An Assessment of the Feasibility of Emergency Electrical Generation Units to Serve System Load Requirements

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Northwest Power Planning Council

Executive Summary

Over the past year a growing power crisis has emerged across the western states. Recent developments in power management in California have raised particular concerns as the Northwest region both plans and reacts to possible power shortages or extreme price increases. Our heavy reliance on electrical power has left millions of Americans vulnerable to severe consequences of power loss. In order to avoid the California experience of rolling blackouts or the effects of higher wholesale power increases, we must look for creative and innovative ways to both produce greater supplies of electric power, provide incentives for conservation and balance environmental needs simultaneously. Many debates have taken place as to what can be done to improve this situation. Some alternative proposals have been considered. One proposal encourages the use of emergency generators, already installed in a variety of buildings, be used to increase power generation.

This study, which is based upon the need to explore the feasibility of power generation from relatively small generators in individual buildings, is limited in size and scope. Interviews were conducted over an eight-week period with building operators and managers in the city of Portland, Oregon who own or manage emergency generating units. Additional interviews were conducted with personnel from local electric utilities. This study sought first to determine the availability of emergency generators and the amount of power that could be generated. Owners and managers of buildings were questioned as to whether and how they would support using private generation in cooperation with utilities. Issues explored included economic, technical and legal ones relating to the practical use of emergency generators and the incentives and problems in establishing a workable program.

This study found that emergency generators are available in a variety of commercial and industrial buildings as well as hospitals, high schools, colleges, jails, and public safety facilities. According to industry information Washington, Oregon, Idaho, and Montana have just over 26,000 generators within their borders. This study contacted 70 facilities or approximately 10% of the total available in the city of Portland.

Federal, state and local jurisdictions govern the use of emergency generators. Agencies such as the federal Environmental Protection Agency and state agencies such as the Oregon Department of Environmental Quality have specific requirements and environmental codes that must be met. At the local level, emergency generators are subject to local structural, mechanical and electrical regulations.

From the information gathered 71% of the industrial and commercial building owners or managers indicated that they would be interested or likely interested in contracting with a utility to supply energy to the power grid using their emergency generating capacity. This level of support was qualified by the desire of respondents for support from utility companies and clear economic incentives to participate.

The results of interviews with utility personnel as well as additional research indicated that local utilities are supportive to the idea of using emergency generating capacity to augment present power production. Most utilities are considering innovative programs to increase the power supply, and see the use of emergency generation as a possible option. Some utilities are beginning to develop specific program parameters and consider legal and contract information that would mutually benefit both the owners of emergency generators as well as the utilities. Further, some program elements have specific environmental benefits.

Emergency generators may be used up to 200 hours per year during peak power needs. In exchange for use of the emergency generators, utilities would supply support, maintenance, fuel and equipment to fully maintain the generators as well as build a centralized and parallel power supply. Building owners would be secure in knowing that they have guaranteed, dependable and non-interruptable power from well-maintained and tested emergency generators.

If the results of this survey are extrapolated region-wide there is significant generating capacity available using the capacity in emergency generators. An estimated 3.7 gigawatts of generating capacity is believed to be available. This additional power provided at reasonable cost, both economically and environmentally offer an important opportunity to meet the power needs of a growing region.

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Millions of Americans, often without thought, rely on our complex electrical power system to meet their daily needs. Without electrical power modern life and the completion of simple daily tasks becomes impossible. Electrical power is the essential backbone of America's culture. Unfortunately, this reliance has left citizens vulnerable to the power system and the negative effects when it does not work properly. Presently the northwestern part of the United States is experiencing a lessening in availability of electrical power. Prices of wholesale power are increasing dramatically. These prices are predicted to continue to be high throughout the next several years. Economic and population growth, poor water conditions, lack of customer incentives to conserve, high natural gas prices and a dysfunctional deregulated power industry in California has resulted in the deterioration of the electrical power system. This situation must be improved to continue the high standard of living Americans enjoy.

Many debates have taken place in a search for ways to improve this situation. No single clear answer has been found, but many alternative proposals have been considered. One idea, the focus of this study, is the use of emergency generation units to produce the demanded amount of power that the utilities are unable to provide. Many commercial and industrial facilities are already equipped with emergency power generation units. These units, which run on diesel fuel, are installed and are used in case of an emergency when the grid that usually provides the electrical power is temporarily out of service. It has been proposed that these emergency generating units also be put in operation to supply power during times of peak demand. The question of whether it is feasible to use these units as part-time power generators is the objective of this study proposed by the Northwest Power Planning Council.

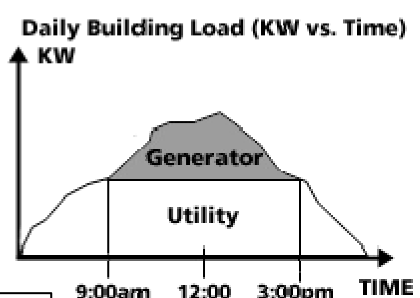
The Northwest Power Planning Council is an interstate compact agency responsible for the assessment of electric power and fish and wildlife issues affecting the states of Idaho, Montana, Oregon and Washington. The Council makes policy recommendations at the request of the governors, legislators, congressional delegation and the Bonneville Power Administration.

This study is based on interviews of facilities operators who own emergency generating units and the utilities that support the power grid. The first goal of the study is to evaluate the current conditions of the emergency power generators. For example, where generators are located, amount of generating capacity, who controls their use, and under what circumstances generators are currently employed, are all questions addressed by the study. Since little was known about the emergency generating units, finding current information about these generators was essential in finding out how they might be used to offset the power demand.

