

ROLE OF ICT IN OPTIMAL MANAGEMENT OF SMART BUILDINGS, SMART CITIES & SMART GRIDS



Keynote Speech

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PPT slides are available at
www.srahman.org

The Smart Grid Ecosystem

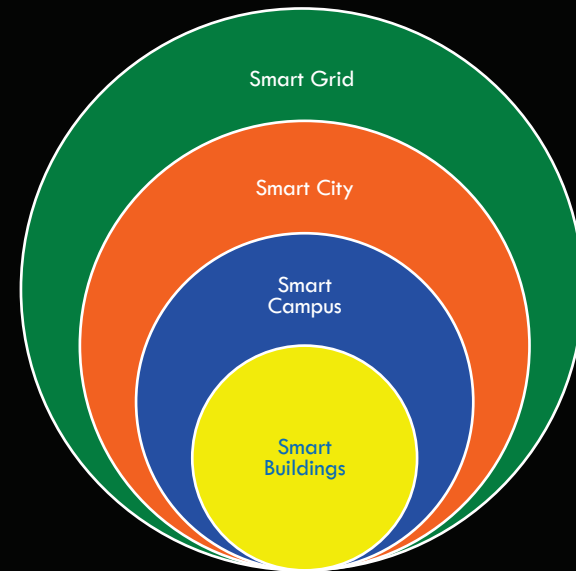
Smart grid: Bi-directional flows of energy, remote control/automation of power, integrated distributed energy...

Smart city: Complex system of interconnected infrastructures and services...

Smart Campus: A collection of buildings managed by the same facility manager...

Smart buildings: Intelligent building automation systems, smart devices, productive users, grid integration...

Ecosystem



Supported by ICT and distributed networks of intelligent sensors, data centers/clouds

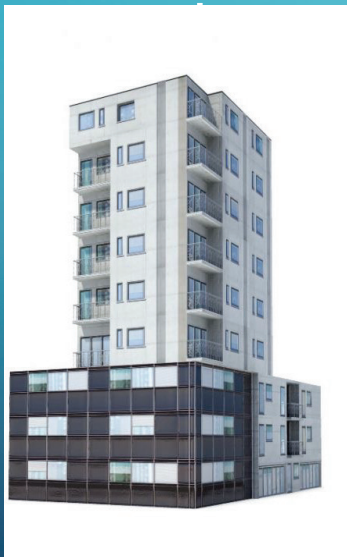
What makes a Building Smart



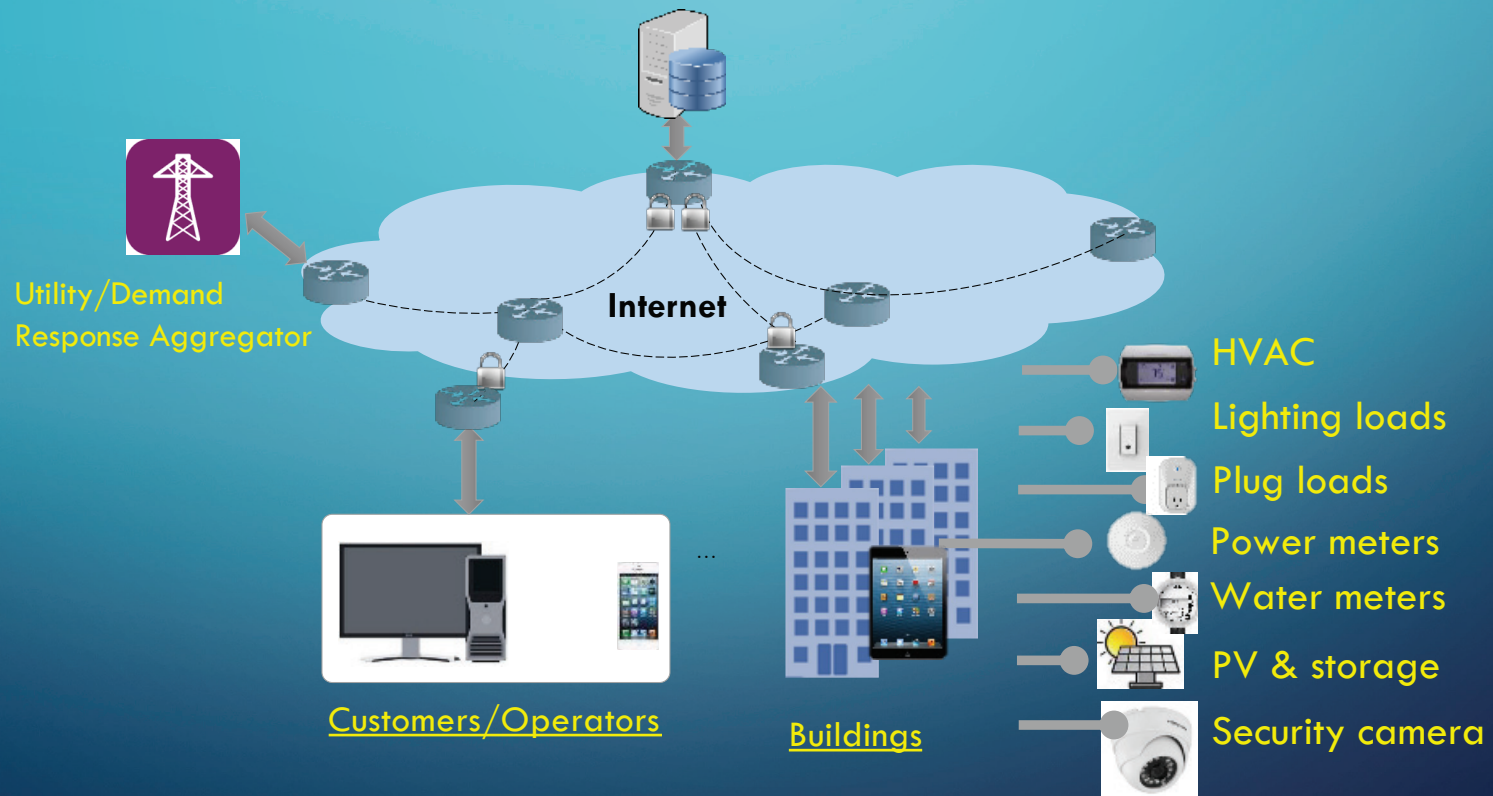
A single platform for monitoring and control of HVAC, lighting, water supply, sensor networks, security camera & fire emergency

Source: Smart Building Market To Grow 30% by 2020, <http://www.iotsolutionprovider.com/smart-building/smart-building-market-to-grow-30-by-2020>, December 2015.

An Open-Architecture Platform for IoT Device Integration in a Smart Building



Smart Campus Management using the Cloud



Building Blocks of a Smart City



Range of Deployments in Smart Cities

Cities across the world are deploying technology to gather data trying to become cleaner, reduce traffic, and improve urban life. Starting with **energy management**, to **disaster preparedness**, to **public safety**, to **parking spot assistance**, to **paying bills online**, to **facilitate emergency vehicle movement**, and much more.

