First International Conference

On New Trends for

Sustainable Energy

Distributed Generation

Presented by

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- ***Expert*** **in electrical energy systems.**

What is meant by Distributed Generation?

Distributed generation (DG) refers to electricity that is produced *at or near the point* where it is used.

Distributed solar energy **can be located on rooftops or ground-mounted, and is typically connected to the local utility distribution grid.**

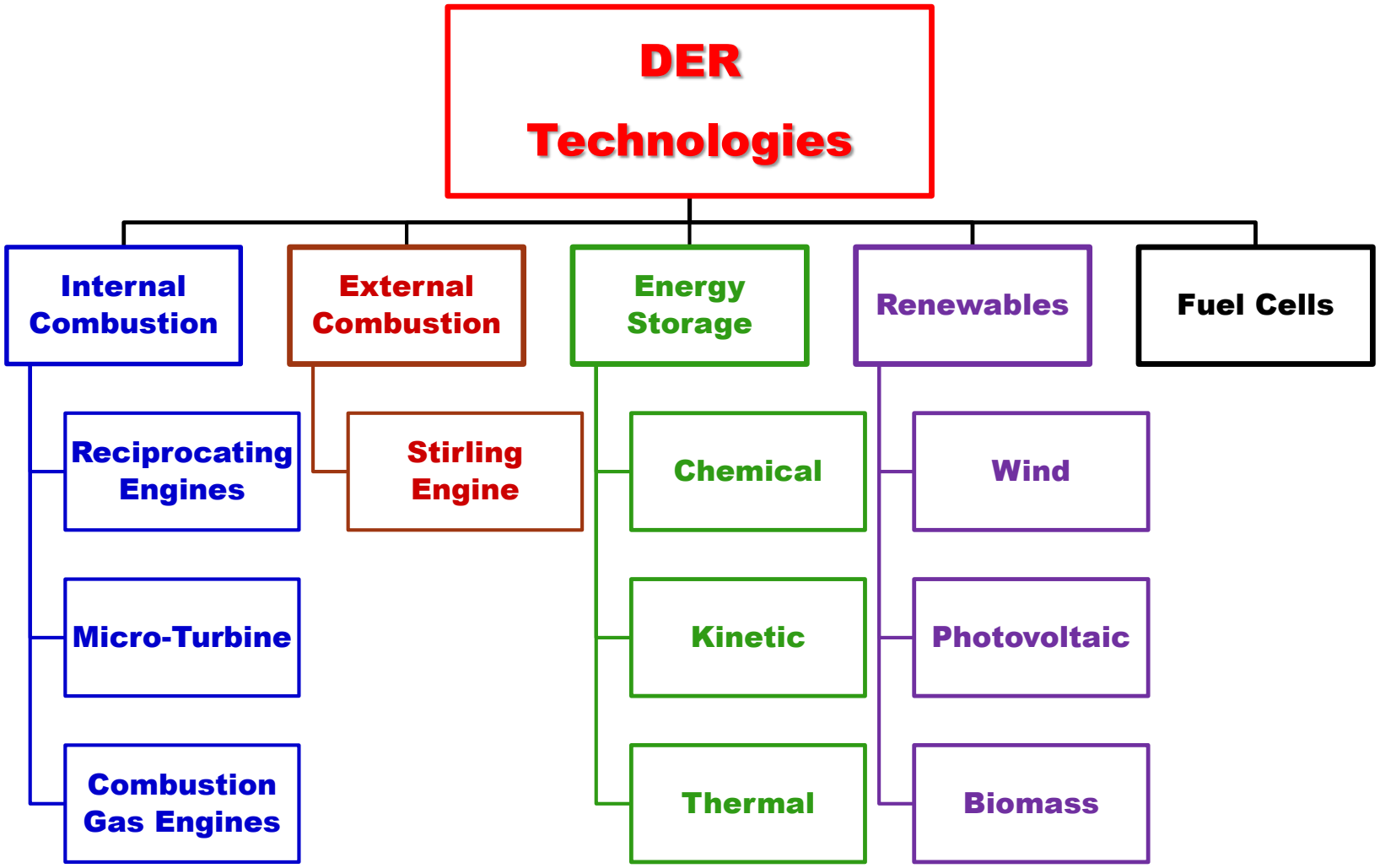
Brief History of DG

1. ***DG is not a new phenomenon.*** **During the initial phase of the electric power industry in the early 20th century - all energy requirements were supplied at or near their point of use.**

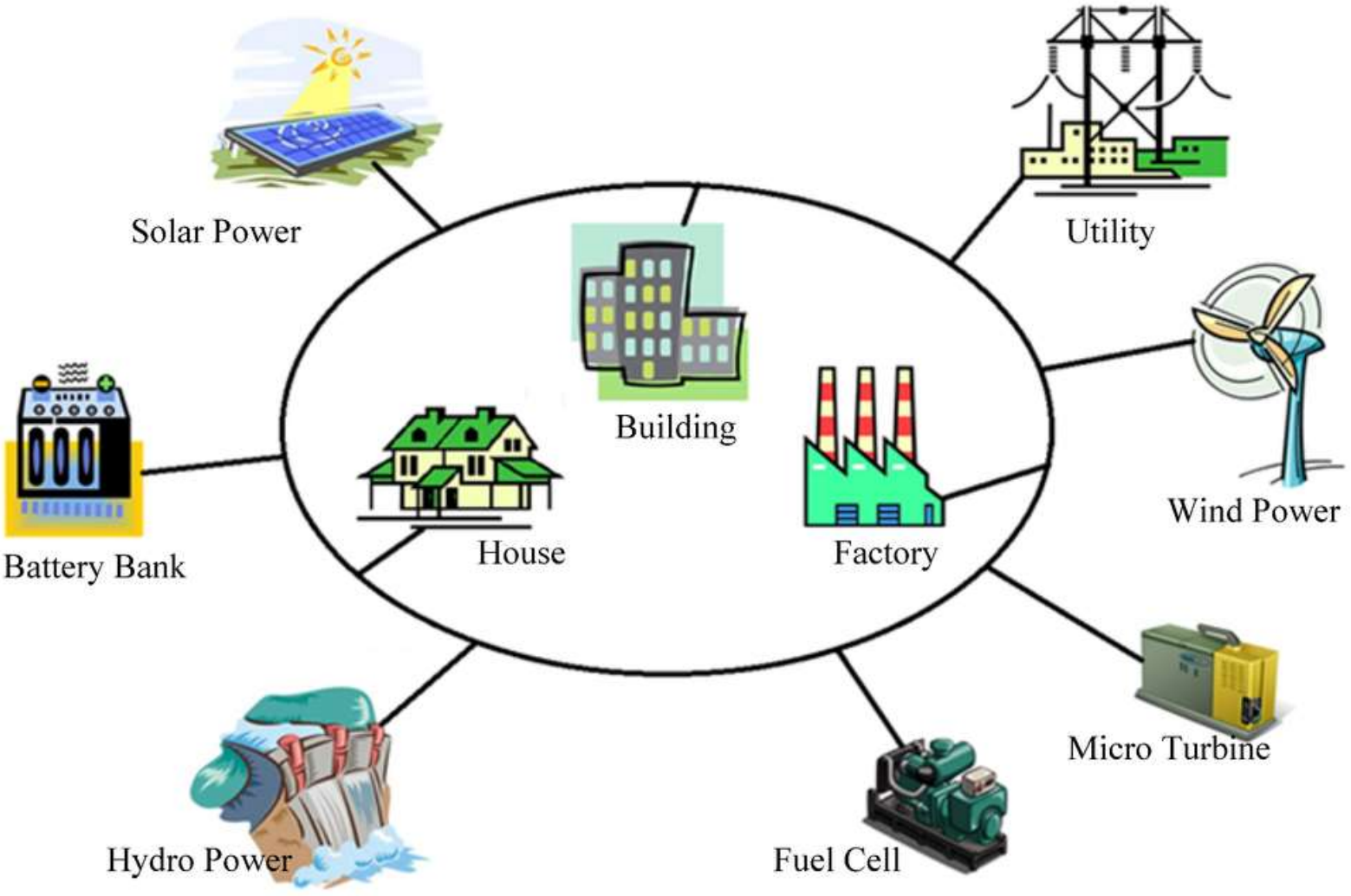
2. **Technical advances, economies of scale in power production and delivery, the expanding role of electricity in day-to-day life, enable the network of gigawatt-scale thermal power plants located far from urban centers, with high-voltage transmission carrying electricity to load centers.**

