nationalgrid

Regional Workshop on Clean Energy Development strategies in East Africa

July 16-18, 2012
Arusha, Tanzania

Fouad Dagher
National Grid

nationalgrid

Renewable Energy Sources

Benefits and Hurdles

nationalgrid

Transmission Build-out is a Benefits

- power from remote renewable generation to load centers far away
- help create jobs
- spur economic growth
- achieve the mandated renewable portfolio standard
- significant environmental benefits

nationalgrid

Cape Wind: first off shore wind farm in the US

- Off the coast of Massachusetts
- 130 Wind Turbines
- The towers are 79 m tall
- highest blade tip height will be 134 m above water
- Maximum production 454 MW
- Average production 174 MW
- Projected cost $2.5 B
- Projected saving $7.5 B over 25 years
- Power sold thru PPA

nationalgrid

National Grid's Renewable Technology

- Six Photovoltaic Sites
  - Dorchester
    - 1250kW nameplate
    - 575 MWh to date
  - Everett
    - 605kW nameplate
    - 1049 MWh to date
  - Haverhill
    - 1016 kW nameplate
    - 1736 MWh to date
  - Revere
    - 750 kW nameplate
    - 1272 MWh to date
  - Sutton
    - 983 kW nameplate
    - 2315 MWh to date
  - Waltham
    - 225 kW nameplate
    - 775 MWh to date

Total PV Capacity: 4829 kW
Total Production to Date: 7722 MWh

nationalgrid

Renewable Energy Credits (RECs)

- **RECs are another opportunity for renewable plants to create income**
- **A REC is attained for each MWh produced by a renewable energy**
  - Want to increase plant efficiency and decrease power consumption
- **Companies create renewable portfolios**
  - Some states mandate Renewable Portfolio Standards (RPS)

nationalgrid

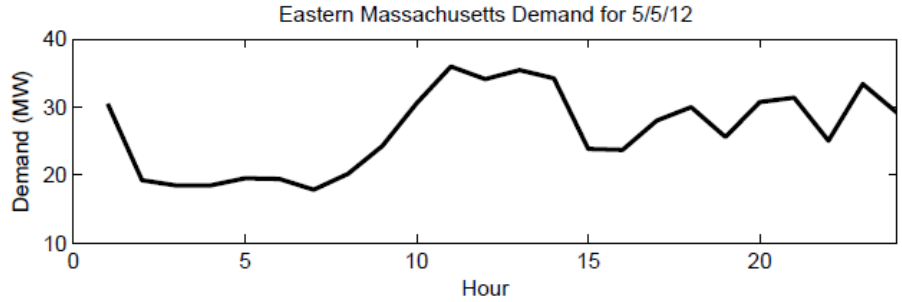
Hurdles for Renewable on Transmission Lines

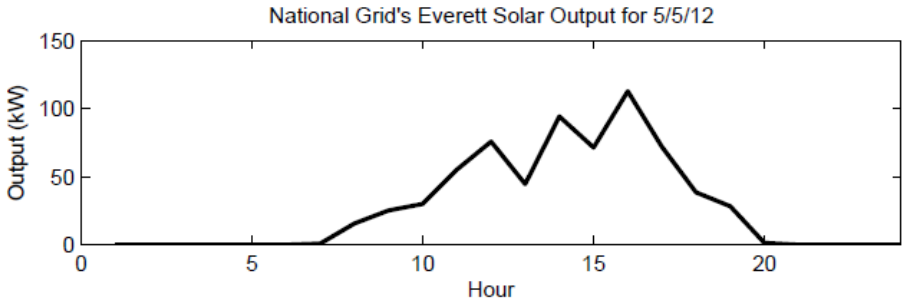
- Interconnection costs
- Siting
- Intermittency
- Available resources (land, wind corridor)
- overlapping state, regional, and federal policies at play in siting new transmission to facilitate the growth of renewable energy
- Objections include charges that new construction obstructs views, reduces property values, and could harm endangered species and habitats.

