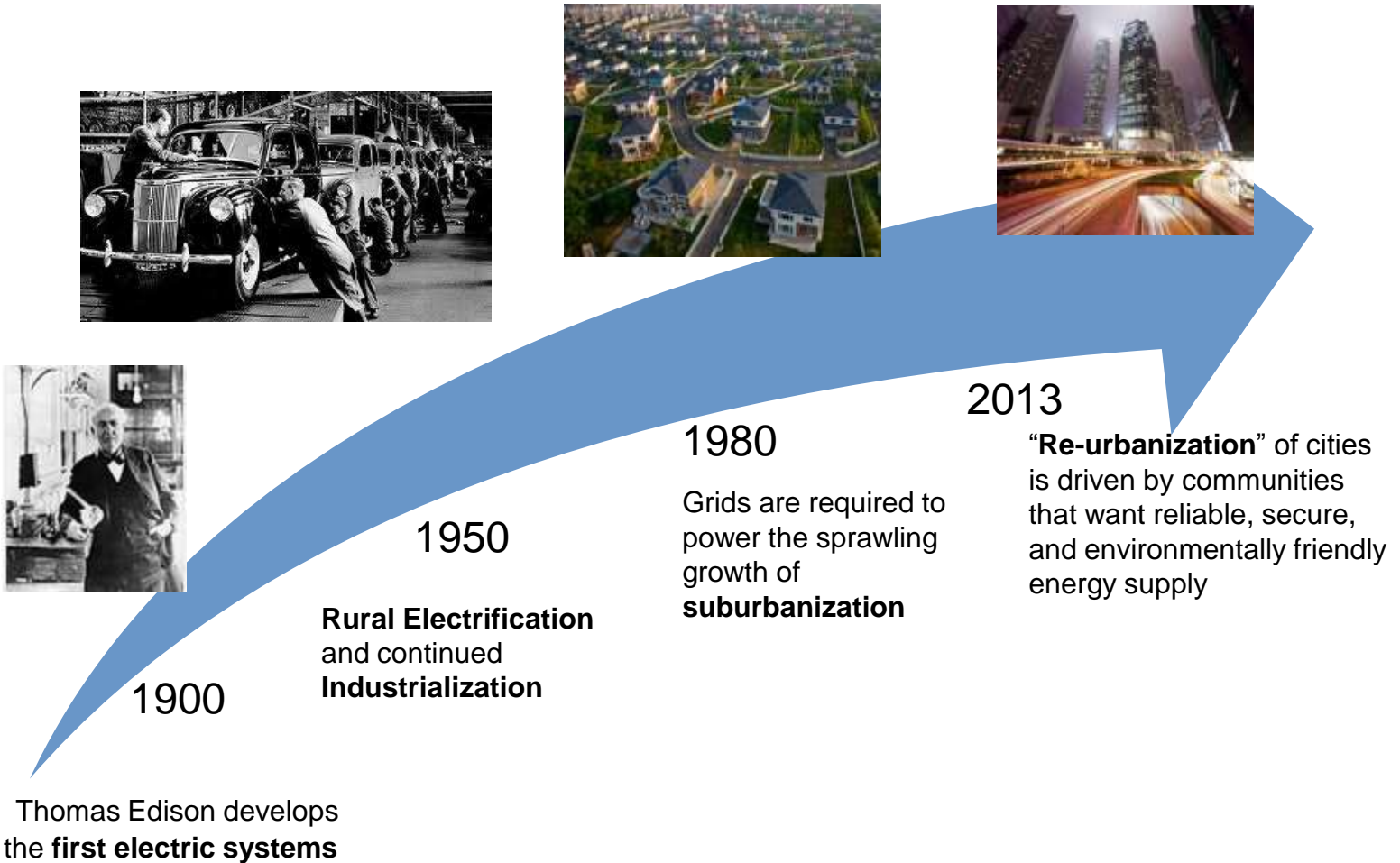


# Micro Grid Opportunities



## Evolution of the Energy Grid



# Today's Electric Delivery System has Yesterday's Design



## Design Characteristic

- One-way limited communication
- One-way power flow
- Centralized generation
- Little to no consumer choice
- Reactive

