

# SMART GRID THINKING, INNERVATION, AND INFRASTRUCTURE THREATS

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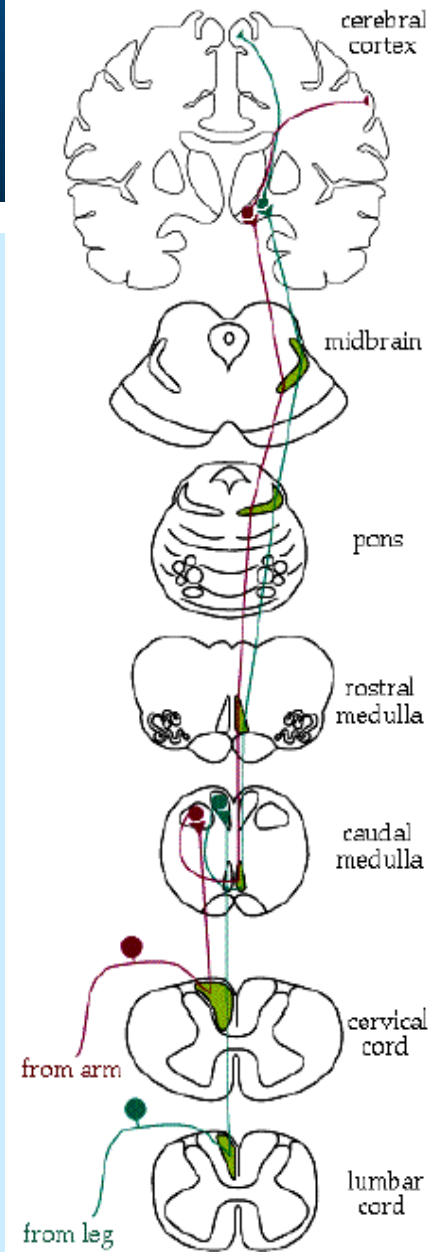
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# KEYS TO A RESILIENT SMART GRID

- New way of doing SCADA -- Innervation, self-locating, self-organizing, self-identifying, and the data they produce self-storing.
- In order to control, one needs to model – Approximate Dynamic Programming (ADP). Five examples: ThreatSim (whole grid), Load/Source Optimization Controller (LSOC) and Dynamic Treatment (distribution grid), FedEx truck charging, intelligent building management (customer side of transformer)
- Grid and local storage is a key
- Policy changes and awareness are important

# INNERVATION

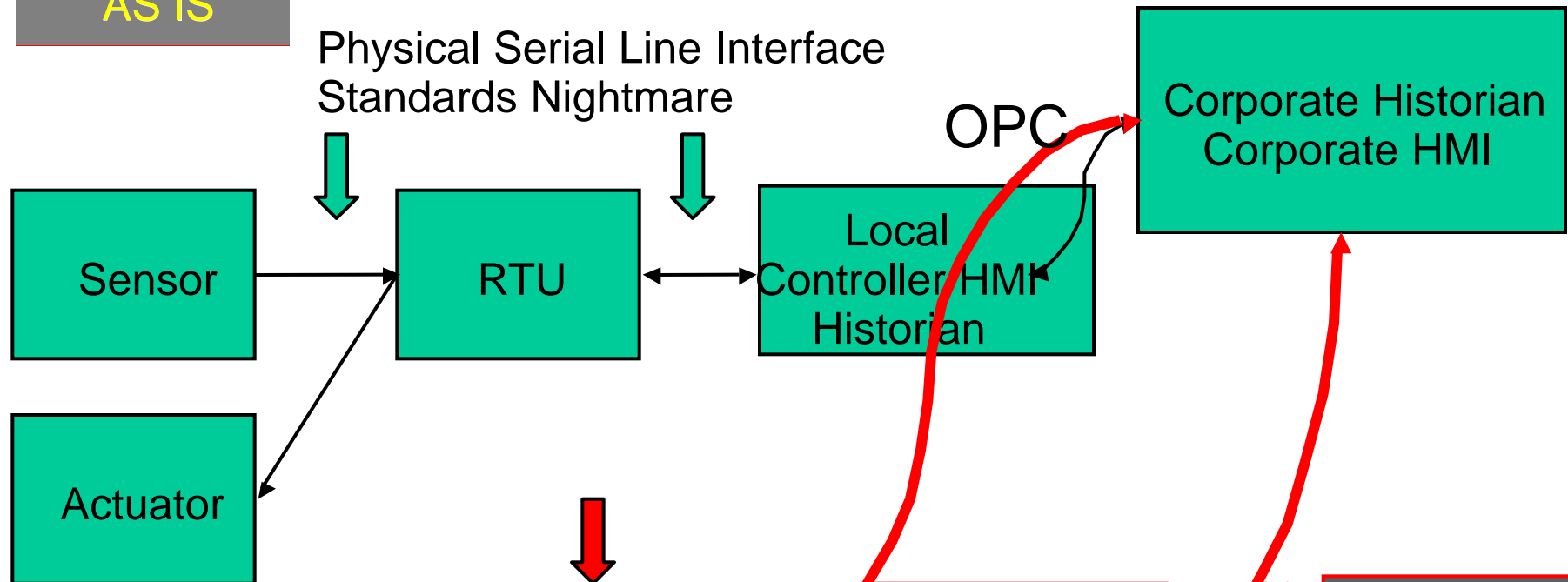
- **Exploit economies of scale**
  - Every company has thousands of “actuators”
    - Generally actuators are isolated physical systems, like wells in an oil company or generators on a power grid, but sometimes they couple. Innervation can optimize for these situations.
    - Clone learning loops and adapt to specifics
- **Homeostasis, autonomous subsystems**
  - Distributed, localized control for isolated subsystems:
    - Sub-tasks, sub-regions, sub-structures, etc.
- **Storage Area Networks: The network is the computer & the storage medium both!**
- **Build it like the Human Nervous System**



