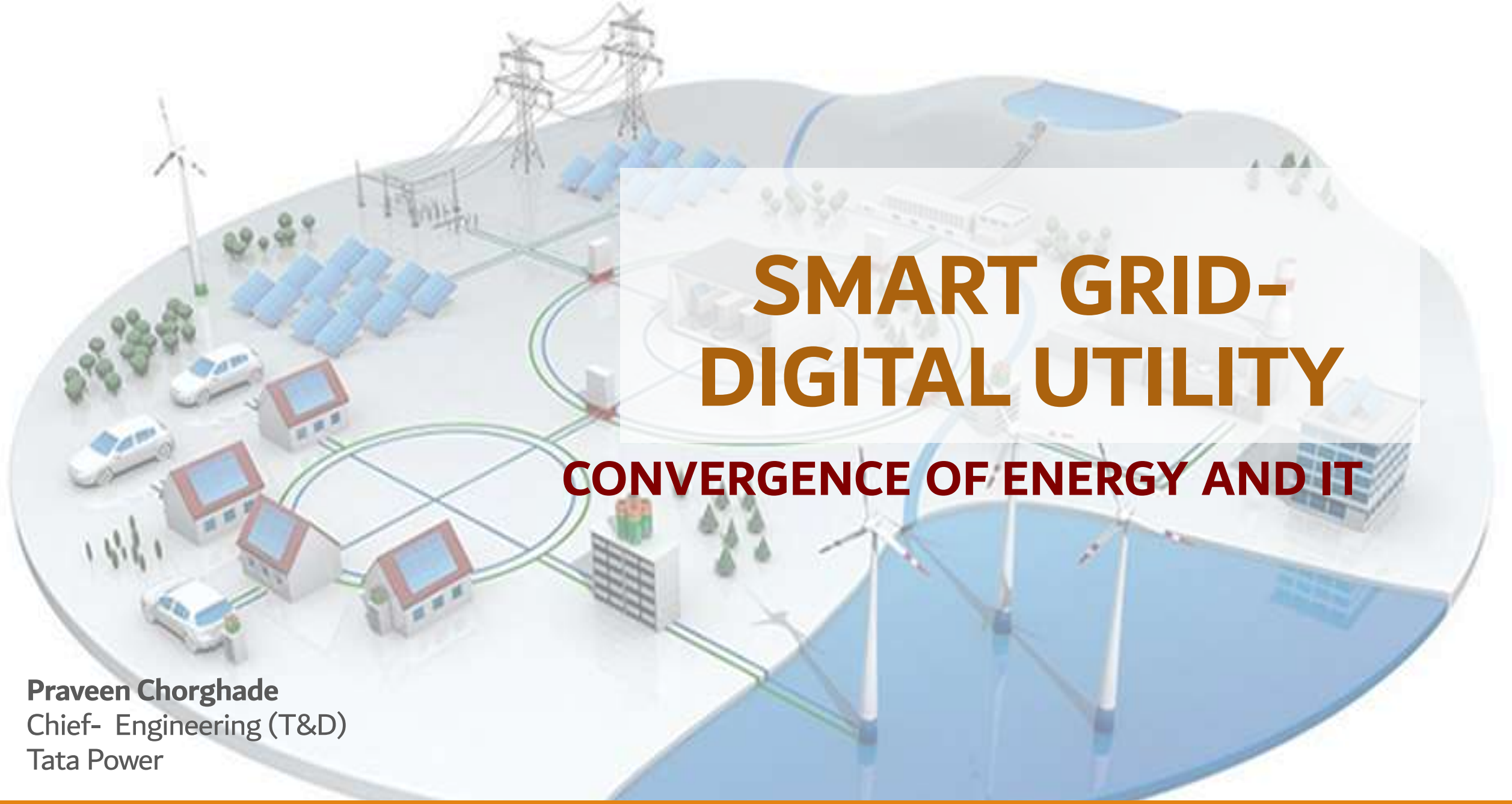


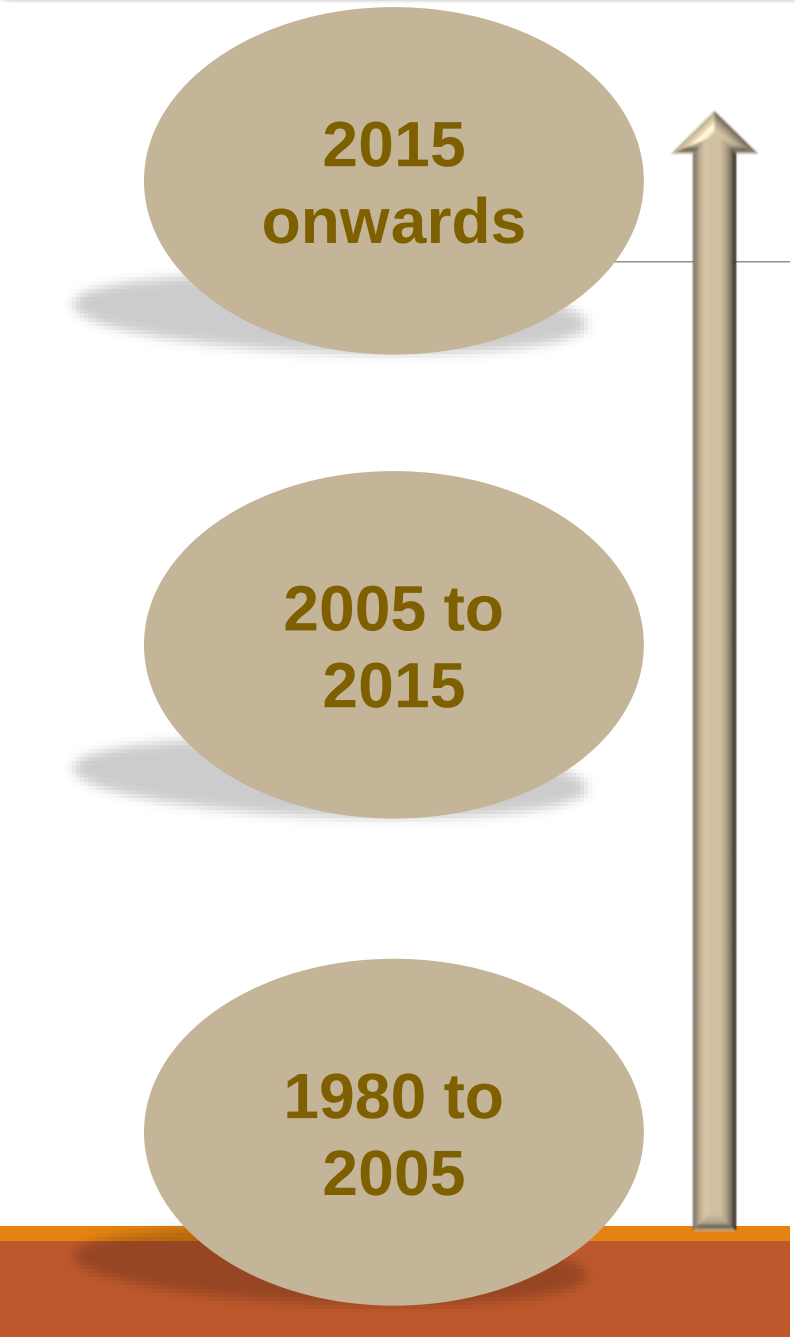
SMART GRID- DIGITAL UTILITY

CONVERGENCE OF ENERGY AND IT

Praveen Chorghade
Chief- Engineering (T&D)
Tata Power

Smart Digital Utility : Components

The Smart Utility - Journey



New frontiers

Emerging themes	• Smart grid • Smart homes • Connected buildings • Distributed generation	• Energy services • Preventive maintenance • Digital billing • Digital commerce

Core of transformation

Customer-experience design	• Digital front-end processes • Multichannel commerce • Digital marketing and social media	• Integrated digital and physical experience • Customer life-cycle management • Customer experience management
Digitized products and components	• Open innovation • Digital innovation	• Intelligent products and components
Value chain	• Automated back-end processes • Automated analytics and intelligence	• End-to-end digitization • Workforce productivity

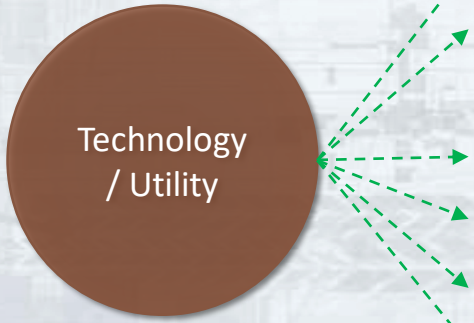
Technical and organizational principles

Technology	• System and data architecture (two-speed IT) • Mobile interactive devices	• Connectivity • Big data and advanced analytics • Data security
Organization and culture	• Project culture • Cross-functional cooperation • Flat hierarchies	• Digital talent • Agility

- ***IT for a smarter grid, smarter home and a smarter customer***
- The digital technology that allows for **two-way communication** between the utility and its customers
- Like the Internet, the Smart Utility will consist of controls, computers, automation, and new technologies and equipment working together, but in this case, these technologies will work with the electrical grid to respond digitally to our quickly changing electric demand.

