Assessing the woody biomass supply chain in the Pacific Northwest and Great Lakes regions: Investigating policy as drivers of change

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Abstract

With the ever-increasing need for clean and accessible energy sources, woody biomass has long been entertained as a potential prospect. As energy markets and business operations are influenced by political decisions, it is essential to know the relationship between policy impacts on business innovation and investment decisions. This study looks at significant changes woody biomass business owners have implemented over the course of their operations, and how state and federal policies have affected those changes. A survey of 175 woody biomass business owners in the upper Midwest Lake States and Pacific Northwest was conducted in 2014 to gain insight into the bioenergy investment decisions of logging and transport businesses, utility companies, pellet and densified fuel producers, and institutional heat users. Failing to understand policy influence on business innovation risks investment in ineffective strategies and business uncertainty. The results of this study will help arm policy makers and energy professionals with knowledge about how current renewable energy policies are influencing business investment decisions along the wood-energy supply chain in hopes of more effective policy planning and implementation.

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Chapter 1 - Introduction

With the ever-increasing need for clean and accessible energy sources, woody biomass has been thought of as a potential prospect by academics, wood industry professionals, and the general public to bolster the renewable energy sector as the country looks to diversify from fossil fuels. As energy markets and business operations are influenced by political decisions, it is essential to know the relationship between policy impacts on business innovation and business investment decisions. This is what this study aims to do. This study looks at wood energy innovations business owners have implemented over the course of their operations, and how, if at all, state and federal policies affected those changes. A survey of 175 woody biomass business owners in the upper Midwest Lakes States and Pacific Northwest was conducted in 2014. The purpose was to gain insight into the decision making process of these businesses along the wood energy supply chain, which consists of four key sectors: harvest and transportation firms, utility companies, pellet and densified fuel producers, and institutional heat users. Failing to understand policy influence on business innovations risks investment in ineffective strategies and can promote business uncertainty. This research will aid and educate policy makers and businesses where changes are taking place and the impact of state and federal policy on innovation by providing a framework of where to focus future policy efforts within the wood-energy industry.

Due to rising concentrations of greenhouse gases (GHG's) such as carbon dioxide and methane, average global temperatures are expected to increase at rapid rates (IPCC 2001). The continued usage of fossil fuels for energy usage is a major source of GHG's. Total estimated energy usage in the United States is 98.32 Quads, or quadrillion British thermal units (Btu). Current biomass contributions to overall energy production in the United States equals approximately 3.9 Quads, or 1,142,977,225 bdt (bone dry ton), with woody

biomass accounting for approximately 58% of the 3.9 quadrillion Btu's of renewable energy produced in the United States (USDOE 2011). This total accounts for over 4% of the nation's primary energy consumption (DOE 2011). Biomass energy consumption increased from 184 million bdt in 2005 to 200 million bdt in 2010 (EIA 2011), indicating its growth in the renewable energy sector.

The U.S. market for heat and electricity produced by woody biomass, which generally consists of bolewood (roundwood), bark, branches, twigs, shrubs and bushes (Myneni et al. 2001), has been mired by high manufacturing costs when compared to fossil fuel production like coal and natural gas (Gan and Smith 2006). Public mentality in the past viewed wood-energy as high-maintenance and "lower-tech" than fossil fuel energy. However, with rising costs of fossil fuels, periodic episodes of fossil fuel shortages, and new and more efficient wood-energy technologies, it became evident that investments in new energy sources would be crucial. The mentality towards energy has since changed, making way for renewable and environmentally friendly energy. Due to sustainability and renewable energy popularity increasing in recent years, catapulting wood as a viable source of heat and energy, especially in areas with adequate material source supplies. In a 2009 study by Li and colleagues, wood energy was seen as having a significant advantage over fossil fuels in public perception pertaining to carbon emissions. In a study of U.S. households, Li and colleagues found that respondents claimed that investments in renewable energy such as wind, solar, and biomass will be instrumental in shaping the energy industry going forward (2009). Not only does woody biomass have a place in climate change mitigation, but it also can play a role in helping curb fuel and food shortages that are on the rise throughout the world, by minimizing land-use change. More energy produced from woody biomass could help alleviate the need for conversion of productive food-producing agricultural lands. In conjunction with land-use change and as the world population grows, so does pressure to produce

increased amounts of food from the same lands targeted for biofuels production (Pimentel et al. 2009). In the United States alone, using corn grain for ethanol increases the cost of beef, chicken, breads, milk, and eggs by 10% to 30% (Pimentel et al. 2009). This is where woody biomass, an already present and sustainable resource, could be considered as a viable replacement or compliment to other energy sources such as fossil fuels and agricultural biomass. To aid in reducing GHG emissions, foster market growth, and reduce impact of land-use change, there have been biomass policies employed by state and federal governments.

As a result of the increase in biomass energy consumption and the need for renewable energy resources, the federal and state governments have created policies with incentives and subsidies to promote renewable energy manufacturing from woody biomass (Zerbe 2006). An abundance of time and resources have been invested in stimulating biomass and bioenergy supply chains, ranging from renewable fuels mandates to a multitude of incentive programs and research and development grants. As more states seek to develop their bioeconomy, many struggle to comprehend what tactics and policies will advance and sustain their natural resources most effectively, and how to work through developing challenges (Becker 2012). However, it is understood that policy should have a prominent role in bioenergy production. A study by Conrad et al (2010) showed that more than 70% of respondents, comprised of forest owners and wood-energy facility personnel, believed that government policies such as subsidies, tax breaks, and mandates should play a larger role in setting up the competition between the forest products industry and wood-energy facilities. To that end, business owners involved in wood-energy were interviewed and questioned about state and federal renewable energy and biomass policies that may have had an influence on their investment decisions. These policies were intended to improve the competitive benefit of woody biomass energy opposed to fossil fuels (Marland and Schlamadinger 1996).

Unfortunately, limited information exists on the effect of policy influence woody biomass energy in the United States (Gan and Smith 2006). Investigating this shortcoming, state and federal policies were classified based on their function, or instrument type. These instruments range from tax credits, rules and regulations, government services such as technical service, research and development, procurement, and financial disbursements such as loans or grants. Policy instruments like these may be defined as "the set of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change" (Vedung 1998). Policies used for this study did not have to be wood-energy specific, as many general renewable energy policies include biomass as a qualifying energy source. An example would be a tax depreciation on equipment, which can apply to more than just the wood-energy industry.

1.1 Study objective

The overall objective of this project is to identify policy influence on business innovations and changes along the wood energy supply chains in the Lake States and Pacific Northwest. The overarching research question is:

How does policy drive innovation and change for businesses along the wood energy supply chain?

Sub-question 1: ***Which state and federal policy instrument(s) has stimulated the wood energy industry most effectively, and why?***

Sub-question 2: ***How can state and federal policy create synergy among sectors along the wood energy supply chain?***

Different state and federal policies were examined from business owners' perspective to assess the degree to which policies affected their investment

decisions in term of drivers of wood energy innovation and operational change at different steps in the supply chain. A better understanding of policy influence on business innovations can help lawmakers and relevant government agency employees as well as businesses make more informed decisions on biomass policy creation, implementation, and utilization. If policy makers know what policy types are spurring innovation and business investment, it will provide them critical information to create effective and efficient policies. Business interactions and attitudes regarding such policies will also aid by providing information about successful and unsuccessful polices in specific states and wood-energy sectors. Knowing what is driving innovation and ultimately the types of changes influenced by those policy interventions will have a positive and focused effect on policy towards the forest industry. As there have not been studies investigating multiple policy influence on woody biomass business behavior and innovation, this study and its findings are unique because it investigates multiple policies that form policy systems rather than investigating singular policies.

Chapter 2 - Literature Review

2.1 Wood Energy Industry History and Motivations

Wood energy institutions, facilities, and companies have existed and endured for decades. With the Middle East oil embargo and subsequent increases in prices in the 1970s, the number of wood energy facilities began to rise (Sorenson, 2008). This initially prompted the federal government, followed by state governments, to implement policies encouraging subsidies for wood energy facility construction. Many gas, coal, and fuel oil systems were converted to utilize woody biomass during this time. As the price for oil decreased in the 1990s, many wood energy systems were abandoned or converted to less expensive natural gas heating and electricity. At that time, the low price of natural gas allowed for the cost of converting back to natural gas to be swiftly reimbursed. With wood energy being a young and unpredictable market at the time, most firms had kept their natural gas systems and did not completely rely on wood for energy.

Even though the number of facilities producing heat and/or electricity from wood decreased in the 1990s, interest from large companies and utilities stimulated the industry (Sorenson, 2008). State mandates, such as Renewable Portfolio Standards (RPS), have helped drive the supply of wood energy (Fischlein and Smith, 2013). Utility companies have since studied and developed facilities to burn wood.

The increase in wood energy interest has ultimately led to a competitive market for woody biomass in wildfire reduction and prevention, fossil fuel competition, local job creation and wealth retention, as well as business opportunities for some existing business owners to become involved in wood energy (Neary and Zieroth 2007; Sorenson 2008). For example, it allowed harvest and transportation firms to supply newly designated woody biomass material (previously unused wood material such as tops and/or limbs) to facilities

for heat and/or electricity production that may have otherwise went unused. However, even with new interest in wood energy, there were still improvements that could be made to the marketplace.

To get to where the industry is today, motivations for wood energy and biomass utilization have adapted. Coal and wood were the primary sources of fuel for energy in the U.S. before the twentieth century (Cooper 1980). Cooper also revealed that during the turn of the century, increasing urbanization and the rise of oil and gas slowed the wood energy industry considerably. The slowdown of wood used for energy took place quickly between the 1940s and 1970s, but rising oil and gas costs created a dramatic increase in wood for energy utilization during the oil embargo around 1973 (Cooper 1980).

Once oil and gas prices began to decrease in the 1980s, wood used for heat and energy again started to decline. The ebb and flow of the industry created uncertainties in whether to fully invest in wood energy. Research in the wood products and energy industry became thwarted by the lack of commercial interest in wood due to lower prices of fossil fuels, although there was significant technical progress made (Simpkins 2006). During the Reagan administration, successful renewable energy tax credits were phased out. Coupled with the steep drop in fossil fuel prices, momentum in the wood energy industry drastically decelerated (Bauen et al. 1994).

In the 1990s, shifting public awareness about the role of forests as areas of biological diversity brought about updated land management approaches for the Northwestern United States (USDA USDI 1994). Regulations were imposed after the change in public perception and environmental awareness, which made it problematic for private landowners to focus exclusively on production (Monserud et al. 2004). However, natural gas remained the dominant focus of the new Clinton administration, as it was viewed as an environmentally friendly solution to coal production (Simpkins 2006). Even though natural gas garnered more focus from energy policies and commercial firms, the Clinton administration

did attempt to foster biomass energy. Building on the Energy Policy Act (EPAct) of 1992, the administration enacted executive order 13134 in 1999 to place more emphasis on bio-based products and biofuels (Simpkins 2006). The main benefits from the expansion of EPAct to include bioenergy were increased research surrounding the biomass field, an extension of EPAct's 1.5-cent/kWh tax credit for electricity produced from biomass, and a 1-cent/kWh tax credit towards electricity produced from co-firing plants (Block 1999). Even with these incentives, the level of funding was inadequate, and the industry stayed relatively flat (Simpkins 2006).

Wood utilization research has expanded since the 1990s, as human influence has amplified resource management objective differences on public and private lands in the western United States (Monserud et al. 2003). Timber production is no longer the primary objective on neither private nor public lands, as most property owners sought information that showed how management techniques for timber can improve or degrade other forest outputs, such as healthy biota (Monserud et al. 2004). In addition, new forest bioenergy opportunities arose as a result of wildfire awareness and the need to reduce fuel load. A growing fuel load due to the slowdown of wood energy in the 1980s created market opportunities for biomass removal for energy use (Neary et al. 1999). These high-severity fires in the early 1990s were out of the normal range of variability for forest fires that were recorded during the 20th century, making a general consensus that programs to remove woody biomass from forests should be a priority (Neary and Zieroth 2007). Neary and Zieroth also mention that one of the barriers to long-term success of the wood energy industry has been proper access and utilization of this resource (2007). However, bioenergy products and wood energy is still considered as having a strong future in the energy industry (Neary and Zieroth 2007).

2.2 Biomass Challenges

Since the bioenergy sector in the United States is relatively young when compared to fossil fuels, impending performance depends upon the proper selection of policies and the extent to which they encourage business innovation and investment (Becker et al. 2012). Prior research from Europe suggests that a major challenge in bioenergy is how to accelerate its implementation to meet specific goals for renewable energy and bioenergy usage (McCormick and Kåberger 2007). McCormick and Kåberger cited that main barriers for bioenergy are financial conditions and situations, information on bioenergy and a firm's ability to employ biomass, and supply chain coordination (2007). Roos et al. listed other barriers for bioenergy production (1999):

- Integration with existing energy systems
- Scale effects (size of sector, industry, bioenergy system)
- Competition within biomass sectors
- Competition with different sectors outside of bioenergy
- National policy (or lack thereof)
- Local policy and opinion on bioenergy

A central challenge to advancing bioenergy systems is the lack of information about policy effectiveness, mainly at the state level and in conjunction with other local, state, and federal effort. There has been less focus on state policy and the mix of tools employed despite being acknowledged as an obstacle to commercialization (Bohlmann 2006 and Wyman 2008). In addition, there has been more research associated with bioenergy policy that is primarily aimed at federal rules and regulations, mandates, and energy standards (Becker et al. 2012). Some states have more robust and long-standing supply chain sectors than others leading to a broader suite of relevant biomass and renewable energy policies, which makes it difficult for policy makers to adequately address policy gaps in wood-energy business innovation.

Another central challenge with renewable energy expansion is the lack of investment capital and financing, which mostly has not had adequate emphasis in recent state bioenergy policies (IEDC 2011). Instead, much of the focus has been geared towards Renewable Portfolio Standards for electricity generation as well as thermal heating. This highlights how crucial policy synchronization between and within states is, as energy regulation is largely in state control. In a case study by McCormick and Kåberger, it was found that renewable energy and biomass grants as well as policy actions (such as green certificate schemes and carbon taxes) were critical to modifying economic conditions in making bioenergy adequately competitive with fossil fuels (2007). They also found that developing knowledge and accessible information for firms often required pilot projects to stimulate the learning process. Another case study by McCormick and Kåberger showed that Finland's bioenergy industry responded favorably to energy taxation, research and development, and investment grants for innovative projects (2007). As these renewable energy policies and instruments have had success in bioenergy systems in Europe, overcoming barriers for bioenergy development and advancement necessitates dealing with shifting circumstances, and understanding the significance and relevance of context for bioenergy systems. In other words, all bioenergy systems are dissimilar, dynamic, and can quickly change (McCormick and Kåberger 2007).

2.3 Supply Chain Coordination

Bioenergy systems and industries must have functioning and relatively organized supply chains that fulfil the requirements of all actors involved (e.g.: harvest and transportation, power and utility, pellet producers, institutional users). Investing in bioenergy systems is first possible if there are energy firms procuring biomass, and creating conversion technologies is first possible if there is an adequate supply of biomass from supply actors (Johansson 2002). Downstream supply chain actors utilize these technologies, which makes supply chain

coordination extremely important to successful bioenergy systems (Johansson 2002). McCormick and Kåberger add that state analysis of both drivers and barriers are critical aspects in fostering and sustaining the bioenergy industry (2007).

A weak forest bioenergy supply chain can be a significant challenge in any region. A weak wood energy supply chain can be described as having a deficiency in biomass stock and quality (Becker et al. 2011), and could also be dampened by inelastic consumer demand (Mayfield et al. 2007). As with increasing competition, climate change knowledge, and technology, the forest products and energy industry has developed multiple sectors. Typically, a supply chain comprises a few dissimilar purposes: inventory, procurement, logistics, planning, multiagency relationships, and performance measures (Arshinder 2008). Supply chains are also relatively complex with many of the activities and functions spread out over long time frames. Because of the complexity, it is essential to have a proper coordination system in place. This can include adequately defined processes, firm responsibilities, and structures that align with the overall goal of the supply chain; this will in turn bring together the functions of the supply chain as well as organizations that comprise it (Arshinder 2008).

The wood energy market facilitates significant opportunities. Electricity, heat, and fuels for transportation are produced from a renewable resource, all while stimulating rural economies and diversifying energy usage types, addressing energy security (Zerbe 2006). This has allowed the wood energy supply chain to diversify and become more mechanized in recent years. Generally, the forest products supply chain consists of forest landowners, harvesting and transportation contactors, processing facilities, and end users (Zerve 2006). Harvest and transportation firms remove material and transport to numerous sites for it to be processed, chipped, or burned for energy. Processing facilities create densified fuel or electricity production. End users are considered the consumer of electricity, heat, or densified fuel.

Below, Table 1 shows more detailed sources of woody biomass that the harvest and transportation sector uses to procure their source material. This table can be applied to the other states in the study.

Table 1. Woody Biomass Sources

Material type	Example
Logging residue	Tops, limbs and trees below industry utilization standards leftover from commercial timber harvest operations.
"Primary" mill residue from sawmills	The majority of available primary mill residue is utilized for various products; most commonly burned to produce energy.
"Secondary" mill residue	The majority of the residue is utilized.
Dedicated energy crops	A very small resource in Minnesota at present.
Land clearing projects	This contributes to the metropolitan wood supply for a major energy facility.
Brush from brushlands	A significant potential resource, but the economics of harvesting and procurement technology need to improve before widespread use.
Pre-commercial thinning, timber stand improvement (tsi), fire hazard reduction, vegetation management	A potential fiber source from intensified forestry and wildlife management.
Urban forests	A fiber source from tree clearing and maintenance and storm cleanup in urban areas. Largely used in mulch markets in major metropolitan areas as well as for energy in St. Paul.
Roundwood	Given mill shutdowns and curtailments, a meaningful amount of woody biomass in the form of roundwood has been used over the past few years.
Whole-tree chips	Lower-valued trees becoming more often utilized for chipping.

* Adapted from the Minnesota DNR. Use this table as conceptual framework for source material type

Once the material is at a processing facility, logs are resorted for efficiency, and residues such as cut ends and shavings left over from processing are sometimes reused (Becker et al. 2011). It is also possible that the material is used for paper production or energy, such as electricity or heat (Becker et al. 2011). Most facilities then move the final product by railroad, highway, electrical lines, or gas pipelines (USDA BRDI 2008). Figure 1 shows a more detailed

system boundary of the wood energy supply chain, including the four sectors this study targets.

Figure. 1 Forest bioenergy and bioproduct supply chain. (Adapted from the National Biofuels Action Plan http://www.usda.gov/documents/NBAP081208.pdf)

End-users are considered those that use the finished product. End-users for this study are institutional users such as schools, hospitals, public buildings, private companies, households, or co-generation facilities that are utilizing thermal energy and/or electricity from woody biomass feedstocks.

Policies geared toward land management, harvesting, and transportation would facilitate source material availability that matches up with the needs of the manufacturing sector (i.e. price, timeliness). Policies applicable to the "manufacturing, delivery and consumption of biofuels would facilitate efficient delivery to market and in turn align with pre-manufacturing constraints" (Becker et al. 2012). Policies have far reaching direct and indirect effects, such as harvesting, how and it what state biomass is transported, the kind of feedstock utilized in production (e.g., forest residues vs. roundwood), type of technology

used by businesses, and the distribution and advertising to end users *Becker et al. 2012).

Aligning policies across the entire supply chain enriches consistency and timeliness of product distribution (McCormick & Kåberger 2007). Any gap in the supply chain created by existing policy, or in its absence, could render the entire supply chain fragmented regardless of the quality or success of any single policy. Understanding policy alignment and efficiency must therefore incorporate examination of the whole system and interaction between policies, not simply individual policy outputs (Becker et al. 2012).

2.4 Policy Mix and Instruments

In renewable energy systems, private firms respond largely to the drivers of financial gain; however, the methods taken by governments should be driven by a need to advance social welfare of the region (White et al. 2013). White and colleagues liken renewable energy social welfare as a toolbox consisting of, but not limited to: improving “energy security, energy supply, energy affordability, sustainability, creating job opportunities and adapting to and mitigating climate change” (2013, pg. 2). Diverse goals and different motivators of governments at each level make clear and consistent policies difficult, which can negatively impact a bioeconomy (Mitchell and Connor 2004). Government policies should be constructed in tandem with public support, because without, policies will have difficulty succeeding and being renewed in future years (White et al. 2013). The most common policy role for governments in the bioenergy industry is influencing behavior of consumer households and firms producing bioenergy products by pushing households to maximize utility (efficiency incentives) while incentivizing firms through tax subsidies, specific regulations, or market control (White et al. 2013). However, while these tools can be successful individually, it is common that diverse bioenergy supply chains struggle to have adequate policy systems that address each barrier effectively.

Present biomass policy research focuses mainly on the efficiency of individual policies or particular policy tools (Carley 2009). It also is focused on particular economic or market outcomes (Morrow et al. 2010). While these studies are valuable in evaluating singular policies, more analysis is needed to understand the variety of policy instruments and how they interact amongst each other at different levels of government as well as supply chain sectors (Eliadis et al. 2005). Analysis of policy systems is therefore necessary for better understanding policy interactions and even unintended consequences (Rametsteiner & Weiss 2006; Becker et al. 2011). This is where the concept of a policy mix becomes useful. A policy mix can be viewed as how certain policy instruments work together to reach anticipated goals, and the concept has been applied limitedly to the bioenergy industry. A good mix of policy instruments, rather than individual policies, complements each other to help promote and foster bioenergy production at multiple steps along the supply chain.

Biomass policies can be classified by their function, also known as instruments. These instruments range from tax credits, rules and regulations, government services such as technical service, research and development, procurement, and financial disbursements such as loans or grants (Becker et al. 2011). Policy instruments like these may be defined as “the set of techniques by which governmental authorities wield their power in attempting to ensure support and effect or prevent social change” (Vedung 1998). A study by Conrad et al (2010) showed that more than 70% of respondents, comprised of forest owners and wood-energy facility personnel, believed that government policies such as subsidies, tax breaks, and mandates should play a larger role in setting up the competition between the forest products industry and wood-energy facilities. This was a significant finding in itself, and makes policy understanding a critical component to a dynamic forest bioeconomy.

Several types of policies have been implemented to incentivize the wood-energy market. Policy instruments have ranged from consumer credits for the

purchase of qualifying biomass products, transportation credits paid on the volume of wood chips transported to a wood energy facility, to a decrease in biomass equipment taxes and vehicle tags (Becker et al. 2011). A variety of policies also exist for assisting the removal of biomass from forests, as well as aid in the production of different bioproducts. Many policies exist at the state and federal level, but little is known among states about effective policy tactics and the mix of policy instruments that drives desired business investment. The particular policies at the state and federal level often aim to address particular challenges with local utilization whether it is the cost of biomass harvesting, handling and transportation, or manufacturing and consumer markets (Becker et al. 2011). Each policy offers a particular incentive associated with a step in the wood energy supply chain, even if not explicitly related to wood energy, for example, capital depreciation. Each policy is also uniquely intended for a particular audience to help them overcome local utilization challenges or to create related forest management or economic development opportunities (Becker). Table 2 displays each policy instrument type along with an example policy. The table can be referred to as part of the policy analysis structure. Table 3 lists the policy classifications with an example policy type used in the database.

Table 2. Policy Classifications

Primary Policy Classification	Secondary Policy Classification
Tax policy	Exemptions, allowances, deductions, credits
Government rules and regulations	RPS, Net metering
Market Activity	Procurement, contracting (e.g. Stewardship contracting)
Direct financial disbursement	Grants, Loan, Cost-share, direct payment (e.g. producer payment)
Research and development	Primary research, demonstration studies, commercialization
Government services	Technical assistance program, infrastructure development (bioenergy ports, rail lines, transmission)
Other policy	Specific but not in any other classification. (e.g. local policies)

Table 3. Database policy type and example (adapted table from Becker et. al 2011).

Policy Type	Example Policy
Tax Policy	Reduction or exemption from state sales tax, the purchase of equipment for harvesting, transportation, or processing of biomass.
	Income tax credits and deductions related to the installation of certain types of renewable energy systems.
Disbursement	Funding through a waiver of fees or supplemental resources for the purchase or operations cost of equipment used.
	Funding through competitive grants to purchase equipment, support research, product commercialization and marketing.
Rules and Regulations	Requires utility companies to use renewable energy for a certain percentage of their retail electricity sales or generating capacity.
	Consumer option to purchase electricity generated from renewable resources.
Market Activity	Mandates or provides incentives for use of bio-based products in the construction, processing, heating, or operation of vehicles or equipment.
	Requires utilities to buy-back excess power generated from renewable sources.
Research and Development	Funding for new technologies and process developments.
	Funding for pilot and demonstration facilities.
Government Services	Coordination of research, disseminates information, or assists with business planning and grant writing.
	Usage of public infrastructure (roads, rail lines, transmission)

2.5 Innovation

Innovation, which is the creation and concept of new ideas, technologies, and processes, has been around since the beginning of mankind. It is inherently human for one to improve upon the way we live. Without innovation, the world would be a much different place, as many of the niceties that are used every day (cars, phones, computers, etc.) may not exist. Innovation pushes products and processes to keep improving to stay relevant in their respective industry, as competition plays a large role in which products are chosen by consumers (Fagerberg 2004). Innovation can be applied to the forest products industry as well. For this study, innovation is compared against policy usage to assess the degree to which bioenergy related policies are driving change in the wood energy sector. This will help illustrate where certain policy types and instruments are influencing innovation, and the type of changes that are being employed by firms.

Innovation can be difficult to describe, as it is easily confused with invention (Fagerberg 2004). Invention can be thought of as creating the idea for a new process or product, whereas innovation is commercializing that idea (Fagerberg 2004). Innovation can be described as new creations of societal and economic importance, typically performed by firms, and is considered the lens used to examine firm-level decisions (Borrás and Edquist 2013; Ramesteiner and Weiss 2006). According to Borrás and Edquist, innovations typically include product and process innovations (2013). A product innovation can be described as a new or improved service or good with more influence on the type of good produced, while a process innovation includes new ways of producing those good and services with emphasis on how they are produced (Borrás and Edquist 2013). Another study by Kubeczko et al. defines innovation as a "remedy to a set of economic and social problems" (2005). Kubeczko cites other research by (Edquist, 1997; Fagerberg, 2004; Malerba, 2004) that assumes innovation to make a country more competitive by providing more jobs and supporting economic growth. This was substantiated by the Lisbon Strategy of the European Commission for Employment, Economic Reform, and Social Cohesion. The main goal of the Lisbon Strategy was "to become the most dynamic and competitive knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs along with greater social cohesion, and respect for the environment" (European Parliament 2010). The Strategy showed that innovation increased firm competitiveness when integrated with effective policy instruments, which in turn fostered more competitive markets (EU 2003).

