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Large-Scale Photovoltaic Solar Implementation: Montanan Stakeholder Opportunities and Challenges

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Abstract: Large-scale photovoltaic (PV) solar projects were operationalized in the 1990s resulting in a plethora of studies focusing on environmental, economic, technological, and policy studies. Minimal research investigates the similarities and differences between conveners using PV solar technology. This case study evaluates stakeholder perceptions regarding project management, project design, and external factors influencing the success of large-scale PV solar projects convened by a qualifying facility, regional utility company, and electric co-operative in Montana. Respondents revealed concepts were similar across conveners; yet, emphasized unique implications for each convener. The results indicated the importance for all conveners to incorporate marketing strategies, local interests and goals, aesthetic considerations, and creative partnerships to maximize the likelihood of success for large-scale PV solar projects. No singular type of convener in Montana provides the greatest opportunities; rather each convener is fulfilling a niche taking advantage of specific project management, project design, and external factors applicable to their organizational structure.

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CHAPTER 1. INTRODUCTION

Photovoltaic (PV) solar technologies were developed in the early 1970s, and market demands have increased in the US through the development of more efficient products (Green, 2005; Solar Energy Industries Association, 2016). The establishment of the 1978 Public Utility Regulatory Policies Act (PURPA) requires utility companies to purchase electricity from smaller facilities (Law360, 2015). This stimulated electric co-operatives and private companies to invest in large-scale solar projects through the qualifying facility application process (2015).

For this study, large-scale PV solar (solar) refers to an array 25kW or greater; developed during a single, primary planning phase; and is located at a single or few sites. This minimum size is fundamentally due to the economies of scale when constructing an array within the parameters of the Montana Public Service Commission's (MT PSC) net metering rates or Montana Electric Co-operative Association (MECA) standards (Bullock, 2015; Energy and Telecommunications, 2016; MT DEQ, 2014). Large-scale solar developments established by electric co-operatives, utilities, and qualifying facilities (QF) began around the late 1990s; however, Montana has not gravitated towards this trend (MT DEQ, 2014; Solar Energy Industries Association, 2016).

Montana is considered an ideal location for solar projects because of the vast amounts of land available for 25 year leases, ability for photovoltaic cells to work better in cold weather, and overall good sunlight conditions (Kalogirou & Tripanagnostopoulos, 2007). Additional opportunities for large-scale solar in Montana include reducing reliance on carbon emitting electricity sources while transitioning education and workforce components to a new market (Bullock, 2015).

Copious amounts of research exist regarding the technological, economic, and policy aspects of solar; however, there is minimal research regarding stakeholders', who focus predominately on project implementation, perceptions on opportunities and challenges associated with large-scale solar supply and demand. The concept of social planning for energy transitions was introduced in 2014 to frame energy policy decisions as, "…understanding and preparing for the societal outcomes of energy transitions," (Miller & Richter, p. 77, 2014). Other research furthers the idea that social aspects must be taken into account to increase success in operationalizing a sustainable energy system because technologies should be implemented according to the acceptance of citizens and decision makers (Schweizer-Ries, 2008). There is currently a limited amount of literature identifying stakeholder processes and perspectives for electric co-operatives, regional utility companies, and QF solar project developments. Thus, the need for research to better understand the opportunities and challenges stakeholders face when implementing large-scale solar projects in Montana.

The purpose of this research delves into an exploratory study of stakeholder opportunities and challenges when implementing large-scale solar in Montana. The findings provided an in-depth understanding of stakeholder interactions and context per type of convener by identifying root causes and themes concerning large-scale solar opportunities and challenges. This research offers valuable insight for policy and decision makers in Montana and throughout the US who are trying to gain a better understanding of large-scale solar at electric co-operatives, regional utility companies, and QF.

The overall research objective was to: understand stakeholders' perceptions on project management, project design, and external factors influencing the success of the planning, implementing, and the long-term maintenance for three types of large-scale PV solar projects in Montana.

To address this objective this case study investigated the following research questions:

1) What project management factors did the identified planning and implementing stakeholders perceive contributing or inhibiting success during the planning and implementation process of their solar project?
2) What project design factors did the identified planning and implementing stakeholders perceive contributing or inhibiting success during the planning and implementation of their solar project?
3) What external factors did the identified planning and implementing stakeholders perceive contributing or inhibiting success during the planning and implementation of their solar project?
4) How did the identified planning and implementing stakeholders navigate through and mitigate challenges during the planning, implementation, and long-term maintenance process of their solar project?
5) Upon analysis, what were the similarities and differences between perceptions by these stakeholders across the three projects?

Photovoltaic Solar Background

There is a widespread understanding of the benefits of using renewable energy (RE) sources such as photovoltaic solar. A few of the major benefits of solar energy power is the reduction of greenhouse gasses, energy independence, decreased long-term costs, and market stimulation through job creation (Shahan, 2013). A 2016 study identified the top overall benefits of community solar were lowered energy costs, helping the environment, low maintenance costs, and limitations with rooftop installation (SEPA & Shelton Group, 2016).

In the early 1970s, the US promoted the development of commercial PV solar panels due to foresight of a potential power crisis (Green, 2005). Over the next ten years, solar panel design increasingly improved and became more efficient while under the US Government Block Program until the US government ceased funding and moved its efforts to other forms of energy (2005). Private markets continued to expand solar technology which reduced manufacturing costs, decreased energy capture losses, and increased available cell sizes for a growing market (Green, 2005; Green et al., 2015). The 1978 Public Utility Regulatory Policies Act (PURPA) requires utility companies to purchase energy from smaller electricity producing facilities (Law360, 2015). While the Act is complicated to navigate through, the premise is that large utility companies cannot completely monopolize an electric utility market. Per state legislative requirements, they must purchase some of their energy from smaller qualifying facilities at rates comparable to their avoided cost for other energy generation (Law360, 2015; Maloney, 2016). In short, PURPA allows electric co-operatives and QF to produce electricity from solar energy and then sell the electricity to the utility company who maintains the transmission lines.

The market slowly expanded to include large-scale public solar projects in the late 1990s (Solar, 2016). There are many factors which play into the slow market development of solar. Complex elements such as social, political, economic, technological, transmission line infrastructure updates, and storage capabilities must be addressed at different levels (Unger, 2016).

History of Solar in the United States

In 2009, former President Obama pledged that America would reduce greenhouse gas emissions by 2020 (Executive, 2013). Part of this plan included the goal to cut carbon pollution from power plants by modernizing the electric grid and by promoting renewable energy leadership. That year Congress considered a bill to create a national Renewable Portfolio Standard with a cap-and-trade emissions trading scheme, but when it died in the Senate individual states were left to create policies to decide how to reduce carbon emissions and incorporate clean energy sources (Unger, 2016). By 2012, the Department of Interior had approved 25 utility-scale solar facilities, and nearly doubled the amount of electricity generated by renewable energy sources (Executive, 2013). Another federal action was taken in 2015 to decrease carbon pollution when the EPA required individual states to meet emission standards by designing policies and programs to meet these reductions (U.S. Environmental, 2016).

By the end of 2015, solar installed worldwide supplied over 1% of the global electricity demand with the US ranked in the top three largest markets due to low power purchase agreement prices made possible by government subsidies (Bolinger & Seel, 2015; Energy Post, 2015). The US federal investment tax credit for solar project construction was set at 30% until the end of 2015 before gradually decreasing to 10% (Bolinger & Seel, 2015; GTM, 2016). By the end of 2016, the US had over one million residential, non-residential, and utility solar installations generating about 25.8 GW of solar power capacity (Unger, 2016). The solar market growth to 97% in 2015 may have been an anomaly due to tax credit policy incentives for solar projects initiated before the end of 2016 (Energy Post, 2015).

The election of a new US President brought uncertainty to the renewable energy market due to different political, institutional, and funding outlooks. At the end of January 2017, President Trump signed an executive order to reduce regulation and controlling regulatory costs. This order states, "… it is important that for every one new regulation issued, at least two prior regulations be identified for elimination…" (The White House, p. 1, 2017a). Another executive order nearly two months later focused on promoting energy independence and economic growth also had potential for unforeseen impacts on the solar market in the US. The order states:

> It is in the national interest to promote clean and safe development of our Nation's vast energy resources, while at the same time avoiding regulatory burdens that unnecessarily encumber energy production, constrain economic growth, and prevent job creation…. The heads of agencies shall review all existing regulations, orders, guidance documents, policies, and any other similar agency actions (collectively, agency actions) that potentially burden the development or use of domestically produced energy resources, with particular attention to oil, natural gas, coal, and nuclear energy resources (The White House, p. 1, 2017b).

These executive orders created a substantially divergent regulatory and funding structure then former President Obama's Clean Power Plan, but did not produced significant ramifications for this case study.

History of Solar in Montana

Historically, Montanans experienced a regulated electricity market with set prices and the ability to export most of their electricity to other states and Canada due to rich natural resources (DEQ, 2004; Johnson, 2001). In 1992, wholesale electricity markets across the United States were deregulated through the Energy Policy Act (DEQ, 2004). In the next five years, about three quarters of the US were considering deregulating electricity retail markets; with Montana making the decision to deregulate in 1997 (DEQ, 2004). Almost immediately after the transition the state's first utility company, Montana Power Company, sold to NorthWestern

Energy partially due to the inability to invest in infrastructure development across the state (2004). Soon after the transition NorthWestern Energy went through bankruptcy, but reemerged from the ordeal by 2004 (2004). Montana began to experience rising retail costs of electricity coupled by the peaks and troughs of a volatile market system (Johnson, 2001; U.S. Energy, 2015). During this time, renewable energy sources still played a minimal role in the electricity supply partially due to lack of storage. The generation of electricity needs a constant balance of supply to meet demand for grid reliability (DEQ, 2004).

In 2008, the Western Governors Association and US Department of Energy (US DoE) began the Western Renewable Energy Zone Project with the goal to utilize vast renewable resources to develop and deliver clean renewable energy to communities (DEQ, 2010). In 2014, most of Montana's renewable energy sources were from wind, geothermal, and biomass resources (U.S. Energy, 2015). The Energy Information System noted in their report that Montana had 4 MW of residential and commercially distributed solar at this time; however, none were generated by utility-scale solar developments (2015).

The beginning of 2015 brought federal and state solar policy debates to the forefront. The US Environmental Protection Agency released the Clean Power Plan requiring utility companies to reduce carbon dioxide emissions from new and existing electrical generation facilities by 47% to meet the plan's 2030 targets (NorthWestern Energy, 2016b). Concurrently, the 2015 Montana Legislative session passed the Senate Joint Resolution 12 Bill which called for a net-metering study over the next two years (Clawson, 2017).

In the meantime, three separate electric co-operatives in Montana were investing in solar arrays for their members. Flathead, Ravalli, and Missoula Electric Co-operatives took advantage of the 1978 PURPA (MT DEQ, 2014). These co-operative solar projects range from

25-50 kW largely due to member interest and economies of scale (Energy and Telecommunications, 2016).

Governor Steve Bullock released The Future of Montana Electricity report at the end of 2015 with his vision of increasing renewable energy sources in Montana (Bullock, 2015). The Governor stated, “But as solar costs continue to drop and solar becomes more cost-competitive as a result, developers are increasingly expressing interest in constructing solar projects in Montana. Unfortunately, development of smaller utility scale renewable projects has proven difficult if not impossible. Challenges include changing and unpredictable policy at both the state and federal level and depressed electricity markets. Over time we can expect these barriers to be addressed, and it is a goal of my administration to move Montana to double the current solar development in the state by 2025,” (Bullock, 2015, p. 11).

Advocates for solar development in Montana acknowledged the potential political and industrial challenges; however, still pursued opportunities for renewable energy projects (Cates-Carney, 2016; Editorial, 2016; Fox, 2015; Headwaters, 2016; Missoulian, 2016; Opinion, 2016). The 2017 Montana Legislative session continued the policy debate when two House Bills concerning raising the net-metering limit died (Monares, 2017; Zolnikov, 2017). Utility companies stated raising the net-metering cap could cut revenues needed for infrastructure updates and shareholder investment, but solar supporters still engaged in projects even with legislation challenges (Cook, 2017; Monares, 2017; NorthWestern Energy, 2016b; Ravalli, 2015).

CHAPTER 2. LITERATURE REVIEW

Large-Scale Photovoltaic Solar Project Definitions

There is a lack of agreement in academic and professional literature as to definitions for large-scale PV solar projects, therefore it was imperative to specifically identify the context of the terms in this case study and how they relate to current literature. As previously stated, this study evaluated large-scale PV solar which refers to an array 25kW or greater; developed during a single, primary planning phase; and is located at a single or few sites. This reflects a convener's ability to construct an array in a cost-efficient manner while conforming to MT PSC net metering rate parameters (Bullock, 2015; Energy and Telecommunications, 2016; MT DEQ, 2014). This case study further differentiated the general term of large-scale solar through the US DoE definition of community solar, "A solar-electric system that, through a voluntary program, provides power and/or financial benefit to, or is owned by, multiple community members," (Coughlin et al., p. 2, 2010). In addition, the US DoE identified a utility managed, community solar project as a co-operative or local, publically convened utility that owns or operates a project with voluntary ratepayer participation (2010).

For this case study, community-scale solar implementation at electric co-operatives is referred to as electric co-operative convened. This specificity allows for improved communication when referencing electric co-operative solar projects across the country while allowing for an understanding that these co-operatives abide by state electric co-operative association standards, and have different directives regarding energy production restrictions and transmission contracts. Community solar describes electric co-operatives who implement solar; however, the definition needed clarification when compared to the solar project convened by the regional utility company.

The US DoE definition did not fully capture the structure and essence of a regional utility company's community-scale solar projects. A regional utility company provides power benefits to multiple community members; however, the company retains the right of owning and managing the solar array. In this case study the solar project managed by the regional utility company is referred to as utility convened. Clarification of this context provides an understanding that solar implemented in this process is largely at the discretion of the regional utility company who may choose to collaborate with local communities while maintaining compliance with state regulations.

Lastly, the definition of a community-scale solar project did not capture the configuration of a privately owned, commercial solar enterprise. Terms such as commercial, private, utilities, and qualifying facilities are loosely used throughout literature to describe convener qualities of large-scale projects which are owned by a company who sells energy directly to a larger utility company maintaining the grid. To increase the clarity of this case study, a commercial enterprise focusing on producing large-scale solar energy is referred to as qualifying facility (QF) convened. These QF companies must also follow specific state regulations for energy production and contracts with transmission companies.

Stakeholder Definitions

The term stakeholder implicitly involves inherent complexity and could concern anyone involved in, or affected by, an action. A stakeholder represents a type of person, such as a concerned citizen, homeowner, or renewable energy activist; or a specific organization like Ravalli Electric Co-operative, Missoula County Public Schools, or Climate Smart Missoula (Margerum, 2011). These individuals or organizational representatives may choose to work together in a deliberative, consensus-building collaborative process if a project or decision might produce a high stake outcome which affects the individual or organization (2011). Furthermore, the way representation is defined is relative to different types of collaboratives. Stakeholders may represent themselves or a sector of the community in an action collaborative, a specific organization in an organization collaborative, or a constituency or interest group in a policy collaborative (2011). This case study predominately represents action collaboratives due to the focus on the direct action of implementing solar array projects; however, there are also organizational and policy collaborative characteristics present due to stakeholder and convener project priorities and interests informing state policy (2011).

Margerum states, "The difficulty of stakeholder selection comes when participation has to be limited, and the competition for stakeholder seats tends to increase as one moves across the spectrum from action- to organizational- to policy-level collaboratives," (p.68, 2011). This difficulty increases when evaluating stakeholder inclusivity across spatial, temporal, and jurisdictional scales and levels (Cash et al., 2006; Margerum, 2011). Stakeholder interests can range from economic, environmental, social, and political, but their level of involvement may be divergent across scales and interests (Jacobson & Robertson, 2012; Young et al., 2013).

