HADAS
HETEROGENEOUS AUTONOMOUS DISTRIBUTED DATA SERVICES

Data Management Challenges in Smart Grids

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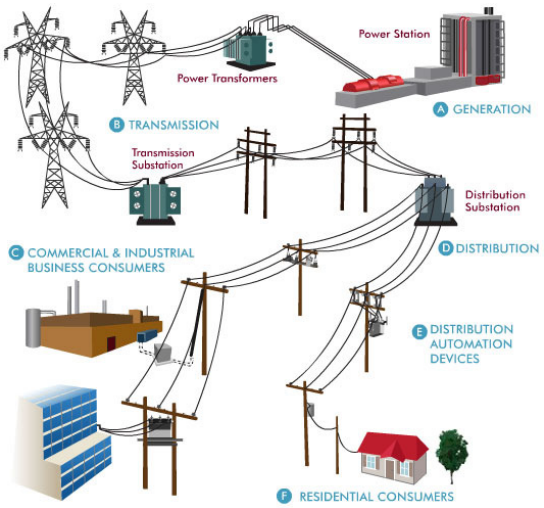
THE TRADITIONAL POWER GRID

- The grid we are using
  - Many implementation decisions were made 120 years ago…
  - Three main components
    - Power generation
    - Power Transmission
    - Power distribution



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

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THE TRADITIONAL POWER GRID

- Problems with current Power Grid
  - It is not efficient
    - Transmission losses ≈ 20%
    - Only 30% of the energy produced is finally consumed
    - Why ?
      - No high reactivity level of power generation sources
      - Avoid blackout at all cost !!
      - Bad exploitation of new/renewable power generation sources
      - No real prediction of energy consumption
  - Bad business model
    - Only one energy provider

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THE TRADITIONAL POWER GRID

- Problems with current Power Grid
  - It has not kept pace with modern chall
    - Limited alternative power generati
    - No solution for conservativ
    - Un-interruptible ene
    - Poor situatio
    - Poor
    - ent of distribution
    - ts from energy suppliers or cyber

A « smarter » grid is needed !

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OUTLINE

- Traditional Power Grid
- Smart Grid
  - What is a Smart Grid ?
  - Key Technologies
- Current Example Applications
- Data management challenges

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WHAT IS A SMART GRID ?

- Smart Grid is an application of digital information technology to optimize electrical power generation, delivery and use
  - Optimize power delivery and generation
  - Self-healing
  - Consumer participation
  - Resists attack
  - High quality power
  - Accommodate generation options

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WHAT IS A SMART GRID ?

- Optimize power delivery and generation
  - Advanced efficient power generation
    - Energy storage
  - Low loss delivery power lines
- Self-healing
  - Real-time awareness and reaction of system problems
- Consumer participation
  - Consumer can monitor and control "smart appliances" to manage energy use and reduce energy cost
  - Prediction of energy consumption

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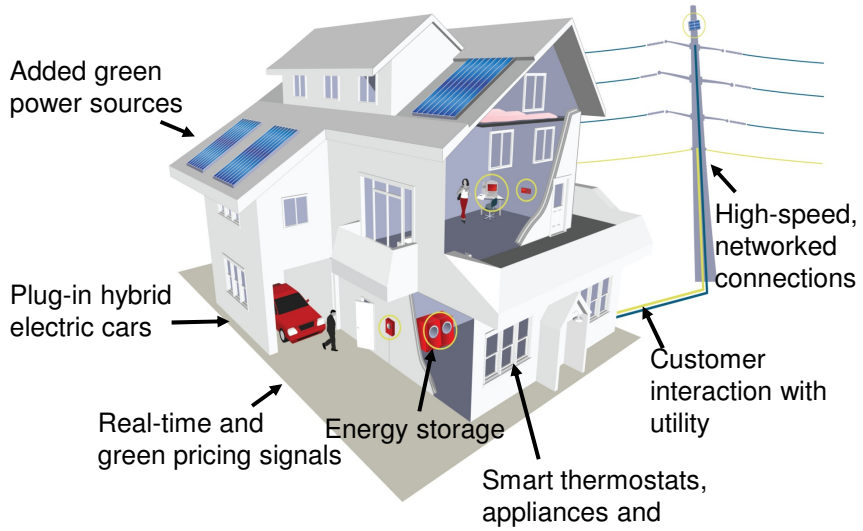
WHAT IS A SMART GRID ?



