Appendix D: Potential Resources

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This appendix provides a description of the resources that were evaluated in the development of the 2010 Integrated Resource Plan by Otter Tail. The development of the resource plan focused on the evaluation of resources that are available to the Company, taking into account a number of factors. These factors include available size increments of the technology, the maturity and commercial availability of the technology, the availability of interested co-owners of large facilities, operational parameters, and available data.

As the Strategist model evaluates each year's resource alternatives, it is able to save a finite number of feasible combinations of solutions, called "states." These states are carried forward as starting points to the following year's evaluation of resource alternatives. The model ranks all states by cost and discards those states that rank higher than a prescribed saved states limit. For example, if the saved states limit is 2000, any plan that ranks 2001 or higher based on cost is discarded. It is possible that a feasible state discarded in 2015 could be the least cost solution over the study period. To minimize the potential error of discarding the true least cost plan, it is prudent to minimize the number of alternatives made available to the model. This effort helps to minimize the number of feasible combinations of alternatives and in turn minimizes the likelihood that the model will discard the least-cost plan. Narrowing the number of alternatives for evaluation also shortens the model run-time, allows the model to be more user-friendly for evaluation of various futures, and provides greater opportunity for verification and validation of model performance. The Company aimed to adequately represent every resource type in the mix of alternatives made available to the model while reducing redundancy as much as possible. Several resource options were therefore eliminated through a pre-screening effort prior to the Proview optimization runs in Strategist. The reasons for eliminating some alternatives are explained later in this section in the discussion of those options.

Specific cost and performance data used for the computer modeling came from a variety of sources and is provided in detail in Appendix F: Assumptions for Strategist Modeling Scenarios. Much of the specific generator performance information came from a Black & Veatch study commissioned by Otter Tail in 2007and from a Burns and MacDonnell study in the spring of 2009. Resource alternatives were within the ranges presented in Boston Pacific's October 21, 2008 report to the Minnesota Public Utilities Commission (Commission) that was provided in the Big Stone Plant II Certificate of Need proceeding (Docket No. E-017/05-619). The alternatives were also comparable to assumptions developed in the spring of 2009 by the Organization of MISO States (OMS) for Cost Allocation and Regional Planning (CARP). Additional data on emerging technologies or less traditional technologies was obtained from a variety of sources, including papers, articles, presentations, and studies completed by others.

1 Bilateral Contracts

Otter Tail contacted area utilities and other known entities within the region close to the Company's service territory to explore the potential to purchase long-term capacity and energy. Over the last twelve months, Otter Tail has entered into several contracts to purchase both capacity and energy. These contracts vary in both length of term and amount. The Company continues to explore other possible purchases with area companies. Generic one-year capacity contracts and spot energy were also available throughout the study period.

Otter Tail has been in preliminary discussions with Manitoba Hydro Electric Board (MHEB) to enter into a long-term PPA for a purchase of hydro power from a new hydro facility that is in the preliminary stages of development. Based on discussions with MHEB, it was learned that this resource alternative would likely not be available until 2023 or later. Due to the lateness and uncertainty of this resource, the alternative was not included in this analysis. Otter Tail continues to solicit input from MHEB regarding potential resource alternatives and availability for long term resource planning.

2 Supply-Side Generation

A discussion of each of the coal- and gas-fired technologies and other supply-side technologies is included in the following pages. The technologies are grouped into the following two categories

Generation Alternatives in the Model

- Environmental project at Big Stone Plant using Best Available Retrofit Technology
- Continued Operation of Hoot Lake Units #2 and #3
- Supercritical Coal, using a brown field site
- Continued Operation of the Frame 5 Peaking Units
- Combined Cycle Gas Turbine (CCGT)
- Simple Cycle Combustion Turbine
- Wind

Pre-screened Generation Alternatives Not in the Model

- Nuclear
- Pulverized Coal - Subcritical
- Atmospheric Circulating Fluidized Bed Coal (ACFB)
- Pulverized Coal – Supercritical and Ultra-supercritical (green field site)
- Integrated Gasification Combined Cycle (IGCC)
- Reciprocating Engine Plants
- Phosphoric Acid Fuel Cell (PAFC)
- Hydro (owned projects)
- Heat Recovery
- Energy Storage
- Solar Photovoltaic
- Anaerobic Digestion
- Landfill Gas
- Microturbines
- Biomass
- Geothermal

