

RESILIENCE, CAPACITY, AND PLACE: A COMPARATIVE CASE STUDY
OF SMALL-SCALE FOREST-BASED BIOMASS ENERGY DEVELOPMENT IN
CALIFORNIA'S SIERRA NEVADA MOUNTAIN RANGE COMMUNITIES

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ABSTRACT

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The buildup of fuels resulting from decades of fire suppression in California's Sierra Nevada mountains has made its dense forests vulnerable to high severity stand replacing wildfires. Local governments in many rural forest-dependent communities view biomass energy production as a method to restore forest health via fuel removal and waste disposal. Forest-based biomass energy facilities have the potential to be compatible with protecting water resources, habitat restoration, forest resilience, and achieving climate standards, while also enhancing regional economic stability. However, while an increasing number of communities and organizations throughout California are advocating for local small-scale renewable energy from forest-based woody biomass, less than 3% of California's energy comes from wood. In this thesis I explored the question: “Why are there so few forest-based small-scale woody biomass energy generation facilities in the Sierra Nevada Mountain Range when there is an abundance of biomass?”

Through reviews of the literature and semi-structured interviews with local representatives of government, non-governmental organizations, and businesses, I utilized an approach grounded in political ecology to explore how stakeholders, place,

collaborative organization, and regulatory frameworks influence small-scale (<3MW) community-based biomass energy facility development projects for the case of two communities in California's Sierra Nevada. I applied a community capitals-based analysis to compare the North Fork and Cabin Creek biomass projects and to identify the major challenges the projects faced. This analysis demonstrated that carrying out small-scale energy project planning, feasibility analysis, fundraising, feedstock procurement, site development, and implementation require substantial community capacity that had not previously been acknowledged. Rural communities hoping to develop small-scale energy projects will need significant long-term support from state energy programs and federal land managers to be successful.

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ABBREVIATIONS

BDT- Bone Dry Ton

BLM- United States Department of Interior Bureau of Land Management

CAL FIRE- California Department of Forestry and Fire Protection

CBD- Center for Biological Diversity

CEC- California Energy Commission

CDC or NFCDC- North Fork Community Development Council

CHP- Combined Heat and Power

EPA- United States Environmental Protection Agency

MW- Megawatts

PPA- Power Purchase Agreement

PG&E- Pacific Gas and Electric

RC&D- Yosemite Sequoia Resource Conservation & Development Council

RFP-Request for Proposal

RPS- Renewable Portfolio Standard Program

SNC- Sierra Nevada Conservancy

SWET- Statewide Wood Energy Team

USGS- United States Geological Survey

INTRODUCTION

Community stakeholders, non-profit organizations, and governmental agencies throughout California are actively exploring small-scale forest-based biomass¹ energy as a method to create ecological, economic, and social resiliency with rural communities (University of California, Division of Agriculture and Natural Resources, 2020). However, to date, most efforts to build small-scale biomass energy generation facilities, with the potential to connect to California's power grid, have yet to come to fruition. In this thesis, I explore why there are so few small-scale forest-based biomass energy generation facilities in California, specifically in the Sierra Nevada.

Management practices such as forest thinning and fuel hazard reduction can enhance forest ecosystems' resilience. Biomass facilities utilize potentially hazardous wood to generate energy. Removing excess forest waste through methods of thinning and removal can reduce the number and severity of wildfires; damages to life, property and natural resources; air quality and public health impacts from wildfire smoke; and fire suppression costs (Western Forestry Leadership Coalition, 2010). Furthermore, the removal of fuel through forest thinning can provide space for the growth of the remaining trees and rejuvenation of understory herbs, resulting in a healthier, more robust, and resilient forest (Caputo, 2009; Kusel et al, 2020). Resilient forests will support healthy watersheds with improved water quality and quantity (EPA, 2018).

¹ Forest-based woody biomass refers to trees, shrubs, or other woody plant products found in forested landscapes (Springsteen et al., 2011).

Historic forest management practices, the legacy of fire suppression management policies, and the decline of the timber industry are critical factors in the deterioration of social-ecological resilience in California forests and forest communities (Gunderson & Holling, 2002; Headley, 2016; Wagtendonk et al., 2018). Community members and other stakeholders in forest-dependent rural communities throughout the state are acutely aware that their communities' economic stability relies on strategic and sustainable development (Kusel et al, 2001). These stakeholders understand that sustainable development indicates diversifying away from past economic development models, which relied on singular sources of resource extraction to fuel the economy and well-being of their communities (Caputo, 2009). Small-scale forest-based biomass energy development has the potential to be an important component of rural communities' larger strategic development to restore economic and ecological resilience. The appeal of biomass energy development effort in forest-dependent communities is that it utilizes local renewable resources while stimulating the growth of other industries, which diversifies economic structure (Hibbard & Lurie, 2013).

Historically, understory trees and fuels in the fire-prone forests of California have burned and been thinned out by natural wildfires. As a result of over a century of fire suppression policy, California forests now have an overabundance of biomass (Wagtendonk et al, 2018). Current forests are more vulnerable to wildfire, insects, and disease outbreaks than ever before and as recent years have shown, wildfires are increasingly catastrophic (USFS, 2018a). There are approximately 40 million acres of forest landscapes in California, with approximately 71 tons/acre of standing tree biomass

(Shih, 2004; USFS, 2010). According to the California Energy Commission (CEC), California forested lands produce approximately 14,300,000 bone dry tons (BDT) of biomass per year (Williams et al., 2015). One bone dry ton (BDT) is about 2,000 pounds of biomass at zero percent moisture (TSS Consultants, 2011). Without the removal of the over-abundance of biomass, wildfires within forested landscapes become more frequent, intense, and severe (BLM, 2020). Wildfires are further exacerbated by climate change.

In the last five years, California has had over 36,500 wildland fires (Cal Fire, 2020a). According to the California Department of Forestry and Fire Protection (Cal Fire), California's fire season has continuously increased in length and severity due to climate change. Specifically, in the Sierra Nevada, wildfire season length has increased by seventy-five days (Cal Fire, 2020a). The increase in length of California's wildfire season has significantly exacerbated the financial cost of suppressing wildland fires. For wildfire suppression in 2019, Cal Fire's emergency fund fire suppression expenditures were over \$630 million (Cal Fire, 2020c).

In addition to this burden on California taxpayers, some of the most significant costs associated with wildfires are to public health, safety, and ecosystem health (Wagtendonk et al., 2018). Furthermore, wildfires not only are affected by climate change, they contribute to it. Mitigating California's catastrophic wildfires will reduce carbon emissions (Cal Fire, 2020b). Small-scale forest-based biomass energy development can contribute to restoring economic resilience in rural communities as well as ecological resilience.

Proponents of forest-based biomass energy predict that these new industries

would add resilience to forest-dependent communities by expanding the tax base, providing revenue for schools and local services, and stabilizing future financial trajectories (Kusel et al, 2020; Morris et al., 2017). When a community is perceived to be economically resilient, diverse businesses and industries may be more likely to establish themselves because these new businesses perceive the community's future financial trajectory can support their business through cycles of depression (EPA, 2015). Besides these economic resilience benefits, the development of a local biomass market can ensure ecological resilience.

Plate et al. (2010) argue that creating a biomass market can incentivize people to maintain forest landscapes. Forest land retains its economic value through the production of goods and services. Biomass energy has the potential to create a market that makes it economically viable for landowners to maintain forest landscapes. Forest thinning and fuel reduction can support other ecosystem services, such as wildlife habitat, carbon sequestration, and recreation opportunities.

As forest-dependent communities explore biomass energy generation development, environmental policymakers, researchers, investors, potential developers, and community members have voiced apprehensions regarding biomass energy in rural communities (Morris et al., 2017). Critics warn that if not managed sustainably, biomass energy can create a market that causes harm to the forest ecosystem through overharvesting to maintain the energy output of a biomass facility (Aguilar & Garrett, 2009; Field et al., 2008; Hohenstein, 1994).

Furthermore, some biomass energy technologies may be unsustainable, emitting

large amounts of greenhouse gas (GHG) emissions and contributing to negative “life cycle” impacts (Schulze, 2012). As a result, some are concerned that biomass energy development may contribute to ecological instability, and negatively impact local economies (Cal Fire, 2020d). To mitigate potential harmful ecological impacts as a result of biomass energy generation, a growing number of stakeholders support small-scale biomass energy production in rural forest communities throughout California (Cal Fire, 2020d; Kusel et al., 2020). Small-scale (3 megawatts or less) biomass energy generation may eliminate the need for high volumes of woody feedstock to meet generation demands, while still removing excess fuels from the ecosystem. I analyze two cases of small-scale biomass energy generation projects in this thesis.

A key objective of this thesis was to critically analyze how stakeholders in these cases have attempted to utilize their collective capacity to develop small-scale forest-based woody biomass energy generation projects and to identify barriers to their success. I utilize an approach grounded in political ecology and community capitals theory to analyze the complex intersectional dynamics between governance, and stakeholders, which shape small-scale forest-based woody biomass energy development in these examples of Sierra Nevada bioregion communities.

In order to address the question “Why are there so few forest-based small-scale woody biomass energy generation facilities in the Sierra Nevada Mountain Range when there is an abundance of biomass?”, I address the following sub-questions in the case studies:

- 1) What steps are involved in developing a biomass energy facility?

- 2) What factors shape small-scale forest-based woody biomass energy development?
- 3) What capacities are required of communities seeking to develop biomass energy generation facilities?

This thesis contextualizes the complexities of regulatory frameworks, collaborative organizations, and various stakeholders and their impact on small-scale (<3MW) forest-based biomass energy project development in the Sierra Nevada through a critical review of the prevailing literature and seeks to bridge knowledge gaps in how these structures, processes, organizations, and stakeholder groups overcome concerns, challenges, and barriers. Utilizing the research methods of semi-structured interviews with local representatives of government, non-governmental organizations, and businesses; document analysis; and archival research; I apply a community capitals-based analysis grounded in political ecology to compare the North Fork Community Power project in the small community of North Fork, California in Madera County and the Cabin Creek Biomass Facility project on the outskirts of Truckee, California in the wealthy Tahoe Basin of Placer County. These case studies reveal key challenges for small-scale forest-based biomass facility development in the Sierra Nevada and potential paths to overcome barriers for future projects.

LITERATURE REVIEW

Sustainable rural development is about creating and maintaining ecological, social, and economic systems which communities can rely on (Perrings, 2006; Walker & Salt, 2006). Community members living in rural places are both stewards of natural resources and beneficiaries of natural resource exploitation and management (Green, 2014; Sen, 1999). In California, many rural economies rely on exporting natural resources. Natural resource economies typically depend on "...commodity production, such as forest or agricultural products, and consumption, through recreation, retirement, and tourism..." (Green, 2014, p. 424). Historically, rural communities' economies have been dependent on a single extractive sector natural resource industry (Green, 2014). Frequently, commodities are processed in urban communities and much of the final products' value does not benefit the rural areas the raw materials are sourced from. Today, as forest-dependent communities are experiencing catastrophic wildfires, reduction in ecosystem health, permanent loss of local jobs, and the exodus of working-age people to urban communities (Kusel et al, 2020; Morris et al., 2017), many rural stakeholders are collaborating to adopt and implement sustainability strategies within their rural community development plans. Some of these are exploring renewable energy development (Cal Fire, 2020d). A sustainable energy system aims for low carbon emissions, low consumption, zero waste, reuses its resources for multiple purposes, creates development opportunities, and is adaptable to dynamic change (Orecchini, 2009; Orecchini, 2011).

For a growing number of community members and stakeholders, small-scale forest-based woody biomass energy is seen as a method to increase their rural communities' resiliency. Small-scale forest-based biomass facilities increase ecological, social, and economic systems' resiliency and sustainability through direct and indirect job creation, value-adding biomass byproducts, ecosystem restoration, and hazardous fuels reductions (Hibbard & Lurie, 2013; Klapwijk et al., 2016; Morris et al., 2017). To date, the literature on forest-based woody biomass energy development has focused primarily on technological challenges and possible environmental impacts of biomass energy development (Bain, 2003; Ferrero et al., 1987; Nicholls et al., 2008; Rosillo Callé, 2008). Few authors acknowledge the challenges of social acceptability and community capacity that must be met for such energy development to succeed. This research seeks to fill this gap.

Social Dimension of Biomass Energy Development

The social dimension of biomass energy development focuses on communities' relationships with the energy source (Bianchi & Ginelli, 2018). In a lecture for the Sustainable Futures Speaker Series at Humboldt State University (2014), Dr. Jesse Abrams described how the social dimension is often the "neglected sphere" in sustainable renewable energy development literature. However, the social dimension can have a tremendous impact on an energy project's success or failure.