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

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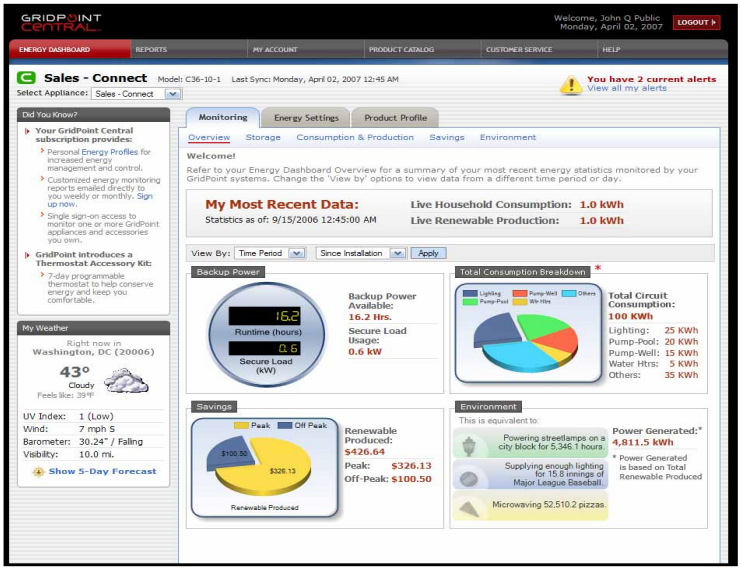
WHAT IS A SMART GRID ?



Consumer participation [1]

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WHAT IS A SMART GRID ?

- Resist attack
  - 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
- High quality power
  - Reduce high losses due to outages and power quality issues
  - Those issues costs US more than $ 100 billion each year !!!

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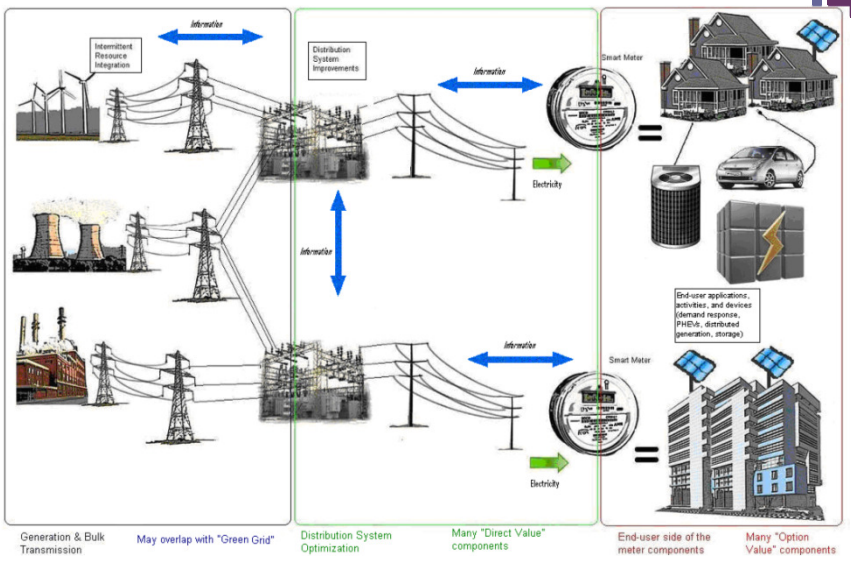
WHAT IS A SMART GRID ?



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KEY TECHNOLOGIES

- Integrated communications
  - 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
  - Examples
    - Zigbee
    - WiMAX
    - WiFi
    - PLC 3

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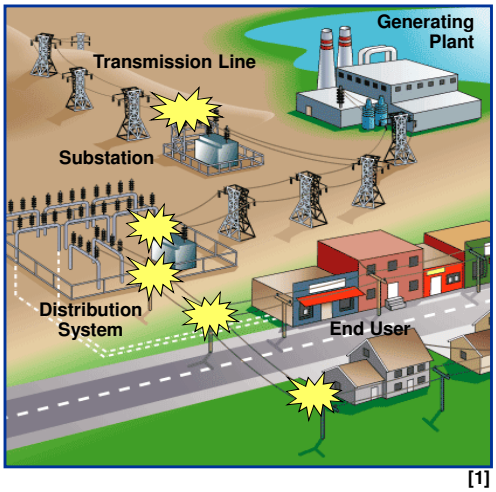
KEY TECHNOLOGIES

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



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KEY TECHNOLOGIES

- 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

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KEY TECHNOLOGIES

- 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

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KEY TECHNOLOGIES

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

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FUIJAN POWER GRID CHINA

- Wide area protection system:
- AI programming techniques to calculate control strategies
- Voltage Stability Monitoring & Control (VSMC) software:
- Sensitivity-based successive linear programming method to determine optimal control solution

