Smart Grid: Is it the Right Choice for the Future?

Arranged by the Energy Institute and the IET Scotland South West

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UNIVERSITY OF STRATHCLYDE

Outline

- University of Strathclyde & Power Electronics Research group
- What is Smart Grid ?
- Smart Grids Challenges
- Key Technologies
- Distributed Energy Resources and Energy Storage
- Smart Grid Development
- Application Examples
- The UK Smart Grid
- Conclusions

UNIVERSITY OF STRATHCLYDE

University of Strathclyde

- **The University of Strathclyde, founded in 1796, has a rich history of teaching and innovation, located in Glasgow, Scotland's largest city.**
- **Our community is from 100 countries, 3,500 staff, 22,000 students,7000 postgraduate students.**

University of Strathclyde

- **Winners of UK Times Higher Ed Awards, University of the Year 2012, Business School of the Year 2016.**
- **A UK top 20 university for research intensity (UK Times, REF2014), rated 5 star by QS.**

Faculty of Engineering

4 Faculties

- Engineering
- Business
- Science
- Humanities and Social Sciences

Engineering:

- Architecture
- Biomedical Engineering
- Civil & Environmental Engineering
- Chemical & Process Engineering
- Design, Manufacture & Engineering Management
- **Electronic & Electrical Engineering**
- Mechanical & Aerospace Engineering
- Naval Architecture, Ocean & Marine Engineering

Faculty of Engineering

Undergraduate Students

- Over 4000 undergraduate students
- Over 40 undergraduate degree courses
- All established courses professionally accredited
- Five of the top eight UK engineering UG courses

Postgraduate Students

- Over 1400 postgraduate students
- 800 taught postgraduate students
- Almost 700 postgraduate research students
- PhD, EngD, MPhil, Mres

- **Top 10 (4) for Electronic and Electrical in the UK (The Times/ Sunday Times Good University Guide 2018)**
- **Largest Faculty of Engineering in Scotland**
- **Largest Electrical Power Engineering research institute in Europe**
- **One of the highest levels of Research funding in the UK - £100 million**

Power Electronics Research Group

- 33 researchers: 5 Academics, 7 post docs, 21 PhD students,

- Research income currently around **£3.5**million:
  - ERC (European Research Council), FP7, H2020
  - EPSRC (Engineering and Physical Sciences Research Council),
  - Qatar National Research Foundation,
  - SSE (Scottish and Southern Energy),
  - Chinese EPRI (Electric Power Research Institute),
  - Scottish Funding Council, and GE Energy

- Membership: CIGRE, IET, IEEE

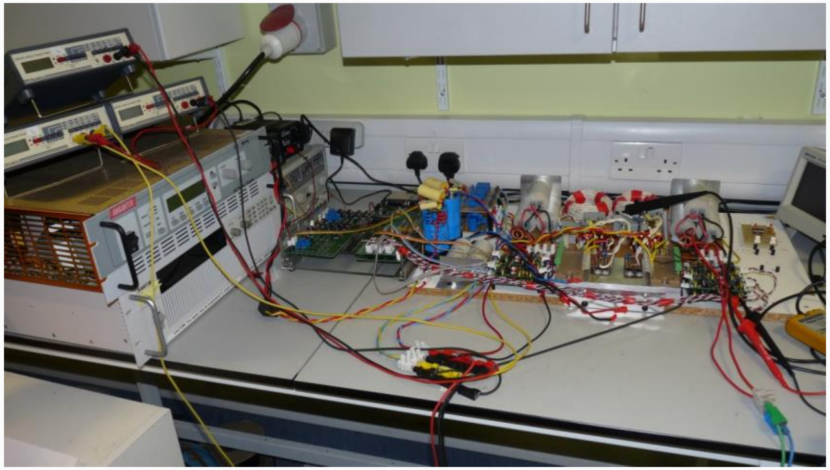
- Research facilities:
  - Simulation platforms - PSCAD, SABER, SimPowerSystems, Digsilent,
  - Power laboratory with medium-power converters (2-30kW),

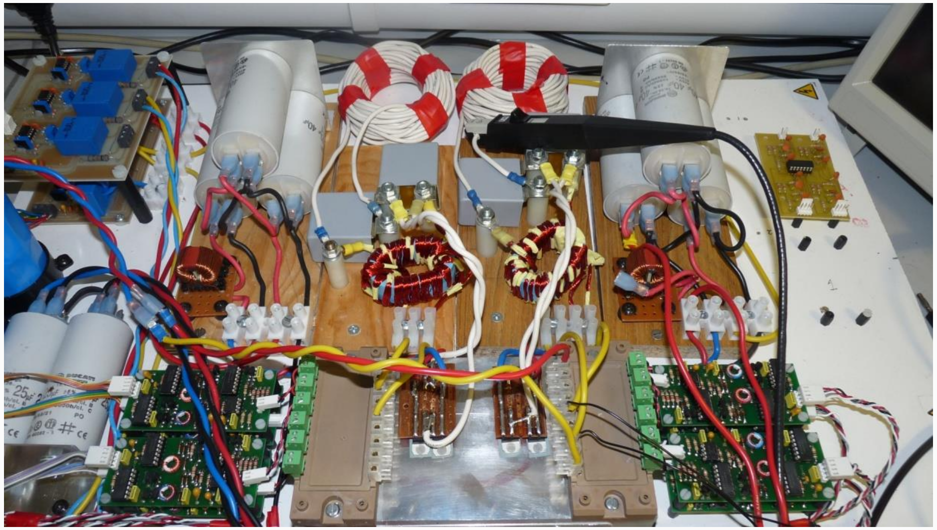
- Research expertise: Power electronics, smart grids, HVDC, DC transmission systems, FACTS (Flexible AC Transmission Systems), and integration of renewables.

PEDEC - Key Areas of Research 1

High-Efficiency Power Conversion

- Automotive, aerospace and grid applications demand high-efficiency power conversion to reduce bulk, weight, the need for forced-cooling systems, and lifetime power consumption.
- Research into very high-efficiency (99%+) systems exploits emerging wide bandgap GaN, and SiC MOSFETs. Also, exploitation of increased switching frequency capability for effective control of high-speed machines and reduced-size passives.

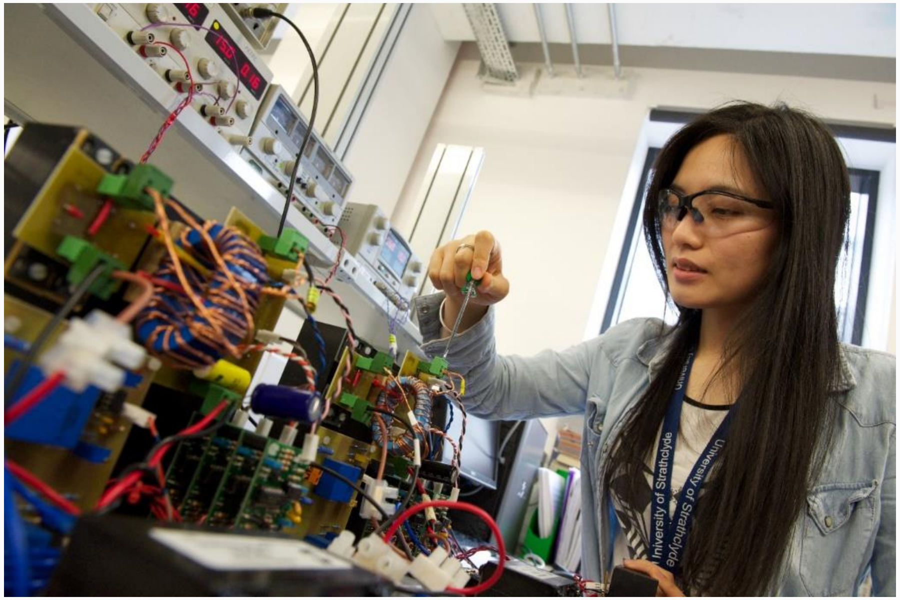




PEDEC - Key Areas of Research 2

High Power Converter Systems

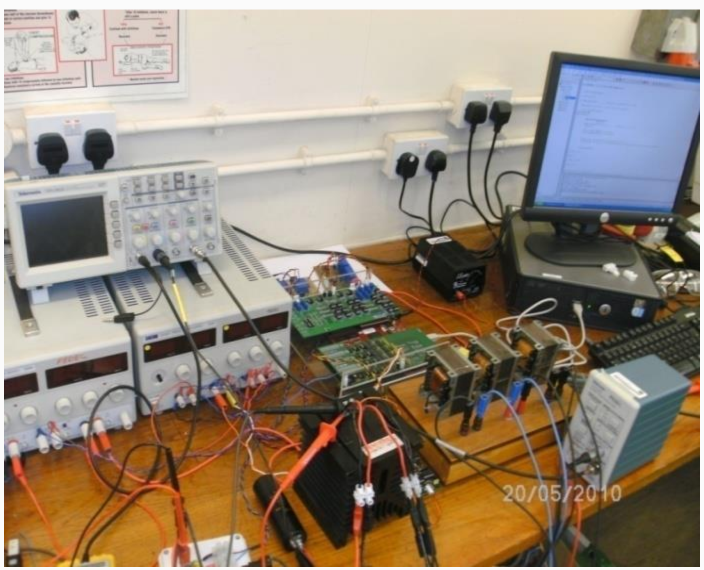
- Power electronics is increasingly employed in energy generation, transmission and bulk process industries, which require composite systems that can function beyond individual device ratings.
- Research includes modelling, simulation, control, and prototyping of series-connected power IGBTs and multi-level converter topologies, hybrid converter topologies, solid-state/hybrid DC circuit breakers, and high-power current-source inverters.

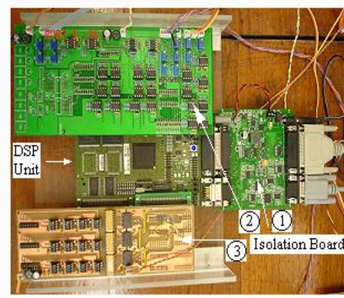


PEDEC - Key Areas of Research 3

Control of Converters for Generator Grid Interface

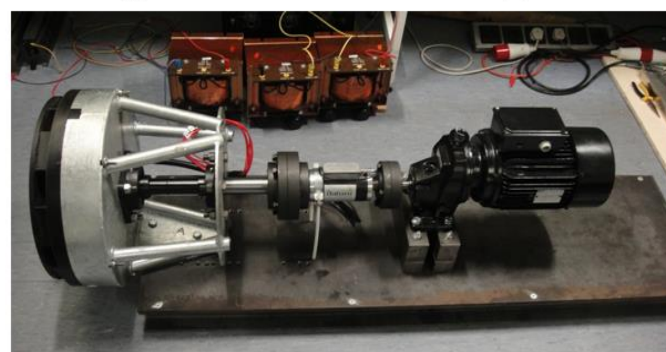
- Increasingly, distributed generation is operated at variable frequency or DC output, introducing the need for a power electronic interface.
- The behaviour of converter-connected generation is fixed by the power electronic circuit and its associated control system.
- Current projects focus on the optimisation of control under transient and distorted grid conditions, and the study of interactions within multi-converter systems.





DSP


Variable speed drive

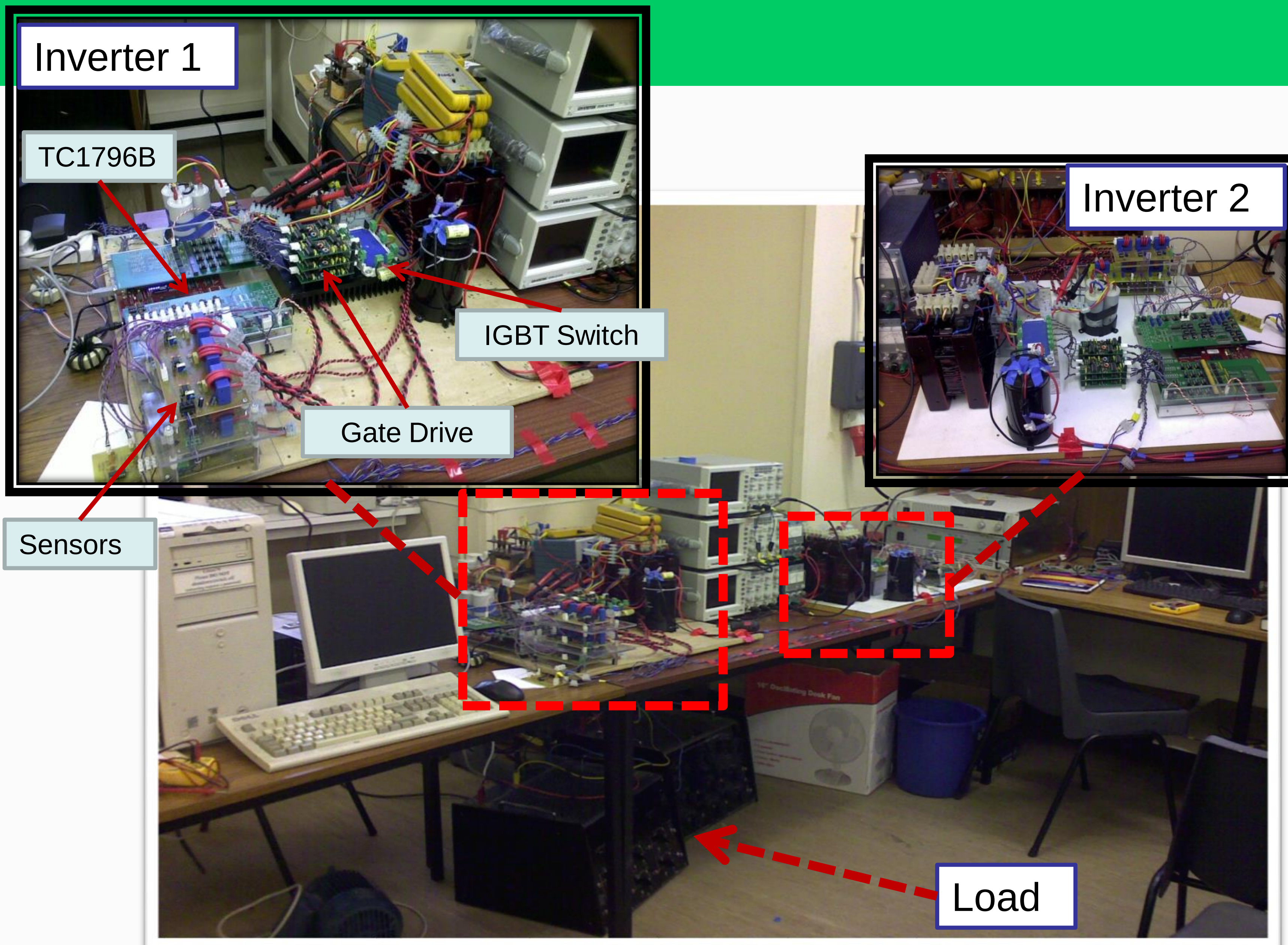

Induction machine & Proven 2.5kW generator

PEDEC - Key Areas of Research 4

DC Power Networks and Smart Grids

- DC power systems are increasingly being applied to new areas ranging from high-voltage transmission to high-reliability aerospace/marine power systems.
- Activities focus on system control and power converter topologies for HVDC networks, MVDC networks, DC micro-grids, multi-terminal unidirectional DC current distribution links, associated integrated grid management systems and smart grids.