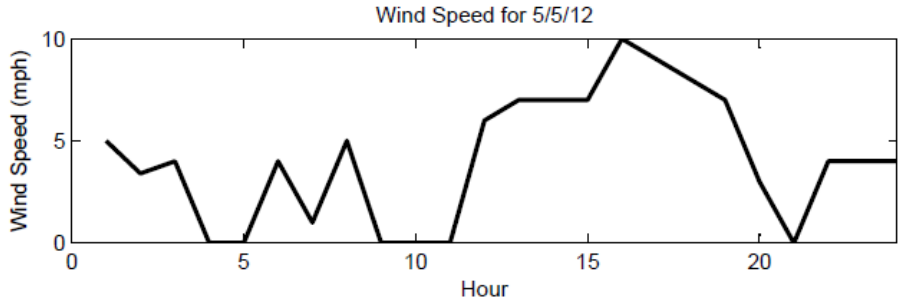
nationalgrid

Renewable Generation vs. Demand

- How do renewable match with demand?
  - Solar seems to be the best fit but still not perfect
  - Wind is much less predictable
  - For large scale integration storage is necessary



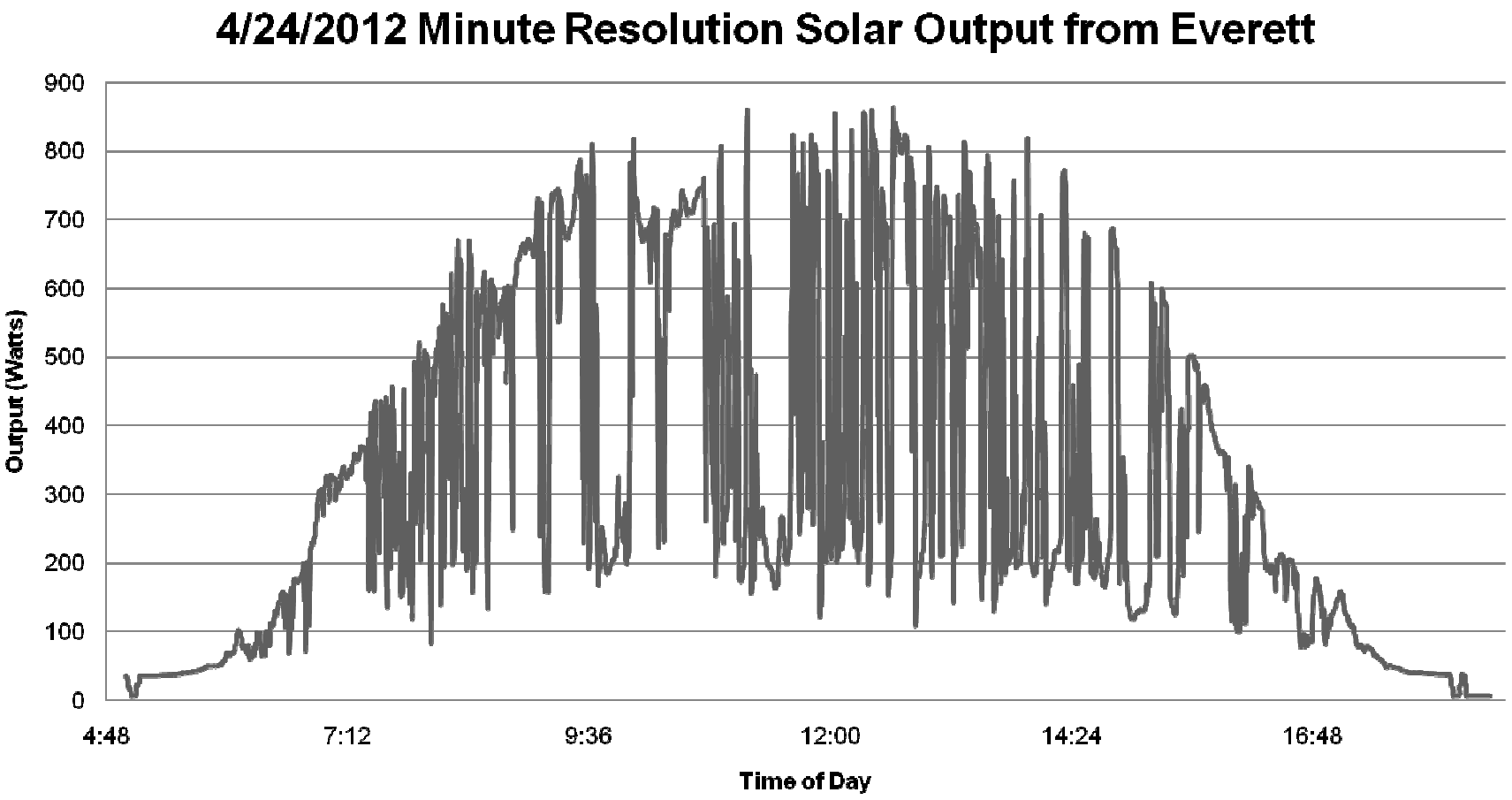




Wind speed data from NOAA
Demand data from ISO New England

nationalgrid

Volatility of Solar



nationalgrid

Renewable's Effects on the Grid

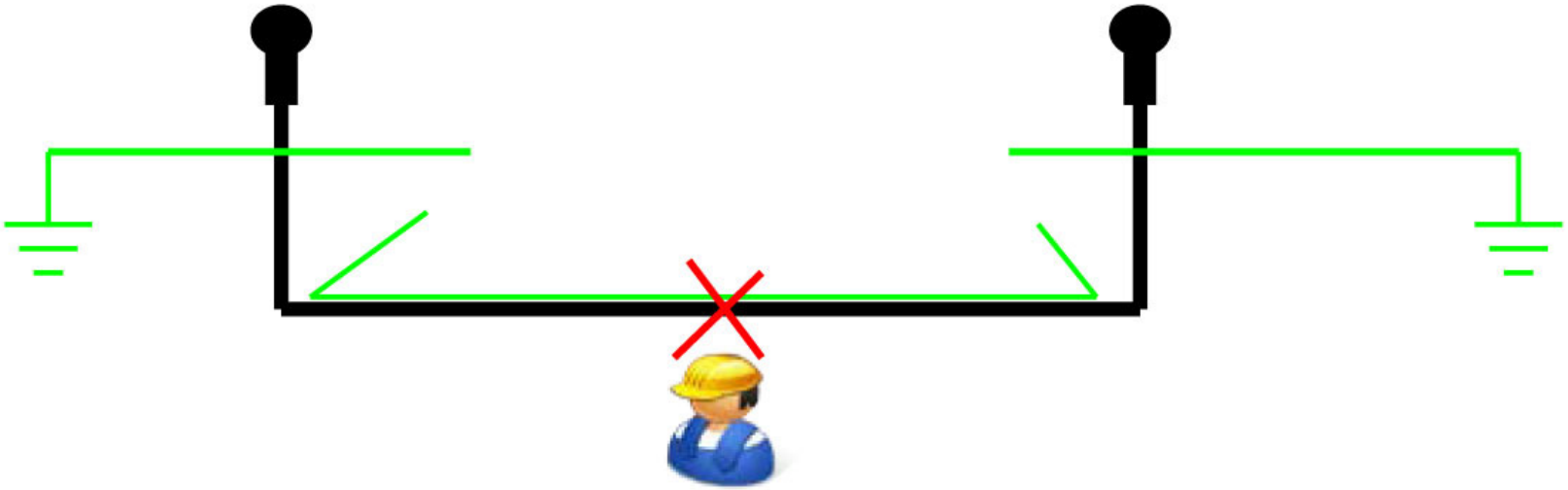
- Slow Transients
  - Created by passing clouds
  - These transients (in the order of seconds) can cause voltage swings on the feeder
    - Electric Power Research Institute (EPRI)
      - Found that they were not significant (1991)
      - However, PV arrays were also distributed
        - 30 houses with 2kW nameplate for 60kW total nameplate

Photo attained form psdpsds.com

nationalgrid

Renewable's Effects on the Grid

- Islanding
  - When the grid has no power on it but the renewable continues to transmit power
  - Creates unsafe work conditions for linesmen



Graphic attained from incedent-prevention.com

Capacity Factor

nationalgrid

$$Capacity\ Factor(CF) = \frac{(MWh\ of\ energy\ produced\ in\ a\ set\ timeframe)}{(Hours\ in\ the\ set\ timeframe) * (Nameplate\ capacity\ in\ MW)}$$

