Biomass Energy

The economic and environmental benefits

Presented by William Strauss, PhD
President, FutureMetrics
Chief Economist, Biomass Thermal Energy Council

At the Florida Forestry Association Annual Conference
September 8, 2011
Why should we care about biomass energy?

![Graph showing oil production](chart)

Source: Various forecasts aggregated by FutureMetrics.

*What, Me Worry?*
Why should we care about biomass energy?

Incremental primary energy demand by fuel & region in the New Policies Scenario, 2008-2035

- Coal
- Oil
- Gas
- Nuclear
- Hydro
- Biomass
- Other renewables

Source: IEA, 2010
The US is very petroleum dependent. The NE states, due to a reliance on heating oil, are very dependent.
At current heating oil prices, the NE states “export” more than 16 BILLION dollars per year*

<table>
<thead>
<tr>
<th>State</th>
<th>Number of Households that Use #2 Heating Oil</th>
<th>Average Gallons Used per Year by those Homes</th>
<th>Average Total Expenditure Per Year (#2 at $3.65/gal)</th>
<th>Amount that Does not Stay in the States (EXPORTED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>688,000</td>
<td>591,680,000</td>
<td>$2,159,632,000</td>
<td>$1,684,513,000</td>
</tr>
<tr>
<td>Maine</td>
<td>434,000</td>
<td>373,240,000</td>
<td>$1,362,326,000</td>
<td>$1,062,614,000</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>955,000</td>
<td>821,300,000</td>
<td>$2,997,745,000</td>
<td>$2,338,241,000</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>291,000</td>
<td>250,260,000</td>
<td>$913,449,000</td>
<td>$712,490,000</td>
</tr>
<tr>
<td>New York</td>
<td>2,609,000</td>
<td>2,243,740,000</td>
<td>$8,189,651,000</td>
<td>$6,387,928,000</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>1,415,000</td>
<td>1,216,900,000</td>
<td>$4,441,685,000</td>
<td>$3,464,514,000</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>170,000</td>
<td>146,200,000</td>
<td>$533,630,000</td>
<td>$416,231,000</td>
</tr>
<tr>
<td>Vermont</td>
<td>148,000</td>
<td>127,280,000</td>
<td>$464,572,000</td>
<td>$362,366,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,710,000</strong></td>
<td><strong>5,770,600,000</strong></td>
<td><strong>$21,062,690,000</strong></td>
<td><strong>$16,428,897,000</strong></td>
</tr>
</tbody>
</table>


*The US EIA data shows that 78% of every dollar spent on heating oil leaves the region and most of those dollars leave the country.
When heating oil prices rise from $3.00/gallon to $4.50/gallon, **hundreds of thousands of jobs are lost** as more and more money is drained from those states’ economies and sent to other places.

<table>
<thead>
<tr>
<th>#2 Distillate Fuel use in Residential, Commercial, and Industrial (not Transportation)</th>
<th>Average Gallons per Year</th>
<th>Money Exported from Regional Economy at $2.75/gal</th>
<th>Money Exported from Regional Economy at $4.50/gal</th>
<th>Annual Increased Loss of Money if Heating Oil goes to $4.50/gal</th>
<th>Permanent Job Destruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maine</td>
<td>414,493,000</td>
<td>$889,087,485</td>
<td>$1,454,870,430</td>
<td>($565,782,945)</td>
<td>-33,908</td>
</tr>
<tr>
<td>Vermont</td>
<td>130,435,000</td>
<td>$279,783,075</td>
<td>$457,826,850</td>
<td>($178,043,775)</td>
<td>-10,447</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>242,029,000</td>
<td>$519,152,205</td>
<td>$849,521,790</td>
<td>($330,369,585)</td>
<td>-18,528</td>
</tr>
<tr>
<td>Connecticut</td>
<td>672,464,000</td>
<td>$1,442,435,280</td>
<td>$2,360,348,640</td>
<td>($917,913,360)</td>
<td>-44,005</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>148,551,000</td>
<td>$318,641,895</td>
<td>$521,414,010</td>
<td>($202,772,115)</td>
<td>-10,091</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>818,841,000</td>
<td>$1,756,413,945</td>
<td>$2,874,131,910</td>
<td>($1,117,717,965)</td>
<td>-57,102</td>
</tr>
<tr>
<td>New York</td>
<td>1,818,841,000</td>
<td>$3,901,413,945</td>
<td>$6,384,131,910</td>
<td>($2,482,717,965)</td>
<td>-122,789</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>840,580,000</td>
<td>$1,803,044,100</td>
<td>$2,950,435,800</td>
<td>($1,147,391,700)</td>
<td>-57,943</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,086,234,000</strong></td>
<td><strong>$10,909,971,930</strong></td>
<td><strong>$17,852,681,340</strong></td>
<td><strong>($6,942,709,410)</strong></td>
<td><strong>-354,812</strong></td>
</tr>
</tbody>
</table>
Most of the heating oil used in the northeast is refined in the Gulf Coast area.

