BEFORE THE STATE OF WASHINGTON
ENERGY FACILITY SITE EVALUATION COUNCIL

IN RE APPLICATION NO. 2002-01 BP WEST COAST PRODUCTS, LLC BP CHERRY POINT COGENERATION PROJECT	**EXHIBIT 23.0** (WDM– T)

APPLICANT'S PREFILED DIRECT TESTIMONY

W. DAVID MONTGOMERY, Ph.D.

Q. Please state your name and business address for the record.

A. David Montgomery. Charles River Associates, Incorporated, 1201 F. Street, NW, Suite 700, Washington DC 20004.

Q. What topics will you address in your testimony?

A. My testimony will address:

1. My background and experience.
2. Greenhouse gas ("GHG") emissions from the BP Cogeneration Project.
3. GHG mitigation.

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Background & Experience

Q. What is Charles River Associates?

A. Founded in 1965, Charles River Associates (CRA) is an economics, finance, and business consulting firm that works with businesses, law firms, accounting firms, and governments, in providing a wide range of services. CRA combines economic and financial analysis with expertise in litigation and regulatory support, business strategy and planning, market and demand forecasting, policy analysis, and engineering and technology management. We currently employ more than 500 people in 16 offices worldwide; about half of these individuals are senior economists with advanced degrees (mostly Ph.D.s) from leading universities. In addition to our full-time personnel, we regularly enlist the consulting services of renowned academic authorities and research specialists on the faculties of Harvard, MIT, Stanford, and other major universities.

Q. Please describe your background and experience as it pertains to global warming and greenhouse gas issues?

A. Since receiving my Ph. D. in Economics from Harvard University in 1971, I have held a series of positions in teaching, research, government service and consulting, all of which have dealt with energy and environmental policy. Since 1988, much of my work, first as a government official and then as a consultant, has dealt with global warming issues.

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From 1971 to 1978, I taught economics at the California Institute of Technology and worked at the Caltech Environmental Quality Laboratory. From 1978 to 1981, I served in the U.S. Department of Energy during the Carter Administration, and became Deputy Assistant Secretary for Systems Analysis. Afterwards, I spent two years at Resources for the Future, where I wrote two books on energy policy. I returned to the Department of Energy in 1983, and headed energy forecasting and economic analysis activities in the Energy Information Administration until 1988. I became Assistant Director of the Congressional Budget Office in 1989, where I began working on climate change issues and produced a major study on the costs and benefits of using carbon taxes to control greenhouse gas emissions.

I left the government and joined Charles River Associates in 1991. Since then, I have also taught as a visiting lecturer at Stanford. A large part of my consulting work has been in the area of climate change, and I believe that I have become recognized internationally as one of the leading experts on the economics of strategies to reduce greenhouse gas emissions. I was invited to be a Principal Lead Author of the Second Assessment Report of the United Nations' Intergovernmental Panel on Climate Change, with responsibility for chapters on the costs of controlling greenhouse gas emissions. I have conducted a number of large scale studies on the design and economic impacts of climate change policies for clients in the public and private sector, including the U.S. Department of Energy, Natural Resources Canada, the government of Ontario, the United Kingdom Department of Environment,

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Trade and Regions, the Electric Power Research Institute, the American Petroleum Institute, the American Automobile Manufacturers Association. On behalf of my clients, I attended many of the negotiating meetings leading up to and following the signing of the Kyoto Protocol, and I made presentations to the delegates at sidebar sessions.

My work on the economics of climate change policy has been extensively peer reviewed and published in leading economics journals. These include studies of the impacts of climate change policy on international trade, impacts on the U.S. economy, regional and distributional impacts of climate change policy, and on the comparison of costs and benefits of reducing greenhouse gas emissions. I have been invited on several occasions to participate in expert workshops organized by the Intergovernmental Panel on Climate Change. I have been a regular participant in Stanford University's Energy Modeling Forum, which brings together the leading modelers working in the field of integrated assessment of climate change to compare and review each other's work. I have also been an invited participant in several of the annual Snowmass Workshops on integrated assessment of climate change, where I have become familiar with the issues involved in measuring the health and other benefits of reducing greenhouse gas emissions. I recently published a peer-reviewed paper on this subject in the journal *Human and Ecological Risk Assessment*, and I currently am completing a book on modeling international economic impacts of climate change policies to be published by Cambridge University Press.