Much of the limited literature on the social dimension of biomass energy development focuses on public perception. Upreti (2004) identified four key factors that

impact public perceptions regarding a biomass energy project: 1) whether the technology utilized for the energy project is unfamiliar to the public; 2) whether the project is imposed on a community; 3) the degree to which the community is included in the decision-making process; 4) whether the bioenergy project's profits primarily benefit external entities rather than the local economy. Public perception, whether enthusiastic, opposed, or apathetic, can significantly impact the outcome of any project (Farhar, 1999; Plate et al., 2010; Stidham & Simon-Brown, 2011; Upreti, 2004).

Public perception has a significant impact on potential locations for energy facilities (Nielsen-Pincus & Moseley, 2009). Stakeholder groups may have concerns that large-scale facilities will lead to the degradation of forest land by overuse of feed-stock and will reduce the value-adding capacity of communities (Nielsen-Pincus & Moseley, 2009). The predominant public concerns about biomass energy facilities center around the possible increase of emission pollutants, increase of noise pollution, increase in traffic as a result of trucks bringing biomass feed-stock to the facility site, and the potential for environmental degradation (Upham & Shackley, 2006). These potentials or perceived adverse effects of renewable energy development can lead to local opposition to community energy projects (Rakos, 2003; Devine-Wright, 2011; Horst, 2007).

The social science literature on public perception of biomass energy provides insight into barriers that stakeholders promoting biomass energy need to overcome. However, because the social science literature, in regards to biomass energy, focuses mainly on the challenges of public perception, there are significant knowledge gaps in how stakeholders are working to overcome other concerns, challenges, and barriers for

forest-based woody biomass energy development. Forest-based woody biomass energy development intersects environmental, economic, and social spheres which are critical for communities' sustainability. Social science lenses can provide a more in-depth understanding of how stakeholders can and have navigated the complex challenges of small-scale forest-based woody biomass energy development towards creating environmental, economic, and social sustainability in rural forest-dependent communities.

Complex Mosaic of Governance

Political ecology is the study of the interactions between politics, economics, and other social dimensions shaping and impacting the natural environment (Robbins, 2004). Political ecology literature provides examples of critical analysis of local environmental issues and how local issues fit within a broader systemic context (Greenberg & Park, 1994; Biersack & Greenberg, 2006). The development of small-scale forest-based woody biomass facilities in the Sierra Nevada are local issues. However, forest-based woody biomass energy fits with the broader systemic contexts of local economic recovery methods, state renewable energy strategies, natural resource governance at the local, state, and federal levels, and global climate change mitigation tactics (Caputo, 2009; Morris et al., 2017).

In the political ecology framework (as seen in Figure 1), institutions, structures,

and processes compose the concept of governance² (Bennett & Satterfield, 2018; Young, 2013). These three elements determine who the decision-makers are, how they make the decisions, for whom they are made, and what measures are undertaken (Bennett & Satterfield, 2018; Lockwood, 2010). Within political ecology literature, institutions are laws, policies, rules, and cultural and social norms that guide human actions (Bennett & Satterfield, 2018; Folke et al., 2005; Lebel et al., 2006; Lockwood, 2010; Young, 2013). Governance structures refer to the organizations, networks, and government agencies that make and enable actions and rules (Folke et al., 2005; Lebel et al., 2006; Lockwood, 2010; Young 2013). Governance processes are the discourse, negotiation, and articulation in decision-making (Folke et al., 2005; Lebel et al., 2006; Lockwood, 2010; Young 2013). Successful governance requires input from structures utilizing the institutions and processes to foster resiliency³ of systems, projects, and organizations (Bulkeley, 2005; Swyngedouw, 2004; Young, 2013). Young (2013) labels this process as a “...complex and shifting mosaic of governance systems...” (p.100).

² Within the political ecology framework, environmental governance is a subset within the broader domain of governance, which “...comprises the rules, practices, policies, and institutions that shape how humans interact with the environment...” (United Nations Environment, 2016). The literature I reviewed to understand the concept of governance focus on environmental governance within political ecology.

³ According to theoretical ecologist C.S. Holling, resilience of a system reflects separate characteristics of stability. In ecology, stability of a system indicates that a system is close to an equilibrium state. In contrast to stability, Holling coined resilience as the amount of shock, disruption or disturbance a system can absorb without significant transformation (Holling, 2017).

Elements of Governance

Institutions	Structures	Processes
<ul style="list-style-type: none"> • Laws • Policies • Rules • Norms 	<ul style="list-style-type: none"> • Decision-making bodies • Formal organizations • Informal networks 	<ul style="list-style-type: none"> • Decision-making • Policy creation • Negotiation of values • Conflict resolution

Figure 1: A framework for understanding institutions, structures, and processes of governance (Bennett & Satterfield, 2018)

Governance structures and processes can converge from the top down⁴ by government regulatory agencies or systems, from the bottom up by communities⁵, or by the exchange of decisions and sovereignty through formal or informal shared management agreements (Bennett & Satterfield, 2018; Eckerberg et al., 2015; Jones, 2012; Saarman & Carr, 2013). However, in practice, these approaches to governance are more nuanced. Small-scale forest-based biomass energy development efforts intersect with complex governance systems for energy and natural resources at federal, state, county, and community levels.

Small-scale forest-based woody biomass energy facilities can be managed by diverse structures such as individual stakeholders, government agencies, non-profit

⁴ The Encyclopedia of Governance defines the top-down approach to governance as an "iron fist" or velvet glove" model characterized as strict and stable governance which the hierarchical state enforces (Bevir, 2007).

⁵ The Encyclopedia of Governance defines bottom-up governance as a community driven democratic approach to problem-solving (Bevir, 2007).

organizations, or private companies. The governance structure may shift from one entity managing the process in the development stage to a different management structure when the facility is operational. Each energy facility development project's governance structure is influenced by its place and community (Bianchi & Ginelli, 2018; Young, 2013). Governance structures for the forests providing feed stock for woody biomass energy facilities are also complex. As with many natural resources, the governance of forest-based woody biomass as a resource does not fit perfectly into a jurisdictional compartment. Private landowners, country, state, and federal government agencies exercise authority over forest landscapes, which provide the feedstock for generation facilities. For small-scale forest-based biomass energy projects throughout California, facility managers secure feedstock with various land managers through stewardship agreements.

California's Energy Governance Institutes, Structures, and Processes

At the federal level, the Federal Energy Regulatory Commission (FERC)⁶, an independent regulatory agency with the U.S. Department of Energy (DOE)⁷, regulates energy transmission, monitors energy sales throughout the United States, and administers financial reporting regulations for jurisdictional companies (California ISO, 2019).

Separate from the DOE, the North American Electric Reliability Corporation (NERC), a

⁶ The Federal Energy Regulatory Commission is an independent federal agency that regulates the interstate wholesale and transmission of natural gas, oil, and electricity (Federal Energy Regulatory Commission, 2019).

⁷ The United States Department of Energy is a cabinet-level agency that focuses on energy policy, security, and technology development (United States Department of Energy, 2019).

non-profit organization, oversees the interconnection of power grids across North America. Through the authority of FERC and NERC, the Western Electricity Coordinating Council (WECC) focuses on interconnection reliability, and grid security in the western region. The state of California falls under the WECC (Western Electricity Coordinating Council, 2019).

At the state level, multiple organizations have authority over various aspects of electrical energy generation and distribution in California. California Independent System Operator (CAISO), a non-profit, focuses on electric grid efficiency and reliability throughout California. FERC regulates CAISO to maintain national standards for electric energy transmission security and reliability. The California Public Utilities Commission (CPUC) regulates the reliability and security of investor-owned electric and gas utilities throughout the state. The CPUC has a responsibility to protect utility customers from fraud. All rates that electric utilities charge their customers are approved and regulated by the CPUC.

State environmental and natural resource agencies have a significant impact on California's electric energy regulation, such as the California State Water Resources Control Board, Department of Water Resources, and California Air Resources Board (CARB). For biomass energy development, CARB plays a critical role. CARB's mission is to protect the public welfare and ecological resources through the reduction of air pollutants to promote sustainability throughout the state of California. CARB sets standards for greenhouse gas (GHG) emissions for every step in the life cycle of biomass fuel development to maintain sustainability standards for air quality (CARB, 2019).

At the federal level, the U.S. Department of Energy (DOE) implements policies that influence energy structures and development in California. As part of the Electricity Advisory Committee, the Efficiency and Renewables Advisory Committee (ERAC) advises DOE on the implementation of renewable energy policies that impact communities throughout the United States. Although the federal government has its own energy policies, California creates its own additional energy policies.

At the state level, California's primary energy planning and policy agency is the California Energy Commission (CEC) (California ISO, 2019). CEC plays a critical role in the formulation of renewable energy systems and provides public policy recommendations regarding energy and distributes energy data to stakeholders (CEC, 2019). As part of the CEC mission to increase the state's renewable energy capacity, the CEC provides a yearly Integrated Energy Policy Report (IEPR) to California's governor and legislature. The IEPR encompasses analyses of California's energy portfolio composition, energy generation, energy distribution, energy demand, and market prices across the state. The IEPR intends to provide state policymakers a 10-year forecast for electricity and natural gas demand, as well as to provide energy policy recommendations that reduce greenhouse gas emissions and maintain California's future energy security. The California Energy Commission's IEPR affects how future energy policies develop as well as how other agencies and utility organizations forecast energy generation and transmission planning (CEC, 2018).

At the state level, California has a Renewables Portfolio Standard (RPS) Program⁸ to increase the use of renewable energy and reduce greenhouse gas emissions.

California's Renewables Portfolio Standard requires 60% of all in-state generated electricity to be from renewable sources by 2030 (CPUC, 2020). In order for California to meet its mandated Renewables Portfolio Standard (RPS) goals, the state needs to increase renewable generation capacity by tens of thousands of megawatts to meet 60% renewable sources over the next 25 years. Diverse groups of stakeholders perceive biomass energy as an essential part of California's RPS because unlike intermittent energy sources such as solar and wind, biomass has the potential to be utilized for baseload⁹ production of energy (Kaffka et al., 2013).

Senate Bill 1122 (2012)¹⁰ is an expansion of feed-in tariffs¹¹ in California Public Utilities Commission's Re-MAT program that explicitly seeks to stimulate the development of biomass energy (Kusel et al, 2020). Through Re-MAT, utilities offer power purchase agreements to renewable energy producers of 3 megawatts or less. Senate

⁸ California's Renewable Portfolio Standard (RPS) is a regulatory mandate designed to increase the generation and use of renewable energy throughout the state. The RPS program, which the California Public Utilities Commission (CPUC) and California Energy Commission administer, establishes renewable source procurement standards for "...state load-serving entities..." (CPUC, 2020; National Renewable Energy Laboratory, 2019).

⁹ Base load power refers to the minimum amount of power required to provide a steady rate of electric power over a set period of time (EIA, 2020).

¹⁰ Senate Bill (SB) 1122 was introduced by state Senator Michael Rubio (D-16th) in 2012 to promote renewable biomass use for electricity generation. Governor Jerry Brown signed SB 1122 into law in September 2012.

¹¹ Feed-in tariffs are mechanisms that compensate residential and commercial customers for the renewable electricity they supply to the grid (PG&E, 2019). California sets feed-in tariffs or long-term price agreements to encourage renewable energy production. According to the CPUC (2019), feed-in tariffs encourage renewable energy producers to develop efficient technologies to reduce costs.

Bill 1122 provides a state-level mandate that large-scale public utilities procure energy from and offer a set price to small-scale renewable energy generation facilities. The bill mandates the California Public Utilities Commission's feed-in-tariff program to include 250 megawatts of small-scale biomass energy generation projects throughout California (PG&E, 2019). Thus, California large-scale public utilities are required to purchase a small portion of their renewable energy generation portfolio from small-scale bioenergy producers. For a segment of rural California communities exploring small-scale forest bioenergy generation project development, Senate Bill 1122 makes small-scale bioenergy generation economically feasible (Kusel et al., 2020).

Local community structures must navigate California's energy governance system in order for small-scale biomass energy facilities to connect to the grid. However, securing a market for energy and byproducts of the facility and accessing the grid system to transport the generated power to energy customers are just one piece of the complex mosaic of challenges for developing forest-based small-scale biomass energy (Kaffka et al., 2013; Jenkins, 2006; Morris et al., 2017). All small-scale biomass energy projects must overcome numerous challenges. These include: procuring reliable biomass feedstock; harvesting and transporting biomass energy to generating facilities; selecting a reliable and efficient technology that converts biomass to electricity; permitting and siting biomass energy plants (which can be complicated and onerous); acquiring a community-approved site for the project within proximity to feedstock suppliers; obtaining funding for development costs; finding an owner for the facility; and training a workforce to operate the facility (Kaffka et al., 2013; Jenkins, 2006; Morris et al., 2017). Because

forest-based small-scale biomass energy projects often start at the community-level, the responsibility for surmounting these challenges often relies on place-based communities' ability to access a mix of capacities.

