The Economic Benefits of Climate Action

Pocantico Conference Center
November 27, 2007

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Global Carbon Project: GHG Emissions Trajectory

50-year constant growth rates to 2050:

- A1FI: 2.4%
- A1B: 1.7%
- A2: 1.8%
- B1: 1.1%

Observed 2000-2006: 3.3%

Raupach et al. 2007, PNAS
Global Carbon Project: Conclusions

Since 2000:

- The growth of carbon emissions from fossil fuels has tripled compared to the 1990s, exceeding the predictions of the highest IPCC scenarios.
- Atmospheric CO$_2$ has grown at 1.9 ppm per year (vs. ~1.5 ppm over last 30 years)
- The carbon intensity of the world’s economy has stopped decreasing (after 100 years of doing so).
- The efficiency of natural sinks has decreased by 10% over the last 50 years — and will continue to do so in the future (⇒ the longer we wait, the larger the cuts needed to stabilize atmospheric CO$_2$).
- All of these changes characterize a carbon cycle that is generating stronger climate forcing and sooner than expected.
Why Are States Leading on Climate?

- **States have always led**
  - Origin of innovative approaches ("Laboratories")
  - Where consensus is built and conflicts resolved
  - Where implementation really happens ("Proving Ground")
  - Prior lead-by-example success (Acid Rain, toxics, Hg, cars, etc.)

- **Proactive**
  - See economic opportunity
    - Get head start on technological opportunities and markets
    - Get savings, productivity, security, and health co-benefits
  - See political opportunity
    - Gretsky: “Skate to where the puck is going to be.”

- **Precautionary**
  - Want to avoid severe climate impacts & risks
  - Know climate policy is coming; want to shape it favorably
  - Are significant GHG emitters
  - Gough: “If you’re not at the table, you’re on the menu.”
States Consistently Shape Federal Policy

More “pioneers” than “laboratories”; where real policy gets hammered out:

<table>
<thead>
<tr>
<th>State Action</th>
<th>When</th>
<th>Corresponding Federal Action</th>
<th>When</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Acid Rain Laws</td>
<td>1985</td>
<td>Federal Acid Rain Program</td>
<td>1990</td>
</tr>
<tr>
<td>State Air Toxics Laws</td>
<td>1987</td>
<td>Federal Air Toxics Program</td>
<td>1990</td>
</tr>
<tr>
<td>State NOx Trading (OTC)</td>
<td>1995</td>
<td>Federal NOx SIP Call</td>
<td>2004</td>
</tr>
<tr>
<td>State RPS Laws</td>
<td>1997-2007</td>
<td>Federal RPS Law</td>
<td>Introduced</td>
</tr>
<tr>
<td>State “4-P” Laws for Power Plants</td>
<td>1997-2002</td>
<td>Federal “4-P” Law</td>
<td>Introduced</td>
</tr>
<tr>
<td>Statewide GHG Reduction Laws</td>
<td>2003-2006</td>
<td>Federal GHG Reduction Law</td>
<td>Introduced</td>
</tr>
<tr>
<td>State GHG Reductions from Vehicles</td>
<td>2002</td>
<td>Federal Vehicle GHG Standards</td>
<td>?</td>
</tr>
</tbody>
</table>
Political Benefits Are Increasingly Clear

States Choose Carbon-Friendly Governors

O'Malley MD Join RGGI
Patrick MA Join RGGI
Richardson NM New Targets
Napolitano AZ New Targets
Schwarzenegger CA State Cap GHG Market

Carbon Market North America
November 8, 2005

States Choose Carbon-Friendly Governors

With Martin O'Malley as governor, the Democratic party in Maryland is going all out for a carbon-friendly agenda with its commitment to the Regional Greenhouse Gas Initiative (RGGI). The state already has a cap-and-trade program for electric utilities. O'Malley has also indicated his state's participation in the scheme, so its entry date is expected in 2007.

With the election of Deval Patrick as governor, Massachusetts has committed itself to a 25% reduction in greenhouse gas emissions by 2020. While Maryland is negotiating the level of its cap, Massachusetts already has a target of 26.8 million short tons of carbon dioxide set for RGGI's Manhatten Cap.