Smart Utility – Future of Power Sector

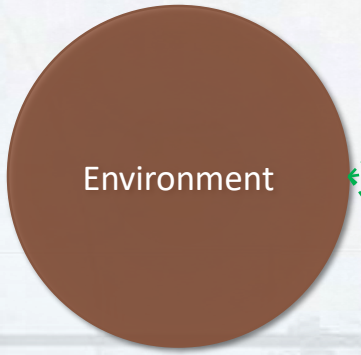
The Smart Utility represents an unprecedented opportunity to move the energy industry into a new era of reliability, availability, and efficiency that will contribute to our economic and environmental health



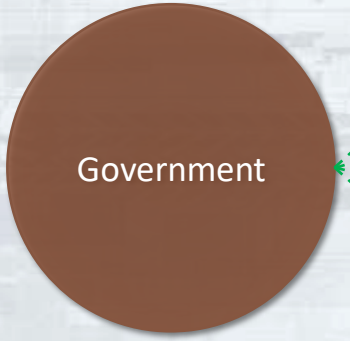
- Add **Resiliency** to electric power System
- Make it better **prepared to address emergencies** such as severe storms, earthquakes, large solar flares, and terrorist attacks
- Will **Automatically reroute the power supply** when equipment fails or outages occur
- Will **detect and isolate the power outages**, containing them before they become large-scale blackouts
- **Smart meters Combined with real-time pricing** will lead to cost optimization of electricity
- Better **data analytics**

Smart Utility – Future of Power Sector

- Will take greater advantage of **customer-owned power generators** to produce power
- Will let **consumers manage** their electricity
- Unprecedented level of **consumer participation** via net-metering, incentives, etc.
- Minimize losses and improve **consumer satisfaction** via reliability of quality power supply



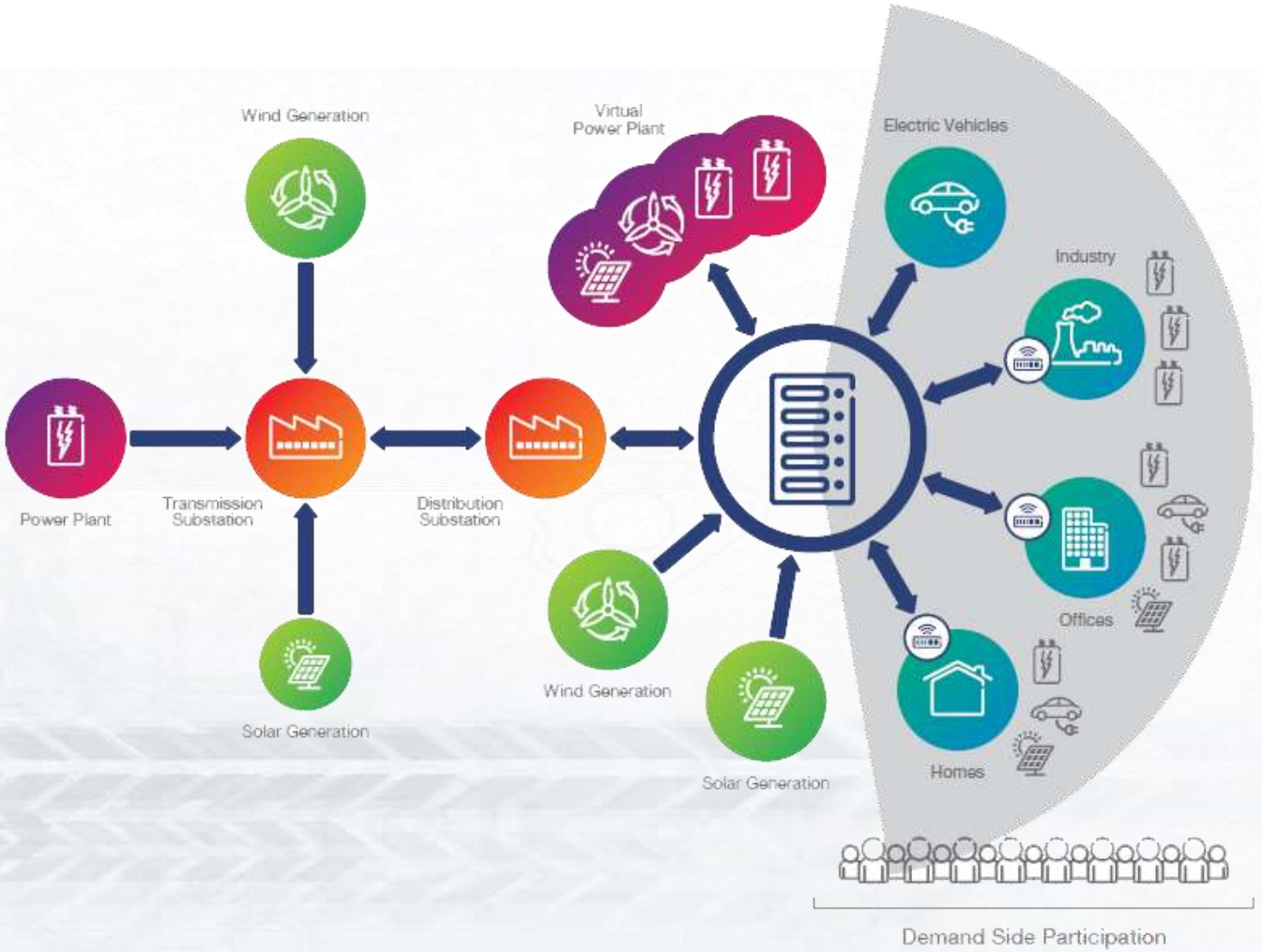
- By combining these "**distributed generation**" resources, a community could keep its health center, police department, traffic lights, phone System, and grocery store operating during emergencies.
- Will bring increased awareness to consumers about the **connection between electricity use and the environment**
- A way to address **energy efficiency**
- Will employ **renewable power**