The second goal of the study is to analyze the feasibility of employing emergency generators fulltime or on a part-time basis as needed. In question is the economic viability of keeping generators running for a longer than normal period of time. The study examines the impact on the utility, and if it is economically feasible for the utility company to pay for extra equipment, contracts, and servicing for emergency generators. The study also addresses the environmental quality issues that appear when the generators are in use. They are noisy and release large amounts of particle waste into the air. The generators also require fuel onsite for their operation, which, when running the generators more often, will result in the need for more onsite diesel fuel.

Other complications may also arise. Health and safety issues may offer challenges. There are also several laws, regulations and institutional constraints on use of emergency generators. It is important to take into account these regulations and the actions necessary to modify regulations that prohibit the use of generators as power producers. At present, the primary purpose of these units is to provide electricity to the customer in case of service interruption. If emergency generators were to be used to augment system loads, as addressed in this study, the generators would no longer be considered emergency generators, but power generators and be subject to a different level of federal and state requirements.

Electricity is provided by the power producer, passed to the utility, and then to the consumer. In an ideal circumstance this is how the power industry would work on a simplified level. The current problem is that it now costs the utility too much to buy the power from the producer due to increased demand and impacts from additional economic factors and unpredicted events. Because the utility must supply energy to consumers, it will look for other options to produce power more efficiently. As shown in figure one, below, demand tends to increase during mid-day. If the utility is only able to fulfill part of their demand during mid-day the result would be blackouts. This study will review the use of emergency generators by the utility to fulfill the demanded amount of power as shown below.



The generator is able to fill the demanded amount of power.

Fig. 1 Typical load profile showing use of engine generator during peak periods.

This beginning study seeks to gather baseline data in regards to emergency power generation use. Conclusions are preliminary and based on limited data and estimated numbers. Yet, this information can provide groundwork for even more future research. It is clear that if the full extent of emergency generation's potential is to be realized, a more in-depth and broader study must be performed. However, it is my intention to provide the most recent and exact information possible. With this information gathered an estimate of generation potential has been made. Hopefully with this new information, producers, utilities and consumers will begin to prepare for innovative changes in the power industry.

Evaluating Conditions of Emergency Generation Facilities

Types of Emergency Generator Units

Emergency generators come in a variety of types and have varying amounts of kilowatt (kW or 1000 watt) capacity. The main manufacturers of emergency generators are Caterpillar, Cummins, Detroit Diesel, Perkins, and Deutz. Photos of the different generators, except Perkins, are included in appendices four, five, six and seven respectively. The average commercial grade generator will produce anywhere from 150 kW to 800 kW. This is the standard range for generators installed in commercial buildings to support emergency equipment, such as lighting or elevators. For smaller buildings or those who only need generation for emergency lighting there are smaller generators available ranging from 50 to 150 kW. Buildings with tenants that require larger generation, or industrial plants, may use generators producing 800 kW to 4 megawatts (MW or 1000 kW). Any generator larger than 4 MW is considered to be a power plant in itself.

Generators are a huge investment for a building owner. A standard 200 kW generator costs around $21,000. 400 kW generators cost about three times as much. There are also added expenditures such as an auto start panel, the auto-transfer switches, fuel tanks, various permits, installation and shipping. This does not include maintenance, which is estimated to be ten to twenty thousand dollars a year for an 800 kW generator. This maintenance figure also includes the amount spent on periodic testing.

Where Generators are Found

Human safety is the number-one reason for the installation of emergency generation units into office buildings. Federal law mandates the existence of emergency lighting in any commercial, industrial or public facility. Emergency lighting can be supplied two different ways. First, a facility may install emergency batteries to supply lighting during a power failure. Batteries are cheaper for the owners to purchase. They are also more environmentally friendly. Emergency battery systems recharge themselves when power is on and do not use any excess fossil fuels, leave any discharge or any particle waste when running. One drawback of emergency battery systems is that they are not as powerful since each can only produce approximately 50 kW. However, batteries can be stacked to reach higher capacities. Also, they are unable to support the building needs for more than a day or so at peak load.

The second form of emergency lighting is through emergency generation units. These units come in all forms and sizes and can produce up to 4 MW of electrical energy. The benefit of an emergency generator is that it can be used to supply emergency lighting, backup the elevator system, run the computer system, or in an industrial building the generator can run the equipment needed to continue production. Generator use has flexibility and can be set up to run any electrical device during an outage. Even though emergency generators cost several thousands of dollars more than battery systems, their ability to continue to run building systems can save tenants lost revenue. In many cases generators can pay for their purchase and operation costs in a few years by the amount of revenue produced from not having to stop production during a power outage.

Emergency generators can be found in hospitals, office buildings, high schools, colleges and universities, jails, public safety facilities (Police, fire, emergency rescue), military facilities, airports, seaports, ski resorts, industrial production facilities, telecommunication facilities, or anywhere else that may need back up power to continue work.

Determining Generator Location, Type and Capacity

One of the goals of this study is to calculate the number, type and capacity of emergency generators available for electrical production in the Northwest. From those numbers I hoped to estimate the generation potential in kilowatts. Originally it was thought that by contacting building managers in buildings with known emergency generators I would be able to find the information necessary for the study. I also hoped to gather information from previous building studies, which along with my survey information of the city of Portland area, would be used to determine the number of generators within the four states of the Northwest Power Planning Council's region. The previous building studies would show me how to extrapolate my generator information from Portland to include all of the four states.