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A copy of my resume is provided as **Exhibit 23.1** (WDM-1).

Q. Have you provided expert testimony regarding greenhouse gas issues before?

A. Yes. I have provided expert testimony to EFSEC on several occasions regarding the Chehalis Generating Facility and the Sumas 2 Generating Facility. I have also been invited to testify on many occasions before Committees of the U.S. Senate and House of Representatives on climate change policy, as described in my resume.

Cogeneration Project's GHG Emissions

Q. What is your understanding of the greenhouse gas emissions associated with the Cogeneration Project?

A. I understand that the proposed project is a 720 MW natural gas-fired combined cycle cogeneration facility with a heat rate of approximately 6,549 Btu/kWh in new and clean condition. If the facility operates at 85% capacity, it will emit approximately 2.1 million metric tons (tonnes) of CO_2 annually. At the same time, however, I understand that, if the facility operates at that rate of capacity, the provision of steam to BP's refinery will result in a reduction in its CO_2 emissions of approximately 0.32 million tonnes each year.

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Q. How do these CO_2 emissions compare to other electrical generating facilities?

A. Since the facility will provide steam to the Cherry Point refinery in addition to generating electricity, it is important to measure future emissions net of the reduction in emissions that will be achieved by not using the existing facilities for producing steam. Baseline CO_2 emissions are those that would be released from continued operation of the current steam facilities. Subtracting baseline emissions from actual future emissions from the new facility that generates both steam and electricity gives the net increase in emissions attributable to electricity generation. Because of the added efficiencies of cogeneration, the net increase in emissions at the Cogeneration Project site will be considerably smaller than the increase in emissions from a stand-alone gas combined cycle power plant without cogeneration.

Gas combined cycle has the lowest emissions of any generation technology other than nuclear that is economic on a large scale.[1] Cogeneration reduces

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[1] This point is made by other independent analysts. The US EPA states that "Gas turbines are one of the cleanest means of generating electricity…. Because of their relatively high efficiency and reliance on natural gas as the primary fuel, gas turbines emit substantially less carbon dioxide (CO_2) per kilowatt-hour (kWh) generated than any other fossil technology in general commercial use." (http://www.epa.gov/chp/chp_tools.htm) The Tellus Institute makes the same point in its study of methods to reduce CO_2 emissions from power generation: "The combined cycle gas turbine (CCGT) is the most efficient technology currently used for central-station power generation." The Path to Carbon Dioxide-Free Power: Switching to Clean Energy in the Utility Sector: A Study for World Wildlife Fund, Alison Bailie, Stephen Bernow, Brian Castelli, Pete O'Connor, Joseph Romm, Tellus Institute and The Center for Energy and Climate Solutions April 2003.

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its net emissions even further. Thus, of all the competitive generation technologies, gas combined cycle with cogeneration is the most benign from a global warming perspective.

Q. Please explain why a cogeneration project has these CO_2 benefits.

A. Cogeneration or combined heat and power ("CHP") technology has an inherent thermodynamic efficiency advantage, which is derived from the co-production of electricity and useful thermal energy (steam). The higher efficiency associated with CHP means that less fuel is needed to produce the same amount of electricity and steam than would be required by separate power generation and steam generation units. Since carbon emissions are directly related to fuel consumption, reducing the fuel use proportionally reduces the carbon dioxide emissions.

Exhibit 23.2 (WDM-2) illustrates the benefits of CHP versus separate power generation and steam generation. The left half of Exhibit 23.2 shows the energy flows and resulting carbon dioxide emissions associated with separate power and steam generation. The assumed power generation efficiency is equal to the efficiency of a stand-alone gas combined cycle unit. The steam produced by the CHP unit will displace boilers currently in operation at the refinery. The efficiency numbers for separate steam generation reflect the efficiencies experienced by those existing facilities. The right half of the exhibit depicts the same parameters for the CHP configuration planned for

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Cherry Point. The energy flows, efficiency, and emission numbers for BP's CHP facility are taken from its designed specifications.

