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Experience with Smart Grids in fast developing countries

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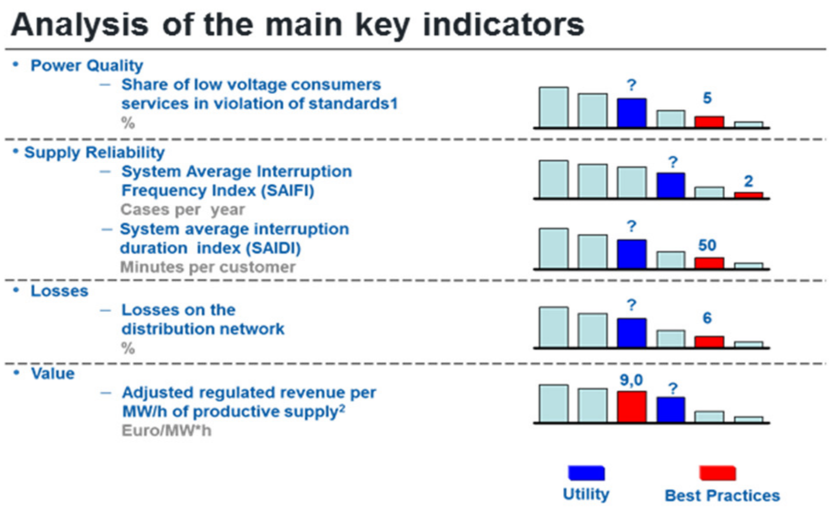
Testing • Consulting • Engineering • Environment

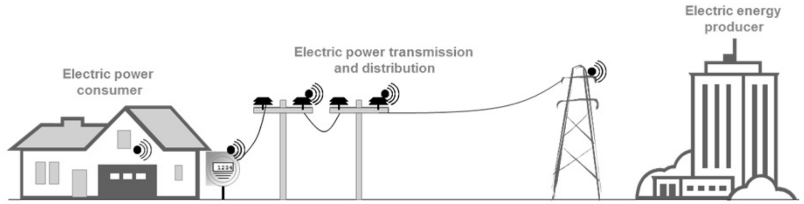
Network Assessment to identify Smart Grid initiatives

At early stage it is important to make an assessment to address the specific needs of the different electric systems

Comparison among the main key indicators of considered networks and international best practices can help in identifying the gaps



Level of the applied technologies



1 Grid configuration

- Proportion of high, medium and low voltage feeders
- Length of the feeders
- Power equipment redundancy level
- Grid topology and schemes (ring, antenna, petal)
- Availability of back-feeding for the customers

2 Grid elements

- Technological characteristics of the main equipment (cables, lines, transformers)
- Technological characteristics of automated management and control elements
- Equipment condition (wear and tear)
- Equipment standardization and certification

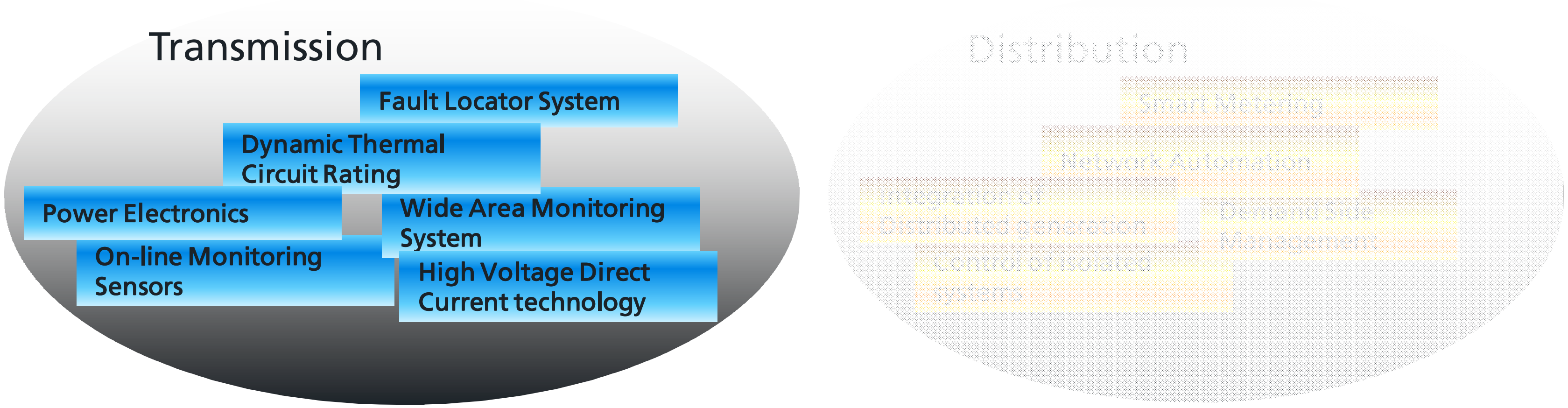
3 Automatization, informatization and technological processes

- Utilization of automated management and control
- On-line monitoring of the technical condition of the equipment
- Asset management tools and procedures
- Localization of faults and automatic removal

Level of already applied technologies must be deeply analyzed as well as possible benefits deriving from implementation of new Smart Grids applications

Smart Grid for Transmission and Distribution in Fast Developing Countries

Talking about Smart Grid initiatives the first huge difference is between transmission and distribution applications

