PNNL-16681, Rev 6

Strategies to Reduce Energy and Water Use by Pacific Northwest National Laboratory Facilities

A Facility Energy and Water Management Plan for the 21st Century – Revision 6

June 2007

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

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Strategies to Reduce Energy and Water Use by Pacific Northwest National Laboratory Facilities

Revision 6, June 2007

Prepared by:	Norman J. Olson, Engineered Systems	6/27/07 Date
	Marc J. Berman, Facility Energy Manager	6/27/07 Date
Concurrence:	Curtis J. Nichols, Energy Program Manager	6-27-07 Date
Approved by:	Larry E. Maples, Director, Facilities and Operations	6/27/07 Date

Contents

Foreword 1
Executive Summary 1
Situation Analysis 2
Progress 8
Using Resources Wisely 8
PNNL Infrastructure 11
Systems Monitoring and Improvement 12
Diversifying Energy Supplies to Meet 21st Century Demands 12
Strengthening Collaboration, Communication, and Education 13
Appendix A – *Energy Management Goals* 14
Appendix B – *Load Reduction Plans* 16
Appendix C – *Energy Audits Completed* 27
Appendix D – *Energy Investment Opportunities* 28
Appendix E – *Progress Toward Meeting FEMP Best Management Practices to Conserve Water* 29

Foreword

This annual revision updates the Pacific Northwest National Laboratory (PNNL) Facility Energy and Water Management Plan to 1) account for program gains in the last 12 months, 2) update the situation analysis for energy challenges facing PNNL, and 3) discuss water use and provide additional details on the Laboratory's strategy for diversifying energy supply and improving infrastructure efficiency and reliability.

The *PNNL Facility Energy and Water Management Plan* reflects the requirements and philosophy of creating a sustainable environment for conducting research and development. It envisions a comprehensive long-term strategy that uses leading-edge technology developed at PNNL, other national laboratories, and industries to produce an integrated approach to energy and water resource conservation and management at the Laboratory. The plan consists of five key strategies:

1) emphasizing conservation
2) modernizing infrastructure
3) diversifying energy supplies including renewable energy sources
4) continuous recommissioning of facility systems
5) collaborating and communicating best practices, successes, and challenges.

The plan is written as a guide to senior PNNL and Department of Energy Pacific Northwest Site Office (DOE-PNSO) managers to communicate the Laboratory's goals and planned actions for achieving greater energy conservation and efficiency, using renewable energy, and conserving water. The plan is updated annually to reflect priority actions scheduled for implementation in subsequent budget years.

Executive Summary

Electrical energy is the largest component of PNNL's energy use. Because of growing computer and supercomputer usage and increased staffing, electrical loads for the Laboratory have been growing faster than efficiency improvements can be installed to offset that growth during the past three years. ***At the same time, the retail rate for electricity has increased at an average rate of 1.4% per year in the Richland facilities while the wholesale cost has changed very little. In fiscal year (FY) 2006, the average retail rate to the Laboratory from the City of Richland was $0.044/kWh. Hanford electrical rates are 30% higher.*** As long as the wholesale cost for electricity is stable, the City of Richland rates for electricity will be stable. The cost for electricity from the City of Richland can be expected to increase at an inflationary rate unless there is a supply shortage providing upward pricing pressure. Shortage causes due to hydropower operations include droughts and fish concerns, increases in costs of fossil fuels such as oil and natural gas, upgrades to the regional transmission grid, and possible carbon taxation (to combat global warming).

The City of Richland contract for wholesale electricity from the Bonneville Power Administration (BPA) is up for renewal in the near future. The rate change will depend on the contract conditions and is unknown at this time.

Natural gas rates are still at historical highs and are projected to increase in volatility, reflecting a national shortage in production versus increasing demand. The retail rate has increased an average of 29%/year over the last three years and peaked at nearly $1.50/therm in the first quarter of FY06.

PNNL has made significant progress toward meeting previous DOE reduction goals for energy consumption. Through a proactive

energy management program and investment in facility infrastructure, PNNL has reduced its energy consumption per square foot by 47.5% in the Laboratory and Industrial Facility category since the FY90 baseline period, compared to the DOE goal of 20% by 2005 and 25% by 2010. PNNL has also reduced its energy consumption per square foot by 42.6% in the General Building category since the FY85 baseline period, compared to a DOE goal of 30% by 2005 and 35% by 2010.

A new conservation goal of reducing energy use by 2% per year is now also mandated by the Energy Policy Act of 2005 (EPAct 2005) for all government facilities. Executive Order 13423 augments the EPAct 2005 mandate to reducing energy usage to 3% per year or more in Federal Facilities. EPAct 2005 also mandates that advanced metering will be installed by 2012 where economically practical.

Conservation efforts at the Laboratory to date have been very successful and have reduced our energy costs by over $4 million per year as of FY06 and eliminated 64 million pounds/year of CO_2 greenhouse gas. However, in order to control future cost increases, PNNL needs to aggressively pursue energy efficiency in the new facilities being built as replacements for the 300 Area facilities and to accommodate Laboratory growth. The Laboratory also needs to renovate its aging boiler plant in the Battelle-owned facilities and convert it from steam to hot water, thus reducing operational costs. Finally, the Laboratory needs to aggressively pursue further energy conservation in its existing facilities to increase efficiency, reduce energy costs, and reduce future cost-escalation risks from further rate increases.

The Environmental Protection Agency (EPA) required the Laboratory to set a goal for water reduction. To this end, ***the Laboratory committed to saving 5 million gallons per year of potable water by the end of FY06***, based on FY03 water consumption of 111.4 million gallons per year. By FY06, PNNL had reduced consumption by over 5 million gallons per year.

Beginning in FY 2008, Executive Order 13423 requires reduction of water consumption intensity, relative to the 2007 baseline of water consumption, through life-cycle cost-effective measures by 2% annually through the end of fiscal year 2015, or a total of 16%.

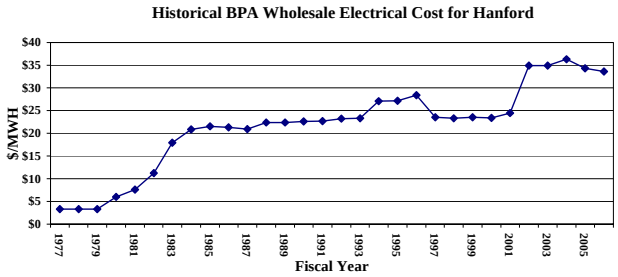
Situation Analysis

Energy and Water Challenges Facing PNNL

Electricity

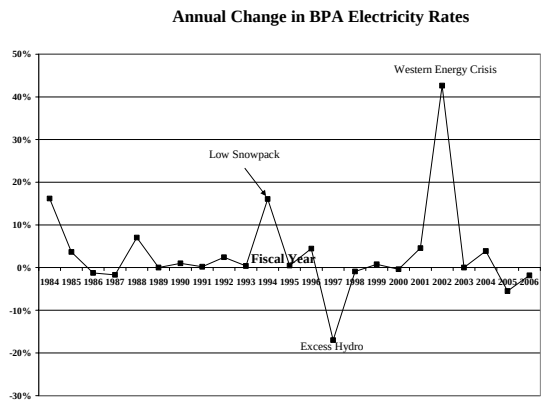
The largest energy component, by cost, at PNNL is electricity. Prior to 1980, the Pacific Northwest enjoyed the lowest power rates in the United States (~$3.30/MWh). The rates increased by more than 500% between 1980 and 1984 to $21/MWh due to a variety of reasons, including newly completed and defaulted electrical generation projects and the need to address fish, wildlife, and environmental issues.

Between 1984 and 1993, BPA rates were fairly stable, with an average increase of $0.20/MWh, or less than an average of 1% per year.



Post-1993 annual fluctuations in the BPA rates, however, have ranged from -17% to *43%*,[1] as shown in the following figure.

[1] FY77–06 Fluor-Hanford electrical utilities cost data.