Place and Community

Places, in the context of forest-based biomass energy facility development, are significant because these facilities are reliant on proximity to forests. In the framework of political ecology, places are more than locations with geographic boundaries (MacGillivray & Franklin, 2015). Places are relational (Biersack & Greenberg, 2006). The three principal elements of place are: the geographic position, the physical medium, and the values and significance people assign as they encounter place. This means that although location is a component of place, the precise structures, objects, tools, resources, mythology, folklore, histories, culture, identities, and people are inseparable components of place (Gieryn, 2000). Places are constructed from combined networks, social stories, and relationships and therefore may have numerous, contradictory identities (Massey, 2013). Both of these explanations of place imply that place is not only geographical, but also social and cultural. Place should not be regarded as a fixed notion, but as a forever evolving variety of social exchanges that are linked through location and space (Gieryn, 2000; MacGillivray & Franklin, 2015; Massey, 2013).

Within the literature, the concept of community is classified and identified as a social system that includes incorporated areas, common ties, and social interactions (Chaskin, 2001; Hollingshead, 1948; Hillery, 1955; Hill & Whiting, 1950). As Jonathan

Kusel (2001) states, “communities are composed of and sustained by individuals, and individuals are shaped by their community” (p. 377). Community refers to the sense of belonging to a group of others through overlapping factors of geographic location, interpersonal networks, and common ties. The sense of community facilitates the possibility for individuals to live together sustainably (Buckner, 1988; Bopp et al., 2000). In regards to small-scale biomass energy development, a sense of community unites individuals and organizations to work towards shared goals of sustainable development to enhance the well-being and resiliency of their community (Bopp et al., 2000).

Community Capacity

In the context of a community's ability to manage forest resources, community capacity “...refers to a community's collective ability to address local social and economic needs and take on the challenges of stewardship” (Kusel et al., 2001, p. 13). Individuals, organizations, and networks must have a sense of community, commitment, mechanisms of problem-solving, and access to resources to plan, make decisions, and advocate for change within their community (Chaskin et al., 2001). Dimensions of community capacity are the qualities that enable a community to endure and thrive (Labonte & Laverack, 2001). The literature identifies physical or built capital, natural capital, financial capital, political capital, human capital, cultural capital, and social capital as the dimensions that contribute to community capacity (Aref et al., 2009; Bopp et al., 2000; Chaskin et al., 2001; Goodman et al., 2016; Kwan et al., 2003; Labonte & Laverack, 2001; Kusel, 2001).

The Community Capital Framework (CCF) illuminates the multidimensional characteristics that contribute to a community's collective ability to adapt to change, and offers an approach that demonstrates what the capitals contribute to community capacity. The CCF involves a focus on systems' stocks of physical and social wealth, which are indispensable to community well-being, and enables a more nuanced understanding of the community-environment relationship (Baker & Kusel, 2003; Emery & Flora, 2006). The CCF can be applied to community capacity to develop biomass energy (See Table 1 below). The capitals function cohesively to enhance healthy ecosystems, economic security, and social inclusion and promote overall community resiliency (Pigg et al., 2013).

Table 1: Community Capitals Framework applied to Biomass Energy Development

<p>Physical Capital refers to the “factors of production” that support development (Sullivan & Sheffrin, 2003). Physical capital encapsulates constructed infrastructure that supports a community (Chaskin et al., 2001). Biomass energy facilities utilize fuel sources that are gathered within a 50-mile radius (i.e. limit of acceptable transport cost) of the facility which requires a facility to convert biomass to energy, a network of roads to deliver feedstock, as well as having a transmission infrastructure in place to transport power to energy customers (Mason, 2008).</p>
<p>Natural Capital consists of the community’s access to ecosystem services and resources such as minerals, soils, water, air, and all living organisms (Kareiva et al., 2011). Forest biomass is product of natural ecosystems (Ferrarini et al., 2017).</p>
<p>Financial Capital refers to a community’s financial assets such as accumulated wealth; business, civic, and social entrepreneurship; tax revenue; and ability to obtain loans and grants (Emery & Flora, 2006). The majority of small-scale biomass energy projects require equity financing, grants, and loans to finance the development of a facility, a practice referred to as stacking capital. Stacking capital allows biomass energy developers to utilize various funding mechanisms at each phase of the developmental process.</p>
<p>Political Capital is the ability to affect the access, distribution, and governance of resources through political relationships and structures (Jacobs, 2011). Individuals, as well as groups, have the ability to leverage political capital. Local, regional, and state level governments grant legitimacy and support for small-scale biomass energy development.</p>
<p>Human Capital encompasses the skills, abilities, and knowledge held by individuals within a community (Salamon, 1991). Human capital enhances a community’s ability to develop sustainably. In the case of small-scale biomass energy development, human capital refers to community members’ grant writing, engineering, forest management, and community organizing skills, which contribute to the community’s capacity to develop energy technology.</p>
<p>Cultural Capital refers to peoples’ collective traditions and practices that form identity (Bourdieu, 1986). Cultural capital includes customs and practices people share to symbolize the collective group (Davies & Rizk, 2018). Cultural capital equips human societies with traditional knowledge to adapt to environment changes (Cochrane, 2006). The cultural capital of a community may influence community members’ knowledge about and choices with regard to supporting biomass energy development or not.</p>
<p>Social Capital refers to collective values, networked relationships, and collective action (Lin et al., 2001). Social capital is embodied in the relationships among people within a community and can be marshalled to achieve shared goals. Social capital can facilitate advancement in economic development and community governance (Krishna, 2002). Interpersonal relations among individuals in the community may have a great impact on the acceptance of biomass energy development.</p>

The Community Capital Framework (CCF) offers an approach to critically analyze how stakeholders for forest-dependent communities' projects can utilize their collective capitals to overcome barriers (Baker & Kusel, 2003) such as advancing through the initial plan and building exploratory capital; locating a feasible and community-approved site; acquiring and harvesting feedstock; transporting biomass feedstock to energy generating facilities; procuring development costs' financing; choosing a reliable and efficient technology to convert forest-based biomass feedstock to electricity; finding a facility owner and training a workforce to operate the facility; and guaranteeing markets for the generated energy and byproducts of the facility (Morris et al., 2017). Stakeholders utilize some or all of the seven capitals to navigate the various complex governance systems and phases throughout the development process. The CCF is used below to illuminate the two case studies within the Sierra Nevada.

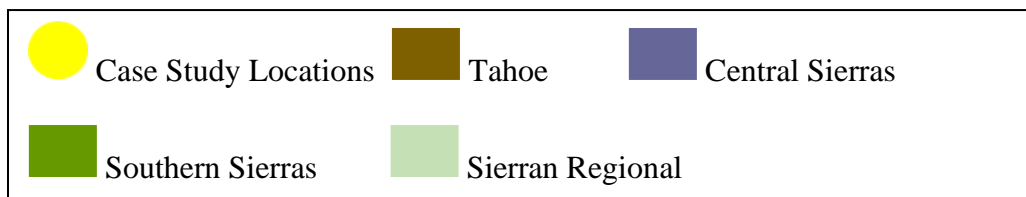
SETTING: THE SIERRA NEVADA MOUNTAIN RANGE

California's "backbone," the Sierra Nevada Mountain Range has a significant impact on the state's overall well-being. Also referred to as the Sierra bioregion, the over nineteen million acres of mountainous terrain includes ten million acres of forest landscape and hundreds of endemic plant species. The Sierra bioregion collects approximately 30% of California's precipitation and includes the headwaters of over twenty river basins. Water from the Sierras distributed through canals, dams, and reservoirs provides 60% of the state's water requirements (Ingram & Kocher, 2015; Hall, 2018). While the Sierra bioregion's ecosystem services provide \$2.2 billion worth of documented services and commodities each year; the overall value of life in the region's ecosystem and its ecosystem services support is unquantifiable (Ingram & Kocher, 2015).

The majority of the Sierra bioregion terrain is held in public trust and managed by federal and state agencies. Approximately 60% of the terrain in the Sierra Nevada is managed by the USFS, the Bureau of Land Management (BLM), and the National Park Service (NPS) (Davis & Strom, 2004). These federal agencies along with California state agencies, counties, municipalities, and private landowners manage approximately ten million acres of forest landscape. Sierra bioregion forests are estimated to produce eight hundred forty million tons of dry biomass per year (Ingram & Kocher, 2015). The two small-scale forest-based biomass energy facility projects, which are the case studies for this thesis, are located in the Central Sierra (North Fork Community Power) and Tahoe Basin (Cabin Creek Biomass Facility Project) (see Figure 2).



Figure 2: Sierra Nevada Mountain Range and Case Study Locations (USGS, 2020)



METHODS

In this thesis, I utilized multiple qualitative methods to research how internal capacity and external factors impact the development of small-scale (3 megawatts or less) forest-based woody biomass energy generation in communities in the Sierra Nevada. Through the research process, I conducted semi-structured interviews, document analysis, archival research, and participant observation to understand how place, community, and regulatory frameworks shape small-scale biomass energy development projects in forest-dependent communities. I focused on the cases of the North Fork Community Power projects in North Fork, California and the Cabin Creek Biomass Facility project in Truckee, California.

Epistemology

Epistemological theories are tools for understanding truths and ways of knowing (Lakoff & Johnson, 1980; Rescher, 2003). In the book, *The Foundations of Social Research*, Michael Crotty (1998) defines epistemology as “...the theory of knowledge embedded in the theoretical perspective and thereby in the methodology” (p. 3). Thus, my epistemology provides a philosophical platform for conducting research (Crotty, 1998; Creswell, 2008). Throughout my research, I utilize a constructivist approach. The constructivist approach relies on developing knowledge through interactions and sharing truths between individuals (Creswell, 2008). The knowledge I share through this thesis I accumulated through document analysis, observation, and interviews with a variety of

individuals who have different perspectives and understandings about the development of small-scale forest-based energy generation in California.

Methodology

Case study research lends itself to constructivist epistemology, because constructivism prompts interaction to enhance more in-depth understanding (Creswell, 2008). My overarching case is about communities' capacity to develop woody biomass energy. I focused on two locations as primary comparative examples of how communities seek to develop woody biomass energy in California. A case study methodological approach allows the researcher to explore a phenomenon in a particular place or situation, "a case" in-depth, and then extrapolate the findings from one or more cases to illuminate the phenomenon of focus (Creswell, 2008).

Access to Research Participants

Before my field research, I communicated with Nick Goulette (Executive Director) and Angela Lottes (Biomass Program Coordinator) at the Watershed Research and Training Center, a forest conservation and community development non-profit organization based in Northern California. Both Goulette and Lottes were actively involved in promoting the growth of woody biomass utilization throughout California. They introduced me to key stakeholders connected to the North Fork Community Power project in North Fork, and the Cabin Creek Biomass Facility project in Truckee. These key stakeholders connected me to other individuals involved in biomass energy

development. Through snowball sampling, I was introduced by these people to a variety of different stakeholders who participated in this thesis research.

Methods of Knowledge Collection

I conducted semi-structured interviews with stakeholders whose interest and involvement affect small-scale forest-based biomass energy development in California. These stakeholders can be grouped into three categories: key stakeholders, primary stakeholders, and secondary stakeholders (Grilli et al., 2015; Stidham & Simon-Brown, 2011; Nasr, 2020). The different types of stakeholders all hold varying degrees of power, are interrelated, and impact the energy facility development process in various ways (Vallet et al., 2019). Key stakeholders significantly impact the development of a forest-based biomass energy project (Grilli et al., 2015; Stidham & Simon-Brown, 2011; Nasr, 2020). Primary stakeholders are directly impacted either positively or negatively by a facility's development (Grilli et al., 2015; Stidham & Simon-Brown, 2011; Nasr, 2020). Secondary stakeholders are distantly connected to a project's development and have minimal impact on the success of a facility's development (Grilli et al., 2015; Stidham & Simon-Brown, 2011; Nasr, 2020). Each development project has diverse stakeholders with differences in levels of power, values, and goals, which have a direct or indirect impact on the development process (Barnaud et al., 2018; Folke et al., 2005; Vallet et al., 2019).

With the permission of these stakeholders, I used an audio recorder as well as took notes to maintain the integrity of the interviewees' comments. I conducted 36

interviews (categorized in Table 2) with stakeholders that included US Forest Service (USFS) staff, local government officials, environmental activists, and other community members. Fourteen of the interviews were with stakeholders directly linked to the North Fork project. I interviewed eleven stakeholders associated with the Cabin Creek project in Truckee. I interviewed eleven stakeholders who were not necessarily directly related to the North Fork project or Cabin Creek project; however, they were key or primary stakeholders for small-scale biomass energy development in California. For each interview, I tailored my questions to the stakeholder's role and position regarding small-scale energy development. Each interview lasted between 20 minutes to an hour depending if the interviewee was a key stakeholder, a primary stakeholder, or a secondary stakeholder. I conducted all of the case study interviews in-person at various locations throughout Madera County, Placer County, and Sacramento County.