Whether a technology was pre-screened or included in the model for capacity expansion evaluation is indicated in the text. The effort on screening resources was necessary to develop a useful modeling tool that was practical in terms of run-time while simultaneously comprehensive in evaluating the forward-looking resource mix. This tension in objectives required an effort to minimize the number of resource alternatives made available to the model in order to maximize model efficiency and responsiveness. However, this tension also required the full representation of options in appropriate generation types, whether peaking, baseload, intermediate, or other. Much compromise and paring went into the options evaluated and it is important to note that any resource used as a potential future addition in the Strategist model was intended to be generic and representative of the Company's needs. In no way do the alternatives selected for modeling purposes exclude future consideration of competing options in similar generation categories.

2.1 Technology options included in the model

Air Quality Control System (AQCS) Project at Big Stone Plant using Best Available Retrofit Technology (BART)
Appendix E provides further background and information on the need and plan for the installation of pollution control equipment at Big Stone Plant. South Dakota's draft proposed Regional Haze State Implementation Plan recommended the existing fabric filter for particulate matter emission control and a spray dryer for sulfur dioxide emissions control, along with emission rates that generally followed Otter Tail's BART analysis. The Department of Environment and Natural Resources (DENR) recommended a Selective Catalytic Reduction (SCR) technology for NOx emission reduction instead of the separated over-fire air that Otter Tail recommended. The DENR proposal required that BART be installed and operating as expeditiously as practicable, but no later than five years from the Environmental Protection Agency's approval of the South Dakota Regional Haze SIP, which is expected no later than January 15, 2011.

A more detailed estimate, optimization of cost and construction factors will be completed during the study phase of this effort. However, recent preliminary internal planning estimates place the cost of the project at $200 to $300 million. Since Otter Tail owns 53.9% of the Big Stone Plant, the Otter Tail portion of the project will be around $161.7 million. This equipment will increase O&M costs at Big Stone and that information is reflected in the modeling inputs.

Continued Operation of Hoot Lake Units #2 and #3

The model currently considers the continued operation of Hoot Lake beyond the currently scheduled 2019 depreciation retirement date. This alternative assumes a $250 million dollar investment in the facility and continued operation, with adjustments for generating and emissions equipment upgrades and increased O&M expenses. Due to the preliminary stage of analysis at this time, these dollars are simply a placeholder until more clear direction on the plant is determined. There are many important factors that must be weighed in the evaluation which include:

- Age of the unit,
- Previous operational history,
- Compliance with future environmental regulations,
- Condition of the plant's existing components
- An assessment of the future operating role of the facility,
- Gas conversion capability and economics, and
- Availability of future low-cost base load resources.

It is the goal of the Company to balance these factors in the best interest of our ratepayers.

The Hoot Lake site location is advantageous for generation. Some of the advantages of the site are the following:

- A highly trained workforce
- Established transmission interconnection rights
- Water supply
- Existing generation facility infrastructure

- An adequately sized site with buffer area.

No matter what the ultimate fate of the current coal facility is, continued generation from the site will be a consideration into the future.

Pulverized Coal – Supercritical and Ultra-Supercritical
Although the current Minnesota Next Generation Act of 2007 eliminates reasonable chance of construction of coal-fired generation for Minnesota, a super-critical coal alternative was included in the model. The Minnesota Next Generation Energy Act of 2007 requires new coal-based generation to offset CO_2 emissions. Any supercritical pulverized coal-fired generation alternative would require Carbon Capture and Sequestration (CCS) to be installed in order to serve load in Minnesota. Otter Tail's view of CCS is that it is a promising technology but not currently commercial. Otter Tail serves customers in North Dakota and South Dakota as well as Minnesota. Neither of these states exclude coal-fired generation from evaluation nor require CO_2 emission abatement measures to be included in evaluation of these resources. For this reason, supercritical coal generation without CCS was included as a resource alternative to serve customer baseload needs. In the event that coal-fired generation was selected by the model, the Company was willing to consider "jurisdictionalizing" the resource plan to comply with the separate state requirements.