Microgrids- Hardware Implementation



WHAT IS SMART GRID ?

What is Smart Grid ?

No Exact Answer !!

Some Smart Grid Definitions

- There are many views of what is smart grid is not a single concept but rather a combination of technologies and methods intended to renew the existing grid in order to improve flexibility, availability, energy efficiency, and costs.

- "An automated, widely distributed energy delivery network characterized by a two-way flow of electricity and information, capable of monitoring and responding to changes in everything from power plants to customer preferences to individual appliances"

- " The electricity delivery system (from generation to consumption) integrated with communications and information technology for enhancing grid operations, customer services, and environmental benefit"

- "It is an electric grid that uses information and communication technology to gather data and act on information about the behaviour of suppliers and consumers in an automated fashion."

ABB Smart Grid Definition

- Smart Grid is a vision of the future evolution of the entire power network. It involves both transmission and distribution.
- It focuses on the integration of renewable, distributed generation (DG), reliability and efficiency of the grid.
- It includes the demand response and the potential of new technologies such as large scale integration of electric vehicles.
- Smart Grid includes both automation/IT and controllable power devices in the whole value chain from production to consumption.

Smart grid approaches - Europe

- EU-led vision (customer and environmentally driven)

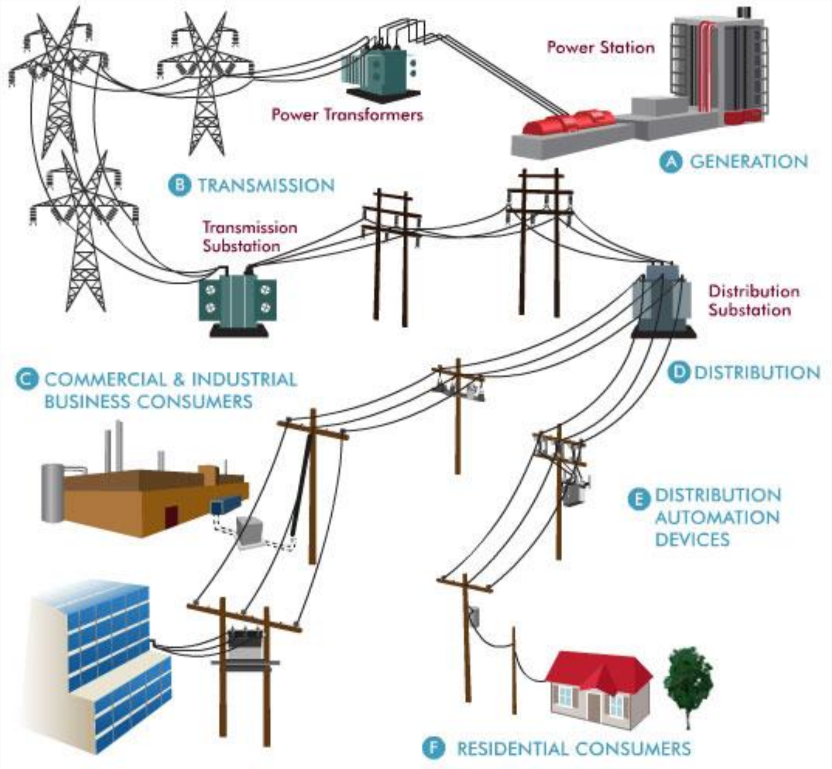
- Europe's electricity networks in 2020 and beyond will be:
  - Flexible: Fulfilling customers' needs whilst responding to the changes and challenges ahead;
  - Accessible: Granting connection access to all network users, particularly for renewable energy sources and high efficiency local generation with zero or low carbon emissions;
  - Reliable: Assuring and improving security and quality of supply, consistent with the demands of the digital age;
  - Economic: Providing best value through innovation, efficient energy management and 'level playing field' competition and regulation.

"European Technology Platform SmartGrids. Vision and Strategy for Europe's Electricity Networks of the Future"
European Commission KI-NA-22040-EN-C EUR 22040

Smart grid approaches - US

- According to the United States Department of Energy, a modern smart grid must US led vision (security and consumer driven):
  - Be able to heal itself
  - Motivate consumers to actively manage usage
  - Resist attack
  - Provide higher quality power
  - Accommodate all generation and storage options
  - Enable electricity markets to flourish
  - Run more efficiently
  - Enable intermittent power generation sources

Conventional (Existing) grid



http://oncor.com/images/content/grid.jpg

Generation, transmission, distribution

Conventional (Existing) grid

- Energy flow in one direction, from generation to consumer (residential and industrial)

- Information flow in one direction from meter to utility – manually read by a meter reader or transmitted information back to the utility

Generation

Home/ Office

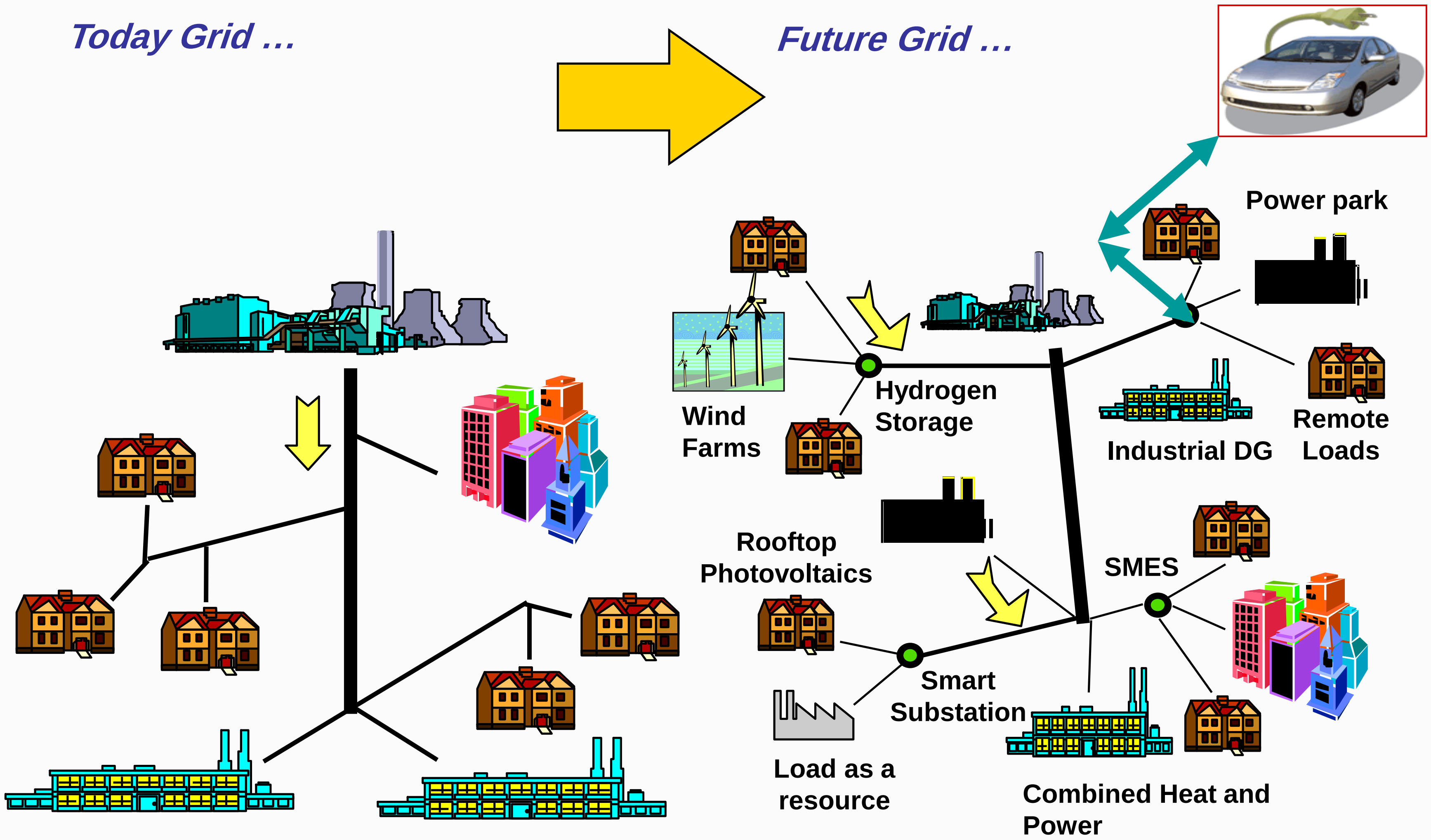
Energy

Information

Conventional (Existing) grid

- Problems with current Power Grid
  - It is not efficient
    - Transmission losses
    - High peak demand, which increase electricity rates
    - Operations and management costs for utilities, and ultimately lower power costs for consumers
  - It has not kept pace with modern challenges
    - Security threats from energy suppliers or cyber attack
    - Limited alternative power generation sources
    - No solutions for conservative use of energy
    - Un-interruptible electricity supply
    - Poor situation awareness
    - Poor control and management of distribution network
- A “SMARTER” grid is needed!

