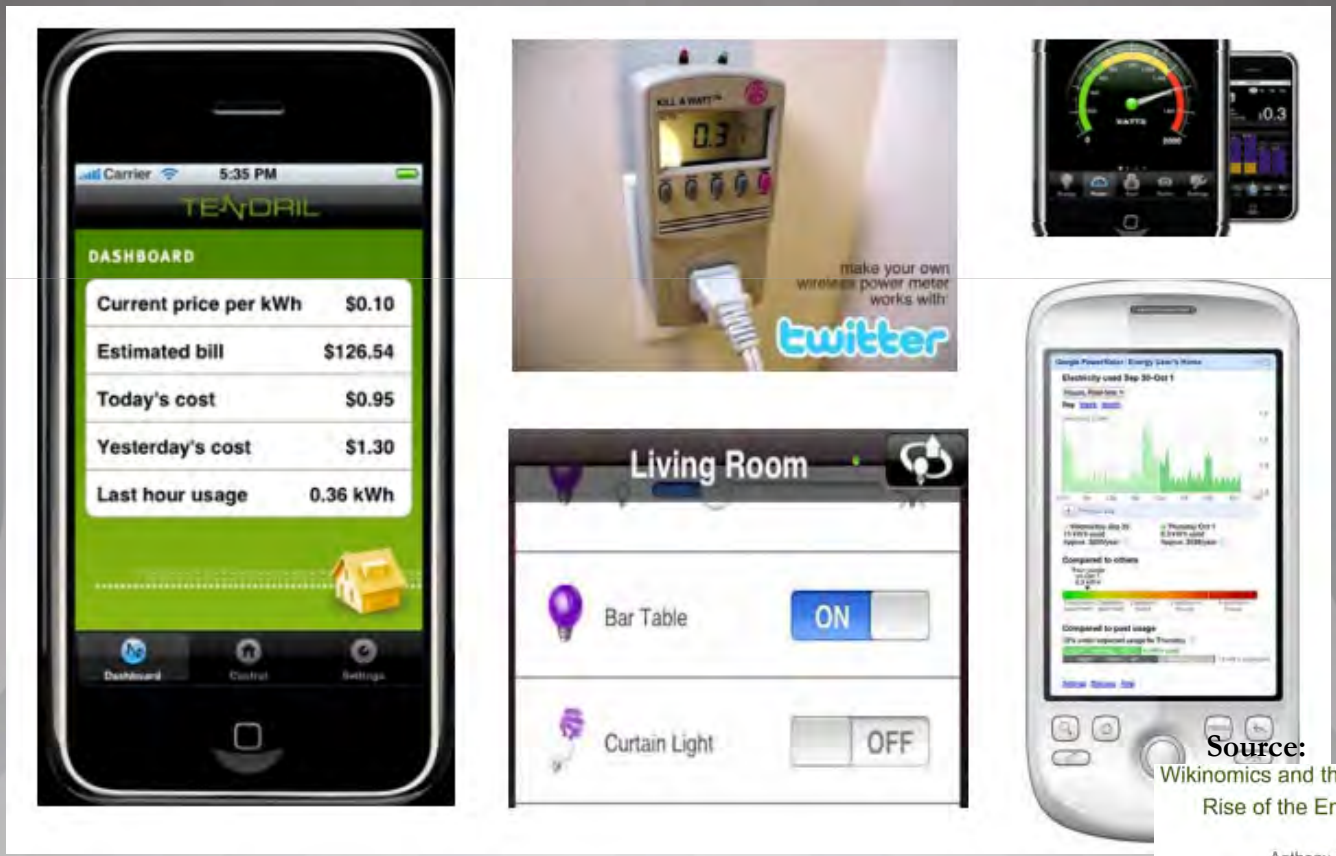
Wikinomics and the Future of Energy: Rise of the Energy Prosumer

Anthony D. Williams
Co-author of *Macrowikinomics*

Bulgaria's Green Energy Challenge, Sofia, October 10th , 2012

Smart Grid

Data is accessible virtually everywhere



Source:

Wikinomics and the Future of Energy:
Rise of the Energy Prosumer

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Smart Grid

Why not energy / energy services app store?

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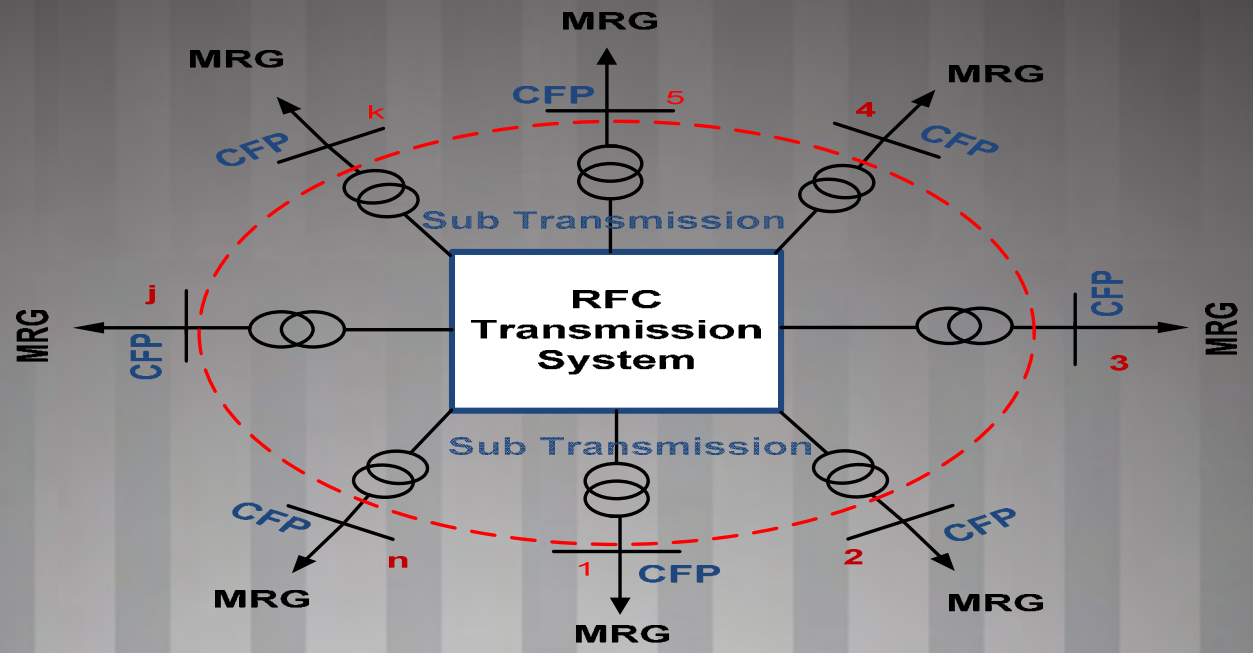
Smart Grid



CFP: Cyber Fusion Point

MRG: Micro-grid Renewable Green Energy System

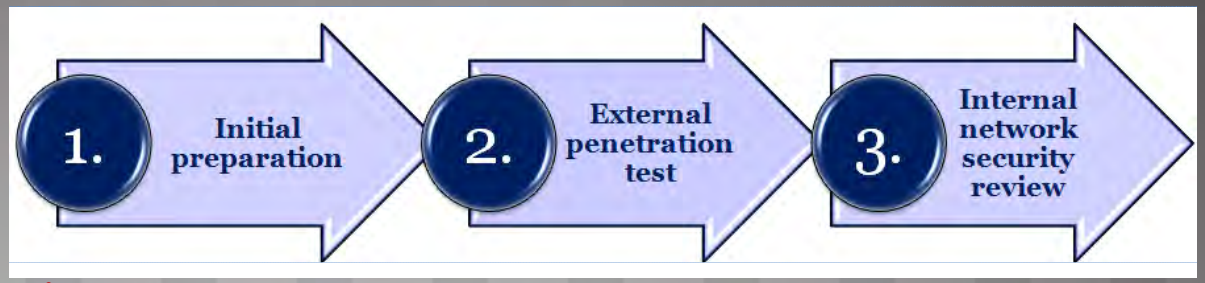
Cyber-Controlled Smart Grid

http://www.ece.osu.edu/~keyhani/

Security & confidentiality – the biggest challenge for the "smart grids"

Smart Grid

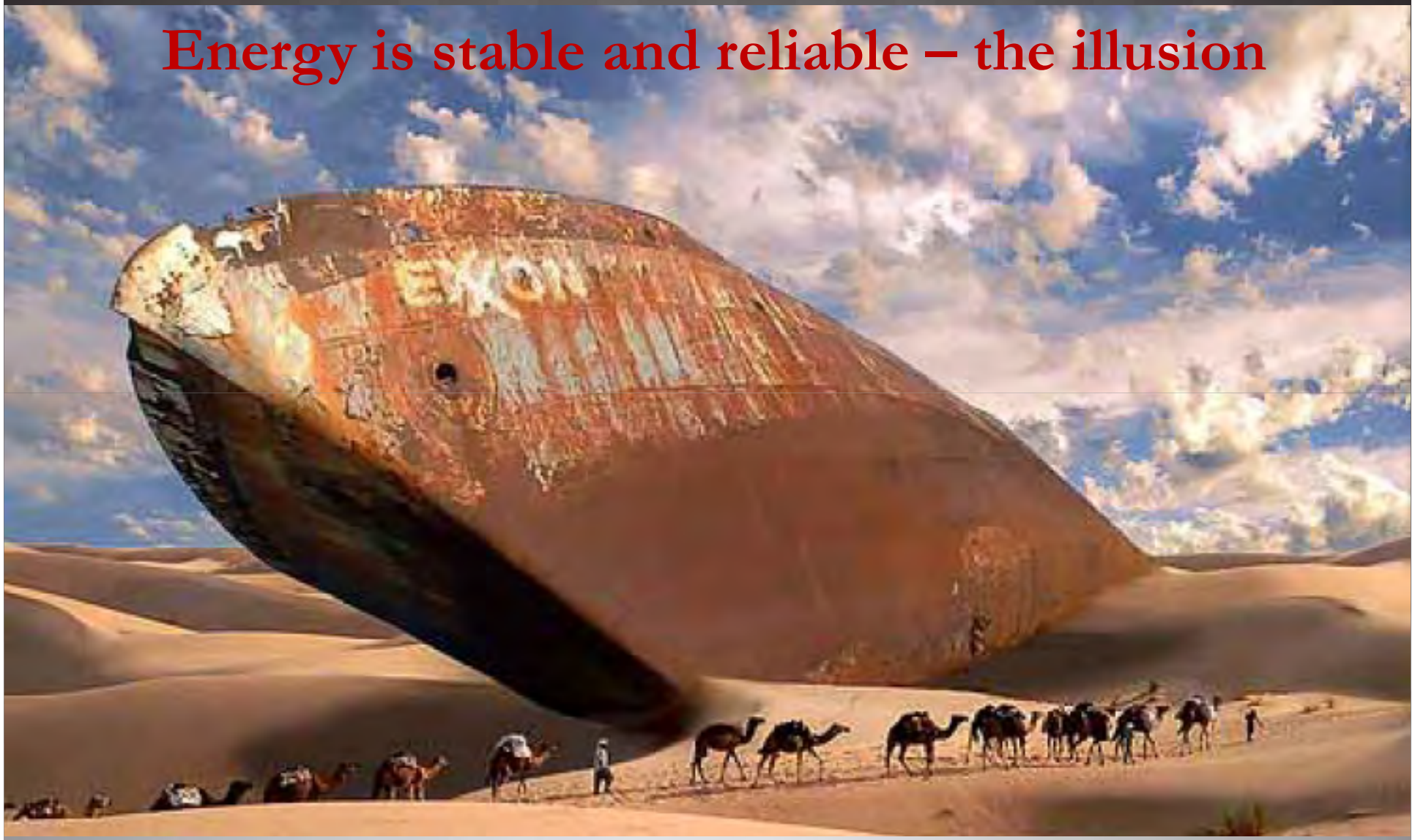
DIGITAL SECURITY SERVICES



- Penetration test
- Forensic reviews
- PCI Compliance Reviews
- like ISO 27001 / PCI DSS / COBIT

