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BEFORE THE MINNESOTA PUBLIC UTILITIES COMMISSION

REBUTTAL TESTIMONY OF RONALD R. RICH

Q: Please state your name, occupation, and business address.

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Q: On whose behalf are you testifying?

A: I'm testifying on behalf of mncoalgasplant.com.

Q: What testimony are you addressing in your rebuttal testimony today?

My rebuttal testimony focuses on the testimony of Excelsior's Daniel P. Schrag, who testifies regarding CO2 and its impacts.

Q: What are your points of contention with the testimony of Daniel P. Schrag?

A: I am challenging the testimony of Daniel P. Schrag, regarding "how advanced coal technologies such as Integrated Gasification Combined Cycle (IGCC) are important for mitigation for future climate change through the potential to capture carbon dioxide emissions and store them in geologic repositories." He also testifies "as an expert on climate change and climate change policy and on the likelihood that strict carbon regulations that require carbon capture and sequestration will be imposed during the lifetime of any coal-fired generating plant built today." A geochemist might be an expert in geologic CO2 sequestration, but not in energy alternatives, energy conservation, ICGG technology, energy production economics, gas reaction dynamics, or climate modeling. Schrag is not qualified to speak on the need for continued fossil fuel or coal use. While

Schrag is unquestionably correct in his testimony about the mounting CO2 problem, and we must address it and do face increased regulation of CO2 emissions, his testimony is off-point in this proceeding, because the Mesaba Project will have no impact whatsoever on emissions of CO2. The Mesaba Project will be a large CO2 emitter and there is no serious intent of capture and sequestration. Schrag's testimony instead heightens the myth surrounding this project, the statement of Excelsior that the Mesaba Project has the "potential" for carbon capture – this is a myth because that potential is not designed into the plant – it will emit CO2, not capture it. The Mesaba Project will contribute to the problem, and Mesaba Phase I and II as designed will contribute more CO2 to the atmosphere than any other coal plant in Minnesota.

Q: You state that the Mesaba Project will not capture and sequester CO2. Why?

A: In my previous testimony, I raised my concern about the cost of carbon dioxide emissions capture and sequestration, and my concern that the costs were not factored in to the Project. On the other hand, this is logical because the Mesaba Project does not promise capture and sequestration. But what is said about carbon capture regarding this project is misleading, because "carbon capture" is utilized as a selling point for this project. It is misleading because there is no intent to capture the carbon, the project is not designed to do so, and even if it could, in the proposed Northern Minnesota, locations are are about as far as possible from a suitable CO2 sequestering site on the North Amercian Continent. Given its location, there is no incentive for capturing CO2 because it cannot be sequestered in Minnesota and piping it to a suitable location is cost prohibitive even in a highly regulated scenario.

Q: What are some specific points in Schrag's testimony that are incorrect?

A: In his testimony, Shrag makes many statements that skirt around truths about IGCC and coal that must be stated. For example, he claims that we need to continue to use coal:

> Given the long lifetime of energy infrastructure, it is difficult to design even the most aggressive mitigation strategy to keep CO2 from doubling, especially with the large deposits of inexpensive coal in those countries that consume the most energy.

Schrag, Direct, p. 3, l. 14-17. He continues:

> The important point is that it is extremely likely that the United States will join the effort to reduce carbon dioxide emissions some time over the next decade, perhaps even sooner.

Schrag, Direct, p. 4, l. 14-16.

> We will be forced to pay for the true cost of fossil fuel, which includes its environmental consequences.

Schrag, Direct, p. 5, l. 1-2.

> One cannot create an energy plan for the U.S. without relying heavily on coal.

Schrag, Direct, p. 5, l. 21-22.

Schrag's testimony indicates a poor understanding of the potential for CO2 emission reductions. It actually is quite easy to design an aggressive mitigation strategy without the use of coal to keep atmospheric CO2 from doubling. Logically, given the near certainty there will be regulation of CO2 emissions soon, any new energy facility must address carbon remediation now, especially when embarking on any substantive infrastructure construction such as the Mesaba Project. Part of addressing this issue is to consider the true cost of fossil fuel derived electricity including CO2 capture and sequestration! If properly considered, available alternative generation and conservation approaches such as use of renewable energy, and enhanced electric efficiency would likely be selected instead.

Renewables and conservation do not always cost more now and would cost even less if these technologies were:

1) Manufactured in significant quantifies to capture economies of volume and scale;

2) Subsidized to the same extent IGCC is now;

3) Compared with the true cost of global fossil fuel production, use and CO2 capture and sequestration; and

4) Compared the true health, safety and environmental impact .

An example of forward thinking energy planning is Minnesota's 1980 Energy Planning and Conservation, which I wrote 26 years ago while working for the State of Minnesota.