- **Capacity Factor vs. System Efficiency**
  - The two values are not related or dependent on each other
  - Efficiency represents losses of energy in the system
    - **Should be accounted for in the nameplate capacity**
  - CF is the percentage of generation capacity potential used on average
    - **Usually due to environmental conditions not being ideal but can account for maintenance**

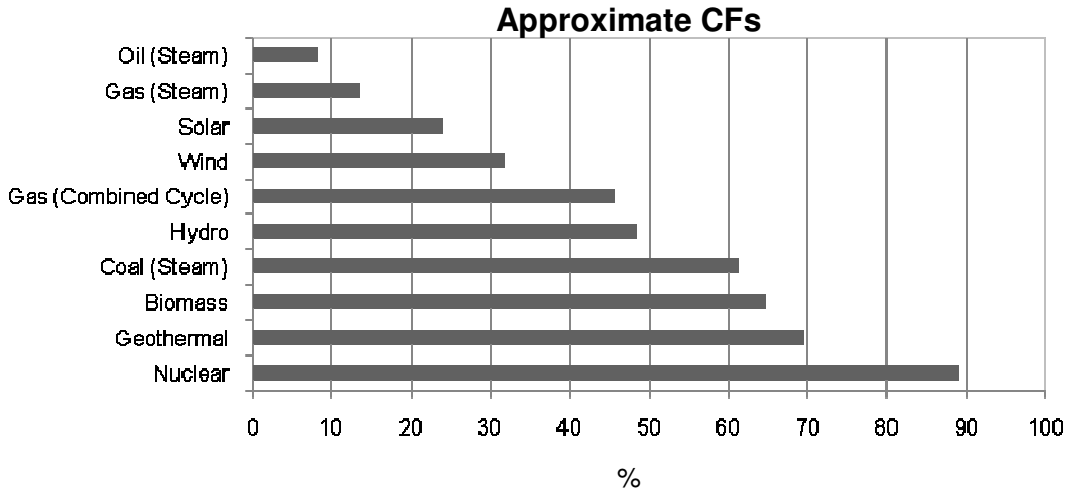


