RENEWABLE ENERGY:
AN OREGON ECONOMIC OPPORTUNITY

A REPORT TO THE OREGON ECONOMIC AND COMMUNITY DEVELOPMENT DEPARTMENT BY THE OREGON BUSINESS ASSOCIATION AND THE OREGON ENVIRONMENTAL COUNCIL

MARCH 25, 2005

INTRODUCTION

In mid-2004, the Oregon Economic and Community Development Department (OECDD) contracted with the Oregon Business Association (OBA) and the Oregon Environmental Council (OEC) to research and prepare a report assessing the economic opportunities presented by the electricity and biofuels sectors of the renewable energy industry. Because the environmental benefits of renewable resources are well-documented in other reports and studies, OECDD asked OBA and OEC to concentrate on the prospects for and barriers to economic development. This report builds on the second draft of the Oregon Department of Energy's (ODOE's) Oregon Renewable Energy Action Plan.[1]

Economic Opportunity

In the context of this report, "economic opportunity" means an opportunity with a potentially wide economic impact relative to the region where the opportunity exists. The term does not include every business opportunity, but only those having a sufficient impact on a local or regional economy to warrant state encouragement through OECDD. A project that generates 100 temporary construction jobs and 10 ongoing operations jobs may have a significant impact on a rural Oregon county but a negligible impact in the Portland area. Such a project might justify state action in the first case but not the second.

Limited Focus

Because renewable resources take so many forms and affect so many different sectors of the national and state economies, OECDD asked OBA and OEC to concentrate its research on two sectors—transportation and electric generation. The first part of the report examines the economic potential for an Oregon renewable transportation fuels industry (ethanol and biodiesel).[2] The second part discusses the economic potential for two representative renewable generating resources: wind and biomass from forest residues.

OECDD selected wind power because that renewable resource already has a solid Oregon foothold, with about 250 megawatts (MW) of capacity already on line and nearly 800 MW of new capacity approved, in permitting, or proposed.[3] Although large, experienced companies have developed most of the state's projects, OECDD also

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[1] The second draft is the only publicly available document. ODOE has not released the draft plan recently sent to the Governor. See http://oregon.gov/ENERGY/RENEW/RenewPlan.shtml.

[2] This section of the report concentrates on economic opportunities in renewable transportation fuels because the transportation section is the largest potential market for biofuels. While there are off-road markets for biodiesel, such as construction, agriculture, and power generation, highway uses will drive the biodiesel market in the next two years. (See discussion of factors driving market demand in later sections.)

[3] See Renewable Northwest Project's Project List (www.rnp.org/Projects/nw_ren_proj.html).

wanted to know more about the potential for community wind farms—smaller scale projects developed by farmers or rural communities.[4] Because forest residue presents a significant wildfire hazard and consequent air pollution problem to rural Oregon, OECDD wanted this report to also look at the economic potential for using biomass from forest residues for electric generation.[5]

Methodology

This report emerged from four stages of research and consultation. First, OECDD, OBA, and OEC consulted government and industry renewable resource proponents in focus groups and in individual interviews to obtain and understand their views. Second, OBA and OEC researched published national and state sources to assess the potential economic benefits to Oregon of accelerated renewable resource development as well as the prospects for and barriers to such development. Third, after drafting the report's findings, conclusions, and recommendations based on the consultations and independent research, OBA and OEC asked earlier contributors to review the draft report. Finally, after incorporating many of the comments received from reviewers, OBA and OEC issued this final report.

[4] The Draft RE Plan sets a 2006 goal of 300 MW of new wind energy resources, "of which 10 percent will be from *community or locally owned* wind energy projects" (p. 5).

[5] ODOE's 2006 goal for biomass is 25 MW of new capacity. Ibid.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Conclusions - Biofuels

Rarely does Oregon find the opportunity to attract a new industry to the state; the renewable fuels industry is such an opportunity. Put simply, there is a strong and growing West Coast demand for 100s of millions of gallons of renewable transportation fuels (ethanol and biodiesel), but there are not yet any large-scale West Coast plants to meet that demand. With a small amount of encouragement and a minimal impact on the state's budget, Oregon stands a very good chance of leading a West Coast biofuels industry—to the advantage of a wide swath of the state's economy.

Federal and state regulations and policy initiatives will stimulate significant West Coast demand for renewable transportation fuels. Renewable fuels markets will generate demand for oilseed crops, such as canola and mustard seed, that Oregon farmers can grow as rotational crops. These new industries will require oilseed crushing and processing facilities that will substantially stimulate local rural economies and generate new job growth during construction and operation.

There is already a very large West Coast ethanol market, but there are no large West Coast facilities to satisfy that market; nor are there any biodiesel plants to meet the expected 2006 national demand for biodiesel. Nonetheless, one of the West Coast states *will* get the jobs the biofuels industry will generate for farmers, construction workers, metals industries, and operations personnel. Will it be Oregon? Our state can capture the economic growth from these industries but needs to act quickly to ensure a stable local market for renewable fuels and to encourage construction of crushing and refining facilities.

Recommendations - Biofuels

This report recommends that Oregon:

Stimulate Demand

- Institute a statewide Renewable Fuels Standard with the following requirements: (1) a minimum two percent biodiesel content (B-2) in all diesel fuel sold in the state for highway use after June 1, 2006, rising to five percent on January 1, 2010 for all diesel uses, and (2) a minimum ten percent ethanol content (E-10) in all gasoline sold in the state beginning January 1, 2010.
- Provide biofuels market analysis and strategy assistance by raising awareness of the uses and benefits of renewable fuels in target markets.
- In order to ensure a stable in-state ethanol market, ban the use of MTBE in the state, and require the use of ethanol to fulfill any oxygenate requirement imposed by state air quality regulations.

Establish Production Facilities

- Permit biodiesel production facilities to use the same property tax exemption that is now available for ethanol production facilities.
- Investigate tax credits or other financial incentives that will encourage construction and operation of oilseed crushing facilities in rural communities and that will enable growers to extract added value from feedstock crops for biofuels plants.

Develop Supplier Networks

- Develop biofuels industry supplier networks by coordinating and connecting state biofuels initiatives with private industry.
- Direct the Oregon Department of Agriculture to identify and recommend actions that could accelerate in-state feedstock cultivation to fulfill the expected demand from Oregon biodiesel production.

Conclusions– Electric Generation from Renewable Energy

Oregon legislators, policymakers, and regulators have consistently promoted the environmental and economic benefits of electricity from renewable resources. The legislature has also backed up its policy statements with incentives for development of these alternative generating resources. Despite all this well-intentioned state encouragement, widespread deployment of renewable generation faces many difficult institutional, regulatory, and, most importantly, market barriers. In particular, some higher cost renewable resources simply have not compared favorably with the state's historically lower electricity prices (wholesale and retail). More recently, some renewable generating resource costs have become more competitive with conventional generation, notably large wind farms and some combined heat and power (CHP) projects using biomass as fuel. Nevertheless, many additional obstacles to renewable resource development remain. Overcoming these barriers requires committed state leadership and a coordinated effort by all state agencies. Utilities, regulators, ratepayer groups, and renewables advocates must also seek mutually beneficial solutions rather than maintaining their often-adversarial postures.

Recommendations – Electric Generation from Renewable Energy

- Removing the barriers to renewable resources development requires committed state leadership. The state should develop a unified message regarding the system and customer benefits of renewable and distributed generation.[6] In particular, the state should actively encourage cooperation among affected groups, such as utilities, IPPs, ratepayer groups, economic development, and environmental advocates, by raising awareness of the opportunities for mutual gain.

[6] ODOE, in its Draft RE Plan, recommends that the Governor appoint a "Renewable Energy Working Group" to guide the implementation of the RE Plan (p. 8)

- A broad-based stakeholder group should analyze the economic costs and benefits of a renewable portfolio standard and report the results to the governor and legislature.[7]
- The state should encourage development of advanced electric system control and communications technologies—for both a more efficient grid and economic development.

[7] The Governor's Advisory Group on Global Warming has also recommended adoption of an Oregon RPS ("GEN 2a"). The Advisory Groups suggests an RPS as an alternative to recommendation GEN 2, "Develop a greenhouse gas allowance standard for delivered energy." GEN-2a reads "Develop an Oregon Renewable Portfolio Standard (RPS) or expanded public purpose charge as an alternative to Gen 2 above (e.g., have new renewable meet 25% of 2025 load). *Oregon Strategy for Greenhouse Gas Reductions, Final Report*, (December 17, 2004), Appendix A, pp. 20-26 (October 13, 2004 Draft). If the state proceeds with recommendation GEN 2a, it could easily combine both RPS recommendations into one initiative.

PART 1 - RENEWABLE TRANSPORTATION FUELS

WHAT ARE RENEWABLE TRANSPORTATION FUELS (BIOFUELS)?

Ethanol is a gasoline additive made primarily from corn, although it can be produced from sugar cane, sugar beets, trees, agricultural waste, or even municipal waste. Ethanol is also an oxygenate. Oxygenates have been added to gasoline since 1979 to increase octane and to reduce air pollution by helping gasoline to burn more efficiently. Some newer passenger vehicles (known as FFVs—flexible fuel vehicles) can burn fuel that contains as much as 85% ethanol.

The Oregon Department of Environmental Quality (DEQ) now requires an oxygenate blend of about 10% each winter in the Portland area to reduce pollution that occurs in the cold air. About 87% of the oxygenate used nationwide is MTBE (Methyl Tertiary Butyl Ether), which some scientists believe is a potential carcinogen if inhaled or consumed in high doses. While the EPA has not finally concluded how risky MTBE is, 20 states, including Washington and California, but not Oregon, have banned MTBE rather than wait for the conclusive evidence of MTBE's harmful effects. Ethanol has none of MTBE's problems. [8]

Biodiesel is also an oxygenated fuel made from renewable sources, including vegetable oils, animal fats, or even recycled cooking oils. Although most biodiesel is currently produced from soybean oil, canola oil's characteristics are much closer to those of diesel fuel. Unlike soybeans, Oregon's climate is well suited for canola and mustard seed (both part of the Brassica family), which is an ideal rotation crop for wheat and grass seed growers. Diesel engine manufacturers have approved the use of up to 5% biodiesel as a blend with petroleum diesel ("petrodiesel" or "conventional" diesel) with no reservations. Newer engine designs can successfully burn even higher blends without modifications. Like burning ethanol in gasoline blends, burning biodiesel in petrodiesel fuel blends reduces air pollution.[9]

FEDERAL AND STATE REGULATORY CHANGES ARE GENERATING NEW DEMAND FOR BIOFUELS AND AN ECONOMIC OPPORTUNITY FOR OREGON.

Private industry will locate ethanol and biodiesel plants on the West Coast in the near future. The only question is where. Federal and state regulatory actions have stimulated the West Coast market demand for ethanol and biodiesel. California and Washington banned the use of MTBE in gasoline sold in those states after December 31, 2003. Other states followed. Those combined state actions have boosted US ethanol

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[8] Most of the oxygenate added to gasoline consumed in Oregon is ethanol. DEQ recommended lifting the current oxygenate requirement for gasoline sold in Portland during the winter months. On December 10, 2004, the Oregon Environmental Quality Commission voted unanimously to retain the current rule until October 2007.

[9] See Appendix F for more information on ethanol and biodiesel performance and emissions.

demand by more than 1.5 billion gallons annually—more than the industry's entire 1998 production. The combined West Coast (California, Oregon, and Washington) annual demand for ethanol-blended fuel is nearly 3 billion gallons, but the entire West Coast ethanol production capacity is only 9.7 million gallons. For the time being, Midwest ethanol plants are capitalizing on the mismatch between West Coast demand and supply.

Biodiesel has gotten its own regulatory boost from the US Environmental Protection Agency (EPA), which has required that all refiners begin producing Ultra-Low Sulfur Diesel (ULSD) for highway use by June 1, 2006 to substantially reduce air pollution from conventional highway diesel. Since ULSD lacks the lubricity properties of highway petrodiesel, diesel refiners will have to add something to ULSD to prevent premature engine wear and failure. A two percent blend of biodiesel in ULSD solves the lubricity problem with no effect on performance for the entire US highway diesel fleet. Oregon alone consumes about 500 million gallons of highway diesel fuel annually, providing a local biodiesel market of 10 million gallons per year (at a 2% blend). California and Washington consume another five *billion* gallons of highway diesel per year—another 100 million gallons of potential biodiesel demand. Yet there are currently no West Coast biodiesel plants to fill the potential Oregon and West Coast demand by 2006.