Together, these actions will increase the likelihood of a statewide cap-and-trade program. As Attorney General of the state of New York, Spitzer was a vocal critic of New York's cap-and-trade program. As the newly elected governor of the state, he is likely to make its policy. As governors, the three have been observed to be pushing for carbon reductions on a nationwide scale. The election of Bill Ritter in Colorado has been seen as a victory for climate change activists and a defeat for the coal industry. Ritter has proposed to end the state's reliance on coal and to develop renewable energy sources. The state has already committed to a 100% renewable energy target by 2050.

The election of Ritter and Pat Quinn in Illinois has been seen as a victory for environmentalists and a defeat for the coal industry. Quinn has proposed to end the state's reliance on coal and to develop renewable energy sources. The state has already committed to a 100% renewable energy target by 2050.

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Comprehensive Climate Plans

~37 States

- Post-2000 Plan
- Recent & Underway
- Partial & Possible
- Initial Contact

4-39-07
Comparison to National Bills

Comparison of Legislative Proposals in 110th Congress
1990-2050

- Business As Usual
- Bush Administration
- Kyoto Protocol
- McCain-Lieberman
- Stabilize at 450ppm
- Stabilize at 550ppm
- Kerry-Snowe
- Udall-Petri
- Sanders-Boxer, Waxman

≈ Leadership States

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1 Discussion draft
2 Projections do not include emissions that may exceed the cap due to a price "safety valve."
3 Submitted in 109th Congress
GHG Reduction Strategies

AZ CCAG Options Ranked by $/MTCO2e 2007-2020

- Clean Cars
- Appliance Efficiency Standards
- DG & CHP
- Electricity Pricing
- Reduce Land Conversion
- RPS
- Increase Reforestation
- Truck Speed Limit
- Reduce Land Conversion
- Carbon Intensity Targets
- Building Codes
- DSM
<table>
<thead>
<tr>
<th>State</th>
<th>End Date</th>
<th>Policy Options</th>
<th>Degree of Unanimity</th>
<th>Amount of GHG Reductions</th>
<th>Overall NPV Cost or Savings</th>
<th>Jobs Impact</th>
</tr>
</thead>
</table>
| AZ    | 2006     | 49             | 92%                 | • 2000 level by 2020  
          |           |                 |                     | • Half 2000 level by 2040  | $5.5 billion savings 2007-2020  | 285,000   |
| CA    | 2008     | n/a            | n/a                 | • AB-32: 1990 level by 2020  
          |           |                 |                     | AB-32 $4 billion savings | AB-32 $4 billion savings  | AB-32 83,000 |
| CO    | 2007     | 70             | 87%                 | • 37% below projected emissions by 2020  | ~$3 billion savings 2007-2020  | Not assessed |
| CT    | 2005     | 55             | High                | • 1990 level by 2010  
          |           |                 |                     | • 10% below 1990 level by 2020  | Net Savings  | Not assessed |
| ME    | 2004     | 54             | High                | • 1990 level by 2010  
          |           |                 |                     | • 10% below 1990 level by 2020  | Net Savings  | Not assessed |
| MT    | 2007     | 54             | 98%                 | • 1990 level by 2020  | $78 million savings 2007-2020  | Not assessed |
| NC    | 2007     | 56             | 85%                 | • 47% below projected emissions by 2020  | $7.5 billion savings 2007-2020  | In process |
| NM    | 2006     | 69             | 97%                 | • 2000 level by 2012  
          |           |                 |                     | • 10% below 2000 level by 2020  | $2.2 billion savings 2007-2020  | Not assessed |
| VT    | 2007     | 37             | 86%                 | • 25% below 1990 level by 2012  
          |           |                 |                     | • 50% below 1990 level by 2028  | $1.3 billion savings 2007-2028  | Not assessed |
### National Emulation of States’ Actions