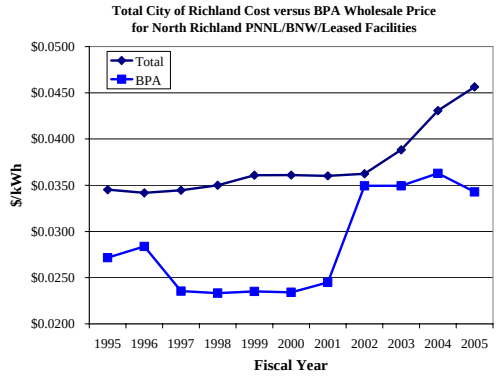


These fluctuations make yearly electrical budget planning very difficult. However, BPA helps customer planning by issuing early warnings of impending rate increases. The estimated rate increases are typically on the high side. For example, the largest fluctuation *(43%)* occurred in FY02 and was caused by the 2001–02 Western Electricity Crisis and significantly reduced river flows supplying hydroelectric power in the Northwest. A smaller increase (16%) occurred in 1994 due to low river-flow conditions and generation plant availability. In 1997, the rate decreased 17% due to unusually good river-flow conditions, plant availability, and reduced operating costs.

In May 2006, BPA announced substantial improvement in its financial performance and had recovered from the severe losses suffered as a result of the 2001–02 Western Electricity Crisis. The wholesale rate for 2007 was announced in September 2006.[2] Since peak BPA rate occurring in 2004, the average wholesale rate for electricity has actually decreased about 3.5% per year as BPA has been able to improve its finances during good hydro years.

The Bonneville Power Administration has achieved substantial improvement in its financial performance, which should continue to stabilize rates during good hydro years unless debt reduction is accelerated.

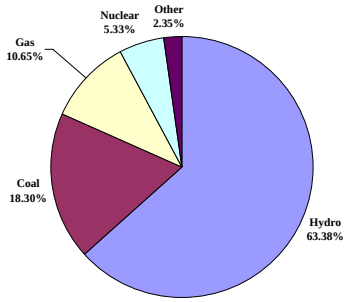
Currently, PNNL buys retail electrical services from the City of Richland for the Richland North campus for an average of $0.044/kWh which is about 30% less than the average cost in the 300 Area. Richland electrical rates have continued to increase about 1.4% per year since 2004 after the shortfall in 2001 was covered by reserves, even though the BPA wholesale rate decreased about 3.5% per year during the same time period. It is anticipated the City of Richland rates will be stable during good hydro years if it continues to contract with BPA.



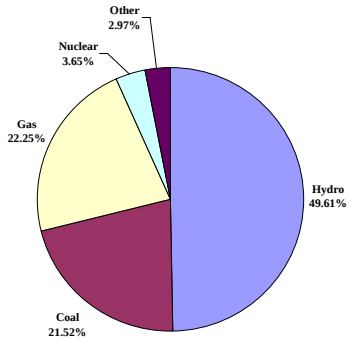
In general, the Richland rate changes have not followed the BPA rate changes in any predictable manner. It may be expected that the Richland rates will continue to increase during the near term due to infrastructure modernization projects to address aging of equipment and community growth. In addition, the unpredictable nature of the weather, river runoff, and the volatility of western power markets could make future rates uncertain. Therefore, this plan includes an aggressive strategy to reduce consumption of electrical energy to minimize the impact of future cost increases. In fact, the strategy is to install energy efficiency measures that will reduce the overall cost of electricity to the Laboratory as PNNL continues to grow.

[2] BPA announcement, September, 2006.

Water will always be a perennial uncertainty in the Northwest and, because the majority of the generation capacity is hydroelectric, will have the largest impact on the price of electricity. Therefore, BPA has recommended that forecasting be done in the most conservative manner regarding hydroelectric power capacity. That is, use the 1937 "lowest historical water year" (hydro contribution 11,688 average MW (aMW) instead of the 50-year average of ~16,000 aMW) as the firm hydroelectric component for forecasting demand versus energy resources to establish the worst-case scenario. While hydroelectric generation is still the major asset, its "firm" contribution decreased from 63% in 2000 to 50% in 2005 (see figures below),[3] with the increased electrical production from gas, coal, and other (e.g., wind) sources.



PNW Electric Power Generation by Fuel (2000)-18,440 aMW Total

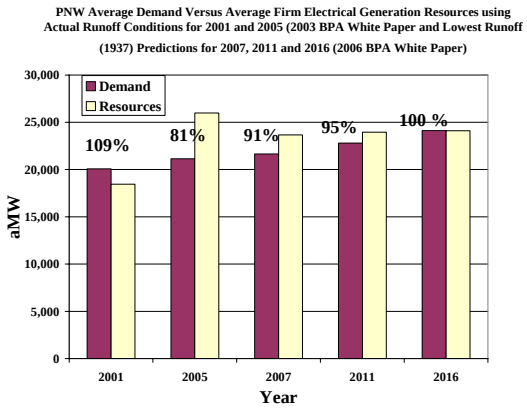


PNW Electric Power Generation by Fuel (2005)-23,559 aMW

BPA updated the Loads and Resource Study in 2006.[4] However, the 2003 study is the required reference to describe how the 2000–01 electrical energy shortage has been addressed and provides a baseline for the changes projected in 2006.

The total Pacific Northwest average firm electrical energy resources have increased by over 5,100 aMW since the year 2000, while the 2005 demand was projected to only increase by 1,055 aMW. While true, it also would have been predicted that the Northwest had exceeded its firm average energy resources in 2000 by 9% (1,640 aMW), so that BPA had to buy more power in low-water years. This is exactly what happened at the start of the 2001–02 Western Electricity Crisis, except there was not any reasonably priced electrical power on the market. A bigger economic crisis was averted because BPA bought back 3,000 aMW of power from the aluminum industry. The price increase was a driver for conservation, effectively lowering the Pacific Northwest demand to pre-1990 levels.

BPA projections for demand and firm energy resources to 2016—without energy conservation and if no other energy sources come online—are shown in the following figure (from BPA 2003 White Paper, footnote 3 below, and BPA 2006 White Paper, footnote 4 below).

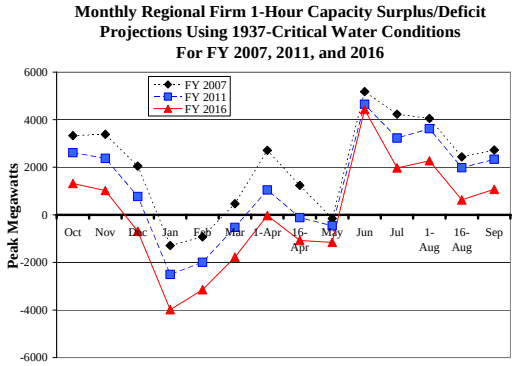


Under these conditions, the systemic conditions that started the 2001–02 Western Electricity Crisis could occur again within 10 years without additional resources and/or conservation measures. Note that this crisis was due to a below-average river runoff in 2000, one of the driest years on record in

[3] 2003 Pacific Northwest Loads and Resources Study BPA White Paper, December 2003.
[4] 2006 Pacific Northwest Loads and Resources Study, BPA White Paper, March 2006.

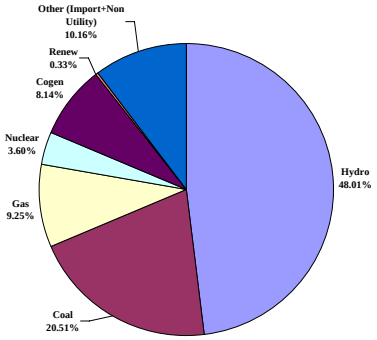
2001, and a reduced supply of non-hydroelectric power. The above-average run offs since then has been the major contributor to the financial health of BPA.

The peak surplus/deficit projections in the 2006 BPA Study[5] are not as forgiving.



While additional margin is available from hydroelectric capacity, which can operate at average levels for sustained times (weeks) giving another 4,000 aMW of temporary capacity in a good water year, this margin may become less available particularly in the high-demand summer months due to fishery protection measures and winter low river flows. Note these projections do not include any capacity increases or conservation efforts that are not already planned. If approximately 4,000 aMW of additional energy resource (green power, conservation, other contracts) could be in place (under contract to BPA) over the next 10 years, then electrical energy prices in the Northwest could remain stable. One can see there is a definite need for planning emergency load curtailment between December and April due to low river flows during the winter months.