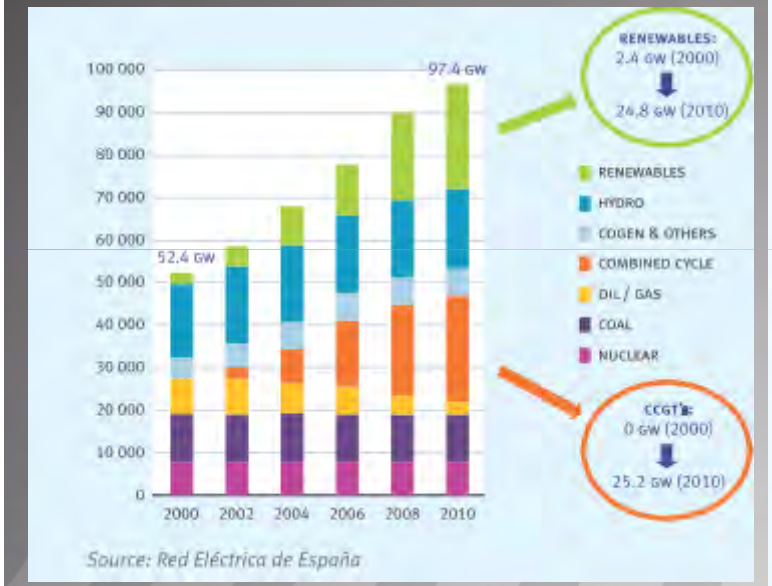
- Wiretap Act (18 U.S.C. 2510-22)
- Pen Registers and Trap and Trace Devices Statute (18 U.S.C. 3121-27)
- Stored Wired and Electronic Communication Act (18 U.S.C. 2701-120)

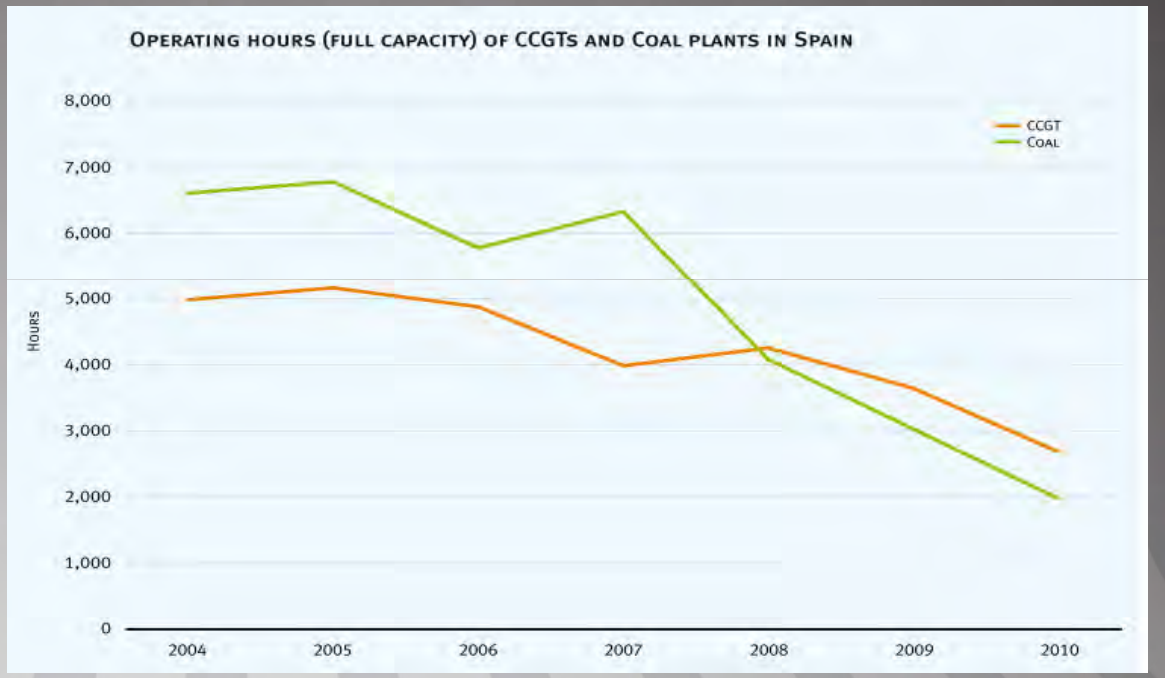
Energy is stable and reliable – the illusion



Balancing
New kind of management & operation

Balancing
New kind of management & operation

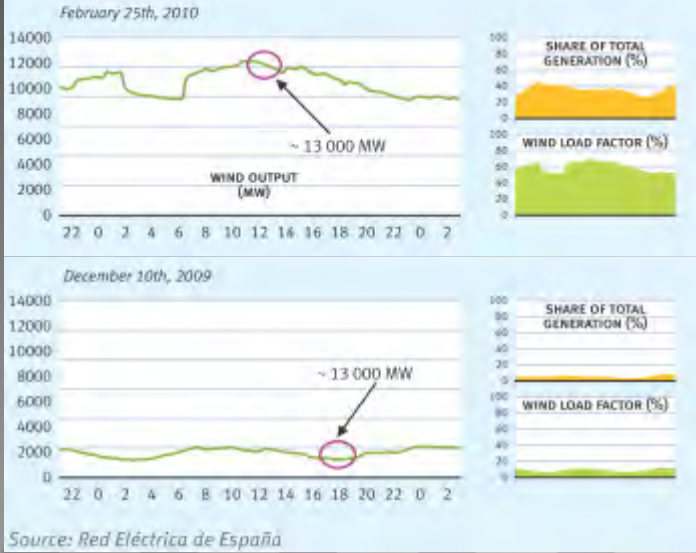




Source: RES Integration and Market Design Report, Euroelectric 2012

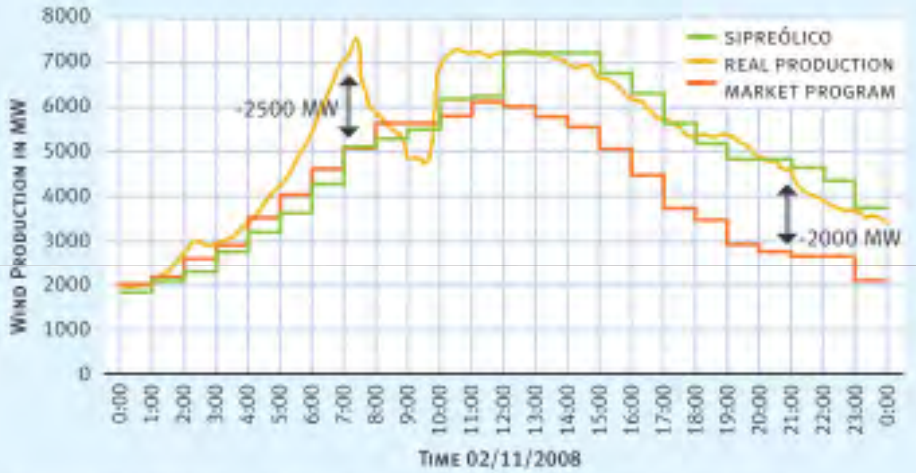
Balancing
New kind of management & operation

FIGURE 15: WIND OUTPUT AND CONTRIBUTION TO DEMAND COVERAGE IN SPAIN DURING TWO DAYS WITH COMPARABLE ELECTRICITY CONSUMPTION AND PEAK DEMAND



Source: Red Eléctrica de España

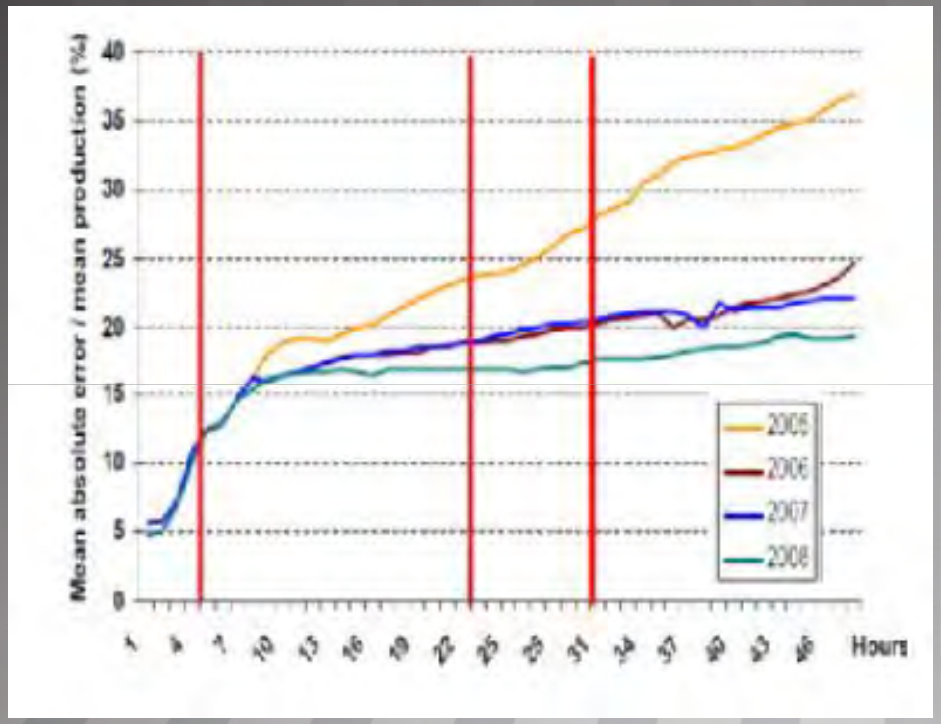
FIGURE 16: WIND FORECAST ERROR IN SPAIN

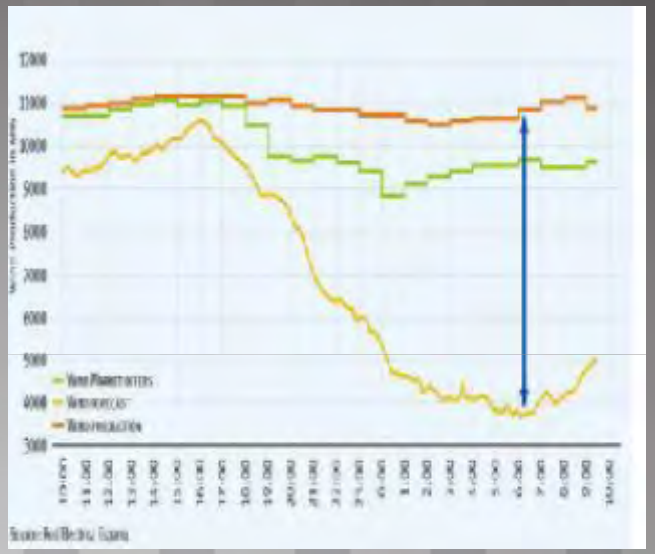


Source: Red Eléctrica de España, figure in EURELECTRIC, Integrating Intermittent Renewables, March 2010

