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Rhonda Whiting
Montana

June 29, 2006

MEMORANDUM

TO: Power Committee members

FROM: Jeff King

SUBJECT: Interim review of the cost of windpower

Bonneville offers rate credits to customers developing renewable energy projects as part of its effort to encourage the development of renewable energy resources. Credits are based on the difference between the expected costs of qualifying new resources and a market price surrogate. Bonneville uses values from the 5th Plan to establish the cost of qualifying resources.

When the 5th Plan was developed, windpower costs (net of the federal production tax credit) were close to par with forecast market prices, with the result that proposed credits for windpower were very small. Since then, windpower (and other new resource costs, as well) have escalated significantly for reasons discussed in the attached paper. Bonneville customers have requested that the windpower costs be revisited so that a more realistic market differential credit could be established. At Bonneville's request, Council staff agreed to assess current windpower costs. The timing of this assessment will also coincide with the scheduled biennial review of the power plan.

The Council staff has contacted utility and independent wind developers, utility customers, turbine vendors and financing houses in an effort to assess the current situation. Our preliminary conclusion is that the levelized lifecycle cost of power from new wind projects has risen by 50 to 70 percent in real terms in the past two years. Higher construction cost is the principal contributor. As described in the attached paper, factors contributing to this increase include a weakening dollar, escalation of commodity and energy costs and increased demand driven by pending expiration of the PTC, state renewable portfolio standards and increased recognition of the risk mitigation values of windpower. Wind turbine efficiency improvements have partly offset construction cost escalation. Financial structures have changed, but as of this writing the net effect of these changes is unclear.

Possible reversal of the current commodity cycle, resolution of the post-2007 tax environment and possible expansion of wind turbine production facilities may lead to some easing of costs post-2007. However, continued demand resulting from a strong global market and state RPS

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requirements plus expansion of development into less desirable resource areas is likely to hold costs at levels higher than anticipated in the 5th Plan.

As noted earlier, these conclusions are preliminary. Staff is scheduled receive comments on the draft paper from a utility customer and to converse with a financing house later this week. While the results of those discussions might affect the specific values cited in the paper, they are unlikely to affect the fundamental conclusions. A final copy of the paper and accompanying presentation will be supplied to the Committee prior to the meeting.

The proposed assumptions are intended to be available for near-term analyses if needed, and do not constitute a proposal to revise the 5th Plan. However, the Power Committee may wish to acknowledge that the findings and conclusions of the paper represent the current situation. The findings and conclusions will be formally considered in the biennial review of the plan scheduled for later this year.

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Northwest Power & Conservation Council

INTERIM REVIEW OF THE COST OF WIND POWER

Revised Draft of June 29, 2006

The Northwest Power and Conservation Council, in its 5th Power Plan estimated the levelized cost of new utility-scale windpower to range from $42 to $53/MWh[1]. The assumptions upon which these costs are based are shown in the following table[2]. These were developed with the assistance of an advisory group comprised of industry and utility representatives. The assumptions date from 2002, a time of moderate wind development activity and were thought to be representative of equilibrium market conditions, suitable for the long-term nature of the Council's Plan. Conditions through late 2004, when the 5th Plan was adopted, did not appear to significantly deviate from these assumptions.

	Year 2000 (2006) dollars
Project Size (MW)	100
Capital ($/kW)	$1010 ($1160)
Fixed O&M ($/kW/yr)	$20[3] ($23)
Variable O&M ($/MWh)	$1 ($1.15)
Capacity Factor (%)	28 - 30%[4]
Shaping & Integration ($/MWh)	$4.55 - $9.75 ($5.23 - $11.20
Wheeling ($/kW/yr)	$20 ($23)
Transmission Losses	1.9%
Project life	20 years
Learning effects (on real cost)	-2.2 %/yr

The cost of new wind projects has risen substantially in real terms over the past two years. Proposals for shaped and delivered energy from projects entering service in 2006 or 2007 range from about $45 to $90/MWh. The principal element leading to the increase in delivered energy cost is an increase in project construction cost of 20 to 30% over the base year capital cost adopted for the 5th Plan. Factors at play include the following:

Weakening dollar: Major components of many of the turbines used in U.S. wind farms are manufactured overseas. A weakening U.S. dollar against overseas currencies has increased the cost of these machines. For example, the value of the Euro against the dollar has increased from $0.98 in July 2002 to $1.21 in March 2006.

