

# Smart Grid

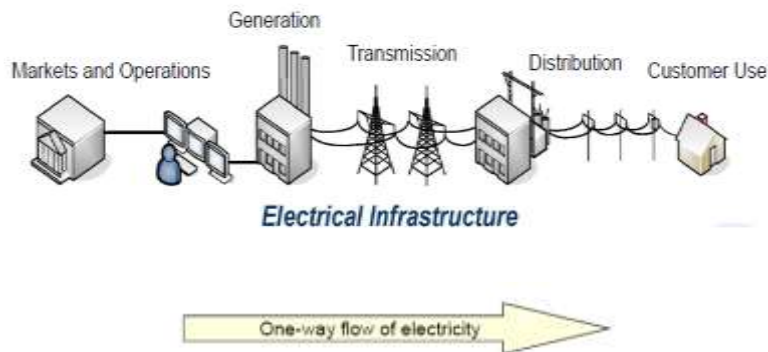
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## Presentation Outline

- Today's Electric Grid
- Electric Power Market
- Challenges and Road Ahead
- Smart Grid
  - Concept
  - Benefits
  - Technology Overview
  - Smart House
  - Smart Meter
- References

## Today's Electric Grid



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## Electric Power Markets

1. Electric grid requires supply and demand to be in balance.
2. Modern society depends upon infinite and constant electricity
3. Grids maintain reliability by continuously anticipating and matching changes in demand with supply, i.e. generation
4. Grid operators place premium value on generation resources they can control, predict and measure



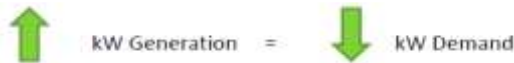
Reliability in Historic Grid Operations

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## Market Pricing Signals

- The markets are designed to be indifferent to whether the next kilowatt is provided by an increase in generation or decrease in demand.



- Generation has the same value as load reduction, and therefore if a customer can decrease load, effectively selling into the market, they will receive the same prevailing market price that a generator would for that energy.
- At moments of extreme price, market operators can balance generation and demand by sending price signals and requesting reductions in customer demands
- Typical Demand Response programs – customers react to extreme market prices

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## What is Needed? Why Now?

Deregulation - driving actions of most utilities

Major driving forces:

- Improved power quality and service reliability
- New energy related services and business areas
- Lower cost of service
- Information needed for improved decision making

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# [ Challenges ... ]



▶ **Increasing demand for energy and electricity**



▶ **Moving towards an environmentally-friendlier energy mix (lower carbon emissions, more renewable energy...)**



▶ **Volatile energy prices and critical energy losses**



▶ **Emerging large regional transmission networks**

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# [ Reinforcing Existing Needs ]



▶ **Reliability and quality**

Ensure security of supply, reliability of the network and quality of the electricity delivered



▶ **The network must be smarter with more intelligence at all levels**

Monitor oscillations and manage the network to prevent blackouts and maximize availability of power



▶ **Environmental concerns**

Provide clean energy (CO<sub>2</sub> free) and reduce environmental impact



▶ **Market efficiency**

Equip energy markets by setting up necessary tools and processes, Enable customers' / end-users' dynamic participation



▶ **Energy efficiency**

Deliver the maximum of electricity to the end-user, starting from a given quantity of energy and from existing assets