Q: What are your concerns about carbon dioxide emissions and sequestration costs?

A: As I testified previously, in the Power Purchase Agreement Petition and accompanying report, Excelsior claims that "[t]he Mesaba Project will significantly reduce emissions of carbon dioxide." Petition, para. 23; Report, Section I, 4; Section II, pps. 3-11; etc. . Current IGCC technology has the potential to emit slightly less CO2 than an SCPC plant with the same net MW output. However without CO2 capture, as Mesaba is planned, the CO2 reduction is trivial.

Because Excelsior touts carbon capture as a "benefit," and because CO2 capture and sequestration will be required in the foreseeable future, the cost of design, installation and operation of CO2 capture and sequestration equipment should be required by the PUC. PUC. This must include costs incurred from point of CO2 generation including its capture and compression at the Mesaba plant, all transportation costs to the point of sequestration and all operating and maintenance costs of long term sequestration. Because a future 90% CO2 capture requirement is likely for an IGCC plant, I have spent some time reviewing studies and discussing with experts to attempt to clarify the

potential for capture and sequestration at Mesaba and elsewhere, and to address the costs with more specificity.

Everyone, including Exclesior, agrees that Mesaba's distance from the nearest potentially suitable geologic CO2 sequestration site is over 450 miles. Most believe 600 miles to be more likely. Therefore, based on siting alone I have come to the conclusion that the location proposed for the Mesaba Project, and in Minnesota generally, results in uneconomic CO2 capture and sequestration. Because of this expense and the cost of adding on a 90% capture capablity after construction, the Mesaba facilty will never be able to comply or implement significant CO2 capture and sequestration even after regulations are in place. This is because the cost of compressing and piping CO2 to a workable location is so high that it is cost prohibitive. It is not reasonable or responsible, given the foreseeable regulation of CO2, to build a project such as Mesaba where CO2 cannot and will not be sequestered. The PUC is charged with assuring that the Mesaba Project is a "likely least-cost" option and that it is in the public interest. In terms of the "CO2 potential," potential regulation and potential of Mesaba to capture and sequester CO2, this is not a "likely least-cost" option and is not in the public interest..

Q: What have you done to investigate carbon capture and sequestration?

A: Since my prior testimony, I have met with the Plains CO2 Reduction (PCOR) group at EERC at the University of North Dakota. I was there because of my work in developing test equipment for process energy monitoring and control at EERC, and installed one of my company's advanced fuel conversion analyzers. Similar analyzers might someday be used for CO2 sequestration monitoring and I am also developing advanced CO2 separation and capture technology. So I was very interested in becoming

current in PCOR's CO2 capture and sequestration projects and potential. I confirmed that the Mesaba facility would be far from any feasible geologic CO2 sequestration, and learned that PCOR considers capture and transport of CO2 to be at least as significant as sequestration due to higher than anticipated power requirements for CO2 compression and the extremely high pressure (2000+ psi) pipelines required for supercritical CO2 transport and injection. Following the meeting, I was provided with copies of two sequestration studies that appear to cast additional doubt as to the feasibility of capture and sequestration. Rich Exhibit 5, MCGP ___, *Environmental Footprints and Costs of Coal-Based Intergrated Gasification Combined Cycle and Pulverized Coal Technologies*(selected), EPA (July, 2006); Rich Exhibit 6, MCGP ___, Heddle, Herzog & Klett, *The Economics of CO2 Storage* (selected)(August 2003); Rich Exhibit 7, MCGP ___, Global Energy Technology Strategy Program, *Carbon Dioxide Capture and Geologic Storage* (selected)(April 2006). PCOR is working on surface carbon capture and sequestration as part of a $21 million grant from the Department of Energy, and potentially in conjunction with Excelsior Energy. However, even PCOR does not consider this surface approach a permanent or long-term solution. Thus we already know that it is not reasonable to expect or to claim that significant carbon sequestration would occur in Minnesota.

Q: Why would you say that carbon capture and sequestration is not reasonable to expect?

A: There are many reasons that add up to a determination, mine and others, that Minnesota, and much of the Midwest, is not suitable for sequestration. As I testified previously, those looking at geological carbon sequestration sites are in agreement that

there is little, if any, potential for sequestration in Minnesota – the sequestration maps show that Minnesota, most of Wisconsin, northern Iowa and eastern North and South Dakota have no potential sequestration sites. We know enough to know that sequestration is not possible in the area, and that any sequestration site would require many miles of expensive pipeline.

The same is true of terrestrial sequestration. After visiting with the PCOR group and from my own investigation, it is my opinion that there is little possibility for surface, or terrestrial, sequestration in any volume, and that only geologic, or underground, sequestration has potential as a permanent sequestration option, but again, not near the proposed Mesaba sites.