Elements of a Smart City

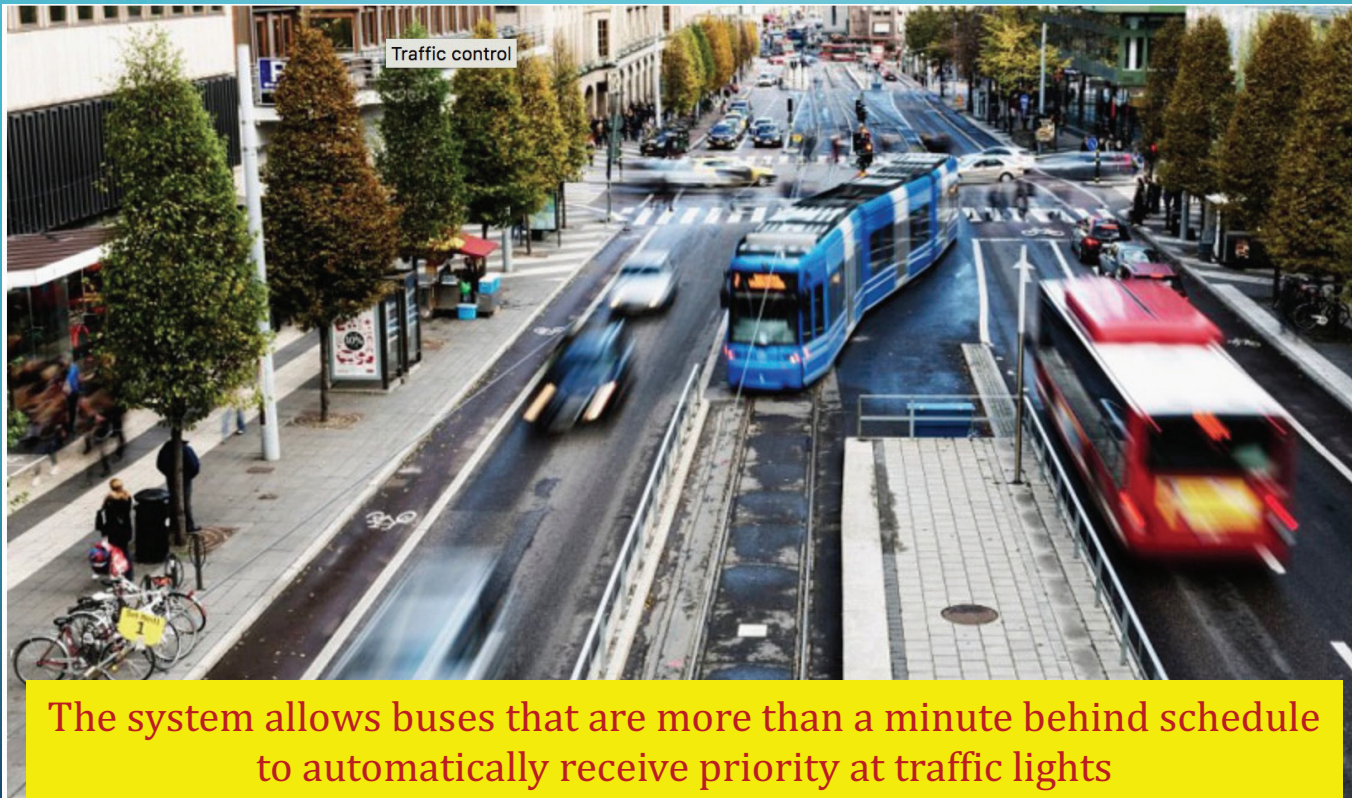


A neighborhood in a smart city:

- A smart traffic crossing sensitive to traffic volume
- Synchronized traffic lights for smooth flow
- Emergency vehicle priority access

