WISCONSIN LEGISLATIVE COUNCIL
STAFF MEMORANDUM

Memo No. 3

TO: MEMBERS OF THE SPECIAL COMMITTEE ON NUCLEAR POWER

FROM: David L. Lovell, Senior Analyst, and John Stolzenberg, Chief of Research Services

RE: Overview of Presentations to the Special Committee

DATE: December 13, 2006

This Memo was prepared for the Special Committee on Nuclear Power. It provides an overview of major points made in presentations to the Special Committee at its meetings on September 9 and 29 and November 15, 2006. It is in outline form in three parts: the first part summarizes information that was presented as background and context for the Special Committee's study; the second part compares various electric power sources with regard to a number of factors important to evaluating their relative merits; and the third part summarizes specific state policy recommendations made by individual speakers.

The outline could be used for several purposes. Most obviously, it provides a very abbreviated overview of the portions of the presentations made to the Special Committee that relate to the three parts identified above. The outline could also be used as a reference during committee discussion or as a framework to facilitate the discussion.

The second part of the outline, the comparison of electric power sources, identifies a series of subjects (status of technology, cost, safety, etc.) and paraphrases under each subject heading major points made by the speakers regarding five broad categories of electric power generation (nuclear, coal, gas, renewables, and conservation). Not all power sources were addressed by speakers under all subjects, so there are numerous headings with no entries beneath them; in many of these instances, the relevant information has been mentioned or discussed in committee meetings and is omitted only because it was not a part of any formal presentation.

The outline identifies, by last name only, the speaker to the Special Committee who made each point cited. The appendix further identifies the speakers and indicates the date of the meeting at which each speaker addressed the Special Committee. Copies of the summaries of the meetings of the Special Committee and of the PowerPoint slides or written remarks of the speakers are posted at the Special Committee's webpage at http://www.legis.state.wi.us/lc.

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One consequence of this organization is that the overview does not reflect remarks by speakers that do not fit into one or more of the three parts in the outline. In addition, judgment was often exercised in reducing a speaker's point to the outline format and in placement of the point. Thus, individual points may provide a paraphrase of the presenters' delivered comments rather than the actual text of the comments.

PART I. BACKGROUND AND CONTEXT

A. ELECTRICITY DEMAND AND SUPPLY

- The Public Service Commission (PSC) projects demand for electricity in Wisconsin to continue to grow at a rate of 2% annually, which will require the addition of about 500 MW of generation capacity every two years. [Callisto]
- Current electric supply is predominantly from coal combustion (61.9%); the balance is dominated by nuclear (16.4%) and power imported from out of state (15.6%). [Callisto]
- The largest portion of power plants being built between the present and 2025 will be coal-fired. [Hewson]
- New power plants in Wisconsin that are announced, approved, or under construction include four coal projects totaling 8,795 MW of capacity, five natural gas projects totaling 1,930 MW, and two wind projects totaling 360 MW. [Callisto]
- Prices for oil, natural gas and even coal have "skyrocketed" in response to worldwide demand, and domestic supplies have dwindled. [Rowe]

B. NUCLEAR POWER

- There are 442 nuclear power plants in 30 countries, including 103 in the United States and three generating units in Wisconsin. [Callisto]
- The United States is the world's largest nuclear power producer, producing more than the combined nuclear power production of the 2nd and 3rd largest (France and Japan). [Corradini]
- There are 27 nuclear units under construction worldwide, the most being in India (7), Russia and China (4 each). [Callisto, Corradini]
- There are 13 to 16 potential orders for nuclear units in the United States. [Callisto, Corradini]
- Nuclear power plants will not be built in the Midwest in the near future due to little near-term need for new base load capacity, lack of a spent fuel solution, and lack of a bipartisan consensus in support, but will proceed first in other regions, where such a consensus exists. [Rowe]

C. GLOBAL CLIMATE CHANGE

Occurrence of Global Warming

- There is now a unanimous consensus within the scientific community, based on extensive empirical evidence, that human activities are causing a marked increase in atmospheric levels of

carbon dioxide (CO_2) and methane, which is causing a significant increase in the average global temperature. [Foley]

