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March 16, 1982

Dear Interested Party:

At the Northwest Power Planning Council January 7th meeting in Olympia, Washington, the Council began discussing a planning methodology that could deal with the growing uncertainties associated with electrical demand forecasting and resource development. The Council continued this discussion at its February 17th meeting in Portland, Oregon, and March 4 meeting in Missoula, Montana.

As a result of these Council discussions and working papers prepared by the Washington State Energy Office and the Council's Central staff, a contractor to the Council has prepared a discussion paper for circulation to the public.

The paper, prepared by Dr. Kai N. Lee of the University of Washington, outlines a process for establishing a range of electrical energy needs and a program of acquiring resources and options to meet that range. The paper also identifies a number of questions raised by the planning concept.

The paper is intended to stimulate discussion on a planning methodology prior to any formal Council action. The Council would appreciate your review *and* comments on this discussion paper.

The Council is particularly interested in reactions to the questions raised on pages 22 and 23 and identification of other questions or problems raised by the discussion paper.

The Council would appreciate your comments by April 7th. Would you please address your comments to me at the address above. If you have *any* questions, please don't hesitate to contact me or Jim Litchfield.

Thank you for your assistance.

Sincerely,

Edward Sheets

Edward Sheets
Executive Director

Enclosure

THE PATH ALONG THE RIDGE:

REGIONAL PLANNING IN THE *FACE OF* UNCERTAINTY A

Discussion Paper*

(March 1982)

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* The Council welcomes comments on and criticisms of the ideas presented in this paper. Please send responses to *Edward* Sheets, executive director, at the Council's Portland office.

This paper was prepared by Kai N. Lee, associate professor of political science and environmental studies at the University of Washington, where he is a Kellogg National Fellow. Many of the concepts discussed here were initially developed in Richard Watson, Steve Aos, John Douglass, and Peter Downey, "Power Planning and Uncertainty," an unpublished paper prepared at the Washington State Energy office.

The Path Along the Ridge:
Regional Planning in the Face of Uncertainty

ABSTRACT

In developing a plan for the regional power system, the Northwest Power Planning Council faces critical uncertainties, both in forecasting demand and in planning for conservation and new generating resources. The risks arising from these uncertainties can be managed on a reg- ional basis, by selecting a combination of programs and resources that yields a risk-resistant and cost-effective regional system.

Such an approach is attractive in concept, but it differs substantially from established utility practice. Discussion and criticism are needed, accordingly, to assess the workability of the planning philosophy outlined here.

Public Law 96-501, the Regional Power Act, responds to the changing circumstances of electric power in the Pacific Northwest by defining policy directions and creating new institutional arrangements for regional power planning. The Northwest Power Planning Council is the agent of the region in meeting the challenges of planning under the act. This paper discusses the conceptual framework of power planning, a task that confronts a degree of uncertainty and risk without historical precedent.

For a quarter-century, electricity demand grew rapidly in the Northwest, roughly doubling every 10 years. This growth was readily met by the low-cost, abundant supply of hydroelectric energy developed by the federal government and Northwest utilities in the Columbia River and its tributaries. Steady growth made for simple planning: build more for a brighter tomorrow. And when the potential of the region's rivers was fully harnessed, it seemed sensible to turn to nuclear and coal, supplies that promised to facilitate further growth at higher -- but still reasonable -- cost. But even as the Regional Power Act was emerging from Congress, the era of steady growth ended, a victim of rising power costs and an unstable economy.

There are no facts about the future, but it is widely believed to be uncertain and risky. If the growth rate differs by only 0.3 per cent per year from the anticipated rate, the gap between anticipated and actual load amounts to the equivalent of a nuclear plant in less than 15 years. The ability to forecast demand falls considerably short of even this 0.3 per cent criterion. It now takes more than 10 years to plan and build a nuclear plant; such a major facility costs several billion dollars. The costs to the economy of not having enough power are similarly huge.

The planning problem is thus a daunting one: the <u>best</u> one can do with current methods seems to entail major risks of either building too much or too little, with heavy penalties either way. The Northwest is walking along a narrow ridge, in the image of Dan Evans, chairman of the Power Planning Council; we can ill afford missteps, but we cannot see as far as we stride. Thus, the question of developing a regional plan goes beyond selecting resources for acquisition by the Bonneville Power Administration: it must also include thinking about <u>how</u> resources should be acquired, together with careful consideration of <u>what</u> <u>kind</u> of resources are suitable for responsible planning in the face of uncertainty. This paper is meant to stimulate discussion of how to do this better.