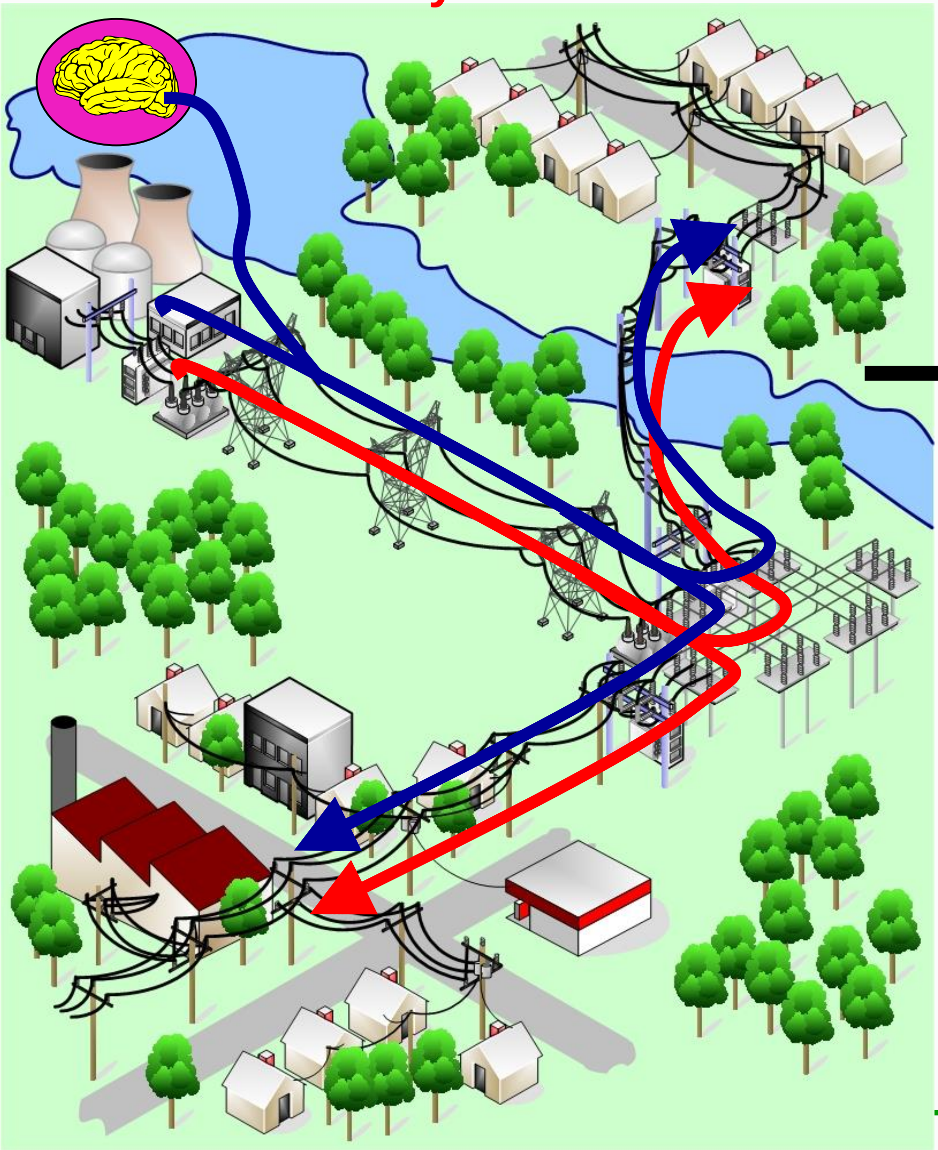
Future grid



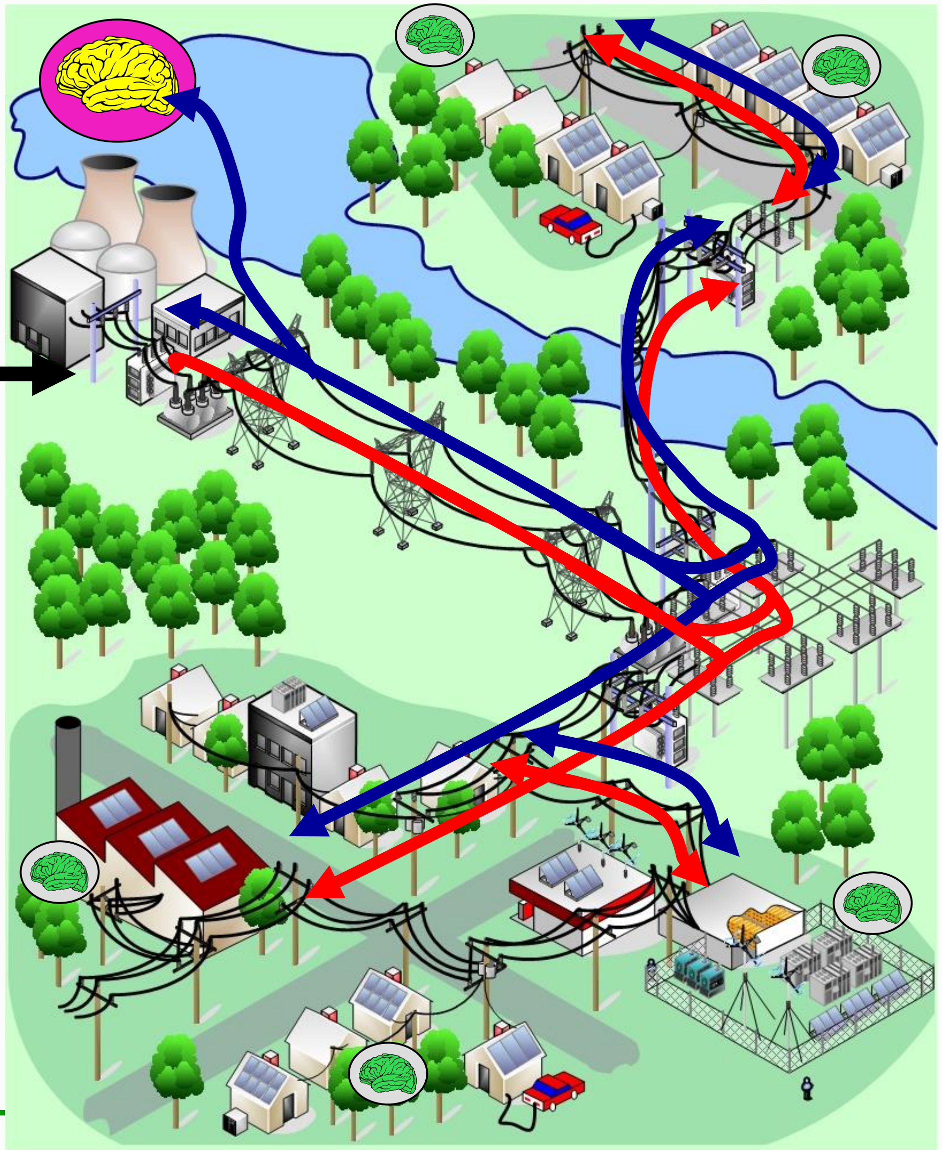
Today Grid …
Future Grid …
Power park
Wind
Farms
Hydrogen
Storage
Industrial DG
Remote
Loads
Rooftop
Photovoltaics
SMES
Smart
Substation
Load as a
resource
Combined Heat and
Power

Future grid

Today Grid …

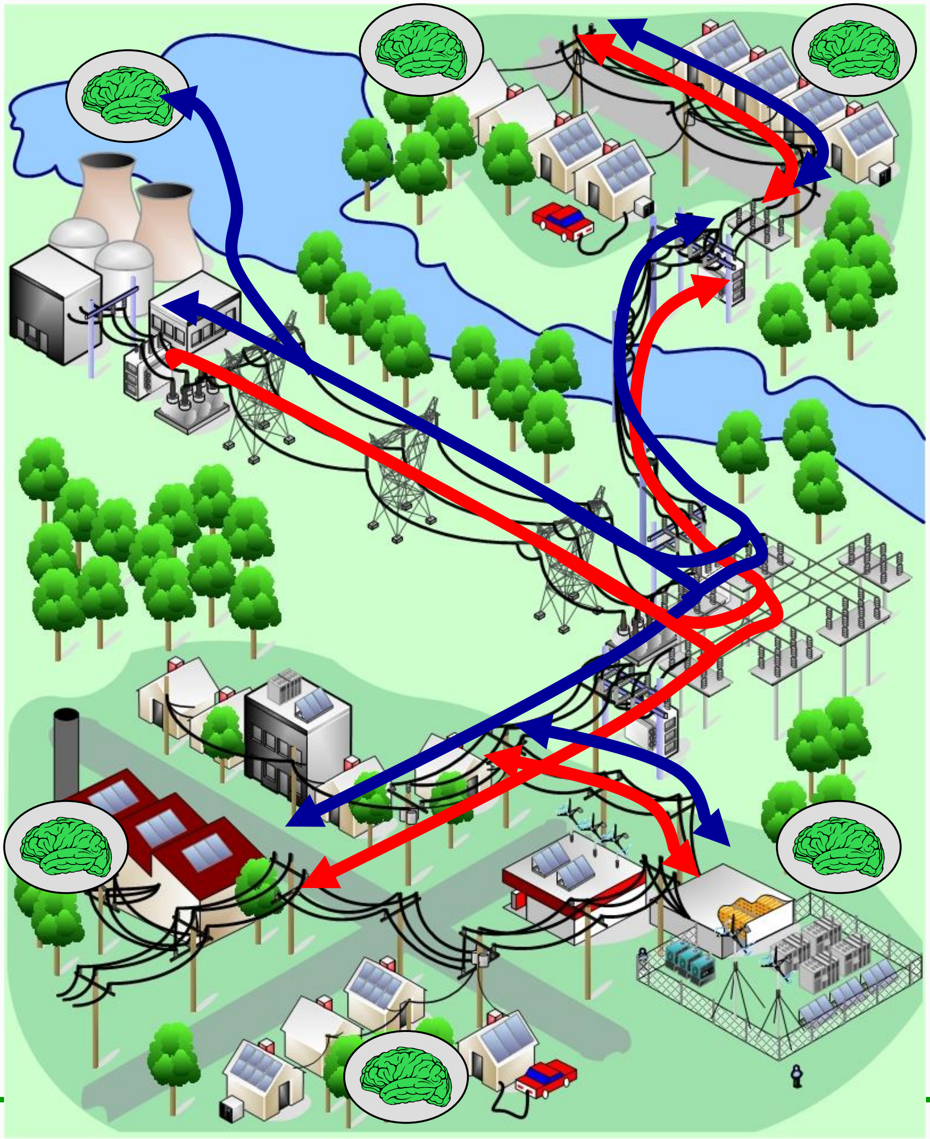


Smart Grid …



Future grid

More Smarter Grid …



Future grid

- Energy flows in many directions, from generation to grid or building, from car to/from building, from utility to customers, from customers to utility.
- Information networks established to create secure communications between devices and people.



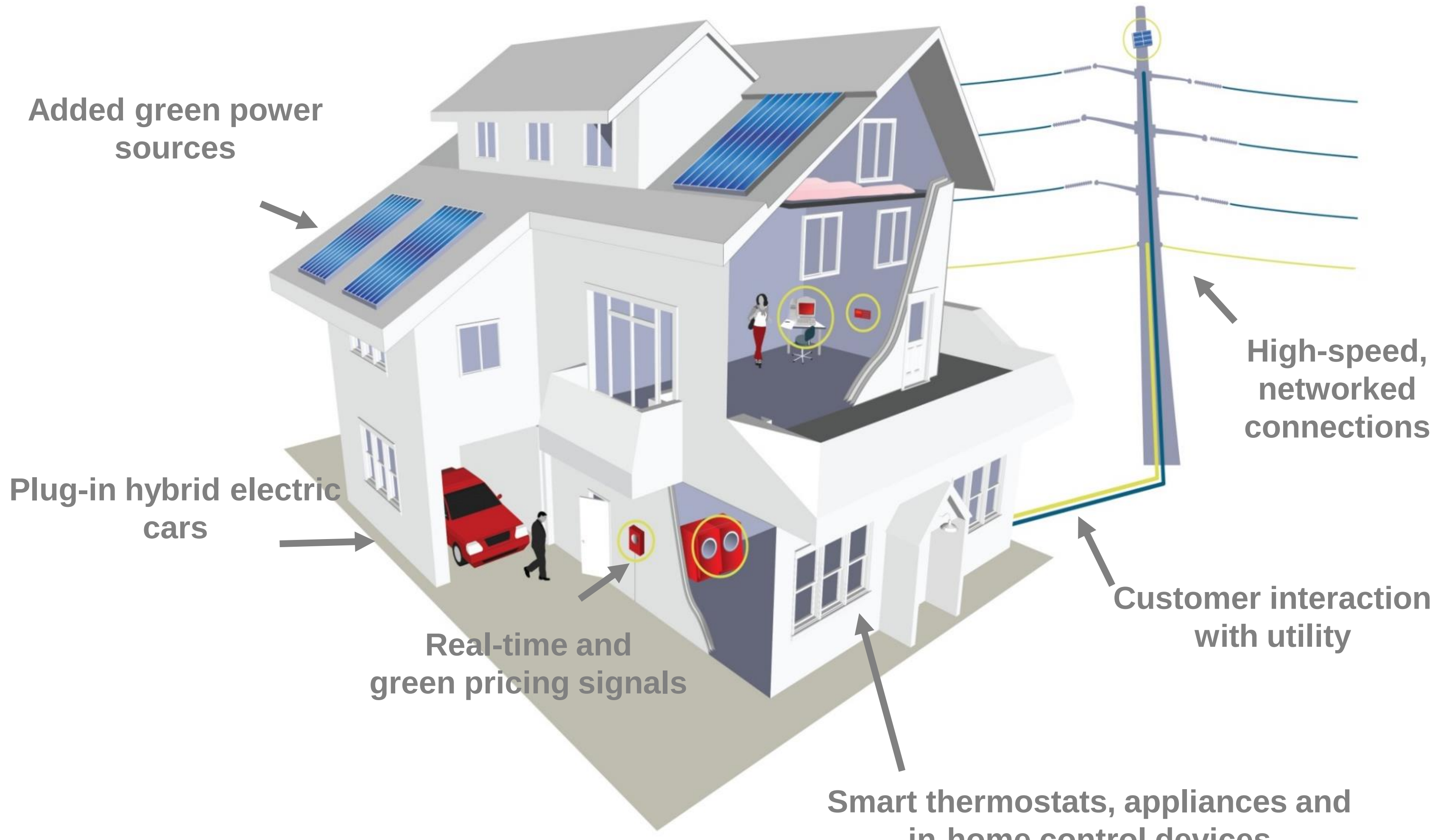





Generation **Transmission** **Distribution** **Home/ Building**

Distributed Generation & Storage

Your future smart home

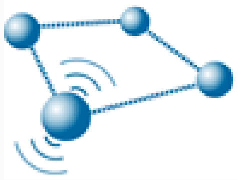


http://www.worldchanging.com/smarthouse.jpg

Your future smart home

- A new digital (smart) meter on your switch board panel

- a wireless network that reads those meters remotely or the data management system that processes the information



- Some solar panels on the roof of your house

- A load-controller on the heating, ventilation, and air conditioning system
- Smart Home is the inclusion of all of these things

Power management App

What type of information for your home !

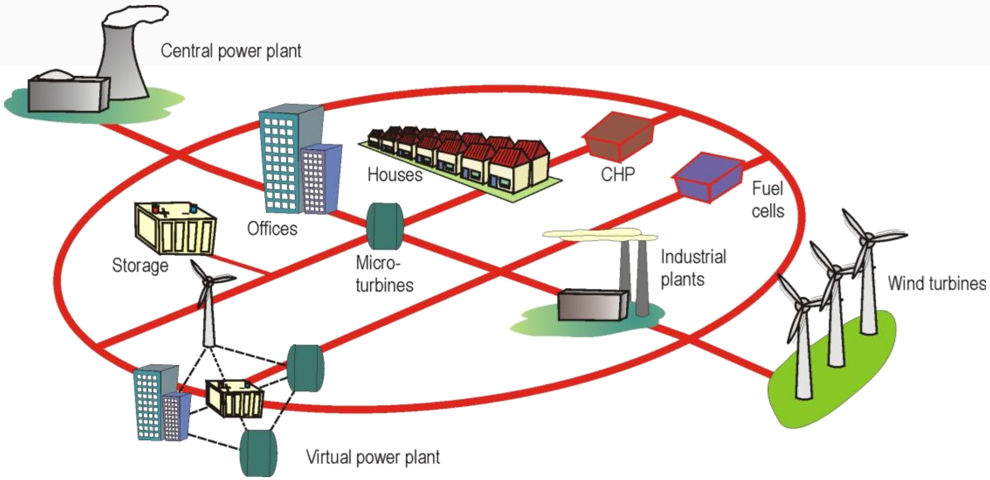
- How many members in your family?
- What hours do you work?
- How frequently you wash your clothing ?
- Do you cook your meals in the microwave or in the oven?
- Do you have ever thought of smart appliances?

