



EPRI

ELECTRIC POWER
RESEARCH INSTITUTE



Enhancing the Ability to Meet Customer Needs

May 15, 2007

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Vice President – Innovation

IntelliGrid Vision

A new electric delivery infrastructure that integrates advances in communications, computing, and electronics to meet the energy needs of the digital society

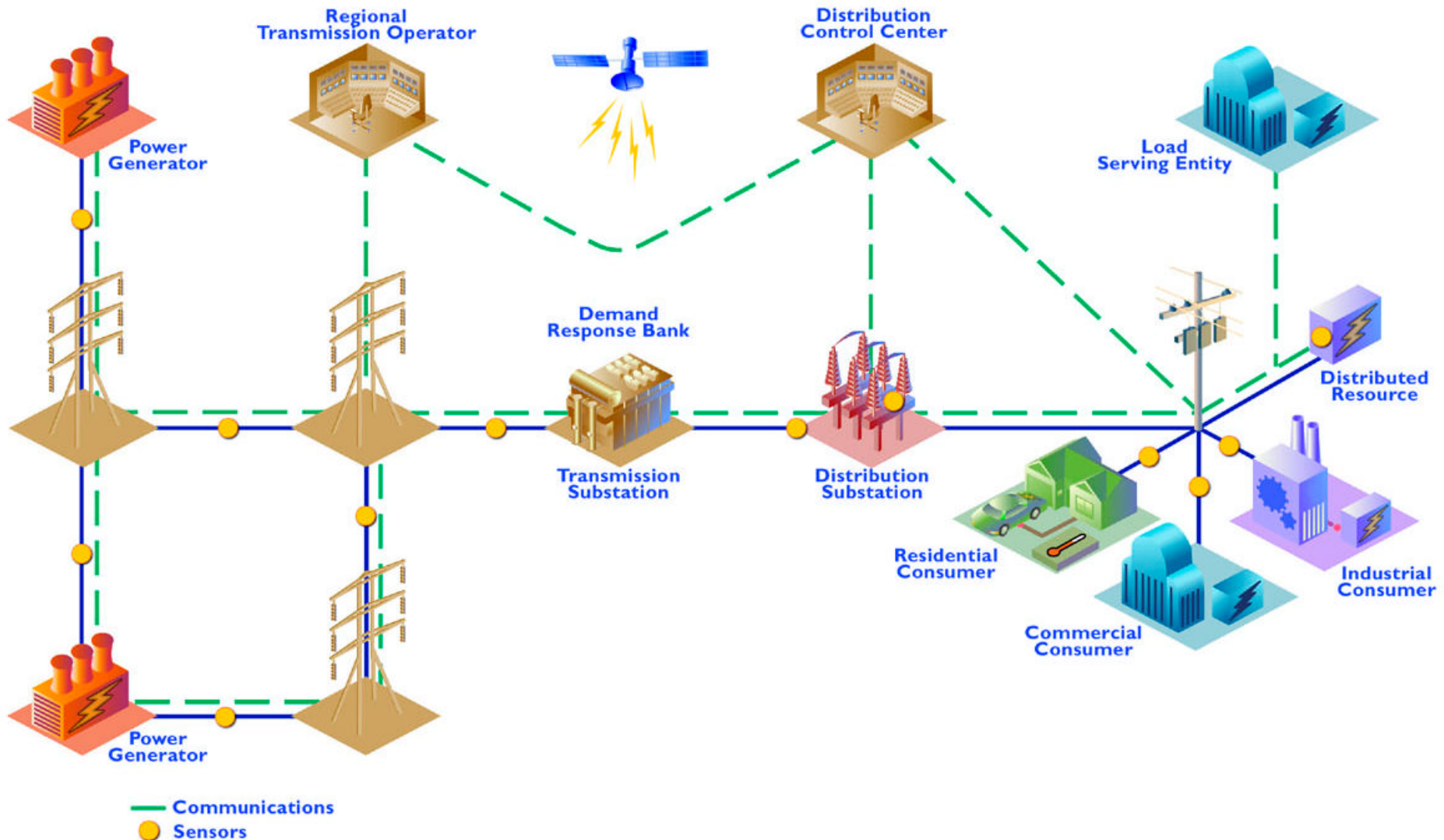


IntelliGridSM

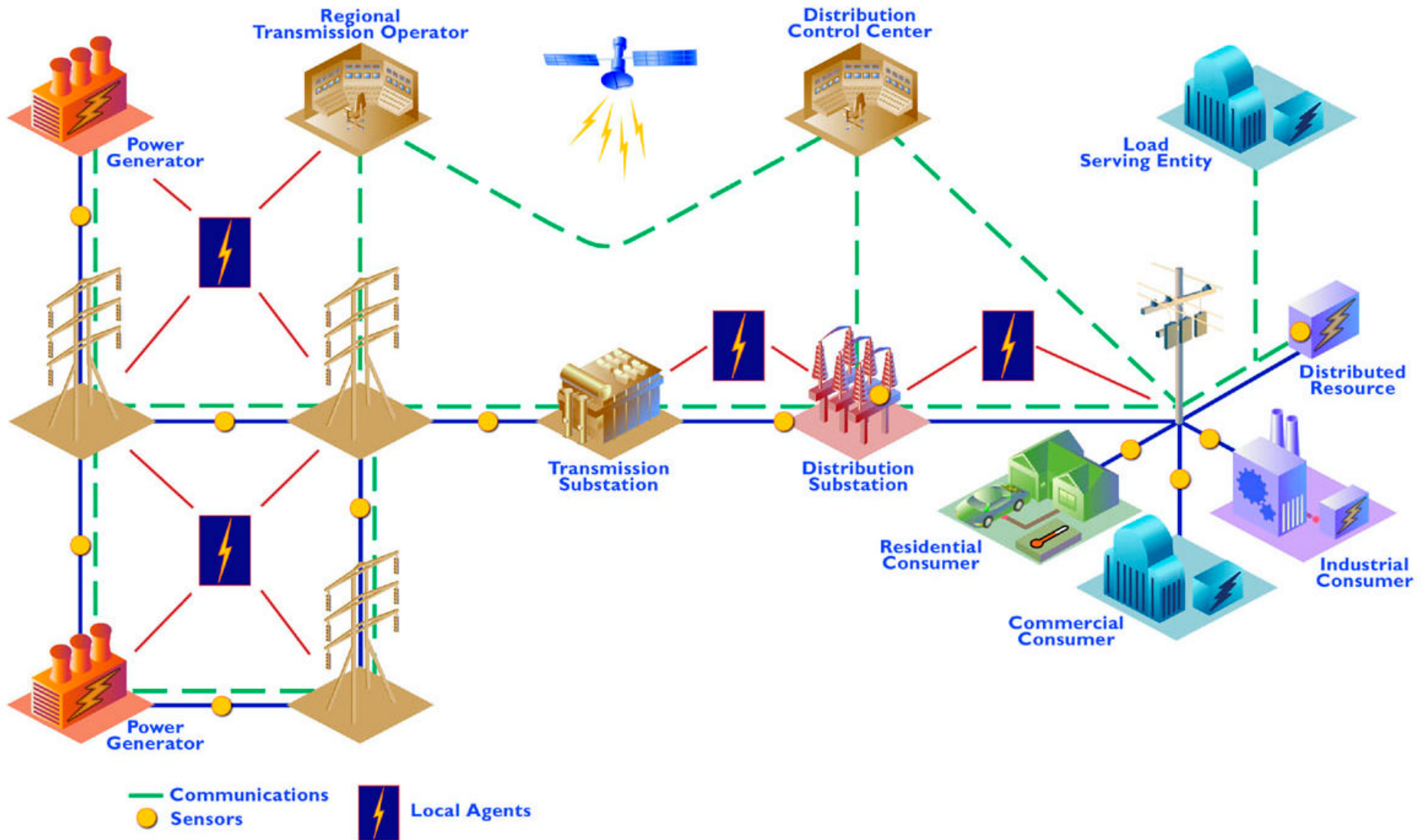
Needed: An Interstate Electricity Communications Superhighway



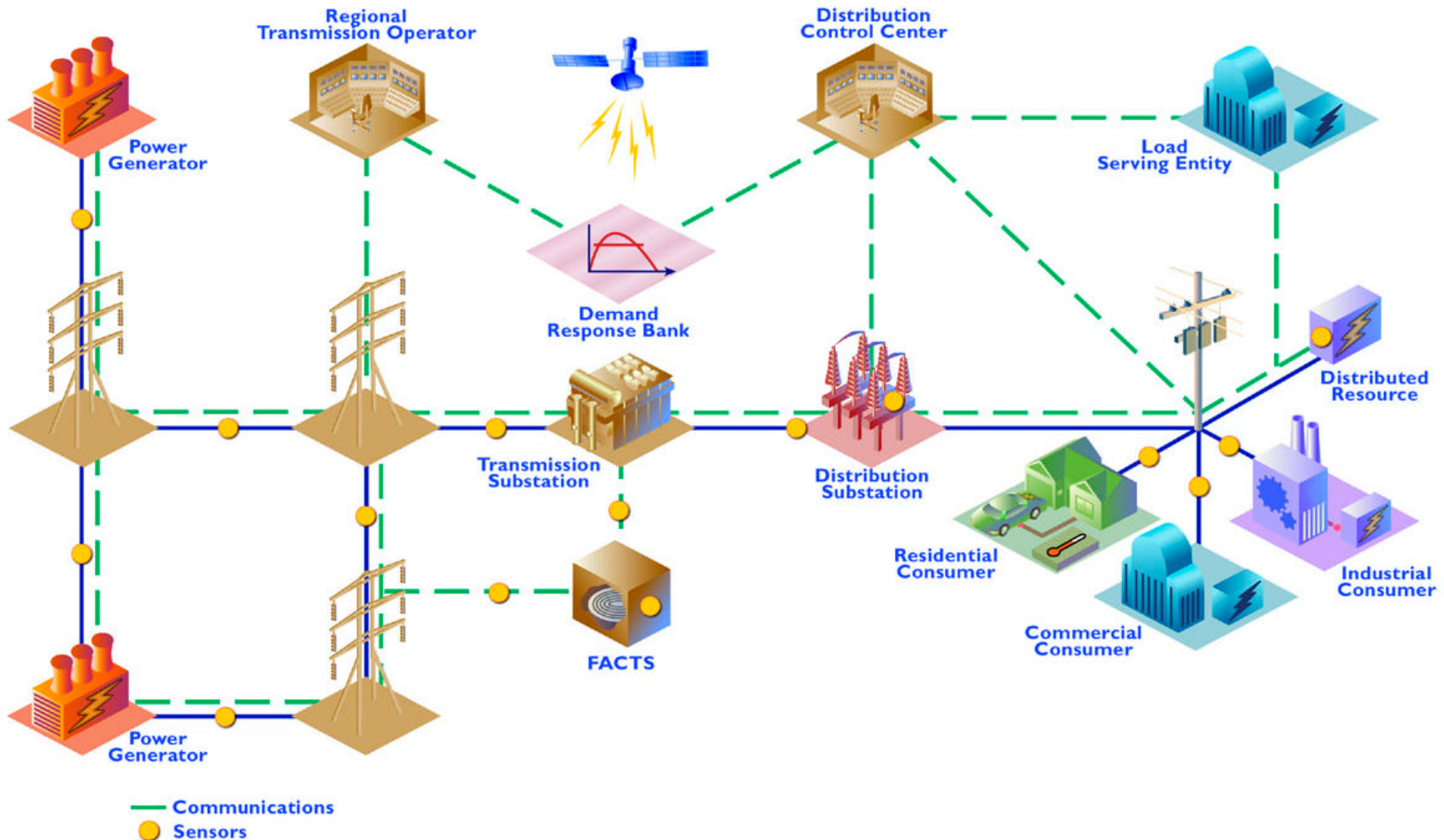
Integrated Electric & Communications Systems