Source: RES Integration and Market Design Report, Euroelectric 2012

Balancing
New kind of management & operation

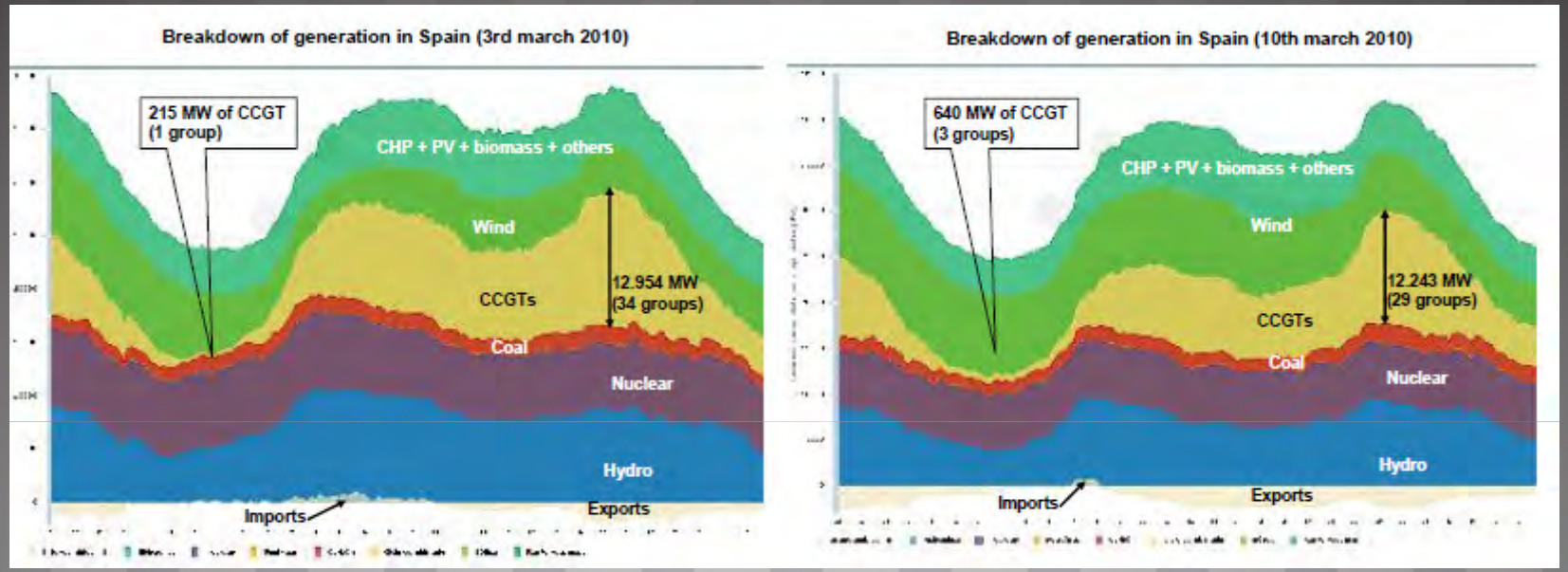




Differences b/n forecasts and real production of wind power plants in Spain

Source: Eurelectric workshop on electricity storage, 2012

Balancing
New kind of management & operation



Power reserve – above 120 %, the flexibility is primarily from WPP and TPP

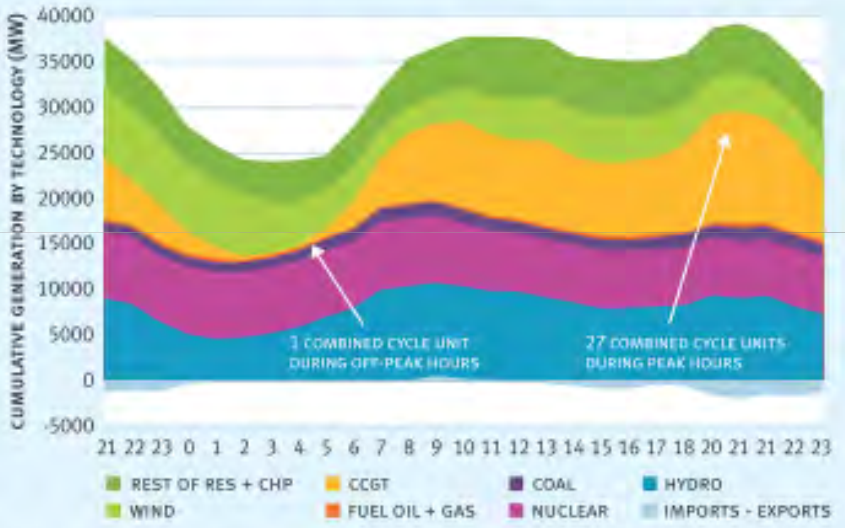
Source: Eurelectric workshop on electricity storage, 2012

Balancing
New kind of management & operation

FIGURE 17: UTILISATION RATES FOR COAL AND CCGTS

Source: Red Eléctrica de España, figure elaborated by Endesa

FIGURE 18: EVOLUTION OF GENERATION IN SPAIN ON 3 MARCH 2010

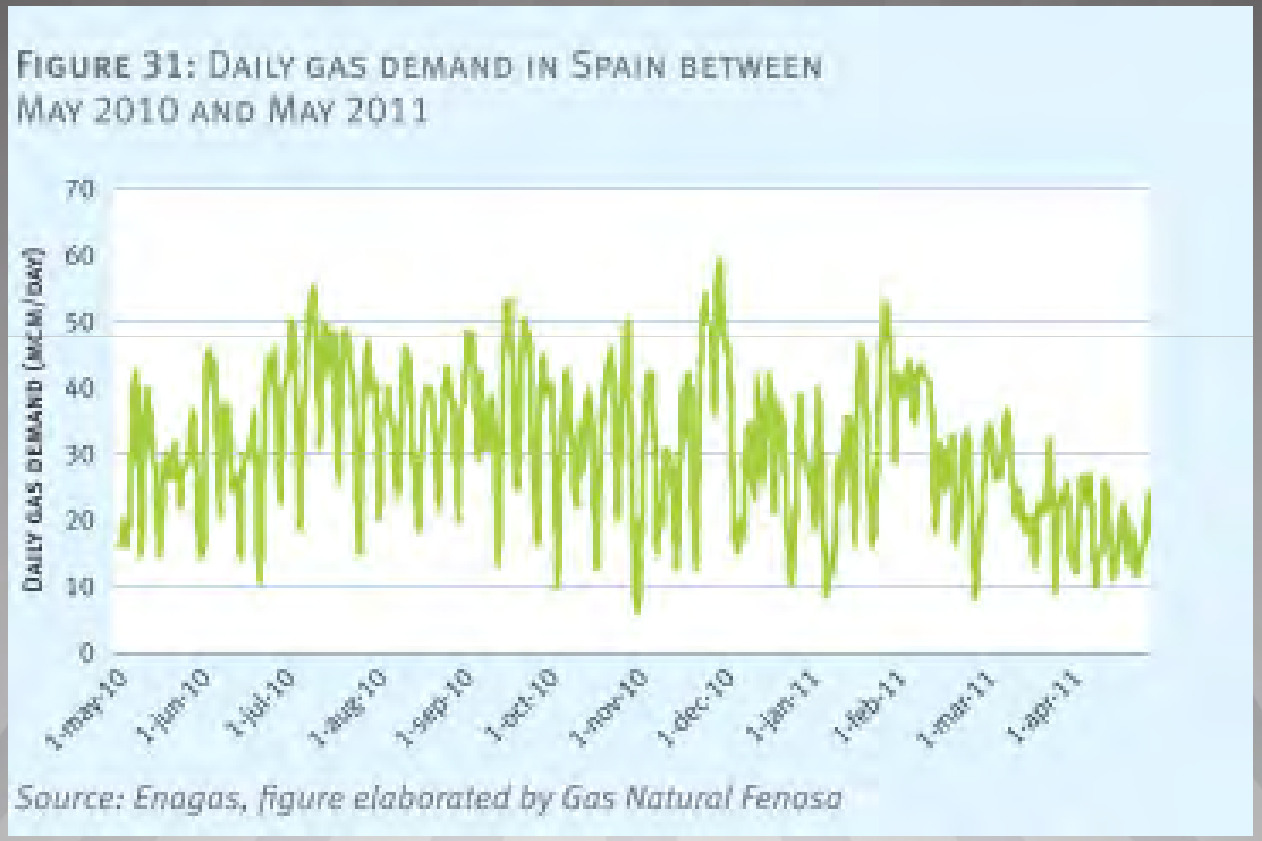


Source: Figure elaborated by Endesa, data from Red Eléctrica de España

Source: RES Integration and Market Design Report, Euroelectric 2012

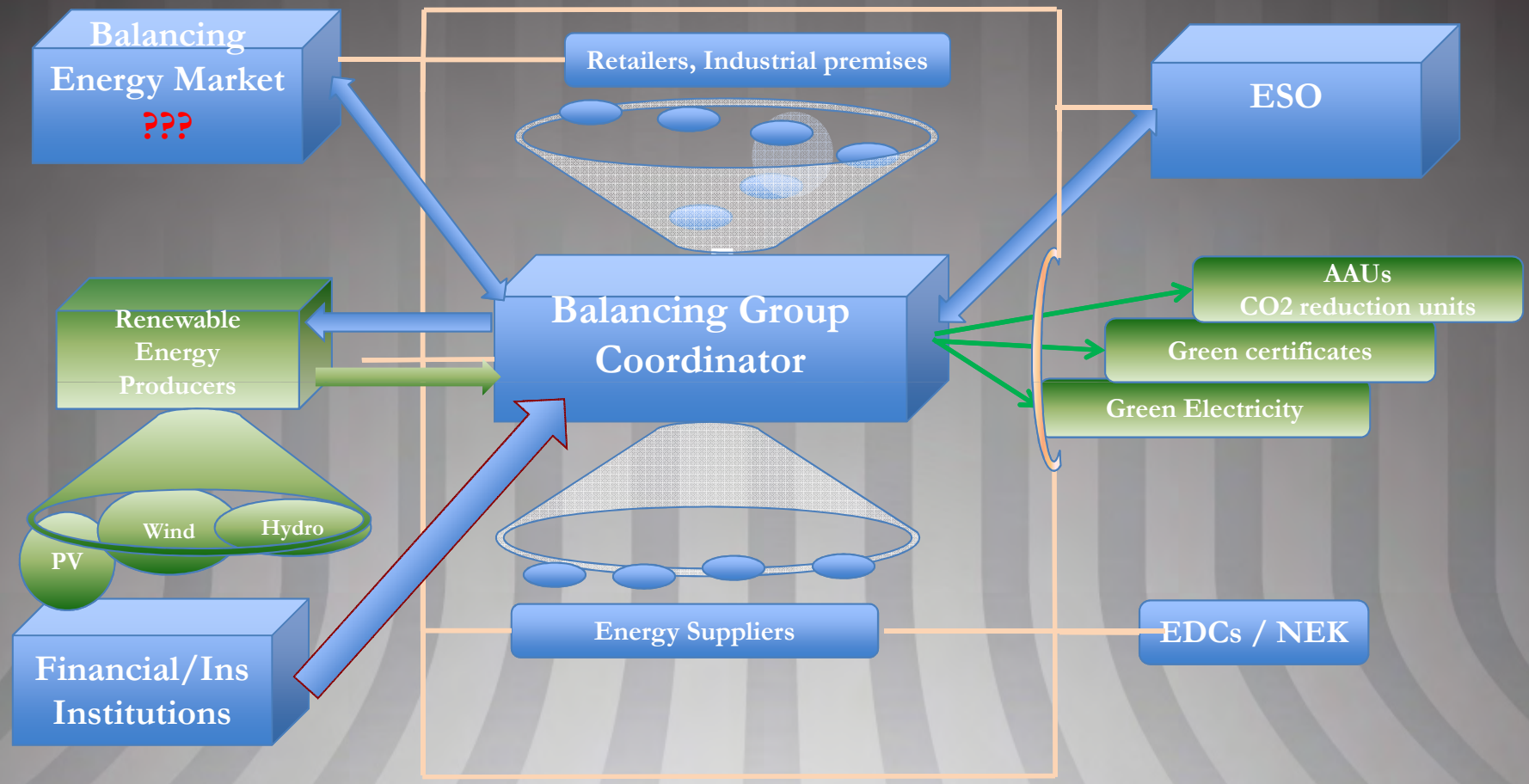
Balancing

The integration & interaction of electricity transmission and gas transmission / operators



