The Future of Power? Power is the Future!

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Seminar 21

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Who is the California ISO?

- Began operations in 1998 - Not for Profit
- Controls 80% of the State grid
- Federally Regulated
- Responsibilities:
  - Reliability
  - Market Development
  - Market Operations
  - Market Monitoring
  - Grid Planning
- Resources:
  - 55,000 MW In-state Generation
  - 10,000 MW Imports
- Peak Demand of the ISO Footprint:
  - 51,000 MW (2006)
  - Total State peak is about 60,000 MW

Reliability Management – EMS

- Load Forecasting
- Network Model
  - 6,000 buses
  - 1,800 generators
  - 3,200 load points
  - 8,000 circuits
  - 35,000 switching devices
  - 1,200 shunt compensators
- State Estimator
  - Every minute based on 17,000 measurements

Reliability Management – EMS (con't)

- Real Time Contingency Analysis
  - 700 potential scenarios
- Security Assessment
- Wide-Area Phasor Measurements
- Visualization – Google Earth

Market Operation

- 15,000 Market Transactions every hour
  - 100 participating entities
- Day-Ahead Market – Integrated Forward Market
- Hour-Ahead Market
- Market Power Mitigation & Reliability Requirement
- Residual Unit Commitment
- Real Time Unit Commitment

Market Operation – (con't)

- Real Time Economic Dispatch
- Real Time Contingency Dispatch
- Real Time Manual Dispatch
- Congestion Revenue Rights
- Long Start Unit

Into the Future – The Resources, Beginning Now

Accommodating the Climate Change Initiatives

33% of Energy Supply from Renewable Resources by 2020

20% of Energy Supply Renewable By 2010

CO2 Emission Level Rolled Back to 1990 Level by 2020

One Million Roof-Top Photo-Voltaic

Storage

Ban Once-through Cooling Technology on all Coastal Plants by 20xx

What is necessary to integrate 20% renewable generation?

- We have published engineering studies on how to integrate renewable generation to meet the 20% RPS.
- Intermittency and timing of renewable resources create operational challenges.
  - Morning and evening ramp will increase 20-30%.
  - Potential wind forecast errors will drive the need for increased regulation capacity (as much as 500 MW) and a much deeper supplemental energy stack.
  - Over-generation will occur during certain hours but can be mitigated by minimal curtailment.
- Needed integration services can be provided by:
  - Hydro, IF there is enough water.
  - New thermal, IF it has the right characteristics.
  - Existing thermal, IF it is kept operating at certain levels (but could defeat the purpose).

What is necessary to integrate 20% renewable generation? (Con't)

- Other mitigation measures are also necessary:
  - Advanced demand response
  - Curtailment mechanisms
  - Improved technology
  - Better forecasting tools
  - Storage

- Maintaining existing generation is essential (although replacement or re-powering can work).

What does it take to integrate a higher RPS in California?