3. **Today, advances in new materials and remote monitoring and control equipment, have expanded the range of opportunities and applications for "modern" DG, and have made it possible to tailor energy systems that meet the specific needs of consumers.**

Distributed Energy Resources (DER)



Supplying Loads with different DER



Site Classification of DER

1. ***On-site DG*** **includes photovoltaic solar arrays, micro-turbines, and fuel cells, as well as CHP, which are installed on-site, and owned and operated by customers themselves.**

2. ***Emergency power units*** **includes diesel generation units that operate in stand-by modes , which are installed, owned, and operated by customers themselves.**

3. ***District energy*** **systems are installed, owned, and operated by third parties, utility companies, or customers. They provide electricity and thermal energy (heat/hot water) to groups of closely located buildings.**

Benefits of Distributed Generation

- Connecting electricity generation closer to the point of use reduces the costs of transmission and distribution networks and reduces power losses.
- Reduced carbon emissions compared with the centralized alternative.
- Improved reliability of transmission and distribution due to reduced peak loading, conductor and transformer cooling.
- Fast ramping within the distribution system, ability to reduce harmonic distortions at customer's site.
- Significant reduction in fuel disruption risk and technology obsolescence.

What is Driving DG Today?

- ***Restructuring*** **of the electric power grids to maintain a reliable and secure electricity infrastructure using Smart Grids.**
- ***Advances*** **in power electronics, communication techniques, advanced digital metering monitoring and management systems.**
- ***New*** **environmental regulations.**
- ***Increasing*** **power quality concerns.**
- ***Heightened*** **reliability awareness.**

Potential Benefits of DG on Increased Electric System Reliability

- While mostly customer-owned, some existing DG units are made available to utilities for operations during times of system need through various incentives and pricing approaches, including demand response.
- Studies show that in many instances utilities could make greater use of DG directly, and deploy units to provide peak power, voltage and VAR support, or other ancillary services to meet electric system reliability needs .

Potential Benefits of DG in Reducing Peak Power Requirements

- Installation and use of DG systems by customers and/or utilities can produce reductions in peak load electricity requirements.
- Reductions in peak load, particularly during critical peak periods, can reduce the costs of electricity because the most expensive power plants to operate are the last ones to be dispatched from the "resource stack."
- Peak load reductions can eliminate or reduce the need for power from these most expensive power plants.
- Reductions in peak load can reduce "wear and tear" on electric delivery equipment, thus reducing maintenance costs and extending equipment life.

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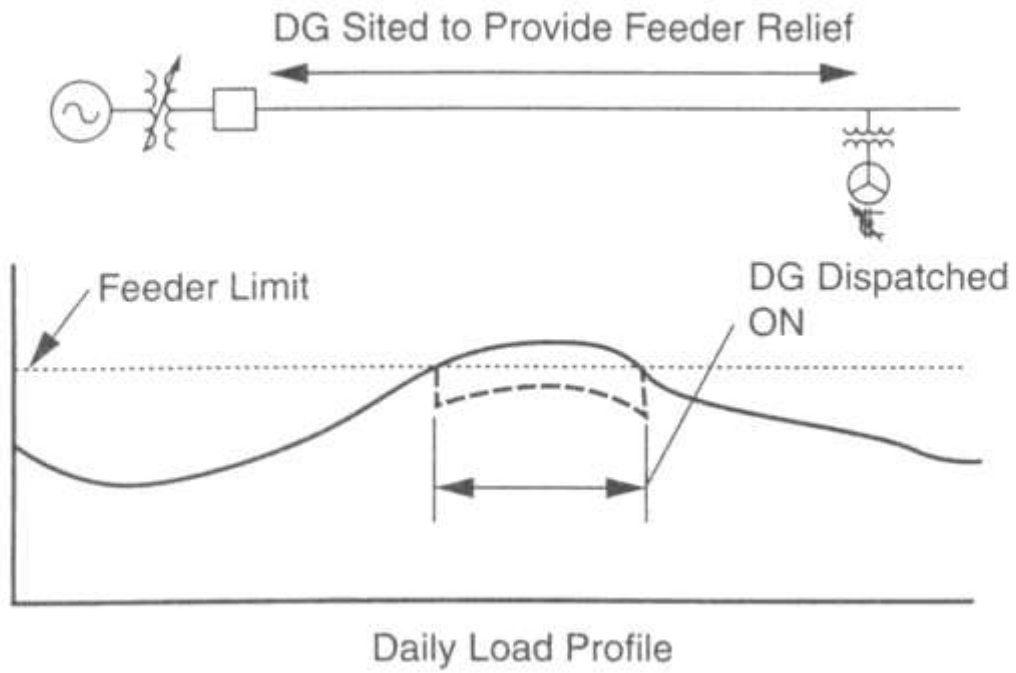
Potential Benefits of DG from Ancillary Services (or from interconnected operations necessary to effect the transfer of electricity between purchaser and seller)

- DG *can supply some of the reactive demand* to local loads and contribute to the supply of reactive losses in distribution circuits.
- DG *can contribute to the reliable operation* of the entire system, such as back-up supplies and supplemental reserve units brought up to full load quickly as "spinning reserve" of the power grid.
- Smaller distributed generators may be designed to provide rapid, large power changes in response to frequency changes to *help preserve system stability*.

