

# The Smart Grid Vision

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# Outline

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Why look at smart grid

Defining a smart grid

Three paths to a smart grid

Systems view

How to avoid vendor lock-in and technology obsolescence

Communication network is a corporate strategic investment

How you too can build a regional smart grid

# Why look at smart grid

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# Headlines

## Environment

- Green House Gas
- Energy Independence



## Legislation

- EPACT 2005
- EISA 2007
- EESA 2008



# Supports the Environment

Enables renewable and clean energy

Enables Vehicle to Grid interface

- Electric Vehicles
- Plug-in hybrid Electric Vehicles

Reduces spinning reserves

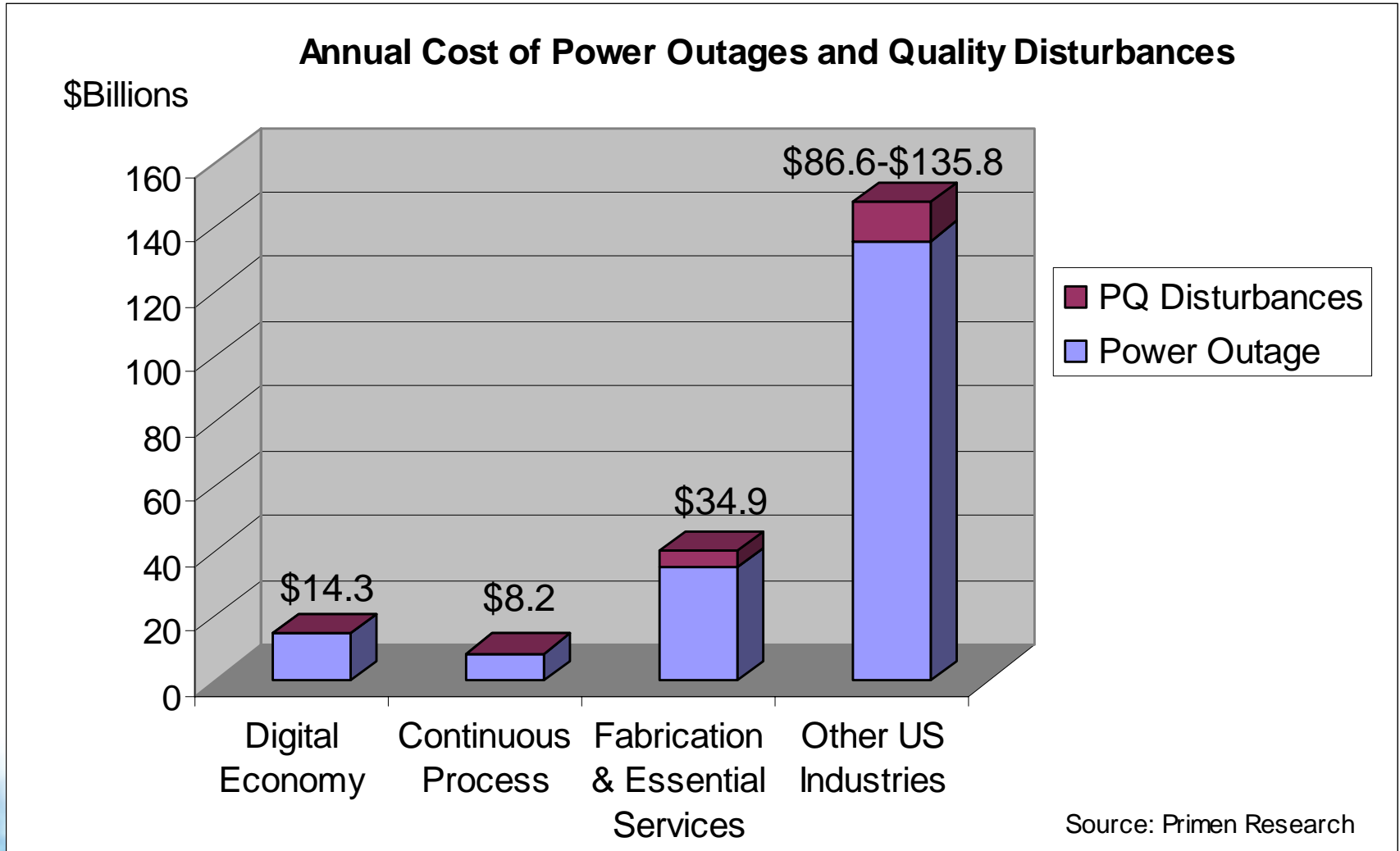
Supports alternative energy supplies

- Reduces dependence on foreign oil

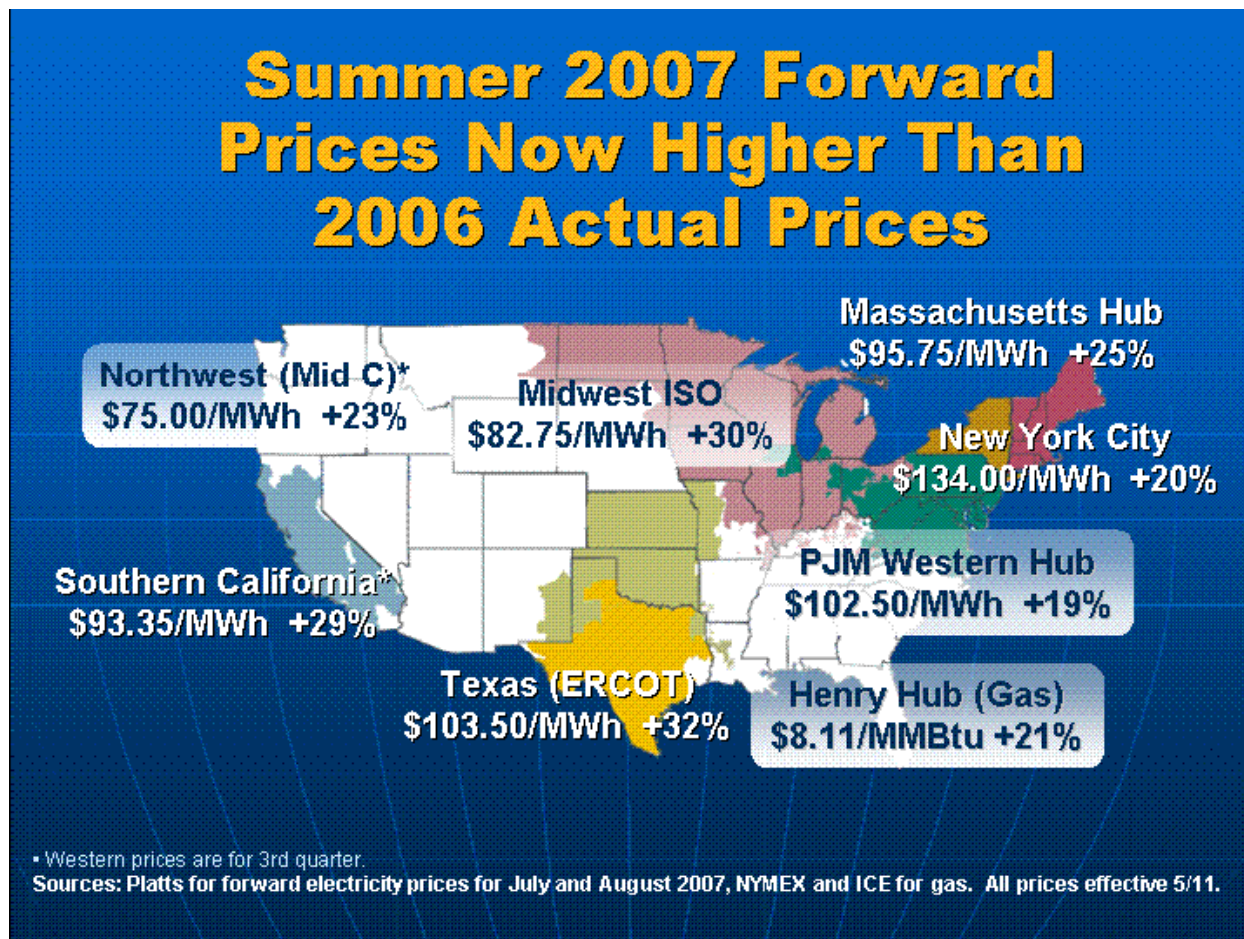
Supports customer choice (photovoltaics)



# Power Disturbance Costs



# Energy Prices



Forward electricity prices are a straightforward signal of anticipated price pressures this summer. The map illustrates recent key summer 2007 forward electricity and natural gas prices. In all, markets are signaling double-digit electricity price increases this summer over last, with natural gas as a clear driver.

