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Idaho's Energy Options

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Idaho National Laboratory

Idaho Falls, Idaho 83415

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ABSTRACT

This report, developed by the Idaho National Laboratory, is provided as an introduction to and an update of the status of technologies for the generation and use of energy. Its purpose is to provide information useful for identifying and evaluating Idaho's energy options, and for developing and implementing Idaho's energy direction and policies.

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ACRONYMS

BPA	Bonneville Power Administration
Btu	British thermal unit
CAFE	Corporate Average Fuel Economy
CARB	California Air Resources Board
CBM	coal bed methane
CEV	city electric vehicle
CHP	combined heat and power
CNG	compressed natural gas
DG	distributed generation
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EBR-II	Experimental Breeder Reactor
EIA	Energy Information Administration
ERO	Electric Reliability Organization
EV	electric vehicle
FERC	Federal Energy Regulatory Commission
FFV	flexible fuel vehicles
FT	Fischer Tropsch
GTL	gas-to-liquid
HEV	hybrid electric vehicle
INL	Idaho National Laboratory
IRP	Integrated Resource Plan
kW	kilowatt
kWe	kilowatt electrical
kW-h	kilowatt-hour

LDD	light-duty diesel
LED	light emitting diode
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LWR	light water reactor
MBPD	million barrels per day
MSW	municipal solid waste
MWe	megawatt electrical
MW-h	megawatt-hour
NERC	North American Electric Reliability Council
NEV	neighborhood electric vehicle
PEM	Proton Exchange Membrane
PHEV	plug-in hybrid electric vehicle
PNWER	Pacific NorthWest Economic Region
PURPA	Public Utility Regulatory Policies Act
PV	photovoltaic
RDF	refuse-derived fuel
RPS	Renewable Portfolio Standards
RTO	Regional Transmission Organization
TCP	thermal conversion process
USGS	U.S. Geological Survey
ZEV	zero-emission vehicle

Idaho's Energy Options

1. INTRODUCTION

The twenty-first century poses new and important energy-related challenges to the state of Idaho. The last few years have seen rapidly rising energy prices and concerns over the adequacy of supply. In addition, Idaho is one of the most rapidly growing states in the country. The U.S. Census Bureau estimated Idaho's population at 1,429,096 in 2005, with a population growth of 28.5% from 1990 to 2000. These challenges raise significant questions, namely: will we have sufficient energy to support our economy and provide for the needs of our population, and at what cost? Furthermore, how will this energy be generated, and what environmental, health and safety, and social impacts will this have?

In response to changes in the cost and supply of energy in the 1970s, Gov. John Evans appointed the Energy Resource Policy Board in 1980 to begin the process of defining the state's role in energy planning and policy. As a result of this effort, the Idaho State Energy Plan was issued in 1982. The purpose of the plan was "to assess Idaho's energy position and resources, to evaluate the potential demand versus supply capabilities, and to set forth policies which can encourage development of adequate supply considering technical, social, and economic factors."

In 2006, in recognition of today's energy challenges, the 58th Idaho Legislature is considering a House Concurrent Resolution (HCR62) that requests the Legislative Council Interim Committee on Energy, Environment and Technology to develop an integrated state energy plan that provides for the state's power generation needs and protects the health and safety of the citizens of Idaho, and to report back to the Governor and the Legislature on its findings and recommendations.

This report, developed by energy experts from the Idaho National Laboratory, is provided as an introduction to and an update of the status of technologies for the generation and use of energy. Its purpose is to provide information useful for identifying and evaluating Idaho's energy options, and for developing and implementing Idaho's energy direction and policies.

As an introduction to this report, it is important to recognize that most of Idaho's energy is imported—over 60% of its electricity consumption (in 2001) and essentially all of its transportation fuel. In 2001, Idaho consumed 501 Trillion Btu of energy; the sources of this energy are shown below in Figure 1.

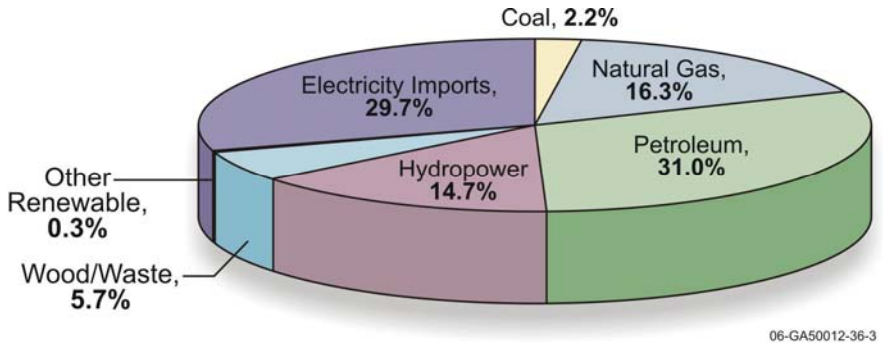

Figure 1. Idaho Energy Consumption by Source (2001) (provided by EIA).

The economy can be considered as being composed of four sectors: residential, commercial, industrial, and transportation. Figure 2 indicates where Idaho's energy was consumed by sector in 2001.

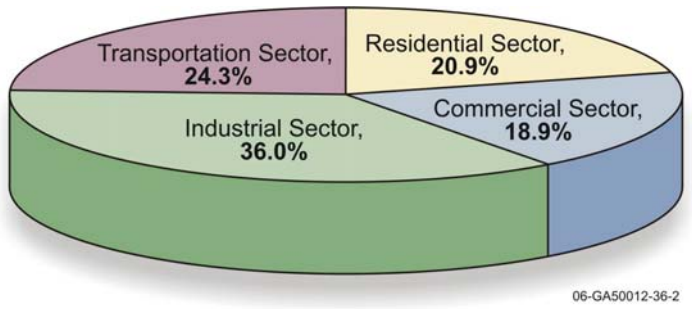

Figure 2. Idaho Energy Consumption by End Use Sector (2001) (provided by EIA).

Idaho requires (2005) about 2,600 megawatts (MW) of electrical capacity to meet its electricity needs. Idaho's electricity rates are among the lowest in the country, averaging 6 cents per kW-h, in large portion due to inexpensive hydropower (generated in Idaho and imported from the Bonneville Power Administration). Idaho consumes about 21 million MW-h of electricity (2002), but typically produces less than half this amount. Electricity produced in Idaho is predominantly from hydropower; however, the amount of hydro generated electricity varies significantly from year to year due primarily to the amount of available water flow. Natural gas accounts for most of the remainder of Idaho's electricity production with wood producing a small amount of electricity from cogeneration. Figure 3 shows the energy sources for Idaho-produced electricity in 2001. While most recent electric generation capacity built in Idaho uses natural gas as a fuel, coal-fired plants have recently been proposed to be built in the state. Small amounts (75MW) of utility-scale wind generated electricity were installed in Idaho in 2005. About 90% of the electricity sales in the state are provided by Idaho's three major private electric utilities (Idaho Power Company, the Utah Power and Light subsidiary of PacifiCorp, and Avista) with the remainder provided by municipal utilities and cooperatives. In 2003, about 42% of the electricity sold by Idaho Power Company was generated from coal-fired plants located in other states; PacifiCorp and Avista also provide significant amounts of electricity produced at out-of-state coal-fired plants.

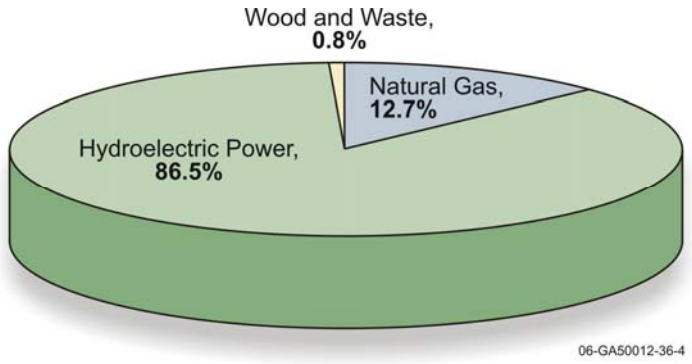

Figure 3. Energy Source for Idaho Produced Electricity (2001) (provided by EIA).

Idaho's current and future energy resource development is closely tied to renewable energy. While hydropower produces the large majority of the electrical power produced in the state, it is unlikely that any additional large hydroelectric plants will be built in the state; however, there are significant small hydropower resources that could potentially be developed using run-of-river plants. The amount of wind electric capacity in Idaho is growing rapidly, from 75MW in 2005, to an expected 265MW total in 2006 and as much as 565MW in 2007. The state's first geothermal electric plant (13MW) at Raft River is expected to come on-line in 2006 and may expand to as much as 90MW. Geothermal energy currently

heats over 5 million square feet of buildings in Boise and provides over 100MW of energy to Idaho. Wood is used for a significant amount of industrial process energy in the state.

The energy supply for transportation in Idaho (and the United States) is almost exclusively petroleum based. As a result, essentially all of the transportation fuel consumed in Idaho is imported. This dependence on petroleum makes Idaho vulnerable to disruptions in foreign and domestic production. Idaho's agriculture is extremely dependent upon adequate supplies of petroleum. Agriculture may in fact be part of the solution for Idaho since there is significant potential for the production of ethanol from agricultural residues and for biodiesel from seed oils and used cooking oils. Hydrogen and the production of synthetic fuels are emerging technologies that may help reduce transportation's dependence on petroleum. Alternate vehicle technologies are being developed that provide improved fuel economy or that do not even use petroleum-based fuels. However, national and international decisions and policies relating to the price and availability of petroleum will continue to affect Idaho for the foreseeable future.

Idaho can play an important role in defining its energy future. Decisions that affect the generation and use of energy in the state will help determine its availability, cost, and impacts on safety, health, and the environment. The Idaho Legislature and Idaho stakeholders should be involved in decision-making processes to ensure that the energy needs of the state and its people are met.

2. ELECTRICITY

Overview

Hydroelectricity continues to be Idaho's principal source of electric power to this day, bringing with it the double benefits of clean energy and relatively low electric rates to its citizens. However, continued growth in electrical demand has exceeded available hydro supply so that those utilities servicing Idaho have increased their investments in thermal generating facilities to meet this demand. The various costs associated with these investments have resulted in a reliable supply with gradual rate increases for Idaho ratepayers as well as a continued increase in reliance on out-of-state resources.

Chief considerations for meeting future growth needs include those related to potentially available sources, economic considerations, environmental considerations, health and safety issues, and social impact considerations.

When considering the demand for electrical energy, a number of key factors will determine future electricity demand within Idaho; there is no absolute consensus as to their relative influence. One of these factors is estimated population growth. Currently, Idaho ranks fourth in the nation in population growth; Idaho's population has grown at an average annual rate of 1.9% from 1990 to 2000. Population growth rate is often used as the starting point for electricity demand planning, but it needs to be substantially modified by other key factors, including among them the average per capita electricity usage, which in Idaho in past times has tended to be higher than in other parts of the country due in some part to traditionally lower costs for power—which is now changing. For example (as taken from the 1982 plan document), population growth rate in the 1970s was 2.84% and per capita electrical demand growth rate was 6.16%. However, more recent numbers show a 1.9% population growth and actually -0.8% for per capita electricity growth during the 1990s. These two key rates, and the difference between them, will continue to vary; most analysts nationwide assume that overall growth in per capita usage will continue to lag behind population growth rates for the foreseeable future.

So-called "peaking" versus "base-load" energy needs, and the effective management of supply to meet those needs, is always a key factor in determining overall policy toward electricity resources. For example, Idaho Power's average megawatt level is cited as being 1,660MW, but its peak load reached 3,000MW in 2003. Attempting to shift demand patterns to reduce the difference between these levels is one management option available. Matching future demand to future supply options is further complicated by the considerations discussed below.

Current Situation

Idaho currently requires about 2,600MW of electric power[1]. Idaho's three major private electric utilities (Idaho Power Company, the Utah Power and Light operating entity of PacifiCorp, and Avista) supplied the state with 2,345 average megawatts of electricity as of 2002, and constituted over 90% of all electricity sales in the state (more than 50% alone from Idaho Power). The remaining and relatively small fraction of the state's requirements is satisfied by the multiple rural electric co-operatives and municipal systems, most of which purchase their power through the Bonneville Power Administration.

Hydroelectric power provides approximately 60% of the state's current total electrical energy needs under normal reservoir capacity assumptions. However, in general, sites for further large-scale hydro facilities are not available, although some potential remains for small and low-head hydro development.

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[1] Idaho Public Utilities Commission 2005 Annual Report, Section II: Electric Information, 2005.

Potential

Planning information on new capacity from coal and other fossil fuel energy resources is discussed in Section 3 of this report. Regarding wind power (Section 4.8), there are approximately 1,900MW of proposed wind turbine installations in various stages of development in Idaho, of which 75MW are already in place as of the end of 2005, with another 190MW to be installed by the end of 2006. Less conventional sources of electrical generation are also under development, including geothermal, municipal waste resource recovery, and various cogeneration options. Although there are no significant indigenous natural gas resources within Idaho, electric power transmitted into the state from generating sources using natural gas feedstock continues to be another supply alternative. Additionally, various conservation measures can act to displace needs for electrical energy and therefore can be argued to be another important means to provide for future energy needs. As presented in its 2004 Integrated Resource Plan, Idaho Power intends to offset the equivalent of 124MW from implementing various conservation measures.

Distributed generation (DG) sources are defined as those sources still grid-connected but physically located either within the user's load site or else nearby. Cogeneration (also known as "combined heat and power" or CHP) is a key form of DG and as such is separately discussed Section 4.4. Estimates for future use of DG within Idaho are relatively uncertain, but if substantial industrial development within the state occurs in the mid-term to long-term, those employers may seek favorable state intervention for DG investments as part of a larger incentive package to maintain low operating costs.

Idaho must also continue to balance the fundamental trade-off between, on the one hand, competing for electricity resources originating from outside the state, and on the other hand, encouraging more in-state electricity resource development. The chief risk associated with the first route is the relative lack of influence on pricing decisions, i.e., perceived lack of control over a key sector directly affecting the economic well-being of Idaho’s citizens. The chief risk associated with the second route may well be the difficulties in developing in-state generation that is both relatively cost-effective. There are many ways in which these trade-offs will be faced. One example is the current discussion in Idaho Falls regarding its options after the contract for 15MW of electric power supply with the Bonneville Power Administration ends in 2011. Another example is direct state involvement in specific subsidies for any particularly preferred alternatives, as the state of California has just chosen to do with its "Million Solar Roofs" program. A third example relates to how strictly the state of Idaho mandates the enforcement of sufficient electrical generation reserve margins for those utilities who provide service within the state but whose generating assets are primarily out-of-state.

Not all proposed new alternative sources of electric generating capacity will actually be developed in the next few years due to various constraints. These include difficulties that prospective proposers may have negotiating specific terms of utility solicitations, availability of power purchase contracts, possible issues with the implementation of the federal Public Utility Regulatory Policies Act (PURPA) legislation within Idaho, possible geographical mismatches between the location of proposed generating sources and the location of actual load centers, and overall transmission system availability in various sections of the state, among other factors.

Decisions made primarily outside the state may dramatically influence electricity investments within Idaho (e.g., siting of transmission lines). For example, as more energy resources are developed in Alberta, Idaho could find itself in the crossroads of new major utility corridors running either between Canada and California or Canada and Midwest states.

Economic Considerations

Other sections of this report on individual generating technologies contain data on their relative economic attractiveness as sources of electrical generating capacity. In 2006, costs for power could range widely, even as much as by a factor of two or more (i.e., between 3 and 6 cents per kW·h in an Idaho setting, with costs much higher than this for various East Coast locations). Economists and investors who forecast alternative energy system costs need to make several critical assumptions such as relative economies of scale (size of larger versus smaller installations), changes in current federal or state law regarding the availability of production tax credits, relative availability of low-interest or (in some cases) no-interest bonds to the financing entity, values of prospective sales of “green tags” for renewable sources where applicable, and the economic impact of any realistic permitting or construction schedule delays. To date, electricity generation using existing coal and hydropower facilities is typically less expensive than other alternatives. However, wind systems for example can be more competitive in some cases because environmental requirements, development costs, and fuel costs for more conventional new power plants are escalating.

Economic planning for overall electric grid reliability must include assessing the performance of various intermittent generating sources, chiefly wind energy in Idaho's case. For example, as discussed in Section 4.8, if the level of wind power sources supplied to a system is kept at 10 to 15%, integration and operation of the power grid is relatively simple. If this is exceeded, additional backup capacity, operational changes, or other techniques are typically required.

Environmental Considerations

Each electrical generating source has its environmental considerations. These considerations range from traditional concerns such as preserving Idaho's air and water quality to specific issues ranging from water usage to visual impacts. In terms of electricity system concerns in general, for planning purposes within Idaho, the prospective delays associated with completion of environmental reviews for new electrical generating facilities need careful attention when evaluating alternatives.

Another perspective regarding environmental impacts is relative environmental benefits. For example, both renewable electricity systems (e.g., solar and wind) and nuclear generating sources emit no greenhouse gases. Also, to the extent that they can be relevant and comparable, conservation measures usually take much less time to take effect in reducing demand and are usually perceived as having zero or positive environmental impact.

Recently, in the United States and overseas there has been considerable activity in the evaluation of "emission credits" of various sorts between those entities who exceed certain pollutant emission limits and those who own facilities that are below-standard emitters (or zero emitters) within a certain geographical area. Depending upon the legislative formula and ownership of the facilities, Idaho could face a situation where the availability of such credits has a substantial financial value to owners and stakeholders, but with the risk of degrading air quality and water quality in the state. The Idaho Public Utilities Commission already requires investor-owned utilities to incorporate an "adder" allowance of $12 per ton carbon in their long-term procurement plans, in anticipation that such credits will be mandated. If global warming credits also become economically recognized over time, in some scenarios they could have large prospective value for Idaho statewide if the state could properly capitalize on assets such as hydro, wind, and nuclear power sources for generating electricity.

Health and Safety Considerations

As with environmental considerations, each electrical generating source has its own health and safety characteristics. For electricity systems in general, workplace safety has been traditionally managed by the utilities and systems owners in a manner that has gradually improved over time. Of course, health and safety range over all parts of the system, ranging from simple household wiring to tree trimming for transmission and distribution lines.

Social Impact Considerations

Development of new or expanded electricity systems in Idaho will depend in part on the public's willingness to accept the perceived social dislocations associated with these facilities. There are also positive impacts such as greater employment and economic development benefits (for example, recently published information on the positive economic development aspects of greater use of renewable energy resources in Colorado[2]). New developments in conservation practices also have social impacts, such as agricultural pump efficiency programs, which promote reduced electrical energy use and improved irrigation practices, enhancing the farming sector within the state.

Social impacts in Idaho associated with electricity are not necessarily restricted to power generation and transmission. In the transportation sector, depending upon the number of years assumed for a planning time horizon, introduction of electric vehicles (either hybrid or 100% electric) could have substantial social impact within Idaho. If Idaho were to choose to become an active "testing ground" for these vehicles, the state could possibly capitalize on incentives for early deployment that may not otherwise be available. The Idaho highway system is used extensively by the trucking industry, and new programs, such as a recent experiment to electrify truck stops to reduce emissions from overnight truck idling, could have substantial future value. Similarly, new building design in Idaho (whether commercial or residential) could become a state priority for energy savings demonstrations if the state so chooses to invest at a level beyond current federal demonstration programs.

[2] Jeff Deyette, and Steve Clemmer (Union of Concerned Scientists), *The Colorado Renewable Energy Standard Ballot Initiative: Impacts on Jobs and the Economy*, October 2004.

3. NONRENEWABLE RESOURCES

Over 66% of the electrical energy and 100% of the transportation fuel used in Idaho come from nonrenewable resources found outside the state, and increasingly outside of the country. Coal, petroleum, natural gas, and uranium all contribute to this energy mix. With the exception of the use of hydropower, Idaho is almost totally dependent upon these imported resources. No large deposits of coal, petroleum, or natural gas have been discovered in the state.

Idaho will continue to be dependent on other states and countries for a large share of its energy needs over the next two decades. National and international decisions and policies relating to price and availability of nonrenewable resources will continue to affect Idaho. Therefore, conservation of these energy resources is the greatest opportunity for the state. By changing our consumption patterns, we can gain time without overly impeding the economy of the state. However, conventional nonrenewable energy resources will continue to play a major role in the Idaho energy mix. This section of the report deals with these resources.