Increased commodity and energy costs: Commodities used in the manufacture and installation of wind turbine generators and ancillary equipment, including cement, copper and steel have increased in cost in recent years. Drivers have included general economic recovery, disaster recovery and increased demand from developing Asian economies. NYMEX copper increased

[1] 2006 dollars, 2005 service, shaped and delivered, inclusive of the federal production tax credit for private financing.
[2] Costs are expressed in year 2000 dollars in the 5th Power Plan. Year 2006 dollars are used here to facilitate comparison to current market conditions.
[3] Excluding property tax and insurance.
[4] Eastern Washington, Oregon and Idaho sites. MT - 36%.

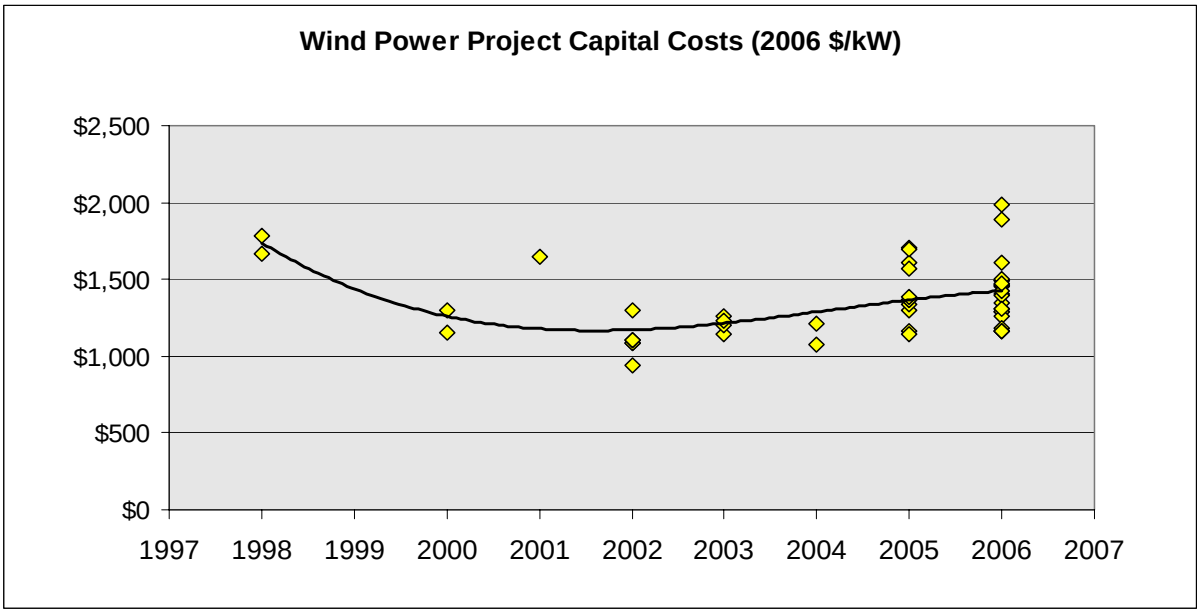
from $0.72/lb in July 2002 to $2.32/lb in March 2006. Rebar has increased about 45% over the same period. Structural concrete is forecast to increase to about $580/cy in 2006, up 50% from 2002. Likewise, the cost of energy needed to fabricate, transport and erect wind turbine generators and related components has also increased. The average U.S. retail price of No. 2 diesel has increased from $0.85/gallon in July 2002 to $2.07/gallon in March 2006. There is evidence that some commodity prices may be peaking as new supply is developed or demand weakening.