Siting DG
for Low-voltage Distribution Network

- **DG to Relieve Feeder Overload**



Siting DG
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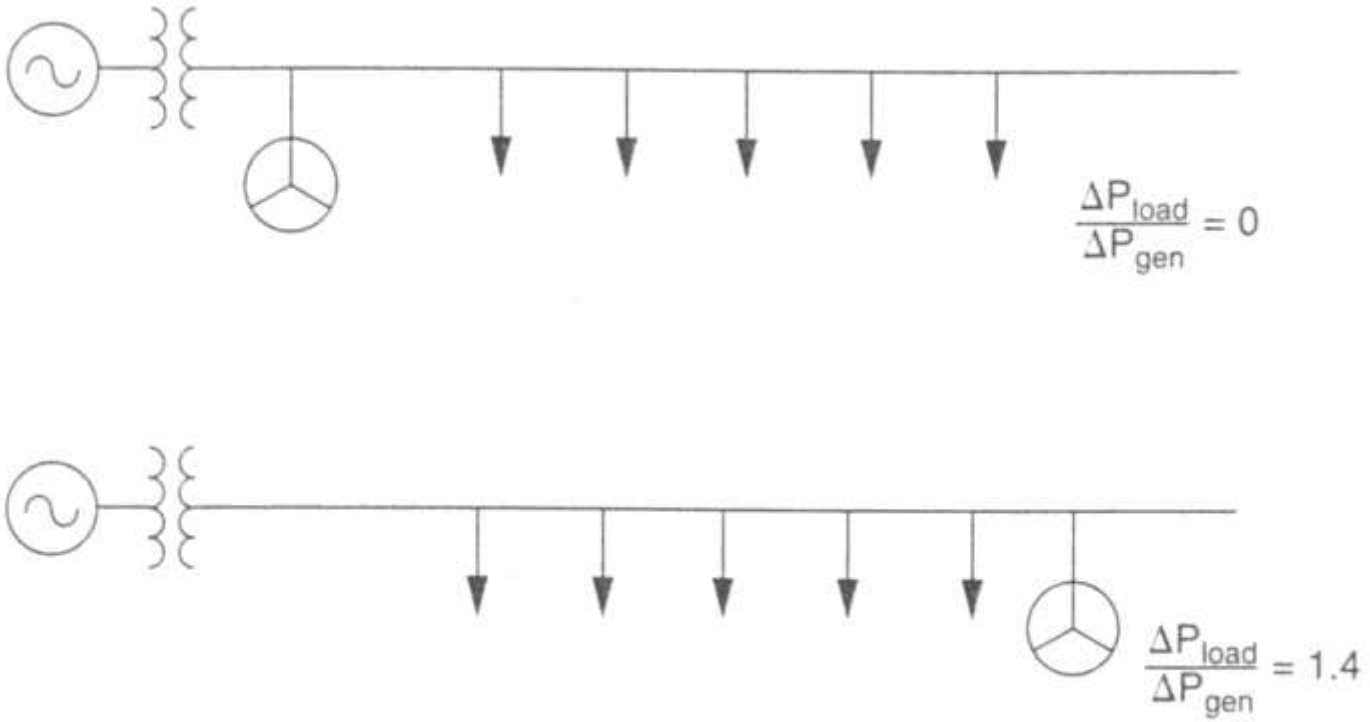
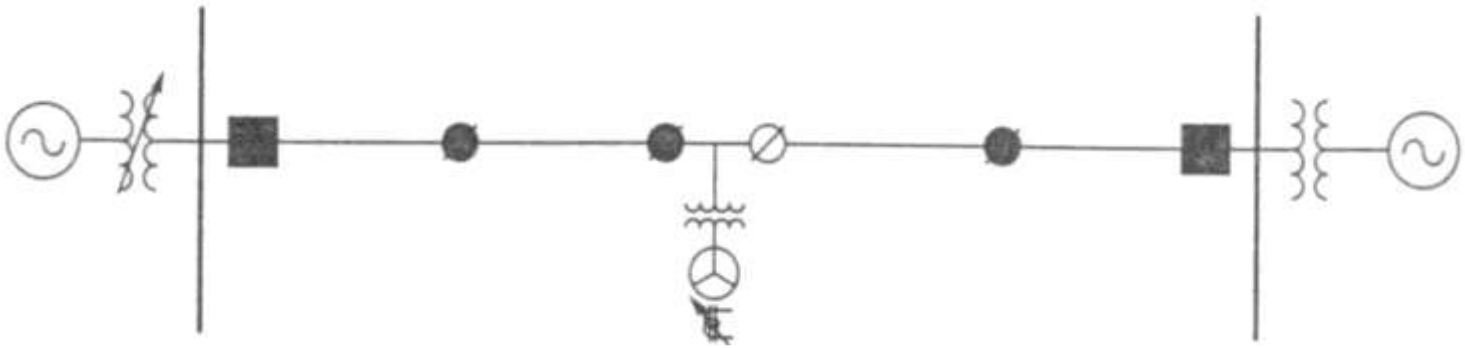
- **DG to Increase Feeder Capacity**



Siting DG
for Low-voltage Distribution Network

- **DG to Provide Voltage Support & Reconfiguration**



Distributed Energy Systems and Sustainable Development

What is a sustainable energy system?

Sustainable energy means the ability of an energy system to '*generate enough power for everybody's needs* at an *affordable price*' and to 'help supply the clean, safe and reliable electricity'.

Twin billers technologies of sustainable energy :

1. **Renewable energy sources.**
2. **Technologies designed to improve energy efficiency.**

Renewable Energy contributing to Sustainable Development

- ***RE can accelerate access to energy***, particularly for the 1.4 billion people without access to electricity using traditional biomass.
- RE deployment can *reduce vulnerability* to supply disruptions and market volatility.
- Low risk of severe accidents.
- Environmental and health benefits.