SMART GRID REQUIRED FEATURES

Smart Grid Required Features

- Identify and resolve faults or attack on electricity grid
  - Real time monitoring of power grids
  - Identify and respond to man-made or natural disruptions
  - Isolate affected areas and redirect power flows around damaged facilities
- Automatically self-heal the grid during disturbances
- Monitor power quality and manage voltage
- Identify devices or subsystems that require maintenance
- Help consumers optimize (active participation by consumers) their individual electricity consumption (minimize their bills)
- Enable the use of smart appliances that can be programmed to run on off-peak power
- Accommodates all generation and storage options
- Enables new products, services and markets
- Optimizes asset utilization and operates efficiently
- Reduces the cost of blackouts
- Reduce CO_2 emissions but integration more renewables sources

Future smarter and greener Smart Grid



Smart Grid Enabling Platform…
3 Pillars of Domain Expertise

Communications Technology	**Information Technology**	**Power Production/ Delivery Technology**

Source: European Technology Platform SmartGrids, Vision and Strategy for Europe's Electricity Networks of the Future

CHALLENGES

Challenges

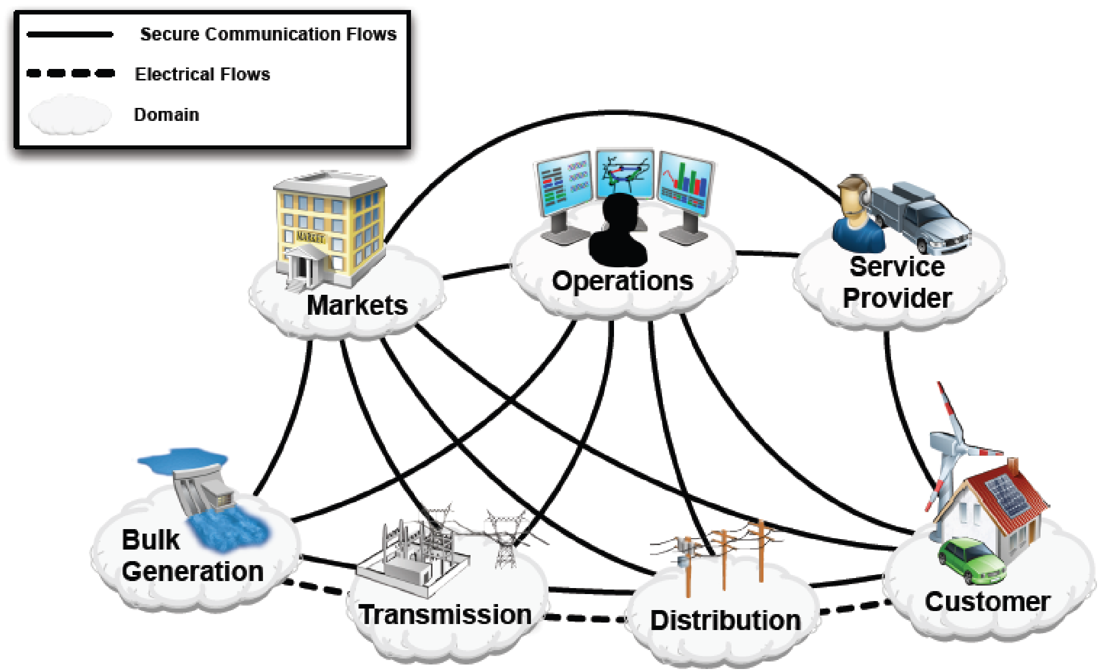
- 1: Power Engineering Technology
  - Energy sources including distribution generation
  - Transmission
  - Substation
  - Distribution
  - Consumer premise
  - Electric Vehicles
  - Safety

Challenges

- 2: Information Technology
  - Cyber security
  - Management protocols
  - Coordination with 1
    - Provide data storage requirements
    - Data retrieval performance requirements
    - Define data interfaces
  - Coordination with 3
    - Communication link
    - Topology control
    - Protocol

Challenges

- 3: Communications Technology
  - Define communication requirements between devices
  - Identify existing communication standards and definitions for use in Smart Grid



NIST Smart Grid Framework 1.0 January 2010

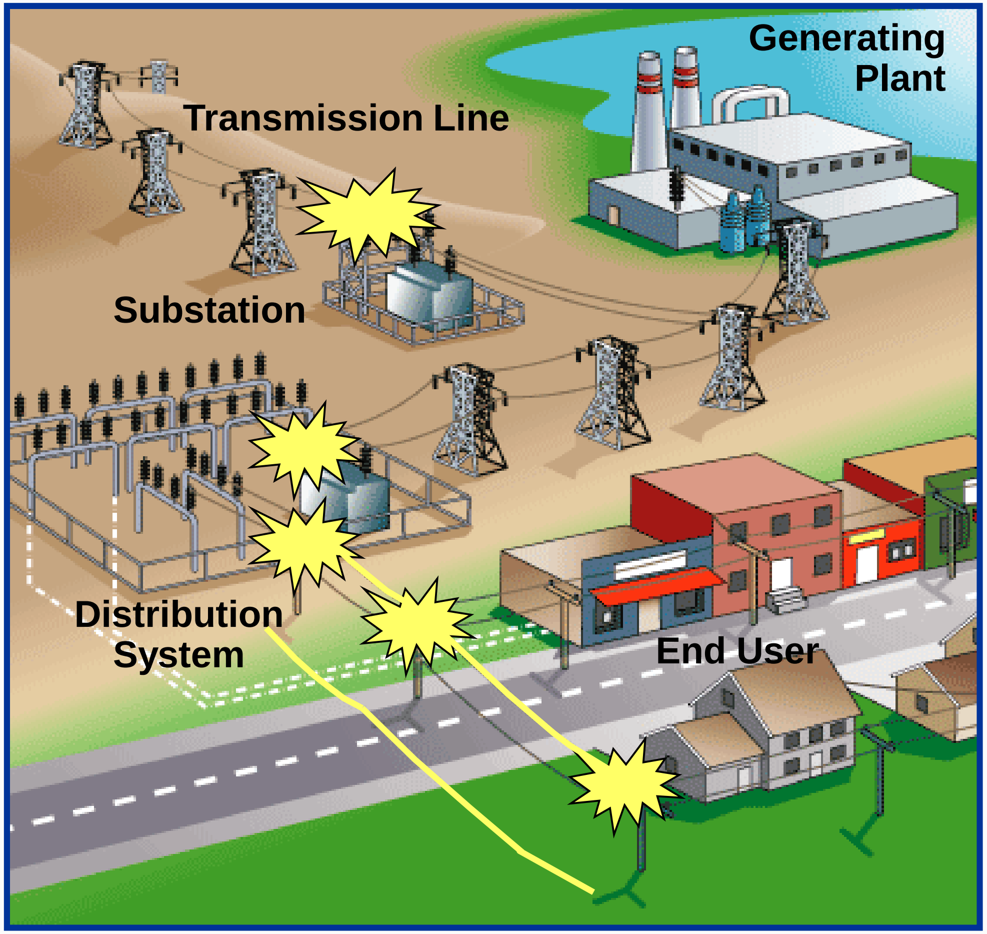
KEY TECHNOLOGIES

Key Technologies - 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.
  - Fast and reliable communications for the grid
  - Allowing the grid for real-time control, information and data exchange to optimize system reliability, asset utilization and security
  - Can be wireless, powerline or fiber-optics
  - For wireless
    - Zigbee
    - WiMAX
    - WiFi
- Cyber Security: the new communication mechanism should consider security, reliability.

Key Technologies - communications and security

- Broadband over Powerlines
  - Provide for two-way communications
- Monitors and smart relays at substations
- Monitors at transformers, circuit breakers and reclosers
- Bi-directional meters with two-way communication



Key Technologies - sensing and measurement

- Sensing and measurement
  - Smart meter technology, real time metering of:
    - Congestion and grid stability
    - Equipment health
    - Energy theft
    - Real time thermal rating
    - Electromagnetic signature measurement/analysis
    - Real time pricing

  - Phasor measurement units (PMU)
    - Real time monitor of power quality
    - Use GPS as a reference for precise measurement

Key Technologies - 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

Key Technologies - sensing and measurement

- 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
  - Italy has the largest smart meter deployment in the world more than 30 million customers.

Key Technologies - sensing and measurement

- 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.

Key Technologies - sensing and measurement

- Power system automation
  - Rapid diagnosis and precise solutions to specific grid disruptions or outages
  - Distributed intelligent agents
  - Analytical tools involving software algorithms and high-speed computers
  - Operational applications

Key Technologies - Demand Response

- Demand Response
  - Smart grid allows customers to shift load and to generate and store energy based on near real-time prices and other economic incentives.
  - Customers can also sell surfeit stored energy back to the grid when the price is high.
  - Such demand-response mechanisms help the grid balance power supply and demand, thus enhancing the efficiency of power usage.

Key Technologies - Advanced components

- Advanced components
  - Flexible AC transmission system devices
  - High voltage direct current
  - Superconducting wire
  - High temperature superconducting cable
  - Distributed energy generation and storage devices
  - Composite conductors
  - “Intelligent” appliances

Key Technologies - Advanced components

- Advanced Energy Storage
  - New Battery Technologies
    - Sodium Sulfur (NaS)
  - Plug-in Hybrid Electric Vehicle (PHEV)
    - Grid-to-Vehicle(G2V) and Vehicle-to-Grid(V2G)
    - Peak load leveling

Key Technologies - PHEV and PEV integration

- Problem: Typical home peak power consumption is below 5 kW. An electric vehicle may require 1 kW to be charged in 8 hrs. or up to 8 kW for shorter charging profiles.
- Also, PEV and PHEV penetration is not uniform (higher for neighborhoods with higher economical household income). Hence, grid's distribution transformers can be easily overloaded PEV and PHEV even if charging is done during nighttime.
- DG avoids overloading distribution transformers but economical issues still need to be addressed.
- Combination of DG and energy storage may be a suitable solution.

Key Technologies - Grid-to-Vehicle (G2V)

Key Technologies - Electricity Market

"Trading Agents for the Smart Electricity Grid,"

- Current practice: Fixed market
  - Few producers, less competition
  - Regulated by government
- The future : **Free market**
  - Many producers (wind, solar, …)
  - Less regulation

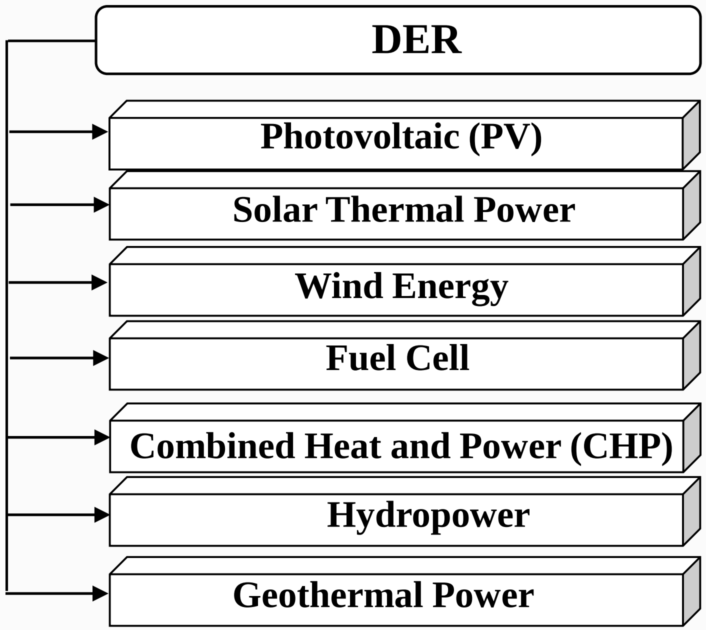
DISTRIBUTED ENERGY RESOURCES

Distributed Energy Resources (DER)

Different technologies are classified in literature according to its rating. The DER technologies include photovoltaics, solar thermal power, wind energy fuel cell, Combined Heat and Power (CHP), Hydropower and geothermal power. These technologies are in a period of rapid expansion.