3.1 Coal/Oil Shale

Overview

The size of America's known coal reserves makes coal an attractive energy resource, and a major alternative to expensive and interruptible supplies of foreign oil. Historically, Idaho has used coal for space and process heating, but with the advent of more economically and environmentally attractive methods of space heating, the use of coal has been nearly eliminated. However, because of abundant national coal reserves, and the potential need for additional energy sources, it is very likely that Idaho will experience a greater reliance on coal for electrical generation in the coming decades. Increased consumption of coal increases the potential for air, water, and land pollution on a global scale.

Current Situation

Potential

In 2003, Idaho ranked ninth nationally in per capita electrical use and 49th in electricity prices paid. The growth of electrical usage has been driven primarily by growth in the commercial and residential sectors. Between 1960 and 2003, the relative usage of power for industrial processes has dropped from roughly 50% to about 35%. As Idaho's population continues to grow, this trend should continue. Idaho had three large suppliers of electricity (IdahoPower, Pacificorp, and Avista) with 58%, 15%, and 14% of the total market, respectively, and with the remainder divided among multiple municipal and co-ops. About 42% of the electricity sold by Idaho Power was generated at out of state coal-fired plants. Approximately 60% of Pacificorp's power and 25% of Avista's is generated from coal.

Because of the proximity of Idaho to the major coal and oil shale fields of the Western United States (primarily in Wyoming, Montana, Utah, and Colorado), coal and oil shale should be considered as an accessible part of Idaho's future energy mix. Coal's greatest near-term potential use is for the generation of electricity, however, in the longer term, coal and oil shales may be used for the production of transportation fuels and commodity petroleum-based chemicals.

Oil shale is very well suited for transportation fuels; it is unlikely to be used for electricity production with the limited exception of cogeneration for captive electricity use where it is processed. Processing of oil shales will most likely be sited where they are found, to minimize transportation costs.

As hydroelectric sites have become limited, all utilities in the state have integrated coal-fired generating facilities into their fleet. The early trend to use coal for space and/or process heat has largely been supplanted with the use of natural gas. Given the volatile and uncertain future supplies of natural gas, it is possible that this trend could reverse during the next two decades.

During the past few years, oil and natural gas supplies have become increasingly volatile and subject to short-term disruptions from a variety of political and natural (e.g., hurricane Katrina) events. In most of these, short-term supplies were abruptly impacted and led to large increases in price. This is one indicator of the low oil production reserve margin. Additionally, as demand has increased in foreign countries (primarily India and China), the excess supply has greatly decreased. The consensus of analysts is that world peak oil and gas production will occur within the next few decades. Consequently, as oil and natural gas production levels off and begins to fall, coal will be called upon to make up the deficit and also meet expected increases in energy demands. It is likely that coal and oil shale will also be used to produce synthetic liquid and/or gas fuels. However, several factors introduce considerable uncertainty as to the levels of synthetic fuels production in the next two decades. These include production cost,

available capital, and potential emission constraints. The costs involved and venture capital available are the greatest constraints. Competing energy sources, as well as technology for direct coal combustion, are in many cases more attractive than synthetic fuels. Also, many technological, environmental, socio-economic, and political issues must be resolved before large-scale synthetic fuel production can become a reality.

In its 2006 session, the Idaho legislature is considering at least two bills (H791 and H792) relating to the construction of coal-fired power plants in Idaho. House Bill 791 places a two year moratorium on construction of certain coal-fired power plants (this bill does not apply to Integrated Gasification Combined Cycle plants) in order to develop and evaluate information on matters such as air and water quality impacts. House Bill 792 requires legislative approval of water rights with a diversion of two cubic feet per second or more (or a storage volume of 1,450 acre-feet or more) for a coal-fired power plant (other than an Integrated Gasification Combined Cycle plant) in order to evaluate the effect of coal-fired generation on the water resources of Idaho.

Economic Considerations

Idaho consumers are experiencing increased electrical rates; much of this increase is the result of Idaho utilities' participation in coal-fired facilities. The price of coal-generated electricity compares favorably with that of other nonrenewable energy sources and on an energy content (Btu) basis coal will continue to cost less than oil and natural gas. Coal is most comparable to, and competitive with, nuclear energy. Coal-fired plants are less capital intensive than nuclear plants, but have higher operating costs, primarily due to fuel costs. The electricity costs from coal and nuclear plants are similar with coal having an advantage in areas that are adjacent to Western coal fields.

Environmental Considerations

Potential environmental concerns normally associated with coal-fired plants include:

- Sulfur oxide emissions
- Nitrogen oxide emissions
- Water use (in certain areas)
- Potential leachate of trace elements from ash/sludge
- Mercury emissions
- Carbon dioxide emissions

New coal-fired plants in Idaho will likely use low-sulfur Wyoming coal, thus mitigating some of these hazards. In addition, new scrubbing technologies developed over the last two decades will be required to be installed at the time of construction and should dramatically reduce the emissions of oxides of nitrogen, sulfur, and probably mercury. An emission receiving increased global focus is carbon dioxide (CO_2). Evidence seems to indicate that man-made emissions of CO_2 are increasing and can result in climatic changes throughout the world. Many nations, and a growing number of individual states, have adopted policies and requirements that limit or otherwise reduce CO_2 emissions. California has recently adopted policies that require new electricity generated out of state for importation to be emissions neutral. This trend is likely to continue and Idaho should consider its position on emissions of CO_2. Other obstacles to overcome for further large-scale development include such factors as the impacts of large mining operations in neighboring states, coal handling logistics, and disposition of combustion waste products. New gasification technologies (with or without CO_2 capture) hold promise for further reducing

many of the environmental problems associated with the use of large-scale coal-burning facilities. These new gasification systems have been operated for short operating periods to test the technology. Two Integrated Coal Gasification Combined Cycle power plants are operating in the United States, the 260MW Polk Unit One near Tampa, FL., and the 262MW Wabash River Plant in West Terre Haute, IN. A very large number (approximately 150) of new gasification plants have been proposed nationwide, including several in Idaho.

The Department of Energy's FutureGen initiative is directed towards demonstrating the world's first zero-emissions coal plant, establishing the technical and economic feasibility of producing electricity and hydrogen from coal, while capturing and sequestering the CO_2 generated in the process. In addition, seven regional Coal Sequestration Partnerships are investigating CO_2 emissions mitigation through capture and immobilization by terrestrial and geologic methods.

Health and Safety Impacts

Although coal has made a substantial contribution to the economic well-being of the country, it has also resulted in significant health and safety challenges, from obtaining the resource and in using it in energy production.

Social Impact

The greatest social impact to Idaho from introducing coal into its energy mix is the potential "boom town" effect on the communities near a coal plant site. The ability of an area, or local unit of government, to deal with the public works developments—i.e., schools, water, sewer—is likely to be an important concern to the people of that locale and the state. Also, coal is perceived to be a dirty, high-emission technology that some communities will not accept.

Many other states are observing the same trends, benefits, and drawbacks, and have determined that it is in their state's interest to deploy new coal-fired power plants. Similarly, many states are active in trying to secure new energy parks where demonstrations of new energy technologies can be tested prior to large-scale implementation.

Issues

- Should Idaho rely on coal as a resource with its attendant environmental, social, and health impacts?
- Should Idaho consider siting a new coal-fired thermal plant, or coal gasification plant?
- Should Idaho develop a policy with regard to emissions of CO_2?
- Should industries be encouraged to convert to coal for combined heat and power applications?
- Should Idaho consider hosting new energy parks?

3.2 Natural Gas

Overview

Idaho has no commercially developed natural gas production. Natural gas enters Idaho through the Northwest Pipeline Corporation transmission system, and is distributed by Intermountain Gas Company (Four Corners area gas) and the new Alliance Pipeline (Canadian gas) to 304,000 Idaho customers. Approximately 50% of the natural gas used by Idahoans is imported from Canada, with the balance coming from resources originating in the Rocky Mountains and the Southwest.

Current Situation

In 2001, natural gas accounted for 16.3% (81.8 Trillion Btu) of Idaho's total energy consumption of 501.0 Trillion Btu. The industrial use sector consumed the largest quantity of natural gas (37.9%); the transportation sector used the least (8.2%). The residential, commercial, and electric power end use sectors were responsible for 23.8%, 17.0%, and 13.2% of natural gas consumption respectively in 2001. Idaho's natural gas consumption increased 31% from 1980 to 2004.

Potential

Currently, the natural gas companies serving the state are generally not capable of increasing supplies to Idaho customers with existing delivery systems. In October 2004, Intermountain Gas filed a growth plan with the Idaho Public Utilities Commission, stating that without an increase in capacity, Intermountain Gas would fall short in meeting peak use delivery requirements by about the winter of 2007. The filing discussed multiple avenues of increasing infrastructure facilities, storage capabilities, and supply contracts.

As recently as 1980, there existed a surplus natural gas supply in Idaho (313 million therms of natural gas per year in Idaho which is enough to supply the needs of 391,000 homes, based on the average use of 800 therms per year). In 2004, there was very limited surplus of natural gas, if any. Domestic production today has declined by 4% since 2001. New pipelines in the Western states allow natural gas that could not be transported to the Midwest and East to be supplied there now as demand requires. More power plants are now relying on natural gas for their supply. All of these issues have changed the supply to the point that Idaho Public Utilities Commissioners have stated publicly that:

- "…the low price gas bubble has collapsed." (Paul Kjellande, president of the Idaho Public Utilities Commission).
- "…recent price levels don't seem to be an isolated event that will go away in a few months or even a year." (Commissioner Marsha Smith)
- "We are urging Idahoans to take a long-term view. The … heating and appliances choices you make now will impact your utility bills for years to come." (Commissioner Dennis Hansen)

Economic Considerations

All of Idaho's natural gas is imported; therefore the state has little influence on price. The state's role is confined to ratemaking, shaping consumption patterns through conservation policies, and the siting of distribution and storage facilities. The state also leases state-owned land for natural gas and oil exploration. The recent high prices for natural gas may promote exploration and discoveries. The wholesale price equilibrium of about $2 per million Btu has disappeared. Wholesale prices (Henry Hub)

varied from 6 to $15 per million Btu in 2005 (Energy Information Agency). The price differential between gas and electricity, which favored use of natural gas over electricity or coal, has already begun to shift in the opposite direction.

Environmental Considerations

Natural gas is the cleanest nonrenewable fuel to supply and use. Pollution controls for gas equipment will continue to be less complex and less costly than those for any other major industrial fuel. Using natural gas as a combustion agent generally produces, according to EPA criteria, fewer pollutants than combustion from either coal or oil using the best available pollution control technology.

Social Impact

Continued or expanded use of natural gas in Idaho will have little social impact, beyond the possible economic benefit to consumers, if the displacement of electricity by natural gas slows the increase of state electrical rates.

Issues

- Does the need exist for policies and programs that will encourage the most efficient use of natural gas relative to other energy sources and as a fuel for space heating?

- Should severance taxes and/or other recompense to the state be encouraged, and should these be used to mitigate the impact on communities affected by any future natural gas development in the state?

3.3 Petroleum

Overview

Petroleum provides a large percentage of Idaho's current energy supply. Included in this section are considerations for light and middle distillates (gasoline, diesel and home heating oils), heavy distillates (residual oil used in industrial boilers and in asphalt) and propane. Our supplies of all of these, except propane, are dependent upon foreign reserves and production rates. Political and natural events abroad have led to shortages of these fuels in the past decade and may lead to more in the future. Idaho's number one economic producer, agriculture, is extremely dependent on adequate supplies of petroleum products.

Petroleum will continue to contribute in a major way to the economy of the state over the next several decades. Even with strong conservation efforts and conversions to alternate energy sources, the increased demand of Idaho's growing population indicates that we may continue to rely on petroleum for as much as 50% of our total energy needs in the year 2020.

Current Situation

In 2001, Idaho consumed 155.3 Trillion Btu of petroleum products. The large majority of this (74%) was for transportation fuels (114.8 Trillion Btu), with the industrial, residential, and commercial sectors consuming 30.8, 6.5, and 3.1 Trillion Btu respectively. Of the petroleum products used for transportation in Idaho, motor gasoline accounted for 75.6 Trillion Btu (approximately 14.5 million barrels or 610 million gallons), distillate fuel for 34.1 Trillion Btu (approximately 5.9 million barrels or 250 million gallons), jet fuel for 4.1 Trillion Btu, with the remainder for lubricants and aviation gasoline.

Idaho's petroleum consumption patterns closely parallel the national oil appetite which has shown a history of growth, except during occasional periods of recession or shortages.

Potential

Idaho has no petroleum production in the state, nor does the state have a refinery. All petroleum supplies are imported in a refined form primarily via pipelines, highways, and rail.

Like many other rural states, Idaho uses petroleum primarily for agriculture, transportation, and very limited home heating. Our electric utilities have no substantial generating facilities dependent on petroleum. As our major user of oil, agriculture has a heavy dependence on adequate supplies for all phases of its operation, from planting, to harvest, to transportation, to sale for processing. Farmers are continuing to expand their plantings and production, resulting in an increased demand for petroleum.

Idaho has taken steps to improve the efficiency of petroleum product usage. Tax incentives exist to encourage the production of ethanol for use as an additive to gasoline. Government and business have instituted programs of flexible work hours and car and van pooling; some cities have provided mass transit systems.

Economic Considerations

Despite a rapidly growing population, the revenue from the current (since 1986) 25 cents per gallon motor fuel tax became stagnant in 1999 and remains that way today (2005). In its Forum on Transportation Investment, the Idaho Transportation Department concluded that the state must prepare for a transition to alternative fuels. The advent of hybrid-fuel vehicles, as well as other new technologies will diminish the tax revenues collected on fossil fuels.

The tourist industry, which contributes greatly to Idaho's economy, is subject to considerable volatility both from availability and prices of petroleum.

Environmental Considerations

Air pollution from auto exhausts poses the biggest environmental concern from the use of petroleum products. This is particularly true in urban areas with higher traffic. Should EPA standards be exceeded regularly, these areas are declared "nonattainment," and the subsequent loss of federal funding for transportation projects would result in major expenses to the state. There are currently no transportation related nonattainment areas in Idaho, although Boise-Northern Ada County was an air quality nonattainment area for carbon monoxide from 1995 through 2001 (Bonner County, Pocatello, and Shoshone County are nonattainment areas for PM-10 particulate).

Health, Safety, and Social Impacts

Proper emission controls on all vehicles considerably reduces the health hazards associated with air pollution caused by the internal combustion engine. Maintenance of vehicle emission controls is important to ensure continued low emissions.

Issues

- Should increased petroleum conservation measures be developed and encourage and if so, how?
- Should the state of Idaho have contingency plans to mitigate the effects of petroleum shortfalls?
- Should the state of Idaho have contingency plans to implement vehicular emissions reductions practices in areas that are near nonattainment criteria?

3.4 Nuclear Energy

Overview

Idaho, through the Idaho National Laboratory, has been the leader in the development of nuclear power technology. In 1951, the world's first usable electricity from a nuclear-fueled system was generated by the EBR-I plant at the Atomic Energy Site near Arco, Idaho. Today, the U.S. electrical industry operates 103 commercial nuclear power plants. Nuclear-generated electrical power supplies about 20% of the nation's electricity each year. Following the Three Mile Island incident in 1978, there was a substantial cutback in plans for new nuclear power plants.

Current Situation

The Experimental Breeder Reactor (EBR-II) at the INL Site which had produced approximately 19.5MWe for distribution was shut down in 1993. A number of utility companies around the country are exploring new nuclear power plant construction, with most companies planning to construct adjacent to existing facilities. Presently, no utility is contemplating construction of a commercial nuclear plant in Idaho. However, the U.S. Department of Energy (DOE) is considering one or two Generation IV reactors at the INL Site.

Potential

Nuclear power represents a long-term option for base-load electrical generation in Idaho. The state’s—and the nation’s—energy demand is increasing. Idaho Power officials estimate that an additional 1,100MW of power will be required by 2013. Advances in nuclear power technologies and the resurging interest in nuclear power plants for economic and pollution-reduction reasons, plus the incentives provided in the Energy Policy Act of 2005, have created a favorable attitude and environment toward new nuclear power plants.

Economic Considerations

Conventional light water reactors (LWRs) have been used to produce electrical power for more than four decades. Plants presently in operation are producing electricity at costs below coal-fired thermal plants. Previously, coal had an advantage because of Idaho’s proximity to the Western coal fields. Economics of generation may now make nuclear power competitive.

In the United States, long lead times for licensing and construction had previously made nuclear projects susceptible to inflation and high interest rates which added enormously to initial cost estimates. Government regulations for design and operation safety have been revised, considerably reducing the previous delays and litigation costs. With the recent regulatory changes for licensing, and the impetus provided by the Energy Policy Act of 2005, the time and cost uncertainties that previously beset nuclear power cost projections have been significantly reduced.

With nuclear power plant construction expense now competitive with other environmentally engineered plants, such as fossil plants with advanced carbon sequestration, their overall cost is competitive. However, waste disposal and end-of-life decommissioning must also be considered for life-cycle nuclear plant economics.

Environmental Considerations

While personal opinions on the environmental impact of nuclear power are quite divergent, the environmental impacts are comparable to other large, base-load generation facilities. Environmental impacts resulting from nuclear power generation include land disruption from uranium mining, localized thermal pollution from the heat produced and a draw down of water supplies for cooling.

Nuclear power is now recognized as the nation's largest source of emission-free electricity. Unlike fossil fuel plants, these plants do not emit sulfur dioxide, nitrogen oxides, or carbon into the atmosphere—the noxious and greenhouse gases.

Health and Safety Impacts

While it is true that no member of the general public has been either injured or killed from commercial nuclear power plant operation in the United States, it is equally true that the potential exists for health and safety problems throughout the fuel cycle. Concerns center on the possibility of a major accident which could release radioactive materials, the effect of direct radiation exposure from the fuel cycle, and the safety of waste storage techniques presently employed.

Mining and milling generates the largest quantity of low-level waste in the form of tailings and constitutes the most direct, localized health hazards to the public. Conversion, enrichment, and fabrication processes all involve minimal releases of radioactive material. It must be recognized that the mining activities occur in natural surroundings and the level of radioactivity is natural to the area. The hazards are more environmental—surface run-off, open pit, access roads, etc.—than they are radioactive.

There are sound scientific and technical arguments to indicate these materials can be safely isolated from humans over time periods of tens of thousands of years and longer using this approach. Although no repository is yet in operation, Finland, Sweden and the United States have made significant progress in clearing the way for these underground storage facilities.

Social Impacts

Nuclear power plants have the same social impacts of any large centralized facility. There are local impacts during construction due to a large influx of workers. However, after start-up, a typical plant employs fewer than 350 people.

On a national level, the political and social impacts relate to security and proliferation. In the present social environment, security of nuclear facilities and fuel shipments has become important. Sabotage and diversion must be guarded against. While this security need results in some reduction in freedom of individual plant employees, it does not impact society as a whole.

Issues

- What are the environmental, stability, and sustainability issues for nuclear power in Idaho as compared to other electricity-generating sources?
- How do the economics of nuclear power compare with other Idaho base-load alternatives?
- What are the effects of nuclear power on the environment and human health as compared with those of coal and other Idaho alternatives?
- Should the state of Idaho encourage private utilities to invest in commercial nuclear generation plants?

4. RENEWABLE RESOURCES

Idaho's current and future energy resource development is closely tied to renewable resources. In 2002, a total of 9,787,000MW-h was generated in Idaho by the total electric industry (electric utilities, independent power producers, and combined heat and power). Renewable resources provided 95% of this electrical energy with hydropower the source of 90% of total in-state generation. 99% of the electricity produced in Idaho by electric utilities in 2002 (8,164,000MW-h) was renewable, generated by hydropower. Other renewable energy resources in Idaho include biomass, geothermal, solar, and wind.

Most of the energy used in Idaho is actually imported; over 60% of the retail electrical energy used in 2002 (20,700,000MW-h) and essentially all of the transportation energy came from sources outside of Idaho. Increased development and utilization of indigenous renewable energy resources could reduce this dependence and keep more of Idaho's energy expenditures in the state. Since most of Idaho's renewable energy resources are located in rural areas, this would also aid in rural revitalization, providing jobs and an increased tax base.

Technological developments, combined with the increased cost of nonrenewable fossil energy resources, are bringing increased opportunity to develop and utilize renewable energy resources.