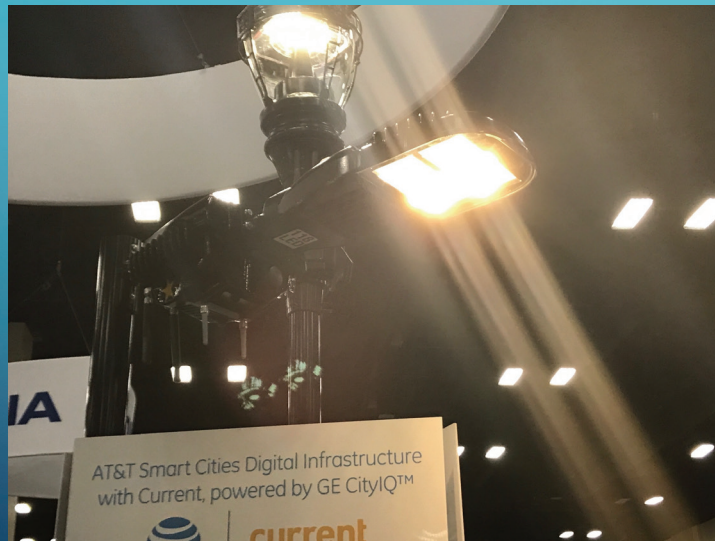


Stockholm City Traffic Management



US Deployment: Smart Lamppost with Camera

Camera provides surveillance and locates empty parking spaces

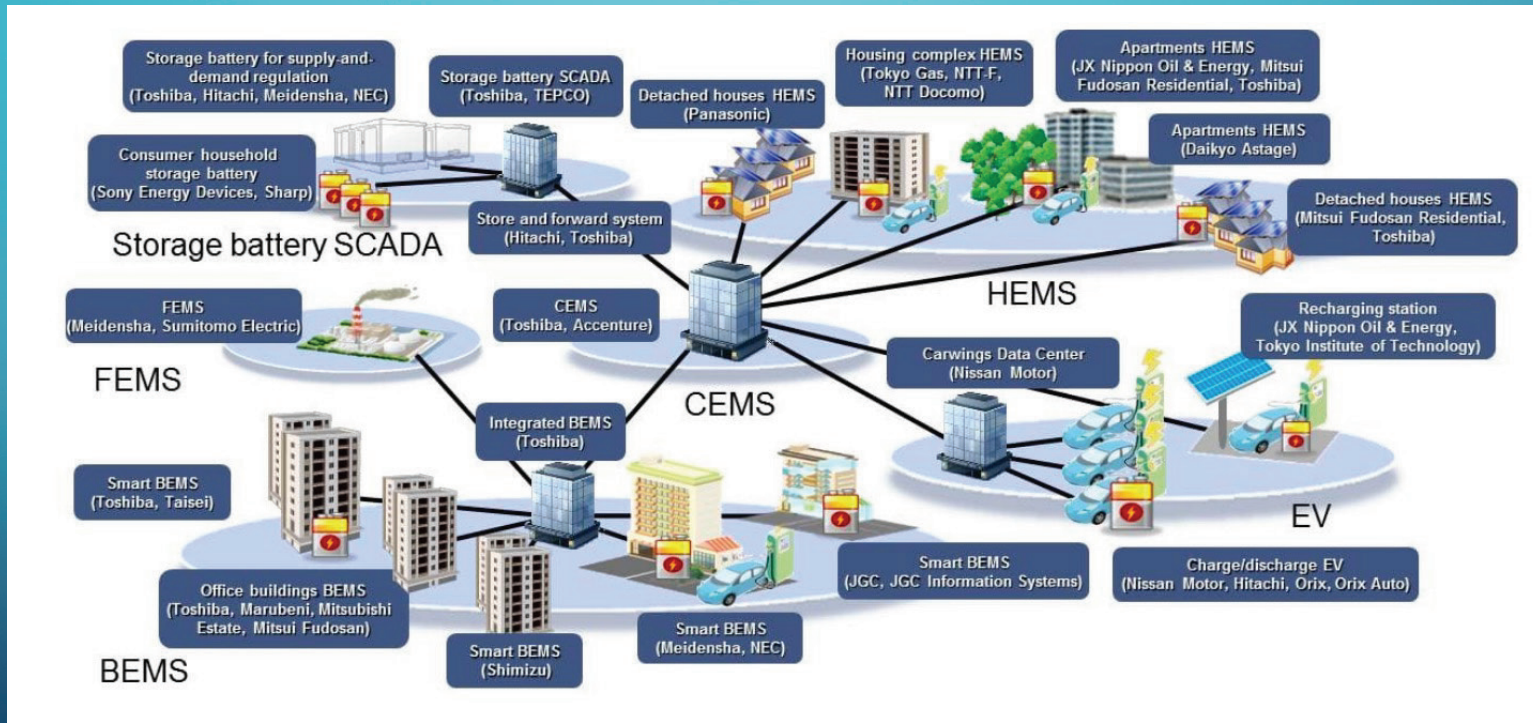


Smart Trash Can in Stockholm, Sweden



Regular trash cans need to be emptied 1-3 times per day
Smart ones only need to be emptied four times a week.