# DIGITAL CONVERGENCE REWRITING THE SCADA EQUATION

AS IS

Physical Serial Line Interface  
Standards Nightmare



To Be

Wireless Web Sensor  
Self Historian

Wireless Local  
Controller &  
Historian

Cloud Service

Web Services  
Sensor ML  
IEEE 1451  
Plug and Play

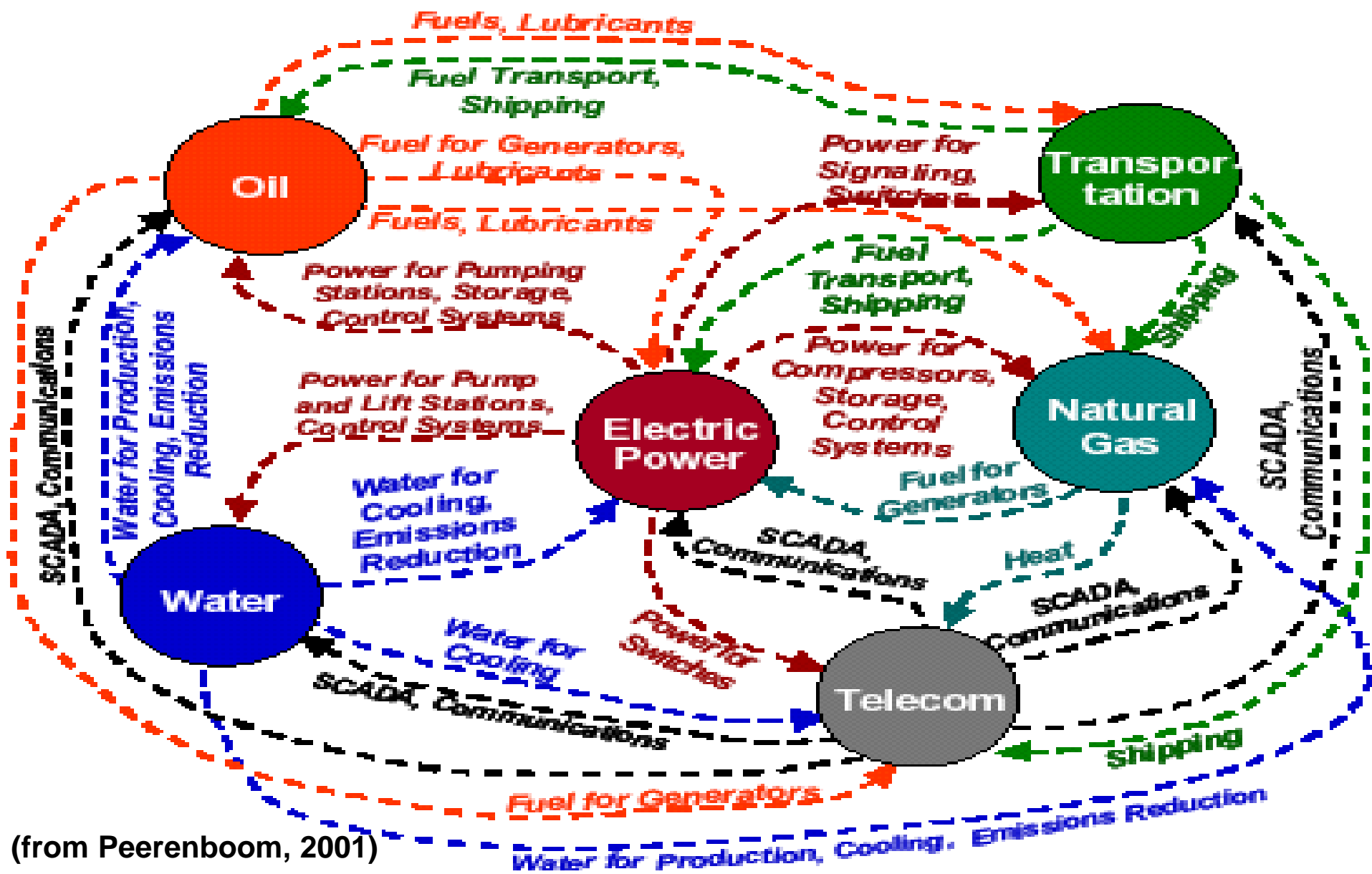
Wireless Lan

Wireless  
to Web

Wireless  
OPC XML  
Web Services

CCLIS

# INFRASTRUCTURE DEPENDENCIES

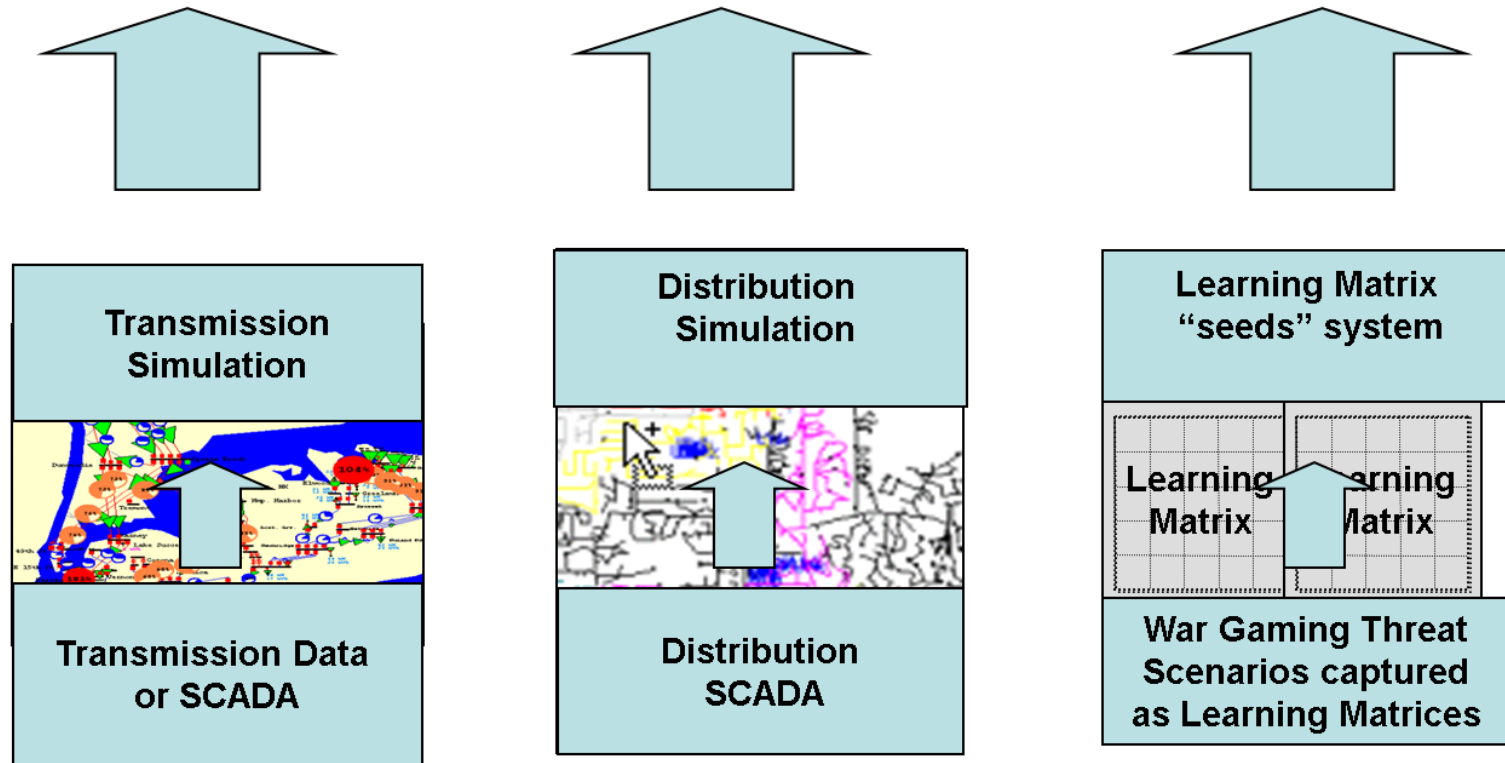


# CCLS SMART GRID WORK

- ThreatSim learning/simulation system
- LSOC - Make distributed resource control precise
- Dynamic Treatment - Make policies algorithmic and adaptive to real time data
- The other side of the transformer
  - GE/FedEx/CCLS Development of optimization of the control of Electric Deliver Truck charging. CCLS won an Ecomagination Award for its work
  - Intelligent operation of Skyscrapers.

# THREATSIM CONCEPT

**ThreatSim Learning System (includes Dimensionality Reduction)**



Single or multiple simulations of aspects of assets under threat



# Machine Learning & ADP Providing Brain of NYC Smart Grid

## SMARTGRID DEMONSTRATION



**Building Management Systems (BMS)** are a critical component in managing a building's energy demands by controlling lighting, power, and ventilation. Building Management Systems can be linked to the utility to provide immediate response to system events.