Table 2: Stakeholder Interview Chart

	Key Stakeholders	Primary Stakeholders	Secondary Stakeholders
North Fork	7	4	4
Cabin Creek	4	3	2
State Level	8	4	

The majority of stakeholders that participated in my research hold multiple positions within their community. As a constructivist researcher conducting semi-structured interviews, I relinquished some of my control over the direction of the interviews so that the participating stakeholders could express freely how their multiple positions overlapped, supported, or conflicted specifically regarding biomass energy. Semi-structured interviews provide the interviewee the freedom to elaborate on the topic (Hay, 2010).

To understand the history and regulatory frameworks of woody biomass energy development in communities throughout the Sierra Nevada, I utilized archival research and document review. I explored a variety of different types of documents including energy policy reports, environmental impact assessments, feasibility reports, census data, local government policy and regulation, newspaper articles, and newsletters. Document review and archival research provided a solid foundation on which to scaffold my research.

As part of my research process, I applied participant observation to formulate a better understanding of the stakeholders and processes involved in the development of small-scale forest-based biomass energy (Hay, 2010). I attended various workshops regarding biomass energy development throughout the state. When I could not physically attend meetings, I watched sessions streamed online provided by the Woody Biomass Utilization group and Statewide Woody Energy Team.

Information Analysis

To analyze the information, I coded themes from the interviews, meetings, archives, and documents. Coding is the analytical process of categorizing data or information to inform research (Bogdan & Biklen, 1992; Creswell, 2008). Through the coding process, I pulled out themes from the interviews with stakeholders involved in forest-based woody biomass energy development projects. I identified recurring themes related to social, political, economic, and social dimensions for each of the case study locations. Lastly, I compared themes between the study locations and with reference to the literature to better understand how forest-dependent communities are developing small-scale woody biomass energy throughout California.

THE NORTH FORK COMMUNITY POWER FOREST BIOENERGY FACILITY: A CASE STUDY OF SMALL-SCALE WOODY ENERGY DEVELOPMENT IN AN UNINCORPORATED COMMUNITY

North Fork lies at the exact center of California, at 2,600 feet elevation in the Sierra Nevada foothills. The unincorporated community of North Fork and the surrounding area has approximately 3,600 residents. The town neighbors the Sierra National Forest and is thirty-one miles from the south entrance of Yosemite National Park. North Fork is an unincorporated community in Madera County. In Spanish, Madera translates to wood, and the North Fork area has an abundance of manzanita, oak, pine, and cedar across its landscape. This forested landscape continuously creates an abundance of biomass. North Fork formed as a community because of its proximity and access to forest resources.

North Fork: A Forest-Based Community

North Fork has been a place where the communities of people who call the area home have a connection to and reliance on the forested landscape. North Fork Mono¹² people have lived there for millennia and continue to utilize pruning, coppicing, irrigating, weeding, burning, and sowing seed, to cyclically manage the natural Sierra

¹² North Fork Mono refers to the native peoples of the North Fork. The descendants of the many groups of people living in and around North Fork have unified around the identity of North Fork Mono for preservation and federal recognition (North Fork Rancheria of Mono Indians of California, 2019). Historically, the people of the Central Sierra Nevada mountains referred to themselves as the Nim people (Anderson, 2013; Lee, 1998).

Nevada landscape for its vast resources (Anderson & Rowney, 1998; Anderson, 1999). As waves of Europeans came to the region, logging, lumber manufacturing, and other forest-dependent industries became the community of North Fork's primary economic foundation.

During the 1940s¹³ the Associated Lumber and Box Company purchased a 135-acre parcel and built a sawmill in the heart of North Fork. Ron Yanke purchased the sawmill in 1985 and renamed it South Fork Timber Industries, which became the largest employer in the area. Because of North Fork's close proximity to the Sierra National Forest, the sawmill had a consistent source of timber and "...from 1985 till to 1991 during the peak lumber harvest, loggers felled an average of 143 million board feet a year..." (North Fork History Group, 2015).

To utilize excess sawdust, fuel the boilers, and generate electricity for the sawmill, South Fork Lumber Industries constructed a cogeneration energy plant. South Fork Lumber Industries sold the surplus power generated from the mill to public utility companies, created humus (soil amendment) from bark and fertilizer from ash, and sold these byproducts. Through interviews, I learned that most North Fork residents viewed the cogeneration plant as a positive aspect of the sawmill because it maximized the utilization of the wood brought to the mill, reduced waste, and created more revenue for the company and North Fork economy. Because of the positive experience the North Fork community had with cogeneration, when North Fork Community Development

¹³ April 1, 1943 marked the beginning of operation of the Associated Lumber and Box Company sawmill (North Fork History Group, 2015).

Council (CDC) proposed the development of a small-scale biomass energy facility, the community was predominantly supportive of the proposal. As one community member stated, “the (bioenergy) technology has only improved since the 80s...”.

Government-mandated forest management regulations in the late 1980s specifically linked to the protection of the California spotted owl under the Endangered Species Act (1973) contributed to a mass decline in the timber industry throughout California's Sierra Nevada (USFS, 1992). Because of its proximity and economic dependence on the Sierra National Forest, North Fork was one of many forest-dependent communities affected by a decline in timber harvesting. South Fork Lumber Industries production decreased from 83.7 million board feet in 1992 to 63.8 million in 1993, and the sawmill was permanently closed on February 25, 1994 (North Fork History Group, 2015). Over 120 workers at the mill and in ancillary positions such as logging and trucking lost their jobs due the sawmill closure.

Lasting Community Impact

The sawmill closure has had a lasting economic impact on the North Fork community. After the sawmill closed in 1994, the town of North Fork lost over half the local restaurants in the area, and the banks, pharmacy, and laundromat closed down. As one North Fork resident stated, “... all the things that made our [North Fork] town a town were gone after the sawmill closed, it was the lifeblood of this town... people had to find work in the valley, and they spend their money in the valley.” As with many rural forest-dependent communities in the early 1990s, people in North Fork either had to move or

commute to find employment opportunities in other communities. Approximately 80% of the North Fork population now commute to Metropolitan Fresno in the San Joaquin Valley for employment (which is approximately 50 miles away and over an hour's drive in one direction).

The community of North Fork was dramatically affected by the closure of the mill. However, members of the North Fork Rancheria of Mono Indians were disproportionately impacted. Members of the North Fork Rancheria of Mono Indians made up a significant portion of the local timber harvesting industry, logging transport, and the sawmill's workforce. Data provided by the North Fork Rancheria Indian Housing Authority for the TSS Consultants feasibility study indicates approximately 57% of Mono families in Madera County have been in economic distress since the closure of the sawmill (TSS Consultants, 2014).

Redevelopment of the Mill Site

Residents of the community realized that the social and economic recovery of North Fork had to start with actions at the community level. In 1994, within four months of the sawmill closure, a group of community members formed the CDC, a non-profit, 501(c)3 organization with a mission, "to promote the social, economic and environmental welfare of North Fork, CA" (CDC, 2020).

Several years after the formation of the CDC, the Madera County Redevelopment Agency donated the use of the abandoned 135-acre mill parcel of the old South Fork Lumber Industries sawmill site to the CDC (Figure 3). In 1997, the Madera County

Redevelopment Agency entrusted the CDC with leadership responsibilities to create and execute redevelopment strategies on the site to promote local economic growth and the development of green space in North Fork. Madera County officially transferred the title of the site to the CDC in 2006. The CDC's vision for the old mill site has consistently been about creating an industrial park that attracts economic opportunities to North Fork. As part of their redevelopment effort, the CDC subdivided the 135 acres into parcels for various industrial uses.



Figure 3: Aerial photo of the industrial park in North Fork, CA (TSS Consultants, 2014).

As a North Fork community resident and retired USFS employee stated, “There is a need for wood utilization industries in the new industrial park. Because of the bark beetle infestation, every year, tree mortality is becoming more of a threat to the health of the Sierra National Forest and North Fork”. California’s severe drought in 2012-2015

escalated the rate of tree mortality throughout the Sierra Nevada. Madera County has one of the highest rates of tree mortality in the Sierra Nevada. As of 2019, the Sierra National Forest had a tree mortality rate of approximately 58%, which has a severe ecological impact on the entire forest (Fettig, 2019). According to the Sierra National Forest Supervisor, “The degree of tree mortality in the Sierra (National Forest), and really the entire South-Central region, is unprecedented.”

North Fork Community Power

The CDC and Phoenix Energy¹⁴ collaborated to form the North Fork Community Power LLC (Walling, 2016). The NFCP would own, manage, and operate a two-megawatt biomass gasification facility¹⁵ at the North Fork industrial park. Approximately 10 acres of the industrial park’s 135 acres would be utilized for biomass energy production. The two-megawatt biomass gasification facility was a part of the CDC and other local stakeholders’ vision for revitalizing the wood utilization industry in North Fork. With the high rate of tree mortality in the area, the gasification facility proposed to convert deadwood into enough energy to power approximately 1,600 homes as well as yielding marketable biochar as a byproduct¹⁶. According to Greg Stangl, CEO of Phoenix

¹⁴ Phoenix Energy is an independent power producer that operates a network of small, distributed generation biomass gasification plants in partnership with businesses and communities (Phoenix Energy, 2020).

¹⁵ Gasification is a thermochemical process which converts organic carbonaceous materials at a high temperature (>700 °C) into synthesis gas (syngas) (White & Plaskett, 1981). “This syngas is then used to fuel a specially modified natural gas genset to produce electricity and heat (Phoenix Energy, 2020). Through the gasification process, the organic materials release the syngas and what remains converts into biochar.

¹⁶ In the absence of oxygen, biomass chemically alters into either a dark liquid known as pyrolysis oil, or pyrolysis gas known as syngas, or a solid deposit known as biochar. Biochar is full of carbon-rich solids

Energy, the biomass energy facility was expected to continuously be in operation and would create a minimum of a dozen new local jobs.

As of July 2020, the NFCP is moving forward with the development of the two-megawatt biomass gasification facility. It has been a long and arduous journey for the CDC, project stakeholders, and residents of North Fork for the project to reach the construction stage. Biomass energy technology has been of interest to the CDC for the old mill site since its formation in 1994. However, as discussed below, it took years of community capacity building; networking and partnership with various government agencies and organizations; changes, development, and implementation of policies at the federal, state, and local level; technological bioenergy improvements; and securing millions of dollars in funding for the NFCP to be in a position to build a small-scale biomass energy facility.

North Fork's Community Capacity to Develop Forest-based Biomass Energy

In the 2000s, the CDC, along with Yosemite/Sequoia Resource Conservation and Development Council (RC&D)¹⁷, and the Sierra Nevada Conservancy (SNC)¹⁸, began a

and is useful in agriculture to enrich the soil as well as prevent soil from leaching nutrients (Bruges, 2010).

¹⁷ The Yosemite/Sequoia Resource Conservation and Development Council (RC&D) is another non-profit organization working to improve the economy, living standards, and environment in Fresno, Mariposa, and Tulare counties. Their mission is “to promote the quality and aesthetic values of our cultural, environmental, and recreational resources by improving the quality of life through sustainable, diverse economic development.”

¹⁸ The Sierra Nevada Conservancy (SNC) is a California state agency formed from the passing of Assembly Bill 2600 to promote the ecological and social well-being in the Sierra Nevada Mountains (Sierra Nevada Conservancy, 2015).

collaborative process of exploring the feasibility of developing small-scale biomass energy on the mill site. According to interviewees, at that time, generating biomass energy did not seem like a feasible option for the CDC because California's energy policy did not support small-scale biomass energy generation, nor did the CDC have the finances or the internal knowledge to move forward with an energy development project.

Members of the North Fork community have historically made their livelihood in the forest and through wood utilization. The CDC's initial interest in biomass energy was its potential to create forest dependent jobs that utilize the knowledge and skills of the community members of North Fork. Living and working in and near the Sierra National Forest is an essential aspect of the North Fork community members' sense of place. As a member of the North Fork History Group stated,

“North Fork became the community it is and attracted people to move from all around the world to live here because of the forest.... there are many North Fork families who have worked in timber for generations. It is a part of our history, and we celebrate that history.... one of our community's biggest yearly events is the Mid-Sierra Loggers Jamboree, which honors our cultural heritage which shaped North Fork.”

The industrial park redevelopment project itself is a part of the community's effort to honor its history of wood utilization and for the community to adapt to economic and ecological change. The North Fork History Group collaborated with the CDC to maintain and restore two giant saws from the old sawmill as installations near the green space, to honor the history of the sawmill. The CDC, RC&D, and SNC collective efforts to attract wood utilization industries to the industrial park, cater to the knowledge and skills of the North Fork community. North Fork's human capital in forestry, timber, and other wood

utilization industries influences and impacts the community's cultural capital and how the community's culture utilizes and develops space to foster adaptive resilience as a community.

