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**Advanced Energy Conference**  
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**CUNY ENERGY INSTITUTE**

# **Sustainable Energy Futures**

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**The City College of New York**

# SUSTAINABLE ENERGY FUTURES

**GENERATION:**



**ENERGY  
STORAGE:**



**ELECTRIC  
GRID:**



**APPLICATIONS:**



**WIND**



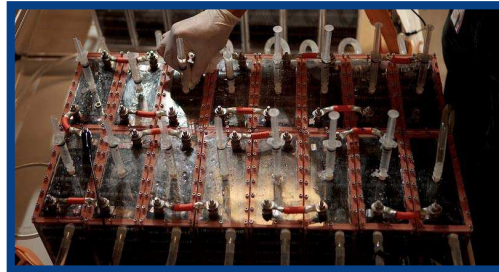
**SOLAR**



**NUCLEAR**



**NATURAL GAS**



**BATTERY**



**HYDRO**



**POWER LINES**



**ELECTRIC CAR**



**APPLIANCES**



**INDUSTRY**

# Increased Generation from Renewables and Natural Gas

Figure 2. U.S. natural gas production, 1990-2035 (trillion cubic feet per year)

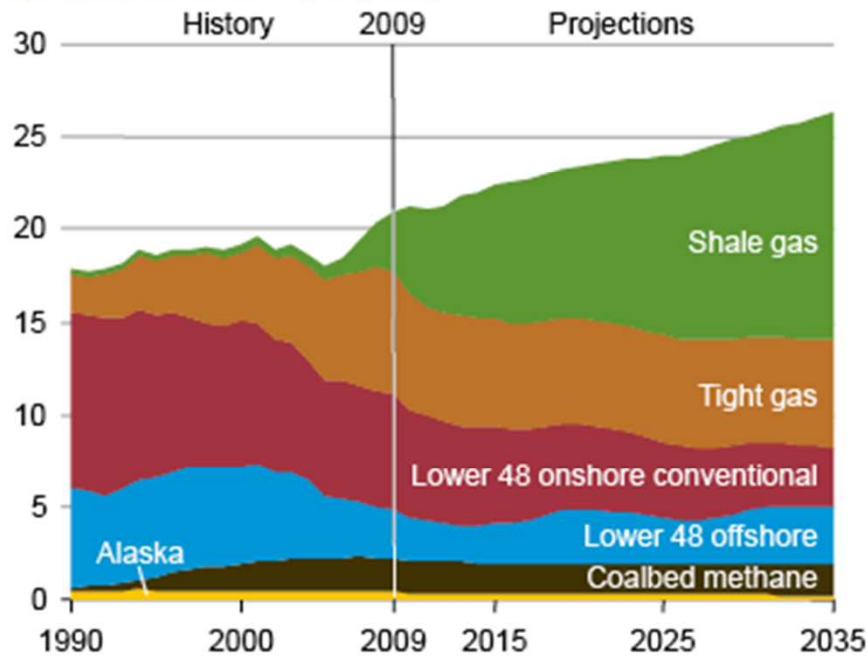
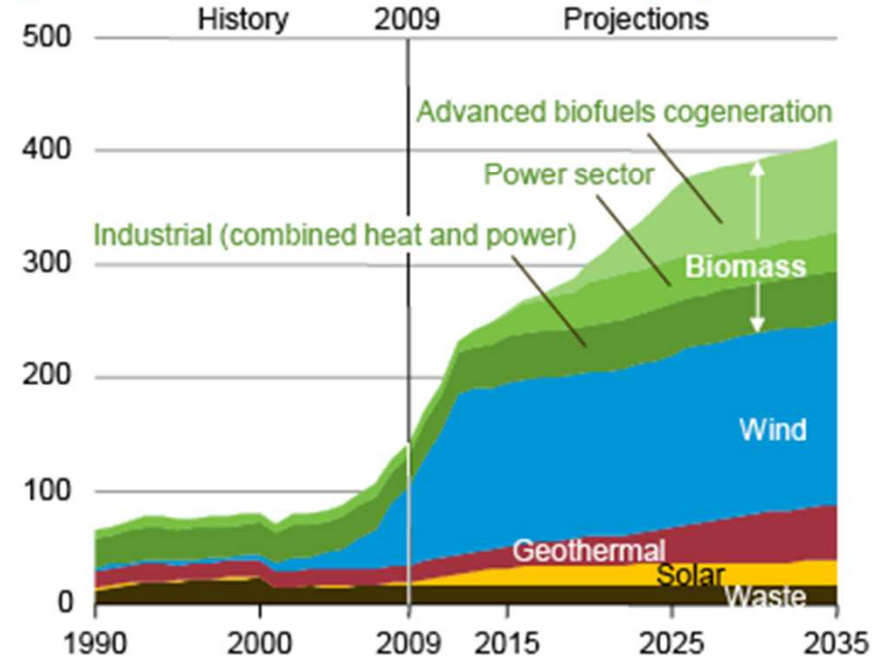
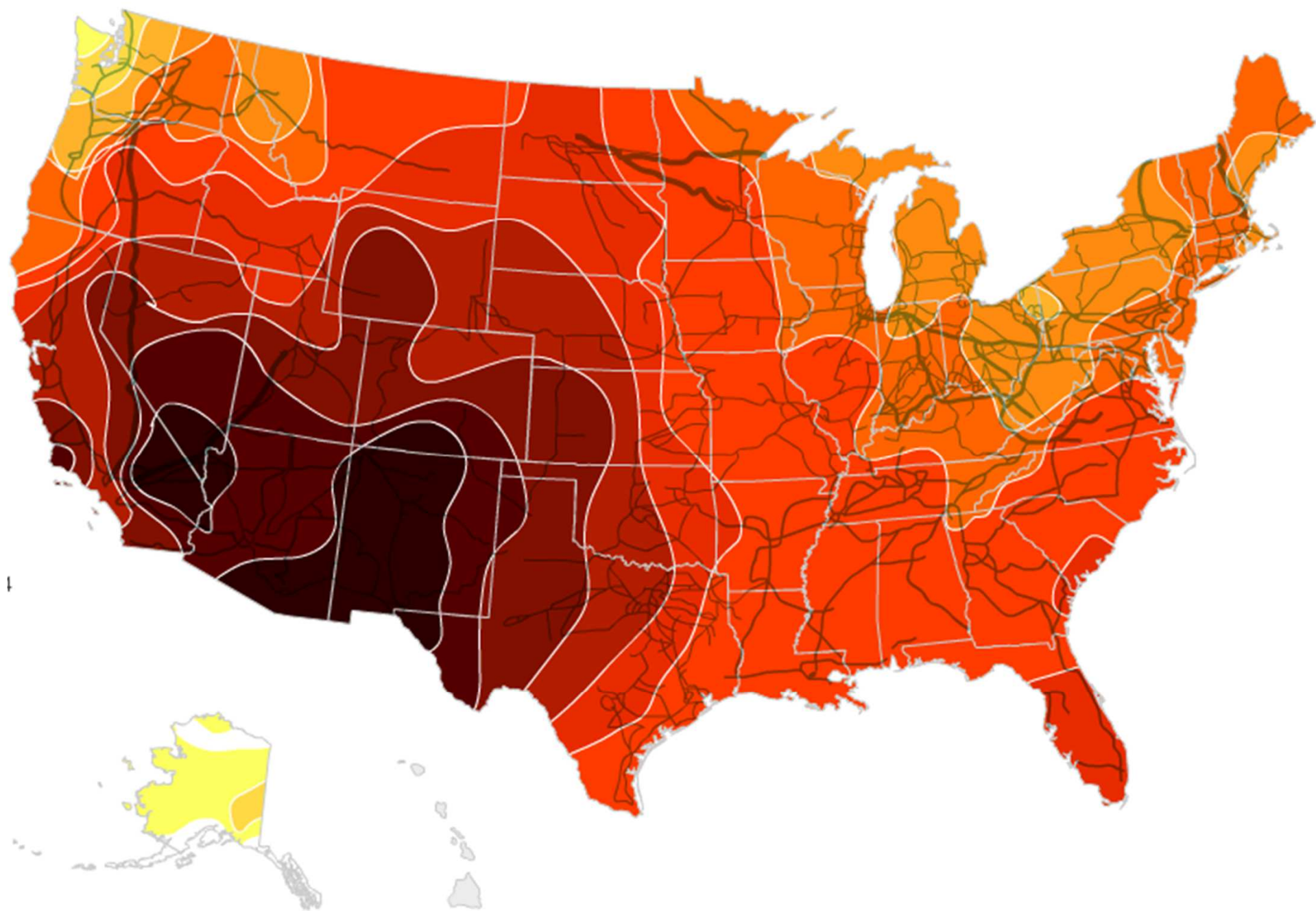