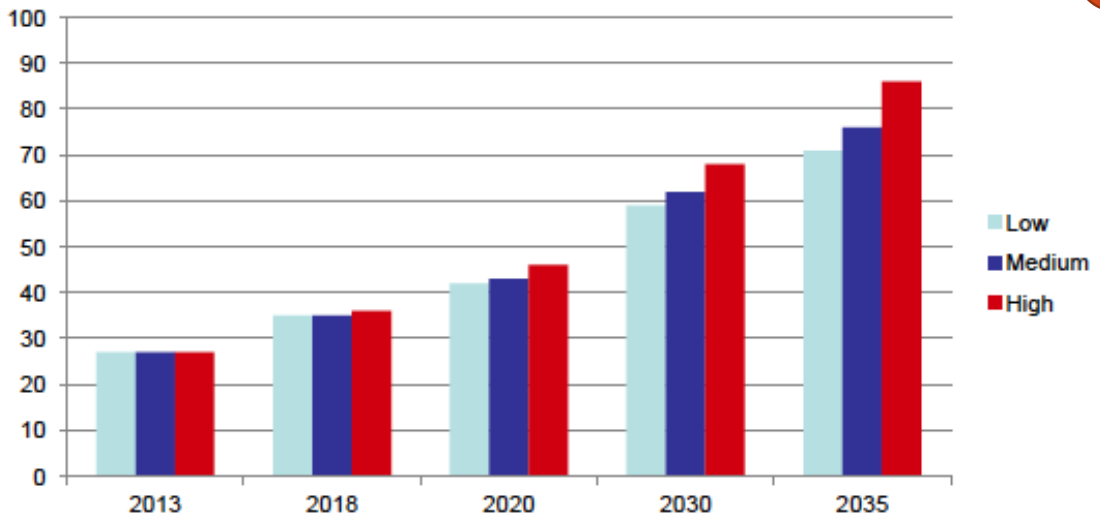
Rule of Energy Efficiency to Sustainable Development

- Power engineering has harmful effects on the environment, thus, there is an urgent need for new approaches to provide an ecologically safe strategy.
- Substantial economic and ecological effects for thermal power projects can be achieved by improvement, upgrading the efficiency of the existing equipment, reduction of electricity loss, saving of fuel, and optimization of its operating conditions and service life.

Electricity demand till 2035

The projections derived from ***TIMES-Egypt Model*** and the 3 scenarios are related to the different economic growth estimations

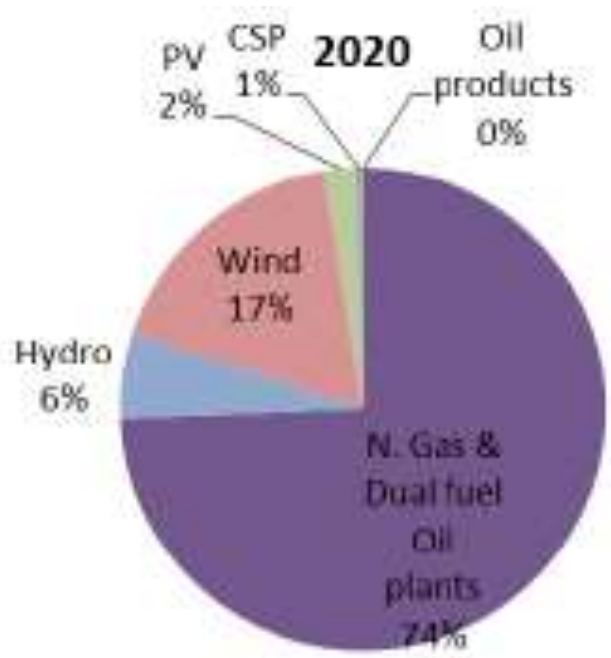
Peak Load Projections (GW)						
Scenarios	average growth (%)	2013	2018	2020	2030	2035
Low	5.2	27	35	42	59	71
Medium	6.2	27	35	43	62	76
High	7.1	27	36	46	68	86

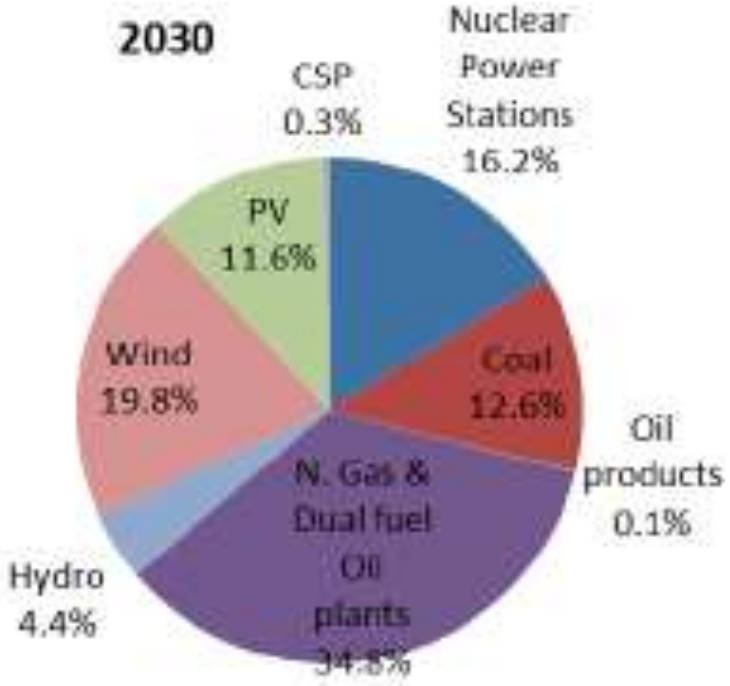


Expected Evolution of Peak Load Till 2035

1. Ensuring Power Generation Security

Generation plans call for a marked acceleration in the construction of 54 GW of new capacity by 2022