Note at the bottom of Exhibit 23.2, I have summarized the energy efficiency and emission advantages of the CHP configuration planned for Cherry Point Refinery. The CHP configuration has an electric energy efficiency of 63%, compared to 56% for separate power and steam generation, assuming state-of-the-art gas-fired combined cycle power generation and 80% efficiency boilers. This efficiency advantage results in a 0.32 million tonne reduction in the amount of carbon dioxide emitted per year.

Mitigation Proposal

Q. What is your understanding of BP's mitigation proposal regarding these greenhouse gas emissions?

A. BP's mitigation proposal is spelled out in Part II, section 3.2.5.2 of the Application for Site Certification. As I understand it, as long as BP has an ownership interest in the Cogeneration Project, BP's equity share of the Project's emissions would be a part of BP's new GHG objective and the Project's emissions would be offset by GHG emission reductions within BP's worldwide operations.

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If, at some point in the future, BP did not own the Cogeneration Project, mitigation would be provided as follows:

(1) The proposed CO_2 emission standard will be 0.675 lbs CO_2/kWh calculated on the basis of Cogeneration Project Fuel Charged to Power in Btu/kWh.

(a) Fuel Charged to Power is Total Fuel Consumed by the Cogeneration Unit less Fuel Charged to Steam, and divided by net kWh generated.

(b) Fuel Charged to Steam is equal to steam energy used by the Refinery divided by a conversion factor of 0.901 (LHV/HHV).

(2) Emissions in excess of the emission standard would be mitigated either by

(a) An annual payment to a qualifying organization such as the Climate Trust of $0.85 per ton of CO_2 to be mitigated, or

(b) GHG reductions obtained by the Cogeneration Project owner, or

(c) A combination of the above.

(3) Mitigation would be satisfied annually for 30 years, which is the assumed economic life of the project. Mitigation would be reported to EFSEC annually.

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Q. In your opinion, should EFSEC require any greenhouse gas mitigation beyond that volunteered in the application?

A. No. Global climate change is a serious issue and I am in favor of an effective global strategy to reduce the threat of global warming, which is then implemented consistently on both the national and local level. Building more highly efficient natural gas power plants is a key component of any sensible policy to reduce greenhouse gas emissions. By imposing the financial burden of full or even substantial offset of greenhouse gas emissions on new facilities under its jurisdiction, EFSEC would discourage construction of new, highly efficient power plants, as well as making it more difficult for any plants that are constructed to compete in the wholesale power market. Doing this would increase greenhouse gas emissions from the Pacific Northwest region, because it would result in less-efficient power plants operating more intensively than they would if cogeneration facilities like BP were built. Failure to build combined cycle power plants and cogeneration facilities would also make room in the market for new power plants with higher emissions to be built outside EFSEC's jurisdiction.

Q. Does that mean you disagree with BP's mitigation proposal?

A. No. BP has made a corporate commitment to limit GHG emissions from its worldwide operations, and has implemented an internal system of trading of emission offsets to achieve that commitment in a cost-effective way. This commitment was made and is being carried out in advance of legal

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requirements in all countries where BP operates, and BP should be commended for its voluntary action.

By the same token, BP cannot make a similar commitment on behalf of potential future owners of the project. Limiting the obligation of potential future owners to something comparable to the Oregon program is necessary. The cost of offsets is likely to be more of a concern to a future owner other than to BP, since BP has an internal emission trading program that allows BP to select the most cost effective means to reduce GHG within its worldwide operations. Any future owner of the project would likely not have access to the same variety of GHG mitigation options, and so the economic disadvantage of GHG mitigation would be much greater. Depending upon the amount of mitigation required, the Cherry Point project could become an unattractive investment; potential buyers would rather consider a stand-alone power plant with higher GHG emissions but which did not have the same GHG mitigation requirement.

Moreover, adding costs to this project may mean that when the final decision to commence construction has to be made, the project will no longer be economic. That would be a tragedy for the State of Washington, for electricity supply in the Western U.S., and for the global climate, because building more new natural gas combined cycle power plants is recognized in every serious study of how to manage climate change as a very important

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contribution to reducing greenhouse gas emissions, and combined cycle power plants with cogeneration are even more beneficial.