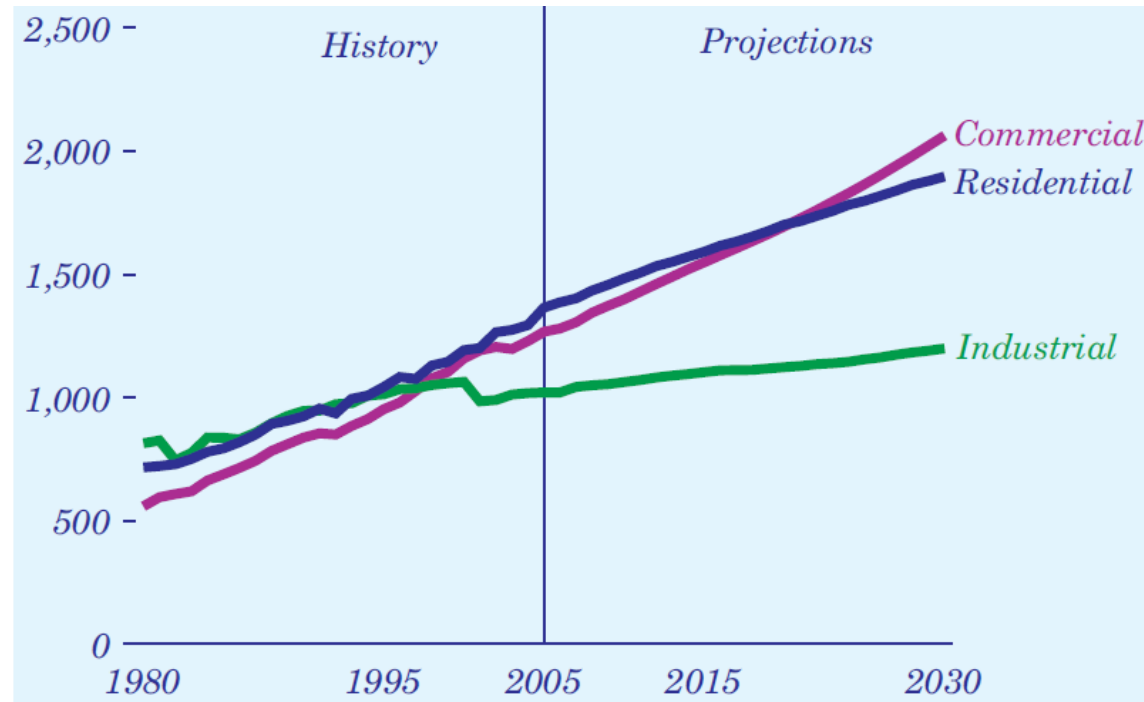
- *FERC 2007 Market Oversight*

# Energy Demand Growth

Total electricity sales are projected to increase from 3,660 billion KWhr in 2005 to 5,168 billion KWhr in 2030.

The largest increase is in the commercial sector, as service industries continue to drive growth.

Electricity sales are strongly affected by the rate of economic growth.



DOE Report, May 2007

# Increasing Smart Grid Stakeholders



## Policy & Regulation

- FERC
- PUC's
- NERC
- NARUC

## Government

- Federal
- State
- Local

## Utilities

- IOU's
- Publics
- RTO / ISO
- Power marketers



## Others

- EPRI
- Financial Firms
- R&D Organizations

## Advocacy

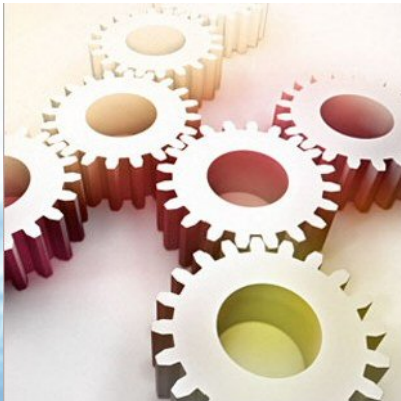
- EEI
- Rate Payer Groups
- Environmental Groups

## Vendors

- Technology
- Services

## Consumers

- Industrial
- Commercial
- Residential



**SDGE**

A Sempra Energy utility

# Federal Analysis

## DOE's Modern Grid Initiative

A Vision for the Modern Grid

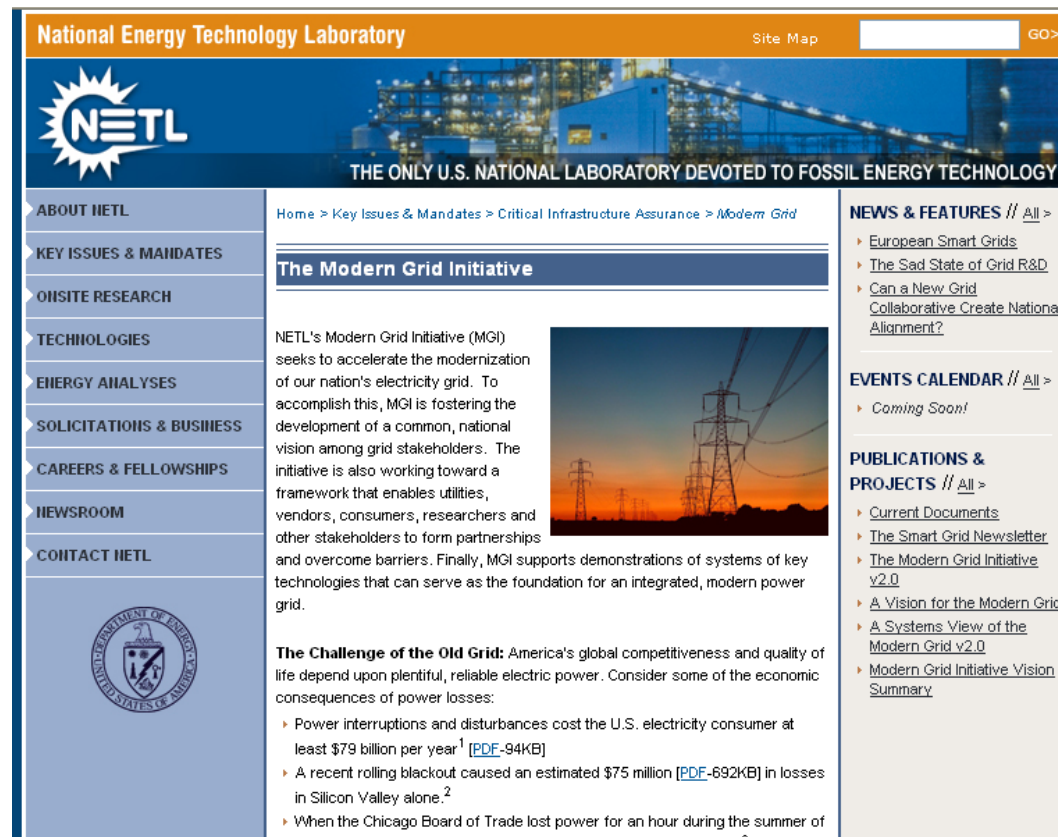
Characteristics of the Modern Grid

Technologies of the Modern Grid

Benefits of the Modern Grid

The Modern Grid Stakeholder

Community



The screenshot shows the NETL website with the following content:

- Header:** National Energy Technology Laboratory, Site Map, GO>
- NETL Logo:** THE ONLY U.S. NATIONAL LABORATORY DEVOTED TO FOSSIL ENERGY TECHNOLOGY
- Navigation Menu:** ABOUT NETL, KEY ISSUES & MANDATES, ON-SITE RESEARCH, TECHNOLOGIES, ENERGY ANALYSES, SOLICITATIONS & BUSINESS, CAREERS & FELLOWSHIPS, NEWSROOM, CONTACT NETL
- Breadcrumbs:** Home > Key Issues & Mandates > Critical Infrastructure Assurance > Modern Grid
- Section Title:** The Modern Grid Initiative
- Main Text:** NETL's Modern Grid Initiative (MGI) seeks to accelerate the modernization of our nation's electricity grid. To accomplish this, MGI is fostering the development of a common, national vision among grid stakeholders. The initiative is also working toward a framework that enables utilities, vendors, consumers, researchers and other stakeholders to form partnerships and overcome barriers. Finally, MGI supports demonstrations of systems of key technologies that can serve as the foundation for an integrated, modern power grid.
- Image:** A photograph of high-voltage power lines against a sunset sky.
- Section: The Challenge of the Old Grid:** America's global competitiveness and quality of life depend upon plentiful, reliable electric power. Consider some of the economic consequences of power losses:
  - Power interruptions and disturbances cost the U.S. electricity consumer at least \$79 billion per year<sup>1</sup> [PDF-94KB]
  - A recent rolling blackout caused an estimated \$75 million [PDF-692KB] in losses in Silicon Valley alone.<sup>2</sup>
  - When the Chicago Board of Trade lost power for an hour during the summer of 2003, it lost \$1.2 billion in trading volume.
- Right Sidebar:** NEWS & FEATURES // All > (European Smart Grids, The Sad State of Grid R&D, Can a New Grid Collaborative Create National Alignment?), EVENTS CALENDAR // All > (Coming Soon!), PUBLICATIONS & PROJECTS // All > (Current Documents, The Smart Grid Newsletter, The Modern Grid Initiative v2.0, A Vision for the Modern Grid, A Systems View of the Modern Grid v2.0, Modern Grid Initiative Vision Summary)
- Footer:** Department of Energy logo

# Advocacy to Modernize

## GridWise Alliance



GridWise vision is new way to think about how we generate, distribute and use energy - using advanced communications and up-to-date information technology, GridWise will improve coordination between supply and demand, and enable a smarter, more efficient, secure and reliable electric power system.

