

Staff Note: The reports highlighted in this document are some of the background resources that KEC staff has reviewed in the past several months. Although not intended as a comprehensive summary of either the literature or the content in each paper, this annotated list highlights some information that seems relevant to the broad issue of electricity generation and the discussion of the Electricity Committee. Note that we have focused primarily on resources that appear to be reasonably objective (e.g., from governmental or educational institutions); however, we also include some reports prepared by advocacy groups that are, arguably, less objective.

To date, the following reports/papers are highlighted in this document:

1. *Transforming America's Power Industry: The Investment Challenge*, The Brattle Group, 2008 (www.edisonfoundation.net/events/2008-04-21/BrattlePresentation.pdf)
2. *Carbon Markets: Why and How?*, Olivia Hartridge, Harvard Electricity Policy Group (HEPG), June 2007 (available at HEPG's website: <http://www.hks.harvard.edu/hepg>)
3. *Federal Financial Interventions and Subsidies in Energy Markets 2007 – Executive Summary*, Energy Information Administration (EIA), 2007 (available at EIA's web site: www.eia.doe.gov)
4. *2007 State of the Market Report, Southwest Power Pool, Inc.*, Prepared by Boston Pacific Company, External Market Advisor for SPP, Inc., April 24, 2008 (http://www.spp.org/publications/2007_State_of_Market_Report.pdf)
5. *The Full Portfolio*, Revis James, Electricity Power Research Institute (EPRI) study, 2007 (available at EPRI's web site: www.epri.com)
6. *Restrictions on the Stringency of State and Local Air Quality Programs: Results of a Survey by the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO)*, December 17, 2002 (www.4cleanair.org/stringency-report.pdf)

Transforming America's Power Industry: The Investment Challenge, The Brattle Group, 2008 (www.edisonfoundation.net/events/2008-04-21/BrattlePresentation.pdf)

- Outlines the challenges facing U.S. electric utilities: record-setting high fuel costs, high costs associated with new plant construction, and the costs of implementing technologies to combat global climate change.
- America's electric utilities will need to invest in production and transmission.
 - Even with substantial energy efficiency measures, the U.S. will need an additional 150,000 MW of new and replacement capacity at a cost of \$560 billion by the year 2030.
 - In addition to this, the need for additional transmission and distribution will require an additional \$900 billion by 2030.
 - "Smart Grid" technologies may make these additions more cost effective, as "smart grid technologies enable greater efficiency improvements, better service, and small-scale resources." (p. 5)
- EIA projects that prices will increase, averaging an additional \$0.01/kWH (2006 dollars) by 2030; during the same interval, average annual sales are projected to grow at a slower rate than previously anticipated.
- Global Climate policies will increase the overall costs of electricity supply, and will affect the mix of new capacity built and add to capital costs.
 - **By switching to advanced coal technologies, energy companies can reduce CO2 emissions by 25% by 2030, at an additional cost of \$192 billion over projected capital costs.**
 - More aggressive energy efficiency programs may lower these costs by 5%, with a maximum potential of 18% lower costs with high adoption.

Carbon Markets: Why and How?, Olivia Hartridge, Harvard Electricity Policy Group (HEPC), June 2007 (available at HEPC's website: <http://www.hks.harvard.edu/hepg>)

- Compares and contrasts cap-and-trade programs with carbon taxes, and uses the European Unions' Emission Trading Scheme (ETS) to model what future programs should contain.
- Cost-effective programs require a uniform world-wide carbon price.
 - To this end, cap-and-trade programs allow for different emission reduction obligations with a uniform carbon price.
 - In contrast, implementation of a world-wide carbon tax is not realistic, and would not necessarily require greater emission reductions from countries which could address climate change sooner.
- Carbon taxes are frequently claimed to be simpler to implement than cap-and-trade policies; however, (1) Monitoring, reporting and verification systems requirements are identical, (2) taxes are rarely applied uniformly, and (3) less certainty exists in future tax levels.
- On the other hand, the European Union has had in place ETS, a cap-and-trade program, since 2005, with substantial involvement (up to \$7 billion).
- Any future cap-and-trade program enacted should address problems/successes seen within ETS, such as the following: (1) uniform monitoring, reporting and verification system, (2) a standardized system of information release, (3) total emission cap placements far enough into the future to allow utilities to appropriate finance and hedge operations, and (4) the use of an independent agency to auction allowances and compensations.
- In all, a "carbon tax (is) not a simpler policy instrument, and not appropriate for addressing a global problem." (p. 18)