Market demand for windpower: The near-term demand for windpower has increased because of increasing natural gas costs, pending expiration of the federal production tax credit at the end of 2007, adoption of state renewable portfolio standards and increasing utility recognition of the risk of future CO_2 control costs. Increased demand has created shortages of turbines, specialized transportation and erection equipment, and experienced construction workers and operations and maintenance personnel. In addition, the buyer's market has likely encouraged increased profit taking where possible among players in an industry that has experienced many lean years. Turbines are generally not available through 2007, last year of the current PTC extension, but remain available for 2008 delivery

Financing: Changes in the structure and terms of project financing have occurred, motivated by a maturing industry, the federal production tax credit and accelerated depreciation rates. Financing trends include (1) increasing investor-owned utility ownership of projects; (2) lower debt fractions including unlevered (pure equity) financing for independently-owned projects; (3) lower equity return among investors in independently-owned projects and (4) emergence of more complex financial stuuctures for the purpose of fully securing PTC and accelerated depreciation benefits.

Performance improvements: Performance improvements are evident, from increases in swept area and hub heights, improved reliability and improved project and turbine siting. Though not a completely reliable indicator of improved performance, the forecast capacity factors of recent and proposed projects appear to have an improved 2 to 3 percentage points above 5th Plan assumptions.

The plot of wind project capital costs shown below was prepared using a combination of announced capital costs of utility-scale projects completed or under construction from 1997 through 2005 plus back-calculated capital costs from recent bids. The back calculations were performed under the assumption that the primary factors leading to recent cost increases have been capital and O&M costs (i.e., wheeling and integration costs have remained relatively constant). Capacity factors were assumed to average 32%. The resulting plot suggests that capital cost continued their historical decline from 1997 through 2002, picked up slightly in 2003, declined in 2004 with the expiration of the PTC, and subsequently increased under the influence of the factors described above. Capital costs in 2006 range from about $1160 to $1990/kW, with an average of about $1450/kW. This finding is confirmed in conversations with industry representatives who suggest capital costs ranging from $1430 to $1550/kW.



The assumptions shown in the following table are proposed for purposes of characterizing typical near-term utility-scale projects. Average project size is assumed to have increased to 150 MW, based on recent Northwest projects. Overnight capital costs, including project development, owner's and typical transmission interconnection costs, are assumed to be $1500/kW. Fixed and variable O&M costs are assumed to have increased proportionally to capital costs. The typical capacity factor of a project located in the inland Northwest, based on energy to the point of interconnection is assumed to have increased to 32%. Wheeling and integration costs, wheeling losses and project life are unchanged from 5th Plan estimates. Learning curve effects are assumed to have no effect on real costs in the near-term.

	Year 2006 dollars
Project Size (MW)	150
Capital ($/kW)	$1500
Fixed O&M ($/kW/yr)	$30
Variable O&M ($/MWh)	$1.50
Capacity Factor (%)	32%
Shaping & Integration ($/MWh)	$4.55 - $9.75
Wheeling ($/kW/yr)	$20
Transmission Losses	1.9%
Project life	20 years
Learning effects (on real cost)	None for near-term

These assumptions yield a levelized energy cost of $58, $78 and $78/MWh for COU, IOU and IPP financing[5], respectively.

[5] 2006 dollars, integrated and delivered based on the existing 5th Plan financing assumptions. IOU and IPP values are inclusive of the current PTC. Consumer-owned utility costs are not credited for REPI.