Smart City Demonstration Yokohama, Japan



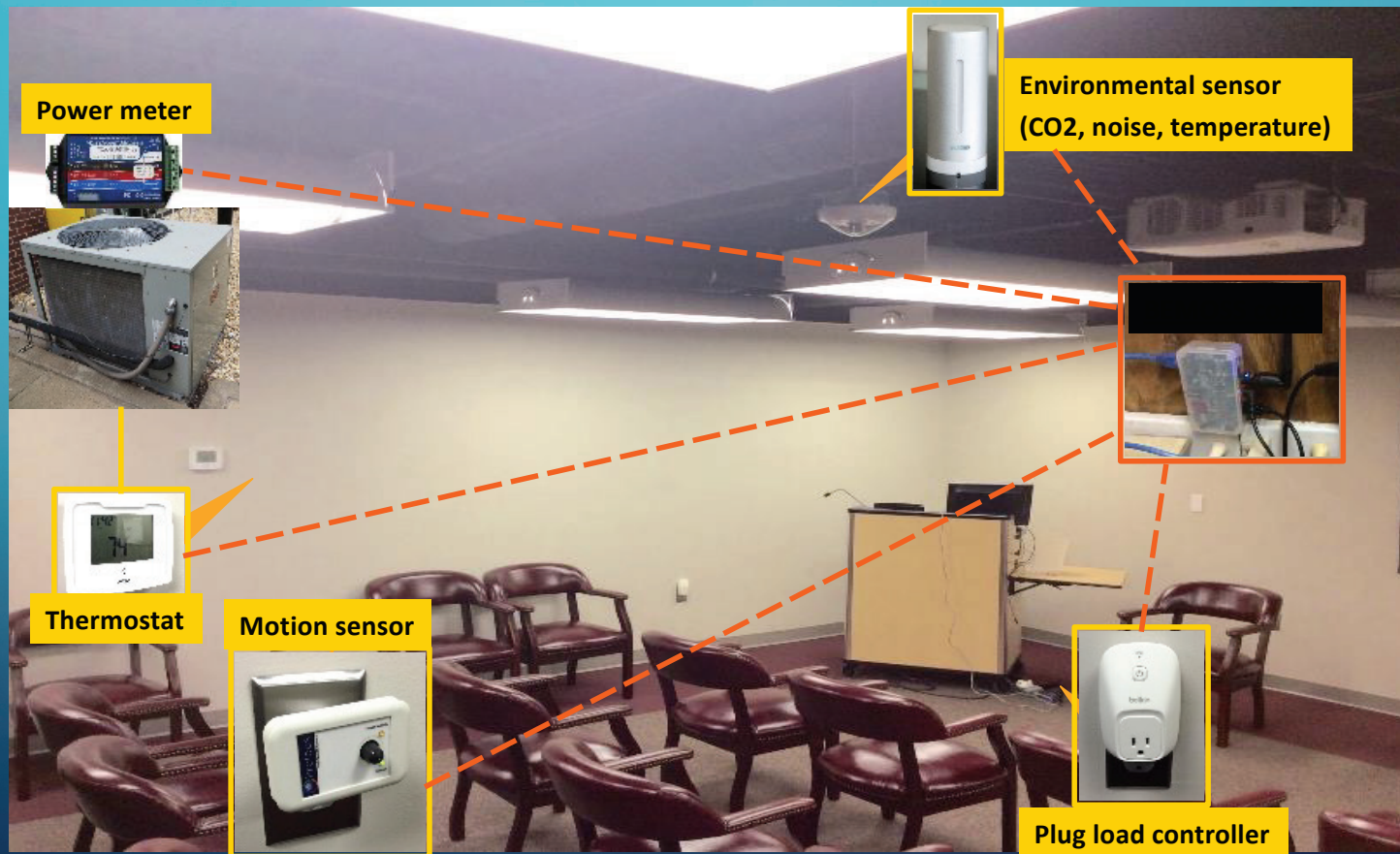
Field Implementation Examples

Academic Building in Alexandria, Virginia

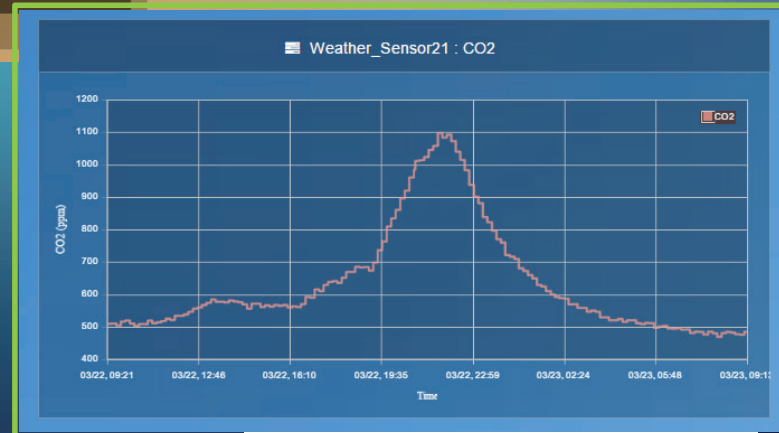
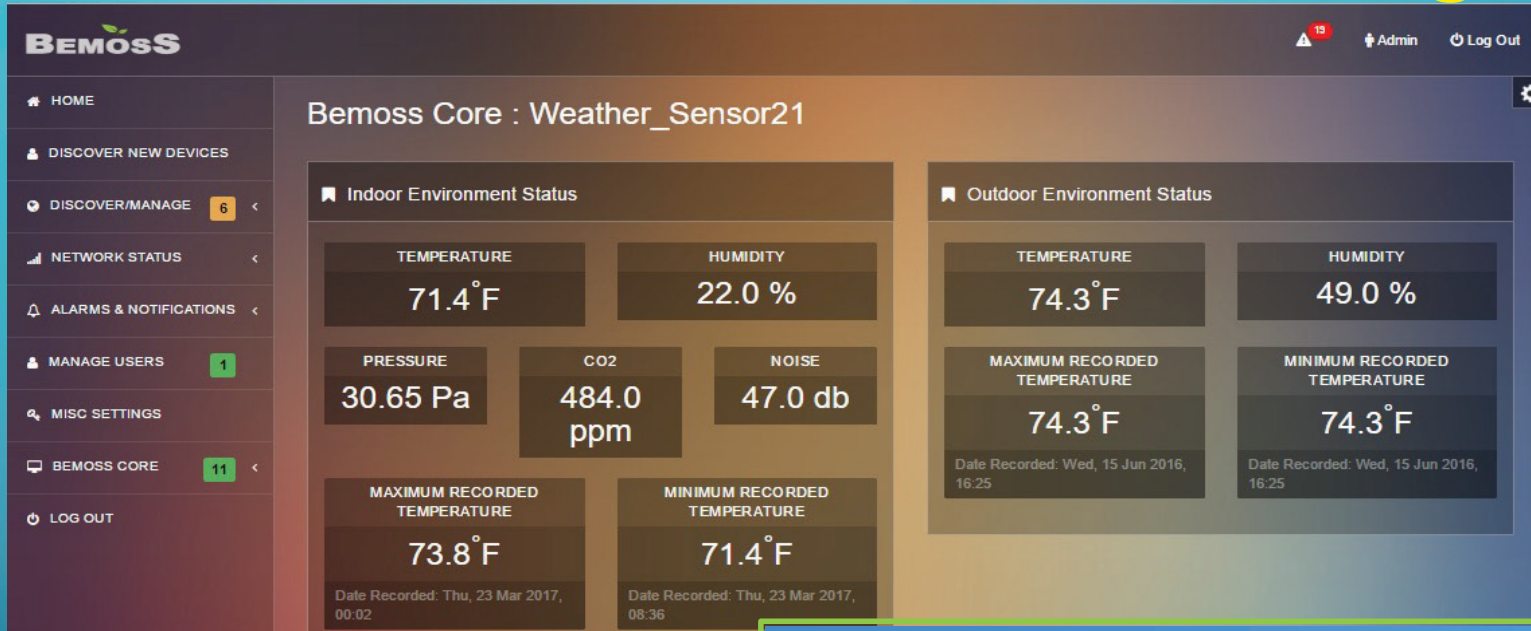


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Classroom under Real-time Monitoring and Control



Indoor Environmental Monitoring



Energy Savings from Air Conditioning Control

Summer Months (June-July-August)	
Compressor consumption 2014 (Before Control)	8,340 kWh
Compressor consumption 2016 (After Control)	6,071 kWh
Average savings	26.8% savings

Office Building, Arlington, Virginia



Lighting Intensity Control



Energy Savings by Controlling Lighting Intensity

Based on occupant requirements, light intensity level was reduced during October – December 2016. Results indicate **the average kWh savings of about 34%**.

Month	Total Measured Energy Consumption (kWh)	Total Calculated Energy Consumption without Dimming (kWh)	Energy Savings by Dimming (%)
October 2016	264.37	399.90	33.89%
November 2016	278.13	423.78	34.37%
December 2016	280.76	426.40	34.16%
Total (October-December)	823.26	1250.08	34.14%

Note: Scheduled dimming level from 6:30am to 9:00pm. Open office area A: 50%; Open office area B: 45%; Chief office's desk area: 60%; Chief office's meeting area: 50%; Conference room A: 50%; Conference room B: 45%. Lights are off after 9:00pm.

Electricity Savings in Street Lighting



HPS vs LED

Existing HPS Lamps
(Dec 2010)



New LED Lamps
(June 2012)

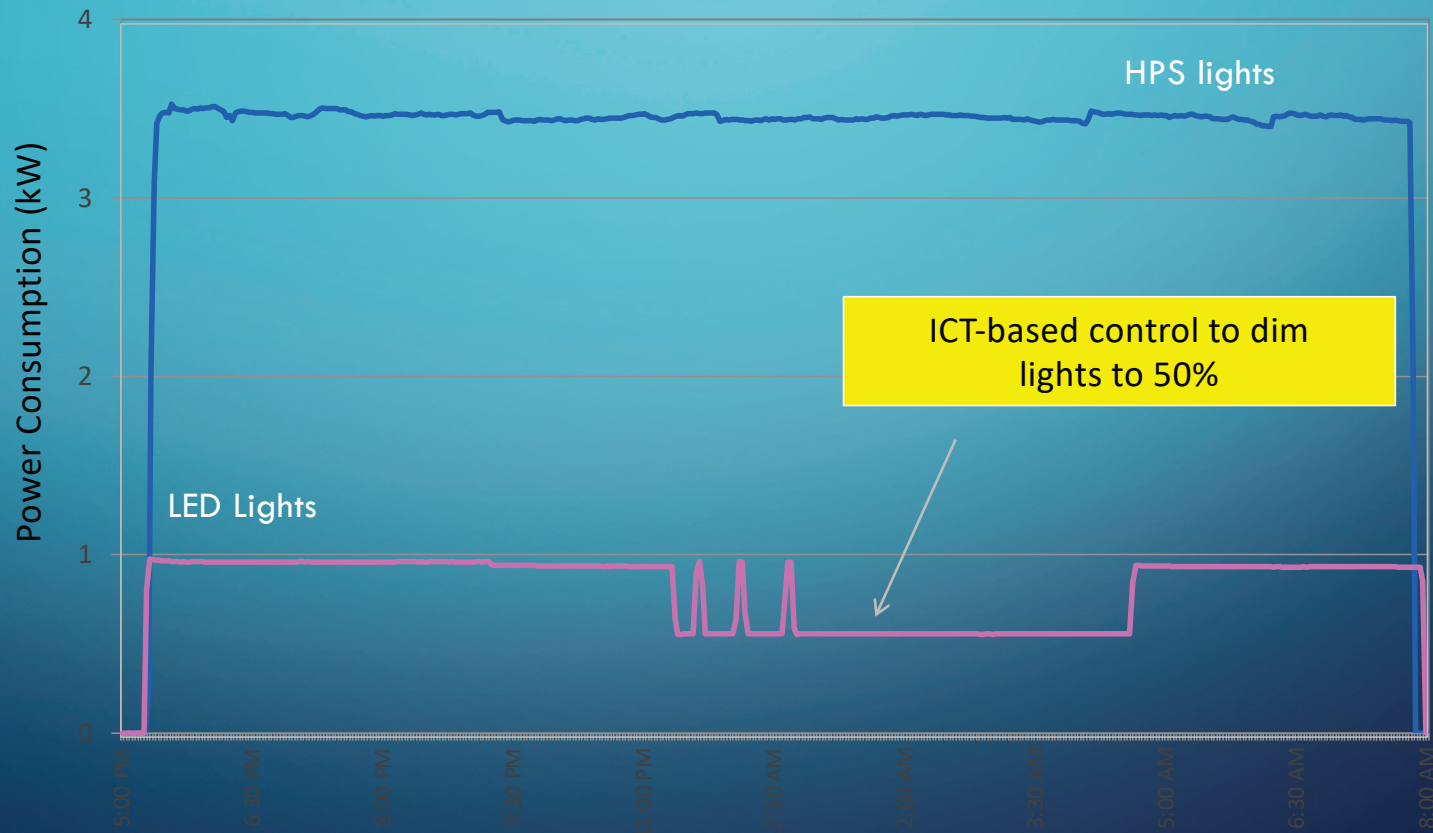


People/cars are clearly visible under the white LED light.

