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SUPPLY CURVE IMPACTS OF QUICK
START PROJECTS IN PHASE ONE OF THE
RESOURCE SUPPLY EXPANSION PROGRAM

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SUMMARY

Two significant objectives of the Resource Supply Expansion Program (RSEP) are 1) to increase the energy potential available to the Bonneville Power Administration (Bonneville) and other utilities in the Northwest region through demand-side conservation measures, and 2) to improve the estimates of this energy potential. Bonneville and the Northwest Power Planning Council (the Council) use resource supply curves to estimate the energy potential of available and cost-effective conservation and renewable generating technologies in Bonneville's service area in the Pacific Northwest. Supply curves are developed from limited data, generally engineering estimates and professional assumptions. RSEP projects link preliminary estimates of resource potential to resource acquisition programs. Though the ultimate goal of RSEP is to aid acquisition of energy resources, an individual project may address barriers to acquisition of a type of conservation measure, or enable acquisition of a resource rather than demonstrating or assessing the potential of a particular technology. Accordingly, RSEP projects have been divided into six project types, based on where they fall between preliminary estimation of conservation potential and conservation resource acquisition. These project types are as follows:

- resource/technology assessment
- barrier identification
- barrier reduction: market, technical, or institutional
- enabling project
- advanced technology demonstration
- pilot program.

This report describes the expected results from Bonneville renewable generation projects as well as the nine demand-side management (DSM) RSEP projects funded in FY 1992, the so-called "Quick Start" projects. Table S.1 lists the Quick Start projects by project type and gives the estimated technical potential, which refers to the energy savings potential before accounting for barriers to acquisition. The list includes three residential-sector

TABLE S.1. RSEP Project Types and Summary Results

Sector	Project Title	Project Type	Est. Technical Potential
Residential	Manufactured Housing Retrofit	Technology Assessment	7-10 aMW
	Baseline Residential Lighting Use	Resource Assessment	NA
	Ground Source Heat Pump Demonstration	Technology Demonstration, Resource Assessment, Barrier Reduction (market & technical)	0.8 aMW
Commercial	Automated Lighting Controls	Barrier Reduction (market and technical)	7-28 aMW
	Daylighting Design	Barrier Reduction (technical and institutional)	NA
Industrial	Electro-Guard Motor Controller	Technology Assessment	180 aMW ^(a)
	Operations and Maintenance (O&M)	Technology Assessment, Barrier Reduction (institutional), Enabling Project	559 aMW
	Electrical Distribution System	Barrier Identification, Barrier Reduction (technical), Enabling Project	NA
Utility	Conservation Voltage Reduction (CVR)	Pilot Program	100 aMW
Renewable Generation	Regional Renewables	Enabling Project	NA
	Geothermal Confirmation Analysis	Pilot Program	500 aMW ^(b)
	RSEP Wind Strategy	Barrier Reduction	600 aMW
TOTAL			1,953-1,977 aMW
<p>(a) Bonneville service territory only.</p> <p>(b) 300 aMW confirmed through three Bonneville demonstrations plus 200 aMW estimated from unspecified sites.</p>			

projects, two commercial-sector projects, three industrial-sector projects, one utility-sector project, and three renewable generation projects.

Technical energy savings potential estimates are based on assumptions in Bonneville's and the Council's existing supply curves; these estimates are intended to provide an indication of the possible contribution of these projects to resource supply. Estimates of achievable potential were based on assumptions in Bonneville's and the Council's supply curves, and/or professional judgement. Levelized costs were estimated where cost data were available, using a discount rate of 3% and a line-loss credit factor of 7.5% (increasing savings by 7.5% to account for avoided transmission line energy losses). All but one of the projects for which levelized costs were estimated appear to be cost effective; that is, the estimated levelized costs are less than 56 mills/kWh. The Manufactured Home Retrofit Project does not appear to be cost effective. Savings or levelized costs were not estimated for some of the projects, because the data are not yet available and these projects do not address specific conservation technologies, but instead address other issues related to successful resource acquisition. In addition, these results have not been corrected to avoid "double counting" of conservation. For example, these savings estimates for the ground source heat pump include the savings Bonneville has in supply curves for air-source heat pumps. As a result, the savings from the ground source heat pump should not be added to those from air source heat pumps.

This report presents a brief description of RSEP, which is itself an experimental approach to energy resource research, demonstration, and development (RD&D). RSEP provided a framework that uses RD&D projects in a systematic manner to link the identification of energy resource technologies and acquisition of the "conservation resource" associated with these technologies. This framework formally recognizes that there are barriers to acquiring unconventional energy resources and that overcoming these barriers requires a direct effort by Bonneville and the utilities wishing to implement a specific technology. This framework also recognizes that initial savings estimates based on engineering assumptions are highly uncertain, and that identifying

and reducing barriers to acquisition inherently reduces the uncertainty in those assumptions. A companion report describes the RSEP experiment in more detail.

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1.0 INTRODUCTION

The Pacific Northwest Laboratory (PNL) prepared this report under contract to the Bonneville Power Administration (Bonneville), as part of the Resource Supply Expansion Project (RSEP). RSEP is a regional program instituted by Bonneville to expand conservation and renewable generation options available to resource planners and utilities. Resource alternatives are increased by RSEP through demonstration projects designed in a collaborative process that targets specific barriers to resource development including institutional, market, and reliability barriers. RSEP was launched with several projects that were designed and implemented quickly in 1992 to lay a foundation for future collaboration. The purpose of this report is to introduce the goal and structure of RSEP and to describe the so-called "Quick Start" RSEP projects in Phase One of RSEP. This description includes a preliminary estimate of the energy savings and/or other expected impacts of RSEP projects funded in FY 1992 and 1993. Similar estimates are also included for Bonneville projects to confirm wind and geothermal generation potential. Bonneville's Geothermal Confirmation Agenda preceded implementation of RSEP, although it has a similar objective and collaborative approach.

The Quick Start projects emerged from collaborative discussions hosted by RSEP. Twelve resource expansion projects were approved for FY 1992 funding:

- Electro-Guard Motor Controller
- Electrical Distribution System
- Industrial Operations and Maintenance
- Automated Lighting Controls
- Daylighting Design
- Baseline Lighting Use
- Manufactured Home Retrofit
- Ground Source Heat Pump
- Conservation Voltage Reduction

- Regional Renewables
- Geothermal Confirmation Agenda
- RSEP Wind Strategy.

These projects are described in detail in this report. Section 2 describes the goals and structure of RSEP. Section 3 describes the project types and relevant issues and/or the methodology used to estimate energy savings. Section 4 describes the nine Quick Start DSM projects, including expected impacts of each project and estimated energy savings for selected projects. Section 5 describes the renewable generation projects. Section 6 presents the conclusions of the report and suggestions for further research. Section 7 lists the references.

2.0 THE RESOURCE SUPPLY EXPANSION PROGRAM

As explained in this chapter RSEP came about in part to improve upon the reliability of Bonneville's supply curve saving estimates for conservation technologies.

2.1 A WORKING DEFINITION OF SUPPLY CURVES

Currently the Northwest Power Planning Council (the Council) and Bonneville develop conservation supply curves that estimate the energy savings potential of available and cost-effective conservation technologies. A conservation supply curve consists of a rank ordering of an exhaustive range of conservation measures on the basis of cost per unit savings (\$/kWh). The inventory of conservation measures constitutes the "supply." When conservation measures' savings potential are displayed on a graph with the measures ordered by increasing cost, the result is an upward sloping "curve." Supply curves used for resource planning are composed of many detailed supply curves, each specific to a market sector, such as new residential construction. These detailed supply curves are aggregated into composite supply curves so that tradeoffs between market sectors (e.g., commercial versus residential) are clear. Supply curves are also used to represent generating resource alternatives.

Supply curves are often developed from limited data, generally engineering estimates and professional assumptions. Although this approach is economical and satisfactory for resource planning, it has often left field demonstrations of supply curve assumptions to resource acquisition programs. Program evaluation results frequently raise questions about the reliability of planning supply curves. As a result, supply curves have been criticized as unrealistic, because they overestimate conservation potential and ignore barriers and obstacles to acquiring unconventional generating and demand-side management (DSM) resources. Skepticism about the reliability of supply curve resources manifests itself in slower than expected acquisition of resources through the implementation of DSM measures and renewable generation that is

deemed to be cost-effective. In response to this skepticism, Bonneville initiated RSEP and the Council adopted Action Item 3, Resource Confirmation, in its 1992 Power Plan.

2.2 EVOLUTION OF RSEP AND A "RESOURCES THROUGH RESEARCH" PARADIGM

The goal of the Council's Action Item 3 and RSEP is to confirm and expand resources available to the region through collaborative research and field demonstrations. The focus of this research was initially expected to be on technical uncertainties regarding the installation, operation, and reliability of DSM and renewable generation, as well as on improved assessment of renewable generating potential.

RSEP was implemented as an experiment itself. The foundation of the "RSEP experiment" was that collaboration between Bonneville, the Council, regional utilities, the Department of Energy, and others with a stake in the development of unconventional energy resources would produce a process for conducting energy resource research, development, and demonstration that would be more effective, efficient, and lower cost than Bonneville alone could produce. Unlike most Bonneville programs, RSEP was not designed in advance and offered as a "take-it-or-leave-it" program. Instead, the goals and operating principals for RSEP were loosely defined and open to revision by program participants.

Bonneville launched RSEP through a series of official and informal meetings with potential collaborators. The scope of RSEP gradually expanded during the course of these meetings to include potential research topics other than technology demonstrations. These topics included DSM resource assessments and the identification and reduction of market and institutional barriers to resource technologies. This was one of the first "experimental results" from RSEP.