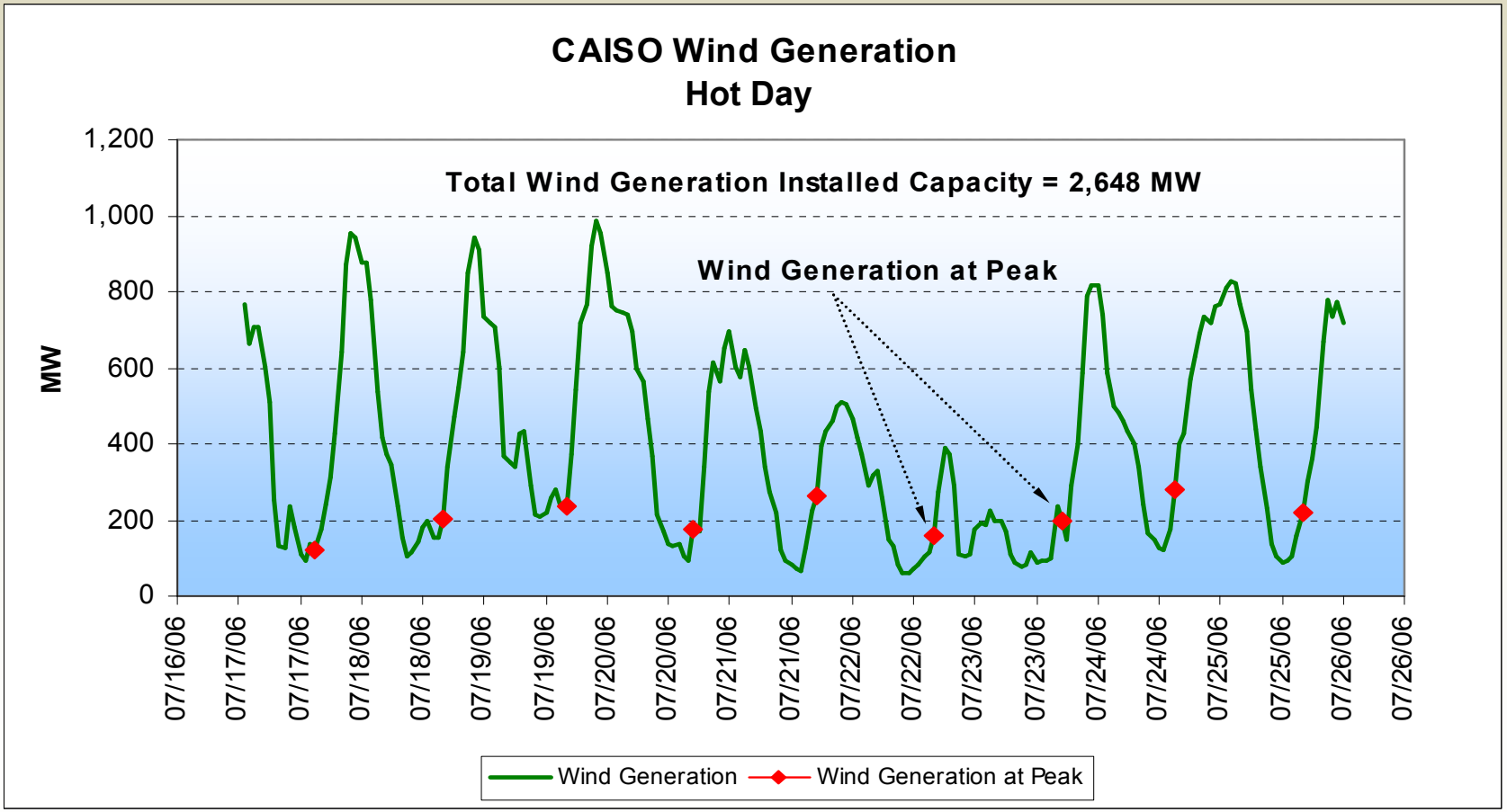
"Out of the Box" on all fronts!

Case	GWh	Avg. Mw	Nameplate Mw
20% RPS (2010)	55,657	6,353	13,614
33% RPS (2020)	102,000	11,600	29,000

- Achieving 33% requires us to meet two times load growth with renewables between now and 2020.
- The increase in need for capacity, ramping, and regulation to achieve 33% RPS is not linear – it is much greater.
- 5-7 major transmission projects.
- Regional diversification is important technically and economically.
- Key questions are:
  - How much "in the box" thinking is still viable?
  - Can we retain and invest in more non base-load facilities?
  - Does retirement or replacement make sense?

Wind Production on Peak Heat Days

You have to go a very long distance to get diversity!