4.1 Ethanol

Overview

Ethanol for use as a transportation fuel is produced by the fermentation of agricultural crops or other biological materials. In its pure form, ethanol is blended with unleaded gasoline for octane enrichment. A mixture of 10% ethanol and 90% gasoline (E10) can be used in unmodified engines. Higher blends containing 20% (E20), 25% (E25), and 85% (E85) ethanol, can be used in gasoline engines with only minor modifications. Several vehicle models capable of using fuel with higher ethanol bends, known as Flexible Fuel Vehicles (FFV), are readily available in the market.

At its peak in the early 1980s, Idaho consumed approximately one million gallons of fuel ethanol with plant capacities estimated to be between 2.5 and 2.8 million gallons per year. Since this time, a lack of state and federal incentives has led to a decline in Idaho's production capacity to one million gallons in 2003. Despite this decline, the yield per acre and total production of Idaho's diverse agricultural feedstocks has steadily increased, giving the state significant potential to produce fuel ethanol having economical, environmental, and social benefits not only to Idaho but to the nation as well.

Ethanol production for transportation fuel use is being strongly encouraged at the national level. A federal Biomass R&D Technical Advisory Committee established by the Biomass R&D Act of 2000 developed Vision and Roadmap documents in 2002 identifying public policy and R&D measures for promoting and producing biobased fuels. Further promotion of the production and use of fuel ethanol is evident in the passage of the Energy Policy Act of 2005. This law contains the first-ever Renewable Fuels Standard (RFS) calling for the usage of 7.5 billion gallons of ethanol by 2012. This standard will be enforced at the state level where regulated parties receive one credit for each gallon of starch- and sugar-crop-based ethanol used (such as wheat, barley, and corn grain, sugarbeets, sugarcane, potatoes, etc.) and 2.5 credits for each gallon of "cellulosic"-based ethanol used (i.e., crop residues such as corn stover, wheat, barley, and rice straw; wood waste from logging; and dedicated energy crops such as prairie grasses).

In its 2006 session, the Idaho legislature considered legislation (S1364) to create a Renewable Fuel Standard requiring that gasoline sold in the state contain 10% ethanol after there is a production capacity of at least 30 million gallons per year of ethanol in Idaho. The bill was approved by the Senate, but referred to committee by the House.

Current Situation

Idaho's current ethanol production capacity is approximately one million gallons per year (2003).

Potential

The tremendous agricultural and forest resources in Idaho provide the state with a significant potential to produce fuel ethanol. A 2002 report by BBI International for the Idaho Department of Water Resources identified statewide ethanol production potential to be approximately 98 million gallons annually using 25% of the available wheat, barley, and corn grain. According to the BBI report, this production would occur from four dry-mill refineries located in the southeast, south central, southwest, and panhandle regions of the state.

Statewide ethanol production potential is further enhanced by the advancement in technologies to convert cellulosic biomass. According to a 1995 University of Idaho report for the Idaho Wheat

Commission, Idaho currently produces 2.3 million tons of available and sustainable wheat, barley, and oat residues. Based on projected technology, this residue has a total ethanol potential of approximately 90 gallons per ton, or 207 million gallons annually. The same four regions identified for starch-based ethanol from crop grains would most likely locate the cellulosic-based ethanol refineries with co-production of starch and cellulosic ethanol at the same facilities Thus, Idaho's combined total ethanol production potential from both starch and cellulosic-based feedstocks is 305 million gallons annually.

Economic Considerations

Fuel ethanol production has the potential to bring significant economic development to Idaho by adding direct and indirect jobs to rural regions, and by adding value to local crops and crop residues. The four ethanol plants identified in the BBI International study, if capable of utilizing both starch and cellulosic-based feedstocks, would conservatively create 3,800 jobs during construction and 1,900 jobs during commercial operation. These new jobs are estimated to generate $122 million in new household income and provide additional corporate and personal income tax revenue to the state. In addition, the value added to local crops and crop residues is estimated to be approximately $0.67 per bushel of grain and between $5-10 per ton of straw residue (assuming mature cellulosic conversion technologies), respectively.

Economic issues pertaining to an ethanol blend delivery and storage system must be considered. Gasoline blends with differing ethanol content cannot be co-mingled and must be stored and distributed separately. As a result, infrastructure designs and development for a fuel ethanol system must consider a standard blend for wide use. However, if discrete step changes to new blends are made on a widely distributed basis, the infrastructure can accommodate the new blend to meet market demands.

Environmental Considerations

The environmental benefits of ethanol-blended gasoline compared to conventional gasoline are shown to be significant. In a 2002 report by the United Sates EPA[3], the emissions profile of an E85 FFV engine has the following characteristics:

- Fewer total toxins are produced
- Reductions in ozone-forming volatile organic compounds of 15%
- Reductions in carbon monoxide of 40%
- Reductions in particulate emissions of 20%
- Reductions in nitrogen oxide emissions of 10%
- Reductions in sulfate emissions of 80%
- Lower reactivity of hydrocarbon emissions
- Higher ethanol and acetaldehyde emissions

Ethanol blends higher than 10% can produce currently unquantified emissions through permeation—evaporative emissions resulting from the migration of particulates through the soft portions of an engine's fuel systems. However, Flexible Fuel Vehicles built to accommodate higher than 10% ethanol blends, especially those manufactured after 2000, have shown an ability to reduce this type of emission.

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[3] EPA, *Clean Alternative Fuels: Ethanol,* EPA420-F-00-035, March 2002.

Health and Safety Impacts

Ethanol is not considered a toxic pollutant at levels likely to be inhaled when used as a transportation fuel. It is much less flammable than standard gasoline, thus fires are less frequent and less severe when spills or releases of vapor occur. Ethanol is less volatile than gasoline and is thus safer to store, transport, and refuel. However, ethanol blended fuel is more corrosive than standard gasoline and requires specialized storage and transportation materials and new handling regulations to manage its distribution to the public. Nevertheless, many of these issues have been addressed over the 30-year life of the industry. Because ethanol is water soluble and biodegradable, land and water spills are usually harmless, dispersing and decomposing quickly; the gasoline portion of a spill is still a problem in these situations.

Because of its octane-enhancing characteristics, ethanol blended fuels improve air quality through reduced greenhouse gas emissions. This is accomplished as ethanol increases the octane content of the blended fuel, helping to increase the efficiency of the combustion process and thus reduce harmful combustion byproducts. In addition, the production of ethanol from starch or sugar-based feedstocks is a proven and well-established technology with a good safety history. Furthermore, nearly all ethanol produced in the United States is co-located with grain wet and dry-mill operations. As such, safety issues associated with ethanol production are shared with proven wet and dry-milling operations. Finally, the feedstock used to produce fuel ethanol is grown in conjunction with traditional farm and forest products and utilizes the same health and safety mitigation practices currently enforced by these industries.

Social Impacts

Development of ethanol as a renewable transportation fuel is dependent in part on the public's willingness to shift from using standard petroleum-based gasoline to gasoline containing 10 to 85% ethanol. Ethanol blended fuels are currently being accepted and used in several parts of the country with the highest usage occurring in the Midwest corn belt. Educating the public on the cost, performance, and impact of ethanol blended fuel compared to standard gasoline is key to gaining acceptance of a relatively new fuel source. Flexible Fuel Vehicles capable of utilizing high ethanol blended fuel are readily available in many popular models at no additional cost to the consumer. However, ethanol blend fueling stations are uncommon in Idaho. Nevertheless, the potential of ethanol production to boost rural economies as a homegrown fuel and reduce greenhouse gas emissions for air quality improvements is a compelling positive aspect of the conversion process.

Issues

- How should the lack of adequate infrastructure in Idaho for ethanol handling, transportation, and distribution be addressed?
- Is public education needed in Idaho to encourage use of ethanol blended fuels?
- What Idaho impacts will result from the Renewable Fuel Standard requirement in the Energy Policy Act of 2005?

4.2 Municipal Solid Waste

Overview

The population of Idaho is estimated to reach 1.45 million in 2006. The state produces approximately 1.7 million tons of municipal solid waste (MSW) per year, or approximately 1.2 tons per capita annually.[4] The majority of Idaho's MSW is landfilled. A few cities, such as Boise, Meridian, and Ketchum, offer curbside pickup for sorted waste aluminum and tin, newsprint and cardboard, glass, and plastic bottles and jugs.[5] However, due to low economic incentives, most communities only offer drop-off/pickup waste recycling for newsprint and in some cases separated commodities. Waste tires are an exception. The state prohibits disposal of waste tires in landfills.[6]

The majority of U.S. municipal waste combustion facilities have been located in the Northeast and South. In the Rocky Mountain region, 90% of all MSW is landfilled, approximately 9% is recycled, and only 1% is converted to energy. Idaho's single significant MSW "mass burn" facility, located in Cassia County, started operation in the 1980s but was permanently closed in 1992 due to poor equipment efficiency and unfavorable economics. Also, the capital cost for power generation from MSW mass burn plants is significantly higher than other power alternatives. However, the rising cost of natural gas and liquid fuels in 2004 and 2005 provides new impetus to consider waste-to-energy conversion projects to offset the higher cost of fossil fuels and rising electrical rates.

The city of Boise is considering a small tire conversion process that could help reduce upwards of 1 million tires per year to liquid and gaseous fuel. Idaho Power is seeking approval from the Idaho Public Utilities Commission for a 3MW purchase agreement with a project cited for the Ada County Hidden Hollow Landfill north of Boise.[7] Similar projects are being considered throughout the state as communities and industry consider the high cost of landfill disposal and increasing energy costs.

Conversion of MSW and waste tires to usable energy or products can proceed by three main pathways: biochemical, thermochemical, or physiochemical processes. The former includes fermentation to produce ethanol. Biochemical processes also include anaerobic or aerobic conversion processes which produce biogas that is high in methane, the same gas that is generated naturally and can be problematic in landfills. Thermochemical processes include combustion, gasification, and pyrolysis. Combustion is used to produce heat and steam, including steam for electrical power. Gasification and pyrolysis can be used to produce combustible gas as well as gas that can be converted to liquid fuels and chemicals such as fertilizers.

The composition of MSW varies according to season and location, but generally contains 70 to 80% organic material (cardboard and paper, wood, plastics, textiles, yard clippings and garden debris, and food wastes). The remainder is mostly comprised of recyclable glass and metals and nonvaluable construction demolition concrete. When sorted using technology developed (and being commercially used) for mass burn facilities, the organic material, also referred to as refuse-derived fuel (RDF), can be used to produce heat, steam, electrical power, process gas, liquid fuels (such as ethanol and diesel), and even chemicals. Waste tires are also viewed as a significant opportunity fuel, as are biomass byproducts

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[4] JG Press, *Biocycle, Journal of Composting& Organic Recycling*, http://www.jgpress.com/archives/_free/000089.html, January 20, 2006.

[5] The Idaho Department of Environmental Quality, *Recycling and Waste Management Directory*, http://www.deq.state.id.us, 2004/2005.

[6] Idaho House Bill 198, "Waste Tire Disposal,"April 14, 2003.

[7] Idaho Public Utilities Commission 2005 Annual Report, Section II: Electric Information, 2005.

from agriculture, farming, dairy, and forestry industry in Idaho. This section focuses on municipal waste and waste tires, but many of the technologies available for MSW conversion are also viable for other organic feedstocks.

More than 200 technologies have been developed worldwide for waste and biomass energy conversion projects. Due to the scarcity of land, as well as social agenda, governments and private companies in Europe and Japan have aggressively pursued testing and deployment of waste converters for energy production. The advancement of new technology in the United States is also maturing. One company in Idaho, Energy Products of Idaho, located in Coeur d'Alene, has been building fluidized-bed combustors and gasifiers for waste and biomass conversion to energy for over 30 years. Finally, in any MSW energy or fuels conversion plant, waste processing and fuel densification are required to separate the organic materials from the waste and to assemble the materials into a feedstock for a given waste converter unit. Waste separation and fuel preparation is commercially practiced in numerous plants worldwide.

Current Situation

Many of Idaho's waste landfills are reaching capacity. The cost and time to permit, construct, and operate a landfill is no longer insignificant. For example, the cost for waste collection and operation of the Bonneville County transfer station and landfill, commissioned into service in 1993, is about $38 per ton. This cost is typical of other Rocky Mountain region landfilling expenses, although it is higher than most rural landfill operations in Idaho which cost as little at $15 per ton for disposal. Some counties, such as Bingham County, have determined that it is less expensive to compact and transfer all of its MSW to a multicounty landfill on the eastern side of the state. The 10-county Milner solid waste landfill near Burley is progressively looking for technology to compact influent wastes, or to enhance sorting and recycling in order to conserve landfill space. Finally, a number of start-up companies and county commissions are investigating MSW energy conversion options, such as the waste-to-energy project proposed for the Hidden Hollow Landfill in Ada County.

The capital cost for power generation based on historical data for "mass burn" plants is approximately $4,000 per kWe.[8] The comparative capital costs of emerging MSW gasification power generation plants are $3,700 to $7,600 per kWe.[9] This compares to a natural gas combined cycle facility cost of less than $1,000 per kWe and to a coal-fired power plant cost of around $1,250 per kWe. The average capital cost for an integrated coal gasification combined cycle cost is around $1,700 per kWe.

Taking into consideration tipping fees (cost to dispose MSW at a landfill) and fuel offset costs (the cost avoiding from the reduction of conventional fuel use), the cost of electricity for a MSW power plant is around $105 per MWe (or $0.105 per kWe) with MSW tipping fees around $25 per ton and down to $46 per MWe when tipping fees are as high as $40 per ton. This compares to current projected costs of electricity in the state of around $62 per MWe for residential customers, $47.6 per MWe for irrigation rates, and as low as $42.4 per MWe for other commercial customers.[10]

The high capital costs of waste-to-power conversion plants and technology maturity risks are impediments to financing projects. As electrical rates for traditional power suppliers increase, and as new

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[8] DOE, *The Impact of Environmental Regulations on Capital Costs of Municipal Waste Combustion Facilities*, U.S. DOE Energy Information Administration, 2001. (adjusted to 2006 dollars)

[9] Alemada Power and Telcom, *Investigation Into Municipal Solid Waste Gasification*, 2004.

[10] Idaho Public Utilities Commission, *2005 Annual Report Section II: Electric Information*, 2005. (considering rate increases for 2006)

MSW gasification and pyrolysis technology is demonstrated, investment costs, and the rate of return on major projects are likely to improve.

In the near term, waste-to-energy conversion projects are mainly considering the production of syngas to offset natural gas by commercial entities and industry. The production of fuels and chemicals is also being considered.

Potential

The energy potential in Idaho MSW is currently about 23.8 million Btu per year. Approximately 200MW electricity could be generated using new waste gasification power generation plants.[11] If only one-half of the state's MSW can be harnessed for electrical power generation, the output of all power plants would be 100MW.

Unfortunately, in spite of much interest throughout the United States, the economics of waste-to-electrical power conversion are unfavorable or only marginally favorable. A plant must be on the scale of 700 tons per day MSW receipt to be potentially economical for electrical power production. Statewide, this would translate to only about six 33MWe (net power output) power plants if all MSW in the state could be harnessed. Looking at population centers that could feasibly support such a project, one plant could be placed in eastern Idaho, one in south-central Idaho, and two in the Boise-Meridian-Nampa area.

The scale for producing syngas is around 150 to 200 tons of MSW per day. Assuming a 65% conversion efficiency, 50% of the state's MSW could be converted to 15.5 million Btu per year, or approximately 45% of the current state nontransportation demand for natural gas. The primary use for MSW-derived synthetic natural gas is for industrial purpose, rather than residential or commercial heating.

The main waste-to-energy opportunities in Idaho are presently intended to produce heat and steam distributed for industrial use, or to produce ethanol as a fuel additive for regional gasoline refineries. Other possibilities include the conversion of MSW to ammonia fertilizer to support Idaho's agriculture industry, or conversion to diesel fuel.

Economic Considerations

The previous section shows that the economics of converting MSW to electrical power are marginal at the present time. However, the production of a synthetic gas for industrial uses (boilers, steam or heat generation) or to produce synthetic liquid fuels or chemicals, may be economical, but are highly dependent upon specific cases. The key to economic feasibility is the MSW tipping fees and setting up guaranteed waste receipt and product contracts. Using agricultural biomass in addition to MSW as a feedstock for power or product generation may greatly improve the economics.

Environmental Considerations

The virtues of gasification over mass burn are lower gaseous pollutant emission rates, reduction in greenhouse gas emissions (by offsetting fossil energy consumption), and relatively low dioxin, furan, and other hazardous organic emissions. Combustion and/or incineration of MSW are subject to strict EPA air emissions standards. Gasification is viewed as a more environmentally friendly technology. In either case, diversion of MSW from present and future landfills reduces the risk of groundwater contamination, avoids the release of microbially produced methane to the atmosphere, and conserves land for other uses.

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[11] Assumes an optimistic overall chemical to thermal to electrical power efficiency of 25%

With these benefits in mind, the EPA is promoting MSW gasification as a preferred alternative to landfilling or mass burn projects.

Health and Safety Impacts

Potential health effects with mass burn of MSW due to toxic emissions (e.g., dioxin from burning plastics) require emission control. Long-term reduction in land disposal will reduce potential drinking water contamination. Diversion of wastes to a waste converter will eliminate the generation of methane gas in the landfill. A waste tire conversion process will eliminate various ecological problems associated with tire disposal, including local habitat for rodents and mosquito breeding.

Social Impact

A strong waste-to-energy program in Idaho will support waste recycling. In order to convert MSW to fuel, most recyclable materials such as aluminum, tin and ferrous metals, and glass will be recycled. Other social benefits would include reduction of unsightly landfills and blowing litter, and reduction of landfill odors.

Issues

- Is the potential for MSW power conversion limited by the state's low population density?
- Should Idaho prefer waste-to-energy conversion to landfill disposal and if so, how should this be encouraged?
- What level of technology demonstration is needed to reduce risks and encourage waste-to-energy conversion in Idaho?

4.3 Wood

Overview

Wood and other waste products provide a portion of residential, commercial and industrial energy and will likely continue to do so in the future. Residential use of wood for energy continues to decline as a percentage of total residential energy use. Commercial consumption of wood-based energy is minimal. Industrial consumption of energy derived from wood and other waste products has stabilized over the past several years, having increased substantially over the past four decades.

Current Situation

Wood (and waste) provided approximately 14% (25.7 Trillion Btu) of industrial sector energy consumption and 2% (2.1 Trillion Btu) of total residential energy use in Idaho in 2001. Use of wood (and waste) produced less than 1% of Idaho's electric generation in 2001 (Energy Information Agency).

Potential

Wood provides a minor contribution to heating and electrical generation in Idaho. Wood-based residential energy consumption has decreased over the past four decades from approximately 16 to 2% of total residential energy use. Commercial wood-based energy consumption has held at 0.2 to 0.3% of total commercial-sector energy use. Industrial consumption of wood and waste-based energy has increased from approximately 5% of total industrial energy consumption during the early 1960s to stabilize at approximately 11 to 14% of total industrial energy consumption over the last 20 years.

Economics

Capital costs for wood and waste-based power plants are estimated in the $2,000 per installed kW capacity range. Given fuel availability and local use, most plants are of limited size. Economics of scale favor larger plants using conventional fossil fuels (such as coal and natural gas). Cost per Btu for wood and wood waste-based energy production is generally greater than for conventional fossil fuels, particularly coal, but has not experienced the high percentage increases associated with natural gas-based electric power production. Recent initiatives for national forest thinning may make for greater availability of wood waste. However, processing and transportation costs may reduce the attractiveness of this potential fuel source. The general decline of logging in the Western United States and potential alternative uses for forest waste residues (such as fabricated wood products, alcohol production) may reduce the availability of wood waste for energy production. The cost of raw wood and processed wood products for residential energy use has increased and will likely continue to do so given the availability of sources and increased transportation costs.

Environmental Considerations

Pollutants released from burning of wood, waste and crop residues are of increasing concern. Emissions from wood burned for private residential use are not regulated. Few, if any, residential systems are equipped with pollution abatement systems, resulting in unrestricted release of particulates and toxic combustion products into the atmosphere. Transportation and other fuels needed to process and deliver raw wood or processed wood fuel products for residential use contribute to air pollution. Commercial and industrial units are regulated by the Idaho Department of Environmental Quality and are required to operate in compliance with local, state and federal regulations.

Health, Safety and Social Impacts

Wood and other waste used for thermal or electric power production are usually a byproduct of existing industrial activities. Additional availability of wood waste may be forthcoming from efforts to conduct forest thinning to reduce the potential (as well as the effects) of wild fires in Western U.S. forests. The Western forest thinning initiatives have generated substantial debate within the affected states. Environmental groups and other concerned entities continue to express societal and environmental concerns with environmental permitting processes and thinning methods potentially impacting the environment and affected localities. Occupational safety hazards associated with the use of wood for energy production are well understood and pose no unique industrial health and safety issues.