Individual firm innovations, when linked to other sectors of a supply chain, form innovation systems. Ramesteiner and Weiss define a forestry innovation system as "the set of distinct actors and institutions which contribute to the development and diffusion of innovations in forestry" (2006). They continue to say the system is a set of interconnected actors of which their performance is

determined not only by the individual performance of each actor, but also how they interrelate to form a collective system. These interactions among actors must be maintained over time to be deemed a successful innovation system, rather than just for a specific innovation (Ramesteiner and Weiss 2006). Edquist describes an innovation system as "being composed of policies, companies, individuals, other major actors and their interactions that may have an effect on the development and diffusion of an innovation into the marketplace" (1997). These notions of maintaining successful interactions over time can be transferred to firm innovations and their effect on sector growth or lack thereof, and is a crux of this study. In addition, innovation systems can serve specific purposes. For example, Edquist and Johnson categorized the functions of innovation systems in three groups (1997): 1) to reduce uncertainties by providing information; 2) to manage conflicts and cooperation; 3) to provide pecuniary and non-pecuniary incentives. The ability to implement these functions has direct implications on the quality and quantity of innovations enacted by firms in each sector.

Ramesteiner and Weiss asked respondents if their innovative behavior led to new products or services, or whether they introduced "significant changes" in technological or organizational processes (2006). To be considered significant, a change on how the forest holding is managed for example, including outsourcing of all harvesting or marketing functions, had to have taken place. Their results showed that forestry innovation systems closely aligned with those of manufacturing innovation systems. Overall innovation costs were seen as the most impeding factor, followed by finance sources, lack of qualified labor and skill, and economic risk. Since the problems between the two industries are similar, it in turn implies that many of the measures taken to enhance the innovation performance of the manufacturing industry may in theory be applied to the forestry industry (Ramesteiner and Weiss 2006).

While innovation systems have been a key subject of interest in academia, literature on innovation systems specific to the US forest industry is limited.

(Rametsteiner and Weiss 2006, Knowles et al. 2008). Previous research from Europe suggests key limitations in the literature (Kubeczko *et al*. 2006, Rametsteiner and Weiss 2006):

1. Existing innovation systems in the forest industry sector largely lack adequate support to encourage innovation;
2. Outside sources provided little policy advantages, few incentives, and poor communication among sectors impeded innovative growth.

With that said, recent acknowledgments by longstanding bioenergy professionals in the industry indicate a shift (Hansen *et al*. 2007) where future success is contingent upon new products, processes, and the use of new raw materials (Blackmon 1998). It was also noted that some modifications for growth would be necessary for the forest industry to further develop competitiveness.

This study aims to utilize significant business changes undertaken by firms as a proxy to innovation that is taking place in multiple sectors and states. For this study, a proxy can be considered a tool used to calculate or represent something else. In this case, those proxies are each business change grouped by similar changes. This will allow innovation to be viewed through the lens of similarly-grouped business changes, providing a landscape of how and where changes are taking place, and if they are driven by policy. A framework for innovation put forth by Weiss and colleagues shows a range of innovations that this study pulls from; figure 2 lists innovation types with subsequent components that make up each category. The five innovation categories provide the framework for which innovation will be measured in this study.

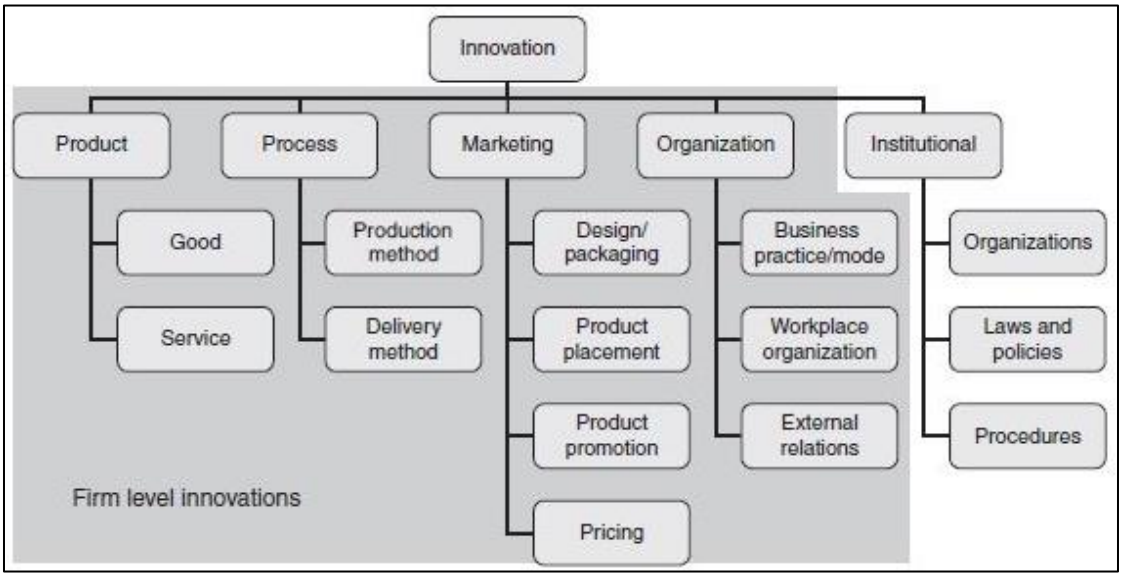

Figure 2. Possible types of innovation in wood energy sectors (Weiss et al., 2010, modified from OECD, 2005)

Chapter 3 - Data Collection and Research Methods

The study is organized into three stages. First, supplemental information was collected on relevant biomass policies (state policy database updating) in California, Oregon, Washington, Minnesota, Wisconsin, and Michigan. Second, a survey was administered to businesses involved in woody biomass along the supply chain in these states (harvest and transportation firms, power/utilities, institutions, pellet producers). Third, collected data was coded, analyzed, organized, and displayed using software programs such as Excel and SAS JMP. These data are used to address the research question of how does policy drive innovation and change for businesses along the wood energy supply chain.

3.1 Study Region

Data was collected on two regional bioenergy systems in the United States: the Pacific Northwest states of California, Oregon, Washington, and the Lake States of Minnesota, Michigan, and Wisconsin. These two regions were selected for differences in land use patterns, biomass utilization motivations, and political and institutional structures. Both regions have significant amounts of available forest logging residues (US DOE 2011). These feedstocks are procured from highly productive western forests, lower-productivity eastern forests, and federal lands, with each area having unique barriers, as each feedstock has different values as well as each region having differing land ownership levels (i.e. federal, state, private). Nationally, there are an estimated 67 million dry tons of logging residue available annually, with 47 million dry tons available after harvesting guidelines and sustainability practices; both at $40/dry ton (USDOE 2011). There are 7.47 million and 4.33 million dry tons of logging residue in the Pacific Northwest and Lakes States annually, at $80 per dry ton (USDOE 2011). Estimated logging residues for individual states are as follows:

Table 4 Annual residual logging biomass (million bdt, roadside)

State	$20/dry ton	$40/dry ton	$80/dry ton
California	0.45	0.80	1.52
Oregon	1.2	1.40	3.25
Washington	0.93	1.10	2.70
Minnesota	0.18	0.20	1.53
Wisconsin	0.35	0.41	1.70
Michigan	0.38	0.54	1.10

Physical features of the regions also played a role in their selection. They have both forest and forest-agriculture land, as well as wide varieties in land ownership (private, public, tribal, etc.). This allows for land ownership to be considered when looking at policy instrument types employed in each state and region. Table 5 shows forest land ownership by state.

Table 5 Area of forest land by ownership and state (1,000's of acres) (Butler 2008)

	Total	------ Private ------		---------- Public ----------		
State	forestland	Family	Other	Federal	State	Local
Minnesota	16,391	5,390	1,724	2,789	4,400	2,089
Wisconsin	16,275	9,083	2,034	1,576	1,075	2,505
Michigan	19,545	8,956	3,161	2,958	4,118	351
Lake States	**52,209**	**23,429**	**6,919**	**7,323**	**9,593**	**4,945**
California	32,817	7,897	5,305	18,409	831	375
Oregon	30,169	4,257	6,802	17,960	969	181
Washington	22,279	2,717	7,088	9,536	2,580	358
Pacific NW	**85,265**	**14,871**	**19,195**	**45,905**	**4,380**	**914**

The Lake States have a wider mix of public and private ownership compared to the Pacific Northwest, which may help show policy influence on land

ownership type. Policies in this area have been relatively aggressive regarding biofuel production, but varied in support for broad biofuel production. On the other hand, the Pacific Northwest primarily offers strong state incentives for bioenergy production from federal public lands (Becker et al. 2011b). These states also contain a variety of policies to help incentivize and increase biofuel energy production (Becker et al. 2011b). Policies to promote bioenergy, and range from production tax credits, contracting rules for raw material procurement, grants and cost-share programs, as well as state RPS (renewable portfolio standards) (Becker et al. 2011b). A wider variety of policies employed at the state level allows for each state to be an individual laboratory for policy implementation. Both regional bioenergy systems are grouped by states, and political boundaries do not always define a supply chain, as many times raw material procurement, end product, and power/heat are sold beyond political borders. For this study, it is important to maintain those boundaries to assist with assessing state and regional policy influence.

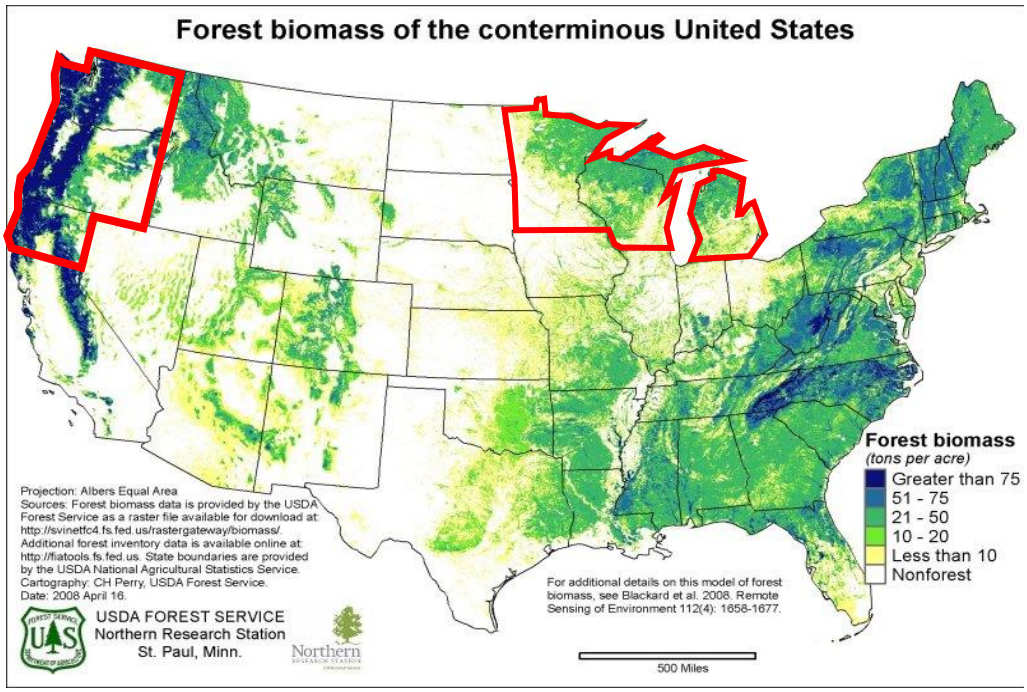

Figure 3 Study area

3.2 Policy Database

Policies generally seek to create incentives that spur investment, or are thought of as a rule or mandate that influence behavior (Ungar et al. 2012). This study aims to grasp what those investment and behavior changes are within different regions and bioenergy supply chains. An existing state policy database created by (Becker et al. 2011) was updated to reflect the current policy climate in each state. All states were updated, but for the purposes of this analysis, only California, Oregon, Washington, Minnesota, Wisconsin, and Michigan were utilized.

Many policies were found using the Database of State Incentives for Renewable Energy (DSIRE) (http://www.dsireusa.org), which offers detailed reviews of state renewable energy policies. There were instances where DSIRE did not yield information, especially in select sectors (e.g. harvesting and transportation). In this situation, keyword searches of biomass-relevant legislation were also used using the FindLaw.com legal search engine (http://www.findlaw.com/casecode/). Finally, bioenergy experts in each state were contacted to verify or amend the data as necessary. The primary point of contact was typically the director or manager of the state energy office, or state biomass utilization specialists. All inquiries sought information on policy requirements, instrument type authorities, dates enacted, and target audiences. Information for federal policies was collected in a similar manner. A summary of each policy by state and instrument type are available at http://woodenergyproject.com/StatePolicies/.

In state statutes, qualifying forest biomass is commonly defined as the by-product of forest product manufacturing, forest restoration, and hazardous fuel management including trees and woody plants such as tops, leaves, limbs, and needles (Becker et al. 2011). To be included in the database and be considered relevant, a policy must have qualified biomass as a qualifying material source. Policies aimed at other types of biomass such as anaerobic digestion of

agriculture materials, were included in the database, but were not used in this study. Table 6 displays totals for each policy type collected in the state policy database for this study.

From table 6 below, there are currently 71 total known biomass-related polices in all the study states that allow woody biomass as a qualifying feedstock. The policies are mostly active, but ones that are not were included as respondents may have utilized the policy before it was discontinued. These policies were classified as one of the six policy instruments. Oregon reported the most policies, 21, while Washington had the least in the database, with 1. The Pacific Northwest states combined for 38 total policies, while the Lake States combined for 33, respectively.

Table 6 Known biomass and renewable energy policies with primary instrument in each state and region

State	Disbursement	Government Services	Market Activity	Research and Development	Rules and Regulations	Tax Policy	Grand Total
CA	1	2	1	3	2	7	16
OR	9	0	1	1	5	5	21
WA	0	0	0	0	1	0	1
Pacific NW	***10***	***2***	***2***	***4***	***8***	***12***	***38***
MN	4	0	0	1	4	0	9
WI	4	0	1	3	6	2	16
MI	3	0	0	1	2	2	8
Lake States	***11***	***0***	***1***	***5***	***12***	***4***	***33***
Grand Total	**21**	**2**	**3**	**9**	**20**	**16**	**71**

3.3 Population, Survey, Sampling, and Responses

3.31 Population

The main source of firm information was Wood2Energy. Subcontractors developed and maintain a database that houses information regarding

businesses involved in woody biomass (Wood2Energy 2014). The data is derived from state-level collaborators, reputable industry magazines such as Biomass Magazine, Department of Energy, tax information, and forest industry directories such as Timber associations. (Wood2Energy 2014).

The facility types classified in the W2E database are: Wood-based Manufacturer, Biomass Power Producer, Institutional Wood Energy User, Sawmill, Wood Pellet Producer, Cellulosic Ethanol Producer, Pulp and Paper, Chip Mill, Commercial Wood Energy User, and Other (W2E 2014).

As of spring 2014, 6,012 wood-based facilities, not necessarily wood energy facilities, were found in the six-state study region. The Lake States had significantly more active facilities (5,352) than did the Pacific Northwest states (660). Table 7 shows each region's total facility population, which includes both wood-energy facilities and non-wood energy facility types.

Regionally, the Lake States had significantly higher wood-based facilities than in the Pacific Northwest. The Lake States had higher sawmill totals, accounting for 88% of the total sawmill population in both regions, including cogeneration of heat and power (CHP) mills. However, less than 1% (0.7%) participates in wood-energy. The sawmill industry was much different in the Pacific Northwest. But sawmills in the Pacific Northwest had a higher percentage of participation in wood-energy, at 13.2% of the regional mill total. The same pattern was true for pulp and paper facilities. Of the total pulp and paper facilities in the Lake States, 28% were identified as CHP facilities and 32% in the Pacific Northwest.

The largest number of facilities was wood-based manufacturers, which were defined in the W2E database as producers of: pallets, furniture, advertising signs, wood buildings, cabinets, animal bedding, flooring/paneling/fencing, doors and frame, and miscellaneous small wood products (W2E 2015). No wood-based manufacturing facilities were classification in the W2E database as energy producers.

One of the smaller populations derived from the Wood2Energy database was institutional users. California and Washington both showed very low facility totals (CA = 0) and the other four states were relatively even, and were close to being reflective of the response rate later experienced.

This study helped categorize wood energy firms by supply chain in each of the six states, with updated contact information. This provided an up-to-date roster of businesses in the six state study area. Such a database was largely unavailable, or information was not centralized or easily accessible.

Table 7 Total of all wood facilities from Wood2Eenergy database by state and region

Facility type	CA	OR	WA	Subtotal	MN	MI	WI	Subtotal
Energy Generation								
Cellulosic ethanol	4	2	1	7	0	3	2	5
Institutional bioenergy user	2	25	5	32	20	22	25	67
Power/ Utility	63	12	5	80	8	16	6	30
Wood pellet producer	5	18	7	30	7	21	21	49
Pulp and paper	1	5	8	14	5	2	11	18
Sawmills	8	14	8	30	1	0	12	13
Non-Energy								
Pulp and paper	15	8	7	30	9	18	20	47
Other	12	10	16	38	28	259	654	941
Wood-based manufacturer (e.g. sawmill, chip mill)	69	201	129	399	998	2411	773	4182
Total	**179**	**295**	**186**	**660**	**1076**	**2752**	**1524**	**5352**

A shortcoming of the population was that it was difficult to effectively classify a business that was unreachable, or a “no response.” “No response” indicated the facility was classified as a wood energy participant in the Wood2Energy database as well as verified by research staff, but unable to gain contact. Those potential respondents were added to the estimated population. However, with the high error rate experienced with the W2E database (22%), it is plausible that the overall participation rate may have been slightly higher than

reported, as well as the overall population of wood-energy users could be lower. Therefore, the estimated population was re-created, but it is possible that some firms are still misclassified or missing. Table 8 below displays irrelevant contacts that were misclassified in the W2E database, and were removed from our survey database. The table also shows total contacted in parentheses. Table 9 shows each sector's estimated population along with total firms contacted.

Table 8 Irrelevant contacts with total contacted in parentheses by industrial sector. Eg.: irrelevant contact (total contacted) error rate

State	Harvest and Transport	Pellet Production	Power/Utility	Institutional	All
CA	3 (19) 16%	3 (3) 100%	8 (56) 14%	3 (3) 100%	**17 (81) 21%**
MI	8 (32) 25%	2 (17) 12%	0 (14) 0%	13 (43) 30%	**23 (106) 22%**
MN	1 (24) 4%	7 (13) 54%	4 (16) 25%	5 (46) 11%	**17 (99) 17%**
OR	2 (45) 4%	2 (14) 14%	10 (26) 38%	8 (30) 27%	**22 (115) 19%**
WA	4 (24) 17%	1 (6) 17%	3 (17) 18%	6 (14) 43%	**14 (61) 23%**
WI	3 (27) 11%	7 (19) 37%	2 (14) 14%	8 (41) 20%	**20 (101) 20%**
All	**21 (171) 12%**	**22 (72) 31%**	**27 (143) 19%**	**43 (177) 24%**	**113 (563) 21%**

Table 9 Total estimated wood-energy facilities (population) by supply chain with total contacted in parenthesis.

State	Harvest and Transport	Pellet Production	Power/Utility	Institutional	Total
CA	16 (19)	0 (3)	48 (56)	0 (3)	**64 (81)**
MI	24 (32)	15 (17)	14 (14)	30 (43)	**83 (106)**
MN	23 (24)	6 (13)	12 (16)	41 (46)	**82 (99)**
OR	43 (45)	12 (14)	16 (26)	22 (30)	**93 (115)**
WA	20 (24)	5 (6)	14 (17)	8 (14)	**47 (61)**
WI	24 (27)	12 (19)	12 (14)	33 (41)	**81 (101)**
Total	**150 (171)**	**50 (72)**	**116 (143)**	**134 (177)**	**450 (563)**

3.32 Survey and Sampling

A business survey was created to administer to businesses associated with woody biomass within the six state study area. Four main wood-energy business types, or supply chain sectors, were sampled from the facility type database:

- Harvest and transportation (loggers)
- Power generation (electrical utilities, co-generation of heat and power)
- Pellet producers
- Institutional users (hospital, school)

These wood-energy businesses were chosen because they made up the majority of woody biomass businesses in each region, and encompass the best representation of wood-energy producers and users. The professionals interviewed were individuals that have direct experience with their local area as well as policy climate in their state and region. Agencies of interest may include, but are not limited to the Department of Agriculture, Department of Energy, Energy Information Administration, and the Environmental Protection Agency, as well as multiple state agencies that are involved in wood energy.

Respondents were purposively sampled, and where necessary, a snowball sampling technique (Miles & Huberman 1994) was employed. This technique was used when the populations were relatively unknown, or when current databases of wood energy firms were limited. Snowball sampling occurs when new potential respondents are recruited, or pass along contact information, during the survey process by their peers (Miles & Huberman 1994). Respondents were also stratified by supply chain step: loggers, power/utility companies, institutional users, and pellet producers. Stratification, or breaking the entire population into similar subgroups, was chosen since populations were spread throughout states and regions; similarity was most readily found with stratifying by supply chain sector. This allows policy usage to be compared with like firms across and within states and regions in the study. All survey responses

adhered to accepted qualitative methodology using open and axial coding (ground theory) to identify similar themes within and across regions/states (Corbin & Strauss 2007). This is expanded later in this chapter, subsection 3.4 Analysis and Coding.

Before interviewees took the survey, they were mailed an introductory letter explaining the importance of the study, sample questions related to their business investments and wood energy decisions, and a timeline of relevant state and federal biomass policies. See appendices 2-7 for all state timelines. Sample survey questions included:

- Please briefly describe your business and its involvement in wood energy production.
- Please list your business's three most significant changes.
- What were the main factors influencing this decision? (for each change)
- What was it about the policy (or policies) from the timeline that was not attractive or effective in your case?
- What are the two most important factors affecting your business' ability to expand production or use of wood-based energy?
- Can you identify examples where state and/or federal policies are working well together or coordinated across your supply chain?
- Can you identify any examples or areas where state and/or federal policies are NOT working well together or where there are gaps in the coordination of activities across your supply chain?

The fundamental question asked of respondents was whether state or federal policies influenced their business decisions regarding wood energy. This question gave respondents a chance to divulge which policy type, or instrument, they claimed to have taken advantage of, how it influenced their investments in wood energy, and the degree to which policies at different levels were or were not coordinated across the supply chain. The objective was to look at what type of changes businesses have made and what the driver of that change was.

The business survey was administered via telephone and web. Phone surveys consisted of an interviewer asking respondents questions, and keying in the responses themselves. This was an attempt to increase response rates and

probe on specific questions. Individuals who opted out of the phone survey were given the option to take the online version. Survey length varied, but was typically one-half hour long, with some stretching to over one hour. Both survey versions contained the same questions.

The survey was developed in Qualtrics, a web-based survey program that allowed for advanced question setup and support. Once each version of the survey was competed (telephone and online), it was piloted to test for technical issues as well as how well the software would accompany the question types and format of the survey. Once piloting was complete, the survey was ready to roll out. There were three main interviewers, with a fourth in place for data management and quality control. Responses from each interviewer were checked for inter-rater reliability to maintain consistency across all responses.

3.33 Response Rates

Firms were first randomly sampled within states and sectors. In sectors with low response rates or limited knowledge on total population, firms were purposively sampled. It was also attempted to create a census in sectors with low estimated firm totals. Snowball sampling was employed as well where the population was small or unknown. Each respondent was first mailed the survey packet of and introductory letter explaining the study, sample questions, and a timeline of policies in their state. After two weeks from mailing the survey packet, the respondent was called. If not reached, they were called up to three total times before the respondent was classified as “no response.” An online survey was e-mailed to any respondent that was unreachable, if an e-mail address was provided. The intent was to get the respondent to complete the phone survey with an interviewer, with the online survey being the second choice of questioning.

The wood energy business survey produced a total of 191 responses (141 phone-based, 50 web-based). Five responses were blank, and of the 186

responses that had answers, 175 were relevant and usable, meaning the business participated in wood-energy. Table 10 indicates total usable responses in each state's wood-energy supply chain sector.

Table 10 Total survey responses by supply chain sector with estimated population in parenthesis. E.g: responses (population) response %

State	Harvest and Transport	Pellet Production	Power/Utility	Institutional	Total
California	5 (16) 31%	0 (3) 0%	11 (48) 23%	0 (3) 0%	**16 (64) 25%**
Oregon	24 (43) 56%	5 (12) 42%	7 (16) 44%	12 (22) 55%	**48 (93) 52%**
Washington	4 (20) 20%	2 (5) 40%	3 (14) 21%	6 (8) 75%	**15 (47) 32%**
PNW subtotal	***33 (79) 42%***	***7 (20) 35%***	***21 (78) 27%***	***18 (33) 55%***	***79 (204) 39%***
Minnesota	9 (23) 39%	1 (6) 17%	9 (12) 75%	16 (41) 39%	**35 (82) 43%**
Wisconsin	10 (24) 42%	4 (12) 33%	6 (12) 50%	12 (33) 36%	**32 (81) 40%**
Michigan	10 (24) 42%	4 (15) 27%	7 (14) 50%	8 (30) 27%	**29 (83) 35%**
Lake subtotal	***29 (71) 41%***	***9 (33) 27%***	***22 (38) 58%***	***36 (104) 35%***	***96 (246) 39%***
Total	**62 (150) 41%**	**16 (50) 32%**	**43 (116) 37%**	**54 (134) 40%**	**175 (450) 39%**

It was important to observe the supply chain steps that had 0 respondents, as it was a significant finding itself. In California, both the pellet industry and institutional sector were not represented in our results. The reason is that the populations were so low, or non-existent. It was found that there were no active institutional users in California, which was verified by state officials and academic professionals familiar with wood-energy facilities in each area (John Shelly, personal communication, May 2014). Where California did report well was in the power and utility sector, with 11 responses, which made up 69% of the state's responses. The next highest power and utility response total was in Minnesota, with 9; however, that total comprised only 26% of Minnesota's responses. Other notable response figures include: the highest wood-energy facility totals were retrieved from Oregon, 48, with half being in the harvest and transportation sector. The lowest total from an individual state was Washington, with a total of 15 responses. The two supply chain sectors that had the largest response total

harvest and transportation sector (logging and hauling) produced a total of 62 respondents, while there were 54 responses from institutional users. As mentioned, no responses were obtained from pellet producers and institutional users in California, and the populations were found to be zero in their respective sectors. These findings were confirmed by local experts (John Shelly; John Sessions, personal communication, May 2014).

The harvest and transportation sector along with institutional users made up 66% of the total estimated population of wood-energy facilities in the study area. However, of the 54 institutional facilities who responded, 36 (67%) were in the Lakes States.