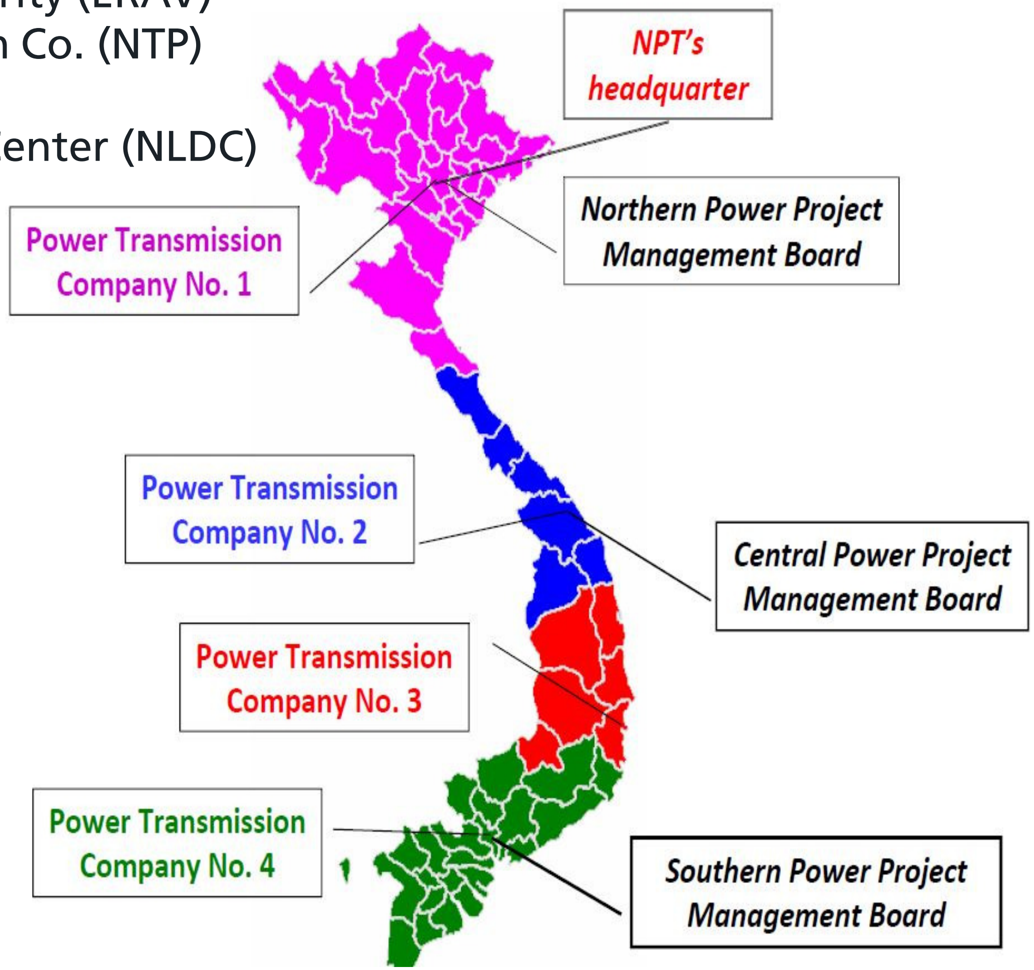


In fast developing countries according to CESI experience there are currently clear drivers for Smart Grid implementations

Smart Grid for Transmission – the Vietnamese case

Organization of the Vietnamese electricity sector:

- Electricity Regulatory Authority (ERAV)
- National Power Transmission Co. (NTP)
- 4 NPT subsidiaries
- National Load Dispatching Center (NLDC)



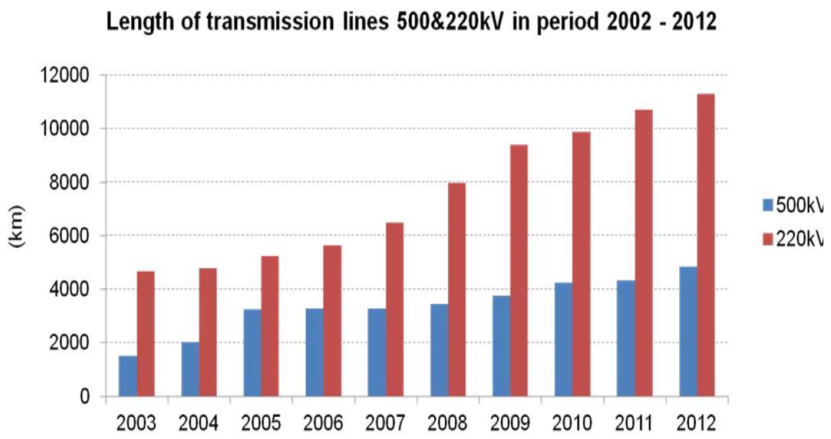
Main features in 2013:

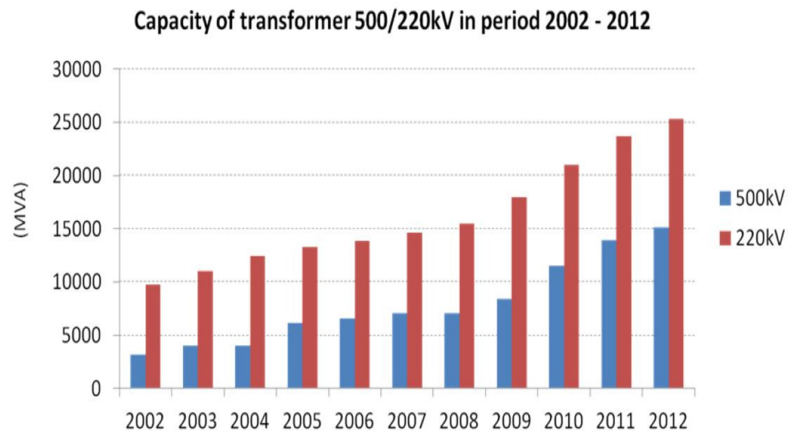
Population (million)	90
Land Area (km²)	331.698
Energy Consumption (GWh)	115.420
Installed Capacity (MW)	30.400
Electrification Rate (%)	97

Vietnamese fast growth in network assets

Looking at the period 2002-2012 we can see an impressive growth in transmission assets:

- 500 kV transmission lines tripled
- 220 kV transmission lines more than doubled
- Capacity of 500 kV transformers five time greater
- Capacity of 220 kV transformers almost tripled