The Uncertain Environment

From the late '40s until approximately 1970, demand for electricity in the United States grew in parallel with the gross national product. Growth reflected the fact that electric power was a good buy. Not only was electricity convenient, but the real cost of supplying power steadily declined, as new technology captured economies of scale. In the Northwest, the dominant resource was (and remains) hydropower, developed on a large scale since the federal government launched Grand Coulee Dam during the New Deal.' Northwest hydro projects, built during an era of low construction costs and low interest rates -- often backed by the federal government -- produced the cheapest electricity in the nation. As steady economic growth gave way in the '70s to stagflation and energy crisis, the conditions underlying utility planning changed. Planning should have changed too, but it lagged, with serious consequences for utilities and their ratepayers.

Seven conditions shape the futures:

1. <u>Federal</u> <u>sponsorship remains limited</u> in reach. Despite the region authority to acquire resources under the act, the initiative still rests with utilities, local

governments, and other project sponsors.

2. The marginal cost of power is rising, but its magnitude for any given project remains uncertain. The troubles of the Washington Public Power Supply System have ignited a citizen revolt, drawing attention-to rising rates.

3. Conservation entails the stimulation and coordination of activities undertaken by thousands of individuals and firms. The utilities have had relatively little experience with conservation or decentralized sources of supply, and both planning and regulatory oversight have been hesitant and often confused.

4. Although the Northwest has a strong tradition of public utility ownership, the open planning process created in the Regional Power Act is unfamiliar and uncomfortable for the utilities, especially now. Openness and a complex agenda make the planning process difficult for the council to manage, as well.

5. Forecasting demand has become extraordinarily difficult. We're the smooth and rapid growth of the '50s and '60s allowed planners simply to extrapolate historical behavior, the period beyond the mid-'70s continues to be elusive, despite ever more sophisticated methods of analyzing past demand patterns.

6. Large, capital-intensive resource projects now pose sub-stantial risks. Costs an schedules have been difficult to control. Moreover, with the slowing of load growth, arrangements for fully utilizing large facilities have become unexpectedly important.

7. A consequence of the last two points is that commitments to large resources a decade or more in advance -- standard practice now -- are no longer tenable without substantial change.

Despite the explosion of uncertainty -- indeed, because of it -- it is more urgent than ever to plan on a regional basis. A central feature of the Regional Power Act is the ability to plan a cost-effective mix of resources on a regional basis. The uncert-ainties listed above imply a need for regional risk management as well -- a process for insuring long-term cost-effectiveness in the face of uncertainty.

Principles for managing risk

Regional planning can be organized around eight principles, several drawn directly from the Regional Power Act. These principles form a coherent framework for dealing with the uncertainties facing the Pacific Northwest. To facilitate exposition, they are first listed briefly:

1. In place of deterministic planning, there should be a regional risk-management process that stresses flexibility.

2. In particular, the planning process should prepare the region to meet a wide range of loads in all the years encompassed by the plan, instead of relying upon a most-likely demand forecast.

3. The regional plan should shift the burden of risk from individual project proponents to the region as a whole, as a form of regionwide insurance.

4. The act establishes a fundamental priority for resource planning: to minimize expected cost, giving first priority to conservation; second, to renewable resources; third, to resources utilizing waste heat or generating methods of high fuel conversion efficiency; and fourth, to "all other resources."

5. The act also creates an institutional structure for decentralized implementation of a centrally written plan.

6. In place of the conventional bias toward economies of scale in power generation, planners should search for cost-effective combinations of conservation and resources that can provide planning flexibility. When comparing projects that are equally costly to the region, those available on short notice should be given priority over those with long lead-times; small projects should be preferred to large ones; and programs that can be slowed, halted, or reversed should be more useful than those entailing inflexible commitments.

7. The planning process should manage the burdens of financing, licensing, and institutional change by making regional commitments on a schedule that reflects the slower load growth that characterizes a period of rising real rates.

8. The integrated hydro system has been augmented with thermal generation developed on a piecemeal basis. The Regional Power Act -- and the risk-management approach in particular -- seems to lead to <u>a substantially more complex</u> regional power system, one encompassing activities and actors unfamiliar to the utility community. The challenge of this additional complexity must be taken seriously in the planning process.

The paradox of regional planning and decentralized execution can be resolved in two somewhat different, but complementary, ways. First, there should be liberal use-of markets and market--like incentives. Second, the plan and planning process should be instruments of political leadership, articulating purposes and mobilizing the energies of the diverse interests whose partly independent activities constitute the implementation of the plan. Decentralized execution will not be easy to achieve, but there is an important opportunity for council leadership in the fact that the economic interests of the region parallel the goals of the act.