Oregon had the highest response rate, with 52% of the estimated population participating. The lowest response rate was in California, at 25%. The harvest and transportation sector reported at 41%, institutional users reported at 40%, while the lowest response percentage was pellet producers, at 32%.

3.34 Respondent Profiles

Survey respondents reported varying levels of experience and involvement in wood energy. Respondents were asked what their position was with their respective company, how long they have been working at the company, as well as how long that business had been involved in wood energy production or use. Not every respondent was able to give information on when their business entered the wood-energy market. When possible, respondents in each sector of each state supplied their employment duration with the business they represented, as well as how long that business had been in the wood-energy market.

From table 11 below, it was found that the overall estimated mean experience level of respondents with their business to be 16 years. On average, Oregon had the highest level of experience with 18 years. Washington had the

lowest experience level on average per firm with 13 years. These experience levels are reflective of the respondent's experience with their current business, and doesn't reflect cumulative experience if a respondent changed positions with a different firm. It can, however, suggest possible turnover rates in each supply chain sector in each state. It was found that 1990 was the overall mean year that businesses in all six states entered the wood energy market. Pellet producers, on average, entered the market later, in 1998.

Table 11 Respondent duration with business (mean yrs)

Sector	Mean Employee Duration with business (yrs)	Max duration w/firm	Std Dev
Harvest and Transportation	20.37	49	13.52
Pellet Production	14.06	37	11.04
Power/Utility	13.14	36	10.29
Institutional	13.13	49	12.49
Total	**15.78**	**49**	**12.62**

Knowing respondent position was helpful in determining experience level within their business, as well as with the wood-energy supply chain and related policies. Each respondent was asked their position with their respective firm. Nearly three quarters of respondents identified as the owner of the sampled business, or upper management within the company, such as President, VP, Director, CEO, or COO. The graphic in Figure 4 shows the range of positions respondents identified as.

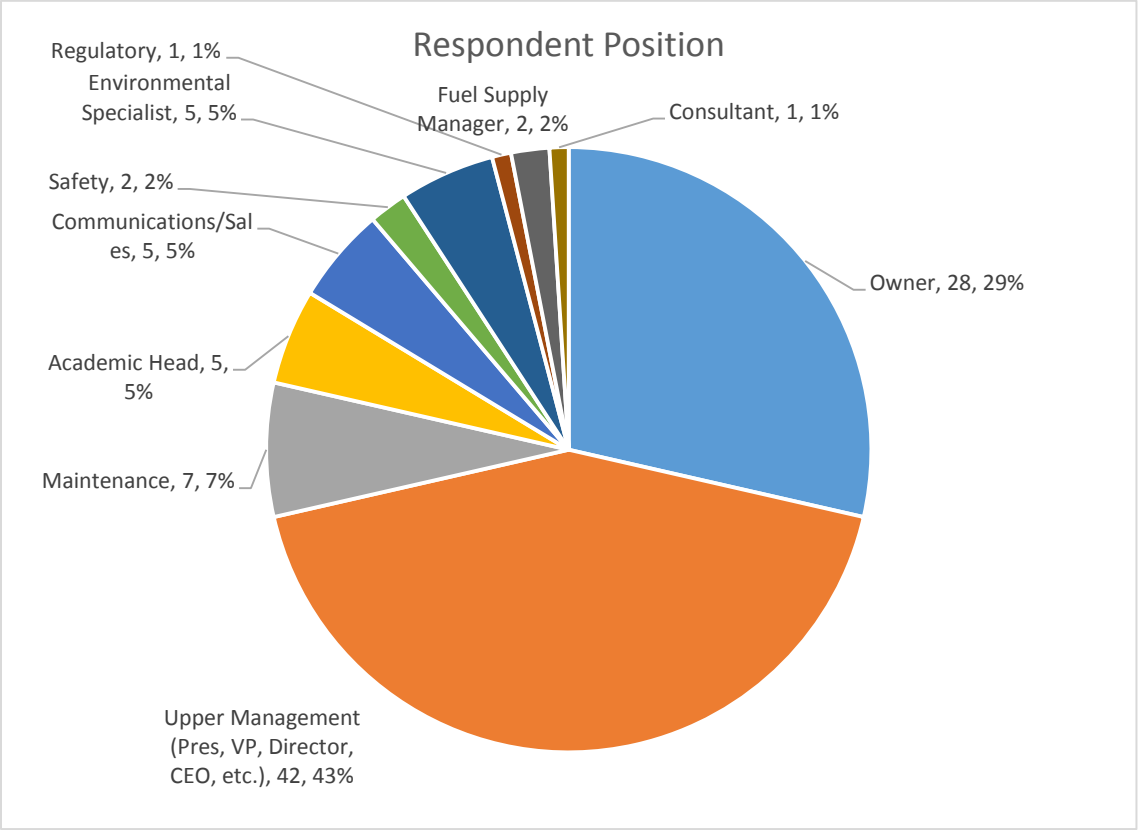

Figure 4 Respondent Position with business

3.4 Analysis and Coding

Open coding was used to give umbrella codes to each significant change to help develop core categories. Open coding consists of creating tentative labels for certain parts of the data that can be grouped in a similar manner (Holton 2007). Selective coding was then applied once themes developed to saturate the core concepts (Holton 2007). Selective coding is when descriptions of phenomena (e.g. process, event, etc.) begin to appear (Corbin and Strauss 1990).

Analysis was broken into two parts: policies that were associated with business changes, as well as change types that did not correlate with policy. Significant business changes were coded into five categories:

- Operational
- Process
- Equipment
- Market force
- Research and Development

These categories were developed from respondents' significant changes. Equipment changes involved a physical equipment installation or upgrade, and were easily defined by the respondent. Research and development changes involved gathering information and skills on new products or services, or to educate the public or other firms on the market and services produces. Market forces were found as where the change was completed due to outside pressure such as, but not limited to: increased demand forced more production, seeking new markets (domestic and international) due to a sluggish local market, or limited feedstock availability and material source procurements. Descriptions of each theme as well as examples, in no particular order, are in Table 12.

It was strategic to differentiate an operational and process change because they appear similar, but have a difference in scale and specifics of the type of change. An operation change indicated the umbrella goal of the business, and includes all subsequent processes that made the business function. The difference between operational and process changes is an operational change encompasses each process of the business, whereas a process change doesn't necessarily affect the entire business operation. For example, if a business claimed that it "increased production" as its significant change, it was assumed that multiple faucets of the business were impacted to meet the increase in production. However, building off the same example, if a specific function of the business operation added labor (e.g. warehouse workers), then it was categorized as a process change. A process change changes how the company is functioning from within, but the end product remains the same. An example of a process change is, but not limited to: new source material, advanced technologies, utilizing residues, etc.

Table 12 Significant change type with description and example

Change type	Description	Example
Equipment	New or upgraded equipment	Boiler, plant addition, chipper, wood-burner, maintenance
Market force	Businesses changed as a result of because market influence	Increased demand, more/less feedstock availability, needing new markets (international and domestic)
Operational	Business-wide; change in business goal or overall operation. Impacts each individual business process	Entry or exit biomass, second energy stream, add new skilled labor, new programs
Process	Subset processes of operation. Make up overall operation.	Source material change, advanced technologies, residue usage, logistical improvement
Research and development	Sole purpose was to improve knowledge of technologies, industry, and educate public.	Market and product analyses, collaboration with other firms or universities, public education

Chapter 4 - Findings

As the need for clean energy and environmental solutions persists, woody biomass is now viewed as a key player in renewable energy implementation. This has caused an increase in wood energy and biomass related policies, such as credits for biomass energy generation, financial disbursements for equipment upgrades and replacements, as well as new contracting rules. The increase in policies has taken place so quickly that a basic understanding of how these policies have or are influencing business decision making is unknown (Becker et al. 2011). Knowing market dynamics such as major changes or innovations that firms make and if policies are influencing those changes in desired ways will help policy makers create more efficient policies for their supply chain sectors in wood energy.

Reiterating the purpose of this study, it is to analyze the significant business innovations enacted by woody bioenergy firms and users in terms of the type of innovation they represent, and the extent to which state and federal bioenergy policies are instrumental in driving, influencing, and/or limiting change. This chapter discusses findings from the business survey. Specific topics include descriptions of significant business changes, policy results from each state as well as a brief regional comparison, and discussion on business changes that respondents did not cite policy being influential in implementing those changes.

This chapter displays results from the study. First, business profiles are discussed. This includes data such as firm duration in the wood-energy market, employment totals, and material inputs and product outputs. Next, significant business changes are discussed, followed by policy results from each state.

4.1 Business Profiles

Each respondent was given the option to provide their total volume of biomass harvested, total output, and raw material consumption. They were

asked to provide information on the last year of operation in 2013. Responses were reported in dry tons, green tons, board feet, mmbf, cords, feet, yards, square yards, and pounds. Where appropriate, responses were converted to common units for consistency. Output from the power/utility sector was reported by respondents in MWh, kWh, Btu, MMBtu, GWh, bdt, green tons, and dry tons, and converted to MWh for comparison. Responses were crosschecked on their annual output versus consumption to verify that reporting units were consistent and realistic. Where units were unclear, pellet production and consumption was assumed to be bone dry tons; wood chip users were assumed to be green tons at 50% wet moisture content.

Each respondent, if able, provided the year of which their firm entered the wood-energy market. On average, firms in the Power and Utility sector entered into the wood-energy market earlier than other sectors, while the pellet sector entered the market in 1998, on average. The earliest any firm reported entering into the wood-energy market was in 1890, while the latest was 2014. Both power/utility and harvest and transportation sectors reported higher variability in their market entry years, while pellet producers and institutional users reported slightly lower variability. See table 13 for more information on when firms were entering the wood-energy market.

Respondents also were asked to report the amount of full-time equivalent (FTE) employees involved in woody biomass that their firm employs. The power and utility sector was the largest employer of people, employing more than 50 people per firm on average. The institutional sector employed just over 9 people per firm on average, the least of any sector. As there were no responses from California's pellet and institutional sectors, no firm employment totals were reported. Aside from power and utility firms, Pacific Northwest firms typically employed more FTE employees than did firms in the Lake States. Table 14 shows mean FTE employees per firm that work in wood-energy.

Table 13 Business yr. entry into biomass (mean yrs)

Sector	Firm mean yr. entry in biomass	Min (Max) year	StdDev
Pellet Production	1998	1938 (2011)	18.69
Power/Utility	1988	1896 (2014)	26.94
Institutional	1990	1914 (2012)	18.69
Harvest and Transport	1990	1890 (2012)	24.73
Total	**1990**	**1890 (2014)**	**23.06**

Table 14 Mean Full-Time Equivalent employees per firm

State/Region	Harvest and Transport	Pellet Production	Power/Utility	Institutional
Michigan	11.9	9.5	18.1	2.4
Minnesota	5.9	4	30.2	2.9
Wisconsin	12	14.3	132.8	11.1
California	3.3	N/A	59	N/A
Oregon	14.3	22.6	48.8	1.2
Washington	5.7	10.5	15	32.5
Lakes States	9.3	11	52.7	5.4
PNW states	11.4	19.1	50.7	13.7

4.11 Total annual biomass harvested

Harvest and transportation sector respondents were asked to estimate the total amount of biomass harvested in 2013. A total of 37 of 62 respondents in this sector provided harvest data (60%). Table 15 below reports mean bone dry ton (bdt) harvest per facility by state and sector. The highest mean bdt, Washington, reported a mean bdt per facility of 267,500. Only two facilities from WA provided their harvest totals, and both facilities were greater than 170,000 bdt/year. Pacific Northwest states reported mean bdt per respondent as 110,764, while we saw 14,136 mean bdt per respondent in the Lakes States. There were 17 respondents from the PNW states able to provide their annual volume, while 20 respondents from the Lakes States did the same.

Table 15 Harvest and Transport sector - Total annual volume of biomass harvested

State	Mean BTD/Facility	Max	Min	n responses
California	6,031	6,563	5,500	2
Oregon	58,762	250,000	50	13
Washington	267,500	360,000	175,000	2
Minnesota	14,653	35,000	74	7
Wisconsin	16,464	25,000	6,000	7
Michigan	11,292	30,000	500	6
Total	**43,150**		**31,187**	**37**

4.12 Annual raw material consumption/total annual output

The pellet and power/utility sectors provided annual material consumption and production output totals for 2013. Pellet producers in all states aside from California reported similar outputs. All units are showed in bdt, with the exception of the power/utility sector in annual output, which is displayed in MWh. Pellet companies in western states reported slightly higher outputs than Lakes states. Power/utility facilities in the Lakes states, however, reported nearly three times the amount of mean electricity output per facility than their counterparts in the PNW. The table 16 shows mean annual facility consumption as well as mean annual output for pellet producers and power/utility companies.

Table 16 Mean annual consumption (bdt) and output (bdt and MWh) per facility

Sector/State	Annual consumption	Annual Output
Pellet Production	**(bdt)**	**(bdt)**
MI	25,314	24,555
MN	15,000	15,000
OR	74,800	42,600
WA	40,000	35,500
WI	29,125	28,500
Total	**42,922**	**31,951**

Power/Utility	(bdt)	(MWh)
CA	352,467	110,246
MI	181,821	217,091
MN	166,158	200,175
OR	655,019	108,007
WA	94,667	5,012
WI	204,088	411,250
Total	**278,941**	**171,250**

California had one respondent from the power/utility sector that did not use chips or pellets, but rather walnut shells, which were used for firing the driers. The facility consumed roughly 350 bdt of shells annually. Institutional users also provided their annual raw material consumption in chips or pellets. Table 17 below shows the reported totals.

Table 17 Institutional Sector - Mean annual raw material consumption

State	Mean BDT/Facility
MI	1,427
MN	4,832
OR	149
WA	9,243
WI	26,206
Total	**8,426**

4.2 Significant business changes

A significant change can be described as, but not limited to, a change a business undertook to stay competitive, increase efficiencies or output, open up new markets, or research potentially new products and services. Also, a firm may conduct research and development on new and efficient facilities or a pilot plant, and decide not to implement the change. The firm still retained the knowledge and research that was invested, which is considered an innovation.

Not all innovation leads to a physical change, and the information gained can be applied in the future if the company so desires.

Respondents were then prompted about significant changes that the company had made related to wood energy production. The respondent was presented examples showing that changes could be anything such new equipment, processes, products, supply sources, locations, or anything else that affected their business or their ability to produce and/or use biomass.

In terms of the types of changes that firms were employing, respondents were asked to list three most significant business changes relating to wood energy that their business had made in the previous five years. Out of 175 respondents, 228 total significant changes were identified. Significant business changes in each supply chain sector in each state were identified and contrasted with policies within and across states to study a wide range of approaches used. In addition, the same significant business changes and their correlated policy (if applicable) were then contrasted across states and regions to classify the mix of policy instruments that produce improved bioenergy production and innovation.

Although Oregon had 27% of the total responses in the study, the state also reported 31% of the total business changes (71), more than any other state, with nearly half (31) being implemented by the harvest and transport sector. Washington had the least total changes, with 17. Cumulatively, the harvest and transport sector reported the most total changes (75) across all six states, while the pellet sector reported the least, with 22.

Table 18 below shows significant change totals in each state by sector and the ratio of changes to response. The ratios help illustrate how active each sector was regarding business innovation. California reported the highest innovation ratio (1.69) of any individual state without any business changes recorded from the pellet and institutional supply chain sectors. The lowest innovation ratio for a single state was Michigan (1.00). However, Michigan's institutional sector was relatively strong (1.75), easily making it Michigan's most

active sector regarding business change. As a whole, power and utility facilities from all states reported the highest innovation ratio for significant business changes in the wood energy market. The ratio helps shed light on how active individual facilities are within their supply chain and policy climate in their state. Table 18 displays total changes by region and change ratios by region.

Table 18 Business Change Ratios (changes per sector/responses per sector) with significant change total in parentheses.

State	Harvest and Transport	Power/ Utility	Pellet Production	Institutional	Total
CA	1.60 (8)	1.73 (19)	0.00 (0)	0.00 (0)	**1.69 (27)**
OR	1.29 (31)	2.14 (15)	2.40 (12)	1.08 (13)	**1.48 (71)**
WA	0.75 (3)	1.67 (5)	0.50 (1)	1.33 (8)	**1.13 (17)**
MN	1.22 (11)	1.78 (16)	1.00 (1)	1.00 (16)	**1.26 (44)**
WI	1.40 (14)	1.33 (8)	1.75 (7)	0.92 (11)	**1.25 (40)**
MI	0.80 (8)	0.86 (6)	0.25 (1)	1.75 (14)	**1.00 (29)**
Total	**1.21 (75)**	**1.60 (69)**	**1.38 (22)**	**1.15 (62)**	**1.30 (228)**

Table 19 Business Change Ratios by region and sector with total significant changes in parentheses

State	Harvest and Transport	Power/ Utility	Pellet Production	Institutional	Total
Lakes	1.14 (33)	1.36 (30)	1.00 (9)	1.14 (41)	**1.18 (113)**
PNW	1.27 (42)	1.86 (39)	1.86 (13)	1.17 (21)	**1.46 (115)**
Total	**1.21 (75)**	**1.60 (69)**	**1.38 (22)**	**1.15 (62)**	**1.30 (228)**

Aside from institutional users, supply chains in each region were relatively similar in changes reported, and both regions' pellet industries had the least amount of business changes. For the entire study, the vast majority (91%) of changes fell under equipment, operational, and process categories. Of that total, 51% were found in the Pacific Northwest and 49% were found in the Lake States. Both regions had relatively large numbers of equipment changes for their harvest and transportation sectors. In the PNW, new equipment additions such as

skidders, chippers, semis, and trailers accounted for nearly half (48%) of the sector's changes in relation to wood energy production. Equipment upgrades, though not necessarily new equipment, accounted for 17%. In the Lake States, those numbers were similar, at 53% and 10%, respectively.

The Lake States had double the institutional changes than the PNW states. However, the Lake States also had 2.77 times the total number of institutional firms contacted than did the PNW states, at 130 to 47. There were 36 institutional responses in the Lakes States versus 18 in the Pacific Northwest states. The large majority (85%) of institutional changes in the Lakes States were clustered in equipment and process changes. These typically consisted of new or upgraded boiler installations, increased material storage, additional advanced technologies, as well as energy efficiency improvements for sustainability. One explanation for more institutional changes in the Lake States would be that facilities there have been around longer than Pacific Northwest institutional facilities. Four facilities in the Lake States reported changes from 1995 and older, while the oldest change in the PNW was reported in 2000. However, since 2008, the Lake States reported 17 changes, while the PNW reported 18. Institutional business changes in the Pacific Northwest were more spread out by change type, and there were three institutional users in the Pacific Northwest that made their change solely on the premise of wanting to cut out fossil fuels from their business opposed to only two in the Lake States.

Equipment-based changes were prevalent in the power and utility sector. In the Lake States, 14 (47% of sector total) changes fell under this category, and included new biomass plants, upgrades to existing equipment (general), additional boilers and boiler upgrades, air quality kits, and new steam turbines. Power companies reported 9 (30% of sector total) process changes like general plant processing efficiency improvements, alternative fuel usage, and diversifying source material like railroad ties and walnut shells. Operational changes (6, 20% of sector total) consisted of an existing company entering into the biomass

market (4 changes), as well as implementation of new programs, such as facility-wide quality control programs. Pacific Northwest power and utility companies' change totals mirrored the Lakes States in operational, process, and equipment changes, but had slightly higher change totals. All but one change came in these three categories. Fifty-four percent (21) of the changes in this sector for the Pacific Northwest were also equipment-based changes. Evenly spread out, they were new boilers, general equipment upgrades to existing utilities, new equipment purchases (conveyor systems, turbines), and new biomass plant additions. Outside of the one research and development change (market development and research for dedicated energy crops), the remaining 17 changes fit into process (10) and operation (7) changes. Process changes here included technological advances (CPU controlled facility sections, gasification improvements) and increased residue usage for electricity production. Operational changes included two new biomass facilities, a substantial increase in overall production, quality control program implementation, and the addition of a second energy stream to subsidize the original when the market slows. Tables 20 and 21 below tabulate type of change for each region and state, as well as supply chain.

Table 20 Change type by region and state

State	Sector	Equipment	Market force	Operational	Process	R & D	Unknown	All
CA	Harvest and Transport	7	0	0	0	0	1	**8**
	Institutional	0	0	0	0	0	0	**0**
	Power/Utility	6	0	4	9	0	0	**19**
	Pellet Production	0	0	0	0	0	0	**0**
	All	13	0	4	9	0	1	**27**
MI	Harvest and Transport	5	1	2	0	0	0	**8**
	Institutional	9	0	1	4	0	0	**14**
	Power/Utility	1	0	1	4	0	0	**6**
	Pellet production	0	0	0	1	0	0	**1**
	All	15	1	4	9	0	0	**29**
MN	Harvest and Transport	6	0	2	3	0	0	**11**
	Institutional	8	0	5	3	0	0	**16**
	Power/Utility	11	0	4	1	0	0	**16**
	Pellet production	1	0	0	0	0	0	**1**
	All	26	0	11	7	0	0	**44**

State	Sector	Equipment	Market force	Operational	Process	R & D	Unknown	All
OR	Harvest and Transport	21	0	3	5	2	0	**31**
	Institutional	7	2	2	0	2	0	**13**
	Power/Utility	11	0	2	1	1	0	**15**
	Pellet production	8	2	1	1	0	0	**12**
	All	47	4	8	7	5	0	**71**
WA	Harvest and Transport	2	0	1	0	0	0	**3**
	Institutional	3	0	1	4	0	0	**8**
	Power/Utility	4	0	1	0	0	0	**5**
	Pellet production	0	1	0	0	0	0	**1**
	All	9	1	3	4	0	0	**17**
WI	Harvest and Transport	11	2	1	0	0	0	**14**
	Institutional	7	0	0	4	0	0	**11**
	Power/Utility	2	1	1	4	0	0	**8**
	Pellet production	0	1	0	1	5	0	**7**
	All	20	4	2	9	5	0	**40**
All	**All**	**130**	**10**	**32**	**45**	**10**	**1**	**228**

Table 21 Change type by region and sector

Region	Sector	Equipment	Market force	Operational	Process	R & D	Unknown	All
Lakes	Harvest and Transport	22	3	5	3	0	0	**33**
	Institutional	24	0	6	11	0	0	**41**
	Power/Utility	14	1	6	9	0	0	**30**
	Pellet production	1	1	0	2	5	0	**9**
	All	61	5	17	25	5	0	**113**
PNW	Harvest and Transport	30	0	4	5	2	1	**42**
	Institutional	10	2	3	4	2	0	**21**
	Power/Utility	21	0	7	10	1	0	**39**
	Pellet production	8	3	1	1	0	0	**13**
	All	69	5	15	20	5	1	**115**
All	**All**	**130**	**10**	**32**	**45**	**10**	**1**	**228**

4.3 Policy Results

Each state represents its own unique policy climate, making effective policy creation more difficult because wood energy supply chains often cross political boundaries. Understanding if policies are impacting business changes is important for policy makers to be able to understand. More focus can be asserted to supply chain sectors that are stagnant or underperforming. For this study, two policy classification schemes were used: primary and secondary. Primary classifications are the umbrella category for all policies collected for the

study. Secondary classifications are subsets of primary classification, and are typically more detailed. See table 2 in Chapter 2 for a list and examples.

The following two tables serve as a precursor to the next few subsections. Table 22 displays total policies cited by each sector in each state, and table 23 displays the same information, but by region.

Table 22. Policy type totals identified by State and Sector

State	Sector	Tax Policy	Gov Regulations	Gov involvement	Disbursement	R&D	Gov Services	Other	All
CA	Harvest and Transport	0	1	0	3	0	0	0	**4**
	Institutional	0	0	0	0	0	0	0	**0**
	Pellet Producer	0	0	0	0	0	0	0	**0**
	Power/Utilities	1	3	1	2	2	0	0	**9**
	All	1	4	1	5	2	0	0	**13**
OR	Harvest and Transport	20	1	0	6	0	0	1	**28**
	Institutional	1	0	0	6	0	1	4	**12**
	Pellet Producer	2	1	0	2	0	0	2	**7**
	Power/Utilities	12	3	0	0	0	0	0	**15**
	All	34	5	0	14	0	1	7	**62**
WA	Harvest and Transport	0	0	0	1	0	0	1	**2**
	Institutional	0	1	0	1	0	0	2	**4**
	Pellet Producer	0	1	0	0	0	0	0	**1**
	Power/Utilities	3	1	0	1	0	1	0	**6**
	All	3	3	0	3	0	1	3	**13**
MN	Harvest and Transport	0	0	0	3	0	0	1	**4**
	Institutional	0	0	0	3	0	0	0	**3**
	Pellet Producer	0	0	0	0	0	0	1	**1**
	Power/Utilities	3	1	0	1	0	0	0	**5**
	All	3	1	0	7	0	0	2	**13**
WI	Harvest and Transport	2	0	0	3	0	0	0	**5**
	Institutional	0	1	0	1	0	0	0	**2**
	Pellet Producer	1	0	0	1	0	0	0	**2**
	Power/Utilities	0	0	1	3	0	0	0	**4**
	All	3	1	1	8	0	0	0	**13**
MI	Harvest and Transport	0	0	0	1	0	0	0	**1**
	Institutional	0	1	0	4	0	0	1	**6**
	Power/Utilities	0	0	0	0	0	0	1	**1**
	Pellet Producer	0	0	0	0	0	0	0	**0**
	All	0	1	0	5	0	0	2	**8**
All	**All**	**43**	**15**	**2**	**42**	**2**	**2**	**14**	**122**

Table 23. Policy type totals identified by Region and Sector

Region	Sector	Tax Policy	Gov Regulations	Gov involvement	Disbursement	R&D	Gov Services	Other	All
Lakes	Harvest and Transport	2	0	0	7	0	0	1	**10**
	Institutional	0	2	0	8	0	0	1	**11**
	Pellet Producer	1	0	0	1	0	0	1	**3**
	Power/Utilities	3	1	1	4	0	0	1	**10**
	All	6	3	1	20	0	0	4	**34**
PNW	Harvest and Transport	20	2	0	10	0	0	2	**34**
	Institutional	1	1	0	7	0	1	6	**16**
	Pellet Producer	2	2	0	2	0	0	2	**8**
	Power/Utilities	16	7	1	3	2	1	0	**30**
	All	39	12	1	22	2	2	10	**88**
All	**All**	**45**	**15**	**2**	**42**	**2**	**2**	**14**	**122**

Each respondent was given the chance to correlate any of the policy instruments with any business changes. This was done by asking each respondent first why they made the change followed by if their business took advantage of any of the policies listed on the timeline that was provided. One change may have been correlated with multiple polices, as some businesses were better than others at diversifying their policy program applications.