- A way to address an **aging energy infrastructure** that needs to be upgraded or replaced
- A way to bring increased **national security** to our energy System
- A way to enhance **safety** of employees, network and consumers
- Attract **investors**

The Smart Utility is not just about utilities and technologies; it is about giving the information and tools you need to make choices about your energy use.

SMART GRID


Wind Generation
Virtual Power Plant
Electric Vehicles
Industry
Power Plant
Transmission Substation
Distribution Substation
Offices
Wind Generation
Solar Generation
Solar Generation
Homes
Demand Side Participation

SMART GRID

→ *Uses information technologies to improve how electricity travels from power plants to consumers*

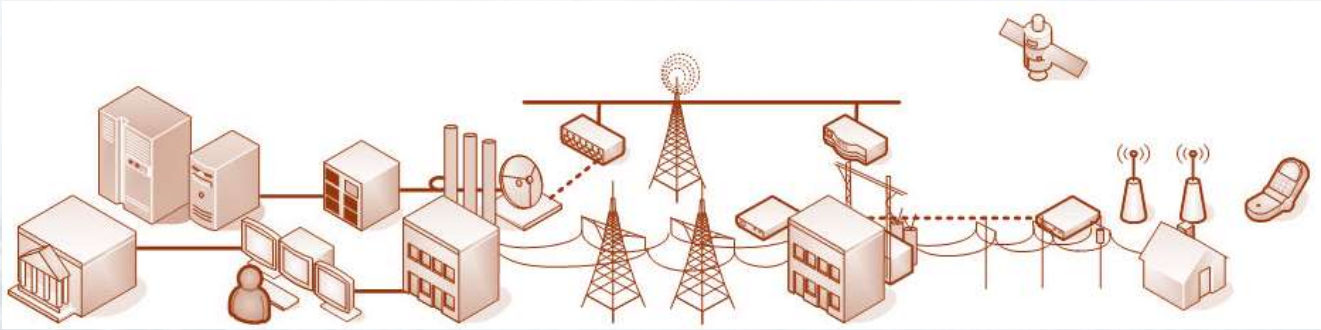
→ *Allows consumers to interact with the grid*

→ *Integrates new and improved technologies into the operation of the grid*

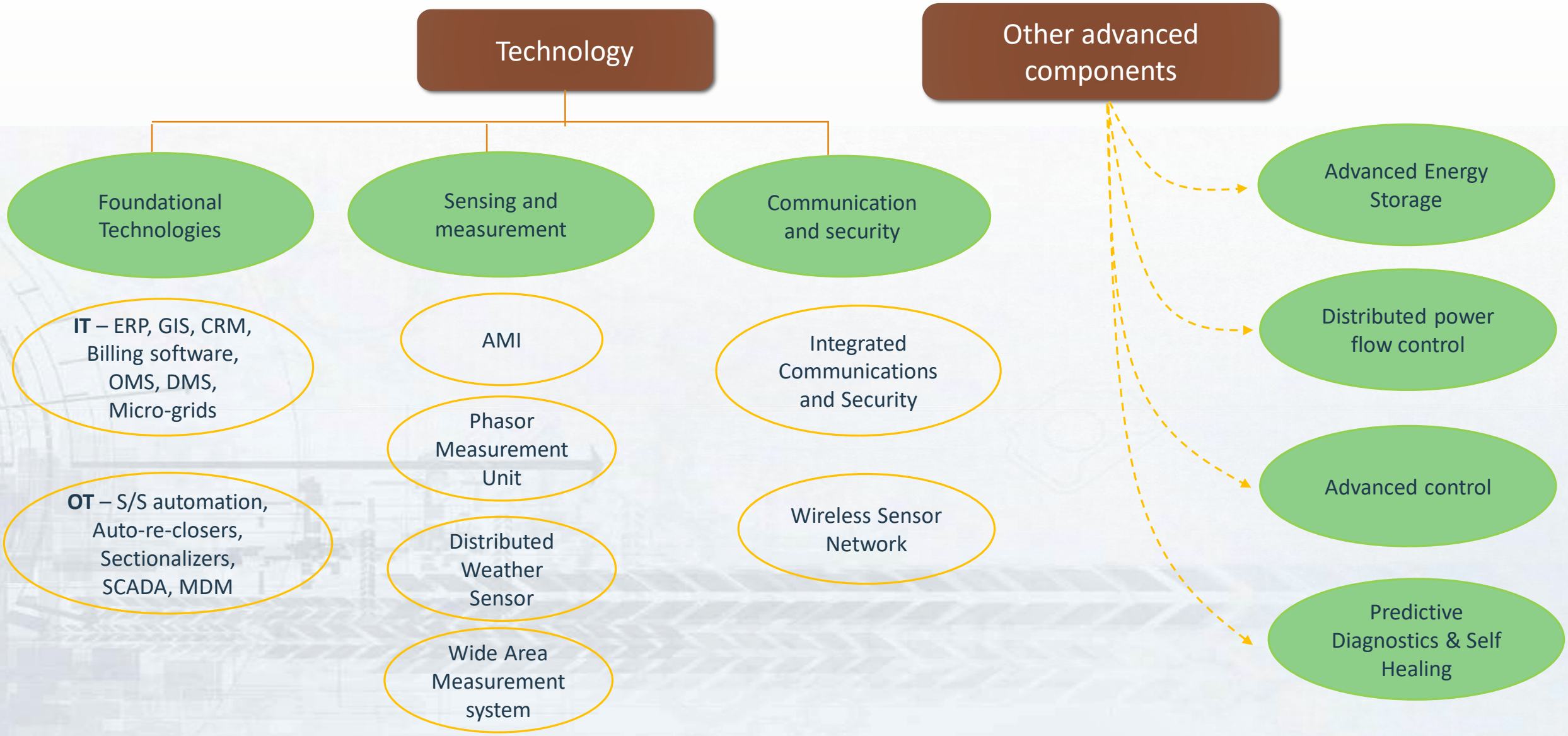
A smart grid includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficiency resources along with application of digital processing and communications to the power grid, making data flow and information management central to the smart grid.