Federal Financial Interventions and Subsidies in Energy Markets 2007 – Executive Summary, Energy Information Administration (EIA), 2007 (available at EIA’s web site: www.eia.doe.gov)

- Provides a detailed analysis of federal subsidies currently given to energy markets, and how these programs have changed since 1999.
- Total federal subsidies within the energy markets are estimated at \$16.6 billion.
 - This amount has more than doubled in real terms since 1999, when total subsidies were \$8.2 billion.
 - Furthermore, subsidies devoted to research and development and transmission have remained largely unchanged, while tax expenditures have more than tripled, rising from \$3.2 billion in 1999 to more than \$10.4 billion in 2007.
- \$6.7 billion or 41% of total energy subsidies are directed towards electricity production.
- Changes in priorities have shifted these subsidies greatly over the last eight years.
 - Subsidies for renewable resources have increased from 17% of total subsidies in 1999 to 29% of total subsidies in 2007.
 - Natural gas and petroleum subsidies have declined from 25% of total subsidies in 1999 to 14% of total subsidies in 2007.
 - Coal subsidies have declined slightly, receiving 7% of total subsidies in 1999 and now receiving 6% of total subsidies.
- Even with the doubling of subsidies to the energy market of the past eight years, “U.S. energy production is virtually unchanged since 1999.” (p. 13)
 - Statutory limitations on oil and natural gas exploration in environmentally sensitive areas, uncertainty regarding potential GHG policy, and a production decline from existing oil and natural gas fields may have impeded growth despite a growth in consumption.
- “Electricity production subsidies and support per unit of production vary widely by fuel.” (p. 15) **Refined coal, solar, and wind power receive by far the highest amount of subsidies when viewed in a per unit bases, ranging from \$23 to \$30 per megawatt hour (MWh).**
 - These numbers are even more striking when one considers that the wholesale price of electricity averages \$53/MWh, while prices to end users averages \$92/MWh
 - It should be noted that this is simply a reflection of current subsidies, and that “some electricity sources, such as nuclear, coal, oil, and natural gas, have received varying levels of subsidies and support in the past which may have aided them in reaching their current role in electricity production.” (p. 16)
- Determining the exact impact of particular subsidies is often hard to predict.
 - For instance without the Alternative Fuel Production Tax Credit refined coal production would be almost entirely replaced by conventional coal..
 - On the other hand, wind generation would likely be replaced by a wide array of fuels with the removal of this credit.

2007 State of the Market Report, Southwest Power Pool, Inc.

- Provides (1) an overview of supply and demand conditions and transmission systems in SPP, (2) an assessment of the results of the first eleven months of the SPP’s new Energy Imbalance Service (EIS) market, and (3) some broad recommendations.