ICT-based Lighting Intensity control

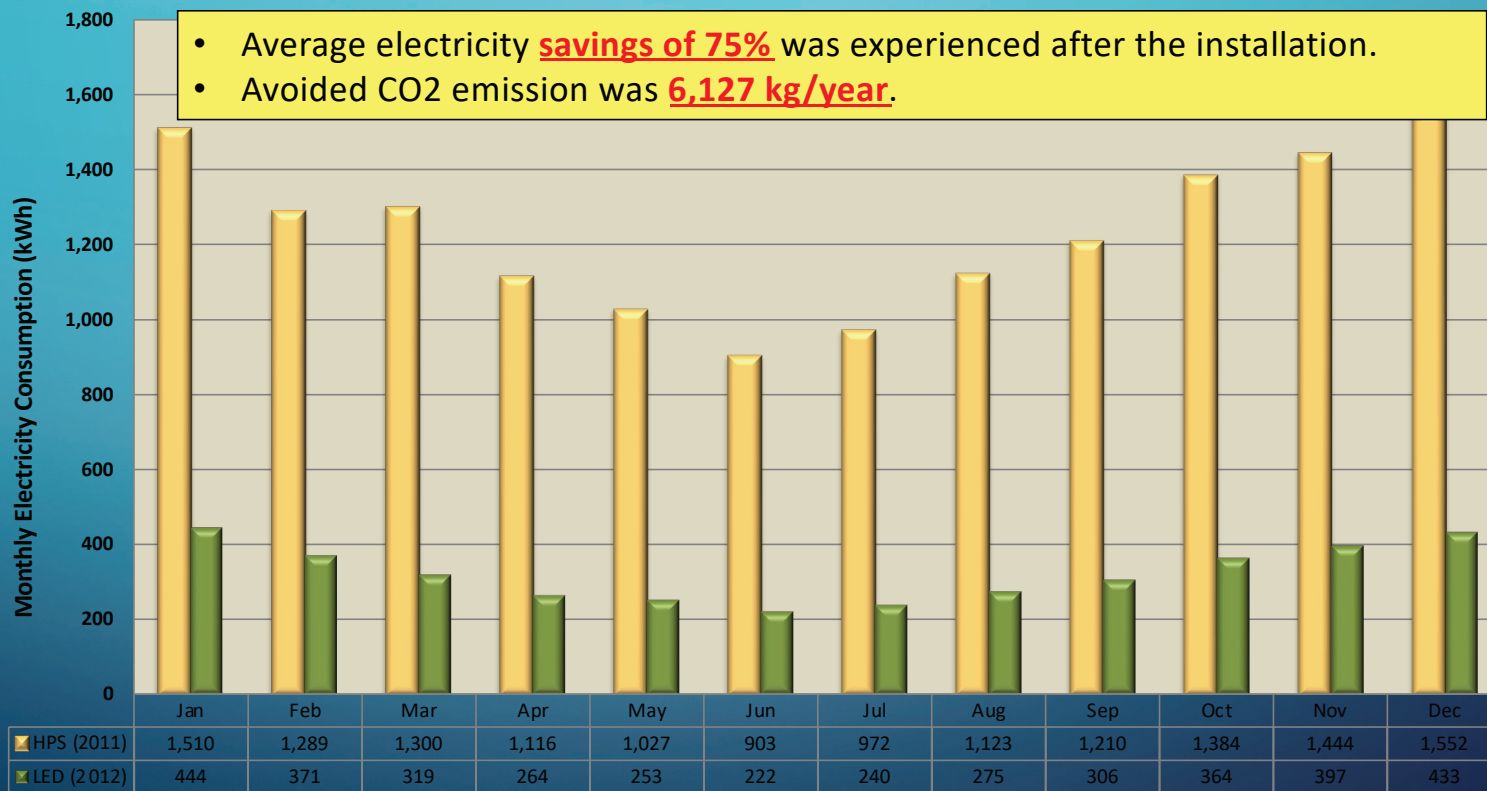


Infrared Sensors to Monitor Traffic



HPS vs LED

Monthly Electricity Consumption

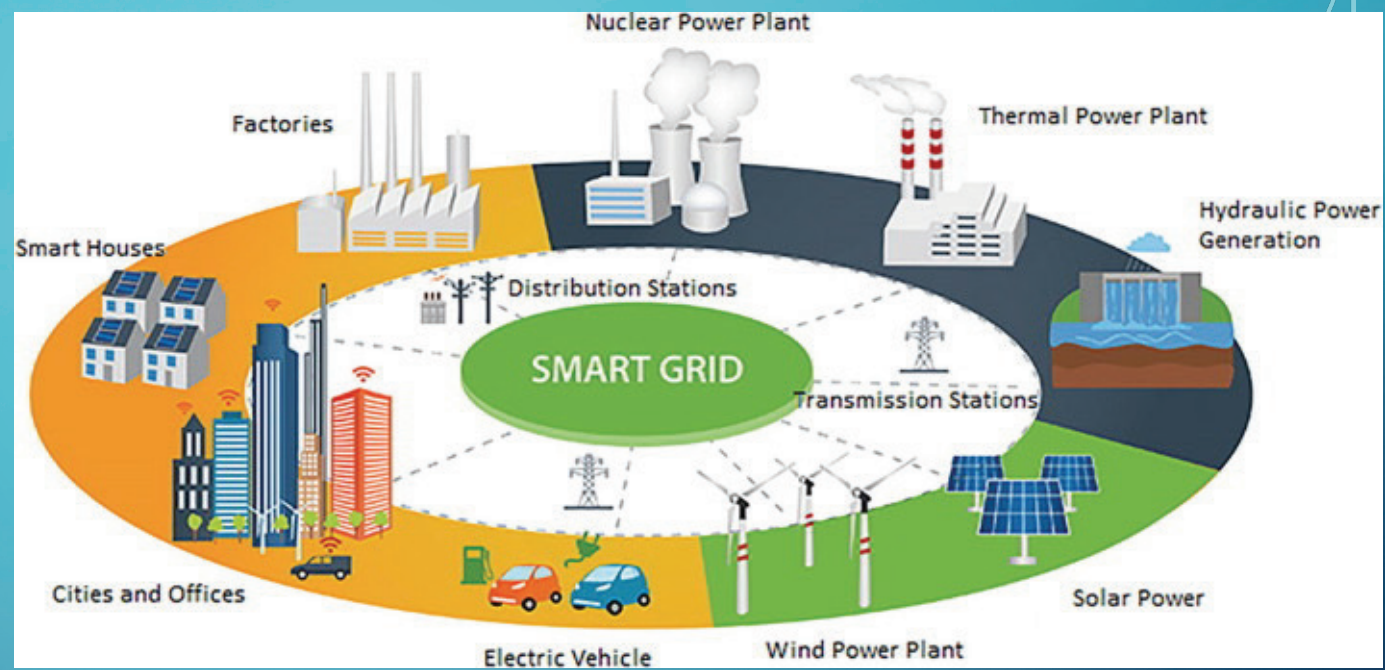


Changing Landscape
for the Electric Utility

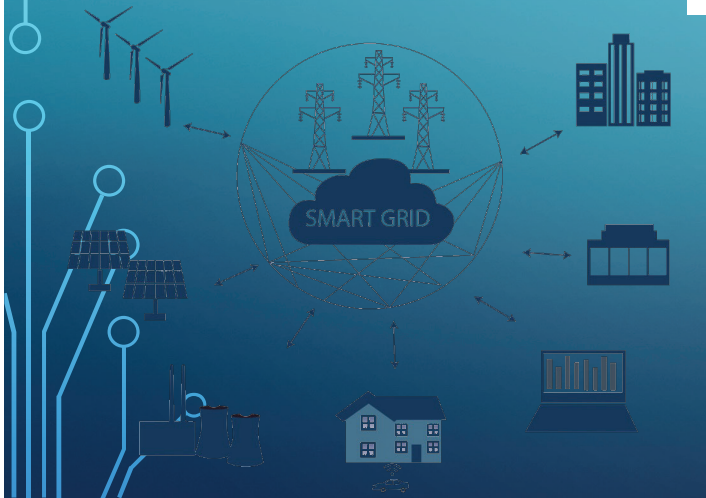


How Can the Smart Grid Help ?

What is a Smart Grid

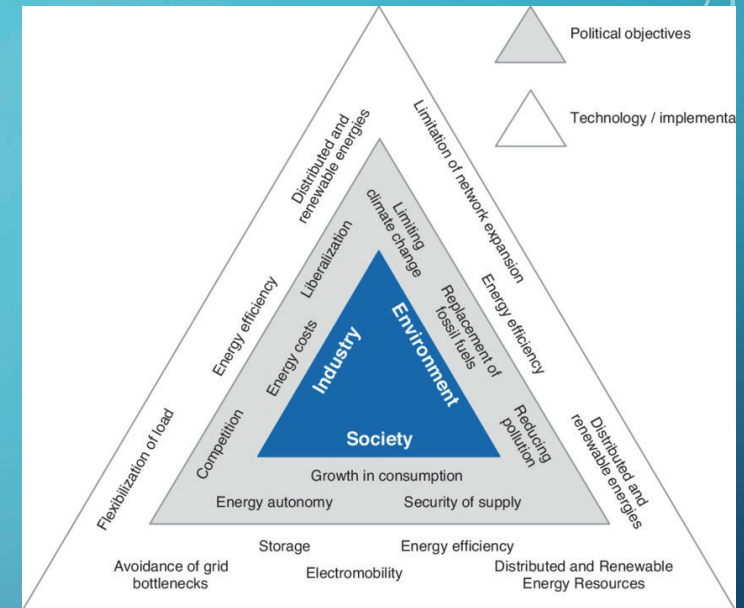


"Smart grid" is a concept with many elements where monitoring and control of each element in the chain of generation, transmission, distribution and end-use allow the electricity delivery and use to be more efficient.

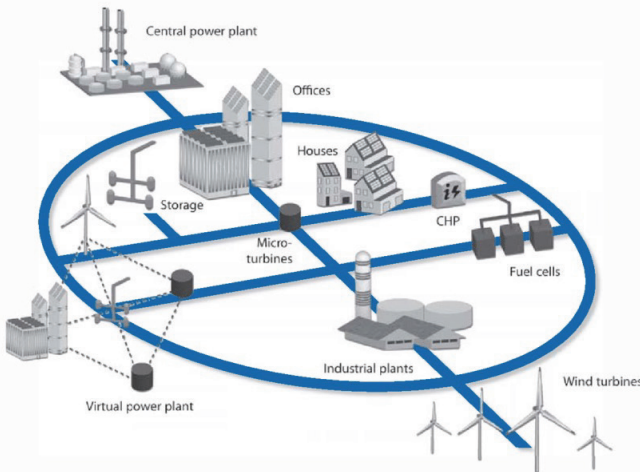


Motivation for a Smart Grid