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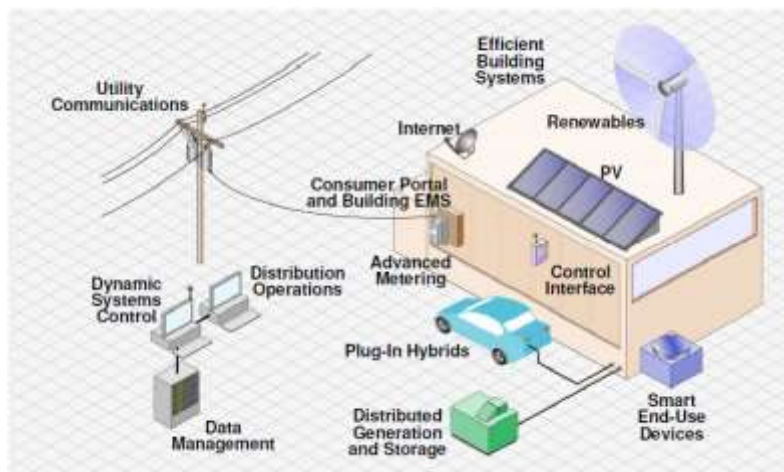
## Changing Industry Scenario



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## Changing Consumer Scenario



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## [ Revolution? ]

“We can’t solve problems by using the same kind of thinking we used when we created them.”

- Albert Einstein

- Running today's digital society through yesterday's grid is like running the Internet through an old telephone switchboard

## Evolution !

- To respond to these challenges, grids need to evolve to become more efficient, environmentally-friendlier and more reliable, in a word the smarter grids.

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## [ What are we talking about? ]

- ... a fully automated electrical power delivery and management network... ensuring a two-way flow of electricity and information between the Grid and appliance, and all points in between. Its distributed intelligence, coupled with broadband communications and automated control systems, enables real-time transactions and seamless interface among people, buildings, industrial plants, generation facilities and the electric network.

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# What is 'Smart Grid' ?

20 <sup>th</sup> Century Grid	21 <sup>st</sup> Century Smart Grid
Electromechanical	Digital
One-way communications (if any)	Two-way communications
Built for centralised generation	Accommodates distributed generation
Radial topology	Network topology
Few sensors (limited to Zone SCADA)	Monitors and sensors at all levels of T&D network
"Blind"	Self-monitoring & timely
Manual restoration	Semi-automated restoration and, eventually self-healing
Prone to failures and blackouts	Adaptive protection and islanding
Check equipment manually	Monitor equipment remotely
Emergency decisions by committee	Decision support systems , predictive reliability
Limited control over power flows	Pervasive control systems
Limited price information	Smart Grid Fully price information
Few choices to customer	Offers many choices to customer

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## Smart Grid – All in one

- A dynamic system rich in information technology
- High-speed, real-time, two-way communications
- Sensors throughout the grid enabling rapid diagnoses and corrections
- Data warehousing with decision support system
- Integrated large central and Distributed generation technologies (such as wind turbines, solar panels and plug-in hybrid electric vehicles)
- Automated "Smart Substations"
- In-home energy control devices
- Automated home energy use
- User-centric, user specified, DSM supporting
- Accessible to all network users
- Real-time Power balancing

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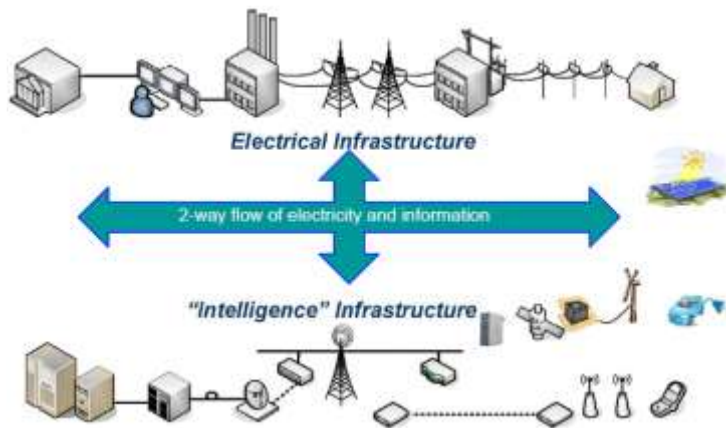
# Smart Grid Benefits



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# Smart Grid = Electric Grid + Intelligence