"Self-Healing" Grid

A combination of **New high-power electronics & technology** and a **new level of control** to dampen unwanted power oscillations, avoid unproductive flows of current through the grid, **Reroute the power** in a way that causes minimal disruptions to the grid and enable a new **automated approach to controlling the grid.**



Smart Grid : Components

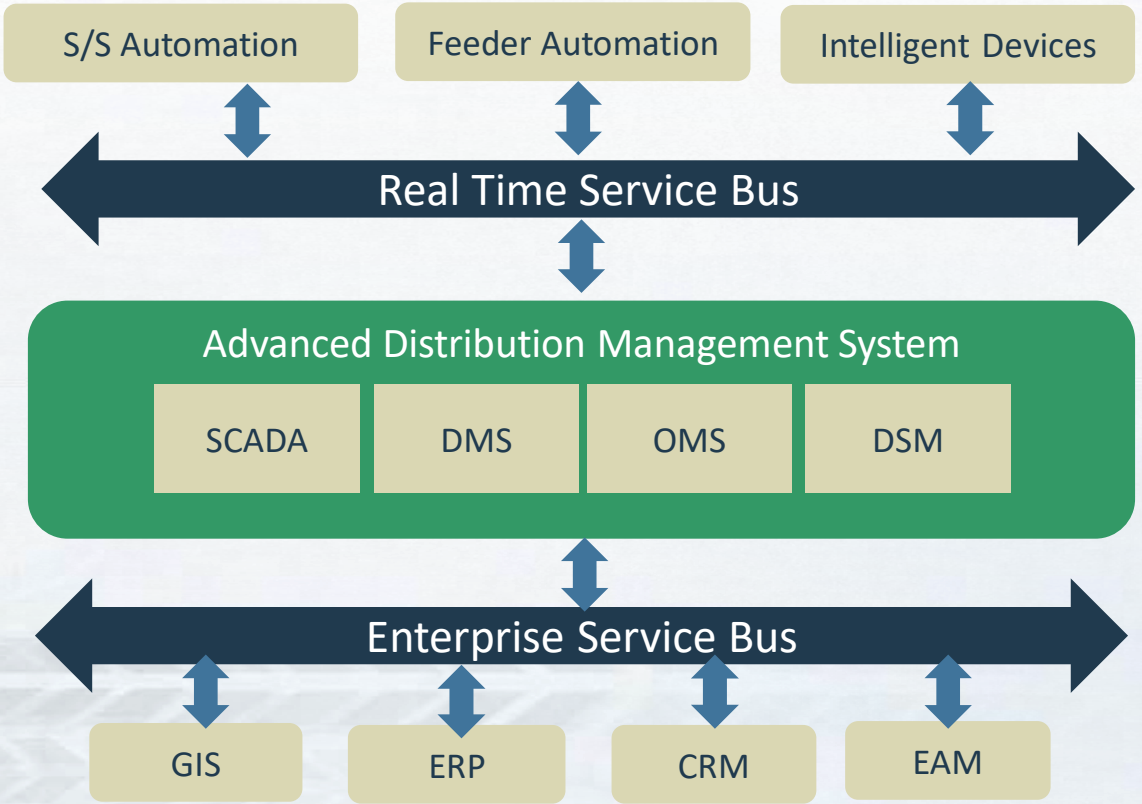


Foundational Technologies : IT/OT systems

A smart grid platform implies the convergence of Operations Technology (OT) – the grid physical infrastructure assets and applications–and Information Technology (IT) – the human interface that enables rapid and informed decision making.

ADVANCED DISTRIBUTION MANAGEMENT SYSTEM

- ADMS offers many optimization and grid improvement functions for demand and efficiency management; analyzing and managing distributed energy resources; and supporting automated switching for self healing along with managing high volume of IT/OT information.
- An advanced ADMS can support 'closed loop' control, in which the operator simulates the forecasted grid conditions, typically with forecast data from advanced weather systems, and selects an optimization scheme from a set of potential solutions proposed by the system.
- ADMS then executes the grid optimization program; it monitors and readjusts switching or volt/VAR settings automatically as grid parameters change. .



Technology : Sensing and Measurement

- Enhance power system measurements and enable the transformation of data into information.
- Evaluate the health of equipment, the integrity of the grid, and support advanced protective relaying.
- Enable consumer choice and demand response, and help relieve congestion

Advanced Metering Infrastructure (AMI)

- Provide interface between the utility and its customers: **bi-direction control**
- Advanced functionality
  - **Real-time** electricity pricing
  - Accurate **load characterization**
  - **Outage detection/restoration**
- Smart meters:
  - Record usage information usually at 5, 15, 30 or 60 minute time intervals
  - Have a Home Automation Network **(HAN)** gateway
  - Include **Remote** connect/disconnect switch

Health Monitor: Phasor measurement unit (PMU)

- Measure the electrical waves and determine the health of the system.
- Increase the reliability by detecting faults early, allowing for isolation of operative system, and the prevention of power outages.

Distributed weather sensing

- Widely distributed **solar irradiance, wind speed, temperature measurement systems** to improve the predictability of renewable energy.
- The grid control systems can **dynamically adjust** the source of power supply.
- Effective tool for efficient power management

Wide Area Measurement System (WAMS)

- A network of PMUS that can provide **real-time monitoring** on a regional and national scale.