## GridWise Architecture Council

Assemble ideas & resources to ensure interoperability

Leverage the GridWise interoperability framework as an organizing platform

# Standards Create Markets



## OpenAMI

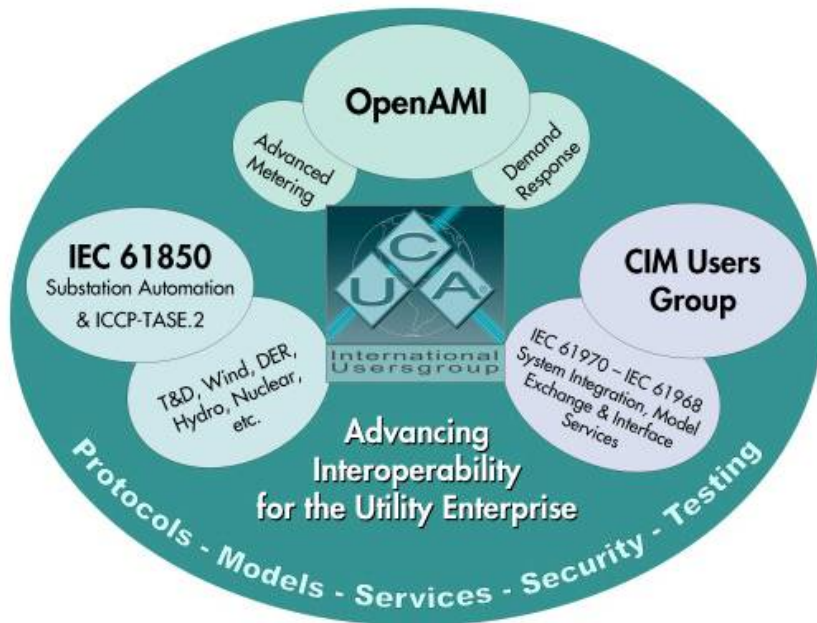
- 200+ members
- UtilityAMI
- OpenHAN
- OpenSEC
- AMI-ENT



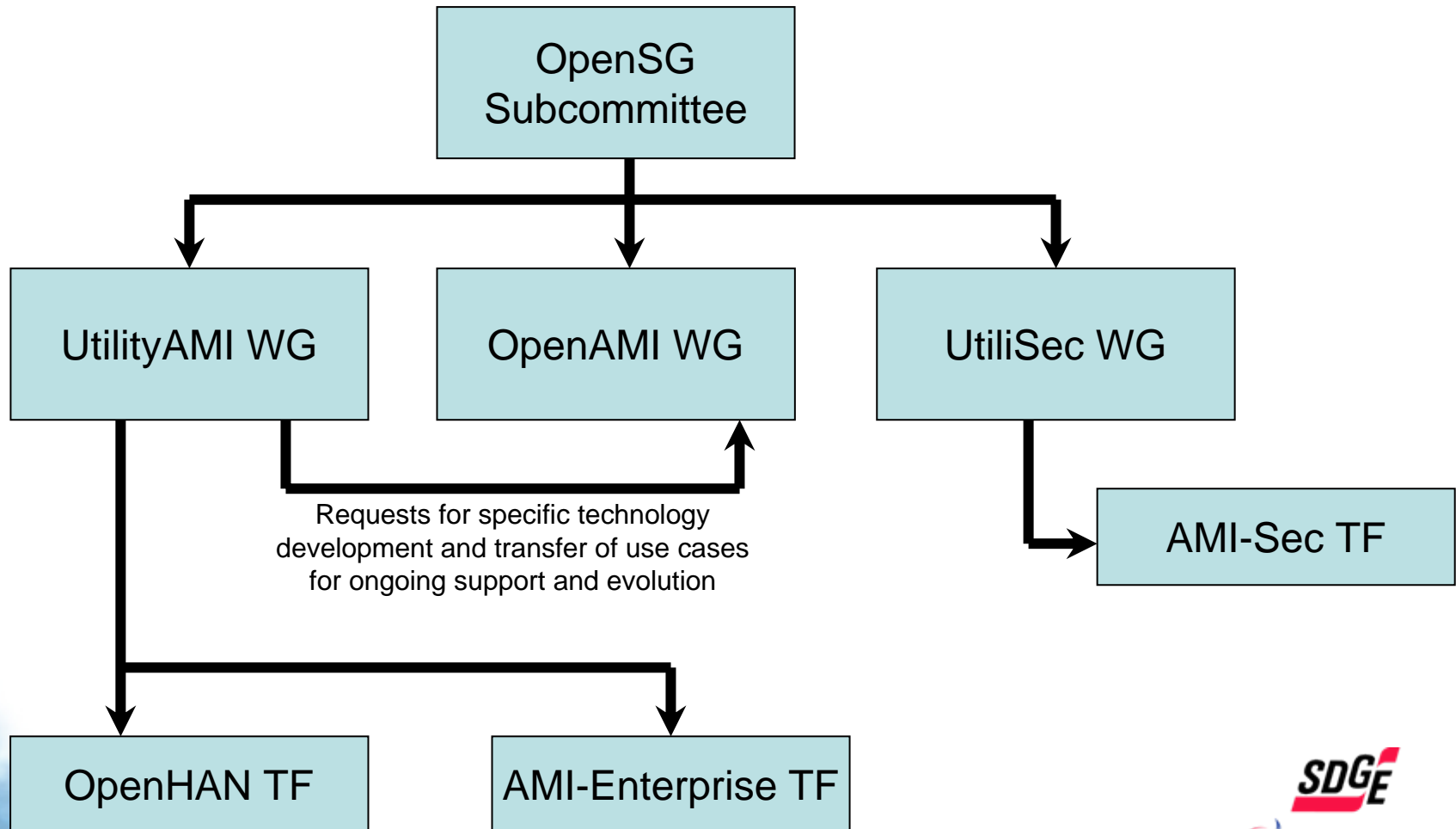
Open AMI is a User Community affiliated with the UCA International Users Group, a non-profit organization whose members are utilities, vendors, and users of communications for utility automation.

OpenAMI is represented by a Technical Subcommittee focused on OpenAMI issues, working in coordination with the UCAIUG Technical Subcommittees representing the IEC61850 and CIM users communities.

The UCAIUG's UtilityAMI User Community provides the "High-Level Advanced Metering Infrastructure and Demand Response System Requirements Input & Oversight" to the  OpenAMI Task Force. 



# OpenSG Organization (Part of IEC WG)



# Defining the smart grid

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# A smart, integrated grid

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Detects and fixes emerging problems

Incorporates measurement, diagnostics and feedback

Re-routes power flows

Enables loads and distributed resources

Incorporate advances in IT and communication technologies



# Characteristics

## Self-healing

- A grid able to rapidly detect, analyze, respond and restore from perturbations.

## Empower and incorporate the consumer

- The ability to incorporate consumer equipment and behavior in the design and operation of the grid.

## Tolerant of attack

- A grid that mitigates and stands resilient to physical and cyber security attacks.

## Provides power quality needed by 21st century users

- A grid that provides a quality of power consistent with consumer and industry needs.

## Accommodates a wide variety of generation options

- A grid that accommodates a wide variety of local and regional generation technologies (including green power).

## Fully enables maturing electricity markets

- Allows competitive markets for those who want them.

## Optimizes assets

- A grid that uses IT and monitoring to continually optimize its capital assets while minimizing operations and maintenance costs.

