Northwest Power and Conservation Council

THE ROLE OF RENEWABLE RESOURCES IN THE FIFTH POWER PLAN

October 5, 2006

The current rate of renewable resource development in the Northwest is unprecedented in the history of the Council. More than 450 megawatts of generation using renewable fuel sources has been placed in service since release of the Fifth Northwest Electric Power and Conservation Plan in December 2004 (5th Plan). About 560 megawatts are under construction and an additional 710 megawatts are currently scheduled for completion by the end of 2008. Over 99 percent of this capacity is windpower. Factors contributing to this rapid rate of development include sustained high natural gas prices, climate change concerns, the Federal Production Tax Credit (PTC) and state renewable portfolio standards (RPS). Adoption of proposed RPS for Washington and Oregon could lead to sustained development at these rates.

While renewable resources, windpower in particular, play an important role in the 5th Plan, current rates of development greatly exceed the rate of renewable resource development foreseen in the Plan. In this paper, we first review directives of the Regional Power Act that bear on renewable resources. The role of renewable resources in the 5th Power Plan is then described. Next, we contrast that role with current renewable resource development trends. Finally, we identify possible implications of continuation of current rates of development.

DIRECTIVES OF THE REGIONAL POWER ACT

One of the four specific purposes stated in the preamble of the Regional Power Act (Act) is "… to encourage the development of renewable energy resources". This is elaborated in Section 2, Purposes:

2.(1) to encourage, through the unique opportunity provided by the Federal Columbia River Power System -
2.(1)(A) conservation and efficiency in the use of electric power, and
2.(1)(B) the development of renewable resources within the Pacific Northwest

The Act's definition of renewable resources (Section 3.(16)) is broad:
"… a resource which utilizes solar, wind, hydro, geothermal, biomass or similar sources of energy and which either is used for electric power generation or will reduce the electric power

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requirements of a consumer, including by direct application". Initiatives, certification programs and legislation dealing with renewable resources now often exclude certain renewable resources such as large hydropower and certain organic waste materials popularly associated with unacceptable environmental impacts.

The development of renewable resources from the perspective of the Act comes about from the Administrator acquiring major resources to meet his obligations in a manner consistent with the Power Plan, and minor resources in a manner consistent with the resource criteria set forth in the Act. These criteria also govern the development of the resource recommendations of the Plan.

The composition of the Plan's resource recommendations, or to use the Act's parlance, "forecast of power resources", called for in Section 4.(e)(3)(D) the Act, is to be based on a resource priority scheme. The resource priority scheme requires all resources to be cost-effective, and gives conservation the highest priority, followed by renewable resources, resources utilizing waste heat or high fuel conversion efficiency resources and finally, "all other" resources. Cost-effectiveness requires a resource to be reliable and available within the time needed, and to meet or reduce electric power demand at an estimated incremental system cost no greater than that of the least cost alternative. System costs include all direct costs over the effective resource life including (among other costs) quantifiable environmental costs and benefits. Conservation retains its priority by virtue of a ten percent cost-effectiveness credit; the remaining priorities in effect are tiebreakers for non-conservation resources of equal cost-effectiveness.

ROLE OF RENEWABLE RESOURCES IN THE PLAN

The 5th Plan is the first Power Plan to find commercial-scale development of renewable resources to be cost effective and to recommend commercial-scale acquisition of these resources in the 5-year Action Plan. The rationale leading to these recommendations and the specific recommendations are described in this section.

Renewable Resource Cost and Availability

Because of wind's expected leading role compared to other new renewable resources, an in-depth assessment of windpower was prepared for the 5th Plan. In addition, brief assessments were prepared of the resource potential and cost of flashed steam geothermal and biomass residue resources including wood residue, landfill gas and animal manure and chemical pulping (black) liquor energy recovery. A detailed assessment of small-scale solar photovoltaic and wind technology and cost was also included. New hydropower, hydropower upgrades, geothermal and wave and other ocean energy resources were briefly described, but estimates of resource availability and cost omitted because of lack of data, limited resource potential or immature technology. The renewable resources assessment of the 5th Plan is summarized in the following table:

Resource	***Potential (MW)***	***Cost ($/MWh)***	***Notes***
Animal manure	50	$56	
Geothermal	"Several hundred"	$35	
Hydropower upgrades	Not estimated	Not estimated	Acquisition where cost-effective recommended
Landfill gas	100 - 200	$45	
New hydropower	480	Up to $90	

Ocean current	Local tidal current potential in Puget Sound and coastal estuaries.	Not estimated	Unlikely to be cost-effective in foreseeable future
Ocean salinity gradient	Substantial theoretical potential in PNW	Not estimated	Technologies are in their infancy
Ocean thermal gradient	Insufficient temperature differentials in PNW	Not estimated	
Pulping liquor	280	$23	Upgrades to existing mills
Solar photovoltaics	No practical limit	$250	Considerable potential for cost reduction
Tidal hydroelectric	Insufficient tidal range	Not estimated	
Wastewater treatment	7 (implied from fuel estimate included in Plan)	Not estimated	
Wave energy	400 - 2500 (technical potential)	Not estimated	Technology winnowing is underway
Wind	5000 developable potential exclusive of MT, plus committed projects	$35 - $43 (WA/OR/ID) $33 (MT local)	"6000 MW" rounded total commonly referred to
Wood residues	1000 - 1700	$58 - 70 (no CHP[1]) $54-65 (w/CHP)	Mill residue, urban wood waste, logging and forest management residues

Methods used to Develop the Plan

The resource acquisition recommendations of the early Power Plans were generally based on the then-current lifecycle costs (including forecast changes in fuel prices and the cost of compliance with current environmental regulations) of available and reliable resource types. As the region was in surplus at the time, recommendations focused on securing construction options - an inventory of ready-to-construct projects in advance of need, to be developed as needed, but not sooner. Subsequent Plans incorporated forecasts of future technology performance and cost and consideration of project development risk.

The 5th Plan introduced a major advance - the explicit and rigorous evaluation of future uncertainties and risks. These include natural gas price uncertainty and volatility, inter-annual variation in hydro output, project development risks, project performance (outage) risk, the cost risk of future greenhouse gas control requirements and wholesale market price uncertainty and volatility. The future value of the production tax credit and of renewable energy credits (green tags) were also modeled. Many candidate plans, differing in types, amounts and scheduling of resources were evaluated for many futures. Each future is defined by the play of the risk factors described above over the 20-year planning period. The product of this evaluation is the estimated cost (average of all outcomes) and risk (average of high cost outcomes) of the various candidate plans. Because of the trade-off between cost and risk, no single "best" portfolio emerges. Priority must be assigned to cost and risk to choose a preferred plan. The Council chose a low-risk plan.

The resource portfolio of the 5th Power Plan is therefore based on meeting demand at the lowest cost consistent with a given (low) level of risk considering plausible future conditions. The cost-effectiveness test considers the value of the combined resource portfolio including risk (high-cost

[1] CHP - Combined Heat and Power, a.k.a. cogeneration.

outcomes) as well as expected cost. Planning flexibility in the face of an uncertain future is emphasized, accordingly, most of the generating resource acquisition recommendations are expressed as acquisition of options by a specified date. These would be constructed as needed to meet load and reliability requirements.

Renewable Resources in the Portfolio Analysis

The base case resource portfolio studies assumed the development of about 1100 megawatts of committed renewable projects and up to 5000 megawatts of discretionary windpower. Committed resources, modeled as windpower, are those secured through state (Oregon and Montana) system benefit charge programs and near-term utility resource acquisition activities. These were assumed to be developed through 2012. The 5000 megawatts of discretionary windpower was based on the resource assessment described above, and was modeled as two 2500 megawatt blocks - the second block having a somewhat lower capacity factor and higher integration costs than the first block.

In most futures, wind actually delivers less value than its cost. However, because it provides hedge value against several potentially costly risks including natural gas price excursions, electricity market price excursions and high CO2 control costs, windpower comprised a significant element of all except the lowest-cost, highest-risk candidate plans. Moreover, sensitivity analyses indicated that wind would provide sufficient risk protection to warrant inclusion of the full discretionary resource, even if windpower capital costs did not decline over time as assumed in the base case. In the recommended (least-risk) portfolio, development of discretionary windpower commenced as early as 2010. The full 5000 megawatts of discretionary windpower was developed by the end of the 20-year planning period in over 80 percent of the futures tested.