<table>
<thead>
<tr>
<th>Potential US in 2020</th>
<th>% of National Gap</th>
<th>Sample Cost/Cost Savings</th>
<th>M Tons GHG</th>
<th>Total Savings (Best Guess)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Efficiency and Conservation</td>
<td>~24%</td>
<td>-$10 to -$30</td>
<td>555</td>
<td>-$11 Billion</td>
</tr>
<tr>
<td>Clean and Renewable Energy</td>
<td>~24%</td>
<td>$7 to $21</td>
<td>565</td>
<td>$8 Billion</td>
</tr>
<tr>
<td>Transportation and Land Use Efficiency</td>
<td>~36%</td>
<td>-$32 to -$36</td>
<td>831</td>
<td>-$28 Billion</td>
</tr>
<tr>
<td>Agriculture and Forestry Conservation</td>
<td>~6%</td>
<td>-$1 to -$5</td>
<td>132</td>
<td>-$0.4 Billion</td>
</tr>
<tr>
<td>Waste Management, Industrial Processes, and Other</td>
<td>~11%</td>
<td>?</td>
<td>246</td>
<td>?</td>
</tr>
<tr>
<td>Additional Federal Actions</td>
<td>(~6-18%)</td>
<td>?</td>
<td>264</td>
<td>?</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>~2,500</td>
<td>-$31 Billion +</td>
</tr>
</tbody>
</table>

**NPV 2007-2020: –$117 Billion**
Potential Global Link-Up?

- Potentially a ~$0.5-1 trillion, state-driven carbon market.
- Leverage to secure China & India GHG reductions? …Allow a share of “offshore offsets” in return for meaningful commitments (e.g., 30% = $300 billion).
- States might succeed where Kyoto has not.
Three problems:

1. Problem gets 5 GtCO2e worse

2. “Wedges” are smaller and reduce less, so reductions from “Unknown” sources must double.

3. The effort required to achieve required reductions (i.e., slope of the line) will be twice as hard.
We waste more energy than Japan uses…
Economic Impact of EE in Florida

Table ES-2. Economic Impact on the State of Florida of Expanded Energy Efficiency

<table>
<thead>
<tr>
<th>Financial Impacts (Millions of $2004)</th>
<th>2008</th>
<th>2013</th>
<th>2018</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Consumer Outlays</td>
<td>1</td>
<td>1,585</td>
<td>2,172</td>
<td>2,584</td>
</tr>
<tr>
<td>Annual Electricity Savings</td>
<td>3</td>
<td>1,174</td>
<td>2,679</td>
<td>4,674</td>
</tr>
<tr>
<td>Electricity Supply Cost Adjustment</td>
<td>(1)</td>
<td>(894)</td>
<td>(1,867)</td>
<td>(2,975)</td>
</tr>
<tr>
<td>Net Consumer Savings</td>
<td>3</td>
<td>484</td>
<td>2,375</td>
<td>5,005</td>
</tr>
<tr>
<td>Net Cumulative Energy Savings</td>
<td>2</td>
<td>840</td>
<td>8,652</td>
<td>28,250</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Macroeconomic Impacts</th>
<th>2008</th>
<th>2013</th>
<th>2018</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobs (Actual)</td>
<td>(33)</td>
<td>366</td>
<td>7,557</td>
<td>14,264</td>
</tr>
<tr>
<td>Wages (Million $2004)</td>
<td>(2)</td>
<td>(168)</td>
<td>(62)</td>
<td>64</td>
</tr>
<tr>
<td>GSP (Million $2004)</td>
<td>(4)</td>
<td>(1,134)</td>
<td>(1,857)</td>
<td>(2,745)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimate of Avoided Emissions *</th>
<th>2008</th>
<th>2013</th>
<th>2018</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO₂ (thousand short tons)</td>
<td>0.0</td>
<td>5.9</td>
<td>10.8</td>
<td>16.3</td>
</tr>
<tr>
<td>NOₓ (thousand short tons)</td>
<td>0.0</td>
<td>3.7</td>
<td>6.7</td>
<td>10.9</td>
</tr>
<tr>
<td>CO₂ (million metric tons)</td>
<td>0.0</td>
<td>11.1</td>
<td>21.8</td>
<td>37.1</td>
</tr>
</tbody>
</table>

* Note: Emissions are based on average emission rates.