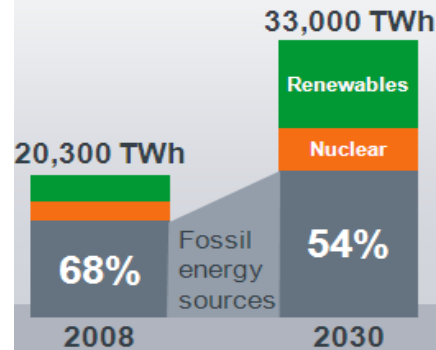
## Impact

- Single point of failure can bring down a whole grid
- Limited data and decision capability
- Grid overload
  - Demand from Population Growth & electric cars
  - Renewable On-Site Generation Limitations

# Why do energy grids need to change?

## Increasing Energy Demand/Cost

By 2030, power consumption will grow to roughly 33,000 TWh - a 63 percent leap!



## Security Concerns & Regulation

7 Million people without power during 2012 Hurricane Sandy



## Renewable Energy Adoption

In 2011, renewable sources of energy accounted for about 9.3% of total U.S. energy consumption and 12.7% of electricity generation



## Aging Infrastructure & Electrical Loss

Today, in the U.S. power grid: 70% of transformers and 60% of switchgear are over 25 years old



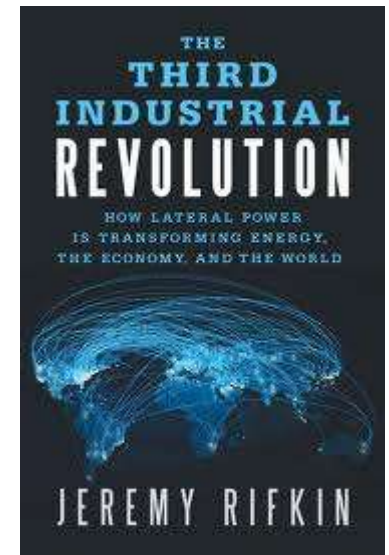
## The Confluence of Energy and Technology

Based on Jeremy Rifkin's 2011 Book:

### **“The Third Industrial Revolution**

How Lateral Power is Transforming Energy, the Economy, and the World”

Great economic revolutions occur when  
new communication technologies  
converge with new energy systems.



# 1<sup>st</sup> & 2<sup>nd</sup> Industrial Revolutions

## First Industrial Revolution

Coal / Steam Power

+ Printing Press

Established Public Schools  
in Europe and North America

= Print Literate Workforce

## Second Industrial Revolution

Fossil Fuel (oil and Natural Gas)

Combustion Engine & Centralized Electricity

+ Telephony, Radio and Television

Increased Mobility & Suburban  
Construction

= Mass Consumer Society

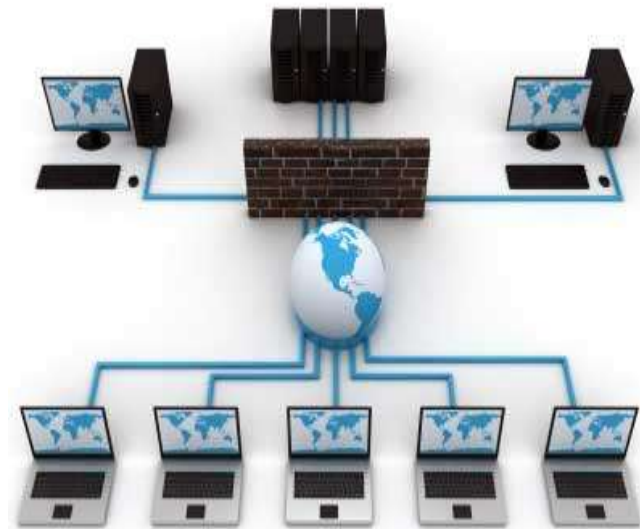
## 3<sup>rd</sup> Industrial Revolution

Distributed Energies  
Solar, Wind, Hydro,  
Geothermal, Biomass

+

Internet and High Speed  
Computing / Mobile  
Communication

= Democratization and  
Decentralization of Knowledge  
and Energy



## **Factors Driving This Change**

### **Tipping Point in Global Demand for Energy**

- Entire Economy Based on Oil
- Diminishing Supply
- Increasing Cost (Direct and “Externalities”)

### **Climate Change**

- Scientific Community Consensus
- Costs Associated with More Frequent Extreme Weather Events