Lines	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
500 kV (km)	1528	1528	2023	3265	3286	3286	3455	3758	4243	4330	4847
220 kV (km)	4266	4671	4798	5230	5650	6487	7987	9400	9870	10712	11313

Transformers	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
500 kV (MVA)	3150	4050	4050	6150	6600	7050	7050	8400	11550	13950	15150
220 kV (MVA)	9726	11039	12414	13289	13852	14602	15477	17977	21039	23726	25351

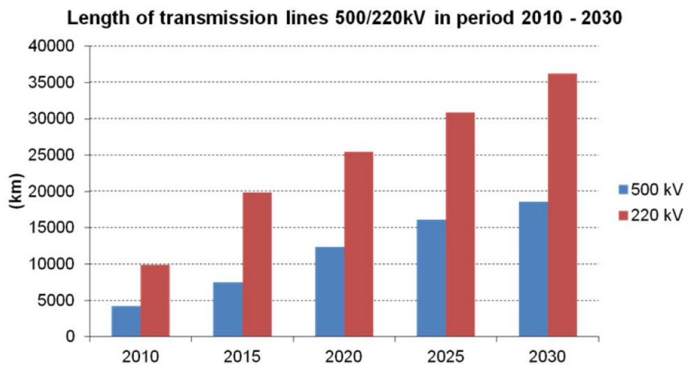
Forecasted growth in consumption and assets

The growth in consumption and assets will continue over the next 15 years with an estimated rate of 8 - 10% per year

Period	2011 - 2015	2016 - 2020	2021 - 2025	2026 - 2030
BASE SCENARIO	14.6%	11.1%	8.2%	7.8%

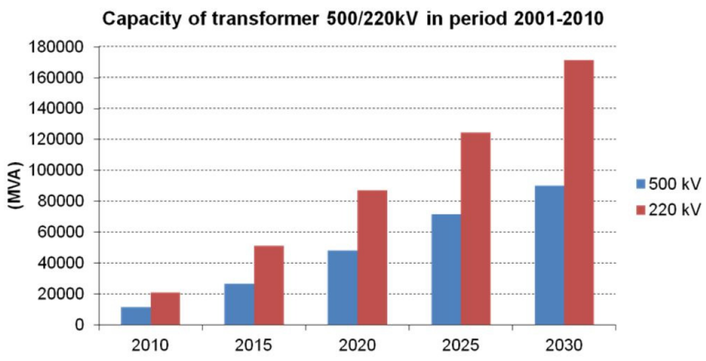
Year	2015	2020	2025	2030
Base Scenario				
Energy Production (GWh)	194.304	329.412	489.621	695.147
Peak Load (MW)	30.803	52.040	77.084	110.215

Source: Institute of Energy (Master Plan VII)



Lines	2010	2015	2020	2025	2030
500 kV (km)	4.243	7.463	12.337	16.141	18.579
220 kV (km)	9.870	19.890	25.471	30.902	36.206

Source: Institute of Energy (Master Plan VII)



Transformers	2010	2015	2020	2025	2030
500 kV (MVA)	11.550	26.400	48.150	71.550	90.000
220 kV (MVA)	21.039	51.277	87.165	124.365	171.303

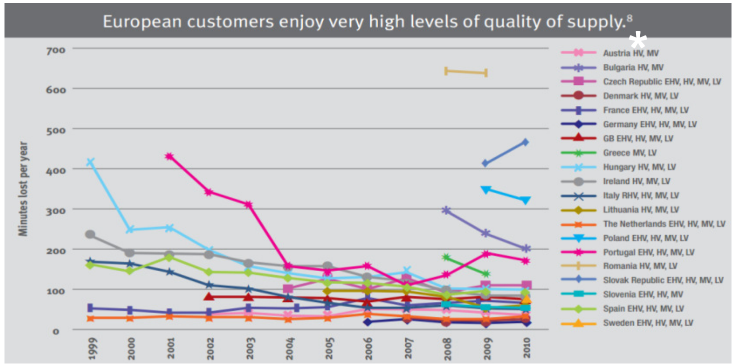
Source: Institute of Energy (Master Plan VII)

Lack of reliability: from asset growth to smartness

Unfortunately the system is characterized by a lack of network reliability as shown by the main key performance indicators and the high number of power system collapses.

Electric System KPI:

- **Network losses:** 2.33%
- **SAIFI:** 27 (6 times cfr. Europe)
- **SAIDI:** 4.461 minutes (20 times)



