The Energy Problem

(1) Economic prosperity is intimately tied to affordable energy.

(2) There is potential for geopolitical conflict due to escalating competition for energy resources.

(3) The risk of adverse Climate Change.
Oil Dependency is a Drain on our Economy

(Using EIA data)
Oil Dependency is a Drain on our Economy

Oil price shocks using Hamilton’s price-increase transformation

Percentage price increase

Gray bars indicate a recession

FRBSF Economic Letter 11/18/05
US oil became a net oil importer in the 1940s

China's Oil Production and Consumption, 1990-2010*

Source: EIA International Energy Annual 2006; Short-Term Energy Outlook (March 2009) *forecasted
Energy is a security issue

Russia to cut Ukraine gas supply
Monday, 5 January 2009

Iran uses oil to woo allies abroad
By TAREK EL-TABLAWY, 04.02.09, 12:55 PM EDT

Iraq and China Sign $3 Billion Oil Contract
Deal Is First of Its Kind Since Invasion

By Amit R. Paley
Washington Post Foreign Service
Friday, August 29, 2008; A08
Global average temperature

Departures in temperature in °C (from the 1961-1990 average)

the past 1000 years (Northern Hemisphere)
Projections of Sierra snow-pack and implications for water

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Emission Level</th>
<th>Remaining Snowpack (%)</th>
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</thead>
<tbody>
<tr>
<td>2020-2049</td>
<td>Lower</td>
<td>74%</td>
</tr>
<tr>
<td></td>
<td>Higher</td>
<td>60%</td>
</tr>
<tr>
<td>2070-2099</td>
<td>Lower</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>Higher</td>
<td>11%</td>
</tr>
</tbody>
</table>
The standard of living of a country is *not* proportional to its energy consumption:

**Human Development Index vs. Electricity use**

![Graph showing the correlation between Human Development Index and Electricity Consumption](image-url)
Electricity use per person (1960 – 2008)

From 1973 to 2008, the GDP/capita in California has doubled.

2005 Differences
= 5,300kWh/yr
= $165/capita
Clean Energy Economy

President Obama’s plan:

Create new green jobs that can’t be outsourced and
add to America’s future competitiveness
New Energy for America’s Economy

American Competitiveness
Building Efficiency: Where we are & where we can be.

- 3x improvement demonstrated
- 6 - 8x improvement is possible
An energy efficient economy requires:

- Federal investments to promote efficiency
- Strong and sensible standards
- Research, development, and deployment of new technologies
- The collective will of the American people.
New Energy for America’s Economy

Fuel Fights!
SAVE YOUR SHARE

1. Keep temperature at 65°F. during day - lower at night.
2. Don’t heat unused rooms.
4. Draw window shades at night.
5. Shut off heat when weather permits.
6. Keep heating plant in top condition.
7. Use less hot water.

Saving fuel also saves manpower, material, equipment
CONSERVE COAL, OIL, GAS... FOR WAR

Another tanker torpedoed off the Atlantic Coast!
Should brave men die so you can drive . . . ?

Have you really tried to save gas by getting into a car club?
Step 1: Federal investments to promote efficiency
President Obama’s American Recovery and Reinvestment Act

Double alternative energy production over three years

- $6 billion in loan guarantees
- $8.2 billion for weatherization and energy efficiency
- $3.1 billion for state energy efforts
- $11 billion for smart grid

President Obama wants R & D tax credit to be permanent
Modest but **stable** fiscal incentives were essential to stimulate long term development. Energy transmission/storage is also needed.

6 MW generator (126 m diameter rotors).
Step 2: Strong and sensible standards
Higher standards stimulate technology and innovation:

Refrigerator efficiency

- Adjusted Average Volume (cubic feet)
- U.S. Sales-Weighted Average Energy Use
- Average Real Price
Step 3: Research, development, and deployment of new technologies
Cost of electricity generation vs. installed capacity (1990 dollars / installed Megawatt hour)

- **Photovoltaics**
- **Windmills**
- **Gas turbines**

5x cost difference (not including distribution, energy storage and back-up generation costs)
A transformative technology

• An essential component transcontinental telephone line was the vacuum tube.

• Vacuum tubes generated a lot of heat and burned out.

• AT&T Bell Laboratories invested heavily in improving vacuum tubes. They also embarked on a research program to develop a solid state replacement to the vacuum tube.
Reel-to-reel mass production of efficient solar cells based on rapidly developing nano-technology may be possible.
The Department of Energy must become the modern Bell Labs

Argonne National Laboratory

Oak Ridge National Laboratory

National Renewable Energy Laboratory

Berkeley National Laboratory
Department of Energy

Largest science funder
17 National Laboratories
Researchers at 300 universities
88 Nobel Prize winners
Time to harness our intellectual horsepower
New Energy for America’s Economy

President Obama: Double investment in science over 10 years
Sunlight to energy via Bio-mass

Sunlight
$\text{CO}_2, \text{H}_2\text{O}$, 
Nutrients

Biomass

Chemical energy

Develop energy plants that can use marginal agricultural land, need less nutrients, water, and are easier to breakdown into simple sugars.

Improved conversion of cellulose into fuel. New organisms for biomass conversion.
1960: Population = 3 B
2005: Population = 6.5 B

Source: Food and Agriculture Organization (FAO), United Nations
The invention of ammonia synthesis by Haber and Bosch made possible artificial fertilizers.
Man first learned to fly by imitating nature
The first important step:
Sunlight + 2H₂O → O₂ + 4H⁺ + 4e⁻
Earthrise from Apollo 8 (December 24, 1968)