Issues

- Should the state address pollutant control for nonregulated wood and waste burning?
- Should the state develop a policy to address potentially competing uses of wood and other waste for feedstock for thermal and electrical energy production versus ethanol or synthetic fuels production?
- Should the state promote increased forest production for carbon-neutral energy production through financial incentives?

4.4 Cogeneration

Overview

Cogeneration, commonly referred to as combined heat and power or CHP, is the production of both process heat and electricity from the same consumed fuel. Cogeneration can result in an overall energy efficiency increase of 50% over separate generation of electricity and thermal energy. Cogeneration can be accomplished through the use of gas or steam turbines, reciprocating engines and fuel cells, and with a wide variety of fuels.

Cogeneration systems are normally classified as either “topping cycle” or “bottoming cycle.” In a typical turbine generator system, fuel is used to produce steam or hot gas which is routed to a turbine generator to produce electricity. When waste heat available after electric power production is used for industrial process heat or for district steam heating, this is the form of cogeneration referred to as a “topping cycle”. A “bottoming cycle” is cogeneration in which waste heat from an industrial process is used to generate electricity. In either type of system, cogeneration is most effective when a suitable balance between process heat production and electrical generation is achieved.

Electrical power produced from cogeneration can be used exclusively by the power producer or sold in part or in whole by qualifying facilities to the electric power utility grid at the avoided cost of power generation. In the small cogeneration plants typical of Idaho facilities, electric power produced from cogeneration is normally used at or close to the point of generation and is considered to be distributed generation. Distributed generation is advantageous for several reasons. Electric power transmission system losses are reduced, as is transmission system congestion or overloading. Distributed generation reduces the need for electric power transmission systems that deliver power from long distances.

Current Situation

Potential

Cogeneration potential in Idaho comes primarily from small or modest-sized generation units fueled by natural gas, residual forest products, and agricultural and food processing residuals. Indeed, 96% of electric power generated in Idaho is from hydropower and tradition fossil energy sources with some generation attributed to cogeneration, primarily natural gas fueled. The remaining 4% of electrical power generation is from nontraditional fuels and includes cogenerated electric power.

Economic Considerations

Cogeneration cost-effectiveness hinges on matching availability of fuel source, electric power demand and sales, and mass of steam or other needs for thermal energy. Effective cogeneration often uses forest products or agricultural residuals where process heat and electricity can be produced from waste products and directly used at the production facility.

Several facilities in Idaho use natural gas-fired cogeneration to provide process steam and electricity for agricultural products processing. These are classical cogeneration and distributed energy use scenarios. Cogeneration in large-scale facilities is less likely in Idaho due to the inherent difficulty in matching large industrial heat needs with large electrical generating facilities.

Environmental Considerations

Regardless of fuel source, cogeneration provides higher thermal efficiency and overall fuel efficiency than simple electrical power generating cycles, resulting in a net reduction in environmental impacts. For renewable fuels, environmental impacts are additionally reduced with some fuels yielding a net zero increase in greenhouse gases. If the cogeneration plant is a distributed energy facility, environmental impacts resulting from the construction of additional electric power transmission systems from large central power plants are reduced or eliminated.

The majority of cogeneration plants use technologies based on combustion of fossil fuels or other fuels. Combustion of nonrenewable fuels will contribute to greenhouse gas production.

Health, Safety and Social Impacts

Cogeneration and distributed generation reduce the reliance on electric power produced from areas distant from the point-of-use and may provide lower cost and more reliable production of heat and electric power from local or regional fuel sources. Cogeneration produces emissions regulated by the Idaho Department of Environmental Quality. Occupational safety hazards associated with cogeneration are well understood and pose no unique industrial health and safety issues.

Issues

- Should the state develop additional policy to encourage cogeneration and distributed generation to reduce the dependency on hydroelectric power and imported power, and reduce the need for transmission system upgrades to alleviate system congestion?
- Should the state provide financial incentives for municipal, commercial and industrial development of cogeneration systems in appropriate localities to reduce environmental impacts?
- Should the state permanently extend the tax credits currently available for cogeneration systems?

4.5 Geothermal

Overview

Geothermal energy, a resource that has been important to Idaho in the past, is making considerable contributions now and can make substantial contributions to Idaho's energy future. Geothermal resources were used in the region long before Idaho became a state. Artifacts and petroglyphs near hot springs indicate Native Americans congregated at these geothermal resources. By the mid-1800s, hot springs were also being used by settlers, miners, and trappers. In 1893, the city of Boise began operating the nation's first district heating system. That system is still in operation over 100 years later, and three more district heating systems have been added in the Boise area.

Unlike other Western states, much of Idaho's population resides near geothermal resources. Idaho has over 1,500 documented springs and wells with temperatures over 20°C (68°F). Over two-thirds of the state's population is near known geothermal resources found along the Snake River plain. In addition, there are a number of geothermal resource areas in central and far southeast Idaho. These are primarily moderate temperature geothermal resources with significant potential for applications ranging from space heating to agricultural product processing. However, there are some high-temperature resources that are being developed for electrical power generation.

With rising energy costs, geothermal resource development is receiving more attention. Idaho's geothermal energy can be utilized with available technology, and can be competitive with conventional fuels for a variety of applications.

Current Situation

Geothermal aquaculture is big business in Idaho. Catfish, tilapia, ornamental fish, coral, aquatic plants, and alligators are all being raised in the state thanks to our geothermal water. Individuals have been using Idaho's natural hot water since 1973 for aquaculture businesses and research.

Geothermal water has been used for greenhouse operations in Idaho since the 1930s, when Thomas Edwards began using the resources to grow plants in northwest Boise. In 2006, there were 10 greenhouse operations across southern Idaho that were using geothermal water to grow a variety of vegetation including flowers, vegetables, bedding plants, and decorative plants. These operations sell products to both the wholesale and retail markets. Commercial greenhouses are located in Ada, Boise, Fremont, Owyhee, and Twin Falls counties.

Idaho has about 200 geothermal springs with surface water temperatures that range from 86 to 199°F. In 2006, there were 34 developed resort swimming pools, soaking pools, hot tubs, indoor baths, etc., in 14 counties throughout central and southern Idaho including Adams, Bannock, Bear Lake, Boise, Camas, Custer, Franklin, Fremont, Idaho, Jefferson, Owyhee, Power, Twin Falls and Valley counties.

Geothermal water is used to heat homes and buildings in several areas of Idaho. When a well is used to supply heat for multiple homes or buildings through a system of distribution lines, it is called a district heating system. Idaho has a number of district heating systems in operation, including the Boise Warm Springs Water District, which is the oldest system in the United States. The College of Southern Idaho (CSI) in Twin Falls, which is heated almost exclusively with geothermal water and the city of Twin Falls employ district heating systems for some of their facilities. The CSI heating system, in operation since 1981, serves 12 buildings and four greenhouses, with over 440,000 square feet heated geothermally. The three systems in Twin Falls County are used to heat homes, college buildings, an elementary school,

and the Twin Falls Community swimming pool. The four district heating systems in the Boise area heat about 300 homes, government buildings (including the state Capitol), and businesses with a total of over 5 million square feet of space. At least 10 other areas in Idaho have been studied for potential district heating operations.

There are currently no geothermal electric power plants in Idaho, although U.S. Geothermal is building a 13MWe plant at Raft River. This plant is scheduled to come on line in 2006.

Potential

Geothermal potential in Idaho can be grouped into two main categories: a) direct use and b) power generation. In general, direct use projects use geothermal fluids with temperatures between 70 and 300°F. In this range, temperatures above 130°F are well suited to space heating of homes and buildings and many industrial applications. To produce electricity, resource temperatures are generally above 230°F and large volumes of geothermal fluid are necessary.

Many areas in Idaho have been studied for potential district heating projects in the last 20 years. They include Hailey, Fairfield, Stanley, Grand View, Mountain Home Air Force Base, and Ketchum. In Nampa, studies were conducted to address the feasibility of converting Parkview and Lakeview schools and Mercy Medical Center to geothermal heat sources. Studies have also been done which described a plan to heat 12 buildings on the Alberstons College campus (previously College of Idaho) in Caldwell using geothermal water from a proposed 3,500-foot production well. With the increasing cost of natural gas and electricity as primary heating sources, these projects will begin to look increasingly competitive in terms of energy costs.

Cascade, Idaho, may possibly be the next geothermal district heating system in Idaho. Two unused geothermal wells are located within the city limits. One of the wells was used to heat some of the Boise Cascade Company Lumber Mill buildings. The Boise Cascade Mill is closed, and the lumberyard grounds are to be cleaned. There has been some discussion between the city of Cascade and Valley County regarding the potential for a recreation center and/or industrial park with geothermal resources playing a significant role in any new development. Cascade and the Bruneau-Grand View area, where high-yield irrigation wells tap thermal aquifers with water temperatures ranging from 68 to 183° F, is a logical location for industrial geothermal development. Industrial processes that use geothermal heat include fruit and vegetable drying, food processing, pulp and paper processing and lumber drying.

Idaho does not appear to have any high temperature resources like the 400°F dry steam sources utilized at some electrical generating plants in California. However, moderate temperature waters can produce electricity utilizing a binary cycle system which transfers the heat to a secondary working fluid, such as isobutane, which in turn is used to drive a turbine generator. The first geothermal binary cycle power plant in the world, a 7MW dual pressure isobutene system, was successfully designed, constructed, and tested at the Raft River, Idaho, site in 1979 where the Department of Energy conducted research from 1974 to 1982. The DOE plant at Raft River pioneered the binary system that is now in use in over 15 plants in the United States and many more in other countries throughout the world. The Raft River geothermal site is now under development by U.S. Geothermal Inc. They have begun construction on a 13MWe geothermal power plant that will go online in 2006. The power produced at Raft River will be sold to Idaho Power. U.S. Geothermal has indicated the Raft River site could support 90MWe of production in the future.

In 2006, the U.S. Geological Survey (USGS) started the process of gathering data for a congressionally mandated update of geothermal potential in the United States. Information from this

study, when made available, will provide greater insight into the long-term potential of geothermal resource development in Idaho.

Developers and geothermal experts in Idaho are not waiting for the updated USGS report. They are actively promoting geothermal power production opportunities in southeast, south central and southwestern Idaho. For example, Idatherm has announced large prospects at Willow Springs and China Cap in Southeastern Idaho. A January 2006 study prepared for the Western Governors Association's Clean and Diversified Energy Initiative identified a total of 860MW of "near-term new geothermal power capacity" at six sites in Idaho.

Economic Considerations

Geothermal energy provides reliable energy and base-load power. Geothermal power plants operate at the among the highest capacity factors of any power generating facility. Geothermal energy generates economic opportunities, especially in rural areas, providing heat for agricultural, industrial and space heating applications. Developing geothermal resources can provide economic development opportunities for states and counties in the form of property taxes, royalty payments, and jobs. It can also price savings from displacement of fossil fuels. For example, buildings on the Capitol Mall district heating system were projected to have a savings of $9,066,904 in natural gas costs over a 20-year period at the time the initial planning was done.

In support of geothermal development, the legislature passed amendments in 1979 that expanded the authority of local units of government to utilize geothermal resources. Counties now have the authority to establish and operate geothermal space heating systems, IDAHO CODE 31-868 (31869) (Supp. 1981). Cities are empowered to establish and operate geothermal space heating or cooling systems, Id. §50-323, (1980); moreover, cities may finance the systems either with city coupon bonds, Id. §50-1029 (1980), or revenue bonds, Id §50-1020(b) and 50-1030(e) (1980).

Environmental Considerations

Geothermal power plants produce minimal amounts of pollutant emissions when compared to traditional fossil fuel plants. Many of the new binary geothermal plants produce no emissions at all with 100% reinjection of the geothermal fluid back into the ground after use. Geothermal power plants use less freshwater resources than most other forms of power production. A binary air-cooled geothermal plant consumes no fresh water, compared to the average natural gas-fired facility using 361 gallons per MW·h.

The disposition of spent geothermal water can pose the potential for thermal pollution of adjacent waterways. In the case of the Capitol Mall in Boise, and many other geothermal systems, this presents no problem, as the spent water is injected into a second well to return to the aquifer. Idaho has adequate laws and regulations which address geothermal applications and environmental protection.

Health and Safety Impacts

When developed and operated within the laws and regulations currently enacted in the state of Idaho, geothermal applications and businesses using them pose no risk to health and safety of Idahoans.

Social Impacts

In general, people appear to be more comfortable with geothermal projects than with other types of energy production. Much of this is attributed to the fact that geothermal resources are well known and experienced first hand by much of the population.

Issues

- What financial mechanisms can be enacted or generated to assist with geothermal development?
- How can the state move forward as a leader in developing its geothermal resources around the state and not just in the Boise area?

4.6 Hydropower

Overview

Of the approximately 10 million MW·h of in-state generation, 90% is generated by hydroelectric plants. The state's 136 hydroelectric plants have a total capacity of about 2,500MW. Private utilities own nearly 60% of the hydropower capacity and the federal government owns approximately 30%, with the remainder owned by private, nonutility entities.

The principal utilities supplying electricity to Idaho are Idaho Power, PacifiCorp, and Avista. Of Idaho Power's 22 plants, 17 are hydroelectric plants. Nearly 70% of Idaho Power's 3,280MW of capacity lies in its hydroelectric plants. Hydropower is 5% of PacifiCorp's 8,420MW of capacity. Avista has eight hydroelectric plants comprising 60% of its 1,931MW of capacity.

Idaho's electricity rates are among the lowest in the country, averaging 6¢ per kW·h, in large portion due to inexpensive hydroelectric power. While hydropower generates approximately 10 million MW·h of electricity, the state consumes over twice this amount. Of electrical generation in Idaho in 2002, hydropower produced 90% of this energy. In a good water year (1997), hydropower produced 15 million MW-h, reducing Idaho's imported electricity from 60% (2002) to 30%.

Current Situation

Potential

With hydropower being the principal Idaho energy source by a wide margin, it might be assumed that this energy source is fully developed. Two studies conducted by Idaho National Laboratory have shown this not to be the case. A site-based resource assessment conducted during the 1990s identified 373 opportunities for capacity increase totaling 7,713MW. These opportunities included development of new sites, addition of electricity-generating plants at existing dams, and increasing capacity at existing hydroelectric plants. Review of the opportunities considering legal, institutional, and environmental factors indicated that there are 74 opportunities totaling 470MW of increased capacity that had a 90% likelihood of success, if implemented. These opportunities represent a 19% increase in the state's hydropower capacity.

A recently completed stream-based assessment identified 6,700 potential hydropower projects that were determined to be feasible using a set of feasibility criteria considering land use and environmental sensitivities, site access, and transmission and load proximity. These potential projects represent 2,122 annual average MW of additional power. While nearly 70% of these potential projects are microhydro (less than 100 kW), about 20% are small hydro potential projects (annual average power greater than or equal to 1 megawatt and less than or equal to 30MW). These projects represent opportunities for a total capacity increase of 1,500MW corresponding to an annual electricity generation increase of 13 million MW-h. If developed, these projects would double Idaho's total electricity generation.

Idaho's water energy resources are not limited to its natural streams. Water delivery systems; effluent from waste treatment plants, industrial plants, and power plants; and irrigation canals may be water energy resources that could contribute to the state's electrical power generation.

Economic Considerations

Investigating the cost of developing previously identified opportunities for capacity increases of 1MW or greater, a study found that the median cost of realizing these opportunities ranged from $1,300 per kW for adding capacity at existing hydroelectric plants (seven plants) to $3,800 per kW for developing new sites (74 sites)[12]. Hydroelectric plants typically have a 50-year life.

The principal impediments to new hydropower development are: licensing costs, financing, and long-term power contracts. The Federal Energy Regulatory Commission (FERC) instituted an Integrated Licensing Process as the default process for licensing in July 2005. FERC also offers licensing exemptions for small hydroelectric projects of 5MW or less, and conduit projects up to 15MW. The new licensing process and exemptions are intended to reduce the time and cost of qualifying a plant to come online. Financing for the long life of hydroelectric plants remains a problem.

The Energy Policy Act of 2005 prescribes hydroelectric production incentives for conduit projects and projects adding a hydroelectric powerhouse to an existing dam. While this incentive does not apply to a majority of feasible potential projects in Idaho identified in the most recent resource assessment, it does apply to 65 known opportunities for capacity increase at existing dams, representing an additional 400MW of capacity.

Trends currently exist that could increase small hydropower development in the near future. In addition to lower licensing costs, availability of long-term power contracts, and development incentives, the rising cost of fossil fuel, increasing emphasis on reduction of greenhouse gas emissions, transmission system load, and concerns about energy security favor distributed hydroelectric generation.

Environmental Considerations

The environmental issues surrounding large hydroelectric plants include:

- Inundation of land by water impoundment affecting land use and habitat
- Impediment of anadromous fish migration
- Adverse effects on water quality due to depletion of dissolved oxygen
- Varying river flows dictated by power demand.

While one or more of these issues may apply to Idaho's large hydroelectric plants, they are legacy issues that have been mitigated to an acceptable degree to permit continued operation. However, it is unlikely that any additional large hydroelectric plants will be built in the state in the foreseeable future.

In contrast to new, large hydroelectric plants requiring additional water impoundment using a dam, opportunities exist for adding hydropower at existing dams. Many of these dams serve other functions such as flood control, water supply, or providing water for special uses, and their impact has already been mitigated. Addition of a powerhouse would have little additional impact. Significant hydropower potential also exists in the state that could be harnessed without the need for additional dams and reservoirs; thus having significantly smaller environmental impacts than some of the previous developments. Hydroelectric generation is emission free.

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[12] INL, *Estimation of Economic Parameters of U.S. Hydropower Resources*, INEEL/EXT-03-00662, June 2003.

Health and Safety Impacts

Since hydroelectric generation is emissions-free, it significantly contributes to the state's high air quality.

Hydroelectric plants are relatively safe. The principal safety issue associated with the larger existing plants is the integrity of the dam, which is subject to a rigorous state and federal inspection. New damless installations—particularly if they are sited in unmanned, remote locations—will require appropriate physical barriers to ensure that the public is not exposed to hazards associated with water withdrawal, tailwater return to the stream, and electrical hazards.

Social Impact

Hydroelectric dams and the reservoirs they create have benefits beyond electricity generation—flood and river flow control, domestic water storage, and water sports recreation are just a few examples. Small hydropower plants could be connected to the grid or operated as distributed generation.

Issues

- Should Idaho provide incentives and long-term financing for small hydropower development?
- Is Idaho's heavy dependence on hydroelectric power a liability in the event of a prolonged drought, and if so, should additional hydropower development be encouraged.

4.7 Solar Energy

Overview

Solar energy offers the potential to supply more of Idaho's energy needs during the next several years because Idaho has the climate to effectively utilize solar energy. Solar power and heating systems are now proven technologies with tens of thousands of MW installed around the world. Solar energy installations are increasing rapidly and operational experience is growing and improving. Solar energy system net outputs can be readily calculated based upon location, insulation data and the type of solar energy system to be used, thereby making solar energy relatively predictable and easy to integrate into power systems with mixed generation energy resources.

Solar energy systems include photovoltaic (PV) cells to produce electricity, solar thermal collection systems for power generation, solar space heating and water heating. Building designs that take into account the sun's energy contributions are continually being developed, improved and utilized. These systems often use passive and/or active (e.g., pumps) circulation or other systems to transfer heat to the appropriate locations. Even with new advances in technology and relative cost improvements, the primary deterrent to increased utilization of solar energy is still the relatively high installation costs for active systems.

Current Situation

Solar energy is currently being utilized in Idaho for many different applications. These include remote water pumping, various solar hot water and building heating systems, both on and off-grid electricity generation, solar greenhouses, and stock watering systems. Some examples of solar systems in Idaho include an 80 kW PV array to provide power for a remote Mountain Home Air Force Base radar site and a hot water heating system for Idaho State University dormitories.

Many different solar energy programs and incentives have been utilized in Idaho over the last several years. Most of the state's private and public utilities have implemented some form of solar demonstration, incentive and/or technical assistance programs. Idaho also has net metering for projects that are 25 kW and less. The State Energy Division has various solar energy programs such as solar site assessment rebates, low-interest loans, and other assistance.