Bonneville's early proposals for RSEP included a model for identification of new energy resources through research. This model used an arrow to illustrate the progress of promising energy resources from invention through acquisition. The process of launching RSEP provided useful feedback from Bonneville customer utilities and other collaborators that expanded on this

model. The evolution of the early Bonneville model for "resources through research" through the early stages of RSEP implementation into an "RSEP Paradigm" is one of key outcomes from RSEP. It should be noted that this paradigm was developed during the implementation of RSEP and the design and implementation of demonstration projects. True to the term "evolution," this specific paradigm did not exist at the outset of RSEP and hence did not explicitly guide the selection of RSEP projects. It is, in fact, a retrospective interpretation of how RSEP "worked" that seems both accurate and useful for reviewing the projects in the first phase of RSEP.

The path from identifying a new energy technology or measure to acquiring it as an energy resource can be viewed as a continuum, as illustrated in Figure 2.1. Supply curves for a technology are developed early in the process. Bonneville and the Council assess the total technical potential in the region and estimate how much of that technical potential is achievable, once a technology has been identified as available and cost-effective in the region. At this point in the process, however, the specific technology has often not been demonstrated; therefore, barriers to acquiring the technology have not been identified, though they are assumed to exist. These obstacles can be market barriers, technical barriers, or institutional barriers, and they can reduce the amount of conservation acquired from a measure or even block acquisition.

FIGURE 2.1. RSEP Path for Confirming Resources

RSEP's role is to use demonstration projects to overcome barriers between identification of a resource and acquisition of that resource. RSEP projects serve a variety of purposes:

- Demonstrate the conservation potential of new, often untested, technologies not currently in supply curves to encourage their inclusion in supply curves.
- Improve the availability of and/or savings from existing technologies, which improves their cost-effectiveness.
- Improve Bonneville's estimates of savings from existing technologies to increase both the reliability of supply curves for planning and confidence in resources in the supply curves for acquisition programs.
- Improve the baseline data used to develop model assumptions, which includes better defining realistic market targets.

Figure 2.1 presented a framework for adoption of technologies as energy resources. This continuum reflects various levels of confidence in a specific technology or resource. Confidence is built through improved knowledge as well as barrier reduction. In fact, improved knowledge is a key to barrier reduction in most cases. The "end point" for RSEP projects is "confirmed" energy resources, including "real world" costs. RSEP project selection is guided by estimates of these end points from supply curves and other sources. These estimates are not as reliable as field results, thus the need for RSEP demonstrations. As field and other experience accumulates, supply curve estimates more closely mirror realistic acquisition targets.

Figure 2.2 illustrates how the certainty of these initial estimates improves the closer the technology or project is to "acquisition." As RSEP projects are completed, and technologies move along the continuum, energy resource estimates will change as they more accurately reflect "real world" conditions. This report presents the "starting point" estimates for the 12 RSEP "Quick Start" projects.

FIGURE 2.2. The RSEP Continuum Showing Increasing Certainty in Savings

2.3 CONTINGENT ENERGY RESOURCES: AN EXAMPLE FROM THE OIL INDUSTRY

An analogy can be made between RSEP's resource confirmation objectives and estimates used in the oil industry to represent resource potential (Figure 2.3). Although there are no hard and fast definitions, conventions in the oil industry divide resources into two broad categories: discovered and undiscovered. As the names suggest, discovered resources are those that are known to exist based on physical evidence. Undiscovered resources are speculated to exist due to similarities with sites with discovered resources or similar extrapolation. Discovered resources are divided into two additional categories: reserves and contingent resources. Contingent resources are those that are known to exist but have significant technical barriers to their

development, such as no known drilling technology can reach them or the oil-bearing rock is resistant to current extractive methods. In this scheme of things, undiscovered resources are more "real" than discovered, but contingent, ones. Discovered resources are further divided into "proved" and "prospective" reserves. Proved reserves are those that have or had producing wells with recoverable oil remaining. Prospective reserves are those associated with proved reserves but not currently producing oil. Both types of reserves are further classified as "recoverable" or "economic" reserves, and unrecoverable reserves. This definition depends on assumptions about the cost of developing the resource as well as the price of oil. As a result, estimates of economic reserves vary.

FIGURE 2.3. The Oil Industry as an Example of Resource Potential

This analogy is readily extended to supply curves. Proved reserves are similar to resources that have been or are being acquired through energy resource programs. Field experience has confirmed the existence, performance, and cost of these resources. Prospective resources are like DSM measures and renewable generation that are known, but not currently cost-effective. Changes in assumptions about future power costs or measure or renewable generation costs can change the status of these resources. Contingent resources are like generation technologies that are known, but difficult or uneconomic to develop, such as hydrogen generation or solar power from outer space. Undiscovered resources are those that could be anticipated by extrapolating from current technologies, but are not specifically known today. These could include improvements from research into more efficient appliances that are not yet included in commercially available products.

This analogy is stronger for renewable generation, especially wind and geothermal generation, than for DSM resources. For renewables, proved reserves are similar to geothermal wells or wind farms that are producing power in a specific area. Prospective reserves would be the remaining energy producing potential in that same area and areas with very similar characteristics. Undiscovered resources would be similar to the energy producing potential from similar resources using similar but not identical technology. For example, the geothermal resources in one area may be a different temperature or in a different type of rock formation than a producing site. As a result, although extrapolations can be made about the performance of the steam generator, these are subject to error due to uncertain temperature and drilling cost.

The same is true of wind generation, where variations in wind speed, direction, and duration all affect the performance of a wind farm. (Contingent resources for wind and geothermal would include resource potential in areas that are set aside from development, such as in National Parks and scenic areas and areas where the resource potential is too small to develop.)

The overall goal of RSEP is confined to reducing the uncertainties associated with specific resources and moving them from being "prospective" to "recoverable" and "proved." Figure 2.2 combines this objective with the

"resources through research" continuum to reflect how RSEP projects improve assumptions about resources, reduce uncertainty associated with specific resources, and facilitate the acquisition of these resources.

3.0 PROJECT TYPES AND SAVINGS ESTIMATES ALONG THE RSEP PROCESS CONTINUUM

The project types and estimating methodologies used in this report are described below.

3.1 PHASE ONE PROJECT TYPES

The 12 Quick Start RSEP projects have been divided into six project types, based on where they fall between preliminary estimation of conservation potential and conservation resource acquisition. These project types are as follows:

- resource/technology assessment
- barrier identification
- barrier reduction: market, technical, or institutional
- enabling project
- advanced technology demonstration
- pilot program.

Table 3.1 shows the 12 Quick Start projects by sector and project type. There are three residential-sector projects: the first is a technology assessment; the second is an enabling project; and the third is a resource assessment, barrier reduction, and technology demonstration project. There are two commercial-sector projects; both are barrier reduction projects. There are three industrial-sector projects: one technology assessment, one barrier identification/enabling project, and one technology assessment/institutional barrier reduction project. There is one utility-sector project, a pilot program. There are three renewable generation projects: one pilot program, and two barrier reduction/enabling/pilot projects.

3.1.1 Resource and Technology Assessment

Resource assessment projects address the amount of energy used by a particular piece of equipment or activity, which determines how much energy a conservation measure or technology aimed at that activity can save at the

TABLE 3.1 RSEP Project Types by Sector

Sector and Project	Project Type							
	Resource/ Technology Assessment	Barrier Identifi- cation	Barrier Reduction			Enabling Projects	Advanced Tech- nology Demon- strations	Pilot Pro- grams
			Market	Technical	Institu- tional			
Industrial								
Electro-Guard Motor Controller	X							
Electrical Distribution System		X		X		X		
Operations & Maintenance	X				X			
Commercial								
Automated Lighting Controls			X	X				
Daylighting Design				X	X			
Residential								
Baseline Lighting Use	X							
Manufactured Home Retrofit	X							
Ground Source Heat Pump	X		X	X			X	
Utility								
Conservation Voltage Reduction								X
Renewable Generation								
Regional Renewables						X		
Geothermal Confirmation Agenda			X	X	X	X		X
RSEP Wind Strategy			X	X	X	X		X

regional level. There are two resource assessments in the "Quick Start" projects: a residential baseline lighting use study, and a ground source heat pump demonstration.

Technology assessments, the flip side of resource assessments, involve estimating the savings potential of new and "advanced" technologies not

currently included in supply curves but similar to current measures, such as better light bulbs or motors. Savings for these technologies were estimated by using the best available information on measure performance. This information was combined with either Bonneville's or the Council's existing supply curve assumptions of energy consumption and achievable penetration for similar measures for the pertinent sector and end-use. Achievable potential estimates, though uncertain, have reliability similar to many measures in supply curves.

There are three technology assessment projects: the manufactured home retrofit project, the Electro-Guard motor controller project, and the industrial operations and Maintenance (O&M) project.

3.1.2 Barrier Identification

Once it has been determined that a conservation measure "works," that it saves energy in a research setting at least, the next step is to identify the barriers to acquiring it. Barriers can be divided into three categories: market, technical, and institutional barriers. Market barriers are barriers in the market other than cost; for instance nobody knows about the technology. Technical barriers are conditions or equipment, other than the conservation technology, that inhibit acquisition of conservation; for example the technology works in isolation but in a realistic setting it creates problems in the electrical system. Institutional barriers are non-market resistance to conservation technologies, where a measure's success may require a change in policy, attitude, or behaviors; for example building codes that do not recognize certain construction practices that will save space-conditioning energy.

There is one barrier identification project: the industrial electrical distribution system study.