Each change was compared and contrasted by state, sector, and region against both primary and secondary classifications. Table 24 displays policy utilization ratios for significant changes in each state in their respective sectors. The ratios were derived by taking the total policies cited in each respective sector and state, by the total significant business changes in the same sectors. These ratios can be referred to when looking at state policy usage in the next section. For a complete list of policies by name that were reported in each region, along with how many times they were cited, please see Appendix 4.

Table 24. Ratio (policies/changes) of policies correlated directly with a business change – all states by sector

State	Power/Utilities	Harvest and Transportation	Pellet Producer	Institutional User	Total
CA	0.47	0.50	0.00	0.00	**0.48**
MI	0.17	0.13	0.00	0.43	**0.28**
MN	0.31	0.36	1.00	0.19	**0.30**
OR	1.00	0.90	0.58	0.92	**0.85**
WA	1.20	0.67	1.00	0.50	**0.76**
WI	0.50	0.36	0.29	0.18	**0.33**
All	**0.60**	**0.50**	**0.50**	**0.44**	**0.54**

4.31 California

Out of 16 respondents and 27 total business changes, there were 13 policies utilized by California wood-energy businesses. Since the populations of both the pellet and institutional sectors were zero, analysis was only conducted on harvest and transportation sector, and the power and utilities sector. Figure 5 displays clustered change types by policy instrument for California. This figure provides a snapshot of where policy types are clustered regarding innovation and change. Each sector's density is based on its own policy count, illustrated at the top of the graph.

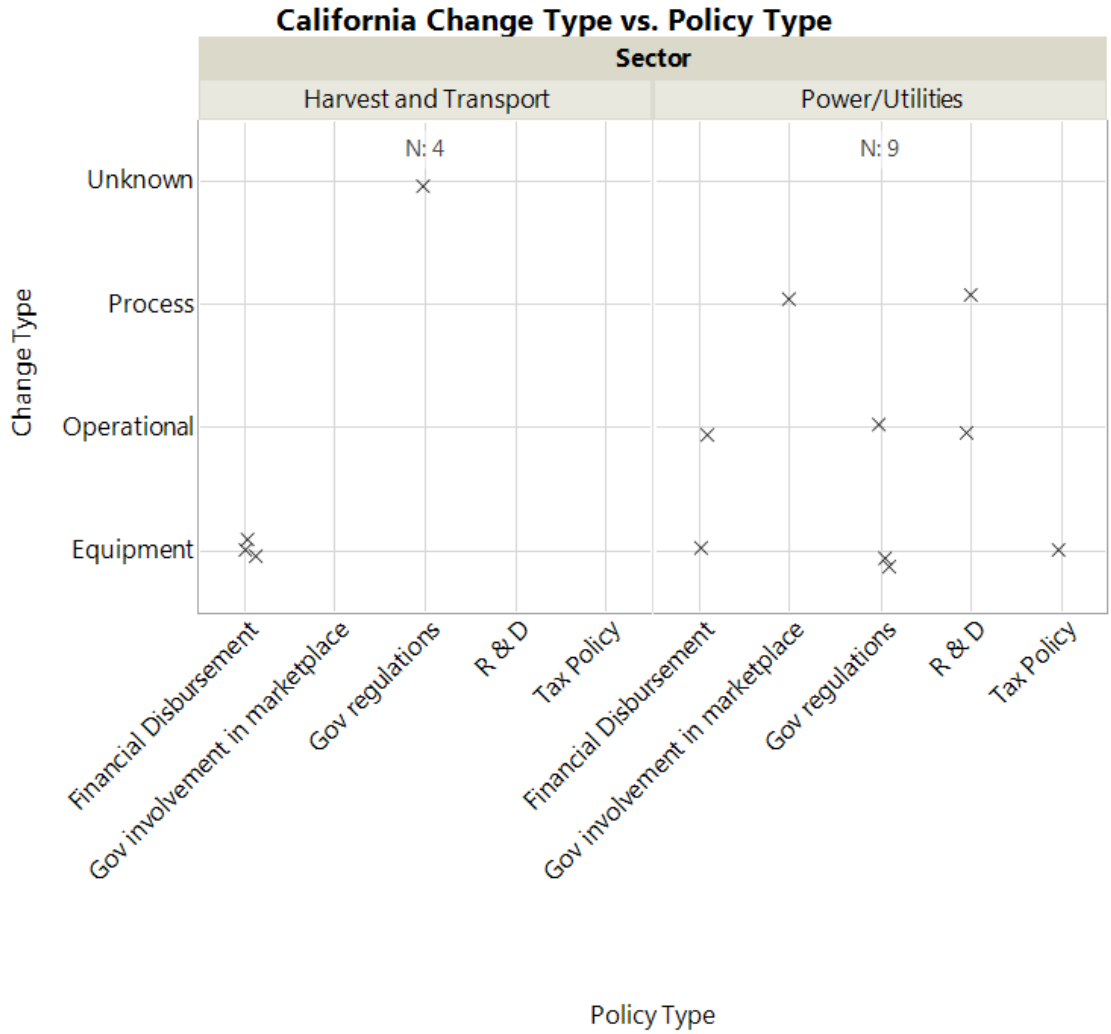

Figure 5 California change type by policy type in each sector

Harvest and Transportation

Out of the five harvest and transportation businesses interviewed in California, three provided information on policies that influenced their business change. One firm utilized a federal grant to purchase new equipment; both the grant and equipment types were unknown. The same firm reported that unknown government regulations caused a business change, but did not list a specific type of change nor policy. A second firm took advantage of a federal grant to purchase harvesting equipment, but the grant type was unknown. The

third firm cited the USDA's Biomass Crop Assistance Program (BCAP) as helpful in obtaining funds to purchase transportation equipment (semi, trailer, etc.), but was unable to go into more detail. BCAP is a federal program administered by the Farm Service Agency (FSA) which utilizes Commodity Credit Corporation (CCC) funds to help match payments to eligible material owners for the delivery of qualified feedstock to biomass conversion facilities (Federal Register 2015). The program allows qualified producers to produce or harvest biomass crops on specified contracted acres within BCAP project areas. However, the same firm that utilized BCAP in the past reported that they were on their way out of business. The firm mentioned that the state of California enacted the Renewable Energy Portfolio, which the respondent claimed helped smaller firms (3 MWh's of electrical generation), but wished the law included larger businesses. The firm felt they could try to expand, as facilities would have to utilize larger amounts woody biomass to meet environmental standards. The business also cited that in 2014, state and federal agencies burned slash that is left over, which could be used for electricity. It was noted by multiple firms in the harvest and transportation sector that having access to slash and litter on public lands would be a benefit to their business, and likely expand the entire supply chain. A handful of respondents all shared the same viewpoint on the difficulty that takes place obtaining source material from public lands (namely federal), and expressed concern for the wasted material. It was found that many of the firms thought the actions by public land managers to burn residue are outdated and need to be addressed.

Power/Utility

There were 11 responses from power and utility companies in California, but only identified one general tax credit that assisted with equipment upgrades and routine maintenance in 1992; the specific policy is unknown or if it was employed at the state or federal level. The Public Utility Regulatory Policies Act

(PURPA), was cited as influential for one firm installing a new boiler in 1998. PURPA, originally enacted in 1978 by Congress, was established to increase energy efficiency awareness as help utilize more domestic renewable energy (Public Utility Regulatory Policies Act of 1978, Pub.L. 95–617 1978). The implementation of PURPA was left to individual states. PURPA assisted this respondent by requiring large non-renewable energy companies to purchase renewable energy from their firm. This helped this firm to install a new boiler based on speculation that they would need to purchase green energy to meet the requirement set forth by PURPA.

California's Renewables Portfolio Standard drove two firms to improve facility efficiencies. One facility added a BioMax 100 system in 2010, to convert woody biomass into usable forms of power and heat (Community Power Corporation 2015). This same facility also cited a general energy grant which helped offset costs for the new Biomax 100 system. The other facility upgraded their emissions technologies as well as maintenance upkeep. The Renewables Portfolio Standard requires electricity providers to increase procurement from renewable resources to 33% by 2020 (SB 1078, 2002).

Two other policies that power and utility companies cited to be beneficial were: the Public Interest Energy Research (PIER) and the Self-Generation Incentive Program (SGIP). The PIER program, which is no longer accepting projects, but existing projects are funded through the end of 2015, was originally enacted to foster research and development programs that drive innovation and help advance renewable energy technologies and efficiencies (California Energy Commission 2015). The Self-Generation Incentive Program (SGIP) offers rebates ranging from $0.44 - $1.65/W to firms who produce electricity with various forms of renewable electricity, including cogeneration of heat and power, emerging technologies (SB 412, 2009).

One firm cited two other general policy types: research and development funding, and potential for purchase agreements with the United States military.

This company used its research dollars to invest in updated gasification fuel cell technology in 2013.

Areas to highlight:

- Equipment and facility upgrades made up 54% of policies associated with a business change
- No state policies were utilized in the harvest and transportation sector
- All state policies utilized (4) were in the power/utility sector
- The only two (2) demonstration and research-based changes linked to policy in any of the six states were in California's power/utility sector
- Of reported policies, state and federal policies were relatively even (4:5), 4 unknown level
- Unlike other states, the harvest and transportation sector did not report the use of any tax policies

4.32 Oregon

Oregon businesses were by far the most active state regarding utilization of biomass polices. Of the 48 responses, firms cited 62 policies as influential on their 71 total significant business changes. Figure 6 shows policy types identified in each sector in Oregon based on the type of change that the business made. Pellet businesses in Oregon identified only 7 total policies that were spread out between tax policies for equipment and process-based changes to market-forced changes that garnered each business a financial disbursement.

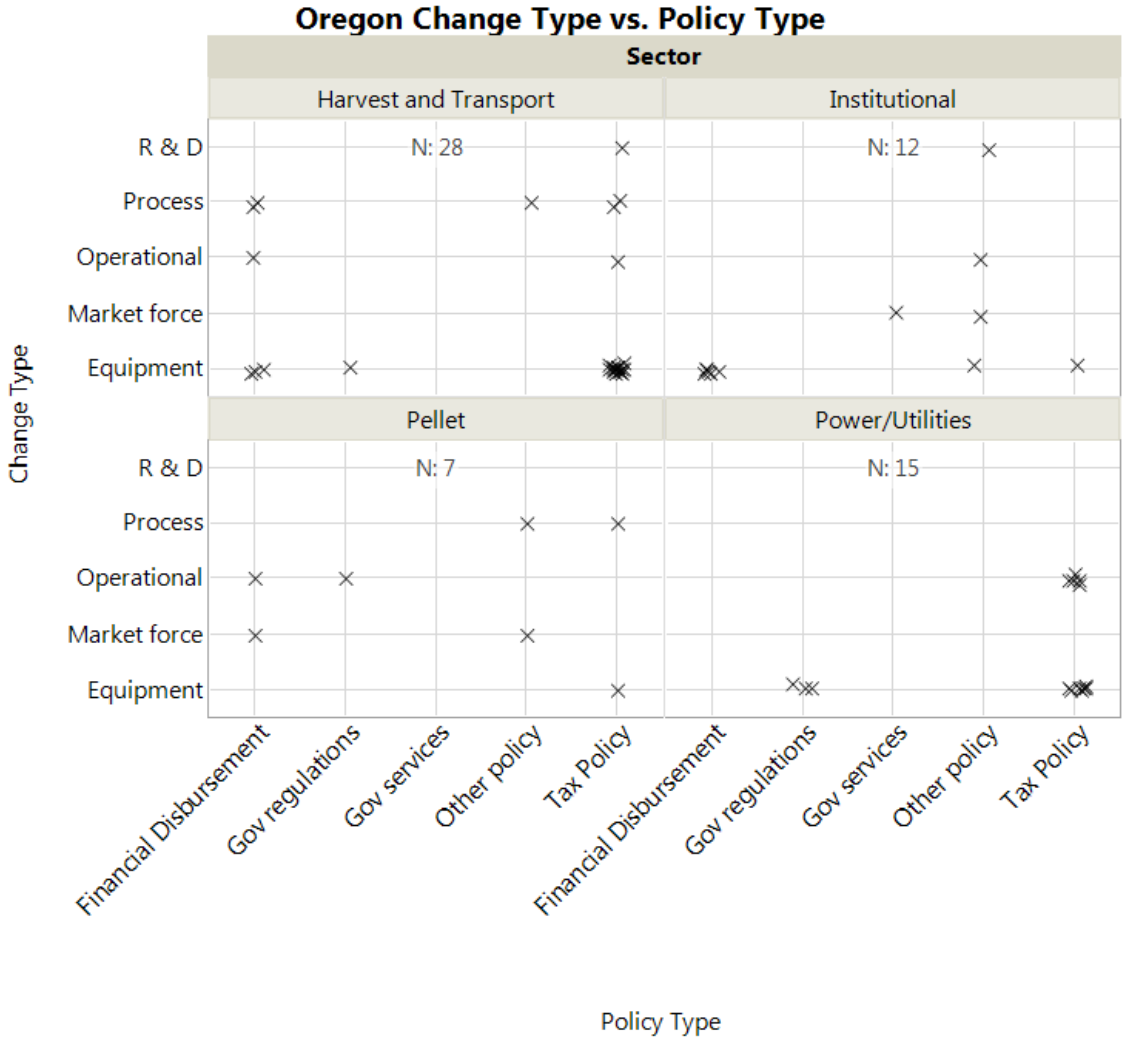

Figure 6. Oregon change type by policy type in each sector

Harvest and Transportation

This sector had the largest response total of any sector surveyed, with 24 respondents. The harvest and transportation sector identified the vast majority of policies reported in the state, with 28 (46%). Of those 28 policies, 20 (71%) were tax-based policies. Of these tax credits, four businesses could not specify a policy name. Remaining businesses cited the Business Energy Tax Credit (BETC) five times between 2006-2009 regarding equipment purchases such as grinders, chippers, trucks and semis, and a new boiler.

The Biomass Producer or Consumer Tax Credit (BPC) was identified seven times by loggers as effecting their business change. These changes took place between 2006 and 2012, with three in 2011. BPC, which is still an active program, targets agricultural producers and collectors of biomass. The $10/dry ton credit can be applied for qualified biomass used to produce biofuel; biomass used in facilities such as those producing electricity from anaerobic digestion, pellets, or torrefaction also qualifies (ORS 315.141 2013). Biomass used as biofuel or used to produce biofuel - in a solid, liquid or gaseous state - qualifies for this tax credit. The production or collection of biomass must take place in Oregon and must also be used in Oregon. Certain types of biomass are ineligible for this credit, including biomass to be used for firewood or charcoal, construction and demolition debris, urban wood waste, yard debris, residual wood waste generated at a mill (such as sawdust or bark), algae, and material from pre-construction or construction activities and golf courses (ORS 315.141 2013). Six businesses cited that the policy helped by allowing purchases of a chipper, grinder, and excavator. One respondent said their business was negatively impacted by BPC, explaining an increase in business that would not have otherwise been involved in the market drove down woody biomass prices, causing their facility to scale back overall production.

Another specific policy that was widely cited by the harvest and transportation sector was BCAP. Five businesses reported BCAP as influential on their operation, by providing financial assistance that included feedstock diversification (process change) in 2002, a new wood chipper and also a new stump splitter, both in 2011. One of those five businesses said BCAP assisted with opening access to remove small diameter woods from local forestlands in 2006. However, another business cited BCAP as being a detrimental factor in lowering woody biomass prices in 2011, which caused them to scale back production.

The Tax Credit for Renewable Energy Resource Equipment Manufacturers (TCREEM) was cited 5 times by businesses in the harvest and transportation sector, all for equipment changes. TCREEM was enacted in 2007 as part of Oregon's Business Energy Tax Credit (BETC) to financially assist companies that manufacture systems that harness energy from wood waste or other waste sources from forests, wind, water, geothermal, solar, farm waste, or other non-petroleum plant or animal based biomass (ORS 315.341 2011). The tax credit can be applied to cover up to 50% of the construction costs of a new facility as well as machinery, and can also be applied to cover up to 50% of improving existing facilities (ORS 315.341 2011). The 50% credit is taken over 5 years at 10% per year, with a $20 million maximum credit; this was expanded from $10 million in 2008 (ORS 315.341). The changes that Oregon respondents reported with assistance from TCREEM were new wood chippers, new wood loaders, and a new horizontal grinder. All changes took place between 2007 and 2011.

Institutional users

Oregon's second largest respondent totals came from the institutional sector, with 12. Institutional users reported 12 policies relating to their significant business changes. The majority (67%) were found to be equipment-based changes, although many businesses were not able to cite a specific policy. Respondents cited general policy instruments for 60% of their changes. Specific policies mentioned were the Business Energy Tax Credit (BETC), and the American Recovery and Reinvestment Act. The BETC was cited once by an elementary school, which installed a wood biomass boiler in 2011. The American Recovery and Reinvestment Act (ARRA) is a federal policy enacted in 2009 that has a broad mission of spurring economic growth and producing jobs, while initiating clean energy projects across the country (American Recovery and Reinvestment Act 2009). One business in this sector reported that this policy

assisted with “diversifying biomass market opportunities” in 2009, while another reported that the policy helped their business “remove fossil fuels” from their operations in 2009.

Pellet Producers

Oregon’s pellet industry reported fewer total policies (7), and they were not clustered in any specific area on the density graphs. This could be attributed to a low response total of only 5 respondents. Nonetheless, pellet producers cited the following specific policies: Oregon Business Energy Tax Credit (BETC), Biomass Producer or Consumer Tax Credit (BPC), and Biomass Crop Assistance Program (BCAP). BETC allowed one facility to double its physical size in 2008, allowing for increased production. Another pellet producer reported that in 2013, BPC was positively influential in helping stabilize supply of material source used for production. Lastly, one pellet facility cited international agreements with Japan and Korea as being influential in future outlook, as the respondent felt the local market was sluggish. These agreements took place in 2011, and it was unclear if the business was referring to an actual policy or general market influences.

Power/Utility

There were 7 respondents in Oregon’s power and utility sector. This sector had little variability in policy instruments as types of changes. Those businesses only utilized tax policies for equipment and operational changes, citing regulations that pushed three businesses to implement an equipment change.

It was observed that most equipment changes in the power/utility sector included the addition of a new plant or biomass facility or additional equipment purchases and upgrades. One facility was actively and aggressively trying to develop a market for unspecified dedicated energy crops. The Oregon Business

Energy Tax Credit (BETC) was reported by four different power companies as influential in their changes, and was the most cited policy in this sector.

BETC is a non-refundable state tax credit against Oregon personal and corporate income taxes based on the certified cost of qualifying investments in energy conservation, recycling, renewable energy resources, or reduced use of polluting transportation fuels (Kimmelfield 2008). Enacted in 1979, the BETC was significantly expanded in 2007, and again in 2008 to boost alternative energy expansion (Kimmelfield 2008). Alternative energy was described as a system that uses biomass, solar, geothermal, hydroelectric, wind, landfill gas, biogas or wave, tidal or ocean thermal energy technology to produce energy (OR HB3672 2011). Two of the changes power and utility businesses reported were facility equipment related, i.e. utilizing the credits for plant equipment upgrades such as a new steam turbine and updating hot water recovery systems. These took place in 2007 and 2011. Two operational changes that BETC assisted with in the same sector were the additions of cogeneration of heat and power (CHP) facilities by two separate businesses in 2009 and 2011. One power facility cited Oregon's Renewable Energy Portfolio Standard (RPS), which required new designs, sourcing, and building of a test torrefaction facility in 2013. The same facility also indicated that the Clean Air Act had implications on the RPS, influencing their change by needing to update emissions equipment on site. The RPS requires the largest utilities in Oregon to provide 25 percent of their retail sales of electricity from newer, clean, renewable sources of energy by 2025 (ORS. 469A, 2014). Other polices reported by this sector were general, and stayed within operational and equipment change categories. These policies were cited as "energy tax credit", "federal tax credit", or "government regulations."

As a state, Oregon wood-energy businesses cited state policies more often than any other governmental level of policy. There were 32 state policies, 20 federal policies, 8 where the level of government was unknown, one policy

that covered at least two levels of government and one that cited international agreements.

Areas to highlight:

- Harvest and Transportation firms had half of all state policies (popular with BETC, BCP, etc.)
- Harvest and Transportation firms reported state policy usage to federal policy usage by nearly a 3:1 ratio
- Power/Utilities were nearly split between federal and state (4:3)
- Institutional reported more impact/assistance from federal policies than state
- Pellet producers reported more federal policies than state policies
- Tax credits accounted for 55% of all policy types reported
- Tax credits correlated highly with equipment-based changes/upgrades across all sectors (especially harvest and transportation), except institutional users
- Almost half (42%) of all policies reported by the institutional sector were grants for equipment-based changes

4.33 Washington

Of 15 respondents, Washington state bioenergy firms identified 13 polices that were influential in their business decisions. A total of 17 business changes were cited. Nearly half (6) of the associated policies occurred with power and utility companies (figure 7).

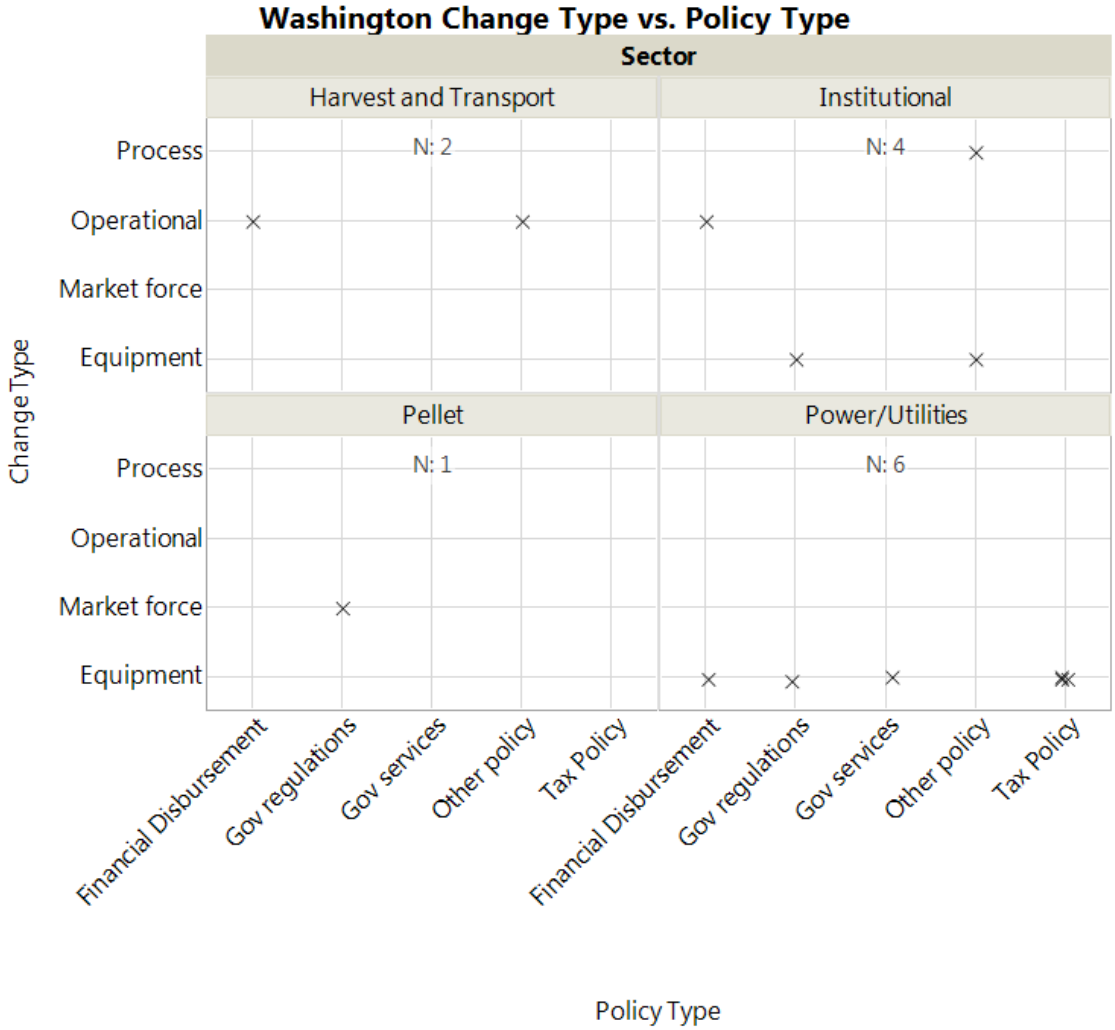

Figure 7 Washington change type by policy type in each sector

Harvest and transportation

Washington's harvest and transportation sector was underwhelming in reporting policies associated with business changes. This can be partially attributed to the estimated low population (20) of wood-energy businesses that exist in the state. In addition, it was difficult in Washington to discern harvest and transportation firms who did not participate in wood-energy versus those that did participate. Pitfalls aside, one logging firm identified the USDA Biomass Crop Assistance Program (BCAP) as helpful in obtaining woody material to later

convert to chips for sale to local biomass energy markets as well as to Mexico in 2010. The same firm also claims to have utilized general state and federal subsidies for the same change. Both policies, BCAP and the state and federal subsidies, helped this particular logging business enter into the wood-to-energy market in Washington in 2010.

Institutional users

Three institutional users cited policies that corresponded to their business changes. One business replaced their existing boiler in 2004 and described the Clean Air Act regulations as the driving force. The second firm took advantage of a state grant in 2011 that allowed the company to enter into the wood to energy market for the first time, though they were unable to specify a specific policy. The third firm made use of the Bonneville Power Administration's Energy Smart Industrial (ESI) program to add automated control systems to their operation in 2014, as well as new and more efficient equipment in 2013. The Bonneville Power Association, more well-known for its wholesale electrical power production from hydroelectric dams, is a non-profit agency based in the Pacific Northwest; and while part of the United States Department of Energy (DOE), it is self-funded by selling products and services, predominantly in the form of electricity (BPA 2015). The Energy Smart Industrial program was formed to support BPA utility customers in growing economical energy efficiency investments in the industrial sector (BPA 2015). The Energy Smart Industrial program is primed to include all Bonneville Power Association industrial sector energy-related programs in the future.

Pellet Producers

The pellet production industry in Washington is nearly non-existent. There is an estimated population of five pellet producers involved in wood energy in the state. Of the two respondents, one firm explained how government regulations

pushed them to explore new markets. As the prices fell domestically, it became more attractive to export pellet sales to Korea. They cited that the Kyoto Protocol initiated Korea into purchasing pellets. This led to the company producing bulk export sales and filling an ocean-going container instead of domestic bags. The regulations acted as a driver for the firm, and resulted in a positive outcome.