Only about 21% of the crude oil refined in the Gulf Coast area is from domestic offshore production in the Gulf of Mexico.

The rest is imported.

About 60% of the imports are from OPEC nations.*

*EIA, Special Report, Gulf of Mexico Fact Sheet, June 15, 2010
Where Gulf Coast OPEC Oil Comes From

- Venezuela, 26.6%
- Saudi Arabia, 23.8%
- Nigeria, 18.2%
- Algeria, 8.8%
- Angola, 8.6%
- Iraq, 6.3%
- Kuwait, 6.0%
- Libya, 1.8%

Source: EIA, Gulf Coast Total Crude Oil and Products Imports, June, 2010, Analysis by FutureMetrics
What is the Role of Southern Forests in Biomass Energy?

Renewables are a rapidly growing sector that is in its infancy.

And southern forests are well suited to provide the raw materials for producing power, heat, and wood pellets.
Land-use shares

- **Yellow**: Cropland
- **Green**: Grassland pasture and range
- **Dark Green**: Forest-use land
- **Black**: Special uses/urban/other land

Note: The size of the pie charts is proportional to the land area in each State. Shares for Alaska are 25% in forest-use land, 75% in special uses/urban/other land, and less than 0.5% in all other uses. Shares for Hawaii are 5% in cropland, 24% in grassland pasture and range, 38% in forest use, and 33% in special uses/urban/other land.

Source: The State of Maine’s Environment 2010, a report produced by the Environmental Policy Group in the Environmental Studies Program at Colby College in Waterville, Maine
What are the economic and environmental consequences of wood-to-energy?

Economic consequences flow from the production and transportation of wood and wood fuels. Economic consequences are also created by the cost of the energy. Energy cost effects can be positive or negative.

Environmental consequences result from forestry methods, from transportation, and from combustion. These also can be positive or negative.
What are the economic consequences?

<table>
<thead>
<tr>
<th>Direct Forest Products Jobs Created by Chip Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>(per 100,000 tons per year of wood chips)</td>
</tr>
<tr>
<td>Chipping Jobs</td>
</tr>
<tr>
<td>Logging Jobs</td>
</tr>
<tr>
<td>Trucking Jobs (Logs and Chips)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
</tr>
<tr>
<td>Indirect and Induced Jobs</td>
</tr>
<tr>
<td><strong>Total Jobs per 100,000 tons per year of wood chips</strong></td>
</tr>
</tbody>
</table>
What are the economic consequences?

BUT if the energy is costly, the benefits accrued in the forest products industry (jobs, commerce, multiplier effects) can be cancelled out by the reduction in disposable income from higher end user energy costs.