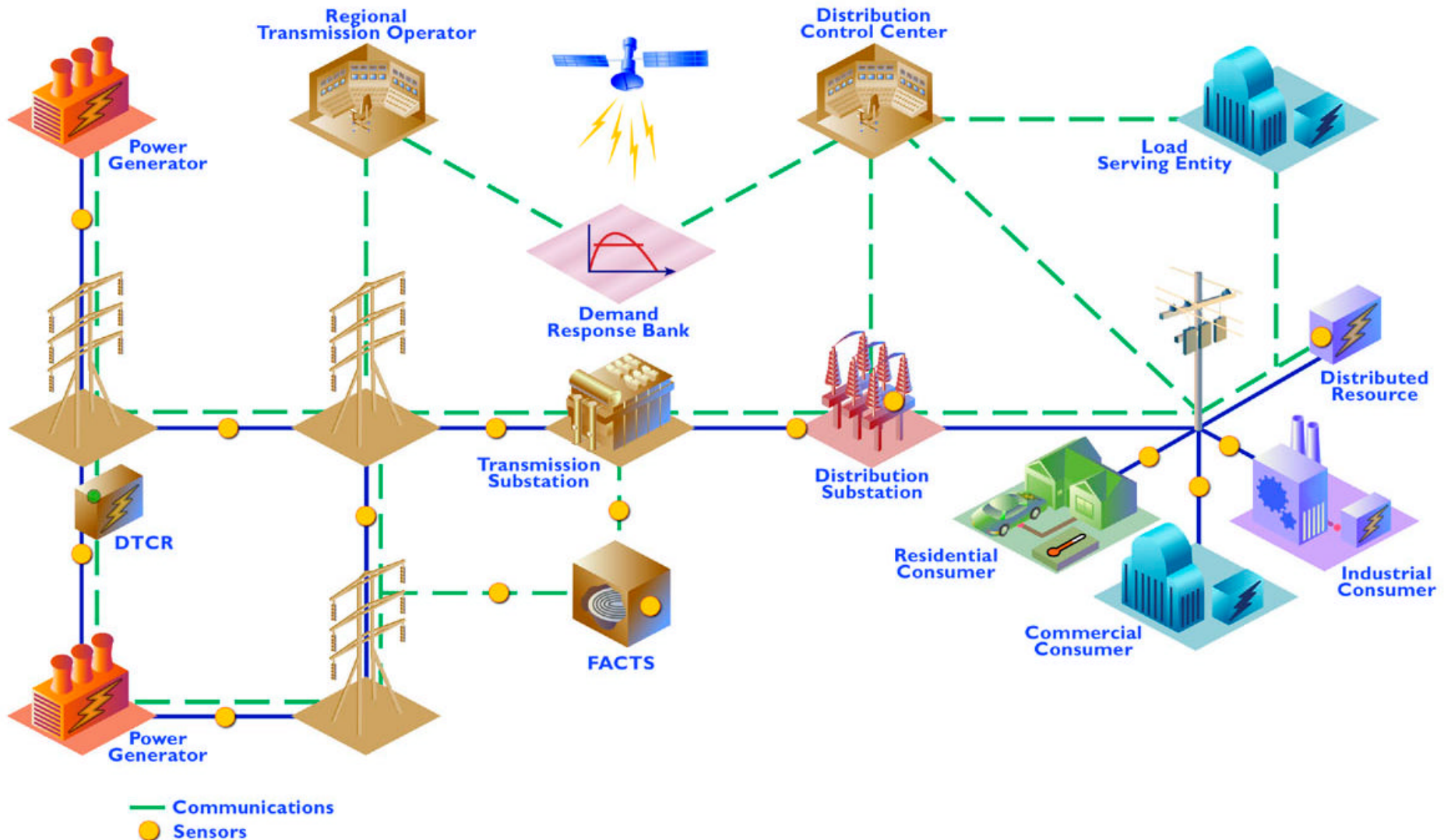
Deploy Local Computational Agents



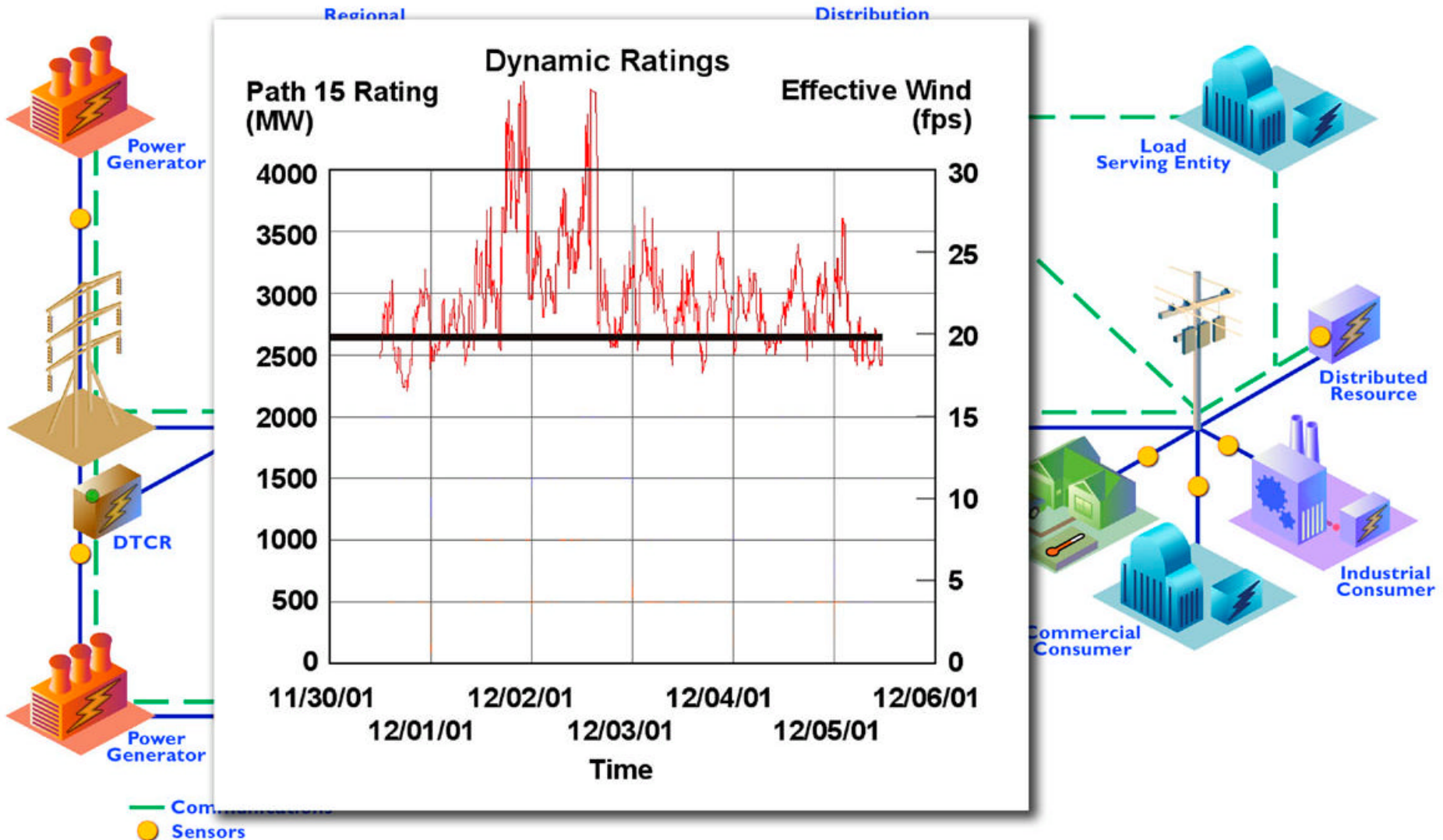
Apply Power Flow Control



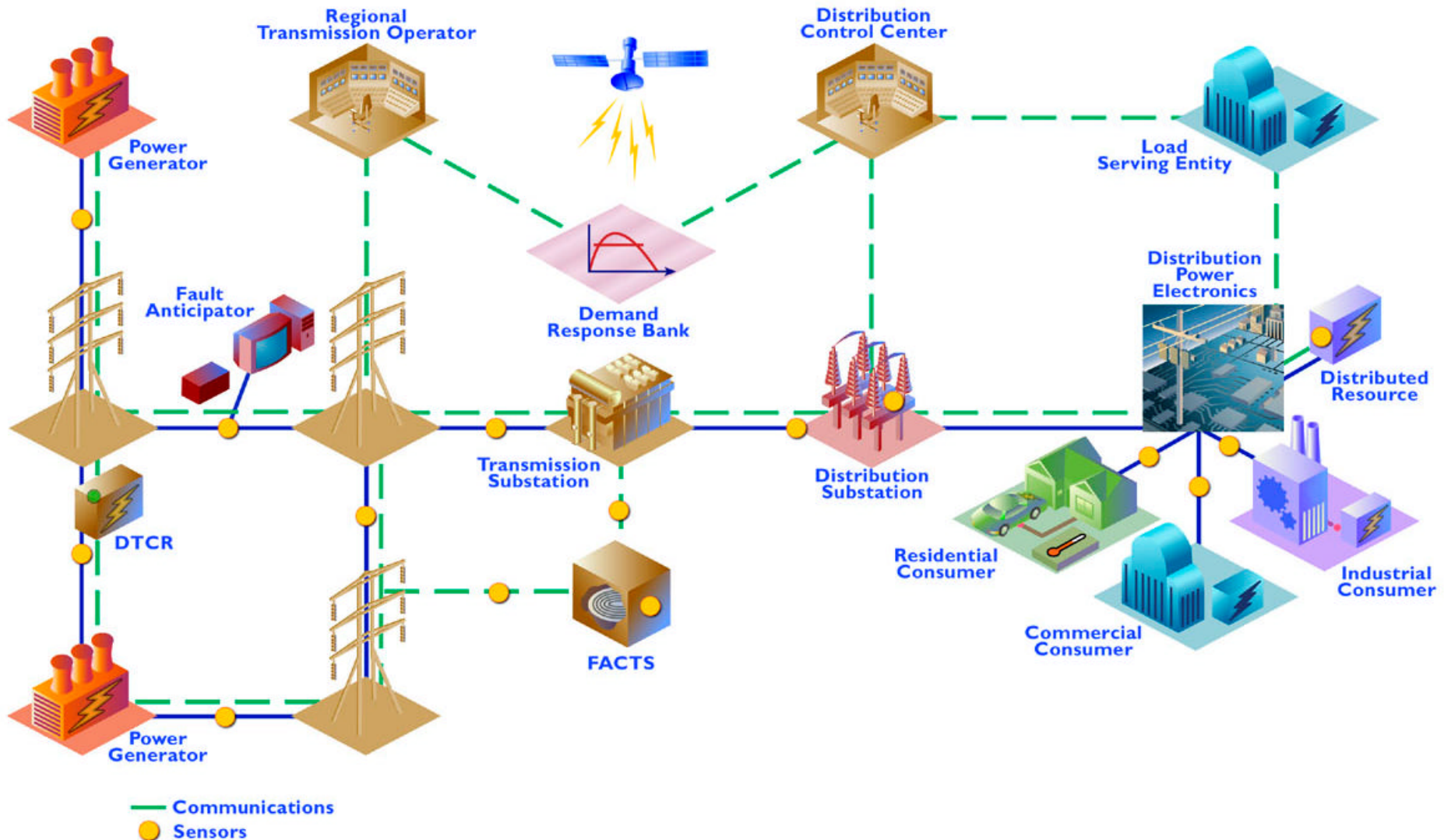
Apply Dynamic Thermal Circuit Rating (DTCR)



