

Good News for Health

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From Local to Global

The Rhode Island Model for
Harnessing Wind Power Worldwide

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Health Impacts of Wind Power

- Based on linear extrapolation of Harvard Model¹ with offsets by non-polluting energy
- Prior results: 2002
 - Assume offset of 1.5 million MWh from wind
 - Mortality offset: ~12 to 15 premature deaths/yr
 - 5,000 Asthma attacks, upper respiratory, etc.
 - Monetary valuation: ~\$53 million
- Significant recent emission reductions impact: CMR 7.29 regs & more gas generation

Footnote 1, "Estimated Public Health Impacts of Criteria Pollutant Air Emissions from the Salem Harbor and Brayton Point Power Plants," Harvard School of Public Health, Levy & Spengler, May, 2000

"Modeling the Benefits of Power Plant Emission Controls in MA," Levy & Spengler, J Air & Waste Management, Jan. 2002

CMR 7.29 Regulations & ISO NE Marginal Emission Rate Improvements

- Massachusetts CMR 7.29 Emission Regs for old plants:
- NO_x: Typ. 3 #/MWh 1999, to 1.5 #/MWh start Oct. 2006
- SO₂: Typ. 10 #/MWh 1999, to 6.0 #/MWh start Oct. 2006
- SO₂: then step 2, to 3.0 #/MWh on Oct. 2008
- Or: buy SO₂ allowances (3 for 1) to comply w. step 2

- ISO NE marginal emission rates:
 - Year 2000: NO_x @ 1.9 #/MWh, SO₂ @ 6.2 #/MWh
 - Year 2004: NO_x @ 0.5 #/MWh, SO₂ @ 2.0 #/MWh
 - Reason: Oil & Natural Gas set the clearing price 80% of all hours¹
 - Why? High cost of oil & gas vs. coal & nuclear fuel

Footnote 1: Gordon van Welie, CEO ISO NE, March 30, 2006

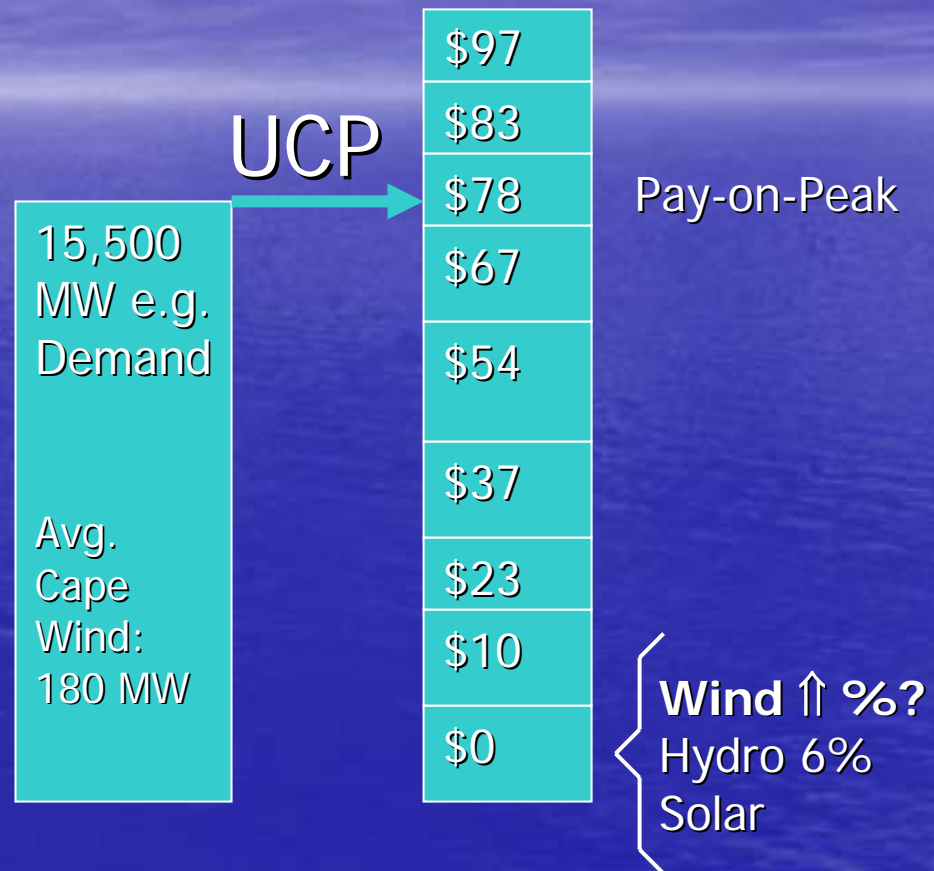
Recent Plant Emission Reductions

- Canal Plant: Units #1 & 2, Residual fuel oil, 1,120 MW Capacity
 - 1997 to 1999 average SO₂: 10.5 #/MWh
 - 2006 (calendar year) SO₂: 8.2 #/MWh ↓ Lower S oil
 - 1997 to 1999 average NO_x: 2.9 #/MWh
 - 2006 (calendar year) NO_x: 1.7 #/MWh ↓ SCR & SNCR #1 & 2
- Brayton Point: Units #1, 2, & 3, Bituminous coal, 1,130 MW
 - 1997 SO₂: 10.3 #/MWh
 - 2006 SO₂: 7.0 #/MWh ↓ Low S & installing scrubbers #1 & 2
 - 1997 NO_x: 3.2 #/MWh
 - 2006 NO_x: 1.7 #/MWh ↓ SNCRs on #1 & 3 now
- Both will comply with CMR 7.29 by Oct. 2007
- Step 2 SO₂ compliance to 3 #/MWh 2009, yes but:
 - Use low S fuel, scrubbers, or SO₂ acid rain allowances (3 for 1)?
 - Cost tradeoff decision
- SCR/SNCR Ammonia slip: 2 ppm? Formation PM_{2.5}

Who gets backed off?