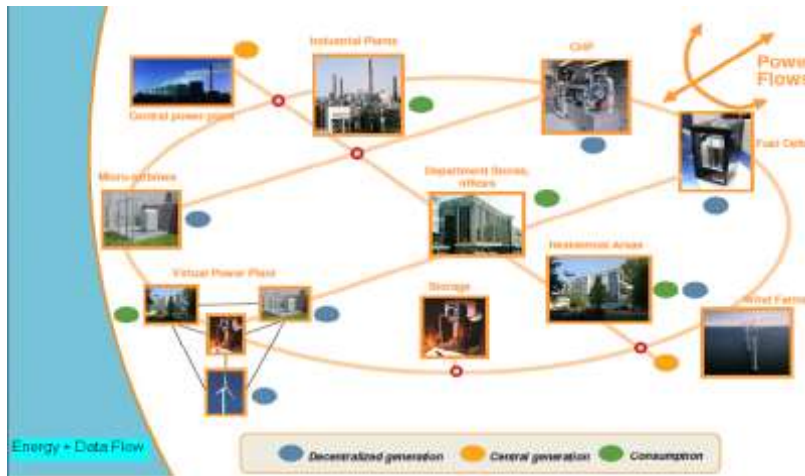


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## [ Dynamic and Bi-Directional Energy and Data Flow ]



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## [ Electric Grid - Tomorrow ]



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## [ ... SUPPORT FROM NEW TECHNOLOGY AND REGULATION ]

New Technological Capabilities

- Technological Convergence
- Modeling and simulation
- Complex systems control
- Energy storage
- Power electronics applications

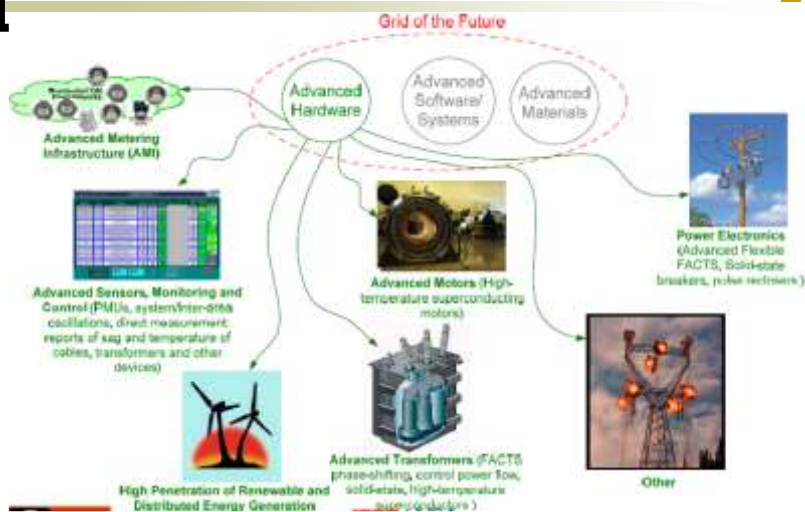
Emerging governmental energy policies for

- Energy & Environment
- Energy supply
- Blackout prevention
- Energy demand management

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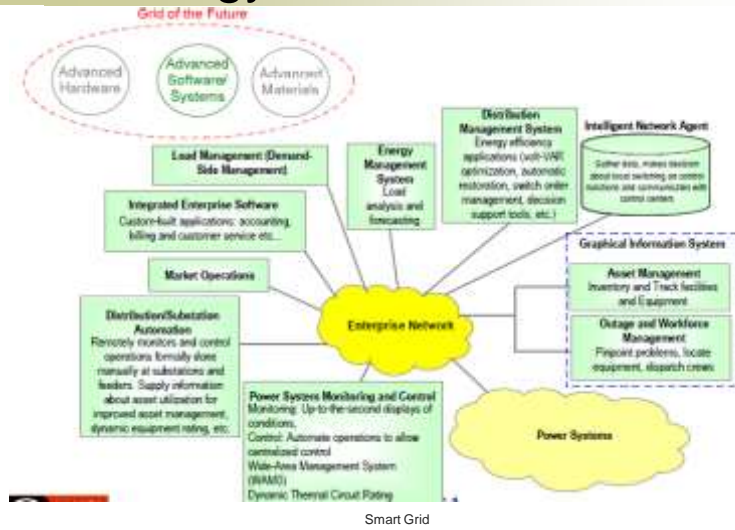
## [ Technology Overview ]