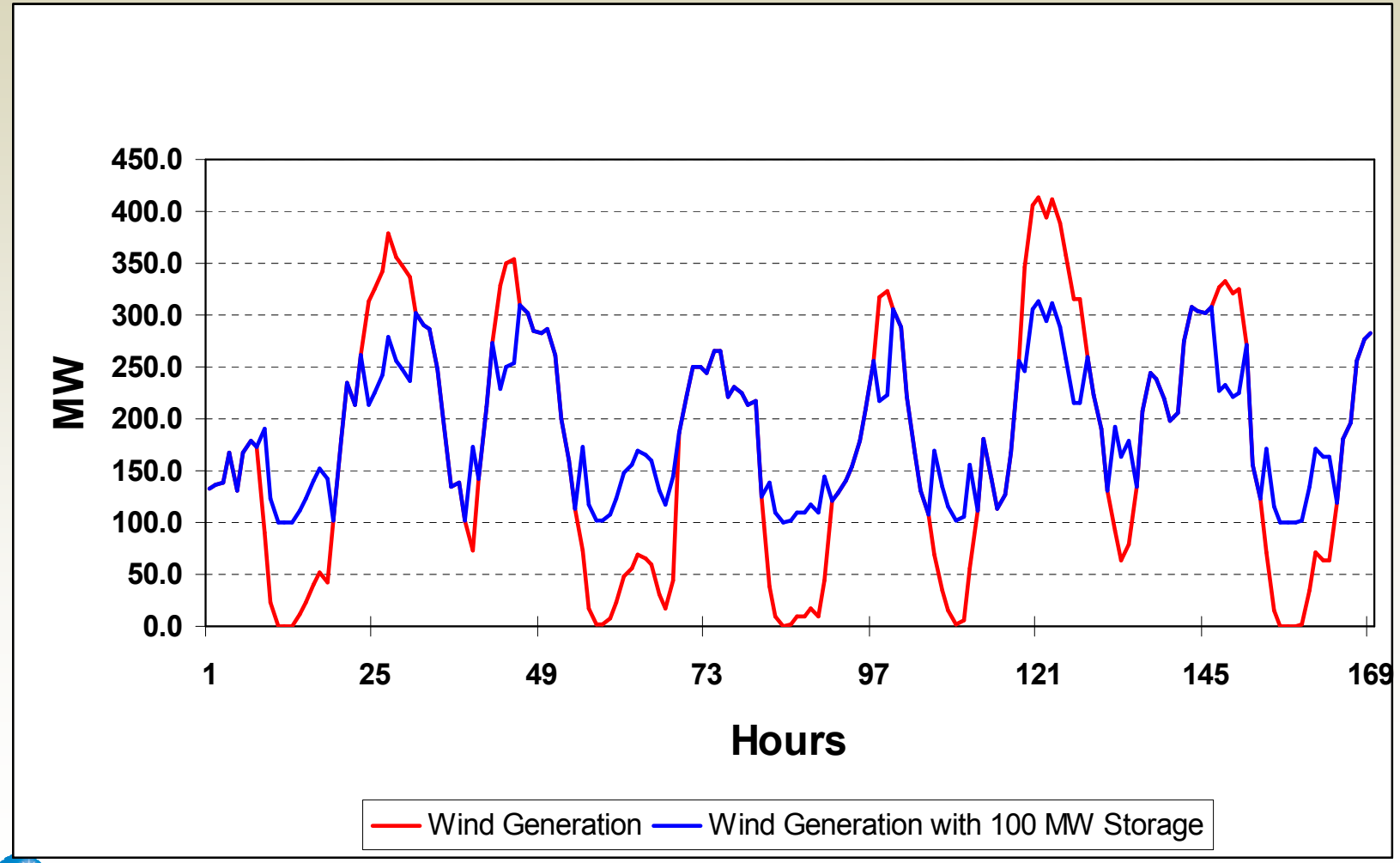


Towards RPS – Green Energy

The capacity element and the crown prince (storage)!

	Wind	Solar PV (non-DG)	Solar Thermal	Geothermal
Capacity Value	15-30% prior CPUC Approx. 3-8% new CPUC	65%	71-80%	80-90%
Capacity Factors	18-20% historical <30% new turbines	18-24%	20-28%	80-90%

