SUSTAINABLE ENERGY ALTERNATIVES IN THE USA

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IEEE OTTAWA SECTION & PES CHAPTER

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By

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MY PERSONAL BACKGROUND

- Active member of IEEE PES Substation Committee from 1995-2001
- IEEE PES Treasurer 2004-2007
- IEEE PES President-Elect 2008-2009
- IEEE PES President starting 1/1/10
- Retired from PPL Electric Utilities April 2010 after 40 year career
- Worked in almost every department of an electric utility EXCEPT…..Generation

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WHAT IS SUSTAINABLE ENERGY?

- Is it only renewable or “green” energy sources? (Not my personal definition)
- How long does it have to survive to be called “sustainable”?? 50 years? 100? 500? Forever?

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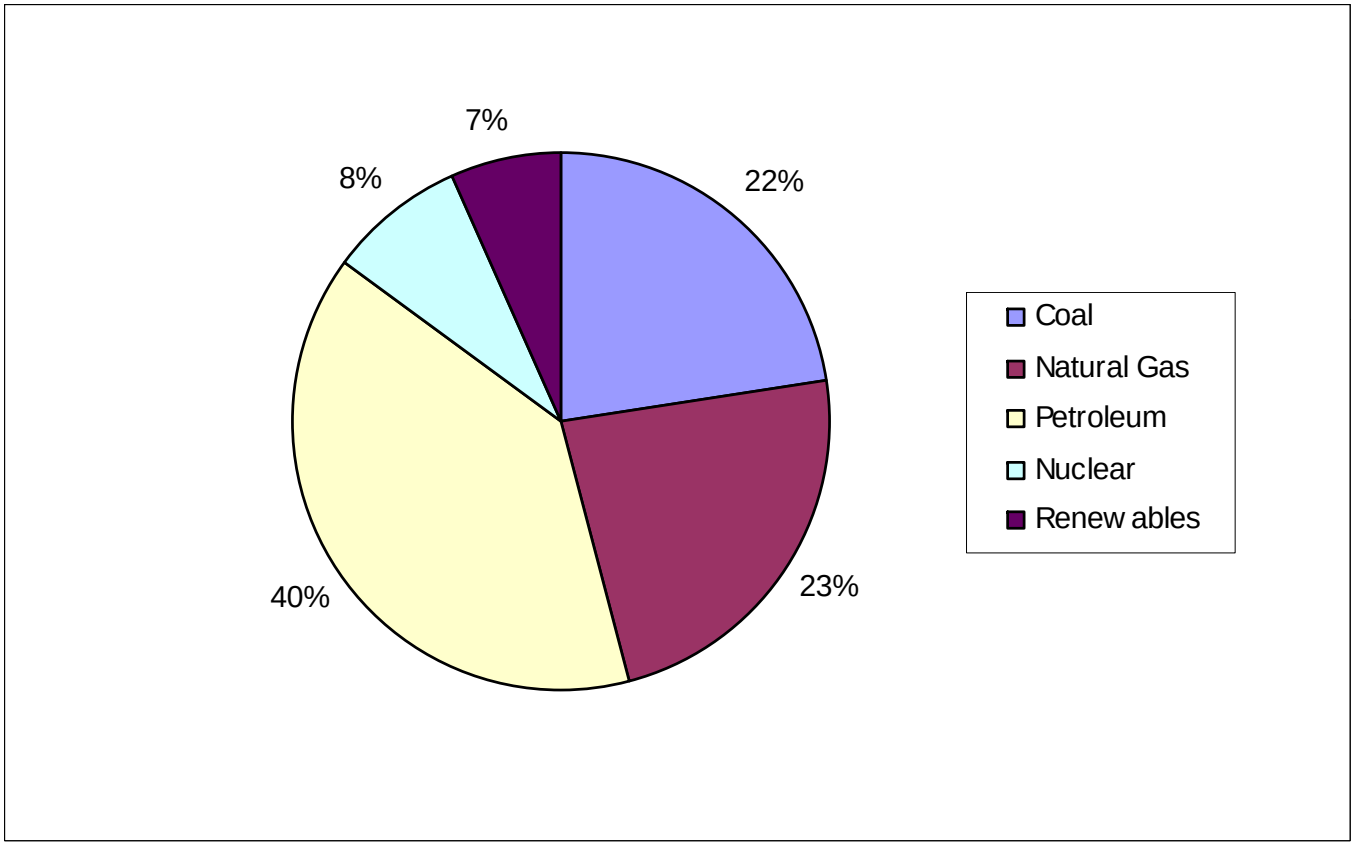
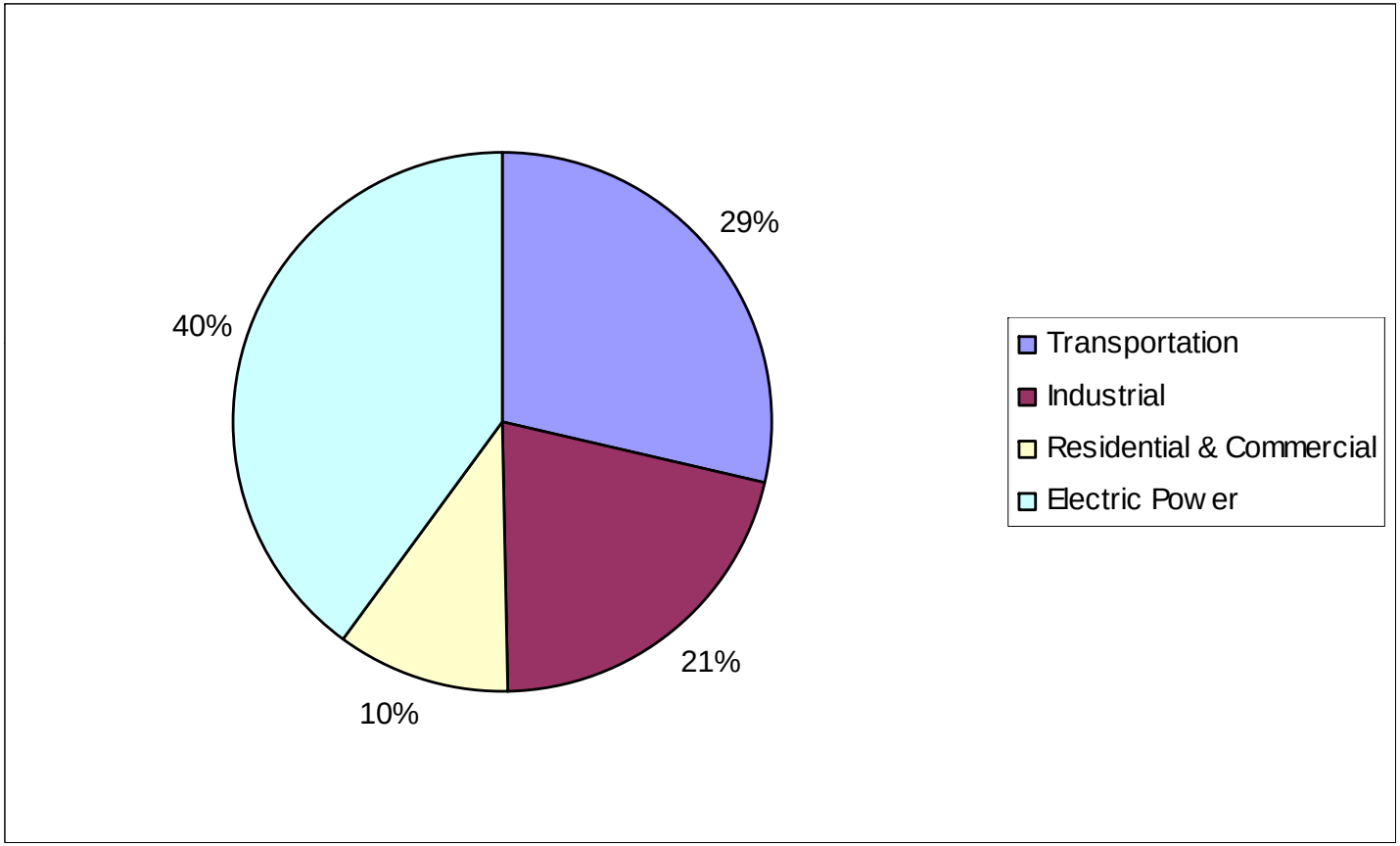
USA ENERGY SOURCES