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# Technology Overview



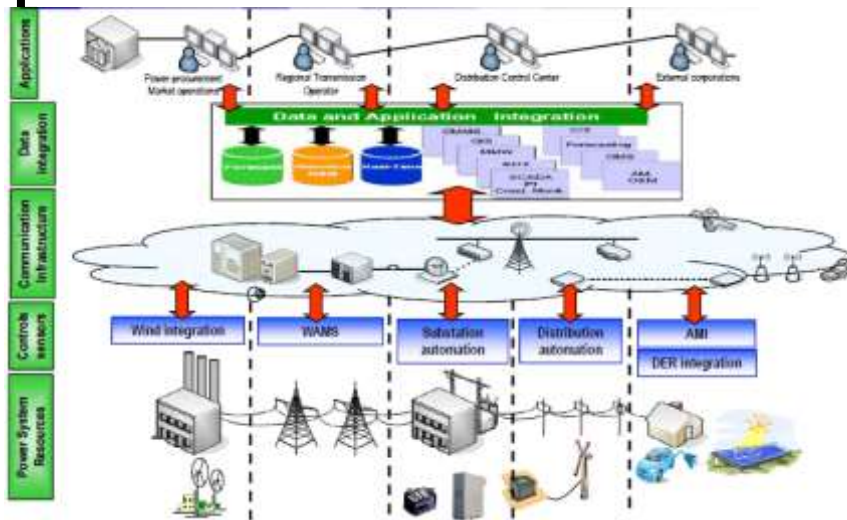
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# Technology Overview

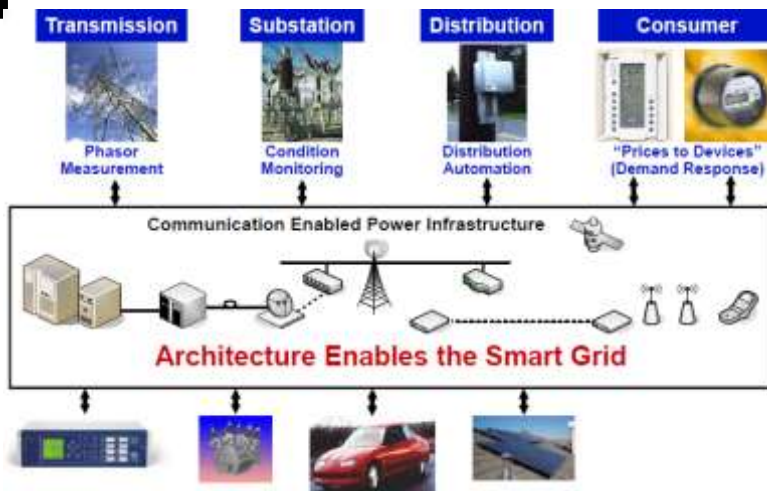


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## Smart Grid applications at all levels