Figure 3. U.S. nonhydropower renewable electricity generation, 1990-2035 (billion kilowatts per year)

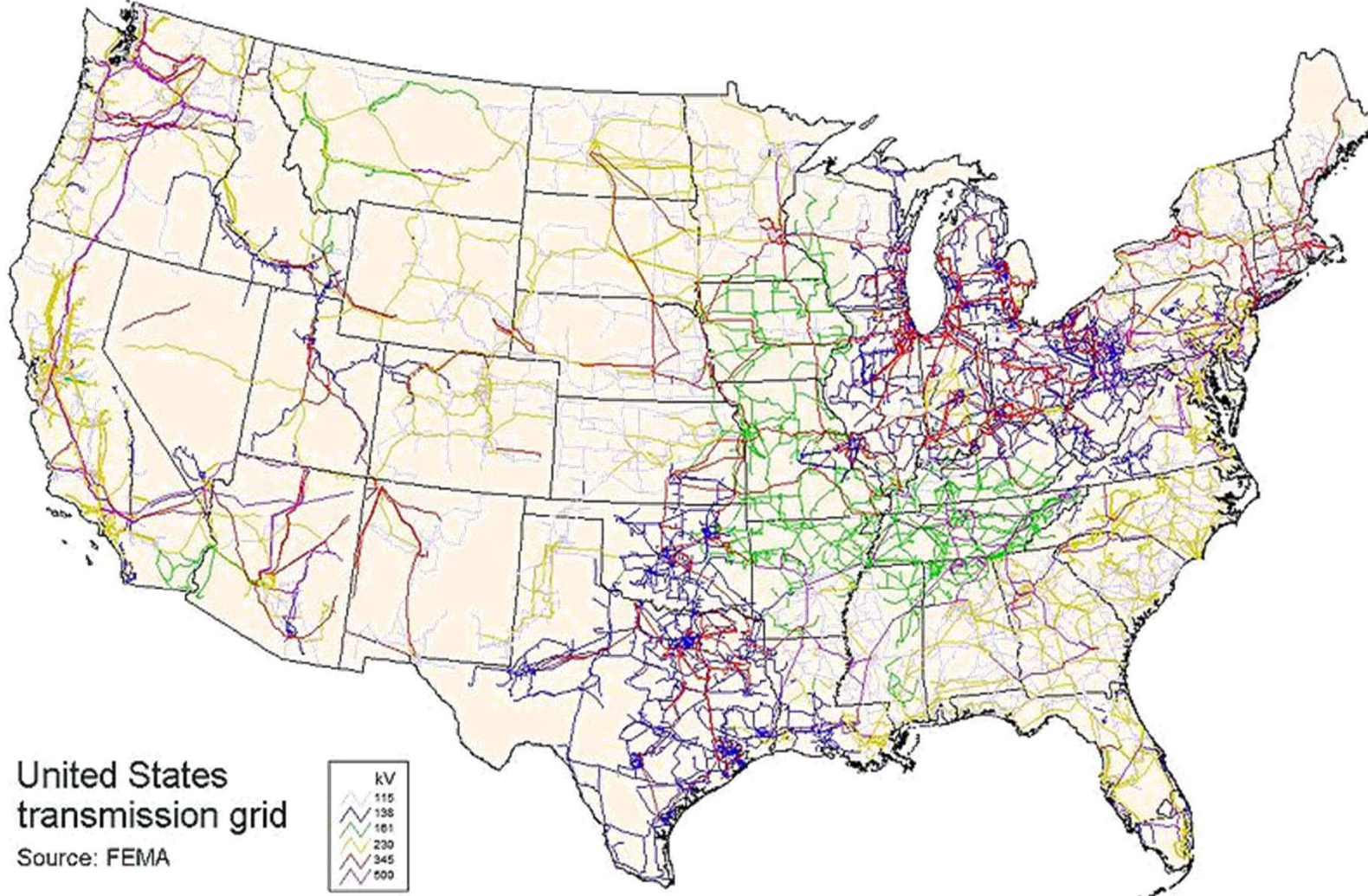


U.S. Energy Information Administration | Annual Energy Outlook 2011



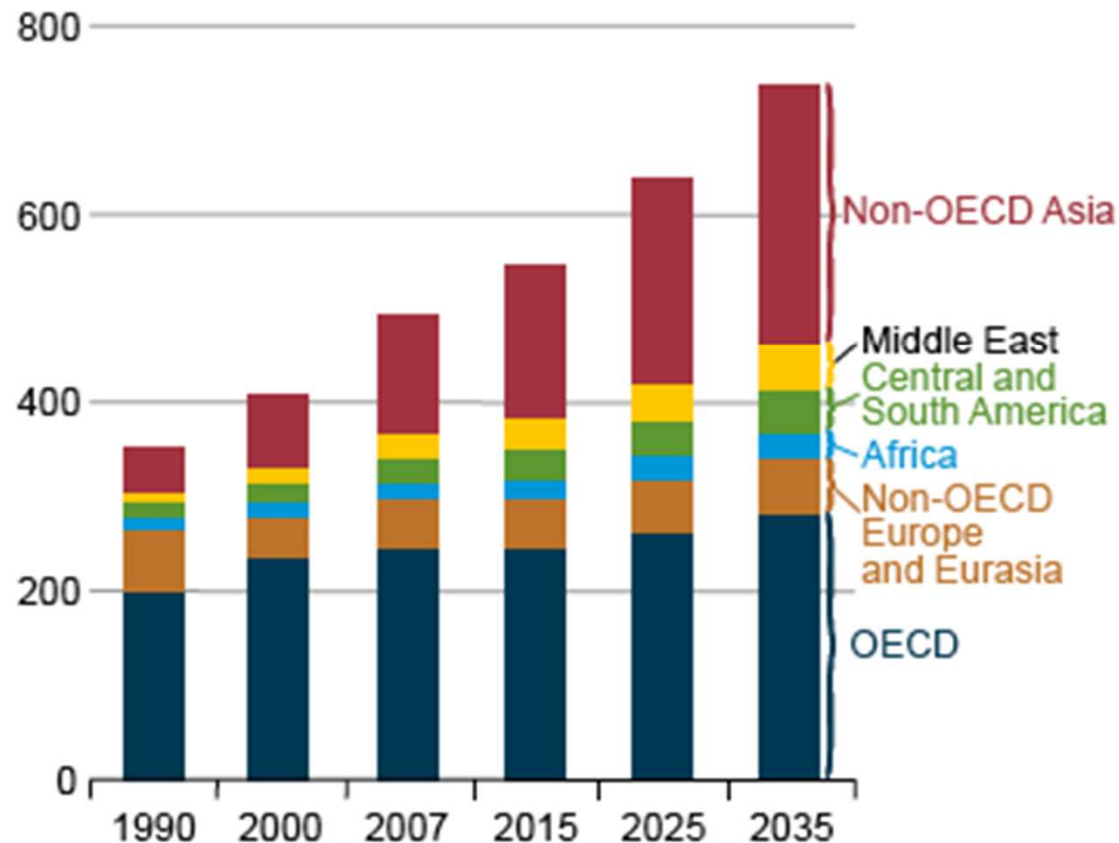


# Intermittent Renewable Generation Requires Flexible, Two-Way Grid System

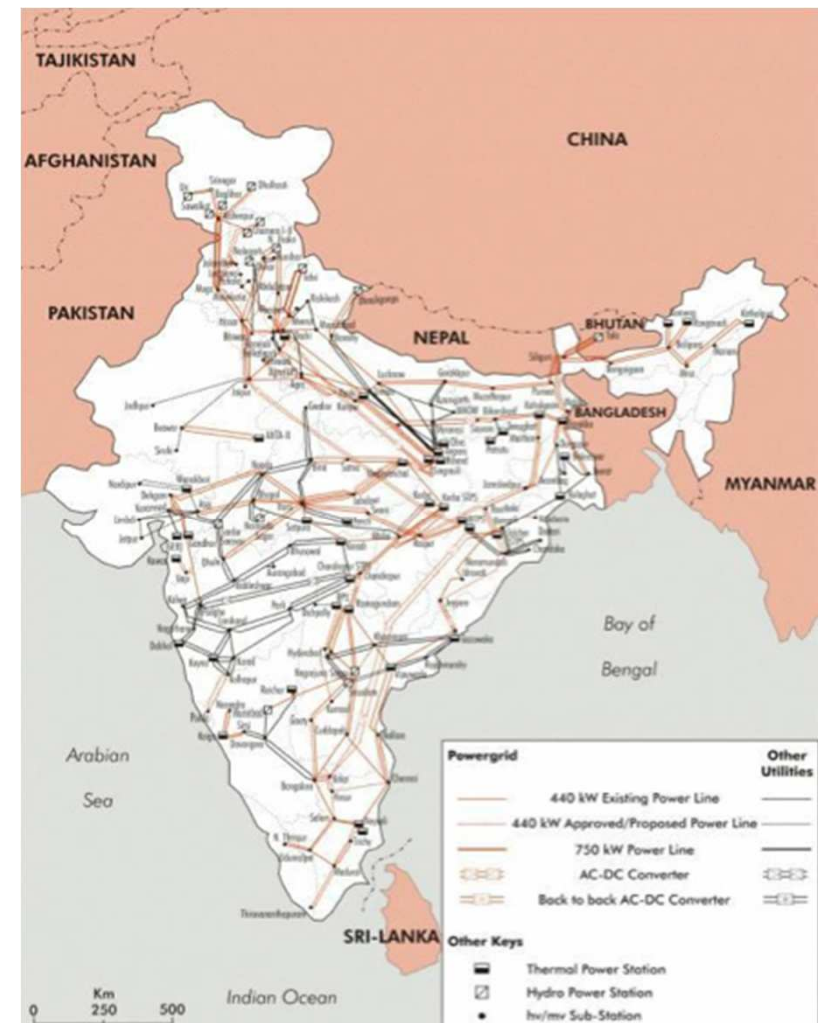