This study narrowed down the range of stakeholders in order to focus interview questions on the stakeholder decision making processes. Therefore, stakeholders in this study were operationalized as those whose level of involvement focused on the planning, implementation, and long-term maintenance of the three solar projects. Conveners are individuals or organizations who own, manage, and implement the solar project. They are also considered stakeholders since they are involved in the planning, implementation, and long-term maintenance of a solar project. The conveners of the solar projects identified and defined which stakeholders were invited to be a part of the planning and implementation process. This consequently resulted in dissimilar stakeholders across the three projects. Additionally, this study categorized general the public as individuals or groups who have a stake in the outcome of the solar project, but are not directly involved in the planning or implementation process. This selection of particular stakeholders constitutes a known discrepancy across the projects because differences may exist between the chosen stakeholders and the general public impacted by each solar project (Devine-Wright, 2011; Margerum, 2011). Furthermore, as a study on community renewable energy in the UK identified the costs and benefits of RE projects may not be distributed equally due to who the project is built for, or which stakeholders are targeted (Walker & Devine-Wright, 2007). In order to mitigate these challenges stakeholder and project convener definitions are reiterated throughout the study (Figure 1).

Term	Definition
Large-Scale PV Solar	A 25kW or greater PV solar array; conforms to convener and Montana PSC net metering parameters; developed during a single, primary planning phase; and is located at a single or few sites. (Bullock, 2015; Energy and Telecommunications, 2016; MT DEQ, 2014).
Community-Solar	A solar-electric system that, through a voluntary program, provides power and/or financial benefit to, or is owned by, multiple community members (Coughlin et al., 2010).
Electric Co-operative Convened	Solar projects owned, managed and implemented by an electric co-operative.
Utility Convened	Solar projects owned, managed and implemented by a regional utility company.
Qualifying Facility Convened	Solar projects owned, managed and implemented by a commercial enterprise.
Convener	Stakeholders who own, manage, and implement the solar project as individuals or organizations.
Stakeholder	Individuals or organizations who directly influence the planning, implementation, or long-term maintenance phases of a solar project in this case study. These stakeholders represent action collaboratives due to the focus on the direct action of implementing solar projects; however, some may also present policy collaborative characteristics due to stakeholder and convener project priorities and interests in informing state policy (Margerum, 2011).
General Public	Individuals or groups who have a stake in the decision making outcome of a solar project, but were not invited by a convener to directly influence the planning, implementation, or long-term maintenance phases of a solar project in this case study.

Figure 1. Common terminology and definitions found in this case study.

Project Management

There are many project management concepts which play important roles in the opportunities and challenges of RE projects. These include process management, establishment of trust and credibility, incorporating the correct leadership type, shared learning, distribution of power, and conflict resolution (Carpenter & Kennedy, 1988; Margerum, 2011; Mckinney, 2015a, 2015b). Additionally, customer awareness, level of trust, perceived fairness, social influences, and commitment are concepts that lead to citizen engagement and increased support for RE investments (Bauwens, 2014).

The first project management concept identified was **stakeholder and general public engagement**. A plethora of natural resource collaboration literature and renewable energy studies investigate this concept in detail. Four critical components of stakeholder and general public engagement were: 1) *representation and inclusivity; 2) project information accessibility; 3) opportunity for participation; and 4) convener trust and credibility*.

Representation and inclusivity for all interests in the project is identified as critical to project success (Devine-Wright, 2011; Cruikshank & Susskind, 1987; Margerum, 2011). Research states using a collaborative approach with diverse community stakeholders provides a deliberative process to solve complex problems, build networks, and develop consensus seeking results (Margerum, 2011). For this approach, the identified stakeholders in a project should possess a high degree of inclusivity for interests in their community (McKinney, 2011). Inclusivity is inhibited by a decreased degree of collaborative adaptive management after the planning phase if there is not a systematic process for the current stakeholders to be involved in the monitoring, evaluation, and long-term decisions making process (Scarlett, 2013).

Studies indicate, an organization must have a level of adaptive capacity to mitigate social-ecological, policy, and economic impacts (Carpenter & Brock, 2008). Adaptive capacity is the ability for a system to adjust to responses from fluctuating internal and external drivers (2008). An organization may become a victim of a poverty trap if low network connectivity and resiliency exist, and therefore negate the opportunity for change (2008). On the other end of the spectrum, if an organization is unable to apply novel or innovative solutions when a disturbance or crisis occurs, then they may fall into a perpetual rigidity trap (Butler & Goldstein, 2010). These challenging circumstances may be mitigated by incorporating multi-scale networks who have the ability to influence action, organizational, or policy collaboratives by encouraging innovative solutions (Butler & Goldstein, 2010; Margerum, 2011).

When planning RE projects, research suggests conveners could either use an inclusive, informative, deliberative, and consensus-seeking, collaborative leadership approach; or employ bureaucratic leadership to singularly make all decisions (Imperial et al., 2016; Margerum, 2011; Mckinney, 2011). In collaboration literature, informed and deliberative participation are emphasized to create equal opportunities to share views and information, clarify interests, and subsequently seek solutions to incorporate as many interests as possible (Mckinney, 2011). Other research specifies opportunities for groups to utilize either collaborative leadership or a bureaucratic management style focused on internal, hierarchical decision making during different project stages (Imperial et al., 2016).

The next two concepts, *project information access* and *opportunity to participate*, are cited as critical for local support of renewable energy projects (Olson-Hazboun et al., 2016). During the planning phase, successful projects were found to have ample two-way communication between the convener, stakeholders, and community which include the distribution and dialog of information regarding a project's long-term plans (Margerum, 2011). This communication component is important for the collaborative process and essential for mitigating impacts during the dynamics of negotiation (Margerum, 2011; Mnookin et al., 2000). Furthermore, the choice of the correct type of forum is necessary to analyze issues with the project, understand community interests, and establish trust and credibility between the community and convener (Carpenter & Kennedy, 1988; Chase, 2016). Findings illustrate when sufficient information and opportunities to participate regarding the planning and siting process for local wind projects is available to local residents they are about 20% more likely to support the project (Olson-Hazboun et al., 2016). These studies indicate the benefits of evaluating different types of active stakeholders during specific project phases to gain an understanding of the outcomes (Olson-Hazboun et al., 2016; Ruggiero et al., 2014).

Lastly, the community's perceptions on *convener trust and credibility* is also conveyed as important to the outcome of renewable energy projects (Jobert et al., 2007; Ruggiero et al., 2014). A case study in France and Germany identified the establishment of trust between wind farm conveners and local residents as extremely challenging, but almost necessary for project success (Jobert et al., 2007). The establishment of trust was gained by both the convener's integration into the community through the frequency of maintaining a physical appearance in the community, building networks, having knowledge of local context, and the ability to integrate stakeholder interests into the project (Jobert et al., 2007).

The second project management consideration focuses on **conflict resolution**. Conflict resolution consists of using a range of formal and informal *compromising strategies* such as negotiations and arbitration to resolve differences, and *mitigation of impacts* between multiple parties (Margerum, 2011). Impacts from a project involve social components such as environmental, policy, economics, and community acceptance which may not be distributed evenly across the local populous (Devine-Wright, 2011; Wüstenhagen et al., 2007). Major components of conflict resolution include *compromising strategies* through being purpose-driven while focusing on stakeholder interests, inclusive of these interests, deliberative in creating solutions, and consensus-seeking (Mckinney & Kemmis, 2011). Additionally, power distribution to stakeholders, negotiations around project impacts, and seeking compromises for trade-offs in multiple impacted populations are important compromise strategies (Margerum, 2011; Mnookin et al., 1999; Mnookin, et al., 2000). Articles on negotiations suggest understanding how and why actors group together to work towards a common goal, or form side agreements are important underlying factors of negotiation outcomes (Margerum, 2011; Mnookin et al., 2000).

Project Design

Project design concepts refer to both **spatial and technological components** of a system (Green, 2005). Two spatial components, *site considerations* and *scale*, may play a substantial role in local acceptance concerning the location of an energy project (Paine et al., 1996). *Site considerations* includes the energy capacity of the energy project due to geographical location and closeness to the grid (Thirumurthy et al., 2012). Additionally, rural community members will often weigh site considerations of place attachment against the benefits of an energy project (Devine-Wright, 2009a). These include landowner intentions and traditional land-use patterns, such as ranching on open grasslands and other ecological uses (Dayer et al., 2016; Hoogwijk et al., 2005; Paine et al., 1996). Researchers have proposed frameworks for policymakers and conveners to aid in understanding local perspectives of spatial components which take into account place attachment and local identity (Devine-Wright, 2009a).

The aesthetics of a project is a site consideration strongly related to local support for the development of a RE project in a community (Olson-Hazboun et al., 2016). Social scientists have provided a hearty critique of why the aesthetic impact and feelings of equity and fairness towards a project better explain a development's opposition than the theory of 'Not in my backyard' (Devine-Wright, 2009a; Wolsink, 2006, 2007). A 2016 study on wind energy in the Rocky Mountains found locals who perceived wind energy facilities as unattractive on their landscape would support a project only 25% of the time (Jobert et al., 2007).

Furthermore, an environmental governance study cited examining *scale* provided a unique opportunity to evaluate if scale dependency factors into the success of large-scale solar projects (Wyborn & Bixler, 2013). Scale refers to the size of the spatial or quantitative dimension used to measure and study the solar project (Gibson et al., 2000). Scale dependency incorporates the three aspects of technical capacity to manage, functional specialization to access pertinent networks, and enabling policies to initiate collective action across multiple scales (Cash et al., 2006; Margerum, 2011; Wyborn & Bixler, 2013).

Technological components are another project design consideration identified as an opportunity or challenge in previous literature. The term photovoltaic originates from its process of solar radiation, or photons, striking a layer of semiconductor material which directs freed electrons from the initial, negative layer into a second, positive layer creating an electrical, or voltaic, Direct Current (Alternative, 2017). This electrical current is then converted into an Alternating Current through a transformer and is either dispersed through transmission lines or stored in a battery (SparkFun, 2018). Multiple studies indicate technical barriers for solar include the use of non-renewable components, limits on availability and reliability for solar technology to produce timely marketable energy, and solar power storage (Dincer, 1999; Green, 2005; Mulvaney, 2013).

The first two technological components, *effective renewable energy source* and *storage*, are identified as both a potential challenge or opportunity if stakeholders account for solar array life-cycle impacts (Angelis-Dimakis et al., 2011). Effective renewable energy sources consider trade-offs regarding the use of non-renewable components that produce toxic waste during manufacturing; energy output limitations regarding the production of reliable, timely, marketable energy; and solar power storage. A UK review of renewable energy exploitation advises decision makers to take into account the benefits and impacts of an energy plants' entire life-cycle to fully weigh RE impacts (Angelis-Dimakis et al., 2011). Since the cost of producing arrays is now amiable to making a net profit a major challenge identified in past research is scalability and the need for storage (Shahan, 2013). Most solar technologies still rely on a battery or the transmission grid to store or contain electricity (Carmody, 2017).

The last technological component was *energy output*. Professional and academic research identified monitoring energy output of a system is important to alleviate producing energy overflows on the transmission grid by essentially matching energy consumption with production (Carmody, 2017; Zerrahn, 2016). A study from India reinforces this concept by noting the importance of monitoring solar systems to optimize efficiency (Ganeshprabu & Geethanjali, 2016). Even though this study focused on monitoring a wireless sensor across the entire grid, the study was able to identify areas which reduce efficiency and are consequently removed from the system (2016). From a technical standpoint, this may be a logical solution, but social construction components such as social acceptability, concerns for population growth and pollution, RE preferences, and maintaining rural enterprises are important concepts to weigh when evaluating whether to use a potentially less efficient solar array system than extractive energy sources (Angelis-Dimakis et al., 2011; Bergmann et al., 2008; Gupta, 2003;

Van der Schoor et al., 2016). Currently, Montanan utility conveners are monitoring solar pilot projects across the state to evaluate how this electricity resource should be incorporated and valued on the grid (NorthWestern Energy, 2016b).

External Factors

The final category of inquiry focused on external factor considerations. A 2007 article from the Netherlands identified acceptance of renewable energy as three dimensional: socio-political, market, and community acceptance (Wüstenhagen et al., 2007). Studies found social-ecological, economic, and policy and administration opportunities and challenges are important renewable energy external factor concepts.

Studies suggest there are four major **social and ecological** considerations related to the opportunities and challenges faced by renewable energy projects: *local community support*, *long-term implications*, *environmental effects*, and *distribution of trade-offs*. These considerations are closely related to other external factors and intricately tied to project management and project design concepts.

The social concept of *local community support*, often elevated by community engagement, is suggested by researchers to revolve around the level of support for an actual RE project in the community (Wüstenhagen et al., 2007). There is an important distinction that general social acceptance of renewable energy projects is not necessarily indicative of community acceptance for a specific RE project (Wolsink, 2006; Wüstenhagen et al., 2007). Studies found factors such as procedural justice through the guise of collaboration, distributional justice for project costs and benefits, and trust in the investors to influence community acceptance of wind energy projects when respondents indicate an existing generalized acceptance for the clean technology (2006; 2007). Other research ascertained social aspects must be taken into account to increase success when developing sustainable energy projects because technologies should be implemented according to the acceptance of not only decision makers but also community members (Schweizer-Ries, 2008; Sterling, 2015). As an outcome, evaluating public preferences has proved effective in mitigating costs and maximizing net benefits during energy development projects (Álvarez-Farizo & Hanley, 2002).

Multiple authors address the need to identify long-term expectations, and outcomes. Conveners who identify and weigh aspects concerning the longevity of a project may deem the long-term application of RE projects are not worthwhile at this time (Omer, 2008). Robinson identifies the need for sustainable energy developments to address long-term, community-based, social and economic perspectives in order to minimize vagueness and delusions about the project (2004).

Another study found if the RE planning process does not incorporate long-term community outcomes, then the project often becomes controversial because the benefits are institutionalized while the costs are accrued by the local populous (Walker & Devine-Wright, 2007). Additionally, industries needed to expand their approach of development beyond merely technical fixes and incorporate social construction factors in communities (Robinson, 2004). The study suggests values and expectations for social-ecological, and economic components of the community must be addressed to create a successful sustainable development project (2004). Past research also suggests the use of social networks and community communication to influence the long-term promotion of the solar projects are necessary to mitigate project impacts (Schweizer-Ries, 2008; Van der Schoor et al., 2016).

Other research suggests relationships between general environmental beliefs and renewable energy attitudes may be context-dependent at a local level (Jobert, Laborgne, &

Mimler, 2007). Community members are cited to be skeptical about accruing positive *environmental effects* from renewable energy projects. For example, project size must be adequate to create enough electricity to decrease pollution (Angelis-Dimakis et al., 2011; Kalogirou, 2004; Lewis, 2013). Additional studies subsequently found general social-ecological impacts of solar are considered by some stakeholders as negative project impacts (Alsema et al., 2006; Tsoutsos et al., 2005).

The final concept, *distribution of trade-offs*, is imperative to identify when addressing local support for changes in energy system organizations (Miller & Richter, 2014). Distribution of trade-offs refers to beliefs about the positive and negative impacts of a project, and how these are distributed at local and non-local scales (Devine-Wright, 2011). A study on local acceptance of tidal energy in the UK developed a conceptual framework which reveals how different stakeholders perceive a project's process and outcomes (2011). This framework identifies where a project's process may be perceived on the spectrum, from open and participatory to closed and institutional, and is coupled with the distribution of trade-offs from distant and private to local and collective (2011). This framework is vital to understanding where societal impacts and trade-offs occur during the development of renewable energy facilities.

The two primary **economic considerations** when developing RE projects are *economic effects,* and *project ownership*. Negative economic effects are important to consider because even though opportunities such as job creation in the RE sector may be identified as positive effect by stakeholders other social, ecological or environmental costs may outweigh these benefits and impede the success of a project (Moreno & López, 2008; Wei et al., 2010). A study on wood-based bioenergy in Western Montana found capital costs, competition of current markets, lack of subsidies, and transportation costs as negative economic impacts (Beeton & Galvin, 2017). Studies recommend it is necessary to gain an understanding of how negotiations have distributed these economic impacts (Menegaki, 2008).

Studies also indicate an emphasis on positive economic effects and project ownership. These elements may provide the greatest opportunities to increase the inclusivity of project support (Jobert et al., 2007; Smith, 2011; Wüstenhagen et al., 2007). A Rocky Mountain wind energy study found individuals who believe local construction of wind energy farms brings positive community economic impacts through development are about 50% more likely to support local projects than those who do not believe the project would bring financial benefits (Olson-Hazboun et al., 2016). The influence of financial or legal ownership in a renewable energy project also contribute to the level of community acceptance (Jobert, Laborgne, & Mimler, 2007; Wüstenhagen, Wolsink, & Bürer, 2007). A study on wind farms in Scotland found that community ownership positively affected attitudes and increased the long-term support for projects (Warren & McFadyen, 2010).