Forest-based biomass energy is a part of North Fork history. However, the CDC, RC&D, and SNC were mindful that there may be concerns from the community about developing forest-based biomass energy for North Fork's future. North Fork is composed of a diverse population of ex-loggers, foresters, the Vipassana meditation community, organic farmers, and artists, and the CDC, RC&D, and SNC wanted the industrial park to represent the cultural values of today's North Fork community.

The CDC held monthly meetings during the formative stages of the project to include the community in the redevelopment process. As part of these meetings, the CDC addressed the public's environmental and economic concerns regarding forest-based biomass energy. However, for most North Fork community members, the idea of forest-based biomass energy development promised more advantages than disadvantages for their community. According to interviewees, wood utilization in various forms was a part of North Fork, and with the rise of tree mortality, the community needed an economically feasible method to take the deadwood out of the forest.

As planned the future two-megawatt biomass gasification facility would have access to available feedstock from the Sierra National Forest managed by the USFS, forested landscapes owned and managed by private landowners, agriculture wood waste from local orchards, and urban wood waste. Based on an initial 2012 and 2014 updated feasibility assessment, the North Fork biomass energy facility had access to 21,670 BDT

per year of woody biomass and would be able to function sustainably¹⁹ (TSS Consultants, 2014). A two-megawatt biomass gasification facility utilizes approximately 16,000 BDT per year.

However, at the time of the evaluation, tree mortality in Madera County was far less rampant.²⁰ Due to its proximity to the future biomass gasification facility, plans called for approximately 65% of the facility's feedstock to be sourced near Bass Lake Road which is managed by the Bass Lake Ranger District of the Sierra National Forest. Securing a long-term 10-year stewardship agreement for biomass feedstock was an important accomplishment for the success of North Fork's biomass energy development, because the enterprise could not obtain loans without guaranteed available long-term feedstock. The CDC²¹ collaborated with the Bass Lake Ranger District staff, the Sierra National Forest and the USFS Regional Office to establish a 10-year stewardship agreement with NFCP and specifically with the CDC for access to biomass feedstock. This guaranteed supply of feedstock solidified the biomass energy project's ability to move forward with the development process. The next step for the CDC was focusing on site development for the facility.

¹⁹ For the feasibility evaluation (2014), TSS Consultants evaluated biomass feedstock availability within a 30-mile radius from the proposed biomass energy facility development site (TSS Consultants, 2014).

²⁰ Today, there is a continuously increasing amount of deadwood in forested landscapes due to high tree mortality throughout the Sierra Nevada.

²¹ The CDC also advocated for the stewardship agreements for the extended benefits to the local economy. In traditional federal contracting, if an agency solicits a Request for Proposal (RFP), the agency can consider a contractor's experience and price, but the agency cannot consider the local benefit. Stewardship agreements, in contrast, may consider local economic benefits. Therefore, with a stewardship agreement, local contractors have an opportunity to compete for a contract with larger regional contractors and secure the bid to clear biomass slash from the forest.

North Fork's industrial park is a key to the development of the two-megawatt biomass gasification facility. The land use and zoning designation of the industrial park were for Heavy Industry, and further, the industrial park had existing infrastructure from the sawmill. The industrial park, for example, had onsite wells with gravity-fed water storage. Madera County's municipal code required elevated water storage that feeds the flow via gravity to the demand point (Madera County, 2020). The Madera County Fire Marshall certified that the industrial park's water supply system was adequate for fire protection flows (TSS Consultants, 2014).

Road access to the facility was another potential concern. As a CDC member stated, "[T]he general rule with biomass energy requires two truckloads per day per megawatt to fuel the facility." Large haul trucks would have easy access to the industrial park via Madera County Road 225 and Douglas Ranger Station Road and these roads had the capacity to accommodate the four truckloads per day required to supply the facility with an adequate woody biomass stock. During the CEQA review process, there were no access challenges for the project (TSS Consultants, 2014).

According to a former RC&D Executive Director, the SNC hired a local grant-writing consultant to enhance Sierra Nevada communities' capacity to secure funding for forest restoration projects, increase the utilization of sub-merchantable timber, and create economic value for forest waste. Development of the North Fork biomass energy facility directly aligned with this mission. Thus, as part of their SNC work, the grant-writing consultant wrote a rural business enterprise grant in 2012, which funded feasibility studies for the North Fork biomass facility and for a potential biomass facility in

Calaveras County (another biomass project in the Sierra Nevada). Hiring a local grant-writing consultant had a significant impact on moving the biomass energy facility from an idea to a feasible project for North Fork.

Working with the SNC grant-writing consultant, the CDC received a Rebuild America grant through the Department of Energy. The CDC and other members of the community used the funds from the Rebuild America grant to coordinate a workshop on sustainable ruralism. The North Fork community collaborated and pooled their shared human and social networks to bring people who worked for large environmental non-profits to North Fork. The workshop provided the CDC with the opportunity to share with the visitors the potential for small-scale biomass energy to promote economic, ecological, and social resilience in North Fork and other rural Sierra Nevada Mountain communities.

Since the commencement of the North Fork biomass energy project, the CDC, RC&D, and SNC, have worked together to move the project forward. These stakeholders continued to progress all these years through sheer tenacity and staying power. However, agency members understood that they could only go so far to achieve their goals with the three agencies alone. More collaboration was needed. They and other community and environmental groups interested in biomass energy development realized that if small-scale biomass energy was to be a viable option in California, diverse interest groups had to pool their resources and work collaboratively towards accomplishing each phase of the development process together.

Along with the RC&D and SNC, the CDC collaborated with other organizations such as the Sierra Resource Conservation District (SRCD),²² Sierra Institute,²³ and The Watershed Research and Training Center (WRTC)²⁴ to promote forest-based biomass utilization. These organizations partnered with stakeholders in government agencies such as CEC, USFS, and CAL FIRE to be a part of the California Statewide Wood Energy Team (SWET), a subgroup of California's ad-hoc Forest Biomass Working Group (CA FBWG)²⁵ which focuses on community wood energy development throughout the state. The Statewide Wood Energy Team collaborates with wood energy business and community projects to assist with "...expertise, technical assistance, and small grants..." (SWET, 2020). The North Fork biomass facility works with the USFS under an interagency Memorandum of Understanding (MOU) (North Fork Bioenergy Project, 2015). The Sierra Resource Conservation District, USFS Region 5, Sierra National Forest, and Sierra Nevada Conservancy have an interagency MOU for the purpose of support and collaboration to develop biomass processing and utilization operations in the Southern Sierra Nevada region (Sierra Resource Conservation District, 2019). This

²² The Sierra Resource Conservation District's mission is to locate fiscal, technical, and educational resources and organize them within the community to provide for the local land user's current and future needs. SRCD works alongside federal, state, and county bodies, academic establishments, non-profits, and private and public landowners to conserve natural resources (SRCD, 2020).

²³ The Sierra Institute focuses on the well-being of rural communities while enhancing their involvement in the decision-making process of sustainable natural resource management (Sierra Institute, 2020).

²⁴ The Watershed Research and Training Center, located in Trinity County, is a non-profit which provides watershed and land management services, creates partnerships toward greater fire resilience and biomass utilization, and through relationships with organizations and public agencies in the community, cares for the land, creates sustainable jobs, and creates connections between the people and the land (WRTC, 2020).

²⁵ CA FBWG is composed of diverse individuals and organizations focused on rural forest community well-being and resilience through collective strategies to increase forest wood utilization (SWET, 2020).

collaboration with outside partners allowed the stakeholders to work together to leverage political capital.

From a political perspective, the stakeholders involved in North Fork picture themselves as part of something bigger than a two-megawatt forest-based biomass gasification facility. As the RC&D Project Manager stated, “This is the pilot project for small-scale biomass energy in California.” Key North Fork stakeholders involved in the biomass project have been actively working with other rural forest-dependent communities throughout the Sierra Nevada to increase these communities' capacity to develop small-scale forest-based woody biomass energy.

State political representatives have been supportive of the idea of small-scale forest-based woody biomass energy. However, most of these political representatives have thus far not provided tangible support for small-scale biomass energy. One SWET member stated, “California politicians are not passing actual updates to policies that would further the growth of small-scale biomass energy usage...It is strategically important for individuals and groups involved in biomass energy development to know their regional and state politicians. These relationships will, hopefully, motivate politicians to enact policy to support the technology.”

County level government has also influenced the biomass gasification facility project development. The North Fork industrial park and the development of the gasification facility have strong support from the local government. According to interviewees, Madera County District 5 Supervisor and life-long resident of North Fork, Tom Wheeler, actively supports forest-based biomass energy development in the

industrial park. In North Fork, as in many rural communities, community leaders wear many hats. The community members who moved development of the two-megawatt biomass gasification facility forward are leaders within the community in many other community projects and enjoy trust, good-will, and influence with the community. As one North Fork community member stated, “I may not be directly involved in the mill site's decision-making process, but I trust the people that are. I work with all of them on so many projects, and I know that they have our town’s best interest...”. This trust and influence of the CDC members within the community strengthen their ability to move project development forward in the industrial park with the support of the North Fork community.

Securing funding for the North Fork biomass energy project has been achieved substantially through collaboration within the network of forest-based biomass energy stakeholders (see Figure 4). Working with SWET, key stakeholders on the North Fork project gained access to funding and grants, feasibility studies, project development, equipment, and construction. The estimated cost of the future biomass gasification facility is \$14.5 million (Lathey, 2017). As of this writing, the North Fork bioenergy project has been awarded \$5 million from an EPIC grant, \$900,000 from New Market Tax Credits, and has raised the rest of the \$14.5 million from smaller grants and private equity.

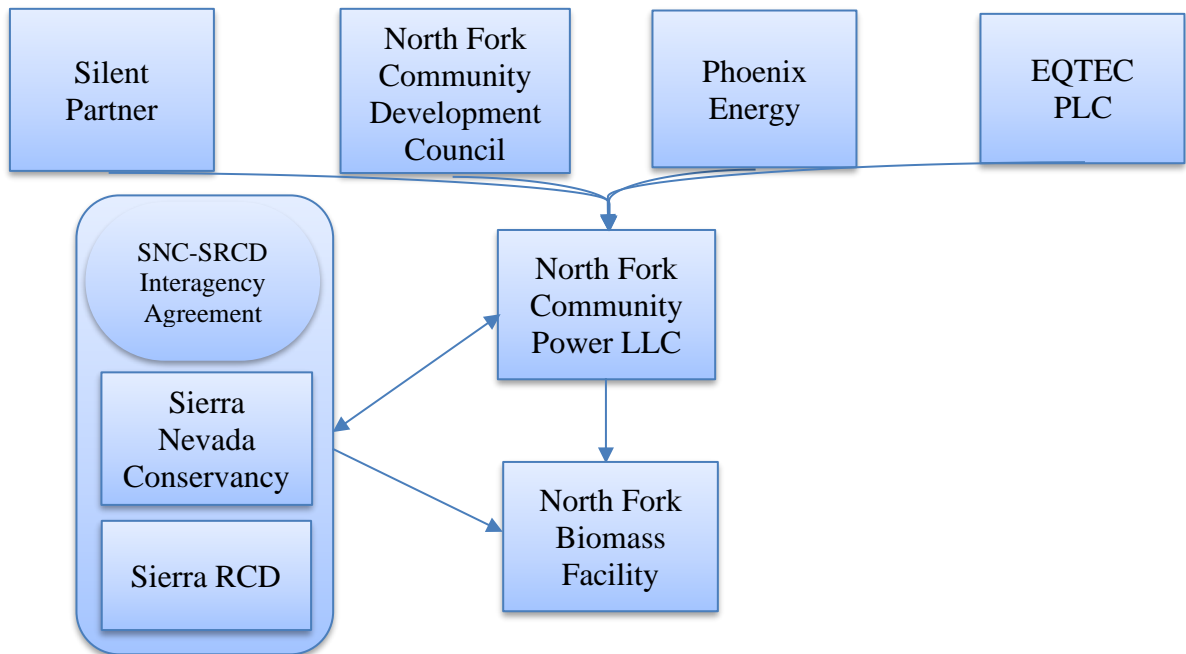


Figure 4: Project Organization of North Fork Biomass Facility

In the summer of 2013, the CDC received a grant from California’s SWET. SWET procured \$2,500 in funding for the CDC to hire a bioenergy consultant to assist in developing a stewardship agreement with the USFS. Members of the CDC knew that the energy project would most likely need funding through a bank and that the banks would want the CDC to have a feedstock contract before providing any funding for the facility development. As one CDC member explained, “Relying on the Forest Service, the Forest Service without a contract can be unreadable because the U.S. Forest Service does not know what funding it will have in the future. Therefore, feedstock availability and the feedstock price are unreliable to present to potential investors.” Stewardship agreements allow interested parties to create a contract with the USFS to guarantee sustainable management of a certain amount of acreage over a 10-year period.

