

IMPACT OF CLOSING VERMONT YANKEE by Willem Post; February 20, 2011

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INTRODUCTION

The New England grid managed by ISO-NE has a capacity of about 32,000 megawatts, power supplied about 130,000 GWh/yr, includes over 350 central power plants and 8,000 miles of high-voltage transmission lines to provide power to about 6.5 million customers. The power is 62% from CO2-producing fossil fuels, 26% from CO2-free nuclear, 6% from CO2-free hydro, 4% from CO2-producing wood waste, 2% from CO2-producing solid waste and 1% other (i.e., CO-free wind, solar, etc.). Almost all of this power is STEADY power and the grid is designed accordingly. The reason the few New England nuclear plants produce so much electricity is because their capacity factors, CFs, are about 0.92, much higher than the other plants on the grid.

Vermont Yankee, VY, Mark 1 boiling water reactor, BWR, rating 620 MW, replacement cost about \$4.5 billion, produces 4,500-5,000 GWh/yr of LOW-COST, CO2-FREE, 24/7/365, STEADY power. VY's license expires in 2012. Entergy, the owner of VY, has requested that VY's license be extended to 2032. An unusual request? In the US, 17 of 36 plants with BWRs had their license extended from about 40 years to about 60 years and 12 of 31 decommissioned power reactors are in Safestore. All of the extensions, except one, were for Mark 1 reactors.

The closing of VY in 2012 would immediately require increased power purchases from Hydro-Quebec, HQ, (if it is available) and from ISO-NE, and ultimately would require spending billions of dollars for the construction of PV solar and wind systems to provide 2,086 GWh/yr to replace the power provided by VY to Vermont. Other states also will have to increase their purchases and, if so inclined, raise billions of dollars for PV solar and wind systems to provide about 2,500-3,000 GWh/yr. Removing VY, fully paid for, from the CO2-free column into Safestore for 60 years is an unwise waste of CO2-free resources. We should be ADDING steady power plants to the CO2-free column to reduce global warming.

Fossil fuel power purchases from ISO-NE by Vermont (and others currently buying from VY) will last for many years, because it will take many years to construct the renewables capacity to replace VY. This means the CO2-producing plants have to increase their outputs to provide power to Vermont and other states on the ; the nuclear plants on the grid already are operating near maximum capacity. A step backwards for global warming.

Vermont and other New England states will have deficits for some years to come. People, including voters, are suffering; the Great Recession is here and now. Closing VY by a unilateral act of the Vermont Legislature is irrational exuberance and emotional hubris to the nth degree. Vermont would be shooting itself (and other states) in the foot at the worst of times. Vermont will become a pariah state in New England at exactly the time it needs to coordinate with other states to integrate PV solar and wind power into the grid.

STUDY SUMMARY

- Closing Vermont Yankee will increase power cost by \$620,500,000 during the 6-yr period after VY is closed.
- Closing Vermont Yankee will raise electric rates from \$0.120/kWh to \$0.137 kWh, or 14.2%.
- Closing Vermont Yankee will require a capital expenditure to implement renewable power systems in 6 years = 2,086/3,595 (\$2.49 billion + \$5.14 billion) = \$4.43 billion, as proposed by VPIRG "Repowering Vermont" report, Strong Case.
- Closing Vermont Yankee will add 66 billion lbs of CO2 to atmosphere, because of CO2 power purchases from the grid for 6 years.
- Closing Vermont Yankee will eliminate 635 high-paying union jobs PLUS at least that many more in the VY area, because of the lesser spending by these laid-off workers who will find it difficult to find work that pays as well, who will be paying LESS in state taxes, who will be collecting MORE in state benefits for some years, all while the state is dealing with deficits during the Great Recession.
- Vermont, a very marginal state for PV solar and wind power, will have to offer a PV solar FIT of at least \$0.30/kWh and a wind FIT of at least \$0.08/kWh and a 20-year power purchase agreement, PPA, to attract the resources to build the PV solar and wind systems.

- The quantity of variable and intermittent power cannot be fed into the Vermont grid, unless an economical way is found to store it. The grid is not designed for large variable and intermittent power inputs.

- PV solar power for true-south-facing, correctly-angled, single-axis systems in Vermont has a theoretical maximum capacity factor, CF, of about 0.143, the statewide actual CF is a dismal 0.12. PV power output varies with the sunlight, of not much use on cloudy days, during the winter (when panels are snow-covered about 20 days, or more, of a winter season), and not "there" at night, requiring CO2 power purchases from the grid throughout the year. Solar power, without major financial incentives, is expensive relative to utility power, especially for residences.

- Big wind power on high ridgelines in Vermont has a CF of about 0.33, the output varies with the wind strength, steadiness and duration, of not much use with too little, no wind and too windy days, requiring CO2 power purchases from the grid throughout the year. Big wind power cost is about 1/5th of the PV solar power cost. Wind turbines must be located on high ridgelines with good winds, such as on Lowell Mountain, be accessible by roads (which must be maintained year-round), must be near existing power lines, the site geology must provide adequate foundation support and should be about a mile from private residences to reduce noise impact. There are not that many miles of ridge line in Vermont that satisfy all these conditions.

- Small wind, 10 kW or less, usually located away from high ridgelines, has a CF of about 0.10; its power is even more expensive than PV solar power. Subsidies for small wind are poor policy, an egregious waste of scarce taxpayer money. See attached spreadsheet.