Super-critical pulverized coal units have been part of the U.S. power generation mix since the mid-1950's. Since the 1980's, the development of high strength materials and Distributed Control Systems (DCS) have helped to make supercritical units easier to control and operate. Supercritical units typically operate at 3500 psig and up to 1050° F or 1080° F. at the steam turbine inlet. In addition, while there is no current technical definition of an ultra-supercritical unit, it seems to be generally accepted that units designed to operate at 1100° F or higher are ultra-supercritical. There is currently at least one new unit that is being constructed in the United States where the design steam temperatures are above 1100° F. Heat rates for supercritical or ultra-supercritical units can be lower than 9,000 btu/kWh. If the average heat rate of the current coal fleet is 11,500 but/kWh, use of a modern supercritical or ultra-supercritical unit would result in over 20% less coal being burned per MWh or 20% less CO_2 emissions per MWh.

Continued Operation of the Frame 5 Peaking Units
Based on the approved September 2008 Depreciation Study, the three Frame 5 peaking units (two in Jamestown, ND and one in Lake Preston, SD) also have accounting retirement dates of December 31, 2019. These units have had limited hours of operation since their installation in the 1970s. Industry experience has shown that with proper maintenance, these units should be able to continue operation beyond that date. For modeling purposes, the units are assumed to retire in 2019. Similar to how the Hoot Lake retirement was handled in the model, there is an alternative resource option that has the attributes of the three Frame units (emissions profile, NDC and UCAP ratings, and O&M costs) and a one-time investment of $9.0 million total to continue the operation of these units for 35 years. The $9.0 million cost estimate was derived based on the net present value of a stream of projected capital cost expenditures that are consistent with historical values. The purpose of this alternative is to provide a preliminary indication of the viability of continued operation of the Frame 5 peaking units beyond their current accounting retirement date.

Combined Cycle Gas Turbine (CCGT)
The basic principle of the Combined Cycle Gas Turbine is to use a gaseous fuel such as natural gas, or a liquid fuel such as no. 2 fuel oil, to produce power in a gas turbine and to use the hot exhaust gases from

the gas turbine to produce steam in a Heat Recovery Steam Generator (HRSG). The steam would be used to generate electric power with a steam driven turbine-generator set. Typical CCGT units operate with natural gas as the operating fuel, but often dual-fuel capability with oil as a backup is used to increase the availability of the generation when natural gas supplies are curtailed.

The model was given the option of two combined cycle alternatives during the study period. A smaller heavy duty frame combined cycle was made available as a conversion alternative throughout the study period. This alternative required that a heavy duty frame combustion turbine be selected first in the resource plan and then a HRSG would be added to convert that unit to combined cycle if economic. This alternative had an ISO rating of about 130.2 MW.

Simple Cycle Combustion Turbine

The model was given the option of two simple cycle natural gas-fired combustion turbines to evaluate for installation. The first is a heavy-duty frame unit with an ISO rating of about 85 MW. The heavy-duty frame units are characterized by a lower capital cost per kW and lower maintenance cost, but a higher heat rate than an aeroderivative unit. The second simple cycle combustion turbine option within the model was based on a aeroderivative natural gas-fired combustion turbine with an ISO rating of about 100 MW. The combustion turbines were based on operation on interruptible natural gas with backup dual-fuel capability based on fuel oil. Prior to 2016, the Company has a specific alternative for a simple cycle, natural gas-fired aeroderivative combustion turbine at a preferred site. This alternative is based on a smaller aeroderivative natural-gas fired combustion turbine with an ISO rating of about 44 MW. All simple cycle units were made available to the model as whole units, rather than in smaller block sizes of capacity.

Wind Generation

Wind generation was made available to the model in multiple 50 MW blocks throughout the study period. The financial costs of wind generation vary greatly based on the year of commercial operation and the tax incentives that are in effect for that time period. The American Recovery and Reinvestment Act (ARRA), signed into law on February 17, 2009 contains an extension of the Production Tax Credit for wind generation projects placed in service prior to December 31, 2012. The ND tax credit for wind generation projects was also factored into the financial costs for projects implemented prior to December 31, 2012. It was assumed that the wind alternatives could achieve a capacity factor of 40-41% and would be accredited for resource adequacy at 8% through 2010 and 3% thereafter. The 3% accreditation factor is an assumption for long-term planning, as MISO has indicated the net effective reliability contribution of wind generation decreases as wind penetration increases. Otter Tail’s wind generation generally outperforms wind generation in other areas of the MISO footprint due to the prime wind resources in the Otter Tail service territory. For this reason, the Company has requested that MISO accredit wind resources individually based on actual performance during peak demands. At this time, however, it is not clear whether MISO will allow for site- or unit- specific accreditations for wind resources in the future. The 3% accreditation level was included in the most recent MISO study on intermittent resources and is therefore used as a conservative assumption for future accreditation.