(For all end uses, not just electricity)



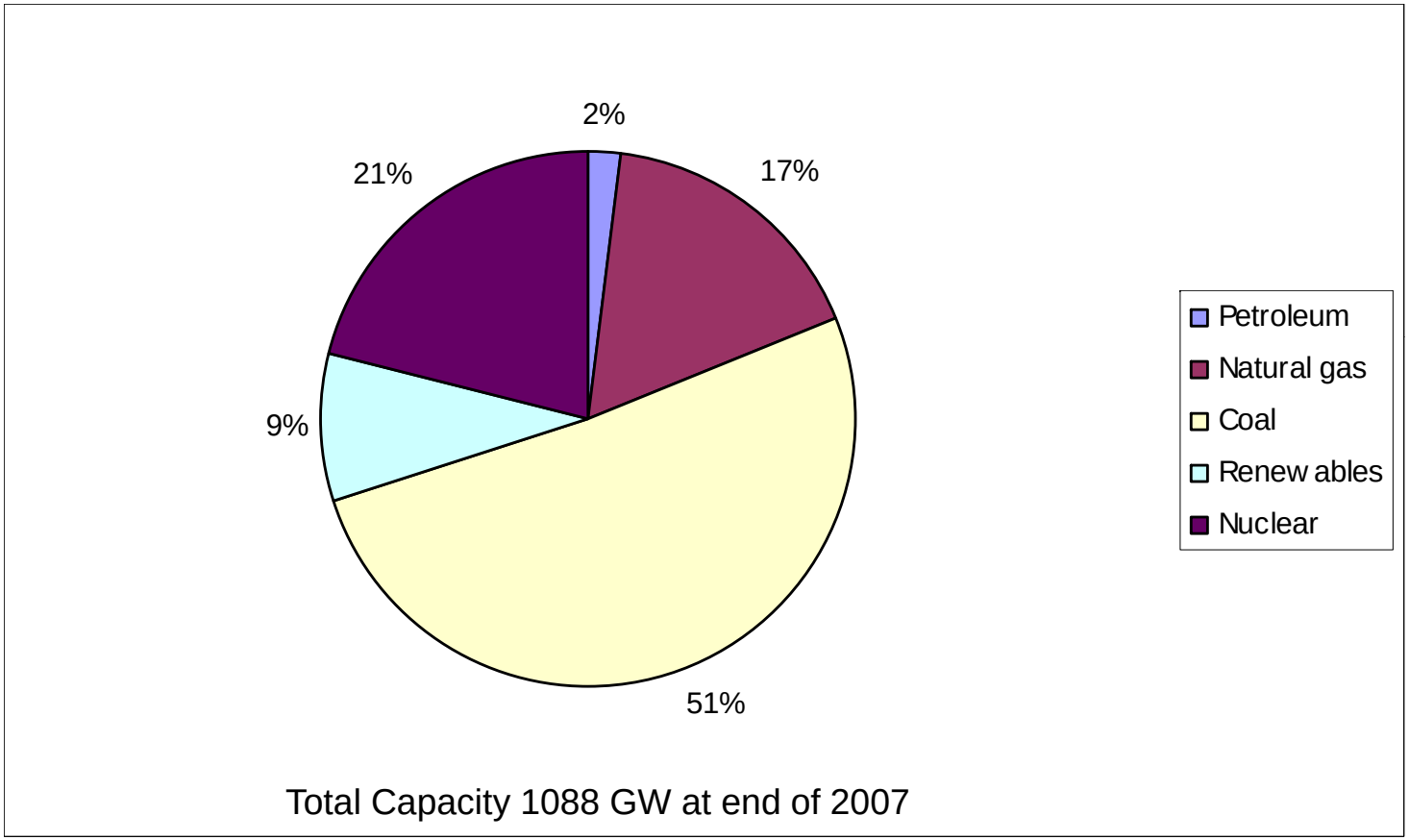
Source – DOE Website

USA ENERGY USES



Source – DOE Website

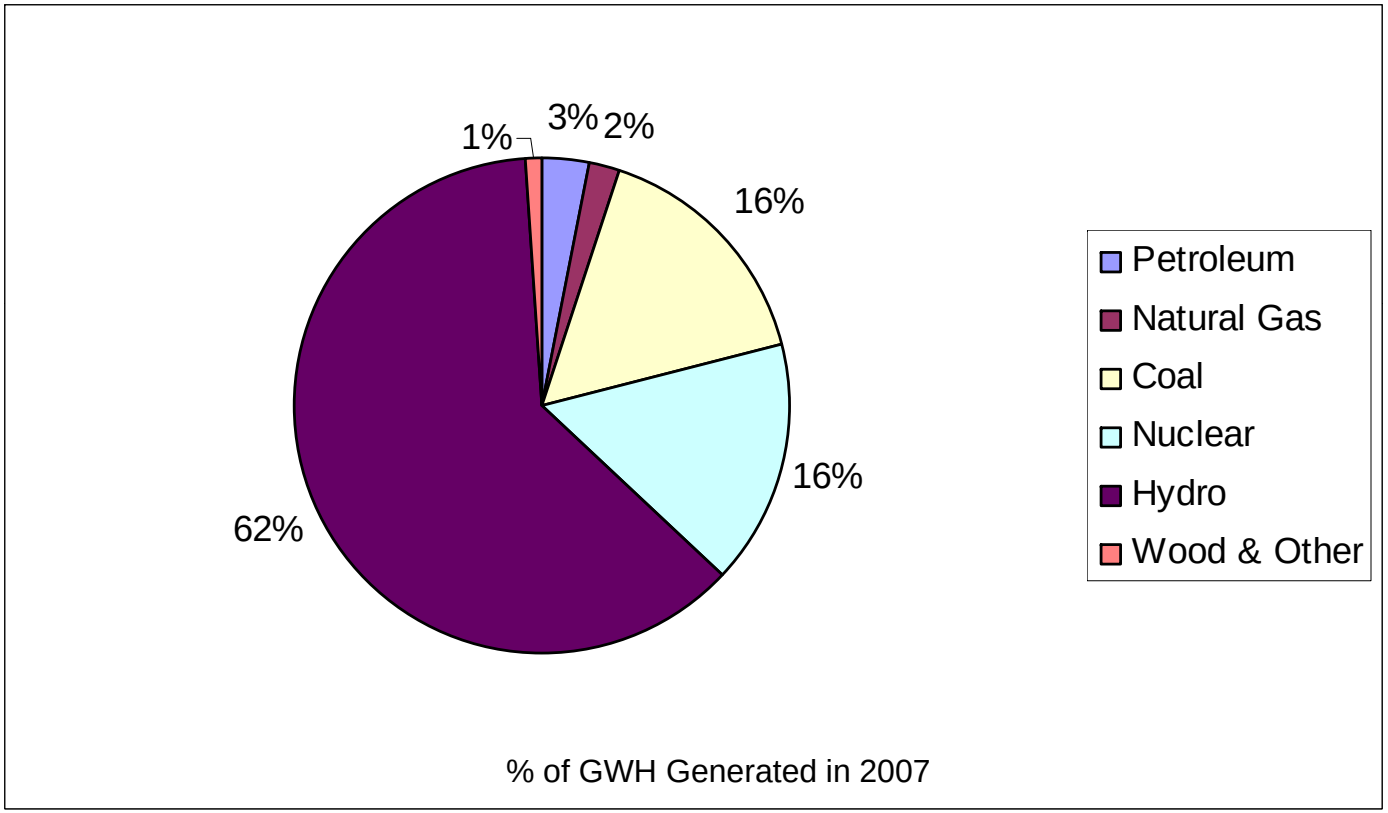
SOURCES OF ELECTRIC ENERGY



Total Capacity 1088 GW at end of 2007

Source – DOE Website

CANADA
SOURCES OF ELECTRIC ENERGY



Source- Natural Resources Canada

POSSIBLE FUTURE GENERATION SOURCES

NON-TRADITIONAL

- BioEnergy
- Fusion
- Geothermal
- Wind
- Solar
- Hydrogen

TRADITIONAL

- Coal
- Oil
- Natural Gas
- Nuclear
- Hydro

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BIOENERGY

- Requires stream of organic material to be sustainable, e.g.:
  - Dedicated energy crops (trees, corn, etc)
  - Agricultural crop and food wastes
  - Animal & municipal wastes
- Environmentally-friendly and economic choice when fuel source is otherwise unused wastes
- Total amount of generation limited by fuel sources
- Many untapped sources exist, but insufficient to supply major portion of energy needs
- Still an important source that needs to be expanded