**Control Centers** collect data from sensors located throughout the electrical system and display it to control center operators, ensuring the safe and reliable operation of the system. This project will use tools that enable quick and accurate decision making, including decision-aid tools to assist operators in identifying problem areas, prioritizing corrective actions, and optimizing the use of controllable field assets to improve the electrical system's reliability.



**Residential Home Area Networks (HAN)** enable customers to control and optimize their energy usage habits, including remotely controlling appliances. HANs may help more customers participate in curtailable electric programs, and/or utility control of customer load.



**Cyber Security** enables secure communications for controlling and distributing energy across the electrical system, and maintaining consumer privacy. Cyber security must be implemented on all smart-grid assets and communications to provide reliable operation, and prevent cyber attacks.

**Smart Building Technologies** are in-house energy management systems that empower customers to track their energy usage, receive messages from the utility, and participate in demand-response programs.

**Control Centers** analyze critical information in real time throughout the grid, enabling us to manage, plan, and forecast events in the energy system to meet ever changing needs.

**Intelligent Grid Systems** use sophisticated communications technology to find problems on the grid and fix them faster, thereby enhancing reliability.

**Energy Storage Devices** can be charged during off-peak hours and used to feed power back into the grid, when needed.

**Smart Grid** technologies must accommodate the unique qualities of New York's electric system and population. The city's buildings and underground electric infrastructure require unique solutions. The overall density of the company's electric infrastructure is a challenge compared to other population centers and electric utilities. The solutions developed in New York City's smart grid could contribute to success in implementing smart-grid technology in other areas with similar challenges.

**Fuel Cells** are a high-efficiency, ultra-low emission energy source that can be integrated into the electric system, lessening our dependence on foreign oil.

**Feeder Switches** are devices that can be controlled to isolate faults, restore service, and optimize load to improve grid efficiency.

**Plug-In Electric-Vehicle Charging Stations** can recharge vehicles at a slow rate, which reduces peak power demand.

**Plug-In Electric Vehicles** can connect to the grid and charge when demand is low, and may be used as an energy resource to feed power back into the grid.

**Smart Appliances** communicate with an in-home energy monitor, allowing customers to use less energy.

**Smart Meters** gather information about customer energy use, monitor energy needs more efficiently, and anticipate challenging peaks.

**Remote Monitoring Equipment** provides information about the electrical system and feeds this data to load-flow modeling software, which can identify potential problems.

