Beyond Business as Usual: Investigating a Future Without Coal and Nuclear Power – Focusing on the Northwestern U.S.

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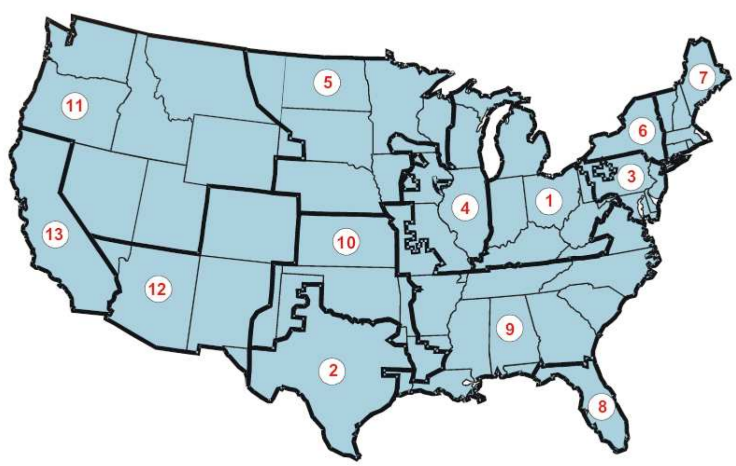
A recent study conducted by Synapse Energy Economics for the Civil Society Institute[1] investigates a scenario in which the U.S. transitions away from coal and nuclear power and toward more efficient electricity use and renewable energy sources. Specifically, coal-fired generation is eliminated by 2050 and nuclear generation is reduced by over one quarter. This "Transition" Scenario is compared in terms of direct costs and environmental impacts to a "Reference" or "Business and Usual" (BAU) Case – the U.S. Energy Information Administration's (EIA) 2010 Annual Energy Outlook. While the study is primarily national in scope, results are presented for each of eight regions. This summary of the report focuses on the results in the Northwest U.S.

The Implications for the Northwest

As the "Figure 1" map below indicates, the Northwest region in the study is the region marked "11", including Washington state, Oregon, Idaho, most of Montana, Wyoming, Utah and nearly all of Nevada.

Figure 1: The Regions of EIA's Electricity Sector Model



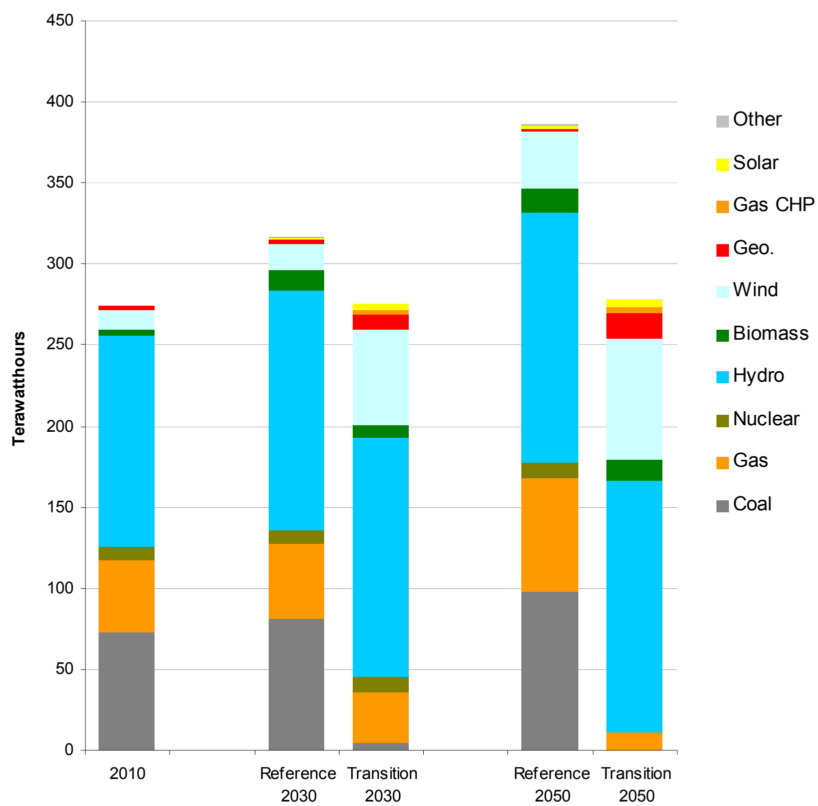
The chart below compares the Northwest energy mix in the Reference/BAU and Transition Cases in 2010, 2030, and 2050.