# Technologies

## Grid-wide integrated communications

- Internet for the power grid

## Sensing, metering, measurement

- Digital two-way communication devices
- Enable generation connect and disconnect
- Enhance operator information

## Advanced control capabilities

- Computer based grid monitoring
- Enables dispatch of distributed resource

## Advance grid components











































- Energy storage
- Distributed generation

## Decision Support

- Analytics to guide grid operators
- Semi-autonomous agent software

# Characteristics and Key Technologies

 = high influence  
  = medium influence  
  = low influence

Characteristic Mutual Influence To Key Technology	Self Healing	Empowers Consumer	Attack Tolerant	Power Quality	Generation Options	Enables Energy Markets	Asset Optimization
Integrated Communications							
Digital Power System							
Automated Distribution							
Transformed Metering							
Integrated DER							
Enhanced Efficiency							

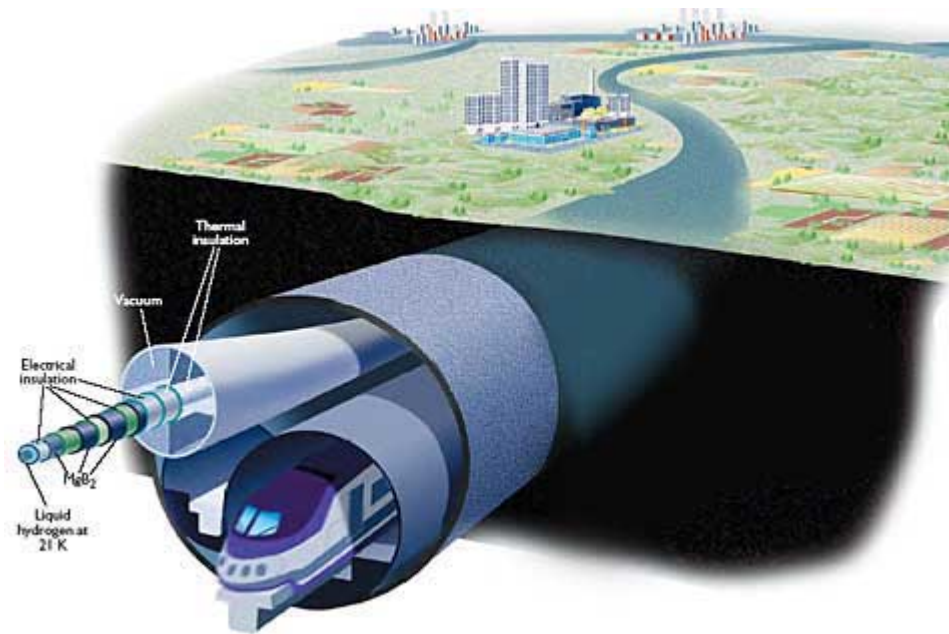
# Three paths to a smart grid

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# Vision

## Electric grid evolves

- Ubiquitous communications backbone
- Operational technologies
- Information technologies



# Three paths to starting a regional smart grid

## Organic – business as usual

- Huge capital expenditures as assets retire
- New technologies lead to declining costs

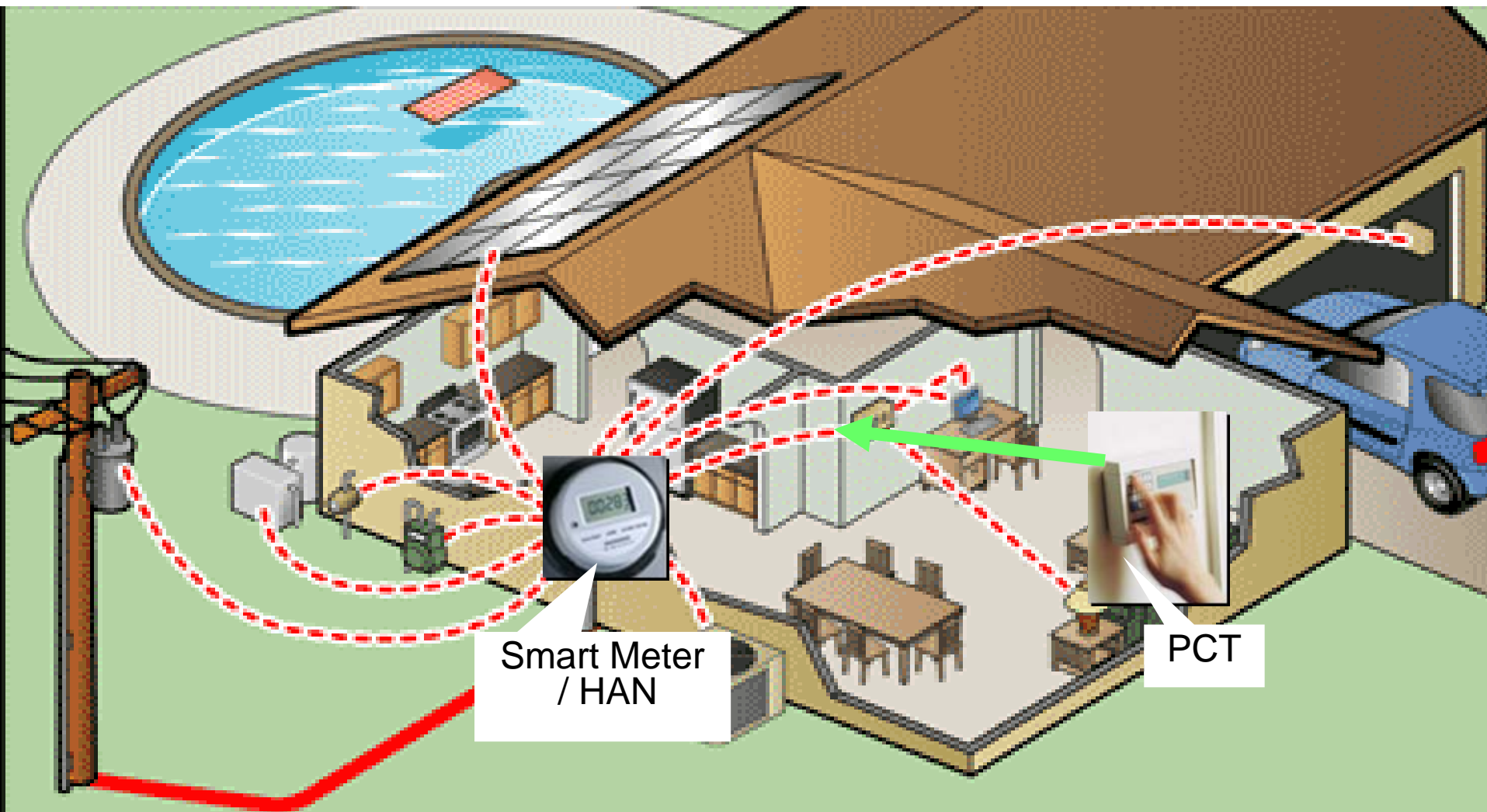
## Utility of the future

- Spread costs across several projects

## Smart Meter

- Communication infrastructure is key
- Digital electric meters are also sensors

# Smart Grid, Meter, Home



# Smart Grid – it's a concept, not a system

Interactive with Consumers and Markets

Adaptive

Optimized to make best use of resources

Predictive rather than reactive to prevent emergencies

Accommodates a variety of generation options

Integrated

- merging monitoring
- control
- protection
- maintenance

Secure from attack



# Smart Meter - It's more than meters, it's foundational

## Digital Meters

- Data storage
- Calibrated
- Upgradeable Software
- Bi-directional, secure communication
- “near” real-time rates and energy measurement

Remote connect and disconnect

Home Area Network

Designed for distribution automation, distributed generation, autonomous islanding

Net metering for consumer generation choices

- Hydrogen
- Solar
- Electric vehicles

New utility applications – OMS, DMS, GIS, ERP, SOA

Fiber and wireless everywhere – transmission and distribution

Blurring the lines between IT and Electric T&D



# Smart Home - It's consumer choice

Alignment with Renewable Energy, Demand Response & Energy Efficiency Goals

Infrastructure, tariffs, programs & services

Energy usage measurement protocol

Educate customers about

- Pricing & the time varying nature of the cost of energy
- Actions that can be taken to impact usage & lower energy bills
- The environmental benefits of reducing energy usage & renewable energy

Requires an Interactive Customer Interface for information & resources

- A universal platform (open architecture)
- Technology that utilizes smart meter / HAN

# Self Healing Grid

## Decentralized

Requires specific field hardware

Localized communication

Limited software and circuit modeling costs

## Pilot project:

- initiated energized October 2007
- installed Summer 2007
- energized Oct 2007

## Centralized:

Currently implementing on 4 pilot circuits



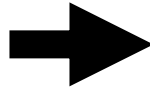
**SDGE**

A  Sempra Energy utility™

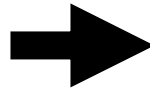
# HAN Capabilities with related Device Commissioning & Program Enrollment