On April 8, 2015, the CEC awarded the WRTC an approximately \$5 million Electric Program Investment Charge (EPIC) grant for bioenergy utilization research and facility construction. As the grant's primary manager, the WRTC managed the allocation

of the grant's funds between bioenergy research and facility construction concerning elevating small-scale biomass energy development. The WRTC focused the EPIC grant on the North Fork biomass energy project because, at the time, it led all other potential small-scale biomass energy projects in its community capacity for moving a project forward to the construction and operational phases. The members of SWET believed that the EPIC grant was critical to the North Fork project moving forward and being the first small-scale forest-based biomass energy project under the SB 1122 policy and would lead the way for more small-scale forest-based biomass energy projects throughout the state.

Working with the SNC's grant-writing consultant, the CDC was able to finance a systems impact study, which was the last step that the community of North Fork needed to be eligible to be a part of the five small-scale biomass energy facilities to be developed under the SB 1122 policy. Once North Fork was an eligible project, the North Fork development team negotiated a Pacific Gas & Electric (PG&E) power purchase agreement in 2017. Under the Bioenergy Market Adjusting Tariff (BioMAT)²⁶, PG&E awarded the NFCP a 20-year at \$199.72 per MWh rate power purchase agreement (PPA). With this PPA and the stewardship agreement for the biomass feedstock, the North Fork development team could get financing and move forward into implementation.

²⁶ The California Public Utilities Commission developed the Bioenergy Market Adjusting Tariff (BioMAT) to implement California Senate Bill 1122. The BioMAT program operates through February 2021, and Pacific Gas & Electric expects to award 47 MW for small-scale forest-based fuel facilities under the BioMAT program. (CPUC, 2019).

Bankruptcy, Resiliency, and Brink of Construction

In 2019, PG&E filed for bankruptcy. Due to the bankruptcy and lack of funds, PG&E paused all contracts and PPAs. The uncertainty of a secured PPA with PG&E has significantly affected the NFCP's ability to move forward with its biomass energy development process. Although the bankruptcy created uncertainty, project stakeholders were still expecting PG&E to honor the PPA to purchase electricity from NFCP for \$0.199/Kwh (Lurie, 2019).

PG&E filing for bankruptcy significantly affected the project. The bankruptcy deterred prospective tax credit investors. Tax credits worth millions of dollars connected to the project were set to expire at the end of 2019 unless sold or renewed by the state. The stakeholders sold the tax-exempt bonds just hours before the new year (Lurie, 2020).

The CDC and Phoenix Energy signed an agreement with EQTEC PLC²⁷ to become a 20% equal partner of NFCP. As part of its partnership with CDC and Phoenix Energy, EQTEC promised \$2.5 million worth of equipment for the biomass gasification facility in North Fork. Even with the uncertainty of the impact of PG&E's bankruptcy to the project, permitting and construction moved forward (Lurie, 2019).

The second case study focuses on the Cabin Creek Biomass Facility project in the Tahoe Basin. This case differed from North Fork in that it was run by the county rather than more localized community-based organizations. The populations of each region also differ greatly. North Fork is an unincorporated area with a population of 3,600 people and

²⁷ EQTEC PLC is European based gasification technology company (Lurie, 2019).

the Cabin Creek project was located near Lake Tahoe in Placer County with a population of 200,000. The Lake Tahoe area is a tourist destination and is very prosperous. Where North Fork utilized SB 1122 in development, Cabin Creek decided to forgo SB 1122 in favor of a partnership with a private utility company.

THE CABIN CREEK BIOMASS FACILITY PROJECT: PLACER COUNTY EFFORTS TO BUILD A SMALL-SCALE BIOMASS ENERGY FACILITY

Placer County is one of the wealthiest counties in the Sierra Nevada Mountain Region, and the population is continuously increasing²⁸ (ESRI, 2018). Approximately 200,000 county residents get their water from the Bear River and Yuba River watersheds near the proposed small-scale biomass facility. Watershed protection is a critical motivator for Placer County to thin forests and reduce fire hazards. The landscape ranges from the foothills around Auburn to the greater Lake Tahoe region and includes over 550,000 acres of forest land. Fire suppression and years of drought have resulted in large amounts of fuel on the ground and standing dead trees, which increase the risk of wildfire.

Due to the significant increase in population living in the wildland-urban interface combined with several years of drought, by 2014 Placer County had experienced frequent and intense forest fires over the previous decade. Throughout the Tahoe region, homeowners were at risk of having their fire insurance canceled because of the wildfire hazard. The county government prioritized constituents' ability to secure insurance and protect the county's forests from catastrophic wildfire. In response to the increase in forest fires, the USFS began open pile burning to reduce fuels. However, the use of more

²⁸ Data collected from the U.S. Census Bureau; the County of Placer's population grew from 248,399 in 2000 to a population of 348,432 by the year 2010.

open pile burning caused significant increases in emissions and respiratory health issues throughout the county (Sequoia Foundation, 2013).

The Placer County government took on the leadership role in planning for the development of Cabin Creek Biomass Facility project (Figure 5). The biomass energy facility project was proposed as a two-megawatt biomass gasification facility to be located between Truckee and North Lake Tahoe.

In 2006, Placer County hired a Project Manager to find a long-term solution for forest waste (Simet, 2014). The Project Manager conducted interviews with loggers, Cal Fire employees, truckers, and homeowners, as well as industry investors. Through these interviews, the Project Manager evaluated the effectiveness of forest waste management strategies and identified the need to increase the effort to remove forest waste. Placer County secured grant funding to explore cost factors for forest waste management methods and a team of county employees began exploring alternative approaches to manage forest waste throughout the Truckee/Tahoe region. This project was called the Biomass Utilization Program (County of Placer Community Development Resource Agency, 2019).



Figure 5: Development Rendering of the proposed Cabin Creek Biomass Facility in Placer County (Haas, 2014).

The Biomass Utilization Program team identified the importance of creating a market for forest waste. A market for woody biomass would provide incentives for forest management and fuel reduction projects. According to interviewees, the Biomass Utilization Program team determined that producing energy from biomass would be a viable option for creating a market for otherwise valueless forest waste. That led to the planning for a biomass energy facility that would create a market for forest waste.

The High Sierra Resource Conservation and Development Council, the USFS, and Placer County secured a grant which funded a feasibility study to evaluate biomass energy technologies. The Biomass Utilization Program team hired a consulting firm to

conduct a small-scale biomass combined heat and power technologies feasibility assessment (TSS Consultants, 2008).

Placer County received three grants from the Department of Energy to fund the three phases of the feasibility planning and environmental assessment for developing a biomass energy facility at the proposed Cabin Creek location. A Congressionally Directed Grant for \$492,000 was awarded to Placer County to fund the feasibility study. Another Congressionally Directed Grant for \$1,427,250 was allocated for environmental assessments as required by the California Environmental Quality Act, to review permits from the Placer County Air Pollution Control District and compliance with county guidelines. The final Congressionally Directed Grant for \$1,000,000 was utilized to create design plans and cover the initial construction cost of the Cabin Creek biomass energy facility (County of Placer Community Development Resource Agency, 2019).

As the Biomass Energy Project Manager explained in an interview, grants were critical for funding the feasibility and assessment phases. However, to complete the biomass project, the county needed a sustainable business plan to secure financing. Placer County's Biomass Project Manager approached the strategic plan project as a business and created a public-private facility development plan. The majority of funding to finance the Cabin Creek Biomass Energy Facility came from private investment groups.

Historically, stakeholders interested in small-scale biomass energy development have struggled to secure investors. Investors want the security of an established contract

such as a master stewardship agreement²⁹ before investing in a forest-based energy facility. In the Cabin Creek Biomass Energy Project Manager's experience, potential investors wanted a 10-year supply contract before investing in a forest-based biomass energy facility. Therefore, in 2011, Placer County and the USFS³⁰ entered into a master stewardship agreement to guarantee feedstock for the biomass energy facility. The master stewardship agreement was a 10-year agreement between the county and the federal government to meet their mutual goal of reducing fuels on USFS land located in Placer County. Under the guidelines of the master stewardship agreement,³¹ the USFS was to put out requests for bids on clean-up projects to local contractors collaborating with the county to supply the waste wood to the Cabin Creek energy facility.

Placer County conducted a request for proposal (RFP)³² to find qualified vendors and contractors to work in the forest. Any action involving the USFS, Placer County, and contractors had to adhere to the National Environmental Policy Act (NEPA)³³. To adhere to NEPA guidelines, Placer County government project managers required, for example, that all contractors submit paperwork to the Placer County Pollution Control District to verify that air pollution control devices were in place on all contractors' equipment while working on USFS land.

²⁹ In 2003 the USFS and the Bureau of Land Management were given authority by Congress to commence stewardship agreements to manage the land for the national forests in a way that meets the necessities of local communities (USFS, 2018b).

³⁰ The USFS manages the majority of the land in the Truckee/Tahoe region.

³¹ Under the authority of Section 323 of Public Law 108-7, the USFS has the ability to enter into stewardship agreements for the exchange of goods for services (USFS, 2019).

³² Request for Proposal (RFP) is a bidding application process in which agencies or organizations announce that funding is available for a particular project (Darnay & Magee, 2007, 951-952).

³³ The National Environmental Policy Act (NEPA) is a United States environmental policy that promotes awareness that actions have on the environment (Council on Environmental Quality, 2007).

Due to the Cabin Creek biomass energy project's proximity to environmentally fragile and economically significant Lake Tahoe, Placer County conducted a full Environmental Impact Report (EIR)³⁴. As Cabin Creek stakeholders expressed, Placer County wanted to set the environmental standard for small-scale biomass energy projects. Placer County's EIR on the Cabin Creek Biomass Energy Project provided more research indicating that small-scale biomass energy projects have the potential to be clean, sustainable, and an environmental benefit for the community (Storey, 2012).

Cabin Creek Community Power

Placer County's Biomass Utilization Program team knew that the project needed to be sustainable and situated in an isolated area out of sight for community support (Storey, 2012). Critically, the county also needed to sell the energy produced from the facility. To secure an energy market, Placer County needed a power purchase agreement (PPA)³⁵ for electricity, with a contract of 10 years or longer.³⁶ Placer County did not apply for the Cabin Creek biomass energy facility to be considered one of the small-scale facilities funded by the Senate Bill (SB) 1122 program, even though Placer County staff were involved in the development of SB 1122. Instead, Placer County chose to work with a small utility company called Liberty Energy Utilities Co³⁷. Instead of utilizing SB

³⁴ In the state of California, the Environmental Impact Report (EIR) informs governmental agencies and the public of a projects' environmental impacts (Perea, 2010).

³⁵ A power purchase agreement (PPA) is a long-term contract between the owner of an electricity generation facility and the wholesale energy purchaser (Yarano, 2015).

³⁶ Most power purchase agreements (PPAs) between utilities and renewable energy generation facilities range from 10-25 years (Solar Energy Industries Association, 2020).

³⁷ Small utilities companies are not subjected to Senate Bill 1122 guidelines.

1122, Placer County wanted to run the small-scale biomass energy facility as a for-profit business.

At the time of negotiations between Placer County and Liberty Energy Utilities Co., all parties anticipated that they could secure a Power Purchase Agreement (PPA) that benefited both the producer of energy and the utility company. Liberty Energy Utilities Co. purchased most of their renewable energy outside of California because of the price. However, the company recognized the importance of reducing fire hazards and maintaining the landscape near its transmission lines throughout the Tahoe/Truckee region. Liberty Energy Utilities Co. was also willing to pay more for local renewable energy because they needed to meet the state's renewable energy standards³⁸, whereas large utilities already had large-scale renewable energy facilities to meet renewable energy standards. Because the Cabin Creek project was going to utilize gasification biomass energy technology, the county calculated that the energy producer could offset some of the biomass energy costs with biochar. To secure the feasibility of the gasification biomass energy facility, the Biomass Energy Project Manager proposed a 10-year minimum contract to the Placer County Board of Supervisors³⁹. With this 10-year biochar contract, the Placer County Biomass Utilization Program team anticipated that the project could secure investors and reach a PPA with Liberty Energy Utilities Co.

³⁸ According to a representative of Liberty Energy Utilities Co., the Cabin Creek two megawatts facility would have made up approximately 10% of Liberty Energy Utilities Co.'s renewable energy standards.

³⁹ The Placer County biochar 10-year contract was the first contract of its kind for biochar.

The proposed biomass facility was to be two-story 100 feet by 120 feet building on an over 2-acre site already owned by Placer County. The site was home to a landfill at one point and currently hosts a transfer and processing facility on a portion of the parcel. The Cabin Creek biomass facility planned to tie the electricity produced directly into the local grid through existing transmission lines (Storey, 2012). Five major roadways were deemed transportation corridors for the Cabin Creek biomass facility.⁴⁰ All of these roadways provided access to the proposed Cabin Creek biomass facility and could accommodate five-axle trucks (Proactive Customer Services, 2011).