Initially I had no idea as to how we would be able to get the names and phone numbers of so many building managers for the many different types of buildings in Portland. But after contacting the Building Owners and Managers Association (BOMA), they provided me with a list of building managers and their phone numbers. I then contacted the building managers and interviewed them using the questionnaire I produced. (See Appendix 1) Unfortunately, several problems arose. First the list provided by BOMA only included commercial buildings, and it was necessary for me to contact all types of buildings. Secondly, the list did not indicate information on who had emergency generation capabilities. Out of the seven hundred buildings listed for Downtown Portland I had no idea how many or who specifically had the generators.

In my survey I interviewed managers in 70 buildings. (10% of the 700 available.) Since buildings are not legally required to have generators (See codes and requirements p. 9) I found that only about 20 percent of the buildings I surveyed owned generators. This small of number was too small to be statistically used to estimate generation kilowatt capacity in the four northwestern states.

Other errors also appeared. The previous building studies I had hoped to use were at least ten years old. Numbers from these old studies made their use for estimation inaccurate and unusable.

In the interest of determining a more accurate number of generators, I requested from Caterpillar Inc. a list or number of generators installed around the four states. I knew Caterpillar periodically prepared a list of domestic generating units installed around the world. Caterpillar's list was last updated Fall 2000 and holds the most accurate data as to how many generators are installed in Washington, Oregon, Idaho, and Montana. Caterpillar uses the list to enable its regional dealers to identify maintenance opportunities. The list is a comprehensive list, in that the list includes not only Caterpillar brand equipment, but also generating sets manufactured by other companies. The data provided by Caterpillar is presented below in table 1.

Table 1

Numbers refer to the amounts of generators of a particular kilowatt production size installed in a state.

Range (kW) State	**50-70**	**71-150**	**151-300**	**301-700**	**701-1200**	**1201-200**	**2000+**	**Total**
Oregon	2,143	2,058	1,960	811	530	470	176	8,148
Washington	3,699	3,553	4,060	1,400	916	812	304	14,744
Idaho	321	494	323	122	80	71	27	1,438
Montana	547	621	538	222	146	129	48	2251
Total	6,710	6,726	6,881	2555	1672	1482	555	26,581

Table 1 shows that at last count, the state of Oregon had as many as 2,143 individual small generating units, posting a capacity rating of between 50 and 70 kilowatts. The total number of standby generation sets rises to 8,148 when we take into account units of a size ranging from 50 to 2000+ kW.

Obviously, not all of the generating units identified in Table 1 are available for delivering electricity into the grid. Some may not be operable; others may be used on remote sites. Further, the data in Table 1 may not be completely accurate, even though the data is based on an actual count of generator units as opposed to my original plan. However, I was assured by the manufacturer that the vast majority of these generators are serving as emergency generators standing ready to operate when the local distribution grid stops delivering electricity to a customer location. Typically such calls for emergency generation occur when there is a distribution fault or when rolling blackouts have been implemented.

How much power is possible?

Finding out exactly how much emergency generation power or capacity is available is one of the main goals of the study. Assuming that we get full cooperation from building managers and do not run into any regulatory problems the total generation power becomes the maximum power available from emergency generation. In the table below I evaluate the total production capacity of the generation units indicated in Table 1. To calculate total production capacity for the units in each of the first six columns, I have taken the midpoint of the range and assigned that number to the column as the capacity. For the last column, with generator capacity in excess of 2000 kW, I have used 3000 kW as the average capacity of this column. It is then simple multiplication. For instance, Oregon's 2,143 generators producing 50-70 kW results in 2,143 x 60 = 128,580 kilowatts or about 129 megawatts. Based on this evaluation method, there are 9,528 megawatts or 9.5 gigawatts of electrical distributed generation installed in the four northwestern states. 9.5 gigawatts are the maximum amount of electrical capacity from emergency generators available in the northwestern states. This number is high enough to cover the expected amount of power generation needed in the Northwest throughout the next several years. 9500 MW is about a quarter of the present utility generating capacity in the Northwest.

Table 2 The numbers refer to the amount of production capacity at each generator size.

Range (kW)	50-70	71-150	151-300	301-700	701-1200	1201-2000	2001+	Total
Capacity (kW) State	60	110	220	500	950	1600	3000	
Oregon	129	226	431	406	504	752	528	2,975
Washington	222	391	893	700	870	1,299	912	5,287
Idaho	19	54	71	61	76	114	81	476
Montana	33	68	118	111	139	206	114	820
Total	403	739	1513	1278	1589	2371	1635	9,528

Other Necessary Equipment

Automatic Transfer Switch and Parallel Switching Gear

The Automatic Transfer Switch (ATS) is a key component of any emergency and standby generator system. It is the device that monitors the sources and transfers the critical load from the preferred or normal source, to the alternate, or emergency source. Automatic Transfer Switches can switch between alternative and normal power sources with only a thousandth of a second interruption. The interruption is so small the tenant rarely notices it. If a company, such as a microchip fabrication plant needed switching gear they would need to be on parallel gear already. Because of its importance, it is imperative that generator owners be aware of the many transfer scenarios and the solutions to the various standby power applications. Automatic transfer switches are a vital but expensive part of an emergency generation system. Without the switching gear, personnel from the building where the generator is located would have to turn on the generator manually. A model of the automatic switching gear is shown below.