ISO-NE Load
[source www.iso-ne.com]

Hourly Bids ISO-NE
[source www.iso-ne.com]
California – It’s Already Working

Per Capita Electricity Consumption

United States

California

Draft 5.17.05 mlw
## Energy Supply & Jobs

<table>
<thead>
<tr>
<th>Scenarios (to meet 20% of current US electricity demand)</th>
<th>Construction, Manufacturing, Installation</th>
<th>O&amp;M and Fuel Processing</th>
<th>Total Jobs</th>
<th>Ratio Over “BAU”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 20% RPS by 2020 85% biomass, 14% wind, 1% PV</td>
<td>52,533</td>
<td>111,136</td>
<td>163,669</td>
<td>1.89</td>
</tr>
<tr>
<td>2. 20% RPS by 2020 60% biomass, 37% wind, 3% PV</td>
<td>85,008</td>
<td>91,436</td>
<td>176,444</td>
<td>2.04</td>
</tr>
<tr>
<td>3. 20% RPS by 2020 40% biomass, 55% wind, 5% PV</td>
<td>111,879</td>
<td>76,139</td>
<td>188,018</td>
<td>2.18</td>
</tr>
<tr>
<td>4. Fossil Fuels as Usual to 2020 50% coal, 50% natural gas</td>
<td>22,711</td>
<td>63,657</td>
<td>86,369</td>
<td>1.00</td>
</tr>
<tr>
<td>5. 20% Gas Intensive by 2020 100% natural gas</td>
<td>22,023</td>
<td>61,964</td>
<td>83,897</td>
<td>0.97</td>
</tr>
</tbody>
</table>

a) “Across a broad range of scenarios, the renewable energy sector generates more jobs than the fossil fuel-based energy sector per unit of energy delivered (i.e., per average megawatt).”

b) “Supporting renewables within a comprehensive energy policy that includes EE and sustainable transportation will yield far greater employment benefits than supporting 1-2 of these sectors separately.”

c) More effort => more jobs.

*Source: Daniel Kammen et al, UC Berkeley, Putting Renewables to Work, April 2004.*
### Economics 101: Factors of Production

<table>
<thead>
<tr>
<th>Factor</th>
<th>BAU</th>
<th>EE/RE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man (Labor)</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Machine (Capital)</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>Material (Raw Material)</td>
<td>+</td>
<td>−</td>
</tr>
<tr>
<td>Method (Technology)</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Energy Security</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Regulatory Certainty</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Quality / Time-to-Market</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>“Ecosystem Services”</td>
<td>−</td>
<td>+</td>
</tr>
</tbody>
</table>
Climate change is “a tectonic force that [will] change the economic landscape; firms that recognize early, and respond imaginatively and constructively will create opportunities for themselves and thereby prosper.”

US clean-tech investment:
- 2005 – ~$1.5 billion
- 2006 – ~$2.9 billion
- 2009 – ~$8.7 billion (projected)

International carbon market:
- 2005 – $12 billion
- 2006 – $29 billion
- 2007 – $31 billion (estimated)

U.S. energy sector investment (now through 2030): ~$21 trillion

Energy will be the “largest economic opportunity this century.”

*John Doerr, Venture Capitalist (Google, Amazon)*
The bolder proposition we should be considering:

Climate policy as a path to economic development and job growth
Cleantech Venture Investments by Sector

Figure 1.1 North American Cleantech Venture Capital Investments by Industry Segment, 2005-2006 (Millions of dollars)

Future Economy: Fuel Cell Technology in North America

- Gary Simon, Sigma Energy Group

Symbols Designate Company Size
- Large
- Medium
- Small

Economic Development: Connecticut
This chart compares the energy security and climate characteristics of different energy options. Bubble size corresponds to incremental energy provided or avoided in 2025. The reference point is the “business as usual” mix in 2025. The horizontal axis includes sustainability as well as traditional aspects of sufficiency, reliability, and affordability. The vertical axis illustrates lifecycle greenhouse gas intensity. Bubble placements are based on quantitative analysis and WRI expert judgment.

For specific details on the assumptions underlying the options on this chart, go to www.wri.org/usenergyoptions
Non-OPEC Hubbert’s Peak is Here
Inflation Adjusted Monthly CRUDE
OIL PRICES (1946- Present)
In Jan 2007 Dollars
© www.InflationData.com
Updated 2/22/07

- Dec. 1979 Monthly Ave. Peak
  $100.28 in Jan. 2007 Dollars

- Nominal Peak $38 (Mo. Ave. Price)
  Intraday Prices peaked much higher

- July 2006 Monthly Ave.
  Oil Price $65.93

- January 2007 Monthly
  Ave. Oil Price $46.63

Nominal Monthly Ave. Oil Price
Inflation Adjusted Monthly Average Oil Price

Source of Data:
Oil Prices - www.baa.com/special/Nominal_Hist.htm
CPI-U Inflation Index - www.bls.gov
Renewable Energy Cost Trends

Levelized cost of energy in constant 2005$


¹These graphs are reflections of historical cost trends NOT precise annual historical data. DRAFT November 2005
Which is the Wiser Path?