As important as these explicit regulatory requirements are, many states and the federal government are also churning out new policy initiatives to reduce global warming (from burning fossil fuels) and dependence on Middle East oil. One surefire way to help achieve those goals is to increase the use of cleaner, renewable fuels produced from US-grown crops. For example, the Oregon Governor's Advisory Group on Global Warming has recommended immediate state actions to reduce greenhouse gas emissions as part of the West Coast Governors' Global Warming Initiative. Among other actions, the Advisory Group recommends that the state:

- Require diesel fuel sold in Oregon for highway use to contain at least two percent biodiesel (B-2) by the middle of 2006, when EPA's ULSD requirement kicks in.
- Establish a goal that all diesel fuel sold in Oregon for all uses will contain five percent biodiesel (B-5) by 2010, and grow to 20 percent (B-20) by 2025.
- Require that all gasoline sold in Oregon contain ten percent ethanol (E-10) by 2010.
- Mandate minimum biofuel content requirements for all state-owned fueling stations.
- Review the effectiveness of federal and state incentives for transportation fuel producers, blenders, and retailers.

As a direct result of current state and federal air quality regulations, the West Coast, as well as the rest of the country, will see a substantial upsurge in demand for renewable transportation fuels. There are presently no large West Coast plants to meet the expected demand. By moving quickly, Oregon can capture these economic opportunities for its farmers, construction trades, metals industries, and entrepreneurs.

BIOFUELS PRODUCTION FACILITIES HAVE A SIGNIFICANT IMPACT ON LOCAL AND STATE ECONOMIES.

What's the potential impact of a biofuels plant on the Oregon economy? A recent study[10] of the economic impacts of a new 40 million gallon ethanol plant (equally applicable to a biodiesel plant) found that such a plant would:

- Provide a one-time boost of $142 million during construction.
- Expand the local economic base by $110.2 million each year through direct spending of $56 million.
- Create 41 full-time jobs at the plant and 694 jobs throughout the entire economy.
- Increase annual household income for the community by $19.6 million.
- Increase state income and local property or business tax receipts.

Several business groups have proposed biofuels plants in rural western, eastern, and central Oregon. One proposed 100 million-gallon ethanol plant in Clatskanie would be one of the nation's largest, and would provide proportionally higher impacts on rural northwestern Oregon than those identified in the foregoing study. A proposed 75 million gallon biodiesel plant would also provide nearly double the impacts than those identified in the study.

THE DRIVERS BEHIND THE GROWTH IN THE ETHANOL MARKET AND HOW OREGON CAN CAPTURE A LARGE SHARE OF THE WEST COAST DEMAND.

Gasoline refiners and marketers already regularly blend ethanol with their products for three reasons: (1) to raise the octane levels of their gasoline grades; (2) to extend gasoline volumes with a lower cost product when petroleum prices rise, [11] and (3) to add a oxygenate when required to reduce harmful emissions. While there are other products that can boost octane levels, ethanol is the only renewable fuel product that boosts octane and reduces harmful emissions.

Let's consider both the national and local factors that are pushing the growth of the ethanol market and creating an economic opportunity for Oregon.

- Ethanol is an oxygenated fuel that reduces emissions that contribute to global warming and local air pollution. Air pollution regulators require the addition of an oxygenate to gasoline in highly polluted communities, including several in California.
- Twenty states, including California and Washington, have banned the use of MTBE as a gasoline oxygenate in their states. Ethanol is the logical substitute, since other chemical, non-renewable oxygenates are less desirable.

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[10] J.M. Urbanchuk & J. Kapell, *Ethanol and the Local Community* (June 2002).

[11] Gas marketers will receive a Federal blenders tax credit of $0.51/gallon beginning in 2005.

- Increased use of ethanol, a renewable fuel, will reduce dependence on foreign oil from unstable areas of the world.
- Twenty-five percent of US corn exports already flow through Pacific Northwest ports, giving Oregon an opportunity to capture part of that flow for ethanol production for instate, West Coast, and export market consumption.
- A Canadian biotechnology company (Iogen) has already developed and commercialized a process to produce ethanol from cellulose, including agricultural and wood waste, which could provide a path for utilization of local Oregon feedstock for an ethanol plant.
- The co-products of ethanol production (high protein distillers dry grains and CO2) are important to Oregon and Pacific Northwest industries (dairy, beverages, high tech manufacturing).
- Governor Kulongoski, as a member of the national Governors' Ethanol Coalition, backs "investments in infrastructure to support expansion of the ethanol market."
- Oregon presently consumes 58 million gallons per year of ethanol, all of which is produced outside the state and shipped here. That consumption is about three percent of the annual Oregon gasoline consumption of 1.8 billion gallons.
- Oregon already provides targeted tax credits or tax reductions for ethanol production facilities (Appendix C).
- With the exception of one small plant in Olympia, there are no ethanol plants in the Pacific Northwest to supply Oregon and Washington requirements for oxygenated gasoline. More importantly, there are only two small plants in California to supply the enormous ethanol demand there.

By stimulating the Oregon market for ethanol, Oregon will provide a sound financial footing for the construction of new ethanol plants (including three now on the drawing boards). The state will also reduce harmful air pollution from gasoline, encourage development of Oregon-grown, renewable feedstocks for ethanol production (such as cellulose from forest products and agricultural waste), reduce our dependence on foreign oil, and promote sustainable Oregon jobs.

HOW OREGON CAN LEAD THE WEST COAST BIODIESEL MARKET.

Unlike the well-established ethanol market, biodiesel is just getting started, although biodiesel blends already have a strong foothold in Europe. Here's why Oregon can lead the way in this new market.

- Beginning June 1, 2006, refiners must begin producing ultra-low sulfur highway diesel fuel (ULSD) that reduces the sulfur content of petrodiesel by 97% to a maximum of 15 parts per million (ppm).[12]

[12] Currently, the maximum sulfur content in highway diesel (called Low Sulfur Diesel, or LSD) is 500 ppm. There is no sulfur content limit for current nonroad diesel fuel (including distillate—"light" diesel—or residual fuel, a heavier diesel fuel). That will change beginning in 2007, when

- Oregon consumes about 500 million gallons of highway diesel fuel annually. All of that fuel must meet the 2006 EPA low-sulfur standard of 15 ppm. Washington refineries (where most of the conventional diesel bound for Oregon is produced) cannot produce enough ULSD to supply Washington and Oregon.
- ULSD has substantially less lubricity (the lubricating quality in diesel fuel) than conventional diesel fuel, which will require a lubricity additive to prevent premature engine wear. Biodiesel, with its higher viscosity, has better lubricity properties than today's petrodiesel. A two percent blend of biodiesel with ULSD will solve ULSD's lubricity shortcoming. Unlike other potential lubricity additives, biodiesel also reduces harmful emissions. The EPA rules do not require refiners to include a lubricity additive. But as long as some lubricity additive will be necessary, biodiesel makes more sense for Oregon than a new chemical additive that has no environmental, economic, or energy security benefits.
- Most biodiesel producers currently use soybeans as the feedstock, but canola (or mustard seed), which can be readily grown in Oregon, provides a feedstock yielding characteristics much closer to petrodiesel. Moreover, canola has a lower sulfur content than soybean oil, making it ideal for blending with ULSD.
- Oregon wheat and grass seed growers can grow canola as a rotation crop. Those same growers can also participate in the growth of the biodiesel industry by forming cooperative crushing facilities, adding even more value for rural Oregon.
- Like ethanol, an important and valuable co-product of biodiesel production is the generation of tons of high-protein meal for dairies and feedlots in Oregon and Washington.
- Biodiesel production facilities can also benefit from state tax incentives already in place for biofuels (Appendix C).

By energizing the growth of this new biodiesel industry, Oregon can meet EPA's 2006 ULSD requirement, solve the ULSD lubricity problem, promote Oregon job growth, and provide a new source of revenue for Oregon farmers. A two percent biodiesel blend in 500 million gallons of conventional highway petrodiesel requires 10 million gallons of biodiesel. A five percent blend would require 25 million gallons. That's just for Oregon. The combined annual California and Washington consumption of highway diesel exceeds 5 billion gallons, all of which will require a lubricity additive that Oregon biodiesel plants can supply.

The entire US biodiesel industry only shipped 25 million gallons in 2003, but the potential West Coast market is more than 110 million gallons of biodiesel at a two percent blend. Compare that to 2003 US ethanol shipments of 2.81 billion gallons (a 32% increase in one year, due mainly to California's MTBE ban). Moreover, the potential market for biodiesel will leap ahead again in 2010 and 2012 when EPA's ULSD

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the EPA will limit sulfur levels in nonroad diesel fuel to the 500-ppm sulfur limit now applicable to highway diesel. In 2010, nonroad diesel fuel for all uses except marine and locomotive must meet the same 15-ppm sulfur content limit that will apply to highway uses in 2006. By 2012 all diesel fuel for all applications (highway and nonroad) must meet the 15-ppm maximum sulfur content requirement.

requirement hits off-road uses. Because of rail, water, and highway connections and the right climate, Oregon is perfectly positioned to lead the biodiesel revolution.

WHAT THE STATE CAN DO TO CAPTURE THESE ECONOMIC OPPORTUNITIES.

This report demonstrates that a small amount of help from Oregon's Governor and the 2005 Legislature can put Oregon in the lead for location of a West Coast ethanol and biodiesel industry. These limited actions, when combined with incentives already in place, will lead to hundreds of sustainable, traded-sector jobs, increased state and local tax collections, improved rural economies, and cleaner air through the use of renewable fuels.

All of the recommendations in this report came from focus groups and interviews with industry and government experts (Appendix B). These contributors generated a large number of potential actions the state could take to stimulate the growth of an Oregon biofuels industry. (See the action plan summaries below.) This report focuses on those state actions that could have the highest impact in the immediate future. These recommendations should lead to (1) increased market demand for renewable fuels, (2) establishment of in-state production facilities, (3) availability of qualified suppliers (e.g., growers, construction, metals manufacturers), and (4) industry innovation (e.g., university R&D for ethanol production from cellulose).

Creating strong demand for renewable fuels is the first step toward development of this market and an Oregon biofuels industry. With demand assured, entrepreneurs can find the financing to build production facilities. New production facilities will require agricultural feedstocks—a demand for crops and crushing facilities that Oregon farmers can fill. The recommended Renewable Fuels Standard will stimulate the Oregon market for biofuels. The remaining proposed actions will naturally follow and expand the biofuels market, but nothing will happen without the market demand for renewable fuels.

Here is a summary of the recommendations for short-term state actions. Additional discussion of particular recommendations follows the summary. The table on pages 12-13 identifies all the potential actions discussed by the report's contributors.

Stimulate Demand

Institute a statewide Renewable Fuels Standard with the following requirements: (1) a minimum two percent biodiesel content (B-2) in all diesel fuel sold in the state for highway use after June 1, 2006, rising to five percent on January 1, 2010 for all diesel uses, and (2) a minimum ten percent ethanol content (E-10) in all gasoline sold in the state beginning January 1, 2010.

Provide biofuels market analysis and strategy assistance by raising awareness of the uses and benefits of renewable fuels in target markets.

In order to ensure a stable in-state ethanol market, ban the use of MTBE and require the use of ethanol to fulfill any oxygenate requirement imposed by state air quality regulations.

Establish Production Facilities

Permit biodiesel production facilities to use the same property tax exemption that is now available for ethanol production facilities.

Investigate tax credits or other financial incentives that will encourage construction and operation of oilseed crushing facilities in rural communities and that will enable growers to extract added value from feedstock crops for biofuels plants.

Develop Supplier Networks

Develop biofuels industry supplier networks by coordinating and connecting state biofuels initiatives with private industry.

Direct the Oregon Department of Agriculture to identify and recommend actions that could accelerate in-state feedstock cultivation to fulfill the expected demand from Oregon biodiesel production.

Recommendation: An Oregon Renewable Fuels Standard

The most important recommendation for creating an Oregon renewable transportation fuels industry is to adopt a Renewable Fuels Standard that establishes minimum content requirements for ethanol in gasoline and biodiesel in diesel fuel sold in Oregon. The legislation should provide sufficient lead-time to enable businesses and regulators to adjust. This recommendation follows the patterns of actions already taken in other states. The Oregon Department of Agriculture's Measurement Standards Division (MSD) already has the authority and responsibility to inspect liquid petroleum fuels sold throughout the state to enforce compliance with (among other things) standard fuel specifications.[13]

Ethanol

Consistent with ODOE's renewable energy plan, with the staff recommendations to the Governor's Advisory Committee on Global Warming, and with the Governor's commitment to increased ethanol use, this report recommends that the state set a statutory minimum requirement of a ten percent (10%) blend ethanol for all gasoline sold in Oregon by 2010.