Technology : Communication and Security

Integrated Communications and Security

- High-speed, fully integrated, two-way communication technologies that make the smart grid a dynamic, interactive “mega-infrastructure” for real-time information and power exchange.
- Cyber Security: the new communication mechanism should consider security, reliability.

Wireless Sensor Network

- The challenges of wireless sensor network in smart grid
  - Harsh environmental conditions.
  - Reliability and latency requirements
  - Packet errors and variable link capacity
  - Resource constraints.
- The interference will severely affect the quality of wireless sensor network.

Communication Infrastructure

- System Integrators
- WAN Network
- LAN Network
- Data Storage Management and Analytics
- CRM

Other Advanced Components

Advanced Energy Storage

- New Battery Technologies to store electrical energy from sources like renewable sources or electric vehicle or grid.
- Will give power back to or take power from grid/electric vehicle depending on the power demand.

Distributed power flow control

- Power flow control devices clamp onto existing transmission lines to control the flow of power within.
- Transmission lines enabled with such devices support greater use of renewable energy by providing more consistent, real-time control over how that energy is routed within the grid.
- This technology enables the grid to more effectively store intermittent energy from renewables for later use.

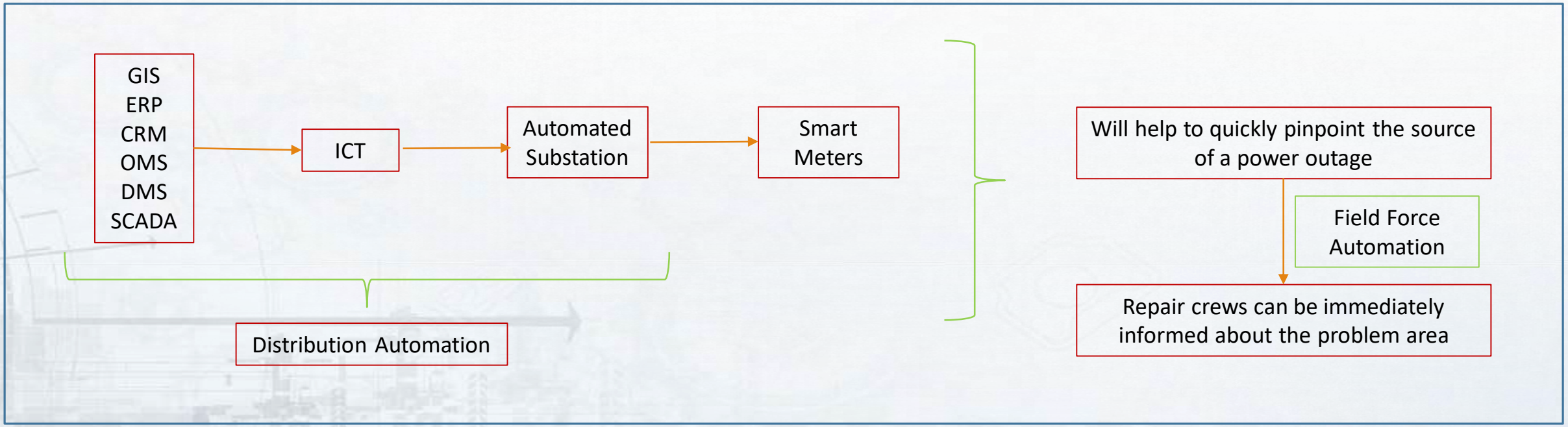
Advanced control

- Power system automation enables rapid diagnosis of and precise solutions to specific grid disruptions or outages.
- Advanced control methods are:
  - Distributed intelligent agents (control systems)
  - Analytical tools (software algorithms and high speed computers)
  - Operational applications (SCADA, substation automation, demand response, etc.)
  - Artificial intelligence programming techniques

DISTRIBUTION INTELLIGENCE

DISTRIBUTION INTELLIGENCE

Refers to a robust utility distribution System with automated feeders, switches, and transformers that connect the utility substation to the customers.



Eg. TPDDL has employed State-of-the-Art Outage Management System integrated with SCADA and GIS systems

DISTRIBUTION INTELLIGENCE

Helping the Grid Run More Efficiently and Reliably

Ability to Optimize the balance between real and reactive power	Employ Power Electronics
Protection and Control of Feeder lines	In addition to automated breakers and relays, will use sophisticated monitoring and control system to detect and correct faults
Accurate Power Forecasting	Use of distributed weather sensors, data from IT & OT systems, data from SLDC
Efficient Power Management	Integrated Data Management system, Software algorithms for scheduling and Merit order dispatch

Eg. TPDDL has developed in-house power management software "Power Manager" which forecasts power demand, does scheduling of power and manages power procurement on a real-time basis

CONSUMER ENGAGEMENT

Time-of-Day Programs – an initiative of Demand Side Management

- The demand for energy changes throughout the day.
- During peak energy usage,
  - Utilities sometimes have to bring less-efficient—and often more-polluting—power generation facilities on line or
  - Purchase power from neighboring utilities or
  - Purchase short-term power from power exchange

} Cost of Energy is increases

- Time-of-use rates encourage you to
  - **Use energy → when demand is low → at lower price for electricity → Distribute the demand more evenly**

- Home energy management systems will help in making the most of time-of-use pricing.
- Accessed with a home computer or hand-held mobile device, you will be able to see when prices are highest, which appliances use the most electricity, and even—at some point down the line—be alerted when prices go up, so you can remotely turn off unnecessary appliances until demand lowers and prices go back down.