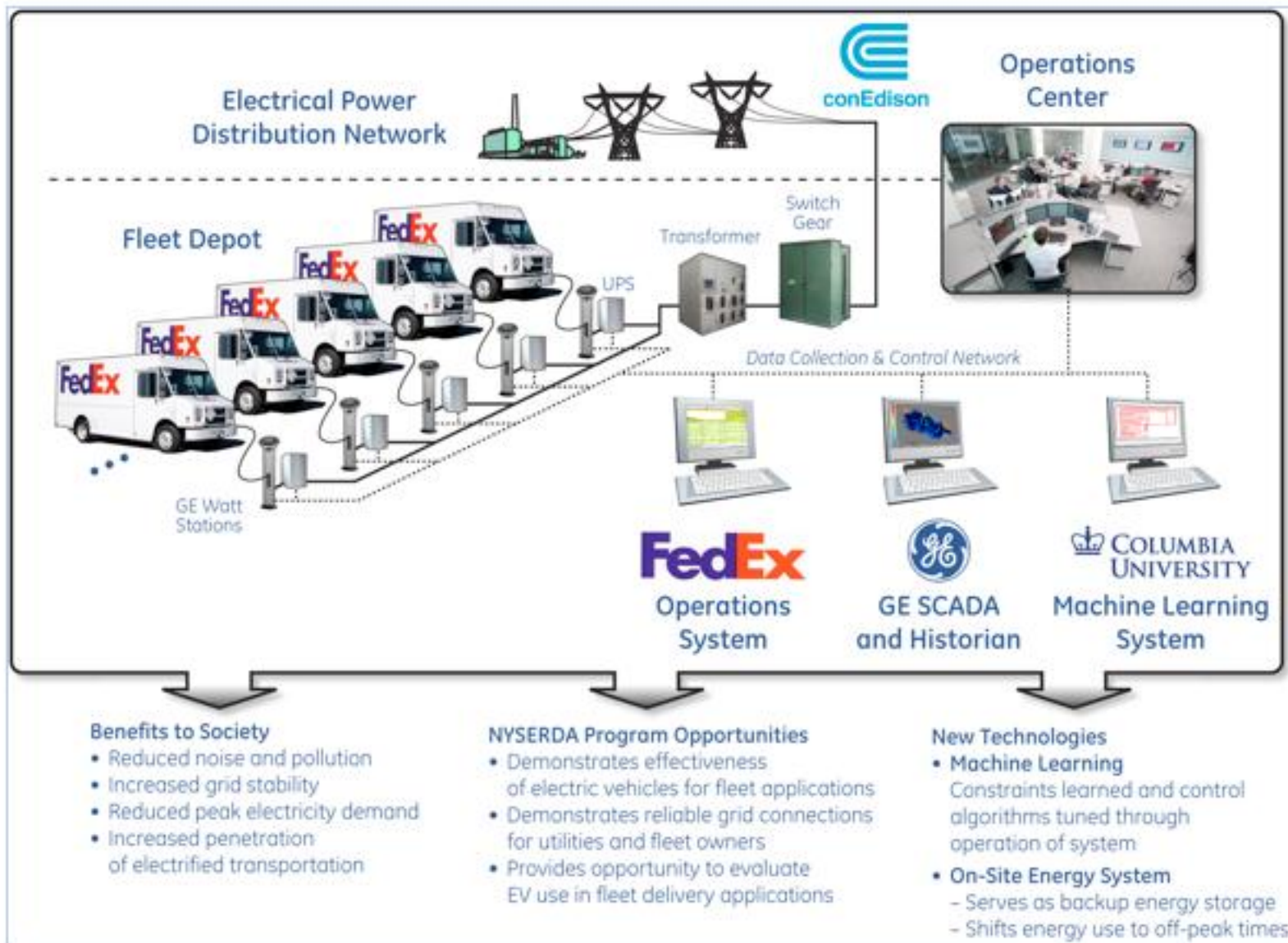
**Distributed Generation Customers** can generate their own power and send excess energy back to the grid.