2.2 Technology options not allowed in the model

Nuclear

Electricity from a nuclear power plant remains a very clean and safe form of electrical generation in the

United States and the world. In 1994, the Minnesota Legislature passed a law that created a moratorium on the construction of new nuclear generation facilities in Minnesota (216B.243, subd. 3b). Efforts made in recent years to repeal the moratorium have failed. Nuclear energy was not considered as a resource alternative because of the law listed above, and what appear to be very high costs related to siting, permitting, and construction. Estimates for nuclear plants have been listed between $5,000 - $8,000/kW, with one reference to $10,000/kW. Additionally, the Company is not aware of any nuclear project under development soliciting joint ownership. Due to the factors listed above, the addition of nuclear generation was not included in the model.

Carbon Capture and Sequestration (CCS)
There is significant research currently being conducted on the possibility of developing technologies and regulations around the concept of capturing carbon dioxide from electric generating units using fossil fuels. While there is much information in the public domain about development work, demonstration projects, and future-looking analysis for resource planning purposes, it is the position of Otter Tail that CCS is not commercially available and will not be considered a likely technology to employ within the current planning period. If regulations or successful demonstration projects develop into full-scale projects which can be offered with commercial and performance guarantees, the Company will reconsider this position.

Pulverized Coal - Subcritical
Pulverized coal boiler technology is a mature and reliable energy producing technology around the world. The operating pressure of conventional coal-fired power plants can be classified as sub-critical and super-critical. Sub-critical and super-critical technologies refer to the state of the water that is used in the steam generation process. The critical point of water is 3208.2 psia and 705.47° F. At this critical point, there is no difference in the density of water and steam. At pressures of about 3208.2 psia, heat addition no longer results in the typical boiling process in which there is an exact division between steam and water. The fluid becomes a composite mixture throughout the heating process. A sub-critical pulverized coal unit was eliminated from consideration as an option because of higher emissions and a less efficient heat rate.

Atmospheric Circulating Fluidized Bed Coal (ACFB)
The consideration of a baseload coal-fired unit at the Big Stone Plant (BSP) site included evaluation of a large ACFB facility. The combustion within a fluidized bed boiler occurs in a suspended bed of solid particles in the lower section of the boiler. Combustion within the bed occurs at a slower rate and lower temperature than a conventional pulverized coal-fired boiler. Deviations in fuel type, size, or Btu content have minimal effect on the furnace performance characteristics. The bed allows for re-injection of a sorbent, such as fly ash or limestone, to reduce SO_2 emissions. This type of operation requires approximately 1.5 times the quantity of limestone to achieve a reduction in SO_2 similar to that of a wet limestone scrubber.

One of the benefits of an ACFB facility would have been an increased ability to use biomass fuels. The BSPI unit already has an alternative fuels handling facility and the capability to burn alternate fuels. There has been difficulty in expanding the use of biomass fuels at BSPI due to cost and availability. The benefit of being able to use biomass fuels was outweighed by a number of other factors, and a large fluidized bed unit was eliminated from consideration. The Minnesota Next Generation Energy Act of 2007 requires new coal-based generation to offset CO2 emissions. Any ACFB alternative would require CCS to be installed in order to serve load in Minnesota. Otter Tail Power’s view of CCS is that it is a promising technology but not currently commercial.

Integrated Gasification Combined Cycle (IGCC)

IGCC technology produces a low energy value syngas from coal or solid waste, for firing in a conventional combined cycle plant. The gasification process in itself is a proven technology having been previously used extensively for production of chemical products such as ammonia for use in fertilizer. The U.S. Department of Energy (DOE) has jointly funded several power plant facilities through the U.S. The majority of the DOE test facilities use entrained flow gasification design with coal as feedstock. In that process, coal is fed in conjunction with water and oxygen from an air separation unit, into the gasifier at around 450 psig where the partial oxidation of the coal occurs. The raw syngas produced by the reaction in the gasifier exists at around 2400° F. and is then cooled to less than 400° F. in a gas cooler, which produces additional steam for both the steam turbine and the gasification process. Particulate, ammonia (NH_3), hydrogen chloride, and sulfur are then removed from the raw syngas stream. The cooled and treated syngas then feeds into a modified combustion chamber of a gas turbine specifically designed to accept the low calorific value syngas. Exhaust heat from the gas turbine then generates steam in a HRSG which in turn powers a steam turbine.