Tehachapi Wind Generation with 100 MW Storage

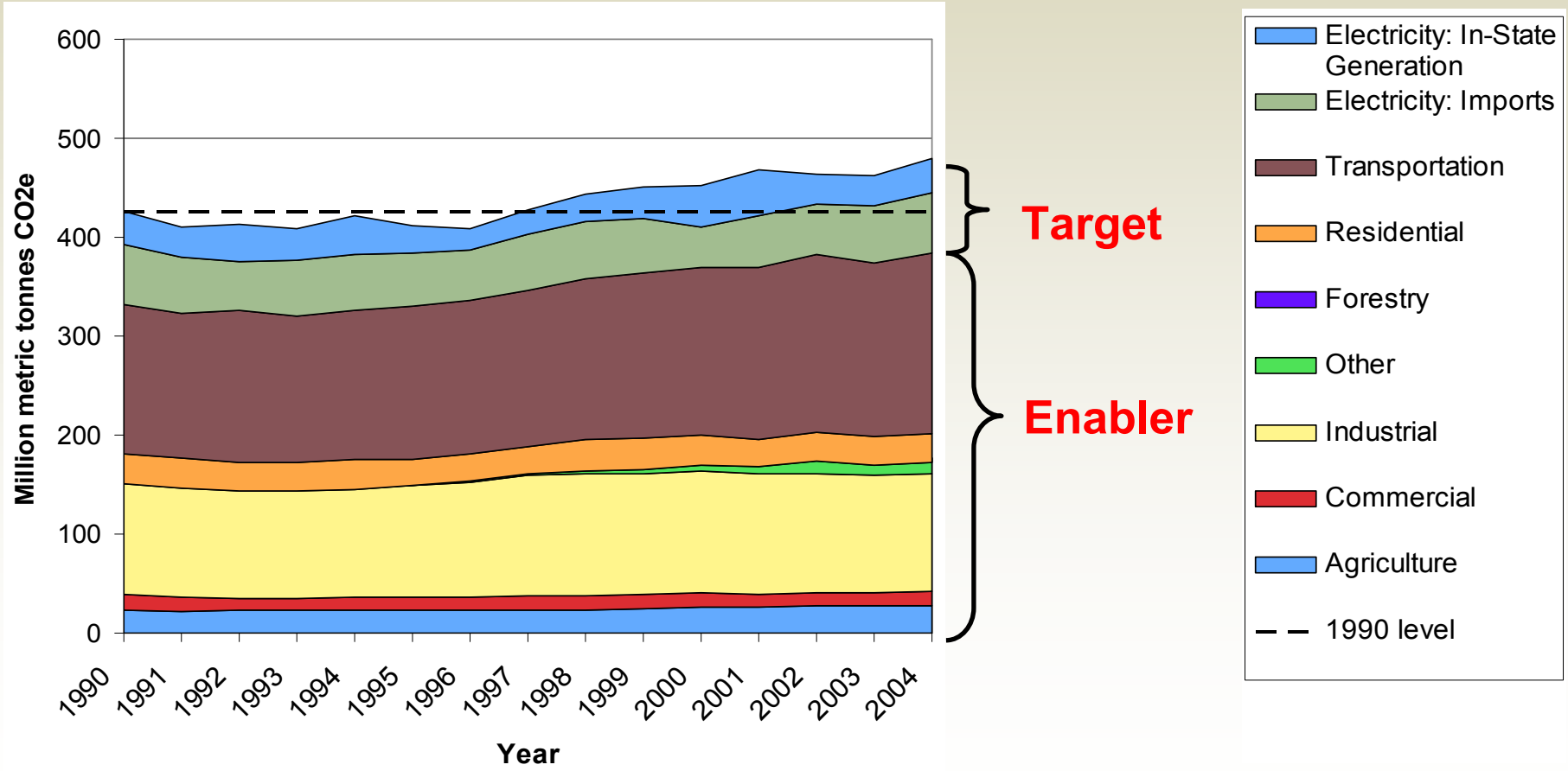


The Future – The Grid

- The Smarter Grid
  - IT
  - Telecom
  - Power Equipment
  - Demand Side
- The Greener Grid

Into the Future

Achieving Statewide 1990 Level Emissions by 2020 (CA Assembly Bill 32)