[1] http://www.civilsocietyinstitute.org/media/pdfs/Beyond%20BAU%205-11-10.pdf

In the Reference/BAU Case, demand grows by 1.2% per year on average, and generation increases by over 110 terawatt hours (TWh) (41%) in 2050. Coal-fired generation increases by 25 TWh (34%), and gas-fired generation increases by 27 TWh (60%). Hydro generation increases by 24 TWh or 19%, due to upgrades at existing dams. No new dams are built in either scenario. Wind generation increases by only 63 TWh to become 9% of the region's generation in 2050. Biomass-fired generation becomes 5%, and the region's net exports fall by about two thirds to 10 TWh in 2050.

In the Transition Scenario, aggressive energy efficiency in the Northwest pushes down demand, and the region develops its ample wind, geothermal and biomass resources. Because the Northwest has a relatively small amount of coal and nuclear capacity and an extensive renewable resource base, the transition is much easier there than in many other regions. In fact, over time the Northwest exports more electricity in the Transition Scenario than in the Reference Case with net exports rising from 31 TWh in 2010 to 53 TWh in 2050. This resource development path would bring energy jobs to the region and could make the Northwest a leader in clean energy technology development.

Figure 2: The Generating Fuel Mix in the Northwest, Reference Case and Transition Scenario



Key aspects of the Transition Scenario in the Northwest include the following:

- All coal and nuclear capacity is retired – 11,800 MW of coal and 1,100 MW of nuclear.

- Gas-fired generation is not only lower than in the Reference Case, it falls by 33 TWh (74%) relative to 2010 levels.

- Hydro generation increases modestly, as in the Reference Case, due to upgrades at existing dams.

- The region adds 12,000 MW of wind capacity, a relatively modest development of the resource. Wind energy increases by 63 TWh to become 27% of generation.

- 1,800 MW of geothermal capacity is added, and this resource provides 6% of energy in 2050. The region's biomass resource is developed conservatively: 430 MW of combined heat and power (CHP) capacity is added, bringing biomass up to 5% of regional generation. This is less aggressive use of biomass than in the Reference Case.

- Biomass- and gas-fired CHP plants generate 7 TWh (2%) in 2050. Waste gases also produce 7 TWh in 2050.

Reserve Margins and System Operation

The study includes an analysis of reserve margins in each region of the U.S. In the Northwest, as in most regions, a current capacity surplus coupled with aggressive energy efficiency efforts would provide ample room to add variable generators like wind turbines and still meet peak loads. Based on the capacity in the EIA model, the reserve margin of the entire Northwest region is approximately 30% in 2010. This margin would grow in the Transition Scenario, allowing the region to retire many of its older, less efficient generators as it added new renewable capacity.

The Transition Scenario results in a generating mix in the Northwest that appears quite workable from the standpoint of power system operation. Variable generation from wind turbines would rise to become 27% of total regional generation in 2050; however, roughly 150 TWh of hydro generation (56% of the mix) and 15 TWh of gas-fired generation (5% of the mix) would be available to integrate this wind energy. Further, the region's least flexible generating units – the coal and nuclear units – would be gone, making it easier for system operators to integrate variable generation.

Air Emissions

Table 1 shows the estimated air impacts of the Reference and Transition Cases in the Northwest. The figures shown are annual totals for 2010 and 2050. Electric sector emissions of CO_2 rise in the Reference Case by 30% and fall in the Transition Scenario by well over 90%. Cumulative CO_2 reductions from the Transition Scenario relative to the Reference Case total nearly 3.1 billion tons by 2050. (Note that EIA's 2010 Reference Case does not include carbon regulations that result in significant carbon emissions reductions.)