3.1.3 Barrier Reduction

Seven Quick Start projects are partially or wholly classified as barrier reduction projects: the industrial O&M project, the industrial electrical distribution system study, the commercial automated lighting controls project, the commercial daylighting design, the ground source heat pump demonstration,

the Geothermal Confirmation Agenda, and the RSEP wind strategy. The industrial O&M project is also classified as a technology assessment. The industrial electrical distribution system study is also classified as a barrier identification project. The ground source heat pump study is also classified as a resource assessment and an advanced technology demonstration. The Geothermal Confirmation Agenda and the RSEP wind strategy are also enabling projects and pilot programs.

None of the projects addresses market barriers exclusively. The commercial automated lighting controls project addresses market and technical barriers against lighting controls by demonstrating the controls in a variety of settings. The commercial daylighting design project is classified as a technical and institutional barrier reduction project.

3.1.4 Enabling Projects

Enabling projects are not directly related to a conservation technology or measure but make it possible to acquire a conservation resource by addressing a barrier or obstacle to acquisition. Four Quick Start projects are partially or wholly classified as enabling projects: the regional renewables project, the industrial electrical distribution system study, the Geothermal Confirmation Agenda, and the RSEP Wind Strategy.

3.1.5 Advanced Technology Demonstrations

The only advanced technology demonstration project is the ground source heat pump demonstration. Advanced technology demonstrations will involve technologies that have not been widely implemented in the Pacific Northwest, but are similar enough to technologies currently available that resource assessments, barrier identifications, and barrier reduction projects may not be needed.

3.1.6 Pilot Programs

A pilot program is the last step before acquisition of a resource on the continuum in Figure 1.1. Pilot programs address technologies already in Bonneville's supply curves. The expected savings impacts of the pilot program were estimated using existing assumptions for the activities in question. Generally the goal of RSEP projects that demonstrate activities or

technologies which are already in the supply curves is to confirm and/or improve the achievable potential of the measure by eliminating market barriers and/or by improving utilities' confidence in the measure. In many cases, the targeted "achievable" penetration for a measure is significantly greater than its current actual penetration. The three pilot programs are the conservation voltage reduction (CVR) project, the Geothermal Confirmation Agenda, and RSEP wind strategy.

3.2 PRELIMINARY ENERGY SAVINGS AND LEVELIZED COST ESTIMATES

Preliminary energy savings impacts and costs were estimated for seven projects as shown in Table 3.2. These estimates are not based on project results since the projects are not yet complete; instead we used various methods of estimation based on assumptions in the existing supply curves to clarify expectations regarding the contributions these projects may make to increasing resource supply. For measures where cost data were available, levelized costs were estimated. All levelized cost calculations use a discount rate of 3% and a line loss credit factor of 7.5% (savings are increased by 7.5% to reflect avoided line losses). If adequate cost data were not available no levelized costs were estimated.

It should be remembered, however, that one of the purposes of RSEP is also to improve the reliability of supply curves. These energy savings and levelized cost estimates will be updated later in this process as projects proceed. This report should be seen as an interim step in the process, not an end in itself.

Several projects are expected to produce significant energy savings that cannot feasibly be estimated at this time because the savings attributable to the specific project are not quantifiable. These include the resource assessment, barrier identification, and enabling projects, as well as three of the five projects partially or wholly classified as barrier reduction projects — the electrical distribution system, the commercial daylighting design project, and an advanced technology demonstration project — ground source heat pumps (see Table 3.2). The expected impacts of these projects are described below. For those projects expected to have direct savings impacts — technology

TABLE 3.2. Estimate of Resources Confirmed Through the First Phase of RSEP

PROJECT	TECHNOLOGY	ENERGY SAVINGS	LEVELIZED COST
Residential-Sector Projects			
Manufactured Housing Retrofit	Weatherize walls, ceiling, floors	Technical potential 6.9-10.2 aMW; achievable potential 3.5-5.1 aMW, assuming 50% penetration. ^(f)	709 to 5,950 mills/kWh
	Heat pump retrofit	Technical potential 112 aMW; achievable potential 32 aMW, assuming 30% penetration. ^(f)	56 mills/kWh
	Ground Source Heat Pumps	Technical potential 0.8 aMW in 2000; achievable potential 0.18 aMW, assuming 20% penetration among public customers and 25% among customers of investor-owned utilities.	
Commercial-Sector Projects			
Automated Lighting Controls	Electronic ballast dimmers	Technical potential 28 aMW; achievable potential 20 aMW, assuming increased penetration, from 60% to 70%. ^(e)	7 to 37 mills/kWh
	Stepped switch dimmers	Technical potential 7.2 aMW; achievable potential 5 aMW, assuming 70% penetration. ^(e)	8 to 40 mills/kWh
Industrial-Sector Projects			
Electro-Guard Motor Controller	Motor controller for 1 hp - 200 hp motors	Technical potential 180 aMW; achievable potential 27 aMW, assuming 15% penetration. ^{(a)(e)}	13 mills/kWh ^(e)
Operations and Maintenance (O&M)	Various activities	Technical potential 559 aMW, from energy audit data; ^{(b)(f)} achievable potential highly uncertain.	NA
Electrical Distribution System	Electric Motors (wiring and controls only)	NA	NA
Utility-Sector Projects			
Conservation Voltage Reduction	CVR	40 ^{(c)(e)} to 100 aMW ^{(d)(f)}	14 mills/kWh ^{(c)(d)}
Renewable Generation Projects			
Geothermal Confirmation Agenda	Geothermal Energy Production	300 ^(g) to 500 aMW	37 ^(g)
Wind Strategy	Wind Energy Production	50 ^(h) to 600 aMW	(h)
<p>(a) Aluminum and other direct service industries not included in savings estimates.</p> <p>(b) Aluminum direct service industries not included in savings estimates.</p> <p>(c) Bonneville 1992, p.11-4.</p> <p>(d) Council 1991, p.618.</p> <p>(e) Bonneville service area only.</p> <p>(f) Pacific Northwest region.</p> <p>(g) 90 MW are guaranteed - Bonneville will purchase up to 300 MW if available at demonstration sites.</p> <p>(h) Negotiations are under way for two 25-aMW wind farms with options for future expansion. Costs and total production contingent on negotiations.</p>			

assessments, one of the barrier reduction projects, and a pilot program — the estimated energy savings are presented in this section and with the project discussions in Chapter 3.

Savings were estimated for one market and technical barrier reduction project, the automated lighting controls project. There are three other barrier reduction projects for which savings could not be estimated.

The renewable generation projects include the full spectrum of project types. However, the primary focus of those activities is on reducing barriers, particularly institutional barriers. Generation demonstrations are implemented through contracts with costs and production expectations specific to each site. Cost reflected in this report are for contracts which have been negotiated. Several contracts remain in process.

4.0 DESCRIPTIONS AND PRELIMINARY RESULTS OF THE QUICK START DSM PROJECTS

The nine Quick Start projects described in this section address a broad range of technologies, sectors, and issues related to successful acquisition of conservation resources. The projects are arranged by the market sector to which they apply: residential, commercial, industrial, utility, or renewable generation.

4.1 RESIDENTIAL SECTOR

The three residential sector projects are the manufactured housing retrofit study, the baseline residential lighting use project and the ground source heat pump demonstration.

4.1.1 Manufactured Housing Retrofit Study

Type: Technology Assessment

This two-part project examines the feasibility of retrofitting existing manufactured homes to reduce energy consumption for space heating. The first part of the project is to weatherize 25 manufactured homes, using some combination of measures for insulating the walls, underbelly, and ceiling, as well as sealing the ducts. As the second part of the project, heat pumps have been installed in 10 manufactured homes. Market assessments of the number, vintage, and general repair of manufactured homes in the Northwest will help determine the approximate number and location of appropriate sites in the region for retrofits. The weatherization project is identifying characteristics that qualify contractors to weatherize manufactured homes and the conditions under which weatherization is cost-effective. The heat pump demonstrations assess the potential for cost-effective energy savings from heat pumps.

The Manufactured Housing Study applies a general category of measures that are in the supply curves, but no savings are estimated for these applications. The purpose of the project is to find out if weatherization will cost-effectively produce significant savings in existing manufactured homes. The weatherization of existing manufactured homes involves measures similar to those used in existing single-family homes of comparable size.

For this preliminary estimate, the measures were assumed to consist of insulating the ceiling, walls, and floor to the maximum level physically possible without making major structural changes. These limits were defined according to the Hood River Conservation Project data on physical characteristics of manufactured homes, by vintage.^(a) Sealing of ducts was not included as a measure in the savings estimate due to lack of data. Savings were estimated for three prototypes, corresponding to the year of construction. All homes are assumed to be double-wide (in the range of 1,300 to 1,500 square feet), based on size distributions found in the Hood River Conservation Project data. The three age groups considered were 1970-1975, 1976-1979, and 1980-1988, and the distribution of vintages was taken from Hood River Conservation Project data.

Levelized costs were calculated based on retrofit cost data for insulating the ceiling, walls, and floor of a prototypical manufactured home (Lee et al. 1988). For this analysis, the cost data for each measure (floor, ceiling or wall insulation) were converted to average incremental costs per square foot per unit increase in R-value.

Achievable penetration is assumed to be 50%, i.e., if the measure is cost effective it will be feasible to weatherize only 50% of the manufactured homes in the region. This assumed penetration rate is set low to account for the possibility that much of the existing manufactured home retrofit market may be in hard-to-reach rural areas, and individual structural characteristics in some homes may preclude weatherization.

Several policies impact the retrofit potential in manufactured homes. The Department of Housing and Urban Development (HUD) established a code for insulation levels for manufactured homes in 1976. In 1989 Bonneville initiated the Super Good Cents Program. Under this program, participating manufacturers received incentives for insulating new manufactured homes to a specified (higher than HUD code) level. The Manufactured Housing Acquisition Program (MAP), which began in 1991, is a voluntary program in the Northwest region, requiring a level of insulation in all new manufactured homes that is

(a) Personal communication with Allen Lee, PNL, 12/13/92.

higher than the Super Good Cents or HUD-code requirements. All manufactured home producers in Bonneville's region have committed to participation in MAP for the next 5 years. It was assumed that manufactured homes constructed after 1989 do not have any retrofit potential, because most of the manufactured homes constructed after 1989 were built to Super Good Cents or MAP insulation requirements.

