Animal Byproduct Technology Assessment and Market Analysis: Options for Oregon

Final Report

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Preface

The animal byproduct technology assessment and market analysis was administered through the Agricultural Development and Marketing Division of the Oregon Department of Agriculture, and is the outcome of a public-private initiative known as the Oregon Solutions team. The Oregon Solutions team was formed by the Governor in 2006 to address and develop short- and long-term solutions to the problem of animal byproduct processing and disposal.

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In the course of our investigation, the study team had the opportunity to interview and discuss with many individuals the issues surrounding animal byproduct disposal and use. They included persons from farming and ranching businesses, butchers and meat cutters, renderers, transporters, manufacturers of compost, alternative energy producers, state agencies responsible for protecting public health and safety and for promoting economic development, political leaders, entrepreneurs, and associations interested in these issues. The study team has directly interviewed the following persons:

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- Dennis Hays, Northwest Meat Processors Association
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- Barbi Riggs, Oregon State University Extension Service
- Gary Stevens, Jackson County Environmental Health
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Executive Summary

Introduction

For half a century, Oregon had two in-state rendering plants that handled and processed more than 40 thousand tons of animal mortality and meat processing byproducts derived from butchering beef, hogs, and game animals. The material must be safely processed into marketable products, or disposed of properly to protect public health.

Recent events have resulted in significant changes to the rendering business in Oregon. The discovery of *bovine spongiform encephalopathy* (BSE) has raised concerns about possible disease transmission to humans and animals through the processed byproducts, resulting in a decrease in demand for those products. In addition, import sources have increased the supplies of products traditionally made by rendering firms, resulting in much lower prices. Combined with local environmental issues, these conditions have largely contributed to the closure in 2006 of the two Oregon rendering companies.

The closures have an effect on the cost structure of the livestock industry, which must pay more to utilize rendering services from California or Washington. Grocery stores and meat cutting establishments, horse owners and breeders, and livestock owners with on-farm mortalities are also significantly affected, as they face fewer options for animal waste disposal. Some landfills have received limited duration approval from the state to accept animal waste; however, this is not considered a viable long term solution.

The Governor formed the Oregon Solutions Team with a focus of exploring both short term and potential long term solutions to the animal byproducts processing and disposal problem. They have sponsored this study to examine the practicality of composting, a review of other technologies for processing, and a preliminary examination of existing and future markets for animal byproducts.

Major Findings and Conclusions

1. Loss of rendering plants has left fewer options available to many Oregon businesses that used them, and additional expense incurred.
    a. Geographically, businesses engaged in ranching and dairying, hogs, or other livestock, and meat packers and butchers in Central and Southern Oregon are most directly affected.
    b. Elsewhere, particularly in Northwest Oregon and Eastern Oregon, the effects are varied, depending upon whether or not the businesses already used other services.

c. Many meat packers and wholesale processors, statewide, report increases of 33 to 50 percent in animal byproduct disposal costs during the past year.
d. The largest dairy cooperative in the state has, in the past, used in-state rendering. In recent years, the cooperative shifted to landfills for disposal of dairy mortalities, but continue to seek safe, effective, and lower cost options.
e. Rendering continues to be a major method of disposal in Oregon, but it is accomplished by transporting to out-of-state processing plants. For some, the out-of-state processors have always represented the best (least-cost) alternatives for disposal.
f. Many generators of mortality and animal byproducts believe transporting wastes long distances to out-of-state renderers is not sustainable as fuel costs continue to rise.
g. The cost of rendering would increase significantly if a proposed Food and Drug Administration rule were to go into effect. This rule will require removing brains and spinal cord materials from ruminant animals over 30 months of age prior to rendering, as a means of limiting possible BSE transmission.

2. The study team estimates that about 91.65 million lbs. of animal byproducts are generated annually in Oregon, with about 81.98 million lbs. recoverable (see Table ES-1). A large share of the animal mortality is beef cattle (and to a lesser extent, other livestock); this includes range animals that are not retrieved and instead are left to natural processes.
   a. More than half (55 percent) of recoverable byproducts is offal (processed meat byproduct), about a quarter (26 percent) is animal mortalities, and the remainder (19 percent) is grocery trim and scrap.
   b. In terms of animal mortalities, nearly two-thirds (64.5 percent) are beef cattle and calves, with the remainder as dairy cows (16.7 percent), horses (14.4 percent), sheep (3.5 percent), and hogs (1.0 percent).

Table ES-1
Estimated Recoverable Mortality and Byproducts Generated, by Region of Oregon and Source Type (million lbs)

Region	Recoverable Animal Mortality	Offal	Grocery Trim and Scrap	Total Weight
Northwest	8.70	25.32	11.36	45.38
Southwest	3.00	0.54	1.54	5.08
North Central	1.91	4.70	0.33	6.94
South Central	2.52	14.09	1.60	18.21
Eastern	5.33	0.08	0.96	6.37
Total	21.46	44.73	15.79	81.98
Percent	26%	55%	19%	100%

3. The future supply of animal byproducts is expected to increase a total of four to seven percent, depending upon source and type, within the next five years. This is based on projections for each of the major animal species groups.

4. There is relatively little seasonal variability in mortality and meat byproduct processing volumes. This is an important and positive consideration for establishing continuously operating processing technologies.

5. Landfill disposal of animal mortality is currently allowed at some 13 landfills throughout Oregon. DEQ, the Oregon Solutions Team, and indeed most landfill operators, view landfill disposal of animal mortalities as only a short term option.
   a. Two large landfills (Columbia Ridge in Arlington and Coffin Butte near Corvallis) have several years remaining on their permits for accepting animal byproducts. The landfills represent the least cost disposal option for many who require animal byproduct disposal, depending on the distance to the landfill.
   b. To the extent that landfills remain affordable and available to accept animal byproducts, they will continue to attract these materials. This option will hinder to some extent the development of new markets for potential products by effectively "bidding away" supplies of animal byproduct source material.

6. The study team considered seven generic types of processing options for animal byproducts: composting, anaerobic digestion, thermal gasification and pyrolysis, direct combustion (incineration), plasma arc, alkaline hydrolysis, and acid and enzymatic hydrolysis.
   a. Each of the alternatives has been used to process some type of solid waste. A few of the processes have been used to process animal byproducts. Each of the alternative processes has the potential to yield a product.
   b. Four of the seven processes met certain technical factors and characteristics to be considered for further analysis during the study. Among the factors were technological risk, health and safety, and feedstock versatility.
   c. The four processes subjected to additional analysis were composting, anaerobic digestion, alkaline hydrolysis, and thermal gasification.
   d. Screening criteria supplied by the Oregon Solutions Team were applied to the four processes selected for further analysis. Composting, anaerobic digestion, and thermal gasification were found to be "conditionally feasible," and alkaline hydrolysis was found to be "feasible."

7. A preliminary market analysis was conducted for each of the potential products that could be derived from processed animal byproducts. The potential products included compost, biofuels (ethanol and biodiesel), biogas, biochar, biooil, and hydolyzate.

8. The technical analysis described above yielded four processes that were considered "conditionally feasible" or "feasible." These processes yield products that were subjected to more detailed analysis of market potential. These products are discussed below.
   a. <u>Compost</u>: Oregon has a modest, but growing market for compost generated from organic materials. There is strong interest among farmers for generating compost from animal mortalities. However, there are significant barriers to composting of

animal byproducts (ABP) and to the commercial use and public acceptance of compost derived from ABP:

   i. It is uncertain whether composting processes will reduce pathogens to safe levels, particularly prions responsible for BSE. Safe design and operating conditions for ABP composting should be established.
   ii. The market for compost in general is modest in size relative to potential supplies of organic materials, and animal-based sources of compost will not compete well in the near future.
   iii. Composting of ABP has the potential to be a relatively low cost means of treating animal byproducts. However, the design and operating conditions of the facilities should reflect local conditions, including the characteristics of ABP, magnitude (size) of processing operation, and proximity of natural resources and humans to the operations.

b. Gaseous Fuels (biogas or syngas): Anaerobic digestion and thermal gasification can yield medium- and low-Btu fuel gas, respectively, from animal byproduct feedstocks. The fuel gas is often used in on-site electricity generation or cogeneration applications. The market for these alternative types of fuel gas is small but increasing, and its closest competitor is high-Btu natural gas.

   i. Comparatively flat forecasts for natural gas prices in the medium-to-long term future argue against rapid technological advance or increases in supply and demand for fuel gases generated from waste materials. However, an expanding interest in this country to use energy from renewable sources, including government subsidies and tax credits, should improve the prospects for alternative fuel gas markets in the future.

c. Hydrolyzate: Alkaline hydrolysis will yield hydrolyzate by using animal byproducts as feedstock. There is evidence that the hydrolyzate can be used as fertilizer, and as a feedstock for biogas generation or biodiesel refinement. The market is in its infancy, although development of processes to turn hydrolyzate into biofuels should increase commercial viability in the future.

Recommendations

1. Perform a detailed characterization and analysis of the sources, locations, quantities, and properties of animal byproducts generated in Oregon.
2. Conduct an analysis of federal, state, and local regulations that are, or could potentially be, applicable to the management and processing of animal byproducts.
3. Develop engineering field trials and develop data regarding technical and economic performance, environmental protection, and yield and quality of energy products that could be generated from specific types of animal byproducts using the processing technologies considered in this evaluation.
4. Review DEQ policies associated with landfill disposal of animal byproducts, to ensure that landfills truly operate as a short term solution, while still providing a "last resort" option for suppliers. Policy changes placing limits on landfill disposal should be tied to finding or, if necessary, seek public or private sector support for affordable alternatives.

5. The State of Oregon, in coordination with local governments, should consider the viability of establishing refrigerated transfer stations at strategic locations. Central and Southern Oregon locations would be among the highest priorities, as they have been most directly affected by the closure of the rendering facilities.
6. Research institutions and the public sector should continue to investigate and develop technical solutions for animal byproduct disposal, including but not limited to, the physical and chemical properties of compost and the output of other processes, and analysis of product markets.
7. The State should consider opportunities for involvement with the private sector, including both siting and financial assistance, for a new animal byproducts processing facility that could (1) serve meat processors and farmers with a viable and affordable disposal option, and (2) be a research and technology development center for production of alternative, renewable fuels.

Section 1
Introduction

1.1 The Problem with Animal Byproducts in Oregon

"Animal byproducts" are the collection of material from commercial slaughtering and processing that is generally disposed of or developed into secondary products. Animal byproducts include on-farm animal mortalities which are a natural occurrence that must be managed by livestock and dairy operators. Meat cutting at wholesale and retail establishments also generates byproducts requiring proper disposal. In Oregon, more than 91 million pounds (lbs.) of animal byproducts are produced annually from all sources. The material must be safely processed in order to prevent nuisances and public health hazards.

Unprocessed animal byproducts and mortalities contain large numbers of microorganisms, including pathogenic bacteria and viruses. These materials provide an excellent environment for the growth of organisms that has the potential to threaten human and animal health. If left uncontrolled, the materials could become a significant biohazard, promoting disease, and attracting and harboring rodents, insects, and other disease vectors.

Rendering is a common and effective process for recycling or disposing of animal byproducts. In Oregon, two rendering firms have traditionally provided meat processing and livestock industries with disposal services and, in doing so, created marketable products useful in a variety of industries. Recent events have resulted in significant changes to the rendering business in Oregon. The discovery of *bovine spongiform encephalopathy* (BSE) has raised concerns about possible disease transmission to humans and animals through the processed byproducts, resulting in a decrease in demand for those products. In addition, import sources have increased the supplies of products traditionally made by rendering firms, resulting in much lower prices. Combined with environmental issues, these two conditions have largely contributed to the closure in 2006 of the two Oregon rendering companies.

1.1.1 The Loss of Oregon Rendering: Effects on Industry

The closures of the Oregon rendering companies have an effect on the cost structure of the livestock and dairy industries, which must pay more to utilize rendering services from California or Washington. Dairies and livestock production are each consistently ranked among the five highest revenue generating agricultural commodities in Oregon, and are significant to the economic structure of many rural Oregon communities. Yet, they operate on low margins, and the effect of higher costs on profitability could be substantial.

Ranchers routinely manage animal mortalities as a normal part of raising cattle, and off-farm disposal is necessary in some circumstances in order to limit disease transmission. Recovery of dead livestock may be limited or impractical where cattle and horses are turned out in very large pastures or rangeland, and they are instead left to scavengers or natural decomposition.

Dairy cows, hogs, and sheep are generally raised in sufficiently confined pastures or pens such that all death loss is accountable, and timely management of the mortality is required. It is largely impractical and often undesirable for operators in these industries to use on-farm means of disposal. For those businesses that were dependent on either of the two Oregon rendering companies, the effects of the closures on their profitability are quite significant.

Grocery stores and meat cutting establishments are also affected. Larger grocery chains typically establish contractual arrangements with byproduct haulers, who deposit the material at landfills or rendering plants. The closure of the two Oregon plants may affect their per-unit costs to a limited extent if the material must be transported farther distances. However, smaller stores, especially those in rural areas, and custom meat cutters, could be significantly affected. Their options or alternatives tend to be fewer, they have smaller loads and higher costs per unit, and their ability to pass along cost increases to consumers is more limited. It is possible that some may cease operations if the cost of disposal is too great.

Horse owners and breeders, large animal veterinarians, and small livestock owners with on-farm mortalities are also significantly affected by the closures. They typically use rendering services and have little or no opportunity for other disposal options for animal waste disposal.

1.1.2 Public Health and Safety: The Cost of Doing Nothing

The state of Oregon faces greater potential public health and safety hazards and nuisances due to the loss of in-state rendering options. Renderers heat-treat dead animals and similar material to kill pathogens while creating byproducts for resale or use. In general, the rendering process is very effective as a mechanism to control risks from microbial pathogens such as bacteria, viruses, parasites, and protozoa, and produce an aseptic protein product that is free of environmental threats. Rendering is also highly effective at reducing the amount of potential BSE infectivity.[1]

Rendering is not the only means available for protecting public health from animal byproduct disposal. Incineration and alkaline digestion processes will also reduce infectivity. However, at present, opportunities for these options are limited or non-existent.

In Oregon, some landfills have received limited duration approval from the state to accept animal waste; however, this is not considered a viable long term solution. There is concern about warm weather operations and procedures, and the potential impact on leachate quality which could affect ground water for many years to come. There is also a general distaste for direct visual exposure by the public to dead animals in landfills.

1 "Rendering is the Safest Disposal Option," National By-Products Technical Bulletin, 2002, cites several research studies that have examined BSE infectivity; http://www.nationalby-products.com.

Composting of animal materials is a useable process under certain conditions, primarily larger farms and ranches. Guidelines have been established for composting procedures, but there is little ability to regulate its use. Furthermore, there are no restrictions on the use of compost materials, and concerns about its use on crops later consumed by humans or animals may inhibit its widespread adoption.

Without a comprehensive examination of the options, the loss of rendering facilities in Oregon will lead to increased disposal of animal byproducts in landfills and greater use of on-farm composting. There is also a likelihood that more dead animals will be left in fields, other public or private locations, or near waterways to decompose or be carried off by scavengers. This has serious implications for the expansion and transmission of disease.

1.2 The Search for Solutions

The Governor has made a high priority the resolution of the animal byproduct processing and disposal problem, and formed the Oregon Solutions Team. The focus of the team is to explore short term and potential long term solutions to the animal byproducts processing and disposal problem. This will require an examination of options including the practicality of composting, a review of other technologies, and a preliminary examination of existing and future markets for animal byproducts. Successful outcomes, as envisioned by the Oregon Solutions Team, are measured by the expedited adoption by businesses of new, emerging, or enhanced technologies that can also have added benefits to Oregon. These added benefits may include the expansion of volume and markets for compost produced under controlled and safe manufacturing practices, or new sources of "green" or alternative energy for electricity produced from processed biological materials. In turn, these outcomes will reduce nuisance and health hazards to the residents of the state due to potential use of illegal practices such as road-side disposal or unlawful burial of animal mortalities.

One of the key aspects of the practical problems now facing businesses with animal byproducts is the lack of multiple locations within Oregon accepting animal mortalities and meat byproducts. Long distance transportation of the organic materials adds significantly to the total disposal cost. It is more likely to meet the user needs if solutions are developed that allow for multiple sites for processing, and in fact if more than one processing method is adopted. Thus, the establishment of markets for byproducts may require additional incentives to reestablish in-state rendering or processing facilities, or create new sites for acceptance of byproduct material.

1.3 Purpose and Scope

The Oregon Solutions Team has identified a need to examine short term and potential long term solutions to the problem of animal byproduct processing and disposal. The purpose of this study is to review current technologies and examine current and future markets for products that could derive from animal byproducts. The analysis of potential long term solutions should consider the perspective of conventional disposal by suppliers of animal byproducts, and the perspective of a resource that could be utilized in a sustainable business generating profit.

This report is intended to assist in-state decision makers in developing policies designed to protect public health, safety, and the environment; protect Oregon businesses; and promote and foster economic development in Oregon. The report may also serve as a resource for entrepreneurs and businesses that may choose to develop a market.

1.4 Organization of the Report

This report contains seven additional sections. In Section 2, the recent history and factors leading to the closure of Oregon's rendering facilities is presented. Short term solutions are discussed, as well as the effects on Oregon businesses and need for solutions. Section 3 contains an analysis of current and future supply of animal mortalities and byproducts, with a view to supplies anticipated in five years. This is followed in Section 4 with an analysis of costs of disposal of animal mortalities and other byproducts. Much of the information in Section 4 derives from direct interviews with suppliers, renderers, transporters, and landfill operators.

Section 5 contains an overview of the general markets for products that could be derived from animal byproducts. The discussion considers supply, alternatives (competitors), and consideration for current and future demand. Section 6 presents research and identification of technical options and opportunities. It presents seven generic processing methods, narrows the list to four which meet certain technical factors and characteristics, and subjects the four technologies to a set of criteria that were developed by the Oregon Solutions Team. The findings of this technical analysis are presented, along with a discussion of issues and considerations.

Section 7 contains an analysis of the demand and economic significance of the primary products dervied from processing animal byproducts. The analysis is focused on the specific markets of those products that would result from the processes meeting the Oregon Solutions Team criteria, and presents information on current and future market conditions for each product. Finally, Section 8 contains a set of conclusions that can be drawn from this analysis, plus a set of recommendations.

Section 2
Recent History and Current Conditions

2.1 Background and Factors Leading to the Closure of Oregon Rendering Facilities

For half a century, Oregon has had two in-state rendering plants that primarily handled animal mortality and meat processing byproducts derived from butchering beef, hogs, and game animals. These two Oregon rendering plants both closed in 2006, though for independent reasons. Many factors led to their closure.

Redmond Tallow in Redmond, and Southern Oregon Tallow in Eagle Point, both opened for business over 50 years ago. By current industry standards, each was a small volume processor of rendered animal products. Their closures follow a similar pattern across the U.S. as smaller independent renderers have faced difficulty generating sufficient profit to modernize equipment and expand to achieve needed economies of scale.

The Oregon companies each followed a traditional rendering business model. They collected animal wastes with their own trucks, as well as received self-haul products at their processing facilities, and they processed the animal waste into saleable products. Neither operation had outlying transfer stations at distant collection points. Transfer stations are increasingly used by renderers as existing plants handle larger supply regions with their large volume capacity and expensive environmental controls for air and water quality management. Modern rendering plants typically handle 3 to 10 million pounds of incoming feedstock per week. The Oregon tallow plants were far smaller than the capacities of these modern plants.

Low product prices plagued the U.S. rendering industry following the detection several years ago of BSE in Canadian cattle. The detection of BSE in Washington in 2003 had a particularly negative impact on the financial returns to this region's renderers. The two Oregon businesses were hurt by low prices for meat and bone meal, and animal fats. Owners of Southern Oregon Tallow also reported that increasing competition from a California rendering business further diminished their economic viability.

By rendering industry standards, the two Oregon businesses were making only modest upgrades to capacity and new process technology in recent years. Without volumes expanding, the collection of animal mortality, meat waste, and grease had an increasing share of expenses for their businesses. Closure became inevitable as revenues stagnated and they had insufficient profits to provide capital for maintenance and upgrades of buildings and equipment. In addition, especially for Redmond Tallow, costs increased dramatically for them to meet environmental standards.

Financial strain led Southern Oregon Tallow to decide that it would no longer process blood. In 2006, the company elected to not make a major capital expenditure for a major upgrade of their blood meal processing equipment. The single customer who supplied Southern Oregon Tallow with blood was Masami Foods, a slaughter facility in Klamath Falls. Masami Foods was by far the largest customer of Southern Oregon Tallow. Masami selected another renderer to take all of their animal wastes when Southern Oregon Tallow stopped processing blood. This left Southern Oregon Tallow with insufficient total feedstocks to process and at that point they closed their operations.

The two Oregon rendering companies were impacted very differently by environmental regulations. Southern Oregon Tallow's relatively rural site was well suited for rendering operations. The Oregon Department of Environmental Quality (DEQ) reports that the waste water management and air quality at Southern Oregon Tallow was acceptable. However, Redmond Tallow's operations had significant environmental violations and this compounded their financial problems.