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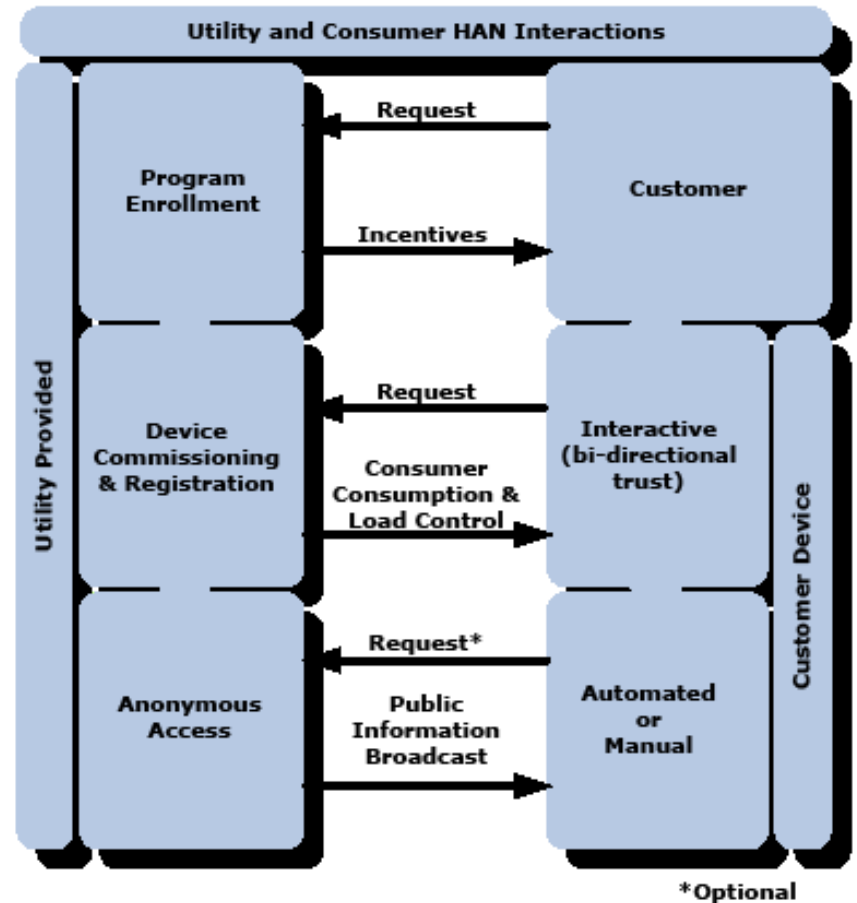
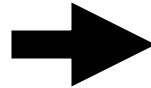
**Control Signaling**  
(e.g., Load Control)



**Consumer Specific Signaling**  
(e.g., Meter Data Access)



**Public Price Signaling**  
(e.g., CPP Event Notification)



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# Systems view

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# Systems View

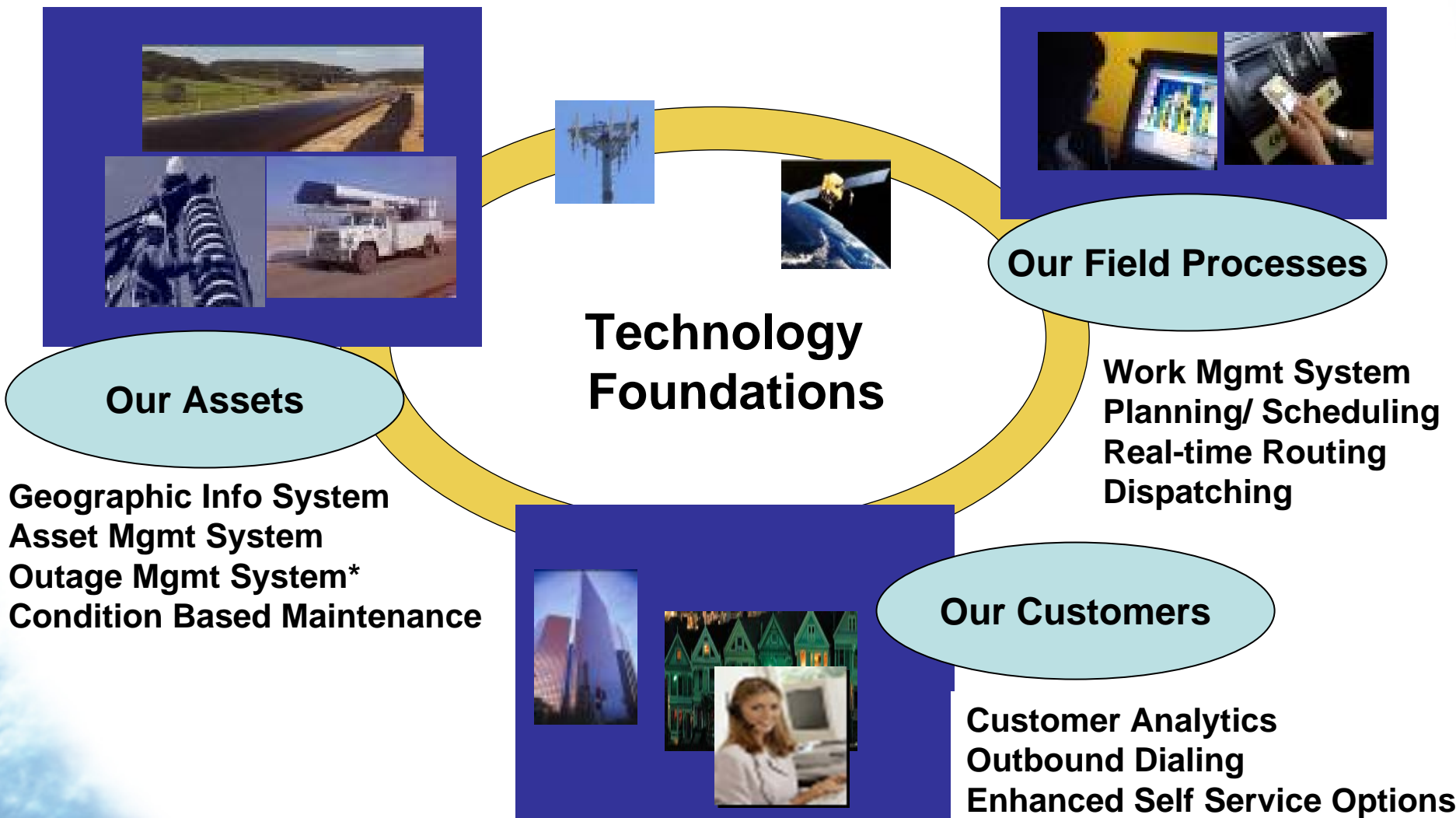
The “Systems View” perspective takes a holistic and objective approach to a subject, including technical, economic, regulatory, political, and societal aspects.

It includes the complete recognition of the power system as one integrated machine having many interdependent parts.

It recognizes that solutions can come from a wide and diverse range of sources.

A “Systems View” also takes account of the full range of costs and benefits to society associated with the provision of reliable power.