Another important consideration in weatherizing manufactured homes is the remaining life of the home itself. In general the earlier the home was constructed the shorter its total and remaining lifetime. The persistence of measures was included in the levelized cost calculation. Persistence was assumed to be equal to the remaining lifetime of the homes, using the median age of each vintage group (e.g., 1972 for homes built between 1970 and 1975) as a starting point for the estimated life of the home. Savings are accrued after 1993. Thirty years is an optimistic estimate of the lifetime of homes built before 1970, meaning that the remaining life of these homes is 6 years at best. Homes built between 1970 and 1989 are likely to have lifetimes of 30 years, and homes built after 1989 are likely to last 40 years or more.^(a) For this estimate, only homes built between 1970 and 1988 are considered, as they are the most likely to have cost-effective retrofit opportunities.

The energy savings from weatherizing manufactured homes are estimated using a prototype spreadsheet developed by PNL which converts R-values to UA values. R-value refers to the thermal conductivity of a material and is the unit of measurement used for insulation. UA-value is an instantaneous heat loss factor which measures the heat loss per hour per degree Fahrenheit. The space heating energy savings can be estimated from the change in UA value due to adding insulation, given the initial space heating load. Space heating load was approximated for the Council's Zone 1 (west of the Cascades) and Zone 2 (east of the Cascades) from typical climate data.

Savings estimates are based on a change in total building UA (an instantaneous heat loss factor) due to adding insulation. The change in UA is converted to an estimated energy savings for each climate zone, using typical

(a) Personal communication with Allen Lee, PNL, 12/13/92.

heating degree days of 4,792 for Zone 1 and 7,117 for Zone 2.^(a) The resulting technical potential for the Northwest from weatherization is estimated to be between 6.9 and 10.2 aMW, with achievable potential at 3.5 to 5.1 aMW based on an assumed 50% penetration rate. Levelized costs range from about 600 mills/kWh to 4,300 mills/kWh (see Appendix A for calculation details), well above the Council's cost-effective cutoff point of 110 mills/kWh. Based on this analysis, weatherizing existing manufactured homes does not appear to be cost-effective; however incremental levels of insulation less than the maximum level physically possible may turn out to be cost-effective.

In the second part of the project, 10 manufactured homes were selected as demonstration sites for heat pumps. All 10 homes currently use electric furnaces and the residents are willing to pay for air conditioning. The original project design called for 2 to 4 of the heat pumps to be dual-fuel heat pumps with gas or propane back-up; however, Portland General Electric, the project sponsor, decided to install all-electric heat pumps in all of the homes. The Oregon Public Utilities Commission will not allow utilities to cover all of the costs of retrofitting homes with heat pumps because they can build cooling load.

Heat pumps have very high first costs and relatively short lifetimes. The number of manufactured home residents willing to pay for air conditioning and able to pay for installation of heat pumps is expected to be low, without a utility subsidy.^(b) Because the lifetime of a heat pump is assumed to be 15 years, only homes built after 1975 are considered in this analysis. The eligible population of homes is assumed to be those built between 1975 and 1990. This estimate could be refined using data on the geographic

(a) From the Standard Heat Loss Methodology of October 1984 (Exhibit F) prepared by Bonneville Power Administration.

(b) Conrad Eustis of Portland General Electric stated that he expected the market penetration for heat pumps to be approximately 30 to 40%, personal communication, 8/31/92.

distribution of manufactured homes, from the Pacific Northwest Residential Energy Use Survey (PNRES) (Bonneville 1983) and/or other data on the demand for air conditioning.

For the estimate of heat pump savings, the major uncertainty is in the achievable penetration, which depends on the number of manufactured home owners both willing and able to pay the significant up-front costs of a heat pump. Measure savings were assumed to be 4,500 kWh/year on average, based on preliminary project results. The cost of a heat pump is assumed to be \$3,000, and the average lifetime is assumed to be 15 years.^(a)

The technical potential of heat pump savings in manufactured homes built after 1975 is approximately 89 aMW, and the achievable potential is about 27 aMW, based on the 30% penetration assumption. Levelized cost, assuming no equipment replacement and considering heating savings only, is approximately 56 mills/kWh (See Appendix A for calculation details).

4.1.2 Baseline Residential Lighting Energy Use

Type: Resource Assessment

The purpose of this project is to gather baseline lighting-use data from a representative sample of residences because current data on residential lighting use are very limited. The project may also identify cost-effective applications of compact fluorescent lighting. Currently it does not appear that compact fluorescents are cost-effective for most residential retrofit situations. The bulbs are much more expensive than incandescents, so they have to be installed in high-use locations to recover their cost. With compact fluorescent bulbs that fit into standard fixtures there is a high probability that the bulbs will be removed and replaced with incandescent bulbs. In many cases new fixtures also have to be installed because many of the compact fluorescent bulbs currently available do not fit in standard fixtures, adding installation costs.^(b)

(a) Personal communication with Conrad Eustis, Portland General Electric, 6/24/93.

(b) Bonneville internal memo from ZoeAnne Arrington to Doug Couch, on retrofit residential lighting, July 22, 1992.

Under current Bonneville guidelines for evaluating residential lighting program proposals from utilities, estimated savings from residential lighting retrofits must be reduced to account for bulb removal (-30%), increased heating load (-47%) and increased power factor (-2%). For a typical case of replacing 60-Watt incandescent bulbs with 16-Watt compact fluorescent bulbs in a single-family home (2-3 sites per home), estimated savings are 15.6 kWh per year. The levelized cost for this typical case comes to 90 mills/kWh, well above the cost-effective cutoff of 56 mills/kWh.^(a)

This project also includes an incentive program of giving five compact fluorescent lights to participating households. The incentive portion of the project may increase consumer and utility confidence in compact fluorescents, however, Bonneville research found that other utilities have experienced high removal rates and low consumer satisfaction with compact fluorescent bulbs.^(b) In practice it has been found, that single-family residences have at most two or three viable sites for compact fluorescents (in terms of light level needed, burn hours, and aesthetic preferences), and multifamily residences average one site per unit (Bonneville 1992). So it is likely that the participants would only use one to three of the incentive bulbs at a time.

4.1.3 Ground Source Heat Pump Demonstration

Type: Resource Assessment, Barrier Reduction: Marketing and Technology Demonstration

The goals of this project are to quantify energy savings potential through the evaluation of actual performance, lower the installation costs by installing several units at the same time, and familiarize the community with the technology. Ground source heat pumps use a water loop as the heat exchanger instead of air as in the more common air source heat pumps. The water loop itself consists of tubes that are sunk vertically into the ground at a sufficient depth to take advantage of the difference in temperatures. The project is being undertaken by the Missoula Electric Corporation and is expected to last for a period of 4 years. During that time period a total of

(a) Bonneville internal memo from John Holmstrom and Ruth Bennett to Area Energy Resource Managers, on guidelines for responding to utility residential lighting proposals, October 30, 1992.

40 homes will be built with ground source heat pumps: data collection at the first 20 homes is expected to start in November 1993 and data collection at the second 20 homes will begin in November 1994.

The savings from the ground source heat pump actually has three components: the primary savings are from the decrease in heating energy requirements, the heat pump provides additional savings by providing air cooling and hot water. The average heating savings for a single unit is expected to be 3,300 kWh per year, when compared to a standard electrical furnace. The total technical potential of ground source heat pumps is estimated to be about 2 MW for the region over the 1993-2010 period. (Assuming savings of roughly 1,000 kWh per home and increasing penetration of geothermal heat pumps to a maximum of about 21% by 2000. No savings estimates have been developed for the cooling and hot water portions. Measured data from the sites will be compared to typical energy usage in the area to provide more accurate savings estimates from all three savings components.

Installation costs are higher than with traditional air source heat pumps because a trench is required to hold the vertical water loop. Among other things, this project will quantify the cost differential between digging a trench for a single house and digging trenches for all the houses in a subdivision at one time.

As the public becomes more aware of the ground source heat pump systems and wants to acquire the technology, the market barriers will drop. Additionally, the installation costs will drop as developers learn how to cost effectively install the units.

4.2 COMMERCIAL SECTOR

The two commercial sector projects are the automated lighting controls project and the daylighting design project.

4.2.1 Automated Lighting Controls Project

Type: Barrier Reduction, Market and Technical

In this project, two types of light dimmers are demonstrated in commercial buildings: daylighting-controlled dimmable ballasts and

daylighting-controlled (photocell) stepped-switch systems. The dimmers have been installed in five sites covering a range of building types and settings.

Four of the five RSEP project sites are using dimmable ballasts, while the fifth is using both dimmable ballasts and photocell-controlled, stepped-switch systems. The long-term actual savings could be quite different from the estimated savings, both for individual building types and the region, since one of the goals of this RSEP Project is to develop a "standardized data protocol" for measuring automated lighting controls performance. A long-term goal of this project is to develop standard savings potentials for these measures over a variety of situations.