Power/Utility

Here, three firms comprised all six policies reported. One firm was able to apply a state hog fuel tax exemption in 2010 to upgrade electrical generator wiring as well as upgrade their hog fuel dryer to increase Btu efficiency. The Revised Code of Washington 82.08.956 states that hog fuel can be defined as wood waste and other residuals, including biomass; however, it does not include wood pellets or firewood (S. 1002 2013, S. 301 2009). The code also states that taxes levied by the state do not apply to sales of hog fuel that are produced for electricity use, including steam, heat, and biofuels. (S. 1002 2013, S. 301 2009). Another firm was able to diversify their policy involvement, as it reported using a general production tax credit (not specified), the USDA Biomass Crop Assistance Program (BCAP), and a partnership program called the Biomass Initiative that is overseen by the Washington Department of Natural Resources. Financial compensation due to increased feedstock access from the federal BCAP was coupled with a state production tax credit to acquire new equipment for the firm in 2004. The Biomass Initiative, originally enacted in 2009, was implemented to help foster development of forest biomass-to-energy pilot projects and demonstrations (WA HB 2165 2009). Funding for the Biomass Initiative is received through the U.S. Forest Service and also the Washington State Energy Program (SEP), which is partially funded by the federal American Recovery and Reinvestment Act (WA HB 2165 2009). The second firm utilized these funds as well as technical assistance from the Washington Department of Natural Resources to install a new biomass boiler with attached cogeneration of heat and

power (CHP) equipment. The same business mentioned that government regulations have negatively impacted their ability to procure biomass, but was also a driving force to seek out additional financial support to alleviate associated burdens to operations. This respondent did not specify particular regulations or which means of financial support were pursued.

Areas to highlight:

- Federal and state policy utilization was equal
- Power/Utility sector accounted for 46% of policies associated with a business change
- Harvest and transportation firms and pellet producers were most likely underrepresented, and had the least amount of policy usage
- Equipment-based changes (new boilers, upgrade wiring, general equipment) dominated policy usage (62%)
- No policy instrument was more instrumental than another overall, though tax policies and financial disbursements correlated mostly with equipment changes

4.34 Minnesota

Minnesota wood-energy businesses reported 44 significant changes from 35 respondents, with 13 changes being correlated to policies targeted specifically for biomass and general renewable energy operations. The estimated population of wood-energy firms in the state is 82, with half of those estimated businesses being in the institutional sector. However, Minnesota's harvest and transportation sector along with the power/utility sector were responsible for nearly 70% of policy usage, while institutional firms only cited three policies that correlated with their business changes. Figure 8 indicates policies correlated with business changes for Minnesota.

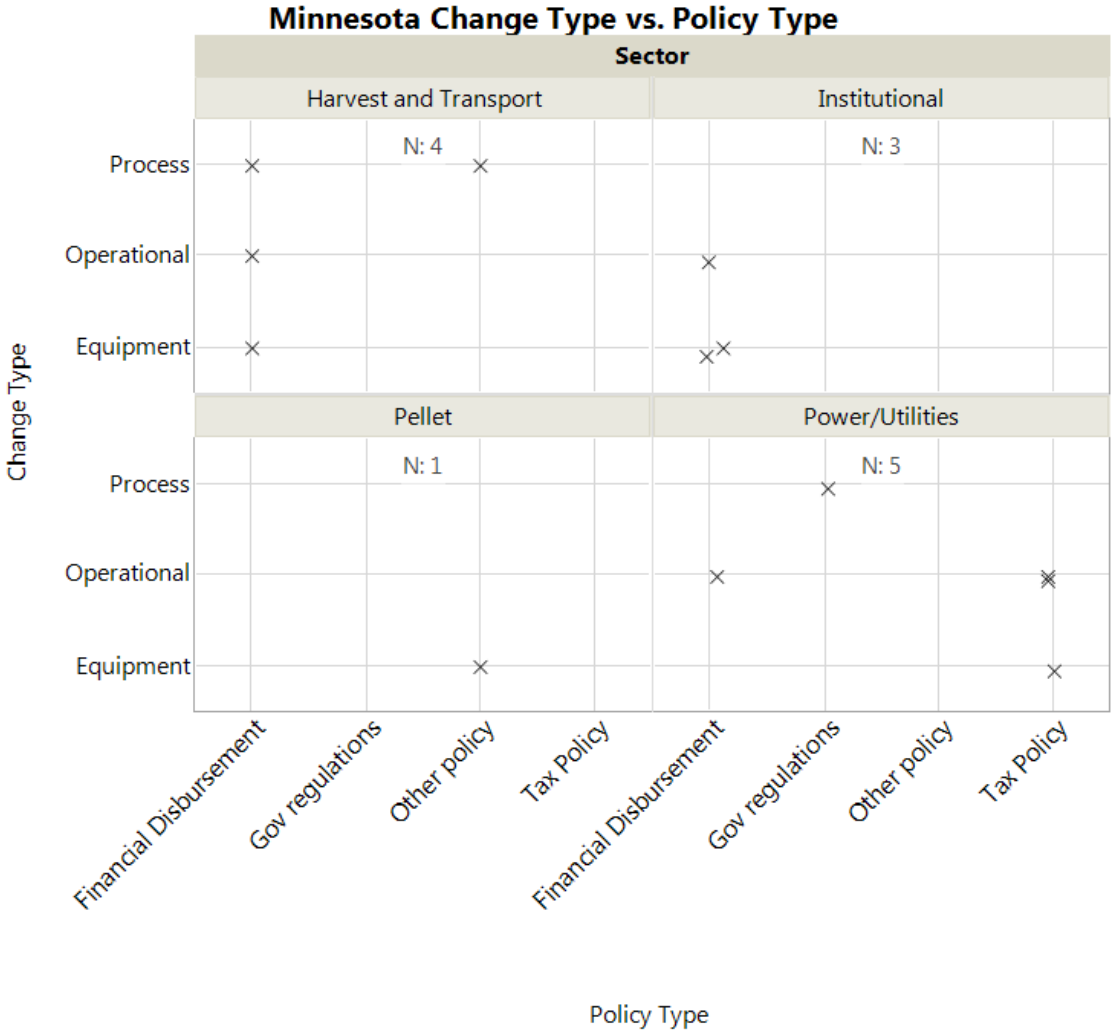

Figure 8 Minnesota change type by policy type in each sector

Harvest and Transportation

The harvest in transportation sector in Minnesota reported four polices being useful when they made their business changes. BCAP was used once by two different firms, each for different reasons. The first firm cited an operational change where BCAP helped increased total production of their business in 2006, allowing for more production and hauling. The second firm attributed BCAP with a process change in 2010 that allowed them to reduce their usage of chips for traditional forest products (i.e. hardboard products) and increased their usage of

chips for wood-based energy. The same firm also used an unspecified policy in 2010 for acquiring additional equipment for source material extraction from the forest. However, one respondent expressed concerns for the immediate outlook of wood-energy in this sector. With so few logging companies left in Minnesota, increasing output for thermal energy and electricity is difficult because many loggers have tight contracts with paper mills. The USDA's BCAP was the only identifiable policy reported by loggers and haulers in Minnesota.

Institutional Users

This sector had an estimated population of 41 businesses, while the response total was 16 firms. Of 16 total business changes reported, three policies were cited by institutional as affecting their business changes. All three policies were disbursement-based policy instrument types. One firm accounted for two of the changes, and linked policy influence to both. The first change was a general state grant that helped the company makes its inaugural conversion into wood-energy in 2008. The same company also cited a general federal Department of Energy grant that covered costs on a new storage tank installation in the same year when they were entering the wood-energy market.

Another policy cited in this sector was BCAP. In this case, BCAP subsidized fuel purchases as well as transport, allowing for more capital to be left over to upgrade a boiler. BCAP is a federal program administered by the Farm Service Agency (FSA) which utilizes Commodity Credit Corporation (CCC) funds to help match payments to eligible material owners for the delivery of qualified feedstock to biomass conversion facilities (Federal Register 2015). Currently, this program allows qualified producers to produce or harvest biomass crops on specified contracted acres within BCAP project areas. When BCAP was originally enacted within the 2008 Farm Bill, biomass volumes were measured in green tons, meaning the moisture was not removed from the material. However, when BCAP was reauthorized in 2014, controversial changes to how the

program measured biomass volumes took place. Biomass Conversion Facilities were used to convert biomass into heat, power, or other bio-based products and biofuels (USDA 2015). When a Biomass Conversion Facility signed a contract with the USDA Farm Service Agency (FSA), the FSA required these facilities to purchase biomass in dry tons (USDA 2015). As a result, the amount that is paid out is dependent upon the initial agreement, which financially hurt businesses that previously were contracted in green tons. In addition, the program no longer subsidizes transportation of forest biomass, making it solely a dedicated feedstock supply program, negatively impacting firms that relied on the transportation subsidy.

Pellet Producers

The pellet industry in Minnesota had one only response. This firm made equipment upgrades in 2013, and were awaiting qualification for a policy that was not identified.

Power/Utilities

Power companies in Minnesota reported five policies correlated with their business change(s). Low totals of cited policies in this sector made it difficult to visualize any policy clustering on figure 8. Three polices reported were tax credits that went directly towards facility improvements (including equipment upgrades) or expansions. Two of these were generally reported as a tax credit and federal tax credit, with the former being applied on a new wood drying facility in 2012 and the latter for a new turbine in 1992 that powered the cogeneration of heat and power facility. The remaining tax credit that was reported was the black liquor tax credit. Black liquor, a by-product of papermaking, is often used by the mill itself for energy purposes and heating (De Simone et. al 2014). Even though tax credits for this fuel type expired in 2009, one firm reported substantial financial gain and reinvested it back into biomass and renewable energy

development. During that time, the same firm also utilized BCAP but was unable to elaborate on how it affected the firm.

One power company identified with the Next Generation Energy Act of 2007, which established a mandate that utility companies in the state generate at least 25% of their power from renewable sources by 2025 (30% by 2025 for Xcel Energy, which is a large regional energy provider) (HF 436 2007). This policy was a rules and regulations driver for a process change in that it pushed this firm to reconstruct their fuel site for future use preparation. The firm reported that previously to the mandate, they paid to have their fuel dried before utilization. However, since they would be required to increase their production from renewable sources, and woody biomass was readily available, they decided to dry the material onsite. The firm went on to say it has been a positive experience, as it provided them with a more stable fuel supply and better quality control over material size and moisture content.

Areas to highlight:

- Harvest and Transport (4) and Power/Utility (5) make up 9 of 13 policies in MN
- All institutional users reported financial disbursements as the instrument type used
- Power/Utilities utilized more federal policies than state, at 3:1
- Pellet industry currently slow

4.35 Wisconsin

Wisconsin had 32 respondents out of an estimated population of 81 firms who reported 40 total business changes, and cited 13 total policies correlated with those changes. Policy totals were relatively split between sectors. Figure 9 displays types of business changes by their correlated policy instrument in each supply chain sector for Wisconsin.

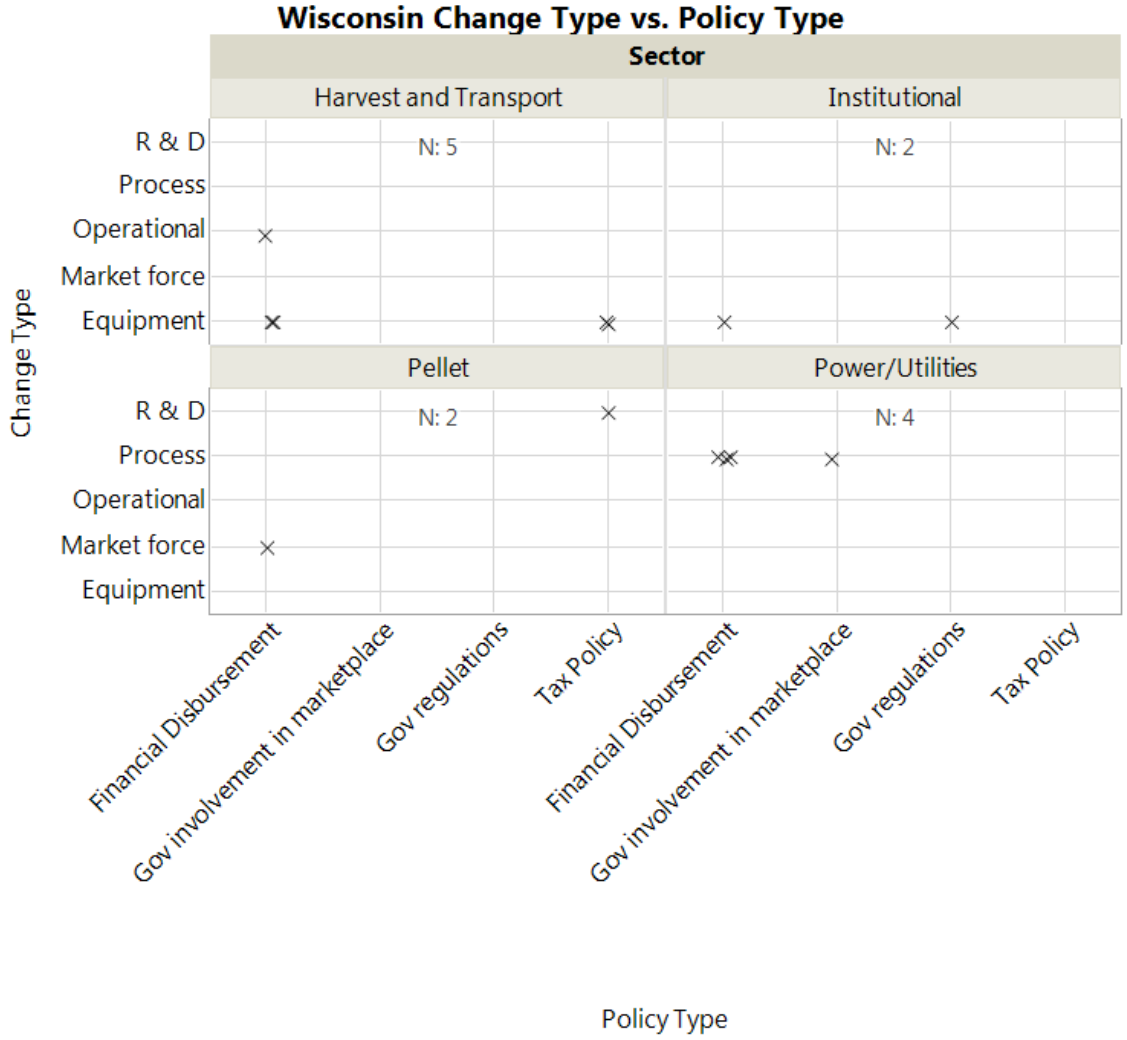

Figure 9 Wisconsin change type by policy type in each sector

Harvest and Transportation

This sector had an estimated population of 24 firms, and reported 10 responses. They cited a total of five policies associated with business changes: two tax credits, and three financial disbursements. The two tax credits were utilized by the same firm for two separate changes; one was purchasing new harvesting equipment, and the other was helpful in buying new chippers. Both changes were implemented in 2010, but the firm was unable to provide further details on these two tax credits outside of them being state imposed. Of the

three disbursement policy instruments cited, two were by the same facility for a single change. However, two separate policies were referenced. This business made an equipment change for the installation of a wood-fired boiler in 2009, and had assistance from two policies: Alliant to Energy Incentive and Focus on Energy.

Alliant to Energy Incentive is an agreement that Alliant Energy, a Midwest U.S. Energy Company primarily engaged in electric generation and the distribution of electricity and natural gas, has with the state of Wisconsin to increase energy efficiencies of existing homes and appliances in the state. The Alliant to Energy Incentive is a subset of Focus on Energy program, effectively making it part of the same policy (Focus on Energy 2015). Focus on Energy, which is now referred to as Focus on Energy: Renewable Energy Cash Back Rewards, offers incentives for installing or expanding renewable-energy systems on businesses and homes. Payments are based on the estimated amount of electricity or thermal energy produced annually by an eligible system. Eligible projects include wind, photovoltaics (PV), solar hot water, and biomass combustion (S. 35.18 2015). BCAP was also cited as allowing more source material procurement for one company in 2011, allowing them to expand into the wood-energy market by 2012. The firm cited BCAP as influential in helping them build their business over a short period of time, until the program “ran out of money.” The business did say their expenses were altered once they were no longer benefitting from BCAP, but it did not hurt their business too much.

Power/Utilities

The population of wood-energy firms in this sector in Wisconsin is estimated at 12 firms. Out of 6 responses, two firms cited 4 policies as influencing their business changes. The first facility only had one business change, but was able to spread out the financial burden over two separate policy instruments. The facility took advantage of the Focus on Energy Renewable

Energy Cash Back Rewards program as well as Green Power Purchasing to implement a process change to increase the amount of wood waste that could be burned. The original Focus on Energy program was used by one firm in two separate years (2006 and 2007) to help implement two process-based changes to their business: improving the initial biomass drying process, and increasing efficiencies of their boiler.

Institutional Users

Institutional users in Wisconsin reported only two policies correlated to significant business changes, both being equipment-based. The population in this sector was estimated at 33 firms, with 12 firms responding to the survey. The first firm that cited policy utilized Focus on Energy: Renewable Cash Back Rewards in 2012 to offset costs of new and updated boiler controls. The second firm was driven by government rules and regulations, reporting that the Occupational Health and Safety Administration (OSHA) was prominent in their installation of explosion proof technologies such as new ward gates, sensors, and dampeners in 2011.

Pellet Producers

Wisconsin's pellet industry had two facilities that each reported a policy linkage to their single business change. One firm used the USDA's Advanced Biofuel Tax Credit in 2009 to help promote visibility of pellets in the area by means of research and development. This business had a goal of promoting pellets as a viable and sustainable form of energy and heat, and felt the surrounding communities needed more information on the pellet industry. Currently available until fiscal year 2018, the USDA's Bioenergy Program for Advanced Biofuels (Section 9005) states that eligible producers of advanced biofuels, or fuels originating from renewable biomass other than corn kernel starch, may collect payments to support extended production of advanced

biofuels (Pub. L. 113-79 2014). The second firm cited a local financing program administered by Marathon County Development Corporation that disbursed low interest loans, which allowed this firm to "grow the business a bit larger as we wanted." The firm was not able to specify any more details such as physical change type or policy details. Local policies are noted but not solicited when looking across states' wood energy sectors.

Areas to highlight:

- No sectors stand out or have many policy clusters (could be due to low N)
- Focus on Energy program (state program coupled with private utilities) reported in nearly 40% of changes that used policy
- State policies outnumbered reported federal policies by more than double (7:3), which could be attributed to the success of Focus on Energy or double dipping (one firm using more than one policy)

4.36 Michigan

Michigan wood-energy firms reported 8 bioenergy policies associated with their respective significant changes. The estimated population of wood energy businesses in the state was 83, with 29 firms participating in the study. Figure 10 display change types by policy instrument in each sector where data was available.

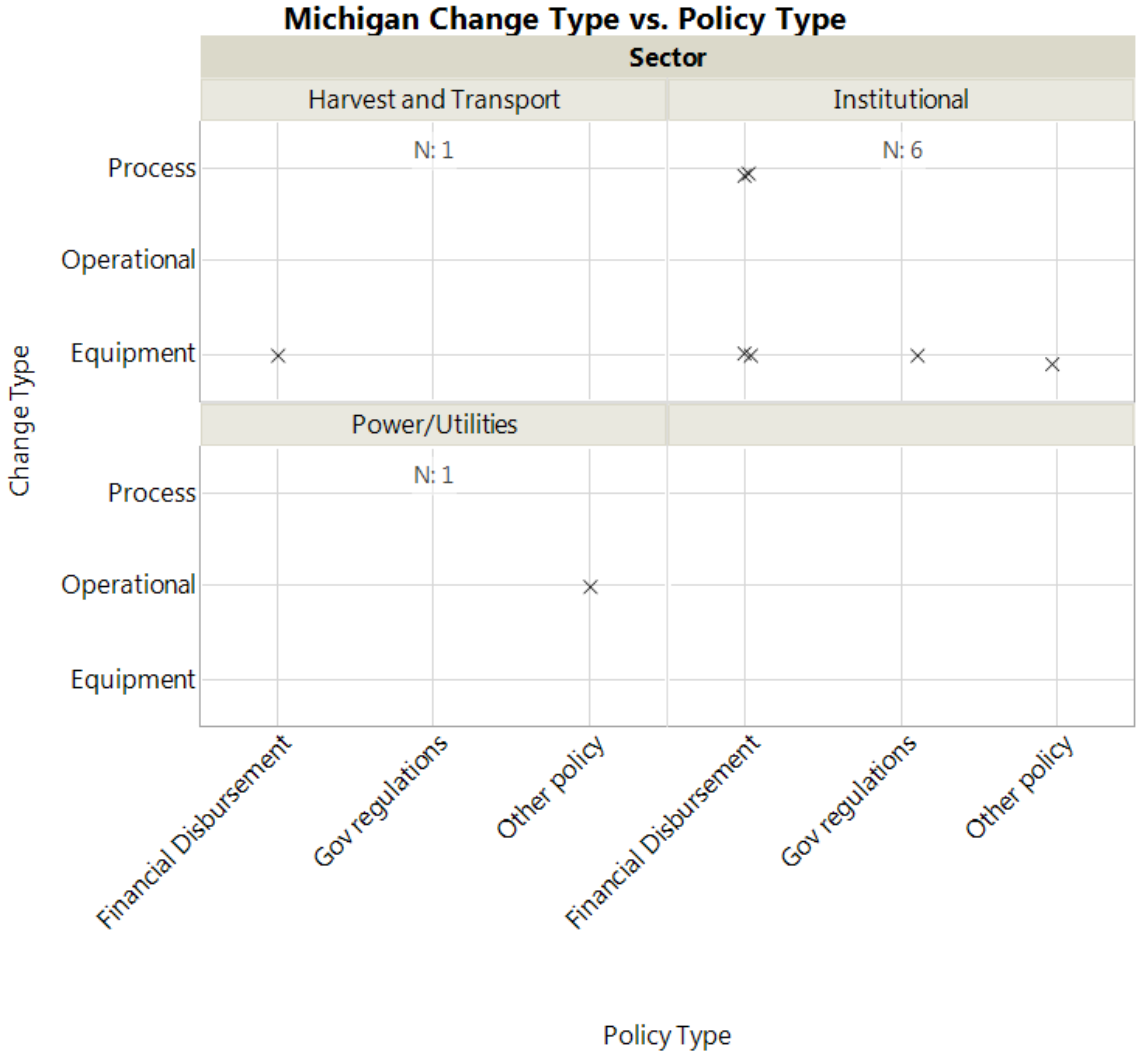

Figure 10 Michigan change type by policy type in each sector

Harvest and Transportation

This sector had 10 respondents out of an estimated 24 firms. Those 10 firms reported 8 business changes, with only one change being correlated with a policy. The one policy utilized in this sector was BCAP. This firm purchased a new chipper in 2007, but claimed that a contract they had with a local paper mill dissolved. The mill rescinded the contract, which made the cost of the chipper a detrimental financial burden that was difficult to recover, as their purchaser of wood chips no longer existed. The firm sought any way to recover the immediate

lost costs of the chipper, and in 2008, utilized BCAP as helpful in the firm "surviving" after the negative experience with the paper mill. This business also thought that BCAP had very broad rules, which was helpful to qualify at first, but as more businesses took advantage of the program, the money was harder to get, and payments stopped. Once the program was revised, they no longer could participate.

Institutional Users

There were 8 institutional firms that participated in the study out of the estimated population of 30 firms. There were a total of 14 business changes in this sector, with six being correlated with policy. Four of the six (67%) policy instruments identified were financial disbursements, all being grants. One firm was only able to identify the grant as a "USDA grant", which allowed for a myriad of equipment and process upgrades to the firm in 2010. These included: boiler upgrades, an automated chemical feed unit, and new variable frequency drives.

Another firm cited the Southeast Michigan Resource Conservation and Development Council Grant as beneficial in adding funds for a new boiler in 2011. The Southeast Michigan Resource Conservation and Development Council is similar to the structure of a conservation district 501(c)(3) organization that puts emphasis on educating and empowering local individuals to make ground-up changes in environmental sustainability (SE MI RCD 2015). The development counsel administers certain programs based on funding availability and priority of environmental issues.

The two remaining policies that were cited and correlate to business changes were the Clean Air Act and a local University Energy Action Plan. These policies were accompanied by the same change from the same firm, and the imposed regulations served as a driver to require improved conveyance system changes and emissions efficiency. It was unknown when the changes occurred.

Power/Utilities

This sector had 7 responses out of an estimated 14 firms in the state of Michigan. There were 6 total business changes reported. However, the sector was not able to provide much detail on policy pertaining to significant business changes. One policy was reported; a federal Office of Asset Enterprise Management (OAEM) loan that helped this particular company transition into the wood-energy market in 2014 by burning woody residue for electricity alongside natural gas. This policy was not part of the classification scheme and is considered an "other" policy type.

Areas to highlight:

- No policies reported in the pellet sector
- Institutional users reported 75% of total policies utilized
- Of known policy levels, federal policies outnumbered state policies by 5:1 (1 unknown level, 1 local level)
- 63% of all reported policies were financial disbursements

4.4 Regional Policy Comparison

While the Pacific Northwest only had two more significant business changes than the Lake States, surveyed businesses reported 88 policies versus 34 in the Lake States. Business respondents in the Lake States largely utilized financial disbursement-type policies (grant, loan, financing program, direct payment, etc.) for their corresponding significant changes, making up for 59% of total policy instruments identified in the region. All but one of these disbursement policies identified was used for process, operational and equipment-based business changes such as automated facility equipment, designing of district heating plants, or a new wood boiler. Institutional users and loggers and haulers accounted for utilizing 75% of all disbursement-based policies. What was virtually unseen in the Lake States, were market force-type business changes, as well as correlating a policy type with the change. A market force change, also defined in table 11, underlines that a business felt compelled to make a change

due to outside pressure, and the main pressure that became a theme was searching for new markets (domestic and international), as local markets became sluggish. However, most of these market force changes occurred in the Pacific Northwest, and did not appear to show any clustering of policy instrument type. By looking at figure 11, policy clusters by region are more readily seen than by individual states due to higher response totals. Policy totals are also denoted by "N" at the top of the figure.