Electricity Costs vs. Time

- Conventional Supply
- GHG Regs
- LICAP/FCM
- RE, EE, DG
International Competitiveness

Renewable energy and energy efficiency reduce the risks associated with fuel price volatility and can facilitate an industrial boom, create millions of jobs, foster new technology, and revitalize the manufacturing sector.

From: Worldwatch Institute [mailer@worldwatch.org]
To: kcolburn@symbioticstrategies.com
Cc:  
Subject: New Report on Renewable Energy: Which Country is Poised to Lead?

China on Pace to Become Global Leader in Renewables

If China’s commitment to diversifying its energy supply and becoming a global leader in renewables manufacturing persists, renewable energy could provide over 30 percent of the nation’s energy by 2050. This is the major conclusion of Powering China’s Development: The Role of Renewable Energy, written by Beijing-based researcher Eric Martinot, a Worldwatch senior fellow, and Li Junfeng, Vice Chair of China’s Renewable Energy Society in Beijing.

"A combination of policy leadership and entrepreneurial savvy is leading to spectacular growth in renewable energy, increasing its share of the market for electricity, heating, and transport fuels," said Martinot. "China is poised to become a leader in renewables manufacturing, which will have global implications for the future of the technology."

More than $50 billion was invested in renewable energy worldwide in 2006, and China is expected to invest over $10 billion in new renewables capacity in 2007, second only to Germany.
Old or New Energy Path?

**Sustainability**

Energy Efficiency & Renewables Path (MORE jobs, reliable, secure, clean, and exportable)

Energy Intensity Path (LESS jobs, reliable, secure, clean, and exportable)

**Competitive Advantage Lost to Delay**

**ECONOMIC EFFICIENCY**

Higher

Lower

**TIME**

Now Later

Old or New Energy Path?
Energy Opportunity is the Third Industrial Revolution
The Center for Climate Strategies (CCS) has calculated overall net economic cost savings from the CCAG's policy option recommendations of more than $5.5 billion from 2007-2020. The CCS also has calculated that the average cost for each ton of GHGs removed would be $12.74, meaning that there would be a net economic cost savings of $12.74 for each ton of GHGs removed.15

+285,000 jobs
Similar Results in Other States…

- 69 Recommendations;
  67 Unanimous
- NPV: $2.1 Billion Savings
- Reductions exceeded Governor’s goals.
Leadership States’ “Wedges”

<table>
<thead>
<tr>
<th>% of Gap</th>
<th>Sample Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>~24%</td>
<td>-$10 to -$30</td>
</tr>
<tr>
<td>~24-30%</td>
<td>$7 to $21</td>
</tr>
<tr>
<td>~20-36%</td>
<td>-$32 to -$36</td>
</tr>
<tr>
<td>~6-9%</td>
<td>-$1 to -$5</td>
</tr>
<tr>
<td>~11-18%</td>
<td>?</td>
</tr>
<tr>
<td>~6-18%</td>
<td>?</td>
</tr>
</tbody>
</table>
The Task is Daunting…

![Figure 6: Stabilizing Emissions Requires a Minimum 30 Gt](source: Adapted from Stern Review, 2006; BAU emissions ~WEO A2 scenario; 450 ppm budget range based on Stern and preliminary IPCC analysis)

It’ll Cost a Lot If We Don’t Act…

Limiting temperature increases to 2°C could avoid $12 trillion in annual damages by 2100 at 1/4 of the cost.

Cost to act: ~1% global GDP.
Cost of not acting: 5-20% of global GDP by mid-century.