Q: Is it feasible to transport CO2 elsewhere for sequestration?

A: First, there must be a feasible site, and the nearest possible site would be on the other side of the Missouri River in North Dakota, but it should be noted that for the Beulah synfuels plant sequestration demonstration project located in western North Dakota, CO2 is sent about 300 miles by pipeline to Saskatchewan. Mesaba would have to go much further in search of an appropriate sequestration site – a reasonable guess is that nearly 600 miles of pipeline would be required, and probably more.

The cost of pipeline to get the CO2 to the site would be at least $33,853/in/mile, and Operation and Maintenance costs are expected to be roughly $5,000 per mile. Rich Rebuttal Ex. ___, MCGP___, The Economics of CO2 Storage, p. 1 (selected), Laboratory for Energy and the Environment(August 2003). And there is a lot of CO2 to transport, because a typical 500MW IGCC plant will generate at least 7,389 tons of CO2 daily, not considering CO2 capture and compression. Id. (The amount of CO2 Mesaba will

generate is unknown – the section labeled "Carbon Dioxide" references an earlier chart with values for CO, not CO2, as do the other tables – this should be clarified).

In addition to the costly pipeline, the CO2 must be highly pressurized, and may require boost compressors at regular intervals. Rich Exhibit 6, MCGP ____, *The Economics of CO2 Storage*, Figure 22, p. 67; see also *Environmental Footprints*, p. 5-8. I have learned that I underestimated the pressurization required, and that rather than 400 psi that many studies assume, and which I had assumed to be 700 psi, the PCOR group believes that CO2 must be pressurized to supercritical conditions, at 2,000 psi or more, which means that the pipeline cost will be significantly higher and that the increased compression further decreases the efficiency of the plant. From my discussions with PCOR staff and research, I estimate that capture and sequestration and the parasitic load that pipeline transport entails drops plant efficiency by a total 40% or more. Carbon capture alone lowers efficiency by at least 28-30%. Rich Exhibit 8, MCGP _____, Argus Coal Daily, p. 6, August 23, 2006. This loss of efficiency is significant. This must be addressed in terms of the costs enumerated in the proposed PPA (I do not have access to this information, therefore this is left to those who have access).

Q: What is the impact of carbon capture on the plant's efficiency?

A: Capturing and compressing CO2 would require a significant portion of the plant's energy output, reducing net electrical output and further increasing ratepayer costs. Most DOE estimates for carbon capture range from 10-40% of the net output of an IGCC plant and do not include the additional energy required for CO2 transportation and sequestration. If the PCOR estimates are correct, and I believe they are, the net power reduction is prohibitive. In fact, per net megawatt, cost of power would be about 1.7

times higher than Mesaba now estimates, excluding CO2 transportaion costs and sequestration. If this efficiency loss is known by Excelsior Energy and not disclosed (likely, given the decision to design for adoption, though not inclusion, of only a 33% capture of their CO2 emissions), this section of the application as well as all net power output and per KWh emissions presented elsewhere in the report are purposefully misleading and need to be revised. If they are not known by Excelsior Energy the document language should state the anticipated performance penalties based on best available information. The PUC should require these disclosures and their related economics. Even under the assumption the discharged combustion gas is relatively clean of "criteria" and "hazardous" air pollutants, costly steps must be taken to capture the CO2 in an acceptable form for transportation to the sequestration site:

As I testified previously, these components represent a very significant additional cost of electricity from this facility. Excelsior claims "capture ready" or "capture potential" as a benefit, and if this is taken as a benefit, the costs of realizing this potential must also be considered. It also must be determined whether the Mesaba Project has any chance of realizing this potential, and I believe it cannot economically capture carbon and sequester it due to the location of the plant, far from any reasonable sequestration site.

Q: What experience and studies address whether carbon capture and sequestration is feasible?

A: I am struck by the lack of substantive information provided in the Excelsior materials and testimony regarding CO2, general costs and characteristics. The most informative study that I have attached is *The Economics of Storage*, which was issued in 2003, and should be common knowledge in the industry, but is not. It appears that many

are banking on capture and sequestration when all the factors are not taken into account, perhaps not even known.

Q: Do you have any recommendations?

A: Yes, I have a recommendation. The Commission must consider the costs of accomplishing carbon capture and sequestration and the costs if this is not accomplished. If the Mesaba Project cannot deliver, it should not be approved based on a false promise. This is at minimum a 50 year commitment to infrastructure, a commitment to a demonstration project, experimental technology, one that has had significant problems in prior demonstrations. The PUC must exercise caution, act with deliberation, with the public interest in mind.

Q: Does this conclude your testimony?

A: Yes, it does.