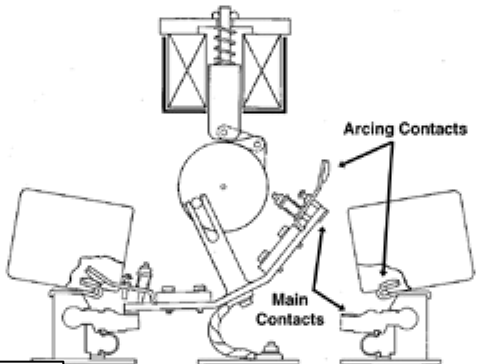
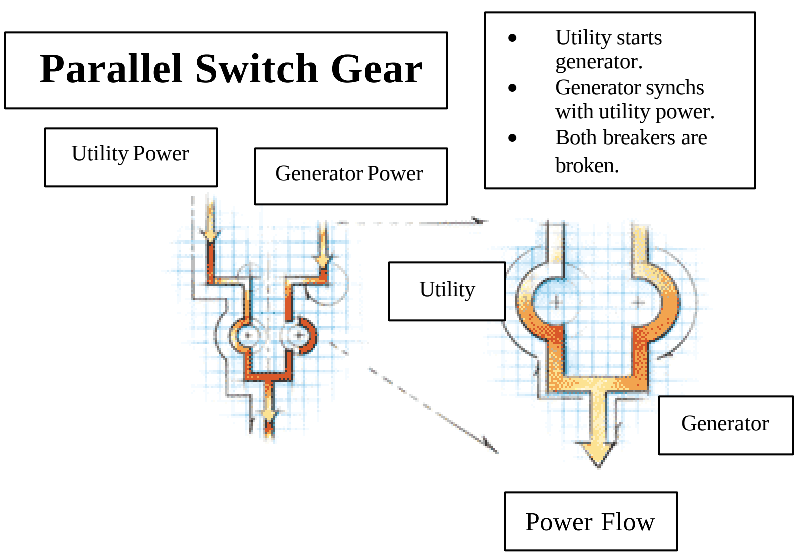


Fig. 2 The single solenoid operator of the automatic transfer switch offer high reliability for varied and critical needs.

Parallel switching gear is used to hook the utility to the generator and the generator to the building. With this switch the utility is able to draw from the power produced by the generator and use it to support the system. Parallel switching gear is vital to the operation of a generator with a utility. There is no interruption when switching from generator to utility because the generator is always on standby ready to work and is capable of holding the building's load at the moment of disconnection. The utility's main concern is the financial investment involved in the cost of the gear. Switching gear costs several thousands of dollars, and replaces the automatic transfer switch gear. One may be able to sell the highly priced automatic transfer switch to raise money for the even more expensive parallel switch.



Underground Storage Tanks

Underground storage tanks are often used to store fuel for generators used during emergency situations. Most of these underground storage tanks are regulated and must have a general permit registration certificate to operate to receive fuel. Some may be exempt from many state and federal regulations. Nevertheless building owners may spend several thousands of dollars a year obtaining permits for underground storage tanks.

Analysis of Feasibility

Codes and Requirements

Federal, state and local jurisdictions govern the use of emergency generators. Agencies such as the federal Environment Protection Agency (EPA) and state agencies such as the Oregon Department of Environmental Quality (DEQ) have specific requirements and environmental codes. At the local level, emergency generators are subject to local structural, mechanical and electrical regulations.

Both federal, state and local building codes require emergency lighting and other emergency equipment (i.e. water pumps and other fire-fighting tools) be accessible in any commercial, industrial, or public facility. This is a requirement due to the need for public safety and to reduce the risk of public panic in an emergency situation, such as storms or earthquakes. A building must meet these standards when being built and must reevaluate and requalify their emergency system, which includes all emergency equipment, every 5 years. Emergency electrical systems may be ether battery or generator systems. Using generators to augment power demand does not interfere with federal regulations as long as the emergency lighting system stays in service during emergency situations. No extra federal permits are needed in order for a generator to supply energy to a utility. The parallel switching gear works with the generator. Thus, the primary purpose of the emergency generator is not compromised.

Both Oregon and Washington State building codes require the presence of back up power to elevators if the building was built after 1970. There are many rules of exception and other appendices to the code that in general do not affect most buildings. In order to install a generator, state law mandates an inspection to ensure the proper installation of the generator and exhaust system. In addition, several different codes mandate the placement of the generator in a building. Usually the generator must be installed in the basement, using adequate ventilation, or on the roof of the building. After initial installation and inspection, the generators are inspected only on a complaint basis. This means the state will only inspect if there are complaints with the use of the generator. Locally, generators must have trade-permits, both mechanical and electrical. This is standard for almost all cities in the Northwest. Permits last five years before reapplication is needed. None of the building permits prevent the use of emergency generators used in parallel with the utility.

The Environmental Protection Agency believes that emergency generators should be dedicated to emergency uses, and used only during periods when electric power from public utilities is unavailable. Since emergency generators are used intermittently and on an “as needed” basis it is difficult to determine their exact amounts of power generation. However, although power outages may vary considerably during a year, it is still possible to estimate their annual use by using information provided by the EPA. Estimates provided by the EPA suggest use levels for emergency generators at approximately 500 hours per year. Based on this estimate EPA has determined use and emission requirements for these generators.