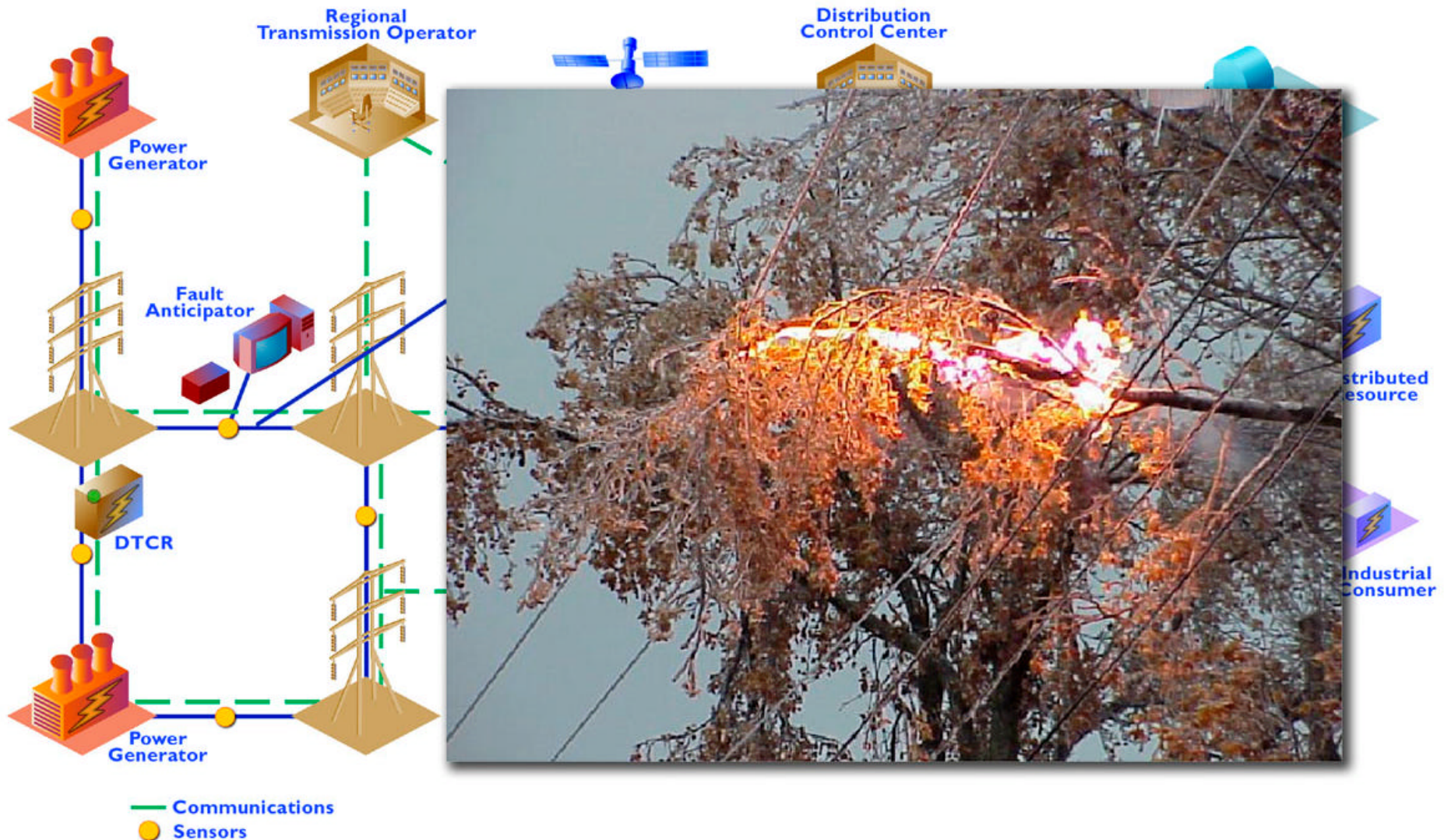
Apply Dynamic Thermal Circuit Rating



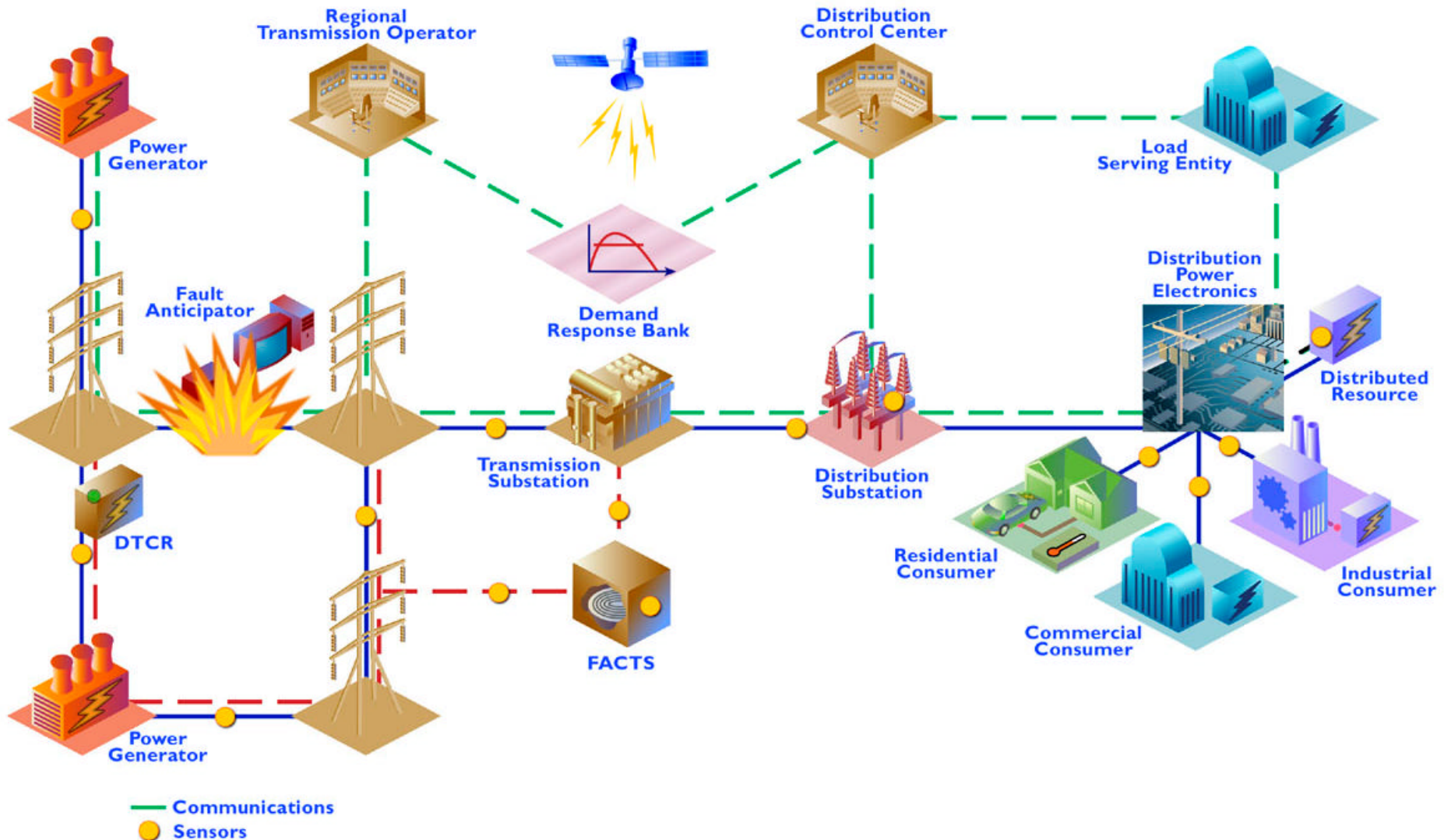
Apply Fault Anticipation & Distribution Electronics



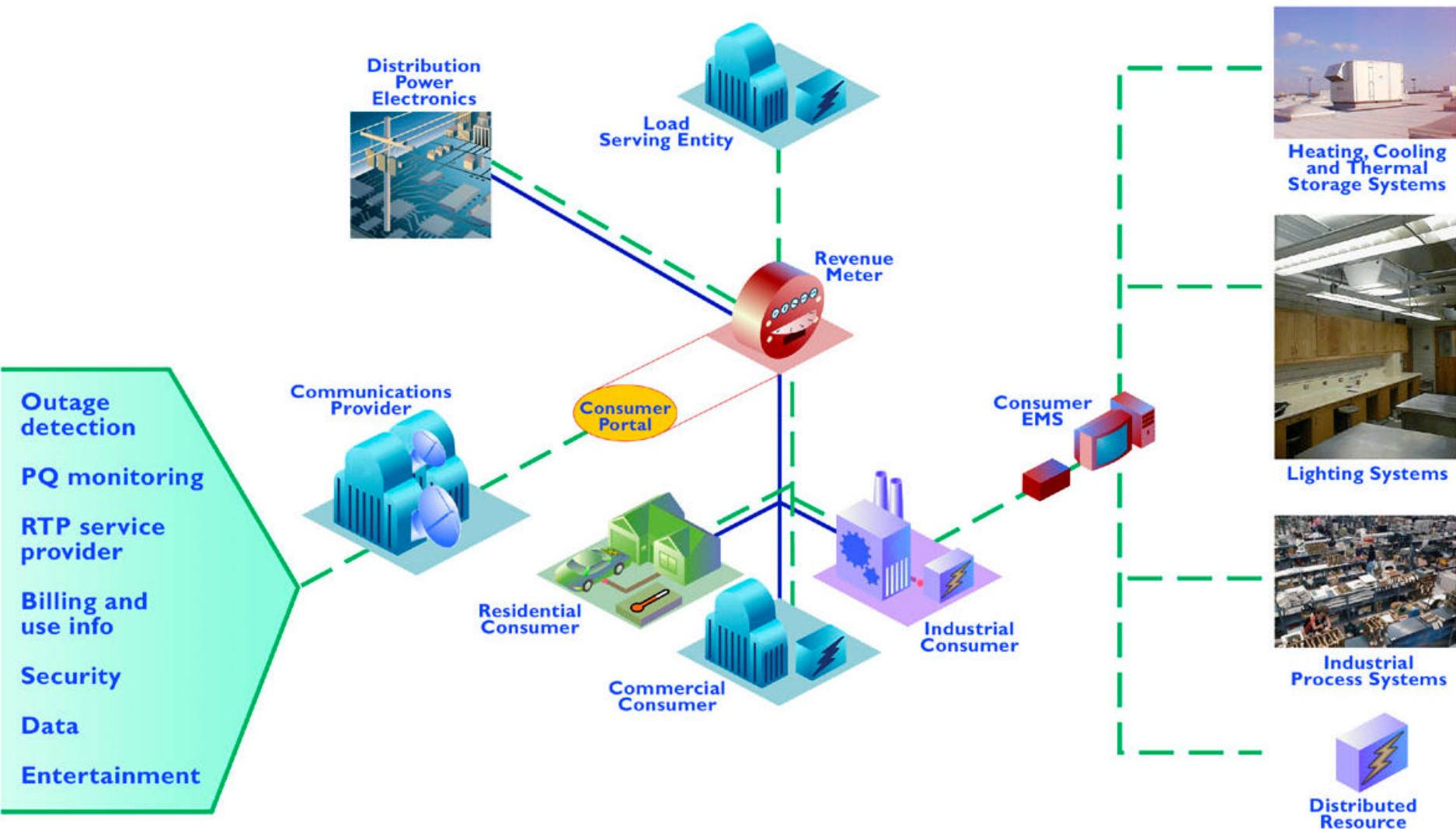
Apply Fault Anticipation



Enable A Self-Healing Power Delivery System



Consumer Portal

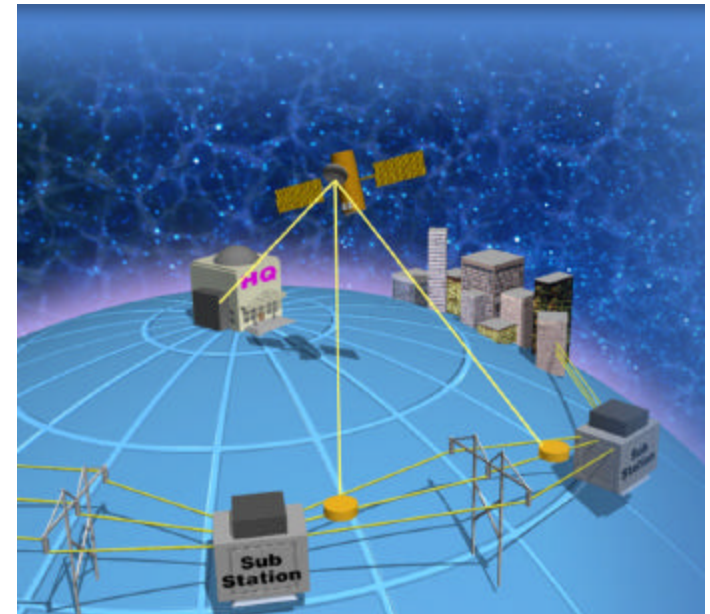


The IntelliGrid Vision

Key Technologies

- Communications
- Monitoring
- Embedded computing
- Advanced components
 - Superconductors, power electronics, storage, etc.
- Advanced configurations
 - Looped circuits, microgrids, DC service

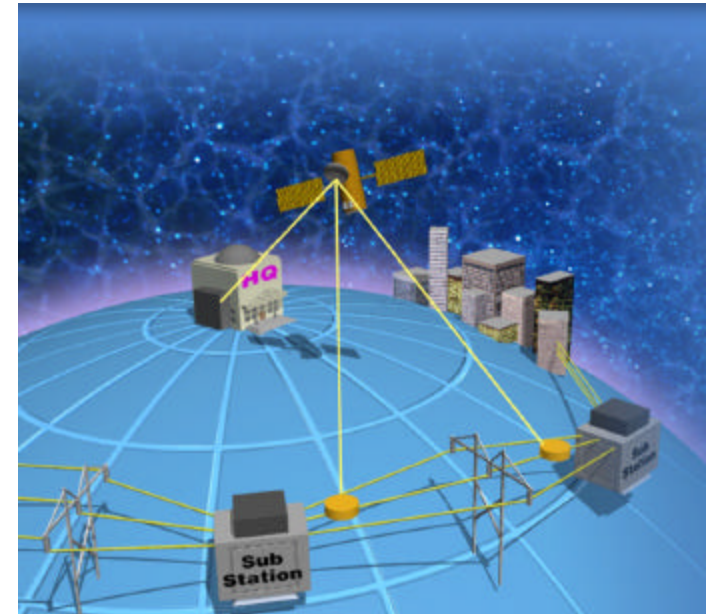
Data: collecting, moving and converting data into useful information



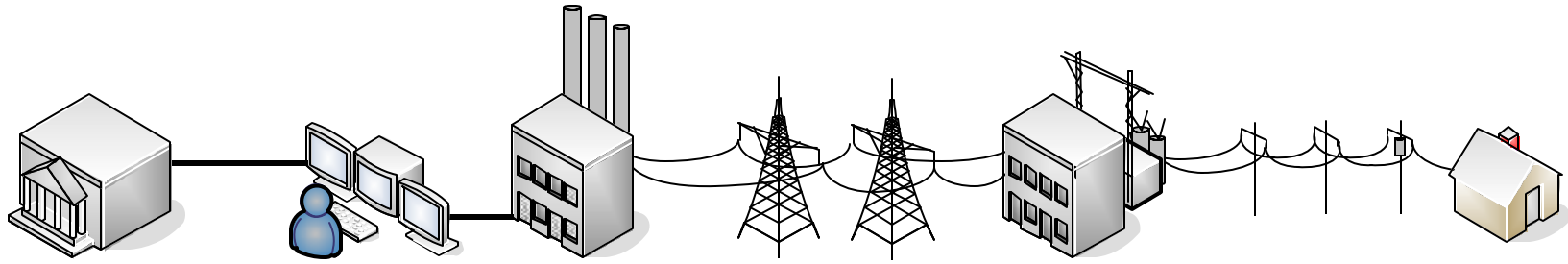
The Power Delivery System of the Future: *Characteristics*

The power delivery system of the future will be:

- *Interactive* with consumers and markets
- *Self-Healing* and *Adaptive*
- *Optimized* to make best use of resources and equipment
- *Predictive* rather than reactive, to prevent emergencies
- *Accommodates* a variety of generation options
- *Integrated*, merging monitoring, control, protection, maintenance, EMS, DMS, marketing, and IT
- *More Secure* from attack

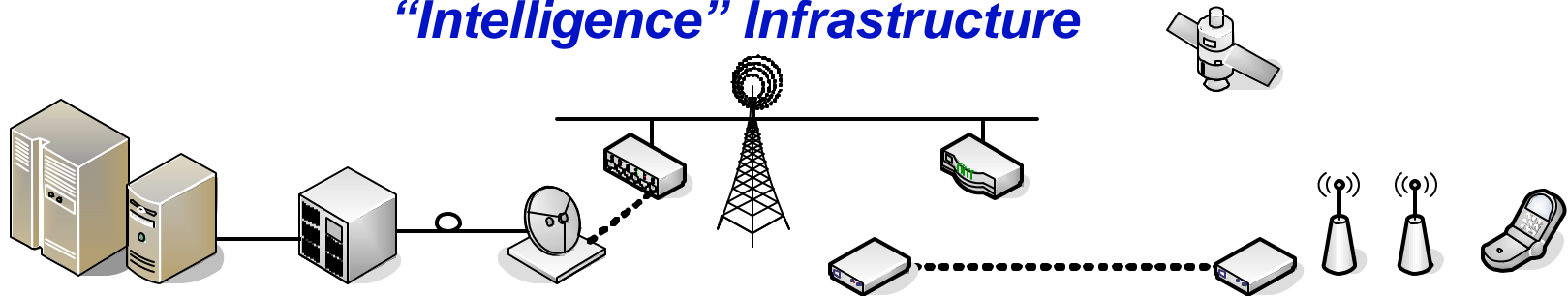


Achieving the Power Delivery System of the Future: *Integrating Two Infrastructures*