Water quality was the greatest environmental obstacle for Redmond Tallow. During 2001 to 2002, DEQ determined that Redmond Tallow had elevated levels of nitrates in their on-site ground water. This was found to be the cause for elevated nitrate levels in at least one off-site domestic well. In 2003, DEQ ordered the company to decommission its groundwater discharge system (a septic system with a drain field) and install a lined pond system to contain the polluted waste water.

Since Redmond Tallow was found to have adversely impacted groundwater beneath their facility, they were required to hire a private consultant to prepare a Remedial Investigation and Feasibility Study (RI/FS) for approval by DEQ. The RI/FS was a study to determine the extent of impacted groundwater and to include a proposal for the remediation of the groundwater that was adversely impacted from the company's past activities. This compliance cost also added to the expense of their daily operation.

The environmental study led Redmond Tallow to install a pond containment system. The condensed liquid from this system was allowed to be field applied at agronomic rates or otherwise disposed of in accordance with their waste management plan. The company has been hauling the waste to a municipal sewage treatment facility and even after closure the owner continues to do so. This ongoing requirement has proven to be very costly and it has contributed to the decision to cease operations.

Odor complaints were also a problem at Redmond Tallow. Odor problems persisted in spite of the owner working closely with DEQ to contain odors by use of a condenser that captured steam released by the cooking equipment in an enclosed tank. Odors were a particular problem in the summer months with regular nuisance complaints reported by neighbors. Noticeable odor problems remained even after following improved management practices such as limiting the opening of the cooker for batch processing and changing the hours of operation. The pond system for leachate control was also a source of odor. Redmond Tallow was never forced to close due to emission of odors, but the actions taken to reduce odor also led to higher operating costs.

Another environmental problem for Redmond Tallow was considerable stockpiling of paunch manure (undigested matter in the stomachs and intestines of dead animals). This material was held in un-composted piles on site. The 2003 DEQ order also required that Redmond Tallow properly dispose of this contaminated waste, which is still being removed from the site.

Both of these Oregon rendering businesses were family run operations. In each case there were no younger family members interested in taking over the ownership or management. Also there was not a viable business outlook to attract outside prospective buyers to purchase these businesses. The two Oregon renderers faced the general trend of the rendering businesses across the U.S. That is, rendering is proving to be unprofitable for smaller operators.

In response to receiving lower prices for their products following the BSE incidents, the two Oregon companies began charging in 2003 for collecting animal mortalities, meat trimmings and grease. These charges were necessary to cover the high cost of collection and contribute to overall business revenues. Both operators sent their trucks up to 150 miles or sometimes farther to pick up animal mortalities, trimmings from meat cutters and restaurant grease. Collection was costly due to the long distances traveled with low density in terms of the number of collections per route in the more rural areas that they served. Furthermore many suppliers such as restaurants and meat cutters need frequent collection of small volumes. Frequent pick up (particularly in summer months) is necessary to preserve the quality of the product for rendering and to avoid odor and health issues. These conditions added to the costs of operations and it became even more difficult to recover costs with increasing fuel prices.

For animal mortalities, the rendering companies implemented a collection charge (and steadily increased this charge in an attempt to maintain business revenue). This led to decreasing demand for this service as disposers of animal mortalities found less costly alternatives. In the rural parts of Oregon, this often meant "back field" burial or mere carcass dumping. The availability of open spaces for this purpose as well as the difficulty of enforcing illegal dumping has made it difficult to monitor and curb this practice.

Another reason small independent rendering companies are having business difficulties is increased competition for the feedstocks, particularly the high value yellow grease. For example, EC Restaurant Services is collecting restaurant grease from throughout central Oregon. They regularly pick up the grease as a specialty service. The strong market for grease as a renewable energy source in biofuel means that a local renderer would face strong competition for sourcing restaurant grease from other businesses.

2.1.1 Will In-State Rendering Return to Oregon?

Is there a reasonable prospect that a firm can be attracted into Oregon for in-state processing of raw materials into rendered products? For reasons discussed below, it is very unlikely this will occur without direct support (financially and otherwise) from the state or local entities.

One reason is that several well established rendering plants operate on the perimeter of Oregon's borders. Consequently, Oregon is still directly served by renderers despite the recent closure of the two in-state processors. Darling International, Inc. (Darling) and Baker Commodities Inc. (Baker) each have transfer stations in Portland and they operate route trucks within the state. Darling has rendering plants in Tacoma and Boise. Baker Commodities has rendering plants in Seattle and Spokane, and a transfer station in Sunnyside, Washington. North State Rendering operates a rendering facility near Oroville, California, with a truck depot in Crescent City, California. These firms have positioned themselves to maximize their access to Oregon given the locations of their existing plant facilities.

Nationwide trends in the meat packing industry are also driving change in the rendering industry. The following description of the livestock industry is principally summarized from the book, Essential Rendering: All About the Animal Byproduct Industry, published by the National Renderers Association (NRA), 2006.

Livestock industry innovations in the last 50 years have dramatically altered the size and scope of U.S. rendering businesses. The first of these innovations was the development of boxed beef, which is the breaking of carcasses into primal, sub-primal and consumer cuts. This innovation began in the large beef slaughter plants in the late 1960s and early 1970s. The second innovation is the advent of large scale livestock production due to improved animal health care and improved livestock business management. Large cattle and hog feedlots have an advantage over smaller operators in both cost of production and in negotiating favorable sales agreements with packing plants. Larger scale confined feeding operations have been observed for decades but very large finish feedlots (one time capacity of 25,000 head and more) have become more common in the last 10 to 15 years. There has also been a parallel increase in the size of meat packing plants. The result is that packing plants are strategically located in relationship to both sources of animals as well as destination to consumer markets.

Structural change in livestock production and meat packing has led to parallel changes in the rendering industry. First, the large volumes of meat byproduct available at the modern packing plants allow them to efficiently operate their own rendering facilities next to their slaughter plants. Consequently, independent renderers (those who are not in the slaughter/meat processing business) have lost much of their supply of the high value raw material from slaughter plants. The National Renderers Association (NRA) estimates that in 1970, independent renderers had a 44 percent share of raw material procurement in beef. This has shrunk to an estimated 15 percent in 2000. NRA indicates that the independent renderers have had a declining volume to process since the 1960's. The lone exception is that they have expanded their processing of cooking grease.

The response in the rendering industry is consolidation among the independent renderers. Darling and Baker are among the four or five largest independent rendering companies in the United States. Successful smaller scale renderers have generally remained in business by increasing the volume that they handle and by adopting streamlined operations to be efficient processors of rendered products. As demonstrated in Oregon, the smallest size rendering businesses have found it much more difficult to compete under these conditions and they are exiting the industry.

The newest western U.S. single location processing facility is the John Kuhni & Sons rendering plant which was moved from an urban location in Provo, Utah in 2005 to a new plant built 50 miles from Provo. The Kuhni plant is the only independent rendering plant in Utah and it serves the entire state of Utah. The only other rendering plant in Utah is the in-house facility at the E.A. Miller meat packing plant and it does not accept outside rendering feedstock. Provo officials pressed the owner of the old Kuhni operation to move it out of its former site in a populated area of the city. The new plant cost was reported to be $6.5 million by trade sources (Renders Magazine, April 2005). State and local government grants covered $4.5 million of the total. In addition, Kuhni reported that they are now completing, at their own expense, a waste water treatment facility for an additional cost of $1.5 million.

Our conclusion is that the capital cost to construct a modern rendering plant with proper environmental controls would total $7.5 million or more. This would pay for the building and equipment to construct a new plant with the latest technology for continuous processing of feedstocks and meet the air and water environmental standards. This would also be built with the capacity to process most of the available mortality and meat byproducts generated in Oregon.

There are no definitive estimates of the smallest scale new rendering plant that can be established and profitably operated. However, based on some capacity information given to us by renderers, it is likely that a plant must process at least 50 to 75 million pounds of raw material feedstock per year in order to cover the capital costs and environmental compliance costs associated with these types of businesses. The larger rendering plants in the U.S. are processing well over 100 million pounds per year. Since Oregon has a relatively small volume of livestock products and this production is widely disbursed across the state, it is unlikely that a new, privately funded processing plant for rendered products will be established in Oregon in the near future without public incentives.

2.2 Short Term Responses in Oregon

2.2.1 Out of State Rendering

Existing renderers operate processing plants in Washington, Idaho, and California. These out-of-state renderers have operated extensively in Oregon along with the in-state processors prior to the recent closures. For example, Baker and Darling each have transfer stations in Portland, with long established accounts in the state. They each have extensive routes through central, southwest, south central and northeast Oregon to collect mortality and byproduct waste, and these routes have expanded as the need for disposal options expanded due to the closure of the two in-state rendering plants.

Baker has a Sunnyside, Washington transfer station. This station is the receiving location for Baker’s collection service over large areas in northeast and north central Oregon, as well as eastern Washington. Eastern Oregon is served by Darling’s Boise area rendering plant and this has been the traditional processing location for much of east-central Oregon, even while Redmond Tallow was operating.

In southern Oregon, service is extended by North State Rendering with a processing plant in Oroville, California. North State maintains trucks in Crescent City, California which improves its access to the far Southwest corner of Oregon. They pick up grease and meat byproducts from custom packing and butcher shops in an area extending from Klamath Falls to the north as far as Roseburg and west to the Oregon coast. Due to the Oroville plant distance from Oregon (approximately 200 miles), North State’s owner says it is not cost effective for them to pick up mortalities and process them at their plant.

2.2.2 Landfill Disposal

Landfill operators and Oregon DEQ have worked closely to ensure that animal mortality and meat processing byproduct waste disposal is available to Oregon companies, while also maintaining health and safety standards. Landfill disposal of animal mortality is allowed at approximately 13 landfills throughout Oregon through DEQ approved special waste management plans. Most of these also accept meat processing byproduct waste, although in some landfills, especially in eastern Oregon, very little if any mortality or meat byproduct waste is received in these facilities.

DEQ views landfill disposal of animal mortalities as a short term option. However, there are cases where the landfills are currently the least cost disposal option for the agriculture sector and meat processors. Unless conditions or regulations change, landfills will continue to attract these products.

In some landfills, especially those that accept large volumes of animal material, generators (or their haulers) must be individually permitted to deliver waste and they must give advance notice of delivery to the landfills. This gives landfills the chance to dig pits or otherwise prepare to accept the waste. Arrangements for disposal vary from site to site, and the cost of disposal also is highly variable.

2.2.3 On-Farm Composting and Burial

On-farm composting is a potentially cost-effective way to dispose of animal mortality in Oregon, particularly as the cost of the alternatives increase. The amount of mortality that can be diverted by farm composting is hard to predict. Rules governing composting and agricultural composting facilities exempt from DEQ permits are in draft form and they are going to be reviewed through the public comment process in the winter of 2008. Current DEQ adopted rules governing farm composting only allow composting of animal mortality and meat byproduct waste if it is generated and composted at the same agricultural operation and the compost facility is operating under an Oregon Department of Agriculture (ODA) approved Compost Management Plan. However, changes to the composting rules have been discussed with stakeholders and a final rule is nearly ready for public comment. *It is the intent of the proposed draft rules to allow a farm compost facility to accept animal mortality from other farmers. Butcher waste could be accepted under special approval from the regulatory authority overseeing the facility (DEQ or ODA). If the rule language is adopted as intended, then there would be an opportunity for significant quantities of mortality from dairies and other confined feeding operations and, potentially, other animal byproduct waste to be processed on a farm compost operation and the compost land-applied on large farm acreages associated with the farm compost operation. Farm compost could be sold to other farmers for land application, but the most likely initial utilization may be to apply the material on the farmers' own land. This scenario offers significant potential to reduce the cost of disposal for farmers who are located near farm compost facilities.* However, until the regulations are finalized and adopted, it is unclear exactly what changes in on-farm composting will occur. The best estimate for when DEQ can finalize these rules is currently Spring 2008.

It should be noted that the state's largest dairy cooperative, while not opposed to on-farm composting in concept, would prefer to have its own members utilize a centralized composting facility rather than engage in such efforts on an individual farm basis. They are extremely concerned about protecting their company image and avoiding any possibility of an isolated bad experience on a member farm reflecting negatively on the company as a whole. Furthermore, a centralized composting operation would allow for much better oversight and control.

Burial is allowed if a farm or ranch is handling its own animal mortality. This is a reasonable disposal option for many beef producers and small herd dairies in more rural areas of Oregon. However, simple burial is generally not feasible for disposal of several animals or on a frequent basis. In such cases, DEQ staff indicated that the agency would probably require that the burial pit be lined for leachate control, which would make this a prohibitively expense operation.

2.3 Adequacy of Current Disposal Options

2.3.1 Public Health & Safety Concerns

If diseased animals or animal waste is being processed, high temperature incineration is considered the most fail-safe method of protecting human health. Under normal conditions however, the rendering process is a time tested method to safely recycle mortality and meat byproducts. Other options can also protect public health, but there are human safety issues to consider.

Composting is often regarded as an economical way to dispose of animal mortality and byproducts. Oregon farms can compost if they prepare a composting plan which they follow and which is approved by the state Department of Agriculture. According to guidelines in a fact sheet published by OSU Dairy Specialist Mike Gamroth in coordination with DEQ and ODA staff, compost piles that reach an internal temperature of over 131 degrees Fahrenheit for at least three days kill human and animal pathogens. However, it is unclear whether prions, the proteins that cause BSE, are destroyed in the composting process. Animals with signs of neurological disease must be reported to ODA and should not be composted. Also animals that may have anthrax should not be composted.

Farm composting also raises concerns among some agricultural producers that not all farm compost producers will maintain adequate product safety standards. If problems arise from production of sub-standard compost, some believe Oregon agriculture will incur added environmental costs and there could be a tarnished reputation to Oregon food producers.

Any new regulations regarding on-farm composting could be important in determining if farm compost is a suitable means of disposing of the livestock industry's waste and byproduct materials.

Burial is safe if it involves a single animal mortality and the animal is placed in a dry hole (above the water table) and the guidelines of ORS 601.090(7) are followed. Public health can be compromised if the burial is close to waterways or single animals are buried in close proximity over a relatively short period of time. Burial is not an acceptable disposal method for byproducts from butchering.

Section 3
Current and Future Supply of Animal Mortalities and Byproducts

3.1 Volume of Animal Mortality and Byproducts

3.1.1 Animal Mortalities

Oregon's livestock industry is dominated by beef and cattle, yet it is diverse in terms of livestock species represented. The animal mortality is widely disbursed across the state (see Table 1). The largest area in terms of animal mortalities is in eastern Oregon, with an estimated 11.28 million pounds per year (see Appendix A for a list of counties by region). About 78 percent (8.8 million pounds) of the eastern region's total mortality are comprised of cattle and beef mortality, most of which is not recoverable for any type of disposal processing. This area features vast stretches of remote and mountainous areas, often in public grazing lands. On much of this land, cows are turned out onto grazing lands to calve, and the dead stock are left to natural processes and never recovered.

The second largest region in terms of volume is the Northwest part of the state, which includes 13 counties and most of the metropolitan areas of Portland, Salem, and Eugene and the populous outlying areas. This region has almost 9 million pounds of annual mortality, or about 28 percent of all mortality weight in the state. The main livestock sectors are dairies. Most of the dairies are concentrated in Tillamook County, and there is an estimated 3.3 million pounds of mortality from dairy animals in this region. This represents over half of the state's total mortality from the dairy industry. Beef and other cattle mortality is also on par with dairy mortality in the northwest region with about 3.1 million pounds.

The third largest region for animal mortality is the South Central region. In this five-county area, there is about 5.1 million pounds of animal mortality generated each year, with about 80 percent from cattle and beef production.

The last two regions are the Southwest and the North Central regions. Combined they represent about 5.8 million pounds of mortality loss each year. Again, this is mostly from cattle. The dairy sector is quite small in these areas.

In total, horses represent about 14 percent of all mortality in the state, with the largest amount in the Northwest region. Sheep and hogs together represent about 5 percent of all mortality weight.

Table 1
Estimated Total Animal Mortality Per Year, by Region and Type (lbs)

Region	Cattle & Calves, Incl. Beef	Dairy	Sheep	Hogs	Horses	Total Weight
Northwest	3,096,400	3,289,000	564,250	200,400	1,802,500	8,952,550
Southwest	1,667,400	294,800	281,500	24,000	1,025,500	3,293,200
North Central	2,369,400	0	43,500	25,200	68,250	2,506,350
South Central	4,063,400	275,000	74,500	28,800	638,750	5,080,450
Eastern	8,870,400	1,333,200	123,750	21,600	939,750	11,288,700
Total	20,067,000	5,192,000	1,087,500	300,000	4,474,750	31,121,250
Percent	64.5%	16.7%	3.5%	1.0%	14.4%	100.0%

Sources: Data for cattle, beef, dairy, sheep and hogs is from Agriculture & Fisheries Statistics compiled by USDA's NASS Oregon field office in cooperation with the Oregon Dept of Agriculture. Data is the average of the inventory as of January 1, 2006 and 2007, except for hogs which is for 2006 only. Horse inventory data is from Oregon Extension (OSU) Oregon Agriculture Information Network (OAIN) and is an average of the 2005 and 2006 inventory. See Appendix A for a further description of the mortality rates used in this table and the county groupings for each region.

3.1.2 Recoverable Animal Mortality

The estimates displayed in Table 1 reflect total mortalities production, but not all is recoverable for processing or beneficial disposal. In this section, estimates are presented of the portion of mortality that can be recovered practically and utilized by renderers or processors who use non-rendering process technologies.

Recovery of dead livestock is limited or impractical where cattle and horses are turned out in wide-open spaces such as very large pastures or rangeland. In these conditions, dead cattle and horses may not be located or removed in a timely or economical way, and they are subject to scavengers or natural decomposition. Unrecovered mortality is highest in the most rural parts of Oregon, but every region of the state has open grazing lands where losses are unrecoverable.

Dairy cattle, hogs, and sheep are generally raised in sufficiently confined pastures or pens such that all death loss is recoverable. Table 2 is a summary of the recovery estimates for cattle and horses for the regions defined in this report based on the estimated recoverable quantities of animal mortality.

Table 2
Estimated Recovery of Cattle and Horse Mortality, by Region

Region	Mortality Recovery (Percent)	Mortality Recovery (million lbs)
Northwest	Cattle & Calves: 95% Horses: 95%	Cattle & Calves: 2.94 Horses: 1.71
Southwest	Cattle & Calves: 90% Horses: 90%	Cattle & Calves: 1.50 Horses: 0.93
North Central	Cattle & Calves: 75% Horses: 85%	Cattle & Calves: 1.78 Horses: 0.06
South Central	Cattle & Calves: 40% Horses: 80%	Cattle & Calves: 1.63 Horses: 0.51
Eastern	Cattle & Calves: 35% Horses: 80%	Cattle & Calves: 3.10 Horses: 0.75
Total		Cattle & Calves: 10.95 Horses: 3.96

Note: The recovery percentages are applied to the total mortality estimates in Table 1 to give the net recover pounds in column three of this table.

3.1.3 Offal and Related Processed Meat Byproduct Volume

Offal refers to the parts of butchered animals that are considered inedible by humans. This material is generally shipped to renderers and includes the hide, bones, blood, muscle tissue, and inedible internal organs, among other animal parts. A considerable amount of offal is generated at the time of slaughter. Additional scrap byproducts are generated in specialty meat markets where carcasses or primal meat cuts are further processed in the final meat "cutting and wrapping" processes. Packing houses include the traditional federally inspected meat packing plants as well as the federally exempt custom packers who slaughter an individual's animal and where there is no re-sale of the meat. Oregon has many custom kill packers and also many independent meat cutters who purchase and then sell wholesale meats to retailers, restaurants and others who re-sell meat to the ultimate consumer.

Table 3 displays the estimated volume of byproduct material generated by the meat packing and custom processing industry. The data from this table derives from a survey of these businesses in early 2007 conducted by the Oregon Department of Agriculture.

In total there is an estimated 44.7 million pounds of offal generated per year in Oregon. Well over half of this volume (25.3 million pounds) is generated in the Northwest region of the state and much of the remainder is generated in the south central region (14 million pounds).

Table 3
Estimated Offal and Meat Scraps Generated Per Year, by Region and Type (lbs)

Region	Offal	Grocery Trim and Scrap	Total Weight
Northwest	25,317,000	11,357,000	36,674,000
Southwest	540,000	1,535,000	2,075,000
North Central	4,702,000	328,000	5,030,000
South Central	14,087,000	1,600,000	15,687,000
Eastern	78,000	955,000	1,033,000
Total Lbs/Yr	44,724,000	15,775,000	60,499,000
Percent	74%	26%	100%

Sources: Offal estimated from Oregon Department of Agriculture survey of slaughter operations (ODA license #'s 40,41,42,43, and 44). Grocery scrap estimates are estimated by Globalwise based on per store estimates of material generated and the number of grocery stores in Oregon.