# Renovating Key Operating Systems



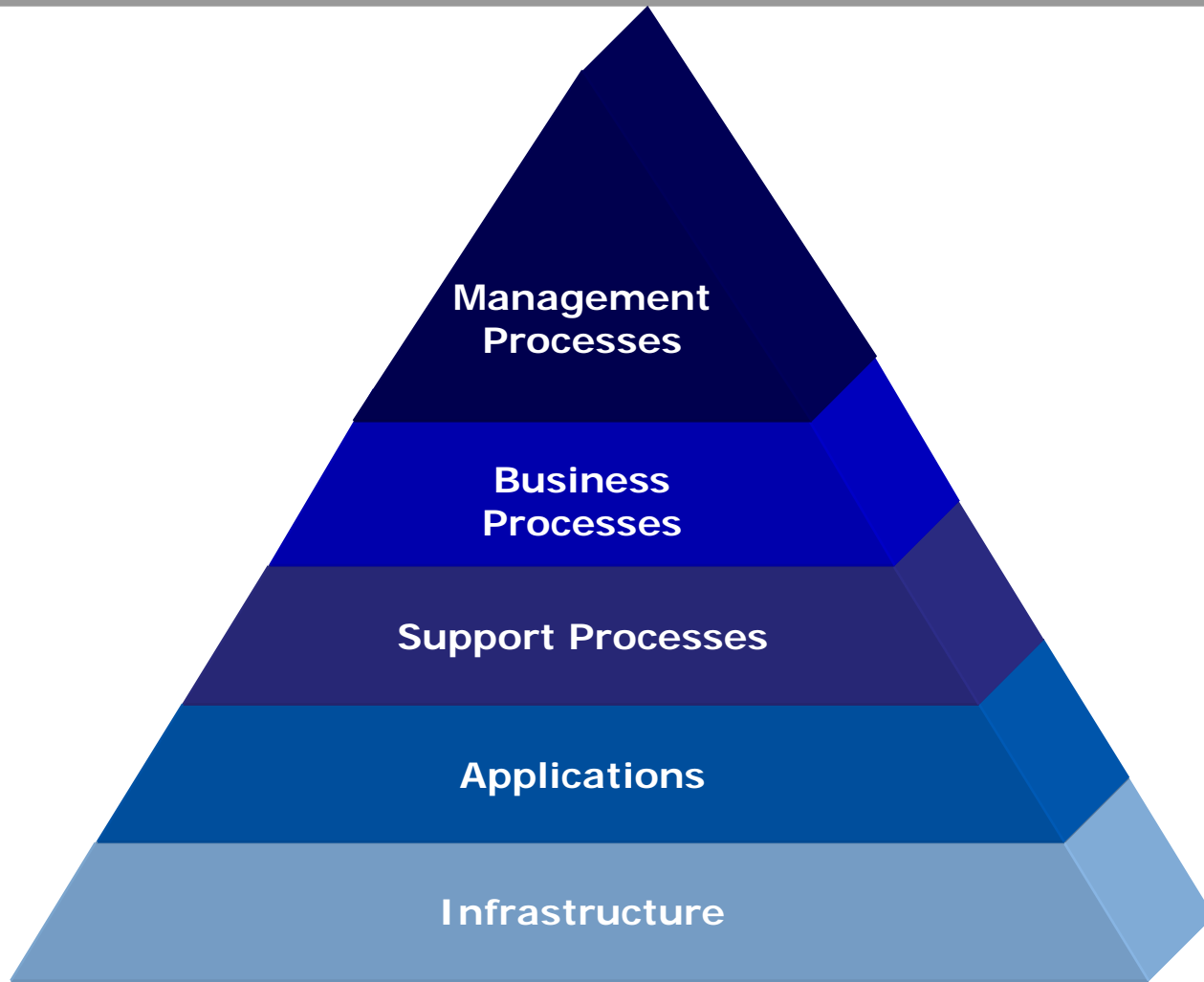
**Current State – Data IS NOT Easily Visible Across Operational Units**

**Future State – Easily Visible Data Across Operational Units**

# How to avoid vendor lock-in and technology obsolescence

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# Levels of Optimization



## Hierarchy of Needs

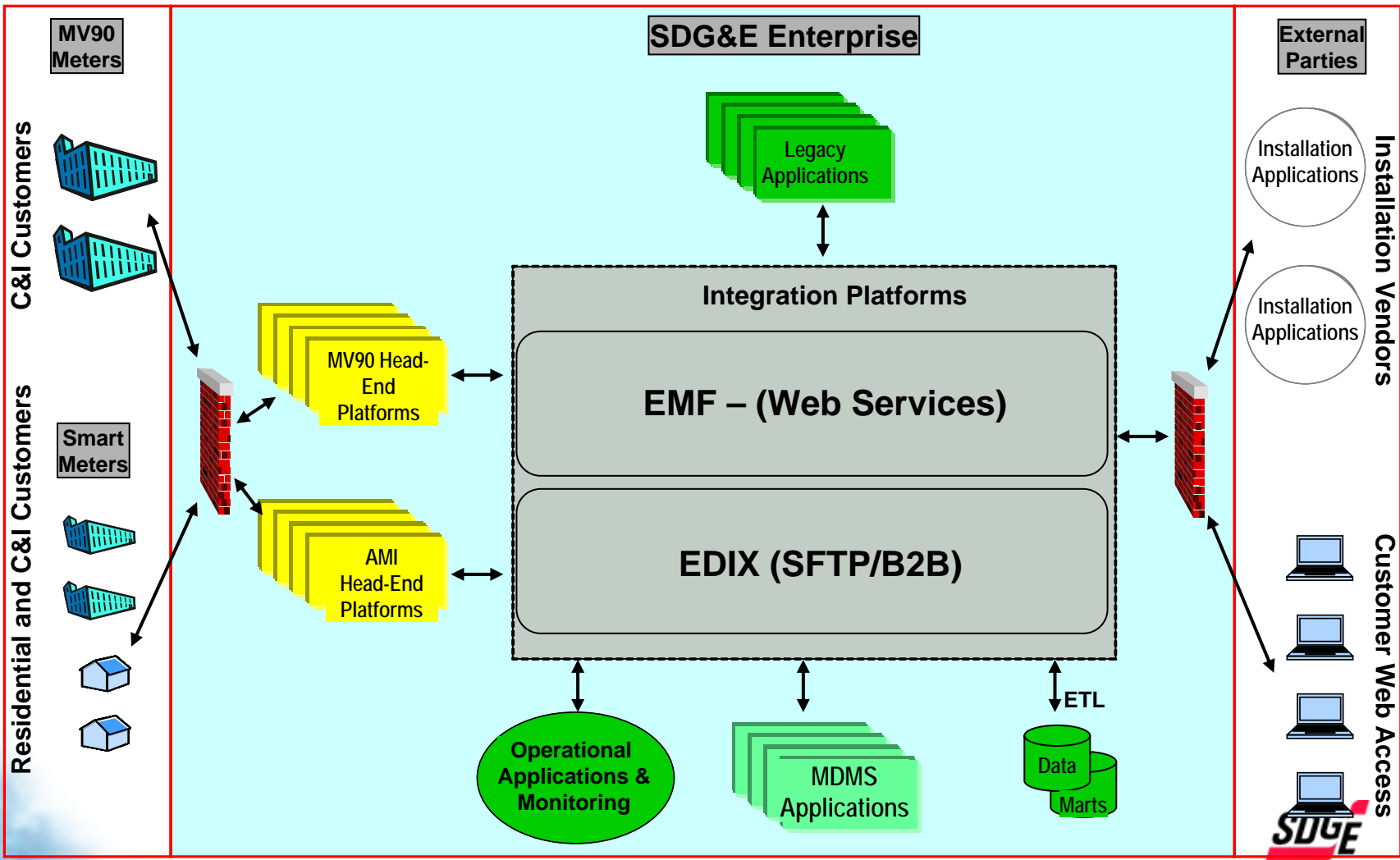
# Enterprise Architecture

A comprehensive set of principles, policies and standards used to align Information Technology (IT) assets with an organization's business processes to support the organization's overall strategy.

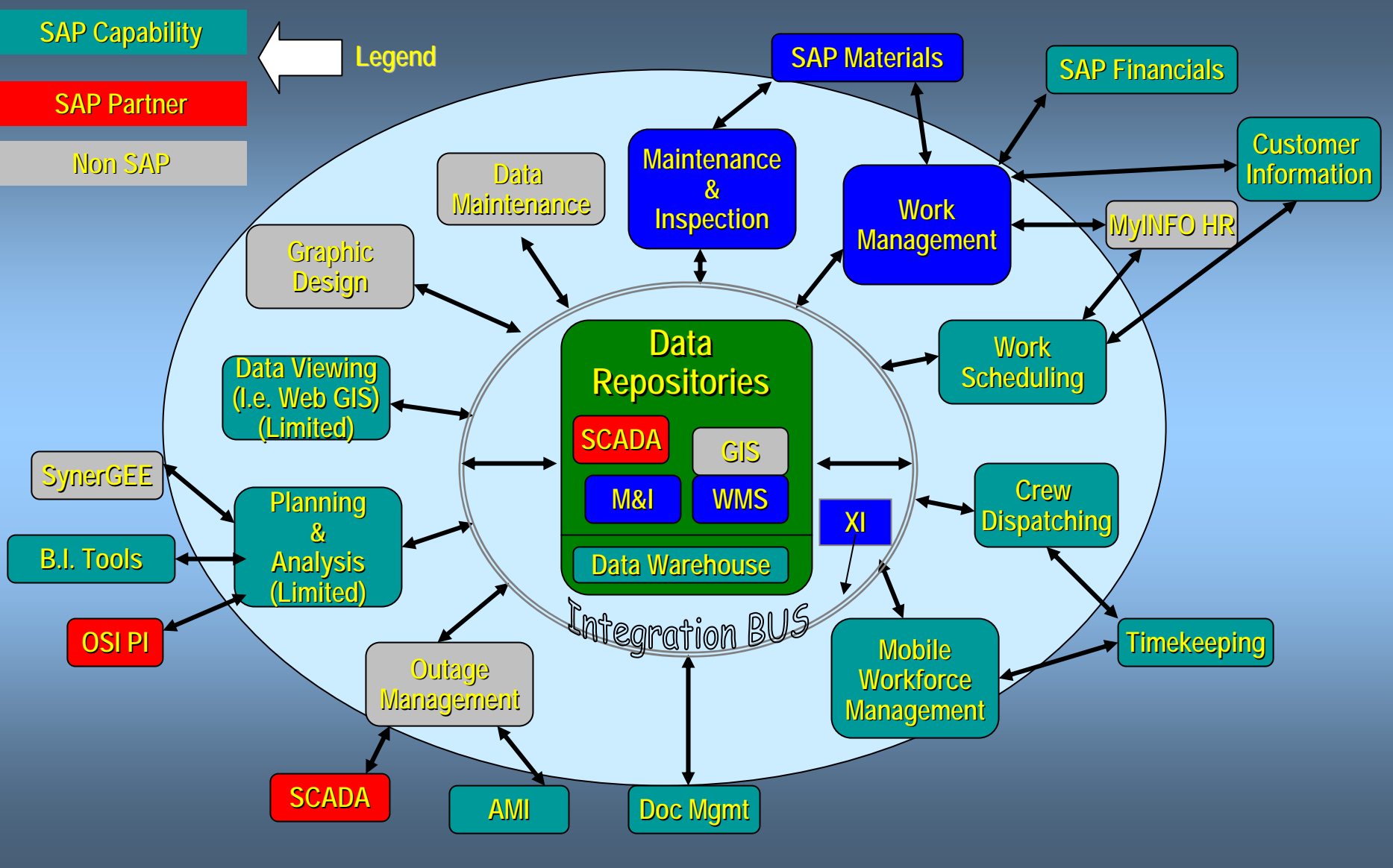
An enterprise architecture describes and documents current and future (desired) relationships