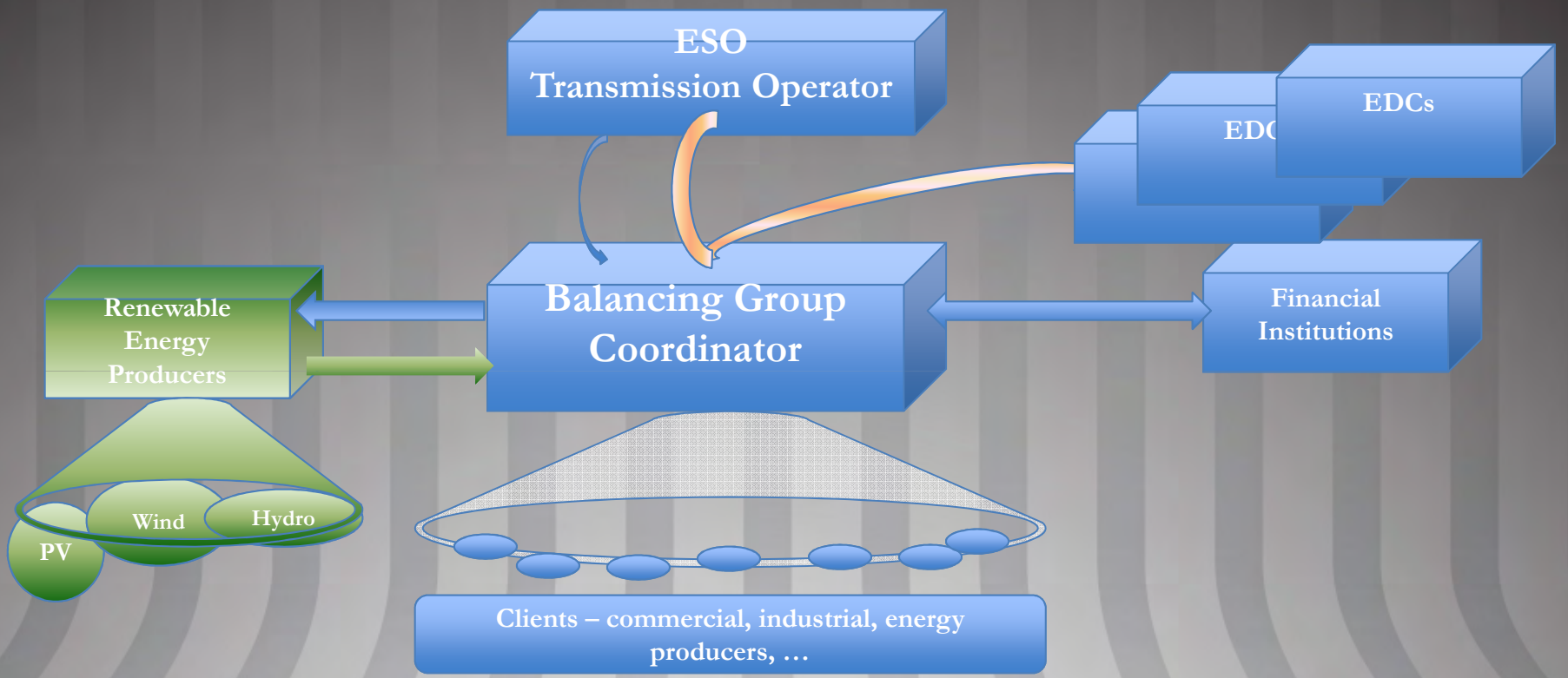
Source: RES Integration and Market Design Report, Euroelectric 2012

Balancing – example models



Multiple Balancing Coordinators General Model

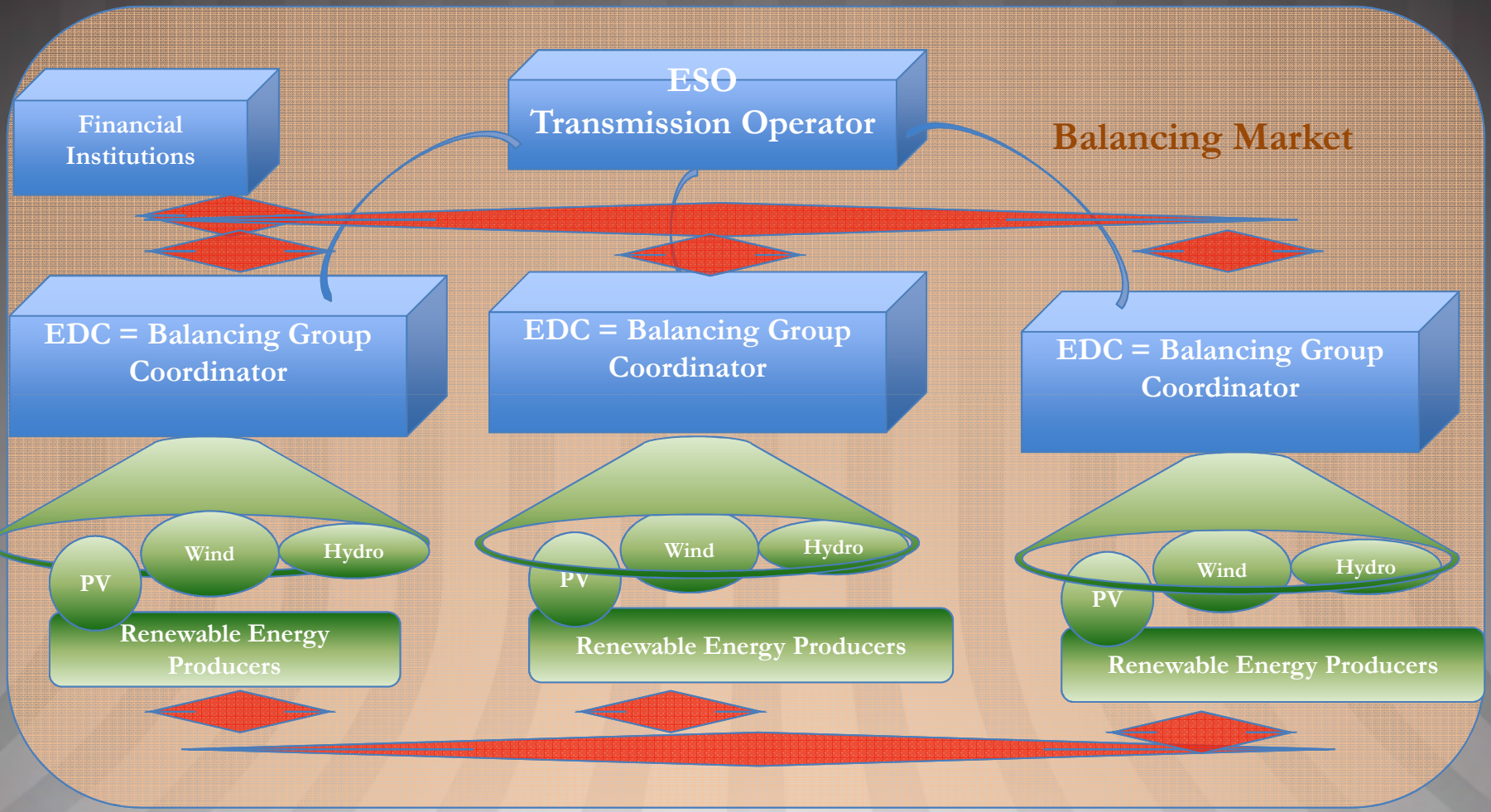
Balancing – example models



Multiple Balancing Coordinators Model

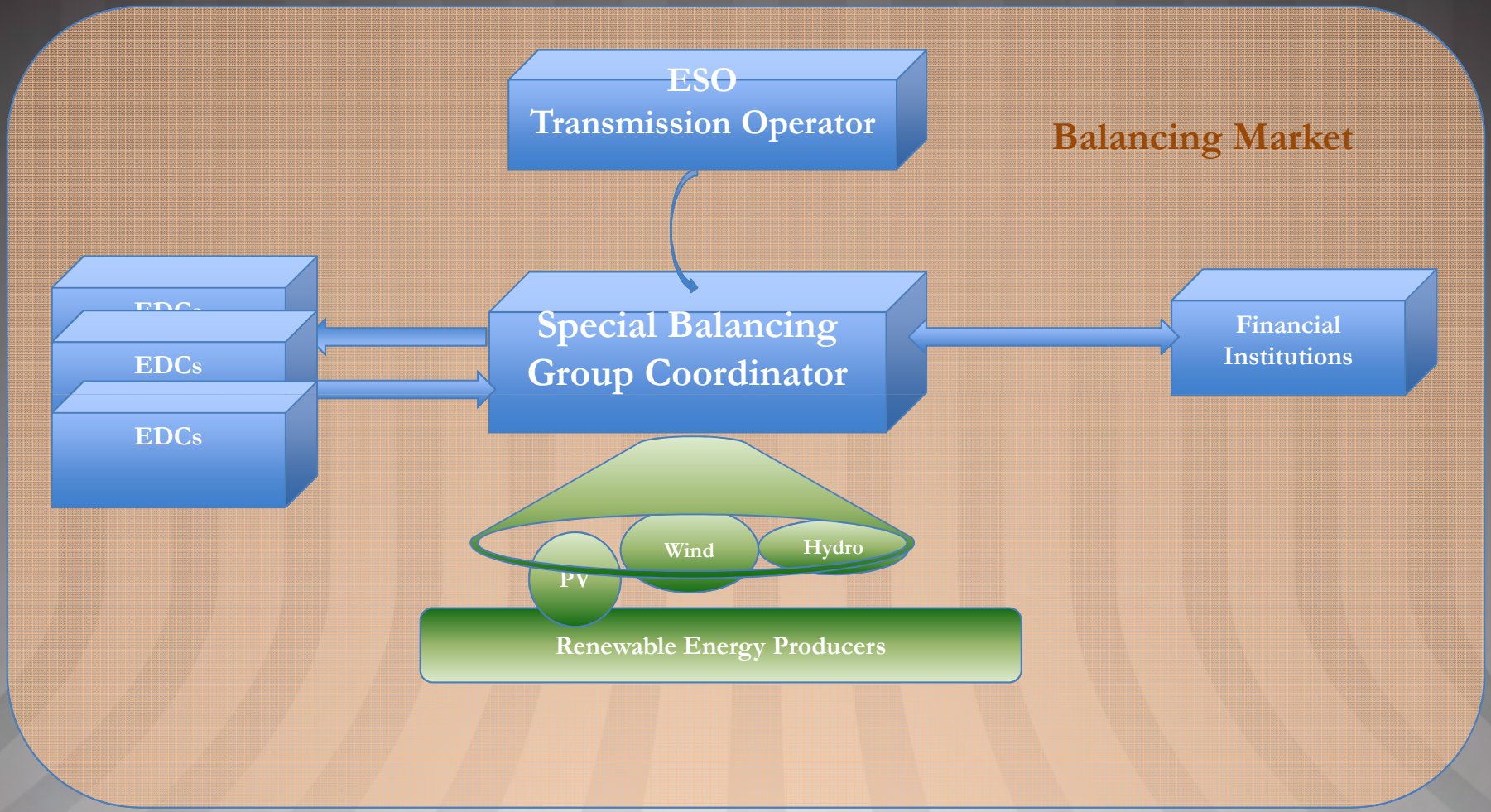
Bulgaria's Green Energy Challenge, Sofia, October 10th , 2012