Emissions of SO_2 and NO_X fall in the Reference Case, as the EIA model simulates implementation of new air regulations, but emissions fall much more in the Transition Scenario due to the phase-out of coal and the reduction in natural gas use. Emissions of mercury stay essentially flat in the Reference Case, while they are virtually eliminated in the Transition Scenario. Emissions of SO_2 are reduced by over 99%.

Table 1: Air Emissions in the Reference and Transition Cases

Case	2010	2050	% Change
CO_2 Reference (000 tons)	100,000	130,000	30%
CO_2 Transition (000 tons)	100,000	6,000	-94%
SO_2 Reference (000 tons)	100	98	-2%
SO_2 Transition (000 tons)	100	1	-99%
NO_X Reference (000 tons)	130	160	23%
NO_X Transition (000 tons)	130	20	-85%
Mercury Reference (tons)	1.5	1.5	0%
Mercury Transition (tons)	1.5	0	-100%

In addition to these reductions in air emissions, the study estimates reductions nationwide in power plant water consumption of roughly 730 billion gallons in 2050 relative to 2010. Reductions relative to the Reference Case, in which new coal-fired and nuclear plants are built, would total over 1,100 billion gallons. (The study does not estimate reductions in water consumption by region.)

On top of these direct environmental benefits, a transition away from coal and nuclear energy would provide substantial indirect benefits, such as: reduced mortality and health care costs from air pollution and from coal mining, reduced environmental impacts from coal mining and coal-ash disposal, reduced production of nuclear waste, and reduced risk of an accident at a nuclear power plant or waste storage facility.

Costs

Because this study assesses only the cost of electricity production, it does not estimate the cost of the Transition Scenario at the regional level. (For example, regions that generate more electricity in this scenario will incur greater costs but also receive greater revenue from sales to other regions.) At the national level, the study finds that the Transition Scenario could be achieved by 2050 at moderate near term costs and long term savings.

Table 2: The Net Costs of the Transition Scenario at the National Level

	2020	2030	2040	2050
Cost of Generation	($1,000)	($35,000)	($85,000)	($130,000)
Wind Integration Costs	$330	$1,600	$2,900	$3,900
Energy Efficiency	$14,000	$48,000	$79,000	$110,000
Incremental Transmission	$800	$1,600	$2,300	$3,100
Avoided Emission Control	($4,500)	($4,500)	($4,500)	$0
Total Net Cost	$9,630	$11,700	($5,300)	($13,000)

Total Net Cost (¢/kWh)	0.25	0.34	(0.17)	(0.43)

For a typical residential consumer the cost increase would amount to about $2.20 per month in 2020, and savings in 2050 would be nearly $3.90 per month. The table above shows the net cost of the Transition Scenario; negative numbers indicate that the scenario saves money relative to the Reference Case. "Incremental Transmission" refers to the cost of new transmission capacity needed to move additional energy between regions in the Transition Scenario. "Avoided Emission Control" refers to the savings captured by retiring coal-fired plants in the near term rather than retrofitting them with new emission controls.

To put these costs in perspective, a recent National Academies study estimated the annual damages in 2005, not including climate change, from the U.S. fleet of coal-fired power plants, to be $62 billion (expressed in 2007 dollars).[2] This figure alone greatly exceeds the annual cost of the Transition Scenario. It is also important to consider the fact that *CO_2 emissions grow in the Reference Case of this study*. The cost and feasibility of a coal-based future that achieves large-scale CO_2 reductions is currently unknown.

Key Assumptions

The costs of various generating technologies are based on an extensive review of the literature, including data from projects completed in the 2005 to 2008 period. Few of EIA's cost inputs were used because these do not appear to account for increases in construction and materials costs during the 2005 to 2010 period.