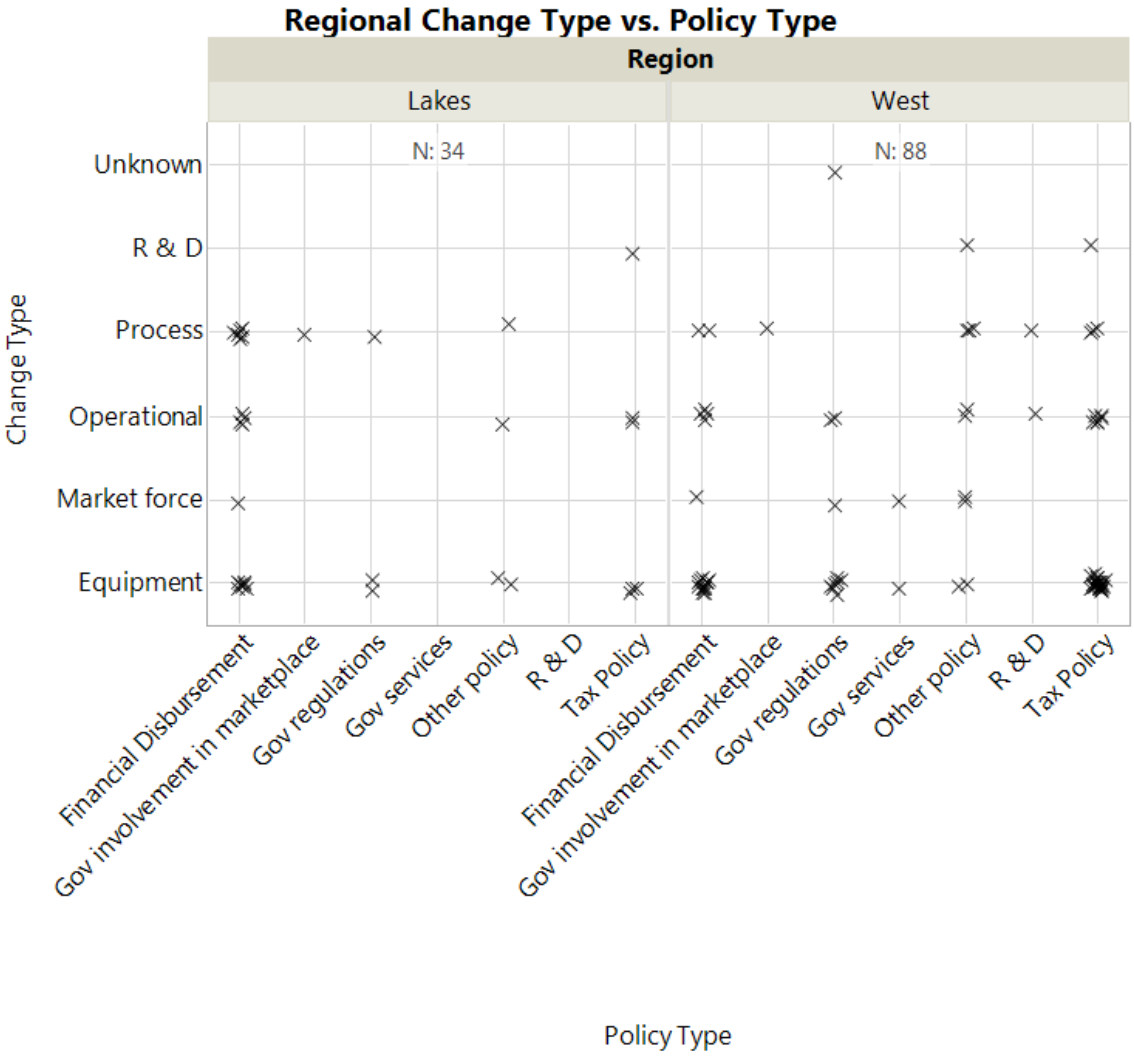

Figure 11 Change type by policy instrument type by region

With more policies reported by surveyed businesses in the Pacific Northwest with 88 than the Lake States with 34, it was easier to identify policy instrument type clusters. Figure 10 shows tax policies and financial disbursements far more cited for physical equipment and facility purchases, retrofits, and upgrades. These policy instrument types made up 69% of the total policy instrument types cited in the Pacific Northwest, with tax policies at 44% and financial disbursements at 25%, respectively. Oregon response inflated regionally cited policies in the Pacific Northwest, as it had 62 of the 88 policies itself. To a lesser magnitude, tax policies and financial disbursements were also reported as influential for operational changes (defined in table 11). Operational change types were typically business-wide, implying that for those businesses these policies were influential in at least supplying financial compensation that helped reduce enough risk for the business to make a large change. Pacific Northwest business respondents reported four times as many government regulation-based policies (12:3) that impacted business changes. Most changes were driven by regulations and forced equipment changes which, resulting in increased efficiencies. Here, it was important to understand that as a motivator of change, government regulations did not provide a direct financial incentive, and were undergone to remain compliant in each sector's industry.

Areas to highlight:

- Pacific Northwest accounts for 72% of all reported policies
- Equipment-based changes accounted for 58% of all change types associated with a policy or policies in both regions (77% of all equipment changes with a policy took place in the Pacific Northwest)
- 87% of all tax policies occurred in the Pacific Northwest
- 61% of policies reported in the Pacific Northwest went towards equipment
- 59% of policies reported in the Lakes States were financial disbursements

4.5 Significant business changes without policy influence

This section discusses the business changes that firms were employing that were reportedly not influenced by policy in any way. There were 146 total business changes that were not linked to a policy. It is important to keep in mind that there were reported 40 policies that were linked to more than one change; however, they were treated independently when viewing any policy linage. This is why the difference between total changes (228) and non-policy changes (146) does not match up with the total policies linked to a change (122). The difference is the 40 cited policies that were linked to more than one policy. This did not change the analysis, but it important to consider when viewing change and policy totals, as they will appear to not add up.

As with the changes correlated with a policy, equipment-based changes dominated the scene for changes that did not utilize policy. Of 146 reported non-policy changes, 81 (55%) were equipment changes. Of these 81 equipment changes, 57 took place in the states of Oregon (21), Minnesota (21), and Wisconsin (15). Michigan reported 11, California 9, and Washington reported only 4. Equipment change types were largely similar to changes that utilized policy, suggesting that surveyed firms potentially had plans to upgrade or purchase new equipment and found a policy that provided financial compensation. One Oregon harvest and transportation firm upgraded their chipper in 2009, while another firm in Oregon's harvest and transportation sector added a new skidder in early 2014 to assist with source material removal. Equipment change types from the Lake States also mirrored Pacific Northwest equipment changes, as well as having similarities to policy influenced changes. One Minnesota harvest and transportation firm purchased a new wood chipper in 2008, and did not cite any policy usage to complete the change.

Change types generally stayed the same across all sectors regardless of policy connection, aside from Research and Development. Meaning, it did not appear that policy influenced the type of change, most likely because policies

that the majority of respondents were utilizing were geared for their sector and operation. However, it was observed that no pilot plants were constructed without the assistance of a policy that aided the firm financially. In other words, new test facilities and demonstrations were dependent upon policy funds to incentivize research of that magnitude. A couple firms, one in Oregon and the other in Wisconsin, did do minor R & D projects on their own, consisting of preliminary market supply chain development for a dedicated energy crop supply and new product development.

The second largest total of changes that took place without policy influence was process-based business changes. Respondents reported 33 total process changes, 23% of all non-policy changes. California reported the highest total, with 8, all in the power and utility sector. Here, one power and utility firm reportedly utilized juniper as fuelwood in 2010, citing that the United States Bureau of Land Management along with other forest owners wish to remove juniper, as it utilizes a lot of water resources. Another firm started utilizing mill waste sawdust for electricity in 2013. In addition, institutional respondents from schools explained how they needed to be environmentally aware and set a good example, which in many instances also saved the schools money by having two energy sources that could subsidize each other. These changes were typically wood-fired boilers.

There were 17 operational changes that were not associated with any policy, or 12% of all non-policy business changes. Minnesota had the most, with 7, followed by Oregon and Michigan with 3, California with 2, and Washington and Wisconsin both had one operational change without policy influence. One harvest and transportation firm in Minnesota partnered with Sweden in the fall of 2013 “to obtain the appropriate type of wood fuel needed”, and did not explain the partnership more in-depth, but claimed it was very helpful. A power and utility firm in Wisconsin installed a new wood handling system in 1988, and cited

that the “changes or modifications were cost-effective driven - no policies were utilized.”

Oregon and Wisconsin were the only two states to report any research and development business changes that were not linked with policy. Each state reported 4 changes. Oregon’s changes were spread between harvest and transportation (2), power and utility (1), and institutional users (1), whereas Wisconsin’s were all centralized in the pellet industry (4). The changes were relatively basic, ranging from promoting visibility of whole house heating appliances, to being a leader in supporting biofuel production, to innovating pellets to burn at different temperatures as well as different aromas.

The remaining business changes were 7 market force changes in Oregon (2), Wisconsin (3), Michigan (1), and Washington (1). Figure 12 displays significant business change clusters in each sector and state. Table 25 and table 26 display all significant business changes that were completed without the usage of state of federal policies.

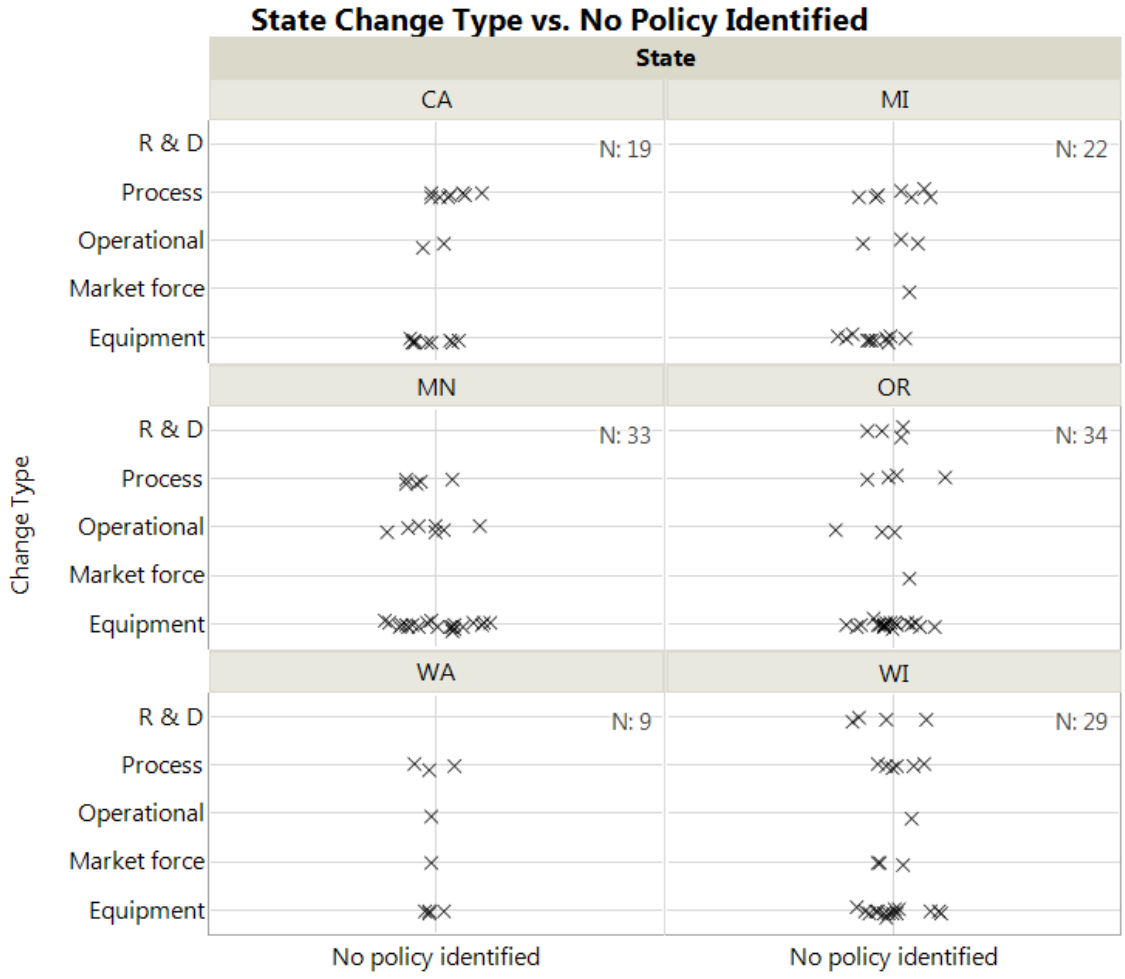

Figure 12 Change Type vs. No Policy Identified – All States

Table 25 Total change types without policy – state and sector

		Change Type					
State	**Sector**	**Equipment**	**Market force**	**Operational**	**Process**	**R & D**	**All**
CA	Harvest and Transport	5	0	0	0	0	**5**
	Institutional	0	0	0	0	0	**0**
	Pellet Producer	0	0	0	0	0	**0**
	Power/Utilities	4	0	2	8	0	**14**
	All	9	0	2	8	0	**19**
MI	Harvest and Transport	4	1	2	0	0	**7**
	Institutional	6	0	1	2	0	**9**
	Pellet Producer	0	0	0	1	0	**1**
	Power/Utilities	1	0	0	4	0	**5**
	All	11	1	3	7	0	**22**
MN	Harvest and Transport	5	0	1	1	0	**7**
	Institutional	6	0	4	4	0	**14**
	Pellet Producer	0	0	0	0	0	**0**
	Power/Utilities	10	0	2	0	0	**12**
	All	21	0	7	5	0	**33**
OR	Harvest and Transport	8	0	2	2	2	**14**
	Institutional	2	1	1	0	1	**5**
	Pellet	7	1	0	1	0	**9**
	Power/Utilities	4	0	0	1	1	**6**
	All	21	2	3	4	4	**34**
WA	Harvest and Transport	2	0	0	0	0	**2**
	Institutional	1	0	0	3	0	**4**
	Pellet	0	1	0	0	0	**1**
	Power/Utilities	1	0	1	0	0	**2**
	All	4	1	1	3	0	**9**
WI	Harvest and Transport	8	2	0	0	0	**10**
	Institutional	5	0	0	4	0	**9**
	Pellet	0	0	0	1	4	**5**
	Power/Utilities	2	1	1	1	0	**5**
	All	15	3	1	6	4	**29**
All	**All**	**81**	**7**	**17**	**33**	**8**	**146**

Table 26 Total change types without policy – region and sector

		Change Type					
Region	**Sector**	**Equipment**	**Market force**	**Operational**	**Process**	**R & D**	**All**
Lakes	Harvest and Transport	17	3	3	1	0	**24**
	Institutional	17	0	5	10	0	**32**
	Pellet	0	0	0	2	4	**6**
	Power/Utilities	13	1	3	5	0	**22**
	All	47	4	11	18	4	**84**
PNW	Harvest and Transport	15	0	2	2	2	**21**
	Institutional	3	1	1	3	1	**9**
	Pellet	7	2	0	1	0	**10**
	Power/Utilities	9	0	3	9	1	**22**
	All	34	3	6	15	4	**62**
All	**All**	**81**	**7**	**17**	**33**	**8**	**146**

Chapter 5 - Discussion and Implications

Bioenergy systems encompass multiple resources across the supply chain, such as raw material, transportation systems, conversion technologies, energy services, and end users (McCormick 2005). In addition, there are a variety of markets, policies, and actors operating at different state, regional, and national scales, (firms, households, individuals, etc.) when it comes to bioenergy systems (White et al. 2013). Households seek efficiency and financial stability, while firms are primarily driven by profits and costs. With differing geography, raw material sources, land ownership, and political influence, many different combinations of policies instruments are possible. This study investigated the impact of state and federal policy on firm-level innovations and changes implemented along each supply chain step in two different regions across six different states. The results show where changes are perceived by business owners to be taking place and what policies, if any, are driving the change. Identifying where policies may influence innovation will help policy makers and business owners alike to be able to support investment in the bioenergy supply chain with lower risk and a potentially rewarding outcome for many in the industry, including consumers. To this end, the following sections provide an overview of how the mix of policy instruments, interactions within and across states and regions, and related significant business changes can help improve the policy schemes in wood-energy.

5.1 General Trends

Each sector and region had varying levels of innovation and perceived policy influence. This section explains the extent of how states, regions, and sectors are similar or dissimilar, as well as the extent that policy influences different steps in the supply chain. Tables 29 and 30 highlight these findings in

relation to the types of significant changes firms were undertaking, as well as the policies they reported utilizing in conjunction with their changes.

It was widely seen at the state level that financial incentive policies (i.e. tax credits, grants, loans) were perceived by business owners to be influential and facilitated physical facility changes such as boiler upgrades or installations, new CHP facilities, upgraded storage, or new source material harvesting equipment. It was also observed to a lesser extent, that government emissions regulations influenced business changes such as needing additional or more efficient equipment to maintain compliance. These types of changes were made due to a government policy; for example, a Renewable Portfolio Standard putting pressure on a utility company to produce a certain amount of renewable energy, in this case wood-energy, by a certain date. In these cases, it was generally seen as an established company, possibly without a second energy stream (e.g. natural gas, propane) adapting to the new regulation to stay relevant. However, even though rules and regulations can at times be a motivator of innovation, it also was perceived as a barrier. It was reported by respondents of these firms that the "red tape" created too many "hoops" to jump through, and the economic benefit was degraded. While not identifying with a specific policy, a Minnesota pellet firm said the reason they do not apply for any incentives (policy) is because the process is too complex and time consuming to be uncertain of receiving anything (financial benefit), which is very discouraging. A respondent of a power and utility firm in California also expressed concerns with how components of rules and regulations are indirectly closing off feedstock sources. In this case, the firm previously utilized old railroad ties as a supplementary feedstock, but cited California's Renewable Energy Portfolio Standard as responsible for inhibiting the use of ties. The RPS disqualified old railroad ties on account of them being classified as urban waste instead of a renewable resource, and an air quality issue of concern. The respondent did not list which year they were forced

to stop using old railroad ties as a feedstock, but the RPS in California was originally enacted in 2002.

Many notable policies such as BCAP, BPC (Biomass Producer and Consumer Tax Credit), and BETC (Business Energy Tax Credit) were well known among surveyed firms and found to be influential in their investment decisions, especially for tax and financial incentive-based policy types. However, many respondents also expressed frustration with the administrative aspects of participating, such as difficulty interpreting policy language, lack of knowledge and direction by agencies responsible for assistance with their program, and changing qualifications. This led to somewhat polarizing attitudes among respondents towards these policies. For example, the USDA's Biomass Crop Assistance Program and Oregon's Biomass Producer and Consumer Tax Credit were both widely utilized and perceived as beneficial for businesses; however, mixed feelings were observed when asked about the details of the policies. There was frustration with qualifications and requirements changing too quickly, as well as funding running out too early. Respondents claimed that these factors wasted their time applying, especially where the paperwork and "red tape" was perceived to already be an issue. However, businesses that receive support through these same polices largely reported them to be a positive experience, in which they helped expand their business or keep it going. For example, one Michigan harvest and transportation firm cited BCAP in instrumental in keeping their operation going after a deal with a local paper mill fell through. It was apparent that if a firm was able to receive any sort of measureable or impactful benefit from a policy, it was viewed in a positive light. The cost of the business change apart from any policy incentive did not appear to alter this viewpoint. However, it was also observed that firms who were rejected, did not qualify, or did not complete the application process had a negative view of the same policy. It suggests that ease of access to policy programs had a larger impact on policy attitude than originally thought. It is less known if a poor attitude towards policy

would lessen policy utilization or not. Some respondents claimed they did not seek policies due to either political viewpoints (i.e. against subsidies or higher taxes) or the frustrations listed above with the administrative aspects of applying for a program, which makes it plausible that overall policy utilization is slightly less than if those firms had even a neutral viewpoint on policy. However, the extent of this is not well known.

Ordinarily, when a respondent was able to identify a policy in tandem with their significant business change, it was in a positive light. However, in some cases, policy negatively impacted firms. One respondent in Oregon's harvest and transportation sector said their business was negatively impacted by the BPC. The respondent explained that an increase in competition among firms that are not normally involved in the wood energy market drove down woody biomass prices by increasing supply, causing their facility to scale back production. The implications are twofold. First, the BPC policy could be described as achieving its intended objective from the perspective of adding production capacity. On the other hand, one firm claimed that the success BPC had in gaining firms to participate ultimately slowed the market as prices fell and an oversaturation of firms took hold. It is also worth noting that in some instances, businesses that knew of existing policies, their intent, and how to qualify, would then utilize them to facilitate innovations or changes they already had planned. The business was savvy enough to seek out a specific policy and apply it to their business. When this took place, it showed that polices impact business changes indirectly rather than directly. Another indirect effect of policies is how they can be unknowingly undervalued by firms. Collectively, policies may have the ability to indirectly create or assist a market, making it easier on some firms to participate in wood energy. For example, a state's RPS may require a power and utility firm to increase the amount of electricity produced from renewable energy. This in turn may push the power and utility firm to increase their stock of woody material if biomass is the renewable

technology they move forward with. Nearby harvest and transportation firms would be potential indirect beneficiaries, as their product of woody material has another, or longer term, purchaser. It is possible the harvest and transportation firm may know nothing of the state's RPS, or at a minimum, may know that it doesn't impact their firm directly. However, the mandate required the power producing firm to essentially need more woody material, providing business for the harvest and transportation firm, effectively indirectly influencing the firm without their direct knowledge.

Policies directly impacted business changes when they were reported as the primary motivator, such as a pellet firm increasing their exports outside of their regional supply chain due to a sluggish local market, or an imposed regulation such as a state's Renewables Portfolio Standard requiring a power and utility firm to increase its renewable energy output to remain compliant.

One of the barriers to utilizing policies for firm changes that was reported was the instability in the policy landscape at both the state and federal level. This was largely reported by those who did not cite a policy associated with their significant business change. This translates to even though a state may have many policies available, the ever-changing policy language, qualifications, and unstable funding made it difficult to plan and rely or incorporate policy with a significant business change. The uncertainties with regard to future policies have also played a key role in the stagnation, and sometimes abandonment, of other planned larger investments in the bioenergy field (White et al. 2013).

5.2 State and Region

Each state, to differing degrees, had their own mix of policies that were available to wood-energy users. This section discusses policy implications on innovation within each state and region. For the whole study, there were approximately one policy linkages to every two business changes.

In California, respondents identified 13 policies and 27 total significant business changes across 16 respondents. Nine of those policies where identified in the power and utility sector, which made up 11 of 16 firms sampled in the state. One firm cited the Public Utility Regulatory Policies Act (PURPA) as being a benefit and a detriment at the same time; PURPA was incentivizing other renewables (solar, wind) that were seen as displacing biomass as an energy source. The respondent went on to say that PURPA assisted the firm, but overall it had a negative impact on biomass itself. California also had the most exasperated respondents when discussing the role of environmental regulations. While it was seen in other states how regulations can bring about innovation, California's harvest and transportation sector expressed more difficulties than observed in other study states about obtaining source material. The 5 respondents in this sector identified 4 policies from 8 business changes. In many instances, land ownership, political ideology, and geographical location can impact the type of regulation imposed. For example, one power and utility firm already had a negative view of government and those who are responsible for the creation of renewable energy policies:

> *"…if there is one thing we [the firm] know for certain, it's that government (i.e. politicians) is very inefficient and ineffective when it comes to incentives."*
>
> *- Manager, Power and Utility firm in California*

Another example is wood-energy firms in the Pacific Northwest claimed federal lands with habitat of threatened or endangered species such as the spotted owl made raw material extraction more challenging. Another wood-energy firm reported a disconnect between state and federal policies in California regarding air quality laws:

"The only thing I can say is an issue between state and federal regulations is the air pollution laws. The air pollution policies are neither really state nor federal agencies here in California. It's a bit ambiguous. The air pollution emission laws are not really flexible enough to accommodate this type of technology. They don't address how to handle biomass, and instead point fingers on who should be addressing this change."

- Owner, Power and Utility firm in California

Oregon reported the most changes and policies of any state. Oregon reported the most changes (71) and policies cited (62) in the six-state study area. It was also a significant find in that of Oregon's 71 total changes, 45 were equipment-based. In addition, 37 of the 60 total cited policies were directly applied to those 45 equipment-based significant business changes. The level at which firms were utilizing policy for their business changes and adaptations suggests a knowledgeable industry that sought out programs and funding sources if and when possible. One harvest and transportation business owner had this to add about renewable energy policies in Oregon:

"The State of Oregon Department of Energy has been good in planning and coming out with these tax credits. We hope we can continue to use it because it is beneficial for our business, forest management and the businesses supplied with this material. Perhaps a drawback is the amount of paperwork you have fill out, submit and so on. Personally, I deem it not necessary and sometimes, somewhat burdensome."

- Owner, harvest and transportation firm, Oregon

However, some Oregon respondents also expressed frustrations with BCAP. One firm, which claimed to be a government contractor, had this to say:

BCAP Program. It burned us. It had a 2 year life cycle, but the program was canceled on us after 6 months in use. Unfortunately, I think it experienced some unintended consequences, and spanned out of control when the federal government started the program, impacting us negatively.

- Operations Manager, harvest and transportation firm, Oregon

Washington wood-energy firms cited 13 policies across 15 businesses, linked to 17 total business changes. Of the 13 policies cited, four were specific and identifiable. BCAP was cited twice as assisting a firm, once with new equipment purchases (as a result of increased access to source material) and the "ability to convert woody material to wood-chips and sell it to wood2energy facilities and Mexico." The second firm was able to elaborate on how the program's limited flexibility hindered innovation, as well as opinions on how policies are written:

"My husband is Indian American and obtains some state and federal funding [BCAP] because we are located on an Indian Forest Reservation Area. We do take advantage of those subsidies for our business. In the past, BCAP Program was useful and beneficial for us. The Burned Area Emergency Response (BAER) regulatory system is very restrictive. When we earn contract, most of the contracts do not allow us to deviate. Meaning, sometimes, we would desire to go left, because we see an opportunity blossoming there, but these laws do not allow us to do that. That could be improved - if those laws could be a bit less restrictive, it would be nice. In general, Policy Making is written by people who

have nothing to do with forest management, logging, wood2energy market, etc. and have no idea of what this really entails."

- Co-owner, Harvest and transportation firm, Washington

Minnesota reported the second highest number of significant business changes, with 44 across 35 firms. Respondents linked 13 policies with those business changes. Twenty-five of the 44 changes reported were equipment changes; however, only 5 policies were cited by firms as influencing their decision to make changes. BCAP was again cited as the most influential policy by Minnesota wood-energy firms. Four firms cited the policy, with one citing it negatively. One firm divulged that they utilized BCAP in the past, and it positively helped provide electrical facilities with adequate and high quality feedstock. The firm that cited BCAP as negatively impacting the market explained that the program "distorted the market place negatively impacting traditional users", which is similar to criticisms in other states about BCAP. The same respondent shared that they "strongly believe that state/federal policies may, and in some cases, be terrible, and a company cannot be dependent upon them." BCAP did not influence this firm's investment decision.