Biennial Review of the Power Plan
Wind Power

Jeff King

Northwest Power and Conservation Council

Power Committee

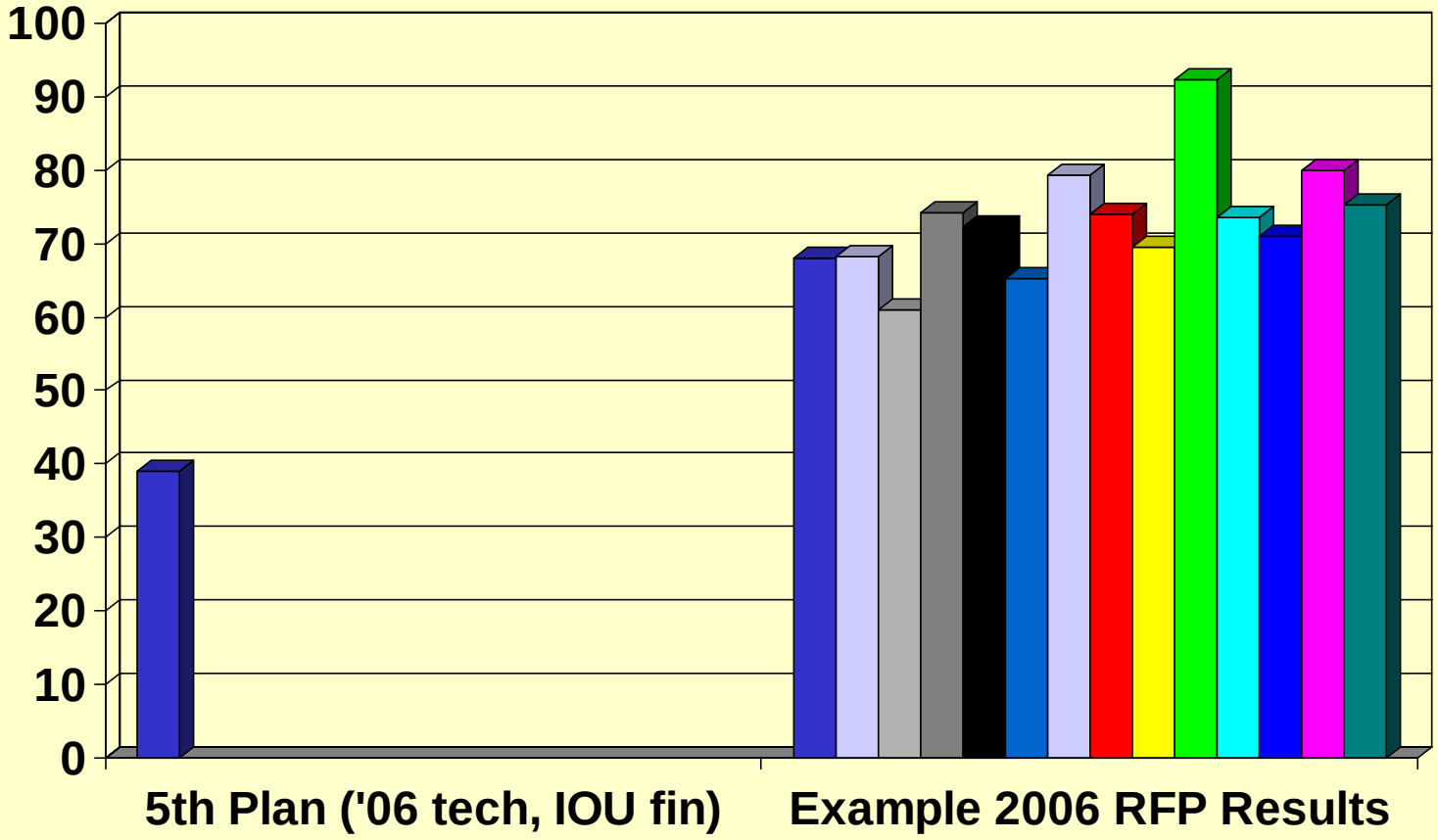
Missoula, MT

July 11, 2006

Purpose

- Bonneville requested a review of the 5th Plan assumptions regarding wind project costs for purposes of updating its renewable rate credit program.
- Staff agreed, having observed that windpower costs had risen considerably in the past two years
- Also, a review would support the scheduled biennial review of the Power Plan

