Clean Energy Technology Policy: The Economics of Why and How

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Sources include:


Clean Energy Policy Economics: What should be the problem we’re trying to solve?

- How fiscally significant is clean energy policy?
- How do markets, left to themselves, get it wrong?
- How can government intervene efficiently?
What is clean energy?

• Low or no carbon

• Low environmental impact generally

• Low life cycle emissions

• Energy efficient goods
Clean energy?

- Nuclear
- Clean coal
- Natural gas
- New hydro

![Graph showing emissions in Kg C/mBTU for Natural Gas, Gasoline, and Coal.](chart.png)
Policy tools to promote clean energy:

- Direct expenditures
- Tax subsidies
- Risk transfers
- Regulation
- Input subsidies
- Government procurement/contracts

Artist’s conception of the six-square-mile Ivanpah solar facility in the Mojave Desert, to be located on U.S. Bureau of Land Management land. Source: Los Angeles Times
Examples of US Clean Energy Policy:

- Basic research
- Production tax credits for renewables
- Alternative fuel blending standards
- Assistance to low-income households for energy retrofits
- Energy labeling requirements for appliances
- Cap-and-trade program for SO₂ emissions
- Loan guarantees for solar and nuclear firms
Table ES1. Value of energy subsidies by major use, FY 2007 and FY 2010 (million 2010 dollars)

<table>
<thead>
<tr>
<th>Subsidy and Support Category</th>
<th>FY 2007</th>
<th>FY 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity-Related</td>
<td>7,663</td>
<td>11,873</td>
</tr>
<tr>
<td>Fuels and Technologies Used for Electricity Production</td>
<td>6,582</td>
<td>10,902</td>
</tr>
<tr>
<td>Transmission and Distribution</td>
<td>1,081</td>
<td>971</td>
</tr>
<tr>
<td>Fuels Used Outside the Electricity Sector</td>
<td>6,246</td>
<td>10,448</td>
</tr>
<tr>
<td>Conservation, End Use and LIHEAP</td>
<td>3,987</td>
<td>14,838</td>
</tr>
<tr>
<td>Conservation</td>
<td>369</td>
<td>6,597</td>
</tr>
<tr>
<td>End-Use/Other</td>
<td>1,342</td>
<td>3,241</td>
</tr>
<tr>
<td>LIHEAP (Low Income Home Energy Assistance Program)</td>
<td>2,276</td>
<td>5,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17,895</strong></td>
<td><strong>37,160</strong></td>
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</tbody>
</table>
Clean Energy Subsidies are Relatively Large

- Renewables were 10.3% of electricity generation in 2010 and received 55.3% of federal subsidies.
- In 2009, renewable energy tax subsidies were 49 times greater than fossil fuel subsidies on a per BTU basis.

Sources: US Energy Information Administration; Congressional Research Service; Institute for Energy Research
U.S. Energy Related Tax Expenditures ($ billions)
Source: Subsidyscope.org

Largest component: grants for new renewable facilities
Largest component: expensing exploration

Fiscal Year
1999 2001 2003 2005 2007 2009 2011 2013 2015

- Support fossil fuels
- Support renewable and alternative fuels
- Encourage energy efficiency or conservation
- Multi-use
U.S. Energy-Related R&D Spending 2000-2010
(in millions of US $2010)

Source: International Energy Agency
Three common arguments for clean energy policy:

1. Greenhouse gas emissions from conventional energy
2. Energy security
3. Strategic industrial or trade potential

(Want to distinguish economic arguments from rent-seeking)
How do arguments for clean energy policy line up with economic principles?

1. Environmental damages from conventional energy
2. Energy security
3. Strategic industrial or trade potential

A. Market failures
   » External costs
   » Public goods

B. Macroeconomic risk from volatile oil price

C. Distributional objectives
   » Potential to benefit U.S. economy at expense of others

How strong are these arguments?
Rationale 1: Environmental Damages from Conventional Energy

- Prices don’t reflect damage to the environment.
- Damages are *external costs*.
- An economy-wide price on greenhouse gases ensures that all economic decisions incorporate both private and social costs.
- US government estimates 2010 Social Cost of Carbon ≈ $4.70 to $64.90/ton CO$_2$
Greenhouse Gas Abatement Cost Curve

$/\text{ton CO}_2\ \text{equiv}

Marginal abatement cost

Area under curve = Total cost of abatement

Reductions from Business as Usual
Example: Set a price on carbon and reduce emissions. Cost effective technology deploys.
Increasing carbon price lowers emissions further...