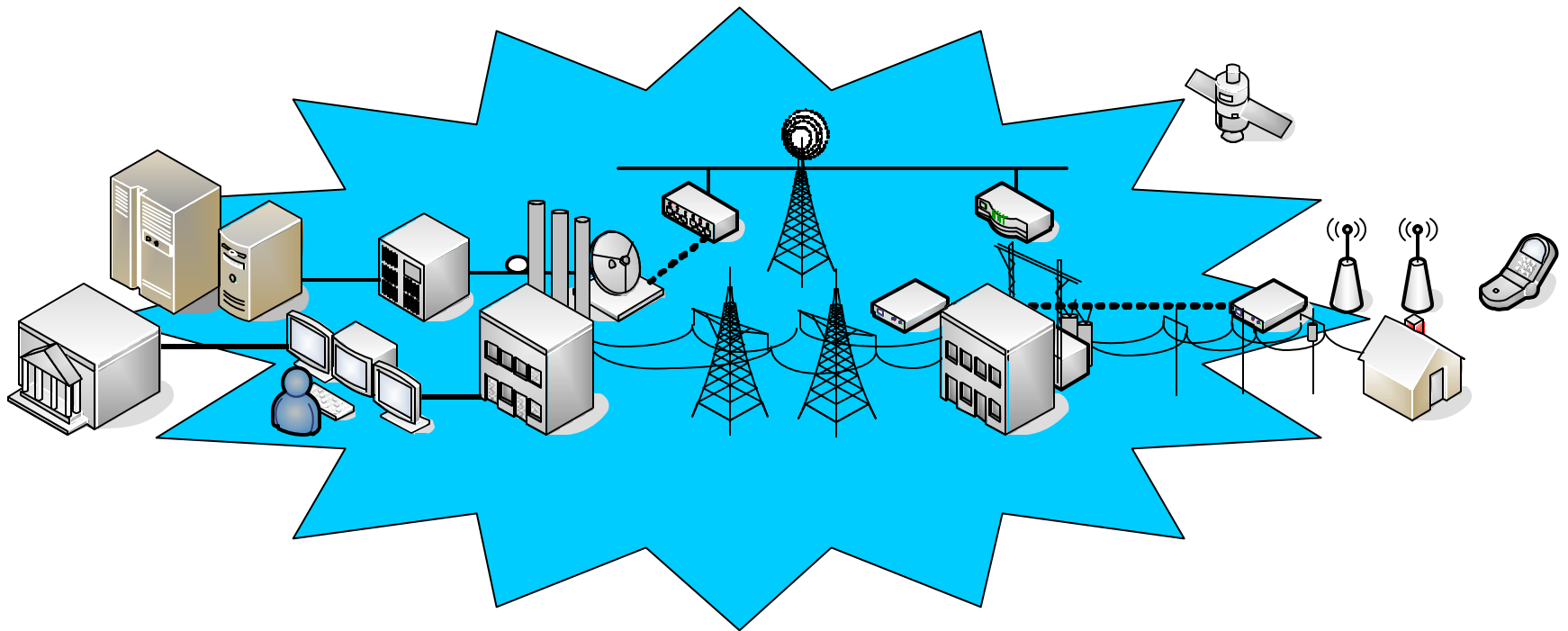


Electrical Infrastructure

“Intelligence” Infrastructure



The Intelligent Grid



IntelliGrid Program

Developing the Technical Foundation

Communications:

Enable devices and controllers to “talk” to each other

- ***IntelliGrid Architecture:*** a framework consisting of principles for interoperability, tools, methodologies, recommendations for standards and technologies and best practices that are applied during the design and deployment of grid upgrades
- ***Consumer Portal:*** two-way communications gateway between consumers and service providers

Computing:

Software to run the smart grid must model and simulate the power system faster than real time

- ***Fast Simulation and Modeling:*** high-performance look-ahead and optimization capability of software for both the transmission and distribution system (Functional requirements completed, prototypes in development)

Monitoring:

Measurement of parameters necessary for operating and maintaining an intelligent grid

- ***Integrated Monitoring:*** defines data requirements – single measurements for multiple applications

IntelliGrid Partners Cut Across All Stakeholder Groups

U.S. Utilities

- Kansas City Power & Light
- Long Island Power Authority
- New York Power Authority
- Salt River Project
- TXU
- Public Service New Mexico
- Tri-State G&T
- Arkansas Electric Cooperative
- Great River Energy
- Richmond Power & Light
- Dairyland Power Cooperative
- Golden Valley Electric Assn.
- Hoosier Energy Rural Electric Cooperative
- Lincoln Electric
- Hetch Hetchy Water & Power

International Utilities

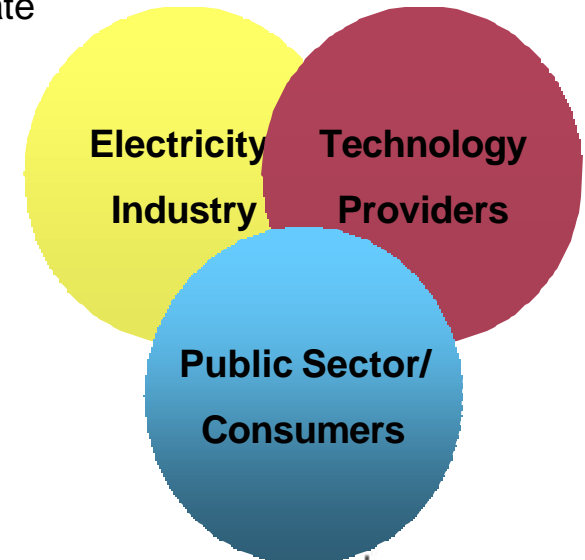
- Electricite de France
- Polish Power Grid Company
- Korea Electric Power

Public Agencies

- Association of State Energy Research and Technology Transfer Institutions
- International Brotherhood of Electrical Workers
- National Association of Regulatory Utility Commissioners
- National Association of State Energy Officials
- National Conference of State Legislatures
- National Governors Association
- State Energy Offices and Research Programs

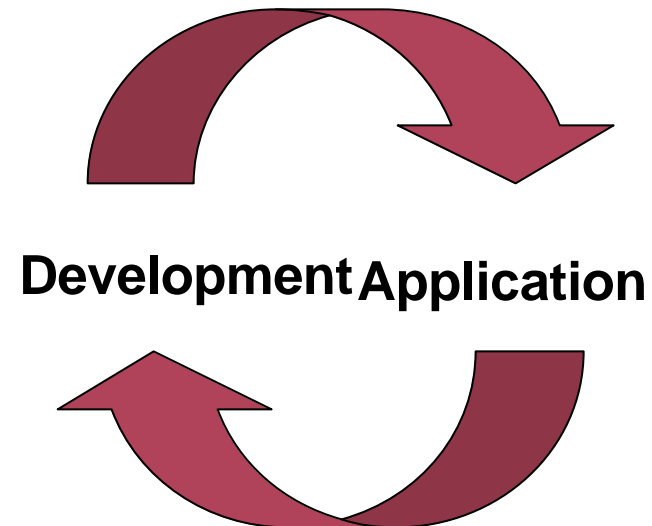
Manufacturers

- ABB
- Hitachi



Applications of the IntelliGrid Architecture

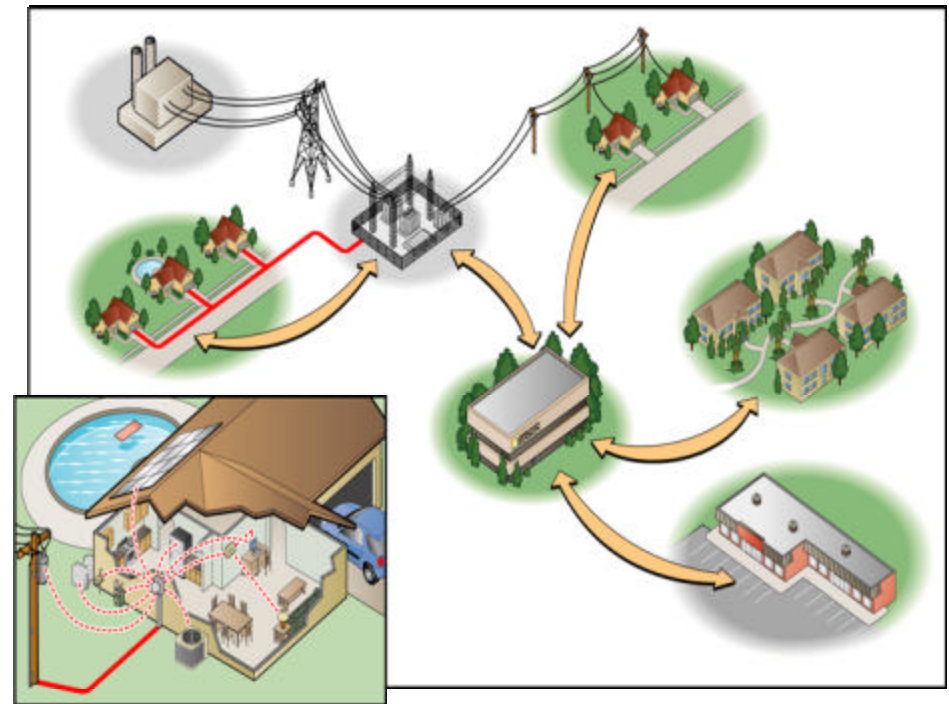
- **Southern California Edison** – applying the IntelliGrid Architecture \$1.5B AMI project
- **TXU** – applying IntelliGrid Architecture to \$400M automated meter reading project
- **Salt River Project** – applying IntelliGrid Architecture for substation data integration
- **Alliant Energy** – applying IntelliGrid Architecture for distribution monitoring system
- **Long Island Power Authority** – Utility and Consumer Device SCADA via Broadband over Power Line (BPL) and Wireless Communications
- **Polish Power Grid Operator** – applying the IntelliGrid Architecture and Fast Simulation and Modeling for Volt/VAR control of the Polish Transmission Grid



How is Southern California Edison Using IntelliGrid Results?

Advanced Metering Infrastructure

- Apply methods & tools to capture requirements
- Build on defined applications
- Apply approach for mapping requirements to technologies
- Apply recommendations for standards and technologies
- Contribute the results of their work to the industry



IntelliGrid Program

Key Results To Date

- **Communications**

- IntelliGrid Architecture volumes 1-4
- Guidelines for Implementing the IntelliGrid Architecture
- Case Studies on Implementations of the IntelliGrid Architecture
- Consumer Portal concepts, drivers and barriers to development
- Consumer Portal Telecommunications Assessment
- Consumer Portal Business Case

- **Computing**

- Distributed Computing Conceptual framework and Computational Architecture
- Business Case

- **Monitoring**

- Requirements and Technology Assessment





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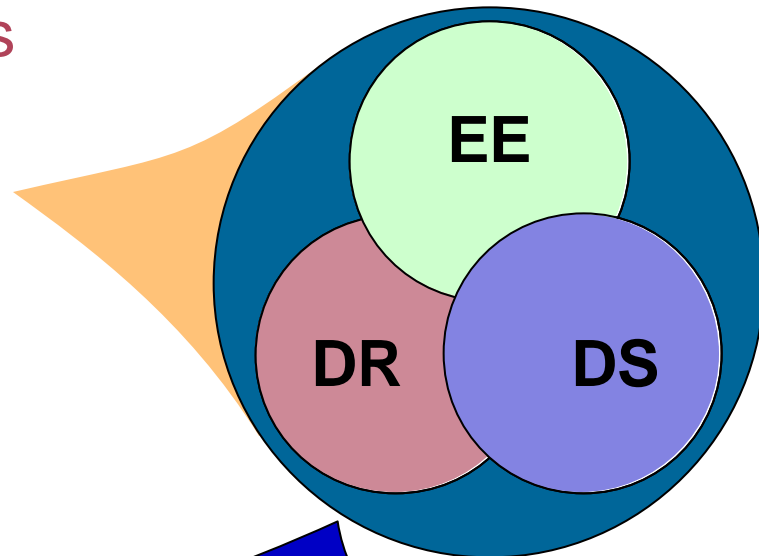
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Energy Efficiency (EE) & Demand Response (DR)

Strategies for Efficient Use of Electricity

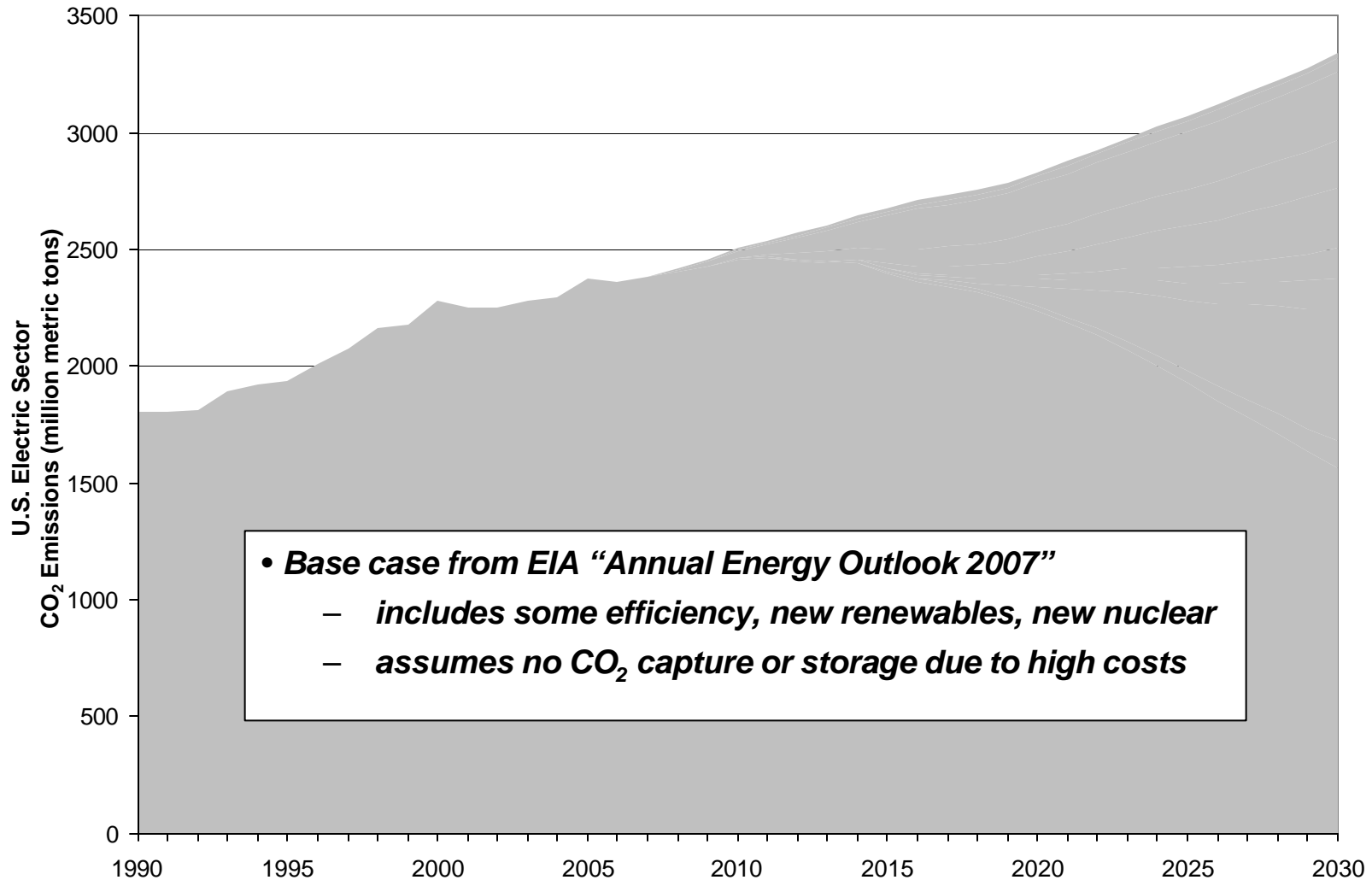
Three Interrelated Strategies

- Energy Efficiency (EE)
- Demand Response (DR)
- Dynamic Systems (DS)