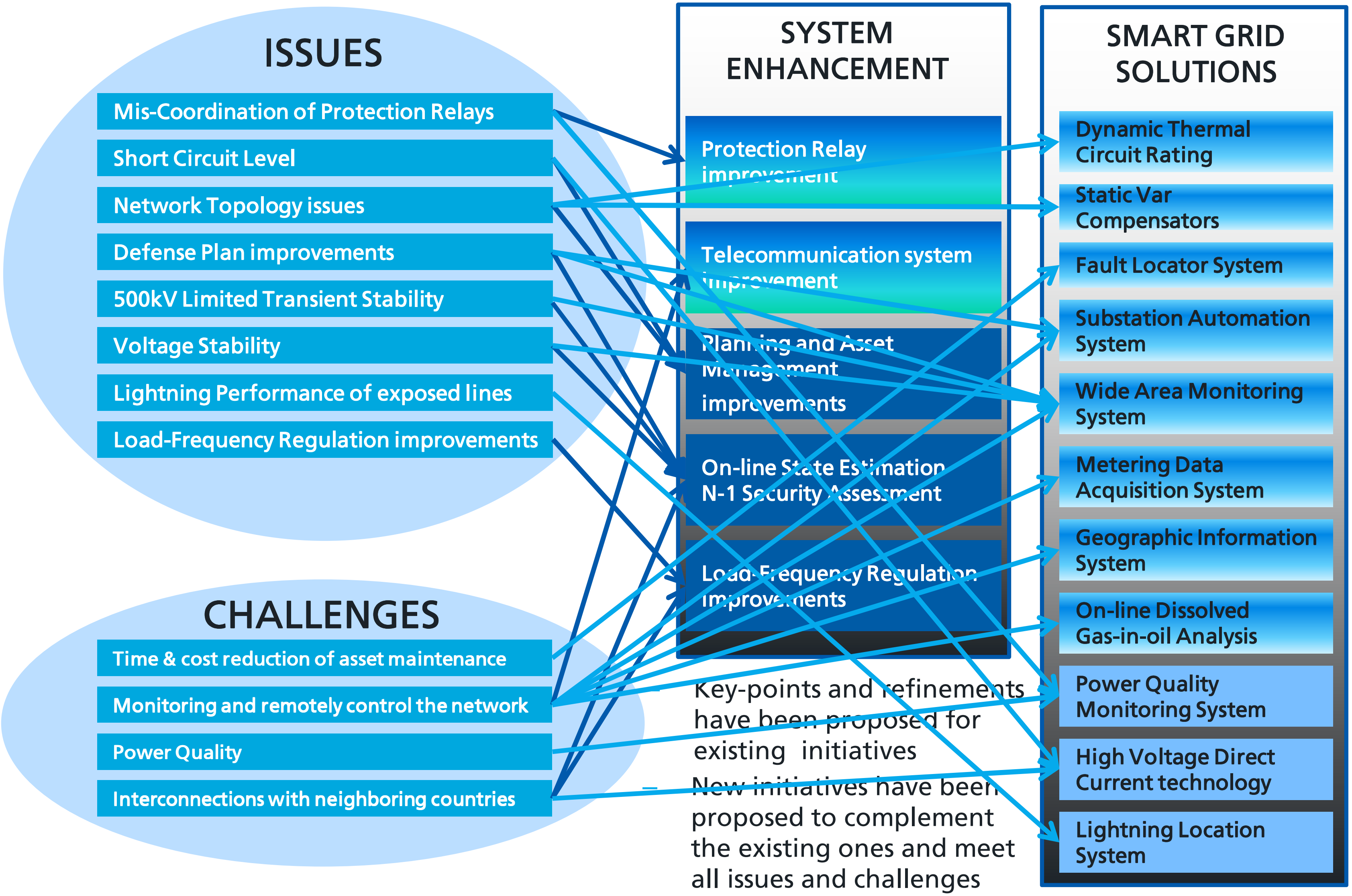
Power System collapses in the period 1995 - 2006

Year	95	96	97	98	99	00	01	02	03	04	05	06
Times	3	3	1	3	2	1	1	0	1	0	2	1

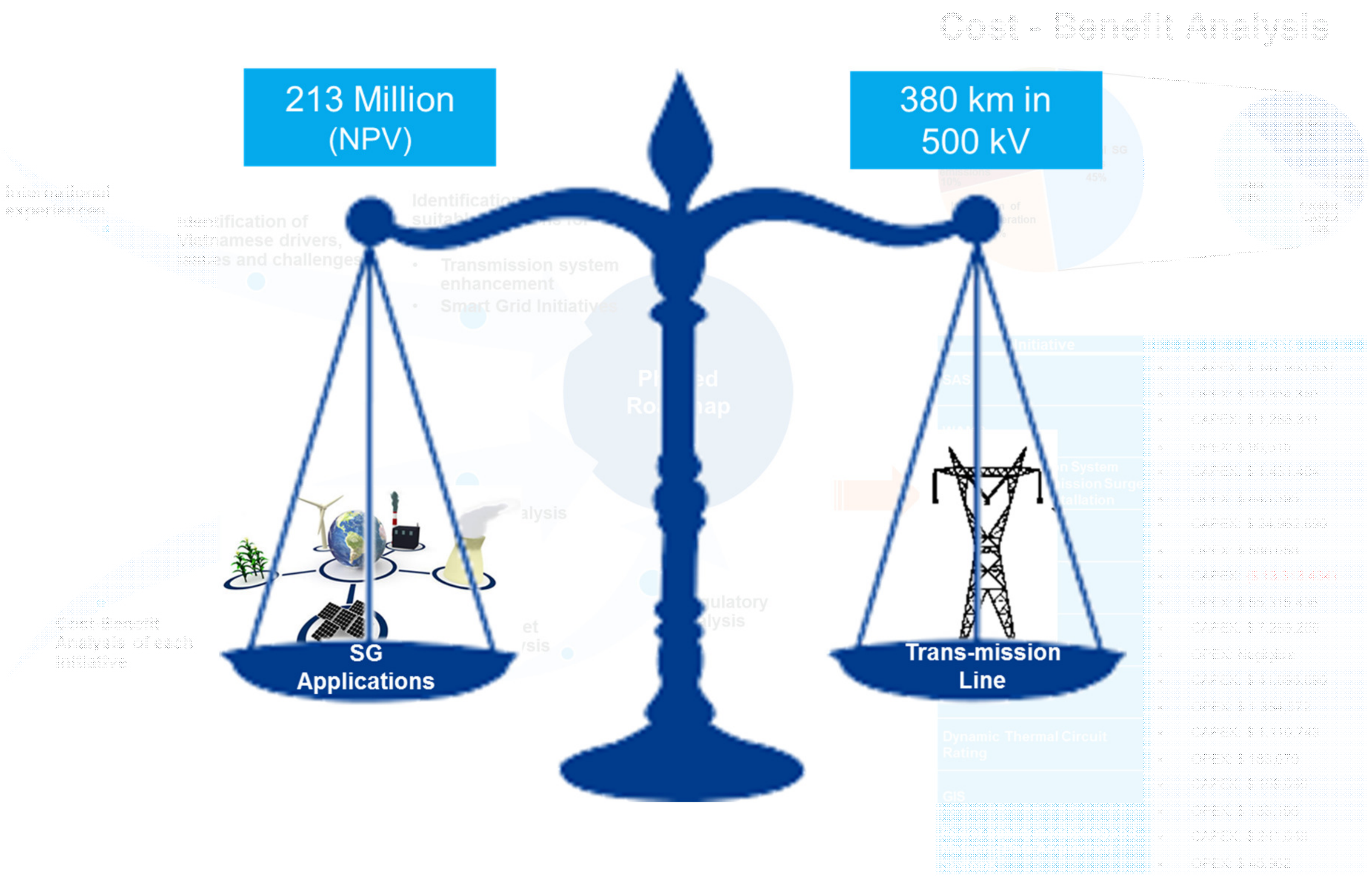
- 8 times in Northern Power System
- 9 times in Southern Power System