Motivation for a Smart Grid on the basis of the energy management triangle - political objectives and technical implementation.



https://www.researchgate.net/figure/Motivation-for-a-Smart-Grid-on-the-basis-of-the-energy-management-triangle-political_fig1_263264024



Desire to make the grid smarter, safer, reliable and more cost-effective using advanced sensors, communication technologies and distributed computing.

Difference Between a Normal Grid and a Smart Grid



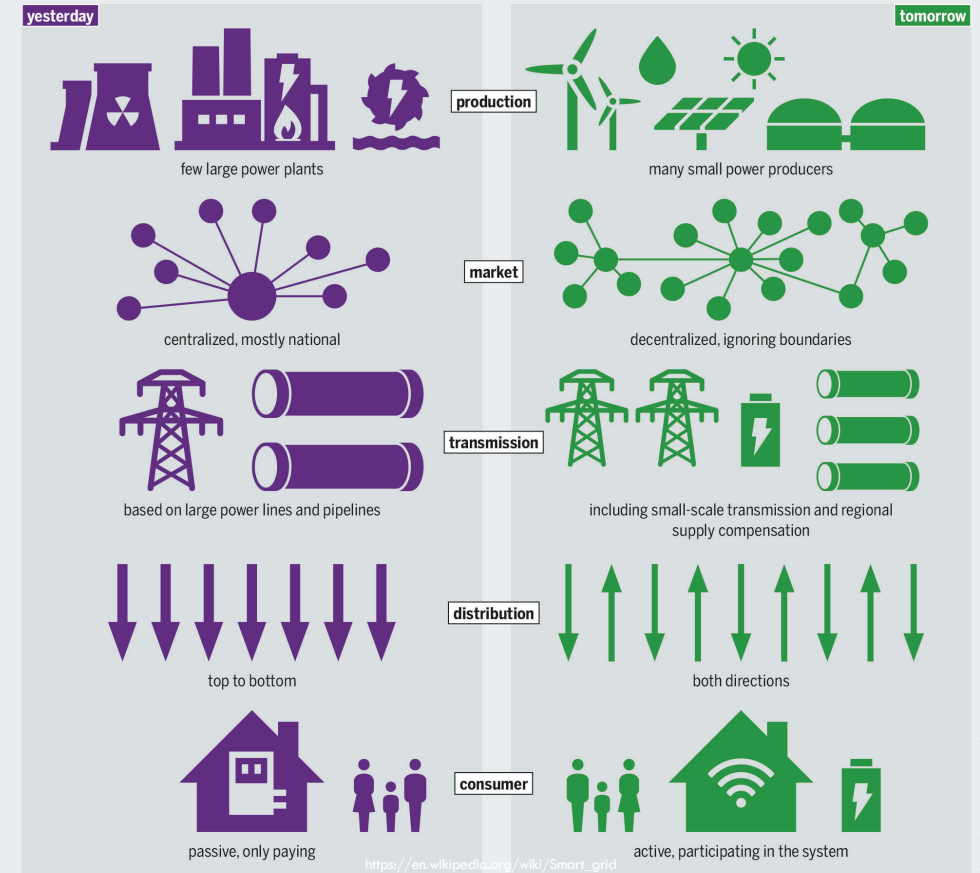
Normal Phone



Smart Phone

STAYING BIG OR GETTING SMALLER

Expected structural changes in the energy system made possible by the increased use of digital tools