...Will It Cost a Lot If We Do?
Prior Experience with Regulatory Costs

Costs of Environmental Compliance

US Dollars per Unit

- SOx
- CFCs
- CFCs - Automotive
- Coke Ovens
- Cotton Dust
- Mine Reclamation
- Vinyl Chloride

- Projected
- Actual

Note that the scale is exponential!
<table>
<thead>
<tr>
<th>COMPANY</th>
<th>SECTOR</th>
<th>CARBON FOOTPRINT (Tons CO₂e)</th>
<th>REDUCTIONS / ACHIEVEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3M</td>
<td>Chemicals</td>
<td>14 million</td>
<td>Reduced GHG emissions by approx. 37% between 1990 and 2004.</td>
</tr>
<tr>
<td>ABN AMRO</td>
<td>Banking</td>
<td>39.6283</td>
<td>Reduced worldwide direct CO₂ emissions by 4%, and indirect emissions by 9% between 2002 and 2004.</td>
</tr>
<tr>
<td>AGL</td>
<td>Energy and Utilities</td>
<td>147 million</td>
<td>Alcan reduced direct and indirect GHG emissions by 13% between 1990 and 2003.</td>
</tr>
<tr>
<td>ACCO</td>
<td>Metals and Mining</td>
<td>33.6 billion</td>
<td>Reduced CO₂ emissions by 13% between 2002 and 2004.</td>
</tr>
<tr>
<td>AGLAIA</td>
<td>Metals and Mining</td>
<td>34.3 billion</td>
<td>Reduced PFC emissions by 80%, and achieved 2% reduction in GHG emissions between 2002 and 2003.</td>
</tr>
<tr>
<td>ALLIANCE</td>
<td>Insurance</td>
<td>Direct and indirect CO₂ emissions were 570,000 tonnes in 2003.</td>
<td>27% reduction in CO₂ emissions (kg/m²) between 2000 and 2003.</td>
</tr>
<tr>
<td>ANZCO</td>
<td>Industrial Manufacturing</td>
<td>Not documented</td>
<td>Annual reduction in GHG emissions by 56,000 tonnes through energy efficiency.</td>
</tr>
<tr>
<td>BAA</td>
<td>Transportation Services</td>
<td>436,852</td>
<td>Reduced CO₂ emissions per passenger by 44% between 1997 and 2004.</td>
</tr>
<tr>
<td>BASF</td>
<td>Chemicals</td>
<td>27.5 million</td>
<td>Reducing absolute GHG emissions by 35% between 1990 and 2003.</td>
</tr>
<tr>
<td>Bayer</td>
<td>Chemicals</td>
<td>5.6 million</td>
<td>65% reduction in direct emissions between 1990 and 2004.</td>
</tr>
<tr>
<td>BP</td>
<td>Energy and Utilities (Oil and Gas)</td>
<td>Direct and indirect CO₂ emissions were 91.5 billion in 2004.</td>
<td>Wet GHG reduction target in 2001, three years ahead of schedule. Between 2001 and 2004, energy and climate reduction programs contributed a further 4 million tonnes of GHG reductions. Absolute reduction in emissions of 14% between 1990 and 2004.</td>
</tr>
<tr>
<td>BT</td>
<td>Telecommunications Services</td>
<td>842 million</td>
<td>Reduced energy-related CO₂ emissions by 71% between 1991 and 2004.</td>
</tr>
<tr>
<td>CANON</td>
<td>Consumer Products Manufacturing</td>
<td>71.4 million</td>
<td>74% reduction in non-00 (GHG) between 1993 and 2003 (IP), (IP), (IP), 35% reduction from 1990 CO₂ emissions per unit of production.</td>
</tr>
<tr>
<td>COTOPOLIA</td>
<td>Industrial Manufacturing</td>
<td>To be released by EIA Climate Leaders this year.</td>
<td>Reduced direct GHG from facilities by 35% between 1990 and 2003 in the US.</td>
</tr>
<tr>
<td>CHEVRON</td>
<td>Energy and Utilities</td>
<td>59.2 million</td>
<td>7.5% reduction in emissions between 2002 and 2004.</td>
</tr>
<tr>
<td>DHL</td>
<td>Transportation Services (Government Owned)</td>
<td>7.4 million</td>
<td>Producing 13% of energy from renewables.</td>
</tr>
<tr>
<td>DHL DHL</td>
<td>Telecommunications Services</td>
<td>25.9 million</td>
<td>Reduced direct emissions by 84% between 1995 and 2000.</td>
</tr>
<tr>
<td>DLH/TIANNI</td>
<td>Telecommunications Services</td>
<td>25.9 million</td>
<td>Reduced direct CO₂ emissions by 80%, Reduced energy intensity by 21% between 1994 and 2006.</td>
</tr>
</tbody>
</table>
• Dupont:
  – 69% GHG cut 1990-2005; saved $2 billion