ANALYSIS OF ALTERNATIVES

Per VPIRG "Repowering Vermont" report, Strong Case, renewable power is to be 15.4% PV solar and 27.4% wind, for a total of 42.8% = 3,595 GWh/yr by 2032. The installed capital costs of the VPIRG Strong Case is about \$2.49 billion for small and big wind and about \$5.14 billion for small and big PV solar (2010\$). Vermont uses about 40% of VY's output = 2,086 GWh/yr = 34% of Vermont's 2008 electricity consumption. See attached spreadsheet. The impact of providing the 2,086/3,595 fraction of the VPIRG Strong Case will be studied.

Before rushing into closing VY, some questions need to be answered:

- What is the installed capital cost of the renewable power systems?
- What is the electric rate increase?
- How much additional CO2 is produced due to closing VY?
- What is the impact on the economy in the vicinity of VY and on the State of Vermont.

Two alternatives will be studied to answer these questions:

BASE CASE: VY CONTINUES OPERATING

ALTERNATIVE CASE: VY IS CLOSED

The assumptions are:

- It will take at least 6 years to produce the renewables
- A new PPA with VY is at \$0.06/kWh (the current PPA at about \$0.042/kWh expires in 2012)
- Grid power is sold to utilities at \$0.06/kWh
- Vermont's 2008 consumption of 6,134 GWh/yr will stay about the same until 2018 to simplify the analysis
- It will take about 6 years to build the PV solar and wind systems and integrate them into the grid which, based on progress to-date, appears wildly optimistic.

BASE CASE: VY CONTINUES OPERATING

Consumer cost of power consisting of: 34% VY power + 66% other power for 6 years = \$4,416,500,000. See note 1.

Consumer statewide average unit cost of power for 6 years = $\$4,416,500,000 / (6,134 \text{ GWh/yr} \times 6 \text{ yrs}) = \$0.120/\text{kWh}$

Capital cost is ZERO dollars.

CO2 impact is unchanged.

ALTERNATIVE CASE: VY IS CLOSED

Build, own, operate, maintain renewable power sources which are assumed to come on line from 2012 to 2018;

Vermont to have an FIT of \$0.30/kWh for solar and \$0.08/kWh for wind, and 20-year PPAs to attract capital, i.e., billions of dollars.

Consumer cost of power consisting of: grid power to replace VY + renewable solar and wind power to replace VY + 66% other power for 6 years = \$5,0370,000,000. See note 2.

Consumer statewide average unit cost of power for 6 years = $\$5,0370,000,000 / (6,124 \text{ GWh/yr} \times 6 \text{ yrs}) = \$0.137/\text{kWh}$

Capital cost to implement renewable power systems in 6 years = 2,086/3,595 (\$2.49 billion + \$5.14 billion) = \$4.43 billion

CO2 charged to Vermont (40%) = $620,000 \text{ kW} \times 8,760 \text{ hrs/yr} \times 0.9 \times 6 \text{ yrs}/2 \times \text{avg } 1.8 \text{ lb CO}_2/\text{kWh} = 26,395,632,000 \text{ lbs}$

CO2 charged to other states (60%) = $1.5 \times 26,395,632,000 \text{ lbs} = 39,593,448,000 \text{ lbs}$

Vermont utilities buy their power at an average of about \$0.06/kWh and sell it at an average of about \$0.12/kWh. The "\$0.06/kWh added by utility" is for distribution, various utility costs and return on investment.

Note 1. $\$0.12/\text{kWh} (\$0.06 + \$0.06, \text{ added by utility}) \times 2,086 \text{ GWh/yr} \times 6 \text{ yrs} + \$0.12/\text{kWh} (\$0.06 + \$0.06 \text{ added by utility}) \times (6,134 \text{ GWh/yr} - 2,086 \text{ GWh/yr}) \times 6 \text{ yrs} = \$4,416,500,000$

Note 2. $\$0.12/\text{kWh} (\$0.06 + \$0.06, \text{ added by utility}) \times 2,086 \text{ GWh/yr} \times 6 \text{ yrs}/2 + [\$0.36/\text{kWh} (\$0.30 + \$0.06, \text{ added by utility}) \times 0.154/0.428 \times 2,086 \text{ GWh/yr} + \$0.14 (\$0.08 + \$0.06, \text{ added by utility}) \times 0.274/0.428 \times 2,086 \text{ GWh/yr}] \times 6 \text{ yrs}/2 + \$0.12/\text{kWh} (\$0.06 + \$0.06 \text{ added by utility}) \times (6,134 \text{ GWh/yr} - 2,086 \text{ GWh/yr}) \times 6 \text{ yrs} = \$5,0370,000,000$

IMPACT ON ELECTRIC RATES AND CO2 EMISSIONS

During the 6 year period, the ALTERNATIVE CASE will:

- Increase electric costs by $\$5,037,000,000 - \$4,416,500,000 = \$620,500,000$, equivalent to raising the unit cost from \$0.120/kWh to \$0.137 kWh, or 14.2%; this is in addition to future increases due to rising energy prices and any additional acts of the Vermont Legislature that will raise energy prices. If all of the VPIRG Strong Case were implemented more power would be bought at \$0.30/kWh for PV solar and more at \$0.08/kWh for wind which would increase electric rates by at least another 10% after the 6 year period.
- Add CO2 to atmosphere = 66 billion lbs; a step backwards for global warming.
- Rushing into expensive, variable, intermittent wind and solar power without, what engineers call, systems planning (in this case grid-wide planning, including HQ) is unwise.
- Each state acting on its own to encourage renewables will not lead to a desired overall result.
- Vermont acting on its own to shut down VY is unfair to the CO2 reduction efforts of the people in other states.