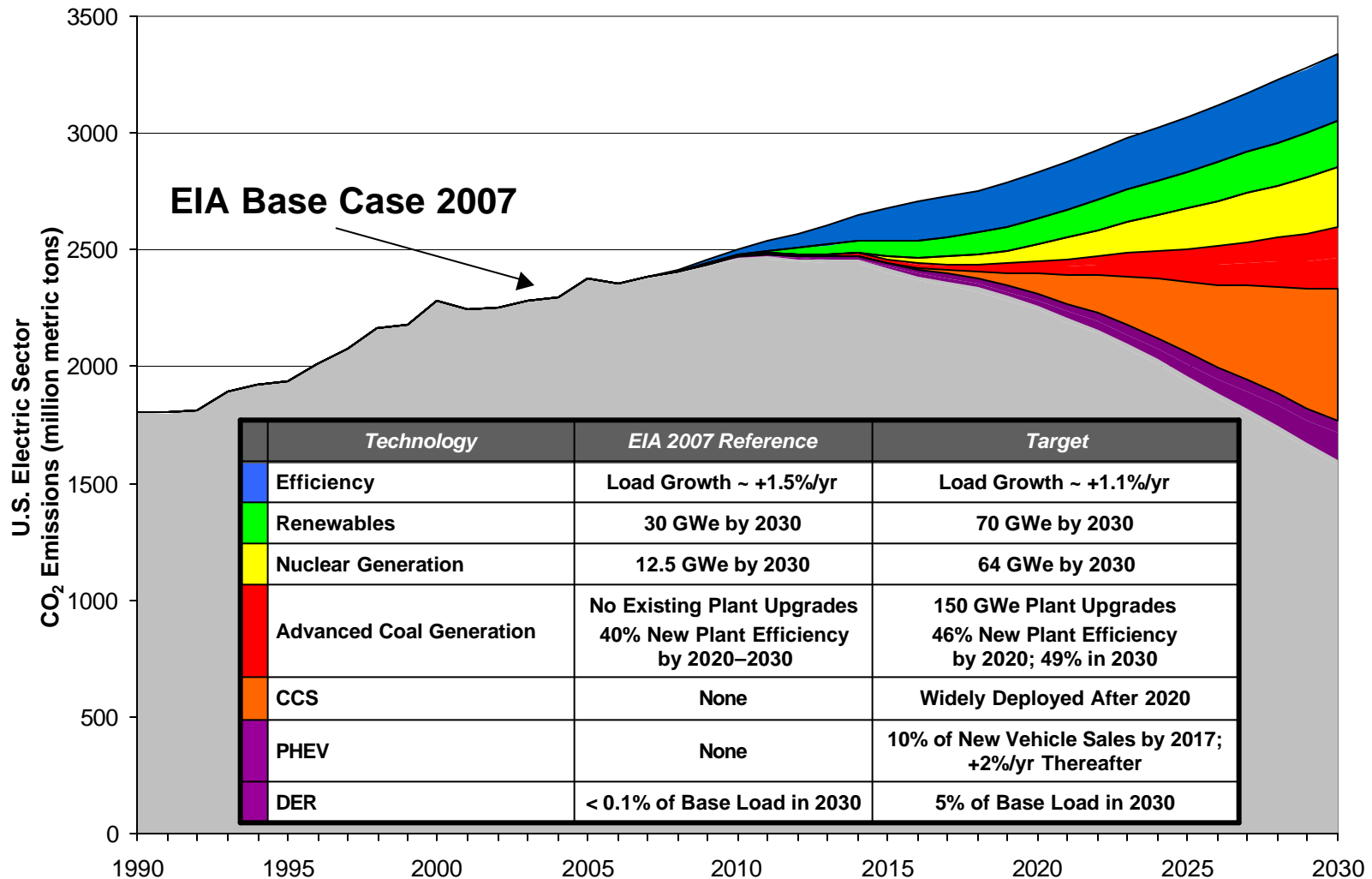


**Implemented Through an
Electricity Efficiency Infrastructure**

U.S. Electricity Sector CO₂ Emissions

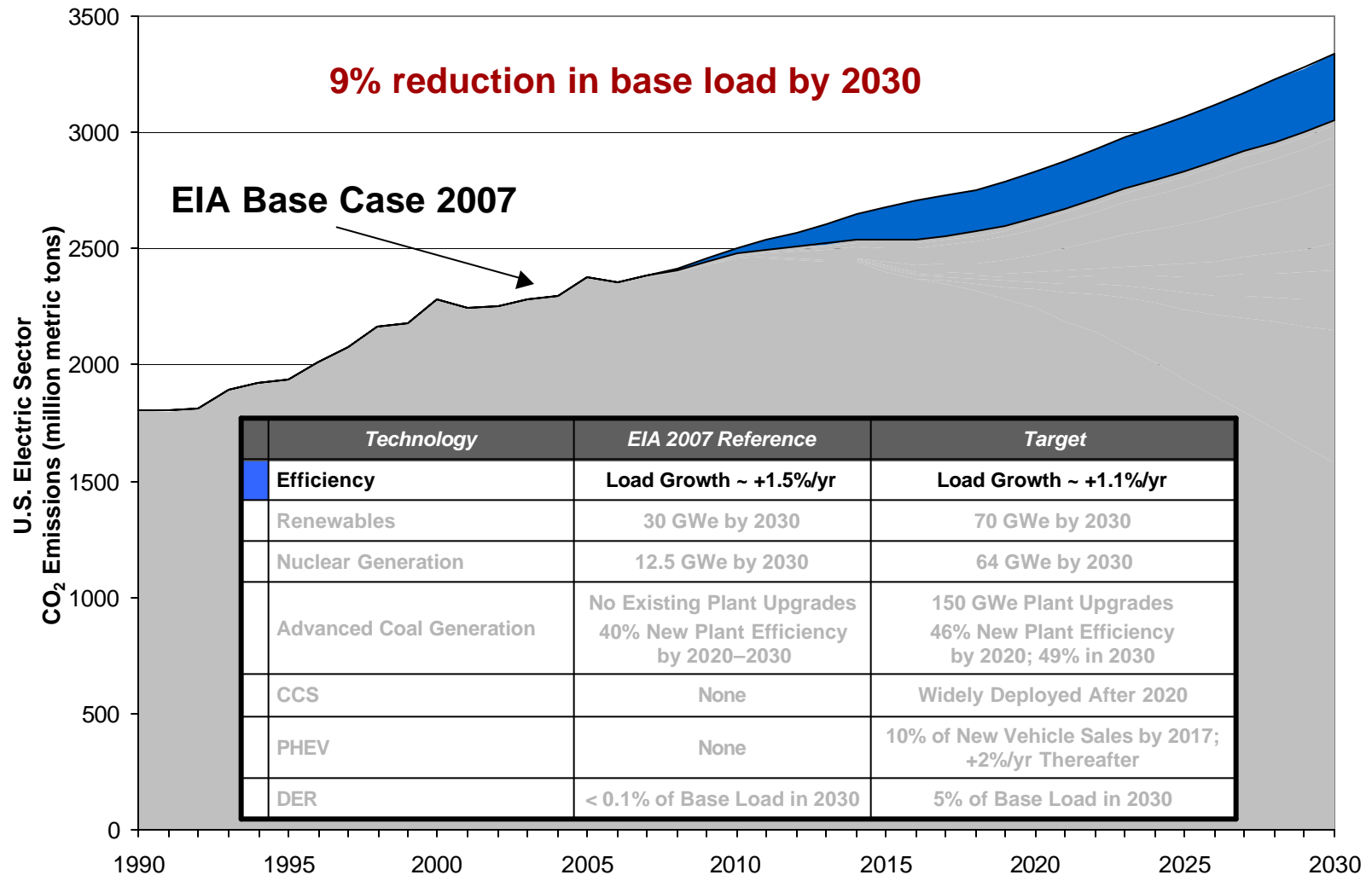


CO₂ Reductions ... Technical Potential*

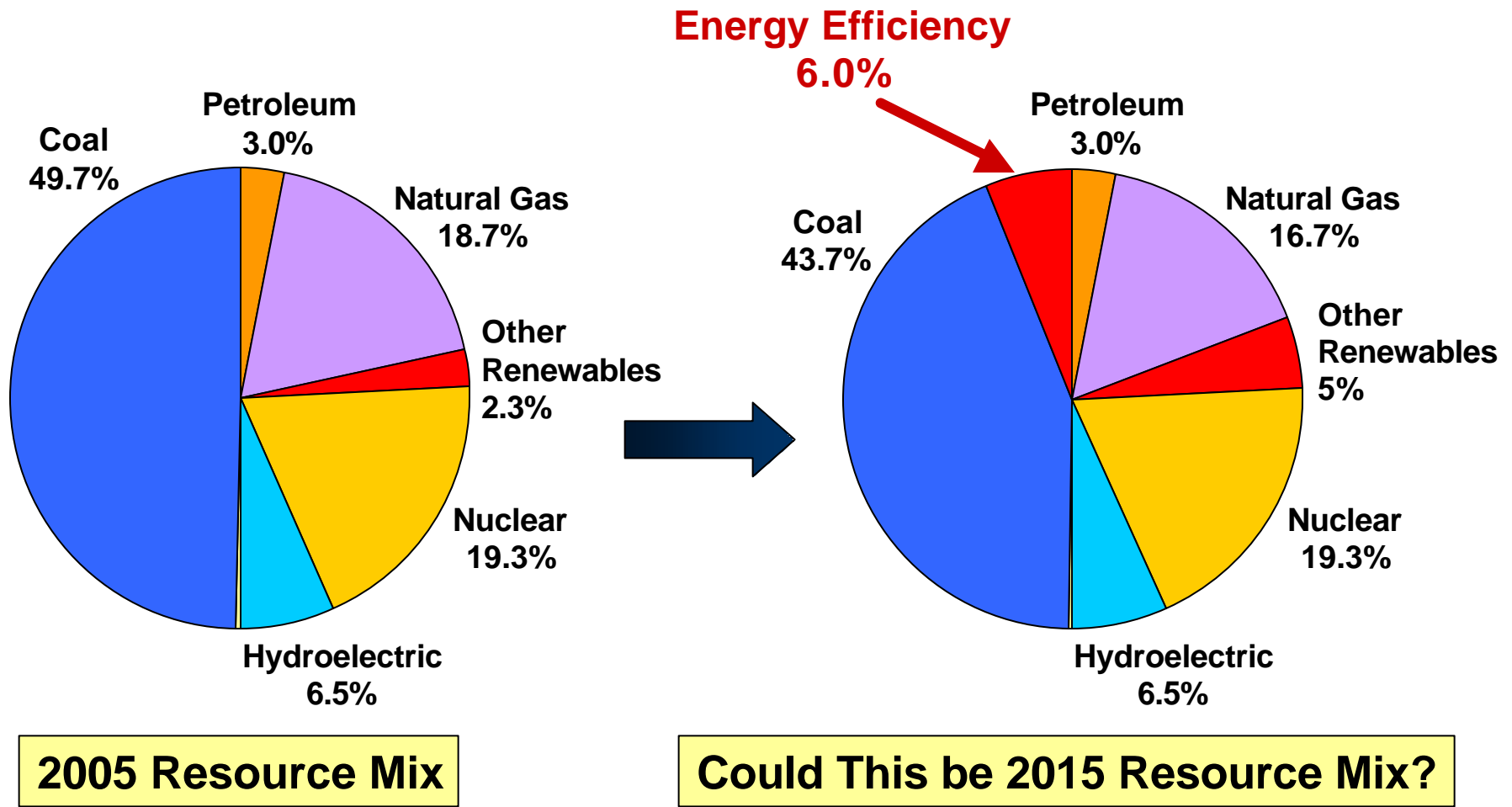


* Achieving all targets is very aggressive, but potentially feasible.