Wind power costs are well above 5th Plan forecasts



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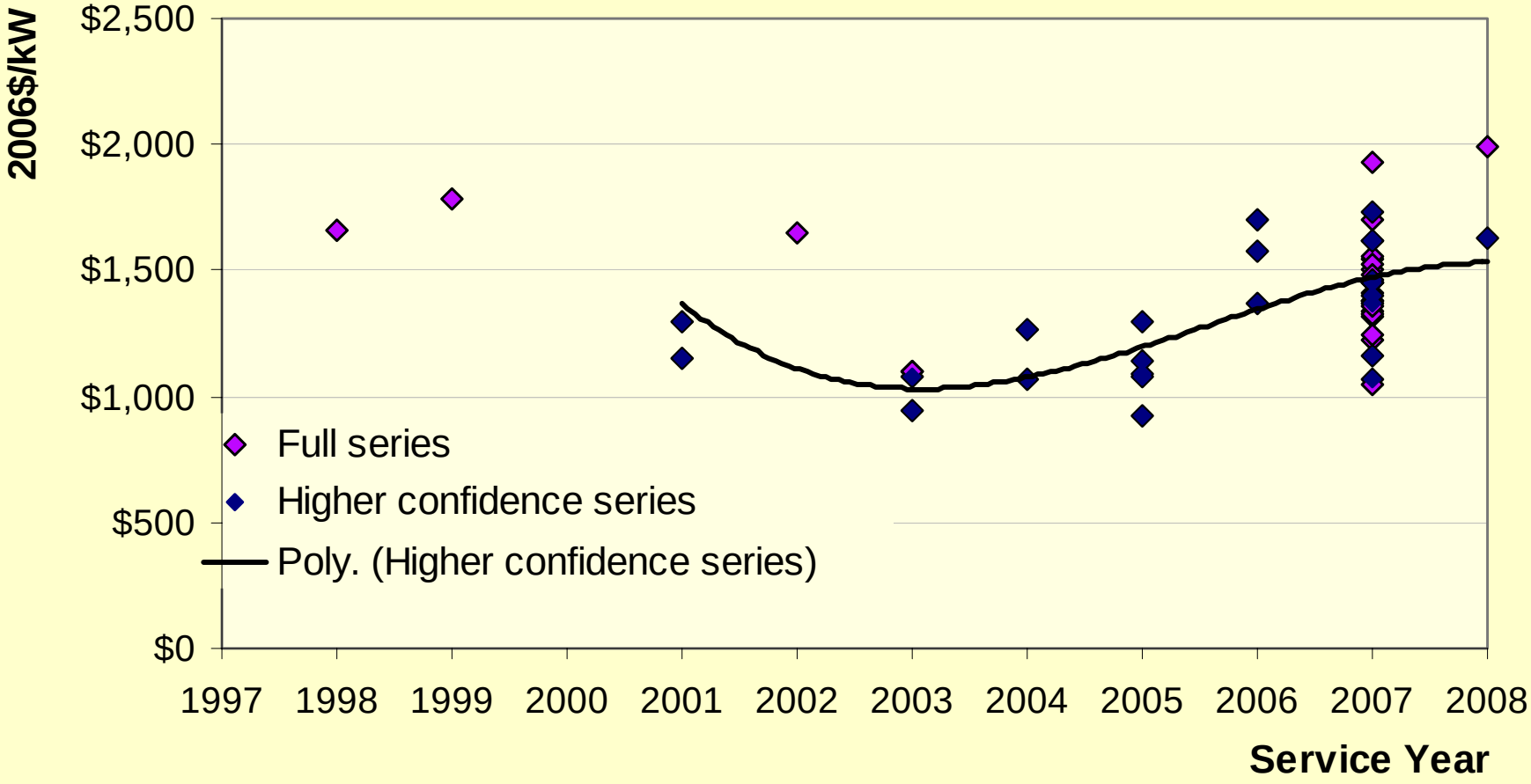
Sources of Info

- Literature
- PNW utilities acquiring wind
- Project developers
- Project financers
- Turbine vendors

Factors at play

- Weakening dollar
- Increased commodity and energy costs
- Demand for windpower
  - Natural gas cost
  - Climate change concerns
  - State renewable portfolio standards
  - Federal tax benefits (PTC & accelerated depreciation)
- Financing
- Performance improvements
- Other costs