3.1.4 Grocery Store (Retail) Meat Byproduct Volume

Table 3 above also shows the estimated volume of byproduct trim and scrap materials generated in the meat departments of grocery stores in the state. This estimate was made using estimates of the volume of material generated per store and multiplying this by the number of stores in each county. Grocery store byproducts total about one-fourth the volume of offal. The Northwest region dominates with over 11 million pounds generated out of 15.8 million pounds generated statewide.

3.1.5 Summary of Recoverable Material Generated

Table 4 provides a summary of Oregon's recoverable annual mortality and byproduct material production. This table shows that Oregon has about 82 million pounds of annual raw material feedstock available for processing after considering the non-recoverable supply. Over half (55 percent) of this total is offal that is generated by meat packers and secondary meat processors. Animal mortality accounts for another 26 percent of total production state-wide, and the grocery industry adds about 19 percent as trim and scrap to the final total.

Table 4
Estimated Recoverable Mortality and Byproducts Generated, by Region and Type (million lbs)

Region	Recoverable Animal Mortality *	Offal	Grocery Trim and Scrap	Total Weight
Northwest	8.70	25.32	11.36	45.38
Southwest	3.00	0.54	1.54	5.08
North Central	1.91	4.70	0.33	6.94
South Central	2.52	14.09	1.60	18.21
Eastern	5.33	0.08	0.96	6.37
Total	21.46	44.73	15.79	81.98
Percent	26%	55%	19%	100%

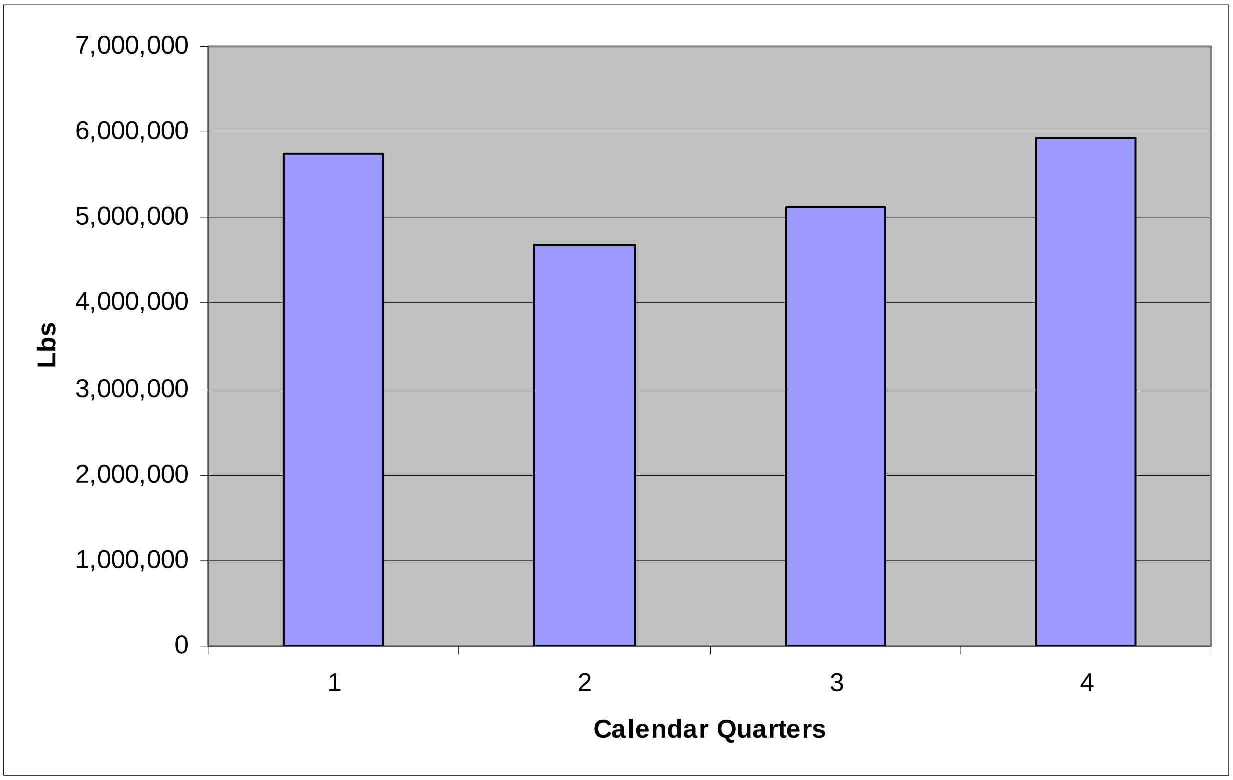
* Animal mortality includes only the estimated recoverable quantities for cattle and horses from Table 2. Total mortality for dairy, sheep and hogs is used and the source is Table 1.

3.2 Seasonality of Supply

The volume of animal mortality and meat processing in Oregon varies to a relatively minor degree by season of the year. Seasonality of supply was determined based on discussions with livestock and meat processing industry members for all species produced in the state and weighted by quarter from the volume produced as discussed in section 3.1 of this report. The recoverable volumes were used for the seasonality estimates.

For animal mortality, seasonal difference in volume is not particularly significant for several reasons. First, dairy cow mortality is very uniform across the year. Dairies generally want to have uniform milk production, and they set up calving to occur on a uniform, year-round basis. Death loss is highest at calving time in dairies, so this moderates seasonal variation. Second, while beef cattle mortality is relatively seasonal, cow-calf operations have lower mortality recovery, especially in Eastern Oregon. This leads to reduced seasonal variation. Horses have more seasonal death loss in the fall and winter, but they are a small share of overall mortality. Finally, hogs and sheep are relatively uniform in death loss across the year and represent a minor part of the state's overall animal mortality. Figure 1 shows the seasonal mortality volume.

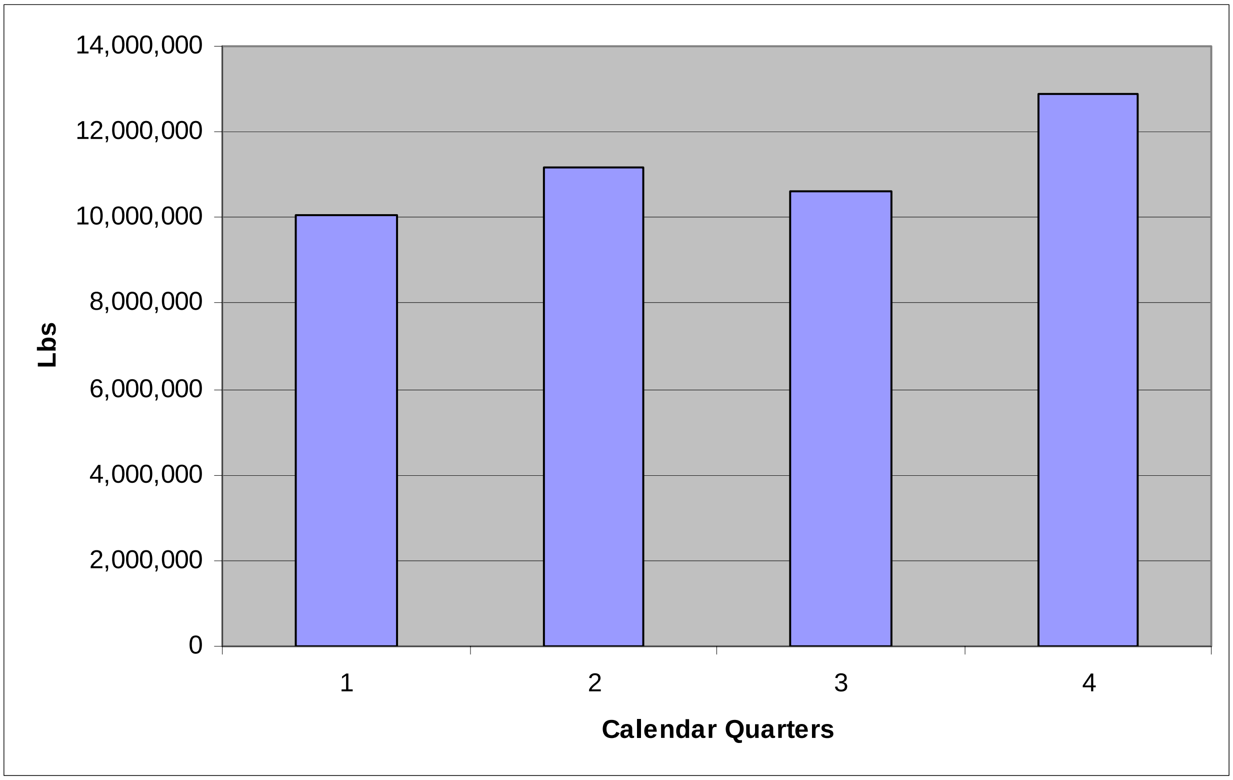
Figure 1
Seasonal Recoverable Mortality Volume, by Quarter (lbs)



In general, the meat processing industry experiences relatively little seasonal change in volume. Seasonal variation was determined by discussions with meat packers in the state and applied to the annual offal volume that was estimated from the survey of meat processors conducted by the ODA, as discussed above in Section 3.1.

The major federally inspected plants, which account for the largest volume of meat processing in Oregon, have about a fifteen percent increase in average processing volumes during the fall and winter months, and about a ten percent below average production level in the late winter and early spring months. The small custom packers have more fall and winter seasonality but they do not process as much volume as the federally inspected plants. We have not estimated hunting season processing volume, which would add somewhat to the fall-winter volume for custom packers. Figure 2 shows the seasonal volumes by quarter available for meat processing in Oregon.

Figure 2
Seasonal Volume of Meat Processing Byproducts, by Quarter
(lbs)



3.3 Expected Future Supply for Disposal (One to Five Years)

3.3.1 Animal Mortalities

Over the next five years, animal mortality for disposal will change in relation to the number of beef and dairy cattle produced in the state, along with the number of horses, hogs, and sheep. Of primary importance are the forecasts for beef, dairy, horse, and hog numbers in the state.

Beef Cattle

One of the major factors that will impact cattle production is the cattle cycle. The cattle cycle is a long term pattern where the industry enters a period of two to three years of expansion, followed by a "turning point" of production that can last several years, and then a contraction phase that also lasts two to three years. The current cattle cycle has been more volatile than past cycles due to the economic downturn in the U.S. after the events of September 11, 2001, as well as extended periods of drought and the decrease in demand associated with BSE discoveries. Oregon's industry, which is very small in relation to total U.S. beef industry, follows the national cattle cycle. Currently the U.S. is in the mature phase of the cattle cycle. This means that with other factors being constant, cattle numbers will expand for two to three more years and then start to decline. If the industry follows the historical pattern of the cattle cycle, cattle prices should soon start to decline.

Another important factor that impacts cattle production is the strength and direction of consumer demand. Demand for beef has been rising in the U.S. as consumers seek higher quality beef products. Natural or hormone-free beef is also a component of the trend toward high quality beef. Although this is a relatively small segment, Oregon has been expanding production in this segment. There is also a niche market for local, source-identified beef, and this segment is targeted and filled by Oregon's geographically disbursed, small volume beef producers.

Expansion of beef production in the Pacific Northwest has historically been constrained by the lack of competitively priced grain such as corn in comparison to the Midwest. Northwest feedlot operators have to rely on low cost byproducts such as potato waste from processing plants. Also the Pacific Northwest is more competitive when grain prices strengthen, as they have recently with the advent of more ethanol production in the Midwest.

Finally, there is the impact on cattle production caused by the emerging energy supply complex. The relative cost and availability of feed is a major factor in determining competitiveness of cattle production in various regions of the United States and indeed the world. Rapidly expanding demand for corn and soybeans as well as other major crops for renewable energy production such as biodiesel and ethanol are likely to have a profound effect on the cattle feeding industry. The net result for Oregon and its Northwest neighbors in the competitive production of beef cattle is very difficult to predict at this stage. USDA predicts that prices for poultry and pork in the United States will rise relative to the price of beef because cattle can more effectively use the increasing supply of distiller's grains, a co-product of dry mill ethanol production. Corn, needed for broilers and swine, becomes more expensive while distillers grains, used for cattle, become more abundant and relatively less expensive.

The rapid growth of ethanol production will produce more feed byproducts, especially distillers corn which will be available for feeding. However there will also be a squeeze on producers from higher feed prices as ethanol producers in the Midwest and elsewhere bid up the price for grains. The Midwest of course already has a sizable cattle and related meat animal feeding industry. At the same time the Pacific Northwest is developing new varieties of oil seed crops such as mustard and canola that are better adapted to this area which will potentially aid the protein feed supply outlook in the Pacific Northwest and in turn boost production of cattle and other livestock.

Because the Midwest has a sizable near-term advantage for renewable fuel production, It is likely that the Northwest will not see sizable new opportunities for these livestock feed crops over the next one to three years. However, within five years it is reasonable to consider that the Northwest will be in a more favorable position to expand livestock production due to the greater supply of energy crop byproducts for feed.[2]

Taking all of these factors into consideration, it is likely that Oregon and its neighboring states will have a modest expansion in beef cattle production in the next five years. However, Oregon does not have emerging competitive advantages in beef cattle production and packing to suggest that the state's share of cattle slaughter and processing will increase relative to the major cattle

2 See *Biodiesel* magazine for details on this topic.

producing states such as Kansas, Missouri, Oklahoma, or Texas. Our estimate is that Oregon's beef industry may increase at a level of two to three percent per year in the near term (up to five years) over 2006 to 2007 production levels. Thus, beef animal mortality and beef processing waste should expand but not by a significant amount in the next few years.

Considering all factors, our best judgment is that beef produced in Oregon will increase by a range of four to six percent in the next five years compared to current conditions. This will increase mortality and meat processing byproduct production by the same percentage range.

Dairy Cattle

Oregon's dairy sector is quite stable. Oregon has about 121,000 head of dairy cows. The overall size of this industry has been holding steady recently even though milk prices in 2005-2006 were at very low levels. Recently, producer prices have risen significantly for a number of reasons. In the summer of 2006, California experienced a major heat wave that led to significant decreases in milk production and stress on the herds. California, which is a leading dairy producing state, saw major declines in milk cow numbers over the June to August period as death rates and culling of herds soared. Nationally as well, herd size declined in 2006 in response to low milk prices. Demand for milk and milk products remains strong, bringing higher milk prices to Northwest dairies.

If new large dairies are successful in getting approval to locate in Eastern Oregon (in the Boardman area) then overall milk cow numbers will increase in the state. Three or four large dairies have announced their desire to locate in Eastern Oregon; however, opposition is strong on environmental grounds. If new dairies are not established, the industry should remain stable at the current level of about 120,000 to 123,000 head of cows.

The best estimate is that Oregon's total herd size will increase by five to seven percent. This will add a similar amount to the dairy industry's generation of mortality and meat processing byproduct volume.

Horses

According to county level estimates from OSU Extension Service, there were approximately 128,000 horses in Oregon in 2006. The vast majority of horses are owned for the personal enjoyment of their owners, with a relatively small number used as working animals in herd management of beef livestock operations. Forty percent of the state's horses are in the populous Northwest part of Oregon.

There is federal legislation under consideration that would ban the slaughter of horses in the U.S. (There are no horse slaughter facilities in Oregon.) If this legislation passes, the number of horses in Oregon would rise somewhat (as would mortality), since some horse buyers at livestock auctions are purchasing animals for out-of-state shipment for the purpose of slaughter. The National Renderers Association estimates that a horse slaughter ban will not significantly increase horse mortality received by renderers. Therefore, the state would likely see a proportionate increase in mortalities in landfills or, in some cases, on-farm burial.

In the future, it is likely that Oregon's horse population will remain close to its current size or grow slightly by two to three percent during the next five years. Although horse ownership remains popular, countervailing pressures – rising exurban land costs, increasing feed prices, *and decreasing availability of suitable and affordable horse boarding facilities – will place some limits on growth in the state's horse population.*

<u>Hogs and Sheep</u>

Oregon is a minor hog and sheep producing state. It is realistic to expect that the low-level production base of hogs and sheep will by and large not be influenced by the main macro economic factors in Oregon's economy. Much of the livestock supply conditions for hogs and sheep is a direct response to the demand for local production by consumers who seek meat products outside of the conventional food supply channels in retail or food service markets. This demand is likely to grow in the next five years under relatively normal conditions for rising consumer incomes and there is no significant disruption to the local supply channel.

Our estimate is that there will likely be very little change in production in the next three to five years. It is reasonable to assume that hog and sheep production in Oregon will be quite stable, with growth in the two to four percent per year range over the next five years.

3.3.2 Summary Projections of Mortality Volume

The livestock and animal mortality projections presented above indicate that during the next five years, Oregon will realize a very modest level of growth in production of animal byproduct source materials. At the highest growth projection level for livestock, an additional one million pounds would be generated, with a lesser amount that is actually recoverable.

Section 4
Costs for Disposal for Mortality and Byproducts

4.1 Costs of Disposal

4.1.1 Current Conditions

The consultant team conducted surveys of 17 meat processors (slaughter houses, and custom kill and secondary processing businesses) and 19 landfill operators across Oregon. In addition, renderers were contacted and interviewed. The costs of disposal reported here are principally from the costs reported on the surveys.

Oregon businesses face a wide range of costs for animal mortality and byproduct material disposal (see Table 5). Some cattle operators have no disposal cost because they are located in remote and sparsely populated areas where dead animals are left to naturally decompose. For example, in the Burns area and throughout southeast Oregon, landfills generally report that there is no animal mortality disposal in the landfills from local beef ranches.

Eastern Oregon butcher shops either pay for pick up or haul their byproduct material to landfills. In one case in our survey, a butcher shop self-hauls to the Boise renderer. Their costs were reported at $100 per week (equivalent to $40 per ton) when offal and byproduct materials were delivered to the Boise renderer compared to the $125 disposal charge at the Boardman area landfill (equivalent to $50 per ton). In both cases, these charges are for disposal only; transportation cost is additional and not quantified. Our survey did not include a business which has the pick up service from a renderer, so this cost information is not available.

Costs appear to vary dramatically across the state. In central Oregon, the cost to custom slaughter houses and meat processors will be considerably higher when a new transfer service from an out-of-state renderer becomes operational by September 1, 2007. By October 2007, all disposers will pay a fee of $140 per ton. There will be additional cost incurred by some meat processors to deliver to the Prineville (Crook County) landfill, where the new transfer station will be located for this service. This charge will be among the highest in Oregon, and a dramatic increase over the soon-to-end emergency service disposal charge of $25 per ton at the landfill. The general charge by Redmond Tallow when they closed in 2006 was quoted in the range of $40 to $60 per pick up.[3]

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[3] Unfortunately, the weight of the products collected are not recorded by the meat processors, so the weight of the materials collected per pick up are not known.

In the Lakeview area, there is one custom meat processor who is working on a compost demonstration project. It is in the early test stage. The technical results of composting are favorable. Cost data is not being kept, however the business owner is pleased with the results from composting. This meat processing company has a major advantage in that they have a sizeable amount of land with alkaline soil for land application of the compost. In this case, composting has promise to be a workable, low cost alternative to having the product collected by a rendering company or taking it to the landfill.

There is no renderer pick up service for animal mortality in the Grants Pass and Medford areas. This is apparently infeasible because of the high cost of transporting small unit volumes to the distant Northern California renderer.

Table 5
Indicated Disposal Costs, by Source and Location

Type of Disposal and Location	Disposal Using Rendering	Disposal Using Landfill
Dairy mortality, Tillamook County	$52 per animal*	$73 per animal
Beef or dairy mortality, Redmond/ Central Oregon area	$117 per animal ($40 pick up+$77disposal)	$54 per animal** ($40 pick up+$14 disposal)
Beef or dairy mortality, Grants Pass/Medford area	No service available	$175 per animal ($90 pick up+$85 disposal)
Meat processing byproduct, South-Willamette Valley/Oregon Coast	$210 to $215 per pick up (up to approx 1,800 lbs.)	NA
Meat processing byproduct, Klamath Falls	$85 to $115 per pick up (up to approx 1,800 lbs.)	NA
Meat processing byproduct, Portland Metro Area	$85 to $115 per pick up (up to approx 1,800 lbs.)	NA
Meat processing byproduct, Redmond/Central Oregon Area	$210 to $225 per pick up (up to approx 1,800 lbs.)	NA

Note: Animal mortality calculated based upon a 1,200 lb. weight.

NA: not available

* This rate is based on current, historically high prices for meal and bone meal and tallow; normally the landfill cost option is lower than long distance hauling for rendering.

** Crook County Landfill will not accept mortality or byproducts after October 2007.

Sources: Rendered costs based on discussions with renderers and businesses using their service; pick up charges from collection businesses and landfill disposal costs are from landfill operators.

4.1.2 Cost Increases from One Year Ago

Businesses in Central Oregon have experienced some of the largest disposal cost increases since the closure of the in-state rendering plants. One custom packing and meat locker business reported that the charge for picking up their trim and offal waste has increased from $40 at the time Redmond Tallow closed, to the current cost of $225 per pick up.

Across the state, the changes in disposal charges over the past year have been very uneven. In several cases, the charges are unchanged. However, many packers and wholesale meat cutters report cost increases of 33 to over 50 percent in the last 12 months.