Centralised Decentralised Distributed

Distributed Energy Resources (DER)



Technology	Power Rating
Micro	<5kW
Small	5kW - 5MW
Medium	5MW - 50 MW
Large	>50MW

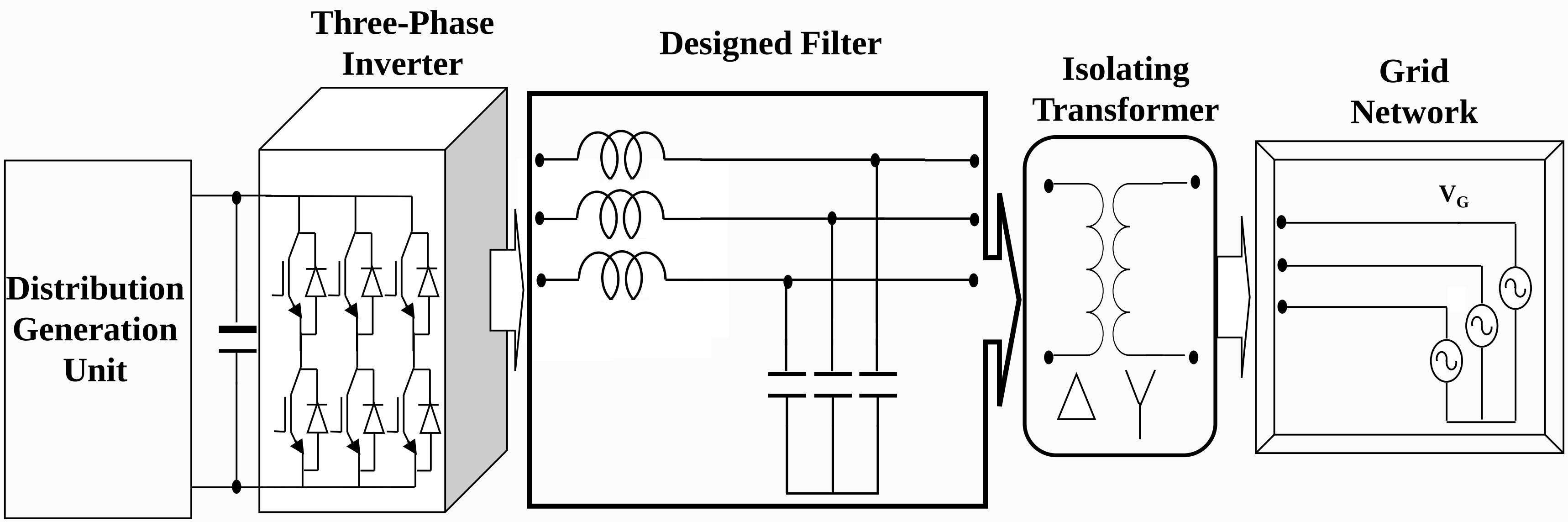
Distributed Energy Resources (DER)

Classification of DER

	Power Rating	Output connection	Barriers
PV	Micro-Small	DC/AC	Price, forecasting
Solar Thermal Power	Small- Medium	AC	Only suited for equatorial areas
Wind Energy	Micro-Medium	AC/DC/AC	Forecast
Hydropower	Micro-Large	AC	Location
CHP	Small-Large	AC	No barriers
Fuel Cell	Small	DC/AC	Fuel infrastructure
Geothermal	Small-Large	AC	Location

Distributed Energy Resources (DER)

Block Diagram of the DER System



Distributed Energy Resources (DER)

State of the Problem

The trend toward using inverters in distributed generation systems and micro grids has raised the importance of achieving low distortion, high quality power export from inverters. Both switching frequency effects and pre-existing grid voltage distortion can contribute to poor power quality.

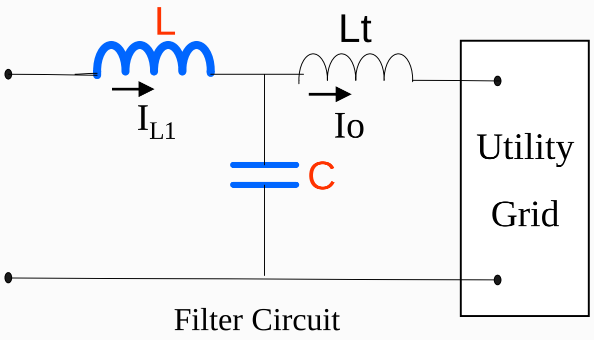
The Objective

One of the main tasks of the DER engineer is to model, analysis and design of the DC-AC coupling inverter and its controller. This system should transfer the energy from the DC link to the three-phase AC system with controlled active and reactive power and without injecting harmonic currents in case of grid connected. The system should also able to operate during island mode with high voltage quality.

Distributed Energy Resources (DER)

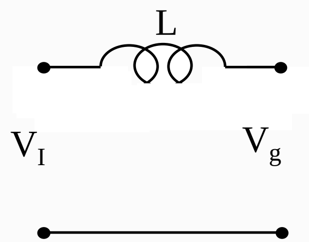
Passive Filter Design

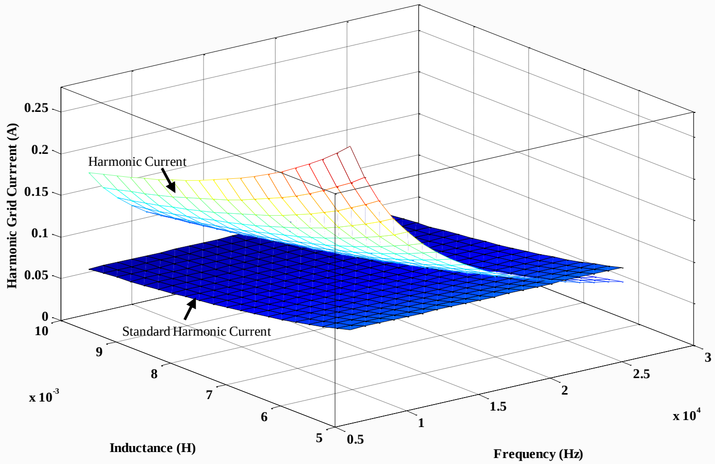
- The harmonics require the connection of low pass filter between the inverter and the grid.
- A design method of the output LC filter for a grid coupled applications in distribution generation systems is proposed.
- The design is according to the standards levels that determine the level of current harmonics injected into the grid network.
- The inductor value is calculated as a function of the max ripple inductor current.
- The design of the capacitor depends on the allowable value of the switched component to be injected.



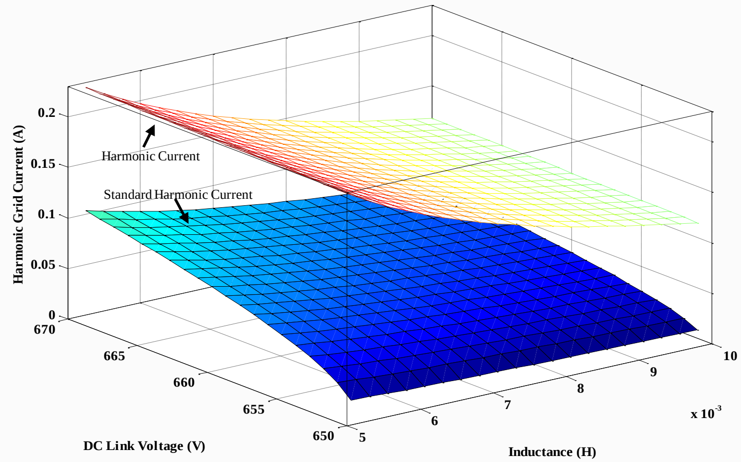
Distributed Energy Resources (DER)

L-filter





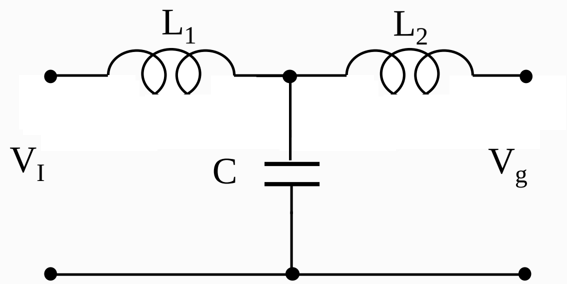
Harmonic current as function of switching frequency and inductor inductance

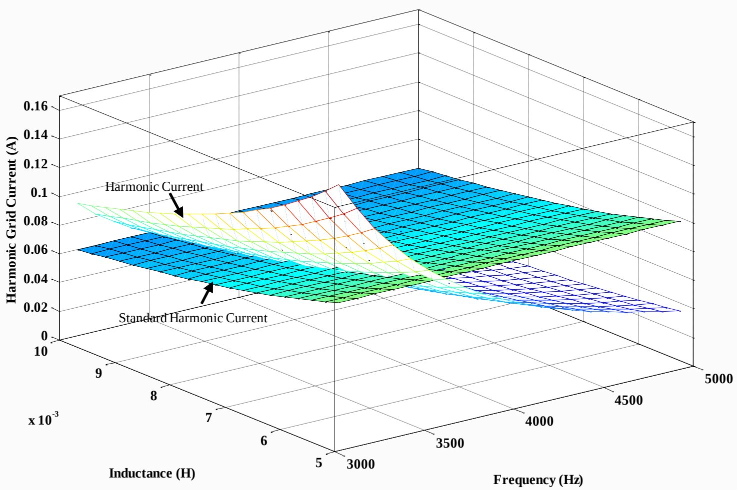


Harmonic current as function of DC link voltage and inductor inductance

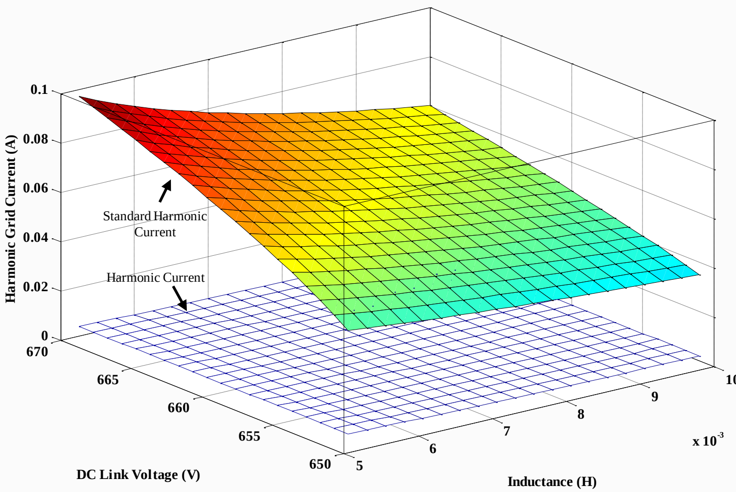
Distributed Energy Resources (DER)

LCL-filter



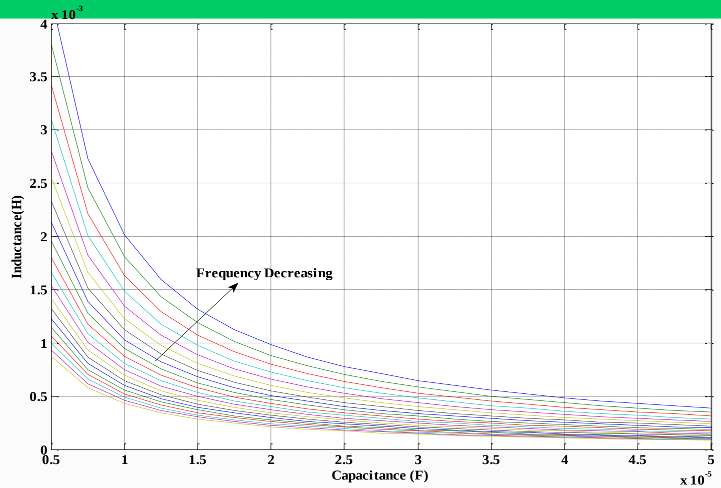


Harmonic current as function of switching frequency and inductor inductance

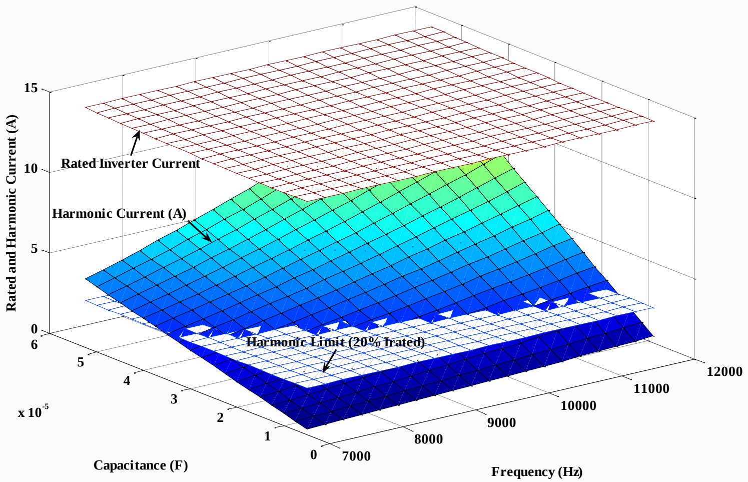


Harmonic current as function of DC link voltage and inductor inductance

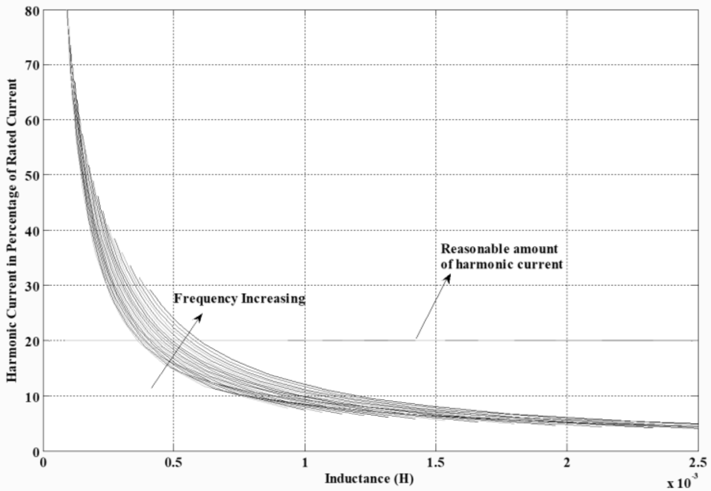
Distributed Energy Resources (DER)