It is recognized that IGCC, in theory, shows potential to become a reliable, low emission source of electrical energy in the future that more easily adapts to the potential of CCS. Compared to supercritical pulverized coal, IGCC projects appear to have nearly 25%-30% higher upfront capital costs, variable O&M about 15%-20% higher, and fixed O&M roughly 50% higher. The Minnesota Next Generation Energy Act of 2007 requires new coal-based generation to offset CO2 emissions. Any IGCC alternative would require CCS to be installed. Otter Tail Power's view of CCS is that it is a promising technology but not currently commercial. Based on all of these considerations, Otter Tail did not include IGCC as an option in the planning model.

Reciprocating Engine Plants

Large-scale reciprocating engine power plants have begun to gain in popularity in some areas of the country in recent years. A reciprocating engine plant is constructed of incrementally sized engines (2 MW – 16 MW each). Most large-scale reciprocating engine plants are fueled with natural gas only. However, some systems may be dual fuel (natural gas and fuel oil). Typically speaking, the construction costs of a reciprocating engine plant are more expensive than a simple cycle combustion turbine (perhaps 10% – 20% higher). However, on a unit to unit comparison, the reciprocating engine is more efficient than a typical aeroderivative combustion turbine. If you consider partial load operation, the overall fuel savings can be considerable. Some energy providers have viewed the installation of reciprocating engine plants as a good fit to a region with high wind or other intermittent energy resources. A generation resource that is capable of high efficiency through a wide range of output may become attractive enough to overcome initial higher installation costs. Through the prescreening process, reciprocating engines were excluded from the alternatives made available to Strategist, largely due to the higher O&M and capital costs. However, if the base case or preferred case calls for the increased addition of peaking resources, a more detailed evaluation could prove them preferable for Otter Tail's resource mix. Recently constructed reciprocating engine plants are listed below;

- Basin Creek Power Services LLC, Butte, MT, 51.8 MW, COD 2007, 9 Caterpillar 16GCM34
- Midwest Energy Incorporated, Hays, KS, 75 MW, COD 2008, 9 Wärtsilä 20V34SG
- CoGentrix, Plains End I, CO, 111 MW, COD 2002, 20 Wärtsilä 18V34SG
- CoGentrix , Plains End II, CO, 116 MW, COD 2008 (est.), 14 Wärtsilä 20V34SG
- Tierra Energy, Hayward, CA, 115.5 MWe, 14 Wärtsilä 20V34SG engines, COD 2009 (est.)

- South Texas Electric Cooperative (STEC), Pearsall Power Plant, Pearsall, Texas, 203 MW, COD 2009/2010 (est.), 24 Wärtsilä 20V34SG

The reciprocating engine plant options investigated are based on variations of three different plants.

- 48.7 MW 3 x Wärtsilä 18V50DF
- 49.5 MW 6 x Wärtsilä 20V34DF
- 99.0 MW 12 x Wärtsilä 20V34SG

Phosphoric Acid Fuel Cell (PAFC)

The model evaluation excluded the option to select fuel cells due to the resource's higher costs compared to other units of similar technology. Fuel cells function by converting hydrogen-rich fuel sources directly to electricity through an electrochemical reaction. Fuel cells can sustain high efficiency operation even under partial load conditions and they have a rapid response to load changes. The construction of fuel cells is inherently modular, making it easy to size facilities according to power requirements. One of the most significant benefits to fuel cells is the lack of emissions. The only significant emissions are water and carbon dioxide.

Hydro

For past resource plan filings Otter Tail has reviewed the potential for cost-effective small hydro development within its service territory. A MN Department of Natural Resources survey of potential sites within the state served as a basis for that review. The DNR conclusion was that the existing economic sites had already been developed. For that reason, Otter Tail did not include any potential development of small hydro within the model.

Otter Tail has been working with several non-utility projects within its service territory that are considering small hydroelectric development, but none of these efforts have progressed to any great extent. Each of these potential projects would be measured in kW, rather than MW.