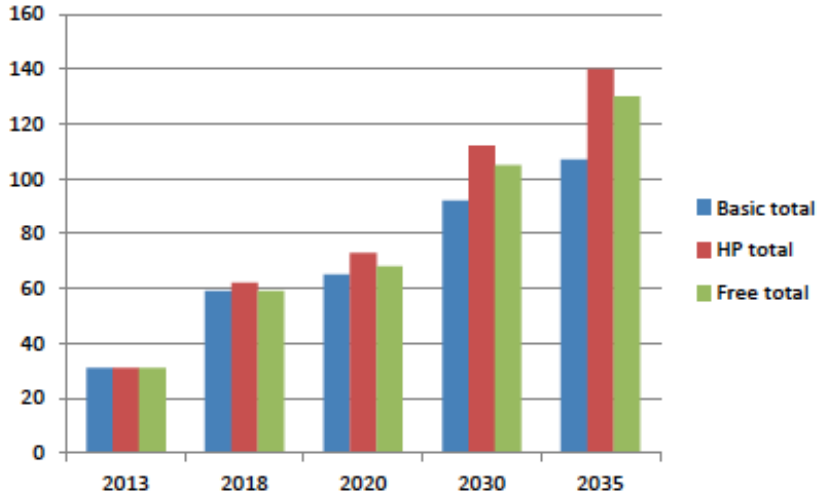


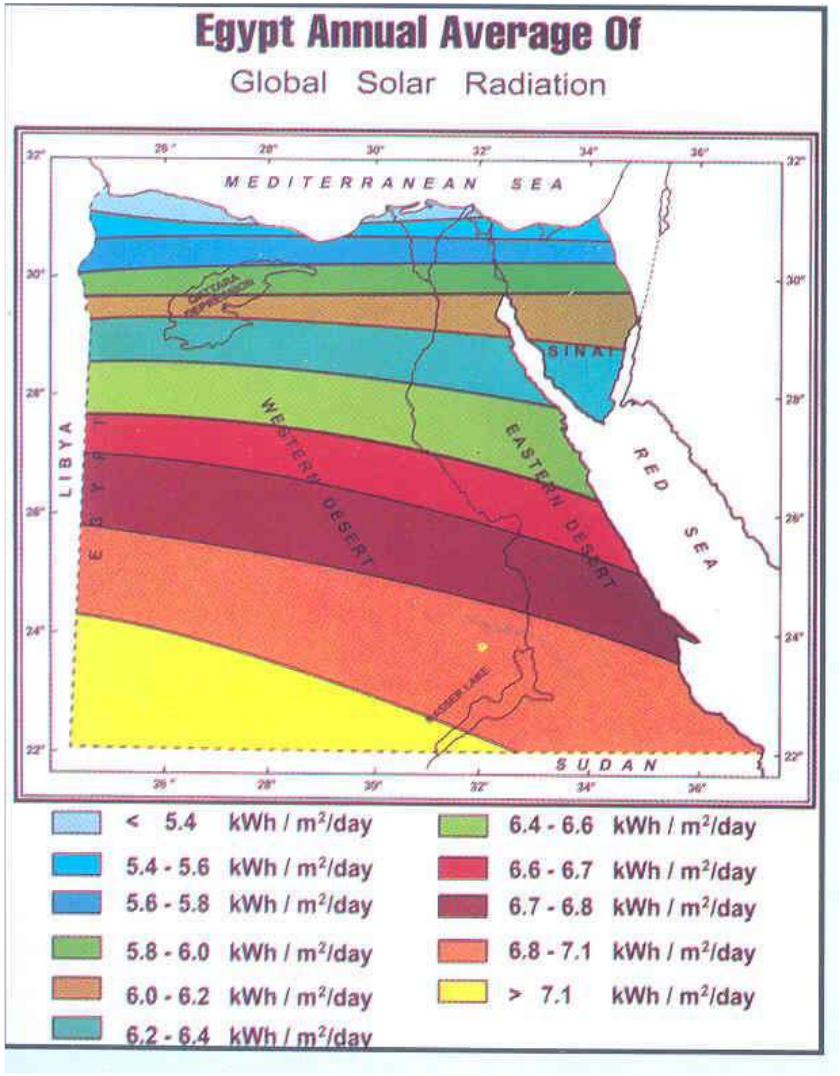
Energy Mix Plan Growth in the Power Sector

Expected Contribution of RE in the Supply Mix based on Different Scenarios

Installed capacities till 2035

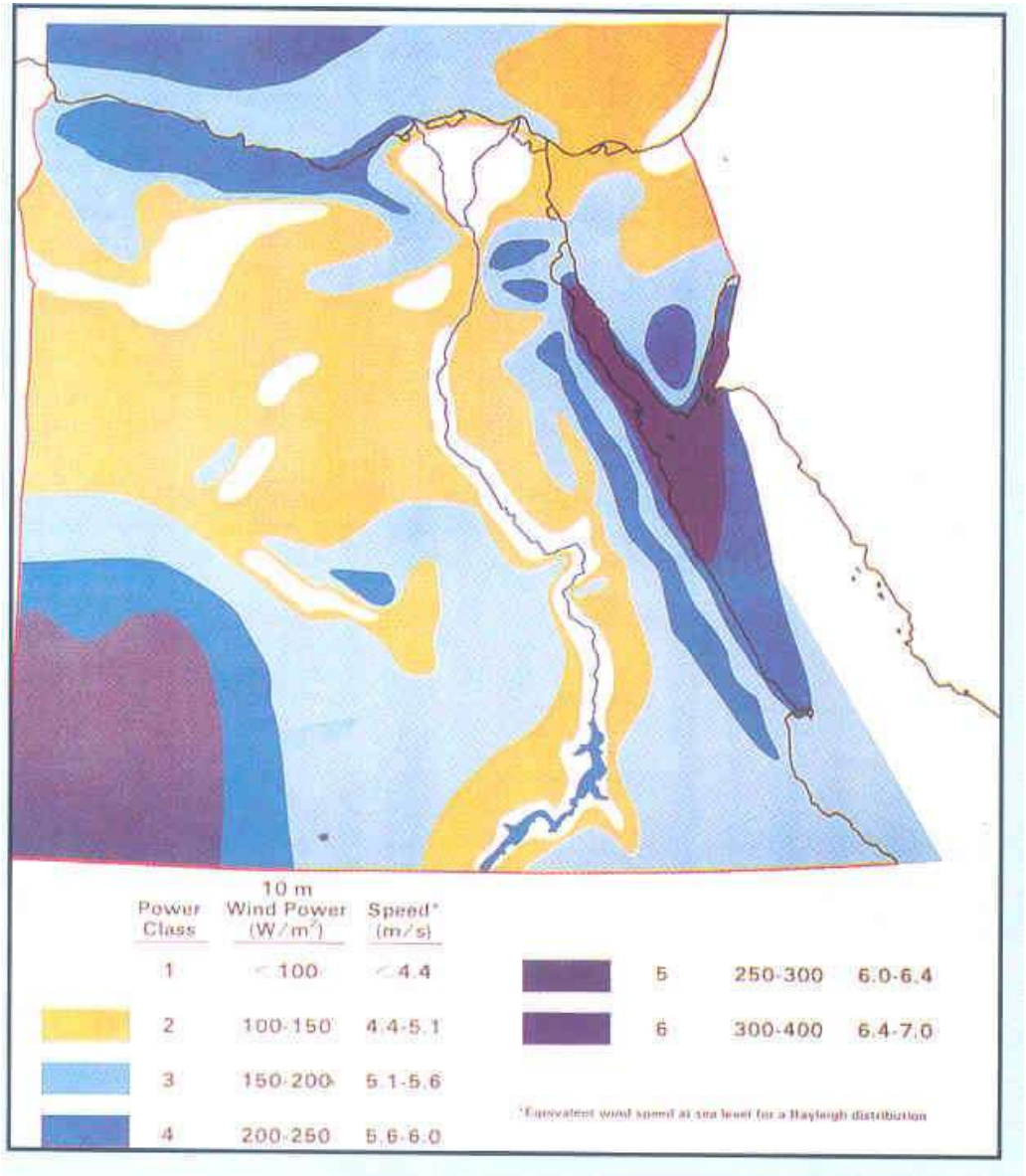
Capacity Installed requirements in GDP medium scenario/ different RES penetration levels						
Scenarios	GW	2013	2018	2020	2030	2035
Basic	*total*	31	59	65	92	107
	non hydro RES	0	6	9	28	33
High Penetration	*total*	31	62	73	112	140
	non hydro RES	0	13	25	58	85
Free	*total*	31	59	68	105	130
	non hydro RES	0	8	17	44	62





Potential of Solar Energy in Egypt

Two third of the country area has a solar energy intensity more than 6.4 kWh/m2 day (an annual global solar radiations of 2300 kWh/m2 year)



Potential of Wind Energy in Egypt

In some areas specially on the Red sea coast the wind speed approaches 10 m/sec or even higher

2. Financial Sustainability

1. **Energy Subsidies** represent a huge fiscal burden:
   - reached 7% of GDP in 13/14.
   - significant % of subsidy does not reach the targeted.
   - In July 2014, the government announced a clear roadmap to bring electricity tariffs to cost recovery levels within the next 5 years.
2. **Inefficient** social safety nets.