### Price at the Generator

<table>
<thead>
<tr>
<th></th>
<th>Costs amortized over 25 years at 10.00%</th>
<th>Natural Gas at $7 per MMBTU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>at 10.00%</td>
<td>Natural Gas at $7 per MMBTU</td>
</tr>
<tr>
<td>Hydro</td>
<td>$2,180</td>
<td>$2,180,000,000</td>
</tr>
<tr>
<td>Natural Gas Combined Cycle</td>
<td>$1,170</td>
<td>$234,000,000</td>
</tr>
<tr>
<td>Coal</td>
<td>$2,749</td>
<td>$1,374,500,000</td>
</tr>
<tr>
<td>Landbased Wind</td>
<td>$1,485</td>
<td>$74,250,000</td>
</tr>
<tr>
<td>Nuclear</td>
<td>$4,930</td>
<td>$4,930,000,000</td>
</tr>
<tr>
<td>Biomass (electricity only)</td>
<td>$3,294</td>
<td>$658,800,000</td>
</tr>
<tr>
<td>Offshore Wind</td>
<td>$2,890</td>
<td>$144,500,000</td>
</tr>
<tr>
<td>Solar PV</td>
<td>$5,750</td>
<td>$575,000,000</td>
</tr>
</tbody>
</table>

Analysis by FutureMetrics
What is the use of wood-to-energy that provides the greatest overall economic and environmental impact?

Pellet production for domestic use in the northern states to replace heating oil and propane. The economic impact is two fold – (a) creates jobs and commerce at the production end and (b) lowers heating bills and keeps the money spent on heating fuel in the US.

Modern wood pellet boilers are common in Europe and are growing in the use in the US.
Video
Total Pounds of Particulate per Year
normalized to the equivalent of the BTU from 1000 gallons of heating oil per year

- Fireplace: 3920.0
- Uncertified Wood Stove: 644.0
- EPA Certified Wood Stove: 196.0
- Pellet Stove: 68.6
- Modern European Pellet Fuel Boiler: 2.94
- Gas Boiler: 1.16
- Old Oil Boiler (pre-1990s): 10.08
- Modern Oil Boiler: 2.52

Total Pounds of CO$_2$ per Year

normalized to the equivalent of the BTU from 1000 gallons of heating oil per year

Heating Oil → 30,716

Propane → 23,240

Natural Gas → 19,502

Pellet Fuel → 4,004

Life Cycle Assessment of Pellet Burning Technologies, Thomas Willem de Haan, Univ. of Amsterdam, June 2010. Wood pellets are not entirely carbon neutral because some fossil fuel is required for the harvesting of trees and shipment. Extraction, refining, and transport emissions are included for each of the four fuel sources.
Combined Heat and Power
Which, with an optimal heat user, can reach efficiencies exceeding 80%.

Wood-fired power plants with heat and power cogeneration

- Installed power: 20.5 MW
- Fresh steam: 21.7 t/h
- Fresh steam parameter: 485°C, 63 bar
- Electricity output: Up to 5.6 MW
- Thermo output: Up to 10 MW
- Raw material need: Approx. 65,000 t/year

This is a BioPower 5 unit made by Metso and Wartsila (MW BioPower)
## Comparison of CO for BP5 with proposed MACT EPA 2011

<table>
<thead>
<tr>
<th>Limiting Value TA-Luft</th>
<th>mg/Nm³</th>
<th>Mess-Nr. 1</th>
<th>Mess-Nr. 2</th>
<th>Mess-Nr. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO-Concentration real</td>
<td>mg/m³</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>CO-Concentration (related to 11 Vol-% O₂)</td>
<td>mg/m³</td>
<td>4,6</td>
<td>4,6</td>
<td>4,6</td>
</tr>
<tr>
<td>CO-Concentration (related to 7 Vol-% O₂)</td>
<td>mg/m³</td>
<td>6,5</td>
<td>6,5</td>
<td>6,5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Limiting Value EPA</th>
<th>mg/Nm³</th>
<th>116,4</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO-Concentration (related to 7 Vol-% O₂)</td>
<td>mg/m³</td>
<td>109,9</td>
</tr>
<tr>
<td>CO-Concentration (related to 7 Vol-% O₂)</td>
<td>%</td>
<td>94,42</td>
</tr>
</tbody>
</table>