Inductance versus capacitance and frequency



Rated and harmonic currents as a function of switching frequency and capacitance



Harmonic current as a function of inductance at different frequencies

Distributed Energy Resources (DER)

- Inductor Value Calculation

$$V_L = L\frac{\Delta I_{L\max}}{d_{\max} T_s} \quad , \quad d_{\max} = 1 - \frac{1}{4} = \frac{3}{4}$$

$$\Delta I_{L\max} = d_{\max}\frac{V_L}{L\ f_s} = \frac{d_{\max}}{6}\frac{V_{DC}}{L\ f_s} \qquad \Delta I_{L\max} = d_{\max} T_s \frac{V_L}{L}$$

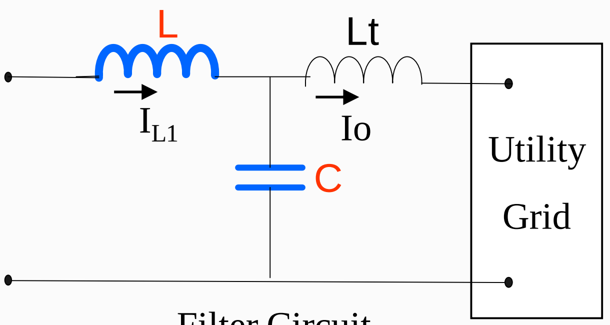
$$\Delta I_{L\max} = \frac{1}{8}\frac{V_{DC}}{L\ f_s} \qquad L = \frac{1}{8}\frac{V_{DC}}{\Delta I_{L\max}\ f_s}$$

- Capacitor Value Calculation

$$\frac{I_o(s)}{I_{L1}(s)} = \frac{Z_c(s)}{Z_c(s) + Z_t(s)}$$

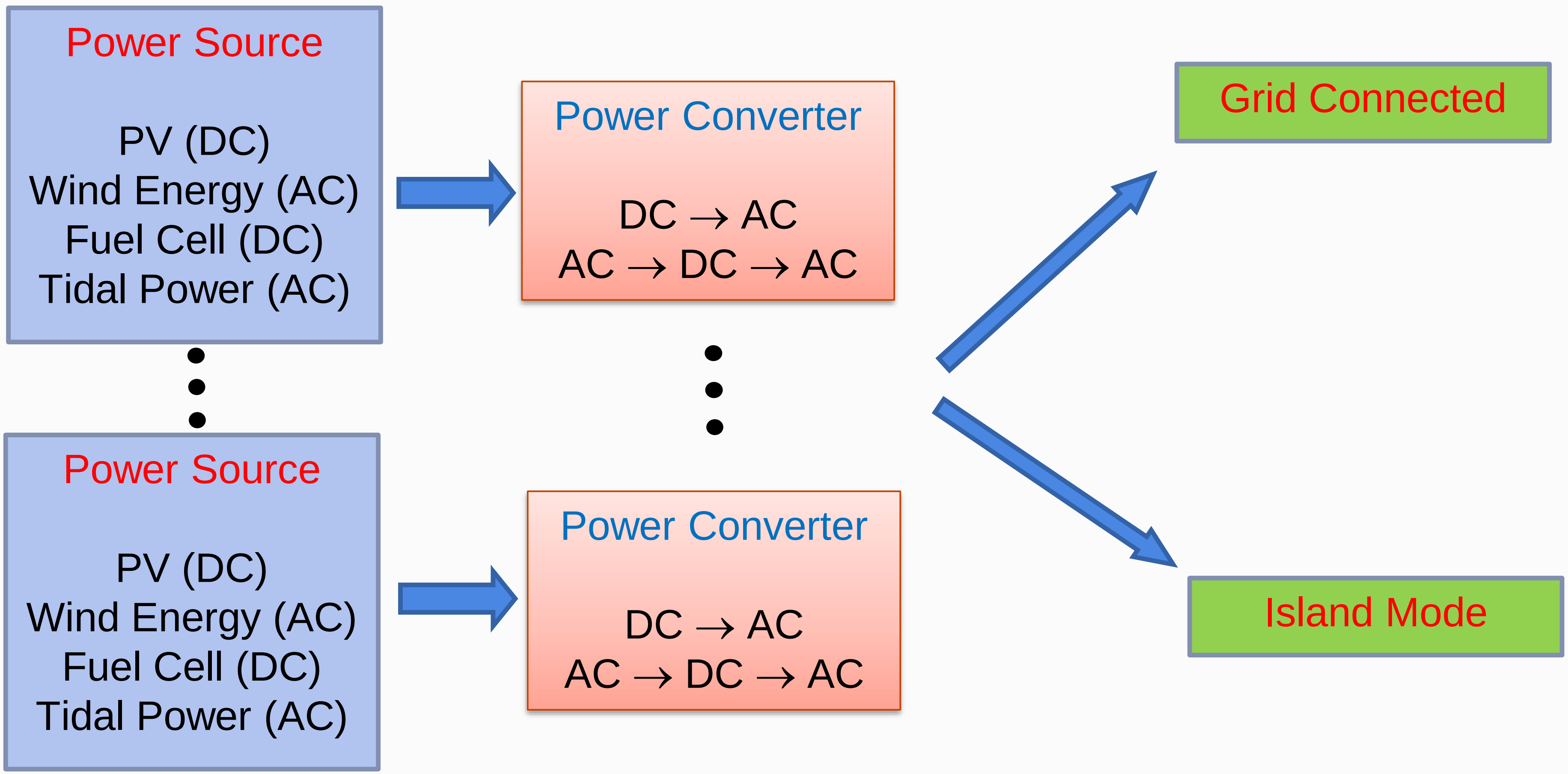
$$\left|Z_c(f-2f_m)\right| = \left|Z_t(f-2f_m)\right|\left|\frac{I_o(f-2f_m)}{I_{L1}(f-2f_m) - I_o(f-2f_m)}\right|$$

$$C = \frac{1}{2\pi(f-2f_m)\left|Z_c(f-2f_m)\right|}$$



Filter Circuit

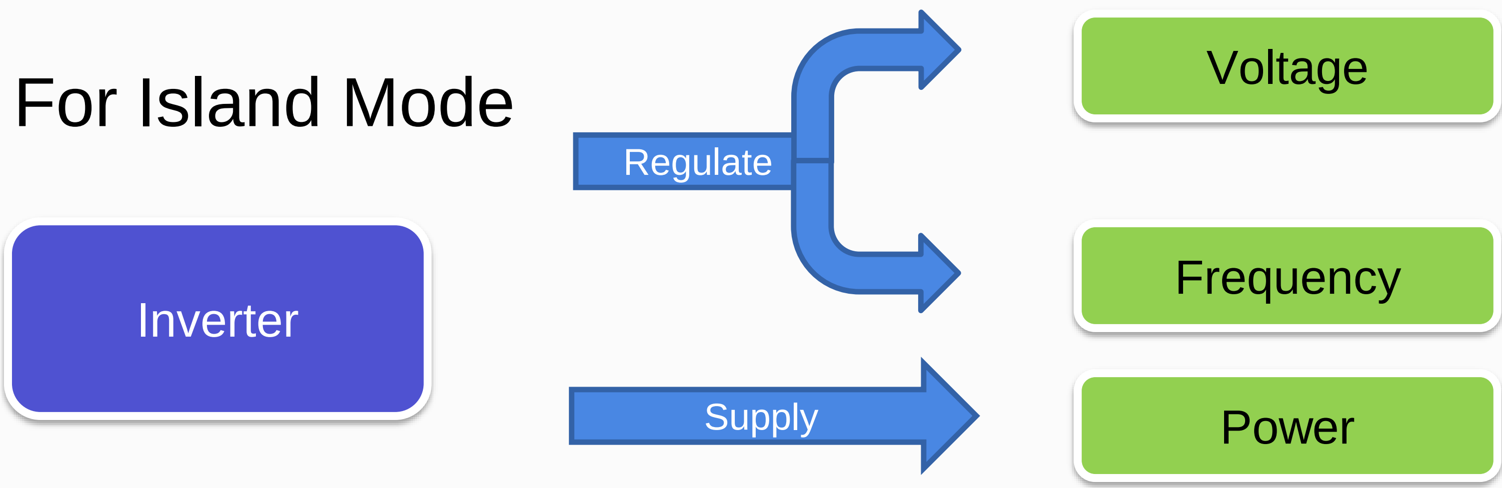
Distributed Energy Resources (DER) - Control



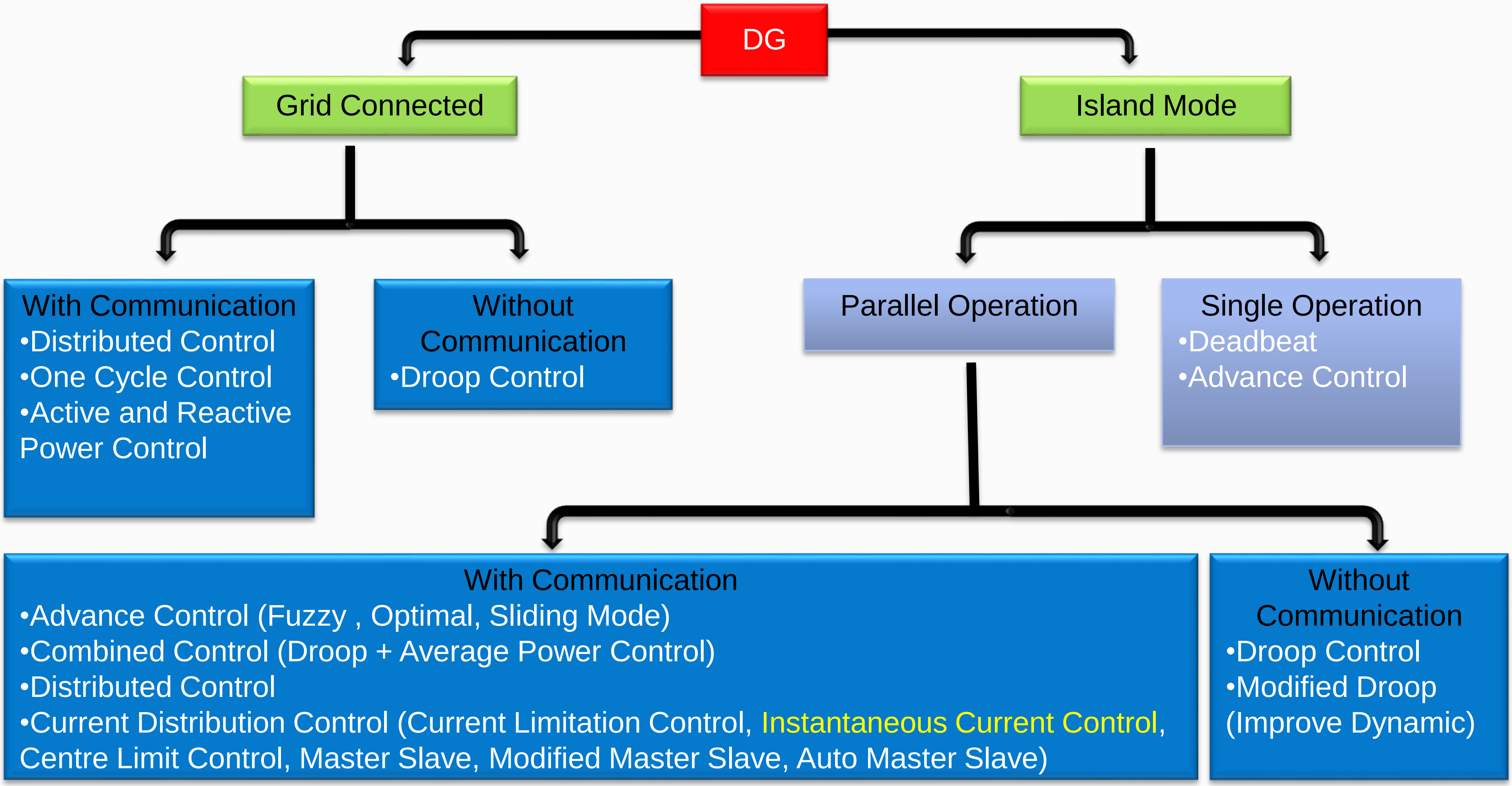
Distributed Energy Resources (DER) - Control

- For Grid Connected

- For Island Mode

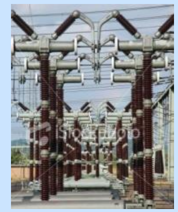


Control Techniques for Three-Phase Inverter-Based Distributed Generation



ENERGY STORAGE

Electricity Supply Chain – Now

Generation	Transmission	Distribution
		 

In the future, no any more the above structure.