Capital cost trend



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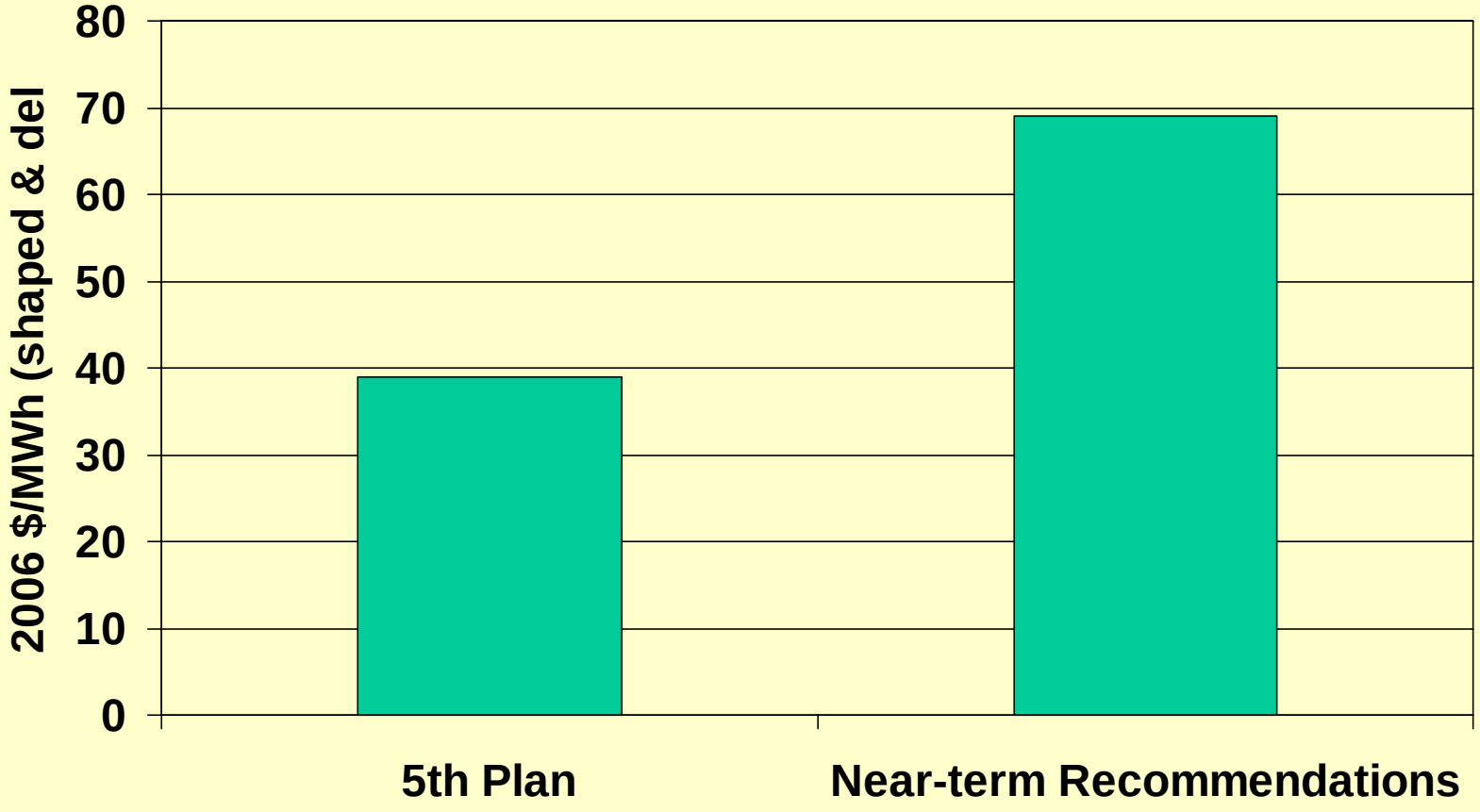
Recommended changes in wind project assumptions

- Capital cost: $1010/kW > $1500/kW
- Near-term learning rate (net of cost & performance): -2.3%/yr > 0.
- IPP D/E ratio: 60/40 > 40/60
- Reduction in IPP return on equity

Prospects

- Many of the same factors will affect future prices
  - Production tax credit
  - Renewable portfolio standards
  - Natural gas prices
  - Climate change policy
  - Commodity cycle
  - Strength of the dollar
  - Less desirable project sites
  - More costly transmission and ancillary services
- PTC extended – stable prices @ current levels
- PTC terminated – drop, followed by slow recovery