Most of the qualities of windpower that contribute to risk hedging, including independence from fuel and electricity price volatility, absence of CO2 production, are shared by other renewable resources. Though other types of renewable resources were not tested in the portfolio analysis, this suggests that at equivalent (or even somewhat greater) resource cost, other types of renewable resources should perform as well as windpower in the regional resource mix. Exceptions might be resources requiring significantly longer construction time than wind power (typically, geothermal, and larger hydropower and biomass-fuelled projects). The risk analysis suggests that an important factor contributing to the risk protection afforded by windpower is the short (15 months assumed from turbine order to completion) construction period. This permits the developers of wind power to better anticipate conditions present at time of completion.

Renewable Resource Recommendations of the 5th Plan

The 5th Plan recommends that options be secured for 100 megawatts of wind power by 2010, an additional 700 megawatts by 2011 and an additional 700 megawatts by 2012. This is in addition to the wind component of the 1100 megawatts of new renewable and CHP resources assumed to be committed. The plan also recommends construction of minimum of 500 megawatts of commercial-scale wind projects at geographically diverse areas over the five year period of the action plan to help confirm promising resource areas and resolve uncertainties associated with subsequent large-scale development of wind[2]. A representative resource build-out for the recommended portfolio is shown in Figure 1.

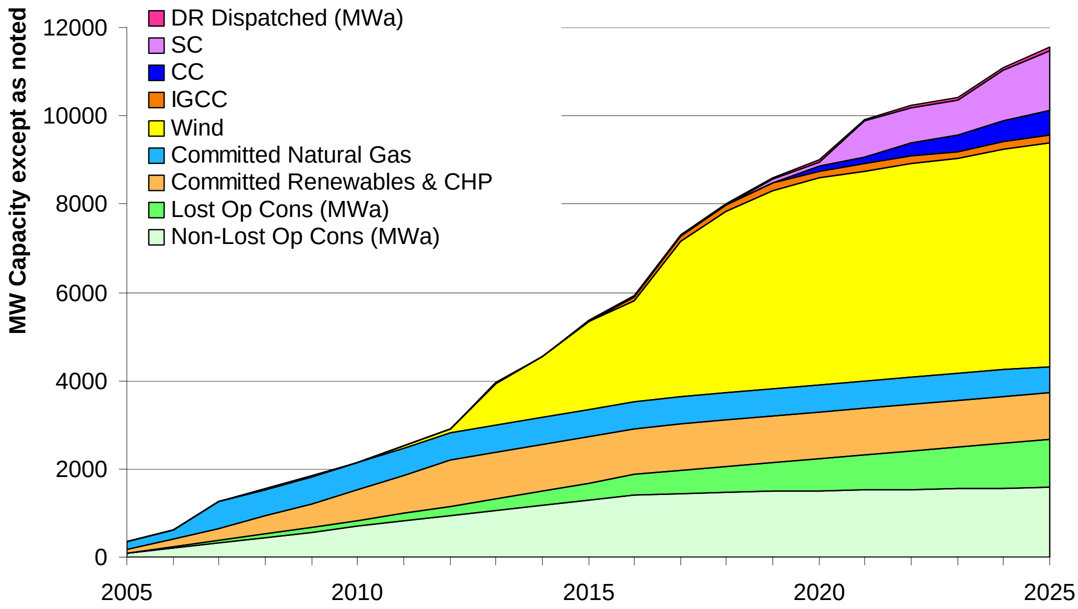

Figure 1: Representative 5th Plan resource development

The majority of generating resource actions in the 5-year action plan are intended to support development of windpower and other cost-effective renewable resources when needed:

- Actions GEN-1 through GEN-6 are intended to encourage the development of cost-effective small scale renewable and cogeneration resources.
- Action GEN-7 calls for securing wind (and other resource) project options as described earlier.
- Action GEN-8 and GEN-9 focus on resolving the uncertainties associated with large-scale windpower development and call for the 500 megawatts of commercial wind projects over the five years of the action plan to support this effort.
- Action GEN-9 is intended to lead to better understanding of the interaction between the use of the hydropower system for wind integration and other uses and constraints of the system.
- Action GEN-10 calls for Bonneville and utilities to offer commercial wind integration products.
- Action GEN-16 is intended to promote energy storage technologies including those that would facilitate integration of intermittent resources such as windpower and solar
- Action GEN-17 is intended to introduce standardized technologies with widespread Northwest application such as packaged biogas energy recovery plants

[2] This capacity was expected to represent a portion of the 1000 MW of committed renewable capacity.

- Action TX-1 is intended to ensure that bulk transmission capacity is available to support the development of cost-effective new resources, including windpower and other renewable resources.
- Action MON-3 directs the Council to monitor progress in confirming large-scale windpower development.

CURRENT RENEWABLE RESOURCE DEVELOPMENT ACTIVITY

Over 2600 megawatts of generating capacity of all resource types will have been placed in service in the Northwest between adoption of the 5th Plan in December 2004 and the end of 2008. About 800 megawatts is operating, 960 megawatts under construction and 880 megawatts currently scheduled for completion by the end of 2008[3] (Figure 2). About 1720 megawatts (65 percent) of the total are renewable energy resources. Nearly all of this (over 99 percent) is wind capacity. This renewable capacity will yield about 600 average megawatts of energy. Whether this rate of renewable resource development continues will depend upon extension of the federal production tax credit beyond 2007, availability of windpower integration services, utility need, relative cost of renewable and conventional resources and expansion of state renewable portfolio standards. If continued, however, through 2012 this rate of development would yield about 1700 average megawatts of new renewable energy generating capability. In comparison, expected levels of development foreseen in the 5th Plan would have yielded about 370 average megawatts over the same period.

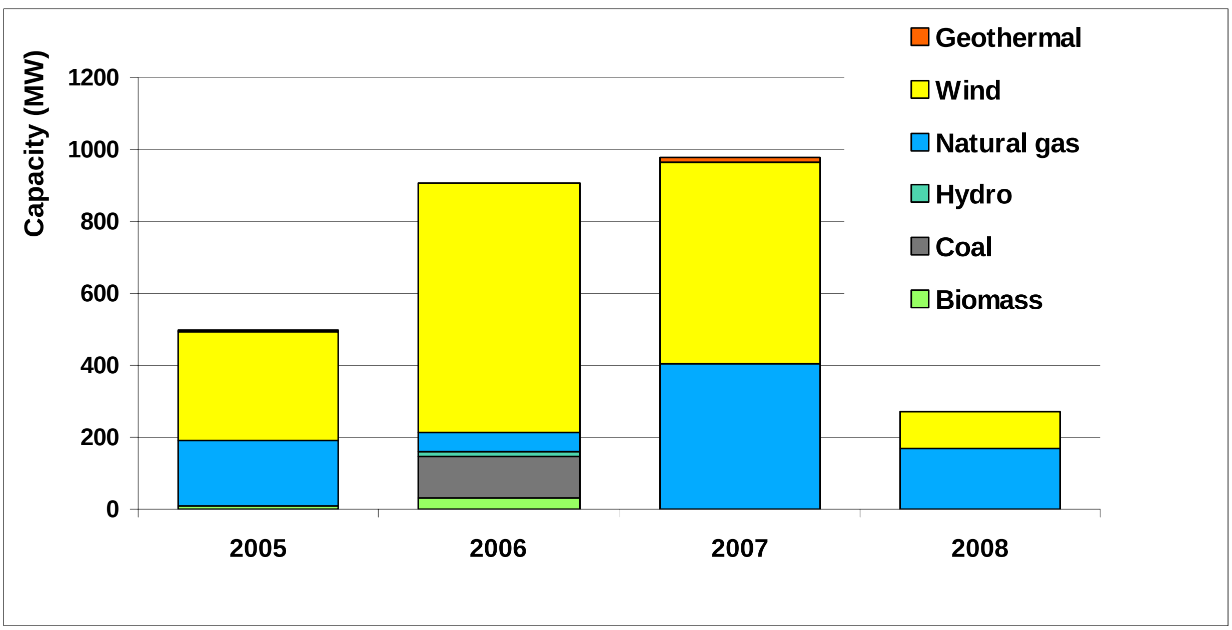

Figure 2: Northwest resource development 2005 - 2008

[3] It is likely the amount of new renewable energy projects actually constructed will exceed the amount currently planned for 2008 if the federal renewable energy production tax credit is extended beyond the current end-of-year 2007 expiration. The general opinion of those in the industry is that the political support exists to extend the credit.