Answers basic questions like: What are the organization's business processes and how is IT enabling them?

# Smart Meter Solution Architecture Context



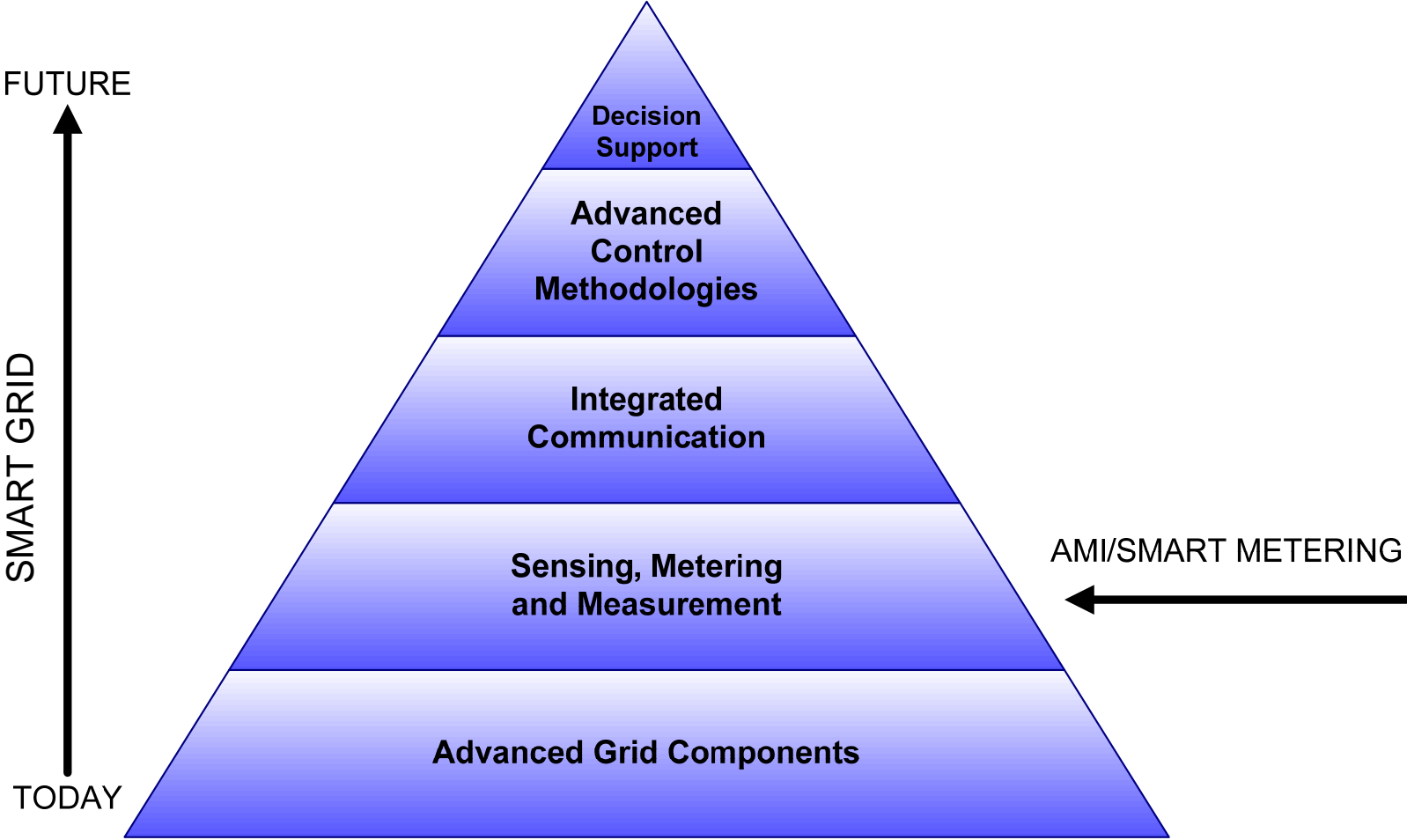
# Operation Technology Vision with SAP Overlay



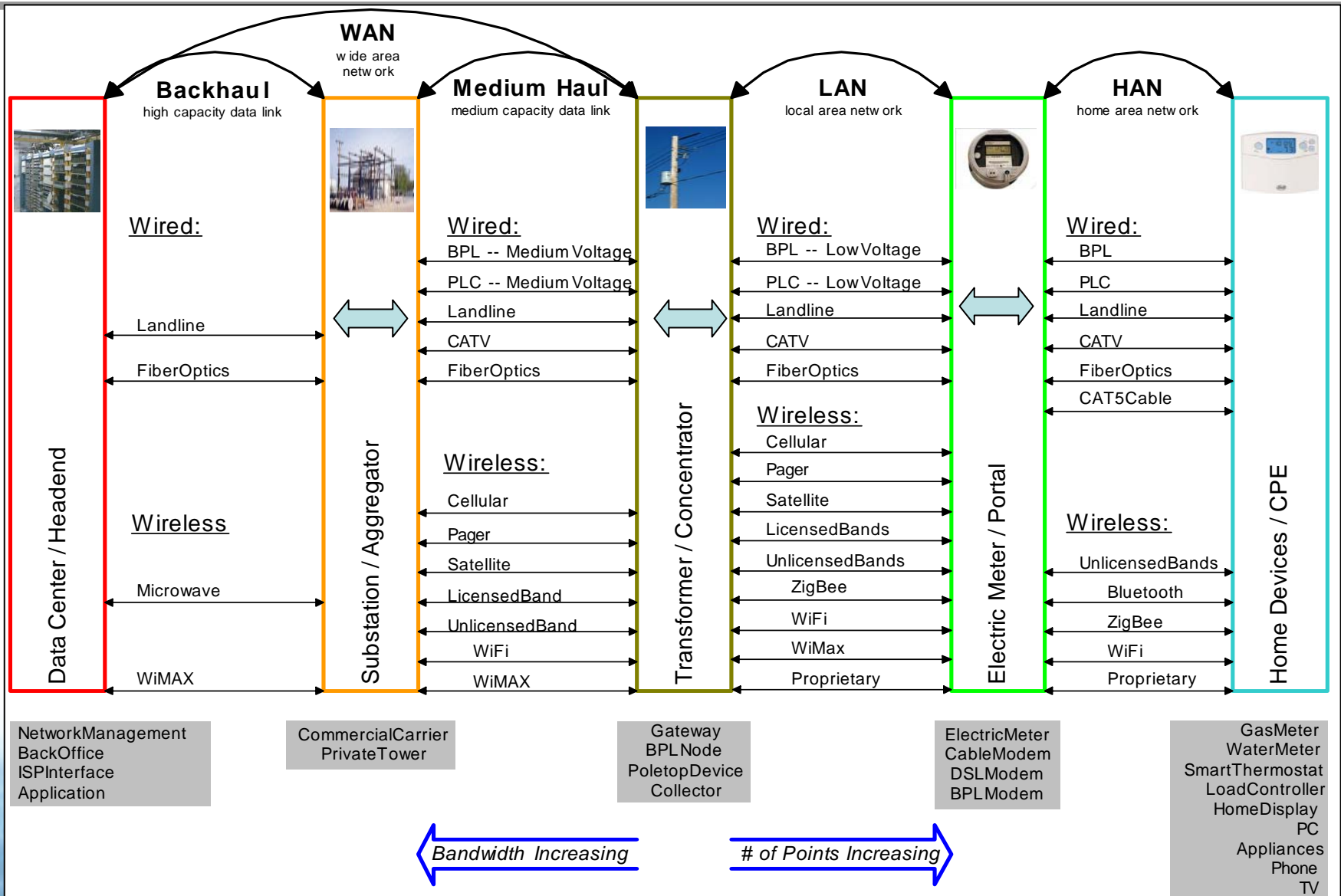
# Communication network is a corporate strategic investment