Potential

The potential for growth of solar energy use in Idaho is large, but will likely be difficult to achieve in the near term because of relatively high implementation costs and lack of technical knowledge in the general public. There are many applications where use of solar energy is both economically and environmentally effective, but these applications can be difficult to find and prove feasible without significant technical assistance.

It is difficult to determine how many MW of power generation could be displaced by solar energy in the next 10 years, but it could be in the tens to hundreds of MW. Much of this growth will be influenced by rising costs of conventional energy and the public's desire for homegrown energy and security.

Economic Considerations

Solar energy system efficiencies and costs have improved over the last several years. However, solar energy, especially generation of electricity with PV cells, is still typically several times (2 to 5 times) the cost of conventional energy in many locations throughout the United States. As mentioned, there are applications and locations where solar energy can be economically competitive, but these are often areas where there are high energy costs or significant incentives. Solar energy is also attractive in remote locations where there are no nearby electric distribution lines. Idaho has tax incentives that apply to solar energy and there are federal incentives as well, such as production tax credits and accelerated depreciation. Many states have significantly more incentives for solar energy than Idaho, such as California with its buydown programs, tax incentives, Renewable Portfolio Standards (RPS) and new building requirements in certain areas.

As conventional energy costs continue to escalate and technological advancements drive solar energy costs down, solar energy systems will become more competitive. Solar hot water heating has become cost-effective in certain areas of Idaho, but the initial cost of equipment is still a deterrent to installation of these systems. Passive solar applications considered during initial construction are typically the most economically favorable. However, technical support and experience is a driver for successful implementation of solar energy systems, and it is often difficult for the general public to access that support.

Environmental Considerations

Most solar energy applications will not adversely affect Idaho's environment. Solar energy systems do have environmental impacts and considerations during manufacturing and installation, but environmental impacts after installation are minimal. One item to consider is the amount of land area that would be required for a large PV power production facility. For example, a 1MW PV system would cover several acres of land.

Health, Safety and Social Impacts

Installed solar energy systems do not typically have adverse health and safety effects, although care must be taken relative to electrical hazards and maintenance of roof-installed systems. Some people may have concerns over the land area required for and visual impact of large PV systems.

Issues

- Should the state continue and even enhance tax and other incentives for all types of solar energy systems?
- How should building codes and access to technical expertise be improved to serve the needs of solar energy utilization?
- Should the state increase its public outreach and information with respect to solar energy applications and development?

4.8 Wind Energy

Overview

Wind power and wind turbines are now proven technologies with over 40,000MW of capacity around the world. Wind turbine installations are increasing rapidly and operational experience for utilities and wind farm owners is growing and improving. Although wind energy is variable on smaller time scales (daily, weekly, seasonally), annual wind energy variability at most sites is only 10 to 15%. Most wind farms are developed in areas where the annual average capacity factor ranges between 30 to 50%, which means the average power output of the wind turbines is 30 to 50% of the nameplate capacity because the wind is not always blowing hard enough for maximum power output. Although annual capacity factors are typically between 30 to 50%, a typical wind turbine is generating some electricity (i.e., blades are rotating) 65 to 90% of the time, depending on the wind speeds at its location. Utility-scale wind turbines start to generate electricity at wind speeds of about 8 miles per hour, but require speeds of about 30 miles per hour to achieve maximum output.

Idaho has significant potential to provide electric generating capacity with wind turbines and wind farms. Until several years ago, the wind data and feasibility studies needed to verify wind energy potential in Idaho were lacking. Since then, wind maps of Idaho based on topographic and meteorological models show that the state ranks 13th in the nation with an estimated 18,000MW of wind power potential. However, such maps are only a starting point and need to be validated with actual wind data. Now that significant amounts of site-specific wind data have been collected through anemometer loan programs and by public entities and private wind developers, wind development interest is materializing.

Select areas of Idaho are highly suitable for wind development projects, while other areas are not because of lack of sufficient wind, remoteness, or access difficulty. Several determining factors establish an area as suitable for development including average wind speeds, elevation, location, ease of access, distances to electrical load centers, proximity to electrical transmission lines, and transmission line available capacities. Medium to large commercial wind opportunities, as well as small-scale projects powering homes and businesses, are viable options for people interested in harnessing the wind.

Wind power can be a beneficial addition to the generation resource mix for any electrical power grid. If the level of wind power in a system is kept at 10 to15% of the overall average electrical load ("penetration level"), integration and operation of a power system with wind turbines is typically relatively simple. Most grid systems already have enough installed backup capacity to deal with this level of variable wind power. When wind power penetration levels start to exceed approximately 15%, additional measures (i.e., addition of more backup capacity, operational changes, other engineering measures, etc.) are typically required in a power system to maintain grid stability and reliability. There are power systems in Europe and remote hybrid power systems around the world where penetration levels of wind power are 20% or higher.

Current Situation

At the end of 2005, there was approximately 75MW of installed and operational wind electric power in Idaho.

Potential

At present, there are approximately 1,900MW of proposed wind turbine installations in various stages of development in Idaho. It is likely that not all of these installations will be developed in the next

few years due to various constraints, which include specific terms of utility Request For Proposals, available power purchase contracts, problems with the implementation of Public Utility Regulatory Policies Act (PURPA) in Idaho, electrical load growth and proximity of load centers, transmission constraints or lack of transmission lines to other load centers, wind turbine availability, competition with surrounding states, etc.

By the end of 2005, 75MW of these proposed wind farms were installed and operational in Idaho. It is expected that approximately 190MW of additional wind power will be installed in Idaho by the end of 2006, bringing the state's total installed wind power capacity to 265MW. It also appears possible that approximately 200 to 300MW of additional wind power will be installed in Idaho in 2007.

Economic Considerations

Production tax credits, no-interest bonds, sale of "green tags" and other available tax incentives and/or renewable energy subsidies allow wind turbines to generate electricity at costs that range from approximately 3.5 to 6 cents per kW·h. Smaller-scale wind power systems have a higher cost per kW·h because of economies of scale. Wind power generation costs depend upon each wind farm's business and financial arrangements, the quality of the wind resource, costs of the wind turbines and ancillary equipment, and other factors. As such, the specific cost per kW·h varies considerably from site to site. Firming charges, applied by a utility to compensate for the intermittent nature of the wind, typically add about 0.3 cents per kW·h to the cost.

Subsidies and incentives make wind power economically competitive with many conventional forms of electricity generation (in some "good" wind areas, wind power is economically competitive without subsides and incentives). Electricity generation using existing coal, nuclear, and hydropower facilities is typically less expensive than installing wind power. However, wind can be competitive when it comes to new generation development and installation of conventional systems because environmental requirements, development costs, and fuel costs for new power plants are escalating. Wind farms can be sited and developed relatively quickly, especially when they are located on private property. In some states, such as Colorado, proposed wind power plants have been selected over proposed fossil fuel-based power plants in recent competitive bid processes to increase generation resources. Wind power is also relatively stable in cost once a wind farm is built because there is no volatility or uncertainty in the fuel cost (the wind is free, and annual wind energy averages are relatively stable). Wind energy deserves serious consideration when utilities and others are planning to expand their power generation system.

Other economic impacts for wind power include increased local tax base (e.g., property taxes), land lease revenue for farmers, ranchers, or other landowners, share of project revenues if some ownership interest is retained by landowners or investors residing in Idaho, increases in construction jobs and the need for local services during construction, and increases in local jobs and equipment purchases for post-construction wind farm operation and maintenance.

Environmental Considerations

Environmental concerns for wind turbines and wind farms include avian and bat fatality issues, noise, visual impacts, electromagnetic interference, land use issues, flora and fauna impacts (including water issues such as runoff), and safety.

Avian and bat fatality issues are a concern, but have actually presented problems at only a very few wind farm sites in the country. Environmental analysis before construction, incorporation of new technologies, and utilization of mitigation concepts can reduce or eliminate major problems. Mitigation concepts include siting to avoid migration corridors and nesting areas, use of tubular towers instead of

lattice towers to reduce perching, other perching deterrent methods and prey base management, burying electrical lines, use of fewer and larger turbines with increased turbine spacing, potential bat deterrent methods, etc. Bat fatality concerns are mostly confined to the Eastern United States in forested areas; there have been no significant bat fatality concerns to date in the Western United States (where wind farms are typically constructed in very open areas with few trees).

Noise is not a significant concern with modern technology and larger wind turbines. At a distance of about 1,000 feet, the noise from a wind turbine/farm is comparable to that of a refrigerator (35 to 45 dB(A)). Smaller home-use wind turbines can be noisy because of their blade designs and braking mechanisms, but large wind turbines do not present a major noise problem.

Visual impact is a legitimate concern for wind farms. Mitigation concepts such as turbine placements (use landscape to advantage), design, number and arrangement of turbines, and wind turbine color and lighting (working within the FAA requirements but keeping visual impact low) can all be used to reduce visual impacts and viewshed alteration.

Electromagnetic interference can be a concern, but is rarely an issue with most wind farm development. As long as wind turbines are not located in communication and radar paths, most electromagnetic interference problems are avoided. In some cases, radar systems have been modified to eliminate or reduce problems when radar paths were not avoided. Military and commercial aircraft flight paths also need similar consideration when planning wind farm developments.

Land use and flora and fauna impacts are typically minimal with most wind farm development. Wind farms use a considerable amount of land, but the wind turbines themselves have a small footprint and large spacing, leaving the large majority of the land open for other use. For example, the Foote Creek Rim wind farm near Arlington, Wyoming consists of sixty-nine 600-kW turbines sited on 2,156 acres. Only 1% of the land is occupied by wind turbines and ancillary facilities; the balance of this land remains available for ranching. Land use compatibility is typically very good. Flora and fauna impacts can be mitigated through ecological survey, avoidance of sensitive areas, addition of new habitat nearby, proper road construction and water management practices (runoff and erosion considerations), and reclamation of temporary roads and lay-down areas built for construction, etc.

Despite these environmental concerns, wind power has many environmental benefits. Once installed, wind turbines produce no greenhouse gases during operation. Wind turbines are estimated to produce approximately 70 times more energy over their lifetime than was used during their manufacture and installation. Also, while conventional power plants typically use large amounts of water for cooling, wind turbines do not use water during operation.

Health and Safety Impacts

Wind turbines generate no gaseous or particulate emissions during operation. Only minor quantities of liquid or solid waste are produced during operations and maintenance.

The wind power industry has an excellent safety record. In areas where winter weather and icing is a concern, turbines should be located away from major roads to avoid the possibility of falling ice or ice thrown from the blades. Other safety items to consider include blade throw, tower failure, and attractive nuisance. Mitigation concepts include distance to wind farm boundary and roads, prohibiting maintenance during adverse conditions, fencing, educational signs, and access limitation.

Social Impacts

Development of wind energy depends in part on the public's willingness to accept the appearance of wind systems and on political and economic drivers. Wind turbines have been installed in many areas of the country with high acceptance levels. Education of the public about energy production options and effects is key to the acceptance of a technology considered relatively new to many people. Initial feedback on wind power through much of Idaho has been a positive majority, but there is resistance. The "Not In My Back Yard" sentiment can be difficult to overcome for any type of new power system development. One aspect that most people see as a positive is that wind power contributes to energy security by offering homegrown energy.

Issues

- What should be done to encourage Idaho utilities to add wind generation to their systems (whether utility owned or independent power producer owned)?
- What requirements should be included for PURPA implementation in Idaho for integration of wind power?
- Should transmission system investments be made to permit more wind power (and other power generation) development and export?

5. ENERGY USE AND CONSERVATION

In 2001, energy consumption in Idaho was 501 Trillion Btu. Of this energy, 21% (104.8 Trillion Btu) was consumed in the residential end use sector, 19% (94.5 Trillion Btu) in the commercial sector, 36% (180.2 Trillion Btu) in the industrial sector, and 24% (121.5 Trillion Btu) in the transportation sector (Energy Information Agency).

The following material will consider energy use and conservation in the framework of the segment of the economy in which it is used. The breakdown used differs somewhat from that mentioned in the previous paragraph. Since agriculture is such an important part of Idaho's economy, it will be considered separately. Commercial and residential buildings are combined since there is much commonality in their utilization of energy. Finally, energy use and conservation in the industrial and transportation sectors are described.

5.1 Agriculture

Overview

Agriculture continues to be one of Idaho's leading economic engines, and the latest economic information backs up that statement. The latest Idaho Department of Agriculture annual report shows that gate receipts for this industry have reached a record of almost $4.4 billion. Technology, urbanization and shifting consumer demands may change the face of Idaho agriculture, but that hasn't changed the fact that the agriculture industry continues to grow and prosper throughout Idaho.

Agriculture continues to become more energy intensive in its petroleum and electric end uses. Energy is used in agriculture for a broad range of purposes. Electricity is used not only for power in homes, barns, and shops, but also to power irrigation pumps, to maintain environmental conditions in potato cellars and other storage buildings, and to power the milking stations and milk handling equipment in dairies. Petroleum is used to power the tractors, trucks, and combines that plant, cultivate, and harvest Idaho's crops. As a result, agriculture is vulnerable to energy price changes. In recent years, fuel price increases have outpaced increases in farm commodity prices, thus contributing to the economic losses by many farm operations.

The Energy Division of the Idaho Department of Water Resources has an Agricultural Efficiency Program that promotes cost-effective energy conservation programs and services for Idaho's agricultural community. The program also works with the state's agriculture-related industries, assisting with their energy needs. Energy and water-use conservation are the primary focus of this program. The program assists farmers, animal production businesses, aquaculture, and greenhouse facilities in locating and implementing alternative energy resources and assisting in analysis of water consumption. Lowering water use can significantly lower energy use and operation costs. It assists and educates Idaho's agricultural community in the maintenance and improvement of irrigation operations and production facilities to increase overall energy efficiency. Pumping system efficiency and irrigation methods can contribute substantially to a business's energy savings. The Energy Division trains and qualifies Irrigation System Auditors statewide to perform pump and system evaluations for agriculture operators interested in assessing the performance of their facility. Utilities also provide pumping plant evaluations. Qualifying participants may be eligible for energy improvement related low-interest loans through the Idaho Energy Division's Agricultural Loan Program.

Current Situation

Potential

Electricity and petroleum are agriculture's major energy sources. The state's ability to deal with the availability and cost of petroleum products is limited. However, several opportunities are becoming available that will improve agriculture's energy position.

In its 2006 session the Idaho Legislature considered legislation (S1364) to implement a Renewable Fuel Standard once Idaho is producing at least 30 million gallons of ethanol. The standard specifies that gasoline sold for motor vehicle use in the state shall contain at least 10.0% ethanol. The production of fuel ethanol in Idaho would provide jobs, increase the local tax base, and provide a new market for farm crops. The bill was approved by the Senate, but referred to committee by the House. Using ethanol-blended fuel in Idaho will reduce dependence on imported fuels and reduce emissions from motor vehicles.

Idaho has been announced as the U.S. location of choice by a major company entering the new ethanol-from-cellulose market. This facility, if sited in Idaho, would purchase about 800,000 tons of cereal straw from Idaho growers annually. This straw would be converted into about 60 million gallons of ethanol.

Other opportunities for energy conservation in Idaho's agriculture industry include use of more efficient irrigation and water management techniques, such as variable-rate irrigation and more efficient use of fertilizers and herbicides/pesticides through variable-rate application. Energy can also be conserved through the use of more energy efficient farm machinery and trucks and state-of-the-art cellar storage systems. In the dairy industry, opportunities exist for energy generation through new manure management systems.

Economic Considerations

Besides the direct benefit to farmers of an estimated $10 per ton for their straw in the windrow for an ethanol plant located in Idaho, there would be approximately the equivalent of 125 full-time jobs related to the collection and transport of the feedstock delivered to the plant. Furthermore, the direct employment in a combined ethanol facility, cogeneration electrical plant and the enzyme unit would be approximately 100 jobs. Beyond this base employment, approximately 400 indirect jobs would be created in the local community. Thus, total direct and indirect incremental jobs would reach approximately 600 on a sustainable annual basis. During the construction phase of the $200 million project, which lasts approximately 24 to 30 months, a total of approximately 1,800 direct and indirect job years would be created.

More efficient use of fuels and electrical power would lower the operating costs for Idaho farmers and ranchers, and improve their bottom line. The cost-effectiveness of different energy conservation investments depends on the specifics of the application, and each investment should be subjected to its own cost/benefit analysis. Some improvements require large capital investments, such as the costs for new machinery, while others might require less investment in equipment, but more investment in modifying agricultural practices such as variable-rate irrigation and fertilization. Other improvements might only be gained through changes made by agricultural equipment manufacturers.

Issues

- Should energy conservation in the agricultural sector be improved by incentives, and if so, how?
- Do water rights rules and regulations need to be modified to improve water and energy conservation in agricultural irrigation systems?
- Do environmental and emissions issues work in support of, or against, energy conservation in agriculture?

5.2 Commercial and Residential Buildings

Overview

Energy conservation and efficiency contribute to a realistic strategy for maintaining a reliable and affordable energy supply for Idaho. Since the energy crises of the 1970s and subsequent legislation to encourage conservation and efficiency, the United States has slowed overall demand growth. In the early 1980s, total household energy consumption actually declined. Since that time, consumption has remained approximately at the 1980 level, even though households are using more appliances and amenities that require energy. This demonstrates that more efficient designs have helped control energy demand, but more is possible. For example, the emerging trend to build "green" buildings has shown that with better design and minimal up-front investment, new buildings can use as much as 30% less energy.

The distinction between conservation and efficiency can be clarified by thinking of use versus technology. Conservation occurs when action is taken to use energy only when needed. For example, using motion sensor controls for lighting, automatic sleep modes for equipment, and raising thermostat settings for air conditioning represent energy conservation. Efficiency is generally a result of technology. Using light emitting diode (LED), T-8 and compact fluorescent lighting are examples of efficiency because the same level of service is provided with less energy.

The good news is that much can be done for both energy conservation and efficiency. The trend of slowing demand since the 1970s has by no means reached a plateau. Opportunities continue to emerge in both the residential and commercial sectors.

Current Situation

Projected Growth in Customers

The three primary electric utilities that serve Idaho—Idaho Power, Avista, and PacifiCorp—collectively project an increase in customers of 2 to 3% per year. These three utilities serve 500,000 residential customers and 100,000 commercial customers in Idaho. All three are planning increased production to meet these needs. There is opportunity for conservation and efficiency in both the residential and commercial sectors.

Electrical and Natural Gas Rates

Intermountain Gas supplies natural gas to 265,000 customers in southern Idaho and Avista Gas serves 65,000 customers in northern Idaho. Rising natural gas prices resulted in recent significant increases to customers of 27.6 and 23.8%, respectively (these increases were approved before production damage due to the hurricanes in 2005). These costs have been creeping upward with the volatile energy market..

In the 1980s, homes and businesses took advantage of low-cost natural gas for heating. Since then, the use of natural gas for utility-scale electrical production has increased demand, and also prevented acquisition of what used to be low-cost "off-season" storage of natural gas in the summer for winter supply. In addition, completion of major pipelines connecting Idaho's Canadian and Rocky Mountain natural gas sources to major markets elsewhere in North America has increased natural gas prices in Idaho.

The growth in natural gas electrical production and resulting price increases has also affected Idaho's electrical rates. Base rate increases between 5 to 12% are expected beyond 2005 for each of the three main utilities serving Idaho. In 2004, Idaho residential customers paid an average of about 6 cents per kW·h, commercial customers paid an average of about 4.8 cents per kW·h.

Conservation

Conservation measures are often simple and can be accomplished without much investment in technology.

Metering is becoming an effective way to reduce peak demand. Automated meter readers have the ability to inform customers of current electrical prices, allowing them to switch off equipment to wait for times when rates are lower. By doing so, customers manage electrical use to reduce their bills. Time-of-day pricing sets a standard low rate for off-peak times such as 9 p.m. to 7 a.m. on weekdays and during weekends to encourage users to switch use and moderate overall demand.

Installing motion or thermal sensors to turn lighting on and off is also an effective conservation technique. Programmable thermostats allow customers to automatically reduce heating and cooling when buildings are not occupied. Likewise, computers, printers, and office copiers can be purchased with automatic timers to shut down after a set period of nonuse.

Campaigns to conserve energy can be effective. Suggestions to increase air conditioning thermostat temperatures or reduce heating temperatures can get the attention of consumers if savings are emphasized. Other measures can be suggested by appealing to less obvious benefits of conservation; examples are line-drying sheets for a fresh air smell, air-drying dishes to prevent clouding of glassware, and cold-water laundering to preserve fibers and dye in clothing.

Efficiency

Energy-efficiency technologies continue to evolve and become more common. Efficiency improving methods range from performing basic maintenance activities to installing state-of-the-art equipment.