The shift from deterministic planning to regional risk management is fundamental. This paper focuses on planning, but a flexible approach implies significant changes in the way that projects are developed and programs managed. Regional risk management also requires coordination of operations with planning, in order to permit adjustment of both plans and operational policies to respond to emerging conditions. The broad ramifications of a risk-management philosophy should not obscure its essential simplicity, however: in an unpredictable world, the ability to adapt is valuable. This is an accepted, even conventional notion in finance, where the sharp economic fluctuations of the past decade have demonstrated the value of flexibility.

A planning concept that provides flexibility in the utility context is the resource option. The Regional Power Act provides a mechanism for acquisition of conservation and generating resources. A resource option is an acquisition contract that explicitly provides for regional control of the timing and magnitude of the project.

In order to be usable in planning an option can be no less real than any other resource in the plan. The experience of the last 15 years indicates that resource plans regarded by the utilities as "real" cannot be counted on. If the regional planning process cannot improve upon this record, one of the main hopes in the Regional Power Act will have been dashed. Thus, if there are unresolved technical questions -- like the feasibility of stack-gas scrubbers on coal plants -- a credible research and development program should be underway to settle them. If there are uncertainties in cost and schedule, these must be managed on the same basis for an option as for an acquired resource. If there are institutional hurdles -- such as approval of a site by a state licensing authority -- these must be addressed in a timely fashion whether the project is an option or an acquired resource. In short, a resource option should be no different from an acquired resource <u>except</u> in the way it is handled by the Bonneville Power Administration and the council.

An option is treated differently by the region in two respects. First, the option agreement authorizes the region to decide to accelerate, delay, or cancel the project, as part of a cost-effective regional power program. The early stages of developing a conservation program or generating resource are typically far less costly than the construction or implementation phase. An option agreement might therefore schedule a regional decision on whether to proceed, and how rapidly to do so, before construction begins.

A second way in which the region treats an option differently from an acquired resource is that the project sponsor may be compensated for the risk that the project will be rescheduled or terminated. An option is a form of insurance to the region, since it improves the ability of the regional planning process to meet a range of loads. The risk payments to the sponsor are insurance premiums.

Regional resource options are an important means of improving the flexibility of planning, but there are additional ways to do so. Smaller projects and resources available on short lead-times both make it easier to respond to changing circumstances. Conservation seems unusually flexible because the size of the resource can be adjusted; if loads grow more rapidly than anticipated, a more aggressive -- and expensive -- conservation effort can be pursued with little lead-time, if this possibility has been planned for. Renewable resource projects promote flexibility as well, when they are smaller than thermal projects. Some uncertainty remains, however, on how much conservation and renewable resources can be developed at cost-effective levels.

It is worth noting, moreover, that large central-station plants can be made more flexible through institutional changes, including option arrangements. Obtaining approval for sites and for engineering designs is a time-consuming part of a power plant project. If sites and licenses can be approved and then "banked," to be used for full-scale development later, the lead-time for large projects can be substantially shortened. Similarly, marketing part or all the output of a power station to utilities outside the Northwest decreases the effective size of the commitment shouldered by the region. If these marketing arrangements include contingency arrangements, perhaps along the lines of the call-back provisions in the Canadian Storage Power Exchange,, both size and timing can be made flexible. Regional control of banked sites and callback options enhances the risk-management capability.

In addition, there are institutional arrangements with consumers that can improve planning flexibility. For instance, rate schedules that are implemented only when a shortage looms can be used to hold down demand on short notice, if loads surge unexpectedly or supplies sag. Such contingent rates would require advance approval by public utility commissions, however, to make them usable as regional options. The fact that secure power supply is more valuable to some industrial customers than others can form the basis for a futures market, in which costly resources can be developed on behalf of those willing to bear the risk of paying for them in order to assure supply. Conversely, there may be consumers willing to purchase interruptible power, who have not had access to lower-quality power in the past; their purchases can provide peakload reserves and flexibility in planning.

The flexible, risk-managing approach differs from deterministic planning in one important economic respect: risk management does not minimize short-run costs. But if the future is really uncertain, a flexible combination of projects can lead to much lower costs than a least-cost investment that turns out to be based upon mistaken assumptions. The concept of portfolio diversification -- not putting all one's eggs in the same basket -- embodies the same risk-managing philosophy. A diversified portfolio may not earn the maximum return, but greatly decreases the probability of substantial losses.