Looking to the future, most of the businesses believe their disposal cost will increase because they expect higher fuel prices to continue to drive costs upward. Most of the businesses want alternatives without long haul transportation, although most businesses also believe they have few, if any, alternatives to pursue.

A consideration for future cost is whether the loss of rendering firms is leading to less competitive conditions, and therefore higher prices paid by those generating mortalities and meat byproducts. As renderers set up routes to collect materials from further distances, costs will rise. However, it is not known if all price increases are justified, as there are no empirical data with which to measure both price and cost changes for the remaining renderers. However, this possibility should be considered in making future plans for alternative means of processing or disposal.

One major factor may add to future rendering processing costs, which would be passed on to Oregon livestock producers and meat processors. The Federal Food and Drug Administration (FDA) is considering a rule which would eliminate the rendering of the brain and spinal cord of ruminant animals. Separation of these animal parts from the rest of the animal would increase the cost of processing, as well as add to the volume of animal parts that would need to be disposed of through alternate means.

4.1.3 Cost Impacts of Disposal on Oregon Businesses and the State's Residents

The direct cost of disposal is not uniformly impacting businesses in Oregon, as confirmed by our surveys and interviews. Federally inspected meat packers, custom meat packers, secondary meat processors, dairies, and livestock feeding operations are among the businesses that have faced large increases in cost. Some are relatively unaffected, due to location or the fact that their existing service did not utilize in-state renderers.

Oregon's largest dairy cooperative has an annual budget of $250,000 for dead animal disposal. This includes farm collection, transportation, and disposal at a landfill in Western Oregon. They indicated that out-of-state rendering, due to the major cost of transportation, is equal to or more costly than landfill disposal. An individual dairy member in the cooperative with a 250-cow herd faces annual disposal costs of approximately $1,000 or more per year. While this may seem to be a relatively small cost, it is significant when viewed against all costs and the marginal overall profits experienced in the dairy industry, especially in the down cycle of fluctuating milk prices at the producer level.

Central Oregon and Southern Oregon both lost their direct access to in-state rendering in 2006 and have been hard hit by disposal cost increases. One of the central Oregon meat processors that we interviewed stated their charge increased by $185 per pick up over the last year. With an average of two pick-ups per month during the four high-season months of the year (September to December) and one pick-up per month the remainder of the year, the result is an added cost of almost $3,000 per year. This is a very significant cost for a small meat processing business, and it is doubtful that all of this cost can be passed on to customers. During the course of the interviews, we encountered several businesses that were for sale or said they were struggling to remain in business. The disposal cost situation is a clear challenge for these small firms.

It is also evident that businesses in each area of the state are financially harmed by the reduced choices for alternative disposal service. Some businesses also appear to be financially vulnerable in any case and these added costs only make them more susceptible to going out of business.

In addition to direct company financial losses, there is the broader environmental cost of illegal dumping of animal carcasses or even processing byproducts. Local heath and other agencies have to recover carcasses from improper "roadside" disposal. Water quality, odor, and human health threats are more common.

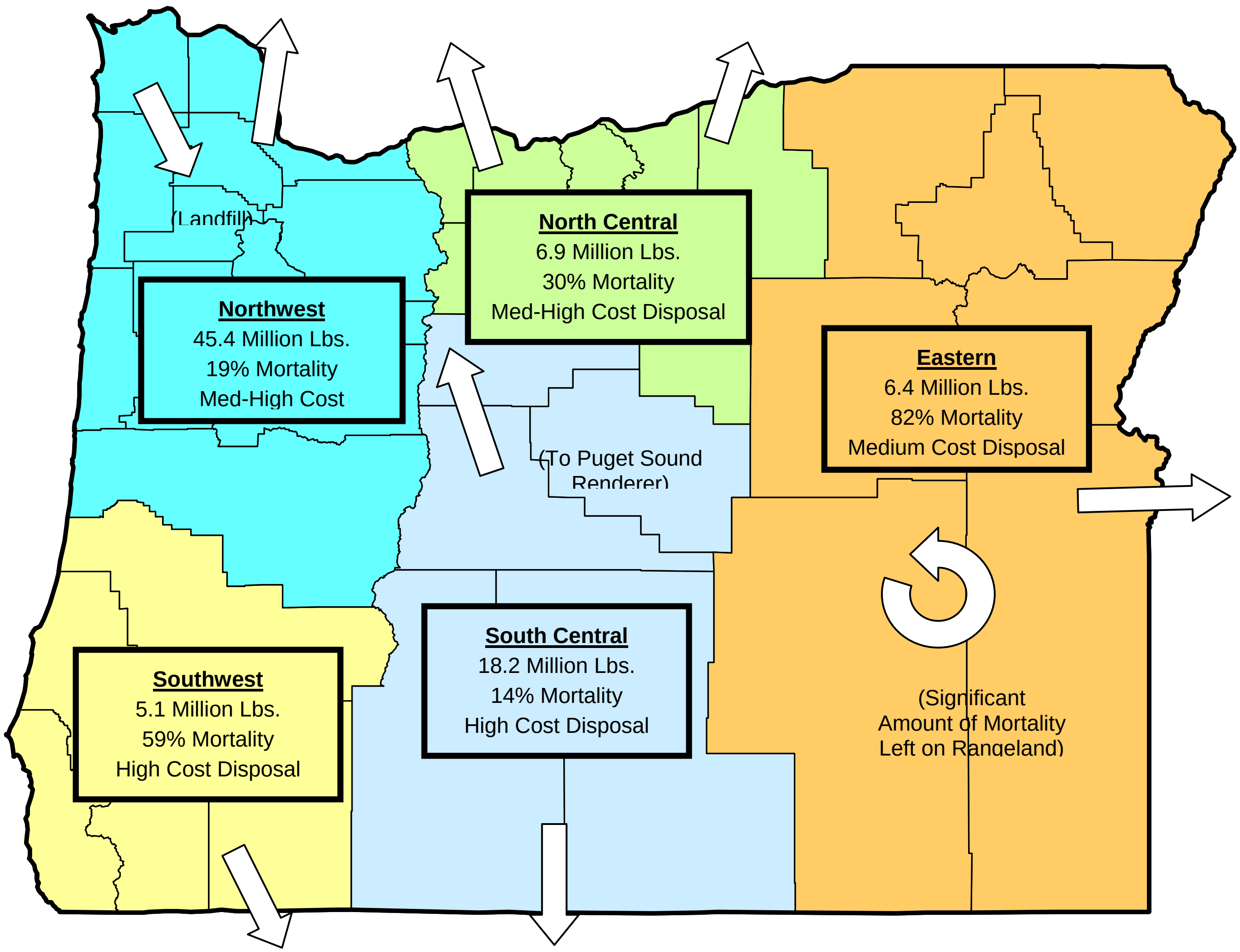
Finally, Oregon businesses who sell meat, dairy and other related products are concerned that their image with consumers will be diminished with reports of dead animals being left in or along waterways or roadsides. Should such activity be tied to Oregon businesses or even agriculture more generally, there is real potential for direct and indirect losses to Oregon businesses as well as the citizens of the state.

4.2 Summary of Geographic Supply of Animal Byproducts and Relative Costs of Disposal

From the previous two sections, it is clear that the quantity of animal byproduct source material varies significantly across the state. Similarly, the disposal method used by suppliers depends upon the nature of the material and the proximity to rendering facilities. Over the past year, since the closure of Oregon's two rendering facilities, some suppliers have seen their disposal costs increase very little while costs have risen by as much as 50 percent for others. The available disposal options and ultimate endpoint for the material are important factors for supplier costs that vary geographically.

Figure 3 presents a summary of the distribution of recoverable animal byproduct supply by area of the state, the portion of supply that is comprised of animal mortalities, where the supply is utilized, and the relative cost of disposal. As the figure indicates, the South Central and Southwest regions are considered most negatively impacted by current conditions, and are therefore in most critical need of enhanced disposal or new processing solutions. However, all regions would realize major benefits from new or enhanced disposal and processing options.

Figure 3
Summary of Mortality and Byproducts Supply and Flow by Region



Section 5
Overview of Existing Markets for Potential Products Derived from Animal Byproducts

5.1 Compost Markets

5.1.1 Establishing Oregon Food Waste Compost Facilities

Oregon's commercial compost manufacturers are optimistic that they can produce high quality compost with animal mortality or byproduct animal parts. However, at the present time, commercial compost is not produced in Oregon using these feedstocks. One main barrier is at play. Composting companies and potential new entrants are uncertain of how the proposed new DEQ rules for composting will impact their costs. At present, compost facilities using green waste feedstocks (referred to as Type 1 or 2 feedstocks under current proposed rules for composting) have fewer conditions in their permits than facilities composting non-green feedstocks (referred to as Type 3 feedstocks under current proposed rules). However, no facility can discharge pollutants to waters of the state. The proposed rules will require that any permitted composting facility have an impervious surface under portions of the facility unless requirements for a variance are met.

A second regulatory constraint for some operators is Oregon's land use law, which prohibits compost facilities on high value farm land. Commercial compost facilities can be located in exclusive farm use zones (not including high value farm land) with the issuance of conditional use permits from counties. When conditional use permits cannot be obtained, one option is locating mortality compost facilities on industrial land. In these cases, this is likely to be too costly for many compost businesses.

As currently drafted, agricultural composting facilities exempted from a DEQ permit would be required to operate with an Agricultural Compost Management Plan approved by the Oregon Department of Agriculture. The composting management plan requires that these facilities comply with all DEQ regulations. Under the proposed new rules, approved facilities can accept animal mortality and meat processing byproduct waste from other farm and processing waste generators.

5.1.2 Potential for Compost Produced with Animal Waste

Oregon has a large and growing market for compost and related products to amend the soil. Compost, is a broad term and it is used in a very wide range of soil-related products. Compost is generally made by blending several feedstocks. Compost is often further blended as an ingredient in "soil amendments" or "soil products." Compost is also added to fertilizers that may produce plant food. Different producers have products that overlap, and there are often non-standard product specifications.

Compost manufacturing is a dynamic industry with fluctuating supply and demand. One of the main ingredients in bulk compost in western Oregon is washed manure from the large dairies in eastern Oregon. Due to the transportation pattern where more truck loads have paid freight going from the Portland area to eastern Oregon and eastern Washington than in the other (back haul) direction, manure compost produced in the Boardman area can be competitively delivered to the Portland area at a wholesale price of about $18 per cubic yard.

Yard debris from curbside residential collection is available in increasing quantities in Northwest Oregon. However, much of this supply source is already being collected. Also the highest energy content woody debris from this source is often being diverted to hog fuel as energy prices rise.

A key future driver of compost supply appears to be food waste. The City of Portland already has commercial collection of pre- and post-consumer food waste. This feedstock is sent to the Seattle area for processing as there is no permitted food waste compost facility in Oregon. The cities of Eugene and Salem are also looking at collecting and composting food waste, but a composting facility is needed in Oregon which is permitted to accept food waste. If this occurs, it may increase the organic waste supply by 40 to 60 percent compared with current levels of yard waste volume. This would be a large amount for markets to absorb and is a major caution to the market potential for composting of animal mortality and meat processing byproducts.

On the demand side, there is expected to be a public perception stigma attached to compost that includes animal mortality and meat processing byproduct material. For this reason, compost manufacturers generally want to produce and market this type of product separately from their conventional lines of compost, soil amendments and related organic products.

Several people in the industry want to produce and market mortality compost to public agencies. There is potential to sell this compost to the Oregon Department of Transportation, the U.S. Forest Service, or perhaps other agencies. However, there are no agencies immediately ready to accept this compost. Necessary steps to market to these agencies include: pilot or demonstration projects and the agencies such as ODOT must establish specifications for the material. Principal issues will be demonstrating the pathogen-free properties of this compost when produced under good manufacturing practices, and the beneficial properties of this compost, including erosion control characteristics, and the ability of this compost to hold heavy metals and/or hydrocarbons. The Oregon Department of Transportation is currently considering using mortality compost produced with road kill deer. ODOT would logically be the first agency to approach while also inviting other agencies such as the Oregon Department of State Lands and the U.S. Forest Service to review and participate in studies and demonstration trials.

The conventional, private sector markets are a long term prospect for acceptance of compost made with these materials. However, many areas in Oregon have a reasonable supply-demand balance in their compost markets. Until there is positive experience with mortality and meat processing byproduct compost in the public sector, conventional markets will probably be slow to develop.

5.2 Biofuels

For purposes of this study, "biofuels" refers to bioethanol and biodiesel that might be produced using hydrolysis processing technologies. However note that the energy content of fuels derived from these processes is uncertain when using animal waste byproducts as a feedstock.

5.2.1 Supply and Alternatives

Bioethanol and biodiesel are direct substitutes for gasoline and diesel, respectively, refined from crude oil. The outlook for biofuels depends on the long-term price of crude oil, advances in biofuels technology and intrinsic demand for biofuels as a renewable alternative to fossil fuels. In their 2007 draft fuel price forecast, the Northwest Power and Conservation Council (NWPCC) identified the following factors affecting the outlook for energy in the Northwest now and in the future:

- A roughly 25% devaluation of the dollar relative to European currency means that oil prices that are denominated in dollars would need to increase 25% just to provide the same income relative to world currencies and costs. That factor could shift the OPEC target price from the mid-twenty dollar range into the mid-thirty dollar range.
- In spite of active natural gas drilling and exploration, the expansion of supplies has been disappointing. In particular, the Western Canadian Sedimentary Basin, which is the source of much of the natural gas supply for the Pacific Northwest, is now expected by many to have declining production in the future.
- Climate change has become a major concern in the world and many state and federal policies have been targeted at reducing consumption of fossil fuels and substituting renewable sources of energy and more efficient use of energy. One side effect of this policy is to create uncertainty about future fossil fuel markets, which may inhibit investment in new traditional supplies and refining capacity.
- The growth of conflict and terrorist activity in the Middle East has created fear and uncertainty about oil and liquid natural gas (LNG) supplies. This fear contributes to volatile and high oil and natural gas prices and has delayed needed investment in increased energy production capacity in the Middle East, which contains a large share of the world's petroleum reserves.
- Rapid growth in developing countries, especially China and India, has increased, rather suddenly and dramatically, the demand for energy and other basic commodities and resources. This rapid increase in demand has occurred faster than world supplies have been able to expand, resulting in a world boom in commodity prices.
- Devastating hurricanes in the Gulf of Mexico in the summer of 2005 caused tremendous damage to the oil and natural gas infrastructure in the energy breadbasket of the United States and created additional fears about the security and vulnerability of our energy supplies.

In 2006, world oil prices averaged $59 per barrel. In 2010 NWPCC projects oil prices ranging from $35 to $70 (in $2006), with the most likely range between $42 and $58. In 2015, NWPCC projects oil prices ranging from $32 to $70 (in $2006), with the most likely range between $40 and $52. These forecasts project that in inflation-adjusted terms, oil prices over the next three to eight years are expected to trend slightly downward compared with 2006 experience. Inflation-adjusted oil prices are projected to be fairly flat between 2015 and 2030.[4]

Ethanol

Ethanol is produced commercially both as a petrochemical through the hydration of ethylene, and biologically by fermentation. Ethanol fermented from corn has recently gained attention and currently receives direct government assistance as a renewable biofuel alternative energy source.

According to the Renewable Fuels Association, as of January 2007 there were 110 ethanol biorefineries in the United States with the capacity to produce 5.5 billion gallons of ethanol per year. The vast majority of this is produced from corn. Additional projects underway could potentially add 6.1 billion gallons of new capacity by 2009. Table 6 shows the 3.9 billion gallons of ethanol produced in 2005 represents 2.77% of the combined gasoline-ethanol fuel pool, up from 1.25% of a smaller pool in 2000.[5]

Table 6
Gasoline and Ethanol Production in the U.S., 2000 - 2005

Year	Gasoline (billion gal)	Ethanol (billion gal)	Ethanol as % of Total Pool
2000	128.7	1.63	1.25%
2001	129.3	1.77	1.35%
2002	132.8	2.13	1.58%
2003	134.1	2.80	2.05%
2004	137.0	3.40	2.42%
2005	136.9	3.90	2.77%

U.S. imports of ethanol have increased rapidly from 45.5 million gallons in 2002 to an estimated 671 million gallons in 2006.

Oregon currently has no in-state ethanol production, however two plants are under construction—Pacific Ethanol's 35 million gallon per year (MMgy) plant in Boardman, and Cascade Grain's 108 MMgy plant in Clatskanie.[6] A March 2007 survey conducted by the Northwest Environmental Business Council (NEBC) identified as many as ten ethanol plants

4 Northwest Power and Conservation Council, Draft Revised Fuel Price Forecasts, Council Document 2007-10, July 3, 2007. http://www.nwcouncil.org/library/2007/2007-10.pdf

5 Source: adapted from: B. Haney, Major Issues Affecting Biofuel Growth and Development in the U.S. (http://www.eia.doe.gov/oiaf/aeo/conf/haney/)

6 Biodiesel Magazine, July 2007. http://www.biodieselmagazine.com/article.jsp?article_id=1715.

being planned for Oregon. If all are completed, it would add 400 MMgy of ethanol production capacity in Oregon.[7]

Biodiesel

Biodiesel refers to a diesel-equivalent processed fuel derived from biological sources that can be used in unmodified diesel-engine vehicles. The term biodiesel is also used for straight vegetable oils or waste vegetable oils used as fuels in some diesel vehicles, although technically these two are not biodiesel but can be refined into biodiesel with processing.

The high cost of production remains the biggest obstacle to use of biodiesel in blends or as a pure fuel. Most biodiesel is currently made from soybean oil, a commodity whose price is historically volatile. The Energy Information Administration (EIA) estimates that in order to expand capacity producers need to receive at least $1.698 per gallon (in $2002) to cover their variable and fixed costs. Although recycled waste oils can be used to reduce costs, these sources present problems in production and usage. For example, waste frying oil is often hydrogenated which increases its pour point (the lowest temperature at which oil will flow) significantly.[8]

In 2004 about 25 million gallons of commercially produced biodiesel were sold in the U.S. compared with less than 0.1 million gallons in 1998. In 2005, sales of biodiesel in the U.S. nearly tripled from the prior year to 75 million gallons. Sales in 2006 were estimated to be 250 million gallons. This growth was spurred in large part by the Blenders Credit provision in the Energy Policy Act.

As of June 7, 2007, there were 148 companies with biodiesel manufacturing plants capable of producing 1.39 billion gallons per year. Ninety-six companies have reported plants currently under construction that are scheduled to be completed within the next 18 months. Five additional plants are expanding operations. If realized, these projects would result in an additional 1.89 billion gallons per year of biodiesel production capacity.[9]

Some of the new plants intend to blend soybean oil feedstock with lower-cost alternatives, such as waste grease and used cooking oil. Increased production combined with increased competition and high crude oil prices should begin to make the cost of biodiesel competitive and supplies more readily available. As an interesting aside, a pilot project in Alaska is producing fish oil biodiesel from the local fish processing industry waste stream.[10]

Biodiesel production in Oregon is currently low, in the 2 MMgy range, with another 4 MMgy expected to be in production by early 2008.[11] The NEBC survey identified as many as 21

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7 See: the Daily Journal of Commerce, July 10, 2007, http://www.portlandonline.com/shared/cfm/-image.cfm?id=162066.

8 Source: http://www.greenfuels.org.

9 Source for these paragraphs is: http://www.biodiesel.org/

10 See: http://www.sfos.uaf.edu/directory/faculty/sathivel/biodiesel.pdf.

11 Biodiesel Magazine, July 2007. http://www.biodieselmagazine.com/article.jsp?article_id=1715.

biodiesel plants being planned for Oregon. If all these plants are completed, biodiesel capacity in Oregon will total about 315 MMgy.[12]

5.2.2 Current and Future Demand

International demand for biofuels is strong and expected to increase. Production of ethanol in China in 2005 totaled 258 million gallons and is predicted to increase to 1.1 billion gallons by 2010. Biodiesel production was around 42 million gallons in 2005, and is predicted to reach 600 million gallons by 2010. The diesel market in China is twice that of the gasoline market, so there is a much greater opportunity for longer term expansion in biodiesel production.[13]

Renewable Fuel Standards under the Energy Policy Act of 2005 call for 7.5 billion gallons of renewable biofuels to be used annually by 2012.[14] The Energy Policy Act of 1992 (EPACT) requires that a share of new purchases of light-duty vehicles for qualified fleets be alternative-fuel vehicles (AFVs). Qualified fleets include vehicles owned by Federal and State agencies and alternative fuel providers that are capable of being fueled at central locations (Law enforcement, emergency, and military vehicles are exempt). For federal and state governments, the AFV requirement is 75% of new fleet purchases. The requirement is 90% for alternative fuel providers. These federal measures are helping to increase demand for biofuels now and into the future.

In Oregon, recent legislation at the state and local levels is likely to increase demand for biofuels in the near future (see below).

Ethanol

The single largest use of ethanol is as a motor fuel and fuel additive. Other uses of ethanol include the alcohol in fermented and distilled alcoholic beverages, a feedstock in the production of vinegar, and as an antiseptic.