Currently, the electrical generation by natural gas has decreased to year 2000 levels due to the high price of natural gas, availability of hydroelectric power and other more economical sources.[5] Hydroelectric power currently accounts for 48% of the average regional capacity.



PNW Electric Power Generation by Fuel (2007)-24,366 aMW

All of the Northwest long-term, sustainable excess electrical energy supply is owned by independent power producers. If additional electrical energy resources do not become available, the price of electricity will not only continue to increase, but could become volatile during high-demand months, similar to what happened during the 2001–02 period. PNNL planning must assume the wholesale price of electricity will remain high, continue to increase, and will be subject to large, periodic short-term price fluctuations. This means PNNL must continue and expand effective energy conservation efforts to minimize the impact of uncontrolled price fluctuations (see the Progress section of this plan).

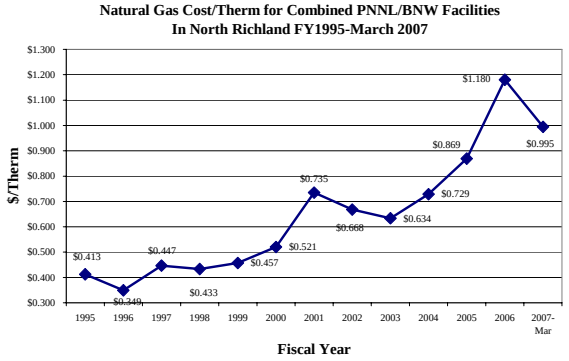
Natural Gas

Natural gas is the second largest component of energy cost for the Laboratory. Prior to 1990, fossil fuel energy used for heating PNNL/BNW facilities made up 58% of the total energy use. By FY05, natural gas was only 34% of the total energy used in these facilities. The decrease in percentage of use was due to several factors. Electrical energy use for computers and the EMSL supercomputer has grown over the last few years. Energy-efficiency measures that reduced natural gas heating loads were installed in older facilities. Finally, all new leased facilities were built with all-electric heating systems, which reduced the capital cost for the buildings but increased the operating costs compared to natural gas.

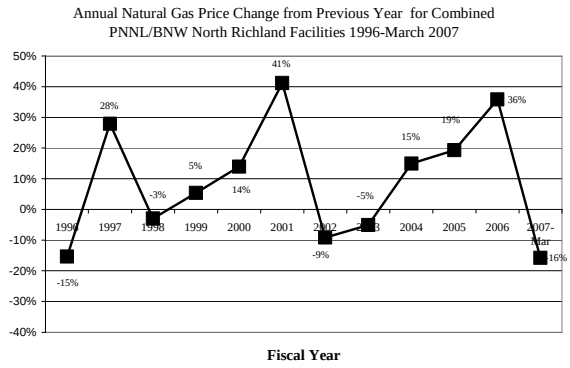
Natural gas prices were fairly stable after deregulation, but started increasing significantly in 2000 due to demand from

[5] 2006 Pacific Northwest Loads and Resources Study, BPA White Paper, March 2006.

new natural gas-fired electrical generation. Market price manipulation in the western and southwestern United States during the California energy crisis in 2001 drove up prices. In addition, western Canadian natural gas, once captive to western U.S. markets, became available to the eastern United States and Canada from a new trans-Canadian pipeline. This east-to-west interconnection has also added to price instability, as eastern U.S. natural gas markets now drive the price of natural gas across the whole North American continent. In addition, Canada is now limiting natural gas exports and production to save natural gas resources for tar sands oil production in the near future. Natural gas will be used to heat the tar sands to increase oil production. The average natural gas price decreased in FY02 and FY03, but had increased 86% between FY03 and FY06 due to low natural gas reserves and the increasing price of oil. From the end of FY06 to mid-FY07, natural gas prices have dropped 16%.



The recent (2004–06) price variation in natural gas is significantly larger than the electrical retail price variation.



PNNL buys a majority of its natural gas through a broker rather than from published tariff rates from the local supplier. This saves PNNL an average of about 20%. However, this also subjects PNNL to the risks of the "ups and downs" of the natural gas markets. To lower this risk, PNNL, in the past, has tried to protect itself from winter price spikes by buying into seasonal, secured contract "pools" for natural gas. During FY05 and FY06, these "pools" have been only somewhat successful. Assured price stability has come at an additional cost over spot market prices.

The Northwest Power and Conservation Planning Council believes that natural gas prices may remain volatile for a number of years.[6] Natural gas supplies have not expanded as expected in response to high prices in 2001, leading to concerns about declining conventional natural gas supplies. This concern is particularly valid if natural gas-fueled electrical power generation increases and the price of crude oil remains high. Natural gas price increases can also be expected to follow or exceed electrical energy price increases in the near term. As long as natural gas usage continues to increase, crude oil prices remain high, and there is little margin between production capacity and reserves, natural gas prices will remain high and volatile. The short-term price variations could be large if gas shortages appear, particularly, in the winter season. The bottom line appears to be higher natural gas prices will continue to increase, and PNNL must continue to focus on measures that conserve natural gas usage.

Renewable Energy

Renewable energy technologies tap natural flows of energy—such as water, wind, solar, geothermal, and biomass sources—to produce electricity, fuels, and heat. In general, they tend to have much lower impacts to the environment than burning fossil fuels.

[6] The 5th Northwest Electric Power and Conservation Plan, Northwest Power and Conservation Planning Council, May 2005.

Since 1998, Pacific Northwest wind power has been growing at a rapid rate. Currently, there are 1,400 MW of wind power on the grid and a total of 3,800 MW are planned for 2009.[7] It is believed about 6,000 MW of wind power can be integrated into the current electrical grid.[7]

With the current restrictions on large thermal coal and nuclear power plants, wind energy offers a limited alternative since it has limited peaking capability and requires extensive load leveling (shaping) to integrate into the grid.

The long-term challenge facing renewable energy remains its economics since external costs like pollution and CO_2 releases are not yet included in market economics. As electricity prices in general increase and renewable energy prices decrease due to increased production efficiency and reduced surcharges, renewable energy becomes more cost competitive as long as it can be integrated into the grid.

In order to encourage the development of local renewable energy sources and to meet DOE goals, PNNL will purchase 12.3% (10,757,040 kWh per year) of its electrical energy from renewable sources other than hydroelectric power in FY07. This is more than the DOE 430.2A goal of 7.5% by 2010. This is also significantly more than the EPAct 2005, Sect 203 goals of 3% for FY07–09; 5% for FY10–12, and 7.5% thereafter. As part of the above purchase, 100% of the electricity used at the Marine Sciences Laboratory in Sequim, Washington, is now 100% renewable. The cost premium for PNNL's renewable energy purchases are as follows: no cost premium is charged for 25% of the renewable purchase, $0.007/kWh is the cost premium for 23% of the purchase, and $0.011/kWh for 52% of the purchase.

Water

PNNL is dedicated to a long-term commitment to manage water resources wisely and in a sustainable way. To carry out this commitment, PNNL initiated a water management plan in 2004 and updates it annually.[8] The purpose of this water management plan is to meet the goal for water planning set in Executive Order 13123, *Greening the Government Through Efficient Energy Management* (Federal Register 1999). The Executive Order requires all federal sites to develop a water management plan and implement four Federal Energy Management Program (FEMP) Water Efficiency Best Management Practices (BMPs) that are described in the plan.

Under the current requirements of Executive Order 13123, there is no mandate for quantitative reduction in water. However, PNNL's Facilities and Operations and Effluent Management groups have set a reduction goal for water use at the Laboratory as part of an EPA Performance Track program in which PNNL is participating. This Performance Track program is a public and private partnership that recognizes top environmental performance of participating facilities across the United States (more information on this program can be found at: http://www.epa.gov/performancetrack/).