Of course, one can hedge one's bets foolishly as well as wisely. Regional risk management is not self-implementing. But the deterministic approach, in the face of the uncertainties that confront the region, may guarantee failure.

Putting these principles into a workable planning process will require technical, organizational, and governmental changes. As a first step it may be sensible to consider a deliberately oversimplified example of how a regional plan could be more flexible.

An example of flexible planning

In conventional utility forecasting the objective is to estimate as accurately as possible the future demand for electric power. A common approach is to make high, low, and intermediate forecasts, using different demographic variables and assumptions about consumer response to rate changes; typically, the intermediate forecast is selected as the planning target. When uncertainty is high, however, there may be insufficient information to identify an appropriate intermediate case. That is, the region may have to meet a demand for power 10 or 20 years in the future that can lie anywhere within a broad range. It is reasonable to think, however, that one can still identify a broad range within which demand is expected to lie; the question for planning is how to use this information.

Figure 1 shows a pair of schematic demand forecasts. They are limiting cases, chosen on the basis of a consensus within the forecasting community that actual demand will lie between the lower and upper bound forecasts. Regional risk management proceeds this way:

- The regional plan must assure that resources are adequate in each year of the planning period to meet the lower bound forecast demand. This requires resource acquisitions.

- The regional plan must also assure that a combination of resources and options is available to meet the upper bound forecast in each year of the planning period. This requires development and acquisition of options, as well as resources.

- In order to be included in the plan, an option must meet standards developed by the council. These standards should insure that the option can, in fact, be converted into a