The phase-out of petroleum based MTBE (methyl-tert-butyl ether), a fuel additive identified as hazardous, has spurred demand for fuel ethanol as a direct replacement for MTBE. Over time, it is believed that a material portion of the approximately 150 billion gallon per year market for gasoline will also begin to be replaced with fuel ethanol. Growth in fuel ethanol in the United States is currently being driven by relatively high oil prices and publicly funded tax credits and subsidies. Ethanol typically costs under $1.50 per gallon to manufacture, depending on corn prices, and is exempt from the federal gasoline tax.[15]

Oregon Governor Ted Kulongoski signed HB 2210 into effect in July 2007. Provisions of the bill include a mandate for 10% ethanol blend after certain production requirements are met. The mandate will take effect three months after in-state production of ethanol reaches 40 MMgy.[16]

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12 See: Portland Daily Journal of Commerce, July 10, 2007, http://www.portlandonline.com/shared/cfm/-image.cfm?id=162066

13 See: February 2007 *Render* magazine.

14 http://en.wikipedia.org/wiki/Energy_Policy_Act_of_2005

15 Source: http://www.greenfuels.org

16 Biodiesel Magazine, July 2007. http://www.biodieselmagazine.com/article.jsp?article_id=1715.

This condition is expected to be met later this year.[17] A City of Portland mandate requiring all fueling stations in the city to sell 10% ethanol began to go into effect September 16, 2007 for distributors, and kicks in for all fueling stations on November 1, 2007.[18]

Most fuel ethanol is sold under long-term agreements between ethanol producers/marketers and petroleum companies. According to industry observers, roughly 90 to 95% of ethanol is sold under these long-term contracts (6 to 12 months). Many of these contracts are "fixed price" so that the price paid for ethanol supplies doesn't change with the spot (wholesale) market price. However some contracts may be pegged to a gasoline benchmark price, in which case, the price paid for ethanol moves accordingly when wholesale gasoline prices move up or down.

The remaining 5-10% of fuel ethanol is sold on the "spot" market. Prices fluctuate daily according to market conditions. Numerous companies track these daily fuels spot prices for clients.[19]

Biodiesel

The price of biodiesel in the United States fell from an average $3.50 per gallon in 1997 to $1.85 per gallon in 2002. Beginning in 2003, tax credits became available for using biodiesel.[20] Recently, West Coast diesel spot (wholesale) prices have increased 75% from $1.28 in January 2005 to $2.24 in June 2007. Retail diesel fuel prices are likely to remain elevated as long as crude oil prices and world demand for distillate fuels remain high. EIA expects that national average retail diesel fuel prices will hover around $2.70 per gallon through 2007 and 2008, assuming the forecast for the price of West Texas Intermediate crude oil averages near $64 per barrel.

EIA forecasts of biodiesel demand include lower-bound projections of 6.5 million gallons (424 barrels per day) in 2010 and 7.3 million gallons (476 barrels per day) in 2020. The upper-bound projections include the assumption that biodiesel will be blended into ultra-low-sulfur diesel at 1% by volume to improve lubricity, resulting in demand projections for biodiesel of 470 million gallons (30,654 barrels per day) in 2010, and 630 million gallons (41,959 barrels per day) in 2020.[21]

Recently, at least 11 states were considering some form of legislation or mandate that would require either a certain percentage of diesel sold in a state to be biodiesel or that all diesel fuel sold in a state contain a minimum of 2% biodiesel. Many states are adding language that would increase the 2% blend rate to 5% biodiesel over time. These states include Florida, Connecticut, Missouri, California, Oregon, Mississippi, Arkansas, Nebraska, Montana and New Mexico.

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17 Correspondence with Mike Grainey, Director, Oregon Department of Energy, July 26, 2007.

18 See: http://www.portlandonline.com/shared/cfm/image.cfm?id=157081

19 For example, see,DTN (www.dtnethanolcenter.com), Platts (www.platts.com), Jim Jordan & Associates (www.jordan-associates.com), Kingsman (www.kingsman.com), and Ethanol Market http://ethanolmarket.aghost.net/. See also: http://www.ethanolrfa.org/industry/statistics/#E.

20 Source: http://en.wikipedia.org/wiki/Biodiesel.

21 Source: http://tonto.eia.doe.gov/FTPROOT/environment/biodiesel.pdf, and http://tonto.eia.doe.gov/FTPROOT/service/sroiaf(2002)06.pdf

Oregon HB 2210 also includes a mandate for sale of 2% biodiesel blends which goes into effect three months after regional production (Oregon, Washington, Idaho and Montana) of biodiesel reaches 15 MMgy.[22] This level of production is not likely to be met before the 2010 to 2012 time frame.[23] The City of Portland's current mandate also requires all fueling stations in the city to sell 5% biodiesel blend beginning August 15, 2007, and 10% biodiesel blend by July 1, 2010.[24]

5.2.3 Analysis

The EIA projects demand for biofuels in the transportation sector to increase by an annual average of 5.5% through 2030, with higher than average growth rates expected through 2010. These forecasts correlate with expected trends in the prices of non-renewable fuels.[25]

Marketing of biodiesel is presently limited to a relatively few companies. In the U.S. it is often easier to find biodiesel in rural areas than in cities because agribusinesses with ties to oilseed farming use biodiesel for public relations reasons. Tests indicate that production costs for biodiesel are 2.5 times that of petroleum diesel. While the technology has advanced considerably, biodiesel is still not economically competitive with diesel nor is it expected to be in the foreseeable future in absence of public subsidies including tax credits. The commercial use of biodiesel in Europe is primarily due to large crop surpluses, land set-aside programs, high fuel taxes, generally higher fuel prices, and air pollution problems. At the current price of crude oil at above $60 per barrel, the viability of biodiesel production economics has improved. [26] However the long-term forecast is for the price to average below $60 per barrel in inflation adjusted terms.

Average U.S. rack prices for fuel ethanol are currently running about $2.40 per gallon. This is lower than both the recent high of $3.60 a year ago, and also below the December 2006 price of $2.45. Spot prices for future deliveries in 2007 and 2008 also seem to be trending downward.[27]

Commodity markets are well developed with accurate price information readily available for both ethanol and biodiesel. If crude oil prices remain relatively high, then most analysts believe demand and prices for bioethanol and biodiesel, direct substitutes for fossil fuels, should also remain relatively high. However, even with relatively high petroleum prices, biofuel production technologies currently available are not yet competitive without significant levels of public subsidy.

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22 Biodiesel Magazine, July 2007. http://www.biodieselmagazine.com/article.jsp?article_id=1715

23 Correspondence with Mike Grainy, Director, Oregon Department of Energy, July 26, 2007.

24 See: http://www.portlandonline.com/shared/cfm/image.cfm?id=157081

25 Source: http://www.eia.doe.gov/oiaf/forecasting.html

26 Source: http://www.greenfuels.org/biodiesel/economics.htm

27 http://ethanolmarket.aghost.net/

5.3 Biogas

5.3.1 Supply and Alternatives

Biogas (including “synthetic biogas” (syngas), “wastewater gas”, and “landfill gas”) includes high, medium, and low-Btu fuel gas. Medium-Btu gas is generated as a product of anaerobic digestion in facilities such as landfills, wastewater treatment plants, and livestock farms. Low-Btu gas is generated by thermal gasification or pyrolysis. High-Btu fuel gas is called renewable natural gas or biomethane and is basically substitutable for pipeline natural gas. Medium and low-Btu fuel gas can be processed into high-Btu fuel gas; used as feedstock to produce methane, hydrogen and other chemicals, including plastics; or burned on-site to produce electricity and/or heat.

Biogas is a substitute for natural gas used on site, but with less than half the heating quality of natural gas. Biogas produced from different feedstocks will have different qualities. Biogas produced from wastewater treatment or landfills is likely to be of consistently higher quality than biogas produced from animal manure.

The outlook for biogas depends in large measure on the long-term price of natural gas, advances in biogas utilization and processing technology, and intrinsic demand for renewable energy as an alternative to fossil fuels.

In 2006, wellhead natural gas prices averaged \$6.29 per MMBtu. In 2010, NWPCC projects gas prices to range from \$4.25 to \$8 per MMBtu (in 2006 dollars), with the most likely range between \$5 and \$7. In 2015, NWPCC projects gas prices ranging from \$3.40 to \$8 per MMBtu (in 2006 dollars), with the most likely range between \$4.25 and \$6. These forecasts project that in inflation-adjusted terms, natural gas prices over the next three to eight years are expected to remain fairly flat or trend slightly downward compared with 2006. However, the trend in projected inflation-adjusted gas prices is for a gradual increase between 2015 and 2030.[28]

Demand for coal, a dirtier but abundant substitute for natural gas, is expected to increase in the future. While large increases in the supply of electricity generated from coal in the Pacific Northwest are unlikely, coal’s overwhelming abundance and dominance as a source of energy in the world market make the price trend for coal an indicator for the prospects of alternative energy sources. Development of more cost-effective technologies for “scrubbing,” coal gasification, and carbon sequestration could make coal much more competitive with cleaner energy sources in the future. In 2006, mine mouth coal prices averaged \$0.45 per MMBtu (in 2000 dollars). In 2010, NWPCC projects coal prices ranging from about \$0.46 to \$0.5 (in 2000 dollars), with the most likely range somewhat narrower. In 2015, NWPCC projects coal prices ranging from \$0.45 to \$0.55 (in 2000 dollars), with the most likely range being somewhat narrower. These forecasts project that in inflation-adjusted terms, coal prices over the next three

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[28] Northwest Power and Conservation Council, Draft Revised Fuel Price Forecasts, Council Document 2007-10, July 3, 2007. http://www.nwcouncil.org/library/2007/2007-10.pdf

to eight years are expected to increase slightly compared with 2006. Coal prices are also projected to increase gradually between 2015 and 2030.[29]

If cleaned sufficiently, biogas has the same characteristics as natural gas. Clean biogas can be piped through the local gas distribution network; however it must be very clean to be pipeline quality: water, hydrogen sulfide, particulates, and carbon dioxide must be removed. Biogas can be used on site without extensive cleaning. It is sometimes co-fired with natural gas to improve combustion.

Currently, the main sources of exploitable biogas are gas recovery systems associated with landfills, waste water treatment plants, and anaerobic digestion of manure from high-density livestock operations such as dairies. These types of operations use the collected biogas to run on-site electricity generators, and also to generate or co-generate heat. Some facilities also sell surplus electricity production into the power grid.

There are probably at least 200 landfill-based systems in the U.S. that use generated biogas to produce electricity.[30] The Klickitat Public Utility District in Goldendale, Washington, currently has capacity to produce at least 10.5 MW of electricity using landfill gas.[31] In Oregon, three landfills currently tap waste methane gas to generate electricity and provide industrial fuel: Coffin Butte landfill near Corvallis has 2.4 MW of capacity; Short Mountain landfill near Eugene has 1.6 MW of capacity; and Dry Creek Landfill near Eagle Point reportedly has 3.2 MW of capacity. Two other landfills in the state currently burn biogas but do not generate electricity; and at least five more landfills, including the giant Columbia Ridge landfill near Arlington, either have gas to energy projects in the works or are rated as “candidates” for future biogas generation. [32]

Nine Oregon wastewater treatment plants have the capacity to use methane to generate up to three megawatts of electricity and/or provide heat for sewage treatment.[33] These facilities include a 395 kW cogenerator plant run by the City of Gresham,[34] and plants run by Clackamas County,[35] the City of Portland, and Washington County. Estimated cost of these projects would be approximately $0.03 to $0.05 per kWh at the larger sites (1 MW and larger), and $0.09 to $0.14 per kWh at the smaller sites (roughly 70 kilowatts to 1 MW). Rather than sell to the wholesale market, most of these projects would use generated power to offset retail power

[29] Northwest Power and Conservation Council, Draft Revised Fuel Price Forecasts, Council Document 2007-10, July 3, 2007. http://www.nwcouncil.org/library/2007/2007-10.pdf

[30] See: Biomass Energy Data Book. http://cta.ornl.gov/bedb/download.shtml.

[31] See: http://www.klickpud.com/power/lfg.asp.

[32] EPA Landfill Methane Outreach Program (LMOP), http://www.epa.gov/lmop/proj/index.htm#1

[33] Oregon’s Renewable Energy Action Plan, Oregon Department of Energy, April 12, 2005. www.oregon.gov/ENERGY/RENEW/docs/FinalREAP.pdf

[34] Personal communication with Guy Graham, City of Gresham, Department of Environmental Services. The Gresham waste water treatment plant co-generator supplies approximately 50-55% of electricity needs and heats several buildings. There are two anaerobic digesters on site with a total design capacity of 1.898 million gallons. The facility also produces approximately six "dry" tons of biosolids per day.

[35] Personal communication with Ted Kyle, Clackamas County, WES. Clackamas County has operated digesters for about 20 years. The facility currently uses digester gas to produce about 15% of its power load.

purchased at rates of approximately $0.06 to $0.07 per kWh, thereby improving the economics of projects in this segment compared with projects that sell into the wholesale market.[36]

Electricity is also generated using manure from dairy cows. For farmers, biogas is often viewed as a byproduct, and production of other benefits (e.g., compost, water quality management) is the main reason for these projects. Locally, there are at least two dairy-based biogas projects: PGE owns and operates a project at Cal-Gon Farms, a medium size dairy (400 cows) near Salem. The project typically generates around 50kW of electricity. Electric sales are made directly to the grid and have reportedly been fairly predictable.[37] The Port of Tillamook operates a methane digester facility using manure from some 3,000 of Tillamook county's 30,000 dairy cows. The project has capacity in place to expand to 4,000 cows. Although generators are on site, low electricity prices mean that it has been more economical to use the biogas to heat the facility than to generate electricity.[38] A large composting firm has reportedly expressed interest in investing in consolidating the Port of Tillamook's waste management infrastructure, including expanding and integrating management of municipal wastewater, animal manure and dairy cow carcasses for production of compost and biogas.[39]

5.3.2 Current and Future Demand

Since biogas gas is about half carbon dioxide and half methane, separation of these two gases can potentially generate two separate sources of revenue – commercial CO_2 and pipeline-quality (high-Btu) methane. However, in practice, biogas is used mostly to replace or reduce use of natural gas and/or electricity on site where it is generated, and create income from sale of surplus electricity. Electricity can be generated on site using several technologies, including combustion turbines, reciprocating engines, Stirling engines, and fuel cells, but the high cost and relatively low quality of the biogas may limit the choice of engine-powered generators.[40]

Federal law requires major public utilities to offer standard contracts to purchase electricity from certified small producers under 10 MW in capacity.[41] Agreements generally include credit for avoided costs, and offer the certainty of setting the price and average quantity for electricity

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36 See Energy Trust of Oregon, Biopower Market Assessment, Phase II, http://www.energytrust.org/RR/bio/market_assessment.html

37 Personal communication with Joe Barra. The project's output is typically around 50kW. The project has had difficulty operating at a profit, especially when capital costs are included. Gas treatment is a big expense, as are engine overhauls due to the impurities that remain in the gas post treatment.

38 Personal communications with George DeVore and Jack Crieder. Port of Tillamook Project has never been profitable even though "scrubbing" of the biogas is not done. A major expense is the cost of hauling manure from local farms to the digester using commercial carriers.

39 Personal communications with George DeVore and Jack Crieder (Port of Tillamook), and Shawn Reiersgaard (Tillamook Creamery).

40 See: Cummins Power Generation Power topic #6015, http://www.cumminspower.com/-www/literature/technicalpapers/F-6015-waste-to-energy.pdf.

41 The Federal Energy Regulatory Commission (FERC) is responsible for certifying qualified facilities.

purchases up to 20 years into the future. Examples of standard power purchase agreement contracts through PGE and PacificCorp are available on line.[42]

Under 1999 Oregon Senate Bill 1149, which took effect March 1, 2002, the state's largest investor-owned utilities must offer renewable energy purchase options to qualifying customers. The utilities charge a slight premium over standard energy prices for the service, and the additional money goes toward marketing renewable power and purchasing additional renewable power resources.

Senate Bill 838, signed by Governor Kulongoski on June 6, 2007, established a Renewable Energy Standard, also known as a Renewable Portfolio Standard (RPS), for electricity. The bill's requirement that 25% of Oregon's electric load come from new renewable energy by 2025 applies to electric utilities and any electricity service suppliers that serve at least 3% of Oregon's electric load. This includes Oregon's three largest utilities, Portland General Electric, Pacificorp, and Eugene Water & Electric Board. The bill also includes interim RPS targets of five percent of electric load served by renewable sources by 2011, fifteen percent by 2015 and twenty percent by 2020 for the largest class of utilities; and lower overall RPS targets for smaller utilities provided they do not acquire coal to meet new load growth. There is also a non-binding goal that one-third of the renewable energy resources will be small projects less than 20 megawatts.[43]

5.3.3 Analysis

The upshot of Senate Bill 838 is that, depending on the rate of load growth, most of the new resources needed to meet this standard are likely to be renewable energy. Currently, wind power and geothermal energy provide the bulk of renewable energy sold in Oregon. However, development of other sources of renewable energy, including biomass, should also receive a boost from this legislation.

In their Fifth Northwest Electric Power and Conservation Plan, the NWPCC assessed the potential for development of renewable energy supplies. The NWPCC estimated that biogas from landfills, animal manure and waste water treatment facilities had the potential to generate 175, 52, and 7 average MW of electricity, respectively, in the Pacific Northwest. However, much of the potential from landfills is unlikely to be developed due to the high cost of electricity production at smaller landfills. The benchmark levelized cost of electricity produced from landfills is about $49 per megawatt-hour, about ten percent higher than the forecast cost of power from gas combined-cycle and other forms of bulk power production. However, incentives such as the recently expanded federal production tax credit and system benefit charge funds will encourage development of this resource.[44]

The development of anaerobic digesters for livestock manure treatment and energy production has accelerated recently due to increasing energy costs; increased technical reliability of anaerobic digesters; growing concern of farm owners about environmental quality; an increasing

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42 See Energy Trust of Oregon website: http://www.energytrust.org/RR/bio/resources.html.

43 Senate Bill 838 Enrolled. http://www.leg.state.or.us/07reg/measpdf/sb0800.dir/sb0838.en.pdf

44 The Fifth Northwest Electric Power and Conservation Plan, NWPCC, May 2005. http://www.nwcouncil.org/energy/powerplan/plan/

number of state and federal programs designed to share costs of these systems; the desire for energy security; and the emergence of new state energy policies (such as net metering legislation) designed to expand growth in reliable renewable energy and green power markets.[45] The benchmark cost of electricity produced from animal manure is $60 per megawatt-hour. While much greater than the forecast wholesale cost of power from gas combined-cycle and other bulk power sources, the cost may be competitive with the retail electricity at some facilities. Moreover, energy recovery is usually a component of an integrated manure disposal system to resolve environmental issues, and produce compost. Animal manure systems may also qualify for system benefit funds or future federal production tax credits, if the scope of these is extended to biomass residues, as has been proposed.[46]

Two recent reports commissioned by the Energy Trust of Oregon assess the market potential for energy generated from biomass sources. These reports predict that sewage treatment plant-based digesters in Oregon have a potential to generate 5 to 7 MW. Most of these projects would use generated power on-site to offset purchased retail power rather than sell into the wholesale market. Dairy-based anaerobic digesters have theoretical capacity to produce 20 to 30 MW of power. However, the actual potential for near-term economic projects is much less - in the range of 10 to 12 MW - due to the variation in farm practices. Large projects (2 to 6 MW) could produce power in the $0.04 to $0.07 per kWh range and may be feasible now. Smaller projects that could be developed in the $0.08 to $0.11 per kWh range could potentially be feasible in the long term, but face significant economic, technological, and regulatory challenges in the near- to mid-term. Landfill gas-to-energy projects have potential to produce 40 to 45 MW across approximately thirteen landfills in the state. More than half of this capacity lies in the Columbia Ridge facility in Arlington. There are five to ten sites with potential of at least 1 MW. Project costs are estimated to be in the $0.025 to $0.045 per kWh for the larger projects (greater than 2 MW), although they could be higher depending on project-specific requirements related to transmission and interconnection costs and other issues. Costs for smaller projects ranging in size down to 70 kW would be in the $0.09 to $0.15 per kWh range.[47]

Off-site demand for un-refined biogas is uncertain but probably limited. Conversion of biogas to LNG or compressed natural gas (CNG) is costly and so best suited to medium-to-large-scale landfills. Nearly all methanol produced today is made from natural gas, so there also may be potential to produce methanol from renewable biogas in the future.[48]

Energy generated from renewable sources may be eligible for carbon offset credits that are traded on established markets, e.g., Chicago Climate Exchange, possibly creating an additional source of revenue for qualifying operations.

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45 See: http://www.epa.gov/agstar/accomplish.html

46 The Fifth Northwest Electric Power and Conservation Plan, NWPCC, May 2005. http://www.nwcouncil.org/energy/powerplan/plan/

47 See: Oregon Energy Trust, Biomass Market Assessment Phase I and II, http://www.energytrust.org/RR/bio/resources.html.

48 U.S. Climate Change Technology Program: Technology Options for the Near and Long Term, http://www.climatetechnology.gov/library/2005/tech-options/tor2005-412.pdf

5.4 Biochar

5.4.1 Supply and Alternatives

Biochar (or char) is a residual carbon material produced during thermal gasification or pyrolysis of organic material. Different pyrolysis/thermal gasification technologies produce differing relative amounts of biochar. Processes can be designed to produce more or less biochar vis-à-vis fuel gas output. The main supply of biochar material is charcoal, a product of the thermal gasification of wood.