Beginning in FY 2008, Executive Order 13423 requires reduction of water consumption intensity, relative to the 2007 baseline of water consumption, through life-cycle cost-effective measures by 2% annually through the end of fiscal year 2015, or 16% by the end of fiscal year 2015.

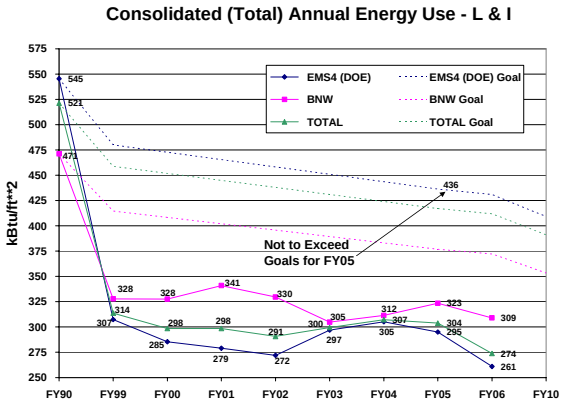
[7] Northwest Wind Integration Action Plan, Northwest Power and Conservation Planning Council and BPA, March 2007.

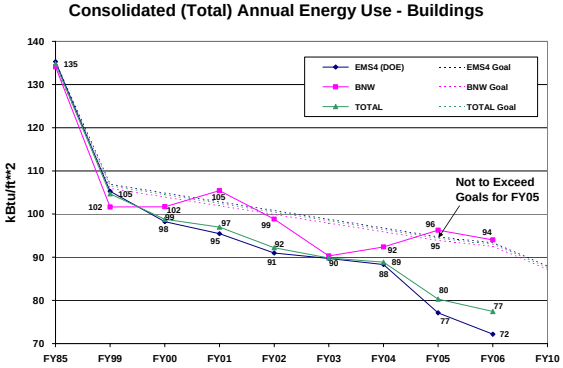
[8] Amy E. Solana et al., *Water Management Plan for Pacific Northwest National Laboratory*, May 2006.

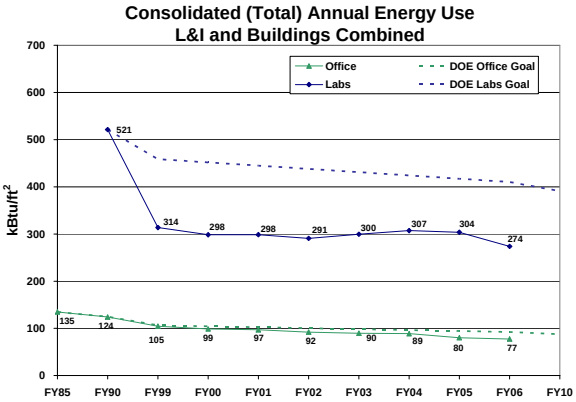
Progress

PNNL's Progress Toward Energy and Water Reduction Goals

PNNL has made significant progress toward meeting DOE reduction goals for energy and water consumption. Through a proactive energy and water management program and investment in facility infrastructure, PNNL has reduced its energy consumption per square foot by 47.5% in the Laboratory and Industrial Facility category since the FY90 baseline period, compared to the DOE goal of 20% by 2005 and 25% by 2010. PNNL has also reduced its energy consumption per square foot by 42.6% in the General Building category since the FY85 baseline period, compared to a DOE goal of 30% by 2005 and 35% by 2010. Appendix A details the Laboratory's energy management goals and current progress toward their achievement.







The Energy Act of 2005 and Executive Order 13423 require continuous energy savings of 2 and 3% per year, respectively. PNNL has already deployed most cost-effective measures and has a growing business. Hence, the new requirements will be difficult to meet without assistance from new construction or large investments in older facilities.

The EPA requires the Laboratory to set a voluntary goal for water reduction. To this end, ***the Laboratory committed to saving 5 million gallons of potable water per year by the end of FY06***, based on FY03 water consumption of 111.4 million gallons per year (see footnote 8, page 7). Through FY06, PNNL had reduced consumption by 5 million gallons per year.

Using Resources Efficiently

Increasing Energy and Water Conservation and Efficiency at PNNL

Conservation and efficiency improvement are crucial components of PNNL's energy and water plan. Energy efficiency is the ability to use less energy to produce the same amount of useful work or services. Energy conservation is closely related and is simply using less (usually by eliminating needless use or wasteful practices). Water conservation and efficiency improvements are similar. Improved energy and water efficiency and conservation reduce

consumption and costs while maintaining the operational readiness of PNNL facilities.

Since 1997, PNNL has significantly improved its energy efficiency by developing and expanding the use of energy-efficient technologies. If PNNL had continued to operate today's facilities as they were operated prior to 1997, the cost for energy would be about $4.3 million per year more than the actual FY06 expense. The avoided energy use (savings) translates to over 17.7 million kWh and 3.4 million therms per year. This energy savings eliminates the generation of 64 million pounds of CO_2 greenhouse gas (http://www.csgnetwork.com/carbonpolcalc.html).

The average energy use per square foot for all PNNL/BNW facilities has been cut nearly 49%, from 437 to 225 kBtu/ft^2. PNNL's past and future strategy for consuming less energy involves:

- Promoting energy-efficiency strategies. Energy-efficiency tips are communicated to staff through the Laboratory's biweekly newsletter.

- Performing continuous building recommissioning.

- Implementing a project in FY03 that installed WattStopper® motion sensor power plug strip technology in offices and laboratories and deploying computer monitor energy savings settings via the internal PNNL computer network. PNNL continues to deploy the WattStopper® units as requested.

- Retrofitting lighting systems and installing motion sensors and separate lighting circuits to allow turning off unneeded lights.

- Conducting a technology demonstration project in FY04, in which PNNL replaced six parking lot lights with solar-powered parking lot lights.

- Fixing the energy infrastructure. PNNL's goal is to reduce energy consumption per gross square foot by 30% by 2005 and 35% by 2010, relative to 1985, for those facilities included within the Buildings energy-reporting category in the DOE Energy Management System database and by 20% and 25%, respectively, compared to a 1990 baseline for those facilities included within the Laboratory and Industrial facilities category. By the end of FY06, PNNL had reduced 47.5% of its lab-intensive energy use in the Laboratory and Industrial category when compared to the 1990 baseline, exceeding the 2010 goal ahead of schedule. By the end of FY06, PNNL exceeded the FY05 Buildings category goal of 30% energy reduction, having achieved a 42.6% reduction in energy use in the Buildings category. The new goal under EPAct 2005 is a 2% reduction per year, and under EO 13423 the reduction is 3% per year compared to a baseline year of FY03.

- Monitoring total facility demand and demands for selected individual major loads.

- Evaluating results of continuous monitoring of energy use in NSB and ETB in FY05 to determine why these buildings were increasing energy use. Low cost conservation measures were identified that saved 13% of the energy use. Currently, FY05 and FY06 data are being evaluated.

- Identifying load reduction measures for PNNL in the event of rolling blackouts or mandatory load reductions of either natural gas or electricity. The internal load reduction procedures and plans submitted to the City of Richland and DOE can be found in Appendix B.

- Developing metering plans for evaluating buildings that do not currently have metered data or improving the energy

efficiency of office buildings to obtain the ENERGY STAR® label.

- Achieving ENERGY STAR®. Two office buildings (Sigma II and Sigma V) achieved the ENERGY STAR® Building in FY03, and Sigma II was recertified in FY05. The User Housing Facility (UHF) achieved the ENERGY STAR® Building in FY05. PNNL is the first DOE Office of Science national laboratory to achieve three facilities designated as ENERGY STAR®. Another distinction of significance is the two office facilities were the first two eastern Washington buildings to achieve this designation. UHF was the second hotel/motel in eastern Washington to achieve the designation. PNNL worked to improve, qualify, and secure this designation by performing energy audits and implementing the identified energy efficiency opportunities. Some of the opportunities included lighting retrofits, lighting controls, and metering strategies.

- Encouraging energy efficiency and conservation to PNNL occupants through a Conserving Energy & Water website and through messages from the Laboratory Director.