The Smart Grid and Energy Storage

Generation	Transmission	Distribution	Consumption
		 	   
Storage			
Utility-scale • Compressed air • Flywheels	Utility-scale • Flywheels • EC Capacitors	Substation-scale • Molten salt • Flow cells	Residential-scale • Electric vehicle • Home battery

Energy Storage technologies underpin centralized and distributed generation

Traditional Grid **Smart Grid Enhancements**

The Smart Grid and Energy Storage

Generation	Transmission	Distribution	Consumption
		 	   
Storage			
Utility-scale • Compressed air • Flywheels	Utility-scale • Flywheels • EC Capacitors	Substation-scale • Molten salt • Flow cells	Residential-scale • Electric vehicle • Home battery
Technology • Utility-scale renewables **Regulatory** • Decoupling • Feed in Tariffs	**Technology** • Superconductivity • Synchrophasors • HVDC **Regulatory** • Interstate trans-mission agency to build lines?	**Technology** • Smart meters • Distribution automation • Microgrids **Regulatory** • Zoning to allow storage	**Technology** • HEMS • Smart appliances **Regulatory** • Net metering • FiTs

☐ **Traditional Grid** ☐ **Smart Grid Enhancements**

Energy Storage - Battery

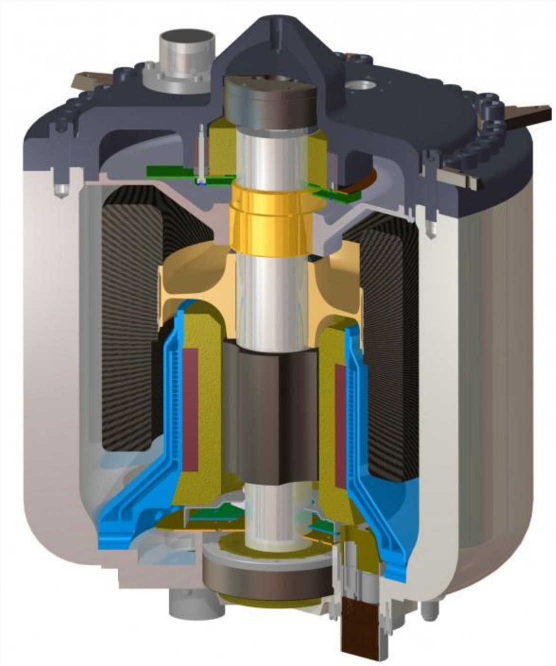
Today used energy storage system

- Lead Acid batteries/gen-sets long backup (> 30 min)
- Energy storage comprise 30 to 50 % of cost and space of the power quality systems.
- Lead Acid drawbacks: footprint, weight, sensitivity to temperature, and failure rate.

Energy Storage - Flywheel

Medium and high speed flywheel interesting alternative for back up time up to 20 seconds

Flywheel energy storage works by accelerating a rotor (flywheel) to a very high speed and maintaining the energy in the system as rotational energy. When energy is extracted from the system, the flywheel's rotational speed is reduced as a consequence of the principle of conservation of energy; adding energy to the system correspondingly results in an increase in the speed of the flywheel.



Advantages
- Wide operating temperature range
- High power density
- Very long service life

Disadvantages
- Cost
- Maintenance
- Noise

Energy Storage - Supercapacitor technologies

An electric double-layer capacitor, also known as supercapacitor, supercondenser, electrochemical double layer capacitor, or ultracapacitor, is an electrochemical capacitor with relatively high energy density, typically on the order of thousands of times greater than an electrolytic capacitor.

Advantages
- Very high rate of charge and discharge
- Good reversibility
- High cycle efficiency (95% or more)

Disadvantages
-Sorted energy amount is lower than batteries
- The voltage varies with the energy stored
- Requires advanced electronic control and power electronics

SMART GRID DEVELOPMENT

Smart Grid Development

Smart Grid v0.0
Networked Meters


Proprietary Meter Data

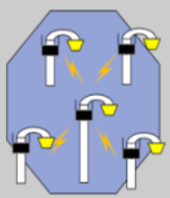

Proprietary Narrow Band Networks

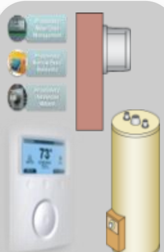

Proprietary Advanced Meters

Isolated Networks

Smart Grid v1.0
Advanced Metering


Enterprise Ops.
- Meter Data Mgt
- Device Management
- TOU Billing


AMI Networks
- Standard Protocols
- Public/Private WANs
- Complete Coverage


Utility Managed
- Critical Peak Pricing
- Smart Meters
- Smart Thermostats
- Load Controls

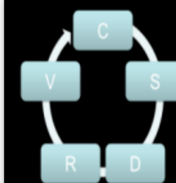
Smart Grid v2.0
Consumer-Grid Connectivity


Smart Energy Services
- Enterprise Services
- Customer Operations Unified
- Multi Service Offerings

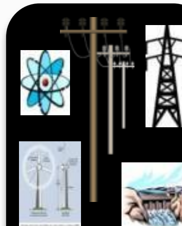

Multi-Service Networks
- Broadband
- Mobility
- Grid
- Community
- Home

Consumer-Oriented Grid
- Consumer Energy Efficiency
- Smart Appliances
- G2V (1-way PHEV charging)

Smart Grid v3.0
True Supply/Demand Integration



Renewables
- Supply Balancing
- Supply/Demand Integration
- Carbon Credits


Dynamic Capacity
- Matrix Grids
- Service Quality
- Local Load Balancing
- Energy Storage

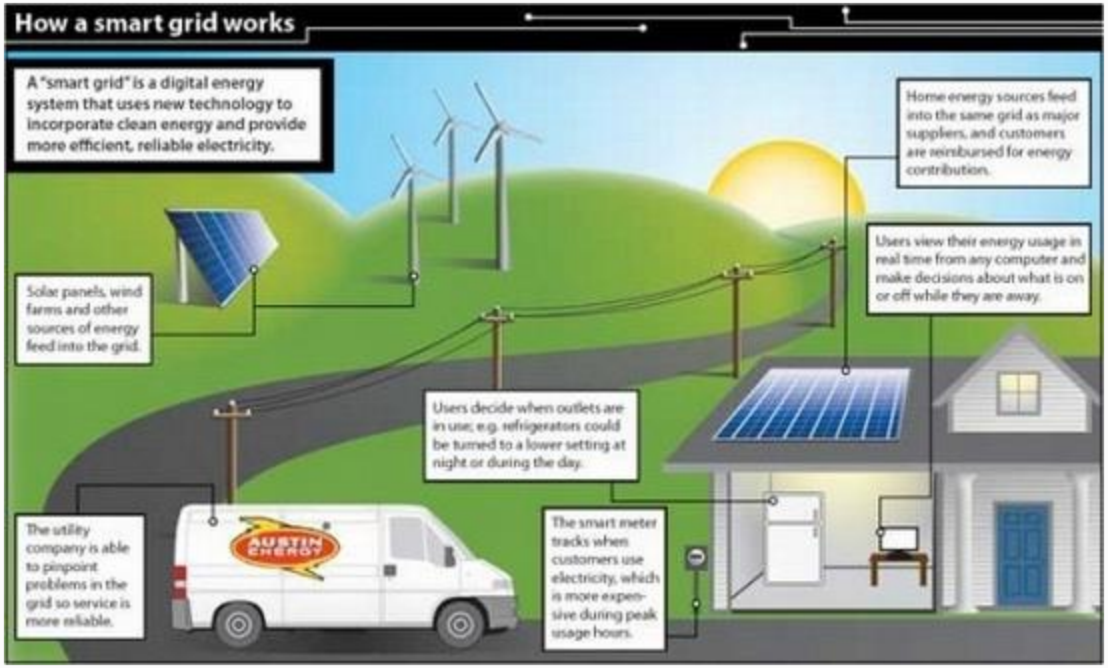

Eco Community
- Micro Grids
- V2G (2-way PHEV)
- Retail services
- Affinity groups

Utility Operations

APPLICATION EXAMPLES

Example applications

- Austin, Texas, 1st Smart Grid city in US/Worldwide



http://www.inhabitat.com/wp-content/uploads/15-grid-537x324.jpg

410,000 smart meters, 86,000 smart thermostats, 2,500 sensors, and 3,000 computers, servers, and other network components. One million consumers and 43,000 businesses are connected to a broadband network that is integrated with the grid in order to monitor, control, and maintain production, transmission, and consumption of electricity in Austin.

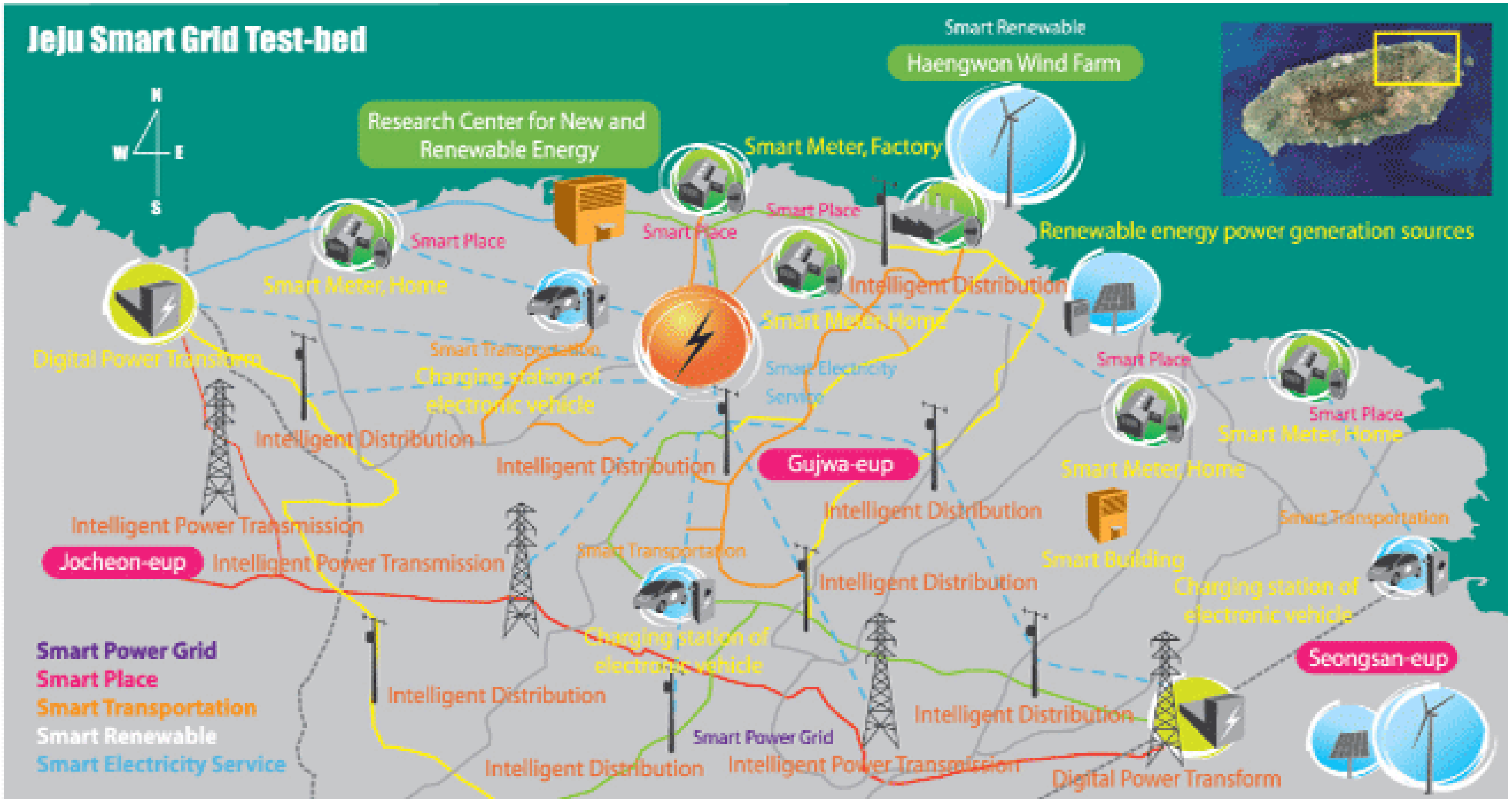
Example applications

- Smart Grid Demonstration Project on Jeju Island

http://www.nuritelecom.com/news/spotlight/jeju_smart_grid.html

Installation of smart meters (1,340 households), installation of rooftop solar power (114 households), Smart Transportation (30 vehicles), installation of battery chargers (95 units), Smart Renewables: Wind power (15.MW×3 turbines), solar power (100kW), power storage system