Biodiesel

Ethanol has already achieved substantial market penetration, and will only grow with California's ban on MTBE and need for high volumes of oxygenate for its polluted cities. Biodiesel, on the other hand, is just getting started. This provides a unique opportunity

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[13] See ORS Chapter 618; OAR 603-027-0400 through -0490. MSD has the infrastructure to inspect and enforce a minimum ethanol content requirement, but may require additional resources to conduct the content test. Because biodiesel is still in the early stages of industry development, MSD has not yet developed the equipment or test protocols to enforce a minimum content requirement for biodiesel. Nevertheless, the proposed deadline for these requirements will permit the Division to adopt appropriate test procedures and acquire the necessary test equipment.

for Oregon to lead this new industry at several levels. Our farmers can readily grow canola or mustard seed as rotation crops to supply the biodiesel feedstock. Local manufacturers can produce nearly all the plant equipment; Oregon contractors can build the plants; and Oregon trucking companies can haul the fuel up and down the length of the West Coast.

Consistent with ODOE's long- and short-term goals—and because this is such a unique opportunity for Oregon's economy—the state should require minimum percentages of biodiesel for petrodiesel fuel sold in Oregon in two stages:

For the period 2006-10	2% for highway diesel uses
After 2010	5% for all uses

The two percent requirement by mid-2006 solves the lubricity problem posed by EPA's rule requiring ULSD by 2006. Moreover, neither the two nor the five percent blends pose any problems for older diesel engines. [14]

Recommendation: Production Incentives

Although Oregon already provides some incentives for biofuels production (Appendix C), those existing incentives may not be sufficient to permit Oregon biofuels plants to compete with well-established Midwest plants having the benefit of extensive state economic incentives. Fifteen states, for example, provide production tax credits. As a first step, the state should at least extend the existing property tax exemption for ethanol plants to biodiesel plants.

In the next couple of years, the state should also identify the potential array of economic incentives for biofuels plants and weigh the cost of each incentive against the potential long-term economic benefits of attracting this industry to Oregon. In particular, the Oregon Department of Agriculture or OECDD should investigate appropriate incentives to encourage formation of farmer-owned oilseed crushing ventures to extract the added value of the oil and meal from their crops. When that analysis is complete, the appropriate agency should prepare a production incentive package for the 2007 Legislature.

Recommendation: Grower Incentives for Feedstock Cultivation

The state may successfully structure production incentives to encourage growers to participate in oilseed crushing operations, but the state may also consider incentives to encourage farmers to grow oilseed crops as feedstock for Oregon biofuels plants. Since no such plants presently exist, the state has time to identify and provide appropriate grower incentives to jump start Oregon oilseed production. Production facilities can buy their initial feedstock requirements from out-of-state sources.

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[14] The actual legislation must contain the necessary details to implement and enforce these requirements for both ethanol and biodiesel content in accordance with market realities (the existence of sufficient production capacity to supply the market) and the state's ability to ensure compliance. The legislation would also require that ethanol and biodiesel produced and blended meet appropriate ASTM standards.

Nevertheless, since Oregon farmers will initially compete with cheaper Midwest soybean and corn feedstock sources for biodiesel and ethanol plants, growers may need some short-term incentives, such as price supports, to jump start local oilseed or other feedstock production. The Department of Agriculture should lay the groundwork for in-state feedstock production by identifying the feedstock cost and quality requirements of the proposed biofuels plants. The Department can then assist potential growers in planning to meet those requirements. After laying this groundwork, the Department will be in a better position to recommend incentives to promote local feedstock production.

Recommendation: MTBE Ban

While not all the evidence is in, Oregon Graduate Institute's Center for Groundwater Research has collected enough evidence to show that MTBE is a potential source of carcinogenic groundwater pollution. Twenty other states, including Washington and California, have already banned MTBE as a gasoline oxygenate. An Oregon MTBE ban ensures that ethanol will be the only viable alternative for gasoline oxygenate on the West Coast. To further solidify the ethanol market, the state should ban the use of any oxygenate for gasoline other than ethanol.

Recommendation: Coordinated Marketing and Technical Support for the Biofuels Industry

Oregon has considerable experience in promoting key industries (such as wheat, wine, nurseries, and tourism). Because of the absence of widespread knowledge or understanding of the potential uses and benefits of renewable fuels, the state could provide invaluable assistance to these new industries by identifying potential biofuels markets and raising the visibility of Oregon's biofuels industries within those target markets. Similarly, the state could perform an important coordinating role for these new industries by ensuring alignment (and eliminating duplication) among the many public and private groups seeking to advance the biofuels industry.

SUMMARY OF POTENTIAL STATE ACTIONS TO STIMULATE A RENEWABLE TRANSPORTATION FUELS INDUSTRY

In focus group sessions and in personal interviews industry and government contributors identified a wide range of actions Oregon could take to stimulate a renewable fuels industry. The following table summarizes those potential actions.

SUMMARY OF POTENTIAL STATE ACTIONS TO STIMULATE A BIOFUELS INDUSTRY

Suggested State Action	Description	Goal	Impact (1-4, low to high)	Action Required/ Key Partners	Feasibility
Renewable Fuel Standard (RFS)	Require minimum ethanol & biodiesel blends. Tie to local production.	Stimulate Demand	4 Contributors described this action as essential--the surest way to stimulate demand and production facilities	Legislation Biofuels proponents, particularly producers & agriculture community	Small state fiscal impact, but potential rift between legislators opposed to government directives & those who recognize economic potential for rural communities.
Production Tax Credit	Allow taxpaying entities a credit against the corporate income tax of X cents per gallon of ethanol or biodiesel produced.	Establish Production Facilities	3 Oregon would benefit from an in-state incentive in order to compete with the Midwest market.	Legislation All biofuels proponents, but primarily biofuels producers & agriculture community	Small to medium fiscal impact. Because action is an incentive, not a mandate, it may win legislative approval; any new tax credit will have tough sledding.
Coordinated Industry Support	Assist with vertical integration of the industry, including R&D, education, production, & demand.	Develop Supplier and Customer Networks	3 Lack of coordination & knowledge transfer slows industry development. There's a particular need to engage growers	Agency commitment & more agency resources ODA, ODOE, university extension personnel, & industry proponents	Feasible if resources are secured
MTBE Ban	Ban in-state use of MTBE as a gasoline additive because of potential groundwater contamination.	Stimulate Demand	2 ODOE believes blenders may have to use MTBE because an ethanol shortage will arise as MTBE-banning states use more ethanol. DEQ disagrees.	Legislation	This measure should be relatively easy to pass if someone took the lead to shepherd it through the legislative process.
Market Analysis & Strategy	Identify potential target markets (potential retail or industrial customers) for biofuels. Communications campaign to increase awareness of biofuels uses & benefits.	Stimulate Demand	3 Raising awareness of uses & benefits in target markets through a state marketing campaign will create stable biofuels markets. This strategy is less effective than an RFS, but does jumpstart the market.	Requires funding. Requires coordination among agencies, industry reps and advocates. OECDD, retailers, OBA, OEC, Pacific NW Biofuels Network	Feasible if resources are secured. OECDD secured a grant from the EPA to market biodiesel and has contracted with OEC.

Suggested State Action	Description	Goal	Impact (1-4, low to high)	Action Required/ Key Partners	Feasibility
Diesel Emissions Offset Program	Regional program that allows diesel users to "offset" their diesel emissions by subsidizing biodiesel usage by another diesel consumer.	Stimulate Demand	1 Relatively few diesel users will elect to do this unless it's mandatory to reduce diesel emissions.	Requires framework, such as Climate Trust or BEF's Green Tag program. Retailers, Climate Trust, BEF	If this program worked for Climate Trust or BEF, it would be relatively easy to do (though requiring outreach).
Biodiesel Feedstock Incentives	Investigate tax credits or other financial incentives for oilseed crushing operations.	Establish Production Facilities	3 Providing incentives for the purchase and/or operation of oilseed crushers would lower the cost of biodiesel production.	Rule changes or legislative action ODOE, ODA, OEC, agriculture community, biodiesel proponents	Direct incentives for agriculture face less opposition in Legislature than mandates, but budget impact questions may arise.
R&D	Tie research to industry development. Enhance relationships with Western Region Sun Grant Initiative. Examples include conversion of lignocellulose to ethanol & production of hydrogen through biological fermentation of biomass or via direct biophotolysis.	Promote Industry Innovation	3 R&D is essential to support bio-based industries.	Requires higher ed commitment and additional funding. Higher education institutes, resource economists, extension personnel, ODA, ODOE, federal agencies	If a concerted effort were made, Oregon has the potential to be a leader in such research, and perhaps more importantly to be a leader in applying this research.
Technical Assistance to Businesses Seeking Funding	Bring stakeholders & agencies together in a coalition that helps Oregon companies better access & obtain federal grants and other sources of funding. Ensure agencies devote staff time to hands-on assistance. Seek new financing options such as venture capital (see below) & the state risk fund.	Establish Production Facilities & Support Suppler Networks	2 A more concerted, coordinated effort should enable Oregon producers to secure private capital and federal grants.	Requires state agency commitment & additional agency resources OECDD, economists, ODA, ODOF, Office of Rural Policy, ODOE, biomass/biofuels proponents	Agency representatives tend to be overcommitted. In order to provide technical assistance, priorities will need to be shifted, or additional FTE will need funding.
Increase Venture Funding	Develop a program to increase access to and deals made between renewable energy companies and Northwest venture capital.	Establish Production Facilities	2 There is adequate venture capital in the Northwest, but many Focus Group participants are not convinced this strategy will pay off.	Requires OECDD attention and a small amount of funding for a conference OECDD, Oregon Entrepreneurs Forum, selected venture capitalists	Research into venture capital opportunities has already begun.

CONCLUSION - BIOFUELS

The Midwest has led the nation in building a successful ethanol industry with incentives for production facilities and growers, and by promoting the industry nationwide. Because of significant regulatory changes, the renewable fuels industry is poised to grow dramatically in the next few years. It doesn't take much vision to see how our state can reap the benefits of this renewable fuels revolution:

- Oregon farmers can grow the oilseed feedstock in rotation with wheat and grass seed crops.
- Oregon farm groups can build oilseed crushing facilities to extract added value from their crops.
- Oregon dairies and feedlots can utilize the high-protein meal from oilseed crushing facilities.
- Oregon construction workers can build the biofuels production facilities.
- Oregon metals and equipment manufacturers can provide the plant materials.
- Oregon managers and workers can operate the plants and market the products.
- Oregon trucking companies can haul the products nationwide.

How many other economic opportunities like this come along?

PART 2 -ELECTRIC GENERATION FROM RENEWABLE SOURCES

WHY THE FOCUS ON RENEWABLE ELECTRIC GENERATING RESOURCES?

The state's policy is to "promote the efficient use of energy resources and to develop permanently sustainable [renewable] energy resources,"[15] and to "promote the development of a diverse array of permanently sustainable energy resources using the public and private sectors to the highest degree possible."[16] The Legislature has backed up that goal with state programs (tax credits, low interest loans, other incentives) to encourage development of renewable resources. In 2003, about 3.5% of Oregon electricity requirements came from renewable electric resources, including solar, wind, geothermal, and biomass.[17]

Based on the state's policy decision to encourage development and deployment of renewable generating resources, this report section aims to assess (1) what economic opportunities might flow from the development and widespread deployment of electric generation from renewable sources, (2) whether those economic opportunities are sufficiently great to warrant additional state action, and (3) if warranted, what should those additional actions be?

RENEWABLE AND DISTRIBUTED GENERATION RESOURCES HAVE WIDE-RANGING USES AND BENEFITS.

Renewable sources of electric generation come in many sizes. Hydroelectric projects range from Grand Coulee Dam to small in-stream generators in irrigation canals. Oregon wind farms can be large—dozens of towers and over 300 megawatts (MW) of capacity; community or farmer-owned wind projects might have just a few windmills. Existing biomass plants range from 40 kilowatts (kW) for a generator fueled by a dairy's manure to a 45 MW plant burning sawmill residue or black liquor from paper pulping.

Distributed generation (DG) usually describes generation that is at or near a utility customer's load.[18] Thus sawmills may install cogeneration units that burn available fuel to provide both electricity and process steam or heat; a municipal wastewater plant may burn methane to produce electricity for the plant's pumps or lighting. Utilities might also locate distributed generation strategically on a distribution grid to relieve local transmission congestion or to improve power quality. Renewable and distributed generation projects can be built to serve a local load, to sell electricity to a utility, or some combination thereof. Although this report's primary purpose is to assess the economic opportunities arising from deployment of renewable

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[15] ORS 469.010(2)(a).