Balancing – example models



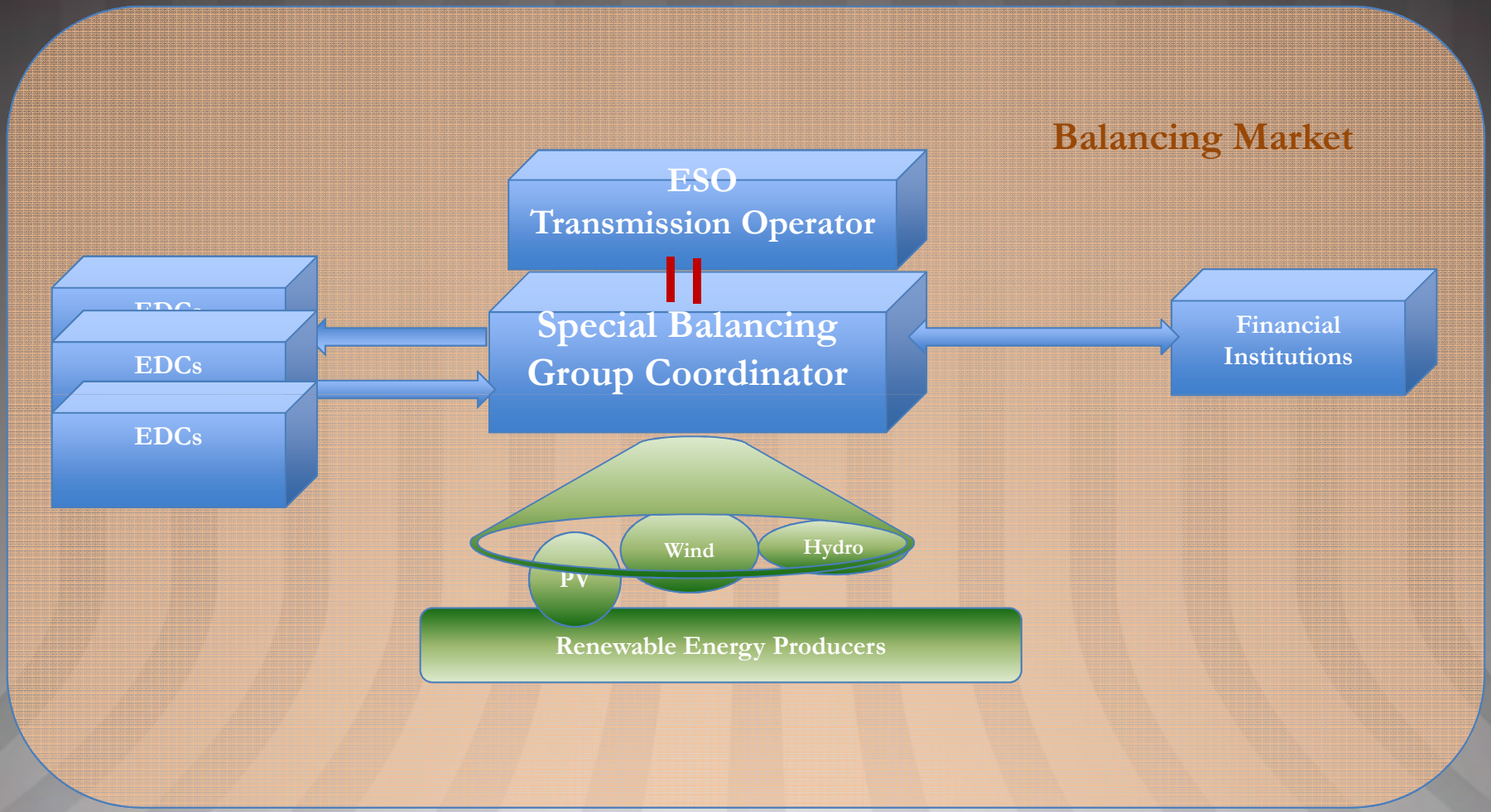
Multiple Balancing Coordinators Model = EDCs coordinators

Balancing - example
Balancing – example models



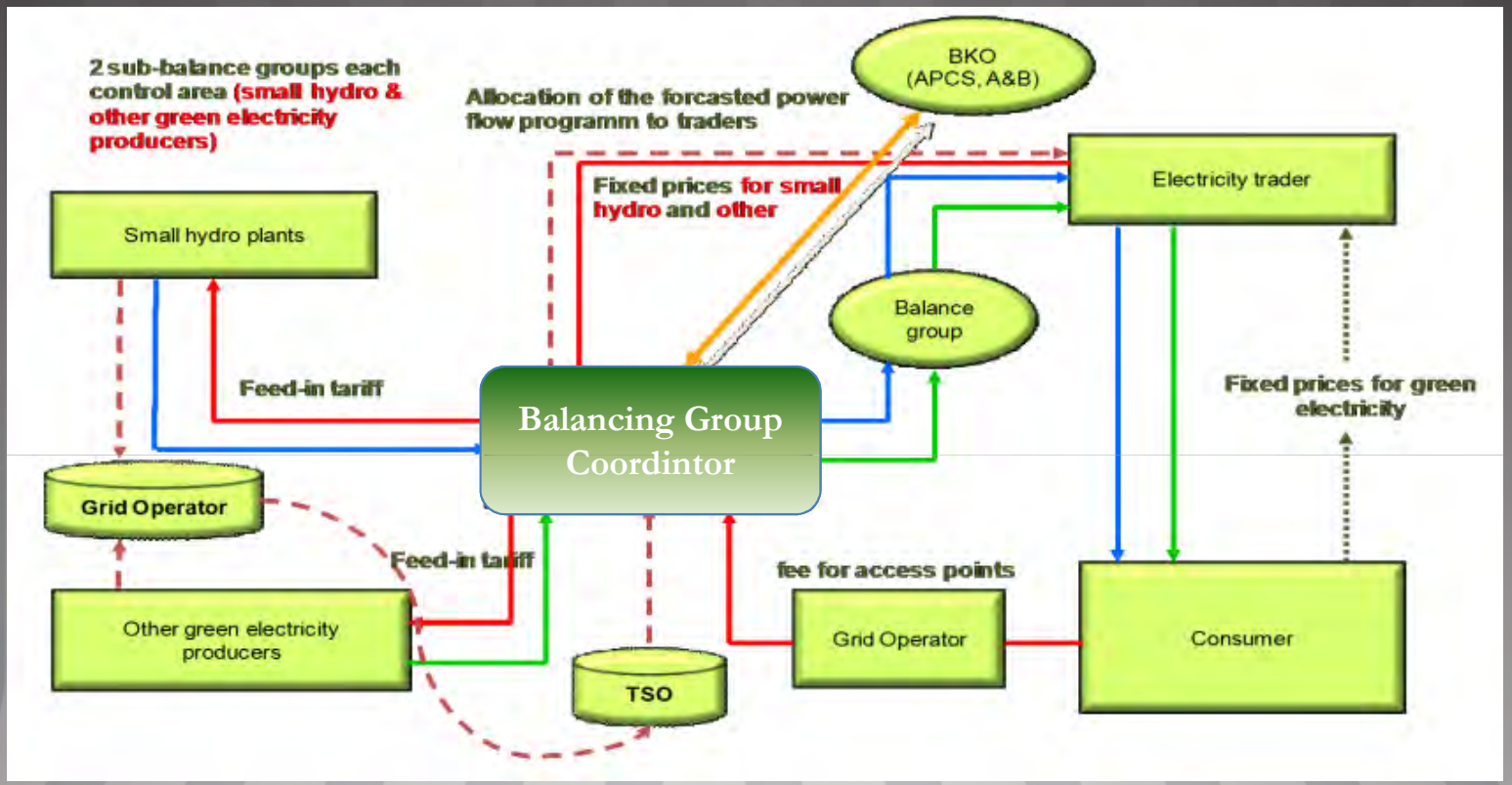
One Balancing Coordinator Model – third party

Balancing – example models



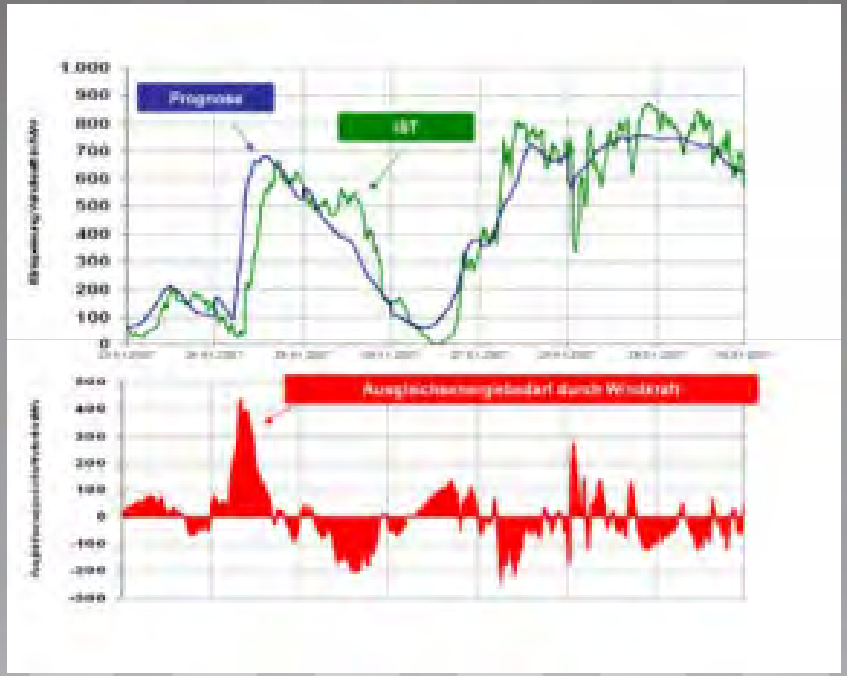
One Balancing Coordinator Model – TSO coordinator

Balancing – working example



Source: OeMAG, balance group responsible for renewables – the Austrian case

Balancing - example



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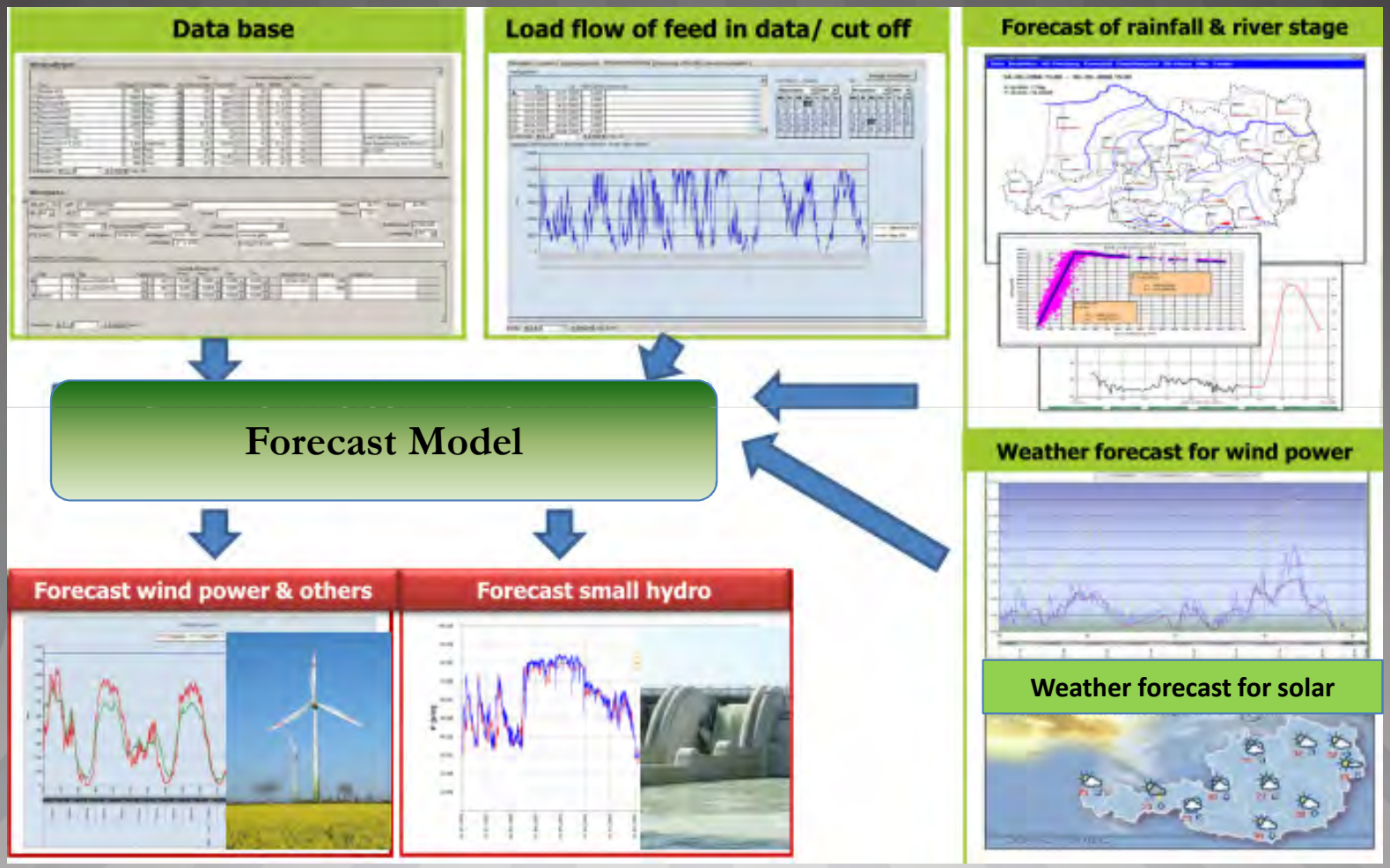
Balancing - example