Table 2 below shows the wind costs used for the Northwest in each scenario, along with the cumulative installed wind capacity. These costs are based on the regional supply curves developed for the Department of Energy's *20% Wind Energy by 2030* report, released in 2008; however, installed costs have been increased to account for recent cost increases not captured in this report. Costs fall faster in the Transition Scenario, as faster market penetration is assumed to result in faster technology and market maturation. (Cost reductions between 2010 and 2020 are driven more by reductions in construction and materials costs than by installed capacity.)

Table 3: Northwest Wind Energy Costs in the Reference and Transition Cases

	2010	2020	2030	2040	2050
Reference Case					
Cum. US Onshore Cap. (MW)	39,000	66,000	68,000	75,000	86,000
Cum. US Offshore Cap. (MW)	0	200	200	200	200
Northwest Onshore Costs ($/kW)	$2,200	$1,700	$1,600	$1,500	$1,400
Transition Scenario					
Cumulative Onshore Cap. (MW)	39,000	99,000	144,000	178,000	222,000
Cumulative Offshore Cap. (MW)	0	4,600	9,400	16,000	27,000

[2] NRC, 2009. National Research Council "Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use." The National Academies Press, Washington, DC, 2009.

Northwest Onshore ($/kW)	$2,200	$1,700	$1,500	$1,400	$1,400

Energy efficiency is assumed to be achieved in the Beyond Business as Usual study at an average cost of $45 per MWh, based on a review of US efficiency programs and data maintained by Synapse Energy Economics. Savings levels in the Transition Scenario are based on the assumption that, by 2020, a large-scale, concerted effort could bring annual electricity savings across the nation to 2% of total sales – close to the levels being achieved by the most successful utilities today. Figure 3 below shows the achievements of a representative group of utility efficiency programs during the 2005 through 2008 period. Savings are stated as a percentage of the previous year's sales. The best companies on this list saved energy equivalent to well over 2% of the previous year's sales, and by mid 2010 a number of other companies had achieved or announced savings targets at or above 2%.[3]

Figure 3: Recent Energy Savings Figures from Selected Utilities

Entity	Annual Savings (%)	Year(s)	Source
Interstate Power & Light (MN)	2.6	2006	Garvey, E. 2007. "Minnesota's Demand Efficiency Program."
Efficiency Vermont (VT)	2.5	2008	Efficiency Vermont 2009. 2008 Highlights
Massachusetts Electric Co.(MA)	2.0	2006	EIA 861
Pacific Gas & Electric (CA)	1.9	2008	CPUC 2009. Energy Efficiency Verification Reports issued on February 5, 2009 and October 15, 2009
Minnesota Power (MN)	1.9	2005	Garvey, E. 2007
Puget Sound Energy (WA)	1.4	2007	Northwest Power and Conservation Council
Connecticut IOUs (CT)	1.3	2006	CT Energy Conservation Management Board (ECMB). 2007
Pacific Corp (ID & WA)	1.3	2007	Northwest Power and Conservation Council
Energy Trust of Oregon (OR)	1.3	2005	Northwest Power and Conservation Council
Southern California Edison (CA)	1.2	2008	CPUC 2009
Avista Corp (ID, WA, MT)	1.1	2005	Northwest Power and Conservation Council
Idaho Power Co (ID)	1.1	2007	Northwest Power and Conservation Council
San Diego Gas & Electric (CA)	1.1	2008	CPUC 2009
PUD No 1 of Snohomish (WA)	1.0	2007	Northwest Power and Conservation Council
Otter Tail (MN)	0.9	2005	Garvey, E. 2007. "Minnesota's Demand Efficiency Program."
Seattle City Light (WA)	0.9	2007	Northwest Power and Conservation Council
MidAmerican (IA)	0.9	2006	Iowa Utilities Board 2009

[3] Note that savings at 2% of last year's sales do not imply a total reduction in energy use of 2% per year. Load continues to grow as companies are achieving these savings. Thus, if load is growing at 1% of sales per year and a utility is saving energy equivalent to 2%, load would be declining by about 1% per year on a net basis.