In Oregon, non-emergency electricity generation is addressed by the state's air emission regulatory agency, the Department of Environmental Quality. The general requirements by the DEQ are more stringent than federal requirements. For electric power generators the DEQ demands two requirements that are not currently required federally. The first requires the use of low sulfur fuel (0.05 % by weight) to ensure that sulfur dioxide emissions are minimized and to reduce the effects of sulfur dioxide poisoning on emission control equipment. The second requirement demands that exhaust emission control systems minimize particulate matter, carbon monoxide, and volatile organic compound emissions. If not properly controlled, diesel engines can generate excessive odors and smoke that may lead to a nuisance condition and exposure to toxic air pollution, especially if the electric power generators are located near residences.

If we are to deploy the use of emergency generators during non-emergency times, how does the state avoid the federal regulations on emergency-use-only generation? What would be a federally acceptable emergency that would legally allow an emergency generator to come online and support the utility? Prior to May 15, 2001 this question of whether emergency generators could be used in circumstances other than traditional emergencies had never been addressed. However, on that date the Oregon Department of Environmental Quality offered a permit that allowed buildings to run their emergency generators parallel to a utility. The permit allows generators that are connected to the utility to be run for up to 200 hours a year. The hours of operation must be structured so those generators run no more than five hours per day or more than 25 hours per week. The other permit requirements are the usual and normal standards required for the generators. In an effort to meet federal regulations the permit allows that generators only be run during of a Regional Emergency Warning of a potential Alert 2 or 3, as defined in the Pacific Northwest Energy Emergency Plan. Thus, using emergency generators during a declared emergency and meeting federal regulations. This policy does not restrict operation of emergency generators during periods of involuntary loss of utility power and brief periods of operation for testing and maintenance. This new policy regarding emergency generators and the DEQ went into effect July 16, 2001. (See Appendix 2 for information regarding code and requirements.)

Support From Building Owner and Tenants

From the information gathered by my limited survey, 55% of the industrial and commercial building owners or managers indicated that they would be interested in developing a contract with a utility to supply energy to the power grid. 32% of the building owners were unsure if they would be interested. The remaining 12% said they were not interested. (Data compiled from appendix 1, Building Managers Questionnaire)

In addition to surveying industrial and commercial sites I also spoke with hospital administrators. Hospitals are required for safety and insurance reasons to have emergency generation back up for use with important electrical equipment such as computer systems and life-support. Often most hospitals have more than one generator, one for their offices and another for emergency equipment. Some hospitals, depending on their size, may have three or four generators. Hospital emergency support generators are dedicated only for emergency support. However, there was some interest in allowing use of office support generators to run in parallel with a utility.

In surveying two local colleges I found that they had multiple generators. Both engineers had the same concerns concerning noise and pollutants as building owners, but they were also interested in exploring the possibility of using their generators in parallel with a utility.

Personnel at Portland International Airport expressed little interest in using their generating capacity outside their own needs. Their emergency generators are dedicated to support emergency communications systems, lighting, safety and security and other essential airport functions.

It became clear through my interviews and survey that the question of using emergency generating power during non-emergency times raised questions and concerns in the minds of building owners and managers. Many indicated that they would need additional information and study to determine the feasibility of such a commitment. Further, many were concerned about capital and repair costs, fuel costs, air quality and noise issues. Some respondents were particularly interested in financial incentives to participate in a program. Those that totally disliked the idea cited concerns about cost of fuel, noise and other pollution as main deterrents.

As I indicated, some building owners and managers were interested in financial incentives to participate in an energy-producing program. This was particularly apparent if generator owners were able to sell excess electricity to a utility at market prices for profit. However, at current market prices only generators of 1 MW or more would be profitable. This is also assuming that the facility uses 80% of their produced energy and sells 20%. Using the more common 100kW generator and using the same ratio, profit could not be made until market price reaches $350. per MW. (Portland General Electric provided market prices).

Support From Utilities

Installing the switch gear necessary for running a generator and a utility in parallel can be a difficult and expensive undertaking. However, if the utility company can profit from the venture, it is likely to be more attractive. From my interviews with two utility companies it is apparent that at today's market price only generators of 1 MW or greater would be profitable. Since the market price of electricity in the Northwest is relatively low, the utilities would most likely be willing to invest in equipment and contractual negotiations necessary only with larger emergency generators. Local utilities in Portland have begun programs to encourage some sharing of power generated independently outside of the traditional power grid. They are currently interested in generators of 1 MW or more to create a parallel system with their utility to supply power during peak power-demand situations. Unfortunately, it is unlikely that utilities will not be interested in smaller generators until the market price increases and maintains at a high price. (See Appendix 3 for the utility questionnaire.)

Environmental Feasibility

The greatest problem with emergency generation lies in the fact that emergency generators burn fossil fuels that are polluting and harm air quality. Advanced filters to control admissions may offer hope in solving this problem.

Some utilities are offering a novel Demand Buyback Program. This program is designed to persuade large industrial concerns to consciously reduce the amount of power they consume by offering an incentive to conserve. The utility will buy-back energy conserved at market price. Basically the utility is paying the industrial company for a reduction of energy. The positive nature of the Demand Buyback Program is that it reduces, on a dramatic level, the amount of energy demanded. Further, it also helps reduce pollutants being released. It is hoped that the reduction of industrial waste and the increased pollution caused by the use of emergency generators will have a total zero sum effect on the environment, and yet increase the amount of total power available.

Conclusions and Recommendations

In conclusion, the use of emergency generation to augment regular power production has a promising future. Current energy forecasts, both in the Northwest and nationally, clearly indicate that power rates will continue to rise, probably in a dramatic fashion. In the short term, the Northwest Power Planning Council forecasts that the market price for Northwest power will soon exceed $100. per megawatt hour and possibly greater. At that price utilities will find it feasible to use emergency generators of 700 kilowatts or less and still make a profit.