RENEWABLE ENERGY

Net Metering

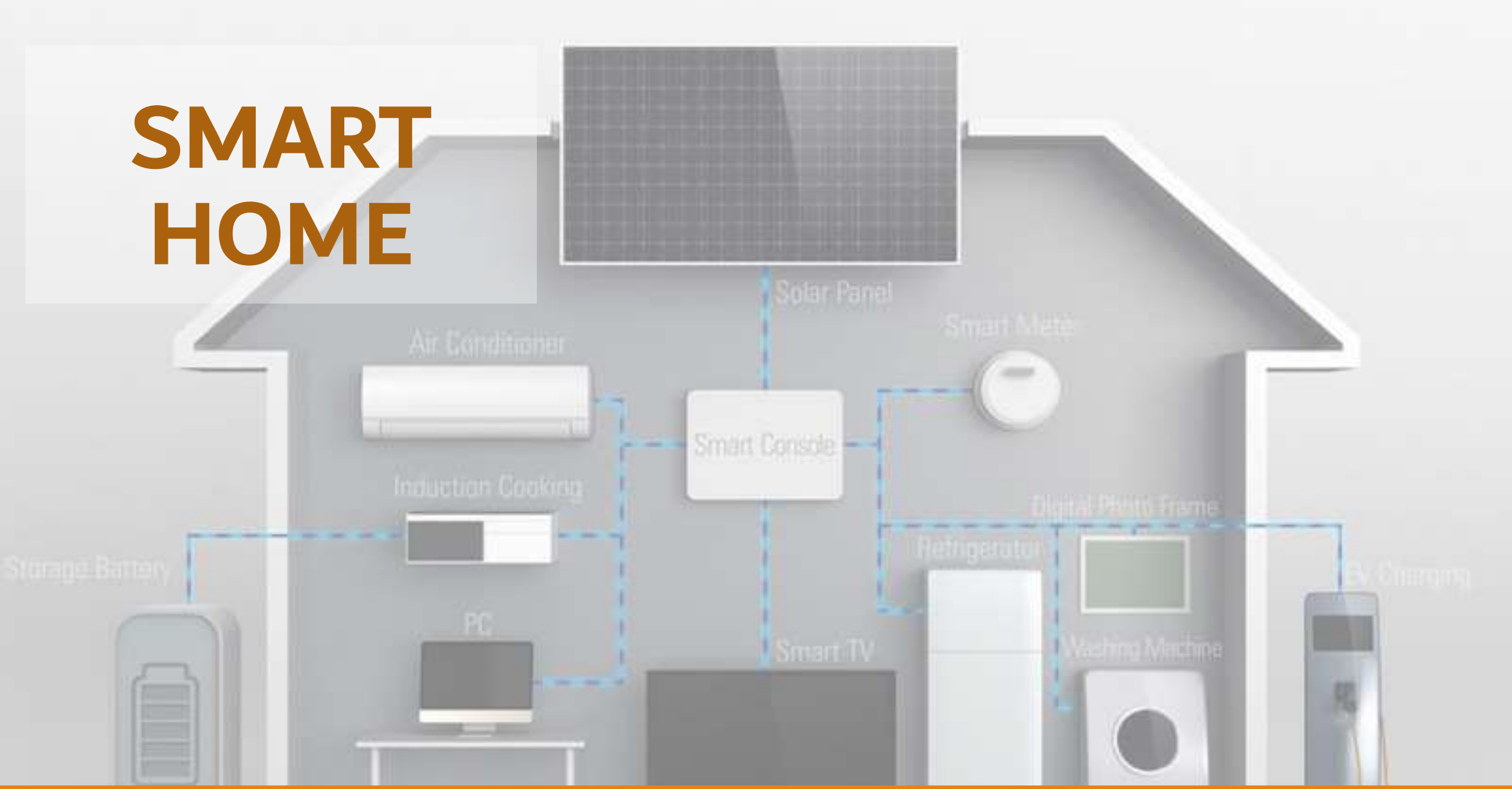
- Net metering involves the **use of a meter that can record the power flow to and back into the grid as a credit**.
- Consumers with Roof-top Solar power systems can now accumulate credits for excess power generation—that is, power fed into the grid from their home power systems—on a monthly basis.
  - **Excess power at the end of the year → Get paid by the Utility**
- The Smart Grid will enable enhancements to these net metering programs. *For instance,*
  - *Power Generated during peak power demand → Utility might pay more*
  - *Power Generated during off-peak power demand → Utility might pay less*
- Will encourage home generators to minimize their energy use during times of peak demand so they can maximize the amount of power fed onto the grid.

Demand Response

- Consumers will be compensated for taking off their load during times of peak demand.
- They can do so using their smart meters and Home Energy Management systems.

- Integrate the power supply from solar and wind plants
- Grid operators new tools to reduce power demand quickly when wind or solar power dips
- Energy storage will help to smooth out the variability in wind and solar resources, making them easier to use.

SMART HOME


Solar Panel
Air Conditioner
Smart Meter
Smart Console
Induction Cooking
Digital Photo Frame
Refrigerator
Storage Battery
EV Charging
PC
Smart TV
Washing Machine

SMART HOME

Smart Meters

- Provide the Smart Grid interface between you and your energy provider.
- Operate digitally
- Allow for automated and complex transfers of information
- Help you cut your energy costs.
- Give greater information about how much electricity is being Consumed

Home Energy Management Systems

- Allows to view on computer or hand-held device, connected to a Home Automation Network (HAN)
- Allows to track energy use in detail
- Shows the energy impact of various appliances while switching the devices on and off
- Allows to monitor real-time information and price signals from your utility and create settings to automatically use power when prices are lowest
- Help to balance the energy load in your area

Smart Appliances

- Certain appliances will be networked together, to be accessed and operated through EMS, remotely.
- Smart appliances will also be able to respond to signals from energy provider to avoid using energy during times of peak demand (Though this is more complicated than a simple on and off switch)

Home Power Generation

  - **Rooftop solar electric systems**
  - **Small wind turbines**
  - **Home fuel cell systems, which produce heat and power from natural gas.**
- The Smart Grid will effectively **connect all these mini-power generating systems to the grid**,
- Will allow a community to use neighbour's solar array to keep the lights on even when there is no power coming from a utility **(Islanding).**

PLUG-IN ELECTRIC VEHICLE

PLUG-IN Electric Vehicle (PEV)

In the future, PEVs may play an important part in balancing the energy on the grid by serving as distributed sources of stored energy, a concept called **"vehicle to grid – batteries in motion"**

By drawing on a multitude of batteries plugged into the Smart Grid throughout its service territory, a utility can potentially inject extra power into the grid during critical peak times, avoiding brownouts and rolling blackouts.

PEVs also have the potential to help keep isolated parts of the grid operating during blackouts.