5.4.2 Current and Future Demand

Biochar has a number of uses, including as fuel, fertilizer or filter material. Biochar can be a high Btu-value solid fuel that can be used in kilns, boilers and the briquette industry. As a soil amendment, there is evidence that biochar stabilizes soils, improves erosion resistance, increases soil permeability and improves soil texture. Carbon sequestration, by burying biochar in landfills or otherwise incorporating into the soil, may be eligible for carbon offset credits.[49]

Biochar is also used as the "activated carbon" filtration media. Activated carbon is used in gas purification, metal extraction, water purification, medicine, sewage treatment, air filters, and many other applications.

5.4.3 Analysis

While existence of formal markets for biochar produced from animal byproducts is unlikely, local, niche markets may exist. However the relatively limited supply and uncertain quality of biochar likely to be produced will make it difficult to attract buyers. The best use for biochar produced from animal byproducts is likely to be on-site as a fuel source; soil amendment; or as a lower volume, lower cost material to land fill compared to the animal byproduct inputs. The potential to earn carbon sequestration credits for land filling or soil application of biochar is likely to increase over time under existing and emerging carbon trading mechanisms. This may become an additional source of revenue for qualifying operations.

5.5 Biooil

5.5.1 Supply and Alternatives

Biooil (or tar) is a product of high temperature reduction processes, obtained when a portion of the gas released during pyrolysis or thermal gasification of organic material is condensed.

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49 See: http://www.iaiconference.org/images/Gaunt_-_Carbon_Trading_Prospects.pdf

5.5.2 Current and Future Demand

Biooils currently being produced may be suitable for use as fuel in on-site boilers for electricity generation, and possibly as a feedstock for producing bio diesel and certain chemicals.

5.5.3 Analysis

While existence of formal markets for biooil is unlikely, local, niche markets may exist. However the relatively limited supply and uncertain quality of biooil likely to be produced from animal byproducts will make it difficult to attract buyers. The best use for biooil produced from animal byproducts is likely to be as an on-site fuel source.

5.6 Hydrolyzate

5.6.1 Supply and Alternatives

In this discussion, hydrolyzate is the term used for the main output of alkaline hydrolysis using animal byproducts as feedstock. ("Bone shadow," is a distinctly separate product of alkaline hydrolysis.) There are currently fifteen to twenty alkaline hydrolysis digesters operating in the U.S. with a capacity of between 10 and 10,000 lbs. (input) per unit. Two companies, WR^2 and Hydrol-Pro Technologies, have to date been supplying the technology.[50]

The Texas Animal Health Commission (TAHC) has recommended alkaline hydrolysis as one of three acceptable treatment and disposal methods for animal tissues and carcasses infected with or suspected of containing prions (the other two methods being incineration and rendering).[51] Alkaline hydrolysis tissue digesters are currently being used in the USDA's two major chronic wasting disease elimination programs. Moreover, large-scale treatment and disposal units are currently being developed for disposal of the specified risk material (SRM) that the USDA has defined (revised regulations 9 CFR 301-9) in response to the first confirmed case of BSE in the US.[52]

While primarily a waste disposal technology, there is evidence that hydrolyzate from alkaline hydrolysis can be used as fertilizer; as an additive to composting systems; as a feedstock for anaerobic digestion in biogas generation plants that produce methane, steam, heat, or electric power; or as an accelerant for burning other forms of biomass. Conversion of hydrolyzate to biodiesel is also reportedly possible.[53]

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50 Personal communication with Keith Davidson, USDA National Veterinary Sciences Laboratory, Ames, Iowa.

51 General Guidelines for the Disposal of Carcasses, Appendix 3.6.5 to the January 2005 TAHC Report. http://www.aphis.usda.gov/vs/ncie/oie/pdf_files/tahc-carcass-disp-jan05.pdf

52 ALN Magazine, http://www.animallab.com/articles.asp?pid=76.

53 ALN Magazine, http://www.animallab.com/articles.asp?pid=76.

5.6.2 Current and Future Demand

For reasons mentioned above, current demand for hydolyzate is uncertain. It is likely to be cheaper and easier to dispose of sterile, hydrolyzed byproducts in a wastewater treatment plant than it is to landfill the animal inputs. However, the relatively high biological oxygen demand of the effluent may make obtaining the necessary permits and approvals for disposal of the hydrolyzate difficult in some jurisdictions. Incineration is possible but difficult, because the hydrolyzate has high water content and is relatively caustic. While land application as a soil nutrient supplement has been tried at the USDA facility in Ames, Iowa, to our knowledge no crop trials have been done to determine the efficacy of applying hydrolyzate as a fertilizer. It may also be difficult to get regulatory approval for off-site soil application or sewage treatment disposal of hydrolyzate until more is understood about the chemical composition and possible long-term or cumulative effects of exposure to the material.[54]

As the technology matures and downstream processing options are developed, it is likely that demand for hydrolyzate as an end product and/or as an input for further processing will expand.

5.6.3 Analysis

Alkaline hydrolysis of animal byproducts is still in an early phase of development. Research needs to be done before it can be determined how easily the byproducts of alkaline hydrolysis can be disposed of, or how useful they will be for downstream processing. However, as apparently the only process other than high-temperature incineration that is currently recommended by the government for disposal of animal tissues potentially containing prions, the number and scale of alkaline hydrolysis facilities are likely to increase in the future.

This may point to a possible first-mover advantage. That is, a facility with a certified alkaline hydrolysis digester would be in place and available to dispose of material potentially infected with prions in the surrounding region, including neighboring states, and thus be able to charge premium prices for that service.[55]

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54 Personal communication with Keith Davidson, USDA National Veterinary Sciences Laboratory, Ames, Iowa.

55 Personal communication with Kim Etherington, PharmaMedSci (Alkaline Hydrolyis equipment vendor).

Section 6
Research and Identification of Technical Options and Opportunities

6.1 Processing Options

CalRecovery analyzed processing options for treating offal, grocery waste, and all-animal mortality generated in the state of Oregon. The ODA estimates that the rate of generation of these waste types in Oregon is approximately 40 thousand tons per year, which is consistent with the study team's estimate of nearly 46 thousand tons (91.65 million lbs, see Table 4 above).

All of the processes and technologies discussed in this section had their genesis primarily as alternatives for solid waste treatment. Over time, the potential of these technologies and processes to generate usable resources as byproducts of treatment has been realized and in many cases instituted as an integral aspect of waste treatment. The technology descriptions cover the important aspects of waste treatment, as well as the primary resource recovery potentials of each process.

The processes described in the following sections are applicable to waste or materials with substantial organic content in the form of carbon and hydrogen, and, therefore, are potentially applicable to treatment of animal byproducts.

The types of environmental control systems required by each of the technologies would primarily depend upon the types and quantities of materials processed, type of technology, characteristics of the uncontrolled emissions, and Federal, State of Oregon, and local land use and environmental regulations.

6.1.1 Composting

In this process, biodegradable materials or wastes are decomposed by microorganisms in an aerobic environment under controlled conditions. When properly practiced, the composting process is exothermic, i.e., the mass of composting materials characteristically generates heat, and thus the temperature in the mass can reach 130° to 140°F. The byproducts of the process of decomposition are gases (primarily carbon dioxide and water vapor, with trace concentrations of volatile organic compounds) and a solid, soil-like material (i.e., compost) that has use as a soil amendment. The process can also produce a liquid, i.e., leachate, which characteristically contains dissolved and suspended organic compounds, depending on waste characteristics, operational conditions, and local meteorological conditions. The soil amendment typically is the usable product of the process. The other two byproducts, namely the gases and leachate, may have to be treated to meet local regulatory, environmental, and/or public health requirements.

The process of composting can be performed in an open environment or enclosed environment (e.g., in an enclosure isolated from the elements), depending on local regulations and conditions, economics, types of feedstocks, and others.

Organic materials that are commonly composted include: leaves and tree trimmings, manure, wastewater treatment sludge (biosolids), food waste, and crop residues.

The more important parameters that govern the process are the following:

- Carbon to nitrogen ratio
- Porosity of the materials to be composted
- Particle size distribution
- Oxygen concentration of the process (i.e., aeration)
- Population of microorganisms
- Moisture content
- Composting time

The process can accept organic waste with a high concentration of moisture provided that the wet waste is mixed with drier materials such that the moisture content of the mixture is approximately 55%. For composting dry organic waste, water must be added to achieve the optimum moisture content during the composting process.

Due to its characteristics, the compost produced by the process has value for growing of plants. The valuable characteristics include nutrient content, organic material (humus) content, water retention capacity, and others.

6.1.2 Anaerobic Digestion

In anaerobic digestion, organic waste or materials are decomposed in an aqueous mixture maintained under controlled, anaerobic (i.e., devoid of oxygen) conditions within a vessel. In order to provide practical rates of degradation of materials, the liquid mixture (at 8% to 12% total solids) usually is heated to approximately 95°F. Some anaerobic digestion systems are operated as “dry” systems and the total solids content of the mixture is maintained at about 25% to 35%. Typically, the container is an open or enclosed pond, or an enclosed reactor. The byproducts of the process are gaseous compounds (primarily carbon dioxide and methane, with trace contents of volatile organic compounds), and semi-solid or solid residue. The gaseous byproduct of anaerobic digestion typically is the primary recoverable resource from the process due to its energy content. Depending on local regulations and conditions, the liquid effluent from the process may require further treatment; in particular, if it is to be discharged from the processing site. The semi-solid or solid residue from the process typically is disposed in a sanitary landfill. In some cases, the solid residue is further treated by composting in order to produce a marketable soil amendment.

Typical organic feedstocks treated by anaerobic digestion include municipal wastewater treatment sludge, manures, and food waste.

The more important parameters that govern the process are the following:

- Carbon to nitrogen ratio
- Particle size distribution
- Population of microorganisms
- Operating temperature
- Total solids content of aqueous mixture
- Detention time of the process
- Organic loading rate

As previously mentioned, the primary marketable product of the process is a fuel gas commonly known as biogas. Due to its composition, the raw biogas has a heating value approximately one half that of natural gas. The raw gas can be further processed to upgrade its heating value to approximately that of natural gas, or to upgrade it in all respects (e.g., allowable trace contamination, etc.) to "pipeline quality" gas (i.e., equivalent to commercial natural gas).

6.1.3 Thermal Gasification and Pyrolysis

These two thermo-chemical processes are similar, so they are jointly described. The primary difference between thermal gasification and pyrolysis is related to the concentration of oxygen that is used in each process.

In these processes, organic materials or waste are processed in a reactor at high temperature and in oxygen conditions inadequate to completely oxidize the chemical constituents, thus yielding partially oxidized chemical compounds in the forms of gas and liquid, and a solid residue. The gas is sometimes referred to as a syngas (short for synthetic gas), particularly if the gas is used as a fuel for energy production. The solid residue is customarily termed "char." For a given type of feedstock composition, the types of chemical compounds and their yields generated by the process are primarily a function of the operating temperature, pressure, oxygen concentration, and residence time.

In pyrolysis, the process is performed in an oxygen-free environment. In the case of thermal gasification, a certain amount of oxygen is allowed in the process, but less than that required to completely oxidize the chemical constituents of the materials, as would be the case for direct combustion for example. Depending upon the type of material used as feedstock, the pyrolysis process also produces a liquid. The liquid generally is highly viscous and has a low pH. Operating conditions impact the relative quantities of liquids and gases produced.

Feedstocks processed in thermal gasification and pyrolysis systems typically include wood, coal, and coke.

The more important parameters that govern the gasification and pyrolysis processes are the following:

- Waste/material composition, in particular, carbon, hydrogen, and moisture contents
- Particle size distribution
- Reaction temperature, pressure, and oxygen content
- Residence time of materials in the reactor

The gases that are generated from gasification and pyrolysis differ primarily in terms of composition and, therefore, in terms of heating value as a result of differences in amount of oxygen and other operating conditions used in the two types of processes. Heating values ranging from 10 to 35 percent of that of natural gas have been reported for gasification and pyrolysis of feedstocks derived from solid waste. The raw gas can be further beneficiated to produce a gas of higher quality or undergo chemical reactions to form chemical commodities. However, the usual practice is to use the raw syngas as a fuel for conversion to energy in the form of heat or electricity.

6.1.4 Direct Combustion (Incineration)

Direct combustion (alternatively referred to as incineration) is a high-temperature thermal process performed in an oxygen-rich environment wherein combustible feedstock is combusted, resulting in a solid residue (ash) and creating a gaseous byproduct/discharge. Direct combustion of waste is practiced with and without recovering energy from the gaseous exhaust stream.

Common feedstocks are municipal solid waste, wood waste, crop waste, and dewatered municipal wastewater treatment sludge. Dry feedstocks generally are preferred since the presence of water reduces the efficiency of combustion.

When energy recovery is integrated into direct combustion systems, the useful products are typically heat and/or electricity. In other cases where there is a market/use for cooling capacity, the heat energy is converted to cooling effect.

6.1.5 Plasma Arc

Plasma arc gasification is a process applied to management of wastes that uses very high temperatures generated by an electric arc to break down waste essentially into elemental gas and an inert solid waste known as slag. Depending upon the type of wastes being treated, system proponents indicate that the plasma arc gasification process is a net generator of electricity and is capable of diverting relatively large quantities of waste away from landfills. The plasma arc technology was developed towards the end of the 19th century for the metals industry and has been widely applied for cutting and melting metals.

In the plasma arc process, electricity at a relatively high voltage and amperage is passed between two electrodes. This results in the generation of an electrical arc. A pressurized inert gas is forced through the arc in a vessel in which the waste material is introduced. The inert gas can be air or inert gases. The gas can reach extremely high temperatures, on the order of 25,000°F. The organic matter contained in the waste is converted into a gaseous form and complex molecules are broken down into individual atoms. The inert matter is vitrified into a glassy mass known as slag.

The gaseous mixture consists of mostly carbon monoxide, hydrogen, and carbon dioxide. The relative concentration of each of the components depends upon the composition of the waste. The gaseous mixture is known as synthetic gas, or simply syngas. The syngas is combustible and can be burned in boilers to produce steam or directly in gas turbines for the production of electricity.

According to proponents of the technology, there are some facilities in Japan using this process to treat municipal solid waste. No information has been found related to the application of plasma arc for the treatment of animal byproducts.

6.1.6 Alkaline Hydrolysis

Alkaline hydrolysis is a treatment process that has been permitted in several regions around the world for the treatment of all types of animal byproducts. The process is conducted in a vessel (digester). The vessel is made of stainless steel and is insulated. Typically, the vessel includes a steam jacket to control operating temperatures. The vessel also is fitted with a lid. A basket is inserted inside the vessel to collect bone remnants. During operation, a certain amount of alkali (potassium hydroxide or sodium hydroxide) is automatically added to material in the digester. The amount of alkali added is proportional to the mass in the basket. Once the alkali is in the vessel, water is added to cover the waste and the unit is sealed. The time and temperature required for the digestion are set according to the type and category of the material in the digester. In the process, the material is dissolved and is hydrolyzed into smaller molecules, resulting in a sterile, alkaline material.

The liquid residue can be neutralized and disposed into the municipal sewerage system or used as a fertilizer.

Large-scale units are capable of processing up to 5 tons of animal byproducts every 5 to 8 hours. These units are capable of handling entire animal carcasses.

Based on a limited literature search, one company claims its alkaline hydrolysis system can process animal byproducts and convert them to a biofuel product. However, CalRecovery has not attempted to verify the validity of the claim.

6.1.7 Acid and Enzymatic Hydrolysis

Acid hydrolysis and enzymatic hydrolysis are processes that occur in dilute aqueous solutions and have a number of similar design and operating features. Thus, they are described together in this subsection. The use of hydrolysis to break down complex carbohydrates and cellulose into simple sugars for their subsequent conversion to ethanol has been known for many years. Several types of solid waste feedstocks are rich in complex carbohydrates, cellulose, or both (including food waste, wastepaper, waste wood, and crop residues), and thus have been used sporadically over the years to produce ethanol. Currently, due to several reasons, there is substantial development and operation of systems to convert crop residues to ethanol using hydrolysis with subsequent fermentation of the intermediate products of the reaction to ethanol.

The hydrolysis step of the process can be performed using an acid or enzymes to decompose the carbohydrate and cellulosic materials. Acid hydrolysis, as the name implies, is a chemical process that uses a chemical (acid) to break down the carbonaceous materials into their simpler constituents. On the other hand, enzymatic hydrolysis is primarily a biological process, and it employs enzymes for the purpose of decomposing the feed materials into simpler constituents for conversion to ethanol. In the case of waste feedstocks, both types of hydrolysis typically require a finely sized feedstock to optimize the decomposition and conversion processes.

Key process control variables for the hydrolysis and fermentation reactions are: particle size of the feedstock, operating temperature and pressure, reaction time, and type and concentration of reactants.

6.2 Analysis of Processing Options

6.2.1 Selecting a Shortlist of Candidate Processes

The treatment processes described in the previous section have potential application to processing animal byproducts due to one or more reasons. CalRecovery analyzed these technologies, considering several factors and process characteristics for selecting (shortlisting) 3 or 4 processes for more detailed analysis in this section. Some of the factors are tabulated for each of the technologies in Table 7.

As part of the analysis, CalRecovery investigated approved methods used in the European Union (EU) for treating and processing animal byproducts, since the EU has been severely impacted by the spread of BSE and exploring effective means for byproduct disposal, and has studied this problem in detail over the past several years. The EU regulations are very detailed and complex with regard to categorizing and characterizing animal byproducts, and with regard to defining acceptable processing methods and technologies, required operating conditions, and process testing and monitoring requirements. A summary of the types and characteristics of animal byproducts regulated in the EU is given in Appendix B. Processing requirements include required processing temperatures and residence times, particle size of feedstock, and types of reactors, depending primarily on the type/classification of animal byproducts and type of processing or treatment system. Types of processing systems include anaerobic digestion and composting after the materials have been heated to “safe” temperature levels for a given period of time.

As a result of the preliminary analysis, CalRecovery eliminated acid and enzymatic hydrolysis from further consideration, primarily for two important reasons: 1) to our knowledge, these feedstock-sensitive processes have not been used at any appreciable scale on animal byproducts; thus, there is a substantial technological risk; and 2) animal byproducts normally lack high concentrations of cellulose from which to produce ethanol. Animal byproducts are typically protein- and, therefore, nitrogen-rich. Grocery waste would have some cellulose, but it is not the emphasis of study. The plasma arc process also was withdrawn from further consideration because, to our knowledge, its operating history with waste materials in general is insufficient, and is lacking for animal byproducts.

The remaining process alternatives (namely, composting, anaerobic digestion, alkaline hydrolysis, and thermal) were retained for further consideration. Of the remaining three types of thermal processes (i.e., thermal gasification, pyrolysis, and incineration), we selected thermal gasification instead of pyrolysis for further analysis because of its more extensive operating history using solid waste materials, and since incineration of waste in Oregon would likely be a more sensitive and controversial subject than thermal gasification. However, of the thermal processes described in this section, incineration of solid waste has the longest operating history and probably the greatest flexibility to treat a variety of animal byproducts.

Table 7
Preliminary Technology/Process Evaluation Factors

Technology	**Feedstock Versatility**	**Technol-ogy Risk**	**Process Capacity**	**Value of Products**	**Cost of Environ-mental Control**	**Footprint Area Required**	**Preprocess-ing Required**	**Effects of Contamina-tion on Material Handling**	**Pathogen Control Capability (using Time/ Temp as basis)**	**Capital and Operating Cost**
Composting	M	L	M to H	L, compost	L to M	H	M	M	M	L to M
Anaerobic digestion	M	L	M to H	M, medium Btu gas	M	H	M	M	M	M to H
Thermal gasification/ pyrolysis	H	M to H	M to H	M, low Btu gas	M to H	L	M	L	H	H
Plasma arc	H	H	L to M	H, medium Btu gas	M to H	L	M	L	H	H
Direct combustion (incineration)	H	L to M	M to H	H, electricity/heat	M to H	L	L	L	H	H
Alkaline hydrolysis	H	L	L	L, biofuel and fertilizer	M to H	M	M	M	H	H
Acid hydrolysis	L	H	L to M	M to H, ethanol	M to H	H	M	H	M	H
Enzymatic hydrolysis	L	H	L	M to H, ethanol	M to H	H	M	H	L	H

Legend: L = low, M = medium, H = High

6.3 Analysis of Shortlisted Processes

The Oregon Solutions Team provided four criteria for evaluating the technology feasibility for this project. The criteria are: economically viable, proven technology, environmentally benign, and stakeholder support. The full description of the criteria is given in Appendix C.

The Oregon Solutions Team did not specify the priority ranking of each of the evaluation criteria. However, as a result of its analysis, CalRecovery believes that the most important criterion of the four at this point in time is “proven technology.” The primary reasons for this rationale are based on the characteristics of animal byproducts and their potential for causing adverse environmental and health impacts and the fact that the processing method ultimately selected for implementation must provide basic occupational and public heath and safety protection. This need would be met by proper design and operation of the processing technology.