If the results of my survey are extrapolated region-wide there is significant generating capacity available. If 71% (55% agree to produce power, 16% likely to agree) of all commercial and industrial buildings that contain emergency generating capacity agree to use that capacity to produce power nearly 3,900 megawatts or 3.9 gigawatts of power can be produced from emergency generators of 700 kW or more. However, since emergency power from airports, hospitals or other public safety facilities is most likely unavailable the 3.9 gigawatt estimate should be lowered to 3.7 gigawatts. This is a conservative estimate. Finally, since emergency generation use is limited by the DEQ to 200 hours per year, 3.7 gigiwatts of generator capacity can produce 740-megawatt hours each year. This number is enough to meet any anticipated energy shortfall. If the market price reaches the once unheard of price of $350. per megawatt hour we could produce over 6.4 gigawatts. This is a total of 1,280 gigawatts of hourly production per year.

For this full amount of generation capacity to be realized strong and mutually beneficial agreements must be made between utilities and generator owners. It will be necessary for a utility to devise a program that allows the generator and the utility to safely and economically run in parallel. Based upon my survey information, I found that building owners wanted strong support from utilities. For example, commercial or industrial customers who install a new generator or already own one would like agreements that guarantee the use of standby generation. Agreements would also include utility assistance with installation and necessary equipment such as sophisticated computer controls that allow the unit to be connected to the utility's electrical distribution system. All maintenance, operation and testing costs for the generators would also be assumed by the utility. This could save the customer up to an estimated $100,000. over a five-year period. (Estimated number gathered from the survey of building owners, Appendix 1, and the utilities, Appendix 2.)

In exchange for this support, utilities could draw on these standby generators during times of peak power for up to 200 hours per year. Utility engineers could operate the generators directly from their control centers, via a direct connection to the generator. Utilities could also test the back-up generation systems on a regular basis to ensure they are operating correctly.

The backup generator would always be available to serve the building needs first without interruption. The generator and utility operation are synchronized and work in parallel automatically protecting one another. If one system fails, the other takes over, ensuring a continuing supply of non-interuptable power. The standby generation system is designed so the building power need loads are automatically served first and any excess power generated flows into the utility's system. For example, if the building load is 1000 kilowatts, and the generator is generating 1,500 kilowatts, only 500 kilowatts are flowing back to the utility.

Use of a centralized emergency generation program would most likely help extend the life of emergency power generators. Program operators would routinely start-up the generators and test them at full load. The generator manufacturer Caterpillar states that more frequent full load runs are better for diesel engines. Testing at full loads can also help assure the building owner that the equipment will start and function properly in a power outage.

Maintenance agreements between building owners and utilities would provide that all regular maintenance and any repair bills would be paid by the utility. The utility assumes this as a reasonable cost to assure that the generator is available and properly working at all times. Lastly, the utility pays for all fuel costs whether power is used in the building or distributed to the utility's power grid system.

I believe binding agreements between owners of emergency power generators and utilities offer an outstanding opportunity to capitalize on additional power generation. I recommend that utilities begin developing agreements with some of the provisions I suggest. These agreements, in conjunction with innovative programs such as Demand Buyback, could surely hold promise and benefit for utilities, building owners and electrical customers throughout our region.

There is an estimated minimum of at least 740 gigawatts of production capacity per year in the four northwestern states. With 3.7 gigawatts production capacity utilities face three important issues:

1. How much capacity should utilities have under contract?
2. Which building owners should receive contracts to provide electricity?
3. What price should the utility pay for capacity provided under such contracts?

In summary, providing sufficient power at reasonable cost remains a challenging endeavor. Because electrical power is a critical commodity we must develop innovative ways and develop incentives to increase production and ensure a non-interruptable power supply. Although my survey was limited in size and scope, I believe it points to some creative possibilities in providing power throughout Oregon and the rest of the three Northwestern states through the use of emergency building generators. It is my hope that continued work be done in this area to bring this possibility to full fruition.

Appendices

Appendix 1

Facilities Director's Questionnaire

Person's name:

Title:

Name of Building:

- What is the type of building? (i.e. Office building, Hospital)
    - How many floors does the building have?
    - How many elevators does the building have?
    - About how many different companies occupy the building?
    - About how many tenants (or people) use the building?
- What type of generator does the building have? Model?
    - How many kilowatts/megawatts does the generator produce? (This is a very important question; the amount should be posted on the side of the generator if it is not known.)
    - Has the generator ever been upgraded, and for what reason?
- What is the specific model of generator? Who is the manufacturer? (i.e. Caterpillar)
    - Does the generator have a Reciprocating engine (Diesel or spark-ignition), Combustion turbine, or Other?
- When was the generator originally put into the building? (Year?)
    - Who supplied the generator to be put in the building?
    - How much did the generator cost the building and its tenants?
- How often is the generator used?
- Can the generator be used at different levels of output? (i.e. 75%) Does the generator usually run at 100% or only in savvier emergencies?
- What is the current condition of the generator? Please specify any current condition problems.
- What type of fuel does the generator burn? Diesel or Dual?