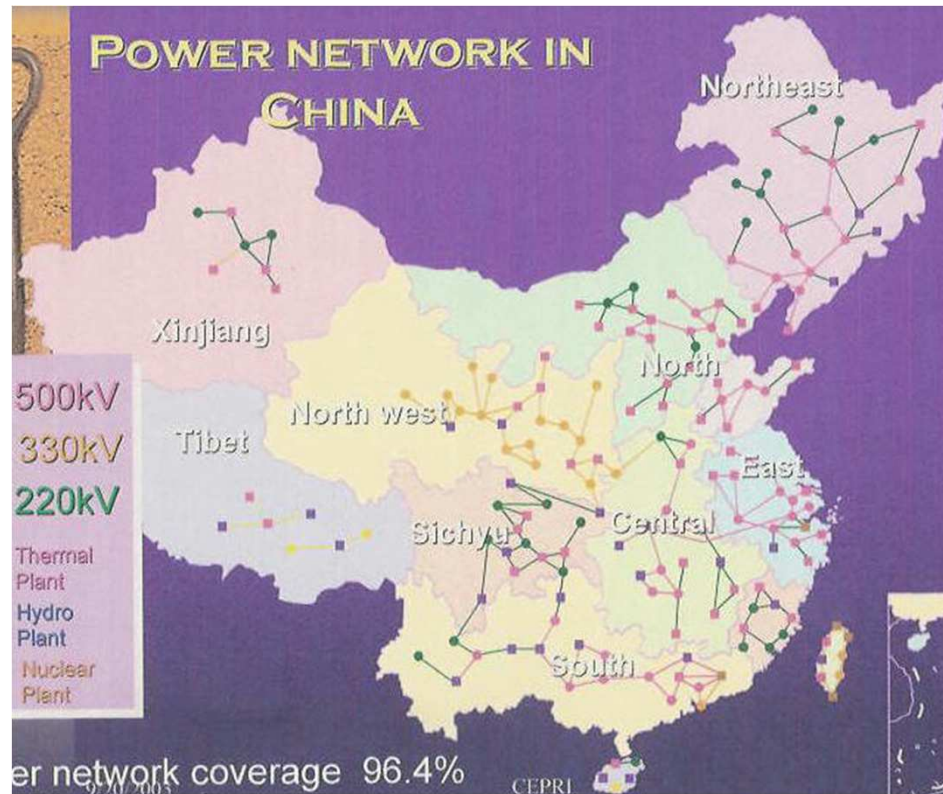


# Growth in Energy Demand Concentrated in Non-OECD Countries

Figure 50. World energy consumption by region, 1990-2035 (quadrillion Btu)