The Automated Lighting Controls Project demonstrates technologies that are (or have been) in conservation supply curves, with the aim of expanding their application and improving the "achievable potential." According to Jeff Harris at the Council, the most recent conservation supply curves for the Council and for Bonneville do not include stepped-switch photocell dimmers, based on anecdotal evidence that the persistence is extremely low for this measure because building occupants override the sensors. Our savings and levelized cost estimates for stepped-switch dimmers are based on energy savings and cost data from the 1988 revision of the commercial building prototypes by United Industries Corporation (UIC).^(a) The savings for dimmable ballasts were estimated based on the Council's existing assumptions for the dimmable ballast's savings in the prototype buildings in the commercial sector. Because neither source estimated savings and penetration with both dimmable ballasts and stepped-switch dimming in the supply curve stack, savings were estimated for each measure separately, based on the cost effective applications in each source.

At a minimum, the project should allow the region to capture the estimated market for dimmable ballasts. An effective demonstration could also improve the penetration of the measure, so we estimated savings for a 10% net

(a) Dimmable ballast estimates from Document Exhibit 7.3, "Achievable Potential by Utility Sector, Vintage, and Type" from Bonneville 1992.

improvement in the achievable conservation potential of these measures, raising the total estimated achievable potential to 70%.^(a)

The technical potential of dimmable ballasts for the year 2010 is estimated to be 28 aMW, at levelized costs ranging from 7 mills/kWh to 37 mills/kWh (Bonneville 1992), and achievable potential at 70% penetration is estimated to be 20 aMW. Dimmable ballasts are cost effective in Bonneville's supply curves for the new and existing small office prototype, the new small retail prototype, and the new hospital prototype. The "new" resource in these estimates is 10% of the technical potential, which is added to the Bonneville estimate of 60% penetration. However, the project will also contribute to acquisition of the 60% penetration now assumed in the supply curves not yet fully acquired.

The technical potential of stepped-switch systems in 2010 is approximately 7.2 aMW^(b) at a levelized cost ranging from 9 to 40 mills/kWh (UIC 1988). Assuming 70% penetration, the achievable potential is about 5 aMW. The UIC prototype review found that stepped switch systems were only cost-effective in three commercial building types, using a cost-effective cut-off point of 52 mills/kWh: new warehouse, new large office, and new hospital (UIC 1988). Technical potential for Bonneville's service territory was calculated by multiplying savings per building by total commercial floorspace in 2010 for each of the three building types, from Bonneville's medium forecast (Bonneville 1992).

The savings in the supply curve for lighting controls are highly dependent on the order in which measures are "stacked" in the supply curve. The supply curve methodology assumes that the cheapest measures are implemented first, and measures are installed in order of cost. This may be an overly neat picture of conservation acquisition. There are other considerations with lighting controls, for instance an effective implementation of daylighting really requires some daylighting controls. Also, the first lighting "measure"

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- (a) Preliminary estimates of savings for daylight dimming photocells in existing commercial buildings were done by Jon Biemer of Bonneville.
 - (b) Does not account for measure interaction differences by space heating fuel type.

for most new construction is installing fewer lights. However, many building designers and owners are reluctant to risk under-lighting a space. Dimmable ballasts can reduce energy use even more if a building owner insists on over-lighting the space.

4.2.2 Commercial Buildings Daylighting Design Project

Type: Barrier Reduction, Technical and Institutional

The Commercial Buildings Daylighting Design Project addresses technical and institutional barriers to incorporating daylighting into building designs. This project incorporates daylighting into commercial building designs by working with the architects and building designers of two buildings: one new construction and one major renovation. In addition, two retrofit sites from the automated lighting controls project have been added to this project. The goal is to increase the use of daylighting in all or part of the buildings without substantially raising the energy consumption needed for heating and cooling. The long-term goal of this project is to institutionalize a set of daylighting options, such as skylights and automated dimmers, that could be easily (and cheaply) incorporated into building designs. Currently building designers do not have a standard list of design options that can provide adequate light use with daylighting. At the same time, this project is working toward reducing the institutional resistance to installing fewer lights in new commercial buildings.

The site-specific case studies in this project will be somewhat difficult to incorporate into the prototype-based commercial-sector supply curves. It is not known what the energy interaction is between daylighting and heating and cooling, or how this interaction could be extrapolated to a regional level to incorporate this measure into supply curves. Though the potential is difficult to estimate at the regional level, it is probably significant considering that lighting represents one-third of the energy use of the commercial sector.

Preliminary project results show savings of about 3% of building energy use. According to Doug Boleyn, the project manager, these savings are low because the lighting controls were improperly calibrated. With controls

correctly calibrated, he expects to get savings as high as 25% of lighting energy use, or about 8% of building energy use. The savings will depend greatly on the interaction between lighting and heating and cooling with the adjusted building design. The project sponsors are working on an analytical strategy to isolate the savings due to reduced cooling. They hope to demonstrate that increased use of daylighting will reduce the lighting energy load without significantly increasing the heating and/or cooling loads.^(a)

4.3 INDUSTRIAL-SECTOR

The industrial sector projects include the Electro-Guard motor controller demonstration, the O&M Resource potential, and the electric distribution system.

4.3.1 Electro-Guard Motor Controller Demonstration Project

Type: Technology Assessment

The "Electro-Guard" motor controller is advertised to match the input voltage to the load on the motor without destabilizing the motor at low speeds. In this project, the motor controller will be installed at a total of 10 industrial sites, and the energy savings will be monitored. This project aims to verify the cost-effectiveness of the controller in various industrial situations, to assess the reliability of the equipment itself over time, and to determine the maintenance benefits for the motors that have the controllers.

The Electro-Guard Motor Controller Project may expand the current inclusion of controllers in the supply curves. Currently Bonneville includes a controller for a compressor in its industrial-sector supply curve. The controller provides an estimated savings of 11% of total compressor energy, for a total estimated regional savings of about 2.9 aMW (Bonneville 1992).

An estimate of savings for the industrial motor end-use was calculated assuming that the controller would be installed on motors ranging in size from

(a) Project description, Washington State Energy Office, O&M Electrical Distribution Study, RSEP Proposed Research, Development and Demonstration Projects, Draft 3/19/92.

1 hp (horsepower) to 200 hp with the savings from the controller assumed to be 12% of motor energy consumption.^(a) The motor controller is expected to have many of the same applications as adjustable speed drives (ASDs), targeting lightly and/or intermittently loaded motors. According to Janelle Schmidt at Bonneville, ASDs are estimated to be applicable to only 30% of industrial motors in Bonneville's industrial supply curve. The costs of the controller and ASDs are comparable.^(b) Because this controller targets the industrial sector, we assumed the motor controller would capture half of the ASD's applicability or 15% of the industrial motors in the region. The applicability could improve if additional applications are identified, such as conveyor belts, which have motors but are not identified as motor loads in Bonneville's supply curves.

The controller is best suited for lightly and/or intermittently loaded motors, but the level of detail in regional industrial motor loads required to identify these applications is not currently available. The savings estimate for the controller could be refined with more detailed information on the load characteristics of motors in the region.

Levelized costs were estimated using manufacturers' price data, which vary according to the size of the controller, ranging from \$2,680 to \$5,194 per unit. The controller in Bonneville's supply curves has an estimated installed cost of \$924.64, yielding a levelized cost of 2.7 mills/kWh for the compressor application (Bonneville 1992). However, the installed cost figure in Bonneville's supply curve refers to a controller rated at 50 hp (Bonneville 1992), and the manufacturer's price data covers controllers with ratings ranging from 2 hp to 450 hp. PNL decided to use the manufacturer's price data because they are more recent and more detailed than the installed cost estimate for the controller in Bonneville's supply curve. Measure lifetime was assumed to be the same as the controller in Bonneville's supply curve, 20 years.

(a) Personal communication with Steve Craig, Tacoma City Light, 8/13/92.

(b) Based on controller price data supplied by the manufacturer and ASD price data in Bonneville's industrial supply curve model. Calculation details are presented in Appendix A.

The estimated savings includes all industries except the aluminum and other direct service industries because these industries represent a special case in regional industrial energy use.

The regional technical potential estimate for the year 2010 is 180 aMW, with achievable potential considerably lower at 27 aMW, at a levelized cost of 13 mills/kWh. Using Bonneville's installed cost estimate, the levelized cost for the application to motors assumed in this analysis drops to 4 mills/kWh. Calculation details are given in Appendix A.

Preliminary project results indicate that these savings are highly uncertain. Northwest Energy Services documented the results of testing the motor controller on a 150-hp chipper motor. The motor is typically lightly loaded and is continuously on during facility operations, meeting the controller manufacturer's application recommendations. Three tests were conducted, with the savings found ranging from 2.8% to 26.4% of motor energy (Van Hersett 1992). Problems encountered in the testing process included inappropriate monitoring equipment, misreading of monitoring equipment, and improper operation of monitoring equipment. In its report, Northwest Energy Services does not specify which, if any, of the savings estimates are most accurate. The third test appears to have used the most appropriate monitoring equipment; however, it is not clear that the measured savings are reliable. The controller manufacturer claims that the power connection to the mill also made it difficult to measure the energy savings from the controller.

Based on the clear need for appropriate monitoring equipment, Northwest Energy Services also conducted a test of monitoring equipment to determine whether a specific monitor (Dranetz 8000-2 wattmeter) could measure the input wattage to the motor (from the controller) over a full load range and with and without the controller (Northwest Energy Services 1993). This test also addressed the ability of the monitor to measure the harmonics produced by the controller.

Ontario Hydro tested several motor controllers and concluded, after testing both single-phase and three-phase motor controllers, that in three-phase applications the motor controllers they tested do not appear to be appropriate. They caused "severe motor instability at just about every load

point...each motor experienced severe surging and oscillation" (Dion 1992). When the motor was stable it was often less efficient at the reduced voltage than it was at the rated voltage. The best results for three-phase applications were for a controller able to make the motor operate in one phase under light load conditions (less than 50% of full load power) (Dion 1992).