No improvements in the last years: well known blackout in December 2013

Identified issues and Smart Grid roadmap

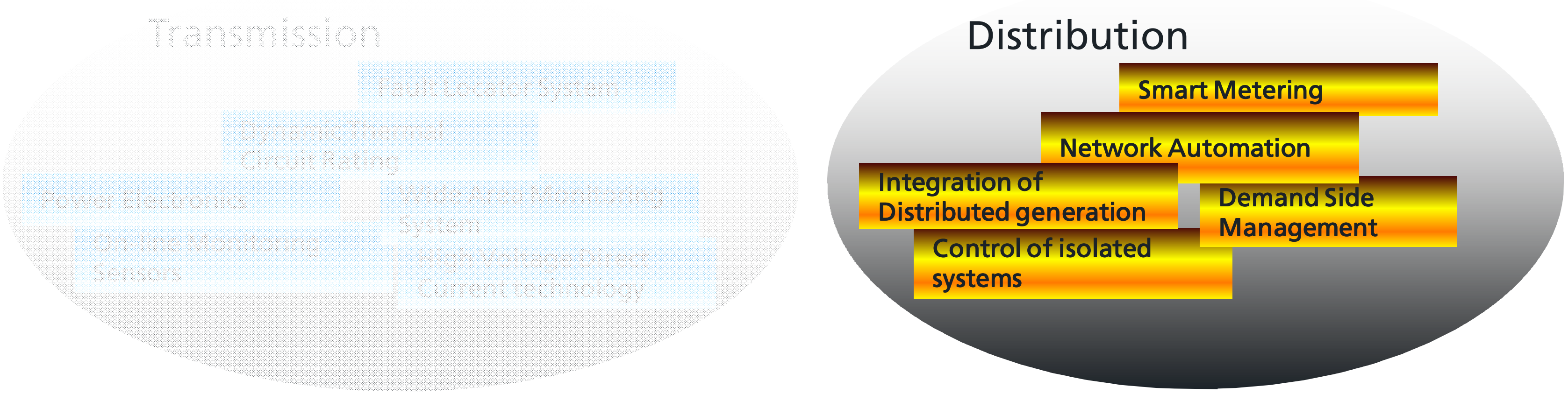


Cost of the overall Smart Grid initiatives



Smart Grid for Distribution in Fast Developing Countries

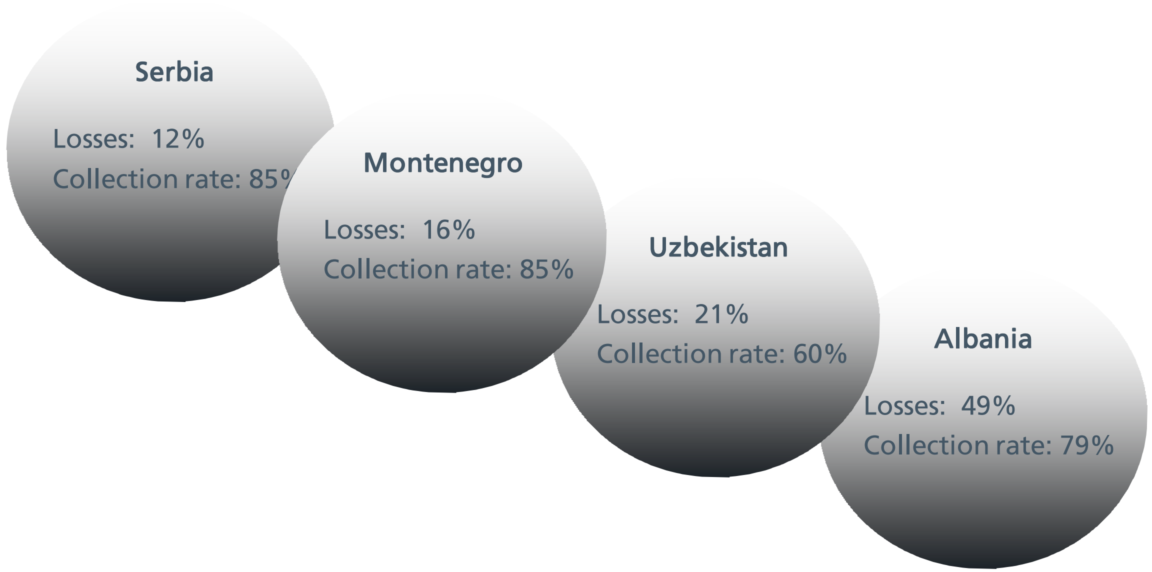
Talking about Smart Grid initiatives the first huge difference is between transmission and distribution applications



In fast developing countries according to CESI experience there are currently clear drivers for Smart Grid implementations