- As a Regional Transmission Organization (RTO), Southwest Power Pool (SPP) provides services using the transmission systems of its members.
- SPP currently has 50 members, which cover a 255,000 square mile region over all or part of 8 states and containing 4.5 million customers.
 - Within this region, known as SPP's Regional Entity (RE) footprint, **peak electric demand** was 42,594 MW in 2007, 0.7% higher than in 2006 (which was slower growth than in 2006, which saw a 5.2% increase over previous year). **Overall demand** increased 1.6% to 207.3 million MWh (which was a slightly higher rate of growth than in the previous year).
- The RE footprint includes 16 separate balancing authority operators, each of which is responsible for matching electricity supply and demand within their territories.
 - 73.0% of total electric usage in SPP comes from customers in the five largest balancing authorities: American Electric Power West (22.7%); Oklahoma Gas & Electric (14.4%); Westar Energy (14.4%), Southwestern Public Service Company (13.4%), and Kansas City Power & Light (8.1%).
- Total generating capacity in SPP at the end of 2007 was 56,668 MW; compared to peak demand of 42,594 MW during 2007, **SPP has a significant (33%) resource margin (generation capacity in excess of peak demand), provided all generating capacity would be deliverable when peak demand occurs.**
- Of the total generating capacity in SPP, 54% is natural gas-fired, and 89% is either coal- or natural gas-fired.
- There are 31,142 MW of new capacity seeking generation interconnection studies in SPP, of which 76.5% is for wind projects (in nominal terms), 8.7% is for coal, and 14.8% is for natural gas.
- SPP has created an active transmission expansion process both to ensure reliability and to increase the availability of competitive generation resources. Approximately \$2.2 billion of transmission investment is included in the SPP Transmission Expansion Plan (STEP) from 2008 to 2017.
- SPP also completed a longer-range assessment of reliability and capacity needs through the use of high-voltage transmission lines, initial estimates project costs of \$4.85 billion.
- In the imbalance market sales are made when a Market Participant either (a) generates more than it has scheduled and/or (b) its actual load is less than it has scheduled; similarly, purchases are made when a Market Participant either (a) generates less than it has scheduled and/or (b) its actual load is more than it has scheduled.
- EIS Market sales from Feb. 1, 2007 through December 31, 2007, totaled 13.2 million MWh, which is roughly 8% of total load within the EIS Market footprint (note that the EIS Market load is not the same as the RE load).
- EIS Market prices were evaluated by comparing them to more mature real-time energy markets in MISO and ERCOT, which provide one measure of competitive market prices (despite differences in resource mix and demand patterns): EIS Market prices were in-line with these neighboring markets. Prices were also evaluated in terms of how they varied in different locations.
- Coal is responsible for 64% of the electricity output in the EIS Market for the 11-month period, with gas/oil accounting for 26% and nuclear for 6% of the output. Renewables such as wind and hydro combined for over 3% of the output.
- Transmission congestion causes locational price divergence. Based on an examination of five-minute dispatch intervals, there was some congestion at a single flowgate 56% of the time. This may not be a good measure of congestion over all of SPP. Study found that 75% of the congestion occurred on just 10 flowgates out of 200 total.

- The start of the EIS Market expanded the range of tools and transactions that can be used to relieve transmission congestion; through redispatch of units, the EIS Market resolved 85% of congestion.
- Regarding wind generation in SPP area, report recommends standardizing the measure of capacity contribution from wind as well as offering to certify RECs as some other RTOs do.

The Full Portfolio, Revis James, Electricity Power Research Institute (EPRI) study, 2007
(available at EPRI's web site: www.epri.com)