Higher limiting value for CO is no problem for BP5
### Biopower 5 – Emissions - PM

<table>
<thead>
<tr>
<th>Dust Concentration BP5</th>
<th>Limiting Value EPA 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 g/mmBTU</td>
<td>&lt; 13.59 g/mmBTU</td>
</tr>
</tbody>
</table>

Higher limiting value for PM of proposed EPA 2011 limits are no problem for the BP5

**Assumptions:**

- **Annual Energy Input BP5:** 65,000 t/yr = 162,500 MWh = 554,493 mmBTU
- **Annual Dust BP5:** max. measured value = 5 mg/Nm³ x 35,000 Nm³/h x 8,000 hr/yr = 1.4 t/yr
- **Dust Concentration BP5:** 1.4 x10⁹ /554,493 mmBTU = 2.525 g/mmBTU
- **Limiting Value EPA 2011:** 0.03 lbs./mmBTU = 13.59 g/mmBTU (0.01 lbs = 4.53 g)

Less than one fireplace!
Pellet production for export to Europe

The southeast has good logistics for export. The market for both premium pellets for home heating system boilers and utility grade pellets for co-firing with coal in utility power boilers is expected to grow dramatically.

European policy will drive the demand:

- 20/20/20 benchmarks for 2020
  - 20% reduction in greenhouse gasses
  - 20% from renewables
  - 20% efficiency gains

Greenhouse gas reduction (more on that later!) is a major benefit of biomass fuel AND biomass fuel is renewable.

The European Renewable Energy Council says that 61% of renewable energy will be from biomass.

Europe will barely create 50% of the needed supply.
What about Domestic Power Plant Co-firing?

Also driven by policy. As long as coal is abundant and CO₂ emissions are not penalized in the US, exports of utility wood pellets will be the major wood-to-energy driver for the southeast.

Renewable Portfolio Standards (RPS) are hit and miss with the states. Currently there are 24 states with RPS policies. Five other states have nonbinding goals for adoption of renewable energy.
As many of you know, most of the world says YES as long as the forests are sustainably managed.*

But a recent study commissioned by the Massachusetts Department of Energy Resources (DOER)** has not only confused policy makers but has also given opponents of wood-to-energy ammunition.

But the emperor has no clothes…

*In the simplest of terms (ignoring all the other ecological sustainability criteria) here we mean that the net stock of the forest systems resource is never depleted. That is, the growth to harvest ratio is equal to or greater than one.

NEW REPORT

Biomass Electricity:
Clean Energy Subsidies for a Dirty Industry

The case for ending taxpayer and rate-payer subsidies that harm public health, environment, climate, and forest


Audio of Report Presentation June 28, 2011 Press Conference Audio.mp3

Speakers:
Meg Sheehan, attorney, Biomass Accountability Project;
William Sammons, M.D., pediatrician with expertise on health and fiscal impacts;
Mary Booth, PhD, founder, Partnership for Policy Integrity, air emissions, forest and climate impacts;
Senator Marc Pacheco, Massachusetts Legislator, author of Global Warming Solutions Act, current Chair, Environment Committee;
James Maloy, Florida, citizen activist, defeated Adage/Duke/Areva biomass project;
Shane Avery, M.D., Indiana, medical doctor assisting biomass opponents;
Lee Ann Warner, citizen activist, Stop Toxic Incineration in Springfield, MA;
Margaret Dodd, Mayor, Traverse City, MI, defeated biomass projects in MI


The so-called Manomet Study has provided these groups a state sponsored source of support.

But does the Manomet Study hold water?