3. New Structure of Egypt's Electricity Market

Egypt will create a two-tiered electricity market:

First tier **of the market will be competitive and will comprise high voltage customers (HV), who will freely choose electricity generator suppliers based on a bilateral contract and negotiated electricity prices.**

The second tier **of the market will pay a regulated tariff and will purchase electricity from the distribution companies who will be supplied by a single Wholesale Public Trader.**

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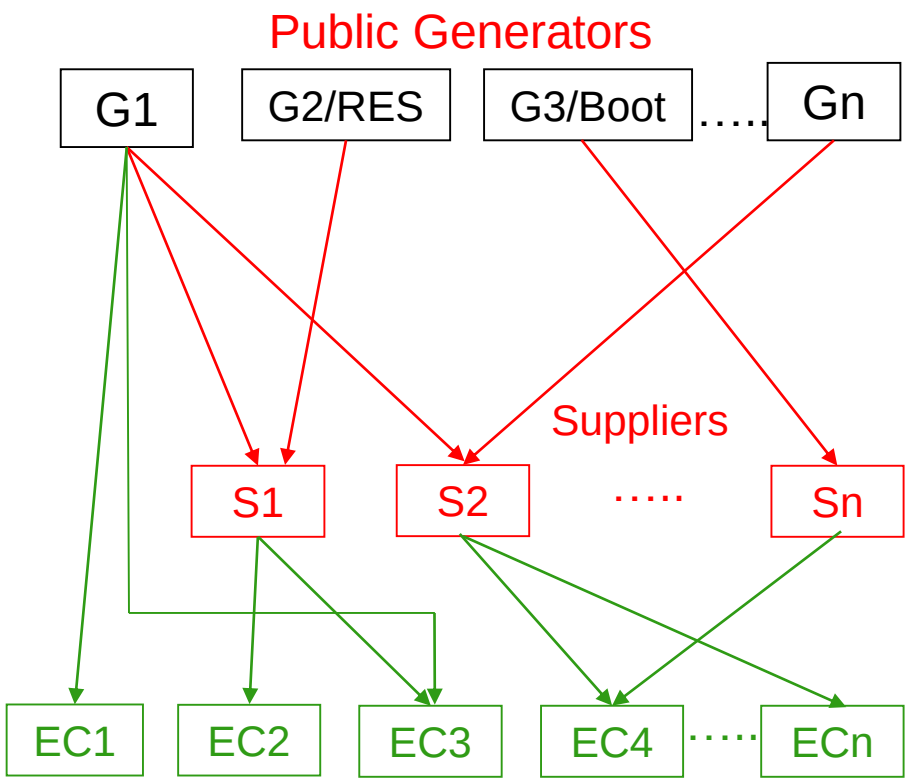
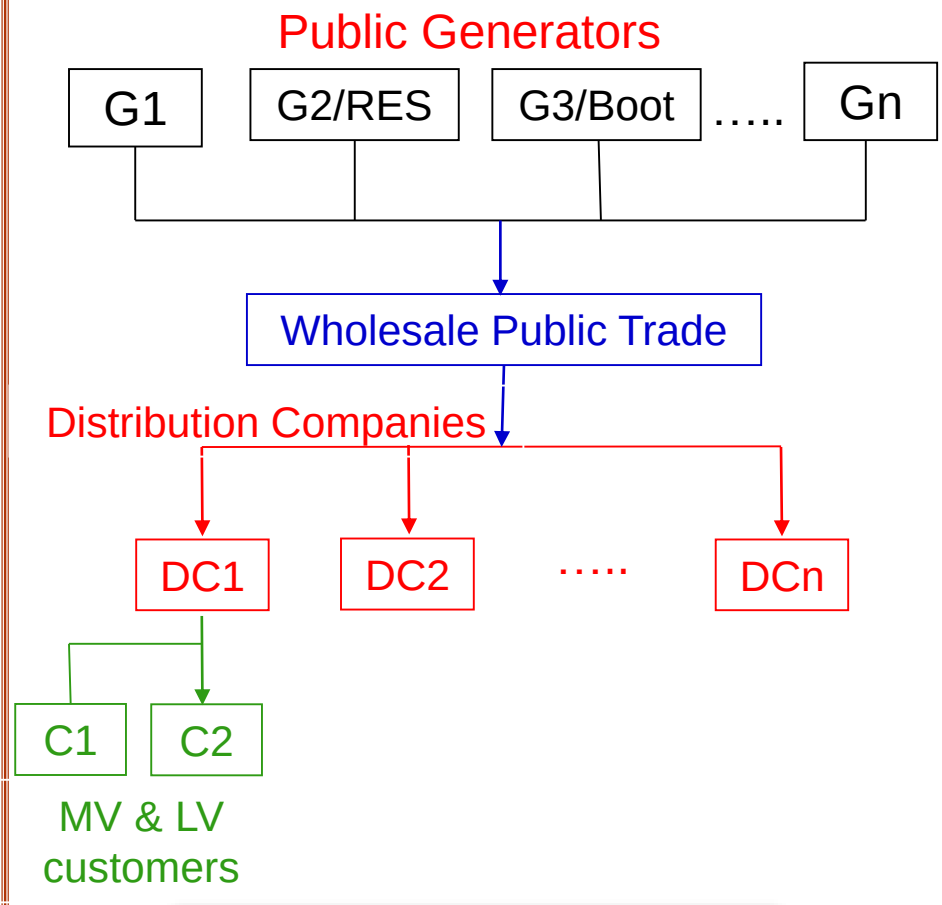




Competitive Market

Regulated Market

Micro grid and Distributed Generation

What is a Micro-Grid?