Smart Grid for Distribution - Eastern Europe and CIS countries

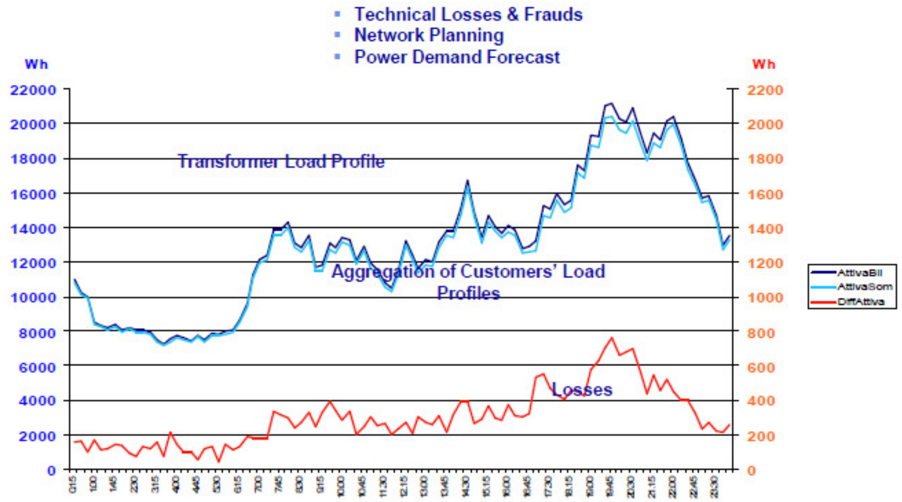
One of the main issues for Distribution Utilities consists in high non-technical losses due to frauds and bad-payers



The first target for these countries is the implementation of reliable and punctual monitoring of customers' consumptions. Problems arise for financial reasons, but also for consequent bad network planning and operation

Smart Metering became the priority

A Smart Metering system (digital meters at customers' premises and balance meters in substations) allows Distribution Companies to detect frauds, reduce losses and monitor the actual development of load profiles.



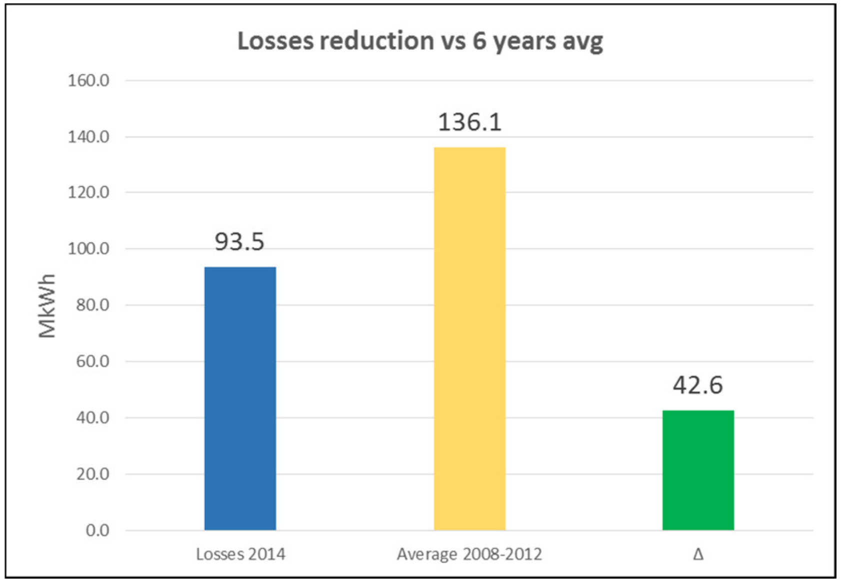
Curtailment of thieves

Better supply for other customers

Remote deactivation without on-field intervention, power limitation, prepayment functionalities and remote restoration, anti-tampering solutions help bad-payers management and increase collection rate.

Finally, accurate and timely invoices foster the energy efficiency: energy not paid is often wasted.

Montenegro Losses reduction and increased collection rate



Key figures (fist stage: march 2012 - march 2014)

Smart Metering allowed a relevant reduction of losses and increased collection rate in the substations involved in the Project ("AMM s.s.").

- Reduction of absolute losses: 30%
- Success rate of disconnection: 85% in «AMM s.s» vs 18% in «non-AMM s.s.»
- Increased collection rate: +15% in «AMM s.s»

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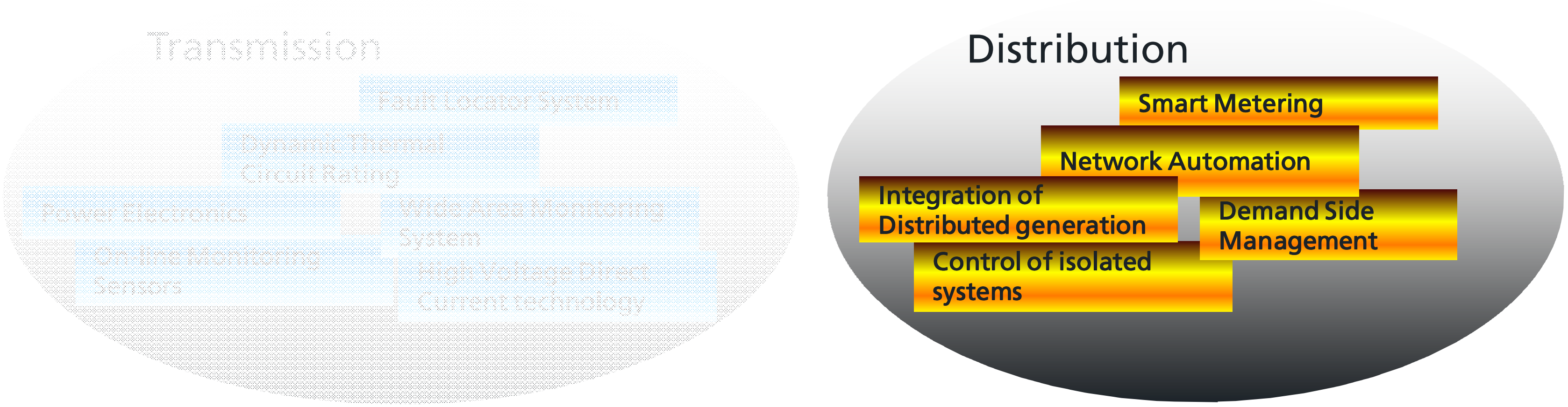