Mechanical systems can be improved by a variety of approaches. Regular maintenance programs can improve efficiency by making sure duct work is sealed, piping and water heaters are insulated, motors and valves are functional, etc. Variable speed drives for motor operations often reap significant energy savings, and combined heat and power systems should be considered. Idaho is also climatically suited for ground-loop heating and cooling, and convective/radiant HVAC alternative technologies.

Commissioning is an emerging technique that measures the mechanical performance of a building system to ensure settings and operation are optimal. Commissioning is often performed by an outside professional just before building occupation; re-commissioning can be performed periodically.

Improving the building envelope can increase efficiency by reducing the volume of air that must be heated, cooled, or re-heated and re-cooled. Insulation, high-performance windows, sealing with weather stripping and caulking are all effective.

Lighting is often a primary energy user in a building. Retrofitting T-12 fluorescent lamps and ballasts with T-8 technology often pays for itself within a few years. LED and compact fluorescent lighting should also be encouraged. Natural lighting through light shelves and skylights can be considered in the building design.

Idaho has an excellent climate for passive solar applications. Solar water heating and transpired solar walls, where a pillow of air between the inner and outer skins of a building is heated passively by the sun, are both inexpensive and effective.

Appliances are often the primary energy consumer for residences. Energy Star-labeled appliances have been tested and shown to be the most efficient appliances offered.

Surrounding landscape can impact the energy efficiency of a building. Berms can deflect heat-stealing winds; deciduous trees on the south side of a building provide shade in the summer and allow light and heat in the winter.

Trends in the Pacific Northwest on Building Performance

Both Oregon and Washington are leaders in a national trend in green building that is moving inland to Idaho. Green building is the industry term for designing and operating a building to reduce its environmental footprint. A major consideration in green building is using highly energy efficient systems, but the concept also focuses on reduced water use, use of local and recycled materials, low-toxicity materials, siting for efficient transportation access, and healthy indoor environments. Developers and owners are seeking green building certification as a way to distinguish their product. Since energy savings are the greatest opportunity for recovering costs, increased interest in efficient energy design is driving market trends for new buildings.

Idaho Code

Energy performance building codes are adopted at the city or county level in Idaho; approximately 98% of the population is covered by codes in Idaho. Those cities and counties that require a code must adopt the 2003 International Building Code with the International Energy Conservation Code and International Residential Code. Meeting these codes provides minimum energy performance for residential and commercial buildings.

Tax Incentives

Idaho offers state tax deductions for weatherizing, and installing alternative energy sources for homeowners. The tax deductions reduce the taxable income upon which the Idaho income tax is calculated.

Homeowners with a primary residence built before 1976 can deduct the cost of adding insulation to the home in the year the insulation was installed. This includes wall insulation materials, mastic caulk, double-pane windows, storm doors, and storm windows.

Homeowners can deduct a portion or all of the cost of an alternate energy device over four years: 20 to 40% or $5,000 per year, whichever is less. Alternate energy devices include wind, geothermal, and solar systems, ground-source heat pumps and water-source heat pumps. Uncertified wood stoves replaced with Environmental Protection Agency-certified wood stoves, pellet stoves, natural gas, or propane heaters are also eligible for this state tax deduction.

The Energy Policy Act of 2005 includes a new federal tax incentive to improve the energy efficiency of commercial buildings. A deduction of as much as $1.80 per square foot of floor area for energy-efficient improvements, including allowances for partial deductions for improvement in interior lighting, HVAC and hot water systems, and building envelope, was adopted.

Programs

Several programs exist within the state to address energy efficiency and conservation. These include the national Weatherization Assistance Program, Utility Demand Side Management programs, and Idaho Department of Water Resources educational programs.

Since 2002, federal funding for Idaho low-income weatherization programs has increased by 30% to nearly $2,000,000 per year. Administered by the Department of Health and Welfare, this program performs weatherization on Idaho residences including weather-stripping doors, caulking windows, performing energy audits, educating residents, etc. The President's FY 2007 budget request significantly reduces Weatherization Assistance Program Grants.

The Idaho Public Utilities Commission has approved riders to electric bills to fund conservation and demand-side management programs. These riders range from 0.5 to 1.5% of the customer's bill, and are invested by the utilities in conservation/efficiency programs. Examples are coupons for reduced prices on compact fluorescent bulbs, lighting upgrade rebates, refrigerator recycling, air conditioning cycling, and automated meter reading designed to shift energy use away from peak times.

The Idaho Department of Water Resources State Energy Program provides energy code training and technical assistance to Idaho construction and design industries. Training is provided for code inspectors, builders, subcontractors, and design professionals.

Issues

- Are additional programs and incentives necessary to stimulate more conservation and efficient use of energy in the commercial and residential sectors?
- Is Idaho prepared to respond to an acute energy shortage through emergency conservation and should it have an up-to-date State Emergency Conservation Plan?

5.3 Industrial Sector

Overview

Industry is the largest and most diverse energy-consuming sector in the United States, and Idaho has a significant potential for industrial conservation. In 2001, the industrial sector consumed 32.3 quadrillion Btu (Quads), or over one-third of the 96 quads consumed in the United States (180.2 Trillion Btu in Idaho, which was 36% of the state's energy consumption). Natural gas, petroleum products, and electricity comprise the major energy sources used to heat and power U.S. factories, farms, and mining operations. Unlike other sectors, energy use in industry is often determined by the specific industrial process in use. However, some important energy applications are common across industry, such as motor drives, steam systems, compressed air, and waste heat recovery. As a result, industrial energy efficiency opportunities exist in both process-specific and cross-cutting energy systems.

Current Situation

Potential

Within the industrial sector of the United States, seven industries account for about 85% of total energy use. These seven industries include agriculture, forest products, and mining, and they are the most energy-intensive industries in Idaho (energy intensity is defined as energy use per unit of product output [i.e., Btu per dollar value of shipments]). From a cross-cutting energy perspective, U.S. Department of Energy (DOE) Secretary Samuel W. Bodman announced the "Easy Ways to Save Energy" campaign in October 2005 in which 200 of the nation's largest energy users can receive an Energy Saving Assessment by DOE-certified energy experts. As of Jan. 4, 2006, 65 manufacturing plants have been selected to receive this expert assistance, including plants belonging to Boise Cascade Company, FMC, J.R. Simplot Company, and Potlatch Corporation. Collectively, the selected plants and other facilities under the same corporate ownership represent 5% of natural gas consumed by the industrial sector.

In addition to cross-cutting energy systems, Idaho industry also has the potential for adopting process-specific technology. For example, in the mining industry, the use of intelligent controlled mineral extraction and comminution offer the potential for significant energy savings. However, it is not simply a matter of installing new technology, but rather of first understanding the potential benefits associated with deploying new technology on a site-specific, mineral-specific basis. Similarly, the forest products industry has potential for adopting new technology, such as black liquor gasification, which not only offers improved plant energy efficiency over current heat recovery from black liquor combustion but also serves as a power producer. However, black liquor gasification poses challenges different from virtually any other biomass gasification technique owing to the high load of inorganic chemicals in the feed stream from the kraft pulping cycle. Again, it is not simply a matter of installing black liquor gasification combined cycle technology, but first understanding the potential benefits associated with deploying new technology on a site-specific basis.

Economic Considerations

The industrial sector will continue to provide one of the biggest opportunities to increase energy efficiency in Idaho. Industrial energy intensity is projected to decline nationally as companies become more energy efficient and the structure of the industrial sector continues to change. The growth of the high-technology (electronics, computer, etc.) industry in Idaho is a prime example of this change. In 2001, the industry posted its lowest energy intensity since the formation of the U.S. Department of Energy (15,200 Btu per dollar of industrial GDP [constant 1996]). This was significantly lower than in

1970 and reflects the change in the economic mix of industries and the diligence of private industry in assimilating energy efficiency technologies. Although manufacturing output surged in the late 1990s, energy use grew at a slower rate despite relatively low energy prices. Energy use projections indicate that increased industrial efficiency will continue to be a major source of future gains in energy efficiency. Industrial operations in Idaho will not be sustainable in the long term if they cannot increase their output with a corresponding increase in energy use.

Issues

- To what extent should the state of Idaho have a role in industrial energy conservation?
- Should the state of Idaho reinvigorate the Idaho Industries of the Future Program initiated on Feb. 23, 2000, to enhance the energy efficiency, environmental protection, and human resource development of the Agriculture, Forest Products, Mining, and High Technology industries in Idaho?

5.4 Transportation Sector

Overview

The energy supply for transportation in the United States and Idaho is almost exclusively petroleum based. Dependence on petroleum has made the United States and Idaho vulnerable to the volatility of foreign and domestic production and delivery. World oil prices have nearly tripled in the last three years. Hurricanes Katrina and Rita interrupted of oil production, refining and transport contributing to a recent peak in 2005 in excess of $70 per barrel of oil. Crude oil is the single largest cost component in the production of transportation fuels, accounting for between 42 and 56% of the price of regular gasoline in the last year. Alternative fuels that are under consideration and in various stages of development and deployment in the United States and worldwide include ethanol, biodiesel, E-diesel, gas-to-liquid, electricity, natural gas, liquefied petroleum gas and hydrogen.

Trains, planes, automobiles, light and heavy-duty trucks and off-road vehicles such as farm equipment, snowmobiles and all-terrain vehicles consume energy for transportation, agriculture and recreation. Automobile manufacturers worldwide are developing higher fuel efficiency vehicles in the form of electric vehicles (EV), hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV). The DOE has a partnership with the three major U.S. automobile companies, DaimlerChrysler Corporation, Ford Motor Company and General Motors Corporation, to develop technology for light-duty HEVs. The DOE is also working with U.S. heavy-duty vehicle manufacturers to develop more fuel-efficient heavy vehicles through hybridization and systems optimization such as reducing rolling resistance and aerodynamic drag.

California continues to lead the nation in energy and environment-related legislation. In 2003, the California Energy Commission and the California Air Resources Board (CARB) jointly adopted a strategy to reduce California's dependence on petroleum[13]. The two agencies recommended that the state of California influence the federal government to double the fuel economy of new vehicles and increase the use of nonpetroleum fuel to 20% of on-road fuel demand by 2020. However, the federal Energy Policy Act of 2005 largely ignores these issues. Nevertheless, California continues its efforts to increase Corporate Average Fuel Economy (CAFE) standards through a coalition of states and stakeholders and to develop a long-term plan by March 2006 to increase the use of alternative fuels.

Current Situation

Alternative Fuels

Ethanol

Ethanol is blended with gasoline to make transportation fuels. Ethanol may be produced from several sources including municipal, agricultural and forestry wastes. Ethanol-blended gasoline in use in the United States ranges from about 5 to 85% ethanol. About 90% of the ethanol used in gasoline arrives by train from the Midwest and is produced from corn. The remaining 10% comes by ship from Caribbean Basin Initiative countries and Brazil, where it is produced from sugar cane. Iogen Corporation is operating an ethanol demonstration plant near Ottawa, Canada, where 260,000 gallons of ethanol per year are produced from straw. Iogen has identified Southeastern Idaho as the preferred U.S. site for a proposed wheat straw to ethanol plant.

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[13] California Air Resources Board and California Energy Commission, *Reducing California's Petroleum Dependence*, P600-03-005F, August 2003.

The federal Energy Policy Act of 2005 repealed the requirement for minimum 2% oxygen content of gasoline, which heretofore had been satisfied by blending with at least 5.7% ethanol content. The Energy Policy Act does, however, require refiners nationwide to use increasing amounts of fuel ethanol up to a maximum of 7.5 billion gallons by 2012, nearly double the amount used today.

Biodiesel

Biodiesel fuel is produced from vegetable oil, animal fat, and used cooking oil. Biodiesel fuel can also be made using several technologies collectively known as thermal conversion processes (TCP) that use a broad range of feedstock including animal waste, animal carcasses, wood wastes, agricultural waste, plastics, tires, sewage sludge, and other waste-containing hydrocarbons, fats, carbohydrates, or protein. Several TCP demonstration plants are operating in the United States and Europe. Biodiesel blended fuels in use range from about 2 to 20% biodiesel.

Ultra-low sulfur diesel fuel regulations become effective beginning in 2006, placing a sulfur limit on all conventional diesel fuel sold in the United States. Clean diesel engines entering the market between 2007 and 2010 will need ultra-low sulfur diesel fuel to meet their emissions targets.

E-Diesel

Ethanol in diesel (e-diesel) has been under active development with many demonstration and evaluation activities initiated in the late 1990s. While both on-road and off-road applications have been explored, e-diesel for general on-highway use in passenger cars and light-duty trucks appears unlikely for the foreseeable future. Automakers view this fuel as experimental and its use in passenger vehicles as problematic due to fuel vapor flammability and related safety issues.

On the other hand, centrally fueled fleet applications are the logical place for this fuel, such as medium- and heavy-duty fleets and off-road equipment. In this environment, fleet owners can undertake vehicle modification, implementation of safety measures, training of personnel, and upgrading of supply tanks and associated equipment without the complexities and costs associated with dispersed use of the fuel in the larger petroleum infrastructure. For example, Long Beach Container Terminal, Inc. is using e-diesel in operating 60 pieces of heavy equipment to move ship containers at the Port of Long Beach, California.

Gas-to-liquid

Gas-to-liquid (GTL) is a synthetic diesel-like fuel that can be used in both conventional diesel engines and fueling systems. GTL is made with a process that converts hydrocarbon gas to a liquid fuel (generally knows as the “Fischer-Tropsch reaction”). GTL is predominantly produced from natural gas. GTL using other feedstocks including coal, petroleum coke and biomass, but are not commercially mature and are more expensive. For example, Rentech Inc. has announced that next year it will break ground for a plant in Wyoming that will produce 33,000 barrels per day of diesel fuel made from coal.

GTL fuel is more expensive than conventional diesel fuel but its superior fuel and emissions properties make GTL fuel ideal for blending with conventional diesel fuel. Tests in Europe show the GTL fuel blends that have between 30 to 50% GTL substantially reduce emissions at cost comparable to conventional European diesel fuel.

Natural Gas

Natural gas is a completely nonpetroleum transportation fuel option. Natural gas is used in the form of compressed natural gas (CNG) and liquefied natural gas (LNG). Vehicles using compressed natural gas include passenger cars and light trucks, medium-duty delivery trucks, and heavy-duty vehicles such as transit buses, school buses, and street sweepers. Liquefied natural gas is also used in heavy-duty vehicles such as refuse haulers, local delivery trucks and transit buses.

The California Department of Motor Vehicles reports that more that 30,000 natural gas vehicles are currently licensed (5,000 heavy-duty vehicles and 25,000 light duty vehicles.) However, heavy-duty CNG/LNG vehicles tend to be more expensive to purchase and operate than conventional diesel vehicles[14]. Further, Ford Motor Company and DaimlerChrysler Corporation have stopped production of natural gas vehicles for the U.S. market, leaving only General Motors and Honda with light-duty natural gas vehicles in the 2005 model year.

Liquefied Petroleum Gas

Liquefied petroleum gas (LPG), or propane, is a domestically produced fuel that is closer to gasoline than other alternative fuels. LPG carries the benefits of reduced vehicle maintenance costs, emissions, and fuel costs when compared with conventional gasoline and diesel. The number of LPG vehicles worldwide is eight million and increasing. But, due to its emission certification requirements, the number of LPG vehicles in California is declining.

Hydrogen

Today, hydrogen is typically produced from natural gas, using steam for reforming. Thus, any reduction in petroleum would likely be offset by a corresponding increase in natural gas. However, DOE is investigating the development for a new technology nuclear power plant that could also be used to generate hydrogen. INL is leading this work.

Both fuel cell vehicles and, with modification, internal combustion engines can use hydrogen. Hydrogen and natural gas blends are in demonstration use now and could provide a logical transition to hydrogen-powered vehicles.

The most promising fuel cell under development for transportation fuel use is the Proton Exchange Membrane (PEM) fuel cell. The PEM fuel cell has high power density, operates at low temperatures, permits adjustable power output, and allows quick start-ups.

Fuel cell vehicles can use either direct hydrogen or on-board reformers using ethanol, methanol, or gasoline. The advantage of hydrogen is that its oxidation byproduct is pure water. The present challenges for the widespread use of hydrogen are the development of generation, delivery and dispensation infrastructures as well as on-vehicle storage. Fuel cells are inherently more efficient than conventional internal combustion engines so that using fuels such as ethanol, methanol or gasoline in a fuel cell yields more useful energy and fewer pollutants on an equivalent comparison basis. The disadvantage of using any hydrocarbon is that in addition to water, oxidation products also include the typical combustion products such as carbon monoxide, carbon dioxide, nitrous oxides and other pollutants.

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[14] Scott Fable, and Raymond K. Schubert, *Comparative Costs of 2010 Heavy-Duty Diesel and Natural Gas Technologies, Final Report*, TIAX DO286/DO288, July 15, 2005.

Electricity

Using electricity as a replacement for gasoline or diesel fuel produces a large reduction in emissions because most modern electricity-generating stations are clean, and electric drivetrains are inherently energy efficient. For example, the California Air Resources Board has estimated that electric vehicles produce only about 6% of the air pollution of the cleanest new internal combustion engine cars available today.

Electric vehicles in wide use include forklifts, industrial tugs, tow tractors, industrial sweepers and scrubbers, and burden and personnel carriers including neighborhood electric vehicles, electric-standby truck refrigeration units and golf carts. All of this equipment has gasoline or diesel counterparts, so the choice of electric equipment displaces petroleum use and reduces emissions of pollutants and greenhouse gases. In California, their use is expected to triple by 2020 due to natural growth and more importantly due to regulatory issues and financial incentive programs that encourage electric technologies because of their inherent emissions benefits.

It was thought that California's zero-emission vehicle (ZEV) requirements would be satisfied by battery-operated electric vehicles, but the ZEV market did not develop as expected. The main barrier has been the slow pace of battery technology development. Persistent problems include limited range, long charging time, low energy density, and high replacement costs. However, recent advancements in lithium-ion battery technology could significantly improve the performance of both full-electric and hybrid-electric vehicles. New generation lithium-ion batteries have a much longer life, can fully recharge in less than one hour, and provide greater power density. Low-speed neighborhood electric vehicles (NEV) and city electric vehicles (CEV) are becoming popular cost-effective alternatives to gasoline vehicles for short and stop-and-go trips.

Production, Delivery, Storage and Refueling Infrastructure

Idaho's current production, delivery and storage infrastructure is adequate for today's conventional transportation fuels. However, as the nation transitions to a hydrogen economy and to keep pace with neighboring states, the state of Idaho may need to stimulate the development of a hydrogen refueling infrastructure similar to California's Hydrogen Highway Network. The Hydrogen Highway Blueprint Plan, which was released in May 2005, calls for a dramatic increase in the use of hydrogen-fueled vehicles and a network of hydrogen fueling stations and other infrastructure. The plan also places great importance on the development of bridging technologies, such as electric-drive technologies, including hybrid, plug-in hybrid and pure electric vehicles.

Conservation

Numerous federal, state and commercial efforts are under way to improve fuel economy and reduce emissions. Among others, these include hybrid electric vehicles, plug-in hybrids, light-duty diesels, low-rolling resistance tires, truck anti-idling, and reduction of aerodynamic drag.

Electric Vehicles

In the past, expectations for EVs were not realistic. But in many applications EVs are doing their job and are expanding their market niches. Their big advantage is the simple drivetrain. With the new high-energy batteries, with energy densities not imaginable 10 years ago, EVs have the potential to come back, even in the mass market.

Hybrid Electric Vehicles

The fuel economy of HEVs is approximately double that of the average fuel economy of cars and light trucks in the United States today[15], and HEVs have overall lower tailpipe emissions The few hybrid models for sale by automakers carry a price premium several thousand dollars above comparable gasoline models, although expected mass production will bring down their cost. In the United States, about 56,000 electric vehicles and about 197,000 hybrid electric vehicles were on the road in 2004 for a combined total of only about 253,000 HEVs, out of a total national vehicle count of over 230 million. With average vehicle turnover at eight years for households and two and one-half years for business fleets[16], influencing individual consumer preference may not be the most effective strategy to encourage HEV use. Providing incentives or requiring public and private fleet owners to buy HEVs could accelerate the rate of HEV market penetration.