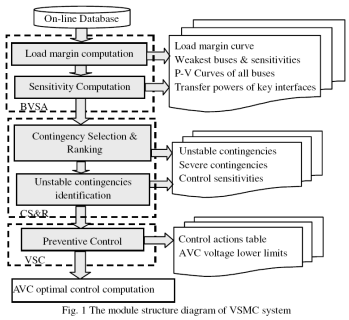
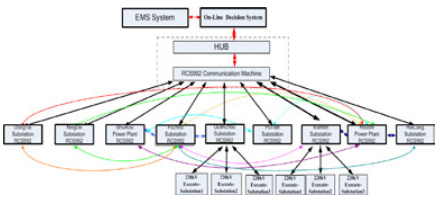
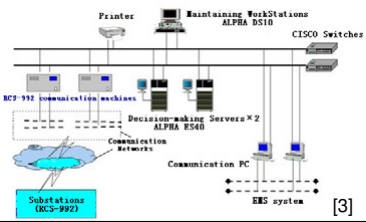


Fig. 1 The module structure diagram of VSMC system





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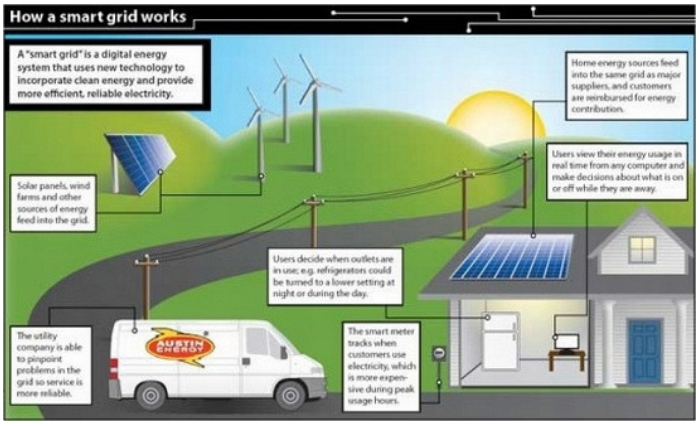
1ST SMARTGRID CITY IN US



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

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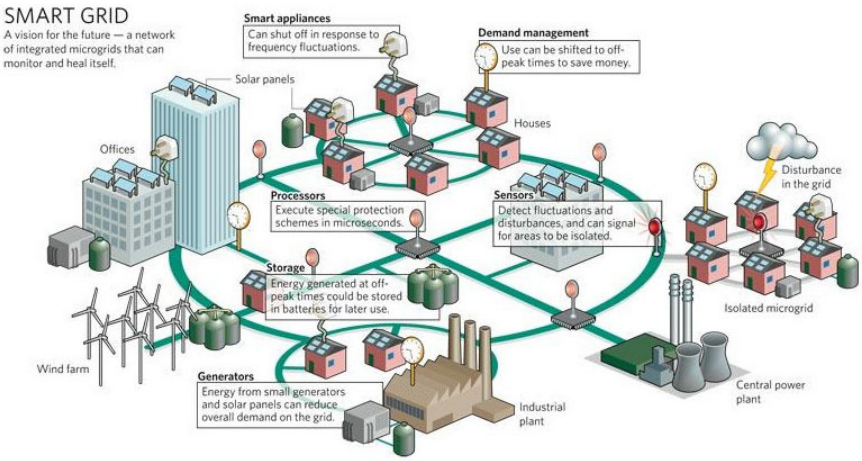
ENERGY SMART IN MIAMI



http://tinycomb.com/wp-content/uploads/2009/05/smart-grid.jpg

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GE PLUG INTO THE SMART GRID

PlugIntoTheSmartGrid.com

http://ge.ecomagination.com/smartgrid

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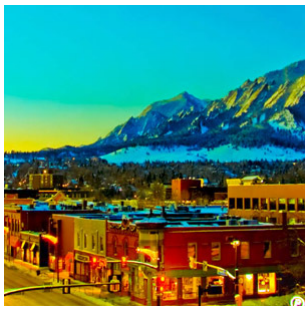
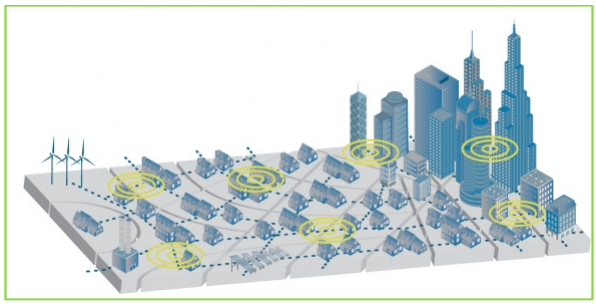
XCEL SMART CITY IN BOULDER