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Network reliability

Network losses

Feeding isolated areas

Smart Grid for Distribution – feeding isolated areas in Africa and Latin America

Setting up Micro Grids according to Smart Grid paradigms is not always an option but sometimes it is an "obliged choice"

Around 1.3 billion people over 7 billion are not yet connected to commercial electricity supply and 80% of them live in rural areas

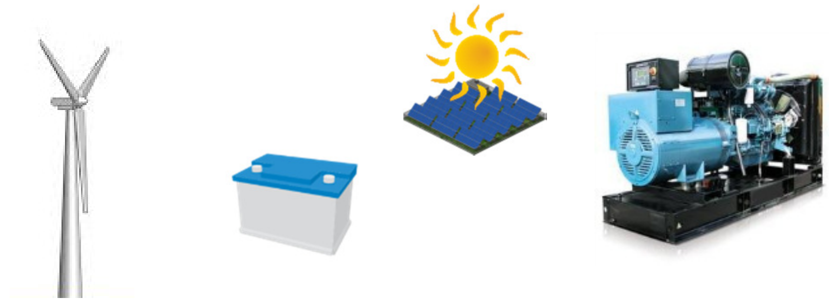
In Sub-Sahara region 600 million people do not avail electricity

To supply electric energy to people that do not have access to it often depends on low density of population in areas far from harbors and main infrastructures

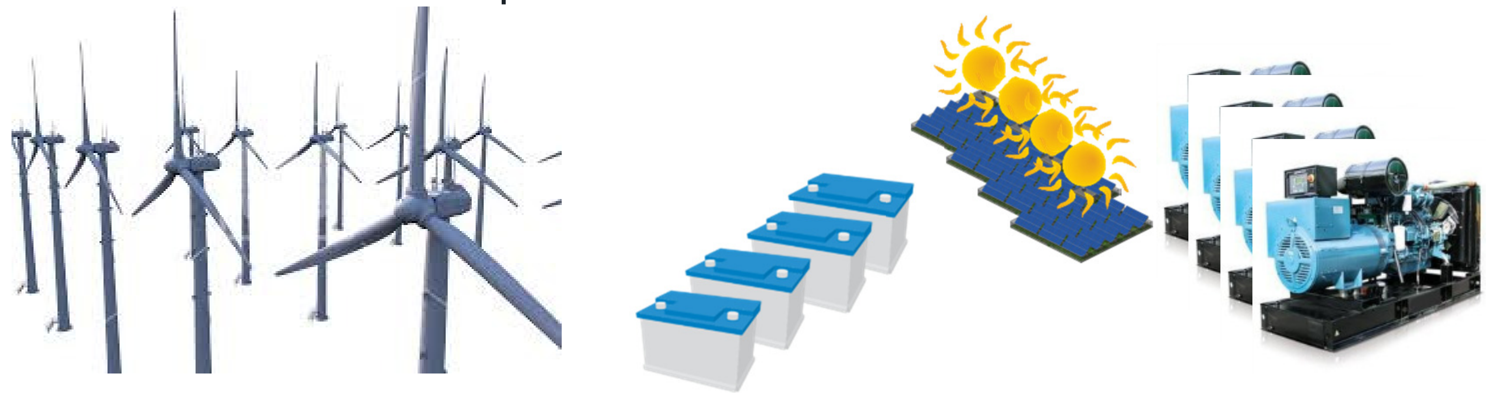
The use of proper generation mixes to set up micro grids represents a win-win solution: renewable generators, like photovoltaic plants and wind turbines, combined with conventional diesel generators and storage systems can supply local loads

Smart Grid for Distribution – generation mix and scalability

A proper **generation mix** from both technical and economical points of view must be chosen in order to guarantee efficiency and reliability of the network



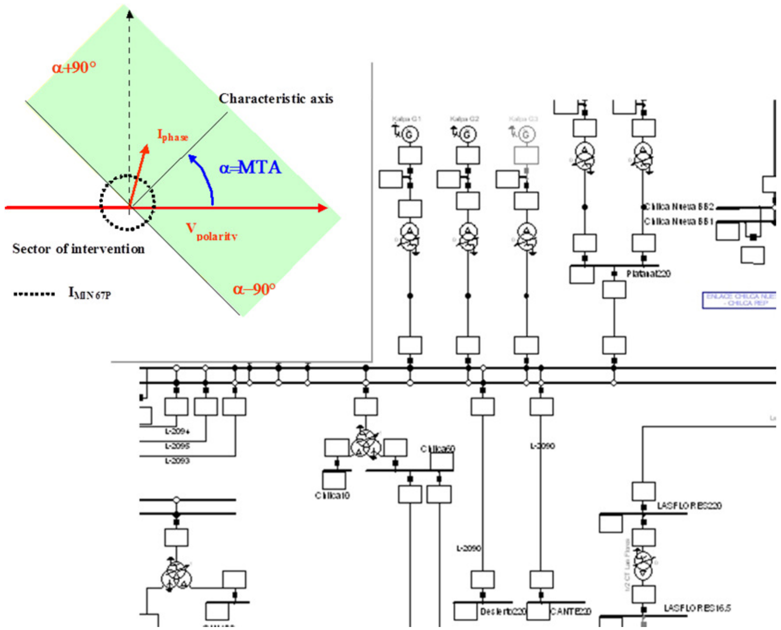
Since a large growth in consumption per year is usually experienced as soon as electricity becomes available (development of small workshops, use of pumps for irrigation, recreation sites, lighting of some streets, etc.…), **scalability** of solution is of the utmost importance



Generators, storage systems and loads must be able to interact each other

Smart Grid for Distribution – protection system issues

Protection coordination, short circuit power, radial vs. meshed networks, multi-directional power flows, …