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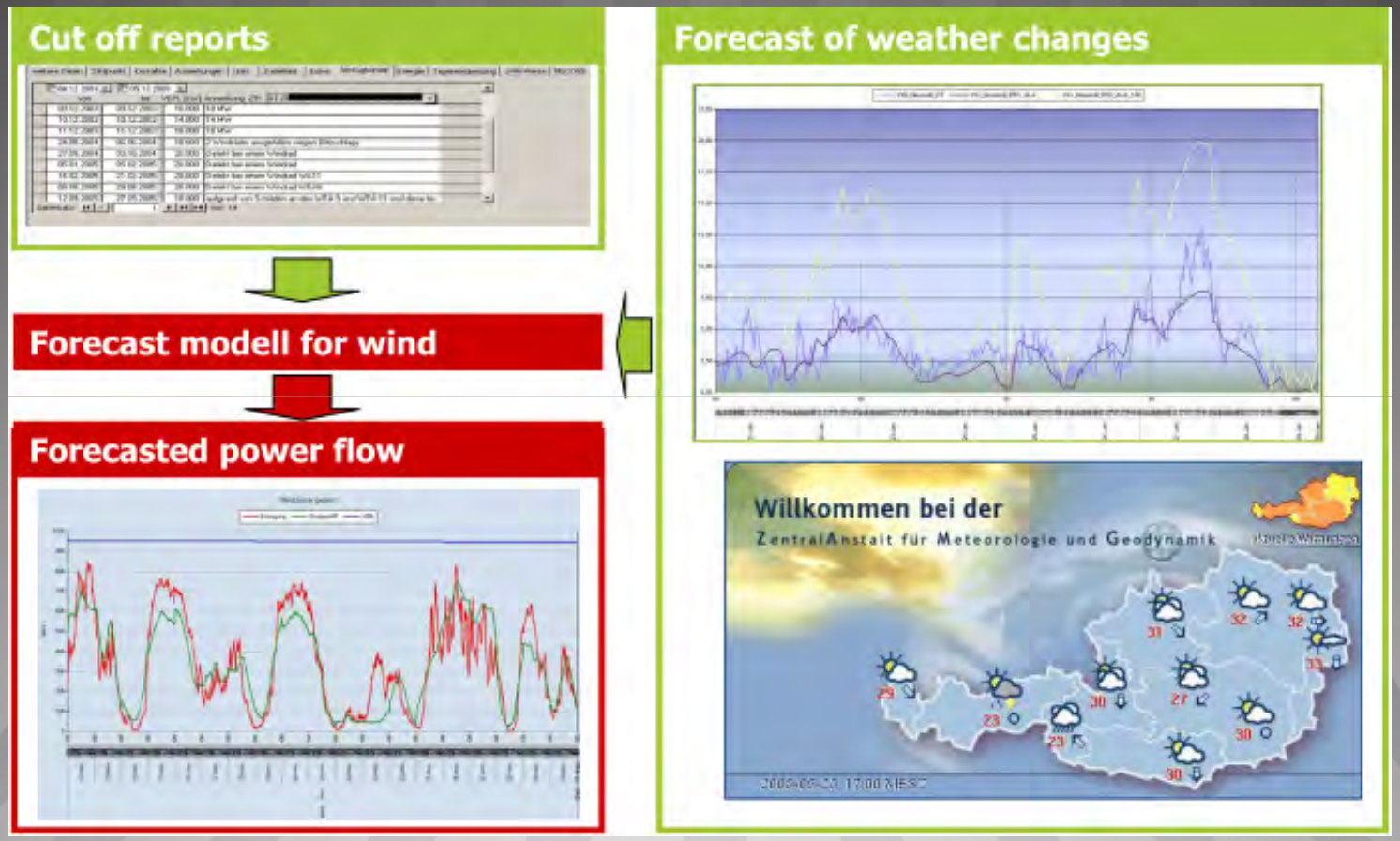
Balancing - example



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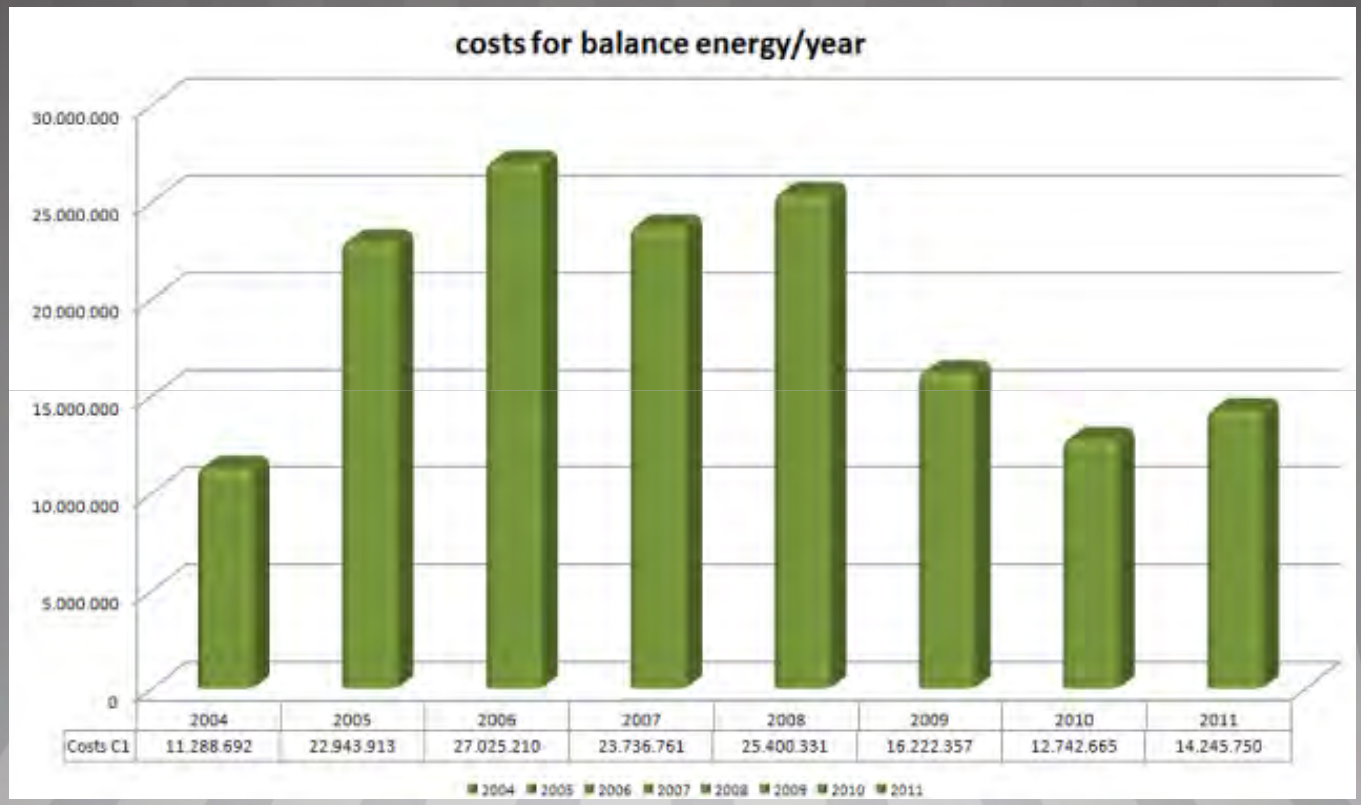
Balancing - example



	2004	2005	2006	2007	2008	2009	2010	2011
Costs C1	11.288.692	22.943.913	27.025.210	23.736.761	25.400.331	16.222.357	12.742.665	14.245.750

Source: OeMAG, balance group responsible for renewables – the Austrian case

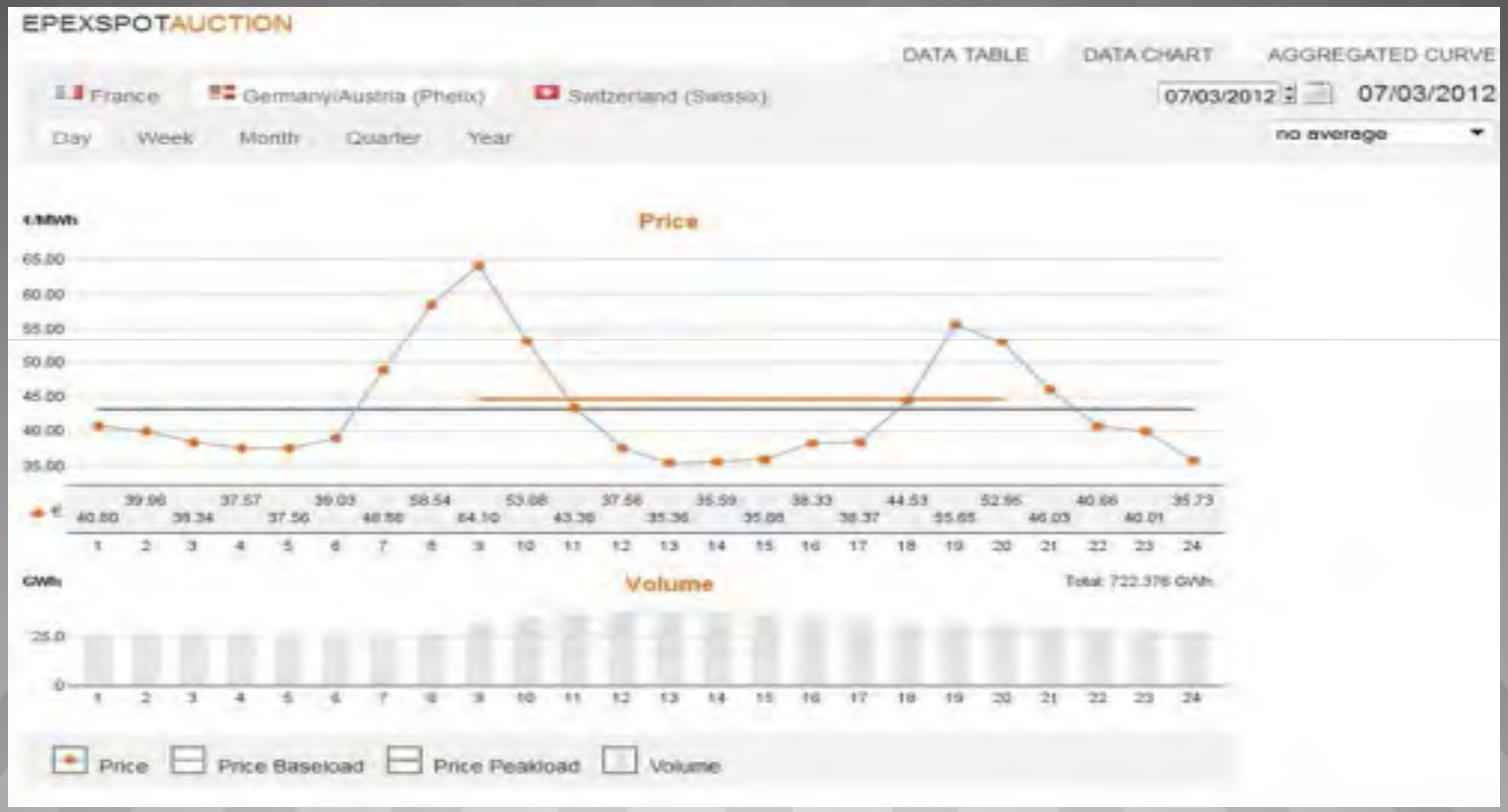
Operation

How solar energy is reducing the electricity price in Germany… and increases the export

цената и консумацията на електроенергия в Германия през март 2008 г.