In addition, I believe it is financially risky at this time for a developer other than BP to agree to offsets, or for a regulator to require them of such a developer, since any offsets created now have only uncertain claims to be recognized as credits against future national or international emission limits on greenhouse gases.

Finally, and this is where I depart from completely endorsing the BP proposal, the proposed calculation of carbon dioxide emissions per kilowatt hour is excessively conservative and gives too little credit to cogeneration for improving the efficiency of producing steam that would be produced whether or not the Cogeneration Project is completed. Emissions per kilowatt hour should be calculated as 1) total annual CO_2 emissions from the Cogeneration Project less 2) actual annual CO_2 emissions from the current method of steam generation. The result is approximately 0.73 lbs of CO_2 emissions per kilowatt hour of electricity generated. This calculation would be consistent with my discussion of how to measure the net emission increase earlier, and is also consistent with the US EPA definition of efficiency applicable to a cogeneration unit.[2]

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[2] EPA defines CHP [combined heat and power, a general category of which cogeneration is an instance] efficiency as "effective electrical efficiency, also known as fuel utilization effectiveness. It expresses CHP efficiency as the ratio of net electrical output to net fuel consumption, where net

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Q. Would requiring mitigation based on this calculation be consistent with your comparison of projected emissions without the Cogeneration Project to emissions with Cogeneration Project?

A. No. **In my view, a** cogeneration project should be seen as a source of offsets for other power plants, and should be awarded offset credit rather than being required to provide offsets. A proper comparison of emissions from the Pacific Northwest region with and without the Cogeneration Project should also account for indirect effects on emissions. If the Cogeneration Project is not built, then the best case is that another combined cycle unit without cogeneration will be built in its place. Under those conditions, the savings in emissions from steam generation at Cherry Point will be lost and total GHG emissions from the PNW region will increase by at least 300,000 tonnes of CO_2 per year, assuming equal kwh of electricity generated from both units (See Exhibit 23.2). Thus under at least one theory of how to measure offsets,[3] it would be appropriate to award a credit of that amount to the Cogeneration

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fuel consumption excludes the portion of fuel that goes to producing useful heat output. The fuel used to produce useful heat is calculated assuming a specific boiler efficiency (typically 80%). Effective electrical efficiency is shown in decimal form or as a percentage. The inverse of this ratio, known as the net heat rate, is usually given in BTUs per kWh. EPA has chosen to use the effective electrical efficiency measure for CHP efficiency because of its accuracy in capturing the value of both the electrical and thermal outputs of CHP plants, and its specific measure of the efficiency of generating power through the incremental fuel consumption of the CHP system." (http://www.epa.gov/chp/chp_tools.htm)

[3] Measurement relative to a baseline, including indirect effects. See U. S. General Accounting Office, *Climate Change: Basic Issues in Considering an Early Action Progra*m GAO/RCED 99-23, November 1998,.p,. 13

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Project. If the Oregon Climate Trust were to arrange for replacement of a planned gas combined cycle unit with a cogeneration project, that is precisely the emission credit that the cogeneration project would be entitled to claim.

Q. Your testimony seems to assume that when the Cogeneration Project is operated, it will displace other less efficient facilities with greater greenhouse gas emissions. Why do you think that would happen?

A. Electricity demand and total electricity generation in the Pacific Northwest will be the same whether or not the Cogeneration Project is operated. The existence of the Cogeneration Project will only affect which generating units operate. Electricity demand varies over the course of a day and between seasons. The amount of generation that will occur during any hour depends on the level of electricity demand. On most days of the year, total electricity demand is well below the maximum capacity of the system, so that not all generating units need to operate. The wholesale power market operates on the principle of economic dispatch, with generating units operated or "dispatched" in "merit order," from lowest to highest cost, until demand is met. All of the available generating units operate simultaneously only on the highest peak demand days. On other days, only some of the available generating units operate. Because the Cherry Point Cogeneration Project is much more efficient, and therefore cheaper, than many other power plants, it would displace power plants with higher heat rates and greenhouse gas emissions in the merit order.