Benefit of Achieving Efficiency Target

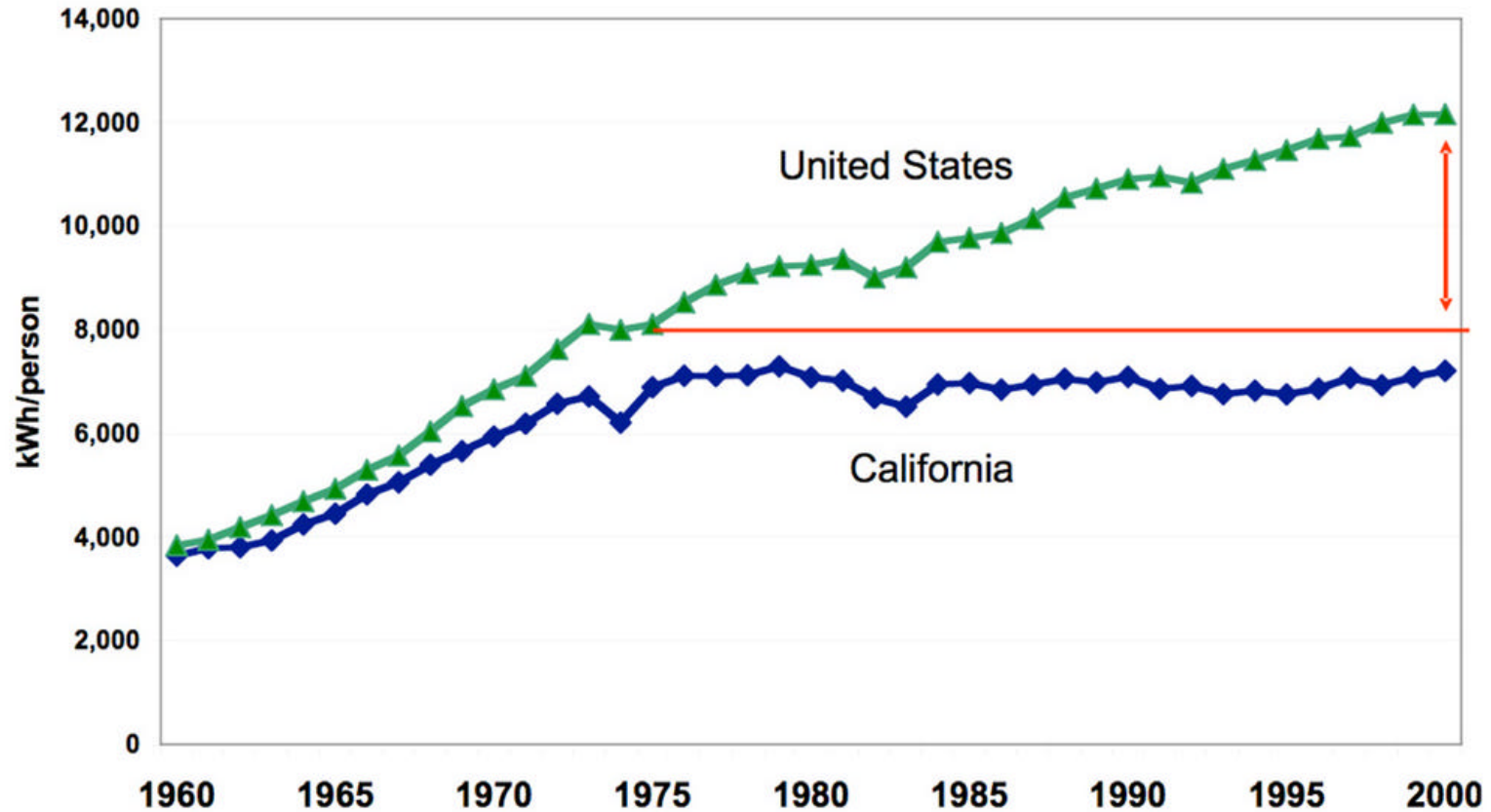


Energy Efficiency – 5th Fuel



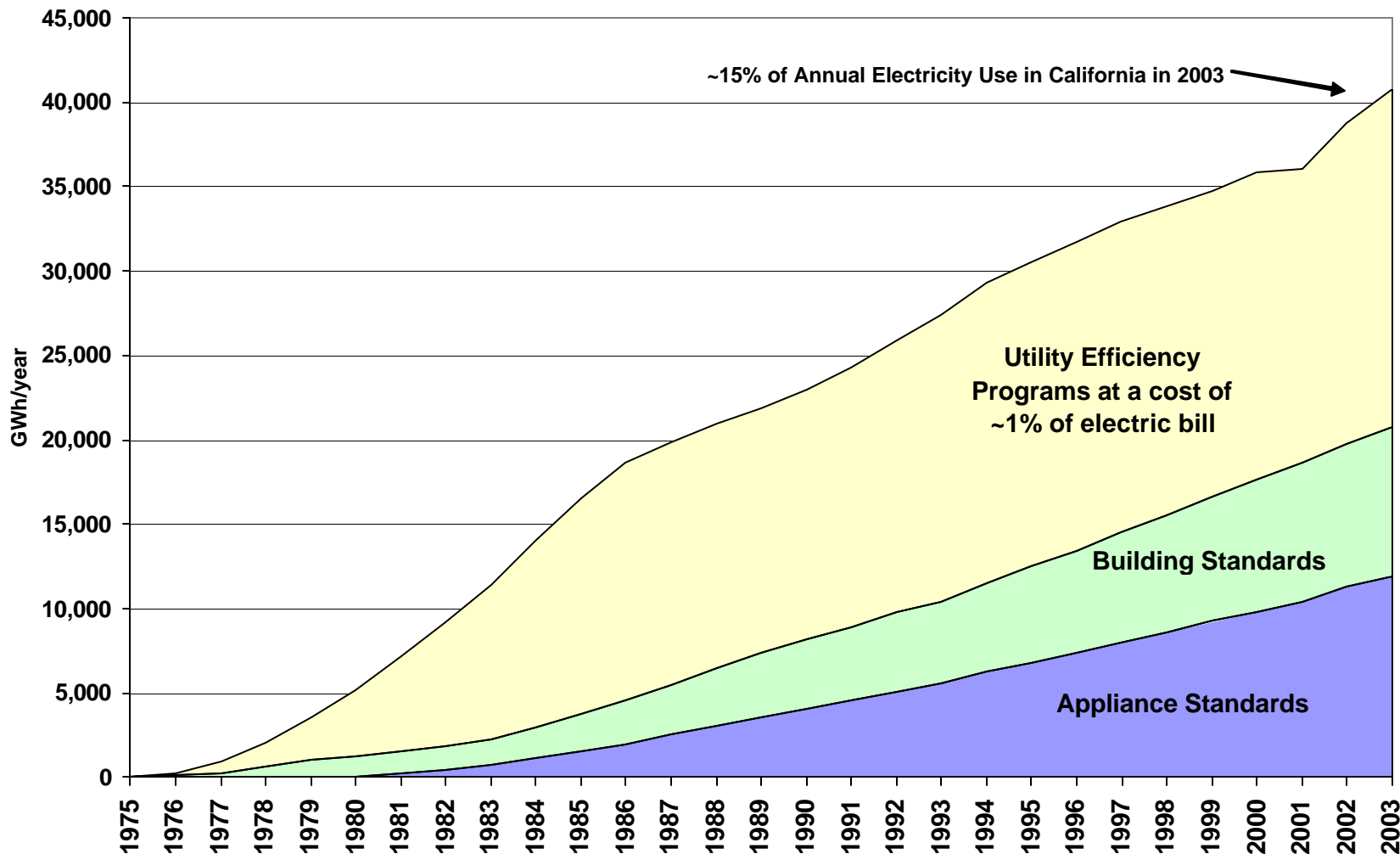
Source: Energy Information Administration / Annual Energy Outlook 2006

Per Capita Electricity Consumption



Source: http://www.eia.doe.gov/emeu/states/sep_use/total/csv/use_csv.html

Annual Energy Savings from Efficiency Programs & Standards

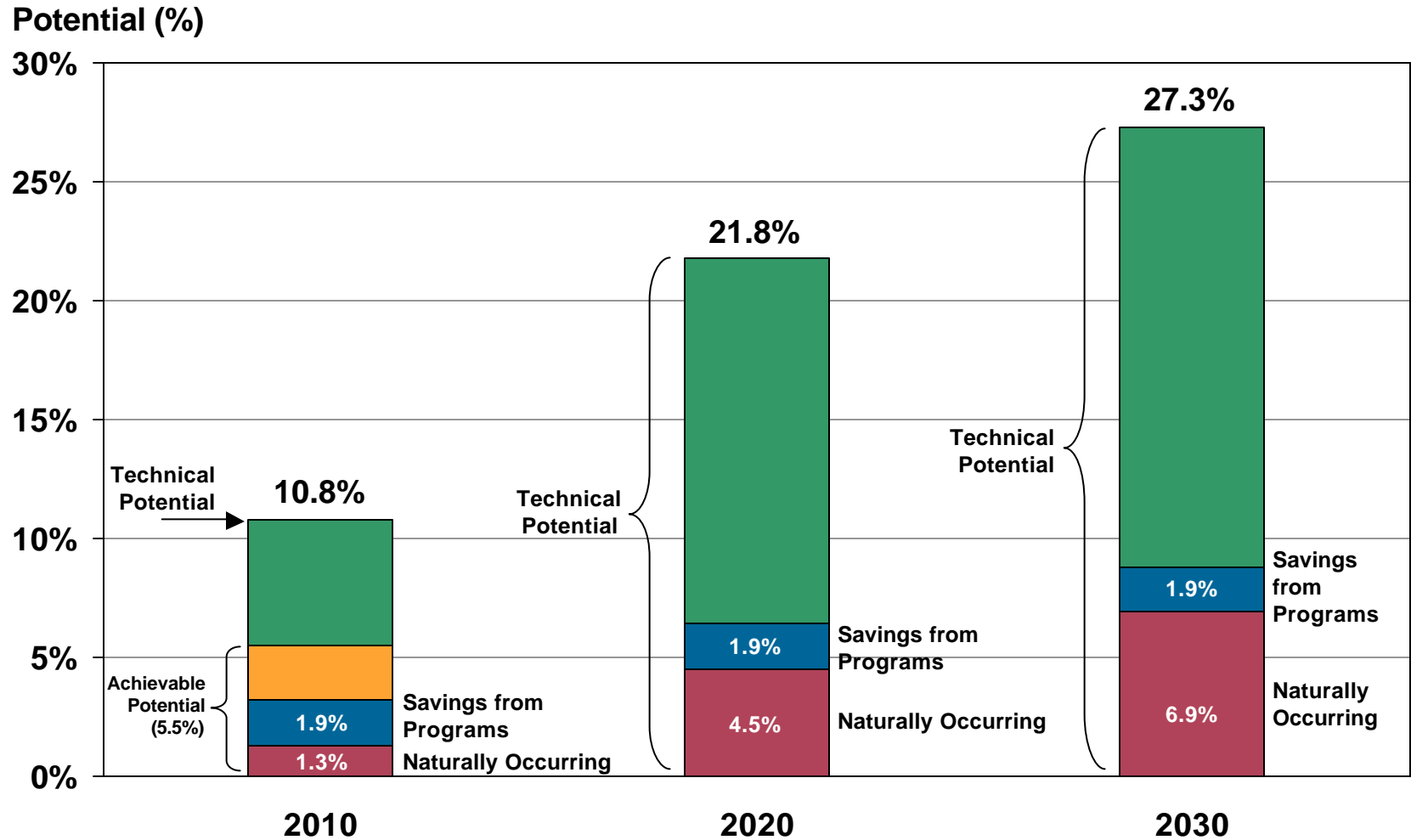


Source: California Energy Commission

CWG/9857P

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Energy Efficiency Potential Estimates

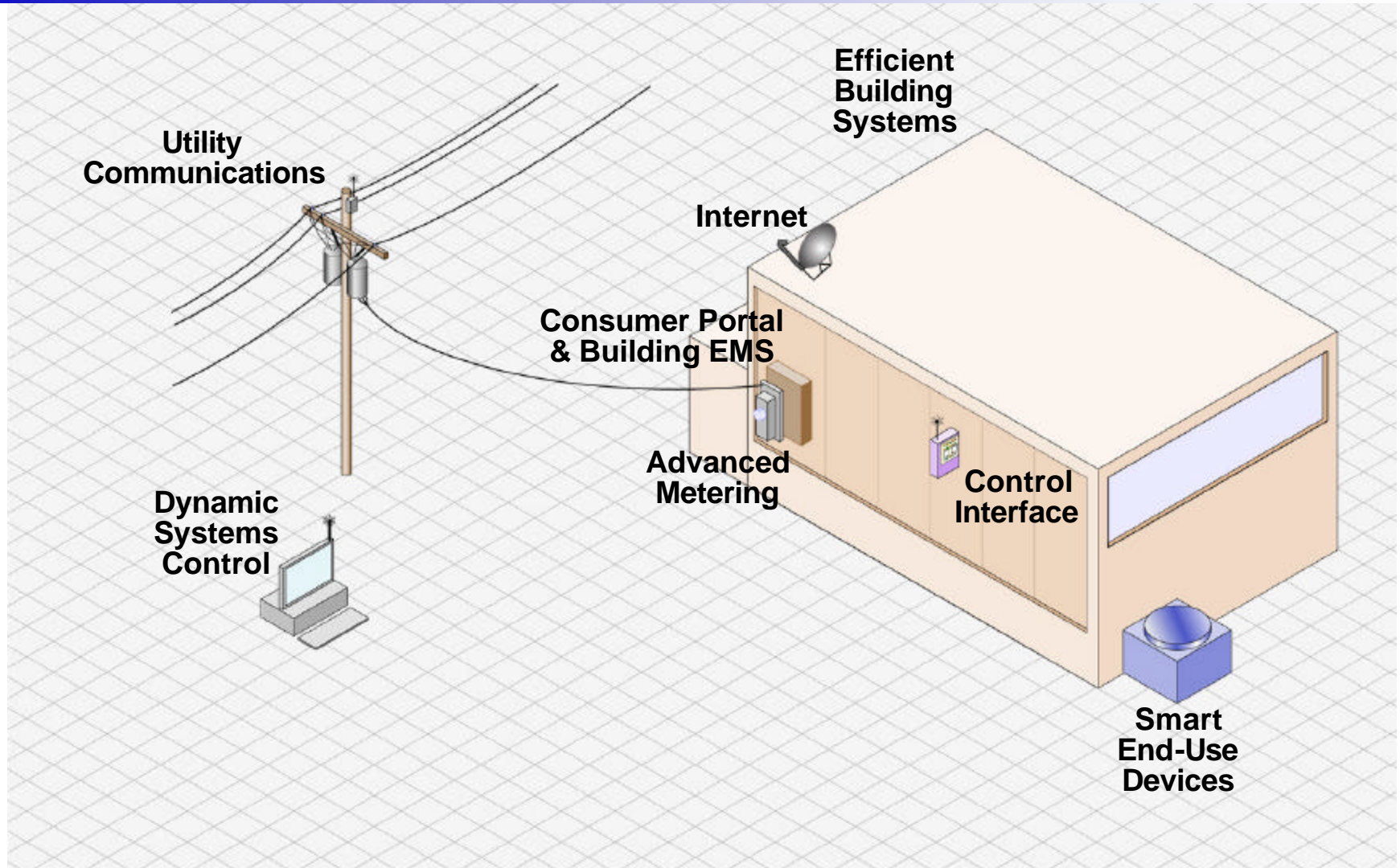


Energy Savings Opportunities & Associated Levelized Costs

- < 5 cents/kWh
 - Residential: appliance removal, audits, lighting, O&M, HVAC tune-up
 - Commercial/Industrial: refrigeration
- 5-10 cents/kWh
 - Commercial: lighting, motors
 - Industrial: motors, compressed air systems, process
- 10-20 cents/kWh
 - Residential: Energy Star appliances
 - Commercial: audits, equipment tune-up, cooling, new construction
 - Industrial: lighting, cooling
- > 20 cents/kWh
 - Residential: HVAC, fans, new construction