With the introduction presented in the previous paragraphs, CalRecovery rates each of the four candidate processes below in terms of feasibility, considering application of the four evaluation criteria. For the purposes of this report, a technology is “Conditionally Feasible” with regard to the four governing criteria if certain conditions must be satisfied or resolved prior to implementation of the technology, as described below. A technology is “Feasible” with regard to the four governing criteria if no substantial conditions have been identified that would adversely affect implementation.

6.3.1 Composting — Conditionally Feasible

Since composting is a relatively “low” temperature process, the need exists to ensure adequate processing temperature and time for pathogen reduction/destruction if the compost product is destined for use on crops that would be consumed by humans. Methods of minimization of risks to occupational and public health could include remote or centralized composting of animal byproducts, processing of only byproducts that are devoid of or containing insignificant concentrations of pathogens or potential pathogens, and compost use for growing crops not intended for human consumption. More information on adequate processing conditions and survival of pathogens is needed to support the feasibility of composting animal byproducts. Only very few studies in the United States have investigated composting of animal byproducts and pathogen survival. Markets and uses of compost derived from waste containing animal byproducts would have to be investigated in order to demonstrate their economic feasibility as a salable product. The cost of composting as a processing method is relatively low in comparison to the other alternatives analyzed here, unless an enclosed reactor would be required for environmental and/or public health reasons.

6.3.2 Anaerobic Digestion — Conditionally Feasible

The results of the analysis for anaerobic digestion (AD) are very similar to those for composting. A primary reason is that, like composting, AD is a biological process characterized by relatively low operating temperatures. AD has an advantage over composting in that the biogas produced typically would have a higher economic value than compost. However, for a given feedstock, the cost of AD is substantially higher than that of composting, although if a fully enclosed composting technology is required for environmental and/or public health reasons, the cost of composting approaches that of AD.

6.3.3 Thermal Gasification — Conditionally Feasible

This process operates at very high temperatures and conceivably could process animal byproducts and render the solid residue nonpathogenic. Commercial use of gasification for processing solid waste has some limited operating history in the United States. Thermal gasification of animal byproducts would have technical challenges associated with the high moisture content of the waste. The costs of gasification could be expected to be high, although the syngas generated by the processing system could be a moderately valuable marketable product, depending on the local situation.

6.3.4 Alkaline Hydrolysis — Feasible

This technology operates at processing conditions that render animal byproducts nonpathogenic. The technology has an operating history for treating animal byproducts; however, processing rates are relatively low. Consequently, scaling up to accommodate higher processing rates would represent some, as yet unknown, technical risk at this point in time, which could translate to greater financial risk for larger-scale alkaline hydrolysis operations. The alternative to meet a relatively "large capacity" would be to operate several units in parallel. The use of this technology to produce energy products (e.g., biofuel) appears to be limited at this time.

6.3.5 Requirements for Feasibility

A summary of the key requirements to increase the feasibility of the three conditionally feasible technologies to feasible is presented in Table 8.

Table 8
Key Requirements to Increase the Feasibility of the Conditionally Feasible Technologies to Feasible

Technology	Key Requirements for Feasibility
Composting	Proven pathogen reduction/destruction and/or use of remote/enclosed facilities; processing of animal byproducts that are devoid of recalcitrant pathogens; proven safety of compost end product
Anaerobic digestion	Proven pathogen reduction/destruction and/or use of remote/enclosed facilities; processing of animal byproducts that are devoid of recalcitrant pathogens; proven safety of digestion residue or of compost end product, if composting is employed
Thermal gasification	Proven capacity to successfully process animal byproducts, which typically have a very high moisture content

6.4 Issues and Considerations

CalRecovery evaluated a variety of processing technologies using general evaluation criteria. Alternatives for safely processing animal byproducts are few, although there are several processes commonly used in the solid waste processing industry that could be feasible, given time to develop. As a result of CalRecovery's evaluation, composting, anaerobic digestion, and thermal gasification are rated conditionally feasible as candidates for processing animal byproducts. Alkaline hydrolysis is rated feasible based primarily on its history of use for processing animal byproducts, although at relatively low processing rates. Each of the four technologies identified as feasible or conditionally feasible could technically be employed to treat small or large daily quantities of animal byproducts. If anaerobic digestion or thermal gasification were employed to produce electric power as a source of revenue or for offsetting on-site electric demand, the economies of scale in most cases would substantially favor large capacity processing, all other conditions being equal.

As a result of our analysis, there is additional information that is needed to further evaluate animal byproduct technology for feasibility of application in Oregon, including:

- **Detailed characterization of the sources, locations, quantities, and properties of animal byproducts generated in Oregon.** The appropriateness, suitability, and performance of alternative processing methods are dependent to a large degree on the characteristics of the feedstock. The characterization of byproducts needs to include types, concentrations, and viability of pathogens in the wastes. This information is needed so that processes can be designed to reduce pathogen concentrations to safe levels. Federal regulations (40 CFR Part 503) describe processes to reduce pathogen content in municipal wastewater treatment sludges (biosolids) to acceptable levels and have been referenced in some cases as justification for use of the processes to safely treat other types of organic wastes. The processes include composting. However, the performance of these processes to reduce pathogens when processing non-biosolids materials, such as animal byproducts, has not been field tested and evaluated extensively.
- **Identification and analysis of Federal, State of Oregon, and local regulations that are, or are potentially, applicable to the management and processing of animal byproducts.** From the standpoint of a facility designer and operator of animal byproduct processes, the regulatory situation and requirements for these types of processes appears to be poorly defined; thus, acting as a disincentive for process development.
- **Little data and information are available with regard to yield and quality of energy products that could be generated from specific types of animal byproducts using the processing technologies considered in this evaluation.** Engineering data (e.g., waste characteristics and process operating conditions) are needed in order to accurately evaluate process feasibility.

Section 7
Demand and Economic Significance of Primary Products Derived from Processing Animal Byproducts

This section summarizes the product characteristics required, commercial market conditions and prospects for commercial transactions and viability for products produced from the technologies identified as feasible and conditionally feasible in the preceding section.

7.1 Animal-Based Compost

Analysis by CalRecovery indicates that composting is a conditionally feasible technology. Compost is a beneficial soil amendment product that results from the composting of organic matter.

7.1.1 Product Characteristics Required

One of the major conclusions of this analysis is that compost made from animal mortality and meat byproducts needs thorough testing to determine if pathogens will be reduced to safe levels. In particular, there is uncertainly about the presence of prions. Conclusive test results are needed that can give commercial users assurance about the absence of pathogen survival with particular regard to prions. Until more is known, usage of this compost is likely to be "pre-commercial" and markets will be limited or non-existent.

Due to the presence of many other feedstock sources for compost, it would be advisable to establish recommended guidelines for key product processing parameters. The intent is to increase confidence that compost manufacturers have consistent quality compost that not only meets pathogen safety standards but also will have the needed product characteristics most desired by buyers.

For example, how would compost with animal byproducts be processed to have superior water-holding capacity compared to current compost products sold in Oregon? Also what processing guidelines should be followed in order for this compost to have beneficial characteristics regarding the uptake of heavy metals? Compost industry members and government agencies can facilitate market acceptance of this specialty compost by addressing these types of key product characteristics.

7.1.2 Commercial Market Conditions

Strong interest has been expressed by Oregon farmers and others to produce animal byproduct compost. The supply side of the market is far more advanced than the demand side, which is quite unknown: there is no animal mortality compost produced and marketed in Oregon.

The future of the market for this compost depends on the ability of compost producers to assure regulatory agencies and the public that they are able to consistently offer products that are safe and effective. The market outlook also rests with the demand side where buyers can objectively evaluate the characteristics of all available soil amendment products and their relative prices.

7.1.3 Prospects for Commercial Transactions

Some observers in the compost industry believe that land application where there is no food crop production for human consumption is the first logical way to utilize this product. This may be acceptable for the generator of the animal mortality or meat processing byproduct, even if there is no revenue recovered, because costs may be lower with this method than the next best alternative. The Cornell Waste Management Institute indicates that the compost can be used on hay, corn, winter wheat, tree plantations, and forestland; however, it is also currently recommended to avoid applying to crops directly consumed by humans.[56]

Other observers believe that public agencies such as Oregon Department of Transportation are the initial prospective buyers. While there is a basis for investigating this market channel, compost testing and documentation of product performance are of paramount importance to establish sales with the agencies.

Ultimately there is promise for establishing conventional sales for compost with the general public. However, product testing and positive pre-commercial experience with this type of product must be gained first.

7.2 Biogas

7.2.1 Product Specifications or Characteristics Required

For this discussion, biogas includes medium-Btu and low-Btu fuel gas generated by anaerobic digestion and thermal gasification processes, respectively, using animal byproducts as feedstock. Biogas also contains other ingredients, such as CO_2, that have commercial applications. Anaerobic digestion is identified as a conditionally feasible technology.

There is much more information available about uses for medium-Btu biogas produced by anaerobic digestion than for low-Btu "syngas" produced by thermal gasification or pyrolysis. The lower the thermal quality of the gas, and the higher the levels of impurities, the less suitable it is for running combustion electricity generators. Scrubbing of the gas to remove impurities or

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[56] Gamroth, Mike, "Disposal of Animal Mortality and Byproducts," Oregon State University Extension Service, updated September 2006.

increase energy quality is possible but expensive. However, on-site burning as a heat source appears to be feasible with either medium or low-Btu gas.

Currently, the primary use for medium-Btu biogas is as fuel for producing on-site heat directly, or on-site electricity and co-generated heat using engine-powered generators. There are an increasing number of small- and medium-sized biogas generators associated with municipal wastewater systems and dairies in the state. These facilities generally use biogas to heat their digesters and/or generate electricity for on-site use, thereby replacing a portion of their commercial energy consumption. A number of facilities are also selling generated electricity to the grid. While this option is generally better suited to larger-scale producers, such as landfills, standard power purchase agreements are available for certified small producers under 10 MW in capacity. These agreements offer the certainty of setting the price and average quantity for electricity purchases up to 20 years into the future, and include credit for the utility's avoided costs.

Examples exist in other states of biogas being transported via pipeline for off-site use.[57] These necessarily involve large capacity landfills with scrubbers and other processing to produce pipeline-quality gas. Examples of landfills processing and selling LNG made from biogas are rare, and there are apparently few companies that manufacture the landfill gas-to-LNG conversion technology.

7.2.2 Commercial Market Conditions

Size of Markets and Frequency of Exchange

It reportedly takes a medium- to large-scale project to be able to economically sell energy produced using biogas. Connection to the grid can be costly, and it is easier to spread these and other capital costs over a larger scale project. Examples of facilities transacting energy produced from biogas tend to be landfills, larger municipal wastewater treatment plants, and large dairies. However, market transactions of electricity appear to be increasing in number and frequency under standard power purchase agreements.

Number of Buyers and Sellers

The number of actors in the market for biogas is increasing. There are at least three landfills located within 200 miles of Portland that are currently equipped to sell electricity produced from on-site biogas. Several area wastewater facilities generate biogas, but generally tend to use it for on-site heat and electricity use rather than selling electricity to the grid. Of the two animal manure biogas generating facilities, both are equipped to sell power to the grid, but only one currently does largely due to the low price received for electricity sold to the grid. Both animal manure digester projects are reported to be unable to make a profit at current electricity prices, especially if capital costs are included.

Scale is apparently a major issue as it seems to take a medium-to-large size facility to be an economic producer of energy. Extensive capital inputs are required to collect biogas, generate electricity, and supply the power to the grid. Costs of electrical transmission infrastructure can

[57] Personal communication with Dan Spitzer, Hodgson Russ LLP.

be considerable, especially in remote areas. Pipelines to transport biogas offsite are also expensive capital improvements. These cost factors will tend to limit the number of sellers in the market.

The main buyers are the facilities themselves, who consume energy produced on-site in lieu of commercial energy supplies; energy utilities purchasing electricity; and, in very limited cases, off-site industrial plants that use large amounts of energy. Municipalities and private-sector companies that maintain medium- and heavy-duty vehicles (buses, trash collection, postal service, etc.) represent other potential markets for refined biogas. These buyers exist in most communities but are relatively fixed in number.

Drivers of Future Supply and Demand

The chief drivers of future supply and demand for biogas are continuing development of cost-effective biogas-using technology, the long-term price forecast for natural gas, and the long-term forecasts for competitive energy sources such as oil and coal. (However, coal has additional disadvantages in being relatively dirty and carbon-intensive.) Comparatively flat forecasts for natural gas prices in the medium-to-long term future seem to argue against rapid technological advance or increases in supply and demand for biogas. It is likely that almost all successful projects will be 500kW or larger, predominantly municipal waste treatment plants, landfills, and a few large dairies. Smaller projects will have a tough time being economically viable. However, new regulations on manure management could change this. If the new regulations mandate significant investment in manure management systems, then the incremental cost to add biogas generation may become more manageable.[58]

Expanding public interest in the use of energy from renewable sources, including direct support in the form of partnerships (such as the power purchase agreement contracts mentioned above), government subsidies, and tax credits will help keep development of biogas technology moving forward in the foreseeable future. New energy supplies established in the future will be overwhelmingly from renewable sources under the Renewable Energy Standards of Senate Bill 838. A description of relevant programs and potential sources of support and financial assistance for renewable energy projects is presented in Appendix D.

7.2.3 Prospects for Commercial Transactions and Viability

There is little evidence of facilities using biogas to produce non-energy CO_2 or other chemicals for market. Available technology for converting biogas into methanol and ethanol is limited and not currently cost effective.[59]

Production of salable energy outputs from biogas digestion is possible with existing gas collection systems. While available subsidies and assistance programs will help to improve the financial outlook of biogas projects, only landfills, municipal wastewater treatment plants, and relatively large dairies are likely to be viable as biogas energy producers due to the capacity requirements and capital costs. However, given the current price forecasts for fuel and

58 Personal communication with Joe Barra, PGE.

59 U.S. Climate Change Technology Program: Technology Options for the Near and Long Term, http://www.climatetechnology.gov/library/2005/tech-options/tor2005-412.pdf

electricity, even these facilities will have difficulty being financially viable in the near- to medium-term future without at least current or increased levels of subsidization, including tax credits.

Wastewater facilities already take in limited amounts of “animal waste” through the sewer (typically the waste comes down through a garbage grinder in a sink). Clackamas County reports having had meat packing companies, dairies, and chicken hatcheries connected to their system. Clackamas County is planning on building a new digester in the next several years. Sizing for additional waste streams is clearly a possibility given the right environment and incentives.[60]

At the county level, concerns about taking animal carcasses fall in three general categories: 1) regulatory environment, 2) the impact of non-digestible solids on biosolids produced and distributed to farmers, and 3) economic feasibility. There is growing awareness of the need for an animal byproducts processing/disposal facility in the area, and there have been limited discussions among wastewater treatment facilities regarding the potential to develop a “regional” food waste-to-energy program, which could probably include animal byproducts.

Involvement of a variety of partners, including agriculture, METRO regional government, and wastewater utilities, would improve prospects for feasibility.[61] Consolidating facilities and input streams, such as the recent discussions with a large composting firm reported by the Port of Tillamook, may point to a way forward, at least for certain areas in the state. Integrating collection of animal carcasses with municipal wastewater, food waste and animal manure for production of compost and biogas may provide sufficient economies of scale and range of products to become commercially feasible.

7.3 Hydrolyzate

7.3.1 Product Specifications or Characteristics Required

Hydrolyzate is produced by alkaline hydrolysis using animal byproducts as feedstock. Alkaline hydrolysis was identified in this document as feasible technology. There is evidence that the hydrolyzate can be used as fertilizer, and as a feedstock for biogas generation or biodiesel refinement. However little is currently known about the suitability of hydrolyzate for these and other uses.

7.3.2 Commercial Market Conditions

Size of Markets and Frequency of Exchange

Current markets for hydrolyzate are unknown, but assumed to be small and undeveloped. There is little evidence of commercial transactions involving hydrolyzate. A facility in Ames, Iowa employs three methods for disposal of hydrolyzate, including soil application as fertilizer, but no

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60 Personal communication with Ted Kyle, Clackamas County WES.

61 Personal communication with Guy Graham, City of Gresham, Department of Environmental Services.

marketing of byproducts.[62] Other reported uses include application as an accelerant for combusting biomass material, and possibly as a feedstock for producing biodiesel, but these reports have not been verified.

Number of Buyers and Sellers

There are reportedly around fifteen to twenty alkaline hydrolysis digesters in operation in the country. Of these, the number of sellers in commercial markets for hydrolyzate is unknown, but assumed to be relatively few. The number of buyers in the market for hydrolyzate is unknown but assumed to be very small.

Drivers of Future Supply and Demand

As one of the only methods currently recognized as effective for neutralizing prions, the volume of hydrolyzate from alkaline hydrolysis processes is expected to increase, along with concurrent research into alternative uses of the hydrolyzate.

7.3.3 Prospects for Commercial Transactions and Viability

Marketing prospects for hydrolyzate are uncertain but currently appear quite low. Development of processes to turn hydrolyzate into biofuels will increase commercial viability, but these are still some ways off. Disposal of sterile hydrolyzed byproducts may be an effective cost reduction strategy compared with landfilling of carcasses, incineration, or other methods of disposal. However, there is a need to research the feasibility of using existing landfills and sewage systems to dispose of hydrolyzate. There is reportedly only one landfill in the state currently able to accept liquids not otherwise generated at the landfill.[63]

There may also be a role for a certified alkaline hydrolysis digester in the region to deal with animal material potentially infected with prions. Such a facility could charge a standard rate for disposing of "normal" carcasses and byproducts, and be available to charge premium rates for disposal of potentially infected materials from Oregon and neighboring states.

62 Carcass Processing and Disposal Facility Information Card, National Veterinary Services Laboratories, Ames IA. http://www.aphis.usda.gov/vs/nvsl

63 Personal communication with Lissa Druback, Oregon DEQ, August 1, 2007.

Section 8
Conclusions and Recommendations

8.1 Primary Conclusions

The technology assessment and market analysis presented in this report led the study team to develop a series of conclusions. They are summarized below:

1. Loss of rendering plants has left fewer options available to many Oregon businesses that used them, and additional expense incurred.
    a. Geographically, businesses engaged in ranching and dairying, hogs, or other livestock, and meat packers and butchers in Central and Southern Oregon are most directly affected.
    b. Many meat packers and wholesale processors, statewide, report increases of 33 to 50 percent in animal byproduct disposal costs during the past year.
    c. Rendering continues to be a major method of disposal in Oregon, but it is accomplished by transporting to out-of-state processing plants. For some, the out-of-state processors have always represented the best (least-cost) alternatives for disposal.
    d. Many generators of mortality and animal byproducts believe transporting wastes long distances to out-of-state renderers is not sustainable as fuel costs continue to rise.

2. The study team estimates that about 91.7 million lbs. of animal byproducts are generated annually in Oregon.
    a. Nearly half (49 percent) is offal (processed meat byproduct), about a third (34 percent) is animal mortalities, and the remainder (17 percent) is grocery scrap and trim.
    b. The total volume of byproducts generated does not represent the amount that is available or disposed. A substantial share of the beef cattle (and to a lesser extent, other livestock) includes range animals that are not retrieved and are left to natural processes.
    c. The future supply of animal byproducts is expected to increase by four to seven percent within the next five years, depending upon source and type.

3. Landfill disposal of animal mortality is currently allowed at some 13 landfills throughout Oregon. DEQ, the Oregon Solutions Team, and indeed most landfill operators, view landfill disposal of animal mortalities as only a short term option.
    a. Two large landfills (Columbia Ridge in Arlington and Coffin Butte near Corvallis) have several years remaining on their permits for accepting animal byproducts. The

landfills represent the least cost disposal option for many who require animal byproduct disposal.

   b. To the extent that landfills remain affordable and available to accept animal byproducts, they will continue to attract these materials. This option will hinder to some extent the development of new markets for potential products by effectively "bidding away" supplies of animal byproduct source material.

4. The study team considered seven generic types of processing options for animal byproducts: composting, anaerobic digestion, thermal gasification and pyrolysis, direct combustion (incineration), plasma arc, alkaline hydrolysis, and acid and enzymatic hydrolysis.
   a. Four of the seven processes (composting, anaerobic digestion, alkaline hydrolysis, and thermal gasification) met certain technical factors and characteristics to be considered for further analysis during the study. Among the factors were technological risk, health and safety, and feedstock versatility.
   b. Screening criteria supplied by the Oregon Solutions Team were applied to the four processes selected for further analysis. Composting, anaerobic digestion, and thermal gasification were found to be "conditionally feasible," and alkaline hydrolysis was found to be "feasible."