Even if potential sites existed within the Company's service territory, it is unlikely that they would be economic for development if the sites were under FERC jurisdiction. If a waterway has a designation as a navigable stream, then it falls under FERC jurisdiction. Otter Tail's small hydros on the Otter Tail River near Fergus Falls were all built prior to FERC licensing requirements. The Otter Tail River was designated as a navigable stream because in the 1800's it was used for transportation and to float logs to the sawmill. In the late 1980's and early 1990's, Otter Tail was ordered to obtain FERC licensing on these units. The licensing process took several years and cost about $400/kW, for existing units. The licensing cost for developing a new site is likely to be so high as to make the process uneconomic.

Heat Recovery

Over the past two years Otter Tail has been working with a developer to use binary cycle moderate temperature geothermal technology to recover waste heat for use in generating electricity. The project would be slightly less than ten (10) megawatts in size and would not require the use of any fossil fuel. While technically feasible, the costs associated with the project are thus far too high to be competitive with other resource options. While Otter Tail and the developer will keep this alternative in mind for future development, it was not included in the current analysis due to the high costs.

Energy Storage

Promising new technologies are being developed, tested, and demonstrated in the field of energy storage. These technologies include battery storage, compressed air energy storage, and proven pumped hydro storage. As the overall percentage of intermittent renewable resources connected to the electrical supply system increases, the focus on energy storage technologies will increase. During the mid-1990's the Minnesota Department of Natural Resources promoted the potential development of a pumped storage hydroelectric facility at the Hill Annex State Park at Calumet, MN. Based on preliminary studies jointly conducted by the DNR and Minnesota Power, it was estimated the site had the potential to support a 75 MW facility. The upper and lower reservoirs of the facility would be former taconite mines that are no longer in operation. Otter Tail has not conducted any further studies on the site. Excelsior Energy has filed for a water appropriations permit with the State of Minnesota to use water from the Hill Annex mine site for their proposed Mesaba IGCC project.

Solar Photovoltaic

Solar photovoltaic technology was not included in the model as a generating option, due to continuing high costs. Any initial installation of a solar photovoltaic system by the Company is likely to be part of a CIP project under the renewable energy provision contained within the CIP statute.

Anaerobic Digestion

Previous study work within Otter Tail concluded the amount of potential generation from anaerobic digestion within Otter Tail's system may result in, at the most 1.2 MW, too small to be of consequence to this resource plan filing. Anaerobic digestion was not included as a generation option within the model. Otter Tail is in the process of negotiating a 10-year PPA with an anaerobic digestion facility located outside of the Company's service territory.

Landfill Gas

According to an EPRI report completed in the late 1990's, the Otter Tail Service territory does not include any landfills of sufficient size to support a landfill gas generating facility. The only two landfills in the area that were identified as having sufficient size are located at Fargo and Grand Forks, both served by another utility. Fargo now has a unit installed. Each of those landfills was identified as having the potential to support two 2 MW generators. Landfill gas was not included as an option within the model.

Microturbines

Microturbines are miniature combustion turbines, similar in concept to the large combustion turbines used in conventional utility power plants. Whereas large combustion turbines range from 20,000 to over 200,000 kW, microturbines fit into the 25 to 400 kW range. Microturbine efficiencies have not met early manufacturer projections of mid-30 percent and higher. Most available units are in the mid-20's for efficiency in a stand-alone configuration. The waste heat from the turbine exhaust can be collected to supply a useful thermal load, which improves the overall cycle efficiency and the economics. However, the capital costs are still higher than the cost of a standard utility size combustion turbine and the efficiencies are much worse. At this point in time, potential economic applications are somewhat limited. The model did not include consideration of microturbines due to their small size, limited application at this time, and high cost.

Biomass

Since the early 1990's Otter Tail has made an effort to use renewable fuels in its existing coal-fired plants. The Big Stone Plant has burned a number of renewable and alternate fuels over the years and has an alternative fuels handling facility to aid in blending such fuels in with coal. Some of the renewable fuels that have been tried or researched over the years include spoiled or research corn seed, wood waste in various types, soybeans, sunflower hulls, and similar agricultural wastes. Some of these materials caused significant problems in test burns by either plugging fuel handling systems (bark wood waste) or plugging boilers (soybeans). Sunflower hulls and soybeans have proven to be problematic due to their high content of potassium. As of January 1, 2010, Big Stone Plant has stopped the alternative fuel program. The primary reasons were the limited availability of fuel and the high cost of maintenance of the handling facilities.