They could also help integrate variable power sources into the grid, including wind and solar power

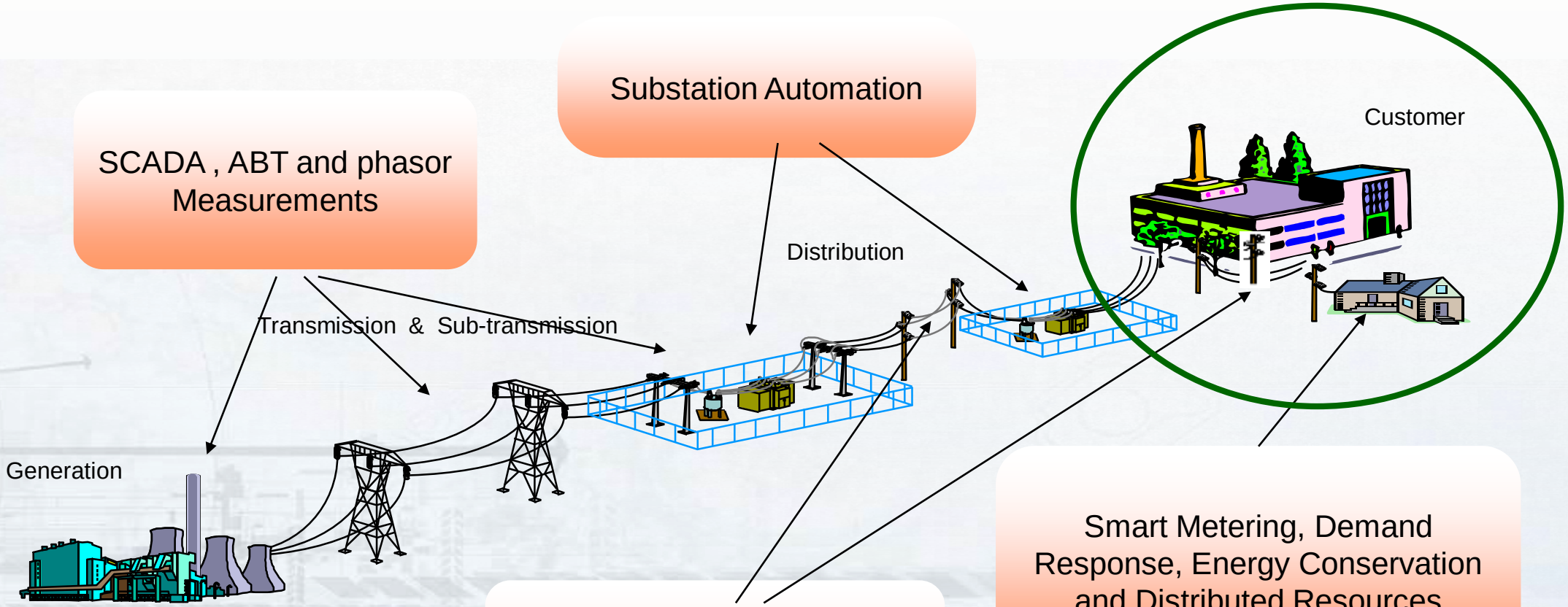
Enabling a Charging Infrastructure for PEVs

With the Smart Grid, PEVs can identify themselves to the charging station when they are plugged in, and the electricity used can be automatically billed to the owner's account.

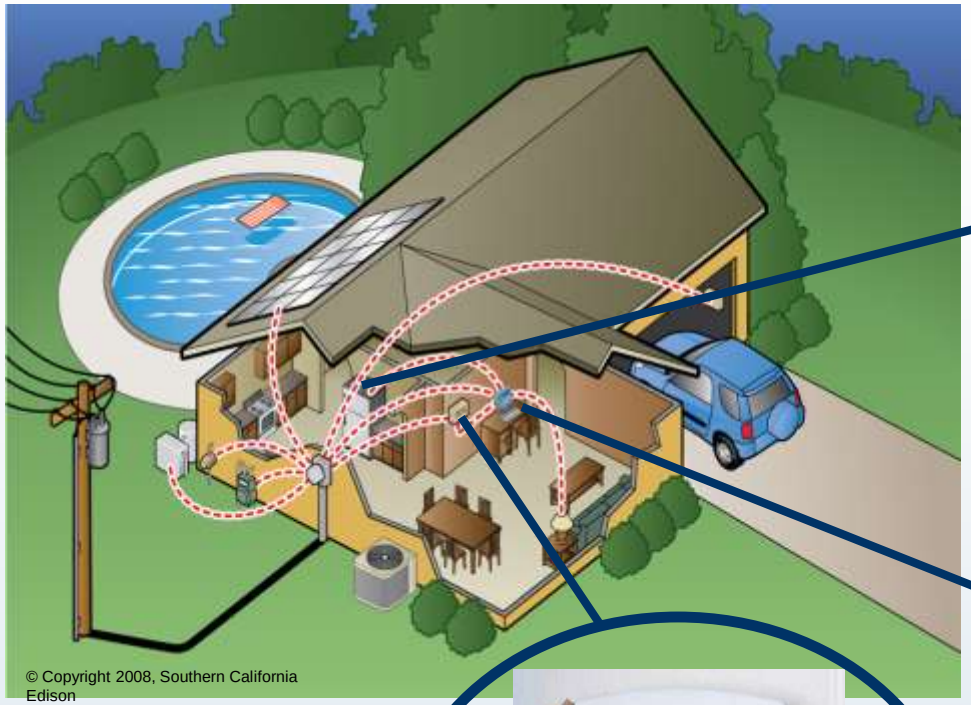
Smart Grid technologies using sophisticated software will assure that Plug-in EV is still fully charged and ready to go when you need it.

And you'll still be able to demand an immediate recharge when you need it.