- How much fuel can the generator store? Or, how long is the generator able to run with a full amount of fuel on site?
    - Would the building be willing to switch to a generator with a more clean fuel? (I.e. Natural gas?)
- What are the manning requirements for start up, operation and shut down of the generator?
- When there is a power outage what machinery uses the power the generator puts out? (i.e. lights, elevators)
- When in use, does the generator work to the full satisfaction of the building?
    - Is there anything the generator does not power that needs to be run in an emergency?
- How reliable has the generator been while in the building?
    - Is the generator checked regularly for mechanical problems?
    - Would more regular use of the generator make it more reliable?
- Is the generator regularly repaired?
    - If so, who repairs the generator?
    - How much do repairs to the generator cost the building and its tenants?
- Was it required that a generator be put in the building? Or, did the tenants of the building request the generator?
- Were there other reasons for initially putting the generator into the building?
- Is there sensitive equipment relying on the existence of a generator during a power crisis?
- Would the building owner be willing to use the generator to help a utility support system load?
- Would the use of the generator by a utility company benefit the building owner in anyway?
    - What problems might occur when the generator is run more often?
- What incentives would cause the owner to consider using the generator to support system load?
    - Would paying for repairs to the generators be an incentive?
- Would the tenants of the building be willing to put up with the generator's waste (noise, vibrations, and fumes?) if it were to be running often?
- Is there any other safety issues that have been overlooked by our study?

Appendix 2

Government Agency Questionnaire

Date: Time:

Person's name: Title:

Agency:

- Related to your agency, what is your current policy regarding the use of emergency generators for serving system load?
- Are there any building requirements related to emergency powered generators?
    - What are the requirements?
- In what types of buildings are the generators required?
- Must emergency generators be permitted?
- Who issues permits for emergency generators?
- What types of permits are there?
    - What permits govern emission standards?
    - What permits govern safety standards?
    - What permits govern maintenance standards?
- Are buildings limited to the amount of time they are allowed to run their generators?
    - Currently how long are buildings allowed to run their generators?
- What regulates the health and safety aspect of emergency generation units?
- Are there regulations of generators that require them to go through regular testing?
    - How often are generators tested?
- What regulations are there related to onsite fuel storage?
- Are you aware of any way to use emergency generators to augment system load?
- Under what circumstances might the regulations change?

Appendix 3

Utility Questionnaire

Date: Time:

Person's name: Title:

Name of utility company:

- Related to your utility company, what is your current policy regarding the use of emergency diesel powered generators?
    - How effective has the policy been?
    - What kind of response does your policy receive?
    - What are the big issues that you concern your policy with?
    - What would be a typical deal to be made with a building with emergency generators?
    - What is typical compellation?
    - Is there special equipment that you supply?
    - How long of a duration do you let the generators run?
    - How often are the generators run?
- Who issues permits for emergency generators?
- Does law require emergency generators?
    - In what types of buildings are the generators required?
- Is there an inventory of where the generators were put in?
- What types of generators are there?
    - How many types of generators are there?
    - What are the different models of generators?
    - What are the specific specifications of the different models?
- Are you aware of a way to use diesel-powered generators to reduce the system load?
- Have you conducted any studies on the effectiveness of emergency generators to reduce system load?
    - What have you learned?

- Is it possible for a utility to control emergency generators from a remote location outside of the building with the generator?

- Is additional equipment required for remote location operation?

- What equipment and personnel is needed to hook up a generator to be turned on from a remote location?

- What equipment and personnel is needed to startup, operate and shutdown a generator?

    - How has equipment been supplied in the past?

- Who controls the generators from the remote location?

- How much would this process cost the utility?

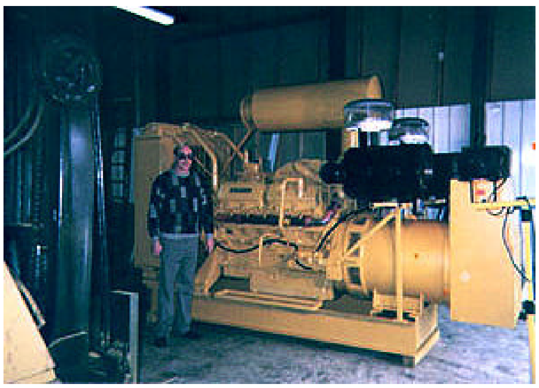
- How much would this process cost the building owner?

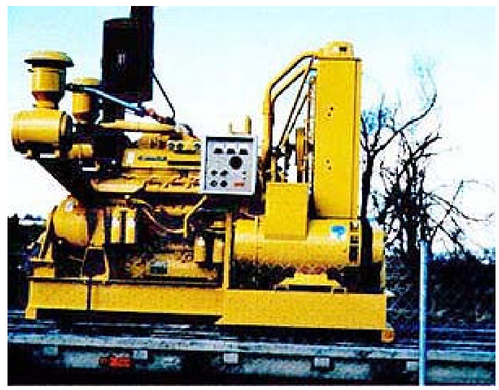
- Would the use of the generator by a utility company benefit the building owner in anyway?

- What incentives would the utility be able to offer the building owner to consider using the generator to support system load?