Comparison: 2007 service; IOU financing



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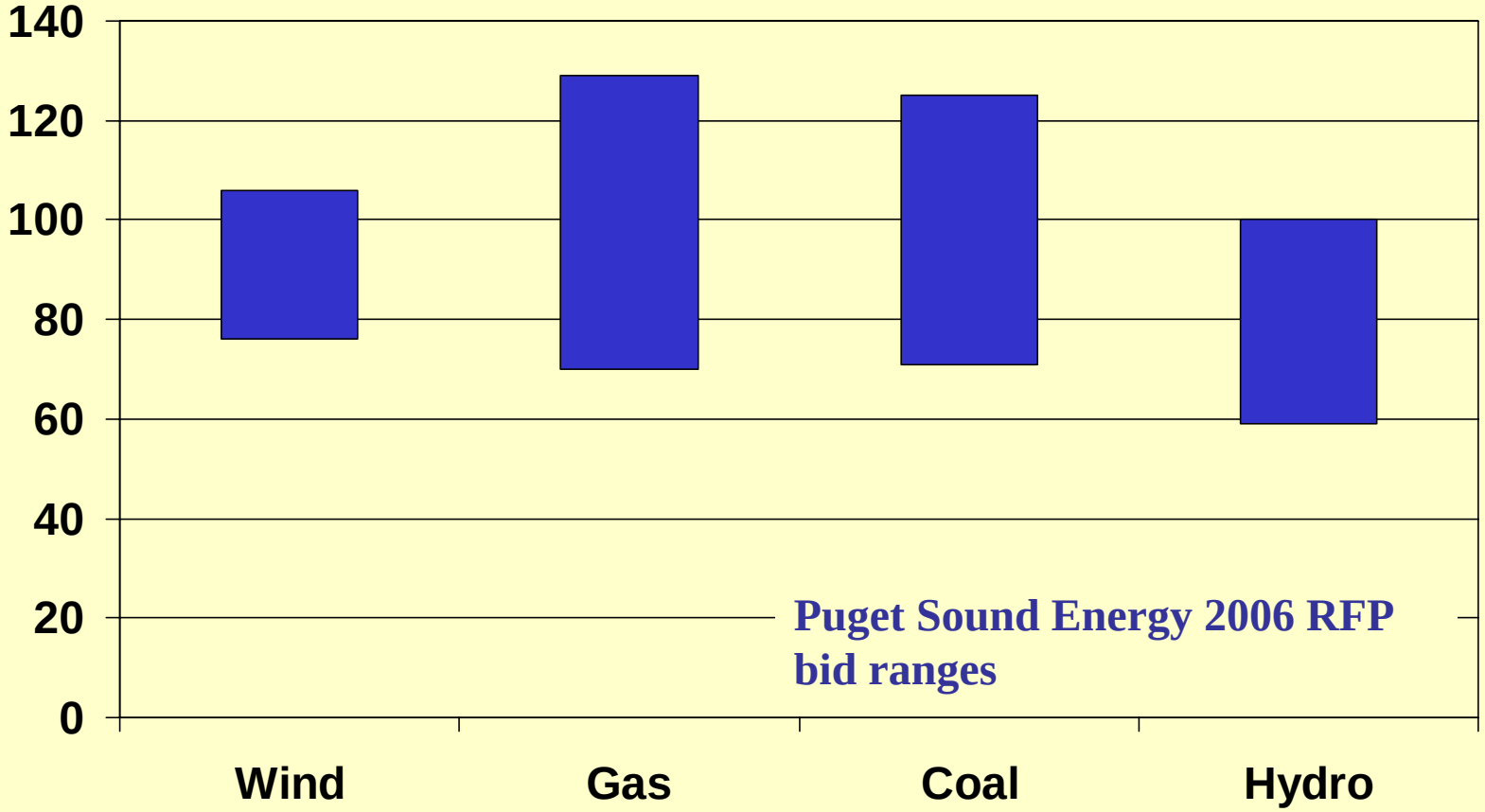
Windpower is not the only resource that has experienced increasing cost



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