- Providing training opportunities on smart energy practices so that PNNL staff can practice energy efficiency year round.

- Purchasing energy-efficient products, such as appliances, office equipment, lighting, and utility systems, and institutionalizing the weigh-in of energy efficiency and conservation into purchasing practices. This includes the selection of DOE/EPA ENERGY STAR® products. Computers and peripheral equipment selected in PNNL's Managed Hardware Program comply with advanced energy efficient criteria developed by the computer industry.

- Implementing variable-frequency drives on motors.

PNNL's strategy for consuming less water involves:

- Auditing grounds management for water savings opportunities. PNNL has reduced its river water use by more than 35% over the past three years on PNNL-owned landscape.

- Developing a water management plan in FY04. PNNL's water management plan goal is to accomplish 70% of identified life-cycle, cost-effective water conservation actions by 2010. It is using as a guide, best management practices published by FEMP and other non-government industry groups.

- Replacing sixteen urinals with waterless urinals in FY04, which reduced our water usage by approximately 576,000 gallons per year.

- Installing a closed-loop lab equipment cooling system in RTL in FY05. This system is estimated to save 7 million gallons of water per year and avoid $16,000 per year of water and sewer charges.

- Installing 14 automatic infrared sink faucets and 19 infrared flushometer retrofit kits in FY05 at RTL.

- Installing 52 automatic infrared sink faucets and 74 infrared flushometers retrofit kits in FY06 at the EDL, Math, PSL, and ROB buildings.

- Replacing single-pass equipment cooling with more efficient technologies (e.g., cooling towers and air cooled).

- Conducting public outreach and education.

- Maintaining water-efficient landscaping.

PNNL Infrastructure

Delivery of Facility Strategic Plan Investments

Over the last 15 years, PNNL has invested in new facilities and facility retrofit and revitalization projects. The end result has been modern facilities that are more energy efficient. In addition, much of the research campus is new, and PNNL has vacated well over a hundred facilities/structures, which has resulted in considerable energy savings for the Laboratory.

In the next 10 years, PNNL will embark on an aggressive campaign to build new facilities and revitalize older ones—an additional half million square feet of new space is planned. The labs in the 300 Area that are being replaced due to Hanford Site closure use 60% of 300 Area total electrical energy; therefore, there will be many opportunities to reduce overall electrical energy usage in the replacement facilities. For example, the Physical Sciences Facility will be LEED certified. It will be important at the start of the design process to thoroughly evaluate the options for implementing comprehensive utility strategies that will modernize PNNL's research infrastructure, minimize operating costs, improve standby power capability, and reduce PNNL's vulnerability to energy supply disruptions. These options include combined heating, cooling, and power systems (either centralized or distributed) and renewable energy technologies such as geothermal heat pumps, photovoltaic solar panels, and wind energy.

Appendix D is a comprehensive list of PNNL investment opportunities and financial returns for planned energy efficiency and conservation technology deployment and/or retrofit projects. This list will be updated annually to reflect investment priorities and new opportunities identified through recommissioning or energy audit activities.

Appendix E is the list of 10 best management practices identified in the PNNL Water Management Plan (footnote 8, page 7) along with a progress summary.

PNNL's strategy for improving infrastructure to increase energy efficiency and conservation involves:

- Eliminating remaining surplus facilities.
- Implementing PNNL's vision for the Research Campus of the Future. New facilities for national security work, biomolecular research, scientific computing, biomass research, and process engineering need to be designed to be very energy efficient. EPAct 2005 mandates that all new federal facilities will be 30% more efficient than required by the ASHRAE 90.1 2004 standard, designating new facilities with significant public access and exposure as "showcase" facilities to highlight energy and water efficiency and renewable energy improvements.
- Designing sustainable buildings with an emphasis on obtaining leadership in this area by achieving new building design certification using the Leadership in Energy and Environmental Design (LEED) Green Building Rating System™.[9]
- Evaluating and implementing, if life-cycle-cost effective, both mature and existing technologies, such as ground source heat pumps and combined heat and power systems, as well as new, distributed-generation technologies, such as microturbines, PV solar, and fuel cells.
- Using energy efficiency and water conservation as selection criteria when acquiring leased buildings or extending existing leases.

[9] Green Building Rating System™, Version 2.0, March 2000, published by the U.S. Green Building Council.

- Expanding the use of or initiating new energy savings performance contracts (ESPCs) and utility energy savings contracts. Through ESPCs and BPA mortgage contracts, PNNL has invested over $13 million to improve infrastructure and reduce utility costs.

- Retrofitting facilities with new, more efficient system designs (e.g., lighting systems, air compressor systems, motor and pump systems, and heating systems).

Systems Monitoring and Improvement

Continuous Recommissioning of Facility Systems to Improve Efficiency

Even with modern control systems, building energy systems gain inefficiencies over time due to sensor drift, equipment aging, and operator efforts to eliminate complaints with less than optimal work-arounds. At the core of PNNL's strategy to conserve energy and improve efficiency is the recommissioning of buildings to identify and implement energy efficiency opportunities.

PNNL's strategy for recommissioning involves:

- Using surveys and inspections to continuously identify and correct low-cost/no-cost operational and maintenance deficiencies that hinder energy conservation.

- Auditing facilities to identify future energy retrofit projects and to accelerate the replacement of inefficient equipment. A detailed Energy Audit Schedule can be found in Appendix C. No formal audits are planned for FY07.

- Developing and implementing energy management monitoring and analysis tools.

- Correcting building operational inefficiencies, verifying energy use, and improving design and construction practices.

- EPAct 2005 requires that all government facilities install advanced metering by 2012. PNNL is developing a metering plan in order to implement this requirement for all its existing and new facilities. Advanced metering will enable the identification of additional conservation measures that can reduce overall energy consumption and cost. It will also greatly assist continuous recommissioning efforts in our facilities.

Diversifying Energy Supplies to Meet 21st Century Demands

Increasing PNNL's Use of Renewable and Alternative Energy

In order to encourage the development of local renewable energy sources and to meet DOE goals, PNNL will purchase 12.3% (10,757,040 kWh/year) of its electrical energy from renewable sources other than hydroelectric power in FY07. This is more than the DOE 430.2A goal of 7.5% by 2010. This is also significantly more than the EPAct 2005, Sect 203 goals of 3% for FY07–09; 5% for FY10–12, and 7.5% thereafter. As part of the above purchase, 100% of the electricity used at the Marine Sciences Laboratory in Sequim, Washington, is now 100% renewable. The cost premium for PNNL's renewable energy purchases are as follows: no cost premium is charged for 25% of the renewable purchase, $0.007/kWh is the cost premium

for 23% of the purchase, and $0.011/kWh for 52% of the purchase.

PNNL's strategy to diversify its energy supply involves:

- Evaluating and implementing the use of off-grid generation systems (such as fuel cells, microturbines, wind energy systems, and photovoltaic systems) when such systems are life-cycle, cost-effective and offer benefits including energy efficiency, pollution prevention, and source energy reductions.
- Evaluating the acquisition of either "green power" or "green tags" to promote the development and use of renewable power.
- Diversifying "green power" purchases to include small hydro, wind, and landfill gas. PNNL will be further reviewing new cost-effective, out-year purchases of an even broader diversification of renewable energy resources.

Strengthening Collaboration, Communication, and Education

Enhancing Relationships with other Labs and PNNL Stakeholders

A key strategy of PNNL is to team researchers and practitioners to field test practical energy solutions. PNNL also partners with government, educational, and commercial institutions to share energy efficiency and best-practice opportunities. PNNL's strategy for collaboration involves:

- Evaluating energy efficiency and best-practice opportunities from other DOE laboratories.
- Replicating model programs from other DOE laboratories.
- Networking with PNNL facility managers to share best practices in energy management.
- Establishing and enhancing communications with utility providers to understand their needs for load reductions and availability of alternative sources of energy (e.g., non-hydro renewable power).
- Participating in facility management association and DOE workshops and conferences.
- Increasing the number of trained energy managers to verify effective implementation of the Laboratory's energy plan.
- Teaming with PNNL researchers to deploy PNNL technologies in laboratory facilities.
- Sharing information about PNNL's energy program and facility diagnostic tools with industry associations, such as the International Facility Managers Association.