This measure could have benefits, such as improving the performance of the motor it controls, and/or reducing the need for maintenance of the motor; however, it could also have costs such as introducing harmonics into the facility electrical system. The industrial electrical distribution project addresses a potential barrier to this technology: a motor may appear to be oversized when in fact it is performing at the correct level due to power quality problems within the facility, or a motor may be appropriate for a controller or ASD, but the ASD or controller will introduce harmonics into the power system if it is not filtered. If the electrical distribution project finds cost-effective solutions to these problems, it will affect the market potential for motor controllers (and ASDs). Oversized motors could be replaced, reducing energy use through "right-sizing" and improved electrical environments could increase the opportunities for appropriate applications of controllers and ASDs.

4.3.2 Industrial Operations and Maintenance Resource Potential

Type: Technology Assessment/Barrier Reduction, Institutional/Enabling Project

This project will involve five or six energy audits of industrial sites to gather, quantify, and evaluate data on energy savings from improved operation and maintenance (O&M) of industrial energy systems. Currently a literature review on O&M activities and savings has been completed. Data from this project will help utilities to develop and justify O&M programs, and facilitate regional savings estimates.

Savings from O&M activities are rarely quantified, though most O&M activities are assumed to be cost effective. According to sponsors of the project,^(a) the savings are likely to be around 25% of total energy use on average.^(b)

Using industrial facility audit data from small- and medium-sized industrial facilities collected by the Energy Analysis and Diagnostic Center, PNL has extrapolated the total O&M resource potential in the Pacific Northwest as the first phase of this project.^(c) O&M activities have been cataloged as part of the project. These data indicate that, based on 1990 consumption, the technical potential for industrial O&M in the Pacific Northwest region is approximately 559 aMW, representing 14% of industrial-sector energy use, excluding direct service industries. Activities considered in this estimate fall into nine broad categories: air compressors and compressed air systems; motors and motor drive systems; lighting; heating, ventilation and air conditioning systems; equipment scheduling and control systems; insulation; ventilation systems; refrigeration systems; and other miscellaneous opportunities.

It is likely that some O&M savings are included in supply curves as savings from conservation measures which are lost due to lack of maintenance. The implication with regard to Bonneville's supply curves is that the supply curves are assuming acquisition of savings that cannot be acquired without O&M and its accompanying cost. When PNL revised the input data for Bonneville's industrial-sector supply curve, this issue was considered; however, no data are currently available documenting how much performance is degraded by lack of O&M for industrial conservation measures.

The problem in implementing O&M is not savings potential but ensuring long-term savings. Measure life, meaning the duration of the effect of O&M activities, is generally a year or less. Managers of firms must support O&M on a continual basis for it to be effective; many don't as long as they can

(a) PNL is one of the participants of the Industrial O&M project.

(b) Personal communication with Rich Szydlowski, PNL, 12/15/92.

(c) Personal communication with Steve Parker, PNL, 6/21/93.

pass the costs of the operating inefficiencies on to their customers. As a result, O&M programs are often excluded from conservation programs.

Successful O&M requires a change in behavior and philosophy from the employees and managers of the facility. Even if changes in behavior required for O&M are instituted, the changes may not address the reason for the problem in the first place. To be successful, O&M needs to have internal support and a well-trained O&M crew, or the persistence of savings will be very short. For O&M measures to persist it is also necessary to change a common management philosophy that doesn't see the value of O&M, and/or institute programs which reinforce maintenance behavior.

Because the Industrial O&M project will attempt to identify and address these barriers, it is also characterized as an enabling project: enabling acquisition of savings from other industrial-sector conservation measures requiring maintenance as well as from O&M.

4.3.3 Industrial Electrical Distribution System Study

Type: Barrier Identification/Enabling Project

Three case studies of industrial facility electrical system "tune-ups" will be prepared in this project. The purpose of the tune-ups is to reduce such problems as under- or over-voltage, phase imbalance, low power factor, poor electrical contacts, leaks to ground, and harmonics. These problems can significantly erode the performance of energy conservation measures like high-efficiency motors.

Such electrical system problems can cause major power quality or safety problems before they cause significant energy loss problems in and of themselves.^(a) They also have indirect impacts on equipment energy use and performance, which may create an electrical environment that is hostile to energy efficient motors, electronic controls, and other efficiency measures. The primary objective of this project is to document how extensive these types of problems are in the region and how they can be corrected to create the appropriate electrical environment for efficient measures, like ASDs.

(a) Personal communication with John DeSteele and Jeff Dagle, PNL, 12/15/92.

Replacements of electrical distribution system components do improve efficiency, but they are too labor-intensive to be cost-effective by themselves as conservation measures. These types of measures provide benefits, such as improving the performance of sensitive high-efficiency equipment, as well as eliminating outages, increasing the productivity of electrical equipment, and extending equipment life.

Another issue related to electrical system tune-ups is that some conservation measures can introduce harmonics that affect certain motors and controls. (Any solid-state equipment without filters, such as electronic ballasts in fluorescent lighting, can introduce harmonics.) This project will attempt to identify these problems so they can be anticipated and mitigated in future programs. Because of these benefits for industrial conservation measures, this study is also characterized as a technical barrier reduction project and an enabling project.

Anecdotal evidence suggests that maintaining power quality is vital for high-efficiency motors, as voltage imbalances, harmonics, and voltage spikes can burn out these motors. Even if these stresses do not destroy the motor, they may cause irreversible damage, resulting in cumulative degradation of performance. Correcting power quality problems would help to preserve the performance of high-efficiency motors and reduce the chances of burning out these motors due to poor electrical environments, as well as improving their applicability.

4.4 UTILITY SECTOR

The one utility sector project is the conservation voltage reduction project.

4.4.1 Conservation Voltage Reduction Project

Type: Pilot Program

Conservation voltage reduction (CVR) refers to utilities reducing the voltage on distribution circuits in order to reduce energy consumption. This project will identify and demonstrate the cost-effective application of CVR on several utility distribution and transmission systems. Currently the

potential savings and cost-effectiveness of CVR are estimated for the region as a whole, but estimates of savings for any individual feeder circuit are subject to high uncertainty. Also, CVR can induce consumer complaints, so it is not known under what conditions CVR will be viable.

The CVR Project does not introduce new savings to the savings included in both the Council's and Bonneville's supply curves; however, this technology has not been widely applied in the Northwest so the actual savings and cost are uncertain. As such, this project has primarily technology transfer benefits. It may also provide a proving ground for development of program evaluation methods.

In the long term, the CVR demonstration project is expected to allow the region to capture the forecasted savings in the supply curves, or a revised level of those savings. PNL developed supply curves for the conservation potential of CVR in the Pacific Northwest in a 1987 report (DeSteele et al. 1987). The authors assumed a fixed 2.5% voltage reduction, and estimated low, intermediate, and high savings using a combination of statistical analysis of CVR experience in other regions and laboratory data on appliance energy demand and consumption.

Conducting an RSEP project to demonstrate CVR presumably will help the region to capture at least some of the savings potential estimated by PNL. It may also help to identify the achievable penetration for CVR in the Northwest, as individual utility conditions may make CVR less attractive at the utility level. CVR is most effective on short feeders in densely populated areas. In this estimate the savings have been assumed to be the same as those estimated in the supply curves.

PNL found that, for the region as a whole, the CVR Project could save between 170 and 268 aMW, at a cost of 5.04 cents/kWh. For publicly-owned utilities only, CVR potential was estimated to be between 65 and 112 aMW at 5.04 cents per kWh.

The Council estimates that for every 1% decrease in the average delivered voltage, savings from CVR will be between 0.5% and 1% of transmitted energy (NWPPC 1991). The long-term savings will depend on how feasible CVR

turns out to be in this region, both in terms of cost effectiveness and in terms of consumer satisfaction (some consumers have complained about low voltage). For this report, achievable potential by 2010 is assumed to be 100 aMW for the region (NWPPC 1991) and 40 aMW for Bonneville's service territory, as stated in Bonneville's supply curves (Bonneville 1992).

5.0 RSEP RENEWABLE GENERATION PROJECTS

The scope of RSEP includes potential research into all forms of renewable energy. Applications of renewable energy that reduce power use rather than generate electricity, so-called "direct application renewables" are considered to be "demand-side" resources; the RSEP Quick Start projects that are demand side resources are described in Section 4. The projects described in this section are projects that generate electricity generation. RSEP's renewable projects focus on two renewable resources, geothermal and wind, as well as an educational project called the "regional renewables project."

Proposals for solar projects were considered, but found little support among potential collaborators. Using the oil industry analogy, solar is currently considered to be "uneconomic" at this time. However, there are a variety of small scale applications of solar and other renewable technologies that may be economic if the contributions they make to increasing the efficiency or extending the life of transmission and distribution systems are included. These niche applications will be considered by Bonneville as part of the RSEP plan for distributed utilities.

The performance, market, and institutional uncertainties associated with the development of renewable resources are similar to those for DSM. As a result, the RSEP paradigm of "confirming" resources through a series of projects to identify and address specific barriers that enable the demonstration of specific technologies that lead to pilot acquisition programs is equally valid. However, the implementation of this paradigm for renewable demonstrations was more direct. A more deliberate approach was needed for renewables largely because the roles, expectations, and needs of the various parties are more sharply defined for renewables than for DSM. For example, developers of generating resources do not expect to collaborate with each other in the design of demonstration projects. They expect to compete for projects using their proprietary designs, site access, and cost bids to win over other competitors. In this competitive environment, research objectives become an unnecessary overhead. In contrast, open identification and resolution of performance problems is key to increasing the acceptability of unconventional

generation among regional utilities. Similarly, state agencies, particularly the state energy offices, have been active advocates for, and developers of, DSM projects. Their role with respect to renewable generation is typically as a regulator, rather than a sponsor.