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BIOENERGY-CANADA

- Biogas—anaerobic digestion for pulp & paper
- Biofuels—restaurant grease to high quality diesel fuel
- Agricultural residues

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GEOTHERMAL

- Important piece of a diverse domestic supply policy
- 1921 - 1st Geothermal in USA – 250 KW
- 1960 – 1st Large scale plant. 1st turbine of 11 MW runs successfully for 30 years
- Currently 69 generating facilities at 18 resource sites around the USA
- About 2200 MW installed capacity (14,000+ GWH annually)
- Clearly clean and sustainable, but somewhat limited in sites and overall potential
- Identify new resource locations
- Maximize existing locations
- Research viability of “creating” resource locations by drilling deep wells and injecting water to create steam

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WIND

- One of oldest energy sources harnessed by man (used to pump water 200 BC in China)
- 16,500 MW installed in US at end of 2007 (almost triple the amount five years earlier)
- Economic viability very dependent on price of traditional fossil fuels
- Obviously very clean and zero fuel cost
- Need backup generation or energy storage when wind is calm, below design capacity, or above design capability
- Sources often remote from load, requiring long transmission lines
- Siting objections (NIMBY, avian mortality, etc)
- Historically high maintenance costs

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WIND—CANADA

- Canadian geography ideally suited to wind generation
- Does not appear to have significant wind generation at this time
- Significant opportunity??

SOLAR

- Like wind, a clean and abundant source
- Expensive compared to other renewables
- Only 500 MW installed in USA at end of 2007
- Solar thermal more viable for large scale. 64MW on 400 acres in Nevada. 354 MW on 1000 acres in S. California
- New 250 MW plant just announced for 1700 acres of desert in California (9/10)
- Like wind, needs storage medium or back up generation
- Large land areas required for “utility-grade” application
- Increases in price of fossil fuels makes solar a more viable energy source
- Increases in % conversion efficiency make it a more competitive option
- Boost might be possible from economical “plug-in” packages for homeowner or distributed generation application

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SOLAR—CANADA

- Solar thermal
  - Heaters for swimming pools
  - Commercial building heating
  - No electricity generation of note
- Solar photovoltaic
  - Stone Mills Ontario 9 MW on 90 acres (Oct 2009) is largest
  - Most others are small residential and commercial/institutional

HYDROGEN

- Very clean energy alternative
- Today's fuel-cell research targeted more to transportation uses
- Current electric applications limited to distributed generation
- Need to improve the efficiency and reliability of fuel cells
- In near term, target distributed generation applications
- Much research and funding needed for larger scale applications

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FUSION

- Same process that powers our sun and other stars – nearly inexhaustible source
- 1 Gallon Water = 300 Gallons Gasoline
- Two atoms of hydrogen combine to form one atom of helium
- Environmentally friendly
- Funded by Russia, Japan, China, USA, European Union, Korea, India

- Current international cooperative effort underway (ITER – Latin for “the way”) located in Cadarache, France
  - Numerous technical glitches have hampered progress
- Much research still needed – earliest commercial venture 40-50 years away
- Recent delays due to funding disagreement. Seven funding countries just agreed to funding allocations clearing way for restart on research.

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HYDROPOWER

- Currently over 95,000 MW (includes 20% pumped-storage)
- Many are maximizing capacity/usage at existing sites
  - Older turbines replaced for efficiency
  - Increases in storage capacity
- DOE has ID'd over 5600 sites with up to 30,000 MW
- Lacks potential to meet wide-scale societal demands in USA
- Environmental impacts on river flows, flooded lands, etc. restrict viability
- More research needed on tidal and run-of-river units.
- Requires backup generation or energy storage during extended regional droughts

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OIL

- Minor player as overall electric generation source
- Demands from transportation sector keep the prices high
- Strategically, oil would be a poor choice for expanded use in generating electricity