Table data from Nuclear Energy Institute

nationalgrid

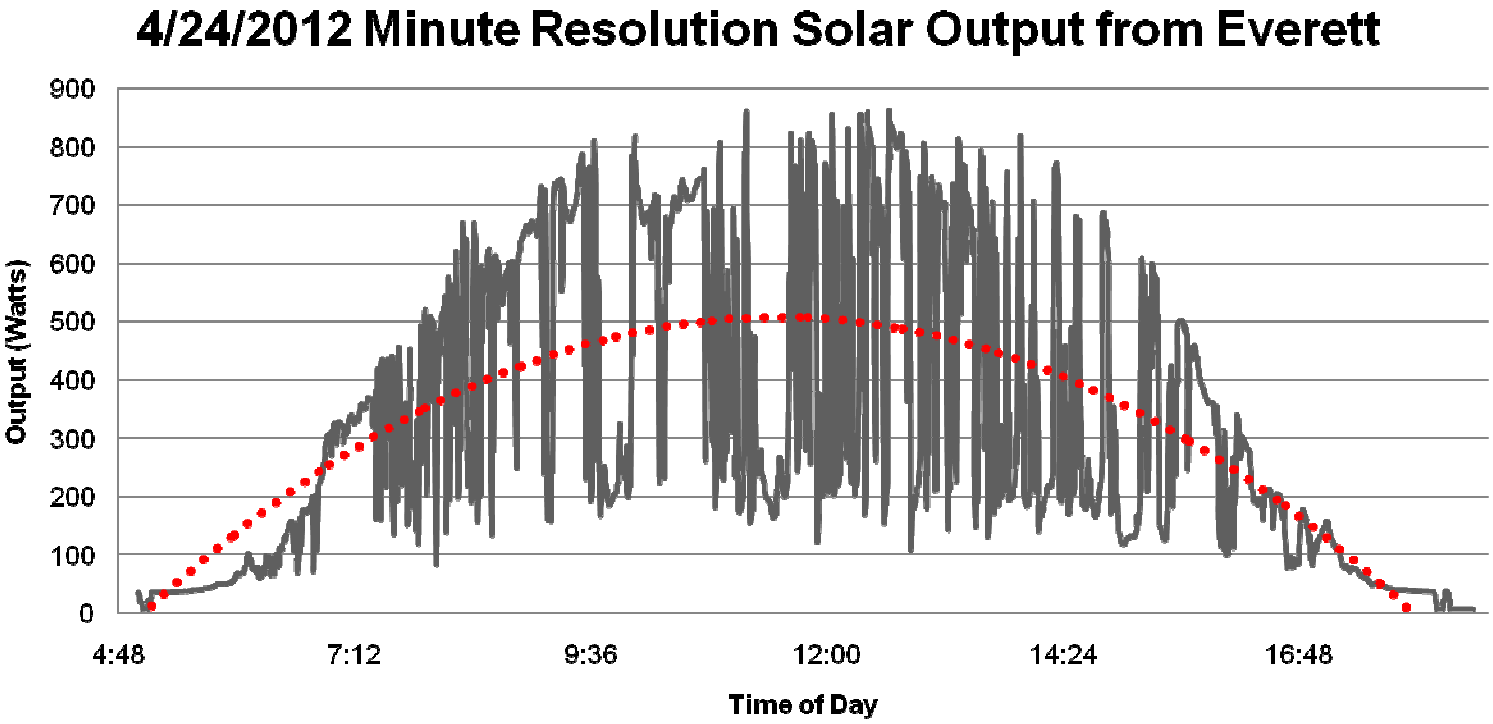
Possible Solutions

Energy Storage

nationalgrid

Energy Storage - Smoothing

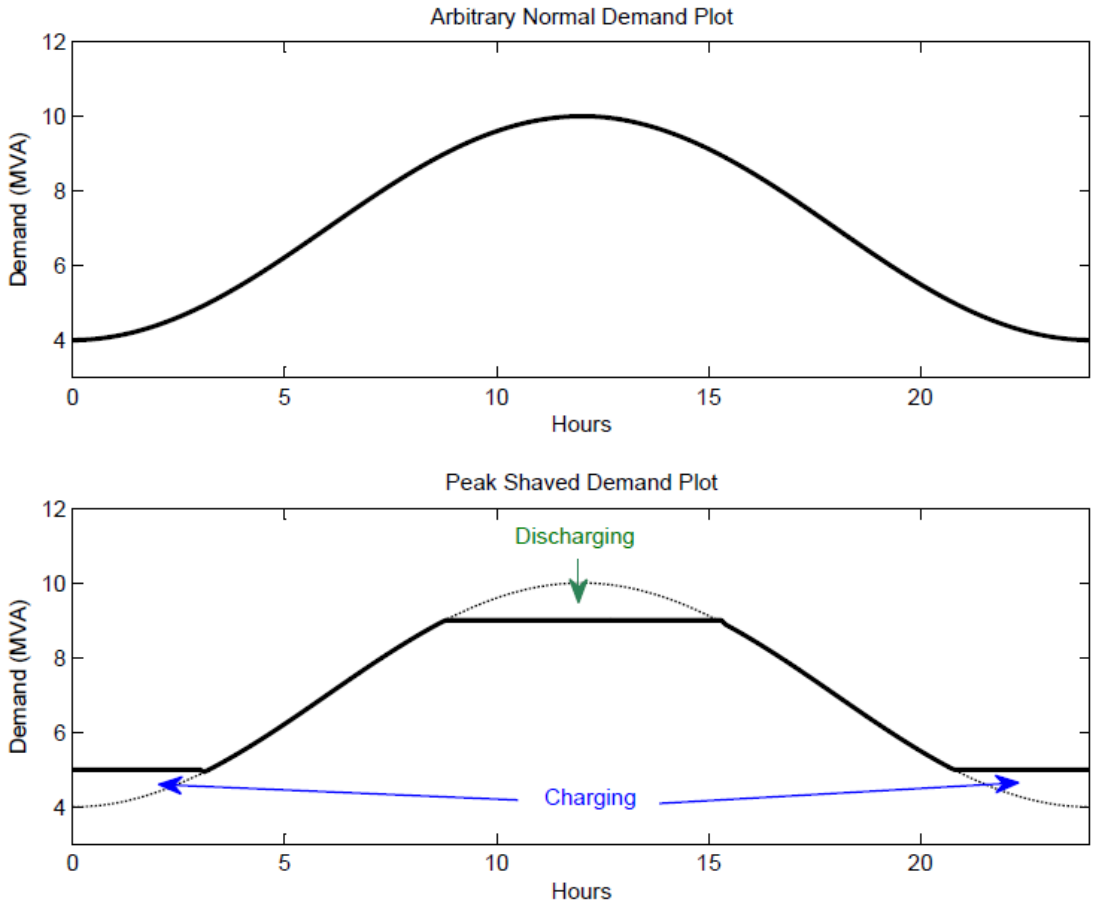
- **Stores during high power outputs and supplies during valleys**
  - Batteries can quickly change the direction of their power flow
  - Requires prediction or simulation in order to size battery correctly