Dynamic Systems Infrastructure: Basics

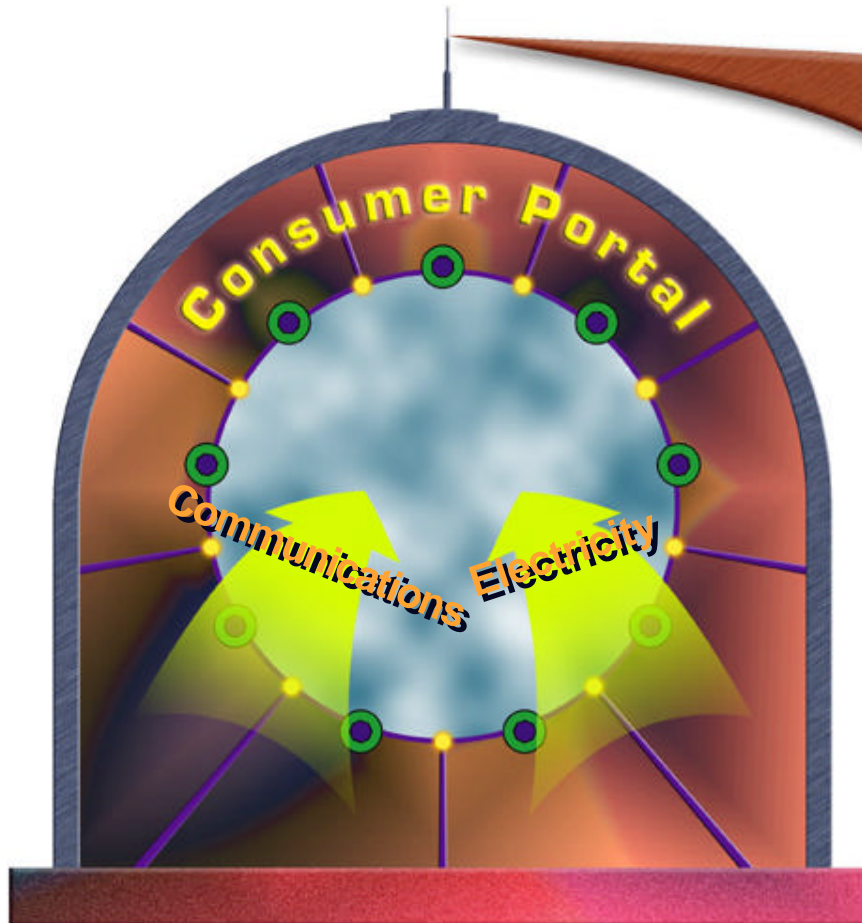


The Portal Empowers Consumers



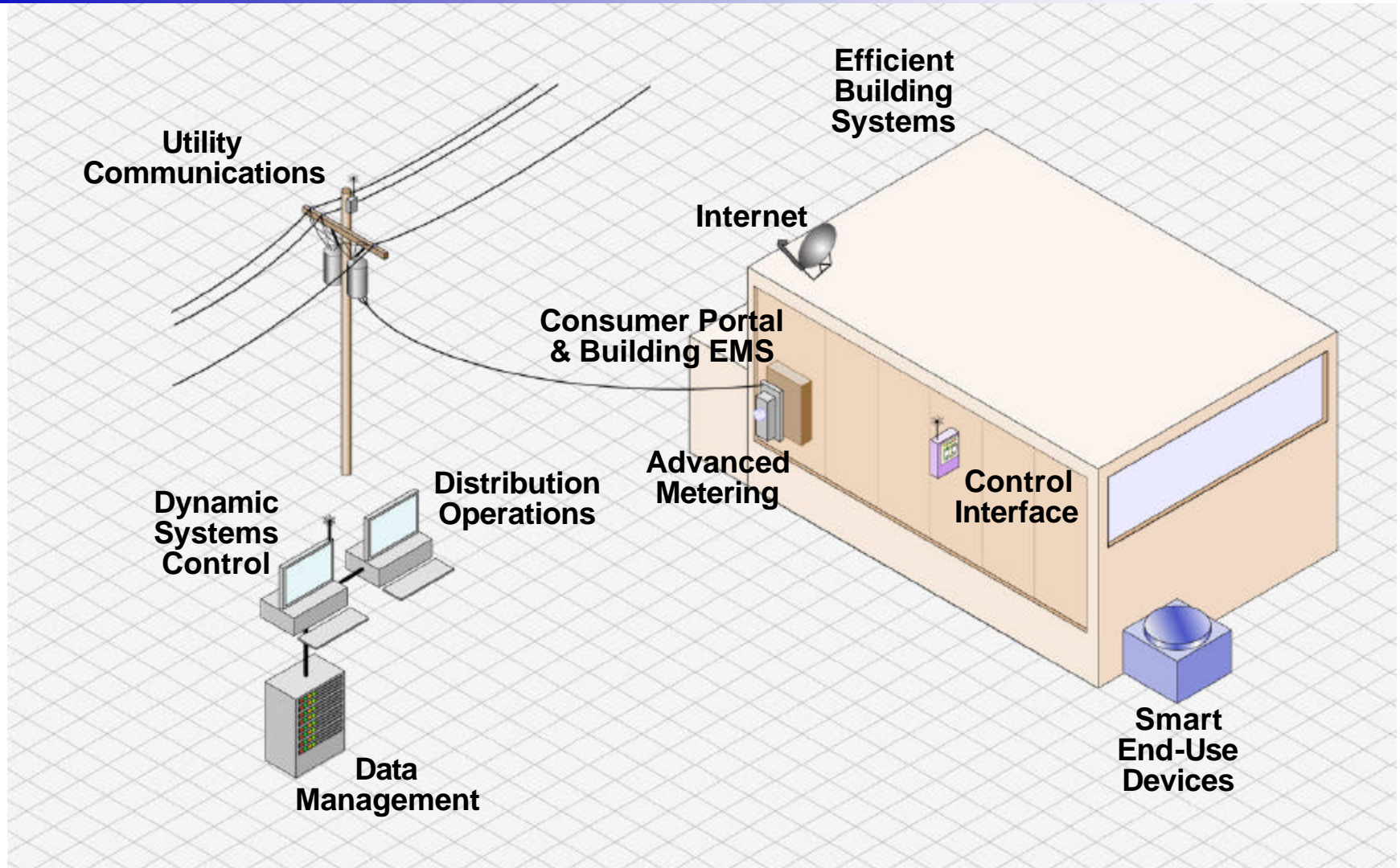
- Connectivity to electricity markets
- Information on consumption
- Access to other services

The Portal Empowers Consumers

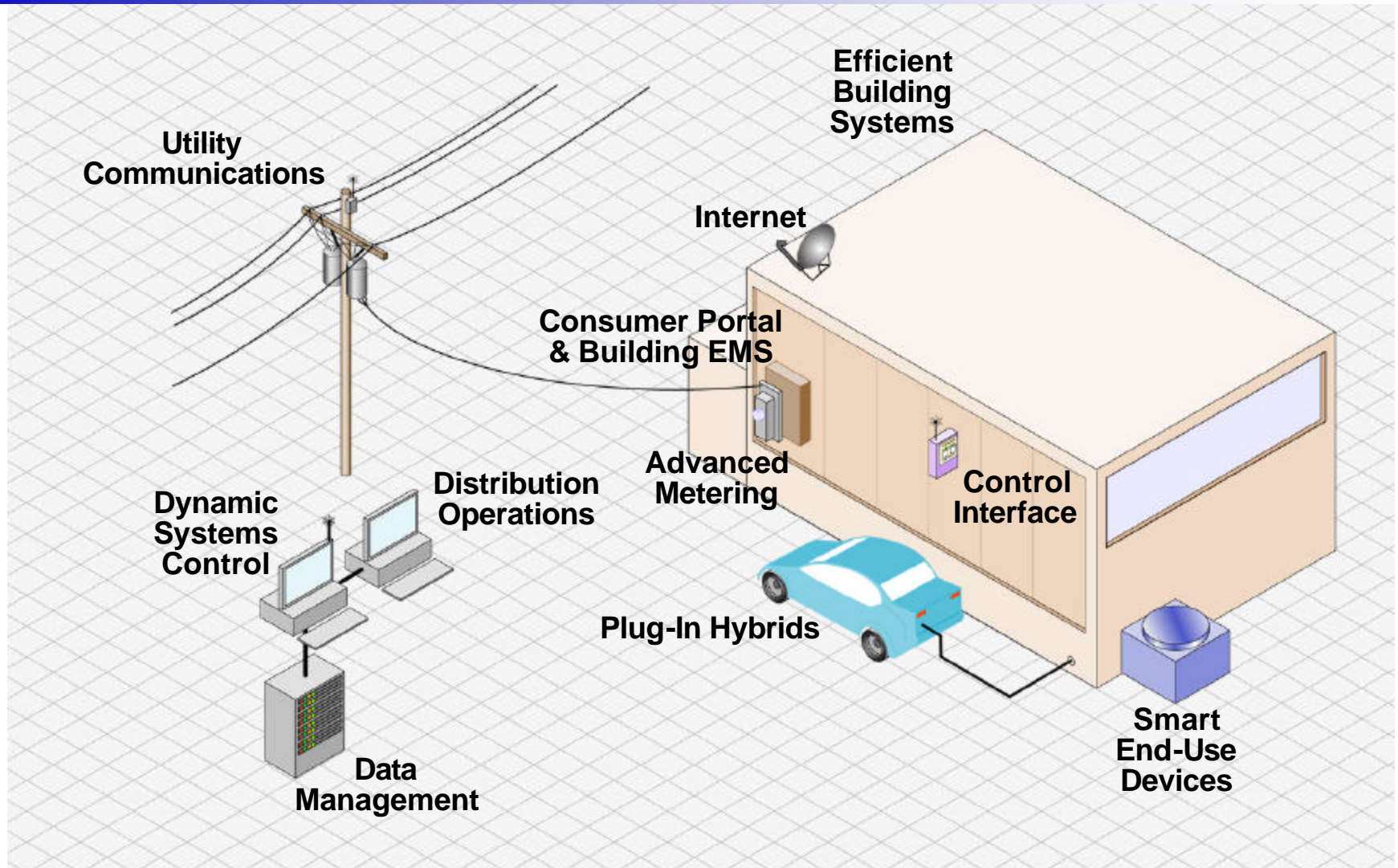


- Choose suppliers
- Select tariff
- Monitoring usage
- Respond to price signals
- Monitor appliances and devices
- Remotely program operations
- Consolidate bills
- Outage detection
- PQ monitoring
- Security
- Data
- Entertainment