Appendix A – *Energy Management Goals*

Goal	Progress
Reduce energy consumption per gross square foot by 30% by 2005 and 35% by 2010 against the 1985 baseline for facilities included in the Building energy-reporting category.	PNNL has reduced 42.6% of its energy use when compared to the 1985 baseline and has met the 2005 goal of 30%. More work will be required to guarantee meeting the 2010 goal of 35% reduction.
Reduce energy consumption per gross square foot by 20% by 2005 and 25% by 2010 against the1990 baseline for facilities included in the Industrial and Laboratory Facilities energy-reporting category.	PNNL has reduced 47.5% of its energy use when compared to the 1990 baseline, exceeding this goal ahead of schedule.
Reduce energy use by 2% per year (using the FY03 baseline) in accordance with the EPAct 2005 requirement. This requirement is about 50% more aggressive than the previous energy conservation goals above. Executive Order 13423 augments the EPAct 2005 mandate to reducing energy usage to 3% per year or more in Federal Facilities. EPAct 2005 also mandates that advanced metering will be installed by 2012.	PNNL, working with Fluor-Hanford, in FY06, was able to establish its official FY03 baseline since PNNL's energy usage in EMS4 was previously part of the overall Hanford site reporting. PNNL was established as a separate reporting site starting in FY04. Achieving this new goal will require substantial investment in infrastructure upgrades or replacement and an aggressive energy management program. The actual result for FY06 compared to the baseline is a 3% increase.
Implement water management through water efficiency programs and plans. Beginning in FY 2008, Executive Order 13423 requires reduction of water consumption intensity, relative to the 2007 baseline of water consumption, through life-cycle cost-effective measures by 2% annually through the end of fiscal year 2015, or 16% by the end of fiscal year 2015.	PNNL has made the following progress on achieving this goal: reduced river water use on PNNL-owned landscape by 35% since 1999, developed the PNNL Water Management Plan, installed 16 waterless urinals in FY04, installed a closed-loop cooling system in PSL in FY04, implemented a closed-loop cooling system in RTL became fully operational in FY05, installed 12 infrared faucets and 19 infrared flushometer retrofit kits in RTL in FY05. Installed 52 infrared faucets and 74 infrared flushometers retrofit kits in EDL, Math, PSL, and ROB in FY06.
Achieve 10% annual progress to complete energy audits in DOE buildings.	Appendix C shows the completed energy audits.
Make annual progress toward qualifying office buildings for the ENERGY STAR® label.	Eight office buildings were evaluated for ENERGY STAR®. Sigma II qualified for the ENERGY STAR® label in FY03 and FY05 after staff led a campaign to reduce energy consumption. Sigma V, after investing $60,000 in energy conservation measures, qualified for the ENERGY STAR® label in FY03. UHF qualified for the ENERGY STAR® label in FY05. PNNL is evaluating what additional investments are required to qualify more buildings in the future.

Appendix A – *Energy Management Goals (contd)*

Goal	Progress
Increase the number of trained energy managers.	PNNL has three Certified Energy Managers assigned to Facilities and Operations; however, there are a number of resident subject matter experts represented who conduct energy research and development (policy and technology) at PNNL.
Increase the use of alternative funding.	Over $14M used to date. In 2002, PNNL started and/or completed ESPCs for Richland North and 300 Area standby power and compressed air. In addition, PNNL secured $600K in BPA obligations to use in the implementation of energy conservation measures in PNNL facilities in FY03. PNNL received more than $227K in FEMP funding in FY02 to implement lighting retrofits in the 300 Area and $60K from BPA for continuous energy monitoring in FY05. Another $42K was received from BPA in FY05 for installation of VFDs in the 300 Area. The Richland North ESPC-3 was completed in FY06 with $38K of BPA funding. Nine additional VFDs were installed in the 300 Area in FY06 with the help of $20K of BPA funding. Lighting retrofits were completed in Sigma 2, 3, and 4 in FY06 with the help of $32K of BPA funding. VFDs will be added to five large motors in LSL-II in FY07 with BPA funding a part of the project. Additional phases are being planned to convert Richland North from steam to hot water, submeter buildings, install VFDs, and implement more lighting retrofits.
Increase the use of off-grid generation systems.	In FY02, PNNL recommissioned a solar heating system in the 337 Building to provide hot water for the kitchen area. Six PV solar-powered parking lot lights were installed in Richland North in FY04.
Achieve 7.5% use of non-hydro renewable power by 2010.	PNNL collaborated with DOE-RL and Fluor-Hanford in 2002 to buy 3.1% green power from BPA. PNNL bought wind power to meet 12.7% of its electrical usage in FY03, 14.9% in FY04, 16.2% in FY05, and 10.4% in FY06. This diversified green power portfolio now also includes landfill gas combustion generation, which covers 100% of MSL's electrical power needs.

Appendix B – *Load Reduction Plans(To be Revised)*

PNNL Electrical Load Curtailment

1.0 Objective

This practice provides guidance to the Pacific Northwest National Laboratory (PNNL) Security Operations Center (OC) regarding actions to be taken in the event that either of the electrical service providers for PNNL, Hanford Electrical Utilities (EU) or City of Richland contacts the PNNL OC to request an electrical load curtailment.

2.0 Applicability

This practice is applicable to the Security Technicians and shall be implemented when notified of an electrical load curtailment.

3.0 Definitions

None

4.0 Roles and Responsibilities

Security Operations Center Supervisor

- Assure Security Operations Center staff are appropriately trained and can perform the actions outlined in this procedure.

Security Technicians

- Assure electrical load curtailment notifications are completed following this practice.
- Gather applicable information from the caller regarding the request for electrical load curtailment. See PNNL Electrical Load Reduction Information Table, Exhibit 1.
- Notify appropriate building manager(s) regarding request for electrical load curtailment.
- Complete PNNL Electrical Load Reduction Information Table, Exhibit 1.
- Submit completed PNNL Electrical Load Reduction Information Table, Exhibit 1 to the Utility Manager (K6-59).

		Reference			
		Use Category			
BW Avery		KE McMullin			
Revised - Security Operations Center Supervisor	Date	Concurrence – Facility Management Lead (South)			Date
FG Buck		S.W. Gority	Original Signed by	11-16-05	
Concurrence – Facility Management Lead (North)	Date	Approved – Security Operations Manager			Date

5.0 Procedure

PNNL receives electricity from two separate service providers for the facilities it owns and operates for the Pacific Northwest Site Office (PSNO). The Hanford Electrical Utilities (EU) Contractor provides service for the PNSO-owned PNNL-operated facilities, most of which are located in the 300 Area. The City of Richland is the electrical services provider for all PNNL-owned facilities in the Richland Complex, including the Environmental Molecular Sciences Laboratory (EMSL) that is operated for the PNSO by PNNL.

This practice outlines actions to be taken in the event that either of the electrical service providers contacts PNNL to request an electrical load curtailment. Both electrical services providers will be instructed to contact the PNNL OC at 375-2400 to initiate electrical load curtailment actions. The service provider contacting the OC will identify themselves by their organization, position title, and name. They will then indicate the level of electrical load curtailment to be achieved (5%, 10%, 15%, or 20%).

- The OC will record the information on the "PNNL Electrical Load Reduction Information Table," Exhibit 1.

Subsequent OC notifications within PNNL are listed below by area:

<u>300Area Electrical Load Curtailment Contacts</u>

- Contact Government Facilities Building Manager (376-7012) and advise of the load curtailment notification and the associated level of reduction.
- Contact the Radiochemical Processing Laboratory (RPL) Building Manager (376-5746) and advise of the load curtailment notification and the associated level of reduction.

<u>EMSL/Richland Area Electrical Load Curtailment Contacts</u>

- Contact the EMSL Building Manager (376-9435) and advise of load curtailment notification and the associated level of reduction.
- Contact the Private Facilities Building Manager (375-6777) and advise of load curtailment notification and the associated level of reduction.
- Contact the Leased Facilities Building Manager (372-6178) and advise of load curtailment notification and the associated level of reduction.