My company, FutureMetrics, has published a research paper that essentially say that the study is highly flawed. The Manomet Center published a rebuttal to our paper and FutureMetrics has replied to that as well.

What follows is the essence of the discussion.

All of the papers are available from www.FutureMetrics.com
The Manomet Study essentially says that the carbon debt created from burning biomass will take decades to unwind.
The preceding chart illustrates the foundation of the Manomet logic.

Taken to the logical extreme, the Manomet study’s logic is essentially beginning with a full grown tree, then they are watching that tree get harvested and used for energy and having its stored carbon released as CO$_2$ (the debt).

Then they continue to watch the empty spot where the tree was for 30 to 50 years while a new tree grows in its place. Only after that regrowth is the carbon debt repaid (the dividend).
The Manomet Study has many flaws but perhaps the most egregious is their failure to take into account the fact that forest systems have been capturing carbon for decades prior to harvest and combustion.
At the system level, the net carbon sequestered is increasing.

The biomass curve assumes that the biomass used in 2011 is from sustainable forests that have already sequestered the CO₂.

The Coal curve is business as usual.

The curves assume a 2.5% annual growth rate in demand.

Improved silviculture increasing yield per acre and/or dedicated energy crops are assumed to match the growth in demand.

The mean net carbon held in the system is increasing with the growth in yield and the stumps etc. that are not harvested.
This is better illustrated using a simple simulation
We begin with a look at the carbon cycle for wood with no combustion of fossil fuels or wood fuels.
This shows the carbon effects of fossil fuel combustion
Now we remove fossil fuel and look at the carbon effects of using a single stand of trees for energy.

Of course in a forest system, trees are at many stages of growth and in aggregate the net stock remains more or less constant (assuming sustainable forestry) or grows (assuming better silviculture).
Finally we add fossil fuel back in at about the proportion it will have to grow to meet energy demand even with a some conversion to wood energy.

This very stylized model has us harvest in 30 year cycles (with no harvest in between). This it totally detached from the reality of how forests are managed but shows the net carbon effect of two cases:

- fossil fuel only and
- fossil fuel with some biomass to offset some of the growth in fossil fuel demand.

Both cases show overall growth in $\text{CO}_2$ because the fossil fuel growth is required in both cases.
The carbon “Bottom Line” shows that there is no merit to anti-biomass for energy based greenhouse gas concerns.

Quite the opposite!

<table>
<thead>
<tr>
<th></th>
<th>Firewood (average of all species)</th>
<th>Wood Pellets</th>
<th>Green Wood Chips</th>
<th>Heating Oil</th>
<th>Natural Gas</th>
<th>LPG</th>
<th>Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinning, Harvesting, Loading</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraction</td>
<td></td>
<td></td>
<td></td>
<td>30.1</td>
<td>7.6</td>
<td>8.1</td>
<td>47.8</td>
</tr>
<tr>
<td>Pipelining (750 miles) and Shipping</td>
<td></td>
<td></td>
<td></td>
<td>5.3</td>
<td>6.1</td>
<td>5.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Refining and Distillation</td>
<td></td>
<td></td>
<td></td>
<td>19.9</td>
<td>5.9</td>
<td>11.9</td>
<td></td>
</tr>
<tr>
<td>Chipping</td>
<td>0.4</td>
<td>0.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedstock transport (150 miles)</td>
<td>2.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drying (using wood chips as energy source)</td>
<td>24.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant operations</td>
<td></td>
<td></td>
<td></td>
<td>18.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product transport (200 miles)</td>
<td>7.2</td>
<td>2.3</td>
<td>7.2</td>
<td>1.9</td>
<td>1.3</td>
<td>2.8</td>
<td>4.7</td>
</tr>
<tr>
<td>Retail Transport (20 miles)</td>
<td>1.6</td>
<td>1.5</td>
<td>1.6</td>
<td>1.4</td>
<td>0.8</td>
<td>0.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Combustion</td>
<td></td>
<td></td>
<td></td>
<td>288.0</td>
<td>232.0</td>
<td>263.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>301.0</td>
<td>285.1</td>
<td>277.0</td>
<td>219.4</td>
<td>139.3</td>
<td>166.0</td>
<td>247.7</td>
</tr>
<tr>
<td>Total Carbon Sequestered (assuming a 35 year growth cycle - entire tree including roots and stumps) - in CO₂ equivalent</td>
<td>341.8</td>
<td>341.8</td>
<td>341.8</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Proportion of Total Tree used in Feedstock</td>
<td>84%</td>
<td>75%</td>
<td>77%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbon (CO₂ equivalent) in the Feedstock</td>
<td>288.0</td>
<td>256.5</td>
<td>263.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net CO₂ Emissions</td>
<td>13.0</td>
<td>28.6</td>
<td>13.4</td>
<td>219.4</td>
<td>139.3</td>
<td>166.0</td>
<td>247.7</td>
</tr>
<tr>
<td>Net Carbon Permanently Sequestered (includes unharvested and uncombusted materials) - in CO₂ equivalent</td>
<td>40.8</td>
<td>56.7</td>
<td>64.8</td>
<td>-219.4</td>
<td>-139.3</td>
<td>-166.0</td>
<td>-247.7</td>
</tr>
</tbody>
</table>
And what about sustainability?