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When an additional natural gas combined cycle unit like the Cherry Point Cogeneration Project is added to the system, in the short run its generation will displace generation from units with higher variable costs in the merit order. The primary difference between power plants using the same fuel that causes them to be located at different points in the merit order is a difference in heat rates – or energy efficiency. Therefore, generation from the Cogeneration Project will displace generation from power plants that have higher carbon dioxide emissions per kilowatt hour of electricity produced, because carbon dioxide emissions are directly proportional to heat rates. There will never be a situation in which the Cogeneration Project is turned on and displaces a more efficient (less emitting) facility. That means that, at any given time, the Cogeneration Project either doesn't operate and emits no greenhouse gases, or it does operate and reduces greenhouse gas emissions by displacing (or preventing the operation of) a less efficient (greater emitting) facility.

I have calculated that in the States of Washington and Oregon there was in 2002 approximately 3,464 MW of gas-fired generating capacity with heat rates in excess of those proposed for Cherry Point Cogeneration Project. **Exhibit 23.3** (WDM-3) compares heat rates of existing units in Washington and Oregon with the Cherry Point Cogeneration Project. All the units identified in Exhibit 23.3 have higher greenhouse gas emissions than the Cogeneration Project, and based on market prices for natural gas, would have higher operating costs than the Cogeneration Project. The average heat rate of

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other natural gas units that could be displaced by the Cogeneration Project is about 9500 btu/kwh, about 44% higher than the Cogeneration Project's projected heat rate of 6549 btu/kwh. As a result, those existing natural gas units on average produce 44% more greenhouse gas emissions than would the Cogeneration Project for every kwh generated. If the Cogeneration Project displaces electricity generated at the average efficiency of units with higher heat rates, the result would be a reduction in annual CO_2 emissions of over 1 million tonnes per year. See **Exhibit 23.4** (WDM-4).

To look at the long run effect of the Cogeneration Project on greenhouse gas emissions, it is necessary to ask what capacity will be built to serve demand if the Cogeneration Project is not built. Virtually every recognized authority on global warming agrees that the reliance on more gas-fired cogeneration and combined-cycle facilities is an important part of the near-term solution to reducing GHG emissions.[4] Bringing more natural gas cogeneration and combined cycle facilities on line will lead to less efficient generating facilities going off-line, at least part of the time, which will be a big step in the right

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[4] Examples of recent studies reaching this conclusion include: EIA, *Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants: Sulfur Dioxide, Nitrogen Dioxide, Carbon Dioxide, and Mercury and a Renewable Portfolio Standard*, July 2001; Alison Bailie, Stephen Bernow, Brian Castelli, Pete O'Connor, Joseph Romm, *The Path to Carbon Dioxide-Free Power: Switching to Clean Energy in the Utility Sector: A Study for World Wildlife Fund*, , Tellus Institute and The Center for Energy and Climate Solutions April 2003; The Pew Center on Global Climate Change, *U.S. Energy Scenarios for the 21st Century*, July 2003; Sergey Paltsev, John M. Reilly, Henry D. Jacoby, A. Denny Ellerman and Kok Hou Tay, *Emissions Trading to Reduce Greenhouse Gas Emissions in the United States: The McCain-Lieberman Proposal*, MIT Joint Program on the Science and Policy of Global Change, June 2003.

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direction for greenhouse gas emissions. Electricity demand will be the same whether or not the Cogeneration project is built, and that demand will be met from some source, and projections of electricity generation in the Northwest, show significant continued use of – and eventually growth in – coal-fired generation. Even the best coal-fired units have greenhouse gas emissions twice those of natural gas combined cycle facilities, and exceed cogeneration units by an even larger factor. Existing oil and natural gas units also have considerably worse heat rates than the new combined cycle and cogeneration facilities. Even if a standard combined cycle gas fired power plant would be built in the absence of the Cogeneration Project, that combined cycle unit would have higher emissions because of lacking the benefit of cogeneration. Thus under all reasonable scenarios, in the long run having the Cogeneration Project online avoids building a power plant with higher emissions. As I discussed earlier in explaining Exhibit 23.2, even with the optimistic assumption that the alternative to the Cogeneration Project is a standard gas combined cycle unit, the Cogeneration Project saves approximately 0.3 million tonnes of carbon dioxide emissions per year.

Q. How do you respond to the claim that GHG emissions are increasing as the use of electricity in the Northwest continues to increase, and that the only way to address it is to require GHG mitigation costs to be included or "internalized" in the cost of the electricity.