- **Micro-grid is a localized grouping of electricity sources and loads that normally operates connected to and synchronized with the traditional centralized electrical grid (macro-grid), but can disconnect and function autonomously as physical and/or economic conditions dictate.**
- **Micro-grid paves a way to effectively integrate Distributed Energy Resources (DER), especially Renewable Resources (RES), and to *achieve independent control* from a large widespread power grid.**
- **Micro-grid provides a good solution for supplying power in case of an emergency by having the ability to change between islanded mode and grid-connected mode.**

Microgrids Structure

Components of a Microgrid

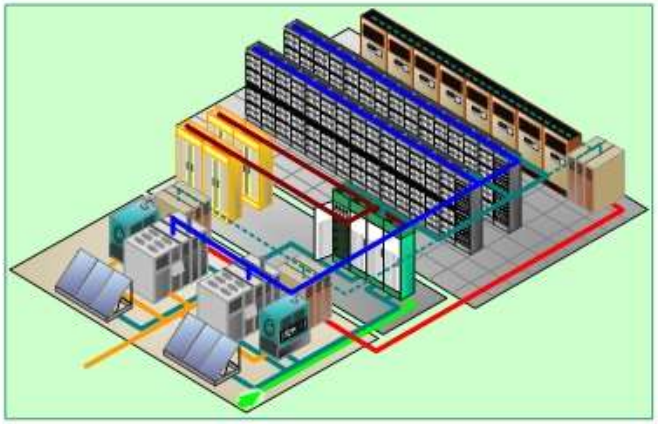
- ***Defining***
  - **Multiple Distributed Generation Points**
  - **Control System / Energy Management**
- ***Additional***
  - **Utility Interconnection Switch – Point of Common Coupling (PCC)**
  - **Energy Storage**

Microgrids Applications

- ***Application range:***
  - **From a few kW to MW**

RESIDENCE

DATA CENTER



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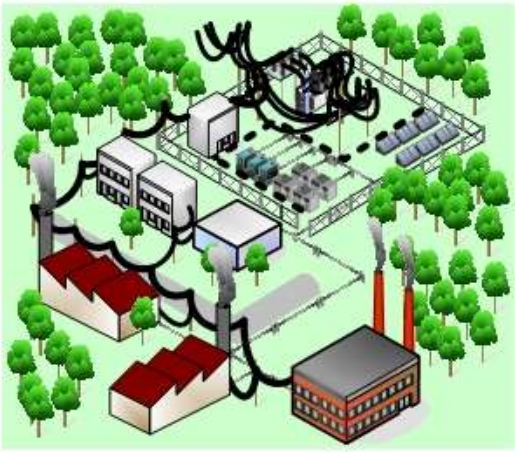


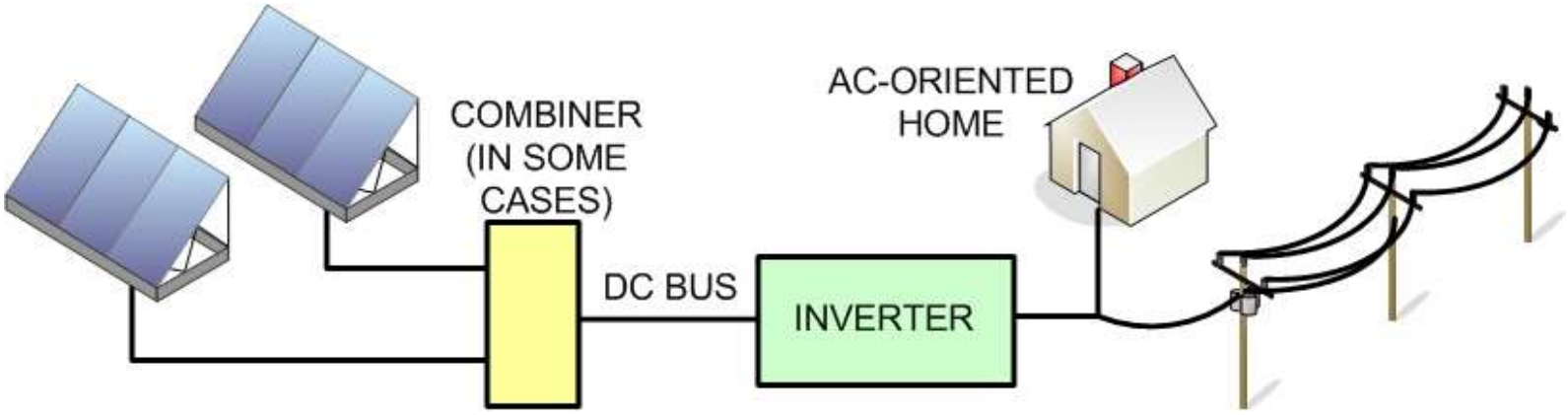
LOW POWER

MEDIUM POWER

HIGH POWER

❑ *What is not a microgrid?*

- **Residential conventional PV systems (grid-tied) are not microgrids but they are distributed generation systems.**
- **Why are they not microgrids? Because they cannot operate isolated from the grid. If the grid experience a power outage the load cannot be powered even when the sun is shinning bright on the sky.**



❑ *Smart Grid?*

- **A smart grid is a modernized electrical grid that uses information and communications technology to gather and act on information.**
- **The smart grid will introduce tools that efficiently and reliably monitor, control, analyze and optimize power through increased communication between all facets of the energy-value chain and take advantage of both renewable resources and distributed assets.**
- **The smart grid will send energy usage updates in real time, improving outage prediction and restoration time, thereby making the power system more reliable and resilient.**