Wisconsin ranked third in total business changes, with 40 across 32 businesses surveyed. Similar to Minnesota, only 13 policies were cited as influencing business changes. Of the 44 changes, 19 were equipment-based, with 6 policies cited as helpful for those changes. Disbursement-based policies (e.g., grants, financing programs, direct payments, cost-share programs) were also largely cited in Wisconsin, making up 62% of all instrument types reported. Focus on Energy was the most widely cited policy in Wisconsin. This grant-based disbursement policy stayed within the general findings of regional differences, as tax-based policies have been vastly more popular in the Pacific Northwest than Lake States, where disbursements-based policies made up 59% of all cited policy types (opposed to 26% in the PNW). Focus on Energy had

largely positive responses in Wisconsin, even from firms that did not participate. A representative from one firm added this about the program:

> *"Grants based on energy savings many of the projects to be attractive and viable. The technical support to identify projects was very, very important." Also, many states are attempting to retain jobs. Federal policies appear to target new technologies."*
>
> *- GM, Power/Utility firm, Wisconsin*

Another power and utility firm that utilized Focus on Energy said that the low interest loan the program provided was relatively easy to obtain, and the process wasn't too tedious. The firm said that the program provided flexible funding that allowed them to increase their total production (i.e. burn more wood). In addition to Focus on Energy, this firm also utilized Green Power Purchasing in 2006 to help procure more source material. In conjunction, the firm had this to say:

"These policies made the climate for them to move away from coal much easier. They were good to us. I cannot say that they were not attractive."

- GM, Power and Utility, Wisconsin

Michigan was comparatively low in the number of significant changes, with 27, but had the lowest amount of policies cited by wood-energy firms, with 8 across 29 businesses. Six policies were reported by the institutional sector, with four of them being equipment changes. In addition, the only policy specifically identified was BCAP. Two different firms had mixed reactions to BCAP. The first noted that it helped their business after a contract with a local paper mill had been terminated over a disagreement with the mill. Even though this firm benefited from BCAP, they went on to note that they thought an "ineffective mechanism about the program was that it started out fairly broad. As a result,

the federal government had to redefine it and find solutions to make it work more effectively." Although the firm did not specify, it did not appear that they were negatively impacted by the change to BCAP's qualifications, as they spoke about BCAP from a neutral to positive perspective. Another firm expressed concern for how much raw material on government lands is not able to enter the market:

> *"There are acres and acres of standing dead trees on both state and federal land that could be utilized for biomass but are not put on the market. It takes the US Forest Service an average of 14 years to start a timber sale and to finish it. The State of Michigan is getting better with acting quickly on some of these diseased impacted timberlands, but the federal government is doing a piss poor job in my opinion."*
>
> *- Operations Manager, Harvest and transportation, Michigan*

5.3 Implications for Policy Makers

It is natural for policies to be altered, tweaked, and changed throughout their lifespan, as there are circumstances where changes are warranted. However, it is imperative to keep major alterations to policies in short time periods as minimal as possible (White et al. 2013). Wood-energy firms surveyed made it apparent that if the government had a goal of stimulating and expanding bioenergy, policies should have long-term goals and benefits to reduce uncertainty in investments. When policies and programs are changed, sometimes annually, it creates hardships on firms by not being able to keep up with qualification requirements, added paperwork, and uncertainty if the policy or program will be available or change again in the near future.

The majority (57%) of changes identified by respondents were equipment-based (i.e. new grinder, upgraded storage facility, new skidder, trucking

equipment, etc.). Nearly the same proportion of policies (58%) was linked to equipment-based changes. Equipment changes could be thought of as low-hanging fruit in which to invest; they are, on average, less expensive than a more robust facility operations change, increase safety, and firms know what they are getting. Updating a skidder or a grinder has less volatility and financial overhead than a building a new co-gen facility. Investments subsidies and general energy taxes have proven to be relatively successful in providing cost-share and financial disbursement opportunities, but are not necessarily considered a long-term solution to advancing the industry. In a study by Thornley and Cooper, it was found that investment subsidies generally increased capacity of a firm, but not necessarily efficiency or utilization factors, two key components to long-term sustainability (2008). With competition from other energy sources (e.g. NG, coal, wind and solar), it is imperative to keep investment cost low and industry outlook favorable. Small equipment changes will stimulate the industry in the short-term, but may have difficulty sustaining it long-term. Equipment wears out, and continually needs to be replaced and upgraded.

A significant general finding was under the operational change category. An operation change is business-wide, and can be described as a change in the business goal or overall operation, and impacts each individual business process. For the whole study, there were 32 operational changes ranging from the implementation of an intensive fuel quality control program to converting to chipping from grinding. However, the interesting find is that 71% of the changes were linked with a policy with some level of influence. These change types typically were more in-depth than a simply equipment upgrade or swap; many times they consisted of upgrading or changing parts within an operation. In some cases, research and piloting were required to fully implement the change. It is possible that the magnitude of change among respondents, as well as risk, were higher than an equipment change, leading a higher rate of firms to seek policy assistance.

Tax policies were the instrument of choice by harvest and transportation and power/utility firms in the Pacific Northwest. In the Lake States, disbursement-based policies were by far the most utilized instrument cited, with policies spread out between each sector except pellet production, where only one disbursement policy was cited. While it is important to know total instrument types in each state and sector, it is critical to pair them with the change type and total to begin to make policy recommendations. Here is where policy utilization ratios can help display, to the extent possible, how each sector or state is taking advantage of available policies in relation to their innovations. Even though equipment changes constitute over half of the changes reported in the study, only about half of them were linked to policy. On the other hand, larger-scale changes, such as operational changes, had a higher utilization ratio yet, even with lower total changes and policies. It is possible that these types of operational business changes may yield an efficient return and maximizing the utility of the policy that was intended for those change types. In addition, the pellet industry generally underperformed in all states except Oregon, where with sector size being relative, it was on par with other sectors. This means that more focus could be given to the pellet industry, not only in direct financial subsidies, credits, or tax breaks, but on education in the other five states studied. A general theme that emerged from pellet producers was how the industry was lagging behind European counterparts, as well as a lack of demand due to low consumer knowledge about pellets. One firm had this to say regarding the pellet industry:

> *"Unintended consequences are difficult to deal with. Not enough boiler incentives, not enough incentives for biomass businesses or demand focused subsidies. I am not saying that state/federal [governments] should incentivize the market all the time, continuously, but should certainly focus more on demand and less on supply incentives. I believe that if federal dollars would go into*

demand, businesses would be more successful over time. I think that many businesses have failed because incentives are primarily focused on supply aspect and that is a problem."

- Vice President, pellet production, Wisconsin

These findings would suggest that the pellet industry would benefit from greater consumer outreach and research and development. It would assist with product exposure, and help rid the industry, both pellets and wood-energy in general, of an old stigma of inefficiencies and strenuous work

Table 29 General findings by state and region

	CA	*OR*	*WA*	*MN*	*WI*	*MI*	*Lakes*	*PNW*
Change	• Nearly half of all changes were equipment. • 70% of all changes occurred in power/utility sector. • No pellet or institutional changes.	• Most changes of all states (71). • Equipment changes made up 66% of all changes.	• Least changes of any state (17). • 52% of changes were equipment-based.	• Second most changes of any state (44). • 57% are equipment changes. • Aside from pellet, each sector had relatively similar change totals.	• 48% of all changes were equipment-based. • Third most changes (40).	• 48% of changes were equipment-based. • Nearly half of all changes were in institutional sector.	• Nearly same change total as PNW (113-115) • Most changes in institutional (41). • 51% of changes were equipment-based.	• 60% of changes were equipment-based. • Harvest and Transport and power/utility sectors make up 70% of PNW changes (81).
Policy	• 13 policies reported. • 31% (4) of reported policies were regulation-based, highest of any state.	• Highest reported policy total (62), half of all in study. • 55% (34) tax-based policy. • Harvest and transport reported 46% (28) of all policies. • 23% (14) disbursement-based.	• 13 policies reported • Relatively spread out between instrument types. • 46% of reported policies used in power/utility sector (half being tax policies).	• 13 policies reported. • 54% (7) of reported policies were disbursement-based.	• 13 policies reported. • 62% (8) of reported polices were disbursement-based.	• Least policies reported (8). • 63% (5) of reported policies were disbursement-based. • 75% (6) reported policies were in the institutional sector.	• 34 policies reported. • 59% (20) of reported policies are disbursement-based. • No R&D or Gov Service policies reported	• 88 policies reported (72% of study total). • Tax policies (39) and disbursements (22) dominate. • Harvest and transport (34) and power/utilities (30) had majority of identified policy types.

Table 30 General Key findings by sector

	Harvest and Transport	***Pellet***	***Power/Utility***	***Institutional***
Change	• 75 total changes (33 Lakes, 42 PNW). • 69% of all changes were equipment-based. • Most respondents from this sector.	• 20 total changes (9 Lakes, 13 PNW). • Least amount of responses. • 5 R&D changes in Lake States (makes up all R&D changes in Lakes and 50% study total). • 62% of PNW pellet changes were equipment-based.	• 69 total changes (30 Lakes, 39 PNW). • Changes spread between equip, operational, and process. (equipment still overshadows)	• 62 total changes (41 Lakes, 21 PNW). • 56% (23) of Lakes Inst. changes were equipment-based, opposed to 38% (8) in PNW.
Policy	• 44 policies reported (10 Lakes, 34 PNW). • 70% (7) of policies in Lakes were disbursements. • 59% (20) of policies in PNW were tax policies. • 30% (10) of policies in PNW were disbursements.	• 11 reported policies (3 Lakes, 8 PNW). • No strong clustering of policy/change type. • Most underrepresented sector in study.	• 40 reported policies (10 Lakes, 30 PNW). • Disbursements (4) and Tax policy (3) made up 70% of Lakes policies reported. • Tax policy (16) and Gov regulations (7) made up 76% of PNW policies reported.	• 27 reported policies (11 Lakes, 16 PNW). • 73% (8) of policies reported in Lakes were disbursements. • 44% (7) of policies reported in PNW were disbursements. • 38% (6) of policies reported in PNW were "other policy"

5.4 Study Limitations

This section discusses the main limitations of the study. Key areas include the difficulty classifying facilities from the Wood2Energy database that participated in wood-energy, low response rates in certain sectors and states, the amount each respondent knew about policy, as well as the sheer scope of the study.

A challenge of creating the sample for the study was classifying facilities as wood-energy participants. Findings indicated that although the wood2energy.org facility database had extensive information, there were pitfalls when trying to effectively build the sample. There was a 21% overall error rate in the wood2energy.org database when identifying wood energy businesses. It is possible the error rate is higher because there was not enough information on non-responses in some cases to exclude them from the population. For this reason, the overall population is unknown. In addition, businesses were purposively sampled from the final database to ensure an adequate number of responses necessary for analysis. A limitation of using purposive sampling technique is that results cannot be extrapolated to non-surveyed firms.

The most difficult sector in all states to create the sample population was the harvest and transportation sector, as contact databases for loggers involved in wood energy were nearly non-existent in each state. Wood2Energy did not have this sector in their database, so potential firms were added to the population by contacting other academics and professionals in states where necessary. If biomass related logging and transportation firms were missed or intentionally left out, it reduces the ability to identify common policy practices and changes across the population of firms in that sector or state. It also could create bias or reduce the strength of findings in this sector if respondents not truly representative of the whole harvest and transportation sector. In addition, harvest and transportation firms that do not participate in wood-energy were not surveyed, reducing the analysis to firms that did participate in wood energy; this could potentially also

create bias towards or against bioenergy policy utilization as well as how innovative the sector really is, since only firms in wood-energy could already be considered innovative by entering the market.. Table 27 shows what sources the harvest and transportation sector sample was created from. All other sector populations were drawn from the wood2energy.org database as well as snowball sampling, when appropriate.

Table 31 Harvest and Transportation population sources

California	Washington	Oregon	Michigan	Wisconsin	Minnesota
Associated California Loggers http://www.calog.com/index.cl	Washington Contract Loggers Association http://63.134.238.39/MLPList.asp	Oregon State Univ. (Personal Contact)	Michigan State Univ. (Personal Contact)	Michigan State Univ. (Personal Contact)	Michigan State Univ. (Personal Contact)
Univ. of California Berkeley (Personal Contact)	Washington Department of Natural Resources (Database pending)		Michigan Association of Timbermen http://www.timbermen.org/		Univ. Of MN (Personal Contact)
Oregon State Univ. (Personal Contact)			Michigan Department of Natural Resources http://www.michigandnr.com/wood/		

*Contact lists retrieved from personal contacts are available upon request from the author of this paper

Facility statuses were updated to operational, closed, or idle, as well as updated addresses, phone numbers, e-mails, websites, and contact names. This information was sent back to Wood2Energy for revisions.

Another limitation of the study was the uneven number of responses per state. Oregon, for instance, had the highest amount of responses, significant business changes, and policies cited, making the other five states look weaker by comparison. One way to combat this phenomenon was the implementation of the change ratios. This ratio shows the amount of changes employed per respondent, and the methodology is the same for each state and sector. The ratio helps eliminate bias when viewing change totals. However, it is a finding in itself for sectors that had low response totals. Effort to find applicable firms was uniform for every state and every sector, so it is plausible that sectors with low

response rates are smaller in size, or diminishing since contact information was many time incorrect and outdated.

Since the sample created was not random, it cannot be said that findings are representative of a sector or state. Findings in states and/or sectors that had a low response rates can only be representative of those firms that were surveyed. The two states with the lowest respondent totals were Washington and California, with 15 and 16 respondents respectively. Also, the pellet production sector for the entire study had 16 respondents. Although it does not imply that the findings are incorrect, it should be mentioned that they are representative of surveyed businesses. On the other hand, sectors with strong response rates, such as power/utility (43), institutional (54), and harvest and transportation (62) were easier to identify some level of policy influence, if any. However, it was important to consider sectors within states, as responses drop within each state.

In addition to the difficulty in identifying wood-energy firms, another limitation was the varying level of policy knowledge of each respondent. Some respondents showed higher levels of opinion than did others, while others had experience and knowledge on specific state and federal renewable policies. Response rates in some sectors, notably the pellet sector, were significantly lower than other sectors. This translates to a decrease in the ability to obtain policy influence details, but doesn't imply that firms in the sector were less knowledgeable on policy. It does, however, present the case that there may be less policies being directed, or encompassing, certain wood-energy sectors.

Another limitation of the analysis was the scope of the study. Six states, two regions, and four wood-energy sectors in each state and region made it difficult to decide which method to use in displaying the data, especially when at a focused level such as a sector within a state. It may be benefit to first remove any geographical reference and analyze policy instrument type by significant business type without cross-matching to a state or region. This would have

allowed correlations to be made between policy type and change type and then extrapolated across each sector, state, and region. Characteristics from each region and state could then be added to form a more comprehensive analysis. Current analysis maintained geographical reference each time analysis was performed, which may have constrained the results. These limitations can be addressed in future studies.

A possible future study that could build on these data is a with-without analysis of changes reportedly influenced by a policy versus changes that were conducted without a policy influence. Such an analysis investigates the worth of policy on business changes as if the policy existed versus if it did not exist. This was mentioned in this paper, but a more detailed analysis would be beneficial. Possible criteria for analysis could include, but are not limited to: firm input and output totals, customer base relative to the surrounding area, magnitude of the business change (i.e. cost), and the importance of the change, which could be qualitatively evaluated and coded into a tiered system. These criteria can then be combined to produce an overall score which can be evaluated by comparing firms that identified with policy influence on their change versus those firms that did not.

Chapter 6 - Conclusion

This study presented a framework for assessing the influence of state and federal policies on specific types of business changes that were found to be common and related to wood energy production. It was found that policy influences business changes with regards to bioenergy specifically in these ways:

- Equipment-based changes can be viewed as “low-hanging fruit”, or most easily completed, with the widest variety of policies available.
- Market forces and regulations can drive businesses to make a change (i.e. installing air emissions kit) indirectly, instead of the firm actively seeking a policy to fit their change. Market forces were seen as a “last resort” to adapt to changing local markets by seeking new domestic or international markets to remain relevant.
- Firms that previously took advantage of a policy were more likely to seek out a second or third policy (not necessarily at the same time).
- Surveyed firms utilized policy more readily for operation-based changes than other types of changes.
- Large-scale research and development projects, such as pilot plants, were rarely reported without a policy linked to the change.
- Tax-based policies (mostly tax credits) were mainly utilized with equipment purchases and upgrades.
- Government regulations were widely viewed as restrictive to growth, but did drive firms to change when they were required to stay compliant.

Policy creation and implementation can have ripple effects on consumers and firms alike. Each person or firm has individual preferences, and are able to transform these into how much they value one good or service over the next. Choices are made based on the information that is available at the time of the decision. In regards to this study and investigating policy influence on firm-level investment decisions, the government’s past performance in sustaining policies becomes an important consideration (White et al 2013).

6.1 Future Research

This study provided current estimated rosters of wood energy firms in the six states that were previously unavailable or did not exist (or on a limited basis) across all supply chain steps. This is important because future research on wood-energy firms and supply chains can be completed more readily. Also, the regions selected for this study (Pacific Northwest and Lake States) have ample supply of woody biomass. Considering one of the most difficult steps in the study was obtaining a proper sample, this is a great benefit to future research.

Types of significant changes that wood-energy businesses completed along with any correlated policy instrument is important because it helps shed light on which areas of the supply chain in each state is most active. This may help state and federal policy makers focus on sectors as well as policy language to cater to certain types of business changes that are popular, or even changes that businesses are contemplating. Without a proper understanding of innovation types in each sector, new or updated policies may create requirements and qualifications that might not best suit a particular sector or business type that it is intended to target.

Firms would like to see more cohesiveness between levels of government, as well as more transparent policy language, access, and implementation. Respondents expressed that it was not always clear what role different agencies had when it came time to roll out a program or policy that the firm participated in. It created hardships, frustrations, and a poor experience. With limited research available on the influence on policy mix on business innovation and change, the following research questions are recommended for future study:

1. Can a monetary value be placed on increased policy knowledge and predictability for firms involved in wood-energy?
2. What actions can governments take to reduce changes to existing policies and cut down on “red tape” (providing better and seamless access to policy programs)?

3. At what diminishing financial level, such as a percentage of cost covered for a new implementation, will firms become disinterested in policy? (i.e. what is the cut-off level for a policy to be deemed “worth it?”)

4. Why are specific policy instruments more effective than others at driving change?

5. How can policy fragmentation/misalignment along the supply chain be reduced?

This study provides a foundation for a proliferation of subsequent studies building off of policy influence on wood-energy firms’ investment decisions. With added research surrounding renewable energy, and more specifically biomass policies, policy makers can be armed with reputable information to make sound decisions that can help grow and expand the wood-energy industry for years to come.

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Appendices

Appendix 1: Business Survey

1 Please enter the five-digit survey ID number below that you were given.

2 Which state is your business located in?
- ❍ MN
- ❍ WI
- ❍ MI
- ❍ WA
- ❍ OR
- ❍ CA

3 Please select the category that best describes how your business produces or uses wood energy
- ❍ Harvest, collection, or transportation of logs / woody material
- ❍ Wood pellet production
- ❍ Wood used to heat a building or facility
- ❍ Electricity generation from woody biomass

4 What is your position in your company?

5 How long have you owned or worked for this company?

6 Please briefly describe your business and its involvement in wood energy production.

7 What year did your company begin harvesting, processing, or using wood energy?
Year

8 What was your total volume of biomass harvested last year? If none, please indicate 0.
Total Volume
Units [green tons, tons, etc.]

9 What was your total output last year? If none, indicate 0.
Output
Units [green tons, tons, MWh-e, Btu, etc]

10 Please indicate your business status. (If INACTIVE, survey will end)
❍ Inactive
❍ Closed

11 About how much raw material do you consume annually?
Input
Units [green tons, tons, etc.]

12 About how much raw material (chips or pellets) did you consume last year?
Total Volume
Units [green tons, tons, etc.]
Chips or Pellets

13 About what percentage of your raw material last year came from?
_____ Harvest residuals (tops, limbs, small diameter)
_____ Roundwood or whole log chips
_____ Byproducts from secondary processors (e.g., sawmill)
_____ Other

14 About what percentage of the biomass harvested last year came from the following sources?
_____ Public lands (federal, state, country, local/municipal)
_____ Tribal lands
_____ Private industrial or non-industrial lands

15 About what percentage of the biomass harvested last year did you sell to the following buyers?
_____ Institutional users (hospitals, schools, etc.)
_____ Pellet producers (other densified production)
_____ Electric utilities
_____ Other

16 About what percentage of your pellet production last year did you sell to the following buyers?
_____ Retail - domestic residential
_____ Retail - international
_____ Wholesale - domestic industrial
_____ Wholesale - international

17 How many full-time equivalent (FTE) employees are directly employed in the use or production of wood-based energy?

What are the three most significant changes or innovations your business has made related to wood energy production? These changes can be anything such new equipment, processes, products, supply sources, locations, or anything else that has affected your business or your ability to produce and/or use biomass. We would like to first note these changes here briefly; in the following questions we will ask for a better description of what the change entailed.

18 Please list your business's three most significant changes. (You will be able on expand on them in the following questions)

Significant Change #1
Significant Change #2
Significant Change #3

19 For the first change, describe the type of change and how it affected your business.

20 What year did you make the change?

21 What were the main factors influencing this decision?

22 On the timeline included in the information sent, there are a number of state and federal policies listed. There are particular types of incentives to encourage you to expand production, regulations on what you can do, and other types of policies to may have affected your operations. Please look at those policies in the 3-5 years prior to you making the change: Did any of the following types of policies influence your decision to make this change: (please use the spaces below each type to identify the specific policy, if possible)

- ❑ Tax policies such as special exemptions, allowances, deductions, or credits _____
- ❑ Government rules and regulations on what you could do _____
- ❑ Direct government involvement in the marketplace, such as procurement _____
- ❑ Direct financial subsidies such as grants, financing programs, or cost-share programs _____
- ❑ Funding for research, development, and demonstration programs _____
- ❑ Government services such as technical assistance programs (or bioenergy ports, rail lines, transmission) _____

- ❑ Other (please explain) _____
- ❑ No policies influenced this decision or change

23 How did the policies or types of policies identified above affect your decision? Describe how they compelled you to make the change, if at all.

24 What was it about the policy (or policies) from the timeline that was not attractive or effective in your case?

Questions 25 – 36 are the same as 18-24 – second and third significant changes and supplemental questions, if applicable.

37 In terms of the business decision to become involved in wood energy production, how did policies in place at that time affect the business start-up? [Review policy timeline as necessary]

38 Are there significant changes that your business has contemplated related to wood energy production, or are currently contemplating, but have not made? Briefly explain.

39 What are the two most important factors affecting your business' ability to expand production or use of wood-based energy?

40 Can you identify examples where state and/or federal policies are working well together or coordinated across your supply chain?

41 Can you identify any examples or areas where state and/or federal policies are NOT working well together or where there are gaps in the coordination of activities across your supply chain?

42 What are specific ways that state and federal policies should work together to benefit your business and supply chain partners?

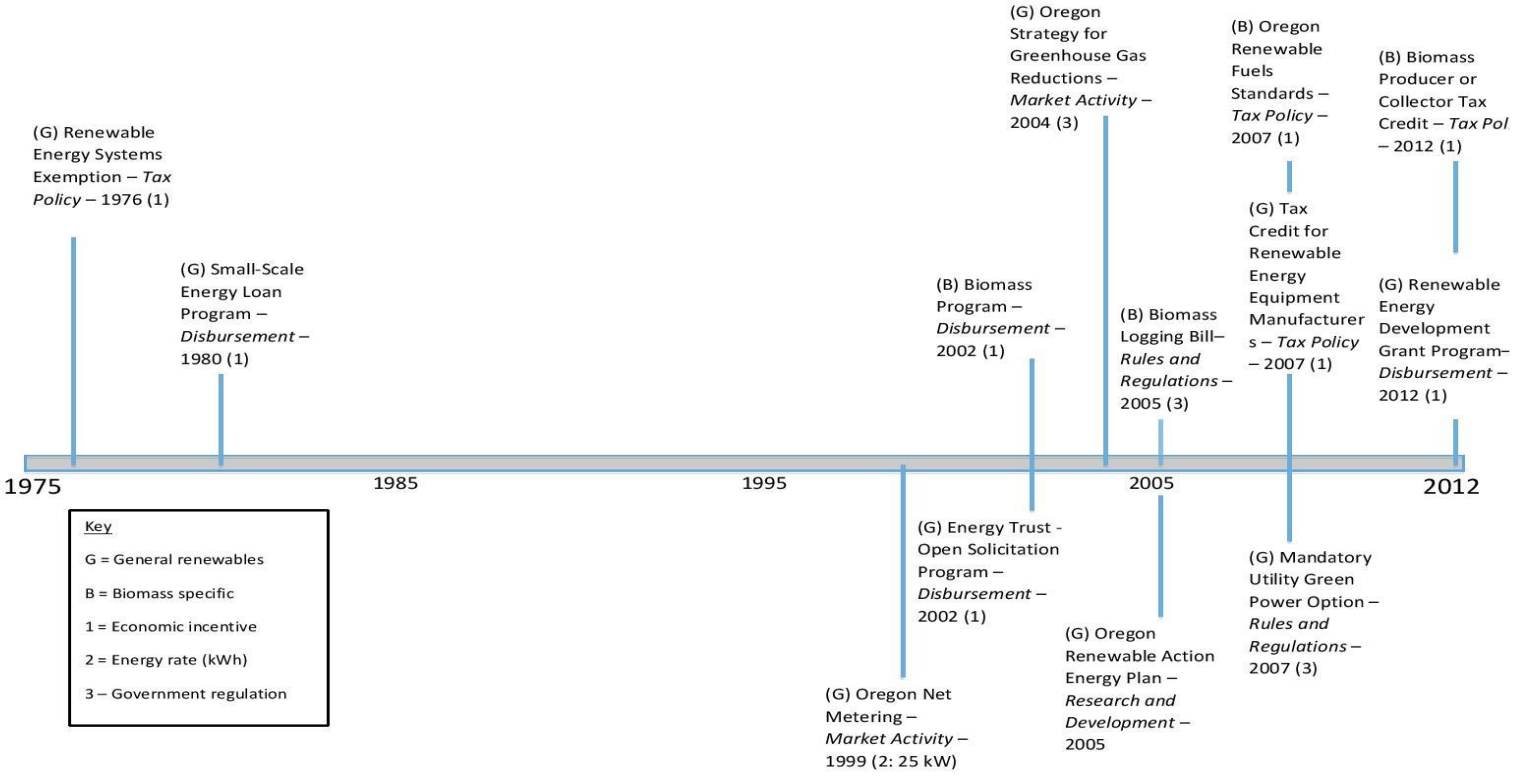
43 Are there other questions or policy impacts you would like to discuss?

