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

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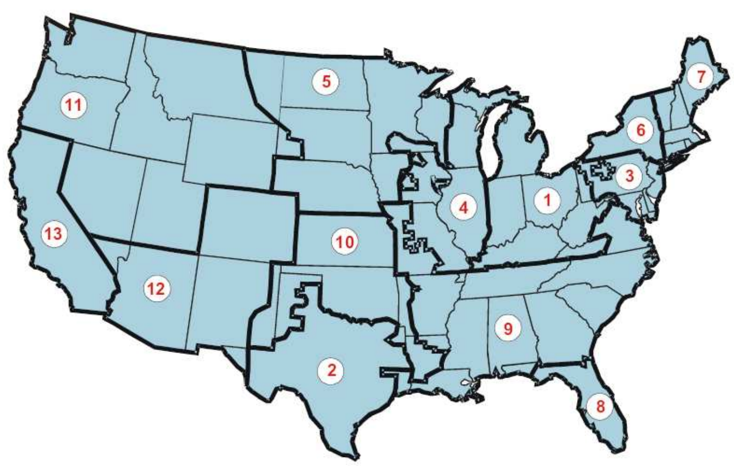
A recent study conducted by Synapse Energy Economics for the Civil Society Institute[1] investigates a scenario in which the U.S. transitions away from coal and nuclear power and toward more efficient electricity use and renewable energy sources. Specifically, all coal-fired generation in the U.S. is eliminated by 2050, and nuclear generation is reduced considerably in some regions of the country. This "Transition" Scenario is compared in terms of direct costs and environmental impacts to a "Business and Usual" (BAU) Scenario – 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 for the Midwestern U.S.

The Implications for the Midwest

The regions in this study are based on those in the EIA's energy model, shown in Figure 1 below. For this summary of the Midwest, the results for regions 1, 4 and 5 have been aggregated.

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



Today, the Midwest burns a considerable amount of coal to generate electricity, and much of this energy is exported to other regions. The region is projected to generate over 750 Terawatt-hours (TWh) of electricity at coal-fired plants in 2010 (69% of total regional generation) and to export 83 TWh of electricity. Thus, while other regions get the benefits of the region's surplus electricity, the air pollution takes its toll primarily on Midwesterners. Under BAU, electricity use in the region continues to grow over time, and the region becomes even more dependent on fossil fuels. Electricity use grows at about

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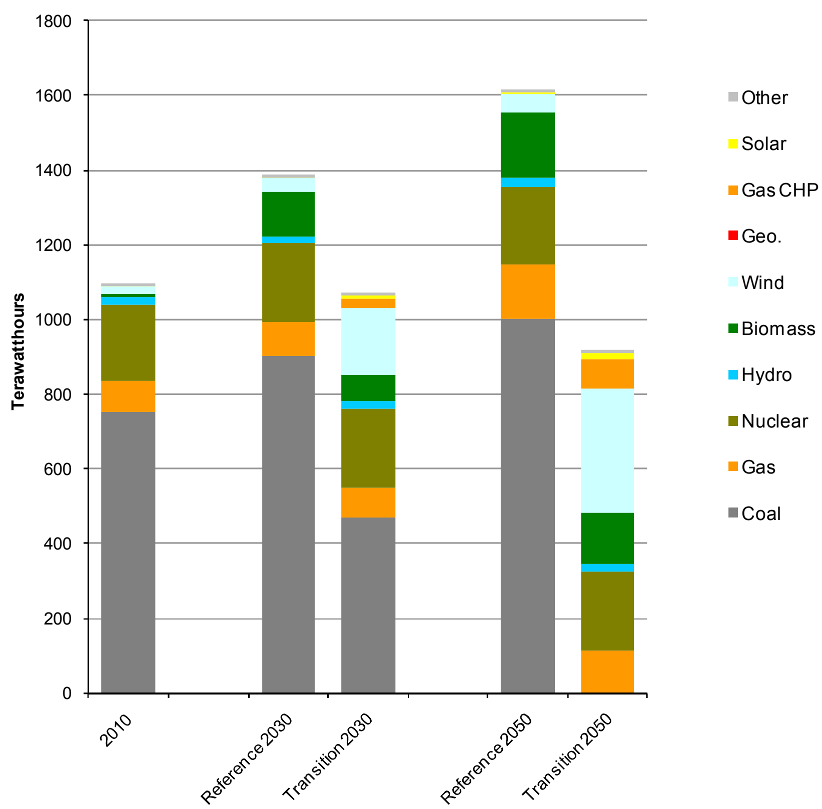
[1] http://www.civilsocietyinstitute.org/media/pdfs/Beyond%20BAU%205-11-10.pdf

1.2% per year on average, and by 2030, coal-fired generation in the region grows to 900 TWh and exports are up to 105 TWh. Extrapolating this trend to 2050, the Midwest would generate over 1,000 TWh from coal in that year – 17% of total national electricity production. In addition, natural gas-fired generation would grow by 61 TWh (74%) between 2010 and 2050, and generation from biomass would increase by 170 TWh (21%). In contrast, generation from wind energy under BAU would grow by only 12 TWh, about 2%.