[16] ORS 758.515(1)(a).

[17] Oregon Department of Energy, http://egov.oregon.gov/ENERGY/RENEW/generate.shtml. This total does not include electricity from large hydro projects.

[18] A recent Oregon Public Utility Staff Paper on distributed generation describes distributed generating facilities as those that produce electricity at or near the place where the electricity is used. L. Schwartz, OPUC Staff, *Distributed Generation in Oregon: Overview, Regulatory Barriers and Recommendations*, (February 2005, p. 1) (hereafter "OPUC Distributed Generation Paper"). See also Northwest Power and Conservation Council, *Fifth Power Plan*, Pre-Publication Draft (December 2004, p. 5-5) (hereafter "Fifth Power Plan."

resources, research revealed that renewable and distributed generating resources face many of the same hurdles to development. Accordingly, this report considers them together.

Renewable or Distributed Generation Uses

- To provide energy and capacity to a utility customer.[19]
- To defer or avoid transmission and distribution system investment by siting DG for the express purpose of relieving power flow congestion. At the very least, DG sited at a customer's facility reduces the utility electric load at that facility, enabling the grid to deliver power to more customers in that area. Because of the well-known congestion problems on cross-Cascades transmission lines, siting DG west of the Cascades could help utilities serve growing westside loads.
- To upgrade reliability in rural areas. Utilities may find it more cost-effective to install distributed generation in lieu of running a new power line or upgrading an old one to remote electric loads. Similarly, DG might improve system reliability and voltage stability for loads served by the long radial lines that are typical of rural electric service areas.
- To reduce air emissions on site through the use of cleaner energy sources.
- To improve power quality and reliability for electric loads with sensitive requirements (e.g., semiconductor plants or sensitive electronic equipment), on-site generation might provide the primary power source with the utility providing backup power.
- To take advantage of waste heat. The most common form of DG currently in operation is cogeneration, where the customer can use waste heat from electric generation for heating, cooling, dehumidifying, or steam in the customer's operations, or uses waste heat from plant processes to drive electric generators.
- To reduce customer power costs during times of high electricity prices or high on-site demand.
- To provide backup power during utility system outages for facilities requiring uninterrupted service, such as hospitals, data centers, telecommunications, and process industries.

Renewable or Distributed Generation Benefits

The OPUC Draft Distributed Generation Paper provides a thorough discussion of the benefits of distributed generation, including renewable resource projects. The following list is illustrative.

- Improved system reliability because of reliance on a large number of smaller units having diverse characteristics (wind, biogas, CHP, biomass, fossil fuel, hydro) rather than on a few large generating stations having less diversity. (Presently Oregon relies principally on large hydro, fossil fuels, and nuclear for about 97% of its electricity.)
- A more decentralized system is less vulnerable to widespread disruption from natural disasters and terrorism.
- Reduced environmental impact, when DG systems using state-of-the art emissions controls or run on renewable resources.

[19] Both the OPUC Distributed Generation Paper (pp. 3-4) and the Fifth Power Plan (pp. 5-5 to 5-6) describe multiple uses for distributed generation; this list is illustrative.

- Reduced investment risk. Smaller, dispersed generating resources require less capital and lead time than large power plants. Smaller units can also better match gradual demand increases, avoiding the large chunks of idle capacity from a new large plant.
- Efficient use of resources. Conventional, fossil fuel fired generating plants waste up to two-thirds of the fuel's value, mostly as heat, and conventional thermal systems forego the opportunity to produce electricity. CHP systems, such as biomass-fired cogeneration projects, are far more energy efficient than producing heat and power separately.
- Improved competition from an increase in electricity sellers and reduced market power, especially where DG is located in transmission-constrained areas.
- Reduced grid costs. Distributed generation can cut utility costs by delaying, reducing, or eliminating the need for transmission and distribution investments if generators are located where the grid is constrained. This benefit works only when DG resources can reliably serve peak loads to relieve congestion.
- Improved reliability and power quality.
- Peak shaving when DG resources can operate reliably during peak periods when power costs are highest.
- Reduced need for utility investment in energy and capacity when customers or third parties invest in electric generation.

ALTERNATIVE GENERATING RESOURCES CAN POTENTIALLY PROVIDE SIGNIFICANT ECONOMIC BENEFITS.

In its Draft Oregon Renewable Energy Action Plan, ODOE estimates the initiatives outlined in that plan "could lead to an investment of $300 million or more by the end of 2006, which would result in about a 3,700 net job increase."[20] Other studies have documented the positive economic national and state impacts of developing renewable energy resources.[21]

Wind power development can provide significant benefits to rural counties and landowners. Because wind towers occupy a small footprint, farmers can plant crops and graze livestock up to the base of the turbines.[22] Wind farms employ construction workers to build the projects, employ full-time maintenance workers for the life of the projects, and pay local property taxes.

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[20] ODOE Draft RE Plan, p. 4. According to ODOE Senior Policy Analyst Carel DeWinkel, this estimate assumes that the State would implement all the initiatives and reach all or most of the Draft RE Plan's stated goals. He relies in part by work done by Stephen Grover of ECONorthwest in the April 2003 *Economic Impact Analysis of Energy Trust of Oregon Program Activities*. That report, at pages 9-10, estimates that the $8.07 million that the ETO projected it would spend in 2003 on renewable energy activities (incentives and program management) would create 102 jobs more than would have occurred without the ETO's program. From that estimate, the ODOE Draft RE Plan deduces that every $100 million of renewable energy investments will create about 1,250 full time jobs, and lead to a net $200 million increase in State economic output. Ibid.

[21] See, for example, J. Horner, J. Barrett, *Smarter, Cleaner, Stronger in Oregon: Secure Jobs, a Clean Environment, and Less Foreign Oil*, a report on Oregon impacts prepared for the Blue/Green Alliance (October 2004).

[22] The development, financing, ownership, and operation of wind farms can take many different paths. For more information, see Government Accounting Office, *Renewable Energy –Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities*, September 2004, and M.

For example, the 41 MW (14 MWa) Combine Hills wind project in Umatilla County (completed November 2003) required a construction work force of 125, and now employs four, full-time maintenance crew and one turbine manufacturer staff for a combined annual payroll exceeding $210,000. The project paid $381,000 in local property taxes in its first year.[23] The initial 24 MW phase of the Klondike Wind Farm in Sherman County (Klondike I) also caused a local economic boost during construction. Over the project's life local landowners collect $2,000-4,000 per turbine in annual royalty payments. Sherman County collected $321, 206 in property taxes in the first year of operation, and should collect $250,000 annually over the 20-30 year life of the project.[24]

Biomass-fired electric generation could also provide economic benefits to rural Oregon counties as well as consuming some of the forest residues that constitute a potential fire hazard that can lead to economic injury and air pollution.[25] The Northwest Power and Conservation Council estimates that nearly 2,000 MWa of potential biomass generation could be developed immediately from renewable sources at competitive prices.[26]

RENEWABLE GENERATION DEVELOPERS CAN UTILIZE MANY FEDERAL AND STATE INCENTIVES TO MAKE RENEWABLE PROJECTS MORE ECONOMICALLY FEASIBLE.

Public Purpose Funds

Since March 2002, Portland General Electric (PGE) and Pacific Power customers have paid an additional three percent charge on their electric bills to fund conservation and renewable resource programs administered by the Energy Trust of Oregon (ETO). ETO aims to have renewable resources provide 10% of the state's electricity needs by 2012, or about 450 MW of new projects. The capacity of ETO projects thus far amounts to roughly 50 MW. [27]

Bolinger, R. Wiser, T. Wind, D. Juhl, R. Grace, *A Comparative Analysis of Community Wind Power Development Options in Oregon*, Energy Trust of Oregon (July 2004).

[23] See D. Bain, *2004 Annual Review of the Eurus Combine Hills I Wind* Project (January 2005, p. 7). The Energy Trust of Oregon used the authority granted by SB 1149 (ORS 757.612) to provide a $3.8 million incentive that enabled the development of Combine Hills (www.energytrust.org/RR/wind/index.html).

[24] B. Ouderkirk, M. Pedden, *Windfall from the Wind Farm, Sherman County, Oregon*, Renewable Northwest Project (December 2004, pp. 12-13). The 75 MW Klondike II project is under construction, and Klondike III, a 300 MW expansion, is in the planning stages.

[25] See McNeil Technologies, Inc., *Biomass Resource Assessment and Utilization Options for Three Counties in Eastern Oregon*, prepared for Oregon DOE (December 2003); S. Aycock, *COPWRR Strategy Framework: Reducing Wildfire Risks in Central Oregon by Removing and Utilizing Forest Fuels*, a project of the Central Oregon Intergovernmental Council in cooperation with the USDA Forest Service Economic Action Program (December 2002).

[26] While woody residues comprise most of the biomass source material, the high cost of generation from that material will constrain the use of that resource in the absence of cogeneration opportunities. *Fifth Power Plan*, Pre-Publication Draft, Table 5-2, pp. 5-10 to 5-11 (December 2004).

[27] ORS 757.612. See ETO website for a more complete description of the ETO's programs, including its renewable resource projects. www.energytrust.org/.

Utility Resource Plans

Several utilities have sought to acquire competitively priced renewable generating resources as part of their new resource plans to meet load growth. For example, PacifiCorp specifically seeks to purchase 1,400 MW of wind power over ten years,[28] and PGE will compare the performance of renewable generating sources against a conventional natural gas-fired generator in its request for new resource proposals. BPA offers incentives to its consumer-owned utility customers for conservation and renewable resource programs when such programs exceed three percent of retail revenues.[29]

Preferred Siting Process for Renewable Resources

If the average generating capacity (the amount of energy produced annually on average) of a wind, geothermal, or solar project is less than 35 MWa (average megawatts), such projects can avoid the state-level energy facility permitting process. (This exemption does not eliminate other permitting requirements.)[30] The state also provides an expedited process for larger renewable resource facilities.

Net Metering

Net metering allows utility customers to install a generator to offset all or part of the customer's electric load and to sell any excess generation to the utility. Oregon's net metering law applies to solar, wind, hydroelectric, and fuel cell systems generating up to 25 kW that also meet national safety and performance standards.[31]

Small Scale Energy Loan Program (SELP)

The Oregon Constitution enables the state to issue general obligation bonds to fund low interest, fixed rate loans for individuals, as well as public and private organizations that invest in conservation, renewable resource, recycling, and alternative fuel projects.[32]

Tax Credits and Incentives

Renters and homeowners can get a state tax credit for renewable resource systems they install. According to ODOE, more than 21,000 taxpayers have taken advantage of this credit.[33] Business taxpayers can earn a tax credit worth up to 35% of an eligible project's cost. ODOE reports that this incentive has led to business investments in over 500 renewable resource

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[28] PacifiCorp and PPM Energy, a major wind power developer, are both based in Portland and are owned by Scottish Power.

[29] See www.bpa.gov/Energy/N/Projects/cr_discount/ for more information.

[30] See http://www.energy.state.or.us/siting/process.htm for a complete description of the energy facility siting process, including guidelines for developers.

[31] ORS 757.300. Senate Bill 84, proposed by the OPUC would allow the OPUC to set the facility size limit for net metering and add biomass as a covered resource.

[32] Article XI-J. See http://egov.oregon.gov/ENERGY/LOANS/index.shtml.

[33] ORS 316.116. See http://egov.oregon.gov/ENERGY/CONS/RES/RETC.shtml.

projects.[34] When a property owner installs a renewable resource for the owner's own use (including wind, solar, geothermal, hydro, fuel cell, or methane gas recovery) for heating, cooling, or generating electricity, any additional property value is exempt from state property tax until the end of 2012.[35]

Federal Incentives

This report does not identify the many federal renewable resource incentives. Readers should consult ODOE's website for more information.

ONCE THE BARRIERS TO WIDESPREAD DEVELOPMENT ARE REDUCED OR REMOVED, THE STATE WILL BE BETTER POSITIONED TO FULLY REALIZE THE ECONOMIC BENEFITS OF RENEWABLE GENERATION.