Present and Future Effects

- Observed global changes resulting from these temperature increases include recession of glaciers and sea ice and localize seasonal changes. [Foley]
- Human impacts of global climate change include changes in agricultural productivity and direct human health impacts. The most sensitive regions emit little CO_2 and include the Artic, coral reefs, tropics, and small island nations. [Foley]
- There is a huge inertia in global systems and, as a result, the climate changes presently being observed are due to emissions in the 1960's; current emissions will have effects decades from now. [Foley]
- Projections of future CO_2 emissions under various scenarios indicate that the cumulative emissions, if not addressed, could result in a "dangerous level" of climate change.
    - Losses will become irreversible, unless actions are taken now. [Foley]
- Climate change from greenhouse gas (GHG) emissions is real and must be addressed. [Rowe]

Responses

- Meeting significant carbon constraints with continued growth in energy consumption requires a major shift toward low CO_2 emitting technologies.
    - Four important alternatives for meeting significant carbon constraints are: energy efficiency, wind and biomass, integrated gasification combined cycle (IGCC) with carbon sequestration, and nuclear power.
    - Each option includes areas of significant uncertainty, including their total economic resource availability.
    - Fundamentally, limiting any option increases both financial risk and environmental risk. [Meier]
- There is a growing consensus that to avoid catastrophic losses due to climate change arising from CO_2 emissions, there is a "narrow window" of time to start stabilizing the atmospheric CO_2 level by holding CO_2 emissions constant for the next 50 years and further reducing these emissions after that period.
    - An approach to stabilizing CO_2 emissions, developed by Robert Sokolov at Princeton University and his associates, is to pursue 7 of 14 currently available and proven strategies (or "wedges") that reduce CO_2 emissions.
    - The strategy of using nuclear to produce electricity calls for 700 GW of new nuclear capacity (twice current capacity) by 2055, not counting replacement of retiring existing nuclear plants. [Foley]
- The National Council on Energy Policy recommends:
    - A mandatory, economywide cap-and-trade program for GHGs.

  - More stringent CAFÉ standards for cars.
  - Affordable, low-carbon energy alternatives. [Rowe]
- At least 25 to 30 nuclear reactors are needed by 2025 to significantly reduce domestic CO_2 emissions. [Rowe]
- Current forecasts of modest growth in nuclear power indicate that nuclear power will not make a significant contribution to displacing CO_2 emissions worldwide over the next 40 years. [Paine]
- Climate-change strategy should focus on rapid deployment of cleaner, more flexible, and clearly sustainable energy technologies and not nuclear, coal, or natural gas. [Paine]

PART II. COMPARISON OF ELECTRIC POWER SOURCES

A. STATUS OF TECHNOLOGY

Nuclear

- Improvements in designs of the current fleet of power plants are commercially available now; advanced designs are under development and will be commercially available within 20-30 years. [Corradini]

Coal

- Coal generation technology continues to improve and become more energy efficient. [Hewson]
- Environmental control technology advancements have made coal-fired power plants lower emitting. [Hewson]
- Carbon capture and sequestration is feasible for reducing CO_2 emissions from coal fired power plants, although further evaluation is required. [Friedmann]
- Carbon sequestration is untested. [Rowe]

Gas

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Renewables

- End use efficiency, waste heat cogeneration, fuel-cells running on biogas, wind power, solar photovoltaics and solar thermal are now available as realistic alternatives to new polluting baseload power plants. [Paine]

Conservation

- New technologies are available that could make a large difference on future electricity demand; e.g., light emitting diodes, in-home displays with intelligent feedback, hybrid cars that recharge fuel cells at night, and integrated zero energy load homes. [Messenger]