The Transition Scenario envisions a much different energy path for the Midwest. First, a major expansion of energy efficiency programs slows the growth in electricity use, and by 2021 these programs begin reducing electricity use each year. As discussed below, energy savings at this level are currently being achieved by a number of utilities, and there is no reason why all Midwestern companies cannot achieve these levels within a decade. Second, as shown in Figure 2, all coal-fired generation is phased out in the Transition Scenario by 2050, nuclear generation remains stable, and the region aggressively develops its renewable resources. In addition, these Midwestern resources are used primarily in the Midwest: annual electricity exports fall from over 80 TWh in 2010 to about 14 TWh in 2050.

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



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

- All coal-fired capacity is retired by 2050 – 137,000 MWs.

- Over 80,000 MWs of wind capacity are added, generating 330 TWh in 2050, or 36% of total regional generation.
- Natural gas-fired generation increases by 112 TWh (nearly 140%). This is greater than the increase in the BAU Scenario (74%). However in the Transition Scenario, much of this new gas-fired generation takes place at combined heat and power (CHP) facilities, and thus it reduces fuel use in other sectors.
- Generation from biomass increases by 129 TWh (16%). This is less aggressive use of biomass than under BAU, in which biomass generation grows by 21%.

In short, the Midwest could reduce air pollution and other environmental impacts dramatically, take huge strides toward mitigating climate change and become a global leader in clean energy production. And with its massive wind resource and skilled workforce, the region would be an attractive location for manufacturers of wind turbines and related components – one of the fastest growing industries in the U.S.

Environmental Benefits

Table 1 shows the estimated air impacts of the BAU and Transition Scenarios in the Midwest. The figures shown are annual totals for 2010 and 2050. Electric sector emissions of CO_2 rise under BAU by 29% and fall in the Transition Scenario by over 90%. (Note that the BAU scenario does not include carbon regulations.)

Emissions of SO_2, NO_X and mercury fall under BAU, 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. Emissions of SO_2 fall by over 99% in the Transition Scenario, and emissions of NO_X fall by 65%. Emissions of mercury fall by 48% under BAU, while they are virtually eliminated in the Transition Scenario.

Table 1: Air Emissions in the Reference and Transition Cases

Case	2010	2050	% Change
CO_2 Reference (000 tons)	860,000	1,110,000	29%
CO_2 Transition (000 tons)	860,000	72,000	-92%
SO_2 Reference (000 tons)	2,820	1,070	-62%
SO_2 Transition (000 tons)	2,820	14	-99%
NO_X Reference (000 tons)	790	540	-32%
NO_X Transition (000 tons)	790	273	-65%
Mercury Reference (tons)	16	8	-48%
Mercury Transition (tons)	16	0	-100%

In addition to these reductions in air emissions, the study estimates nationwide reductions in power plant water consumption of roughly 730 billion gallons in 2050 relative to 2010. Reductions relative to BAU, in which new coal-fired and nuclear plants are built, would total over 1,100 billion gallons per year by 2050. (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 coal mining, and reduced environmental impacts from coal mining and coal-ash disposal.

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. At the national level, the study finds that the Transition Scenario could be achieved at moderate near term costs and long term savings. Table 2 below shows the net cost of the Transition Scenario; negative numbers indicate that the scenario saves money relative to the BAU. "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 the new emission controls that will be required in the coming decade.

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.

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 under BAU*. The cost and feasibility of a coal-based future that achieves large-scale CO_2 reductions is currently unknown.

Reserve Margins and System Operation

The study includes a rough analysis of reserve margins in each region of the U.S. Based on the generating capacity in the EIA model, the current reserve margin aggregated across the entire Midwest is approximately 40%, much higher than required levels. This is due to the current recession and a power plant construction boom in the late 1990s. Reserve margins of this size provide ample room to add variable generators like wind turbines and still meet peak loads.

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

Further, the Transition Scenario results in a generating mix in the Midwest that appears quite workable from the standpoint of power system operation. By 2050 wind provides 36% of the region's electricity, and there is ample gas-fired capacity available, which can operate during low-wind periods and back down during high wind periods. Moreover, current trends in system operation will make it easier over time to integrate variable generation. These trends include: larger balancing areas, better coordination between balancing areas, demand response programs and dynamic pricing. (Even today, only two entities, the Midwest ISO and the PJM Interconnection, operate the grid across the vast majority of the Midwest, and they are working to make the region seamless.)

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. Due to the large amount of energy efficiency and wind energy envisioned in the Transition Scenario, the assumptions about these two resources are most important.

Table 3 below shows the wind costs used for the Midwest in each scenario, along with the cumulative wind capacity installed nationwide. 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: Midwest 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
E. Midwest Onshore ($/kW)	$2,500	$1,800	$1,700	$1,700	$1,600
W. Midwest Onshore ($/kW)	$2,200	$1,700	$1,600	$1,500	$1,400
Transition Scenario					
Cumulative Onshore Cap. (MW)	39,000	99,000	144,000	178,000	222,000
Cumulative Offshore Cap. (MW)	0	4,600	9,400	16,000	27,000
E. Midwest Onshore ($/kW)	$2,500	$1,800	$1,700	$1,600	$1,500
W. Midwest Onshore ($/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.