This report concludes that, despite the potential economic benefits of accelerated deployment of renewable generating resources, such deployment faces so many difficult obstacles that all state agencies, OECDD, ODOE, and OPUC in particular, should concentrate their near-term efforts on eliminating those barriers. This section identifies the major institutional, regulatory, and economic barriers.[36]

Institutional Barriers

Balkanized utility service structure

Oregon electricity consumers get electric service from 3 investor-owned utilities (IOUs), 19 municipal (city) utilities, 6 Peoples Utility Districts (PUDs), and 18 rural electric cooperatives. The service area characteristics for all these utilities vary widely. For example, the OPUC-regulated IOUs serve 74% of the state's population and sell 72% of the electricity consumed in the state in densely populated service areas.[37] But locally owned and regulated electric cooperatives serve only 10% of the population in low density service areas covering 32 counties and 65% of the state's land area with 26,000 miles of distribution lines. Although every service territory contains some potential for renewable or distributed generation, much of that potential may lie in rural areas while the growing demand for the power is mostly in the high-density urban areas.

Inadequate system-wide transmission planning and investment

The Bonneville Power Administration (BPA) owns and operates most of the Pacific Northwest transmission grid. IOUs own and operate smaller portions of the grid. Several different utilities may own or contract for capacity on important transmission paths (such as lines crossing the Cascades). To deliver power to dozens of consumer-owned utilities, BPA relies on IOU transmission facilities and power transfer agreements. In short, like the utility service

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[34] ORS 317.115; ORS 469.185-469.225; ORS 315.354. See http://egov.oregon.gov/ENERGY/CONS/BUS/BETC.shtml.

[35] ORS 307.175.

[36] Lisa Schwartz, Senior OPUC Analyst, identified the principal regulatory barriers in the OPUC Distributed Generation Paper. The Fifth Power Plan also (p. 5-7) identifies many of the same barriers.

[37] OPUC, *2003 Oregon Utility Statistics*, p. 1,

territories, the regional transmission system is a balkanized network of ownership and contractual rights. New, non-utility resources will have an especially difficult time obtaining firm transmission rights to reach potential customers, either because the requested firm transmission path is physically congested or contractually blocked.

The Federal Energy Regulatory Commission (FERC), which regulates interstate transmission facilities, has changed the rules of the wholesale transmission game in its quest to introduce competition to wholesale power markets. Unfortunately, major transmission stakeholders (owners, buyers, power marketers, consumers) have significant disagreements over FERC's vision for wholesale markets and regulation of transmission. Those disagreements, coupled with FERC's seeming inability to finally resolve the debate, has left all parties in limbo. In particular, the rules relating to cost recovery, cost allocation, and allocation of transmission rights remain up in the air. Until FERC clears up those rules, no potential investor in either transmission or generation can be confident of recovering an investment in such facilities.[38] BPA and other transmission owners continue to coordinate power transfers on an hourly basis and to make some new investments, but there is no effective, system-wide planning and investment to meet new load growth and generation demands. The result is congestion on some critical transmission paths, underutilization or sub-optimization of transmission facilities, and a major barrier to the development of non-utility generation.

The existing transmission and distribution grid lacks the necessary control and communications capability to support a robust, competitive wholesale power market.

Utilities designed and built the transmission grid to move power from utility-owned central station generation to utility distribution systems, not to accommodate a dispersed and diversified network of central station and distributed generating resources.[39] The control and communications technology (so-called "Smart Grid" hardware and software) exists to modernize the grid to enable a competitive power market of utility and non-utility generation.[40] Unfortunately, the uncertainty over what entity or entities will plan, finance, own, and operate the regional transmission grid, along with a risk-averse utility culture that resists innovation, stands in the way of upgrading the transmission system with newer technology.

Risk-averse utilities and regulators

After 100 years of regulation, utilities and regulators are very risk averse and resistant to innovation. A utility is reluctant to undertake any program unless it can recover the cost of that program in rates or unless the program otherwise improves financial performance for

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[38] For an enlightening discussion of competing visions over the future of transmission regulation and access, see J. Morrison, *Competing Industry Visions*, Electricity Journal (January 2005, p. 14). See also Consumer Energy Council of America, *Keeping the Power Flowing, Ensuring a Strong Transmission System to Support Consumer Needs for Cost-Effectiveness, Security, and Reliability* (January 2005).

[39] See US DOE, Office of Electric Transmission and Distribution, *National Electric Delivery Technologies Roadmap* (November 2003, p. vi-x).

[40] See Steve Hawk, *Non-Wires Alternatives for Meeting Utility Distribution and Transmission System Needs*, presentation to OPUC workshop (December 2004). In this presentation to the OPUC, Portland General Electric's Vice President for Customer Service and Distribution, painted a compelling vision of a "smart." interactive transmission and distribution network of distributed generation, "smart" homes, businesses, and appliances that would reduce system peaks and add value to the T&D network for customers.

shareholders. Regulators and ratepayer groups are reluctant to agree to any innovations that might raise rates. Even the locally regulated consumer-owned utilities resist the development of new generation in their service areas if it will increase the costs to ratepayer-owners.

BPA net requirements power contracts

Consumer-owned utilities have power contracts with the Bonneville Power Administration (BPA) that discourage development of new generation. These contracts require such utilities to reduce the low-cost power they buy from BPA by the amount of power they acquire from a new (higher-cost) generating resource.[41]

Regulatory Barriers

Failure to consider distributed generation in transmission and distribution planning and construction

Oregon utilities submit annual construction budgets for major traditional transmission and distribution (T&D) investments for OPUC review. These T&D construction budgets often exceed the utilities' generating project budgets. Distributed generation could enable utilities to relieve some transmission congestion or to serve (in rural areas, for example) growing loads on long, radial lines.[42] But T&D engineering staffs do not routinely consider distributed generation (whether built by the utility or a customer) as an alternative to traditional T&D planning.

Rates for backup power may not properly reflect DG costs and benefits

Utilities provide standby service to provide supplemental power (if a customer-owned resource does not meet the entire load), backup power (for planned or unplanned outages), and generation and grid capacity to deliver those services.[43] In July 2004, the OPUC approved new cost-based standby rates for PGE; PacifiCorp proposes a similar standby rate structure in its current rate case.

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[41] US DOE, Bonneville Power Administration, *Policy on Determining Net Requirements of Pacific Northwest Utility Customers under Sections 5(b)(1) and 9(c) of the Northwest Power Act*, Administrator's Record of Decision, May 2000. BPA has not yet resolved its power supply role after the current rate period ends in 2006. Because of that uncertainty, it is not clear whether the foregoing interpretation of "net requirements" will remain a barrier to development of renewable generating resources in consumer-owned utility service areas. BPA, *Bonneville Power Administration's Policy Proposal for Power Supply Role for Fiscal Years 2007*-2011 (July 2004). Some of BPA's Washington utility customers have invested in wind farms through Energy Northwest, a Washington joint operating agency. R. Gluck, *Washington Grows Energy Options on Wind Farms*, Distributed Energy Journal (January/February 2005, p. 36).

[42] The Public Interest Energy Research program within the California Energy Commission, Public Interest Energy Research program funded a 2003-2004 landmark study of distributed generation as a distribution grid tool. The study, which the CEC has not yet released, found that DG provided many grid benefits, including improved safety, deferred costs, reduced dependence on spot markets, lowered emissions, and reduced fuel costs. See D. Engle, *DG Coming to the Grid's Rescue*, Distributed Energy Journal (January/February 2005, p. 56), for a discussion of the study's results.

[43] See a thorough discussion of this barrier in the OPUC Distributed Generation Paper.

Lack of quick, inexpensive, and simple interconnection standards and agreements

The state's utilities do not have uniform technical standards, procedures, or agreements that allow for quick, inexpensive, and simple interconnection of small generators with utility systems (except for systems 25 kW and smaller that qualify for net metering). Consequently, smaller projects experience undue delays and costs that can destroy their economic feasibility. FERC has already adopted some standard interconnection rules for transmission facilities under its jurisdiction, and is considering additional rules.[44] Oregon has not resolved the problem for small projects under the state's jurisdiction, but the Legislature and the OPUC have the authority to adopt appropriate rules. In establishing uniform standards, the state can turn for guidance to several institutions that have addressed most of the technical, procedural, and contractual issues involved in interconnections.[45]

PURPA practices

The US Congress passed the Public Utilities Regulatory Policies Act of 1978 (PURPA) in response to the energy "crisis" of the early 1970s. Sections 201 and 210 of that legislation encourage non-utility generators to improve efficient production of electricity through waste heat recovery and renewable resources. FERC adopted rules to encourage the development of these small independent generators, known as "qualifying facilities" or "QFs." The Oregon Legislature adopted laws to implement PURPA at the state level.[46] Despite this official encouragement, PURPA projects (QFs) never got much of a foothold in Oregon for several reasons. First, QFs sometimes have difficulty competing with low wholesale rates and conventional generation. Second, only the smallest QFs qualify for standard rates and contracts; larger projects have to negotiate all terms with utilities. Third, methods used for calculating avoided costs may put

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[44] FERC has approved an interconnection rule for large projects (over 20 MW) seeking to interconnect to a FERC-regulated (interstate) transmission facility, and has proposed to amend that rule to better accommodate large wind generation Federal Energy Regulatory Commission (), *Standardization of Generator Interconnection Agreements and Procedures, Final Rule*, 18 CFR Part 35 (July 24, 2003) [applies to generators larger than 20 MW]; FERC, *Notice of Proposed Rulemaking, Interconnection for Wind Energy and Other Alternative Technologies*, Docket No. RM05-4-000 (January 24, 2005). FERC is also considering an interconnection rule for smaller projects. FERC, *Standardization of Small Generator Interconnection Agreements and Procedures*, Docket No. RM02-12-000 (July 24, 2003) [applies to generators no larger than 20 MW].

[45] The Institute of Electrical and Electronics Engineers, Inc. (IEEE) approved technical standards (IEEE 1547) for interconnecting distributed resources of 10 MW or less, and is currently developing testing standards and guides. Other utility and regulatory associations have addressed the need for uniform interconnection procedures and agreements. National Association of Regulatory Utility Commissioners (NARUC), *Model Interconnection Standards and Agreement for Small Distributed Generation Resources [under 10 MW]* (October 2003); National Rural Electric Cooperative Association (NRECA), *Model Distribution Cooperative Agreement for Interconnection and Parallel Operation of Distributed Generation (Long or Short Form)*, (March 2002).

[46] ORS 758.505, *et seq.*; OAR 860-29-0001, *et seq*.

QFs at a disadvantage.[47] Finally, because of a 1999 state law, PGE and PacifiCorp are no longer subject to Oregon PURPA statutes and rules.[48]

Market and Economic Barriers

Wholesale power rates

The Pacific Northwest has historically enjoyed relatively low wholesale and retail electric rates. Low wholesale rates in the 1980s dampened efforts to develop qualifying facilities under PURPA. Surplus power and low wholesale market rates in the 1990s allowed many regional utilities to rely increasingly on the spot market to meet native loads and discouraged many renewable resource developers. Even today, the prices many potential renewable resource projects must charge to meet their revenue requirements exceed wholesale rates for alternative sources of power.[49] There are exceptions. Large wind farms and some CHP or cogeneration units can now produce energy at competitive wholesale rates.

Distributed generation's potentially adverse financial impact on utilities

Utilities are in the business of selling power; when they sell less power, their revenues drop. If a customer develops a generating resource of any kind, and that resource reduces or eliminates the customer's load, the serving utility loses the revenues associated with that load. Moreover, if the customer wants the utility to provide standby power when the customer's resource experiences a planned or unplanned outage, the utility must still retain and maintain the capital equipment (poles, wires, transformers) associated with that load, as well as the generating reserves needed to serve that load. Faced with the prospect of losing revenue without a corresponding reduction in costs, utilities may fail to consider the potential benefits of distributed generation, and instead resist a customer's proposal to install on-site generation.

Project economics and lack of financial resources

Electric utility customers with potential distributed generation opportunities are not in the business of generating electricity. Because a customer's principal business will have first call on available investment funds, the business will require a very fast return on any electric generation investment. An industrial customer will therefore shelve any proposed generation project that doesn't meet the company's stringent payback criteria—regardless of the project's benefits to the utility system.

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[47] At this report's writing, the OPUC is currently conducting an investigation (Docket No. UM 1129) related to utility purchases from QFs, including contract length, purchase rates, and other terms and conditions. While all parties support increasing the contract length and project size for QFs eligible for standard rates and contract, they differ on the details. The OPUC staff and Industrial Customers of Northwest Utilities (an industrial ratepayer group) have suggested other significant changes to Oregon's PURPA policies, including pricing options, more reasonable credit and security terms for small QFs, and revisions to avoided cost formulas. The OPUC should decide the case in spring 2005.

[48] ORS 757.612(4). Because the OPUC retains its authority to implement federal PURPA rules (which apply also to Oregon's consumer-owned utilities), the effect of the exemption for PGE and PacifiCorp on State regulation of QFs is minimal.