44 May we contact you again if we have more questions or need clarification?

- ❍ Yes
- ❍ No

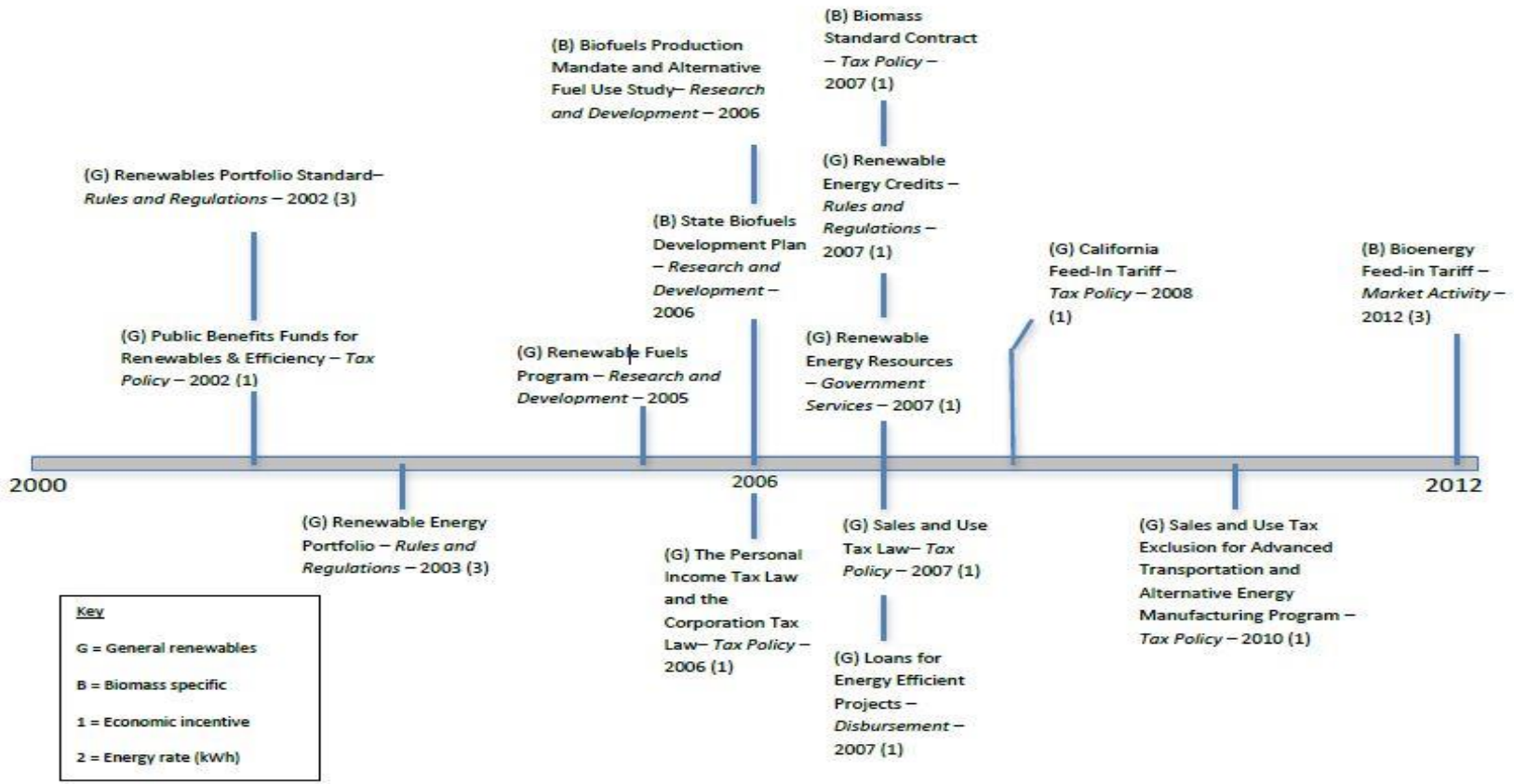
This is the end of the survey, by hitting the next arrow you will submit the survey. We appreciate your response and thank you for taking the time to fill out this survey. Thank you!

Appendix 2: Oregon Policy Timeline



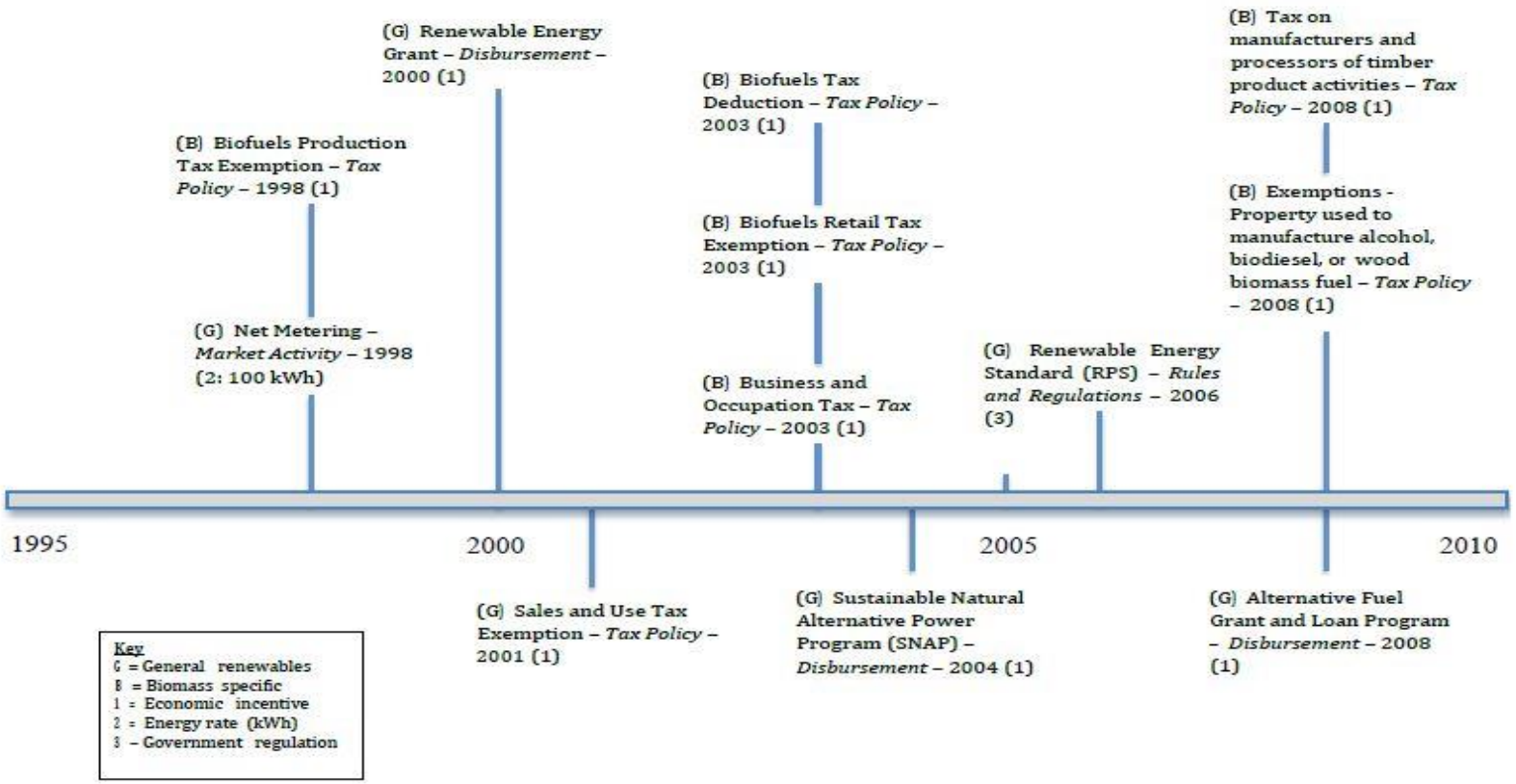
Oregon State Biomass Policies and Instruments, 1975 – 2012

Appendix 3: California Policy Timeline



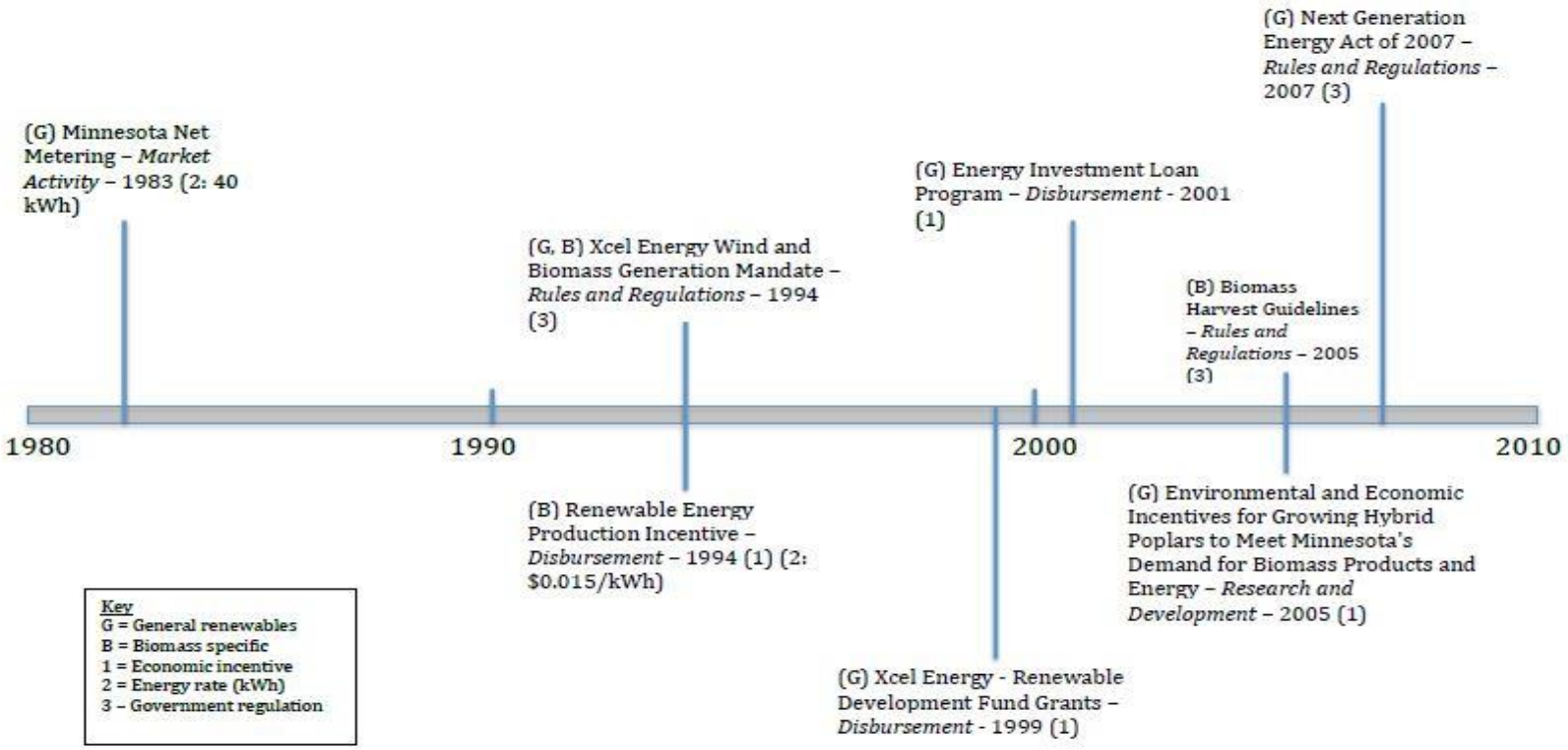
California State Biomass Policies and Instruments, 2000 - 2012

Appendix 4: Washington Policy Timeline



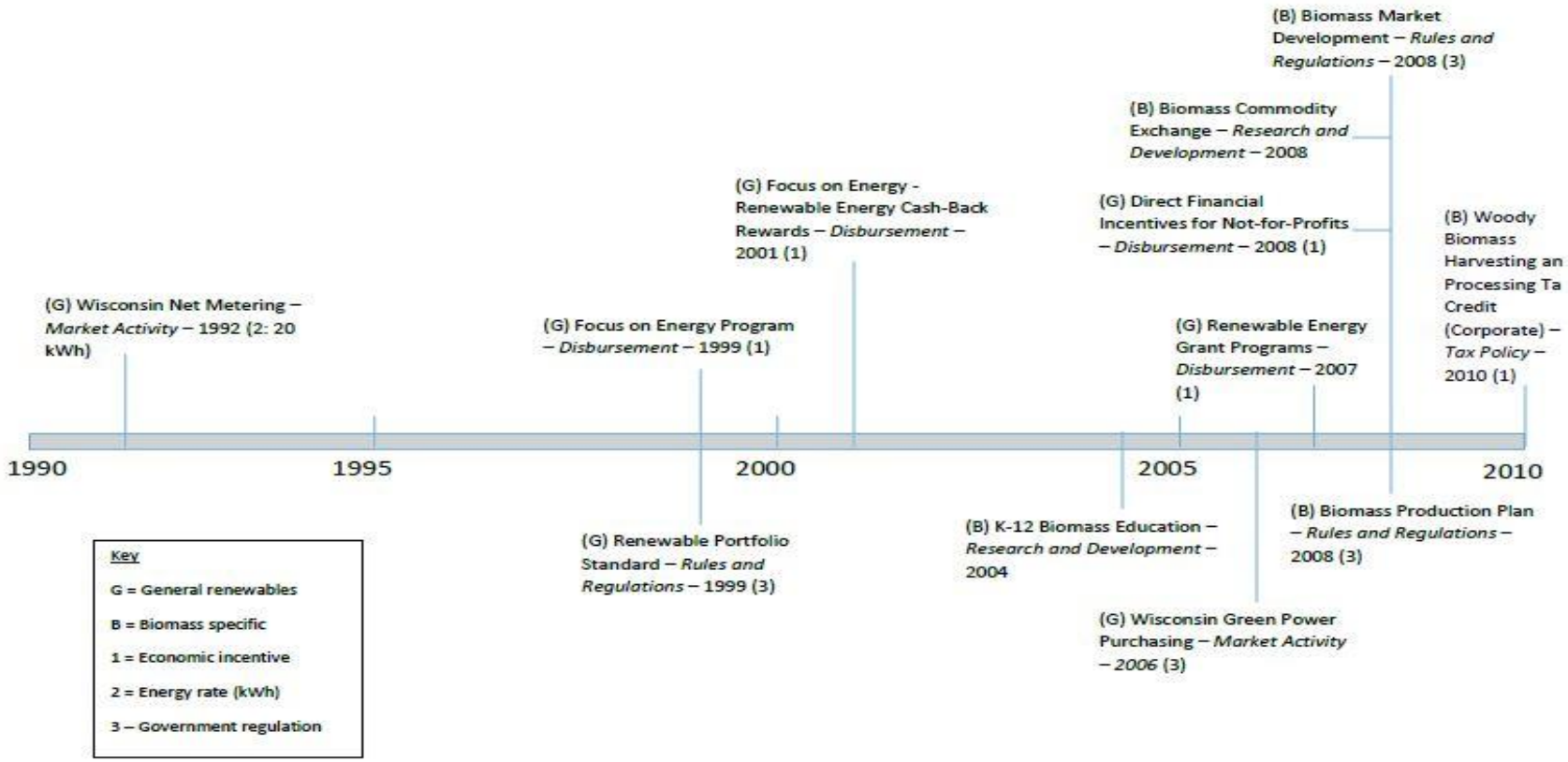
Washington State Biomass Policies and Instruments, 1995 - 2010

Appendix 5: Minnesota Policy Timeline



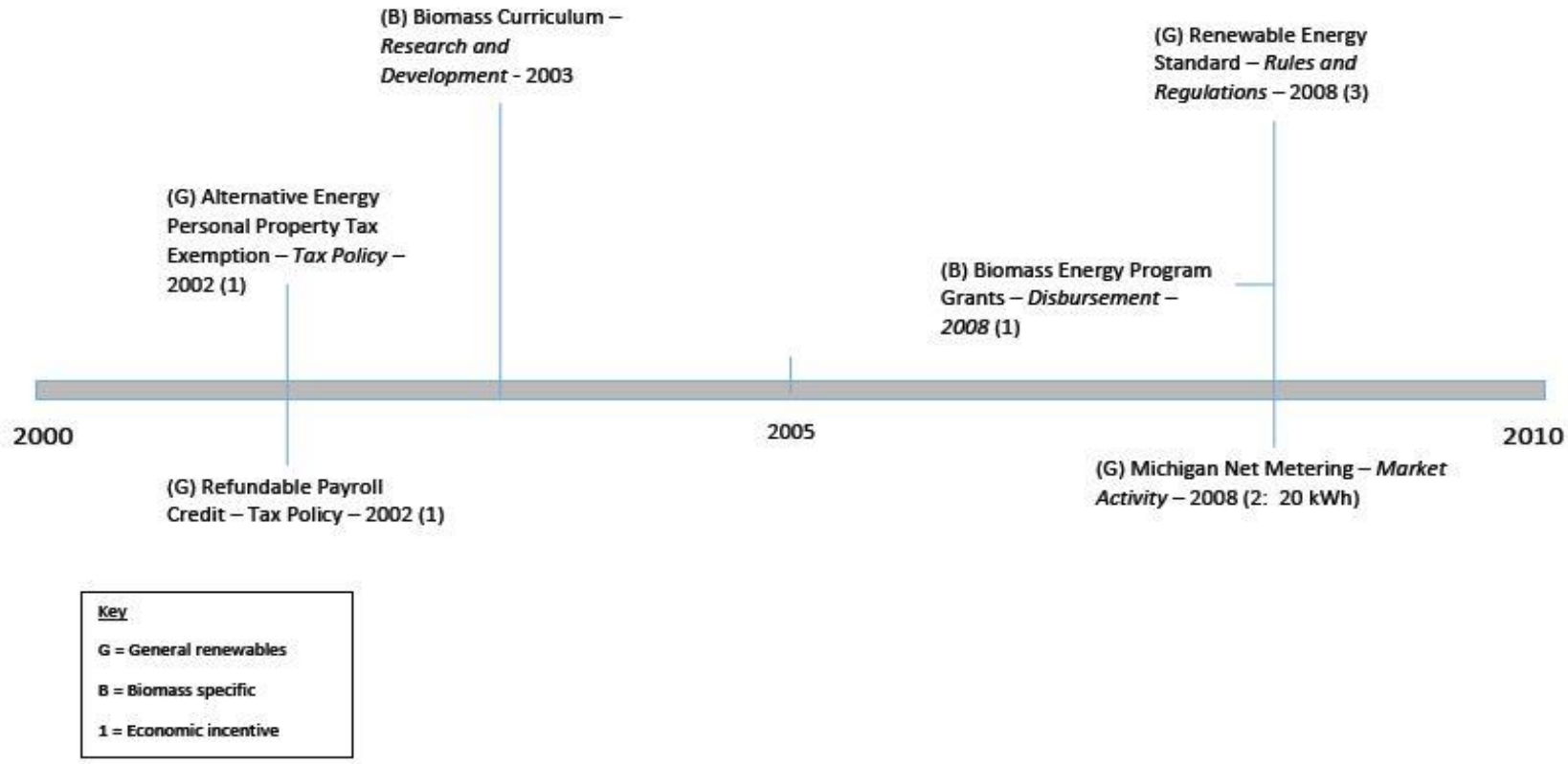
Minnesota State Biomass Policies and Instruments, 1980 - 2010

Appendix 6: Wisconsin Policy Timeline



Wisconsin State Biomass Policies and Instruments, 1990 – 2010

Appendix 7: Michigan Policy Timeline



Michigan State Biomass Policies and Instruments, 2000 - 2010

Appendix 8: Woody Biomass Definitions and Conversion Factors

WOODY BIOMASS DEFINITIONS AND CONVERSION FACTORS

Biomass – Organic matter in trees, agricultural crops and other living plant material.

Woody Biomass – Trees, shrubs, bushes, or products derived from these woody plants that accumulate to an amount that is a hazard or disposal problem

Roundwood – wood in its original round (or near round) form, such as small logs, branches, etc.

Sawlog – A log that meets minimum standards of diameter, length, and defect for sawing into lumber.
Volume - Gross – Measurement of log without any deduction for defect.
Volume - Net – actual amount of merchantable wood in after deductions for defect.

Small Diameter – logs generally less than 10-inches in diameter at the large end

Chips – a generic term used to describe woody materials broken down into small particles by mechanical means.

a. Pulp chips – bark free, produced by chippers that produce a uniform sized particles
b. Fuel chips – particles produced by hammermills, chippers or grinders of varying sizes and shapes
c. Furnish – particle sizes defined specifically for a type of manufacturing process

Weight measure – amount of wood measured in pounds or tons (Kg or mt)
Green Ton (GT) = 2,000 lbs of fresh cut woody material at a "green" moisture content
Bone Dry Ton (BDT or DT) = 2,000 lbs of woody material at 0% moisture content
Bone Dry Unit (BDU) = 2,400 lbs of wood chips at 0% moisture content

Volume measure – amount of wood measured in cubic feet, board feet, or cubic meters
Board Foot (BF) – wood measuring 1 inch thick, 12 inches long, and 12 inches wide.
MBF = 1,000 BF, MMBF = 1,000,000 BF

Moisture Content – a measure of the amount of water in wood, expressed as a percentage. The forest products industry general uses a dry wood basis, the energy industry uses a wet wood basis.
MC dry basis – mass of water in wood divided by the oven dry mass of wood (0 – 150%)
MC wet basis – mass of water in wood divided by the original (green) mass (0 – 100%)

Typical Energy Terms
British Thermal Unit – The quantity of heat required to raise the temperature of one pound of water, 1 degree F (Fahrenheit).
Cogeneration – The combined generation of both heat and power at one facility using the same fuel source. Typically the heat is used to generate steam that is utilized on site (process steam). Power generated is in the form of electricity that is utilized on site or sold to a local utility.
Gasification - a thermochemical conversion of organic solids and liquids into a producer or synthetic gas (syngas) under very controlled conditions of heat and strict control of air or oxygen.
Kilowatt = 1,000 watts, a watt is the measure of the rate of energy use at any moment (a 100 watt bulb uses 100 watts at any given moment)

Appendix 9: All cited policies by state (with amount of times utilized)

Policy Instrument/Policy Name	CA	MI	MN	OR	WA	WI	Total
Tax Policy	1	0	3	34	3	3	**44**
Business energy Tax Credit (BETC)	0	0	0	11	0	0	**11**
Black Liquor Tax Credit	0	0	1	0	0	0	**1**
Biomass Producer and Consumer Tax Credit (BPC)	0	0	0	9	0	0	**9**
Business Enterprise Zone	0	0	0	1	0	0	**1**
Energy Tax Credit	0	0	0	3	0	0	**3**
Federal Tax credit	0	0	1	2	0	0	**3**
Federal Tax deduction	0	0	0	1	0	0	**1**
Hog fuel tax exemption	0	0	0	0	2	0	**2**
Production Tax Credits	0	0	0	0	1	0	**1**
Tax Credit	1	0	1	3	0	2	**7**
Tax Credit for Renewable Energy Equipment Manufacturer (TCREEM)	0	0	0	4	0	0	**4**
USDA Advanced Biofuel Tax Credit	0	0	0	0	0	1	**1**
Government Rules and Reg.	**4**	**1**	**1**	**5**	**3**	**1**	**15**
Clean Air Act	0	1	0	1	1	0	**3**
Endangered Species Act	0	0	0	1	0	0	**1**
Government regulations	1	0	0	2	1	0	**4**
Kyoto Protocol	0	0	0	0	1	0	**1**
Next-Gen Energy Act	0	0	1	0	0	0	**1**
OSHA	0	0	0	0	0	1	**1**
Public Utility Regulatory Policies Act	1	0	0	0	0	0	**1**
Renewable Energy Portfolio Standard	2	0	0	1	0	0	**3**
Direct Gov. involvement in marketplace	**1**	**0**	**0**	**0**	**0**	**1**	**2**
Green Power Purchasing	0	0	0	0	0	1	**1**
Potential for power purchase agreements with the military	1	0	0	0	0	0	**1**
Disbursements	**5**	**5**	**7**	**14**	**3**	**8**	**42**
Alliant to Energy Incentive	0	0	0	0	0	1	**1**
BCAP	1	1	4	6	2	1	**15**
Cool Schools Grant	0	0	0	1	0	0	**1**
Energy Grant	1	0	0	0	0	0	**1**
Federal grant	2	0	0	0	0	0	**2**
Focus on Energy	0	0	0	0	0	5	**5**
Grant	0	0	0	1	0	0	**1**
Indian Energy Office	0	0	1	0	0	0	**1**
Marathon County Development Loan	0	0	0	0	0	1	**1**

Policy Instrument/Policy Name	CA	MI	MN	OR	WA	WI	Total
MN Department of Economic Grant (2008)	0	0	1	0	0	0	**1**
OSCB loan	0	0	0	1	0	0	**1**
Self-Generation Incentive Program (SGIP)	1	0	0	0	0	0	**1**
Small Business Administration (SBA) loan	0	0	0	1	0	0	**1**
Southeast Resource Michigan Development Council Grant	0	1	0	0	0	0	**1**
State Grant	0	0	0	0	1	0	**1**
US DOE grant	0	0	1	1	0	0	**2**
USDA Grant	0	3	0	2	0	0	**5**
USDA Renewable Energy System Grant Program	0	0	0	1	0	0	**1**
R & D	**2**	**0**	**0**	**0**	**0**	**0**	**2**
California PIER	1	0	0	0	0	0	**1**
R & D	1	0	0	0	0	0	**1**
Government Services	**0**	**0**	**0**	**1**	**1**	**0**	**2**
Biomass Partner Initiative	0	0	0	0	1	0	**1**
Provision of high-quality technical assistance from state and federal entities.	0	0	0	1	0	0	**1**
Other Policy	**0**	**2**	**2**	**5**	**3**	**0**	**12**
American Recovery & Reinvestment Act	0	0	0	2	0	0	**2**
Applied and waiting response (general)	0	0	1	0	0	0	**1**
Bonneville Power Administration's Energy Smart Industrial Program	0	0	0	0	2	0	**2**
Credits	0	0	0	1	0	0	**1**
Federal OAEM Funding	0	1	0	0	0	0	**1**
Forest Health Package	0	0	0	1	0	0	**1**
Some assistance in adding equipment	0	0	1	0	0	0	**1**
State and Federal Subsidies	0	0	0	0	1	0	**1**
Stewardship Program	0	0	0	1	0	0	**1**
University Energy Plan	0	1	0	0	0	0	**1**
Grand Total	**13**	**8**	**13**	**60**	**13**	**13**	**120**