Smart Grid – Pictorial representation

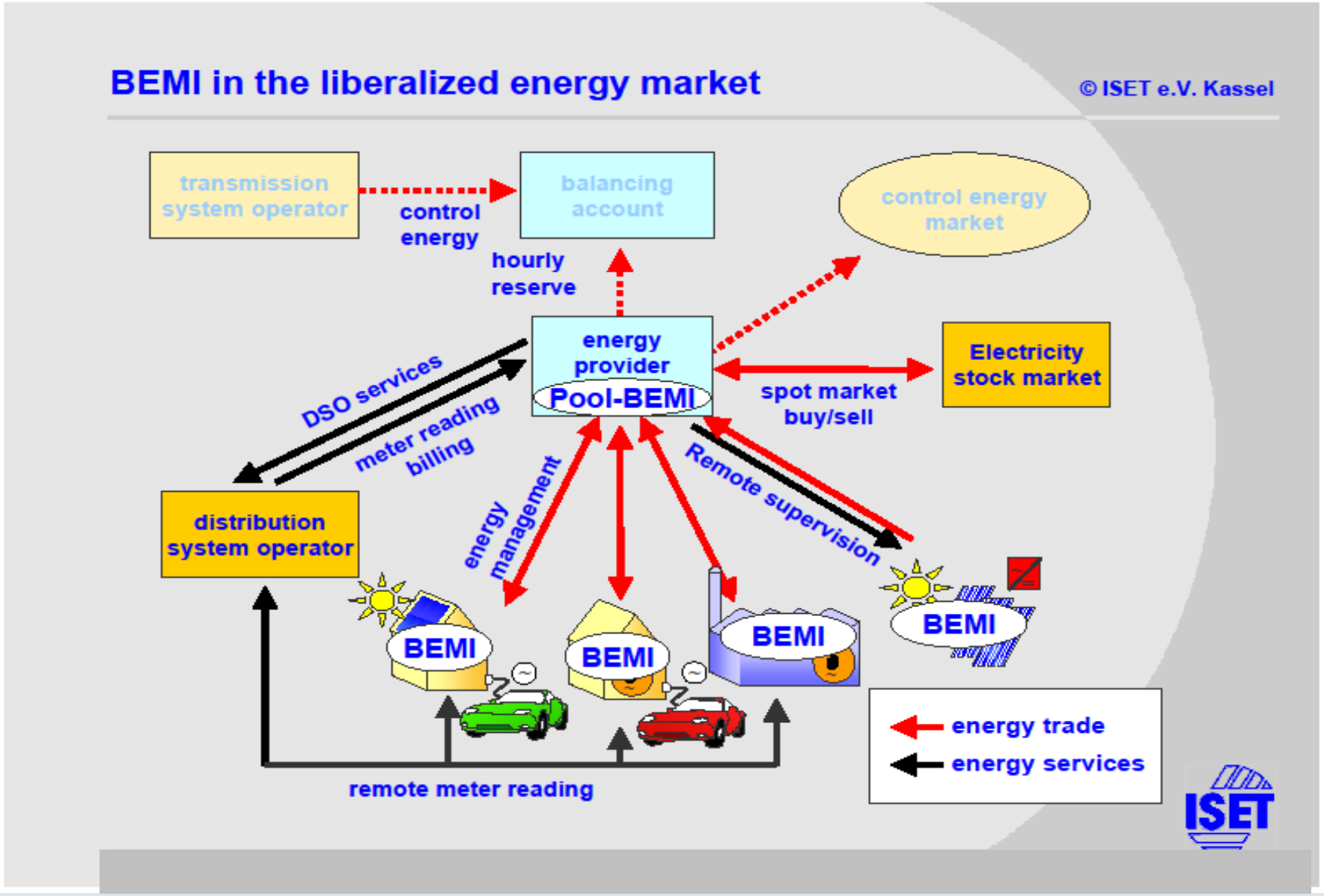


Smart Home– Pictorial representation



Customer enabled automated response through energy-smart appliances

Improved load management through Edison SmartConnect technologies


BEMI in the liberalized energy market
© ISET e.V. Kassel
transmission system operator
control energy
balancing account
control energy market
hourly reserve
energy provider
Pool-BEMI
Electricity stock market
spot market buy/sell
DSO services
meter reading billing
distribution system operator
energy management
Remote supervision
BEMI
BEMI
BEMI
BEMI
remote meter reading
energy trade
energy services
ISET

SMART CITIES MISSION – Concept by MoUD

E-Governance and Citizen Services

1. Public Information, Grievance Redressal
2. Electronic Service Delivery
3. Citizen Engagement
4. Citizens - City's Eyes and Ears
5. Video Crime Monitoring

Waste Management

6. Waste to Energy & fuel
7. Waste to Compost
8. Waste Water to be Treated
9. Recycling and Reduction of C&D Waste

Water Management

10. Smart Meters & Management
11. Leakage Identification, Preventive Maint.
12. Water Quality Monitoring

Energy Management

13. Smart Meters & Management
14. Renewable Sources of Energy
15. Energy Efficient & Green Buildings

Urban Mobility

16. Smart Parking
17. Intelligent Traffic Management
18. Integrated Multi-Modal Transport

Others

19. Tele-Medicine & Tele Education
20. Incubation/Trade Facilitation Centers
21. Skill Development Centers

Power Distribution Reforms Scheme – Baseline for SMART Cities

Sr. No	Cities Covered (out of 98)	Scheme Functionalities	Status	Key Concern
R-APDRP (Part-A) – IT	98	**CRM, Billing, Web-Self-Service, GIS**	Systems are rolled out in most of the cities	**Systems are not being used, GIS data is getting redundant.**
R-APDRP (Part-A) – SCADA	66	**SCADA/DMS**	Only 6-7 towns SCADA system has been rolled out	**Systems are not Operational due to delay in Field enabler equipments, which are to be installed in other scheme.**
IPDS	98	**Network Strengthening, SMART Metering, ERP**	Majorly Network Strengthening is being covered	**Smart metering / ERP Funding is not envisaged by Discoms**
National Smart Grid Mission	2	**AMI, Sub-station Automation and OMS**	Work in Progress or in Tendering	**Only 30% is grant, hence not many utilities are approaching NSGM**

In-experience of Utility Staff on SMART Grid Technologies is the major concern.

INDIA'S FIRST 20 SMART CITIES

Estimated Investment for Smart Grid in 20 Smart Cities (~ Rs. 6500 Crs.)

AMI and PLM (Rs. 4000 Crs.)	Sub-station Automation (Rs. 1000 Crs.)	SCADA/DMS (Rs. 200 Crs.)
EV Charging System (4 per City) (Rs. 120 Crs.)	GIS Management (Rs. 50 Crs. per annum)	24X7 Call Center (Rs. 10 Crs. per annum)
Multi-Function Mobile App (Rs. 5 Crs.)	ERP (only city portion) (Rs. 100 Crs.)	Storage System (5 MW /City) (Rs. 800 Crs.)

Implementation of each SMART City will be through SPV comprising State, Urban Local Bodies and Private Party Equities.

Above estimation is in addition of investment planned under R-APDRP / IPDS

Country Readiness for SMART Grid Systems (First 20 Cities)

Sr. No	State	Smart Cities	Infrastructure and Asthetics						Digital Experience							
			Baseline Reliable Network	O/H to U/G Network	LED Streetlight System with CCMS	EV Charging System	Distributed Energy Resources	Storage System	Network Automation (SCADA/DMS)	CRM and Billing System	GIS System	OMS System	AMI	ERP	24X7 Call Center	Multi-Function Mobile App
1	Odisha	Bhuvneshwar														
2	Maharashtra	Pune														
3	Rajasthan	Jaipur														
4	Gujarat	Surat														
5	Kerala	Kochi														
6	Gujarat	Ahmedabad														
7	MP	Jabalpur														
8	AP	Vijag														
9	Maharashtra	Solapur														
10	Karnataka	Devnagree														
11	MP	Indore														
12	New Delhi	New Delhi														
13	Tamil Nadu	Coimbatore														
14	AP	Kakinada														
15	Karnataka	Belgaum														
16	Rajasthan	Udaipur														
17	Assam	Guwahati														
18	Tamil Nadu	Chennai														
19	Punjab	Ludhiana														
20	MP	Bhopal														

System is partially implemented or not functional | **System to be planned** | **System Available**

Thank You

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