nationalgrid

Energy Storage – Peak Shaving

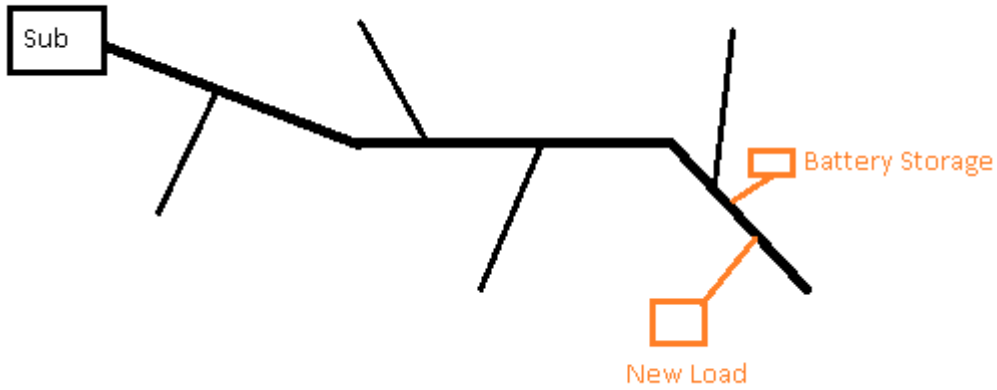
- **Store energy during off hours and supply during peaks**



nationalgrid

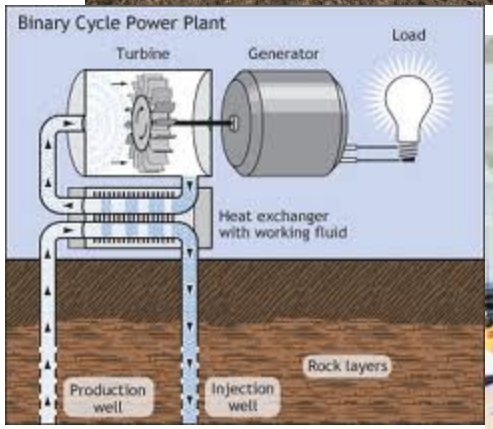
Energy Storage – Capital Deferment

- Adding new loads to a feeder can overload lines
  - Energy storage charges during the night (under loaded lines)
  - Discharges during peak further down the feeder
    - Eliminates the need to reinforce with higher capacity cables