I cannot speak for this region but in Maine sustainable forestry is a way of life for most landowners.
Harvesting Trends in Maine

Source: Maine Forest Service, Silvicultural Reports, analysis by FutureMetrics

Maine Pulpwood Harvest (green tons)

Maine Biomass Chip Harvest (green tons)

Source: Maine Forest Service, 2011, analysis by FutureMetrics

See footnote for explanation of legend.
Thought Experiment!

If I have $1,000,000 saved up and earn 5% per year, at the end of a year I will have $1,050,000.

If I spend $50,000 over the next year, following the Manomet view of the world, I would simply say that I have spent and lost $50,000.

Following a more commonsense view of the world, I would say I have a benefit that was earned by 30 years of management and growth, that I have lost nothing, and that in fact I have sustainably managed my nest egg.
Conclusion

Biomass fuels should be at the top of policymakers’ list of solutions to our dependence on foreign.

Wind and solar get a lot of attention and a lot of help from the government.

Europe has been a world leader in converting to renewable energy for a number of reasons.

Biomass dominates there and should here as well!

| Total Renewable Energy Production in Europe in 1000's of tons of oil equivalent (TOE) |
|---------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
| Solar energy | 0.4% | 0.4% | 0.4% | 0.5% | 0.5% | 0.6% | 0.6% | 0.7% | 0.8% | 0.9% | 1.2% | 1.6% |
| Biomass | 60.7% | 60.5% | 60.1% | 59.2% | 62.3% | 64.1% | 63.8% | 65.4% | 66.0% | 66.8% | 66.6% | 66.8% |
| Geothermal Energy | 4.5% | 4.7% | 4.8% | 4.5% | 4.8% | 5.0% | 4.8% | 4.6% | 4.5% | 4.3% | 4.0% | 3.9% |
| Hydro power | 31.3% | 30.9% | 30.8% | 31.5% | 27.2% | 24.8% | 24.5% | 22.4% | 21.4% | 19.8% | 19.6% | 18.7% |
| Wind power | 1.0% | 1.3% | 1.9% | 2.3% | 3.1% | 3.6% | 4.5% | 5.2% | 5.7% | 6.7% | 7.2% | 7.6% |

Conclusion

Using renewable biomass for energy is a **triple-E solution**.

That is, it makes good sense **Economically**, **Environmentally**, and **Ecologically**.

It should be a key part of our strategic portfolio for making the US more **Energy independent** (another “E”).

**Education of policymakers, emphasizing jobs creation, is key** (another “E”).
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Thank you

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