# China and India Are Rapidly Building Out Regional Grids





# Game-Changing Technologies



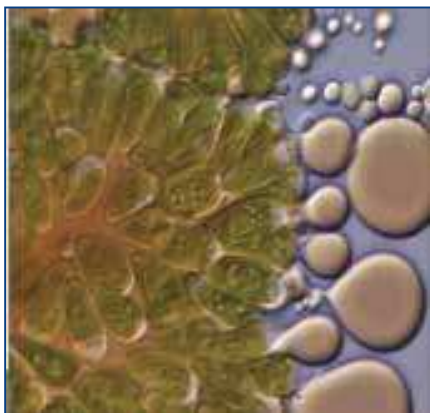
Advanced Wind  
Generation



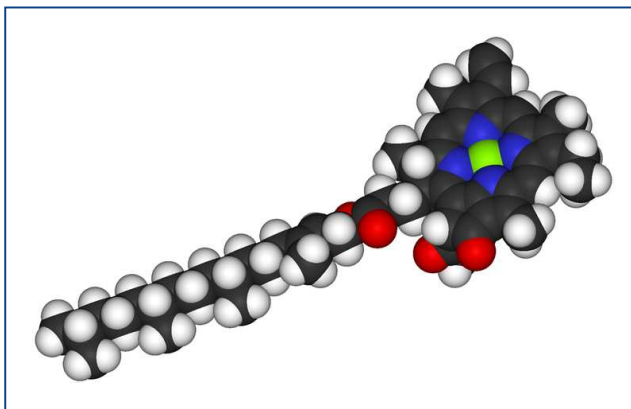
Grid-Connected  
Electricity Storage



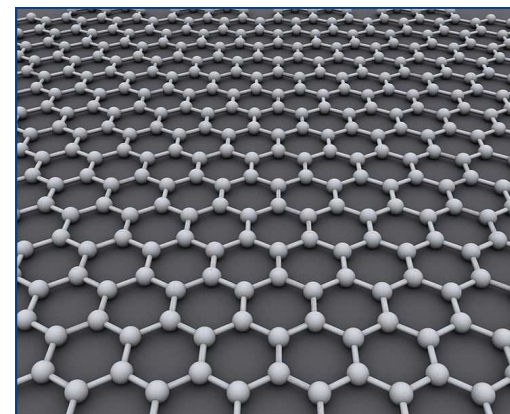
Next Generation  
Nuclear Power



Algal  
Biofuels



Photovoltaic Organic  
Compounds



Graphene  
Semiconductors

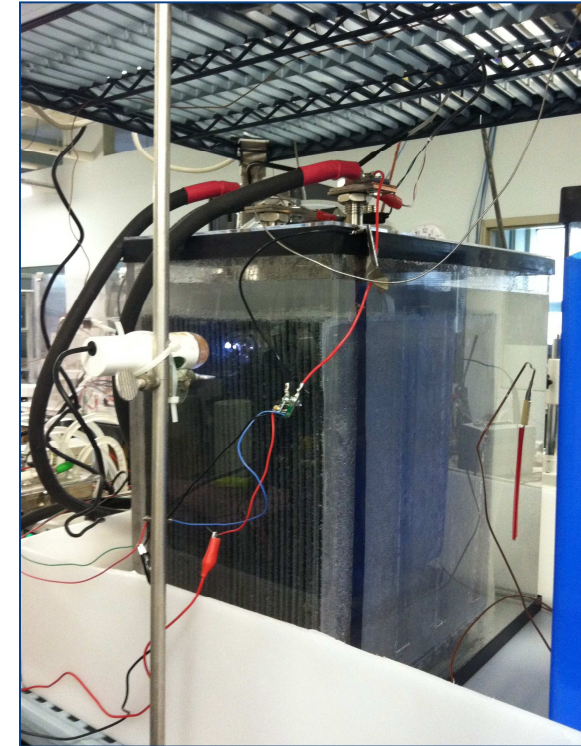




# Emerging Grid-Scale Batteries Meet Target of \$100/kWh

## GRID-SCALE BATTERY ADVANCES

- 10,000 Deep Cycles Achieved
- Dendrite Management with Flow
- Safe Chemistry, Low-Cost Materials
- 1.6 kWh Ni-Zn Operating (Pictured)



## BATTERY SCALE-UP TIMELINE

- 50 kWh Battery & Turnkey 2011
- 200kWh Battery Grid-Connected 2012