Otter Tail did not include any other additional biomass alternatives in the model. As the cost of fossil fuels increases, other markets develop for biomass fuels such as wood waste. In many cases, the wood products companies that create the waste use it as fuel in their own process. Otter Tail has worked with customers on potential wood waste-fired biomass facility investigations. The fuel supply is limited and the costs of such facilities are high. The development potential of these facilities is limited and very site specific. To date, Otter Tail has not found other opportunities for development of such facilities with costs being close to economic.

Geothermal

Otter Tail has worked with the Geology Dept. at the University of North Dakota on investigating the potential for geothermal energy. Western North Dakota has geothermal resources in temperature ranges that would be suitable for binary cycle geothermal technologies. A binary cycle facility typically pumps natural water or brine from underground that has been heated by the earth to moderate temperature ranges of 200° F. - 500° F. The heat in the fluid is transferred to another working fluid such as iso-pentane which is used in place of water in a normal vaporization/condensation cycle. The brine is then reinjected back into the earth. The extraction and reinjection wells are typically from 1,000 – 3,000 feet deep and require significant horsepower to extract the fluid and then reinject it. The resources in western North Dakota are located much too deep to be economic for binary cycle operation, typically in the 10,000 – 12,000 foot range. Otter Tail did not include any geothermal options as potential generating resources in the model.

Otter Tail does have geothermal heat pumps as programs within its CIP process.

The binary cycle technology used for moderate temperature resources would work with any source of waste heat that falls within the moderate temperature range and in sufficient quantity to support a binary cycle unit. Otter Tail has been involved in investigating waste heat generation from combustion turbines used at natural gas compression stations on pipelines. Otter Tail has also searched for other potential waste heat streams that could be used to support a small binary cycle facility. ORMAT is a company that has binary cycle units in the 1.5 – 5 MW range that are designed to be operated remotely. One of the difficulties for developing a small waste heat recovery facility that has been identified is that the State of Minnesota rules require full time staffing of such a facility any time working pressures are in excess of very low pressures. The labor requirements to have staffing 24 hours per day significantly increase the costs and make such facilities uneconomic.

3 Demand Side Resources

The mix of energy efficiency technologies that were included in the resource plan was determined based on filed objectives in each of the states and expected cost recovery. Hourly load profiles associated with each technology were weighted according to stated objectives and used to create a summary residential profile and a summary commercial profile. These two profiles were developed for both Minnesota and non-Minnesota load, creating four profiles altogether. Each conservation profile was modeled as a multiyear program, which included the costs of implementation and the value of avoided transmission and distribution investments.

Six energy efficiency alternatives were provided to the model with varying costs and penetration levels. The mix of conservation technologies that made up the conservation alternatives in the model covered a variety of end-uses, and some are identified below:

- Residential
    - Hotpacks
    - Residential Demand Control
    - Air Source Heat Pumps - Residential
    - Geothermal Heat Pumps - Residential
    - Home Insulation - (New Pilot for 2010)
    - Air Conditioning Control
    - Advertising & Education - Residential
    - Change A Light
    - Appliance Recycling (New)
    - Implementation & Training - Residential
    - Financing - Residential

- Commercial
    - Grant
    - Motors
    - Redirect
    - Lighting
    - Implementation & Training - Commercial
    - Cooking
    - Commercial Refrigeration
    - Air Source Heat Pumps - Commercial
    - Geothermal Heat Pumps - Commercial
    - Adjustable Speed Drives
    - Lighting - New Construction
    - Plan Review
    - Advertising & Education - Commercial
    - Financing - Commercial
    - Compressed Air Audits

A new pilot program in 2010 is included as part of the residential and commercial energy efficiency programs. This pilot, "On For Conservation!" includes a town energy challenge and a secondary education campus energy challenge, both of which are to reduce energy usage by 10-15% by 2015 through better technology, education, and changes in behavior. Low income house therapy also contributes to the residential programs.

In addition to conservation alternatives, the model was able to select a demand side management alternative that incrementally increased summer demand response by 1 MW/year and winter demand response by 2 MW/year. The costs associated with this resource alternative were provided by market planning staff based on annual marketing plans and market intelligence. Demand resources that are accredited under Module E of the Midwest ISO Tariff are able to be netted from the peak demand forecast prior to calculation of the resource adequacy obligation.