Figure 3 compares current and projected renewable resource development with that foreseen in the 5th Plan. The curves of Figure 3 originate in 2005 with 385 average megawatts of energy. This is the yield of renewable resource and high-efficiency cogeneration projects completed between 2000 and 2005. This energy is included in the figure because energy from these projects would likely be eligible to meet renewable portfolio standards.

The "5th Plan" curve in Figure 3 includes committed renewable resources and the expected build-out of discretionary windpower from the 5th Plan resource portfolio. By 2025, the expected post-2000 renewable resource energy capability under 5th Plan assumptions would be about 2500 average megawatts. This would represent between 9 and 10 percent of native Northwest load at the time. Beyond 2020, the contribution of new renewable resources as a fraction of load would be slowly declining because of construction of non-renewable generating resources called for in the Plan.

The "25 by 25" curve of Figure 3 shows the amount of renewable energy required to achieve the penetration of new renewable resources advocated by many RPS proponents. Regionwide, about 6000 average megawatts of energy from eligible resources would be required to achieve this goal.

The "actual + trend" curve of Figure 3 shows current and planned development of eligible resources, projected through 2012. Though many uncertainties cloud the ability to project renewable resource development following pending expiration of the federal PTC at end of 2007, current development rates are roughly consistent with achieving 25% penetration by 2025.