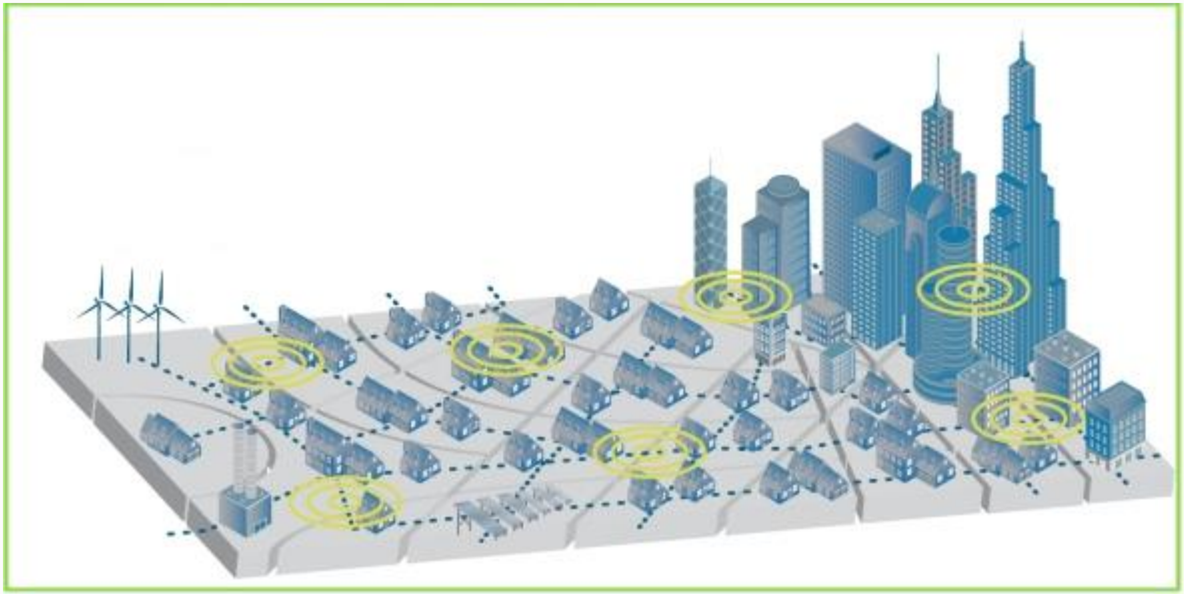
Example applications



https://ecoleader.files.wordpress.com/2011/11/jeju-smart-grid-proof_con011.gif

Example applications

- Xcel Smart City in Boulder, Colorado
  - Involves the entire energy pathway from the power source to the home and all points in between
  - Rich in IT High-speed, real-time, two-way communications
  - Sensors enabling rapid diagnosis and corrections
  - Dispatched distributed generation (PHEVs, wind, solar)
  - Energy storage
  - In-home energy controls



http://smartgridcity.xcelenergy.com

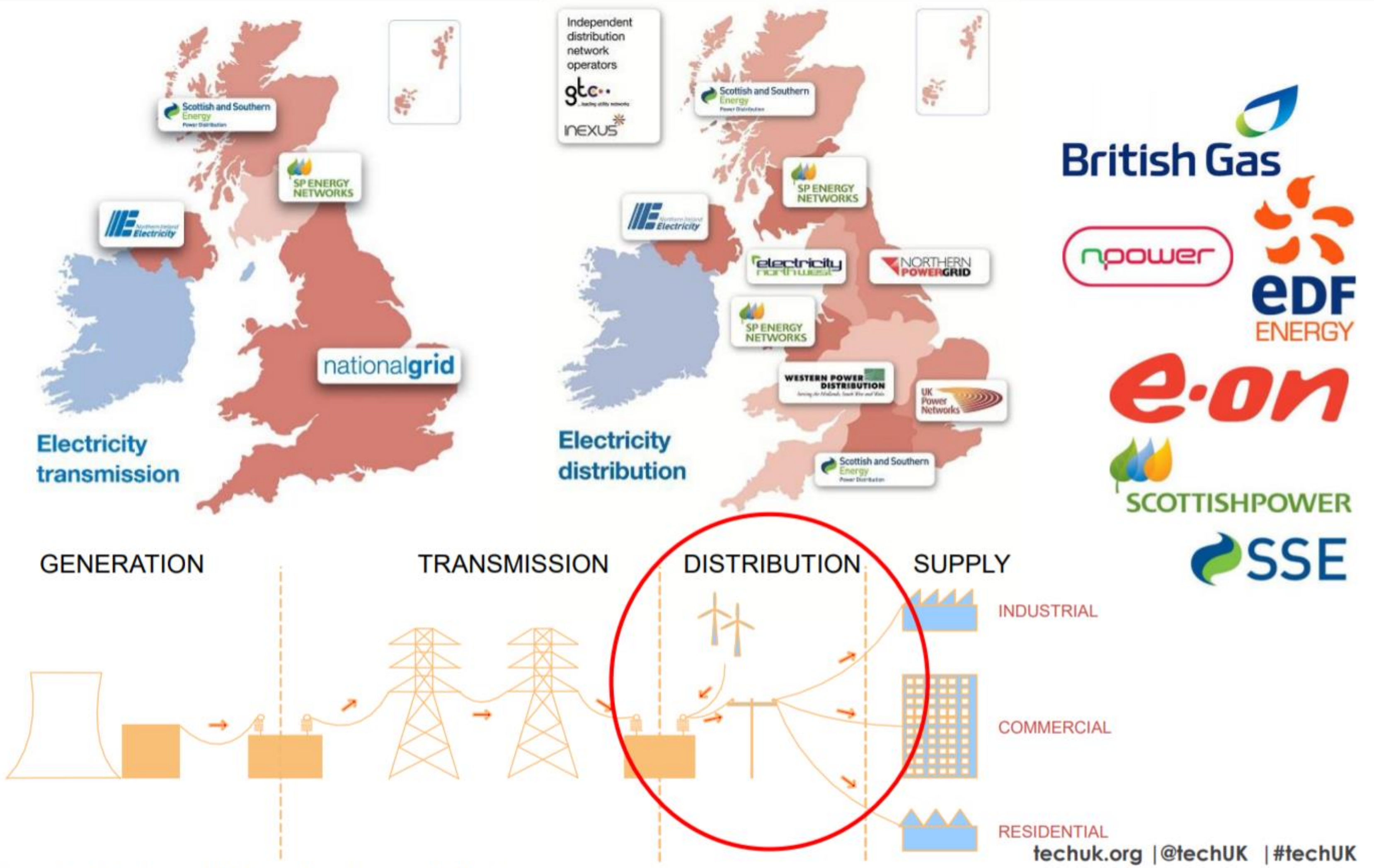
Example applications

- GE “Plug into the Smart Grid”

http://ge.ecomagination.com/smartgrid

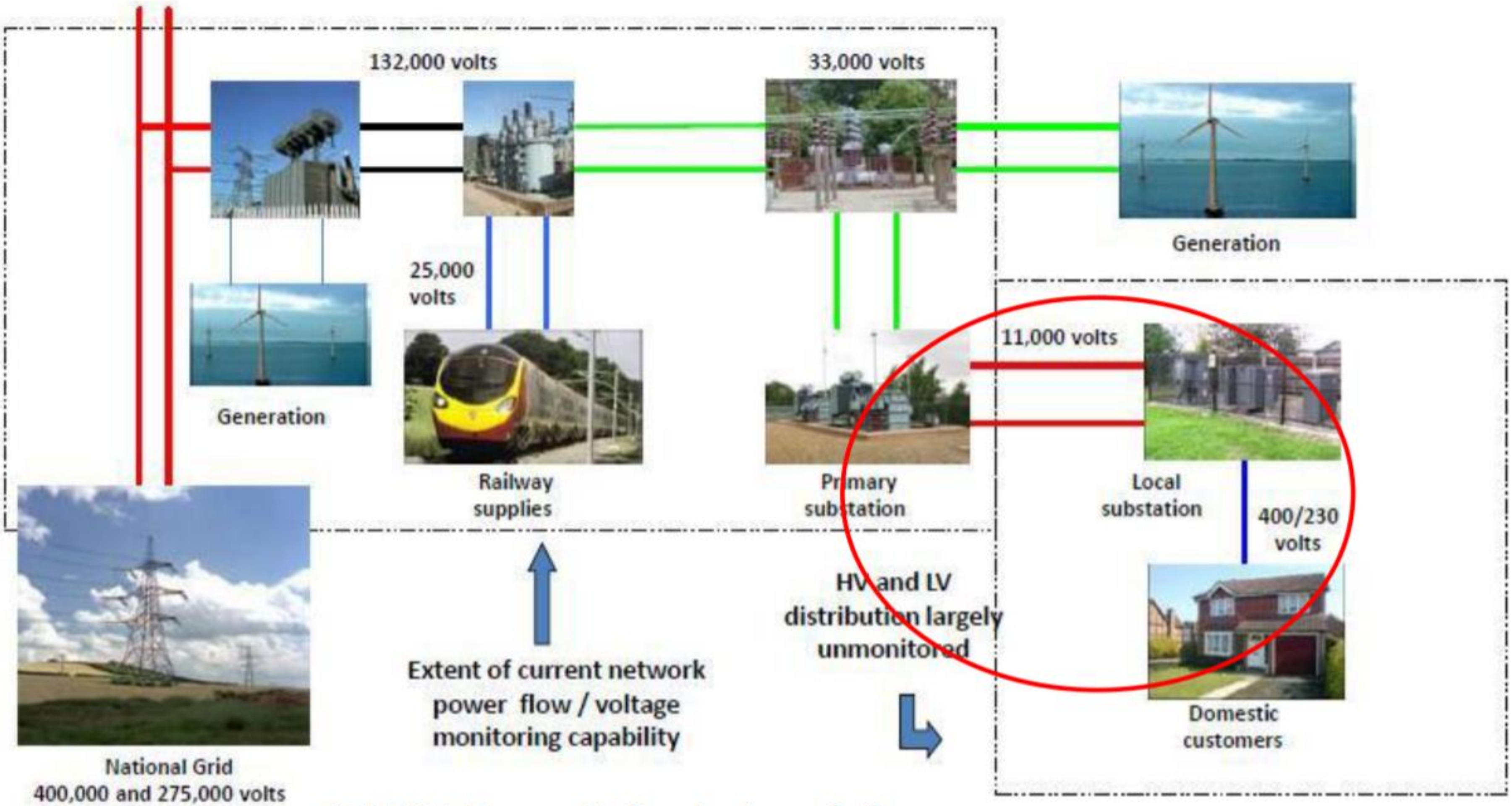
THE UK SMART GRID

UK Market Structure



Source: Energy Networks Association

UK Transmission and Distribution Networks



SOURCE: Energy Networks Association

Phase 1 – UK Smart Meter Plan

- Nationwide rollout to take place from 2015 to 2020, 53 million meters, approx. 26 million homes
- The ‘big six’ energy suppliers are leading the rollout, coordinated by government with industry support
- The creation of a centralized Data and Communications Company (DCC) underpinned by Communications Services and Data Services
- Lays a new national infrastructure to enable greater understanding of our energy networks and consumer behavior – and a whole new market to use it....

Phase 1 – UK Smart Meter Plan

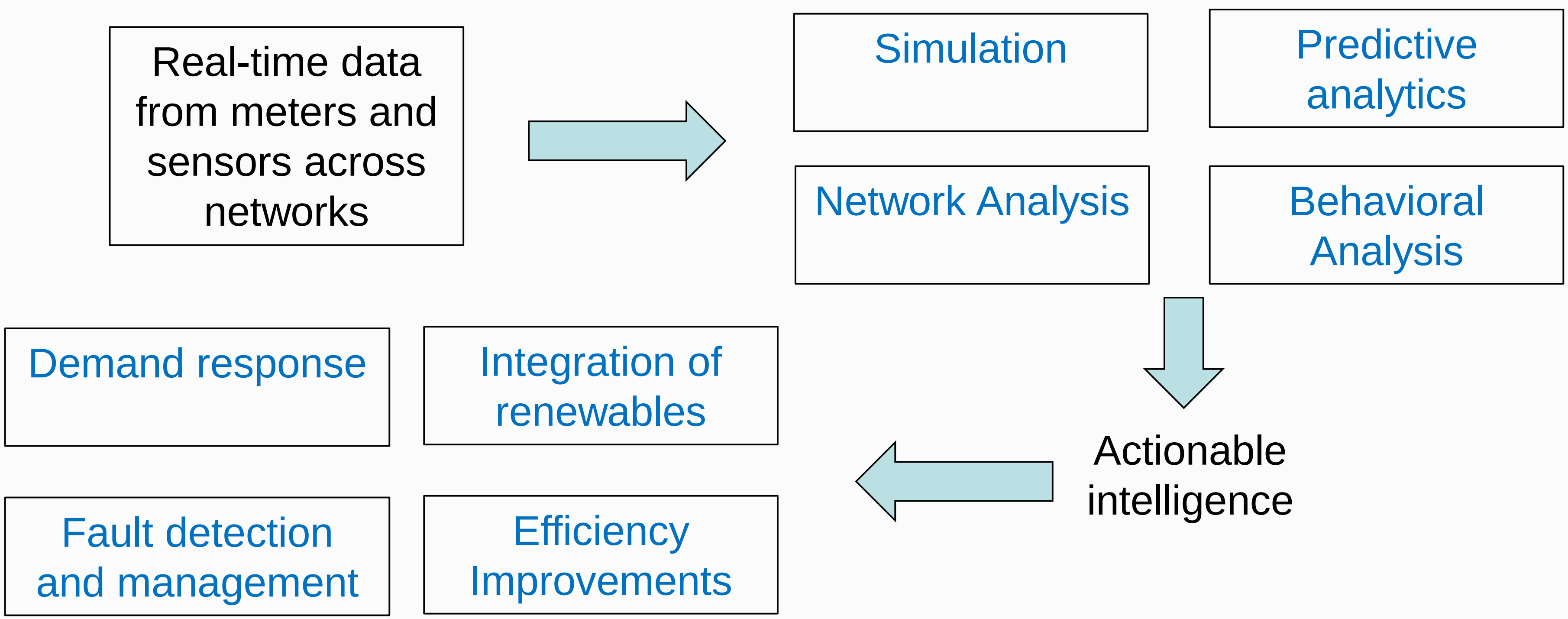
The plan of smart meters in the UK is being coordinated by the Department of Energy and Climate Change (DECC). It will be governed by industry regulator Ofgem once the meters are in place. The ICT community provide the ‘smart’ to a traditional industry via:

- **Communications Services** – Transferring huge new volumes of energy data to the DCC
- **Data Services** – Controlling, securing and using that data to improve the energy system
- **In Home Displays** – Engaging customers in their energy usage
- **Consumer Access Devices** – Building on this to develop an integrated ‘smart home’

Phase 2 – Realising a UK Smart Grid

Smart meters will provide suppliers and networks with vast amount of new data on energy usage, consumer behavior, network operations and distribution weak points....

How to use this data effectively is a key pillar of the smart grid



Core Costs and Benefits

- **£46bn** Spend required if only conventional technologies are employed
- **£27bn** Spend required for deployment of a smart grid

The saving could be £19bn

Source: techuk.org

CONCLUSIONS

Conclusions

- Smart Grid is the next generation Power Grid
- Involve many new technologies
- Cooperation within multiple areas of research
- Billions investment by governments

It’s a big deal!!!

Conclusions

- Remember how the telecom industry looked and acted twenty years ago
- Be prepared for big changes to your relationship with electricity!

Thank You

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