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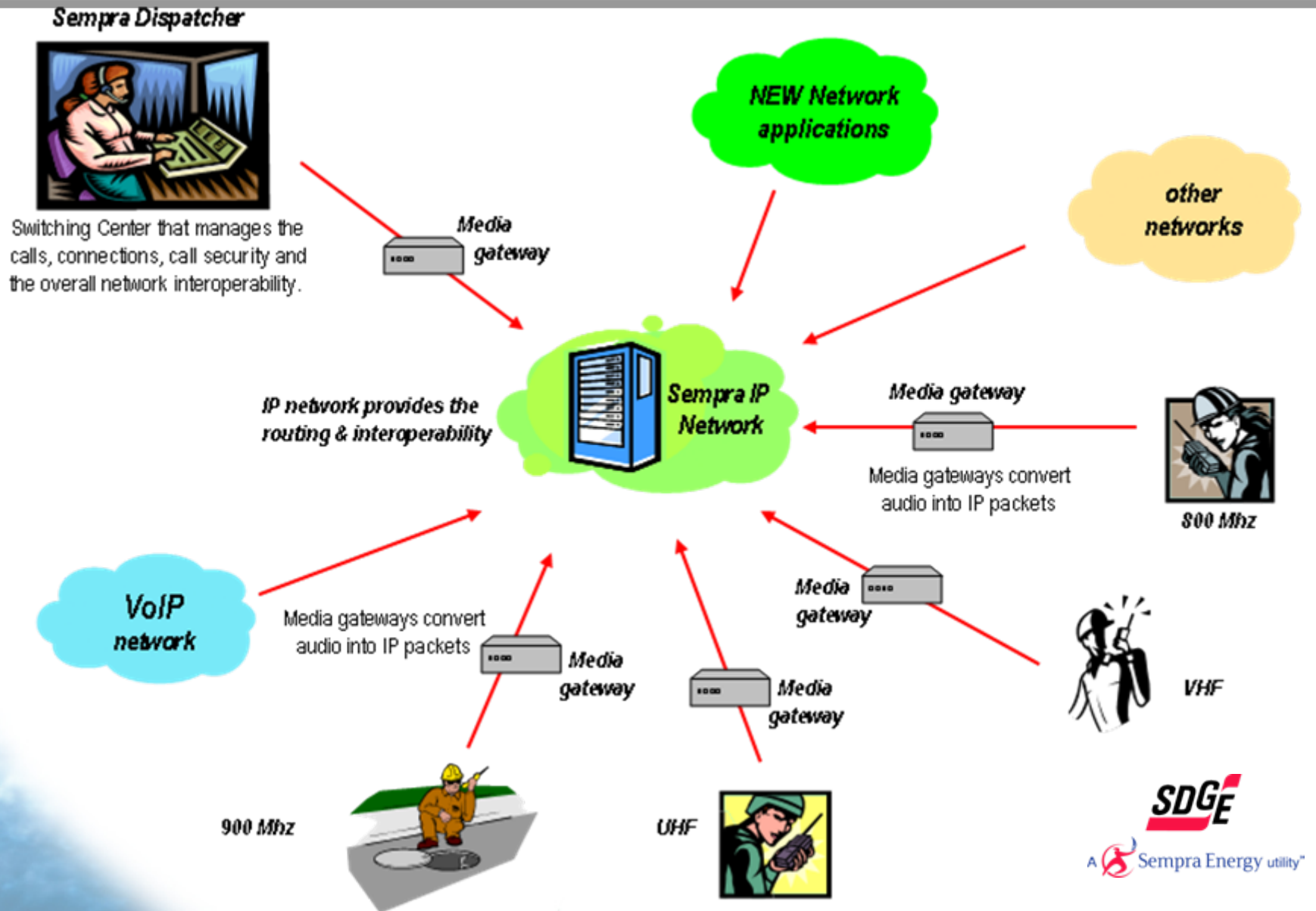
# Technology Building Blocks



# Utility Area Network



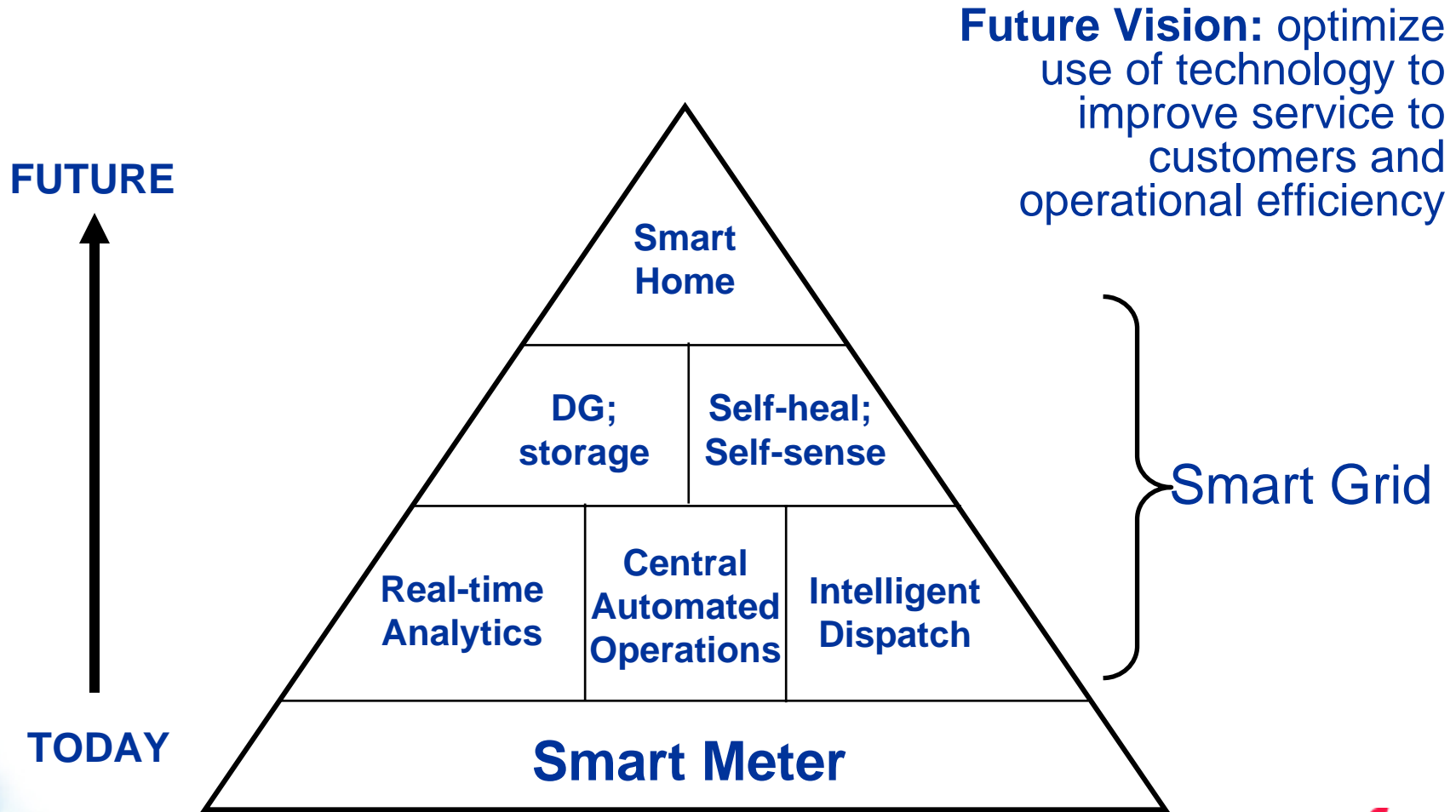
# Convergence



Summary: how you too can build a regional smart grid.

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# Easiest Option is using Smart Meters: Foundational



# High Level Recommendations

Identify financial benefits and costs

To the business

- Rate Structure
- Carbon Footprint
- Reduced Congestion
- Introduce Distributed Generation

To society – not that easy for a utility

- Reliability
- Power Quality
- Environment

Capital projects

Research & development projects

# Possible Next Steps

## Advanced metering infrastructure

- Digital electric meters are also “SENSORS”
- Regional communication system
- Home area network

## Operational initiatives

- Outage management system/distribution management system
- Condition based maintenance

## Feeder automation system technologies

- Pilots of autonomous, automated switching

Q/A

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