**In-Home Energy Monitors** communicate with the smart meter and allow users to track and manage energy use.

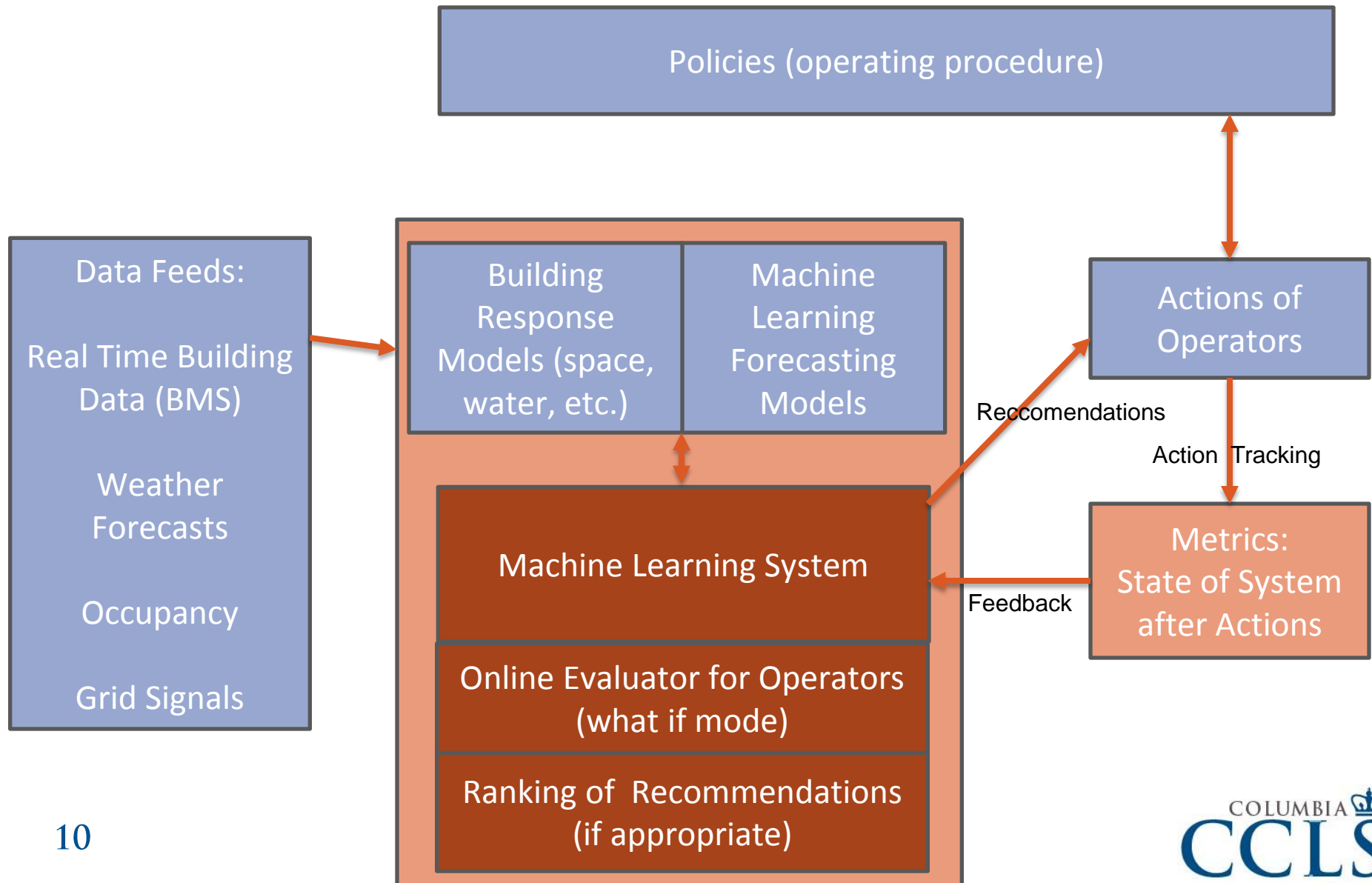
**Smart Meters** gather information about customer energy use, monitor energy needs more efficiently, and anticipate challenging peaks.



# Columbia Machine Learning System developed for FedEx EDV Fleet in Lower Manhattan



# SMART BUILDING SYSTEMS ARCHITECTURE



# STORAGE IS A KEY

- New Battery Technologies are needed and coming like EOS's Zinc-Air battery
  - No flammable or toxic materials.
  - Large number of cycles
- Thermal storage helps!

# POLICY AND AWARENESS IMPORTANT

- Lack of knowledge in the public on what is available, permitting issues, lack of policies and procedures at the city level, non-optimal, contrarian, or nonexistent incentivization hinder EV adoption, connecting renewables to the grid, finding the good in smart meters, etc.
- Role of organizations to change policy and awareness. World Team Now is active in this area.

# THANK YOU

The future ain't what it used to be.  
–Yogi Berra

No problem can be solved from the same  
level of consciousness that created it.  
– Albert Einstein