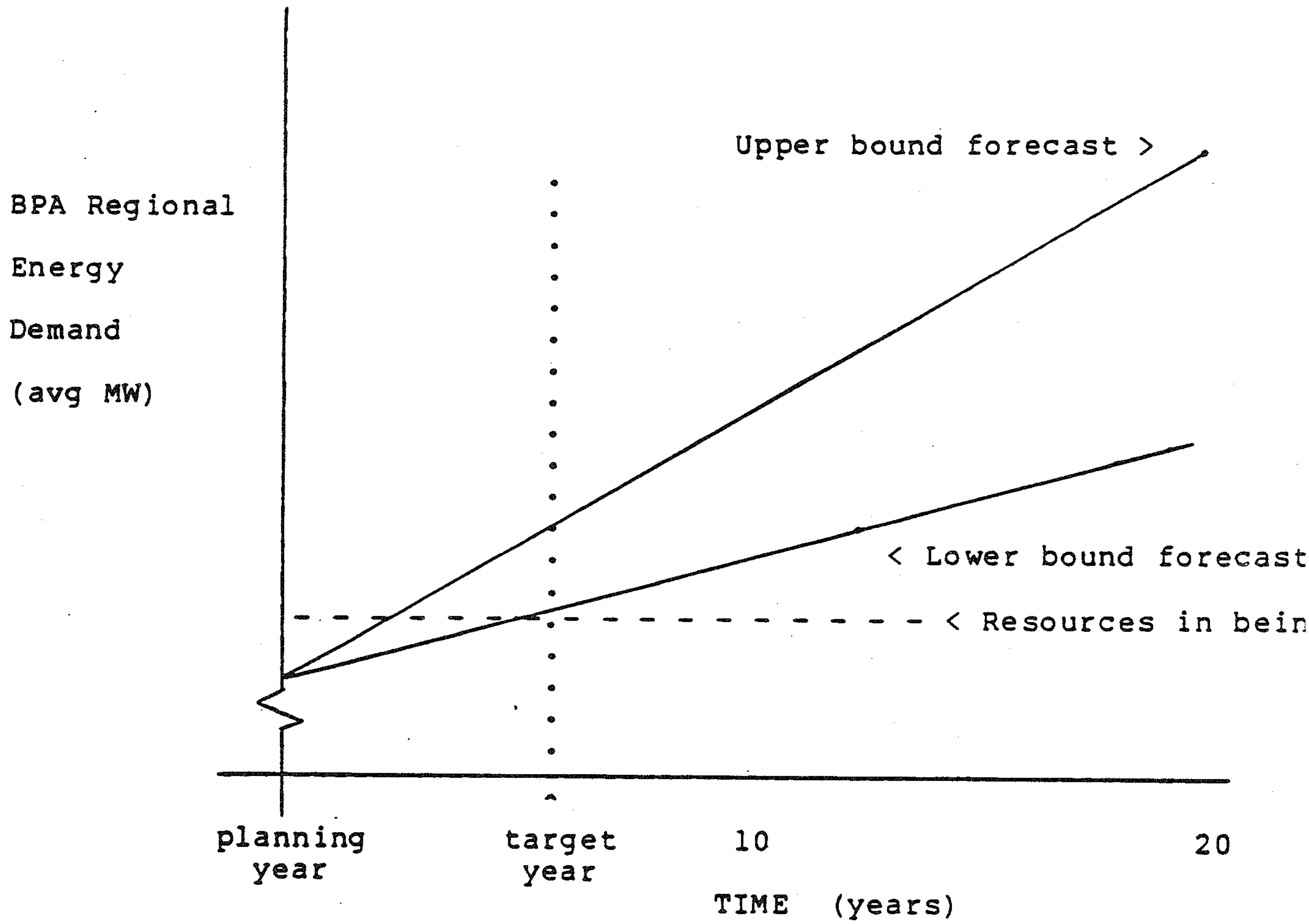

Figure 1. Upper and Lower Bound Forecasts.

resource by the year in which it is listed.

- A regional plan developed in this fashion must be reviewed frequently -- perhaps annually -- so that the mix of options and resources acquired can be adjusted in light of new information. Important kinds of new information include changes in the existing power system; revised lower and upper bound forecasts; data on costs and schedules of resources acquired; data on the costs of options and their availability for the year planned; and new resources and options developed since the last review.

How does one fill in the V-shaped space between the lower and upper bound forecasts? Figure 2 demonstrates an approach for a single target year. Looking at the target year from the vantage of the planning year in Fig. 2, the planner ranks resource possibilities in order of increasing expected cost.<1> The resource possibilities vary in size, but when assembled they span the range from resources in being -- the regional system projected for the target year -- up beyond the upper bound forecast.

Lead times for these resources vary. Some projects have already been optioned or acquired in earlier planning years, though more are needed to reach the lower bound forecast.. Some projects do not need to be started yet, such as project 1. In three cases -- projects 2, 3, and 6 -- a decision must be made in the current planning year. The process concentrates on these decisions.

Thus, project 1 does not have to be examined in detail, even though, among resources available in the target year, it is expected to be lowest in cost. An acquisition decision has to be made on project 2, however. Situations like this illustrate the <u>tradeoff between cost-effectiveness and flexibility.</u> If project 2

1. This expected cost should include measures of the technical, environmental, and institutional differences among resource alternatives. Some of these factors cannot be measured in monetary terms, however, although they are clearly relevant to a decision. For example, where a given resource is located can affect its accessibility to the regional grid, its financing, and the political acceptability to local populations of proceeding with the project. These factors are put aside in this simplified example.