Policy and administrative was the final external factor consideration. A 2015 multi-scale, conceptual review of US federal and state energy policy notes how the current piecemeal governance creates challenges for energy development across jurisdictions (Miller et al., 2015). The study also describes the importance of how the institutional administration, such as a regional utility company's standard operating procedures, significantly impacts new energy systems through their development, operation, and regulatory procedures (2015). Therefore, two primary policy and administrative concepts were *multi-scale governance* and *project compatibility*.

At the institutional and state level, Montana's Public Service Commission sets a state-wide, regulatory contract rate between qualifying facilities and the regional utility company who owns the transmission lines (Sell, 2016). This contract affects terms and rates of solar projects and the qualifying facilities ability to incorporate a variety of resiliency improving innovations (Carpenter & Brock, 2008; Gunderson & Holling, 2002).

Multiple studies reinforce state and federal policy incentives also play an important role in the level of RE development (Dincer, 1999; Walker, 2008). Three UK studies raised awareness of administrative barriers of RE due to lack of incentives to promote energy sources which include externalities such as social and environmental benefits (Dincer, 1999; Hain et al., 2005; Walker, 2008). Additional studies reviewed how energy policy either supports or hinders RE energy companies, and identifies alternative policy framing structures that could increase adaptive planning for RE implementation (Hain et al., 2005; Miller & Richter, 2014). Furthermore, the systematic process of renewable energy technological innovation reduces their long-term relevance and subsequent policy support (Foxon et al., 2005).

In addition, *project compatibility* within the current political and administrative governance was regarded by previous studies as either an opportunity or challenge by stakeholders (Beier & Lovecraft, 2009). Project compatibility refers to perspectives on whether current political and administrative governance allows for the development of energy projects (Omer, 2008). A global study on sustainable development of renewable energy identifies the need for strong links between renewable energy projects, policy framework, and financing options (2008). For a project to be compatible, the majority of stakeholders must believe the legislative, economic, and institutional restraints do not outweigh the benefits to exploit innovative solar technologies adding resilience to the electrical grid (Beier & Lovecraft, 2009; Gunderson & Holling, 2002).

As previously mentioned, these external concepts closely relate to project management and project design considerations which influence RE opportunities or challenges. Project management, specifically mitigation of impacts, requires a critical examination to understand how stakeholders and conveners moderate external factors, particularly in regards to the distribution of trade-offs. Negotiations in renewable energy projects involve the mitigation of impacts such as economic disparities, site considerations, and social-ecological trade-offs (Bergmann, Hanley, & Wright, 2006; Omer, 2008; van der Horst, 2007).

Literature Review Implications

Minimal research cites how electric co-operative, regional utility, or QF solar conveners' project management, project design, and external factors interact to create opportunities or challenges for a large-scale PV solar project. Previous literature identified interactions with stakeholders and the general public, trust between the community and project manager, and process management concepts of conflict resolution and mitigating impacts as crucial to the successful implementation of a project (Bauwens, 2014; Cruikshank & Susskind, 1987; Imperial et al., 2016; Margerum, 2011). Other studies focusing on project design described site considerations and scale in relation to the placement of a project; and technological elements such as effective renewable energy sources, energy output, and storage as critical to the success of energy projects (Angelis-Dimakis et al., 2011; Dincer, 2000; Paine et al., 1996; Shahan, 2013; Wyborn & Bixler, 2013). Lastly, studies found an expanse of external elements proved to be tipping points for renewable energy development (Dincer, 1999; Jobert et al., 2007; Menegaki, 2008; Miller et al., 2015; Wüstenhagen et al., 2007). These include social-ecological considerations which influence local support through perceptions of how trade-offs are distributed, governance and subsequent compatibility with a project, and economic incentives and impacts (Alsema & Nieuwlaar, 2000; Álvarez-Farizo & Hanley, 2002; Beeton & Galvin, 2017; Foxon et al., 2005; Hain et al., 2005; Omer, 2008; Van Der Schoor et al., 2016; Warren & McFadyen, 2010; Wei et al., 2010; Wolsink, 2006).

This study hypothesized that when combined, these theories provide a more in-depth explanation for understanding how stakeholders perceive opportunities and challenges, and mitigate impacts related to the planning, implementation, and long-term maintenance of large-scale PV solar projects (Figure 2). When project management, project design, and external factors were compared between the case study's three projects important similarities and difference were discerned which provided an increased understanding to process components for the three types of large-scale PV solar project conveners.

Large-Scale PV Solar Implementation Considerations		
Project Management	**Stakeholder and Public Engagement**	*Representation and Inclusivity*
		Project Planning
		Project Information Accessibility
		Convener Trust and Credibility
	Conflict Resolution	*Mitigation of Impacts*
		Compromise Strategies
Project Design	**Spatial Components**	*Site Consideration*
		Scale
	Technological Components	*Effective RE source*
		Storage
		Energy Output
External Factors	**Social and Ecological**	*Local Community Support*
		Environmental Effects
		Long-Term Implications
		Distribution of Trade-Offs
	Policy and Administration	*Multi-Scale Governance*
		Compatibility
	Economic Considerations	*Project Economic Effects*
		Project Ownership

Figure 2. Considerations for renewable energy implementation.

Literature Gaps and Need for this Case Study

Thousands of academic articles articulate opportunities and challenges for solar energy; however, only limited studies evaluate considerations other than economic, technological, or generalized costs and benefits for this energy source. The literature review identified community aspects of renewable energy sources, but they were primarily focused on generalized renewable energy concepts, or wind energy in Europe and the Middle East. There is also an expansive gap in the literature regarding the differences and similarities regarding opportunities and challenges of implementing solar projects by co-operative, utility company, or qualifying facility conveners. This study aimed to address these gaps by examining how project management, project design, and external factors influenced opportunities and challenges; and how the process to mitigate impacts resulted in the implementation or rejection of the co-operative, regional utility, or qualifying facility convened large-scale PV solar projects.

CHAPTER 3. METHODS

Research Design

This study was conducted with qualitative research using a case study approach. The research for a qualitative study is comprised of the participants and the data they provide (Corbin & Strauss, 2015). The use of qualitative methods allowed for a more in-depth exploration of respondents' experiences, created a better understanding for the formation of meanings, uncovered important variables for future research, and most importantly for this study explored phenomena not thoroughly researched (Corbin & Strauss, 2015; Pope et al., 2000; Smith & Heshusius, 1985).

There are multiple advantages for pursuing an in-depth case study approach. This approach allows researchers to uncover strategies or trends before formally testing them (Rogers et al., 2008; Stern, 2000). Furthermore, case studies are appropriate when researching context dependent, complex social phenomena (Rogers et al., 2008; Stake 1995). This case study approach proved useful for focusing on social factors of large-scale solar projects at specific locations. This approach used interview questions to understand project management project design, and external factors affecting projects (Karunathilake et al., 2016; Warren & McFadyen, 2010; Yuan et al., 2015). Questions for the multiple projects within the case study were similarly structured yet modified to provide relevant context to interviewees (Warren & McFadyen, 2010).

The purpose of this research was to understand similarities and differences between stakeholder perceptions about opportunities and challenges when implementing large-scale solar at electric co-operatives, the regional utility company, and qualifying facilities in

Montana. These projects were located in three different counties in Montana which vary in their demographics (Appendix A).

This study encompasses exploratory, descriptive, and ideographic research. This initial investigation explored large-scale PV solar projects by the three conveners. Conducting an exploratory study offered a better understanding of large-scale PV solar, identified the feasibility of a more extensive study, and developed methods for future research investigating opportunities and challenges surrounding the implementation of large-scale solar projects (Babbie, 2016). Descriptive research was necessary to develop an in-depth understanding for stakeholder interactions and context concerning large-scale PV solar implementation by electric co-operative, regional utility company, and qualifying facility conveners. In addition, an idiographic explanation helped identify root causes and concepts for the opportunities and challenges while providing a basis to cross-examine project management, project design, and external factors shared between projects. Lastly, this study provides insight for other large-scale PV solar and renewable energy projects within Montana and beyond (2016).

Project Descriptions

The three projects in this case study were chosen for their diverse scales, timely occurrence, stage of implementation, feasibility of stakeholder accessibility, and representation of diverse stakeholder interests across the state of Montana. The pilot project in Missoula County was convened by NorthWestern Energy (NWE), the regional utility company, and is currently in the planning phase for developing about 145kW of solar at Missoula high schools. I was invited to be a part of the working group, so had access to stakeholders. South of Missoula County, Ravalli Electric Co-operative (REC), manages 50 kW of solar for their co-operative customers, and are in the long-term maintenance phase of their project. REC provides online contact information for their Board of Directors and staff who worked on the solar project. Finally, Cypress Creek Renewables (CCR) initiated a qualifying facility solar project proposal in Cascade County on the plains east of the Rocky Mountain Front near Great Falls. The project failed in 2017 during the planning phase due to community resistance; however, public records identified contact information for key stakeholders who were either proponents or opponents of the project. Figure 3 provides an illustration of the counties where the projects in this study are located, and Figure 4 showcases different characteristics for each of the three projects**.**

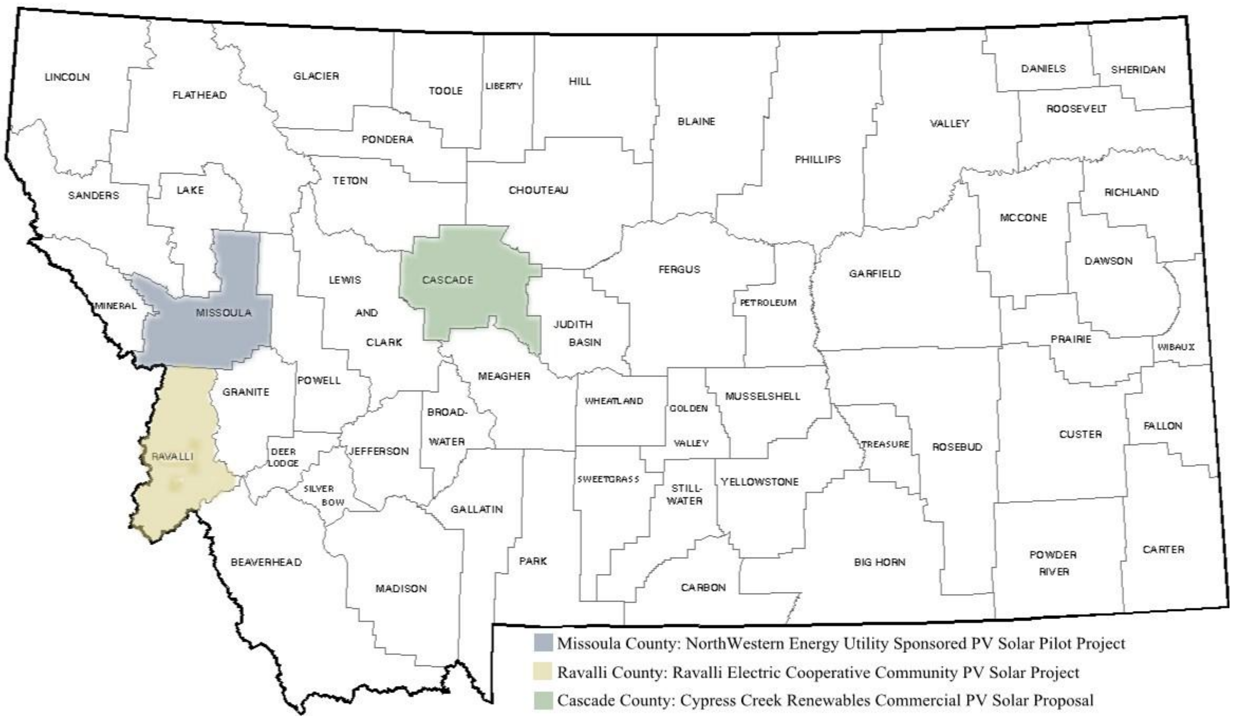

Figure 3. Montana county map illustrating where the case study projects are located.
Map courtesy: Active Rain Montana County Map

Project Characteristics	**Ravalli County:** Electric Co-operative PV Solar Project	**Missoula County:** Utility Company PV Solar Pilot Project	**Cascade County:** Qualifying Facility PV Solar Project
Project Size	50 kW, about 1 acre	145 kW, about 2.5 acres	3 MW, about 30 acres
Construction Timeline	Completed 2016	Estimated 2019	Failed 2017
Current Project Phase	Long-term Maintenance	Planning	Failed in Planning/ Permitting
Stakeholders	Co-operative Staff and Members, University of Montana, Bonneville Power Administration, Bonneville Environmental Foundation, Regional Renewable Energy Organization	Utility Company Staff, Missoula County Public Schools, College of Technology, City of Missoula, Missoula Housing Authority, Local Renewable Energy Organization	Zoning Board Officials, Property Owner, Neighboring Homeowners, Local and Regional Renewable Energy Organizations

Figure 4. Project characteristics by type of convener.

Electric Co-operative Convened: Ravalli Electric Co-operative

Ravalli Electric Co-operative (REC) is one of three co-operatives in Montana who have implemented solar arrays as a source of electricity for their members (America's Electric Co-operatives, 2017). In 2015, the REC Board of Directors initiated a survey of co-operative members to determine if community solar was of interest, and nearly 30% of their members indicated interest in purchasing a solar panel in an electric co-operative array (Barnes, 2015; Ravalli Electric Co-operative, 2015). In August 2015, the co-operative was selected to receive a Rural Energy America Program (REAP) Grant from the USDA to assist with construction costs (Barnes, 2015). REC recognized the majority of the members were not partial to fee increases to develop a solar array, so the project was designed to be fully paid for by the REAP grant and members who were willing to pay for panels (2015). This suggests successful negotiations between stakeholders, but left questions about process accountability and decision making in the co-operative (Margerum, 2011; Mckinney, 2011; Mnookin et al., 1999).

The benefits of installing a community solar array instead of individual home system included the potential for up to a 30% cost break, maintaining private homes' aesthetic values, and increased solar array site suitability for ideal solar conditions (Barnes, 2015). Additional benefits of the community solar program were annual crediting of a members' utility bill based on kilowatt hours of their sponsored solar panels, and bestowing public recognition for contributions to the solar array investment (Ravalli Electric Co-operative, 2017). The Ravalli Electric Co-operative Community Solar Project was completed at the end of 2015 next to Highway 93 in Victor, Montana and resulted in an 88 panel, 25kW solar array sponsored by REC members (2017).

Less than a year after initiating the first 25kW project REC experienced an increased demand for solar, so the Board of Directors voted to increase the project to 50kW which would double the array to 176 panels (Ravalli Electric Co-operative, 2017). REC staff advertised for members to sponsor up to five solar panels for Phase 2 of their Community Solar Project (2017). By April 2016, Phase 2 was completed, with members and the REAP grant sponsoring 100% of the solar panels (Grotbo, 2016; Ravalli Electric Co-operative, 2017).

Regional Utility Convened: NorthWestern Energy Stakeholder Pilot Project

Rob Rowe, NorthWestern Energy's CEO, announced a commitment to initiate collaborative solar pilot projects across Montana to better understand how solar technologies can reliably and cost-effectively integrate into the transmission grid (NorthWestern Energy, 2016b). This came as a response to the 2015 Clean Power Plan carbon emissions reduction requirement and the Montanan legislation session debate. A diverse stakeholder group formed during the 2015 Montanan legislative session and remained active afterwards to visit the various viewpoints of solar (Carmody, 2017).