### **Aged Infrastructure**

- Utility and Building Infrastructure in Need of Repair / Replacement

### **Collaborative Paradigm Shift**

- From Vertical, Centralized to Distributed and Collaborative / Shared



## 5 Pillars of the 3<sup>rd</sup> Industrial Revolution

Shift to Renewable Energy

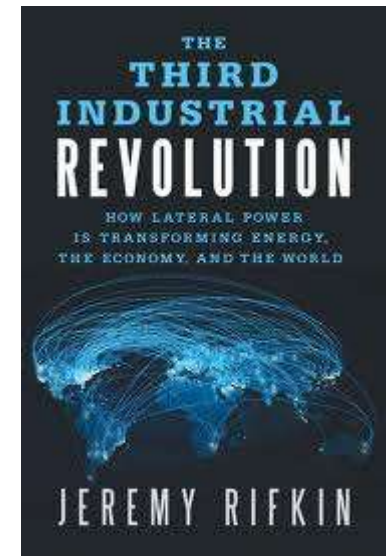
Convert Buildings to Mini Power Plants

- *Energy Conservation + Energy Production*

Energy Storage

“Smart Grid” Energy Transferring System

Conversion of Transportation Fleet



# The Electric Delivery System – Tomorrow’s Smart Grid

## Design Characteristic

- Bi-directional power flow
- Bi-directional and instantaneous communication
- Distributed generation



## Impact / Benefit

- Distributed energy sources can generate and sell energy to the utility
  - Distributed Sources to Meet Volatile Demand
- Peak Load Management /Demand Response Through Communication
- Consumers are able to make real-time consumption choices
  - **Source**
  - **Cost**

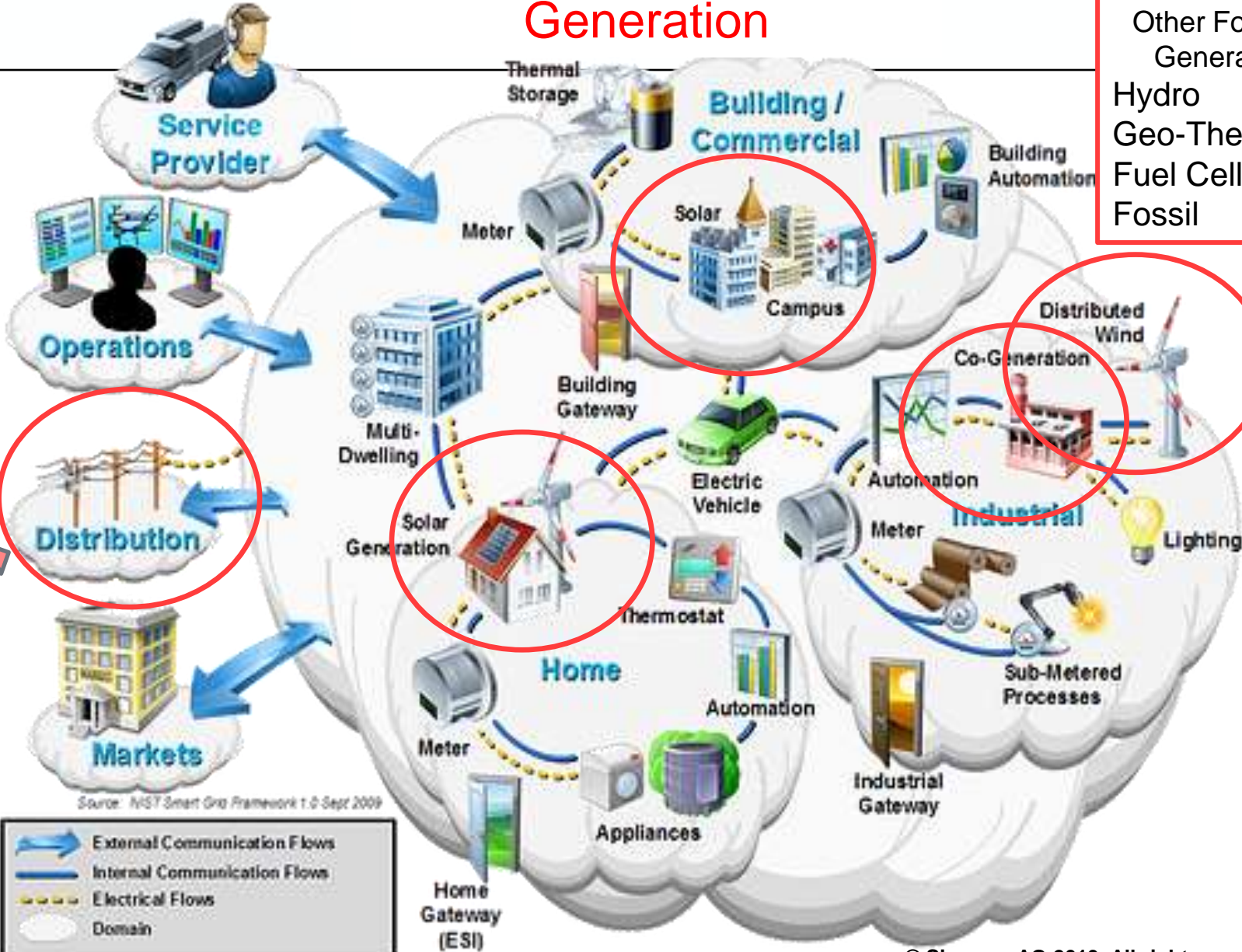
Key Elements of a **MICRO**-Grid:

**Energy Generation**  
**Energy Storage**  
**Energy Management**  
**Security**

# Micro-Grid Generation

**SIEMENS**

Other Forms of Generation:  
Hydro  
Geo-Thermal  
Fuel Cell  
Fossil

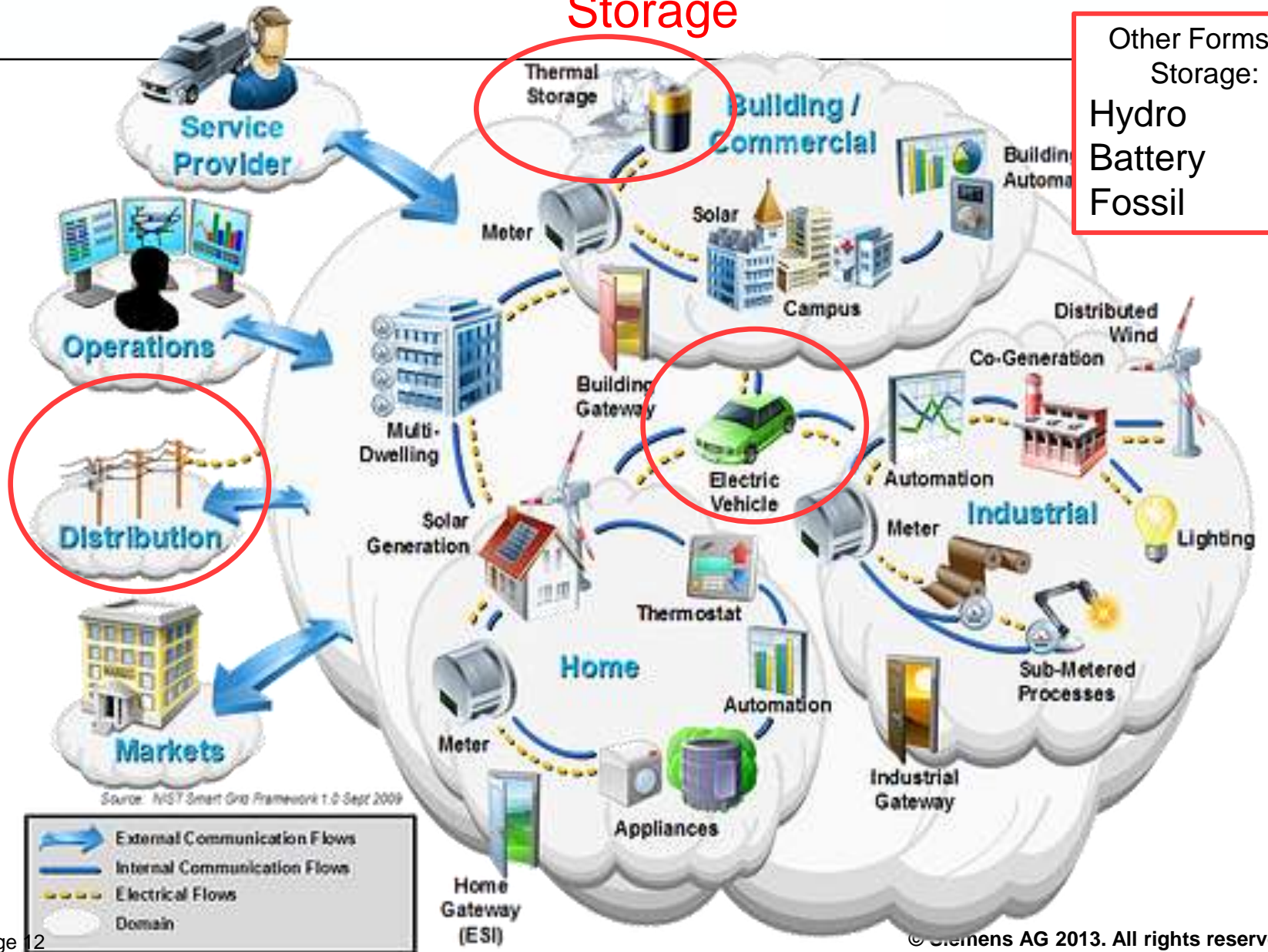


Source: NIST Smart Grid Framework 1.0 Sept 2009

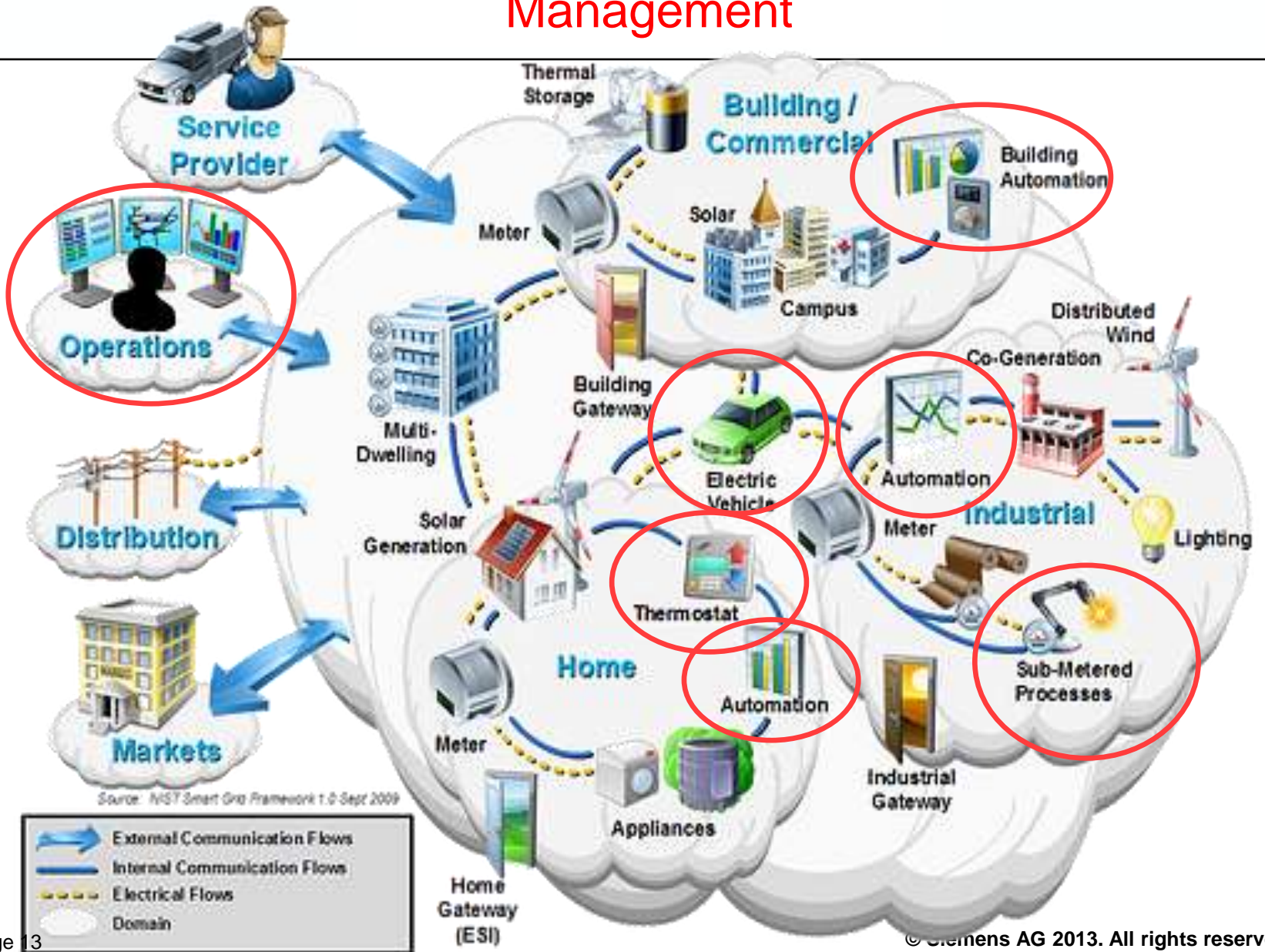
# Micro-Grid

SIEMENS