A. It is certainly true that to reduce GHG emissions in an economically efficient manner it is appropriate to internalize the costs imposed on society by those

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emissions. However, this only works if all sources of GHG emissions face the same additional cost per ton of GHG emissions. A comprehensive internalization of costs in power plants could produce a second-best result, but EFSEC cannot accomplish even this limited coverage.

The policy of requiring offsets for new power plants under EFSEC jurisdiction is very unlikely to have any effect on the level of electricity demand, or the growth in CO_2 emissions from electricity generation. The purpose of internalizing costs is to change decisions. A properly constructed and universal tax on carbon emissions would motivate a large number of decisions in the right direction. It would do so because all sources of carbon emissions would be on a level playing field. Electricity generated from natural gas cogeneration and combined cycle facilities would bear some cost, but electricity generated by less efficient gas facilities would bear a larger cost, and electricity generating from coal would bear a much larger cost. The cost of the GHG emissions would be incorporated into the cost of electricity whether it were generated by a new facility or an old facility, whether the facility were smaller or larger than 350 MW, and whether the facility were located in Washington or another state.

When these conditions are not satisfied, there is no guarantee that internalizing costs will lead to cost-effective choices, or indeed to any emission reductions from the total system.

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Including mitigation costs in the cost of business for some new facilities in the State of Washington will not have a desirable effect on decisions about power generation, because it will create a bias in favor of building facilities outside EFSEC jurisdiction and operating older facilities more intensively. Adding costs to generation at the Cogeneration Project by requiring offsets will not necessarily raise the cost of electricity paid by the consumers who use the electricity that results in GHG emissions, and therefore will not "internalize" the costs of GHG emissions. Wholesale generators differ from public utilities, in that they do not set rates based on cost, but rather sell electricity at a market determined price. Because the Cogeneration Project has to compete with power generators that are not paying comparable GHG mitigation, the operators of the Cogeneration Project, if it is built, will not be able to recover that cost. A public utility would be entitled to pass the entire cost of offsets through in its rates, so that its customers would see higher electricity prices and be encouraged to conserve. The same result is not achieved when a small number of independent power plants are required to acquire offsets.

Q. What would be a more effective way for EFSEC to reduce emissions from electrical generation?

A. The most effective action EFSEC could take to reduce GHG emissions from power generated to meet growing electricity demand is to ensure that facilities like the Cherry Point Cogeneration Project are completed and put in service as rapidly as possible. The larger the share of growing demand for electricity

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served by gas combined cycle cogeneration units, the less will greenhouse gas emissions be.

This opinion is reached by several recent studies of methods of reducing CO_2 emissions from power generation. The Tellus Institute, a well-known environmentally oriented research organization, issued a study recently that emphasized the role of expanded cogeneration in reducing GHG emissions and pointed out the dangers of state policies that discourage cogeneration and importance of policies that encourage it.

Q. Aren't all the power plants planned for the Pacific Northwest likely to be gas fired, so that there is no risk if a particular gas fired project is not built?

A. No, not all the future power plants in the region are likely to be gas fired, and the replacement for the Cogeneration Project, if it is not built, is almost certain to have higher emissions. Even two years ago, when forecasters thought gas prices would be in the $2 – $3 range, significant increases in coal-fired generation were likely, and they are even more likely today with forecasts of gas prices in the $3 – $5 range. Coal in parts of the Pacific Northwest that can easily serve Washington will be highly competitive with natural gas. This can be seen in the most recent EIA forecast, which forecasts an increase in coal-fired generation in the NWPP from 78.1 to 85.5 Bkwh between 2002 and

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2010, and an additional increase to 91.1 Bkwh by 2020.[5] The more gas fired generation is on the ground, the less room there will be for this increased coal-fired generation. Moreover, there is a particular risk in endangering the Cherry Point facility's economics, because as a cogeneration unit it is clearly better in terms of emissions than any unit that would be built to meet market demand in its place.

END OF TESTIMONY

[5] U.S. Energy Information Administration, Annual Energy Outlook 2003, Table 70. Electric Power Projections for EMM Region: Western Electricity Coordinating Council / Northwest Power Pool Area.

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