B. RELIABILITY

Nuclear

- Nuclear power is a highly concentrated source of baseload power. [Paine]
- The operating record of nuclear plants has improved greatly with time and experience, increasing both efficiency and capacity factors. [Corradini, Rowe]
- Many nuclear plants have experienced lengthy shut-downs; 41 plants have had 51 shut-downs over one year in duration. [Lochbaum]
- Nuclear power poses energy security concerns due to infrequent but prolonged unplanned plant shutdowns. [Paine]

Coal

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Gas

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Renewables

- Wind power is not dispatchable. [Rowe]

Conservation

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C. PUBLIC SAFETY

Nuclear

Nuclear Plant Design

- Nuclear power is generally safe, and new designs are safer. [Corradini, Rowe]
- Nuclear power plants have numerous safety features, not all of which are present in other technologies. [Bier]
- There is a low probability of a core melt-down (about one occurrence in 10,000 years of operation of any reactor) but severe consequences; these risks may be comparable to other, less regulated industries, e.g., refining and chemicals manufacturing. [Bier]
- The only nuclear disaster (Chernobyl) was at a plant with a bad design. [Corradini]

Nuclear Plant Operation

- Nuclear power plants can be operated safely. [Bier]

- Safety of plant operation depends greatly on a culture of safety in the operating company. [Bier, Lochbaum]
- Nuclear Regulatory Commission (NRC) regulation is inconsistent, leading to lower safety and higher cost than necessary. [Lochbaum]
- NRC oversight focuses on individual problems, but does not require a culture of safety, potentially compromising the safety of nuclear power. [Lochbaum]
- NRC is now addressing "cross-cutting" issues, such as human performance, a safety-conscious work environment, and problem identification and resolution. [Bier]

Radiation

- Nuclear radiation is lethal at about 2,000 times the natural background level; nuclear workers are allowed exposure of no more than 20 times background. [Corradini]
- Nuclear plants generally release less than 1% of the background level, less than 1/10 the exposure the general public gets from other man-made sources. [Corradini]
- United States nuclear plants are a safe work environment; radiation exposure of workers is well below federal standards. [Rowe]

Coal

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Gas

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Renewables

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Conservation

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D. COST

Nuclear

- Cost is greater than it should be, due to lengthy shut-downs. [Lochbaum]
- Operating cost at existing plants has reduced greatly with time and experience. [Corradini]
- The existing fleet of nuclear plants is the most economical form of baseload generation in the country. [Rowe]
- Nuclear power produces cost-effective power compared to coal- and gas-fired power plants, if CO_2 emissions are effectively "taxed" at a sufficient rate; new nuclear power plants are expensive. [Paine]

- Investment in a new nuclear power plant can become hostage to accidents or near accidents at another reactor. [Paine]

Coal

- Coal remains our cheapest fossil fuel and should play an important role in keeping United States energy costs low. [Hewson]
- Current economics favor the use of pulverized coal technology in new power plants. [Hewson]
- The cost of clean coal technologies are uncertain. [Rowe]

Gas

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Renewables

- Solar power is not yet economic. [Rowe]

Conservation

- Limits on increased energy savings from expanded energy efficiency and renewables arise from program funding constraints, low market acceptance rates, and low overall rates of innovation, and not from economic considerations. [Messenger]
- Energy efficiency has a very large economic potential. [Rowe]

E. FUEL SUPPLY & PRODUCTION

Nuclear

- Nuclear fuel is copious. It is low cost compared to fossil alternatives. [Paine]
- Mining and milling of uranium has a history of contaminating land and water with radioactive materials. [Paine]

Coal

- Coal mining creates unacceptable, irreparable damage to natural environments, human health, communities, and the global climate, such as through mountain top removal and valley filling. [Paine]

Gas

- Natural gas production results in heavy-duty industrialization of affected areas. [Paine]
- Impacts of production and drilling include increased erosion and dust, pollution from noisy machinery, depletion of underground aquifers, contamination of the surface waters with drilling materials, and produced water.
    - Coalbed methane development causes unique and severe water-related problems. [Paine]

Renewables

- A big "ramp up" in solar photovoltaics would require increased mining and refining of specialty materials. [Paine]