After the 2015 legislative session NorthWestern Energy's CEO invited these interested stakeholders, constituents, and government officials to discuss viewpoints about solar energy's integration to the grid (Carmody, 2017). Nearly 100 people attended the meeting, and the

Community Stakeholder Working Group was formed to address different stakeholder and Montana communities' views on these topics. NorthWestern Energy selected stakeholders from the original meeting who were involved, passionate, and wanted to know more about the pilot projects. Smart Electric Power Alliance members facilitated about seven meetings over nine months discussing solar, batteries, and innovative applications. From those discussions the group was able to identify project locations so stakeholders could develop solar data for future policy discussions. The resulting locations were pilot projects in Bozeman, Missoula, and Helena (NorthWestern Energy, 2016a; Carmody, 2017). At this time the state-level group decided the Missoula project would target public schools and low income families by implementing about 300kW of solar with a goal to, "…learn how to maximize education benefits while gathering data, knowledge and experience related to solar installations," (Smart Electric Power Alliance, 2015).

NorthWestern Energy had two primary objectives for these pilot projects: preparing for grid modernization of solar and other RE technologies, and valuing the grid (Carmody, 2017). The objective for grid modernization is to understand how to implement renewable energy sources while ensuring grid reliability and power quality remain as they are today (2017). NorthWestern Energy's valuation goal is to correctly set up pilot projects and gather data so stakeholders and the utility company can start understanding how to value individual pieces of the grid (2017). Aspects of this valuation include identifying what portions of grid modernization should be financially valued by deciding which processes or items should be paid for separately verse what should be bundled under a singular bill (2017).

At a state level scale, NorthWestern Energy is trying to understand what their Montanan customers want (Carmody, 2017). This task's complexity is partially due to having to satisfy different societal scales from individual - county - state levels. Therefore, it is important for NorthWestern Energy to consider how stakeholders in Missoula and other diverse communities support the state's initiative (NorthWestern Energy, 2016a; Carmody, 2017).

Two of the state-level stakeholders, from the City's Renewable Energy Office and Human Resources Council, along with Missoula County Public Schools, City Council and Staff, University of Montana, and Renewable Energy Organization representatives were asked to participate as stakeholders to fulfill the goals for Missoula. Due to my interest in research interests, NorthWestern Energy representatives invited me to participate in this working group. The Missoula working group began meeting in December 2016 with an estimated timeline of project completion in nine months. The pilot project demonstrated a collaborative process which devolves NorthWestern Energy's decision making power and transitions it to the selected stakeholders by promoting collaborative leadership where the stakeholders facilitate, share, and develop a vision for the solar project (Imperial et al., 2016; Margerum, 2011). NorthWestern Energy retained the formal authority to deny or modify decisions which are contrary to the project's mission or outside their financial scope (NorthWestern Energy, 2016a).

The facilitation role was assumed by a NorthWestern Energy staff member who managed meeting logistics, and introduces stakeholders and general topics. As a facilitator, other roles such as interpreting statements, guiding the process, and promoting balanced participation. This technique of the utility company assuming a supportive role in the collaborative process appears to distribute power amongst the working group stakeholders (Margerum, 2011).

Qualifying Facility Convened: Cypress Creek Renewables Solar Proposal

In 2015, there were two out-of-state qualifying facility solar businesses planning projects in Montana (Lutey, 2016). Cypress Creek Renewables (CCR) out of California had 10 projects in the planning stage; and FLS, a North Carolina based company, had applications for 14 projects in Montana (Brooks, 2016; Lutey, 2016). By May 2015, NorthWestern Energy received nearly a dozen applications to connect QF solar projects to their grid (Lutey, 2016).

The vast amount of QF and residential solar hook-up requests fueled the regional utility company to ask the MT PSC to halve the price NorthWestern Energy has to pay QF because these small, wholesale solar projects were greater than the consumer demand (Lutey, 2016). "The Public Service Commission sets the price for which the power is bought, the length of the contract, and a project size under which NorthWestern Energy has to offer a contract with terms set by the state," (2016). At the time, the Public Service Commission required any solar qualifying facility project 3 MW or smaller to receive a 25-year contract from NorthWestern Energy at a rate of $66 per megawatt hour (2016).

On June 16, 2016, the Montana Public Service Commission made a decision, "To temporarily suspend the qualifying facility standard rate availability to new small solar projects, requiring NorthWestern Energy instead to negotiate contracts with any proposed solar facilities of 100 kilowatts to 3 megawatts in size," stated the PSC Communications Director (Sell, 2016). This action was prompted by NorthWestern Energy's submission in May of an 'emergency request' to the PSC which stated the vast amount of requests for 100 kW - 3 MW solar projects would negatively impact customers through a significant increase in additional costs of $215 million over the next 25 years (2016).

A month later, FLS Energy asked the PSC to rehear the decision after the company failed to meet a two-part test designed by the PSC which could allow developers to be grandfathered in at the old rate (2016). Steve Levitas, vice president at FLS stated, "If the decision stands as issued, that will be the end of our development activities in Montana. None of our projects will go forward," (2016). Five months later, Cypress Creek Renewables signed an agreement to acquire FLS Energy in order to combine financial and management strengths (McKay, 2016).

By the end of 2016, the issue went to the Federal Energy Regulatory Commission (FERC), and FERC decided the Montana PSC violated PURPA; however, the federal regulatory commission decided not to pursue an enforcement option (Brooks, 2016). Instead, FERC noted Montana's PSC needed to determine a new avoided cost rate that was an accurate measure of NorthWestern Energy's avoided costs; which is what the Montana PSC stated they were trying to accomplish during the temporary suspension (Brooks, 2016; Sell, 2016). The issue was not completely resolved; however, CCR continued pushing forward with their solar projects.

Cypress Creek Renewables partners with local land owners and utility companies in at least 15 year agreements to produce up to 3 MW solar farms, due to the state legislature cap in Montana (Cypress Creek Renewables, 2017c). They have over 4 gigawatts of solar farms in 15 states and have successfully partnered with five utility companies (Cypress Creek Renewables, 2017b). The company states they are a community-based business who encourages local job creation and economic growth while working with community leaders to ensure their projects are within ordinance compliance and produce minimal visual impacts (Cypress Creek Renewables, 2017a). As a business, CCR does not generally participate in community collaboration processes when initiating projects (Cypress Creek Renewables, 2017b; Margerum, 2011). Instead the company uses a traditional leadership style to make unilateral decisions about solar array considerations while maintaining communications to the leasing landowner and permitting entities (Cypress Creek Renewables, 2017b).

A public announcement was made in May 2016 stating Cypress Creek Renewables was grandfathered into the earlier NorthWestern Energy contract rate and was seeking two land lease contracts in Cascade County for QF solar farms (Fox Montana, 2016; Killoy, 2016). A month later, a public meeting was held by the Cascade County Zoning Board which raised multiple questions about CCR's two sites, of about 17,000 solar panels on 30 acres each, resulting in the proposals being tabled for a month (Chase, 2016; Puckett, 2016). During this time proponent, opponent, and CCR representatives sent correspondence to the zoning board stating the impacts and benefits of implementing the QF solar farms in Cascade County (Berg, 2016; Cascade County Public Record, 2016a, 2016b). A mid-August vote by the Cascade County Zoning Board of Adjustments approved the two CCR QF solar farms to be built on zoned residential and agricultural lands with an unclassified permit; however, an appeal was brought forth and the initial decision was voided on the grounds that the zoning board did not present a quorum at the time of approval (Flathead Beacon, 2016; Puckett, 2016).

A two-day rehearing of the projects in November resulted in the rejection of both solar farms because the unclassified use permit did not meet the guidelines for minimal value impact to the adjoining properties (Johnson, 2016a, 2016b). A Cypress Creek Renewables representative stated they would not pursue an appeal due to timeline restrictions with the NorthWestern Energy contract (Johnson, 2016b).

Data Collection and Study Participants

The goals of this social research cannot be satisfied by probability sampling due to the small number of stakeholders actively participating in these three projects (Babbie, 2016). Judgmental sampling is used to, "Select a sample on the basis of knowledge of a population, its elements, and the purpose of the study," (Babbie, p. 187, 2016). This technique was used during the case study because stakeholders were identified during the initial scoping period.

This study narrowed down the range of stakeholders to 28 individuals and focused interviews on relative questions pertaining to the decision making processes. Stakeholders in this study were operationalized as those whose level of involvement directly affected the planning, implementation, or long-term maintenance of one of the solar projects in the case study. This study did not take into account the general public: individuals or groups not directly involved in a project's decision making process, but who have a stake in the decision. The conveners of the solar projects identified and defined which stakeholders were invited to be a part of the planning, implementation, and long-term maintenance process of the projects. NWE representatives invited me to participate in their working group as a stakeholder. The QF convened project includes stakeholders identified by the convener, but also includes stakeholders who influenced the implementation stage during the permitting process. These slight variations consequently resulted in dissimilar stakeholders across the three types of projects; however, they still provided a chance to understand the opportunities and challenges resulting from the three projects.

This study used semi-structured interviews for data collection. The semi-structured interviews allowed for a consistent coverage of concepts while providing the flexibility to ask the respondent for clarification or expansion on a topic (Corbin & Strauss, 2015). As suggested by research, additional representatives were identified for interviewing during initial interviews through a judgmental sampling process by asking interviewees who else might be interviewed (Babbie, 2016).

Interview Guide Description

The interview guide contained a list of questions and follow-up questions to serve as prompts during the interviews, yet was not meant to rigidify the data collection process (Corbin & Strauss, 2015). Overall, the interviewer let the interviewee guide the revelation of information; however, the interview guide provided a semi-structured format for gaining data relevant to the boundaries of the research (Corbin & Strauss, 2015; Taylor et al., 2016). The guide acted as a question prompt, checklist for the interviewer, provided additional terminology to clarify a question or concept, and ensured project management, project design, and external factors were explored during each interview (2015; 2016). The process of data collection was at a conceptual level, so each interview created a different situation which brought out variations in the data (Corbin & Strauss, 2015).

As suggested by past research, the interview guide for this case study provided open-ended, descriptive questions based on previously published literature questions and terminology (Taylor, Bogdan, & DeVault, 2016b). An interview guide for each case study (Appendix B-D) was prepared to help pose questions in a relative context for the three projects (Taylor et al., 2016b). The questions in the interview guides were formatted in a hierarchy with the first question prompting either project management, project design, or external factors; the second sub-question a prompt or guidance for additional information on the concept; and the follow-up question allowed for increased specificity or clarification of the response. Lastly, the interview guide contained additional, open ended questions to address topics not discussed, and if the respondent had recommendations for additional interviewees. Figures 5-8 indicate stakeholder interest groups and reasoning behind choosing them as interviewees.

Ravalli Electric Co-operative Community-Scale Solar Stakeholders	
Title	**Reasoning**
Co-operative Staff	Active REC staff stakeholders oversaw the implementation of the co-operative projects
REC Board of Directors	Active stakeholders representing the landowner and members in favor of or opposing the projects
Regional Utility Company	Active stakeholder in charge of electricity sources contract
Renewable Energy Non-Profit	Active stakeholder who provided a grant and set up RFP
Renewable Energy Advocate	Active stakeholder representing interests for renewable energy projects

Figure 5. List and reasoning for Ravalli Electric Co-operative stakeholders sampled in the case study.

NorthWestern Energy Solar Pilot Project Stakeholders	
Representative	**Reasoning**
Regional Utility Company Staff	Active stakeholder who oversaw NWE objectives for solar valuation of solar and grid modernization
Landowner	Active stakeholder representing the landowner, and education component
Missoula College of Technology	Active stakeholder representing the COT education component
Missoula Housing Authority	Active stakeholder representing low-income interests, and active in state-wide stakeholder group
Missoula City Councilman	Active stakeholder representing Missoula, education and low-income interests
City of Missoula Energy Conservation Staff	Active stakeholder representing Missoula, education and low-income interests, and was active in state-wide stakeholder group
Local Renewable Energy Advocate	Active stakeholder representing interests for renewable energy projects in Missoula

Figure 6. List and reasoning for Missoula Pilot Project stakeholders who were sampled in this case study.

Cypress Creek Renewables QF Solar Stakeholders	
Title	**Reasoning**
Local Homebuilder	Active stakeholder representing homeowners and builders in neighborhood near the QF solar project
Zoning Board of Adjustment	Active stakeholder representing county government evaluation of the QF solar project
Homeowner and neighbor	Active stakeholder representing neighborhood homeowners in area of QF solar project
Landowner	Active stakeholder representing landowner willing to lease land for QF solar project
Renewable Energy Advocate	Active stakeholder representing interests for renewable energy projects in Cascade County

Figure 7. List and reasoning for the Cascade County stakeholders who were sampled in this case study.

State Level Solar Resources	
Title	**Reasoning**
MT Public Service Commission	Establish rates and terms for the regional utility and QF contracts.
MT Department of Environmental Quality	Part of energy transition conversations for Montana, and provides permits for applicable solar development sites.
State Renewable Energy Advocate	Advocates for socially and environmentally conscious RE development, and willing to write letters of support for RE projects.
Regional Renewable Energy Advocate	Part of energy transition conversations for Montana and the northwest, and advocates for socially and environmentally conscious RE development.

Figure 8. List of state and regional energy specialists sampled in this case study.

Data Analysis

Based on grounded theory methodology, the framework approach of data analysis is useful when statistical analysis is not used due to a small sample size of qualitative data (Babbie, 2016; Pope et al., 2000; Rogers et al., 2008). Corbin and Strauss guide researchers to initially complete a read-through of the interview or observational data before beginning the analysis in order to understand the context of the interview (Corbin & Strauss, 2015; Pope et al., 2000). Furthermore, it is necessary to couple the process of coding with the art of flexibility and dynamic interactions of the data (Corbin & Strauss, 2015).

The initial stage organized the data by coding for basic concepts under the categories of project management, project design, and external factors (Babbie, 2016; Pope et al., 2000). To increase inter-coder reliability, after basic concepts were coded by the researcher a faculty member and graduate students independently coded the interviews, then concepts found by the analysts and researcher were discussed to assure similar concepts were revealed (2016, 2000). NVivo qualitative data analysis software was used once these categories and concepts were defined. During the coding process concepts were compared to the interviews in each project, and also across the three projects. The next stage reduced the amount of original concepts by lumping lower frequency codes together. The final stage involved deducing percentages from project management, project design, and external factor concepts to further illustrate their weights in comparison to other concepts and across projects (Pope et al., 2000). These percentages illustrate the frequency of interviews across the three projects stating a concept.

Research Implications

The state of NorthWestern Energy's solar pilot project in Missoula, Ravalli Electric Co-operatives' Community Solar Project, and the unsuccessful Cypress Creek Renewables proposals were primed for this study examining the exploratory, descriptive, and explanatory factors regarding stakeholder perceptions on opportunities and challenges when implementing large-scale PV solar arrays. The exploratory study revealed opportunities and challenges established by stakeholders and identified the feasibility for a more extensive study of large-scale solar for QFs, utilities, and co-operatives while developing methods for future research. Descriptive research was necessary to develop an in-depth understanding of stakeholders' insights by forming context around the opportunities and challenges for each convener. The idiographic explanation further identified concepts and root causes behind stakeholders' perceptions about these opportunities and challenges, and provided a basis to cross-examine concepts shared in all the projects. Finally, this case study provides insight for other conveners across Montana and the nation.

CHAPTER 4: PROJECT MANAGEMENT and PROJECT DESIGN FACTORS for LARGE-SCALE PV SOLAR PROJECTS in MONTANA

Results Introduction

In Montana, three types of large-scale PV solar developers invested in projects using varying project management and project design concepts with mixed levels of success. Ravalli Electric Co-operative completed their 50kW project in 2016, NorthWestern Energy is scheduled to begin construction on a 145kW project in 2019, and the Cypress Creek Renewables 3MW project failed in 2016. A total of 28 stakeholders were interviewed, and are operationalized as those whose level of involvement focused on the planning, implementation, or long-term maintenance for each case study. The conveners identified and defined which stakeholders were invited to be a part of the planning and implementation process, and consequently resulted in dissimilar stakeholders across the three types of projects. Four of these stakeholders are state level solar representatives from the Montana Public Service Commission, Montana Department of Environmental Quality, regional and state renewable energy organizations. These interviews provided additional context for large-scale PV solar projects, and allowed a comparison of the opportunities and challenges between state level representatives and stakeholders.

The following result sections quantitatively and qualitatively describe project management and project design findings from this case study. Project management concepts found in previous literature are briefly reiterated. Next, the two project management concepts and their opportunities and challenges are described. The process then repeats for project design opportunities and challenges.