http://smartgridcity.xcelenergy.com

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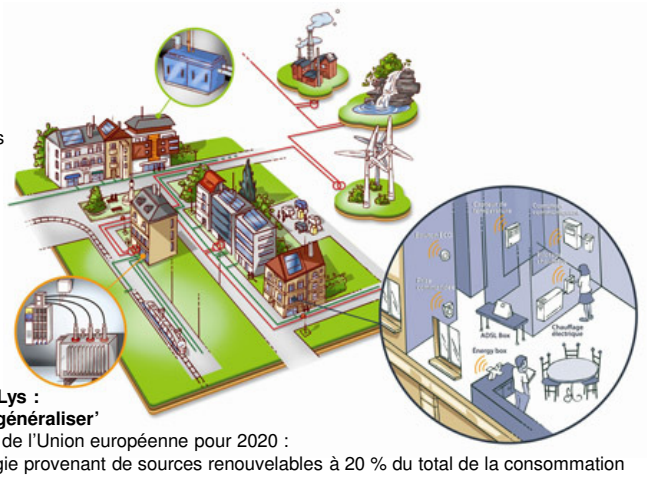
GREENLYS (GRENOBLE ET LYON)

Avec près de 40 millions d'euros d'investissement sur 4 ans (2011-2014), **le projet GreenLys va tester le fonctionnement d'un réseau électrique intelligent dans sa globalité** en créant un démonstrateur grandeur nature qui intègre le consommateur, les installations d'énergies renouvelables (photovoltaïque, hydroélectricité,…), les véhicules électriques, les compteurs communicants Linky.



L'ambition du projet GreenLys :
'Expérimenter, partager et généraliser'
1. Les objectifs énergétiques de l'Union européenne pour 2020 :
• augmenter la part de l'énergie provenant de sources renouvelables à 20 % du total de la consommation (objectif français 23 %),
• réduire la consommation d'énergie de 20 %,
• réduire les émissions de gaz à effet de serre de 20 %.

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PLATEFORME PREDIS (GRENOBLE INP)

Des enjeux importants
Les trois moteurs de l'offre Prédis sont :
- Le développement du territoire au travers d'un projet fédérateur destiné à regrouper et à former les acteurs de demain aux nouveaux métiers de l'énergie
- La prise en compte des impératifs économiques et politiques de la filière énergie en forte évolution : mondialisation, libéralisation de l'énergie, dépendance énergétique ...
- Les exigences environnementales de plus en plus fortes : économie du système, réduction des émissions de gaz à effet de serre, comportement sociétal

Les domaines d'applications :
- Production d'énergie décentralisée et renouvelable
- Gestion intelligente des réseaux et marchandisation de l'énergie
- Usages de l'énergie et technologies basse consommation

Plateformes technologiques :
- Atelier Intégré d'Automatique
- Electronique et instrumentation associée
- Espace associatif pour étudiants et professionnels
- Image et signal pour l'énergie et l'environnement
- Informatique industrielle
- Monitoring et Habitat Intelligent
- Pilotage/Commande et réseaux
- Production décentralisée d'énergie
- Supervision
- Traitement de l'énergie (électronique de puissance)

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DATA MANAGEMENT CHALLENGES

- Efficient Handling of Data (sources)
  - Wide sensor/actuator networks
  - Heterogeneous networks (PLC, xDSL, WiFi, …) Coordinated Static data and/or dataflow management ?
  - Dynamic and autonomous data sources

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Data Management Challenges

- Observation of the Grid For monitoring and control
- Event generation/composition/consumption models
  - Mechanism for taking decision : Active rules, machine learning, …

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Data Management Challenges

- Data integration
  - Of Heterogeneous data sources
- Historic, Traces, Visualization
- Data analysis and prediction
  - Trace analysis, behavior analysis
  - Consumption prediction, definition of adaptive strategies
  - Machine learning

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REFERENCES

- [1] Craig Eicher, "SmartGridCity: Developing the Smart Grid of the Future", Xcel Energy, Presentation.
- [2] Westar Energy, "Smart Grid", Presentation, Jun, 2009
- [3] Jinquan Zhao, Wenying Huang, Zhaoxiong Fang, Feng Chen, Kewen Li and Yong Deng, "On-Line Voltage Stability Monitoring and Control (VSMC) System in Fujian power grid", Proceedings, Power Engineering Society General Meeting, 2007.
- [4] Peng Zhang, Tennessee Technological Univ., "An Introduction to Smart Grid", Presentation, 2011

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THANKYOU

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