- Provides a technical overview of technologies which reduce CO₂ emissions which are currently in development, and how these technologies will affect the electricity production market.
- Meeting challenges to stabilize global concentrations of CO₂ will require a diverse, economy-wide approach.
- Seven new technologies in particular offer promises: (1) end-use energy efficiency, (2) renewable energy sources, (3) advanced light water nuclear reactors (ALWR), (4) advanced coal power plants, (5) CO₂ capture and storage (CCS), (6) plug-in hybrid electric vehicles (PHEVs), and (7) distributed energy resources.
- Together, these seven technologies have the potential to reduce the cost of CO₂ emission reductions to the U.S. economy as measured by gross domestic product (GDP) by \$1 trillion.
 - **However, research, development, and demonstration (RD&D) must be aggressive, "...as no single technology provides a majority of CO₂ emissions reductions."** (p. 36)
- To better analyze the effects these seven technologies can have on both CO₂ emissions, as well as the economy, EPRI creates two models.
 - The model "Prism" is created to measure the potential emission reductions through purely technological means. The model uses "...aggressive but feasible performance and deployment targets..." (p. 38), and provides best-case scenario estimates.
 - "MERGE" (model for estimating the regional and global effects of greenhouse gas reductions) assumes a carbon constraint of 2010 emission levels through 2020, with a 3 percent annual decline thereafter. "MERGE" then generates the costs needed to achieve this target with an assortment of different technology mixes.
- "Prism" shows that **"it is technically feasible to reduce annual emission levels by roughly 45 percent relative to EIA's 2030 projections."** (p. 38)
- In "MERGE's" "limited portfolio" (a low technology mix), achieving the desired emissions reductions is achieved only through the significant use of natural gas and large reductions to electricity demand.
 - Costs to GDP, discounted through 2050 to 2000 dollars, are \$1.5 trillion. However, the widespread availability of PHEVs, CCS, and significant expansion to nuclear power production by 2020 (known as the "full portfolio"), will reduce this amount to \$500 billion.
 - The "full portfolio" technology mix further results in significantly lower wholesale energy prices, due to the decreased reliance on natural gas.
 - In all, "MERGE" shows that "...advanced technology allows the electricity price to remain relatively stable, which provides a 'decarbonization' option for other sectors of the economy..." (p. 40)
- To meet the challenges of reducing emissions of CO₂, the public and private sector must begin aggressively expanding RD&D efforts now.
 - Funding of RD&D efforts must not be limited in scope, as meeting CO₂ emission goals will require a diverse portfolio of advanced technologies.

- “(A technology-based strategy) is a sustainable strategy, which minimizes costs to the U.S. economy and creates opportunities for decarbonization beyond the electricity sector and ultimately beyond the United States.” (p. 51)
- **“The average RD&D expenditure the country must make between now and 2030 is estimated to be \$1.4 billion to \$2.0 billion annually, but considering that this public and private investment could lower the cost of emissions reductions on the order of \$1 trillion, the value of the RD&D investment is clear.”** (p. 51)

Restrictions on the Stringency of State and Local Air Quality Programs, State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO), December 2002 (available at the National Association of Clean Air Agencies’ (NACAA) website: www.4cleanair.org)

- Provides the survey data from 50 state and 42 local air pollution control agencies concerning restrictions placed upon them.
- The Clean Air Act explicitly allows state and local air pollution control agencies to adopt programs as long as they are at least as stringent as those under the federal program.
 - The only exception is section 119, which prohibits certain regulation of mobile sources.
- 26 state agencies reported they are either completely or partially prohibited from being more stringent than the federal government (two states, Idaho and South Dakota, are completely restricted while 24 are partially restricted).
 - Of these state agencies, 22 reported they are restricted due to a state law or regulation, two because of government policy, and one because the procedures to enact such policies have never been developed.
 - Of the 24 state agencies which reported they have the ability to implement stricter regulation, ten stated that there are large barriers to do so.
 - Therefore, **only 14 state agencies have the ability to implement policies freely.**
 - Of interesting note is that **of the 24 agencies not restricted on policy implementation, ten stated they implement stricter policies “infrequently” or “never.”**
 - Also, eight agencies have restrictions on implementing “gap-filling” programs (requirements adopted in the absence of federal programs or standards).
- Nine local agencies reported they are either completely or partially prohibited from being more stringent than the federal government (four are completely restricted, while five are partially restricted).
 - Of these nine local agencies, four are restricted by state or local law/regulation, two by government policy, two by department or agency policy, and one stated that they could not be more stringent when acting as an agent of the state.
 - Of the 33 local agencies not restricted in implement regulation stricter than the federal government, four stated that there are large barriers to do so.
 - Thus, only 29 local agencies have the ability to implement policies freely.
 - In addition, four agencies reported they cannot adopt gap-filling programs, and three reported barriers in doing so.