[49] M. Bolinger, R. Wiser, T. Wind, D. Juhl, R. Grace, *A Comparative Analysis of Community Wind Power Development Options in Oregon*, Energy Trust of Oregon, (July 2004; p. vi). McNeil Technologies, Inc., *Biomass Resource Assessment and Utilization Options for Three Counties in Eastern Oregon*, prepared for Oregon DOE (December 2003, p xxii).

Some independent power developers have a different resource problem; they may simply lack the financial strength and staying power to overcome utility and regulatory delays or significant interconnection or wheeling costs. Those developers with sufficient financial muscle will stay the course only if the proposed project is sufficiently large to absorb the transaction and interconnection costs. [50]

Many small renewable generating resources face yet a different economic barrier: they may not be able to produce electricity at a cost that satisfies their revenue requirements and that is also competitive with other available alternatives. Although large-scale wind projects may be quite competitive with more conventional resources, small-scale wind applications are still expensive (23 cents/kWh for a 10kW system, for example).[51]

These barriers (project economics and financial resources) may be particularly difficult for community- or farmer-owned wind projects to overcome. The authors of a report to the Energy Trust of Oregon (ETO) on community wind power concluded that such on-site projects are not very attractive because of revenue requirements above their benchmark power prices and other factors. Hence that report recommends that the ETO focus its efforts elsewhere.[52] Nevertheless, community wind projects can succeed if local landowners are willing to commit their own capital resources to a utility-scale project and bring in a strong development partner. [53]

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[50] For example, PPM Energy, a unit of global energy company Scottish Power, proposes to add 300 MW to its Klondike wind farm in Sherman County, which would substantially expand that project from the current 100 MW that is either built or under construction. That expansion would require, according to BPA's estimates, nearly $40 million in transmission and interconnection construction, including a 12-mile transmission line, interconnection facilities, and modifications to existing BPA network facilities. Even though $30 million of that BPA-estimated cost represents improvements to BPA's transmission network, PPM Energy might be required to fund the entire cost of the work. In such public/private financial arrangements BPA would likely grant transmission credits to a developer for part of the developer's transmission investment. Moreover, but for the fact that a second developer is proposing to develop another wind farm in that area that will require use of the same transmission facilities, the Klondike project might have had to absorb the entire estimated $40 million itself without any prospect of offsetting transmission credits.

[51] OPUC Distributed Generation Paper at p. 15.

[52] M. Bolinger, R. Wiser, T. Wind, D. Juhl, R. Grace, *A Comparative Analysis of Community Wind Power Development Options in Oregon*, Energy Trust of Oregon, (July 2004; p. xii). This report provides extensive financial modeling on several alternative forms of community wind ownership, and found only two with projected revenues that exceeded projected costs. The report cited several reasons for these results, including low retail rates, demand charges, and standby charges. Id. at vi et seq.

[53] Forty-six Minnesota farmers put up close to $1 million each to develop a 100 MW, utility-scale wind farm consisting of 67-1.5 MW wind turbines. After forming an LLC, raising the capital among the landowners, and hiring professional advisors, Trimont Area Wind Farm, LLC (TAWF) contracted with Great River Energy, a generation and transmission cooperative, to develop the project. TAWF then sold the project to Portland-based PPM Energy in order to acquire the necessary financial muscle and expertise to construct and operate the facility. In return, TAWF receives a development fee, revenue participation, and lease payments. The local community also benefits from 50 construction jobs, six ongoing O&M jobs, and increased tax revenues. J. Cliburn, *Promising New Crop*, Rural Electric Magazine (November 1, 2004).

A 100 MW project may not be the small-scale project that Oregon community wind enthusiasts envision. In fact, some community wind proponents criticized the Trimont project for partnering with PPM Energy, a unit of Scottish Power and a profit-driven company. In the ETO study cited in the previous footnote,

Biomass-fired electric generating facilities currently provide a significant amount of the state's non-utility generation capacity (mostly cogeneration at sawmills or pulp and paper mills).[54] While biomass-fired generation from forest and agricultural residues in rural Oregon is theoretically possible, the project economics are far more challenging. ODOE commissioned a 2003 study that looked at biomass options in three eastern Oregon counties. That report concluded, "[T]he high cost of forest biomass is a major barrier to the development of cost-effective energy outlets in the region." Consequently, the "[e]stimated biomass power generation costs exceed local retail power rates as well as the expected buyback rate from regional electric utilities by a significant margin."[55]

Finally, many utilities may offer only short-term power purchase contracts to independent power producers (IPPs). To obtain project financing, most projects require longer contracts—20 years, for example.[56] Without a long-term utility purchase agreement, smaller IPPs may not be able to obtain the necessary financing.

Selling power to utilities: a series of hurdles

For customer-installed generation intended primarily to serve the customer's load, interconnection and transmission may not be a major obstacle. On the other hand, independent power developers who want to sell either the entire project's output or the excess over customer requirements face significant and sometimes insurmountable hurdles.

- A local utility will have little incentive to purchase power from an IPP, since the utility could lose load and revenue (if the IPP is a customer), and cannot earn a return on a generating plant owned by another party (whether a customer or a developer).
- The project size may be too small for utility solicitations, which often establish MWa (average annual energy output) or MW (nameplate capacity) minimums.[57]
- Negotiations with utility staff can be time-consuming, costly, and ultimately unsuccessful, a particularly burdensome prospect for small projects.
- The project's location may be some distance from a purchasing utility, which could require the project owner to negotiate and pay for interconnection with the local utility's

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the authors considered only two project sizes, 1.5 MW and 10.5 MW. Unfortunately, few of the ownership scenarios studied were economically feasible, and the small project sizes studied would not attract a major wind developer as a partner.

[54] Energy and Environmental Analysis, *Combined Heat and Power in the Pacific Northwest: Market Assessment, Task 1 Final Report*, submitted to S National Laboratory (July 2004, Table 4-A, p. A-5).

[55] McNeil Technologies, Inc., *Biomass Resource Assessment and Utilization Options for Three Counties in Eastern Oregon*, prepared for Oregon DOE (December 2003, p xxii). Because forest residue remains a fire hazard and potential air quality problem for eastern and central Oregon counties, interested groups continue to seek ways to overcome this cost barrier, including state or federal incentives and locating biomass plants to utilize the waste heat (thereby improving the project economics). See, for example, Warm Springs Forest Products Industries, *Expanding Oregon's Emission Reduction and Banking Program to Include Forest Fuel Protocols* (July 2004).

[56] PPM Energy has secured a long-term contract with PGE in order to expand the Klondike Wind Farm, referred to above. PacifiCorp offers long-term contracts in its renewables RFP.

[57] A PacifiCorp 2003 renewable resource solicitation required projects to be capable of delivering 70,000 MWh per year—a 24 MW capacity requirement for a wind facility. A PGE all-resource RFP required renewable resources to meet a standard of 5 MWa—about 15 MW for a wind facility.

distribution grid, and pay multiple wheeling (transportation) charges (including transmission losses) to deliver the power to the purchasing utility. A small project may also have difficulty negotiating a (typically) complex transmission agreement or paying for the attendant transmission studies.

- Because wheeling costs can add up ("pancake") or because the project cannot obtain a firm transmission path, an IPP may opt for nonfirm transmission, which will allow for power transfers except for congested periods. Unfortunately, a nonfirm transmission path may prevent the project from obtaining the necessary financing, since the lenders and investors count on secure cash flow. If the project goes ahead with nonfirm transmission, it is bound to experience cash flow problems when the project operator cannot find a different buyer on a different (uncongested) transmission path during periods of congestion.[58]
- Finally, the wholesale power market is not a likely outlet for a small project because of standard 25 MW trading blocks, risk allocation with marketers, and absence of firm transmission rights.

THE OPUC STAFF HAS RECOMMENDED THAT THE PUBLIC UTILITY COMMISSION ADOPT MAJOR REGULATORY CHANGES TO ENCOURAGE DEVELOPMENT OF DISTRIBUTED GENERATION.

In the OPUC Draft Distributed Generation Paper, the OPUC Staff recommends that the PUC remove many regulatory barriers to deployment of distributed generation:

1. The Commission should implement uniform technical standards, procedures, and agreements for interconnecting generators.
2. The Commission should adopt in PacifiCorp's rate case (UE 170) standby tariffs that properly reflect the costs and benefits of serving customers with distributed generation.
3. Through UM 1129, the Commission should extend the contract length for QFs, increase the size eligible for standard purchase rates, establish Commission-approved standard purchase agreements for facilities eligible for standard rates, and review methods for valuing avoided costs when a utility is resource sufficient.[59]

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[58] The entire project's economic feasibility may fail if it depends on selling power during congested periods, and small projects don't have the financial resources to manage, control, sell, and dispatch power to avoid these congested periods or to contract for those services. Integrated utilities, of course, can easily back off other generating resources to clear the congested transmission path for the IPP. East to west transmission congestion is particularly prevalent for about 25-50 critical hours per year on transmission paths across the Oregon Cascades. There are no plans to relieve that congestion because the region's transmission operators have not agreed on a regional transmission authority with the power to operate existing transmission facilities as a single entity or plan for and construct new transmission. BPA and the OPUC are exploring the extent to which there are potential "non-wires" solutions to some transmission congestion.

[59] To mitigate the risk to ratepayers, the staff recommends that the Commission allow fixed pricing under standard PURPA rates and contracts only for small QFs. Larger QFs will have to negotiate terms with the purchasing utility.

4. The Legislature should add biomass as a qualifying resource for net metering and allow the Commission to increase the eligible project size for PGE and PacifiCorp.[60]
5. The Commission should explore issues related to distributed generators selling power to other retail customers over the distribution system.
6. The Commission should investigate how to include distributed generation in utility planning and acquisition processes to meet energy, capacity, distribution, and transmission system needs at the lowest cost.[61]
7. The Commission should explore mechanisms for removing disincentives for utilities to facilitate cost-effective distributed generation at customer sites.
8. The Commission should consider approval of a utility's request for accounting treatment that would allow a return on capital investments in new customer-owned distributed generation similar to that previously approved for investments in conservation.

THIS REPORT'S RECOMMENDATIONS

Recommendation: Removing the barriers to renewable resources development requires committed state leadership

Widespread deployment of renewable energy generating resources would provide many economic, social, and environmental benefits for all regions of Oregon. The state's executive and legislative branches have made clear their desire to rely increasingly on renewable generating resources to meet the state's growing electric demand. The state has backed up that desire with incentives for developers and utility customers.

For several years ODOE has promoted aggressive renewable energy goals. The latest ODOE Draft Renewable Energy Action Plan identifies many concrete actions state agencies could take to realize the plan's renewable energy goals. Other state and local agencies are continually promoting renewable energy. For example, the Central Oregon Intergovernmental Council (COIC) has been leading a biomass initiative that involves the Oregon Department of Forestry, Oregon Department of Fish and Wildlife, Oregon State University, numerous local governments, non-governmental organizations, the Warm Springs Tribe, and the US Forest Service.[62] ODOE has been promoting biomass energy for nearly 30 years, has sponsored numerous reports, has developed significant resources for developers, and promotes Oregon's biomass incentives.[63] In its Fifth Power Plan, the Northwest Power and Conservation Council identified 1,150 to 1,950

[60] Senate Bill 84, proposed by the OPUC.

[61] The OPUC has recently reactivated UM 1056 (Investigation into Least Cost Planning Requirements), in which the utilities, ratepayer representatives, and IPP advocacy groups have intervened. This proceeding could provide an opportunity for the Commission to explore through public workshops a wide variety of views on the best way to encourage renewable and distributed generation while keeping electric rates as low as possible for consumers.

[62] S. Aycock, *COPWRR Strategy Framework: Reducing Wildfire Risks in Central Oregon by Removing and Utilizing Forest Fuels*, a project of the Central Oregon Intergovernmental Council in cooperation with the USDA Forest Service Economic Action Program (December 2002)

[63] http://egov.oregon.gov/ENERGY/RENEW/Biomass/BiomassHome.shtml.

MWa of potential biomass generation that could be developed from wood residue, landfill gas, and manure in 2006 at competitive prices ranging from 4.5 to 6.5 cents/kWh. [64]

Yet with all this activity, widespread deployment of renewable generating resources remains illusive. One big factor is the cost of some renewable resources compared to conventional alternatives. While the state can do nothing to alter electric generation economics, it can remove many other barriers to development of renewable generation. The OPUC has already made a good start by revisiting the state PURPA rules in UM 1129, by identifying the barriers to non-utility (distributed generation) generation, and by suggesting possible solutions.