Project Management

While few literature sources specifically evaluate electric co-operative, utility, and QF solar conveners, other studies identified project management factors as important to success. Studies focusing on project management regarded interactions with stakeholders and the general public, trust between the community and project convener, and compromise strategies for conflict resolution as crucial to successful project implementation (Bauwens, 2014; Cruikshank & Susskind, 1987; Imperial et al., 2016; Margerum, 2011).

The findings from this study contributed to additional project management concept framing. This study found project management's stakeholder and public engagement concepts consisted of 1) project goals, 2) planning initiation, 3) project information accessibility, 4) representation and inclusivity, and 5) convener trust and credibility. Conflict resolution's two concepts were 1) mitigating impacts and 2) compromise strategies. Important similarities and differences of project management concepts were evaluated within each project and across the three projects furthering the understanding of large-scale PV solar projects.

Project Management Results

The results of this study verified two project management concepts 1) stakeholder and public engagement and 2) conflict resolution had important roles in the opportunities and challenges of the solar projects. Stakeholder and public engagement revealed: 1) project goals, 2) planning initiation, 3) representation and inclusivity, 4) convener trust and credibility, and 5) project information accessibility. Respondents stated stakeholder and public engagement opportunities (86%) and challenges (79%) (Figure 9). The second concept, conflict resolution, revealed two elements: 1) mitigating impacts, and 2) compromise strategies. Conflict resolution opportunities (57%) and challenges (39%) were also reported. In-depth project management quotes from case study respondents are found in Appendix E.

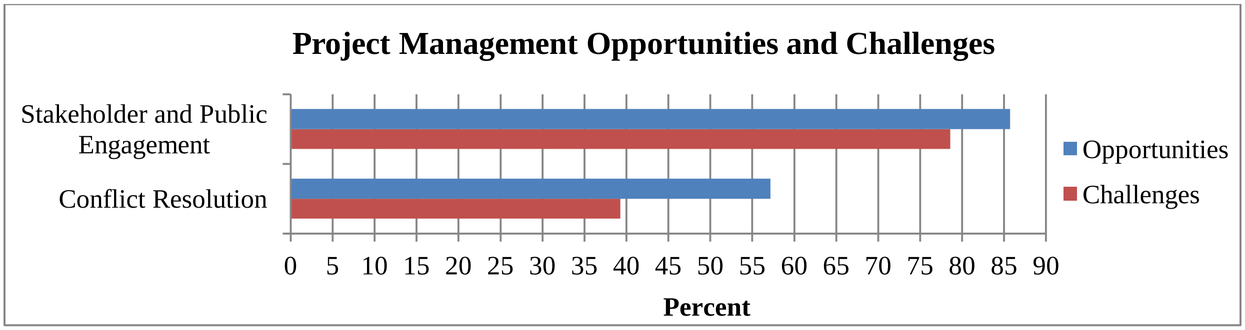

Figure 9. Distribution of interviews specifying project management opportunities and challenges.

Stakeholder and Public Engagement

As indicated by previous research, stakeholder and public engagement is important to consider during renewable energy project management. Under stakeholder and public engagement, interviewees across the projects identified five elements that were discussed as opportunities and challenges (Figure 10): 1) project goals (opportunities 61%, challenges 61%); 2) representation and inclusivity (opportunities 57%, challenges 46%); 3) planning initiation (opportunities 57%, challenges 43%); 4) convener trust and credibility (opportunities 61%, challenges 39%); and 5) project information accessibility (opportunities 46%, challenges 32%).

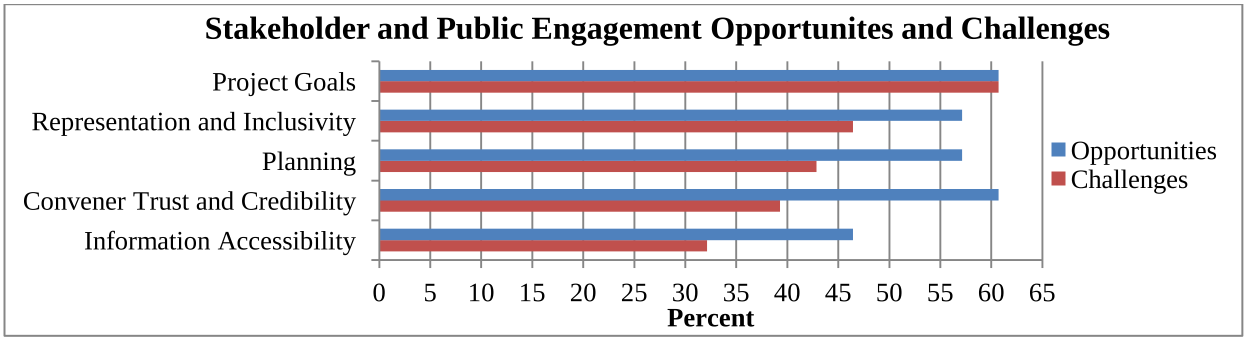

Figure 10. Distribution of interviews specifying stakeholder and public engagement concepts identified in the case study.

Project Goal

Project goals are an important aspect of project management. Interviewees identified several opportunities of project goals including 1) solar energy education, 2) renewable energy communities, 3) project benefiting stakeholders, 4) electricity generation and grid reliability, and 5) low-income populous direct benefits. Stakeholders set education goals by stating, “We have to change what we're doing and it has to start somewhere, so why not at the schools. The key will be making sure that not only the students are involved, but you get the parents involved, and you get the parents companies involved and you just start the dominoes." Respondents from all projects acknowledged the need to set goals for evolving electricity generation sources. For example, "We recognize that the energy landscape is changing and that we must be willing to consider alternatives,” of which these projects, “support the expansion of community scale renewable energy projects.” State solar representatives recognized, “…smaller projects, distributed scale utility investments in solar, have the potential to serve the purpose of providing other ancillary services, or in combination with other grid enhancements could potentially provide more stability on the distribution grid,” and were primarily focused on electricity generation and grid reliability by incorporating renewable energy into communities.

The establishment of project goals also revealed complex challenges for stakeholders when initiating solar projects. For all projects, these challenges predominately stemmed from, “…nobody ever really had this sort of clear view of where this all was headed.” Setting goals to create renewable energy communities that also benefit stakeholders becomes challenging when conveners note, "… we're 89% hydro, and then 11% of that is nuclear, with some solar and wind from the Columbia, so we have no carbon footprint." Additionally, when stakeholders felt, "The only benefit on either [project] was the…[convener] and the owners of the land," then project goals were indicative of not encompassing local community interests.

The establishment of project goals was largely dependent on representation and inclusivity, which differed across the case study projects. Project goals for REC were set by co-operative members, while the working group established NWE, and the CCR convener specified theirs. The following paragraphs provide details regarding differences in project goal opportunities and challenges among conveners.

REC stakeholders expressed an interest in all of the project goal elements. The challenges expressed by the project goals of transitioning to a renewable energy community, benefiting recipients, electricity generation, and low-income populous direct benefits stem from the co-operative already being a carbon-free resource.

> "The vast majority of our system is fed from hydro, which is carbon-free. So therefore, you're not doing it for the carbon footprint. The other piece … is the Bitterroot Valley is not a good wind area because of the mountain valleys on both sides… [and] it's not a great solar area. Our peak [electricity demand] days typically are [January] or February and it's usually about 6:30- 7:00 in the morning and it's still dark…. Energy is one of the few commodities that has to be used at the same moment that it's produced, and [solar peaks in] the day at 1:00- 2:00 in the afternoon, but that isn't when you're using it and there isn't a storage mechanism that's a viable cost alternative."

This indicates other primary energy sources are still needed. The challenge REC faces as a co-operative trying to maintain profits and provide reliable electricity is, "If you don't need the generation and you're carbon free, why are you doing it?" Since the co-operative is membership driven it was, "Because certain members wanted it…. and they didn't do it for the economics." An additional challenge in the decision to install solar is the goal was set by affluent co-operative members. Some stakeholders believe setting goals to focus policy and staff capacity towards energy conservation or energy efficiency programs providing direct benefits for low-income populous in their jurisdiction should be a higher priority than redirecting staff to explore and initiate processes for a new electricity production installation.

NWE stakeholders indicated each of the previously described goals were important in the project, but the working group was particularly focused on integrating solar project data into public school curriculum and providing direct benefits for Missoula's low-income populous during the solar project. The public school education piece accounted for opportunities and challenges due to developing new processes and partnerships between Missoula County Public Schools and NorthWestern Energy. The group decided to modify the establishment of direct benefits to the low-income populous. Instead, the goal was incorporated through the public schools in an effort to move the project forward despite knowing it would be difficult to measure if low-income students and their families actually incur a positive impact or direct benefit from the solar project.

There are many challenges of setting a goal to benefit stakeholders during a pilot project where electricity is only virtually net metered and does not actually decrease the energy bill. Thus, the perceived benefits for each stakeholder group were extremely diverse. For example, "It's important that NorthWestern certainly has an interest in doing this project…. The school district has interests. The city has peripheral interests..." This project benefits NWE because they are trying to valuate solar applications, whereas the public schools are interested in integrating solar production and use data into student curriculum. Finally, the city of Missoula recently committed to upholding the Paris Climate Agreement through signing the Chicago Climate Charter, but is still trying to understand what 100% renewable energy for the community of Missoula entails.

Local community stakeholders interested in the CCR QF project did not collaborate to define specific goals for the project; rather, individuals only stated potential goals that might assimilate with the project. The lack of clarification of goals may be due to the inability to interview a Cypress Creek Renewables staff member, but may also reflect a lack of information accessibility by stakeholders.

Lastly, state-level stakeholders identified each convener had policy and administrative elements influencing the opportunities and challenges of the renewable energy community goal. As an example,

> "For community solar… I think it's a really good model for co-operatives that are looking to supply their members with energy that they want…. The challenge will be just as more of these projects come along, I'm sure the co-operatives will evaluate what crediting rate they want to give to the people participating in these community solar projects. So the main challenge I think will probably be with the co-operative having the expertise to determine what that rate should be."

Montana RSP law offers an opportunity towards the renewable energy community goal through the requirement that, "… public utilities and competitive electricity suppliers must purchase, as a specified fraction of their total required renewable energy acquisition, the electricity and associated renewable energy credits from community renewable energy projects, CREPs." Two examples of challenges are CREP projects cannot be larger than 25 MW, and may be produced by any energy source considered renewable energy. This finding indicates that competition by other renewable energy sources can cause challenges when planning for large-scale solar development.

Planning Initiation

Respondents from the three projects identified 1) project initiation and 2) partnership initiation as two aspects of planning initiation. Some respondents eagerly pursued partnership planning opportunities because, "I believe with all my heart that Missoula is one of the places to do a project… and we invited the local NorthWestern Energy rep to a meeting to make that case; which he had already been warned that we would calling." Other respondents demonstrated the importance of planning for project initiation, "Anytime we do a project... we do need to get our facts and figures, and we go through it really hard and make sure we're making the right decision." State respondents also noted basic planning initiation strategies for conveners, "…they had to have done their due diligence to know what permits they would need."

Project initiation and partnership initiation were also identified as challenges. One respondent noted when project communication began to falter, stakeholders were, "… a little bit disappointed that it kind of just died and we're no longer being updated, or asked about it, or informed about it even," because they worried project development may not occur. A specific example of a partnership challenge was when, "264 respondents said they would buy 813 panels if we offered community solar….When it was all said and done for the project, only 71 members participated."

In comparison, REC and NWE identified similar amounts of planning initiation opportunities and challenges largely regarding gathering stakeholders to participate in their solar project. CCR had nearly double the amount of opportunities and challenges as the other projects that stemmed from, "I would've used a lot of local people to propose it instead all of their so called expert appraisals…" Even though respondents from each project identified project and partnership initiation as potential challenges, the conveners were able to be overcome these challenges.

Representation and Inclusivity

Representation and inclusivity of stakeholders affected in the project varied by convener. The opportunities across the projects similarly revolved around the balance of, "…reaching out to the right people," while incorporating an inclusive initial group and allowing for flexibility to invite others. Another interesting perspective was identified as, "What these consumer owned utilities have going for them is their board is governed by their elected board members. So when the board makes a decision the staff kind of falls in line," indicating a grassroots strategy of incorporating inclusive interests through a formalized representation structure.

Directly related to the previous opportunities, establishing and maintaining the balance of participating stakeholders was challenging especially when there were, “Conflicting perspectives regarding the resource value and the ability to manage ongoing operation and maintenance activities.” Another specific representation challenge example was, “We didn't submit comments, and I didn't give testimony to the zoning board or comments or anything like that. So the process kind of played out before the zoning board without our intervening.”

The three projects revealed distinct representation and inclusivity resulting in dissimilar opportunities and challenges. Project representation structures differed because REC is a membership driven co-operative, NWE established a working group, and CCR used a limited public participation process. To further understand the different convener processes, events relating to representation and inclusivity were distinguished and compared.

As a co-operative, REC provides energy for a largely rural membership ranging from “a very passionate group of members… [who] moved in from areas that were good solar sites,” to “some very passionate people that [said] ‘Do not do it, I do not want to pay for that.’ I mean very passionate people. And it was probably a lot larger percentage of those, than those that wanted it built.” Their long established non-profit, member owned business model increased inclusivity and allowed members to participate in the decision making process.

Alternatively, NWE established diverse representation and an inclusive process by initiating a state-level working group, which identified community values, and interests that could be incorporated into the project by inviting specific stakeholders to collaborate during the planning phase. Interviewees expressed mild challenges towards slightly less diverse representation; however, also noted the group was likely at an optimum size to stay connected to the community and participate in the project. Some members revealed another concern was, "Our role was to help define the project and help them figure out what it looks like and how it's implemented [but] I don't think our role ever was to figure out what to do in three to five years." Others in the group indicated, "I think there's potential as the project is rolled out, and whether it's a five year project or beyond, to continue to bring people together and to learn from the data, and to have that data inform our next steps." These divergent assumptions reveal a lack of clarification about the inclusion of future stakeholder interests.

Initially the CCR projects lacked diverse representation of interests and inclusivity of the local community. During this time, the convener focused on working with a willing landowner to lease from and the local government to ensure regulatory compliance at the proposed site. Project opponents felt the QF convener's process:

> "…found this land owner that was willing to lease it cheap to them. They contacted the Great Falls Development Authority after they realized that [the Fox Farm site] was a residential zone. The Great Falls Development Authority contacted the County Commissioners and the Planning Department, and then proposed the language of the zoning rules…. Most everything was done without any public involvement or notice and even the county got involved in that same thing too. So I think that bothered a lot of people."

In hindsight, proponents noted:

> "Well, that's the other mistake we made… we didn't … right in the beginning get these folks together and talk to them. This is a whole new environment for me so I can make some excuses, but Cypress Creek should've realized that the first thing they want to do when

> they do something like this is talk to the neighbors and minimize the NIMBY. I would think they would have done that. Well they didn't. And I didn't know any better and I didn't do it."

Furthermore, project opponents were aghast about the lack of outreach for the initial public meeting, "I don't know if there [were] 30 people invited to it. It was not the surrounding area," and took the initiation to make face-to-face contact with as many of the 200 neighbors in the immediate area, give them letters addressing concerns about the project, and talked to them about how they would be personally affected by the project. This resulted in the public meetings becoming exponentially larger with opponents. Proponents felt during the public meetings the QF conveners, "… were knocked off their momentum, their initiative, they were caught flat footed. They didn't think there would be any objection because most of their other projects… were approved." The lack of incorporating an adequate amount of inclusive representation resulted in drastic and immediate challenges for the CCR project.

Project Information Accessibility

Information accessibility was found in the case study as critical for the success of each project. Four aspects of project information accessibility were identified by stakeholders as both an opportunity and challenge: 1) a forum to listen to all perspectives, 2) advertising and marketing, 3) use of media outlets, and 4) technical or expert beliefs. Each convener took on a different tact for providing information, and opportunities stemmed from those who took a proactive outreach. The use of multi-step outreach through media outlets were incorporated by each convener,

> "… outreach with community meetings. And we'll do some mailings to the residents around the proposed sites, and invite them to a meeting to learn about it, to see what we're considering as initial design, and to provide us with feedback. So that'd be step one. I think at the time NorthWestern Energy actually seeks permits for construction that it will also have to go through Development

> Services and there's a public hearing process that occurs there, so that would be another opportunity not only for those in the immediate area but for the community at large to respond to the proposal."