Appendix 4

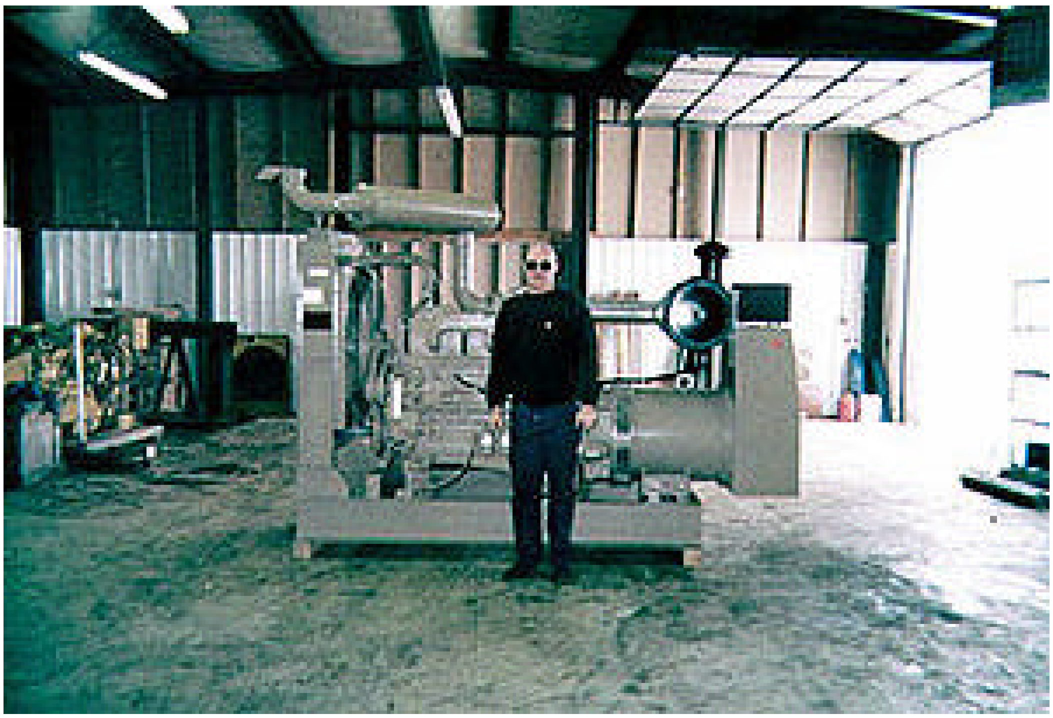
Caterpillar





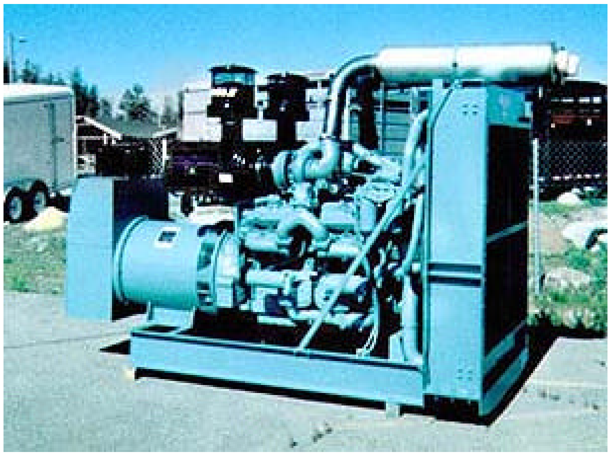
Appendix 5

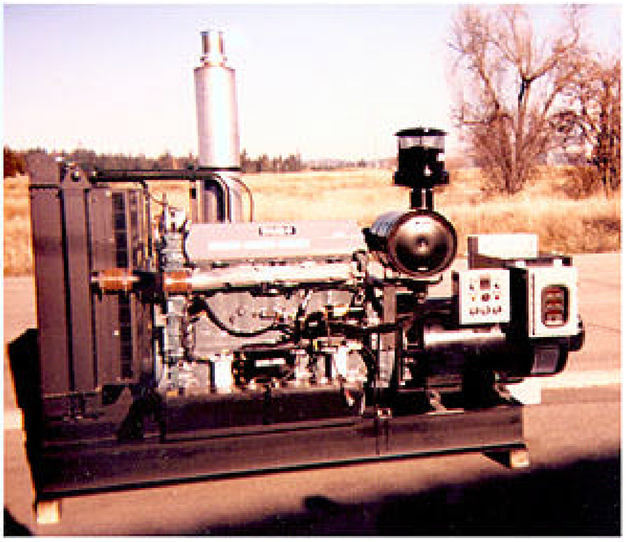
Cummins



Appendix 6

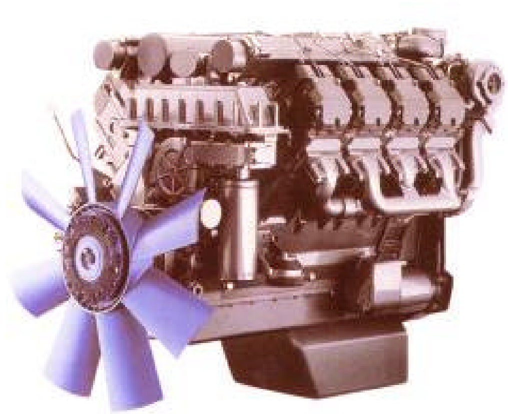
Detroit Diesel

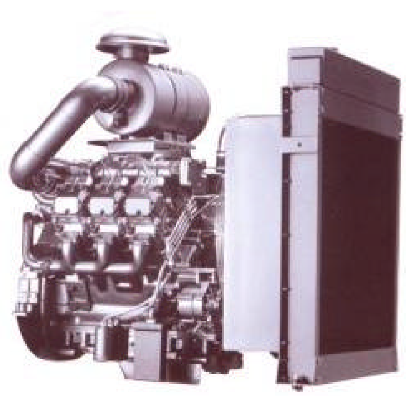




Appendix 7

Deutz





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