5. The four processes from the technical analysis were subjected to more detailed analysis of market potential. These products are discussed below.
   a. <u>Compost</u>: Oregon has a modest, but growing market for compost generated from organic materials. There is strong interest among farmers for generating compost from animal mortalities. However, there are significant barriers to composting of animal byproducts (ABP) and to the commercial use and public acceptance of compost derived from ABP:
      i. It is uncertain whether composting processes will reduce pathogens to safe levels, particularly prions responsible for BSE. Safe design and operating conditions for ABP composting should be established.
      ii. The market for compost in general is modest in size relative to potential supplies of organic materials, and animal-based sources of compost will not compete well in the near future.
      iii. Composting of ABP has the potential to be a relatively low cost means of treating animal byproducts. However, the design and operating conditions of the facilities should reflect local conditions, including the characteristics of ABP, magnitude (size) of processing operation, and proximity of natural resources and humans to the operations.
   b. <u>Gaseous Fuels (biogas or syngas)</u>: Anaerobic digestion and thermal gasification can yield medium- and low-Btu fuel gas, respectively, from animal byproduct feedstocks. The fuel gas is often used in on-site electricity generation or cogeneration applications. The market for these alternative types of fuel gas is small but increasing, and its closest competitor is high-Btu natural gas.
      i. Comparatively flat forecasts for natural gas prices in the medium-to-long term future probably argue against rapid technological advance or increases in supply and demand for fuel gases generated from waste materials. However, an expanding interest in this country to use energy from renewable sources,

including government subsidies and tax credits, should improve the prospects for alternative fuel gas markets in the future.

c. Hydrolyzate: Alkaline hydrolysis of animal byproducts will yield hydrolyzate but of uncertain quality. There is evidence that the hydrolyzate can be used as a fertilizer and as a feedstock for biogas generation or biodiesel refinement. The market is in its infancy, although development of processes to turn hydrolyzate into biofuels should increase commercial viability in the future.

8.2 Recommendations

The study team has developed a set of recommendations for consideration by the Oregon Solutions Team, including possible candidates for a Phase II analysis. They include:

1. Perform a detailed characterization and analysis of the sources, locations, quantities, and properties of animal byproducts generated in Oregon.
2. Conduct an analysis of federal, state, and local regulations that are, or are potentially, applicable to the management and processing of animal byproducts.
3. Develop engineering field trials and develop data regarding technical and economic performance, environmental protection, and yield and quality of energy products that could be generated from specific types of animal byproducts using the processing technologies considered in this evaluation.
4. Review DEQ policies associated with landfill disposal of animal byproducts, to ensure that landfills truly operate as a short term solution, while still providing a "last resort" option for suppliers. Policy changes placing limits on landfill disposal should be tied to finding or, if necessary, seek public or private sector financial support for affordable alternatives.
5. The State of Oregon, in coordination with local governments, should consider the viability of establishing refrigerated transfer stations at strategic locations. Central and Southern Oregon locations would be among the highest priorities, as they have been most directly affected by the closure of the rendering facilities.
6. Research institutions and the public sector should continue to investigate and develop technical solutions for animal byproduct disposal, including but not limited to, the physical and chemical properties of compost and the output of other processes, and analysis of product markets.
7. The State should consider opportunities for involvement with the private sector, including both siting and financial assistance, for a new animal byproducts processing facility that could (1) serve meat processors and farmers with a viable and affordable disposal option, and (2) be a research and technology development center for production of alternative, renewable fuels.

Appendices

Appendix A

Data Description for Animal Mortalities in Table 1

Table 1 presents mortality estimates for five regions in Oregon. Following are the counties for each region:

- Northwest Region: Benton, Clackamas, Clatsop, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington and Yamhill.
- Southwest Region: Coos, Curry, Douglas, Jackson, and Josephine.
- North Central Region: Gilliam, Hood River, Morrow, Sherman, Wasco and Wheeler.
- South Central: Crook, Deschutes, Jefferson, Klamath and Lake.
- Eastern Region: Baker, Grant, Harney, Malheur, Union, Umatilla and Wallowa.

Mortality is based on the average annual death rate for each animal group in the table. Dead rates are determined from discussions with livestock operators and veterinarians and they are considered industry averages. These rates vary among the livestock species for a number of reasons. The following dead rates were used: beef cattle: 2.0%, dairy cows: 4.0%, other cattle & calves: 2.0 %, sheep: 5.0%, hogs: 6.0%, and horses: 3.5%.

Appendix B

Classification of Animal Byproducts Regulated in the European Union (EU)

The legislation classifies animal byproducts into three categories: Categories 1, 2, and 3. Brief descriptions of each category are provided in the following sections.

Category 1 Material

Category 1 material includes the following animal byproducts:

- entire bodies and all body parts, including hides and skins, of animals known to be infected or suspected of being infected by a transmissible spongiform encephalopathy (TSE), animals killed in the context of TSE eradication measures, as well as pets, zoo and circus animals, animals used in experimental work, and wild animals suspected of being infected with a communicable disease;
- specified risk material such as tissue with the potential of carrying an infectious agent;
- products derived from animals that have absorbed prohibited substances or substances that contain products which are dangerous to the environment;
- all animal material collected in the process of treating wastewater from processing plants dealing with Category 1 material and other premises in which specified risk material is removed;
- food residuals from means of transport which are operating internationally;
- mixtures of Category 1 with Category 2 and/or Category 3 material.

Intermediate storage and handling of Category 1 material should be conducted in approved intermediate establishments specifically for the same category. The materials must be collected, transported, and identified as soon as possible. This material shall be:

1. disposed directly as waste by incineration in an approved incineration plant;
2. processed in an approved facility by a specific method, in which case the resulting material shall be marked and finally disposed as waste by incineration or co-incineration;
3. processed by a specific method in an approved plant, in which case the resultant material shall be marked and finally disposed as waste by means of burial in an approved landfill, material originating from carcasses of animals infected (or suspected of being infected) with a TSE are excluded;
4. in the case of food residuals, disposed by burial in a landfill.

Category 2 Material

Category 2 material consists of the following animal byproducts:

- manure and contents of the digestive tract;
- all animal materials other than those belonging to Category 1 that are collected in the process of treating wastewater from slaughterhouses;
- products of animal origin containing residues of veterinary drugs and contaminants in concentrations which exceed the EU limits;
- products of animal origin, other than Category 1 material, that are imported from third countries and fail to comply with the EU veterinary requirements;
- animals other than Category 1 that have not been slaughtered for human consumption;
- mixtures of Category 2 and Category 3 material.

With the exception of manures, the intermediate handling and storage of Category 2 material must take place in approved intermediate establishments of the same category. Collected, transported, and identified as soon as possible, this material must be:

1. disposed directly, as waste, by incineration in an approved incineration plant;
2. processed in an approved processing facility by a specific method, in which case the resultant material or residue shall be marked and finally disposed as waste;
3. in the case of material derived from fish ensiled or composted;
4. in the case of manure, digestive tract content, milk and colostrum not posing any risk of spreading a communicable disease, either 1) used without processing as raw material in a biogas or composting plant or treated in a technical plant, or 2) applied to land;
5. used in a technical facility to produce game trophies.

Category 3 Material

Category 3 material consists of the following animal byproducts:

- parts of animals that have been slaughtered which are fit for human consumption but due to commercial reasons are not intended for human consumption;
- portions of slaughtered animals that are rejected as unfit for human consumption but are not affected by any sign of a communicable disease;
- hides and skins, hooves and horns, pig bristles and feathers originating from animals that are slaughtered in a slaughterhouse and were declared fit for human consumption after undergoing an ante mortem inspection;
- blood obtained from animals declared fit for human consumption after undergoing an ante mortem inspection, other than ruminants slaughtered in a slaughterhouse;

- animal byproducts derived from the production of products intended for human consumption, including degreased bones and greaves;
- former foodstuffs of animal origin, other than food residuals, which are no longer intended for human consumption for commercial reasons or due to problems of manufacturing or packaging defects;
- raw milk originating from animals that do not show any signs of a communicable disease;
- fish or other sea animals, except sea mammals, caught in the open sea for the purpose of fishmeal production, and fresh byproducts from fish from plants manufacturing fish products for human consumption;
- shells of eggs originating from animals that do not show any signs of a communicable disease;
- blood, hides and skins, hooves, feathers, wool, horns, hair, and fur originating from healthy animals;
- food residuals other than those classified as Category 1.

Intermediate handling and storage of Category 3 material must take place in approved intermediate establishments of the same category. Collected, transported, and identified as soon as possible, this material must be:

1. disposed directly as waste by incineration in an approved incineration plant;
2. used as raw material in a plant processing pet food;
3. processed by a specific method in an approved processing, technical, biogas or composting plant;
4. composted or processed in a biogas plant in the case of Category 3 food residual; ensiled or composted in the case of raw material of fish origin.

Appendix C

Technology Evaluation Criteria

The Oregon Department of Agriculture (ODA) provided the following evaluation criteria for the project. Text shown in italics is interpretations that have met with ODA approval.

Economically viable: The processing of the waste stream must produce salable products that are in demand at a price necessary to generate a profit. Examples might include ash, charcoal, biogas, electricity (PGE and Pacific Power), fertilizer, soil amendment, glycerin, meat and bone meal, and/or heat. The business model must provide a satisfactory return on investment (ROI) for the entrepreneur. *If the market price for salable products is too low to generate a profit, consideration should be given to trends or other conditions that may lead to higher market prices in the near future (one to five years) and the potential for profitability.*

The cost of getting these products to market cannot reduce the profitability of the business model. Moreover, the price producers must pay to use the service cannot be prohibitive and should be in line with, or less than, current alternatives such as disposing of the material in landfills. *(Note landfill disposal is considered a temporary solution, and its cost should not be considered a threshold for products.)* The business model should be capable of gaining state support.

Proven technology: The process identified must make use of a commercially available technologies and components. The supplier must be able to guarantee and service the equipment. The application used must rely on science-based principles. The process must conform to all current regulations and demonstrate a history of applied success. Suppliers must warrantee the equipment and process. “Experimental” technologies and equipment are not acceptable. The process must be able to gain bank financing.

Environmentally benign: Both the production process and the products produced must not harm the environment. The goal is to design a process that generates byproducts beneficial for the environment by converting a waste stream into useful materials or products.

Stakeholder support: The solution must take both public and private sensibilities into account.

Appendix D

Relevant Assistance Programs for Alternative Energy Development

Several types of financial assistance are available for alternative energy projects. Below are the primary state, federal and non-government programs identified that may be relevant to alternative energy projects in Oregon.

Oregon Business Energy Tax Credit (http://oregon.gov/energy/cons/bus/betc.shtml)

The Oregon Business Energy Tax Credit (BETC) is an income tax credit calculated as 35% of the eligible project costs - the incremental cost of the system or equipment that go beyond standard practice. The credit is generally claimed over five years: 10% in the first and second years and 5% in years three through five thereafter, with a carryover of unused credit up to eight years. For projects with eligible costs of $20,000 or less the entire credit amount (35%) may be claimed in a single year.

Businesses, non-profit organizations, schools, tribes and public entities with no income tax liability, or businesses that choose not to use their credit, can transfer (pass through) its tax credit eligibility to a taxable third party in exchange for a lump sum cash payment. The pass through rate for five-year credits is currently 25.5% of eligible project costs, and the rate for one-year credits is 30.5%.

The BETC is available for a range of energy-related projects and improvements, but in this context only projects related to alternative energy and, possibly, recycling technologies are applicable. All costs directly related to a project, including equipment cost, engineering and design fees, materials, supplies and installation costs are eligible. Loan fees and permit costs also may be claimed. However the cost of replacing equipment at the end of its useful life, or installing equipment that is required by codes or other government regulations is not eligible. Maintenance costs are not eligible.

Renewable Resource Projects are defined as projects that use solar, wind, hydro, geothermal or biomass to produce energy, displace energy, or reclaim energy from waste. Renewable resource projects must replace at least 10 percent of the electricity, gas, or oil used. The energy can be used on site or sold.

Recycled Material Projects are defined as projects that develop new markets for recycled materials or recycle materials not required by law. New or replacement equipment for sorting or hauling materials where the recycling is required by law is NOT eligible for the tax credit. Other examples of ineligible projects are recycling of chlorofluorocarbons and used motor oil.

Oregon Energy Loan Program (http://oregon.gov/energy/loans/selphm.shtml)

This program offers low-interest, long-term, fixed rate loans for projects in Oregon that save energy; produce energy from renewable resources such as water, wind, geothermal, solar, biomass, waste materials or waste heat; use recycled materials to create products; or use alternative fuels.

Loans can be made to individuals, businesses, schools, cities, counties, special districts, state and federal agencies, public corporations, cooperatives, tribes, and non-profits. Eligible projects must save energy, use recycled materials or alternative fuels, or produce energy from renewable resources. Biomass, waste heat, and other waste materials that can be used to produce energy, such as digester gas, are eligible. Loans vary greatly in size, from as little as $20,000 to more than $16 million. The State provided a $98,000 loan to Craven Farms of Tillamook County for its plug-flow

Currently, the interest rate for residential and commercial projects is 6.95% for a 15 year loan. Rates for very large projects are subject to the bond market. Fees also apply, including an application fee: 0.1% of the loan (maximum $2,500); underwriting fee: 0.5% of the loan (minimum $500; maximum $5,000); and loan fee: 1.0% of loan amount.

Section 319 Grants

Section 319 of the 1987 federal Clean Water Act establishes a grant program to fund innovative nonpoint source pollution management strategies. For fiscal year 2003, Oregon received $3.1 million in federal funds from EPA. The Oregon DEQ administers the grant program with a goal of addressing water quality impairments in priority areas. Although the grant money is not intended for research, it can be used to evaluate or assess the effectiveness of agricultural management practices target for water quality concerns. Funding for these types of projects has varied over the years depending on the research proposed. DEQ has funded research projects from cover crops to improved subsurface irrigation. Development and promotion of best management practices benefitting groundwater quality has been the emphasis for research projects. DEQ typically issues a request for Section 319 proposals in the fall.

Eligible agencies and organizations include: state and local governments; interstate and intrastate agencies; and public and private nonprofits and institutions.

A 40 percent nonfederal cost share of the total project costs is required. An activity that requires a National Pollutant Discharge Elimination System permit is not eligible.

Federal Programs (http://oregon.gov/energy/cons/Federal-Bus.shtml#Business)

The federal government provides business energy tax incentives for production of biofuels (biodiesel or ethanol) and biogas.

Small Ethanol Producer Tax Credit

Under current law, small ethanol producers are allowed a $0.10 per-gallon production income tax credit on up to 15 million gallons of production annually. The credit is capped at $1.5 million per year per producer.

In 2004, the Jumpstart our Business Strength (JOBS) Act, H.R. 4520, enhanced the incentive by allowing the credit to be passed through to the farmer owners of a cooperative. The legislation also allows the credit to be offset against the alternative minimum tax (AMT).

The Energy Policy Act of 2005 (H.R. 6), changed the definition of a "small ethanol producer" from 30 million gallons per year to 60 million gallons per year to reflect the changing nature of the industry. It also created a similar tax credit for small producers of agri-biodiesel.

Biodiesel VEETC Tax Credit

The American Jobs Creation Act of 2004 created the Volumetric Ethanol Excise Tax Credit (VEETC), which includes a tax credit for biodiesel. The Energy Policy Act of 2005, extended the credit through December 31, 2008, and created a similar tax credit for renewable diesel.

- The volumetric excise tax credit for Agri-Biodiesel is $1.00 per gallon. Agri-Biodiesel is defined as diesel fuel made from virgin oils derived from agricultural commodities and animal fats.
- The volumetric excise tax credit for Biodiesel remains at 50¢ per gallon. Biodiesel is defined as diesel fuel made from agricultural products and animal fats.
- The volumetric excise tax credit for Renewable Diesel is $1.00 per gallon. Renewable diesel refers to diesel fuel derived from biomass using a thermal depolymerization process.

Small Biodiesel Producer Tax Credit

The Energy Policy Act also created a new credit for small agri-biodiesel producers equal to 10 cents per gallon on the first 15 million gallons of agri-biodiesel produced at facilities with annual capacity not exceeding 60 million gallons. Historically, small ethanol producers have been allowed a similar credit. The tax credit is capped at $1.5 million per year per producer. Like the small ethanol producers' credit, the small biodiesel producer credit can be passed through to the farmer owners of a cooperative, and can be used to offset alternative minimum tax (AMT) liability. The credit sunsets December 31, 2008.

Production Tax Credit

The production tax credit (PTC) pays $0.019 per kilowatt-hour (kWh) for the first ten years of a renewable energy facility's operation. The PTC was set to expire on December 31, 2007, but it was extended for one year as part of the Tax Relief and Health Care Act of 2006 (H.R. 6408).

There are also funds available from the USDA and DOE by way of competitive grants for research and development of biomass-based products, biofuels, bioenergy and related processes. For example, the USDA's Value-Added Producer Grants (VAPGs) provide funding for feasibility studies that support renewable energy projects at farms, ranches, and dairies. VAPGs are designed for rural small businesses and agricultural producers interested in whether adding a renewable power project would make economic sense.

The Environmental Quality Incentives Program,
http://www.or.nrcs.usda.gov/programs/eqip/index.html

Administered by USDA's Natural Resources Conservation Service (NRCS), the Environmental Quality Incentives Program (EQIP) promotes agricultural production and environmental quality as compatible goals. The 2002 Farm Bill requires that 60 percent of EQIP funds be spent on animal operations. EQIP funds are distributed primarily in priority areas with serious environmental needs and resource concerns.

EQIP may provide up to 75 percent of the costs of certain conservation practices. Incentive payments may be provided for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive. However, limited resource producers and beginning farmers and ranchers may be eligible for cost-share funding up to 90 percent. The contract length is one year after the installation of the last conservation practice, up to a maximum of 10 years.

Workgroups convened by local Soil and Water Conservation Districts identify the specific resource concerns to be addressed, set priority area goals, select cost-share practices, establish ranking criteria for evaluating applications, and set their own schedule for approving applications. Applications are usually awarded based on environmental benefit and cost effectiveness.

An example of biogas recovery project that received EQIP funding is the Haubenschild Farms digester project in Minnesota. The project used EQIP funding to determine the nutrient value of the anaerobic digester end product, which is spread as fertilizer on cropland. Requirements

Landlords, operators, tenants, and nonfederal landowners involved in livestock or agricultural production are eligible for the program. Producers are ineligible for EQIP payments in any year in which their adjusted gross income exceeds $2.5 million, unless 75 percent of that income is derived from farming, ranching, or forestry.

Applications are accepted on an ongoing basis and scored by a local workgroup based on the area's ranking criteria. The application is then submitted to the state's NRCS administrator for approval. All projects are subject to local NRCS technical standards.

Regional Biomass Energy Program

The U.S. Department of Energy Regional Biomass Energy Program (RBEP) was formally established by Congress in 1983. The RBEP carries out activities related to technology transfer, infrastructure development, industry support, stakeholder relationships, technology development and demonstration, and matching available bioenergy resources to conversion technologies. With an emphasis on technologies best suited to near-term applications, its major focus is the transfer of current, reliable economic and technical information to potential biomass users.

There are five RBEP regions that carry out their missions through a network of local, state, and national government organizations, and partnerships with private industry. Each region focuses on goals that reflect the unique aspects of the geographic region:

Pacific Northwest and Alaska Regional Bioenergy Program is managed by the U.S. Department of Energy, Seattle Regional Office for the states of Alaska, Idaho, Oregon, Montana, and Washington. (U. S. Department of Energy Seattle Regional Office, 800 Fifth Avenue, Suite 3950, Seattle, WA 98104, Phone 206-553-2079, FAX 206-553-2200, E-mail: Jeffrey.James@hq.doe.gov). During the 1990s, this program provided a grant for a digester project on an 800 cow dairy in Cloverdale, Oregon. Currently, the program is focusing on bio-refinery process and development projects, so funding for anaerobic digesters is available only as part of a larger project scope.

Grants typically require a cost-share match of 50 to 75 percent of nonfederal money.

The Energy Trust of Oregon (http://www.energytrust.org)

Although not a government agency, the Energy Trust of Oregon, Inc. is a State Public Benefit Fund charged by the Oregon Public Utility Commission with investing in energy conservation and encouraging use of renewable energy resources in Oregon. Funding comes from a 1999 energy restructuring law (Senate Bill 1149), which required Oregon's two largest investor-owned utilities to collect a three percent "public purposes charge" from their customers.

The Energy Trust of Oregon's Open Solicitation Program funds renewable energy and energy efficiency projects throughout Oregon. The Trust provides grants to projects not already involved in any incentive programs. Grants pay the above-market costs for the projects, defined generally as the difference between wholesale or retail electricity prices, and the cost of electricity generated by the project. The objective is to help the state meet its Renewable Portfolio Standard (RPS) for electricity.

Projects most likely to receive funding involve new technology, old technology in new applications, quick implementation, or clever, creative approaches that have not been enacted due to lack of funding. They are evaluated based on feasibility, capacity, cost, and other factors. In some cases, Energy Trust provides funding to share the cost of feasibility studies for projects. Applications for funding are taken on an ongoing basis, and any party seeking to establish a renewable energy project within the state of Oregon may apply.

The Energy Trust also offers financial assistance to eligible participants in the writing of applications for Federal government assistance, such as USDA Value-Added Producer Grants (VAPGs) and "Section 9006" grants and loans.