Recycled Energy: Is the Future In Front of Us?

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Is energy a supply or demand problem?

- October 10, 2010 Rasmussen poll:
  - “58% of U.S. Voters think finding new sources of energy is more important than reducing the amount of energy Americans now consume.”
  - “60% of voters think investing in renewable energy sources like wind and solar is a better long-term investment for America than investing in fossil fuels like oil, gas and coal. 27% feel fossil fuels are the better long-term investment.”
  - “42% of voters believe there is a conflict between economic growth and environmental protection”

- Note consistent assumption that energy conversion efficiency is fixed!
The US “strategic energy efficiency reserve”: how deep?

Source: Skip Laitner, ACEEE
Conversion of energy to useful work, 1900 - 2005

U.S. Conversion Efficiency, Potential Energy to Useful Work

Source: Robert Ayres, INSEAD
Other nations do better.

- Japan, Austria and UK achieve about 20% efficiency of fuel to useful work, versus 12% to 13% in the U.S.
  - Many nations with efficiency- (rather than supply-) focused policies have not yet been studied; expect >25% in Denmark, Netherlands, Finland, others.

- At 25% efficiency, these countries produce useful energy services with half of the fossil carbon dioxide associated with U.S. energy services

- The U.S. has an efficiency deficit versus its trading partners that it can fix
Where does our energy waste go?

US Energy Waste in Quads, by Source (partial summary)

- Industrial waste energy: 11.4 quads
- Power gen waste heat: 26.4 quads
- Transportation waste heat: 22.9 quads
- Sewage dry solids: 1.6 quads
- Solid Waste: 0.1 quad

Note: this leaves ~38 quads unaccounted for given DOE estimate that US uses 100 quads/yr of primary energy
Waste from electric sector is huge – and stagnant.

- Inflates costs
- Increases pollution
- Why stagnant for 50 years?

U.S. Delivered Electric Efficiency

Wasted Energy
Homer Simpson’s power plant
Two-thirds of the energy generated is released into the atmosphere.
Conventional electricity generation

- Fuel 100%
- Waste Heat 65%
- Pollution
- Line Losses 2.5%
- Useful Power 33%

Fuel
Generation
Transmission
Consumption
Recycled energy generation

Conventional generation: use energy once

- Energy Waste
- Energy Waste
- Thermal uses
- Electricity uses
- Remote fuel source
- Ship, train, pipeline, etc.
- Transmission line
- Remote power plant

The RED approach: use energy twice

- Energy
- Waste energy recovery
- Combined heat & power
- Thermal uses
- Electricity uses
- Remote fuel source
- Ship, train, pipeline, etc.
Heat & power generation accounts for $2/3$rd of US CO$_2$

Emissions of U.S. CO$_2$ from Fossil Fuels

- Heat & power account for 69% of fossil fuel emissions

<table>
<thead>
<tr>
<th>Source</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>42%</td>
</tr>
<tr>
<td>Thermal</td>
<td>27%</td>
</tr>
<tr>
<td>Cars</td>
<td>14%</td>
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<tr>
<td>Other Transport</td>
<td>12%</td>
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</tbody>
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Heat & power generation accounts for $2/3$rd of US CO$_2$
Example 1: Glass furnace
Example 2: Steel mill

Produces as much clean energy each year as all grid-connected photo-voltaic solar generation produced in 2004.
Example 3: Silicon production
Recycled energy is the lowest cost source of new power.

Delivered cost of new US generation

2009 US avg. retail electric price ($99/MWh)

- Waste energy recycling
- Renewable
- Conventional
Proof: >250 projects by RED principals ($2B capex)

- **Primary Energy**: Industrial waste heat recovery
  - 14 Projects

- **Turbo Steam**: Steam pressure recovery
  - 205 Projects

- **Trigen**: Combined Heat & Power
  - 56 Projects

U.S. delivered electric efficiency
Rising electric rates create economic urgency.

US Average Retail Electric Rates (2009 $)

$ / MWh

$140

$130

$120

$110

$100

$90

$80

China has recognized that LT growth depends on cheap energy, not cheap labor.

“Behind the [power plant construction boom in China] are myriad forms of government intervention. Most [Chinese utilities] lost money in 2008, made fairly low returns in 2009 and, thanks to a government policy of holding down tariffs are unlikely to be particularly profitable in the future. The huge expansion of generating capacity serves many purposes... **Cheap, reliable electricity is one reason why China remains the preferred destination for manufacturing even as its wages rise.**”

- “China is parlaying it’s hunger for power into yet more economic clout”, *The Economist*, April 29, 2010
Implications for policy makers and manufacturers.

- Our economic growth depends on access to **useful** energy – not coal, gas, or the technology du jour.
  - Good policies reward goals, not paths.

- Decades of falling energy prices have discouraged investments in energy efficiency that our trading partners have already made. As energy prices rise, we have the opportunity to lower energy costs and increase energy supply.
  - But only if we embrace the industrial sector as a part of the solution!

- Our electric and environmental regulations were built for yesterday’s challenges.
  - Neither cost-plus rate-making nor the Clean Air Act reward investments in high-yielding clean generation.
Simple policy tweak 1 to unleash cheap, clean energy.

- Don’t assume market efficiency exists where markets do not; electric sector needs market reform or goal-driven directives to bring clean energy forward.
  - Industrials typically have subsidized, retail electric rates, discouraging investments in efficiency, but cannot wheel onto liquid power markets.
  - ISO-NE has created market solutions (FCM)
  - CA has created goal-driven policies (Std Offers)
Simple policy tweak 2 to unleash cheap, clean energy.

- The Clean Air Act mandates energy inefficiency; CAA reform could be used to profitably reduce CO₂ emissions, even without a carbon bill.
  - “Input-based” pollutions standards + NSR criminalize efficiency, make the industrial sector very reluctant to take measures to lower their energy costs.
  - Solution: output-based standards (can be done at state level: see TX, CT, NY)