Plug-in Hybrid Electric Vehicles

There is increasing attention to grid-connected or "plug-in" hybrids as an on-road electric-drive technology option that can bridge the gap between today's hybrids and the zero-emission vehicles of the future. Plug-in hybrids are like today's hybrids, but with a larger battery pack and the capability to plug into grid-supplied electricity from a standard 110-volt outlet when available. Plug-in hybrids typically have the capability to provide 20 to 60 miles of all-electric battery-only (and zero-emissions) range, before the internal combustion engine comes on to supply the remainder of the needed driving range. This is particularly significant since 63% of consumer trips are shorter than 60 miles. In this way, plug-in hybrids address the limitations that all-electric vehicles have in terms of limited range. Because plug-in hybrids have substantial zero-emission range, they can produce a significant reduction in pollutants and greenhouse gas emissions—even beyond that of the very efficient HEVs available today. Although, at present, no automaker has publicly announced plans to produce plug-in hybrid models, the city of Austin, Texas, has initiated a national Plug-in Partners campaign to create a market for the vehicles.

Light-Duty Diesels

Light-duty diesel (LDD) vehicles are cars, mini and full-sized vans, and small and full-sized pickup trucks that use diesel fuel instead of gasoline. Today's advanced LDDs offer turbo-charged high performance, high fuel economy, and low emissions compared to past gasoline and diesel engines. These new LDDs provide 45% better fuel economy compared to the equivalent gasoline-powered car. Previously, consumer sales in Europe of conventional diesel-powered vehicles were about 20% of the new vehicle market but have now risen to about 48% with the advent of LDDs. However, LDDs cost about $1,000 to $3,000 more than gasoline engine vehicles and currently cannot meet the stringent NOx emissions standards in California with the present high sulfur diesel fuels. However, ultra-low sulfur content diesel fuel is expected to be available in 2006, which should reopen the market for LDDs in California.

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[15] California Energy Commission, California Air Resource Board, and the California Dept. of General Services, *California State Vehicle Fleet Fuel Efficiency Report, Volume II*, 600-03-004, April 2003.

[16] Stacy C. Davis, Susan W. Diegel (prepared for U.S. DOE), *Transportation Energy Data Book, Edition 24*, ORNL-6973, December 2004.

Low Rolling-Resistance Tires

Tires that reduce road friction increase fuel economy. Most automobile manufactures routinely use low rolling-resistance tires on new vehicles to help meet federal fuel economy standards. Replacement tires tend to be less fuel-efficient. Sufficient data, however, is not yet publicly available to draw conclusions regarding the performance and characteristics of fuel-efficient tires[17].

Heavy Vehicle Systems Optimization

Heavy trucks account for about 25% of the energy consumed by highway vehicles. Trucks ship much of the nation's high-value freight, and the propulsion system for over-the-road trucks (Class 8) is dominated by relatively efficient diesel engines. Nevertheless, room exists for energy-efficiency improvements. One element of the U.S. Department of Energy's FreedomCAR and Vehicle Technologies Program is focused on improving medium and heavy-duty truck fuel economy. The research is focused on advanced combustion, improved aerodynamics and rolling resistance, heavy hybrid technology, and weight reduction. One goal is to reduce parasitic loss (aerodynamics, cooling, compressed air) for heavy vehicle systems by 38% by the end of 2006.

Truck Anti-Idling

Many truckers idle their engines in order to operate heaters and air conditioners while they sleep in their trucks at truck stops. This is energy inefficient. Several potential solutions exist including electrification of truck stops that would enable truckers to connect their trucks into heating, cooling, and other services for an hourly fee. A second solution is an on-board auxiliary power unit, which may be a small energy-efficient diesel-fueled generator mounted outside the cab that provides heat, air conditioning, and electricity. These options offer significant fuel saving and emission reductions but are not widely used in the industry because of a general lack of knowledge and the cost of the initial investments.

Economic Considerations

Many technical and economic barriers currently exist for affordable, mass-produced high fuel-economy vehicles, including fuel cell hybrid automobiles fueled by hydrogen. Advanced transportation technologies being developed today must compete with cars and trucks already on the road that are reliable and dependable with a reasonable 15-year service life, and that have been developed and refined for over 100 years. Within the transportation industry, key market barriers include a lack of market drivers, price, risk aversion, and lack of infrastructure.

Environmental Considerations

Transportation accounts for over 30% of all greenhouse gas emissions, over 80% of carbon monoxide emissions, over 55% of nitrogen oxides, and over 40% of volatile organic compound emissions[18].

Issues

- Should Idaho provide incentives for more fuel efficient vehicles and/or mass transportation?
- Should Idaho consider joining the national Plug-in Partners campaign, working with government and private vehicle fleets?

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[17] California Energy Commission, *California State Fuel Efficient Tire Report: Volume 1 – Summary of Findings and Recommendations*, P600-03-001F, Jan. 2003.

[18] DOE, *FreedomCAR and Vehicle Technologies Multi-Year Program Plan*, U.S. Department of Energy, Aug. 2004

6. TRANSMISSION/PIPELINES

Overview

Low-cost, reliable and available energy is crucial to the growth of Idaho's economy. Energy transmission in and throughout Idaho is fast becoming an impediment in delivery, energy security, new development, and availability of cost-effective electricity and natural gas. Less than 40% of Idaho's electricity is generated within the state (2004 Idaho Rural Partnership), and none of the natural gas consumed is produced within the state. As a result, 100% of natural gas and 60% of electrical energy consumed in Idaho is transmitted into from other states. Further, a significant percentage of transmission capacity is used to transmit power and natural gas from one state to others and only transits Idaho.

Idaho has three major private electric utilities (Idaho Power Company, the Utah Power and Light operating entity of PacifiCorp, and Avista) that maintain and operate the existing transmission in Idaho. The majority of the purchased power transits into Idaho from Wyoming, Nevada, and Washington. Many sections of transmission lines are already operating at or above capacity. All of the natural gas transmission lines are approaching capacity.

The state of Idaho is rapidly approaching a critical juncture where delivery of energy will be at the control of transmission entities, not producers and customers, endangering continued delivery of least-cost, reliable energy.

Security of energy is often described as two key elements: energy security (availability and reliability); and operating security (physical and cyber-based security). With Idaho's energy constrained by limited transmission, increased energy security has become a significant concern. These concerns are heightened due to our dependency on external energy sources and multiple single-point nodes in the transmission systems.

Current Situation

Chief considerations for meeting future growth include providing adequate transmission infrastructure to meet peak consumption in a manner that allows competitive energy procurement from regional suppliers. Transmission expansion carries the typical concerns of all major construction activities, such as supply sources, economic considerations, environmental impacts, health and safety issues, permitting issues, and social impact considerations.

Electrical Transmission

The majority of high-capacity transmission within Idaho is situated in Southern Idaho stretching from Wyoming into the Southeastern Idaho border, across the state, through the Treasure Valley and crossing into Eastern Oregon. Additional transmission connects Northern Nevada, Southwestern Montana; other transmission supports Northern Idaho from Washington and Montana. As noted in the 2004 Idaho Power Company Integrated Resource Plan (IRP), there are significant constraints in their transmission systems that impact the ability to import and deliver power during peak power periods. Costs of new energy sources are affected significantly by fossil fuel resource limitations; the ability to complete power purchases independent of transmission constraints is crucial to future competitive power rates in Idaho.

Minor transmission upgrades are under development to improve transmission in the corridors supplying Boise loads, but these upgrades do not allow for significant growth in wheeling or other new

generation. Of particular concern is the lack of transmission infrastructure for new Idaho-based generation, specifically wind and other power development across the state. For example, approximately 1,900MW of proposed wind turbine installations are in various stages of development in Idaho, of which 75MW are already in place as of the end of 2005. Another 190MW is to be installed by the end of 2006. However, less than an additional 350MW can be supported with current transmission systems without significant improvements. Limitations of transmission is a significant impact on the ability to site local wind and other power generation and sell it to large markets. Further, limitations in the Northwest impact the ability to wheel in cost-effective power from the Bonneville Power Administration (BPA) beyond current contract levels, impacting future Idaho costs.

Federal Energy Regulatory Commission (FERC) has “incentivized” development of Regional Transmission Organizations (RTOs) to enhance development of cost-effective transmission and efficient operations across state boundaries. However, the RTOs are voluntary, and as such, have limitations on authority and cost recovery mechanisms. The Western Governors Association recognizes transmission limitations as a significant element in future growth and has several committees at the regional and state levels addressing these issues and making recommendations. Further, independent companies are also looking at multistate large-capacity transmission lines to take cost-effective power generated in rural areas and transporting it to regional population centers. The proposed private party power line with the most potential to benefit Idaho is the Northern Lights DC Inland Project, originating in Western Montana and transiting Eastern Idaho before it enters Nevada to serve Las Vegas and Los Angeles loads. This line could deliver low-cost Montana power and accept Idaho renewable and other energy for sale in other markets, developing jobs and revenues for Eastern Idaho communities.

Another little-understood approach for reducing impacts on overloaded transmission infrastructure is the implementation of distributed generation (DG) throughout Idaho. For example, a DG facility that produces power displaces the need to deliver power from remote-generation sources many hundred miles away, and in the process, reduces transmission load and congestion. Cogeneration (also known as "combined heat and power" or CHP) DG has higher beneficial value in that it can be dispatched more conveniently, but renewable energy DG systems can offer similar benefits and reduce or defer the need for future transmission system investment.

Electrical transmission constraints, congestion, and limitations all contribute to the need to balance the fundamental trade-off between competing for electricity resources originating from outside the state, and encouraging more in-state electricity resource development. Idaho is one of the fastest-growing states, and the growth of electrical loads is a given. With the current transmission limitations, future growth will be impacted by transmission costs and availability. Leveraging Idaho’s future economic growth to external energy providers and long-term transmission system issues is not conducive to managed economic growth.

Natural Gas Transmission

With all natural gas production occurring north of Idaho or southeast of Idaho, interstate transmission is the only source of natural gas for homes and businesses throughout the state. Natural gas consumption is market driven and domestic production has declined by 4% since 2001. Higher costs result in lower consumption or energy source substitution. In recent years, natural gas offered significant savings over oil or electricity-based energy. However, with cost benefits declining, pressure on natural gas growth is uncertain. Regardless of growth rates, it is apparent that natural gas transmission and associated storage infrastructure will have to grow to meet any significant load growth.

Peak electrical power and most combined heat and power cogeneration systems use natural gas as the preferred energy source. Growth in electrical loads and transmission limitations will likely result in

meeting electrical peaking needs with increased peak gas usage. Analysis of peak usage and its potential impact on gas transmission systems may be required to address transmission system (both gas and electric) impacts on Idaho growth and energy costs.

Transmission Security Considerations

Security of transmitted energy is an increasingly important issue in delivering energy to users. As recently as August 2003, energy users were made aware of the fragility and interconnectivity of electrical transmission systems. The Northeast blackout was caused more by transmission overloads and loss of system status awareness, than by a lack of generation or power availability. Idaho's transmission systems abound in single-point nodes, at which entities could affect the economic health of Idaho by damaging those single nodes. Protecting critical infrastructure, especially our energy delivery systems, is increasingly critical if we are to protect our economic health.

Protection of our transmission assets will require change to improve both energy (availability and reliability) and operational (physical and cyber-based security) security elements. Improving availability and reliability is accomplished through additional generation, added transmission paths, increased availability of parallel pathways, and operation within established reserve margins. Managing reliability and availability is an increasingly difficult challenge with transmission and generation constraints abounding, combined with widely varying hydropower generation in the Northwest (as a result of water availability and regulation). Improving physical and cybersecurity of critical infrastructure, including regional transmission systems, is an area that is being addressed slowly. Protecting critical pumping stations, valve stations, substations, generation stations, and other infrastructure systems has been implemented at a simple level with protection afforded by fences, locks, and simple alarms. However, adding cyber protection and advanced physical protection elements have largely been left for future implementation because there are few regulatory requirements mandating advanced levels of protection and there has been very little consensus on the business case of the cost of protection versus cost of implementation (what has been accomplished shows marginal value). Cyber security standards need to be applied to electric distribution systems as well as transmission systems.

FERC and the North American Electric Reliability Council (NERC) have increased regulatory pressure on utilities and offer possibilities to recover reasonable and prudent costs from rate increases. An example of this is NERC's recent critical infrastructure protection requirements that require utilities to address cybersecurity (NERC CIP 2-9). However, even though utilities can recover security-related costs, a rate base increase is required. The political costs and challenges of mounting rate cases dissuade most utilities and PUCs from acting promptly.

The Energy Policy Act of 2005 provides the Federal Energy Regulatory Commission with the authority to certify an Electric Reliability Organization (ERO) for North America. The ERO will be responsible for the establishment, approval and enforcement of electric reliability standards. The North American Electric Reliability Council, which currently oversees the reliability of the electric systems in the United States and Canada has most of that responsibility now and will likely be a significant element in the final ERO. The ERO function will have overriding control of transmission issues and is intended to include Canada and Mexico. It will have impact on the future of Idaho's transmission systems.

Economic Considerations

Other sections of this report deal with individual generating technologies and address the costs of generation. This information is not indicative of the true generation costs when transmission is constrained. For example, a generation plant that uses existing transmission capacity will see little if any

impact on generation cost; however, a plant installed in a constrained system may incur transmission upgrade costs in excess of the plant's capital cost for generation.

Further, system economic planning for overall electric grid reliability must include assessing the performance of intermittent generating sources, chiefly wind energy in Idaho's case. For example, if the level of wind power sources supplied to a system is kept at less than 10 to 15% of the overall average electrical load ("penetration level"), integration and operation of the power grid with wind turbines is typically relatively simple. Most grid systems already have enough installed backup capacity to deal with this level of variable power. In the event that other intermittent power supply sources start to exceed approximately 15%, additional measures (more backup capacity, operational changes, and other engineering techniques) are typically required to maintain grid stability and reliability. Transmission upgrade costs in Idaho have the characteristic of burdening the next connected project based on actual costs of expansion. An example is that many projects in rural farming areas rich in pumps may have low costs for the first few projects, but subsequent projects may have to pay incremental costs many million dollars higher than the previous projects. Current rate recovery methods are not conducive to long-range transmission investment.

Conservative estimates place the cost of added security at less than 1% of operating budgets, and even though that is a large one-time cost, the cost of doing nothing has not been adequately addressed. The costs of the 1996 Northwest and 2003 Northeast blackouts offer insight into the cost of an outage if it were to be deliberately caused and adequate physical and cyber measures were not in place to prevent it.

Environmental Considerations

Each energy transmission system has its own environmental characteristics ranging from traditional concerns such as preserving Idaho's air and water quality on the one hand to more specific matters such as visual impacts associated with large power lines. The prospective delays associated with completion of environmental reviews for new electrical generating facilities need careful attention when evaluating alternatives.

Another perspective regarding environmental impacts from electricity alternatives is to consider relative environmental benefits of using transmission to carry energy from remote areas into populated Idaho communities. For example, renewable electricity systems (e.g., solar and wind) emit no greenhouse gases, but having to add local fossil-based generation to offset expanded transmission facilities raises environmental issues. Trade-offs are needed to address the value and costs of all alternatives. There are few negative environmental impacts attributable to natural gas pipelines; electric transmission lines have higher impact levels, ranging from avian fatalities to visual impacts. There is much speculation concerning electromagnetic impacts from power lines, but scientific evidence is not consistent with any statistically significant impact. Regardless, all of these issues need to be addressed for increasing transmission system capacities to meet the needs of Idaho.

Health and Safety Impacts

As with environmental considerations, each energy transmission system has its own health and safety characteristics. For electricity systems in general, workplace safety has been traditionally managed by the utilities and systems owners in a manner that has gradually improved over time, subject to various federal and state regulations as well as improved enforcement measures. These aspects of the electricity system apply to all parts of that system, ranging from simple household wiring to proper tree trimming procedures for transmission and distribution lines.

Social Impacts

As is true throughout the United States in general, new development of transmission systems in Idaho will depend in part on the public's willingness to accept the perceived social dislocations associated with these facilities. There are also perceived positive social impacts such as greater employment and economic development benefits. Increased access to new remote-generation facilities also has social impacts, such as having access to additional low-cost, low-emission generation plants.

Decisions made primarily outside the state can dramatically influence electricity investments with impact on Idaho, in particular with regard to the siting of transmission lines. For example, as more energy resources are developed in Alberta, Idaho could find itself the crossroads of new major utility corridors running between Canada and California or Canada and certain Midwest states.

Issues

- What should Idaho do to encourage investment in energy transmission systems?
- Are changes needed in energy transmission siting and permitting?
- How can additional natural gas storage capacity be encouraged?
- Are long-range plans for energy transmission adequate to meet Idaho's needs?
- Should investment in energy transmission system security improvements be encouraged and if so, how?

7. LOCAL, STATE, REGIONAL GOVERNMENT'S ROLE IN ENERGY CONSERVATION AND RESOURCE DEVELOPMENT

Overview

Local governments play a vital role in the state's energy future. State governments are also joining together on a regional basis and playing a vital role. There are a vast number of fiscal incentives and regulatory actions that local and state governments can take to influence the development of energy resources. As many barriers to energy development originate locally, the means to redress them often exist within the jurisdiction of local governments. State and local governments are in the unique position of adapting energy programs to local needs and making optimum use of institutional, financial, and human resources. In particular, land use policies, building codes, and community service delivery systems will determine energy requirements at the local level.

Local, state and federal governments share responsibility for most elements of energy security. Jurisdictional issues define who does what in an emergency and who is responsible for ongoing security, planning, regulation and oversight. Local government sometimes serves only as first responder, but sometimes is also the utility as well, as is the case with municipally owned utilities. To maximize efficiency, local, state and federal governments need to collaborate, share information, and develop coordinated plans and responses.

Regionally, all states depend on others for their energy supply. The infrastructure of shipping, pipelines, power plants and transmission lines is vital to every state, but each can exercise control over only a small portion of this system.

State governments can initiate multistate cooperation, but federal action is sometimes required. The federal Energy Policy Act of 2005 recommends the federal government make decisions on long-distance transmission lines, if states do not. To help with regional transmission system planning, the Federal Energy Regulatory Commission has proposed Regional Transmission Organizations.

Current Situation

In the 2005 first legislative session of the 58th Idaho Legislature, the House of Representatives established the Environment, Energy and Technology Committee. This committee has jurisdiction over energy incentive issues, generation and plant siting as well as any other energy-related or technology issues that may come before the legislature.

Idaho has almost 64% of its land administered by a variety of federal agencies. In only two other states does federal land exceed 60% of the state—Nevada at 77% and Utah at 63%.

Of the 50 states, Idaho has the largest proportion of its land (almost 39%) in the National Forest System of lands administered by the U.S. Forest Service. The Bureau of Land Management is responsible for another 22% of the land in Idaho. Other federal agencies have 3% of the land in the state.

Idaho state agencies control 5.1% of the state's land. A breakdown of the percentages is as follows:

Table 1. Control of Idaho's Land by Federal, State, and Local Agencies

	% of Idaho Land
Federal Agencies:	
U.S. Forest Service	38.6%
BLM	22.4
DOE	1.1
Bureau of Reclamation	0.9
U.S. Air Force	0.2
National Park Service	0.2
U.S. Fish & Wildlife Service	0.2
U.S. Army Corps of Engineers	0.1
Agricultural Research	<0.1
Bureau of Indian Affairs	<0.1
Total	**63.8%**
State Agencies:	
Dept. of Lands	4.7%
Dept. of Fish & Game	0.4
Dept. of Parks & Recreation	<0.1
Total	**5.1%**
Tribal Lands	**1.4%**
County	**0.2%**
Municipal	**<0.1%**

The Pacific North West Economic Region (PNWER), a statutory entity created in 1991 by the member states of Alaska, Washington, Idaho, Montana, Oregon, and the Canadian provinces of British Columbia, Alberta, and the Yukon Territory. The Pacific Northwest faces a challenge as it looks to sustain the region's economic growth. Access to comparatively low-cost energy has historically been a competitive advantage for the region.

Sustaining this advantage and meeting the challenges of the future is complicated, given severe congestion in the regional grid, capacity deficits in the next few years (based on current positions, expected load growth, and expiring contracts), the lack of fully comprehensive bi-national transmission planning, obstacles to infrastructure and corridor siting (particularly when proposed projects cross

multiple jurisdictions), and high costs (if transmission corridors are not sited and built soon, consumers may remain vulnerable to spiking energy costs).

Siting and permitting requires working with a range of local, state, provincial and federal authorities and agencies, each with their own unique process for identifying and utilizing appropriate transmission corridors. In the Pacific Northwest, these challenges are made more difficult by the fact that many of the resources (e.g., coal in Montana, or wind in Idaho, eastern Washington and eastern Oregon) are far from areas of load growth such as Seattle, Portland, and southern California.