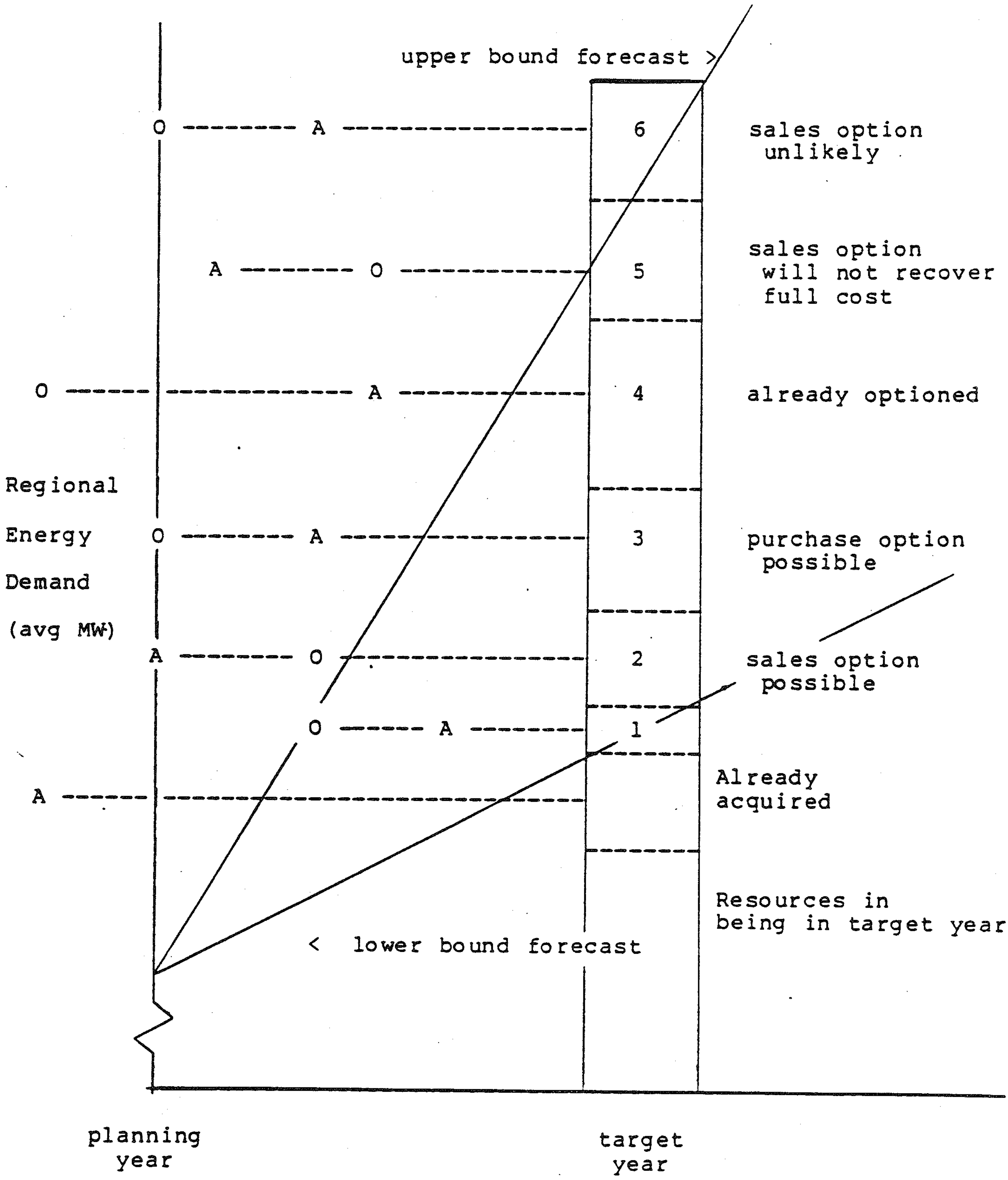

Figure _2. Example of Resource Possibilities for a Target Year, with timing of decisions to option (0) and to is acquired, an irreversible commitment will have been made, before the region has purchased lower-cost power from project 1. The dilemma is that the planning process cannot wait for the project 1 decision point, for project 2 would no longer be available in this target year, and higher cost resources, such as project 5, might then have to be developed. How should one value project 2? There is, unfortunately, no simple method for gauging the relative value of flexibility and cost. Whether to acquire project 2 is, nonetheless, a judgment that can be illuminated through analysis. For example, it is possible to compare the implications of acquisition and deferral of this project. Pulling project '2 out of the resource stack -- the result if the project is not acquired -- would necessitate the addition of more resource possibilities, higher in cost than project 6, so that the range between' lower and upper bound forecasts is still covered. At the same time, deciding not to acquire project 2 could mean that it remains available for development in a later target year, though probably at higher cost. Of course, foregoing acquisition can lead to a lower cost regional system if load growth falls in the low part of the range.

Note that Project 2 has a decision point for an option <u>after</u> it is acquired. This indicates the possibility of a <u>sales</u> option -- a contractual agreement with a wholesale power purchaser for sales beginning in the target year. A sales option protects the possibility of selling power at a given price. The sales-option decision point is an opportunity to evaluate progress just before the bulk of the money is spent on construction; if a sales option can be obtained by that time, the region can proceed, knowing that there is an assured market for part of the project when it comes on line in the target year. At the same time, an option to sell also decreases one's flexibility, since the option is likely to include an assurance that the power will be available to sell in the target year. Without such an assurance, the price of the option would probably be so high that the Northwest would gain little from having it.

Project 3, like project 1, provides the possibility of a <u>purchase</u> option: an agreement to initiate a project with regional financing, subject to later review. The point of no return, economically speaking, occurs soon after the acquisition decision indicated. Project 4 was optioned in an earlier planning year, and the final acquisition decision is still some way off; no decisions need to be made in the current planning year. Note, however, that information obtained since the last planning year may have shifted the costs and schedule of project 4® its position in the stack may thus be different from a year earlier. Project 5 is also a resource possibility for which no decision need be made. It is high enough in the cost stack, however, that -- on the basis of current information -- a future sales option may not permit the Northwest to recover the full cost of the project; this is clearly information with a significant bearing on the acquisition decision. Finally, project 6 requires an option decision in the current planning year. As with project 2, payment to keep project

6 available will have to be made out of order in the cost-effectiveness stacking. The questions that arose earlier in the discussion of project 2 are thus relevant. The answers to these questions may be different, however; both the high expected cost of project 6 and the fact that no sales option may be available for it decrease its desirability.