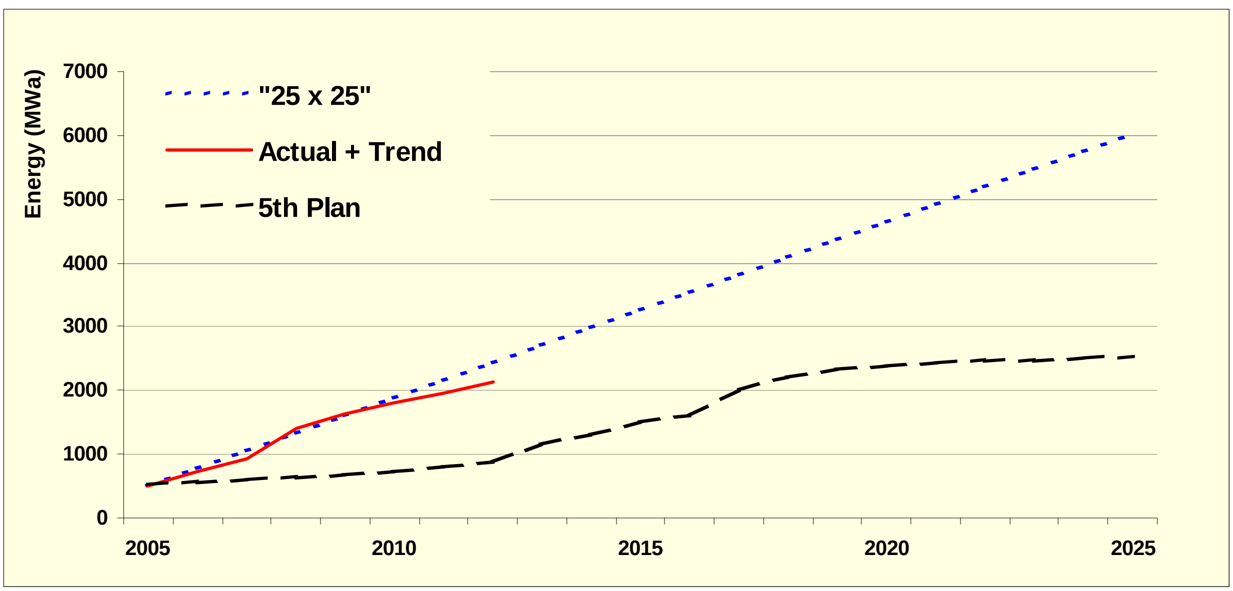

Figure 3: Projected Northwest renewable resource development

IMPLICATIONS OF CONTINUATION OF CURRENT RENEWABLE RESOURCE DEVELOPMENT RATES

Concerns were raised during preparation of the 5th Plan, regarding the ability to develop and integrate the amount of new windpower called for in the Plan. In response, the Plan includes actions for resolving uncertainties associated with large-scale windpower development. The much larger amount of renewable resources possibly resulting from continuation of current development trends may raise additional issues. Several are outlined below.

Resource availability: Continuation of current trends could require as much as 3500 average megawatts of renewable energy in addition to the windpower assumed to be available in the Plan. Up to about 2500 average megawatts might be obtained from geothermal[4], biomass and new hydro inventoried in the Plan but not included in the portfolio risk analysis. The balance could likely be obtained from additional conservation[5], higher cost windpower, imports from other regions, high-efficiency cogeneration, dedicated energy crops, and later, solar and wave power as the technologies for exploiting these resources continues to advance.

Resource cost: As observed in a recent Council paper, the cost of wind power plants has increased substantially since release of the 5th Power Plan. Whereas the Plan forecast delivered power costs of about $42 to 53/MWh for 2006 projects, the actual cost of energy from recent and proposed projects is in the range of $72 to 98/MWh[6]. Factors including increased commodity (steel, copper, resin, etc.) costs, weakening dollar against overseas currencies, strong demand straining equipment production and installation infrastructure have at least temporarily interrupted the long-term decline in real wind power costs observed in the Plan. Many of the factors that have lead to recent increases in windpower costs are cyclical, and are expected to reverse within several years. Moreover, analysis conducted during the development of the plan indicates that even if windpower costs fail to drop in real terms over the long-term, wind would remain a cost-effective component of a low-risk resource portfolio. A further cost issue that has been voiced is that demand resulting from state RPS requirements force a permanent seller's market. However, we expect that sustained demand would create more competition among suppliers, eventually forcing down costs.

System flexibility: Wind, solar, wave and tidal current resources produce power intermittently. Intermittent power production places additional demands on system frequency regulation and load-following resources ("system flexibility"). While existing system flexibility has been adequate to support existing windpower development, concerns have been raised regarding the ability to integrate the new wind generation, estimated to be 1500 to 2000 megawatts, expected within the next two to three years. Augmentation of system flexibility is likely to be required to accommodate the full amount of windpower considered in the Plan and would almost certainly

[4] Since preparation of the Fifth Plan, the Geothermal Task Force of the Western Governor's Association Clean and Diversified Energy Advisory Committee has estimated that 1290 MW of potential geothermal capacity could be developed in Idaho, Oregon and Washington by 2015 at costs ranging from $53 to 79/kWh, inclusive of the current geothermal PTC. Because geothermal power plants normally operate at high capacity factor this capacity could produce about 1200 MWa of energy. The first commercial geothermal power plant in the Northwest is under construction at Raft River, Idaho.

[5] Additional conservation would lower demand, which in turn would lower new renewable resource requirements (most RPS base new renewable resource requirements on energy load).

[6] Council "benchmark" costs in 2006 dollars, 2005 service, shaped and delivered, inclusive of the federal production tax credit for private financing.

be required to accommodate the larger amount of windpower resulting from continuation of current rates of development. The ability to secure additional system flexibility is not in question; regulation and load-following services can be obtained from changes in system control procedures, additional flexible generating capacity such as gas turbines, energy storage technologies and possibly from certain demand response resources. It is the cost, lead time and institutional considerations accompanying the addition of these resources that are in question. The Northwest Wind Integration Action Plan project is addressing these questions.