The state should develop a unified message regarding the system and customer benefits of renewable and distributed generation.[65] The state also should actively encourage cooperation among affected groups, such as utilities, IPPs, ratepayer groups, economic development, and environmental advocates, by raising awareness of the opportunities for mutual gain.

Recommendation: A Broad-Based Stakeholder Group Should Analyze the Economic Costs and Benefits of a Renewable Portfolio Standard and Report the Results to the Governor and Legislature.

Several other states have adopted Renewable Portfolio Standards (RPS) either in legislation or by regulation. California adopted the legislative approach[66] while New York adopted an RPS through a Public Service Commission rule that requires 25% of the electricity sold to consumers in New York State to be generated from renewable resources by 2013. ODOE, in its Draft RE Plan, proposes two long-term renewable resource goals that do not have the force of law. The first is that renewable sources built after 1999 will meet 10% of Oregon electric load 2015, increasing to 25% by 2025.[67] The second is that by 2010 state government will meet 25% of its electricity requirements with renewable electric generating resources, rising to 100% by 2025.[68]

A balanced group of stakeholders, including renewable resource proponents, ratepayer advocates, and utilities should analyze the economic costs and benefits of an Oregon RPS. The group should have sufficient funding to hire a contractor to conduct the economic analysis. Following that analysis, the group will develop and deliver to the Governor and Legislature recommendations for further action.[69]

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[64] *Fifth Power Plan*, Pre-Publication Draft, Table 5-2 (December 2004).

[65] ODOE, in its Draft RE Plan, recommends that the Governor appoint a "Renewable Energy Working Group" to guide the implementation of the RE Plan (p. 8)

[66] California Public Resources Code § 25740 establishes the Legislature's intent to "increase the amount of **renewable** electricity generated per year, so that it equals at least 17 percent of the total electricity generated for consumption in California per year by 2006." Other sections of the California Code implement this intent.

[67] Informed sources at ODOE report that the Draft RE Plan submitted to the Governor contains this goal. The published second draft of the RE Plan sets a different goal.

[68] Draft RE Plan at p. 5.

[69] As discussed in a prior footnote, the Governor's Advisory Group on Global Warming has suggested an RPS as an alternative to its recommendation GEN 2, "Develop a greenhouse gas allowance standard for delivered energy." Appendix A to that report, pp. 20-26, provides an extensive discussion of GEN 2 and GEN 2a recommendations, including projections of the reductions in carbon dioxide emissions as a result of adopting an RPS. *Oregon Strategy for Greenhouse Gas Reductions, Final Report*, (December 17,

Recommendation: Encourage Development of Advanced Electric System Control and Communications Technologies—for Both a More Efficient Grid and Economic Development.

The existing power delivery grid is a "legacy network that was not designed to support wholesale or competitive retail markets for the sale of electric power."[70] Before Oregon can realize the potential economic benefits of renewable generating technologies, the State must promote modernization of the grid as an enabling step. Furthermore, widespread adoption of advanced power technologies has many beneficial economic impacts, such as lowering grid costs, improving energy efficiency, increasing power reliability and quality, improving operational flexibility, and making the grid more amenable to the integration of distributed generation resources. Climate Solutions and others have pointed to Smart Grid technologies as a potential economic engine for new jobs and growth.[71] It will require the Governor's leadership to ignite that engine.

SUMMARY OF POTENTIAL STATE ACTIONS TO STIMULATE RENEWABLE GENERATING RESOURCES

In focus group sessions and in personal interviews industry and government contributors identified a wide range of actions Oregon could take to stimulate wind and biomass-fired generation. Because subsequent research uncovered a substantial number of barriers to widespread deployment of renewable resources (with the exception of large wind projects developed by well-financed and experienced companies), many of the recommended actions (summarized in the following table; pp. 35-37) appeared to be premature. This report's limited recommendations therefore focus mainly on barrier removal.

2004), Appendix A (October 13, 2004). This report's recommendation is that any state task force or advisory group that studies the costs and benefits of an RPS and that makes any subsequent recommendation to the Governor or the Legislature should have a broad base of participants from different stakeholder groups.

[70] *National Electric Delivery Technologies Roadmap*, p. vi.

71 Innovation Network, Smart Energy "Hot Team," Growing the Smart Grid Technology Industry in Oregon, a report to the Portland Business Alliance (October 2004); Athena Institute, Poised for Profit II: Prospects for the Smart Energy Sector in the Pacific Northwest (November 2003); Climate Solutions, Poised for Profit: How Clean Energy Can Power the Next High-Tech Job Surge in the Northwest (November 2001).

Summary of Potential State Actions to Stimulate Electricity Generation from Renewable Sources

Suggested Action	**Description**	**Impact (1-4, low to high)**	**Action Required/ Key Partners**	**Feasibility**
Renewable Portfolio Standard (RPS)	Require minimum amount of renewable energy in electric providers' portfolios (biomass, wind, solar, etc.)	4 Many focus group members feel this is essential and the surest way to create the demand that will stimulate production.	Legislation would require all proponents throughout the renewable energy industry including utilities and ag community. Should be considered in the context of the Governor's Advisory Group's strategy for greenhouse gas reduction.	The Legislature may face challenges from those who are opposed to government directives. Will get support from those who recognize the economic development potential. Some renewables advocates are concerned that successful programs already in place would be harmed by an RPS effort.
Increasing Venture funding for renewable energy projects	Enhance financial support for wind projects and suppliers through bonding options, loan programs, and venture capital funds.	3 Small wind producers in particular lack access to capital	Private sector initiative in conjunction with an interagency team and support from the Governor's office.	Depends on interest level from Governor's office and venture capital firms, as well as the institutional capacity of OBA or some other organization to facilitate.
Vertical Integration Assistance for Wind	Improved coordination among the various agencies (ODOE, OECDD), Governor's office, Oregon universities and other public entities with private industry.	3 The lack of coordination and transfer of knowledge is slowing the development of the wind industry in Oregon. The ODOE has the Wind Working Group but it is perceived as specific to community wind and may not be well integrated into other agency or private sector endeavors.	Agency commitment and additional support from Governor's office. ODOE, OECDD, resource economists, industry proponents, university programs.	Feasible if resources are secured and organization/staff is identified to facilitate.
Marketing Strategy	Inventory Oregon's world-class assets/resources in wind and renewables. Use these assets to develop a comprehensive marketing and education program that can be used for policymakers, communities and business development efforts.	3 A marketing campaign (in conjunction w/Brand Oregon, perhaps) may assist in coordination and cluster development. This strategy creates a less certain market than an RPS, but does heighten awareness about the industry.	Requires funding. Requires coordination among agencies, industry reps and advocates. OECDD, ODOE, utilities, Governor's Office, OBA, RNP	Feasible if resources are secured. OECDD secured a grant from the EPA to market biodiesel and has contracted with OEC. Could the same be done for wind?

Suggested Action	Description	Impact (1-4, low to high)	Action Required/ Key Partners	Feasibility
Resolve transmission and transmission access problems	Participate in on-going efforts to resolve these critical issues. Critical to develop leadership within the Oregon delegation and in the Governor's office in order to overcome political obstacles at BPA.	4 Long-term, multi-generational effort. Critical to industry success.	Coalition building and political will. Industry believes that Governor and business community should make this a top infrastructure development project.	Has been on-going for quite some time. A lot of institutional inertia; rather than create new project, OBA and OECDD should identify where the gaps are in advocating for change and if there is interest in the Governor's office to address this issue.
Outreach/Education to Business Community	Develop inventory/directory of wind-related industries in Oregon as a tool for educating Oregon businesses and obtaining their investment in a long-term strategy to grow the industry. Could be combined with Marketing Strategy suggested above.	2-3. Depends on the scale of the effort and if it was coordinated with utilities' marketing programs. Some advocates believe this would be very helpful; some in industry say it's irrelevant.	Commercial sector input has been lacking in the policy arena. OBA and others could educate and engage their members both in purchasing and at policy level.	OBA or another entity could implement with adequate funding.
Education and technical assistance for local utility boards and cooperatives.	Outreach program focused on opportunities and assistance, emphasizing load growth issues.	2-3 Depends on willingness of utility boards and cooperatives to participate. Many of these rely on low-cost BPA contracts.	Funding for agency (OECDD or ODOE) staff, Rural Electric Cooperative Assoc., PUD Assoc., BPA.	
Outreach and assistance to farm groups and rural communities	Provide farmers and rural businesses with assistance in preparing applications for Federal and other available funding. Use local newspapers and farm bureau newsletters to educate about the economic development potential from wind power and also as a way to hedge against natural gas prices. Could be integrated with Marketing Strategy listed above.	2-3	Non-governmental approach is likely preferable but governmental support may be necessary to initiate program. Collaborate w/on-going efforts w/RNP, Climate Solutions, OEC, and others	
Invest in emerging forecasting tools	New technologies that allow for better long-terrm planning	Unknown	OSU	Funding dependent
Explore the development of tradable credits	Some in the industry believe that it would be helpful to move away from reliance on tax credits	Unknown		

Suggested Action	Description	Impact (1-4, low to high)	Action Required/ Key Partners	Feasibility
Enhance R&D and the funding for it	Work with universities to develop research and educational expertise in mechanical engineering and electrical engineering/transmission areas to support wind and other renewables 72**;** Support and target research and development projects associated with lignocellulose feedstocks	3	Long-term planning among ODOE, OECDD, OSU, OIT and private sector	Depends on resource availability for spearheading an inter-organizational effort
Collaborate with on-going state global warming initiative	Track the proposals of Governor's Advisory Group on Global Warming and opportunities for coordination, especially as their efforts relate to economic development.	2-3 Depending on the strength of the recommendations	OBA, OEC and other groups already tracking plan implementation	Depends on the Governor's implementation of the effort
10 Year Woody Biomass Strategy	Complete statewide assessment of woody biomass; develop strategy to reduce delivered cost.	3 Would meet state's goal of 25 MW of new biomass-fueled electric generation	Requires state agency commitment and additional state resources. ODOE, ODF, USFS, private forest owners	3 Consortium of agencies and organizations have submitted pre-proposal to USDA's SBIR program for similar project
Biomass Emissions Reduction Credit	Extend current ERG program to add air emission credit banking protocols for diverting forest fuels from forest fires. Create market incentives for investments in reduction projects.	2 Would significantly reduce air pollutants, provide some jobs and save costs related to wildfires/health impacts.	DEQ, ODF, USFS, BLM, BIA, Native American tribes, other land management organizations and conservation groups	2

[72] Specific research projects have been proposed by Dr. Stel Walker, OSU: 1) Identification and instrumentation of areas of Oregon suitable for wind cluster development; 2) Expansion of Anemometer Loan Program to areas in Oregon outside PPL and PGE service territories. These proposed action plans are included in this report.

CONCLUSION – RENEWABLE ELECTRIC GENERATION

Unlike the immediate economic opportunity presented by renewable transportation fuels, renewable electric generation faces many hurdles before the state can realize the economic benefits. Because of the complexity of the institutional, regulatory, and market environment, the state cannot easily remove or lower those hurdles. Nevertheless, with bold state leadership, in partnership with private business and nonprofit organizations, the state can dramatically improve the prospects for renewable electric generation.

LIST OF APPENDICES

APPENDIX A – ABBREVIATIONS AND GLOSSARY

Abbreviations

BPA	Bonneville Power Administration
DEQ	Oregon Department of Environmental Quality
DG	Distributed generation
EPA	US Environmental Protection Agency
ETO	Energy Trust of Oregon
GAO	US Government Accounting Office
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IPP	Independent Power Project
kW	Kilowatt
kWh	Kilowatt hour
MTBE	Methyl tertiary butyl ether
MW	Megawatt
MWa	Average annual energy output of a generating facility
MWh	Megawatt hour
NARUC	National Association of Regulatory Utility Commissioners
NRECA	National Rural Electric Cooperative Association
NREL	National Renewable Energy Laboratory
OBA	Oregon Business Association
ODA	Oregon Department of Agriculture
ODOE	Oregon Department of Energy
OEC	Oregon Environmental Council
OECDD	Oregon Economic and Community Development Department
OPUC	Public Utility Commission of Oregon
QF	Qualifying facility
T&D	Transmission and distribution
USDA	US Department of Agriculture
US DOE	US Department of Energy

Biomass. Biomass fuels are from plants and other organic matter, including agricultural waste, forest residue, mill residue, spent pulping liquor, food processing waste, landfill gas, and the organic component of municipal solid waste. ODOE describes biomass as a renewable energy source because "the natural process of photosynthesis constantly produces new organic matter in the growth of trees and plants. "Resource recovery facilities" is another term for electric generating plants using biomass fuels. Such plants can generate electricity alone or electricity plus useful steam or heat.