NATURAL GAS

- Clean fuel compared to other fossil fuels
- Cheap and abundant in USA
- Fuel for most new generation over last several decades
- Short lead times and low $/MW vs. other base load plants. Many are cyclable.
- Combined cycle plants maximize efficiency of fuel usage
- Rising price due to demands from other energy use sectors may eventually make it less attractive for generating electricity
- Optimize usage for cyclable and peaking power applications
- Need to identify new deposits of natural gas

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NUCLEAR

- Existing 103 units supply 20% of overall USA electricity needs
- Most existing plants are being relicensed by the owners for another 20-30 years of operation
- Expected to be a major part of new generation mix
  - Many companies have started licensing activities for new plants.
- France great model for nuclear generation success - supplies 75% of France's electricity, projected to move to 80%
- Biggest frustration is lack of a spent-fuel storage facility after nearly 30 years of promises
- Collaborative designs by consortiums expected to drive down the cost per MW for new units. Reducing $$/MW with no decrease in safety
- Economic/Political challenge - federally guaranteed loans
- A dozen or more permit applications are already queued up

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COAL

- Abundance and low cost = current domination of USA generation
  - 25% of world's known reserves
- Few new plants being built due to environmental constraints and the cited advantages of natural gas.
- Many existing plants are being retrofitted to reduce emissions and extend the life of existing plants for many decades
- DOE has been funding FutureGen demonstration projects to reduce sulfur, nitrogen and mercury emissions
- Need to optimize pollution controls
- Increase output efficiency (in part to offset energy use in pollution controls)
- Research opportunities for removing impurities before combustion
- Continue to identify uses for byproducts (e.g., fly ash) to minimize follow-after impacts on the environment

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2009 INITIAL USA "STIMULUS" SPENDING

- $350 Million for Geothermal exploration, enhancements and demonstrations
- $117 Million for Photovoltaic development, mitigation of deployment roadblocks and concentrating solar power R&D
- $800 Million for Clean Coal Power Initiative

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T&D & SUSTAINABLE ENERGY

- Smart Grid technologies at Transmission voltages will assist with sustainable energy goals by optimizing control of the sources of generation and integration of renewables
- Similarly, technology enhancements on distribution systems will enable the integration of distributed generation, optimization of voltage, etc
- Finally, conservation & technology innovations beyond the customer meter will enable control of demand to match the available generation capacity

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OTHER SUSTAINABLE ENERGY CONSIDERATIONS

- Conservation
  - Insulation
  - Lighting efficiency
  - Appliance Standards
  - “Cash for Clunkers” (appliance recycling)

OTHER SUSTAINABLE ENERGY CONSIDERATIONS

- Storage Technologies
  - Batteries
  - Compressed Air
  - Pumped Hydro
  - Flywheels

IEEE PES POLICY STATEMENT ON ENERGY & ENVIRONMENT

- The IEEE Power and Energy Society encourages governments to promote research, development, commercialization, and utilization of energy as parts of comprehensive, national energy strategies based on:
  - Developing economic new sources of supply and innovative technologies
  - Developing the delivery infrastructure to meet changes in demand and supply
  - Improving energy efficiency and reliability in production, delivery, and customer end use
  - Having due concern for the environmental impacts of energy developments.

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IEEE PES POLICY STATEMENT ON ENERGY & ENVIRONMENT

While energy use will grow, prudent development must seek methods to minimize the negative effects of energy production, delivery and use, and must aim to reduce global dependence on fossil fuels. No single solution fits all situations. A comprehensive energy policy must consider all of the available options in an appropriate manner. The role of the customer in energy choice and usage should be recognized. The value of diversity of energy resources and of technologies must be recognized, and over-dependence on any single fuel or energy source should be avoided where reasonable. The finite nature of environmental and ecological resources must also be recognized. These resources must be managed wisely for current and future generations.

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SUMMARY

- Sustainable energy will continue to be an evolution
- A diversity of energy sources is highly desirable
- Different parts of the world will continue to use the resources in abundance in their geographic proximity to generate electricity
- Development of storage media is essential to the integration of renewables into the grid
- “Green” energy will continue to grow as societal pressures increase and traditional sources of energy increase in price.
- Bottom line is price is still the major driver in energy markets and for most individuals

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