These resource possibilities have been discussed in the abstract. Considerations such as the geographical location of the projects, how they fit into the priority classes mandated by the Regional Power Act, and the operational characteristics of the overall resource mix if these projects should be acquired have all been put aside in this schematic example. These complications matter, of course, and would need to be analyzed in detail, using information developed by SPA, the council, the utilities, and other project sponsors and analysts.

It is also important to keep in mind that the regional risk management process is a dynamic one. As new information comes in about resources and about the outlook for demand, it should be used to adjust plans and commitments.

Consider what is likely to happen in the next planning year. There is now more information about each target year, though it is still incomplete. Upper and lower bound forecasts have shifted; usually, the distance between upper and lower bounds will have narrowed, since each target year is now closer to the point of the V. Second, the expected resources in being may have changed; changes in one target year affect the resources in being in later years. Third, the costs, sizes, and availability of resource possibilities have changed; projects that have been delayed are no longer available in the original target year. This plethora of alterations illustrates the need for frequent review of the plan.

Regional risk management emphasizes the development of options. Resource possibilities whose costs remain in the cost-effectiveness range spanned by the upper and lower bound forecasts are likely to be acquired at some point, though slow demand growth may delay them for a time. On the other hand, if the economics of power supply change dramatically, an option may be priced out of the evolving market. For instance, federal hydro projects introduced an extremely low cost resource to the Northwest, lowering the cost of electricity substantially; the escalating cost of Projects 4 and 5 of the Washington Public Power Supply System, in contrast, undermined their viability in the regional market.

The risk management approach also uses the information produced by forecasting in a novel way. The stress now lies on using the bounding estimates to define the range of resources and options needed in each target year. The traditional reliance on best-estimate forecasts has meant that high and low cases were selected casually. There is considerable room for improvement in choosing defensible upper and lower bound forecasts. Asking experienced forecasting modelers for consensus judgments on input data is a first step: what is the range within which the population trend is nearly certain to lie? how much and little can electric energy users respond to changes in rates? Additional information comes from analyses of the relative costs of over- and under-building. A power shortfall of, say, 3000 megawatts does not have the same impact as a 3000-megawatt surplus. One could choose bounding forecasts so that the upper and lower bounds reflect <u>equivalent</u> costs to the regional economy. Using economic forecasting to set limits for planning is a more modest task than identifying a precise target. There is reason to hope that approaches such as those sketched here would lead to estimates that are more scientifically sound and less burdened by political ideology.

In sum, the schematic risk management approach illustrated here replaces the concept of a single best forecast with an iterative three step process:

1. Use the best forecasting data and methods available to project the highest and lowest plausible cases. These upper and lower bound forecasts should reflect a range of demand broad enough that the actual demand can be confidently assumed to fall between the bounds.

2. Develop a stack of resource possibilities to fill the span between the lower and upper bounds for each year in the plan. The region should retain the right to delay acquisition in light of additional information about expected costs and demand. Options to sell part of the output of large facilities, together with purchase options -- regional financing of project initiation costs -- can facilitate the development of resource possibilities while retaining flexibility.

3. Make decisions as necessary on resource possibilities, so that there will be resources acquired to meet the lower bound forecast, and so that there will be a combination of resources and options capable of covering demand ranging as high as the upper bound forecast in <u>each</u> target year. Acquisitions should be trade following the

cost-effectiveness and resource priorities set forth in the Regional Power Act.

Regional risk management brings to the fore the question of whether it is possible to put a great deal more flexibility into the acquisition process. Before discussing some of the practical issues raised by the idea of options, one should pause to observe that flexibility may not be desirable in all cases, nor may it be obtainable on favorable terms. First, electric power planning does not take place in a vacuum; there are costs and benefits to others, and these costs and benefits depend upon how utility resources are scheduled. For example, Northwest electroprocess industries invest large sums in capital equipment on the assumption that. power will be available to utilize it. The Regional Power Act recognizes the value of secure supply to the direct-service industrial customers. More generally, flexible, risk-oriented planning benefits some and imposes risks and costs on others.