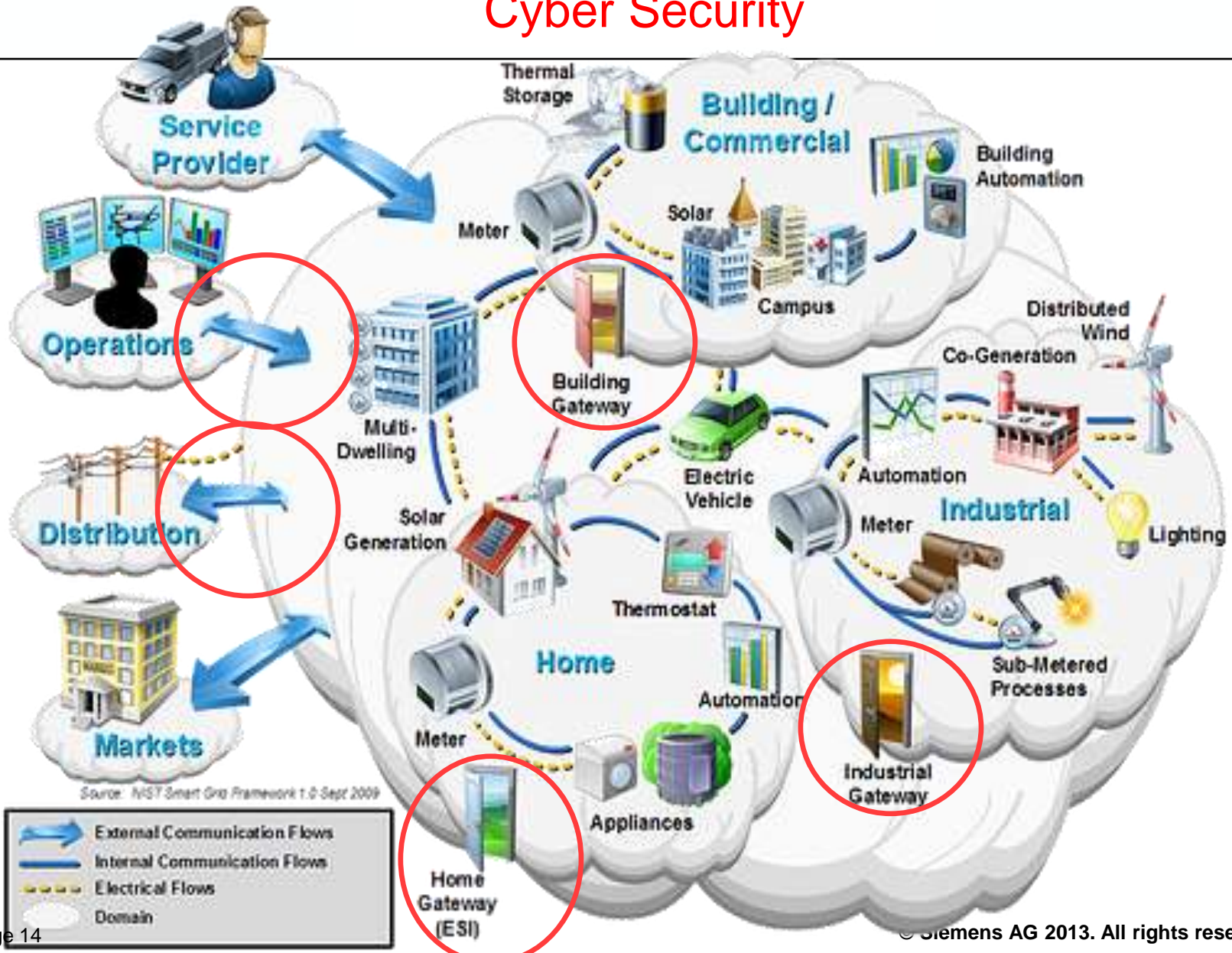
## Storage



# Micro-Grid Management



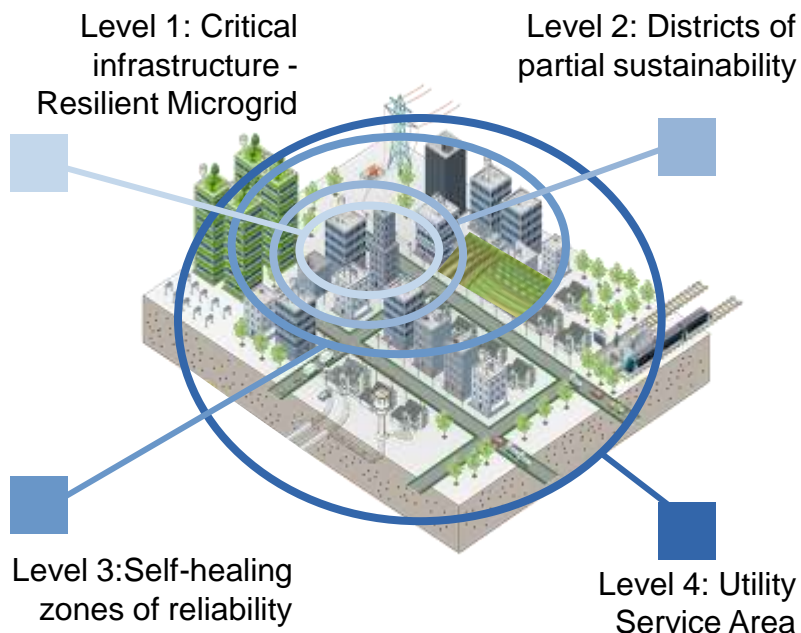
# Micro-Grid Cyber Security



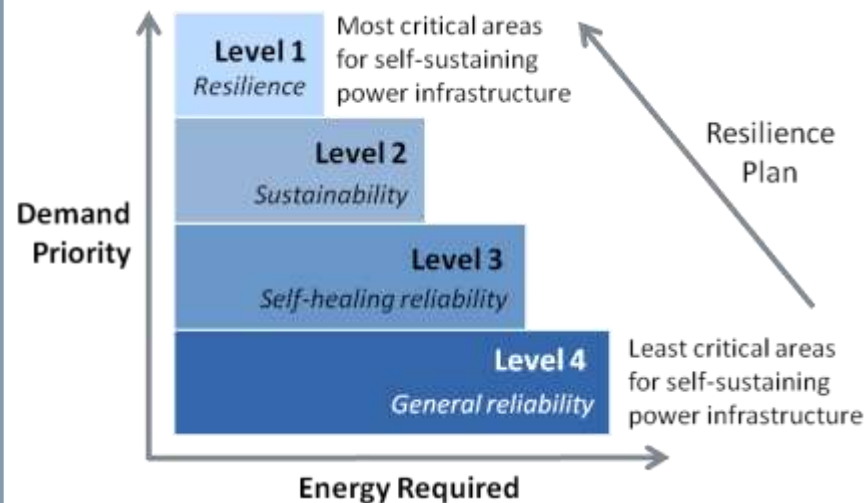
# Energy District solutions are practical, effective for implementing Microgrid technology

- Apply resilience planning as a guiding principle for future infrastructure investments
- Resilience built on Reliability and Sustainability
- Develop a strategy for prioritizing necessary upgrades, investing in new generation assets and allowing the electrical delivery grid to fail in predictable layers of demand priority

## Energy District Structure



## Resilience Plan



# Smart Grid technology addresses energy challenges

## Energy Challenges & Smart Grid Solutions

Integrate Local Power for Energy Security

Failure and Consumption Management

Ideally, Lower Total Energy Cost per kWh Consumed

Integration of Legacy Technology and Disparate Systems



Thank you for your attention!



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