$/\text{ton CO}_2\text{ equiv}$

$40$

Marginal abatement cost

Total cost of abatement

(GHG reduction as a result of the tax)

Tax revenue

Remaining Emissions

Reductions from Business as Usual
Improved technology lowers the marginal abatement cost – more abatement for the same price on carbon.
Price signal does the heavy lifting

• Firms invest in lowest cost abatement and cost effective R&D

• Government still needs to fund under-provided basic R&D
  » Public good quality to basic research
  » Cost effectively shift down cost curve

• No natural connection between carbon tax revenue and optimal R&D spending
Before a price signal takes effect:

- WWFD?
  - What would firms do if there was a price on carbon?
- Establish expectations where possible
- Don’t subsidize, mandate, or under-write risks of high cost abatement.
- Don’t subsidize traditional fuels, either.
How do carbon emissions reductions from energy efficiency tax credits compare to reductions from a carbon tax?

Carbon emissions from fossil energy

-60 -40 -20

0

Carbon tax, revenue
≈ $140 billion per year

Tax credit for energy efficient household capital, revenue loss
≈ $130 billion per year

Why is a carbon tax so much more effective than tax credits?

- Tax affects characteristics of new equipment (like a tax credit) and use of existing equipment.
- Spurs fuel switching.
- With energy efficiency program, people spend some savings on energy, directly and indirectly.
Rationale 2: Energy security

- Electricity fuels in the U.S. are North American.

We use minimal oil for electricity

US Electricity Production by Source 2011

- Coal: 42%
- Natural gas: 25%
- Nuclear: 19%
- Hydropower: 8%
- Other renewable: 5%
- Petroleum: 1%
- Other Renewables: Wind, Biomass, Geothermal, Solar

Other Renewables:
- Wind: 2.9%
- Biomass: 1.4%
- Geothermal: 0.4%
- Solar: 0.04%
Energy Security is About Oil

- Options:
- Oil Substitutes:
  - Biofuels
  - Natural gas and electric vehicles
- More domestic oil production
- Greater fuel economy

Tesla: US Govt. Loan Guarantee, $465 million. Its electric cars sell for $58,000 to $109,000, minus $7,500 tax credit.
Is Increasing Energy Independence Cost Effective?

- We’ll still be vulnerable to world oil price.
- Oil price problems are intermittent.
- Oil substitutes are expensive and require capital stock turnover. Biofuels can also boost food prices.
- Oil substitutes aren’t necessarily clean and may not compete if oil prices fall.
- US economy is less vulnerable to price shocks than in the 1970s.
Figure 3. Total U.S. petroleum and other liquids production, consumption, and net imports, 1970-2035
(million barrels per day)

http://www.eia.gov/forecasts/aeo/chapter_executive_summary.cfm
In 2010, the five largest sources of net crude oil and petroleum product imports were:
- Canada (25%)
- Saudi Arabia (12%)
- Nigeria (11%)
- Venezuela (10%)
- Mexico (9%)
Two kinds of significant macroeconomic costs arise from oil price spikes:

- (1) the loss of national income from a large jump in oil prices sustained for any length of time; and
- (2) the effects of large oil price shocks on inflation and output arising from “imperfections” and rigidities of the macroeconomic system.

- The most effective policy: the Federal Reserve’s prompt response to any current or prospective inflationary threat.
Rationale 3: Clean energy investments can benefit the American economy.

- Fear that without clean energy policies, Americans will forfeit a growth opportunity to other countries.
- Belief that clean energy investments create jobs.
- Consistent with long tradition of industrial policy arguments.
However...

- Hard to influence long run comparative advantage with subsidies or regulation.
- In the long run, labor markets equilibrate. Policy can affect composition, but not number of jobs.
- First mover advantage in clean energy is unclear.
- Clean energy demand is a function of fickle policy.
- The cheaper clean energy is, the better for the environment and the US economy.

Source: www.chinesesolar.com
How does spending related to energy stack up against other forms of fiscal stimulus?

• Timely, targeted, and temporary?
  » Energy efficiency retrofits could work.
  » Renewable deployment, maybe, but electricity demand growth is low in recession.
  » R&D not well suited to counter-cyclical spending

• Guaranteed loans for expanding commercial operations will help only those firms that are nearly competitive.
Finally, theory vs. practice

• “The trouble with picking winners is that each Congressman would want one for his district.”

• Tens of billions wasted on synfuels, breeder reactors, hydrogen economy.

• Need to insulate spending from rent-seeking and fashion.


From 2004 to 2008 the U.S. government spent $1.2 billion on hydrogen vehicles.
Conclusions:

• The strongest economic rationale for promoting clean energy is that it’s clean.

• The most efficient way to promote clean energy is to price greenhouse gas emissions and other pollution.

• Carefully select a portfolio of clean energy R&D investments independent of political whims.