The Building Manager(s) will initiate actions commensurate with their Electrical Load Curtailment plans.

- If any of the above Building Managers cannot be contacted, then contact their associated alternate contacts as provided by Facility Management Services.
- Additional PNNL notifications:
    - Facility Management Services Manager (372-2680)
    - Energy Program Coordinator (376-2971).

6.0 References

None

7.0 Exhibits

Exhibit 1 – PNNL Electrical Load Reduction Information Table.

Exhibit 1 – PNNL Electrical Load Reduction Information Table

Date/Time	Calling Organization, Position & Name	Electrical Load Reduction (5%, 10%, 15%, or 20%)	Estimated Length of Time for Load Reduction	Initials of PNNL OC Staff

Send completed form to the Energy Program Manager at J2-33.

Contractor	PACIFIC NORTHWEST NATIONAL LABORATORY (PNNL)	Area	300
Primary Contact			
Name	PNNL SINGLE POINT CONTACT ROOM (SPC)		
Telephone No.	375-2400		
Cell Phone No.	ALT. # 375-2154		
Pager No.	N/A		
% Curtailment	Action	Fuel Savings	Impacts
5%	1. LOWER/RAISE (SEASONAL) THERMOSTATS IN ALL FACILITIES. TURN OFF ALL ELECTRIC PROCESS HOT WATER HEATERS.	200 kW	MAJOR INCONVENIENCE
10%	2. TURN OFF NON-ESSENTIAL LIGHTING IN ALL FACILITIES. TURN OFF PORTABLE SPACE HEATERS IN ALL FACILITIES.	497 kW (INCLUDES ACTION #1)	MAJOR INCONVENIENCE, POSSIBLE WORK STOPPAGE.
15%	3. SELECTED HVAC SHUTDOWN IN BUILDINGS: 331-H, 350, AND 3760.	686 kW (INCLUDES ACTIONS #1,2)	WORK STOPPAGES, PROBABLE STAFF RELOCATION/SEND HOME.
20%	4. SELECTED HVAC SHUTDOWN IN BUILDINGS: 318, 323, 326, 329, 331, 336, AND 338.	1,054 kW (INCLUDES ACTIONS #1,2,3)	WORK STOPPAGES, PROBABLE STAFF RELOCATION/SEND HOME.

Contractor	PACIFIC NORTHWEST NATIONAL LABORATORY (PNNL)	Area	RICHLAND NORTH
Primary Contact			
Name	PNNL SINGLE POINT CONTACT ROOM (SPC)		
Telephone No.	375-2400		
Cell Phone No.	ALT. # 375-2154		
Pager No.	N/A		

% Curtailment	Action	Fuel Savings	Impacts
5%	1. TURN OFF NON-ESSENTIAL LIGHTING IN ALL BUILDINGS.	255 kW	MINOR INCONVENIENCE.
10%	2. START GENERATORS AND CARRY CONNECTED LOADS AT THE ANNEX, PGF, AND EDL. EMSL HVAC IN NIGHT SET-BACK.	490 kW (INCLUDES ACTION #1)	MAJOR INCONVENIENCE. POSSIBLE AIR EMISSION ISSUES. ADDITIONAL FOSSIL FUEL COSTS.
15%	3. START GENERATORS AND CARRY CONNECTED LOADS AT RTL AND EMSL.	882 kW (INCLUDES ACTIONS #1,2)	MAJOR INCONVENIENCE. POSSIBLE AIR EMISSION ISSUES. ADDITIONAL FOSSIL FUEL COSTS.
20%	4. START GENERATOR AND CARRY CONNECTED LOADS AT LSL-II.	1,264 kW (INCLUDES ACTIONS #1,2,3)	MAJOR INCONVENIENCE. POSSIBLE AIR EMISSION ISSUES. ADDITIONAL FOSSIL FUEL COSTS. REDUCED AUTOMATIC EQUIP. REDUNDANCY AT LSL-II.

PNNL NATURAL GAS ALLOCATION
Supplemental Control Room Procedures

Natural Gas Allocation

1.0 Introduction

This practice provides guidance to the Pacific Northwest National Laboratory (PNNL) Security Operations Center (OC) regarding actions to be taken in the event that Cascade Natural Gas Corporation (CNG) contacts the OC to request a natural gas allocation/reduction.

2.0 Applicability

This practice is applicable to the Security Technicians and shall be implemented when notified of a natural gas allocation/reduction.

3.0 Definitions

None

4.0 Roles and Responsibilities

Security Operations Center Supervisor

- Assure Security Operations Center staff are appropriately trained and can perform the actions outlined in this procedure.

Security Technicians

- Assure natural gas allocation/reduction notifications are completed following this practice.
- Gather applicable information from the caller regarding the request for natural gas allocation/reduction. See Gas Allocation Order (Exhibits 3 or 4).
- Complete Gas Allocation Order.
- Make appropriate PNNL staff notifications to advise of gas allocation.
- Fax gas allocation order to appropriate PNNL staff.

5.0 Procedure

PNNL has contracted with CNG to provide natural gas to the Richland Research Complex (RRC) and the Environmental Molecular Sciences Laboratory (EMSL) that may be subject to an allocation or entitlement (reduced volume) of natural gas. In the event it is necessary for CNG to allocate gas services, they will phone the customer's representative. PNNL has provided CNG with a list of personnel authorized to accept gas allocation orders (see Exhibit 1). A list of CNG representatives is attached as Exhibit 2.

Notification of an allocation will be accomplished by CNG contacting an authorized representative of PNNL by telephone and reading the allocation order. The order number, date, time, allocation volume by service, effective date and time, reason for allocation, PNNL representative, and CNG

dispatcher shall be noted on the allocation order. A blank copy of the allocation order is attached as Exhibit 3 for the RRC, and Exhibit 4 for EMSL.

- The Security Technician will record the information on the "Gas Allocation Order" (Exhibit 3 or 4).
- The Security Technician will read back the completed order before terminating the call.

Subsequent Security Technician notifications within PNNL are listed below by area:

- Notify Mike Bruun (375-2273 or 430-0880 [cellular phone]) and advise of the allocation(s).
- Fax a copy of the complete allocation order(s) to Mike Bruun at 375-6430.
- Fax an additional copy of the completed allocation order(s) to Marc Berman at 372-2686.

If Mike Bruun cannot be contacted as above, then please contact Dwight Hughes at 375-6777 or 967-8094 (home).

6.0 References

None

7.0 Exhibits

Exhibit 1 – PNNL Personnel Authorized to Accept Gas Allocation Orders
Exhibit 2 – Cascade Natural Gas Representatives
Exhibit 3 – Gas Allocation Order Form (RRC)
Exhibit 4 – Gas Allocation Order Form (EMSL)

Exhibit 1 – PNNL Personnel Authorized to Accept Gas Allocation Orders

December 9, 2004 Account #: 0125

Company Name: Battelle Northwest
Mailing Address: 2955 George Washington Way
Richland, WA 99352

Service Address: _____

Website Address: _____

The following individuals are authorized to give and receive communications regarding gas requirements, gas service nominations, allocations, releases and curtailment, plant outages, and other routine operating information. The information is listed in the sequence we wish to have them contacted.