nationalgrid

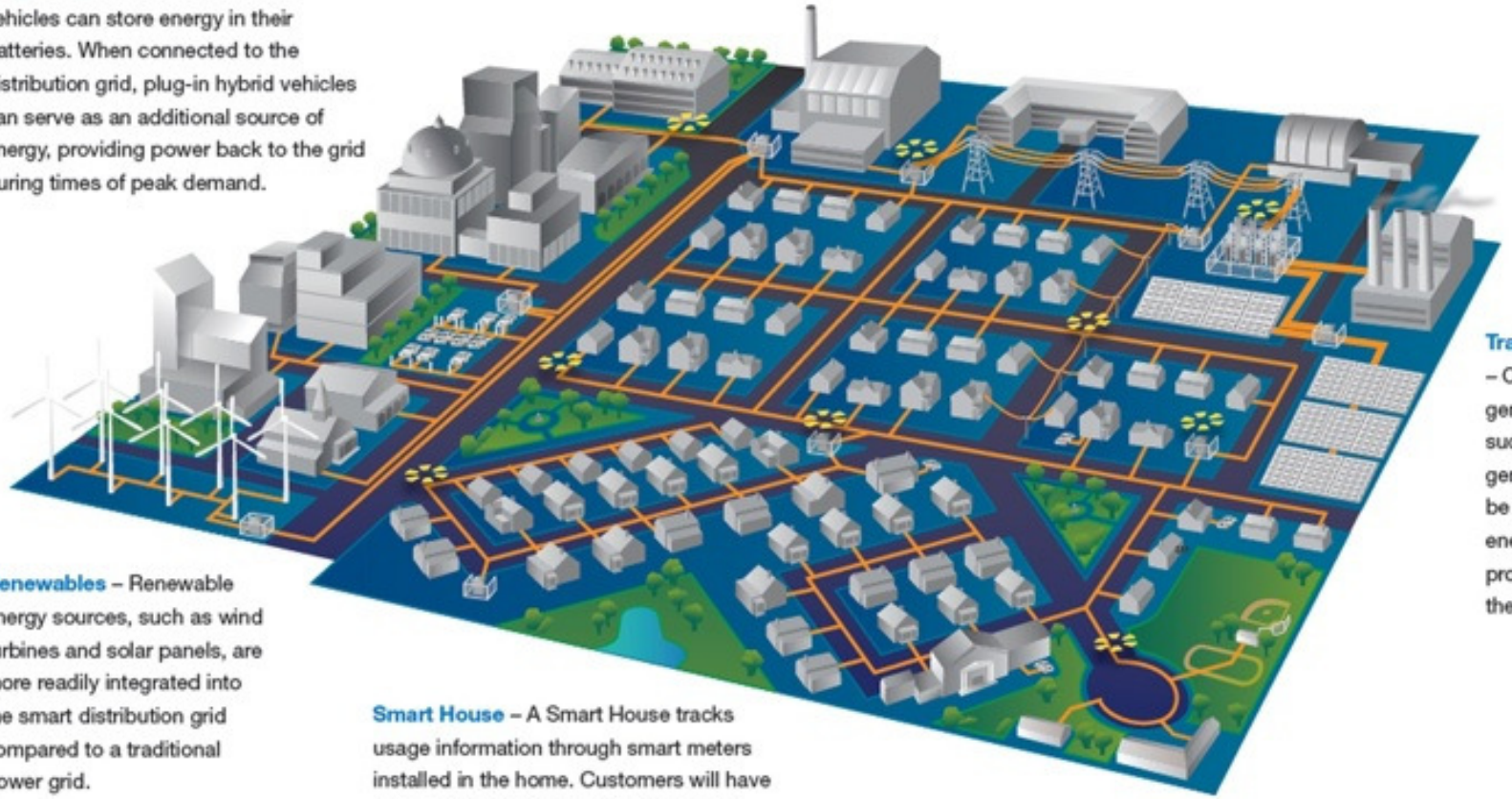
The Power Grid of the Future



America's Energy Future: A Smart Grid City

Sensors – Advanced communication equipment on the grid, including sensors, enable utilities to monitor, identify and quickly correct problems. Increased reliability of power is the result.

Plug-in Hybrid Vehicles – Plug-in hybrid vehicles can store energy in their batteries. When connected to the distribution grid, plug-in hybrid vehicles can serve as an additional source of energy, providing power back to the grid during times of peak demand.



Traditional Generation – Over time, traditional generation assets such as coal-fired generation plants will be offset by renewable energy sources in providing energy to the distribution grid.

Renewables – Renewable energy sources, such as wind turbines and solar panels, are more readily integrated into the smart distribution grid compared to a traditional power grid.

Smart House – A Smart House tracks usage information through smart meters installed in the home. Customers will have a variety of options through which they can interface with to learn about the most cost-efficient energy usage patterns. Increased information empowers consumers to reduce their energy use.

National Grid Smart Grid Pilot Proposal

Worcester, Massachusetts

nationalgrid

The power of action.