TSS estimated that the Tahoe Basin would produce up to 28,863 bone dry tons of biomass stock annually from 2010 to 2014. Currently, most of this biomass material is piled and burned or turned into wood chips and spread on the ground. The core fuel supply area for commercial-scale biomass facilities usually lies in a 50-mile radius of the facility. A 30-mile radius was applied instead because of the small size (2 MW) of the Cabin Creek biomass facility (see Figure 6) (Proactive Customer Services, 2011).

It was planned that up to 75% of the biomass fuel sourced for the Cabin Creek biomass facility would be material supplied from the forest that is a “byproduct from hazardous forest fuels treatments and forest thinning activities” (TSS Consultants, 2011). The remainder of the biomass fuel was to come from urban-sourced material. Urban-sourced material in the Tahoe Basin consisted of tree trimming and yard waste (such as

⁴⁰ They are Interstate 80 from Highway 89 to Highway 267, Highway 89 from Interstate 80 to Highway 28, Highway 28 from Meeks Bay to Highway 267, and Highway 28 from Highway 267 to Zephyr Cove via Highway 50.

pine needles) and wood from building and remodeling endeavors. As communities strive to divert urban-sourced material away from traditional disposal options such as landfills, urban-sourced material is a growing fuel source. A considerable share of the wood waste collected at transfer stations in the Tahoe Basin consists of tree trimmings (40%). This means tree trimmings and yard waste were a crucial opportunity fuel for the Cabin Creek biomass facility (TSS Consultants, 2011).

The Cabin Creek biomass facility location was adjacent to an extensively forested area. The species composition of forests in the region consists of incense cedar, ponderosa pine, white fir, and Douglas fir. The slash (such as tree limbs, tree tops, and logs) from forest thinning and harvest practices is unsuitable for use by the timber industry and can render a substantial amount of woody biomass. Once the woody biomass material has been processed into chips, it is a prime biomass fuel source (TSS Consultants, 2011).

According to a 2011 study, roughly 27,690 BDT of pine needles and tree trimmings were created annually in the Tahoe Basin. According to TSS, about 65% of woody materials generated were eligible to be utilized as biomass fuel. That meant that roughly 18,000 BDT of tree trimmings in the core fuel supply area were available annually as fuel. Pine needles made up about 1% of the tree trimmings (180 BDT per year) (TSS Consultants, 2011).

Roughly 553,820 residents live inside the core fuel supply area. According to TSS, about 10.5% of the 11.5 pounds of solid waste created daily per capita was wood waste. Roughly 122,045 tons of urban wood waste (pallets, construction/demolition

wood) were created each year in the core fuel supply area. When the 20% of the urban wood waste that was moisture content was subtracted, the urban wood waste came to about 97,635 BDT. Because roughly 65% of the 97,635 BDT could be used as fuel, an estimated 63,460 BDT could be utilized (TSS Consultants, 2011).

The Cabin Creek biomass facility was estimated to cost \$12 million to construct. Funding for the facility was planned through public funding and grants from the county, state, and federal government. The Department of Energy funded \$1.5 million of the \$12 million through grants to Placer County. Placer County was planning on financing the facility through the California Infrastructure and Economic Development Bank and the remainder through private investment funding (Moran, 2014).

The central Sierra Nevada region once housed a substantial forest products industry. A considerable amount of the manufacturing infrastructure has closed, mainly as a consequence of the lack of saw timber. Most of the forest inside the core fuel supply area is managed by the USFS. The USFS's attention has shifted from timber outputs to managing ecosystem services over the past three decades. Timber harvesting has decreased by around 95% since 1990 on California public lands (TSS Consultants, 2011).

The closure of the Loyalton and Truckee biomass facilities left skilled workers without employment. These workers had knowledge of biomass facility operations that could be utilized at the Cabin Creek facility. As planned, the creation of the Cabin Creek biomass facility would provide jobs for those laid off at nearby biomass facilities and to timber industry workers no longer employed.

The Tahoe region of the Sierra Nevada has a diverse cultural history. The Tahoe Basin is the ancestral territory of the Washoe or *Wašišiw* people and Pyramid Lake Paiute or *Kuyuidokado* people (Nevada's Indian Territory, 2020; Washoe Tribe of California and Nevada, 2020). For the Washoe people, Lake Tahoe or *Da ow a ga* is the center of the world. The Washoe people utilize spiritual landmarks and sacred sites in the Tahoe Lake Basin for cultural and religious practices (Hurtado, 2019). Both the Washoe and Paiute people collaborate with state and federal agencies as well as other stakeholder groups throughout their ancestral territory to protect its fragile ecosystem (Gautam et al., 2013).

The Basin's ecosystems have increasingly been threatened by the increase in population and thriving tourism industry. Over the last few decades, tourism has increased throughout the Sierra Nevada, and the proposed location of the Cabin Creek small-scale forest-based biomass energy facilities respectively was within a 35 miles radius from one of California's most iconic outdoor recreation locations: Lake Tahoe.⁴¹ Forest ecosystem health for the Tahoe Basin region is physically⁴² and symbolically⁴³ important to people worldwide. Most of these people do not have a vested interest in the small-scale biomass energy development process. However, they care about the welfare of the Sierra Nevada and for the people that call the Tahoe Basin region home, whose livelihoods are intertwined with the health of the forest ecosystem.

⁴¹ Approximately 15 million people visit the Lake Tahoe area annually (Tahoe Regional Planning Agency, 2020).

⁴² The Sierra Nevada physically impacts California's air quality and water systems.

⁴³ The Central Sierras and Tahoe Basin regions are important locations for generations of people's traditions and memories.



Figure 6: Cabin Creek Fuel Supply Radius (Haas, 2014)

The biomass facility project was sponsored by Placer County. The county itself was responsible for the project. Placer County partnered with Phoenix Energy (a bioenergy project developer based out of San Francisco) to own, operate, and construct the facility (Bioenergy Association of California, 2014). The development process gathered input from the Tahoe Lake Basin community through public meetings.

The Tahoe Basin community was not entirely in favor of the biomass facility at first. A Health Impact Assessment was performed by the Sequoia Foundation which identified and addressed these concerns (Sequoia Foundation, 2013). While some residents were supportive of another means to reduce fire hazards, others were less so. Significant concerns for the community were potential impacts on noise, water quality, air quality, traffic, and economic and energy security. The biomass facility's site was moved from the original proposed site to Cabin Creek to allay the concerns.

Abandonment of the Project

When the Tahoe Basin biomass project was initially proposed, Liberty Energy Utilities Co. was interested in purchasing the facility's electricity. In 2018, Placer County's Planning Services Department announced the termination of the Cabin Creek Biomass Energy Facility project (Best, 2018) as Liberty Energy Utilities Co. and Placer County could not reach a Power Purchase Agreement (PPA) price. The expenses of biomass energy production were too costly. Renewable energy sources such as wind and solar cost approximately 3 cents a kilowatt-hour, whereas the Cabin Creek project estimated the cost of biomass electricity at 15 cents a kilowatt-hour.

DISCUSSION

In California fire suppression and logging have changed forest structure and composition, creating unprecedented levels of fuel loading. Public interest lies in removing fuels and restoring resilience to the forest. Generating biomass energy using this ready supply of feedstock seems like a logical and feasible step towards addressing the challenge. Yet, despite interest in biomass energy both as a fuel reduction method and as a renewable energy source, California only has twenty-three operational solid-fuel biomass facilities, all of which provide large-scale (>3 MW) power to the grid⁴⁴ (California Biomass Energy Alliance, 2020; Mayhead, 2012). There are small-scale forest-based biomass cogeneration energy facilities in California. However, there are no small-scale facilities connected to the grid. This research has shown that the dearth of forest-based small-scale woody biomass energy facilities in the Sierra Nevada region is not for lack of trying. Organizations in the community of North Fork and the Placer County government were pioneers in exploring feasible systems for small-scale forest-based biomass energy facility development, which would sell energy to the power grid system.

A comparison and analysis of the North Fork and Cabin Creek cases applying a Community Capitals Framework (Pigg et al., 2013; Baker & Kusel, 2003; Emery &

⁴⁴ In California, most large-scale solid-fuel biomass facilities struggle in the modern era because they are locked into low-priced 30-year contracts with investor-owned utilities (IOUs), making it challenging to remain functional, updated, and operational (Mayhead, 2012).

Flora, 2006) illuminates what the key challenges for the biomass facility proponents were and how these types of barriers might be overcome in the future in these and other communities. The literature lists several technical requirements for biomass energy project development: developing from the initial plan through raising exploratory capital; identifying and acquiring a community-approved site for the project that is in close proximity to feedstock suppliers' site; procuring reliable biomass feedstock; planning to harvest and transport this biomass to energy generating facilities; securing funding for development costs; selecting a reliable and efficient technology to convert biomass to electricity; finding an owner for the facility; training a workforce to operate the facility; and securing a market for energy and byproducts of the facility (Morris et al., 2017). However, the literature does not begin to address the challenges a community faces to pursue these steps. In fact, for communities that seek to house such projects, the road to biomass energy project development encompasses far more investment than just the costs of the facility and actually begins even before these technical steps are undertaken. As this thesis has shown, community capacity as measured, for example, by the ability of a community to marshal community capitals, must be brought to bear during every phase of development.

Table 3: Case Studies Comparative Table

	North Fork	Cabin Creek
Governance of Project	Community level organizations and private sector partners	County level
Site Identification	Restoration of industrial park with a network of wide roads, access to water, & transmission infrastructure to transport generated energy	Decommissioned landfill with a network of wide roads, access to water, & transmission infrastructure to transport generated energy
Level of Community Support	Strong community support of site restoration	Initial site lacked community support and final site proposal had support because of its location in an industrial zone
Feedstock Procurement	10-year stewardship agreement with USFS	10-year stewardship agreement with USFS
Feedstock Harvesting & Transportation	Harvest to occur within a 30-mile radius of site to reduce transportation costs and emissions	Harvest to occur within a 30-mile radius of site to reduce transportation costs and emissions
Funding Sources	EPIC Grant - \$5 million New Market Tax Credits - \$900,000 Grants & private equity - \$8.6 million	DOE - \$1.5 million Remaining \$10.5 million was to be funded through the California Infrastructure and Economic Development Bank & private investment funding
Facility Technology	2MW Gasification Facility	2MW Gasification Facility
Facility Workforce	Planning to employ residents	Planned on employing residents
Securing an Energy Market	Utilizing BioMAT program to procure a PPA with PG&E	Partnered privately with Liberty Energy Utilities Co. to procure energy

Both the North Fork and Cabin Creek projects initially began because of a collective understanding in each community of the need to remove forest fuels, restore

forest health and work towards community resiliency and jobs. Pioneering these projects took a tremendous amount of bonding social capital. North Fork and Placer County each worked for over 10 years towards small-scale biomass energy development. It was these communities' collective values and relationships which kept the stakeholders involved and motivated. The challenges of forging new energy development models then caused them to reach out to develop new partnerships.

Key stakeholders involved in both the North Fork and Placer County projects collaborated with other communities, agencies, and organizations which form California's Statewide Wood Energy Team (SWET). Through networking, education, and access to funding, SWET has played a critical role in providing bridging social capital and enhancing forest-dependent communities' capacity regarding small-scale forest biomass facility development. Specifically, North Fork project stakeholders credit a significant amount of their capacity to move forward with the site's small-scale biomass energy to their active participation in SWET. Through networking and funding, SWET provided North Fork and other rural communities' access to a network of experts with information about bioenergy research and funding, pre-feasibility assessments for biomass energy, assistance to secure funding for full feasibility assessments, and other project needs (SWET, 2020). With access to these critical resources, North Fork's CDC and the Placer County RC&D leveraged the social capital, financial capital, and political capital to secure grants, permits, agreements, funding, and business partners. Stakeholder partnerships with the community were also essential for site approval.

Community approval of a site was essential. A small-scale biomass energy facility must be close to the fuel source, and the local area must also have the physical (built) capital to support a facility. Finding a location with the zoning, infrastructure, and public support required to develop a biomass energy project is not a simple matter. The local social and political capital key stakeholders in North Fork and Placer County had with the general community had an impact on the public's perception of each project and the site locations. The North Fork project site had always been part of the old mill site redevelopment plan located in the center of town and the proposed Cabin Creek site was an old landfill outside of Truckee. These sites were both located in established industrial zones and had the necessary physical capital such as a network of roads that could accommodate large haul trucks, access to a water supply, and transmission infrastructure to transport the generated energy.

In North Fork, redeveloping the mill site had always been the focus of the CDC and the community. As members of the North Fork community, CDC members had a vested interest in developing the mill site and reflecting the community's collective values. The CDC also had an interest in small-scale forest-based biomass energy because it would provide opportunities for the local labor force to utilize the deadwood in the surrounding forested landscape. North Fork community members were actively involved in the biomass energy development process from the beginning. The CDC had the local community's trust.