Although much of the land in the West is administered by the U.S. Department of Interior Bureau of Land Management and the U.S. Department of Agriculture Forest Service, there are also significant amounts of state-administered land and private land. Given the historic difficulties in improving the region's energy infrastructure (such as electric transmission lines and oil and gas pipelines) identification of energy corridors on federal lands may help facilitate the siting process and will encourage owners, operators and developers to move forward with infrastructure development plans.

Ratepayers deserve safe, secure, reliable, and economic energy, and choices for alternative sources of energy. Securing access to these resources depends upon the transportation and transmission capabilities of the region.

Two cutting-edge projects deserve specific mention in any effort to identify energy corridors on federal lands. INL is the potential site for an advanced technology Generation IV nuclear power plant. Additional electrical transmission will be necessary to connect its generating capacity to major load centers to the west and south, should it be built. Secondly, California and British Columbia are independently working on establishing "hydrogen highways" in their respective jurisdictions. California is developing infrastructure that would facilitate the use of hydrogen-powered vehicles along the I-5 corridor and British Columbia is establishing a series of hydrogen and fuel cell demonstration projects in and around Victoria, Vancouver, and Whistler, B.C. PNWER is working with interested parties in Oregon and Washington with a goal of connecting these two hydrogen projects to promote a "hydrogen highway" from San Diego, Calif., to Whistler, British Columbia, so that hydrogen fuel cell cars could be driven all the way to the 2010 Winter Olympic Games in Vancouver, B.C. This will entail siting hydrogen storage facilities and may involve siting pipeline corridors along the proposed route.

8. EMERGING TECHNOLOGIES

In addition to the variety of energy technologies described previously, there are at least two additional technology areas that are receiving significant attention. The following material will consider the potential, economics, and the environmental, safety and health, and social impacts associated with hydrogen and synthetic fuels technologies.

8.1 Hydrogen

Overview

The demand for hydrogen is increasing worldwide, driven primarily by the petroleum and petrochemical industries. This short-term demand is associated with the increasing need for hydrogen to upgrade low-quality petroleum resources such as the Athabasca oil sands and Orinoco heavy crude. In addition, with increasing oil prices, there is growing interest in the development of alternative fuels for the transportation sector. This interest is driven by the desire to reduce U.S. dependence on foreign petroleum and to minimize harmful vehicle emissions to the atmosphere. Hydrogen is of particular interest as a potential energy carrier for transportation because it can be produced from various feedstocks and primary energy sources. Furthermore, hydrogen fuel-cell vehicles can operate with high efficiency and with zero emissions. Alternative strategies, such as the production of synthetic liquid fuels, also require large quantities of hydrogen.

Currently, hydrogen is produced primarily via steam reforming of methane. From a long-term perspective, methane reforming is not a viable process for large-scale production of hydrogen as a major energy carrier because it consumes nonrenewable resources and emits greenhouse gases. Furthermore, the price of natural gas is rising rapidly, commensurate with its wide range of uses including home heating, power generation, ammonia production, petroleum refining, and transportation fuel. If the long-term vision of a pollution-free, sustainable hydrogen economy is to be fully realized, future hydrogen production technologies should be based on water splitting using either renewable energy sources or nuclear energy.

In his 2003 State of the Union Address, President Bush announced the Hydrogen Fuel Initiative, a $1.2 billion commitment over five years to accelerate hydrogen-related research and to overcome obstacles in taking hydrogen fuel-cell vehicles from the laboratory to the showroom. In Idaho, research on hydrogen production technologies and hydrogen utilization is being performed at INL. However, there are currently no other major activities in the state related to the development of hydrogen as an alternative fuel.

Several U.S. states have adopted plans and policies designed to encourage development of hydrogen technologies and infrastructure. Probably the best known program has recently been adopted by the state of California. In April 2004, Gov. Arnold Schwarzenegger signed an executive order intended to jump-start the use and operation of hydrogen-fueled vehicles in California. The governor's order called for a Hydrogen Highway Network, a public/private partnership that will, "Support and catalyze a rapid transition to a clean, hydrogen transportation economy in California, thereby reducing our dependence on foreign oil, and protecting our citizens from health harms related to vehicle emissions." The California Hydrogen Highway Blueprint Plan, which was released in May 2005, calls for a dramatic increase in the use of hydrogen-fueled vehicles and a network of hydrogen fueling stations and other infrastructure in three phases. The first phase calls for 50 to 100 fueling stations and 2,000 vehicles by 2010. It also promotes increased renewable resource use with a goal to use 20% renewable resources for both the energy source and feedstock used in hydrogen production by 2010. The governor's plan places great importance on the development of "bridging technologies," which assist the development of fuel-cell technologies. Electric-drive technologies are bridging technologies, including hybrid, plug-in hybrid, and pure electric vehicles. Several nonpetroleum fuels in use now and proposed for increased roles in California's transportation fuel mix are potential hydrogen carriers (that is, fuels that contain hydrogen and could be reformed to produce hydrogen for fuel cells in the future). Many state agencies are involved in implementing the governor's plan. Other states with hydrogen initiatives include: Florida, New York, Illinois, Pennsylvania, and Ohio.

Current Situation

With the exception of DOE-sponsored research work at INL, there are currently no significant public or private activities in Idaho related to hydrogen production, hydrogen infrastructure, or hydrogen as a transportation fuel. Also, there are no oil refineries or ammonia production facilities within the state of Idaho.

Potential

Hydrogen has excellent potential as a zero-emissions energy carrier, helping to reduce our dependence on foreign petroleum. Development of hydrogen production technologies and hydrogen distribution infrastructure is needed. This could be accomplished through a combination of direct funding (with private and federal government partners) of infrastructure projects, tax incentives, hydrogen vehicle and fueling station demonstration projects, streamlining and standardizing the fueling station permitting process, etc. Another possibility is support for the development of wind-power-based hydrogen production. The outlook for the development of wind power in Idaho is excellent, with approximately 1,900MW of proposed wind turbine installations in various stages of development Many experts see a natural connection between wind power and hydrogen production, due to the intermittent nature of wind power and because wind resources are often not located near transmission.

Fleet vehicle programs based on clean-burning natural gas have been in place in Idaho for many years. Similar programs for hydrogen fuel cell and synthetic fuel vehicles could be supported as the technologies are developed.

Economic Considerations

The economic viability of development and use of hydrogen and hydrogen-related synthetic fuels will be determined by the prices of petroleum, natural gas, and electricity and by market forces. The current production price of hydrogen based on steam methane reforming is around $1.5 per kg (one kg of hydrogen has essentially the same energy content as one gallon of gasoline). However, the market price of compressed hydrogen is closer to $10.00 per kg for trailer-delivered hydrogen and $3.00 per kg for pipeline-delivered hydrogen. The production cost of hydrogen obtained from conventional electrolysis depends on the cost per kW·h of electricity. At $0.10 per kW·h, hydrogen can be produced by conventional electrolysis for about $4.00 per kg (not including the capital cost of the electrolyzer). So even today, the cost of hydrogen is nearly competitive with the cost of gasoline on a per-kg basis. Advanced hydrogen production technologies will reduce the cost of hydrogen production from water splitting. The biggest hurdles for hydrogen as a transportation fuel are its low volumetric energy density and infrastructure development. The initial stages of development for hydrogen technology and infrastructure will have to be subsidized.

Environmental Considerations

The primary drivers for the development of hydrogen as an energy carrier are the desire to reduce U.S. dependence on foreign fossil fuels and to minimize harmful vehicle emissions to the atmosphere, including greenhouse gases like carbon dioxide. This technology has the potential to produce very positive environmental impacts. Of course, any hydrogen that is produced is only as clean as the method that was used to produce it. For example, steam methane reforming produces significant quantities of carbon dioxide. Other proposed hydrogen production technologies such as reforming of coal will have more significant air pollution concerns and will require the use of carbon sequestration. Environmental concerns associated with hydrogen production from water electrolysis are exactly the same as the concerns associated with the electrical power production technology that is used. Advanced high-

efficiency water splitting technologies include thermochemical methods and high-temperature electrolysis. Thermochemical methods require a source of high-temperature (~900°C) process heat. High-temperature electrolysis requires high-temperature process heat and electricity. Both techniques can be achieved with high-temperature nuclear reactors. Research on these technologies is supported by the DOE Nuclear Hydrogen Initiative. Hydrogen production based on water splitting using nuclear energy will not produce any greenhouse gases or other air pollution. The environmental concerns associated with those techniques are the same as the concerns associated with nuclear power in general.

Health and Safety Impacts

Codes and standards associated with the safe use and handling of hydrogen are available from numerous sources. Additional codes and standards are currently in development for hydrogen fueling stations and hydrogen vehicles. Hydrogen is a colorless, odorless, tasteless, highly flammable gas. It is also the lightest weight gas. Since hydrogen is noncorrosive, special materials of construction are not usually required. However, hydrogen embrittlement occurs in some metals at elevated temperatures and pressures. The wide flammability range, 4 to 74% in air, and the small amount of energy required for ignition necessitate special handling to prevent the inadvertent mixing of hydrogen with air. Care should be taken to eliminate sources of ignition such as sparks from electrical equipment, static electricity sparks, open flames, or any extremely hot objects. The hazards associated with handling hydrogen are fire, explosion, and asphyxiation. The potential for forming and igniting flammable mixtures containing hydrogen may be higher than for other flammable gases because hydrogen migrates quickly through small openings and because the minimum ignition energy for flammable mixtures containing hydrogen is extremely low. Burns may result from unknowingly walking into a hydrogen fire. The fire and explosion hazards can be controlled by appropriate design and operating procedures. Preventing the formation of combustible fuel-oxidant mixtures and removing or otherwise inerting potential sources of ignition (electric spark, static electricity, open flames, etc.) in areas where the hydrogen will be used are essential. Careful evacuation and purge operations should be used to prevent the formation of flammable or explosive mixtures. Adequate ventilation will help reduce the possible formation of flammable mixtures in the event of a hydrogen leak and will also eliminate the potential hazard of asphyxiation.

Social Impacts

Ultimate achievement of a hydrogen economy that is completely independent of fossil fuels and greenhouse gas emissions has the potential to have a major social impact in terms of achieving energy independence and a cleaner environment. However, this vision can only be achieved with the support of informed citizens, incentives from local and state governments, and a combination of research funding and incentives on the federal level.

Issues

- Should Idaho take actions to encourage the development of hydrogen production technologies, infrastructure, and/or use?

8.2 Synthetic Fuels

Overview

The market pull for development of alternatives to conventional petroleum and natural gas sources is being driven by growth in the world economy, failure to replace reserves that are used with new discoveries, and geopolitical control of the conventional sources.

There are three items required for producing synthetic fuel: energy, hydrogen, and a carbon source. Depending on the form of the carbon, there may be a higher or lower requirement for energy. The processing system can be modified to accommodate various energy sources, various ways to generate hydrogen, and various carbon sources, but those three elements must be there. For example, whether the hydrogen comes from reforming of natural hydrocarbons, chemical reactions, or disassociation of water; the processing use of that hydrogen is the same. A key then is to understand how a processing system must be modified to accommodate the changes in the generation of fuel necessitated by the changes in the key material inputs to the system.

Current Situation

Potential

The strong economic growth in countries such as China is fueling rapid escalation of prices for conventional energy sources. Imports of crude oil by China grew 30% from 2002 to 2003 (Strategic Issues, DOD, March, 2004) and it has not slowed down in recent years. The United States, the other developed countries, and the developing countries are forecast to increase their energy use at the rate of 1.7 % per year (Energy Information Agency, 2004). This rapid increase in the use of crude oil puts pressure on the price and availability of products based on this feedstock since crude oil is not being replaced at the rate it is being used.

Petroleum production in the United States (lower 48) was predicted by a Shell Oil geologist to peak in 1970. The actual production matched closely the predictions indicating that the United States has passed its peak petroleum production. Similar predictions have been made by the United States Geological Survey and found to be true that the North American (includes Mexico, Alaska, and Canada) fields would peak in 1984 and Europe in 2001. It is predicted that the OPEC members' production will peak in 2010 (Australian Energy News, 2001). This prediction is validated by the steady decline in OPEC reserve capacity of 15 million barrels per day (MBPD) in 1982 to less than 5 MBPD in 2004 (EIA, 2004). The current situation with oil exceeding $50 per barrel and OPEC indicating reserve capacity of no more than 1.5 MBPD (CNN, 2005) suggests that production may reach a peak sooner then expected. These reductions are driving the world toward synthetic fuels.

The customer base for the synthetic fuels and related systems span the government and commercial sectors. In 2003, the U.S. Department of Defense consumed about 110 million barrels of oil (i.e., 4.6 billion gallons) just for transportation (Defense Energy Support Center). This amount is expected to expand in the future, and expands significantly when there is a conflict under way. In 2002, the United States consumed 19.8 MBPD of which 53% was imported (EIA, 2003). By 2025, the estimate is for consumption of 29.2 MBPD with approximately 70% being imported. The opportunity exists to satisfy a customer and to reduce the balance of payment deficit by developing synthetic fuels to imported fuel.

Commercial firms have identified as a key concern the pressure placed on profitability by increases in energy costs. A March 2005 presentation from the Manufacturers Alliance presentation highlighted

growth in oil demand and projected energy prices. It indicated that economic growth in China and India is adding 4 MBPD of demand. This growth is expected to continue through at least 2006 and put further upward pressure on oil prices. Higher prices are likely to increase the $170 billion outflow from U.S. oil purchases in 2004, increasing both the trade deficit and current account deficit. To prevent a drop in the economy, a reliable and secure source of fuel is required. A synthetic fuel program based on domestic energy sources addresses both stability and security.

As shown in Figure 4, three items are necessary for production of synthetic fuels: energy, hydrogen, and a source of carbon. Depending on the form of the carbon, there may be a higher or lower requirement for energy and hydrogen. The processing system that is used can be modified to accommodate various energy sources, various ways to generate hydrogen, and various carbon sources. A key element then is to understand how a processing system must be modified to accommodate changes in the generation of the fuel necessitated by changes in the key material inputs to the system.

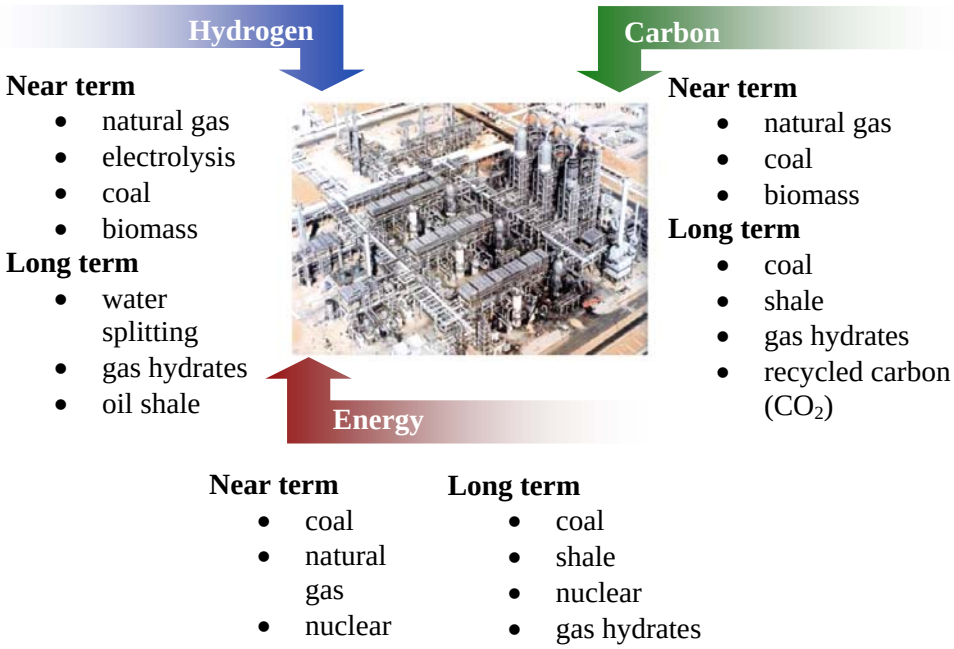

Figure 4. Formation of Synthetic Fuels.

One of the difficulties in addressing the market opportunity described above is the wide variety of technologies that are involved in synthetic fuels and the systems that use those fuels. To understand why so many technologies are involved, it is necessary to identify the breadth of the suggested synthetic fuels. In general, synthetic fuels can be considered to be man-made hydrocarbon fuels (diesel, gasoline, etc.) that are derived from nonpetroleum or non-natural-gas feedstock, biologically derived fuels (alcohols, etc.), and hydrogen.

Nontraditional sources for the preparation of hydrocarbon fuels include coal, oil shale (it is important to note that the United States has over 2 trillion barrels of oil equivalent in oil shale), oil (tar) sands, coal bed methane (CBM), landfill gas, methane hydrates, and various types of biomass. A critical step in taking any of these sources to a usable hydrocarbon fuel is a gasification step that breaks the incoming material into a hydrogen and carbon monoxide stream (i.e., synthesis gas). The step may be called reforming when the input stream is CBM, methane hydrates, or landfill gas but it is still basically a gasification step.

Once gasification has occurred, the next step is to put these molecules back together in the desired form. This is traditionally accomplished by a Fischer Tropsch (FT) reaction or some variant on this well-known process. The FT process is a catalytic process that provides a variety of products that must undergo further processing for separation and upgrading. Technology such as fluid catalytic cracking, hydrocracking, catalytic reforming, isomerization, desulfurization, alkylation, etc., come into play at this step.

In many cases, the processing from the identified feedstock removes excess carbon through conversion to carbon or carbon dioxide. The emission of carbon dioxide is receiving increasing attention and carbon capture and sequestration are other technologies that would be required. Carbon capture and carbon sequestration are also technologies that have multiple value propositions. These technologies prevent carbon dioxide release to the atmosphere and provide the basis for the synthesis of additional hydrocarbon fuels in special circumstances.

Hydrogen is generally identified as the ultimate alternative fuel. Most hydrogen (over 80% by volume) is currently produced by reforming of natural gas and used in the refining and petrochemical industries. When produced from natural gas, the hydrogen would not qualify as an alternative fuel since it is based on conventional technology. There is some sentiment to use naturally derived hydrocarbons for generation of hydrogen at least in the early years of use of hydrogen.

Other sources for production of hydrogen include conventional electrolysis, chemical reaction with water, thermo-chemical water splitting, gasification, and high-temperature electrolysis. Hydrogen is a carrier of energy rather than an energy source. Production of large quantities of hydrogen requires the application of energy from an external source. For example, the high-temperature electrolysis process requires the availability of a high-temperature thermal source (e.g. high-temperature gas reactor) and a source of electricity. As another example, chemical reaction with water (e.g., sodium borohydride) requires the input of energy for the formation of the compound and the regeneration of the sodium borohydride.

INL is the potential site for an advanced technology Generation IV nuclear power plant that is planned to include the production of hydrogen in commercial quantities. If built, this reactor and the associated hydrogen could be a key element in the synthesis of fuels. Naturally occurring hydrocarbons such as coal, oil shale, tar sands, etc., are hydrogen deficient fuels.

Economic Considerations

The economics for synthetic fuels is highly dependent upon the sources of carbon, hydrogen, and energy used as well as the specific production process. At current petroleum costs of $60 per barrel, some synthetic fuels are currently cost competitive or nearly so. Future costs will depend upon technology development and evolution.

Environmental Considerations

Production of synthetic fuels can have significant environmental concerns that need to be effectively mitigated. For example, while oil shale can provide a source of the carbon, hydrogen, or energy needed to produce synthetic fuels, its mining and processing present challenges in water, solids, and air emissions management. Fuels derived from biological feedstocks are favored by many environmental groups because they believe that fuels derived from these sources are carbon neutral. Inputs to a biomass system include grains, cellulose-based material, and various wastes (sewage sludge, offal, etc.). The grains usually use a fermentation-based system to produce alcohols that can then either be used directly, blended with other fuels, or processed further into more conventional fuels such as diesel.

The cellulose-based products usually use either acid hydrolysis or an enzyme-based conversion to alcohols that have the same options for use as the fermentation-based products. The use of waste products generally relies on a gasification step to generate a synthesis gas that can then be converted to liquid synthetic fuel using the same types of processes previously mentioned.

Issues

- Should Idaho encourage the development or use of synthetic fuels?
- Is Idaho biomass a viable source of carbon for production of synthetic fuels?