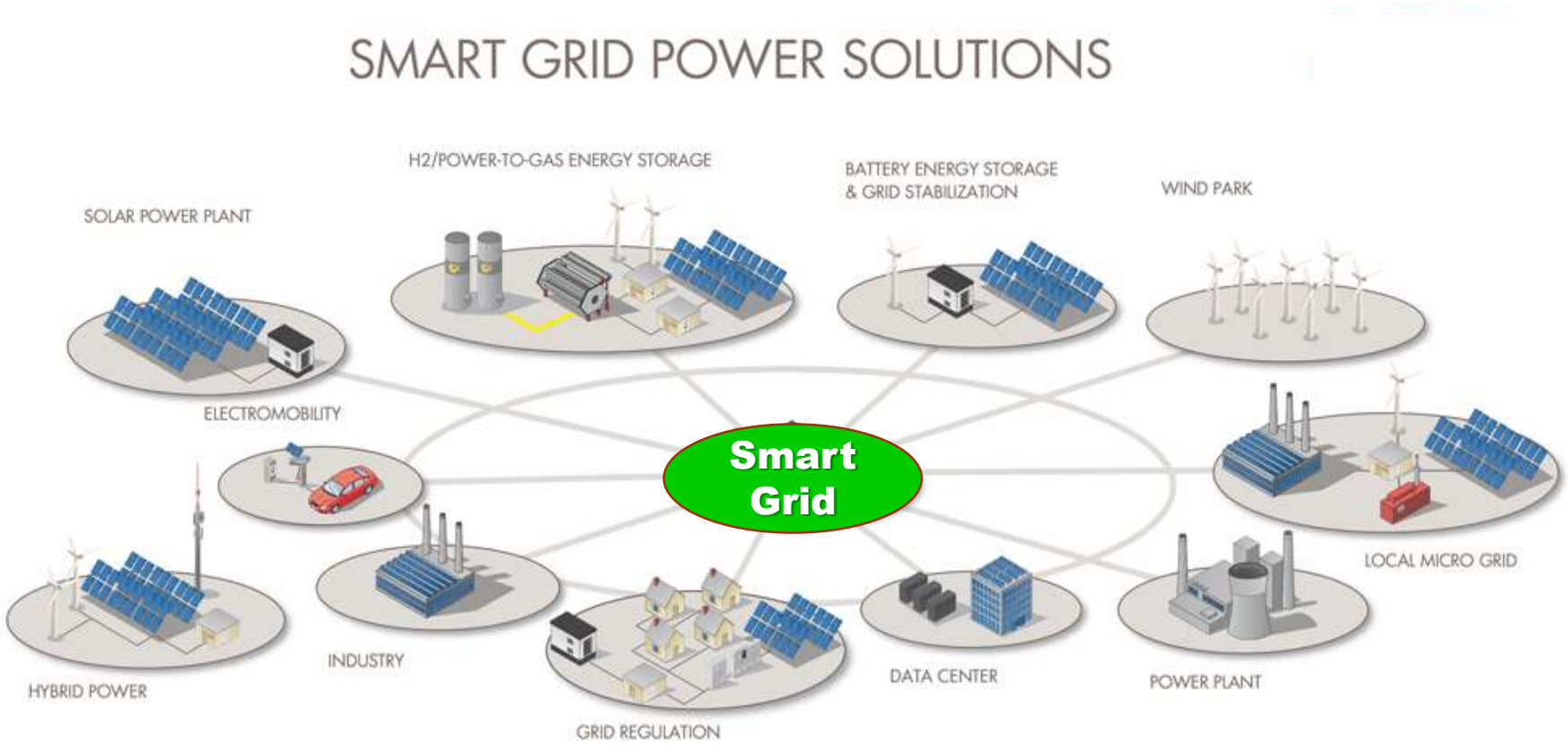
Smart Grid and Microgrids - *What's the Difference?*

- **The current grid encompasses all aspects of generation, transmission and distribution. This system has been around for decades, and today's advances in technology call for a change.**
- **"Smart grid" refers to communications and computer-based technologies designed to revolutionize the power grid. The smart grid will send energy usage updates in real time, improving outage prediction and restoration time, thereby making the power system more reliable.**
- **Microgrids are one piece of a larger system that could eventually allow the smart grid to become a reality. They are an excellent example of how you apply smart grid to the existing grid system and include multiple loads and Distributed Energy Resources (DERs) that can be operated in coordination with the main power grid or run independently.**

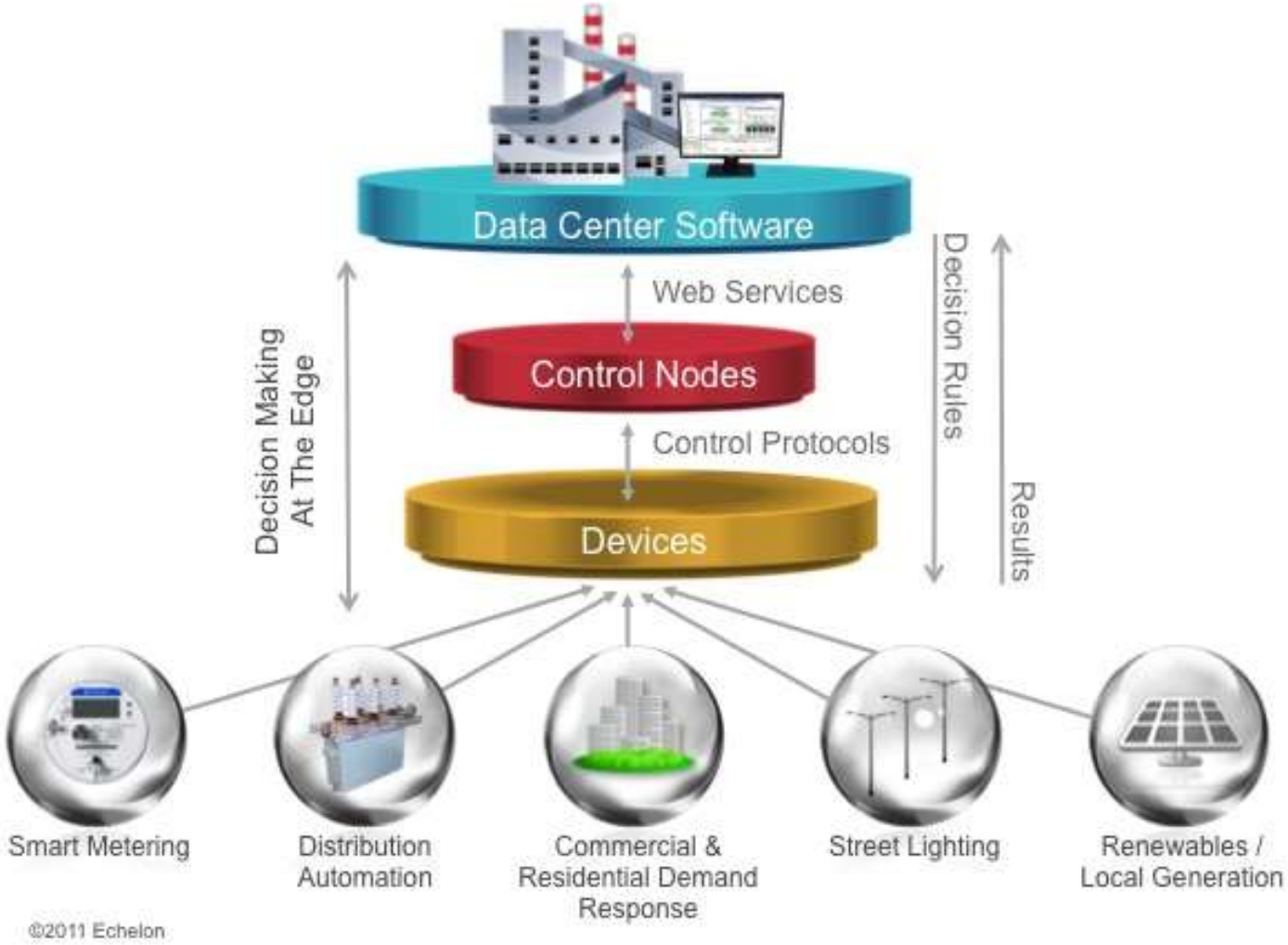
Components of a Smart Grid

- ***Hardware***
  - **Sensors, Embedded processors**
  - **Integration with other hardware**
- ***Basic Software***
  - **SCADA, Energy management**
  - **Vector processors**
- ***Communications***
  - **Slow (existing SCADA or EMS, more or less)**
  - **High-speed, high-bandwidth (need to develop)**

Smart Grid Applications



Smart Grid Energy Control Network



QUESTION