Wholesale
\$/MWh Bid
(Offer)

- ISO Bid Stack
 - Day Ahead, each hour
 - Uniform Clearing Price
- Cost of fuel alone:
 - Oil ~ \$72/MWh
 - Gas ~ \$52/MWh
 - Coal ~ \$20/MWh
 - Nuclear ~ \$20/MWh ?
 - Wind ~ Zero \$
 - Hydro
 - Solar



- Year 2000, all fossil generation fuels:
about \$20/MWh

Plant Production History

- Canal Plant, Residual Fuel Oil
 - CP 1997-99, Base Load Unit #1: ~66%
 - CP 1997-99, Cycling Unit #2: ~50%
 - CP 2006, Unit #1: ~20%
 - CP 2006, Unit #2: ~15%
- Brayton Point, #1, 2, & 3 Coal, #4 Oil
 - CP 1997, all base load coal units: ~90%
 - CP 1997, Unit #4, oil cycling unit: ~16%
 - CP 2006, all coal units: ~74%
 - CP 2006, Unit #4, Oil ~ 1%

CP is Capacity Factor, expressed as % actual generation/max. capacity

Note 1. Canal produced ~1.7 million MWh in 2006, consuming ~2 million bbls oil

Note 2. Cape Wind estimated to generate ~1.6 million MWh per year, @40% CP

Plant Production History

(concluded)

- Salem Harbor, #1, 2, & 3 Coal, #4 Oil
 - CP 1998, all units: ~55%
 - CP 2006, all coal units (314 MW): ~77%
 - CP 2006, Unit #4 (390 MW¹), Oil ~ 5.5%

Footnote 1. Salem #4 average winter/summer capacity: ~390 MW,
Ref: ISO Seasonal Claimed Capability 2007

Wind Impact on Health Extrapolation

- Linear assumption, i.e., 30% emission reduction means ~30% health benefit
- Emission concentrations of SO₂ and PM peak about 5 to 20 miles from source¹
- SO₂ and PM from coal or oil: ~same
- Scheme: Ratio impact offsets in terms of SO₂
 - e.g., Brayton @ 67,000 tons to Wind @ 1,600 tons = 0.024
 - Thus 80 deaths (Brayton) x 0.024 = 1.9 deaths avoided, etc.
 - e.g., Salem @ 25,000 tons to Wind @ 1,600 tons = 0.064
 - Thus, 30 deaths (Salem) x 0.064 = 1.9 deaths avoided, check
 - Average avoided: 1.9 deaths

Cape Wind Example (1.6 million MWh)

Offset Results

- Based on 6#/MWh SO₂ (Oil backoff, step 1)
 - 9,600 tons SO₂ avoidance yields 5.7 premature deaths
 - Along with associated respiratory impacts: \$25 million total
- Based on 3#/MWh SO₂ (Oil backoff, step 2)
 - 4,800 tons SO₂ avoidance yields 2.8 premature deaths
 - Along with associated respiratory impacts: \$12.5 million total
- Based on 2#/MWh SO₂ (ISO 2004 marginal rate)¹
 - 1,600 tons SO₂ avoidance yields 1.9 premature deaths
 - Along with associated respiratory impacts: \$8.3 million total
- Based on PROSYM[®] (1#/MWh, future emissions)²
 - 800 tons SO₂ avoidance yields 0.9 premature deaths
 - Along with associated respiratory impacts: \$4.2 million total

Footnote 1. Cape Wind FEIR, 2/15/07, Table 3.23-6

Footnote 2. PROSYM[®] by La Capra, Cape Wind FEIR, 2/15/07, Table 3.23-3, 2009-13

The NOx Story

- Ground level ozone precursor (formation)
- Health impact: asthma and respiratory
- Cape Cod: worst AQI in MA (Fairhaven 2nd)
 - 50% worse than Boston¹
 - From transport (from Midwest coal gen.)
 - From local power plants & vehicles
 - Victim of dual sea breeze front geography
- Ozone season impact exacerbated
 - Power plant peak production
 - Vehicle use surge
- Positive offshore wind benefit from sea breeze²

Footnote 1: AQI from DEP air monitors in Truro & Roxbury

Footnote 2: Peak Aug. 1 & 2, 2006; 171 & 236 MW, 2-3 PM → Cape Wind

Conclusions

- Uncertainty of SO₂ “real” reductions
- Significant favorable health impact from emission reductions & wind emission avoidance
- Dramatic avoidance of CO₂ emissions:
 - 734,000 tons/year → Cape Wind
- Avoidance of imported oil & natural gas
 - ~2,000,000 barrels oil/year → Cape Wind
- **“Wind: the beginning of the end of oil generated electricity”**

Footnote: The Canal plant is for sale