There are three renewable generation initiatives included in this report, geothermal, wind, and the regional renewables project. The geothermal demonstration program preceded RSEP. However, it also resulted from the interests of the Council and Bonneville in collaborative demonstration of geothermal generating potential. As a result, this program is "RSEP-like" and appropriate to include in this summary of energy resource confirmation results.

Both the geothermal demonstration program and the RSEP Wind Initiative were approached using a more structured plan in order to lay the foundation for collaboration among parties with varied interests and roles. The geothermal plan resulted from collaboration between Bonneville and Council staff and others. This plan was acknowledged by Bonneville and in Council plans and agreements. The RSEP Wind Initiative resulted from a series of meetings with parties interested in wind energy development. These meetings resulted in proposed "wind strategies" that were refined through further meetings and stakeholder feedback. The final "RSEP Wind Strategy" acknowledged activities planned or underway by others and outlined areas where initiatives by RSEP would facilitate wind resource development. In response, Bonneville initiated specific activities to implement the first two elements of the Wind Strategy. Each of these initiatives is described further in the following sections, which place specific activities into the RSEP paradigm and provide preliminary estimates of resource potential resulting from them.

5.1 GEOHERMAL RESOURCE CONFIRMATION

The analogy between estimates of oil resources (see Section 2.3) and geothermal generation is apt. Geothermal generating potential is basically a function of two variables: the performance of the hot water or steam in electricity generation equipment and the availability of geothermal resources that are matched to that equipment. Once the latter is known, the former can

be estimated from similar situations elsewhere or demonstrated with small-scale tests. However, geothermal resources, like oil, are not readily identifiable. Estimating the scope of underground hot water or steam resources, like estimating oil resources, requires drilling and other explorations that provide data to make estimates of resources at specific locations and inferences about potential resources at other locations. Bonneville's geothermal program attempts to address these issues through specific actions encompassed in the Geothermal Confirmation Agenda in the Council's 1991 power plan.

The Geothermal Confirmation Agenda resulted from ongoing research into geothermal potential in the region and a revived interest in geothermal potential by Bonneville, the Council, regional utilities, and developers. These mutually interested parties met under the auspices of the Council to craft a research and demonstration project agenda to increase knowledge about the availability of geothermal resources and the performance and cost of geothermal resource development. These projects were envisioned to confirm estimates of geothermal generation potential in the region and advance geothermal generation for resource acquisition. Although this effort preceded RSEP, these objectives are identical to those of RSEP, as is the collaborative process used to develop the confirmation agenda and cooperatively fund its implementation. The results of this effort are reported alongside RSEP results to reflect, in a comprehensive manner, Bonneville and regional activities related to the resource demonstration and expansion. The Geothermal Confirmation Agenda anticipates a variety of activities that are responsive to the issues reflected in the RSEP paradigm. These are presented in the context of the RSEP paradigm in Table 5.1. In summary, these activities are expected to lead to the development of up to 90 MW of generation (comparable to "proven reserves" in the oil industry) and confirmation of at least 300 MW of potential (comparable to "discovered reserves" in the oil industry).

5.4

[illegible]

5.1.1 Geothermal Confirmation Agenda

Type: Pilot Program/Barrier Reduction: Market, Technical, and Institutional/Enabling Project

Geothermal resources are thought to be plentiful in the Pacific Northwest. Estimates of high temperature (> 300°F) geothermal capacity are around several thousand MW (Brook 1979 and Bloomquist 1985 as reported by Darr 1993).

To prove that the geothermal resources in the region can produce electricity in a cost-effective manner, a Geothermal Confirmation Agenda was adopted in 1991. Geothermal production draws on thermal resources of various temperatures using one of four types of thermal-electric conversion equipment:

- dry steam
- single-flash
- double-flash
- binary.

This equipment needs to be matched to the thermal resource that is available at each production site. The performance of this equipment has been documented elsewhere. However, the chemical characteristics of regional geothermal resources, as well as their temperature and abundance, remain outstanding questions. The confirmation agenda anticipated pilot geothermal generating projects to address these issues.

The next step in demonstration of geothermal resources was to determine how these projects should be financed. Developers came forth who were willing to finance the exploration if Bonneville would guarantee that the developers would be paid for the delivered energy. Several other conditions were stated by Bonneville and a request for bids was sent out in July 1991. In December 1991, three projects were accepted for negotiation:

- Newberry Volcano (Oregon)
- Vale (Oregon)
- Glass Mountain (California).

Memorandums of Understanding (MOU) were signed for the Newberry and Vale projects on December 1992 and January 1993, respectively (the Glass Mountain project was still under negotiation at the time of this report). The levelized costs for the Newberry and Vale projects averaged 36.6 mills/kWh, compared with an average of 37.6 mills/kWh for four hydro projects developed by Bonneville's customers. These comparisons helped to clarify that geothermal resources are a cost-effective alternative to other production sources.

Newberry Volcano Geothermal Project

The Newberry geothermal project was developed by California Energy Company in a joint venture with the Eugene Water and Electric Board. The project is expected to deliver an average capacity of 30 aMW and expected to be on-line in 1996. The Newberry project plans to drill up to four temperature gradient wells to a depth of 5,500 feet and will have production wells at 14 sites. The project will use a double flash power plant to produce energy and will install approximately 9 miles of 115-kV transmission lines.

Vale Geothermal Project

The Vale geothermal project was developed by the Trans-Pacific Geothermal Corporation in a joint venture with the Springfield Water and Electric Board. This project is also expected to deliver an average capacity of 30 aMW and should be on-line in 1996. The project plans to drill up to 10 test wells using a combination of slim holes (at a depth of 5,000 feet) and production wells at depth of 7,000 feet. The project will use an air-cooled binary plant to produce power.

Previous resource assessments referenced in the Council plan indicate several thousand Megawatts of geothermal generating potential exists in the region. This potential is not uniformly distributed. The Council plan segments the resource into four areas on the basis available information about potential, development potential, and other factors. These segments and the Council's estimate of resource potential (comparable to the combination of "discovered" and "undiscovered" resources in the oil industry, follows:

- Cascade Range — over 3,000 MW
- Basin and Range — over 930 MW

- Northern Rocky Mountains – large but unknown potential
- Snake River Plain – large but unknown potential.

The Council focused their assessment of geothermal resource development on the Cascade and Basin and Range regions due to the lack of knowledge about resource potential in the other two areas and identified institutional barriers to resource development. This, coupled with further reductions for economic and other reasons lead to an estimate of 350 MW of development potential in the next 20 years. The Bonneville Geothermal Pilots are expected to confirm 300 MW of potential at the three sites involved. This should enhance prospects for development of the remaining 3,000 MW plus potential in the rest of the Cascades and Basin and Range region. For purposes of this report, this is expected to lead to the confirmation of an additional 200 MW of potential in these two areas, for a total of 500 MW.

5.2 WIND ENERGY CONFIRMATION

Although wind is not visible, it can be measured much more readily than geothermal heat. Like geothermal resource potential, wind energy potential is a function of wind speed, duration, and direction and the performance of wind turbines matched to these resources. Extensive data on wind in the region has been collected for weather forecasting. In addition, more detailed data has been collected by PNL for the Department of Energy specifically to estimate wind energy potential. Locally, Oregon State University has collected even more specific information using direct measurement and other evidence. This information has identified significant potential for wind generation in the region. Translating this potential into the acquisition of wind generated power is the subject of many activities initiated by Bonneville, EPRI, the Council, local utilities, turbine vendors, and DOE. RSEP attempted to focus further efforts in this region through the RSEP Wind Strategy.

The RSEP Wind Strategy resulted in the initiation of two RSEP projects by Bonneville. The primary activity was a wind solicitation to demonstrate wind energy potential at two commercial-scale wind farms. In support of this, Bonneville also initiated activities (described further in Section 5.2.1) to begin addressing state and local regulations that might present barriers to

the development of wind farms in the region. These activities included a general outreach program, the regional renewables education project (described in Section 5.2.2), designed to educate environmental groups, who traditionally oppose energy resource development, about renewable energy resource alternatives. They also included a contract to develop common siting standards for wind farms in the region.

5.2.1 RSEP Wind Strategy

Type: Pilot Program/Barrier Reduction: Market, Technical, and Institutional/Enabling Project

The RSEP wind strategy resulted from a series of meetings with parties interested in the development of wind energy in 1992. The strategy acknowledges the past, current, and planned contributions to this effort by others. These activities have already addressed, or will address, specific issues along the continuum from R&D to resource acquisition (Figure 2.2). The RSEP wind strategy attempted to "fill in the blanks" along this theoretical continuum with projects timed to facilitate the use of others' research results (listed in Table 5.2) to promote wind development in this region.

The activities listed in Table 5.2 illustrate a progression along the R&D continuum. The first activities are resource assessments which are similar to the "basic" research characteristic of R&D. The integration study is designed to address specific, but largely theoretical, issues about integrating energy from wind farms into the regional power grid. The wind strategy provided a focus and timetable for transferring these and other R&D results into resource acquisitions. The education and siting studies just cited, were designed to facilitate both pilot demonstrations and later acquisition.