State representatives noted, "…solar projects are pretty benign… so that is certainly something for developers to be cognizant about, or for public to be cognizant about," emphasizing a need for conveners to take the opportunity to prepare communities for solar development. As a preliminary step, "There is the outreach component to this... marketing if you will, of what happens at these places to the rest of the communities so they know what's going on.... We need the Missoulian and the Independent [Newspapers] to cover these kind of things."

Information accessibility also included challenges. Forums to listen to all perspectives were perceived by some stakeholders as, "… there's a barrier for me in wondering how to communicate with them and how to get news from them.... And so I think a barrier for me is wondering how to engage with a for-profit provider." A lack of advertising and marketing led to challenges when, "I asked them for maybe some references to some of their past projects, and what type of business had followed that solar project into the cities. And I got no response.… I would think that after I did a project like that, I would somehow post that so people would see what a great asset it was that I did that project." Challenges compounded when the lack of project information accessibility led stakeholders to substitute technical information with unverified, "…bad science element of it. People said, 'Oh these things are going to be 20' high!' No they aren't, they are going to be like 6-8' high."A comparison of information access across the projects provides a detailed comparison of the various opportunities and challenges.

After REC staff and Board of Directors were approached about the interest to develop community solar, staff sent out an initial survey to all members as a forum to listen to all perspectives. Responses varied in interest and acceptance for a project, but, "264 respondents said they would buy 813 panels if we offered community solar." Overall, the survey was a productive way to receive feedback from members potentially affected by the project, and was only stated as a challenge in a few interviews due to some members throwing their survey out even though they were interested in participating. Unfortunately, "when it was all said and done for the project, only 71 members participated, and those 71 members bought between them the 76 panels." Stakeholders stated marketing for the panels and actually having members purchase panels became more difficult after the initial spree. "We did it in two phases, 44 panels in the first phase. Then we did a phase two because we sold the first phase out in three months…. but still it took marketing for a year. Those first ten members bought panels, but then to get interest in the remaining panels is what took the time." Overall, stakeholders felt their use of various media outlets such as the newspaper, radio, websites and newsletters provided opportunities for marketing, but were not staggeringly successful.

Information accessibility was not largely regarded by NWE stakeholders during interviews. While still in the planning phase, forethought of marketing the project and using media outlets were already being considered. Stakeholders were considering, "We need the Missoulian and the Independent [Newspapers] to cover these kind of things. We need to set up some competitions. We need to get them in front of city council for presentations, and all that kind of stuff."

The CCR QF stakeholders experienced the most challenges for providing a forum to listen to all perspectives. The challenges stemmed from the small amount of stakeholders who initially knew about the first public meeting, poor PA systems during public meetings, Zoning Board quorums, and lack of communication with conveners. Additionally, opponent champions who, “After the first meeting I took the letter, and I took off on my four wheeler, and I gave letters to every neighbor within miles.”

Limited opportunities for a forum to listen to all perspectives arises from the landowner’s ability to influence neighbors, and work through cultural site trade-offs. “The biggest issue on Portage was the historic Lewis and Clark issue….When they made the portage, the last segment of it was through the field. One of the provisions that I came up with to soften the objections from the historical people was to have some panels telling the historic story on the edge of the solar farm.” This project proponent was able to maintain correspondence with initial project opponents and through negotiations resolved the issue.

A notable contrast to the other projects was stakeholders did not mention CCR using media outlets to advertise or market their project. Possibly as a result, stakeholders mentioned challenges around technical or expert beliefs during public meetings. Comments ranged from extremes of not understanding the size or need of the project, to worrying about electromagnetic radiation, and resistance towards an increase in local taxes.

Convener Trust and Credibility

Aspects of convener trust and credibility included: 1) convener understands local context; 2) leadership; 3) convener image; and 4) motivation. Respondents noted each convener had opportunities of trust and credibility. REC’s identification of the four aspects aligned with state respondent statements, “…it's a really good model for co-operatives that are looking to supply their members with energy that they want…” Overall, respondents felt convener leaders were, “… very enjoyable to work with,” and motivated to initiate their projects.

Stakeholders also noted all convener trust and credibility aspects as a challenge, but the challenges were not perceived as insurmountable. This was reflected in a negative context during public meetings when a convener’s image was described as, “… they looked like a bunch of corporate attorneys...” Respondents also perceived the convener’s lack of understanding of local context as a challenge, “Examples they brought in they were like, ‘In Virginia… nobody even knows it's there.’…Where here … everybody sees it.”

While convener trust and credibility among the projects was not a critical threshold for affecting project success, the element foretells important project management aspects to consider. CCR conveners used local proponent leadership, such as the landowner and renewable energy groups, to increase their credibility, but some trust was lost at meetings where, “they were buttoned up and polished and they looked like a bunch of corporate attorneys coming in against people that didn't have a clue.” Furthermore, examples such as, “In Virginia it didn't drop the house values,” “… in Virginia it's within a quarter mile of these homes and nobody even knows it's there,” did not build credibility for the convener. Locals rebuffed, “… a lot of Virginia is so densely thick with forests you can't see it. Where here they’re trying to put this out in the middle of a big bowl. A big, huge, flat bowl where everybody sees it.”

In contrast, NWE conveners promptly established a working group and used collaborative leadership which increased trust towards the regional utility company. Collaborative leadership was established by allowing individuals in the working group to guide discussions, identify objectives, and establish goals. Challenges felt by stakeholders revolved around the lack of prompt follow-through from the convener decreased some credibility because it, “…didn't engender a feeling that our participation mattered to the extent that we felt like it mattered.”

The REC project’s main challenge stemmed from understanding local context where, “…a handful [of members] said they absolutely didn't want to pay for, so that was one of our main challenges to try to get through to make sure they understood that they weren't paying for it." REC staff only initiated the project after confirming members not willing to pay were not impacted and affirmed trust that the co-operative would comply with membership decisions.

Conflict Resolution

As indicated by previous research, conflict resolution is important to consider during renewable energy project management. The results from this study indicated a need to closely differentiate elements that influence conflict resolution. The incorporation of conflict resolution was noted across all projects as necessary; however, each project revealed diverse underlying issues and ways to either 1) mitigate impacts or 2) create compromise strategies. These elements were separated by case study project to better identify variances in their distribution of opportunities and challenges. State representatives did not provide statements on conflict resolution elements.

Mitigating impacts refers to resolving an issue without changing any physical component of the project. For example, to mitigate impacts conveners could improve communication about project updates. Compromise strategies therefore resolved an issue by changing actual components of the project. For example, one QF site could have negotiated moving panels off the top of a hill to reach a compromise with neighbors. Statements regarding conflict resolution revealed mitigating impacts (opportunities 46%, challenges 29%) which were similar to compromise strategies (opportunities 43%, challenges 29%) (Figure 11).

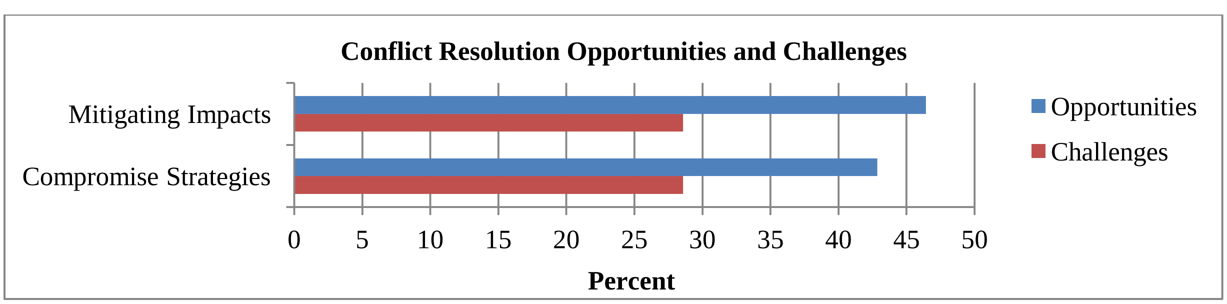

Figure 11. Distribution of interviews specifying conflict resolution opportunities and challenges.

Mitigating Impacts

The three mitigating impacts aspects 1) incorporating local interest; 2) project clarification; and 3) accessible project information were identified as both an opportunity and challenge. The projects were able to incorporate local interest, "… because [the convener] had been approached… about doing a project." Examples of project clarification opportunities were stakeholders' understanding that they could, "… say yay or nay, or [could] refuse to participate..." Accessible project information revealed many creative solutions from using a survey, to producing education panels explaining the project.

Challenges were also present for mitigating impacts. Incorporating local interest was also challenging and described by an interviewee as, "I would've felt a lot better if they had [contractors] from Great Falls and they said we know the area, but that wasn't the case." Similarly, the lack of project clarification around statements such as, "We have more energy right now than we need as a county, than we need as to state," decreased stakeholder buy-in and a sense of value for the projects. Lastly, CCR and NWE faced challenges with accessible project information. For example, a respondent stated, "We don't know what that process is going to be moving forward. It feels like it's faded, and maybe it hasn't for them, but how would we know?" Interviewees generally coupled mitigating impacts with compromise strategies, so differences in the three projects are not distinguished until the end of the next section.

Compromise Strategies

Compromise strategies include opportunities and challenges related to 1) stakeholder negotiations, 2) project compromise complexity, 3) compromise effectiveness, and 4) time considerations. One respondent summarized the opportunities for compromise strategies as, "So the group … agreed that would be a reasonable outcome because if we continued to focus and fixate on components we would never get the project done." The stakeholders were able to negotiate aspects of the project and realized certain complex goals could not be remedied within the project implementation timeframe; therefore they chose to modify the goal resulting in an effective compromise.

Compromise challenges for the projects began early on for all conveners during the initiation of the project. Investments in a diversified energy market were at the root of the issue: “Why build solar when we've got this great hydro resource that's zero carbon already?” Successful projects overcame this challenge when stakeholders insisted and negotiated with conveners to incorporate solar energy. Additional compromise complexity and time consideration challenge examples during the projects were, “…we're introducing another variable into an equation that's already incredibly complex…” and, “It shouldn't take two years to figure this project out.”

Mitigating impacts and compromise strategy elements were closely related throughout the case study, yet each project provided unique opportunities and challenges. While each case study stated the compromise strategy aspect of conducting stakeholder negotiations bespoke of general opportunities and challenges across all projects the remaining compromise strategy aspects were unique.

The structure of REC defined co-operative members as the stakeholders in the project. The co-operative mission outlined a process to identify member goals, provide information accessibility, and resolve any conflicts through the incorporation of member interest. The only noted impacts which resulted in compromise strategies occurred when certain members did not want to pay for the project and strongly voiced their opinion. REC staff mitigated the impact by increasing their communication to members which clarified how the project would be financed, and therefore influenced the ultimate size of the project. Staff routinely provided updates on project progress through multiple media outlets as a mitigation effort. Opportunities for compromise strategies were revealed as having the time to work through stakeholder negotiations such as allowing members to purchase more than one panel in the array, and for negotiating the transfer of ownership of a panel in case of unforeseen life situations.

The structure of the NWE working group placed stakeholders at the forefront to discuss project goals, circulate project information, and participate in negotiations during meetings. Mitigating impacts for this convener had the same amount of opportunities and challenges. Stakeholders stated the incorporation of an educational component into the project with the public schools was a great opportunity while, “Just a little bit better communication along the way to know if the project is still even going on,” would have mitigated project clarification issues.

The CCR QF project management structure did not adequately identify stakeholders; provide an adequate process for accessible plan information; clearly communicate project goals; or provide validation of incorporating local interests with past projects. While the focus on, “…the public education program, with the site taking advantage of the historical [Lewis and Clark Portage Route] aspect that was at the same time the objection,” proved an opportunity to mitigate impacts, the element fell short overall for evaluating and mitigating the broader range of local interest concerns. Stakeholders stated, “I don't think people are against solar, it's just how first of all, it was just kind of shoved down our throat…” and, “[Cypress Creek Renewables] were just kind of walled into the sense that there would be no opposition… They were just kind of taken back flat-footed by the fierce resistance,” were part of the challenges from the lack of mitigating impacts before seeking approval to implement the project.

Compromise strategy opportunities for the project arose from the effectiveness of sending out a letter to landowners and establishing a willing leasee near a substation. Another opportunity was developing connections with stakeholders to reduce the complexity of future compromises. An example of this type of stakeholder is, "I tried to steer them to … some farmers and ranchers who have substations on their property already and said, 'We are happy to put this solar farm in a more rural area.'"

As far as challenges from compromise strategies, stakeholders felt "We don't need it already. If Oregon needs it, then they should build it." More importantly,

> "I think it was a project that would have been approved if it would have been in an area without such a large impact and a large amount of people. The people that were there before the project, to them, their home is an investment. A lot of people that is their retirement, their main investment, and they built and bought those lots and houses relying on a residential zoned area, you know. If it would've been an [agricultural] zone or a commercial zone, then you know you're running that risk. I think that's really the reason it failed."

Lastly, CCR stakeholders stated that due to state level contract timelines the convener did not have the time to further negotiate with stakeholders and seek acceptable compromise strategies.

Project Design

The following result sections describe the project design findings from this case study. First, project design factors found in previous literature are briefly reiterated. Next, 1) spatial components, and 2) technological components and their opportunities, challenges, and project comparisons are described. The final results section in this chapter provides future project management and project design strategies for large-scale PV solar project success.

Project Design Factors Review

The two project design factors iterated in previous research were 1) spatial and 2) technological components. Within spatial components, 1) site considerations and 2) scale were key concepts. For technological components, past research identified 1) effective renewable energy source, 2) storage, and 3) energy output were important renewable energy project design considerations. Within this case study, project design concept results were compared revealing important similarities and difference between the three large-scale solar projects.

Project Design Results

The study confirmed the two predominant project design concepts, spatial and technological components, where the solar projects, "…enabled folks to go solar without having to build it on their own property… and it enables folks to do it on a scalable level." Spatial component (opportunities 86%, and challenges 75%) was comprised of two elements, site considerations and scale (Figure 12). Technological component (opportunities 71%, and challenges 71%) consisted of data management, effective renewable energy source, storage, and energy output elements. Additional quotes on project design concepts may be found in Appendix F.

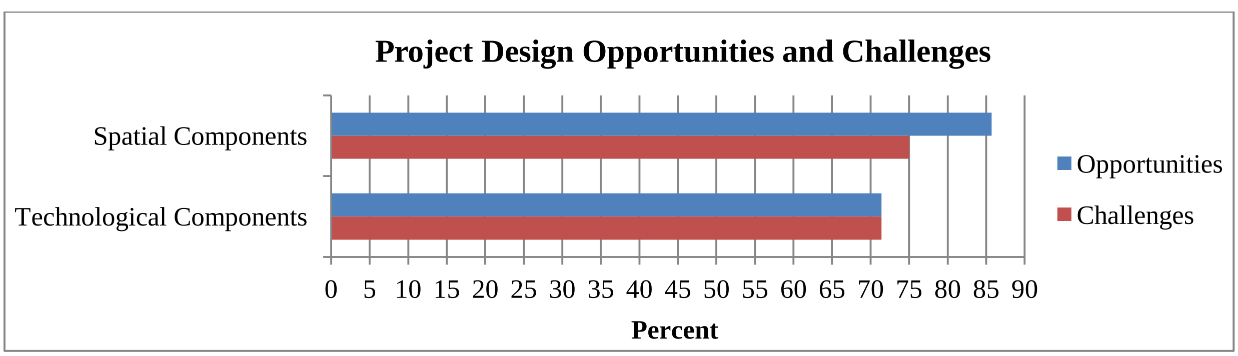

Figure 12. Distribution of interviews specifying project design opportunities and challenges.

Spatial Components

Stakeholders from the three projects were asked about their perceptions on spatial components influencing the success of their large-scale solar project. Statements regarding site consideration and scale revealed both opportunities and challenges. Site considerations opportunities were noted at 75%, and challenges 64% (Figure 13). An example of an opportunity related to site consideration is, "…using areas that have a really low impact on anybody." Whereas an example of a site consideration challenge was framed as, "…what kind of impact in the community are we willing to accept?"