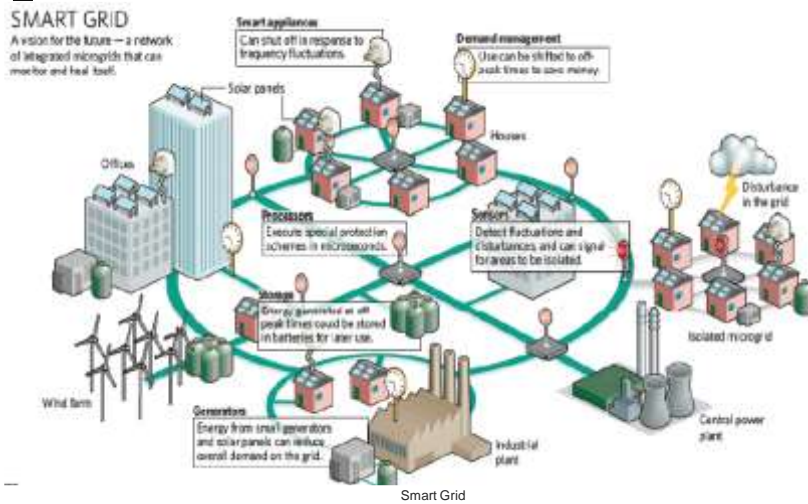
## Applications at all levels



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# Intelligent Power Delivery System



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# Smart Grid Comm Standards Domains

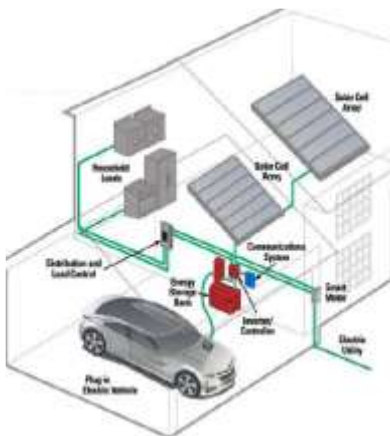


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# The Smart House



# Features of Smart Home



Smart Interface for Plug-In Vehicle with integrated high power charger

- Utilizes grid power, solar power, or stored energy
- Renewable Energy System with energy storage

Able to provide power to the grid, household loads or plug-in vehicle

- Back-up power with load control
- Communication system between utility and home energy management system
  - Utilizes established home control network standards
  - Utilizes power line and/or RF communications
  - Does not require dedicated wiring
- Smart Meter
  - Net metering
  - Wireless, wide area networks
  - Power line communications network



## The Smart Meter, a Smart Grid Enabler

- Multiple tariff structures, real-time usage and historical usage available in real-time to the customer
- Voltage, Load Profile, Outage, Power Quality all available to support grid optimization
- Conduit for Demand Response and Load Control for Energy Efficiency
- Service Switch for advanced services:
  - Prepayment
  - Demand limiting
  - Outage restoration
  - Cold load pick-up

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## How is the Smart Grid Approach Different?

- It is a **journey, not a destination** - not an off-the shelf product, or something you install and turn on the next day
- **It is not a one-time solution** – it is a change in how utilities look at a set of technologies that can enable both strategic and operational processes.
- It is an **integrated solution** based on **open architectures**
- **Not one specific technology enabler** - not necessarily a single vendor solution
- **Builds on the existing infrastructure**
- Provides a **greater level of integration at the enterprise level**
- Has a **long-term and wide-scale deployment focus**.
- It is the means to **leverage synergies and benefits across applications** and remove the barrier of silos of organizational thinking.
- Based on
  - a systematic approach to understand utility business & operating issues...what are the drivers for change?
  - Economic evaluation (cost/benefits analysis) of solutions that have the highest impact to address issues and implement change
  - A **roadmap** of enabling technologies

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## [ Hurdles... ]

- Lack of comprehensive, long-term and integrated Smart Grid strategies and roadmaps tied to quantifiable benefits
- Substantial capital investment required up front
- Regulatory structures that do not fully recognize the benefits of smart grid technologies (e.g., decoupled rates)
- Utility business models that minimize risk and ties returns to electricity revenue
- Interoperability and the need for faster, more comprehensive development of standards, including physical and cyber security
- The need to move away from isolated pilots from “testing” to “phased deployments” on a larger scale (“city-scale”)
- Availability and capability of smart grid educational tools for policymakers, regulators and consumers to change thinking and attitude to smart grid technologies