Displacement of existing resources: Most new renewable energy plants are must-run, either because of the fundamental character of the resource (e.g., wind, solar, small hydropower) or because of the capital-intensive economics (e.g., geothermal). Moreover, because RPS criteria are typically based on energy, even plants such as stand-alone biomass that can technically be dispatched will be run in preference to non-eligible resources. For this reason, new renewable resources developed in advance of need will reduce the hours of operation of existing dispatchable resources. This is, of course, is an objective from the perspective of CO2 reduction, providing that the displaced resource is fossil-fueled. Variable operating costs generally determine which projects get displaced. Unfortunately, from the perspective of CO2 reduction, coal-fired power plants, while the highest CO2 producers among fossil plants, typically have the lowest variable costs and are the least likely to be displaced[7]. However, the resulting surplus of gas-fired capacity may have value as a system flexibility resource. Moreover, much of the region's fossil steam capacity will be approaching retirement age by the latter portion of the 20-year planning period.

Deferment of new non-renewable resources: Accelerated construction of renewable generating capacity may defer or eliminate the need for alternative resources. It may also shift the relative cost-effectiveness of new resource alternatives when new non-renewable capacity is needed. The 5th Plan calls for securing options for 400 megawatts of coal gasification combined cycle capacity by 2012. This follows completion of 1100 megawatts of committed wind capacity and the recommended acquisition of options to build 800 megawatts of wind power and parallels the recommended acquisition of options to build an additional 700 megawatts of wind capacity. The total 2200 megawatts of new wind capacity would yield about 700 average megawatts of energy. As discussed above, it is anticipated that new (post-Plan) wind projects yielding 600 average megawatts of energy will be in service by the end of 2008, and, if development continues at this rate, new projects yielding over 2000 average megawatts will be operating by 2012. This would place the power system in a supply condition envisioned in the 5th Plan for late in the planning period (Figure 1). At this time the cost-effective new thermal generation alternative shifts from coal to gas-fired resources.

System reliability: Because of intermittency and poor longer-term hour-to-hour predictability, wind does not provide full capacity value for system reliability purposes. Individual utilities have used capacity values for wind ranging from zero to the capacity factor (typically 30 to 36 percent in the Northwest). Increasing penetration of windpower and the ongoing efforts in the Northwest to establish system reliability criteria have raised the level of interest in this issue. Task 3.2 of the Northwest Wind Integration Action Plan project will assess the capacity value of wind power.

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[7] Some displacement of coal-fired capacity may occur during low-load periods during the peak runoff season. Coal-fired power plants may be on the economic margin at these times.

Cost-effectiveness: As discussed above, in most futures the 5th Plan portfolio wind delivers less value than its cost. However, the hedge value provided by wind against uncommon but potentially costly risk events resulted in the full 5000 megawatts of windpower being cost-effective. The cost-effectiveness of larger amounts of wind power was not tested. The results of the sensitivity analysis with constant rather than declining wind costs and the large percentage of futures in which all available wind was developed suggest that larger amounts of wind, or other renewable resources providing similar risk protection at comparable cost might be cost-effective. That amount is not known without further analysis.

Transmission: Near-term renewable resource development is unlikely to be constrained by bulk long-distance transmission capacity limits. Larger-scale development in the longer term, however, is expected to require expansion of bulk transmission capacity. The issue is complicated by the relatively low capacity factor of the wind projects expected to comprise the majority of this capacity. Task 3.1 of the Northwest Wind Integration Action Plan project will address transmission planning and expansion issues.

CONCLUSIONS

Current rates of renewable resource construction in the Northwest greatly exceed the rates foreseen in the 5th Power Plan. Continued development of renewable resources at a more rapid rate than foreseen in the Plan is plausible given the probable extension of the federal production tax credit, growing concerns regarding continued high natural gas prices, the need for greenhouse gas control and the possible adoption of additional renewable portfolio standards in the Northwest. The cost of power resulting from resource development in excess of that foreseen in the Plan is somewhat uncertain. The amount of wind included in the Power Plan was limited by a need to verify the cost of integrating substantial amounts of wind into the regional power system. Additional wind and other renewables are likely available though at greater cost than considered in the portfolio analysis of the Fifth Plan. Other issues that may accompany sustained rapid development of renewable resources include the need for additional power system regulating and load following capability, displacement of existing capacity, deferment of new non-renewable resource capacity, system reliability, power system cost-effectiveness and transmission expansion.