In Placer County by contrast, the biomass energy project was a government led effort that had mixed political support. Members of the Tahoe Basin community

protested Placer County's original site location in Kings Beach near Lake Tahoe's North Shore, because they feared the social, economic, and environmental impacts of a biomass facility. Although not the only determinant, public perception was a significant factor in Placer County focusing on the Cabin Creek site development. As discussed above, site location is crucial for the supply of biomass feedstock.

Key stakeholders for both the North Fork and Cabin Creek projects worked to secure biomass feedstock through 10-year stewardship agreements with the USFS. The long-term stewardship agreements provide biomass energy projects the guaranteed feedstock supply and pricing to obtain the financial capital to move forward with project development and stimulate forest ecosystem restoration projects on public lands (USFS, 2018a). To secure 10-year stewardship agreements with the USFS took years of collaborative stakeholder processes for both the North Fork and Cabin Creek projects. Not only did the CDC and RC&D need the social, human, and political capital to engage and negotiate stewardship agreements with the USFS, they also had to negotiate with other stakeholders.

North Fork did not have the same internal structure as Placer County to move the stewardship agreement process forward. North Fork relied on partnerships and networking to secure a 10-year stewardship agreement. The CDC knew early in the biomass energy process that it needed support from community members, local environmental stakeholder groups, and the county government. North Fork project proponents networked and built social capital with environmental organizations that traditionally oppose biomass energy development. Through community engagement, the

CDC worked with various stakeholder groups to focus on technology and fuel sources for the North Fork biomass energy facility. These stakeholders were actively involved in the development process. Thus, the CDC avoided the public resistance Placer County experienced at the Kings Beach site (Thomson, 2011). The CDC's partnership with SWET also had a significant impact on the stewardship agreement process. With a \$2,500 grant procured by SWET, the CDC hired a bioenergy consultant to assist in finalizing a stewardship agreement with the Bass Lake Ranger District staff, the Sierra National Forest, and the USFS Regional Office.

In Placer County, environmental groups such as the Sierra Club, The Center for Biological Diversity (CBD), Sierra Forest Legacy (SFL), and other local community stakeholders took an active interest in the stewardship agreement process. In the stewardship agreement stage, environmental groups and local community stakeholders were more involved in influencing development, specifically in Placer County. As one Placer County stakeholder stated, regional, state and national environmental groups exercised "intense pressure to relocate from the Kings Beach site." The Kings Beach site did not have local support, nor did it have the support from environmental groups that all had apprehensions about a biomass energy facility's potential environmental impact. When Placer County focused on the Cabin Creek site, environmental groups negotiated an agreement with the county that the facility would only burn forest biomass which would otherwise be open pile burned. Placer County had the internal capacity to reach an agreement with these environmental groups because of interdepartmental collaboration with county governance. After the agreement with the environmental groups, Placer

County utilized its social and political capital with USFS to move forward with a master stewardship agreement to supply fuel for the Cabin Creek facility. Communities that might seek to develop small-scale forest-based bioenergy projects may not have the internal structure and access to resources to move locations and work to address issues and create multiple agreements with various groups and agencies.

Due to the financial costs associated with harvesting and transportation, forest-based biomass energy facilities typically utilize fuel sources gathered within a 50-mile radius of the facility (Mason, 2008). The cost of harvesting and transporting biomass to energy facilities can easily surpass direct revenues made through power sales (Morris et al., 2017). However, the potential ecosystem benefits of developing markets for forest waste are not typically included in this calculus. Reducing fuel loading and forest restoration are public investments in healthy forest ecosystems which directly reduce wildfire hazard and benefit California's water supply. Most small-scale biomass energy projects stay within a 30-35-mile radius to reduce transportation haul costs, and maximize local economic benefits by hiring local contractors to harvest the feedstock (TSS Consultants, 2014). In order to reduce the costs associated with harvesting and transporting biomass, one solution is to have more localized biomass facilities to keep the radii small. Reduced feedstock haul transportation radii also reduce greenhouse gas emissions.

While procuring feedstock for biomass facilities in communities surrounded by forests would seem simple, access to natural capital was a challenge in both case study areas. Procuring affordable and reliable forest-based biomass feedstock begins with

securing financial capital. The Sierra Nevada landscape has an abundance of forest waste. However, there are no clear systems for obtaining the funds to remove the forest's biomass materials (Morris et al., 2017). In the Sierra Nevada region, approximately 60% of the landscape is managed by federal agencies (Davis & Strom, 2004). Public lands are often the most accessible forested landscape for harvesting biomass feedstock (Morris et al., 2017). Agency budgets are responsible for the work done on federal land through the stewardship contract. A stewardship contract may allow goods (biomass) for services rendered (getting the fuel out of the woods).

Securing funding for small-scale biomass energy facilities is challenging. Most biomass energy projects require a mix of traditional debt and equity financing and require experienced development partners. The North Fork project cost was approximately \$14.5 million, and in general, high capital projects call for traditional debt as well as equity financing. Equity financing is high-risk because the return on investment is not certain, as little is known of the project's particulars at this stage. The capital involved in equity investment is for the up-front funding required to demonstrate the project's feasibility and capture investors' and developers' attention.

The initial equity funding or feasibility studies, engineering, and design can be funded by state and federal and private grants, as was the case with both the North Fork and Cabin Creek facilities. While equity investment is used to finance the initial phases of high capital projects, debt investors are used during the project's construction and operational phases. The debt is typically obtained through project financing, which means the project's assets and revenue back it. Government loan guarantees can substantially

lower the interest rates connected to the project's financing and appeal to lenders by strengthening investors' confidence in the viability of the project (Morris et al., 2017).

For small-scale biomass energy facilities to secure financial capital and move forward with development, the electricity generation technology must be reliable and efficient and have the capability to connect to the grid. Financial lenders invest in technology that they know can sustainably and efficiently return their investment. Phoenix Energy and TSS Consultants are leaders in the development of biomass electric generation technology in California. Both the North Fork and Cabin Creek projects worked with Phoenix Energy and TSS Consultants to explore the feasibility of different small-scale forest-based biomass energy technologies for each site (Bioenergy Association of California, 2014; Simet, 2014).

The North Fork project worked within the BioMAT program and is on track to be the first forest-based small-scale biomass energy facility to produce for the California energy grid. The CDC in partnership with Phoenix Energy formed the North Fork Community Power LLC to manage the small-scale two-megawatt facility and train a local workforce to operate the facility (Phoenix Energy, 2015).

Natural capital, human capital and social capital often go hand in hand when understanding how communities utilize their internal capacities to address desired outcomes. Both the CDC and Placer County started exploring small-scale forest-based biomass energy development because it would address an environmental challenge and employ the local populations' knowledge, skillset, and abilities. North Fork and Placer County have a long history of forest products industries that translate directly to having a

labor force with the necessary skills to operate a biomass energy facility. In addition, key stakeholders involved in the development process brought vision and critical experience to the table. They had a significant role in moving projects forward. These leaders also drew upon social capital, relationships within and outside the communities to involve more individuals in project development, and these individuals' human capital brought new strength. Neither project reached the operational stage. While the North Fork facility is in development, the Placer County project is not moving forward. Employing local workers with the knowledge, skillset, and abilities of the forest industry is one of the next steps of the North Fork project.

North Fork and Placer County took vastly different strategies to secure a market for the facility's energy and byproducts. For most small-scale biomass energy projects, California's BioMAT program creates the path for development by forcing utilities to offer power purchase agreements (PPAs) to small-scale biomass energy renewable energy producers. As a collective, CA FBWG utilizes its political capital to advance wood energy policy. It is through efforts of the CA FBWG that SB 1122 is a policy in California, and the CA FBWG still actively works toward state-level solutions to make forest-based biomass energy more competitive with other renewables.

Through collaborative efforts with SWET and other small-scale biomass energy projects stakeholders as well as having the human capital of a grant writing consultant, North Fork was the first forest-dependent biomass energy project to secure a PPA with PG&E. However, with PG&E's 2019 bankruptcy, all of the small-scale biomass energy projects under California's BioMAT program under the Re-MAT program paused (Lurie,

2019; Lurie, 2020). The North Fork project was only able to survive the bankruptcy because the CDC and Phoenix Energy partnered with EQTEC PLC. EQTEC PLC provided the financial capital to allow the North Fork project to continue.

Placer County's strategy was to run the project as a business venture. As the Cabin Creek Project Manager stated, "Placer County approached biomass energy development as a sustainable business." Placer County did not move forward with project development after Liberty Energy Utilities Co. terminated negotiations for a PPA. Despite over 10 years of dedicated effort in the Tahoe Basin, Placer County could not make small-scale biomass energy a sustainable business model. Valuing small-scale forest-based biomass energy through its ability to be a for-profit sustainable business does not work in California's current renewable energy market.

Both the Tahoe Basin region and the Central Sierras' forest ecosystems have a critical role in providing ecosystem services for the entire state (Hall, 2018). Small-scale forest-based biomass facilities are not only crucial to the small communities that house them but are a critical way to manage forest resiliency: to reduce fuel loads caused by tree mortality, reduce the risk of wildfires, maintain healthy watersheds, and contribute to the overall restoration of forests. However, the responsibility of developing small-scale forest-based biomass facilities depends too heavily on the capacity of rural forest-dependent communities. It would behoove state-level governments to treat forest-based small-scale biomass energy production as an investment in ecosystem management for the Sierra Nevada to reduce the scale and intensity of wildfires, and to ensure water supplies for California.

CONCLUSION

This research has made obvious certain difficulties and shortfalls in small-scale forest-based biomass energy facilities development, but there are solutions. Biomass energy projects have the potential to provide a multitude of benefits to the local communities and state as a whole and should be pursued despite the difficulties. However, forest-dependent communities exploring small-scale forest-based biomass energy will require substantial community capacity throughout the project planning, feasibility analysis, fundraising, feedstock procurement, site development, and implementation processes of development. As this thesis demonstrates, the development process is long and arduous. Both the North Fork Community Power project in the small community of North Fork, California in Madera County and the Cabin Creek Biomass Facility project on the outskirts of Truckee, California in Placer County spent decades working to navigate complex intersectional dynamics between governments and stakeholders, which shape small-scale forest-based biomass energy development and these facilities' ability to connect to the grid. At this time, the North Fork Community is on track to be the first small-scale forest-based biomass energy project to provide electricity to the California grid. As more forest-dependent communities explore forest-based small-scale biomass energy development throughout the Sierra Nevada, clear paths are needed to navigate the challenges associated with the complex development process.

Recommendations

Biomass facilities can help increase forest resiliency by monetizing small-diameter wood products, encouraging forest managers to reduce fuel loads caused by tree mortality, reduce the risk of wildfires, maintain healthy water systems, and contribute to forests' overall restoration. To realize the many ecosystem service benefits they support in California, small-scale forest-based biomass energy facilities require public subsidies and require an expanded view of benefits to the state as a whole. They will need public subsidies and feasibility analyses should not be limited to expectations of private sector business models. With California and the United States as a whole, moving toward renewable energy and away from fossil fuels, biomass energy is more important than ever before. Government assistance programs are available to finance small-scale forest-based biomass energy facilities. However, programs should be more accessible and more frequently awarded for projects throughout the Sierra Nevada region. These assistance programs include Direct Public Offerings, New Market Tax Credits, Cal Fire Greenhouse Reduction funds, USDA Rural Energy for America Program grant and loan guarantees, and the EPIC and USFS Wood Innovations grants (Morris et al., 2017). There needs to be continuous investment in organizations and network groups which have the social, human, and political capital to access these government assistance programs.

Developing more biomass energy projects under the BioMAT program is recommended. California's BioMAT program under SB 1122 is currently the most supportive policy for small-scale biomass energy in the state. North Fork Community

Power will be the first small-scale forest-based biomass energy facility to participate in the BioMAT program. At this time, stakeholders interested in developing small-scale forest-based biomass energy facilities that connect to California's grid should focus on developing under the BioMAT program, because the policy creates a path for development by forcing utilities to offer power purchase agreements (PPAs) to small-scale facilities. With the interest of bioenergy networks to have more projects participate in the program, there are support systems to assist small-scale bioenergy projects with participating in the BioMAT program.

The majority of stakeholders who participated in my research stated that small-scale biomass projects depend on sharing knowledge and experiences from a wide range of people with diverse expertise and skill sets. Navigating the complex systems and challenges of small-scale biomass energy development requires a significant amount of community capacity. As this thesis demonstrates, it takes a network of stakeholders working together at various development stages to move a project forward. It is essential for potential small-scale forest-based biomass energy projects to connect with bioenergy networks such as SWET that collectively have decades of experience navigating small-scale forest-based biomass energy development in California.

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