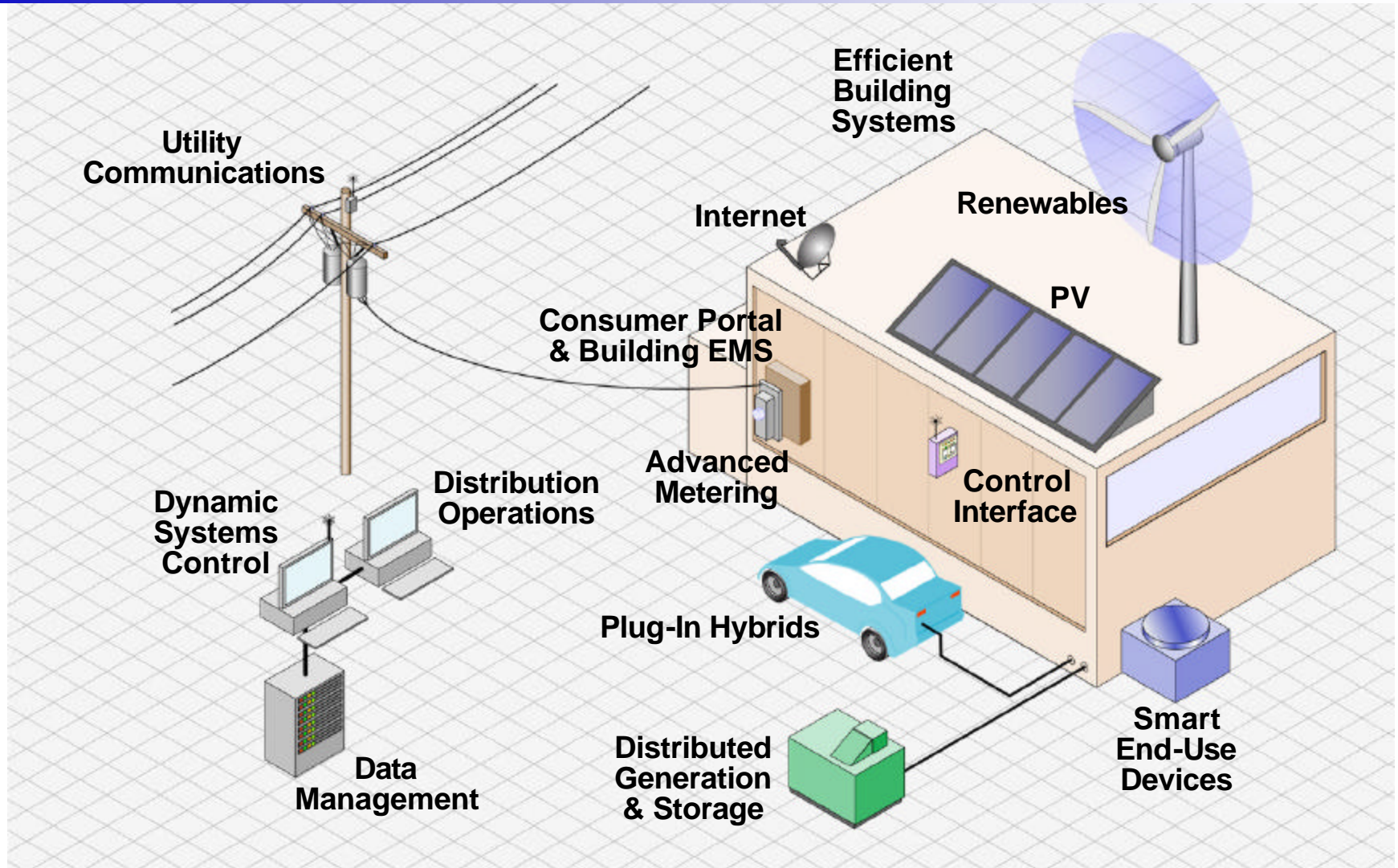
Dynamic Systems Infrastructure: Utility Operations



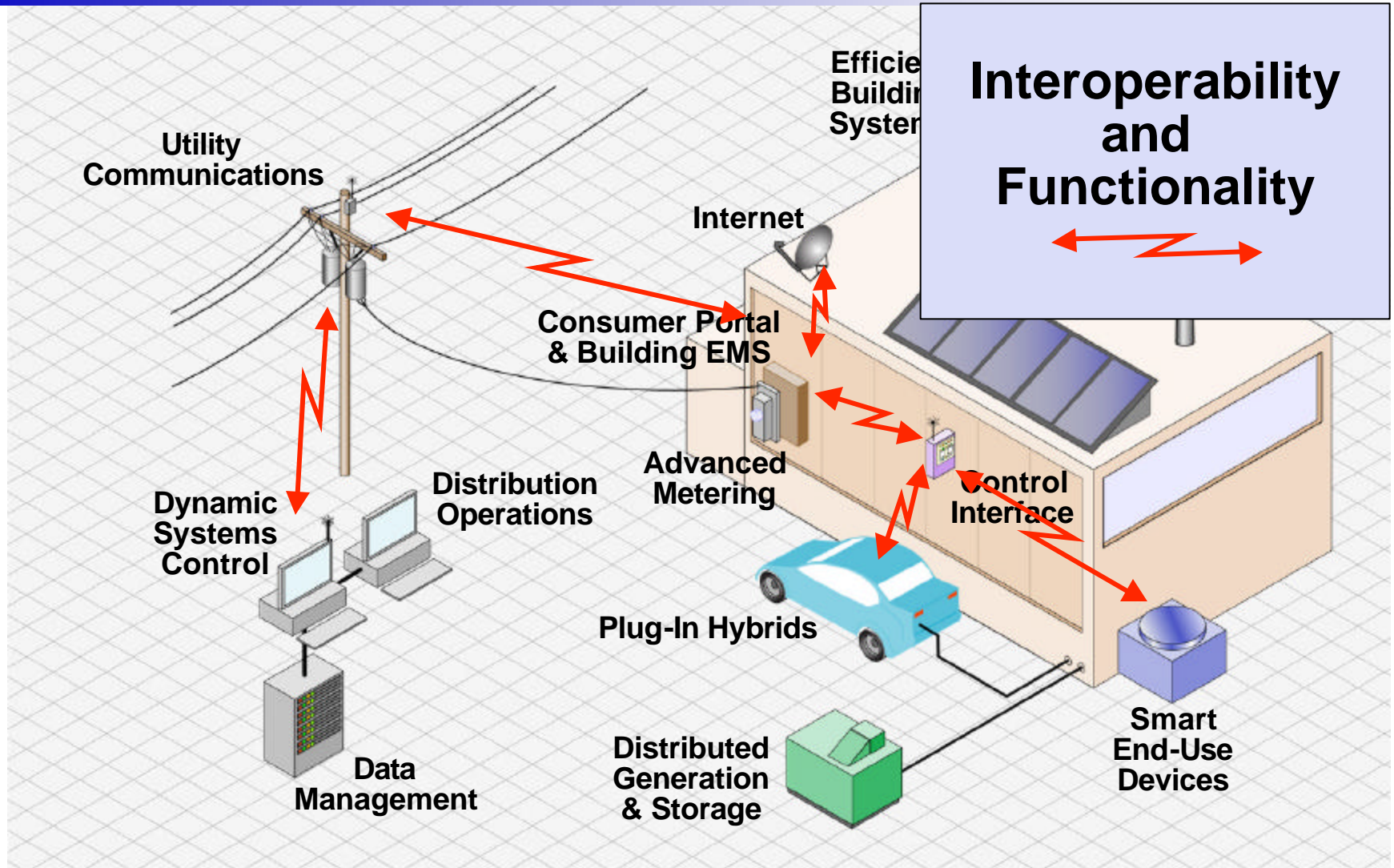
Dynamic Systems Infrastructure: Consumer Opportunities



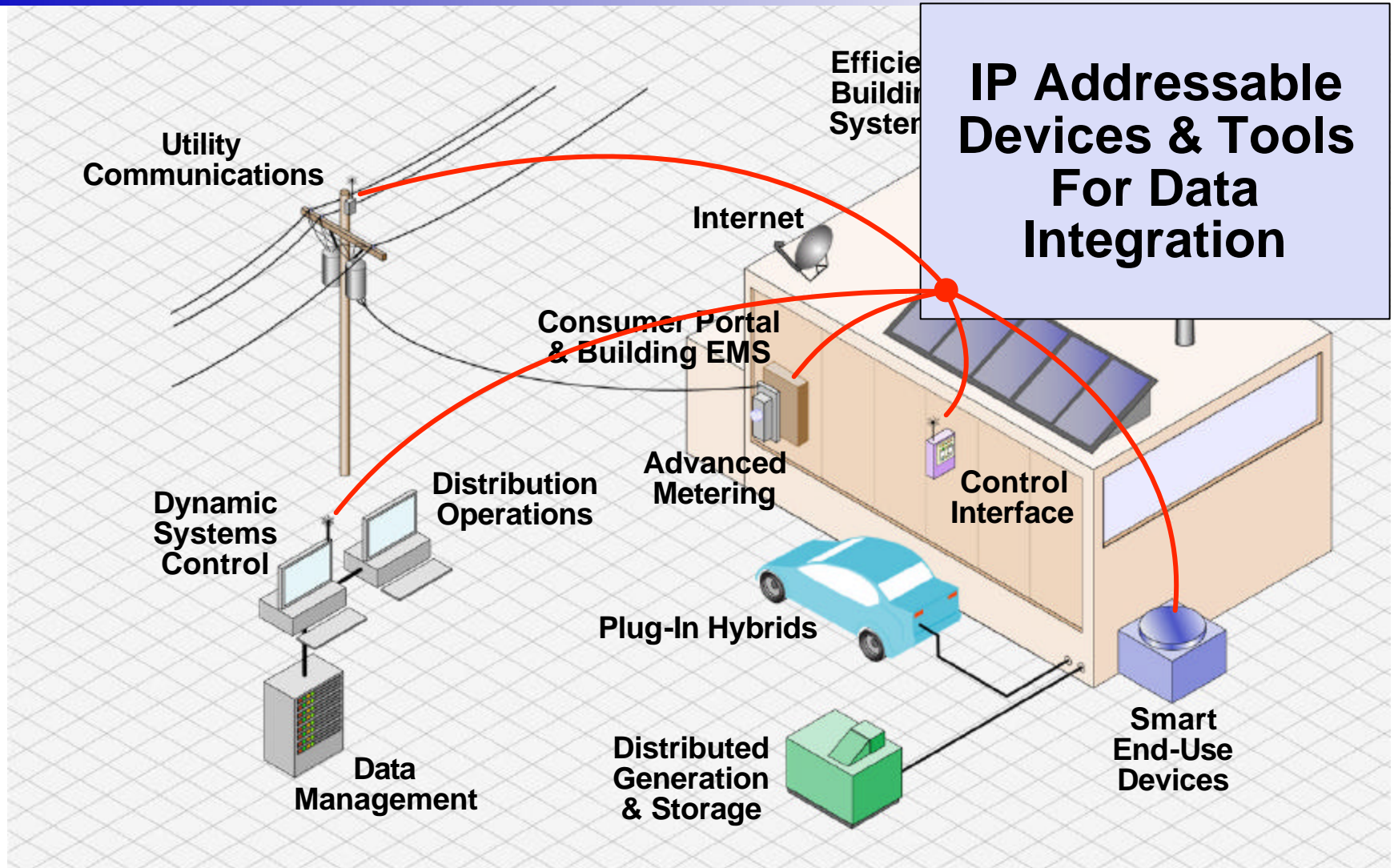
Dynamic Systems Infrastructure: Consumer Opportunities



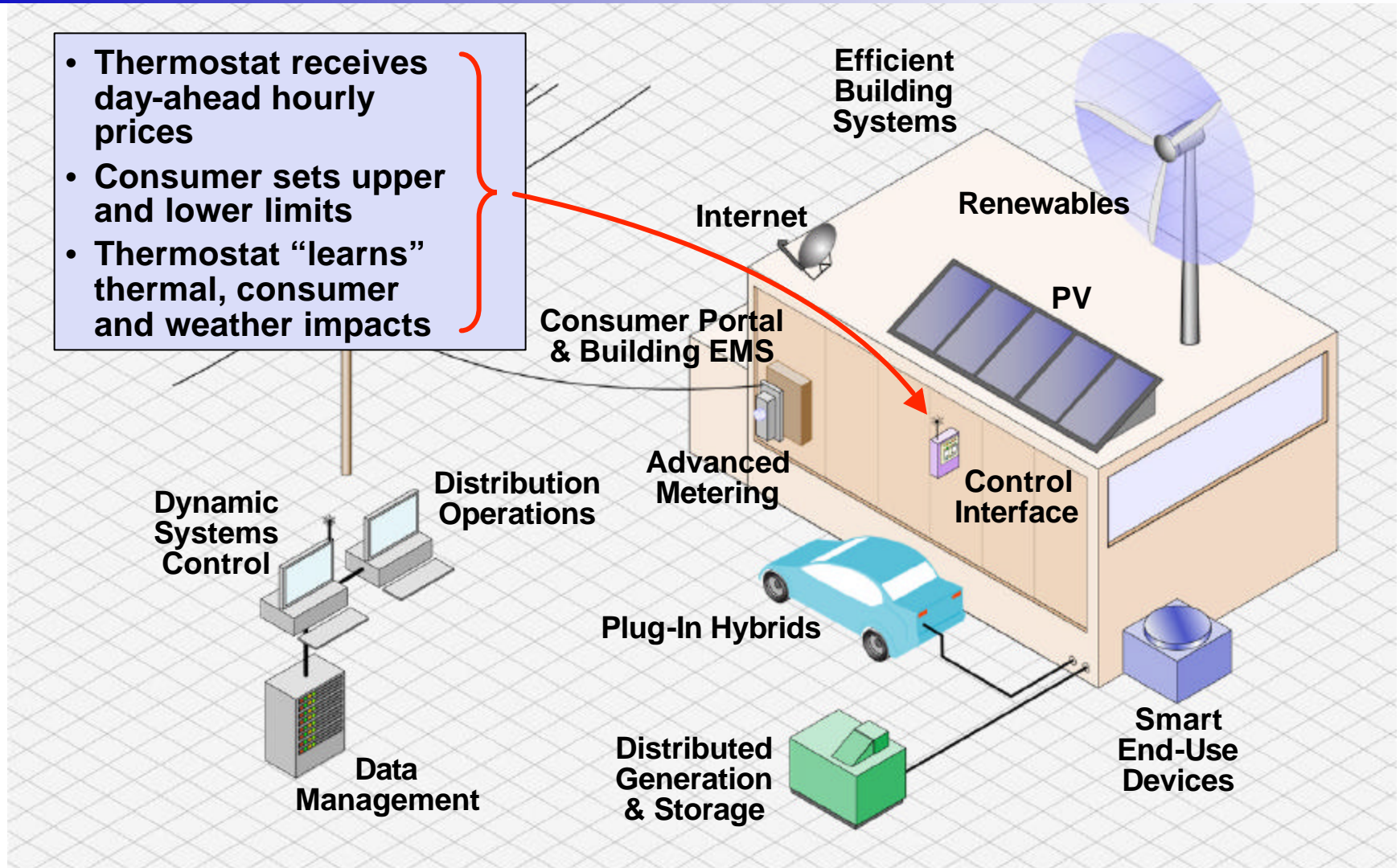
Dynamic Systems Infrastructure



Dynamic Systems Infrastructure



Dynamic Systems Infrastructure – Example



Dynamic Systems Infrastructure – Example