Combined Heat and Power. CHP or cogeneration is a form of distributed generation refers to electric generation systems that capture the waste heat produced during generation for use by industrial processes or for heating and cooling. CHP is about twice as energy-efficient as producing electricity and heat separately, according to ODOE, which proposes to treat CHP as a renewable resource for purposes of eligibility for state benefits.

Distributed Generation (DG). An OPUC draft paper (see sources below) describes DG (also known as "distributed energy resources," or DER) to mean generating plants that produce electricity at or near the place where the electricity is used. A more complete DG definition would include electric generating facilities that are located where the "fuel" is. Fossil fuel-fired DG generators may be located anywhere (from diesel reciprocating engines in remote Alaskan villages to large natural gas-fired steam turbines at pulp and paper mills). Distributed generating plants fueled by renewable resources are typically located where the fuel is plentiful (from dairy farms employing biogas digesters to wind farms on rural windy plains and biomass-fired cogeneration units at sawmills). DG technologies include *combined heat and power (CHP, or cogeneration)*, *renewable energy resources (biomass, wind, geothermal, solar, small hydro)*, and *diesel and gas generators* typically used for backup power in remote locations.

Renewable Energy. According to the Oregon Department of Energy this term refers to energy from a non-nuclear source that is in constant supply over time as contrasted to limited fossil energy sources such as oil, natural gas, or coal. ODOE includes energy derived from the sun, wind, water, biomass, and earth (geothermal) as renewable energy sources. ODOE has also proposed, in the second draft of its *Oregon Renewable Energy Action Plan* (p. 20) to give combined heat and power (CHP or cogeneration) "the same status as renewable energy" in the legislation, rules, and programs or projects that encourage development of renewable resources.

Smart Energy. This term refers to the application of digital technology to the electricity network — the addition of electronics and "intelligence" to the generation, distribution, and consumption of electricity. Proponents believe that the application of Smart Energy solutions increases electric reliability while reducing costs and environmental impacts. Subsets of this term include *Smart Generation* (more efficient, controllable production), *Smart Grid* (the use of advanced technology to upgrade transmission and distribution systems to improve efficiency and accommodate alternative energy, including distributed generation), and *Smart End-Use* (improvements in system efficiency and utilization by using sophisticated software and hardware to reduce peak loads).

APPENDIX B–REPORT CONTRIBUTORS

The following private people contributed to this report either in focus groups or through personal interviews.

Renewable Fuels

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APPENDIX C – EXISTING STATE RENEWABLE FUELS INCENTIVES

Business Energy Tax Credit

The Oregon Business Energy Tax Credit (BETC) is valued at 35% of 'eligible costs' for any particular project. For alternative fuel projects, 'eligible cost' refers to all capital costs associated with developing alternative fuel infrastructure (i.e., production facilities, refiners, blenders, and distributors). Any project that invests in equipment for alternative fuel infrastructure is eligible for the BETC. Eligible alternative fuels include ethanol, methanol, biodiesel (at least 20% blend), compressed natural gas, liquefied natural gas, electricity, hydrogen, or hythane. The credit is a dollar for dollar credit against State of Oregon business taxes owed. Details, contact people and applications can be found at http://www.energy.state.or.us/bus/tax/taxcdt.htm.

Energy Loan Program

The Oregon Energy Loan Program (also known as SELP) promotes energy conservation and renewable energy resource development. The program offers low-interest loans for projects that: save energy; produce energy from renewable resources such as water, geothermal, solar, biomass, biofuels, waste materials, or waste heat; use recycled materials to create products; or use alternative fuels. The Energy Loan Program can loan to individuals, businesses, schools, cities, counties, special districts, state and federal agencies, public corporations, cooperatives, tribes, and non-profits. Projects must be sited in Oregon. http://www.energy.state.or.us/loan/selphme.htm.

Property Tax Exemption - Enterprise Zone Exemption (ORS 285C.055)

Through a short-term tax exemption, an Oregon enterprise zone induces eligible businesses of all sizes to make additional investments that will improve employment opportunities, spur economic growth and diversify business activity. Qualifying new plant & equipment in a zone receives a total exemption for at least three and—in some cases—up to five consecutive years from the local assessment of ad valorem property taxes, which can otherwise have a deterring effect on private investors seeking to start or enlarge operations with a substantial capital outlay. Enterprise zone property (except hotel/resorts and utilities) also is exempt for up to two years while it is being constructed or installed. http://www.econ.state.or.us/enterthezones/whatare.htm

Ethanol production facilities (ORS 307.701)

Upon compliance, the real and personal property of an ethanol production facility that meets the requirements of subsection (3) (below) is exempt from taxation. The exemption shall be 50 percent of the assessed value of the property determined under ORS 308.146. The exemption under this section may be claimed for five assessment years. There is a sunset provision of 7/1/08.

Subsection (3) An ethanol production facility may qualify for exemption from taxation under this section if the facility:

(a) Is first in the process of construction, erection or installation as a new facility after July 1, 1993;

(b) Is or will be placed in service to produce ethanol within four years after January 1 of the first assessment year for which the exemption under this section is claimed; and

(c) Within four years after January 1 of the first assessment year for which the exemption under this section is claimed, is or will be certified by the State Department of Agriculture as a facility that produces ethanol capable of blending or mixing with gasoline. The blend or mixture shall meet the specifications or registration requirements established by the United States Environmental Protection Agency pursuant to section 211 of the Clean Air Act, 42 U.S.C. 7545 and 40 C.F.R. Part 79.

http://www.leg.state.or.us/ors/307.html

APPENDIX D– BIOFUELS TECHNICAL INFORMATION

Specifications

Ethanol

The Renewable Fuel Association has published *Industry Guidelines, Specifications, and Procedures*, (RFA Publication No. 960501; revised December 2003), available at http://www.ethanolrfa.org/Final960501.pdf. That publication contains, among many other subjects, complete specifications for ethanol, ethanol/gasoline blends, quality control methods and tests, and shipping and handling guidelines. All ethanol must meet the quality standard established by the American Society of Testing and Materials Measurement: ASTM D 4806 Standard Specification for Denatured Fuel Ethanol for Blending with Gasoline for Use as Automotive Spark Ignition Engine Fuel.

Readers who want more technical information on ethanol should consult the RFA website (www.ethanolrfa.org). Here are some ethanol highlights:

Ethanol contains 35% oxygen, is non-toxic, water soluble, and biodegradable.

This renewable fuel can be produced from, in addition to corn, sugar cane, sugar beets, municipal waste, and cellulose sources, such as forest residue (from Oregon forests), agricultural residue (from Oregon fields), and pulpwood (such as hybrid poplars or cottonwoods grown in NW Oregon).

Contrary to oil company claims, ethanol can be shipped by pipeline. It's done in Brazil, and Williams Energy Services has successfully tested ethanol pipeline shipments. Nevertheless, pipeline shipments will likely serve niche, short-haul markets, with rail, truck, and barge options remaining the principal shipping modes.

Biodiesel

The US Department of Energy has published a comprehensive guide to biodiesel, including detailed specifications: *2004 Biodiesel Handling and Use Guidelines* (DOE/GO-102004-1999, September 2004). The publication can be downloaded from www.sqbiofuels.com/brochures/2004_Biodiesel_Handling_And_Use_Guidelines.pdf. The National Biodiesel Board also has published biodiesel specifications, production, and quality information, available at http://www.biodiesel.org.

The term "biodiesel" means the monoalkyl esters of long chain fatty acids derived from plant or animal matter which meet the requirements of ASTM D 6751 Standard Specification for Biodiesel Fuel. B-100 is pure, 100%, or "neat" biodiesel. More commonly, B100 is blended with petrodiesel in biodiesel blends, such as B-5 (5% pure biodiesel) and B-20 (20% pure biodiesel).

Performance

Ethanol

The Renewable Fuels Association's website contains a complete discussion of ethanol and engine performance (www.ethanolrfa.org/factfic_enperf.html). Here are some important performance characteristics:

- Ethanol blends clean fuel injectors.
- Ethanol reduces fuel economy. E-10 increases fuel consumption by about 2% compared with pure gasoline.
- A ten percent blend (E-10) contains only 97% of gasoline's energy content, but improved combustion partially compensates for that loss of power.

Biodiesel

Biodiesel offers both advantages and disadvantages when compared to petrodiesel. B-100's energy content is about 11% lower per gallon than petrodiesel, but B-100's higher viscosity (which reduces barrel/plunger leakage, thereby improving injector efficiency) yields a net maximum power output loss of 5-7%. Lower biodiesel blends such as B-5 and B-20 would yield correspondingly lower power losses.

Conventional diesel engines can burn B-100, but users must be sure that the fuel is suitable for the user's engine and application, must observe different maintenance intervals, and must observe other precautionary protocols because of the different properties of B-100 as compared with petrodiesel. Major diesel engine manufacturers (e.g., Caterpillar and Cummins) do not recommend using B-100 in their unmodified factory engines.

Lubricity, another important characteristic of conventional diesel fuel, is a measure of lubricating properties. Fuel injectors and some types of fuel pumps rely on fuel for lubrication. One study, published in 1998 and cited by the National Biodiesel Board, found that one-half of samples of petrodiesel sold in the United States did not meet the recommended minimum standard for lubricity. Biodiesel has better lubricity than current low-sulfur highway petrodiesel, which contains 500 parts per million (ppm) sulfur by weight. The petrodiesel lubricity problem is expected to get worse when ultra-low-sulfur (15 ppm sulfur by weight) petrodiesel for highway use is introduced in mid-2006. A one or two percent volumetric blend of biodiesel in highway ULSD improves lubricity substantially.[73]

While no engine manufacturer may legally void an engine warranty because a user has run the engine with biodiesel (pure or blended), manufacturers make it clear that failures, or problems which can be traced to the use of biodiesel, are not covered by warranties. On the positive side, major engine manufacturers (e.g., Cummins and Caterpillar), the Engine Manufacturers Association, and the World-Wide Fuel Charter

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[73] As noted above in footnote 5, there is presently no sulfur content requirement for petrodiesel used in non-highway applications. The sulfur content of such unregulated distillate (light diesel) and residual (heavy diesel) fuels can run as high as 5,000 ppm by weight. See EPA's Nonroad Diesel Rule, available at www.epa.gov/nonroad-diesel/2004fr.htm.

unanimously approve using B-5 in diesel engines as long as the biodiesel blend meets the technical specifications of ASTM D6751, EN 14214 (European Norm), or the manufacturers own biodiesel specifications. Caterpillar also approves biodiesel blends of up to 30 percent for some of its later design models

Readers desiring more performance information should consult US DOE's *2004 Biodiesel Handling and Use Guidelines* (cited above and in Appendix __ below).

Biofuels and Air Quality Emissions

Ethanol

Readers desiring more detailed emissions and the air quality impact of ethanol in gasoline blends should consult the Renewable Fuels Association's publication public health and environment database at www.ethanolrfa.org/pubs.shtml#one. A recent study by Dr. Gary Whitten summarized ethanol's positive air quality impact:

> Ethanol in Gasoline can favorably impact mobile source emissions in five main air quality areas: these areas are fine particulate matter (e.g., $PM_{2.5}$), carbon monoxide, toxics, ozone, and global warming.

According to the Argonne National Laboratory, in 2003, ethanol use in the US reduced CO2-equivalent greenhouse gas emissions by 5.7 million tons, equal to removing emissions of more than 853,000 cars from the road.

Biodiesel

Readers seeking detailed emissions information on biodiesel in diesel fuel blends should consult EPA's 126 page report, *A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions, Draft Technical Report*, EPA420-P-02-001 (October 2002), available at www.epa.gov/otaq/models/analysis/biodsl/p02001.pdf. That study was limited to the current fleet of diesel vehicles and did not include more recent designs with exhaust gas recirculation (EGR) technology. The results for B-20 show a 10% reduction in particulate matter, a 21% reduction in hydrocarbons, an 11% reduction in carbon monoxide, and a 2% elevation of NOx. The study found no "unambiguous difference" in CO2 emissions between biodiesel and petrodiesel.

In a joint US Department of Agriculture and US DOE study, *Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus*, NREL/SR-580-24089 (May 1998), the researchers found that the use of biodiesel reduced petroleum consumption and emissions of CO2, particulates, CO, and Sulfur Oxides. Biodiesel did increase NOx emissions.

APPENDIX E- SOURCES

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Appendix F: Proposed Action Plans from Contributors