The Bonneville wind solicitation was designed to demonstrate, on a pilot but still commercial scale, wind generation technologies and document performance and cost. This effort will provide definitive evidence of wind energy potential at specific sites, and will permit better estimates of potential at other sites, by inference. It will also provide sufficient data to refine estimates of power costs and potential effects of improved turbine designs. Improved turbine designs were addressed in the RSEP wind strategy to

TABLE 5.2. RSEP Wind Confirmation Strategy

Activities	Assessment	Barrier Identification	Barrier Reduction Projects			Enabling Projects	Advanced Technology Demos	Pilots	MWs Confirmed
			Market Barriers	Technical Barriers	Institutional Barriers				
DOE/PNL Wind Atlas	X(a)								
ODOE Wind Resource Assessment	X(a)								
PNUCC/EPRI Integration Study	X(a)		X(a)		X(a)	X(a)			
<i>RSEP Wind Strategy</i>		X							
<i>Regional Renewables Education</i>					X				
<i>Siting Standards Project</i>				X					
<i>BPA Wind Solicitation (Element 2a)</i>		X		X	X	X			
<i>BPA Wind Solicitation (Element 2b)</i>			X	X	X	X	X		
EPRI Wind Turbine Testing Standards	X(a)			X(a)	X(a)	X(a)			
DOE AWT Project			X(a)	X(a)		X(a)	X(a)		
<i>BPA AWT Solicitation (Element 3)</i>							X	X	
Total									600
(a) Not an RSEP activity, but incorporated in the RSEP Wind Strategy Italics = RSEP projects									

acknowledge planned activities by EPRI and DOE as well as to anticipate continued improvements by the industry in turbine design and performance. The strategy also anticipated a need to demonstrate these "advanced" designs when they become available. In a sense, the last three items listed on Table 5.2 reflect a "new" R&D cycle for wind. This new cycle is much shorter, primarily as a result of the foundation provided by the preceding RSEP projects.

The 1991 Council Plan provided a variety of estimates of wind energy potential. The range in these estimates is similar to the range of estimates for oil resources for similar reasons. Namely, vast potential is thought to exist from limited available data. The Plan estimates 4,500 MW of potential that reflects a combination of what would be called "discovered reserves" and "undiscovered resources" in the oil industry. The fraction of this that could be economically developed is estimated to be 2,900 MW, assuming a high avoided cost. This potential is associated with 46 specific "wind rich" areas in the region, which makes it similar to what the oil industry calls "discovered reserves." In other words, when more detailed data is used, estimates of potential decrease, consistent with the effects of RSEP illustrated in Figure 2.2 (moving along the R&D continuum away from R&D and toward commercial acquisition).

The Council Plan assumed that a single demonstration of a 20- to 30-MW-scale wind farm would confirm its wind energy resource estimates and lead to the development of 600 MW of wind resources in the next 20 years. The RSEP wind strategy was rooted in industry concerns that a single demonstration could not address all of the issues that wind energy development faces in the region. In other words, the 46 wind-rich regions identified by the Council have characteristic problems. A single demonstration would address problems faced in some, but not all of the regions, leaving significant potential unconfirmed. The Council Plan also identified two primary wind resource areas in the region: west of the Rocky Mountains and Montana. The wind strategy discussion segmented the resource further, to highlight the different nature of the resource in these areas, the development challenges, and the approach to their development in terms of wind farm design and timing. These areas were not precisely defined, but basically include Coastal Zones, the Columbia

Gorge, Interior (eastern Oregon and Washington, southern Idaho, and Nevada), Montana North, Montana South, and Wyoming. The division of Montana into two development zones increases the probability of wind development in Montana, although not necessarily in northern Montana which the Council Plan emphasizes. However, the addition of Wyoming significantly enhances regional resource potential (assuming wind development in Wyoming by regional utilities will be used to supply regional loads).

The Bonneville wind solicitation resulted in two wind farm proposals. These will result in up to 50 MW of peak power generation and confirm wind energy potential in two of the six wind-rich areas identified above. These two areas have the potential for up to 600 MW of wind generation development during the next 20 years. The Council identified 250 MW of technical potential in the Columbia Gorge. Technical potential in Wyoming was not included in the Council's assessment; however, it is quite large. For purposes of this report, an estimated 150 MW of confirmed generation potential will result from the Columbia Gorge wind farm demonstration and 250 MW from the Wyoming demonstration. An additional 100 MW of potential will also be confirmed through the Columbia Gorge demonstration in the Interior areas which are adjacent to the Gorge. The Council estimated technical potential in this area at 200 MW.

5.2.2 Regional Renewables Project

Type: Enabling Project

This project is educational rather than demonstrating a technology. The goal of the project is to improve public awareness of the role of renewable energy sources and conservation in the Northwest region's future energy resources. Current projections of renewable resource acquisitions are relatively conservative. This project may increase the potential for renewables by reducing acquisition barriers due to lack of dialogue between developers, environmentalists, and utilities.

The Regional Renewables Project is an educational project that does not focus on one measure or technology. This project is expected to have an indirect effect on the region's ability to acquire renewable resources, by improving knowledge about renewable resources and thus decreasing uninformed

resistance. This effect will not be easy to quantify. It is likely to occur as earlier adoption of renewables, and advance agreement between environmentalists and resource planners on appropriate and inappropriate sites. This may decrease rather than increase supply.

6.0 CONCLUSIONS

The savings estimates presented here are not intended to be predictions; instead their purpose is to give a sense of the scale of the 12 "Quick Start" RSEP projects, the potential impact of these projects on the region's resource supply, and progress toward RSEP's resource expansion goals. In some cases the information about a project is very limited, either because the information about the technology is limited, or because the project is still being developed. Even so, identifying the gaps in information can be as helpful as the information itself, because it is precisely the gaps in information between "discovery" of a conservation technology and acquiring the conservation resource from that technology that RSEP is meant to fill.

The RSEP continuum laid out in this report is a framework for the process of acquiring conservation. This framework represents a progression of steps that are necessary to successfully acquire any conservation resource. Given a promising technology, such as a high-efficiency incandescent light bulb, the first step is to determine whether the technology addresses a high energy use activity or end-use. A high-efficiency incandescent bulb could be applied to residential lighting (among other applications), but to know how much energy it could save in the region a resource assessment of how much energy is used for residential lighting is needed (e.g., the Baseline Residential Lighting Use Project). Then a technology assessment might be necessary to assess the performance of the bulbs outside of the laboratory. Once the technology has been accepted as relevant (in that it addresses an end-use with significant energy use) and its performance has been verified, then its regional energy savings potential and levelized cost are estimated and, if it is cost-effective, it is incorporated into a conservation supply curve.

Before RSEP, once a technology had been added to a conservation supply curve, the promising new technology would be incorporated into a conservation program, and the program would have to try to acquire the conservation. The programs have often had very limited success in acquiring the estimated conservation, however, because there were barriers to the new conservation technologies that had not even been identified, and the programs were not set up

to address. Barriers often are not obvious; for instance the electrical environment in an industrial plant appears to greatly affect the performance of high-efficiency motors. Industrial conservation programs typically do not include correcting voltage spikes and harmonics in the plant electrical system. A technical barrier reduction project would assess the extent and magnitude of these problems and identify ways to fix them, allowing the conservation program to account for these problems before they burn out the motor.

Beyond barrier reduction, the RSEP continuum also has a place for technologies that are almost ready for acquisition, but either lack the confidence of the customers or do not fit into current conservation program structures. For example, advanced technology demonstrations would gain visibility for technologies that Bonneville is confident in but that customers are reluctant about, either because they have not seen the technology or because they do not believe the technology would work under a specific set of conditions. Pilot programs allow the utility and/or Bonneville to test a program structure before committing to a full-scale program.

For several of the "Quick Start" RSEP projects, the long-term impacts are not yet known. Where possible, ongoing results of RSEP projects have been incorporated. It will be important to continue this in future supply curve adjustments. It should also be noted that results reported here are not mutually exclusive and, thus, not truly additive. Some project results include resources included in supply curves already. For example, motor controllers "save" the same energy that adjustable speed (ASDs) and efficient motors do.

This iteration is a first attempt at incorporating RSEP into the conservation supply curves. Supply curve assumptions have not been questioned in this report; however, one product of RSEP as a whole will be a revision of the supply curve assumptions, particularly incorporating the findings of the barrier identification and barrier reduction projects to better guide the conservation program designs.

7.0 REFERENCES

Bonneville Power Administration. 1983. *Pacific Northwest Residential Energy Survey*, Portland, Oregon.

Bonneville Power Administration. 1992. *1992 Conservation Resources Supply Document and Technical Documentation*, DOE/BP-1815, Portland, Oregon.

Darr, G. E. 1993. *1993 Status Report: The Bonneville Power Administration's Geothermal Program Part 1: The Pilot Projects*. Bonneville Power Administration, Portland, Oregon.

DeSteele, J. G., S. B. Merrick, R. C. Tepel, and J. W. Callaway. 1987. *Assessment of Conservation Voltage Reduction Applicable in the BPA Service Area*, DOE/BP-14031-1, Bonneville Power Administration, Portland, Oregon.

Dion, P. P. 1992. *Reduced-Voltage Motor Controller*, Technical Services and Development, Energy Management and Corporate Relations Branch, Ontario Hydro, TSDD-92-061, Ontario, Canada.

Lee, A. D., C. C. Connor, J. E. Englin, D. L. Hadley, R. G. Lucas, N. E. Miller, and W. H. Monroe. 1988. *Cost-Effectiveness of Conservation Upgrades in Manufactured Homes*, PNL-6519 Pacific Northwest Laboratory, Richland, Washington.

Northwest Energy Services. 1993. *Electro-Guard Dranetz Measurement Test Results*, Northwest Energy Services, Spokane, Washington.

Northwest Power Planning Council (NWPPC). 1991. *1991 Northwest Conservation and Electric Power Plan, Volume II*, Portland, Oregon.

United Industries Corporation (UIC). 1988. *DOE-2 Commercial Building Prototype Review and Revision*. UIC-8815, Prepared by UIC, Bellevue, Washington, for Bonneville Power Administration, Portland, Oregon.

Van Hersett, D. G. 1992. *Energy Savings Documentation for Electro-Guard Electric Motor Controller*, Northwest Energy Services, Spokane, Washington.

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