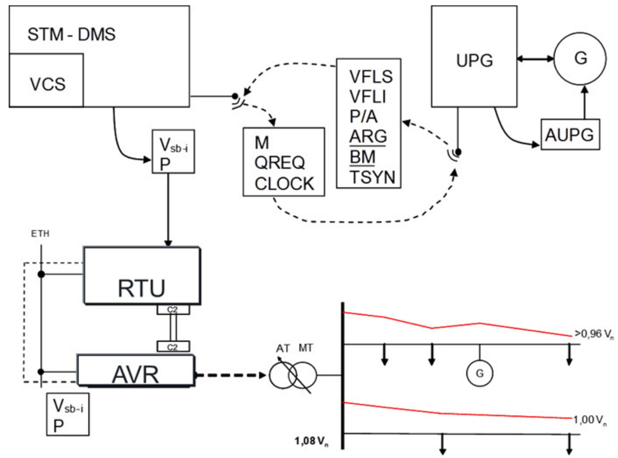


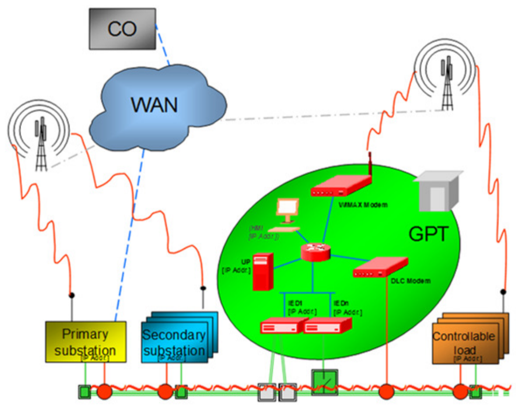
In case of fault or other negative events it is much better to isolate faulted branches since the black- start capability of such network is usually quite poor (no inertia, simultaneous starting of large induction motors, …)

Smart Grid for Distribution – network control

Generation dispatching, renewable forecasting, demand side management (controllable loads), voltage regulation, … become part of network operation

Fostering auto-consumption in such networks can be very effective from a technical point of view





Expertise and skills for network operation, management and control are not necessarily local

The network can be managed by remote (virtual grids)

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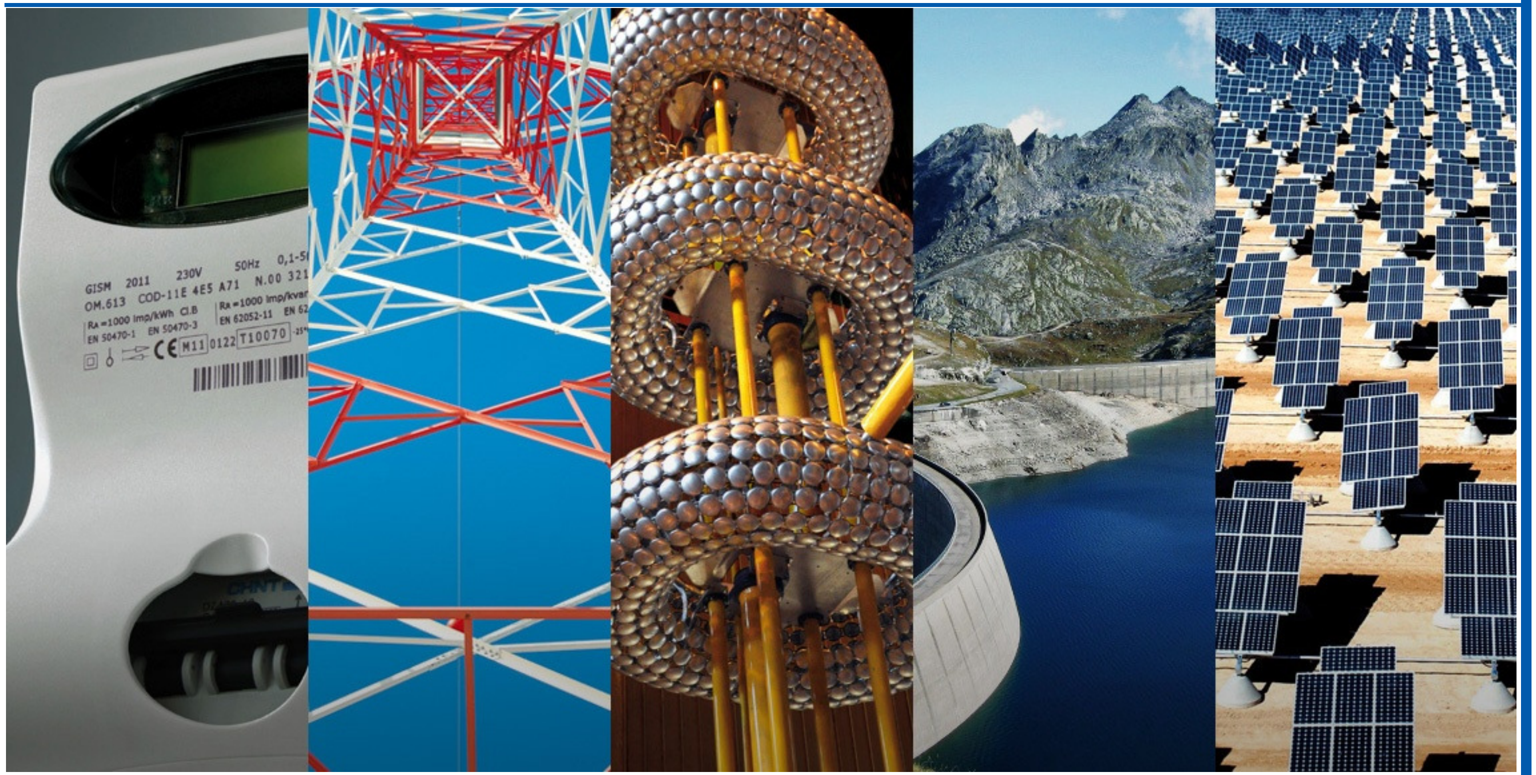

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