Scale emphasizes adequacy of the project's size and its ability to provide enough electricity to a transmission source also included opportunities (71%), and challenges (54%). An example of an opportunity routinely acknowledged by stakeholders was, "Being near a source of electricity demand can decrease what's called line loss." Examples of scale challenges include, "it's not like we have our own line clear from Bonneville." In-depth results and project comparisons are provided in the following sections.

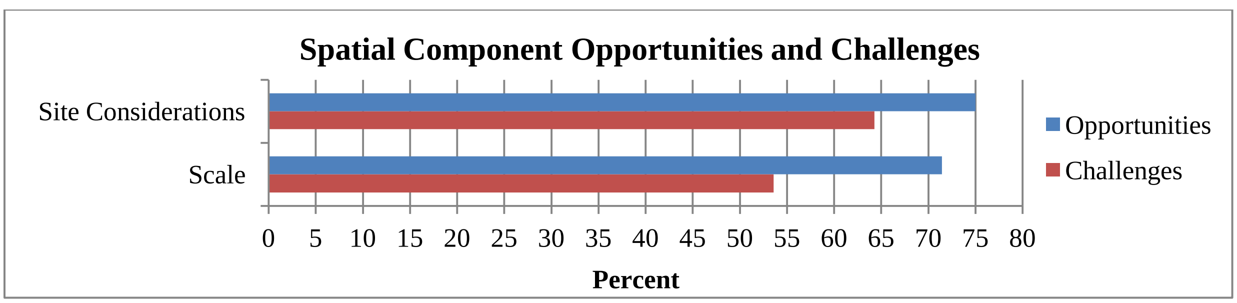

Figure 13. Distribution of interviews specifying spatial component opportunities and challenges.

Site Considerations

Site considerations consisted of multiple aspects which created substantial implications for each project. Aspects of site considerations encompass both opportunities and challenges of 1) type of location, 2) aesthetics and place attachment, and 3) solar site land ownership. Site considerations are unique in that specific details and quotes differ among the projects and are discussed further in the following sections.

Type of Location

The type of location for the solar projects closely corresponds to solar site land ownership with the differentiation that landowners could have various types of zoning or development on their property. There were four types of locations in the case study due to CCR proposing projects at two sites. The case study sites were 1) industrial, 2) agricultural, 3) public, and 4) residential. The industrial and agricultural locations reflected substantial opportunities such as, "… marginal lands, or potentially brown-fields, or former industrial sites. I think those kinds of locations make a lot of sense for solar." Additional location opportunities were, "We have many farmers … that would welcome a solar farm on their place just for the additional income, and it would be out of sight, out of mind." The last site on public and institutional land is not held to zoning compliance, and interviewees did not specifically mentioned any associated opportunities and challenges.

Both the agricultural and residential locations presented challenges. In a ranching setting, "It's just not really viable to graze livestock around solar panels … they rub on the array, bump the wiring and all that." Challenges in a residential location stem from concerns regarding, "… they built homes and invested in that property with the idea that it was a residential zoned area, which it was."

A site located at a non-zoned, industrial site owned by the REC created opportunities with minimal challenges. An opportunity around this type of location is, "there is room to expand either the substation or more panels in the future if need be." The REC location was nearly as understated as the NWE project, which could denote a substantial opportunity as far as type of location.

The agricultural site of the Lewis and Clark Portage proposed project by CCR proved to exhibit a greater amount of opportunities largely due to the impacts or trade-offs affecting less people. Opportunities included diversifying land use for income security and using the solar project to bring awareness of historical events on the property. Interestingly, some interviewees raised arguments which contested this idea because, "… everybody kind of thinks it's out in the middle of nowhere, and it kind of is unless you live there," so a convener still needs to mitigate associated impacts.

The Fox Farm proposal on residentially zoned land provided very few opportunities with the greatest amount of challenges. The challenges predominately arose from the improbability, "… to mitigate the aesthetic impact with the vegetation," because the site was located in a valley below a bluff and visible to homes. These negative aesthetic results are often associated with place attachment considerations when community members weigh traditional land-uses with non-traditional development. This may be mitigated through engaging in communication with community members to better understand local perspectives. Furthermore, the process of events also increased the challenges. The existing local policy stated the land was zoned residential, but then the procedure to gain a special use permit became a point of contention with the surrounding community members, and time constraints to comply with the utility company's terms and contracts did not allow for negotiations or contesting the decision.

Aesthetics and Place Attachment

Site considerations also emphasized the importance of visibility, aesthetics, and place attachment. Visibility refers to stakeholders and the public's ability to actually see the project. Aesthetics is if the presence of the project is regarded as a positive or negative addition to the landscape. Place attachment, often a challenge, is associated with new development uncommon to the area. State-level representatives reiterated, “Some people love to look at [solar projects] and some people hate the way they look,” and acknowledge the CCR project was, “… the first time I have encountered real pushback and effective pushback against any renewable energy project in Montana.”

Opportunities for aesthetics ranged from, “A solar farm is only about eight feet high and it's quiet, it's secure. You don't have any pollution, you don't have any noise. It's everything you'd want in a neighbor, I would think,” to visibility within the community, “As far as added benefit, you drive up and down the valley… It’s visible to everybody.”

The main challenges were more closely associated with type of location and land ownership. In a residential zoned area, challenges related to place attachment incurred by a new solar farm result from, “I look out my bedroom window in the morning and there's six horses out there grazing across the prairie… That's kind of nice. To look at 30 some acres of shiny metal and stuff looking back at you, that's not why we moved out here.” Additionally, an aesthetic hurdle these projects face is reflected as, “Once people learn about the potential value of encouraging that type of development, it no longer becomes an eyesore it becomes kind of just a part of your community, a part of the electric system.”

The CCR proposed project presented the greatest amount of challenges within this element. Respondents noted, “I don't think people are against solar,” rather for the Fox Farm project in particular, “[Cypress Creek Renewables] just needed a different location.” Tying back to type of location with the site being in a residential area, “… if you have the opportunity to not look at a solar field versus looking at solar field, then you're going to buy a house without it, with a nice view… The weeds are bad [at the Fox Farm site] but still … there are six horses out there grazing across the prairie.” This quote demonstrates challenges associated with neighborhood place attachment. Furthermore, the topography of the location provided, "… no way to mitigate the aesthetic impact with the vegetation…" because the surrounding neighborhood is, "… a big bowl, so everything's kind of on an angle and a lot of houses look down into [the proposed site]."

The other CCR proposal, Lewis and Clark Portage solar site, resulted in similar challenges related to visibility and place attachment, but had more opportunities to mitigate concerns. CCR representatives conversed with neighbors about planting trees and moving panels so they were not blocking the neighbors' views, "…but they never got far enough," in the planning phase to negotiate and develop an agreement with neighbors.

The other challenge identified at the old dairy farm site was place attachment associated with multiple historical events on the property. The first major event through the field was the Lewis and Clark portage route around the Missouri River Falls. From the 1940s:

> "There's ruts of a road right through here that in World War II when Pearl Harbor hit all hell broke loose on catching up as you might imagine and they had to build the East Base they called it, now Malstrom. The first gravel came from over here and they were in such a hurry to build the base that it cut right across roads, through fences, back yards, hell bent for election. As straight as they could go, and as quick as they could to the east end of Great Falls to the East Base. Anyway that road is very prominent to this day, and is a good indication and one of the few places left that shows the panic that the United States was in."

The last major event was a fatal 1954 fighter jet plane crash in the field. The positive opportunities were described as, "This solar farm site, educational site, was going to be part of the educating attempt to the heritage area… through panels telling the historic story on the edge of the solar farm… to soften the objections from the historical people."

In contrast, the NWE project had more aesthetic and visibility opportunities than challenges. Unlike the CCR project where the visibility of the project was perceived as a negative aesthetic impact to the location, NWE respondents felt, "…the biggest opportunity is to put something in that is very visible to the public. And if possible has some way of informing the public of what it's doing." This visibility advantage takes into account the land is already used for educational purposes. Challenges arise due to the stratification of stakeholders, "[Missoula] is very supportive community, that's a generalization, and as you go further into the project… we're not talking about the whole community we're talking about these 10 folks that live on the street that look at that school." Aesthetic and place attachment uncertainty exists due to the lack of project scoping in, "…urban neighborhood applications where it's a tight neighborhood feel and these are going to be significant arrays," but overall respondents felt, "… in general aesthetic concerns about previous solar projects are pretty minor in Missoula."

Located at the pre-existing substation site, the REC project incurred the least amount of aesthetic, visibility, and place attachment challenges. Place attachment caused little concern among respondents because the site was already used as an industrial site. Respondents only noted the opportunities of project visibility and aesthetics. "Even if [co-operatives] do a relatively inexpensive, small project the fact that it's visible and showing their customers that they're progressive and pro-renewable, has a benefit."

Solar Site Land Ownership

The location for the solar project was based on the convener's evaluation of spatial components. Similar to type of location, land ownership was unique to each convener in this case study. The land ownership options for the case study included: 1) convener owned land, 2) public entity land, and 3) privately owned land. Land ownership was not originally hypothesized as a major influence on project success, but the respondents stated opportunities and challenges for each land ownership type.

Opportunities for convener owned land specified, “Especially people that didn't own their property or the orientation of their house didn't work and couldn't have solar.” Similar opportunities existed for both the public entity and privately owned land, “…it was close to a substation and the property owner was willing to lease the property.”

Challenges were considerably greater for privately owned land than public or convener owned land. Several stakeholders felt, “We kind of got the feeling… it really didn't matter to [the land owner] what happened to that property,” and became hesitant about supporting the project. Land ownership challenges relate to visibility when, “It would have been built in a residential area of Great Falls that would be easily visible from my home.”

The co-operative owned land had opportunities of being next to a substation and having space for the array. The benefits were for, “… people that didn't own their property or the orientation of their house didn't work and couldn't have solar. The other benefit was it wasn't on their property, and we could maintain it for 25 years.” In contrast, the main challenge was based on the value of the next best alternative, “What’s the cost in land utilization for the amount of energy?” The question closely ties into taxation of the project, “The first five years it isn’t [taxed], but for the next 20 years Ravalli will pay taxes on the community solar because it falls under our net utility plan.” At this time the co-operative is not growing and could use the land for the solar project; however, they are choosing to forego using the land for other uses at least in the next 25 years.

The NWE collaborative working group decided to place the arrays at local high schools around Missoula which are considered public entities. The opportunities and challenges of incorporating public entity land were nearly equal. Incorporating public entities were a unique and valuable way, “… to spark the interest of not only our students but the community. We've got to be a center for innovation on the part of our students." The challenges were nearly all based around understanding and applying the correct processes for leasing the land, but another important component was, "… making a compelling argument that our students will benefit from the curricular side and that there is value to us…. it's going to require an investment of our time and energy and resources to make sure that that happens…"

The use of privately owned land by the CCR QF raised challenges that nearly doubled the opportunities because the neighbors surrounding the Fox Farm proposed project, "… would look out onto 30 plus acres of solar panels, and to be honest I just didn't want that. I'm not anti-solar in the slightest, other than just the location…. Part of it is not in my backyard because you're putting it in a suburban, residential area," that, "…was sited at the bottom of a valley and in a highly residential area of 100 or so homes, maybe not that many, but a lot of homes looking down right on it." Opportunities predominately came from the Portage Route proposed solar site that was on an old dairy farm in the rolling countryside where the landowner wanted to diversify his income, provide educational opportunities, and support renewable energy developments. A few neighbors were in sight of the proposed array and were concerned with the development, but the terrain would have allowed CCR to pursue viewshed mitigation strategies on the privately owned land.

Scale

The second spatial component, scale, highlighted noted the importance of 1) scale dependency and 2) transmission line connection. Scale dependency includes a project's ability to provide enough energy at a site with an electricity demand, whereas transmission line connection refers to a project's ease to connect to the transmission system. These aspects of scale were closely tied to major external factors, and provide critical context for understanding how the technological component influenced external factors. Therefore, unlike the other project design components, scale will not incorporate a convener comparison section.

For example, convener administration, local policy, and project costs determined both the scale dependency for a site near a substation with an electricity demand and the solar project installation size. Conveners optimize scale dependency where, “If you have to run electricity down 400 miles of transmission lines, there's a little bit of electricity lost due to heat as it goes through the line. Versus if you're one mile from where it's consumed you don't have that line loss.”

Each convener faced scale dependency and transmission connection challenges for, “Transmission capacity, i.e. the ability of a transmission line to accept increased energy loads, varies across a utility’s grid and may face limitations due to conductor, pole, and support system characteristics, the viability and expense of a proposed solar project may vary greatly with location.” Additional scale challenges stemming from administrative factors were, “… through the course of the interconnection review they discover that they're going to have to put in a whole new substation and that just blows the economics out of the water and the whole project flops.”

Technological Components

The second project design concept, technological components, include: 1) data management, 2) effective renewable energy source, 3) storage, and 4) energy output. The opportunities and challenges were similar across projects, so a project comparison section is not provided.

Opportunities relating to solar panel design were, “The project was pretty much designed to educate the utility on certain aspects of their delivery system…” These projects allowed conveners to learn about the availability of technology, new or innovative solar panel applications, energy output, battery storage, rapid technological changes, and competing energy sources. Data management provided opportunities for stakeholders as, “It will provide important data from which both [the utility] and our communities can make strategic decisions regarding their energy future.”

Panel design and data management were stated as technological challenges that extend beyond energy development, “In two years, whatever they purchased will start to become, I don't want to say obsolete, but they will become not as productive because there'll be something new on the market. So yes, they will learn something. Now the question is can they extrapolate that to a new technology, and I assume through some engineering calculation they probably could do that.” The use of a storage component at each project site was also noted as a challenge. Respondents from most projects stated it was not cost effective to invest in a storage component. Lastly, respondents identified challenges with the adequacy of their solar array energy output when compared to customer demand or other electricity producing sources.

Strategies for Future Success

At the end of the interview, respondents were asked whether solar development by their convener should be increased, maintained, or reduced. Overall, 38% of REC, 57% of CCR and 78% of NWE respondents suggested their convener should increase solar development (Figure 14). Only 36% of all respondents said current projects should be maintained due to uncertainty of how beneficial the projects really are, and the inability to provide additional funding sources for future projects, as in the case of REC.

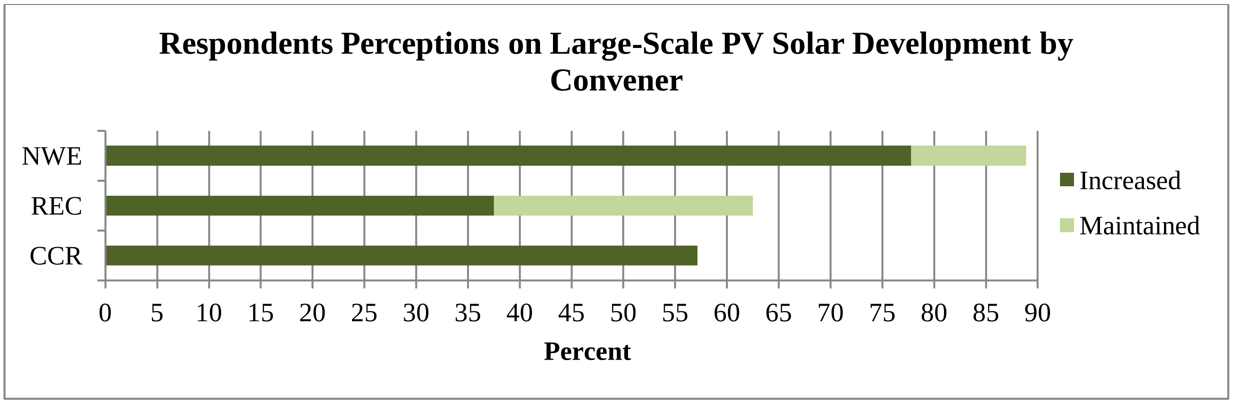

Figure 14. Distribution of interviews specifying future large-scale solar development by convener.

In addition to asking whether their convener should provide more solar projects in the future, stakeholder perceptions on the best type of future solar development were also captured. The responses implied electric co-operatives (36%), regional utility company projects (26%), distributed generation (18%), roof-top solar (18%), and qualifying facilities (14%) offered the best types of future solar developments (Figure 15). This study does not evaluate these perceptions, and therefore only provides a basis for future studies.