Conservation

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F. AIR IMPACTS

Nuclear

- There are low emissions of CO_2 and other air pollutants from nuclear plants; there are non-carbon environmental impacts at all stages of the nuclear fuel cycle. [Paine]

Coal

- Environmental control technology advancements have made coal plants lower emitting of regulated pollutants.
    - Examples include flue gas desulfurization and selective catalytic reduction equipment that reduces nitrogen oxides emissions. [Hewson]
- Mercury removal varies significantly by the type of coal been burned. [Hewson]
- New technologies will be needed to deal with any future constraints on CO_2 emissions. [Hewson]
- CO_2 capture and geologic sequestration is an attractive pathway to substantially reducing releases of greenhouse gases; it is a good bridging technology pending the development and deployment of other energy sources that do not produce CO_2 emissions. [Friedmann]

Gas

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G. ETHICAL AND INTERGENERATIONAL IMPACTS

Nuclear

- In using nuclear power, society must accept responsibility to ensure the safety of nuclear power production and security of nuclear plants, safeguard nuclear materials, and protect the environment. [Barrett]
- In the case of spent fuel and high-level radioactive waste, society's responsibility is to generations far into the future. [Barrett]

Coal

- The mining and burning of coal poses unacceptable, irreparable damage to natural environments, human health, communities, and the global climate. [Paine]

Gas

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Renewables

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Conservation

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H. ISSUES UNIQUE TO NUCLEAR POWER

Spent Fuel Management

General Information

- Yucca Mountain is presently scheduled to begin receiving waste in March 2017, based on the best achievable schedule and passage of the Administration's legislative proposal. [Knox]
- If there are no changes in the 70,000 metric tons cap on wastes going to Yucca Mountain, this limit will be reached before Yucca Mountain receives any waste. [Knox]

Comments in Support of the Yucca Mountain Repository

- The Secretary of Energy and the President recommended, and Congress approved, the Yucca Mountain site for development of a repository.
    - Factors considered in the Secretary's decision include its arid location, isolation from population centers, federal site, placement of waste within a closed hydrologic basin, and 20 years of comprehensive scientific studies. [Knox]
- Radiation from spent fuel will be many orders of magnitude less than the background level for the first 100,000 years and will approach the background level in the 100,000 to 1,000,000 year period. [Corradini]

Comments in Opposition to the Yucca Mountain Repository

- Yucca Mountain is not safe; it cannot isolate the waste. [Frishman]
- The federal Nuclear Waste Fund will not support the cost of the Yucca Mountain repository. [Frishman]
- The NRC and Environmental Protection Agency regulations are not final and may be subject to further challenge. [Frishman]
- "Fix Yucca" bills abound in Congress and compete. [Frishman]
- There has been consistent, strong opposition to Yucca Mountain by the State of Nevada over the last 19 years. [Frishman]

Fuel Cycles and Reprocessing

- Advanced fuel cycles involving reprocessing or recycling can greatly reduce waste volumes; France, Japan, and other countries currently reprocess spent fuel. [Corradini]
- Reprocessing offers a means to manage (use) fissile materials removed from nuclear weapons. [Barrett]

Security and Nuclear Weapons Proliferation

- Spent fuel reprocessing produces weapons-capable fissile materials; control of these materials is critical to prevent the proliferation of nuclear weapons. [Barrett, Suri]
- Security and proliferation concerns include the spread of sensitive knowledge and technologies. [Barrett, Suri]
- Nations of concern to the United States with nuclear capabilities have obtained nuclear materials from research reactors or centrifuge processes; nuclear power plants are not a likely concern regarding weapons proliferation. [Barrett]
- Some nations lack adequate security at nuclear plants and others have histories of using energy resources as tools for geopolitical purposes; both raise proliferation concerns. The nations of greatest concern include Libya, Iran, and Russia. [Suri]
- The Global Nuclear Energy Partnership initiative, proposed by President Bush, offers potential to take advantage of reprocessing while controlling fissile materials. [Barrett, Corradini]