UPDATED INFORMATION					
Name	Business Phone	Home Phone	Cellular Phone/Pager	Fax	E-mail Address
PNNL Security Operations Center	509-375-2154	NA	NA	509-375-6676	
Mike Bruun	509-375-2273	509-943-2697	509-430-0880	509-375-6430	ml.bruun@pnl.gov
Dwight Hughes	509-375-6777	509-967-8094	509-539-1346	509-375-6430	dwight.hughes@pnl.gov

Please mail to:

Jon Stoltz
Vice President, Gas Supply & Regulatory
Cascade Natural Gas Corporation
222 Fairview Avenue North
Seattle, Washington 98109-5312

Name: _____
Title: _____

Exhibit 2 – Cascade Natural Gas Representatives

The following is a listing of employees from CNG who are authorized to give and accept operating information:

Name	Business Telephone
Gas Supply ~ Seattle	206-624-3900
Jon Stolz, Vice President, Gas Supply	206-381-6823
Patricia Grable, Senior Director, Gas Supply	206-381-6829
Steve Pfaff, Manager, Gas Management	206-381-6847
Chuck Kane, Account Executive	509-381-4565
Lynda Goodrich, Senior Director, Energy Services	206-381-6841
Incoming WATS Service	
Washington	1-800-552-0615
Oregon	1-800-426-0242
Fax Numbers:	
Gas Supply	206-654-4039
Energy Services	206-624-7215

Exhibit 3 – Gas Allocation Order Form

CASCADE NATURAL GAS CORPORATION
Gas Allocation Order

Date: _____ Time: _____ PST Order Number: _____

Customer Name: Battelle/PNNL Account Number: 0125

Your natural gas allocation for delivery at your facility for the gas day of _____, 20__, beginning at 7:00 AM PST on this date and continuing until further notice is _____ or

Optional Firm	R/S 181/681	_____	therms
Spot Market	R/S 182/682	_____	therms
Customer Owned	R/S 183/683	_____	therms
Incremental Purchase	R/S 684	_____	therms
Supplier	_____		
Price	_____	per therm	
TOTAL AVAILABLE FOR USE		_____	therms

This allocation is a result of supply and/or capacity deficiency.

NOTE: Volumes used above this level could be subject to unauthorized overrun penalties under the appropriate tariff.

_____ _____
Cascade Representative Battelle Representative

Fax Transmittal

To: Marc Berman
Facilities Engineering
Fax#: 372-2686

To: Mike Bruun
Building Engineer
Fax#: 375-6430

From: _____
PNNL Operations Center

Exhibit 4 – Gas Allocation Order Form

CASCADE NATURAL GAS CORPORATION
Gas Allocation Order

Date: _____ Time: _____ PST Order Number: _____

Customer Name: Battelle/PNNL Account Number: 0140

Your natural gas allocation for delivery at your facility for the gas day of _____, 20__, beginning at 7:00 AM PST on this date and continuing until further notice is _____ or

Optional Firm	R/S 181/681	_____	therms
Spot Market	R/S 182/682	_____	therms
Customer Owned	R/S 183/683	_____	therms
Incremental Purchase	R/S 684	_____	therms
Supplier	_____		
Price	_____ per therm		
TOTAL AVAILABLE FOR USE		_____	therms

This allocation is a result of supply and/or capacity deficiency.

NOTE: Volumes used above this level could be subject to unauthorized overrun penalties under the appropriate tariff.

_____ _____
Cascade Representative Battelle Representative

Fax Transmittal

To: Marc Berman
Facilities Engineering
Fax#: 372-2686

To: Mike Bruun
Building Engineer
Fax#: 375-6430

From: _____
PNNL Operations Center

Appendix C – *Energy Audits Completed*

Building	Square Feet	FY Completed
Sigma 5	47,900	FY01
Sub-Total by Year & % of Total Space	47,900	2.51%
2400 Stevens	93,351	FY02
ISB1	50,200	FY02
ISB2	60,080	FY02
ETB*	100,364	FY02, redone and modeled in FY05
NSB*	99,670	FY02, redone and modeled in FY05
ESB	12,595	FY02
MSL	45,190	FY02
329	39,420	FY02
331	114,978	FY02
3020 (EMSL)	200,000	FY02
Sub-Total by Year & % of Total Space	815,848	42.82%
318	37,025	FY03
320	31,437	FY03
326	63,589	FY03
336	6,438	FY03
337**	N/A	FY03
338	18,315	FY03
350	22,048	FY03
3760	21,700	FY03
Sub-Total by Year & % of Total Space	200,552	10.53%
Sigma 2	20,100	FY06
Sigma 3	20,090	FY06
Sigma 4	20,090	FY06
Sub-Total by Year & % of Total Space	60,280	3.16%
Total and % of Total Space Audited	1,124,580	59.02%
Residual Space & % of Total Space Remaining	780,853	40.98%
Total Space	1,905,433	

* The audits of ETB and NSB were redone in FY05 using metered energy usage data, which resulted in improved energy use modeling.

** Although audited, 70,424 ft2 was not counted for 337 since it is no longer a PNNL building

Appendix D – *Energy Investment Opportunities*

Electrical Savings Projects

Anticipated Year Completed	Planned Project	kWh/year Savings	Total Annual Savings ($K)	Approximate Cost to Implement ($K)	Simple Pay Back (Yrs)
FY07	LSL-II VFD Project	577,964	32	224	7.0
FY07	Sigma 2 Corridor Lighting Control	12,666	0.7	5	7.1
FY08	Sigma 4 Corridor Lighting Control	12,666	0.7	5	7.1
TBD	Real Time Metering – EMSL	420,000	106	50	0.5
TBD	Real Time Metering – Sigma 5	22,400	6	10	1.7
TBD	Real Time Metering – 2400 Stevens	40,600	10	15	1.5
FY09	Sigma 2 Replace Old Heat Pumps with SEER 13 or better (4 replaced in FY07)	19,715	1.2	$42	35.0
FY09	Sigma 3 Replace Old Heat Pumps with SEER 13 or better (1 replaced in FY07)	26,995	1.9	53	27.9
FY09	Sigma 4 Replace Old Heat Pumps with SEER 13 or better	31,646	2.4	76.0	31.7
FY09	350 Replace Old Heat Pumps with SEER 13 or better	47,469	3.6	114.0	31.7
FY09	NSB Common Area Occupancy Sensors	40,000	2	15	7.5
FY09	ETB Common Area Occupancy Sensors	50,000	3	15	5.0
FY09	ISB 2 Common Area Occupancy Sensors	30,000	2	15	7.5
FY10	ETB – Variable Frequency Fan Drives	238,424	12	56	4.7
FY10	NSB – Variable Frequency Fan Drives	160,821	8	56	7.0
FY10	VFD Applications in North Richland with ROI > 5 Years	351,381	18	162	9.0
	Total	**2,082,747**	**210**	**913**	**4.4**

Natural Gas Saving Projects

Anticipated Year Completed	Planned Project	Therms/Year Savings	Total Annual Savings ($K)	Approximate Cost to Implement ($K)	Simple Payback (Yrs)
FY08 – FY11	Conversion of RRC steam system to hot water	120,000	120	2,728	23
	Total	120,000	120	2,728	23

Appendix E – *Progress Toward Meeting FEMP Best Management Practices to Conserve Water*

(The data in the following table is from footnote 8, page 7.)

ITEM	BEST MANAGEMENT PRACTICE	O&M OPTIONS IMPLEMENTED?	RETROFIT & REPLACEMENT OPTIONS IMPLEMENTED?	CREDIT FOR BMP?	COMMENTS
1	Public Information and Education Programs	Has been initiated through website	N/A	No	Needs further education on domestic and process water use
2	Distribution System Audits, Leak Detection, and Repair	No	N/A	No	Only applicable for lines that are downstream of the meter
3	Water-Efficient Landscaping	Yes	Yes	Unknown – *irrigation water is mostly non-potable.*	Consider additional use of native landscaping. Determine if savings in irrigation water satisfies goals of the BMP
4	Toilets and Urinals	No	Has been initiated	No	Need to install all cost-effective fixtures and employ O&M
5	Faucets and Showerheads	No	Has been initiated	No	Need to install all cost-effective fixtures and employ O&M
6	Boiler/Steam Systems	Unknown	Unknown	No	Need to do further audits to understand this area
7	Single-Pass Cooling Equipment	Has been initiated	Has been initiated	No	Very close to meeting BMP
8	Cooling Tower Management	Some are used at EMSL	No	No	Need to do further audits to understand this area
9	Misc. High Water-Using Processes	Unknown	Unknown	Unknown	Need to do further audits to understand this area
10	Water Reuse and Recycling	NA	Reuse of pond water on irrigation	No	Seek other opportunities for recycle and reuse