• IBM:
  – 65% GHG cut 1990-2005; saved $791 million

• BP:
  – 18% GHG cut 1998-2001; saved $650 million

• Alcoa:
  – 25% GHG cut 1990-2003; saved $100 million

• 3M:
  – 35% GHG cut 1995-2005; saved $200 million since 1973

• Dow, UTC, Johnson & Johnson, Intel, Kodak, British Telecom, etc. A similar list for cities…

• “Nobody has lost money undertaking climate action.” – Northrop
### Employment & Energy Supply: Renewables Favor Environment AND Jobs

**Germany, Electricity Market Share, 1998**

<table>
<thead>
<tr>
<th>Generation Source</th>
<th>Generation Market Share</th>
<th>Jobs Supported</th>
<th>Jobs per 1% Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>1.2%</td>
<td>15,000</td>
<td>12,500</td>
</tr>
<tr>
<td>Nuclear</td>
<td>33%</td>
<td>38,000</td>
<td>1,152</td>
</tr>
<tr>
<td>Coal</td>
<td>26%</td>
<td>80,000</td>
<td>3,077</td>
</tr>
</tbody>
</table>

Are We Wedding Ourselves to Energy Technologies of the Past...

...Or to the Energy Technologies of the Future?

Who are the Luddites?

• 2025: 2/3 of U.S. coal capacity > 50 years old.
• NH’s youngest fossil plant > 30
• Using 30-50 year old:
  – Telephone technology?
  – Computer technology?
  – Automotive & aircraft technology?
  – Materials, construction, manufacturing?
  – Internet?
Evidence of an Economic Sea Change

- **ACEEE**: Energy/GDP **fell** 42% from 1970-1999
- **Global Business** **Competitiveness** – It’s not simply about power **cost** anymore…
  - **Power Quality** (e.g., semiconductor manufacturers)
  - **Reliability and Vulnerability**
    - Bank of Omaha – Chose fuel cells
    - Blackouts (CA 2000, Northeast, EU, etc.)
  - **Dollar Cost Savings** that energy efficiency provides
  - **Triple Bottom Line** – Basis of financial performance and international competitiveness is changing
  - **Economic opportunity**: “Who will own the patents?”
An Economic Sea Change is Underway

New Paradigm:

- Economy
- Environment
- Energy
Per Capita Personal Income versus Utility Average Electricity Price for the 50 States and Washington, DC
(Data Sources: US Department of Commerce, Bureau of Economic Analysis
US Energy Information Administration)
Cleantech Venture Investments by Region

Figure 1.2 U.S. Cleantech Venture Capital Investments by Region, 2005-2006 (Millions of dollars)

- West Coast: $503M
- Northeast: $410M
- Southwest: $516M
- Midwest: $260M
- Southeast: $202M
- Northwest: $255M
- Rockies/Plains: $97M
- West Coast: $1,129M
- Northeast: $193M
- Southwest: $123M
- Midwest: $109M
- Southeast: $11M
- Rockies/Plains: $17M
- West Coast: $64M

Upward Policy Spiral

Policy Matters!

United States Refrigerator Use v. Time
Source: David Goldstein

Average Energy Use or Price
Refrigerator Size (cubic ft)
Energy Use per Unit (KWH/Year)
Refrigerator Price in 1983 $
It Can Be Done…

Chlorofluorocarbon Production

- Montreal Protocol
- Vienna Convention (nonbinding)
- Rowland & Molina paper
- Protocol Tightenings

Annual Production (tons)

- CFC-12
- CFC-11

Date


10^3 10^4 10^5 10^6
New Hampshire has a special opportunity to “connect the dots”

“Skate to where the puck is going to be.” – Gretsky
What Will Our Future Be?

Our Decisions Today Will Shape Tomorrow