PART III. POLICY RECOMMENDATIONS

A. NUCLEAR

- Encourage the local storage of spent nuclear fuel and provide incentives to reduce the risk of waste release and the amount generated, such as through reprocessing of these wastes; versus waiting for the federal government to open Yucca Mountain. [Messenger]
- Repeal the limited moratorium on new nuclear power plants. [Rowe]
- Work to build a bipartisan consensus that nuclear power is a necessary part of responding to global climate change. [Rowe]

B. COAL

- Support worldwide large-scale carbon sequestration field experiments and demonstration projects. [Friedmann]
- Support more complete surveys of the capacity of different types of basins to receive CO_2 using consistent assessment methodologies. [Friedmann]
- Conduct an assessment of the potential for geologic sequestration of CO_2 in Wisconsin and Minnesota. [Friedmann]

- Considered creating CO_2 credits by closing or limiting the operation of coal plants in Wisconsin and then selling the credits and reinvesting the proceeds in either making Wisconsin more competitive or developing new carbon-free energy resources. [Messenger]
- Create a level, environmentally sustainable energy playing field via a CO_2 cap and trade program accompanied by major regulatory and mining reforms, that internalize the costs of avoiding or mitigating the risks associated with nuclear-, coal-, and gas-generated electricity. [Paine]

C. ENERGY CONSERVATION AND RENEWABLE RESOURCES

- Include energy conservation and renewable energy sources as important components in responding to GHG emissions. [Rowe]
- Establish a state-level energy savings goal at 50% of incremental electricity growth. [Messenger]
- To increase the amount of carbon-free energy resources to address global warming, first, develop all energy efficiency resources and, second, develop nuclear and renewable resources. [Messenger]
- Establish a state carbon-free portfolio standard for meeting future growth in demand for electricity through carbon-free resources--energy efficiency, renewables, and nuclear power.
    - Set the standard at 50% of incremental demand by 2015, 75% by 2020, and 90% by 2025. [Messenger]
- Specify a climate change strategy by creating 5 to 10 year gigawatt-scale investment "virtual power plant" packages of energy efficiency and distributed renewable energy generation. [Paine]

APPENDIX

SPEAKERS REFERENCED IN THIS MEMO

The preceding Memo identifies by last name only the speaker to the Special Committee who made each point cited. This appendix further identifies the speakers and indicates the date of the meeting at which each speaker addressed the Special Committee.

Lake Barrett, L. Barrett Consulting, September 29, 2006.

Vicki Bier, Professor of Industrial Engineering, University of Wisconsin (UW) Madison, September 29, 2006.

Eric Callisto, Executive Assistant to the Chair of the Public Service Commission, September 14, 2006.

Michael Corradini, Professor and Chair of Engineering Physics, UW-Madison, and public member of the Special Committee, September 29, 2006.

Jonathan Foley, Professor of Atmospheric and Oceanic Science and the Gaylord Nelson Institute for Environmental Studies and Director of the Center for Sustainability and the Global Environment, UW-Madison, September 14, 2006.

Tom Hewson, Energy Ventures Analysis, Inc., November 15, 2006.

Julio Friedmann, Carbon Management Program, Energy and Environment Directorate, Lawrence Livermore National Laboratory, November 15, 2006.

Steve Frishman, Technical Policy Coordinator, Nevada Agency for Nuclear Projects, November 15, 2006.

Eric Knox, Associate Director for Systems and External Relations, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, November 15, 2006.

David Lochbaum, Union of Concerned Scientists, September 29, 2006.

Paul Meier, Director of the UW Energy Institute, UW-Madison, September 14, 2006.

Mike Messenger, Demand Side Management Planning and Evaluation Consultant, Ontario Power Authority (on leave from the California Energy Commission), November 15, 2006.

Christopher Paine, Senior Nuclear Program Analyst, Nuclear Program, Natural Resources Defense Council, November 15, 2006.

John Rowe, Chairman, President, and CEO of Excelon Corp., September 14, 2006.

Jeremi Suri, Professor of History, UW-Madison, September 29, 2006.