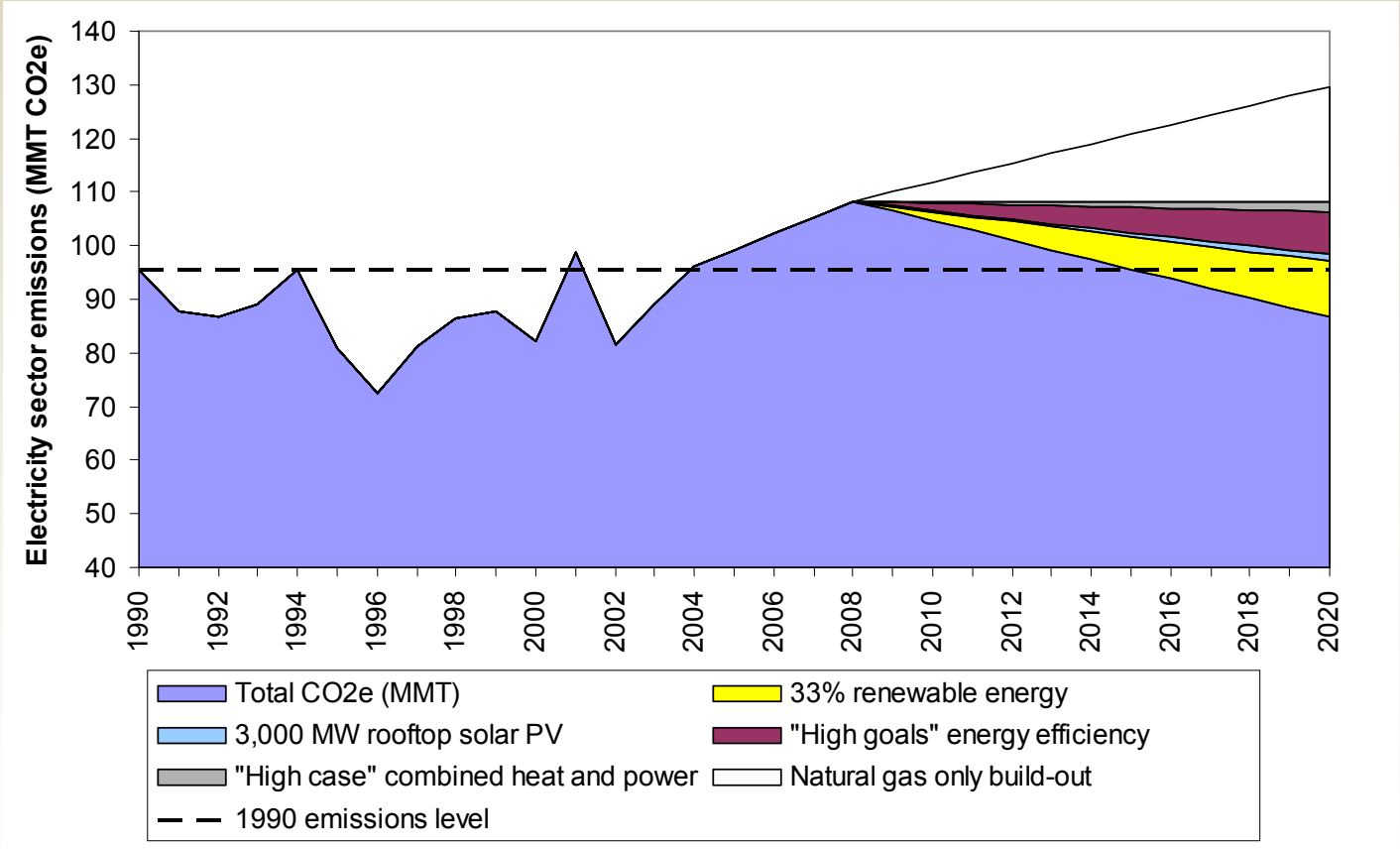


California ISO
Your Link to Power

Source: CARB Emissions Inventory, updated Nov. 2007

Into the Future

Electricity Sector Emission Reductions Potential Compared to Historic Electricity Sector Emissions

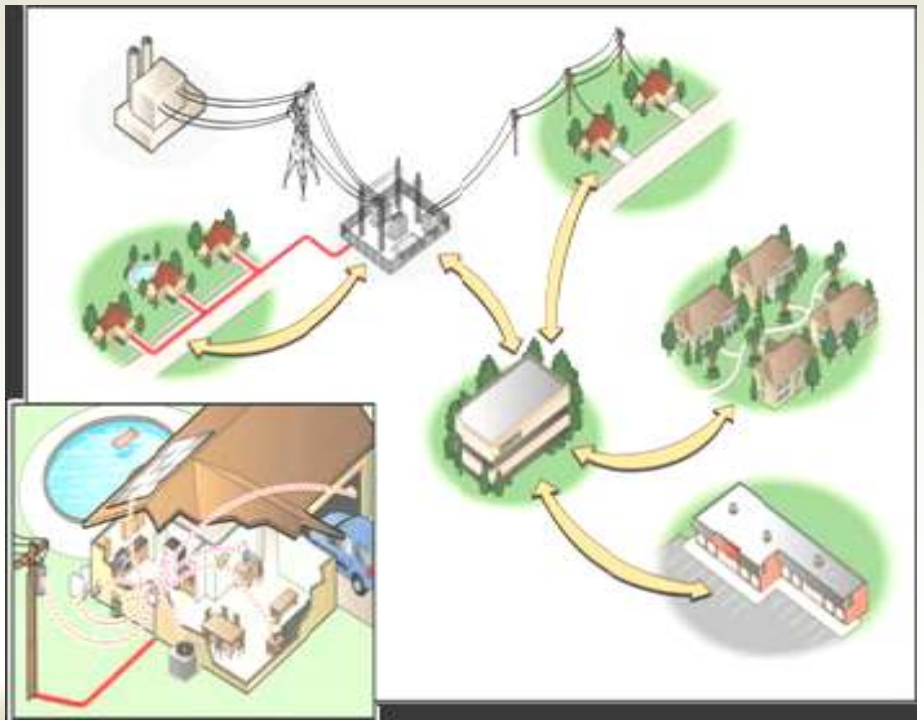


Gas Build-out Reference Case Accelerated Policy Case

Source: Energy & Environment Economics, Inc. (E3)

Into the Future - The Demand

- Smart Homes
- Smart Appliances
- Electrification of the Transportation
- Electrification of Industrial Processes
- Conservation
- Distributed Generation



Into the Future - The Education

- The largest vital single element
- We are all students before becoming teachers
- Inspiring the new and older generations
- The ISO Academy
- The ISO Sabbatical