Second, a flexible, incremental approach encounters the problem of "second best": that is, incremental decisions, each of which is rational, may lead to a suboptimal outcome. Second best is the economists' version of the road paved with good intentions. For instance, vigorous attempts to improve the accuracy of forecasts -- a rational program -- may lead planners to have an inappropriate confidence in their estimates of future demand; thus, incremental improvements in the single best forecast do not lead one to the rather different approach suggested here. On account of both the external effects of planning and the problem of second best, it is wise to be cautious about the value of flexibility. But a flexible approach has obvious merit in the uncertain environment faced by the Northwest.

Practical questions

Regional risk management is clearer conceptually than practically. The ideas discussed in this paper are familiar and well-established in business, especially in finance and other cyclical industries. Yet applying them to the complex web of technological and institutional relationships that constitute electric power in the Northwest will be challenging. The promise of the risk-management approach is large: it is the one conceptual framework that offers significant, and achievable, strengths in facing uncertainty.

The council will be served best by a vigorous critique of the regional risk management concept. What are the barriers that stand in the way of using these ideas to structure the regional plan? What special advantages might accrue from using a risk-management approach, and what special disadvantages are attached to using it? Who will benefit, and who will lose, if a risk-management philosophy is adopted? Most of all, is flexible planning practical given the regional power system as it is, and will a system shaped by regional risk management be a better one for the ratepayers of the Northwest?

The key questions are those that surround measures to increase planning flexibility, especially resource options:

- Who will find it sensible to provide options, and under what conditions? What are the legal, economic, institutional, or psychological barriers that inhibit the development of options?
- Are options compatible with the Regional Power Act? Is the language of Sec. 6(f) , providing for reimbursement of resource development expenses, adequate as a legal framework for using options?
- Are options compatible with regulatory rules? Approval for major generating facilities usually requires a determination of the need for power -- a determination that is eschewed in flexible planning. State and federal regulations could thus be a significant barrier to regional risk management.
- Presumably, the front-end costs of most power supply projects are small near the time of initiation: design, siting, and licensing are-all activities that require far less expenditure than construction. So an option could be purchased at modest cost. But are conservation programs like this? What about experimental resources that may involve substantial research and development costs? More generally, what determines the cost of an option in a technical sense?
- Why would a project sponsor be willing to delay or halt a project once it is begun, and do so on the basis of <u>regional</u> criteria interpreted by the council or BPA? In part, this is a matter of what the region is willing to pay for the option in the first place. So, more generally, what negotiating factors influence the price of an option?
- How reliable are the cost and schedule estimates of options? Can they be made at least as credible as those for projects proposed for acquisition or billing credits under the act?
- Some options involve few direct costs beyond those of negotiation, such as contractual arrangements for power sales or purchases. What options for the Northwest are to be found in the plans of utilities in neighboring regions such as California or western Canada? Note that this question is similar to that of load diversity, but the focus is on planning rather than operations.

- Are there institutional arrangements other than contracts that can facilitate options? Are there conditions in which having shared ownership is advantageous? The aluminum industry has played an important role in the Northwest power system by providing a market for reserves that had no alternative market; are there similar industry-utility compatibilities with respect to resource options?

- If options are obtainable, which characteristics are most valuable? What is the relative value, for instance, of cost as compared to lead-time? of size compared to the uncertainties of completion on time? Does putting a high value on flexibility lead to unanticipated results?<2> This essay has implicitly assumed that cost and flexibility were the only relevant variables, but clearly that is not so. What would one want from an option? what makes an option a valuable form of insurance to the region?<3>

- What sort of options might be helpful if the lower bound forecast indicates <u>declining</u> demand in the region?

- This essay has implicitly assumed that central planning for the whole region will prevail. But it is likely that large utilities will continue to operate autonomously within the Bonneville service area. How are they affected by a shift to a flexible planning process? Neither their technological. or economic ability nor their willingness to participate in a centrally directed risk management strategy can be assumed.

- Can the fragile and complicated regional utility industry structure absorb the complexities of flexible planning? If the region's utilities were a single organization, this would be a question of corporate strategy. Within the existing fragmented situation, there is a danger that this system-level institutional question will not be considered seriously

2. For instance, flexibility can be enhanced by choosing technologies that have low capital costs and high running costs. That way, a project that is little used does not exact a high penalty. So- risk management may be an unrecognized argument for burning oil in combustion turbines, a resource possibility that conflicts with the national goal of limiting dependence on imported petroleum.

3. The insurance value of an option should decrease with the cost of power. A low-cost option is like y to be developed, and thus the ability to delay or terminate it is less valuable than for an option that produces power at higher

enough.

The risks that face the Northwest are plainly visible. Yet surprisingly, technical and institutional means of taking account of these risks in regional planning have not been clearly articulated. This essay attempts a beginning.