Operation

How solar energy is reducing the electricity price in Germany… and increases the export



цената и консумацията на електроенергия в Германия през март 2012 г.

Operation

How solar energy is reducing the electricity price in Germany… and increases the export

Institute for Future Energy Systems (IZES):

✓ Electricity prices in Germany drops with 10 % due to the PV production

✓ Electricity prices in Germany drops 40 % avera due to the PV production in the afternoon hours (peak load).

This phenomena is know as „merit order effect“.

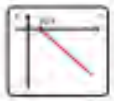
http://cleantechnica.com/2012/02/09/solar-pv-reducing-price-of-electricity-in-germany/?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+IM-cleantechnica+%28CleanTechnica%29

Operation

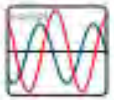
How solar energy is reducing the electricity price in Germany… and increases the export

Operation

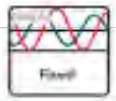
PV Inverters – capabilities for control and operation



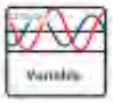
Frequency-dependent control of active power
As of a grid frequency of 50.2 Hz, the inverter will automatically reduce the fed-in active power along a preset characteristic curve and thereby contribute to the stabilization of the grid frequency.



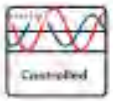
Static grid support based on reactive power
In order to keep the grid voltage constant, Sunny Central HE inverters supply leading or lagging reactive power to the grid. There are three options:



a) Fixed presetting of the reactive power by the grid operator
The grid operator presets a fixed reactive power value or a fixed phase shift between $\cos(\varphi)_{leading} = 0.95$ and $\cos(\varphi)_{lagging} = 0.95$.



b) Dynamic presetting of the reactive power by the grid operator
The grid operator presets a dynamic phase shift - any value between $\cos(\varphi)_{leading} = 0.95$ und $\cos(\varphi)_{lagging} = 0.95$. It is transmitted either via a communication unit or via a standardized current signal (I=4...20 mA) in accordance with DIN IEC.

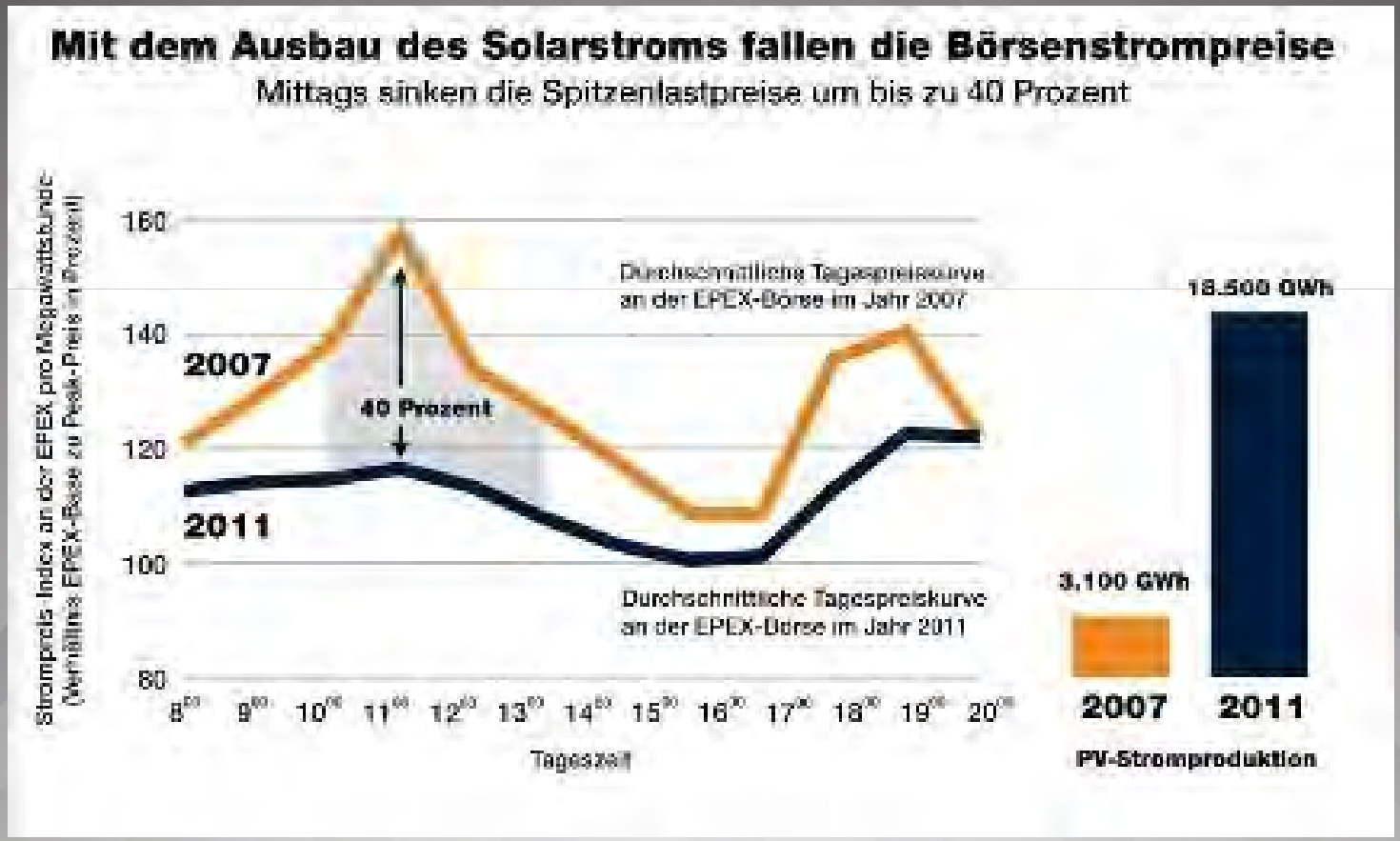


c) Control of the reactive power over a characteristic curve
The reactive power or the phase shift is controlled by a pre-defined characteristic curve - depending on the active power fed into the grid or the grid voltage.

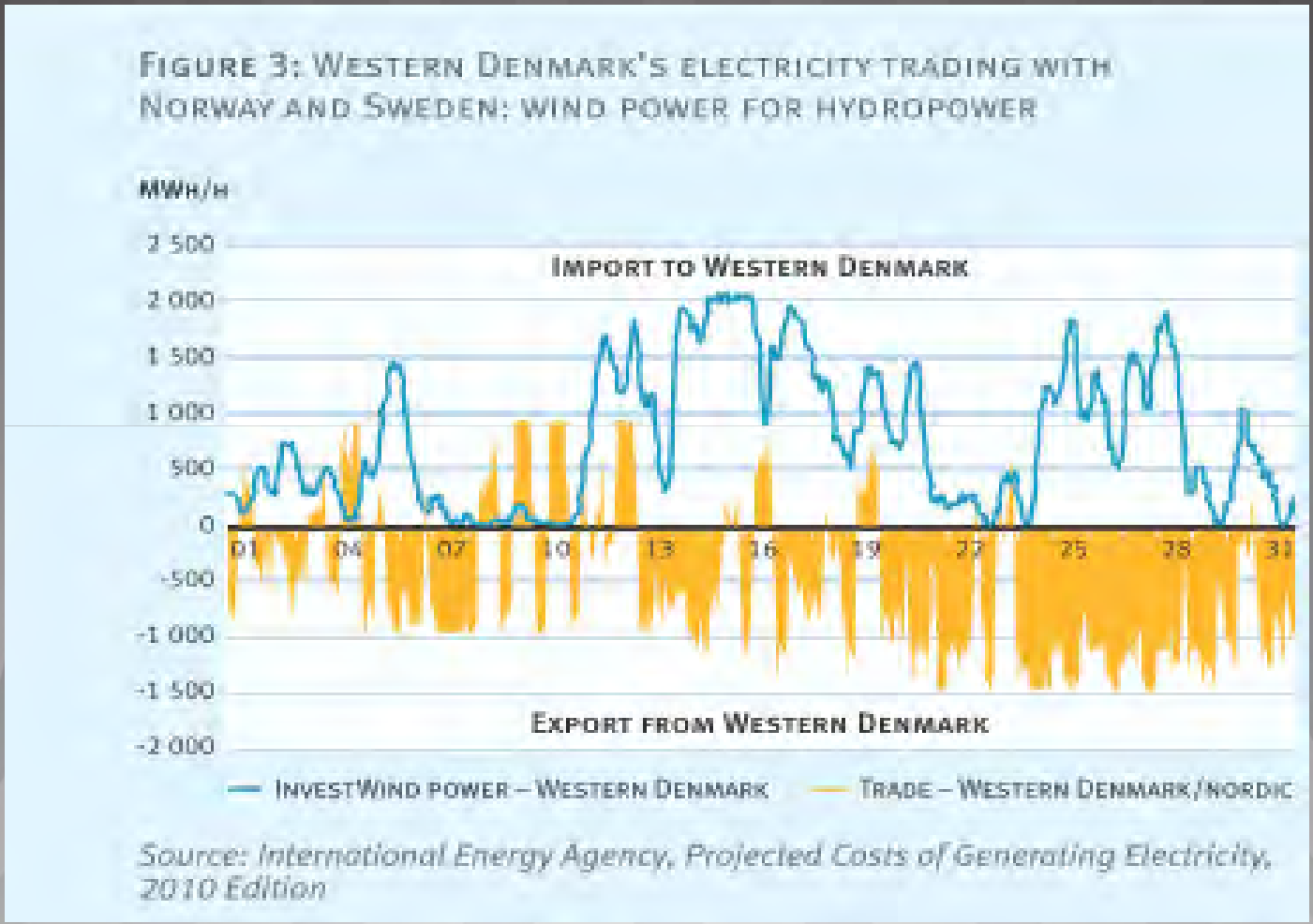
Monitored dynamic grid support LVRT (Low Voltage Ride Through)
Until now, solar systems had to immediately disconnect from the grid when there was even a short disruption in grid voltage. The result was that when a disruption in the grid occurred, nearly all feeding systems shut down one after the next, thus throwing the system further off balance. Using the monitored dynamic grid support, the new Sunny Central HE devices can feed in immediately after short-term voltage losses - as long as the nominal voltage exceeds fixed values. (Optional)

Operation

How solar energy is reducing the electricity price in Germany… and increases the export