Starting and End Points of a Smart Grid

It starts at the Generator and ends at the Refrigerator



Power Plant



Transmission



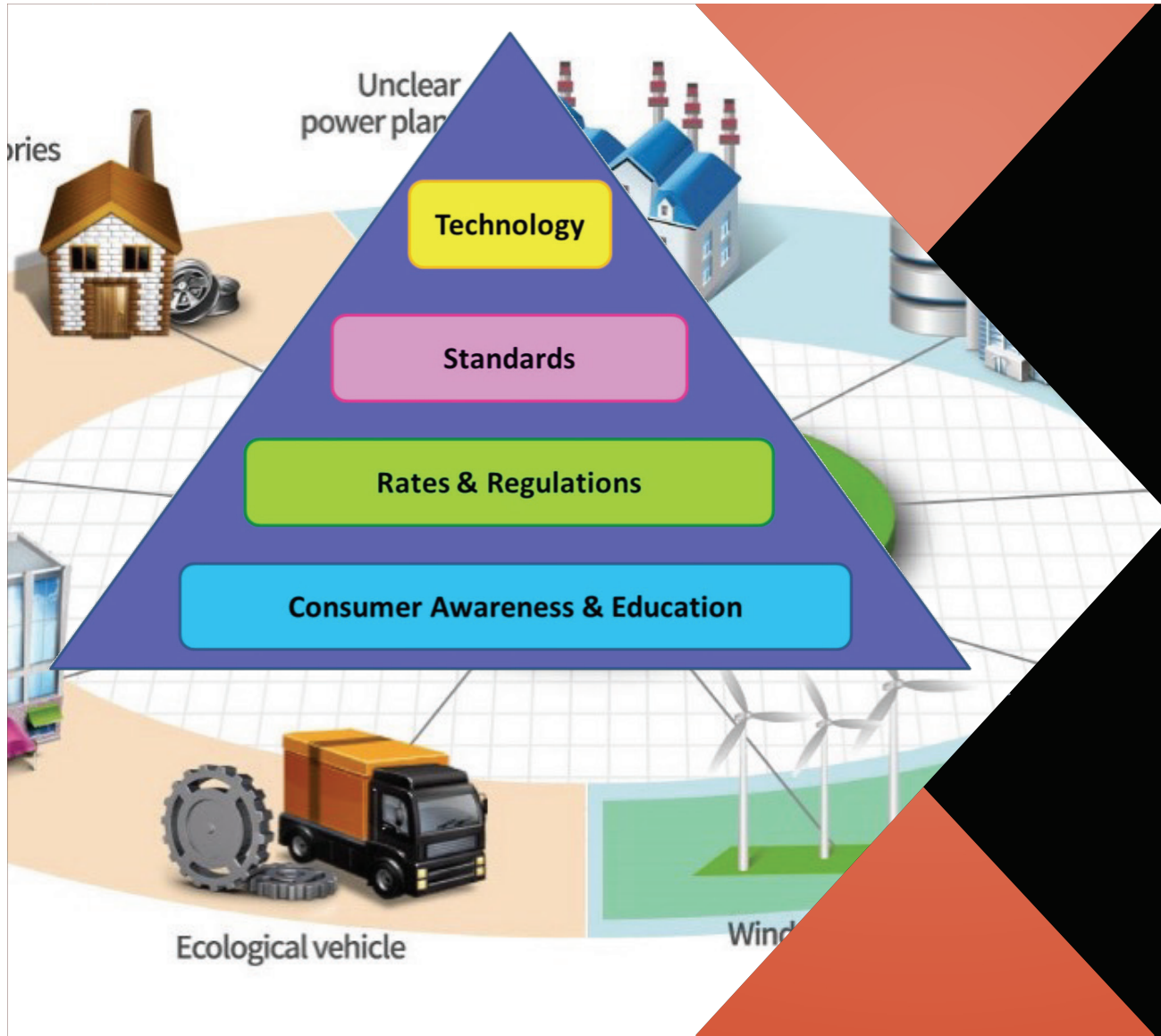
Distribution



Home Business



End-use Appliances



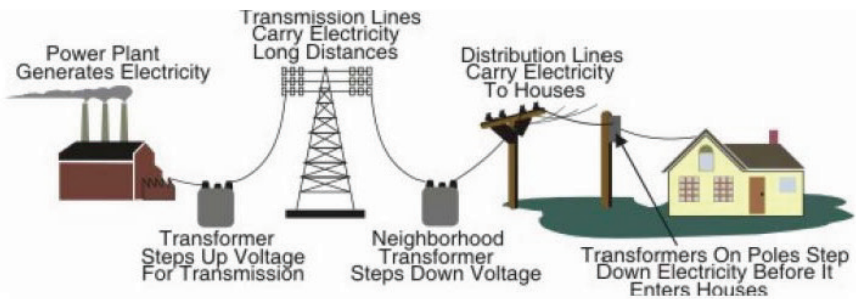
Smart Grid Building Blocks

Evolution of the Grid

Smart Grid

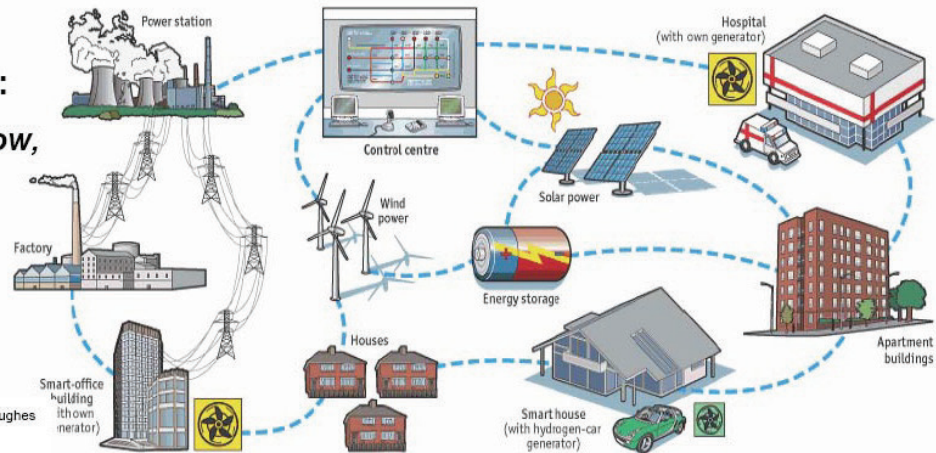
Before Smart Grid:

*One-way power flow,
simple interactions*



After Smart Grid:

*Two-way power flow,
multi-stakeholder
interactions*



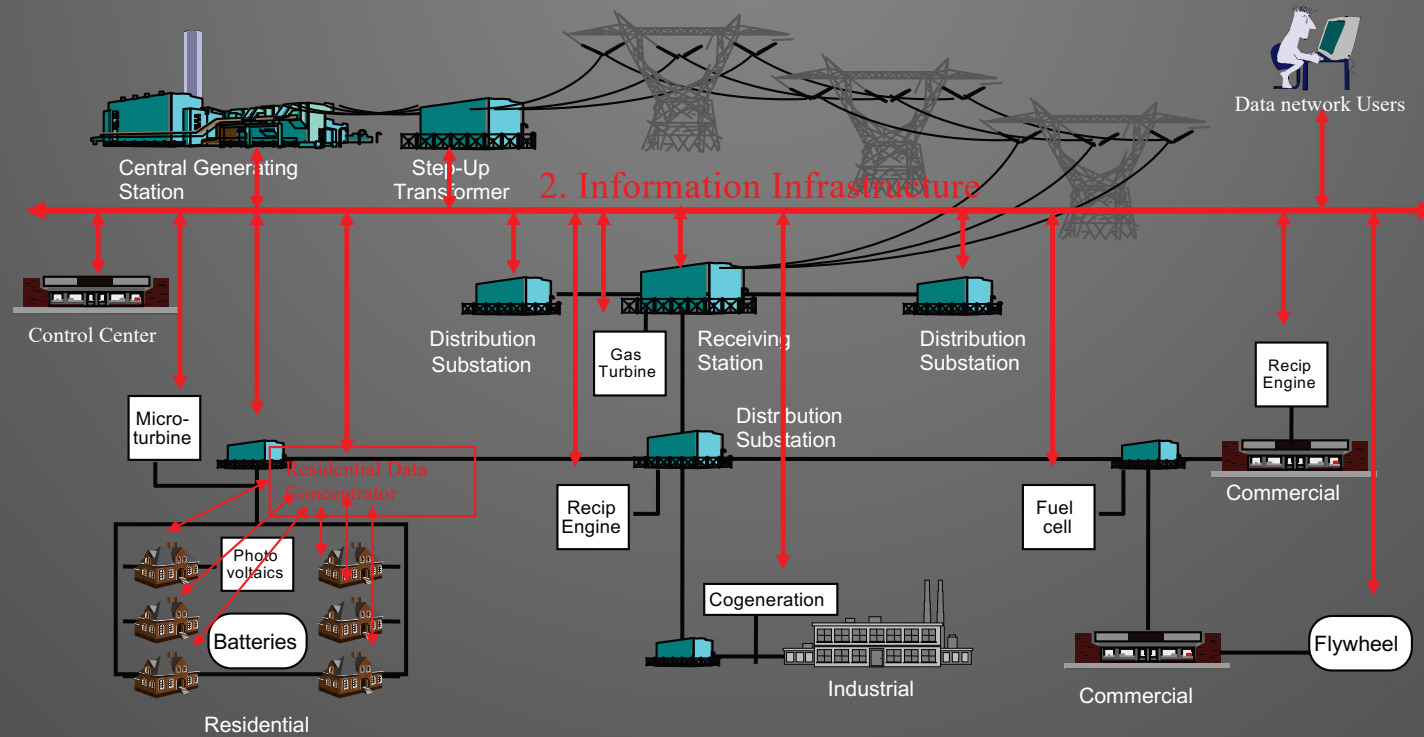
Adapted from EPRI Presentation by Joe Hughes
NIST Standards Workshop
April 28, 2008

Sources: *The Economist*; ABB

Source: Altlank, Alberta, Canada

Electric Power and Communication Infrastructures

1. Power Infrastructure



Source: EPRI

Field Implementation: Intelligent Interconnected Microgrids

Intelligent Load

Demand or price-driven control of appliances

Distribution Network

Interconnected micro grids

Sensors

Detect outages, fluctuations, and disturbances

Distributed Arch.

Local Monitoring and Control

Microgrid

Bulk Power Plant

Wind Power Park

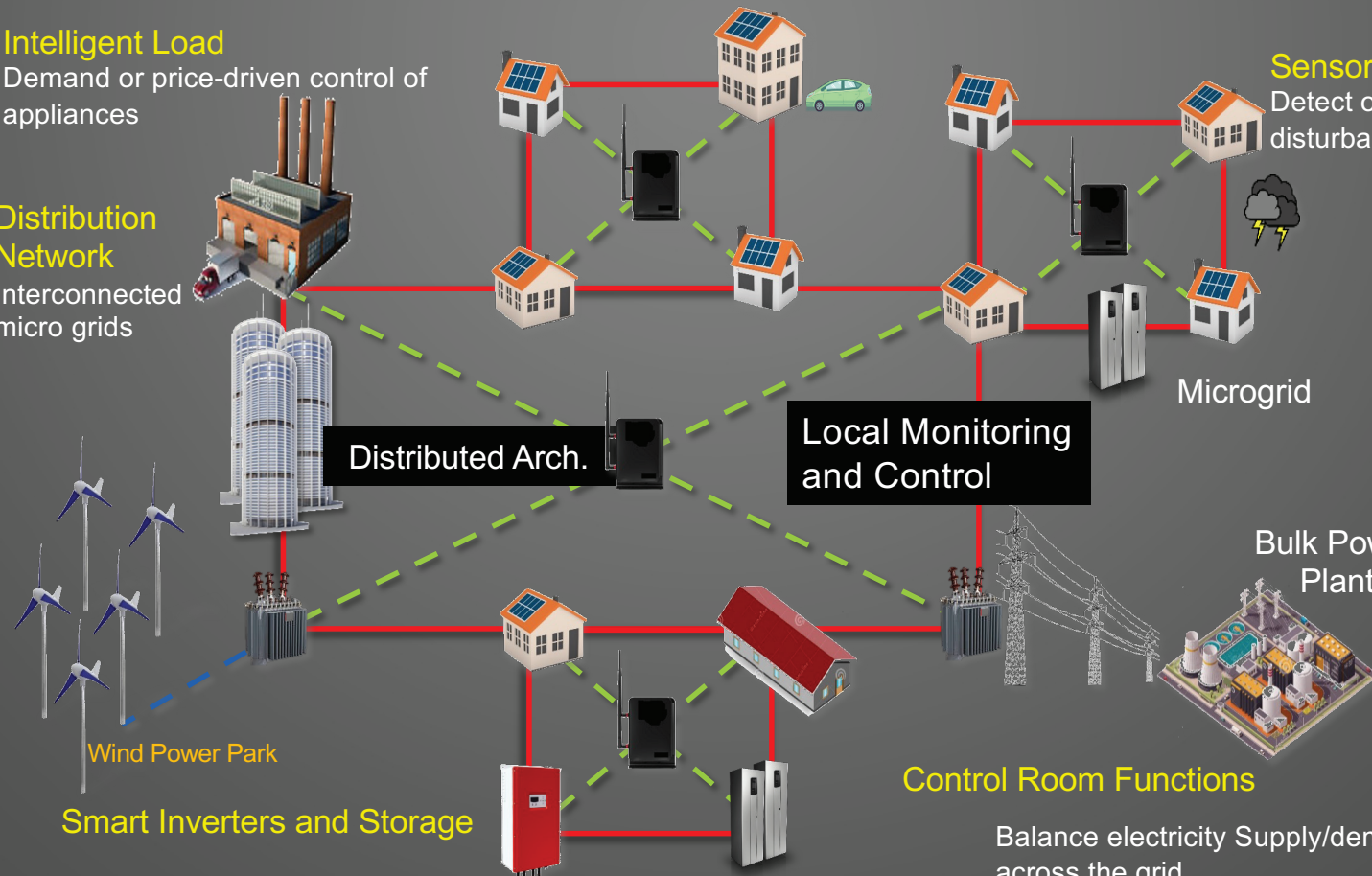
Smart Inverters and Storage

Minimize voltage and power fluctuations

Control Room Functions

Balance electricity Supply/demand across the grid

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New Paradigm for the Electric Power System

Historically: Demand driven supply (supply responds to demand)



New Reality: Supply driven demand (demand needs to adjust to meet fluctuating supply with storage)



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