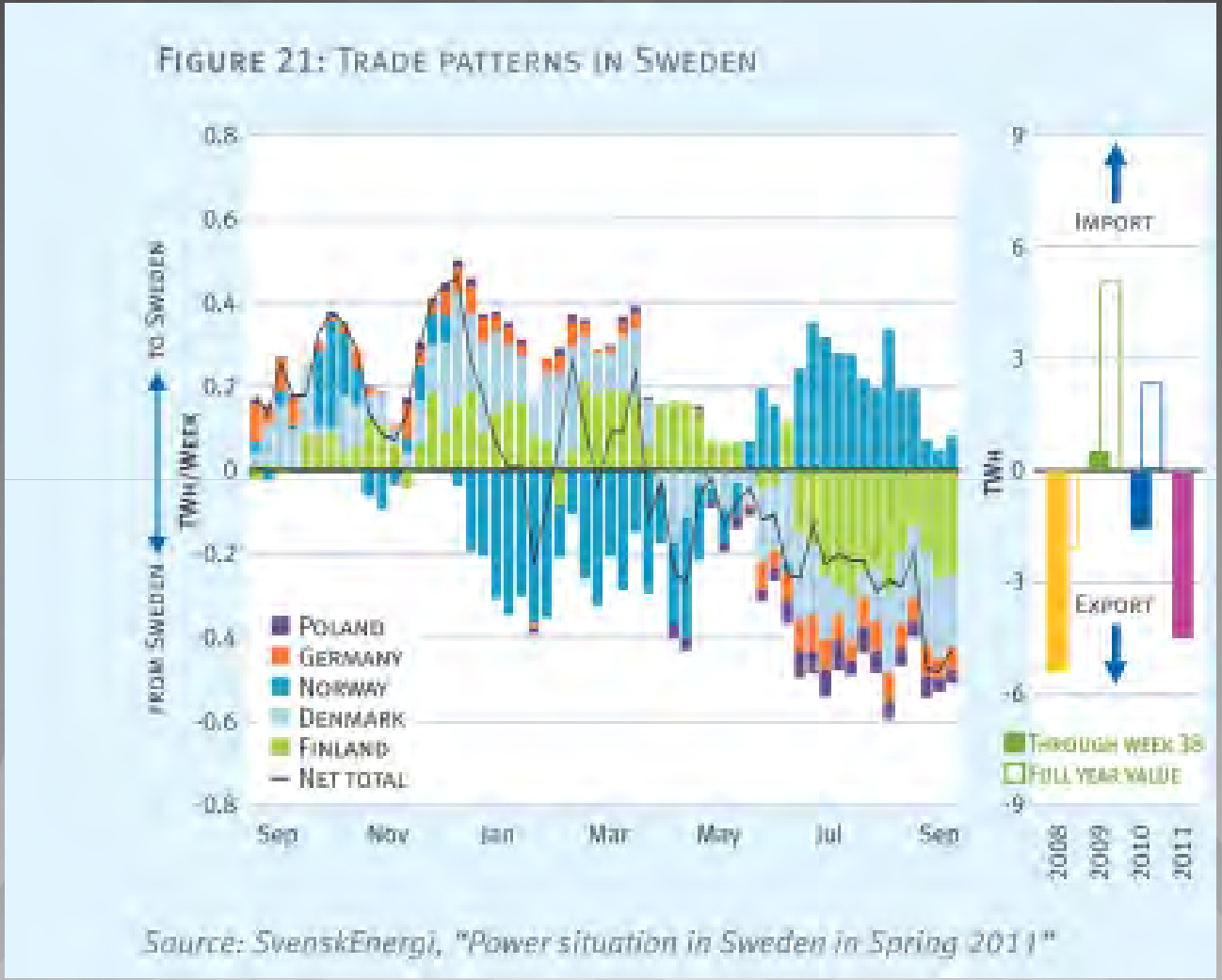


Operation



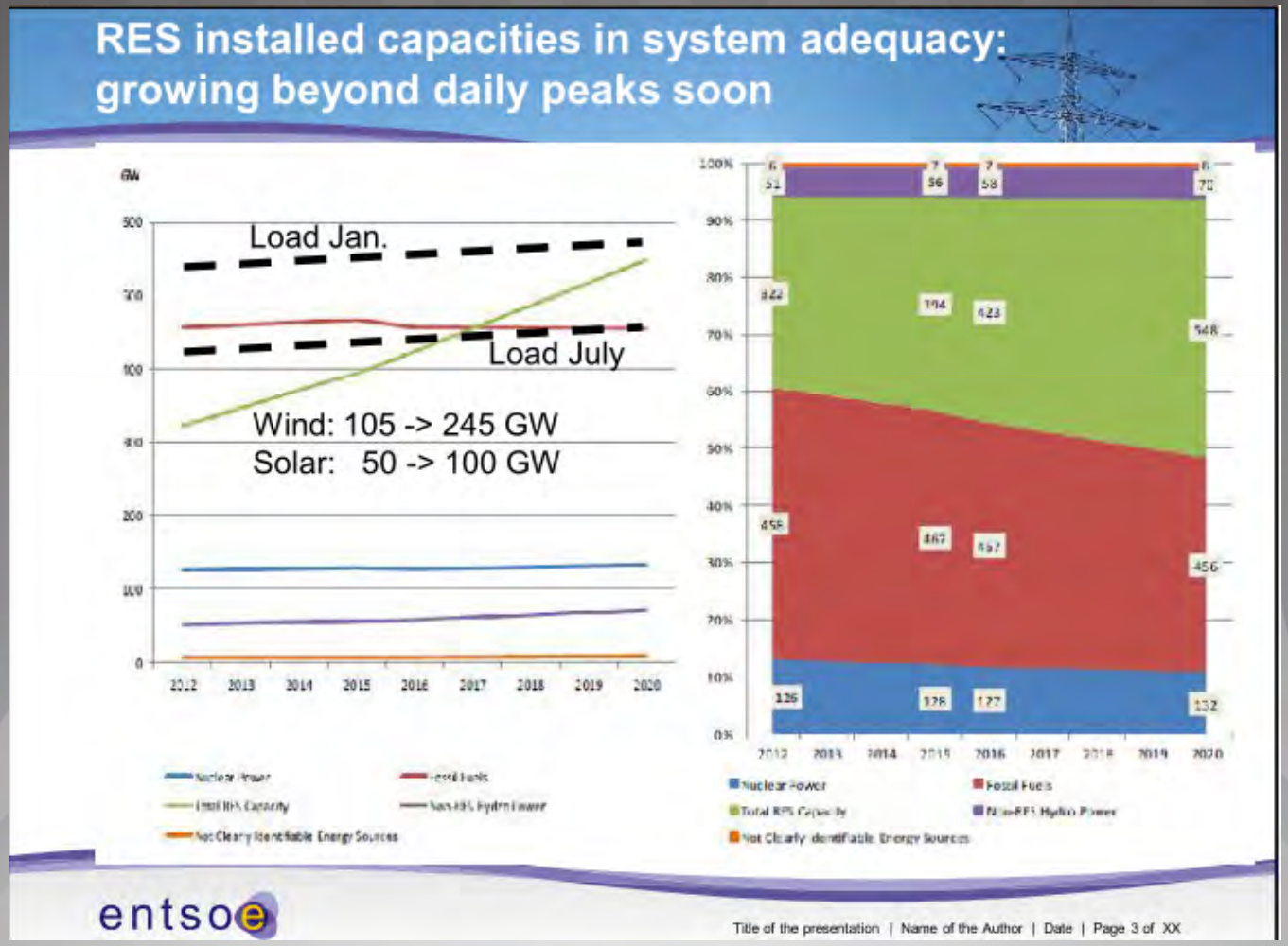
Source: Flexible Generation Report, Euroelectric 2012

Operation



Source: Flexible Generation Report, Euroelectric 2012

Operation


RES installed capacities in system adequacy:
growing beyond daily peaks soon
GW
Load Jan.
Load July
Wind: 105 -> 245 GW
Solar: 50 -> 100 GW
2012
2013
2014
2015
2016
2017
2018
2019
2020
Nuclear Power
Fossil Fuels
Not Clearly Identifiable Energy Sources
entsoe
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Operation

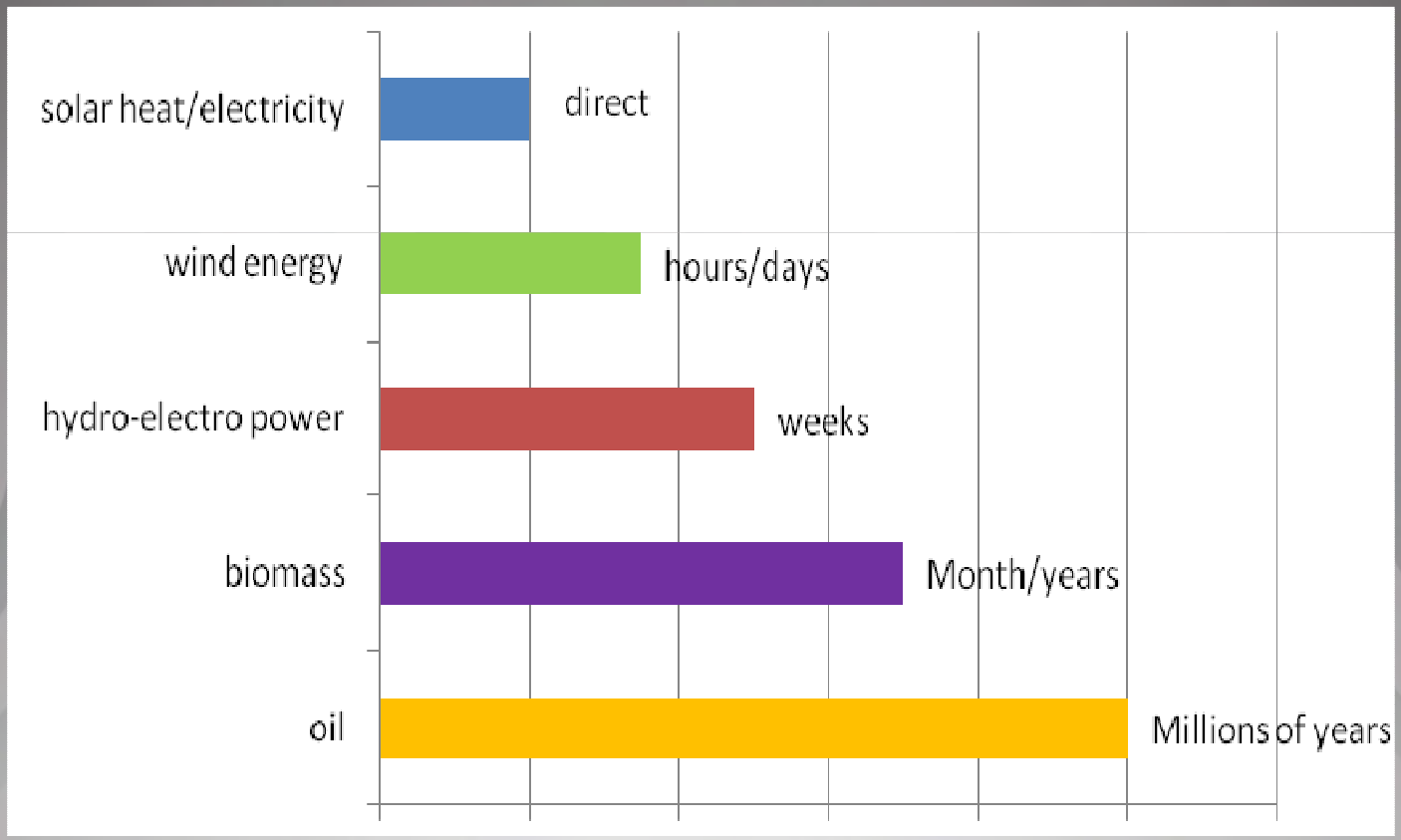
The key is **flexibility**,

Which will allow the distribution/transmission companies to buy the cheapest energy, available at any particular moment.

How open source operating system changed the world in 10 years

Primary energy: Everything we use, comes from the Sun

Energy sustainability demands the use of the resources with the same speed as they are created by the nature…or far lower speed.



A few minutes for questions and comments

"There is no greater harm than that of time wasted"
Michelangelo

Thank you for your attention!

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Knowing is not enough, we must apply.
Willing is not enough, we must do.
Bruce Lee