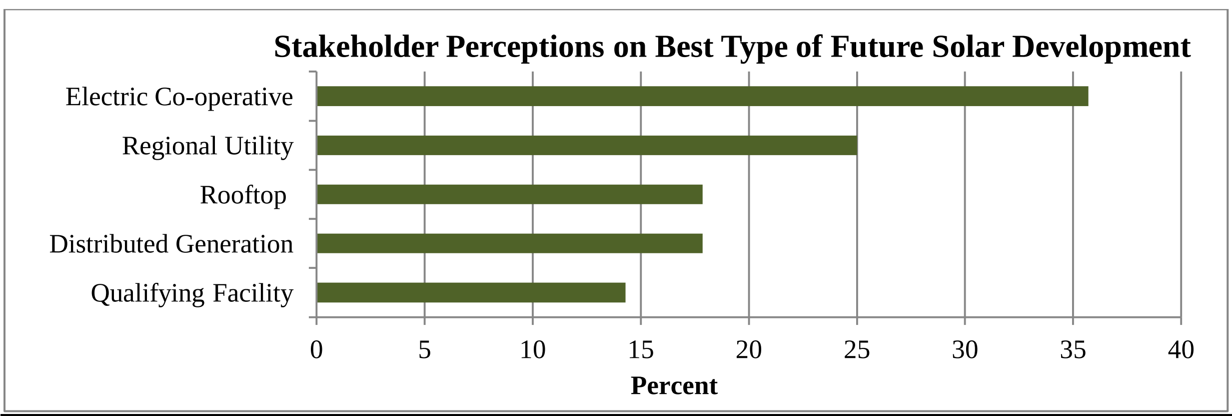

Figure 15. Distribution of interviews specifying perceptions about the best type of future solar developments.

Distributed generation, where electricity is produced and used at a site therefore not transmitted along transmission lines, provides a relatively new opportunity for future large-scale solar research. An example of this type of project is the solar project at the Sibanye Stillwater Smelter in Columbus, Montana. This type of development may be incorporated by any type of convener; however, a better understanding of project management, project design, and external factors is necessary to evaluate the opportunities, challenges, and potential for this type of solar development.

The final interview question asked respondents what they perceived would increase the success of future large-scale PV solar projects. The four strategies identified were 1) site considerations, 2) education about solar project, 3) marketing, advertising, and competitions, and 4) using previous project success examples. These strategies may be applied to any convener, so were calculated as total percentages. Site considerations and education about the solar project both received (18%) (Figure 16). The third and fourth strategies: marketing, advertising and competition for a project (14%); and using previous successful project examples to promote future projects (7%) were also suggested by respondents as strategies to increase future project success.

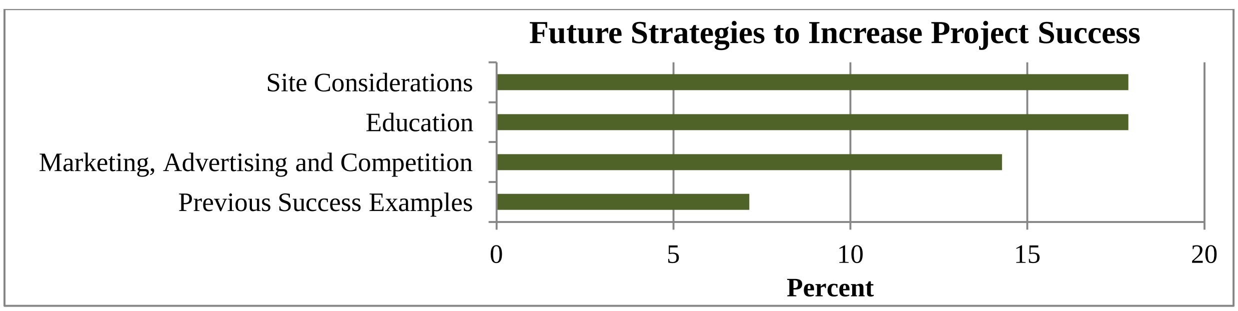

Figure 16. Distribution of interviews specifying perceptions on strategies to increase future project success.

Project Management and Project Design Discussion

Of all the project management and project design concepts revealed in this case study 1) project information accessibility, 2) compromise strategies, and 3) site considerations emerged as critical to the success of the solar projects. This section delves into these three concepts, while Chapter 6 discusses the remaining project management and project design concepts.

Project Information Accessibility

Previous research asserted stakeholder and public engagement access to project information is critical for local support of renewable energy projects (Olson-Hazboun, et al., 2016). Ample communication during different phases not only increases project success, but also creates channels to understand community interests, established convener trust and credibility, and discuss project impacts (Carpenter & Kennedy, 1988; Chase, 2016; Margerum, 2011; Mnookin, et al., 2000). As indicated in the results section, all three projects concur that access to project information is important in varying degrees; however, this study emphasizes an additional aspect not taken into account by previous studies. Project information accessibility is not just about educating and providing a dialogue to stakeholders and the public about the project; rather, it also includes marketing techniques to change behavior and increase the likelihood of success for current and future projects. Suggestions for increased marketing strategies include appealing to the sense of community through community-based marketing messages tailored to effective forms of social pressure and norms, and emphasizing public health and conveniences (Wisner, 1998).

Solar energy is a commodity, a marketable good faced with competition from other energy sources and ever changing technology. Findings from this case study reinforce the role marketing plays in successful projects. Overall, the CCR convener began the process with greater challenges of information accessibility due to not providing a process to advocate for community interest. Their strategy was to send out a generalized letter to landowners who may be willing to lease land for solar arrays, but did not always include in-person, follow-up communication with nearby neighbors once a site was chosen. Instead, the conveners held public meetings at venues that were not conducive to productive meetings. In all, their marketing strategy was not adequate enough to change community members' behavior to more neutral or supportive of the project. One respondent advised part of a marketing strategy could incorporate past project references who would champion positive community aspects of previous projects. This strategy relates to a study suggesting building upon past product efforts develops a platform for future success by gaining insight on effective strategies, distributing the knowledge across the company, and applying knowledge from previous projects through various marketing mechanisms (Marsh & Stock, 2003).

Compromise Strategies

Published literature on conflict resolution highlights two elements, compromising strategies and mitigating impacts. Compromising strategies focuses on stakeholder interests, inclusiveness of these interests, creating deliberate solutions, and seeking consensus (Mckinney & Kemmis, 2011). Mitigating impacts involves negotiations to address project impacts while seeking compromises for mitigating impact trade-offs with multiple stakeholders (Margerum, 2011; Mnookin et al., 1999; Mnookin, et al., 2000). In addition, social components such as environmental, policy, economics, and community acceptance might not be distributed evenly across stakeholders (Devine-Wright, 2011; Wüstenhagen et al., 2007).

During this case study, compromise strategies resolved an issue by changing actual components of the project whereas mitigating impacts refers to resolving an issue without changing any component of the project, such as by including educational displays to promote historical events at the solar site. The three projects in this study reinforced published literature on conflict resolution compromise strategies and impact mitigation (Margerum, 2011; Mckinney & Kemmis, 2011). Additionally, the findings identified similarities across the projects for how impacts were mitigated and found differences in compromise strategies per convener.

The nature of the electric co-operative, regional utility company, and qualifying facility convener helped initiate the fundamental compromising strategies when mitigating impacts for each project (Margerum, 2011). As a co-operative, REC focused on the interests of all members. Through their communication and well established decision making process, the REC created deliberate solution based on membership needs, without necessarily being consensus-seeking for the entire membership (Margerum, 2011; Mnookin et al., 1999; Mnookin, et al., 2000). As this case study revealed, only a relatively small portion of members wanted to initiate and fund solar arrays, but consensus was not necessary since REC staff found solutions to fully fund the project with the limited interest (Margerum, 2011).

Due to current political interest and timing, the NWE convener chose to create a collaborative working group to focus on local stakeholder interests and develop creative solutions for their solar project in Missoula. The working group initially formed ideas that were identified as either feasible or not by NWE experts, and moved forward by presenting solutions that were agreed upon by the majority of the working group. NWE retained the right to modify or discard final suggestions by the working group due to social, economic, or administrative concerns.

In contrast, the CCR project conveners included only a few stakeholder, did not appear as inclusive to local interests, and lacked a collaborative or consensus-seeking approach which may have created deliberate solutions to mitigate impacts (Margerum, 2011; Mckinney & Kemmis, 2011). The majority of CCR respondents conveyed the convener largely focused on landowner and imperative policy interests; yet, did not adequately initiate or invite neighborhood interests (2011, 2011). Previous studies indicate encouraging a proper sized collaborative group to express concerns about project impacts and help create mutual gains solutions creates buy-in which may increase the likelihood of project success (Margerum, 2011; Mckinney & Kemmis, 2011; Mnookin et al., 1999; Mnookin, et al., 2000; Olson-Hazboun et al., 2016).

Site Considerations

The solar projects illuminated how site considerations such as being near substations, and projects with aesthetics or place attachment impacts posed opportunities and challenges. These findings are supported by previous renewable energy studies (Devine-Wright, 2009a; Thirumurthy et al., 2012; Olson-Hazboun, Krannich, & Robertson, 2016; Wolsink, 2006, 2007). Respondents did not necessarily support findings that the attractiveness of the electricity producing facility helped determine the support of the project (Jobert et al., 2007). Visibility and place attachment were the most significant findings in the case study, but resulted in different impacts to the projects.

Visibility of the proposed solar arrays and place attachment were influential for the CCR proposed sites. At the Fox Farm site, neighbors in the bowl around the proposed site weighed place attachment values for high value homes, ecological trade-offs and zoning precedent against the benefits of the energy project and insisted the impacts of a solar farm were greater. These results further literature indicating project aesthetics, place attachment, and environmental effects are site considerations strongly related to local support for renewable energy projects (Dayer et al., 2016; Devine-Wright, 2011; Hoogwijk et al., 2005; Olson-Hazboun, Krannich, & Robertson, 2016; Paine et al., 1996).

On the agricultural land Lewis and Clark Portage proposed site, the solar panels would have been less visible to fewer neighbors. Yet negative feedback about project visibility at both CCR locations resulted in decision makers siding on terms of equality between the two proposed sites. The zoning board decided it was not fair to allow a project to go through just because it impacted fewer neighbors. This further supports previous studies that found aesthetic impacts and aspects of equity better explain opposition than the theory of 'Not in My Backyard' (Devine-Wright, 2009a; Wolsink, 2006, 2007).

In contrast, the REC and NWE projects emphasized visibility as an opportunity for the solar array sites, especially as a way to market the project's success and promote future development. The arrays were placed on sites that were already used for energy purposes or public education, and received nearly no concerns about place attachment. The study's findings contribute to the literature regarding place attachment being compared to benefits of renewable energy sites, and acknowledges types of locations and zones as additional considerations (Devine-Wright, 2009a, 2011).

Project Management and Project Design Implications for Conveners

The findings and discussions create specific implications for the three conveners in the case study. NorthWestern Energy had effective stakeholder and public engagement and were flexible with spatial components, but are not necessarily committed to a long-term solar commitment. Ravalli Electric Co-operative also provided an efficient stakeholder and public engagement structure with largely accepted project design concepts, but had limited on energy output. Lastly, Cypress Creek Renewables had the most difficulty with project management, spatial components and local community support, but provided one of the best opportunities for energy output and long-term commitment to solar development. In-depth explanations of these implications are described below.

NorthWestern Energy's integration of solar pilot projects provides a unique opportunity for collaborators to help design and influence large-scale solar projects in Montana. The company committed resources to these projects which decreased the challenges for planning, convener trust and credibility. Their process of collaborating with stakeholders representing community interests and goals at these various pilot project sites not only ensures they are able to produce projects designed with specific site considerations and local values, but is also useful to collect an assortment of production and use data to help inform their evaluation of solar as an addition to the grid. The predominate concern for NorthWestern Energy's implementation of solar is their narrow focus of only becoming educated about solar from these pilot projects at this time, and not necessarily committed to future, long-term implementation of large-scale solar projects as part of their diversified energy portfolio.

The Ravalli Electric Co-operative project revealed the structure of the non-profit is designed to fulfill membership desires and therefore incorporates a nearly inclusive representation of local interests, ideas, and goals. The co-operative staff was able to take membership ideas about wanting to incorporate solar, create compromise strategies that were acceptable for all members and initiate development at a co-operative owned site that provided positive benefits for the community. The two largest hurdles the co-operative project faced was marketing to get enough financial support from members, and since this is their first large-scale solar project, collecting data about electricity production from the site and implications for future valuation of solar components in their jurisdiction. At this time no additional large-scale solar projects are in the forecast for REC because members would not be able to financially support another project.

Lastly, Cypress Creek Renewables project falls at the other end of the spectrum for incorporating inclusive representation from community members. The convener has received community pushback from multiple projects in the west. This case study indicates a lack of a collaborative process to incorporate local interest, values, and goals may influence the lack of community support. In addition, conflict resolution strategies were not implemented in a timely manner. CCR likely has the best structure to be flexible at choosing sites in their operating area and quickly initiating the most adequate long-term, large-scale solar projects in terms of electricity generation. The community challenges identify a need to invest in a larger scale of community collaboration efforts than current efforts. This investment of resources does not necessarily need to come directly from the convener, but could be built from pre-established community leaders who have an interest in the success of the project.

These leaders could be tasked with generating community interest and tailoring project goals to a local context through marketing and conflict resolution strategies with CCR oversight. Additionally, the community leaders could assist in building after action reports to identify opportunities, challenges, and specific strategies influential to their project. Both the community representatives and reports are important marketing components for future projects as they provide substantial evidence of how the convener is investing in community interests and goals, and able to retain local place attachment values.

Project Management and Project Design Implications beyond the Case Study

Expanding on the previous section, project management and project design implications for each type of convener were extrapolated from the findings and discussion. Regional utility companies have the capacity to incorporate renewable energy technology based on policy and customer demand and are able to maximize project design elements because of their connections in communities; however, face challenges with balancing shareholder and operational interests. Electric Co-operatives are structured to maximize stakeholder engagement and conflict resolution strategies, but will likely be constricted by scale before reaching large-scale PV solar technological capabilities such as an effective quantity of energy output. In contrast, qualifying facilities may lack processes to incorporate stakeholder engagement especially around local interests and information accessibility, but have more flexibility to apply creative project design concepts. Specific implications for each type of convener are further described below.

Regional utility companies interested in implementing large-scale PV solar projects have an immense range of stakeholder interests to take into account, especially if their business model incorporates shareholders. They have a tremendous opportunity to efficiently plan and develop projects that maximize spatial and technological components, and are well connected throughout communities so have the ability to follow NorthWestern Energy's pilot project example of incorporating local interests. This study reinforces the production of electricity through intermittent PV solar sources alone, without the aid of storage, may not be the most practical or efficient way for a utility to maintain reliable electricity to its consumers. When deciding to invest in large-scale solar, the need to provide consistent energy is compounded by their responsibility to maintain the electrical grid and their ability to partner with other renewable energy producers. In contrast, by not investing in large-scale solar projects these companies forego a diversification opportunity to self-sufficiently produce an electricity source sought after by many stakeholders which can conveniently be incorporated in locations of high demand along the grid and provide additional opportunities to expand areas of coverage.

Many respondents across all the case study projects suggested electric co-operatives are the most capable at creating and designing solar projects which incorporate local interests and site considerations. The largest downfall is the structure of co-operatives often keeps the membership and support base localized. This is a catch-22 because on one hand projects are able to reflect local interests and values yet on the other hand the project's scale may be severely limited due to the small amount of members actually willing to pay for projects.

Qualifying facilities perhaps have the most to gain from this study in the terms of understanding how stakeholder and public engagement can impact the success of their projects. QFs may be able to reflect on electric co-operative and regional utility company's solar projects collaborative process, and apply it to their situation by seeking local champions to increase collaborative efforts and promote their projects. Alternative actions to promote projects are to increase marketing strategies that tailor to community values; promote acquiring, compounding, and applying previous project knowledge; and provide context specific compromise strategies. These qualifying facilities are able to fulfill a unique niche which can maximize scale and solar energy output, but currently lacks marketable versatility to regional utility companies such as from limited storage components.

CHAPTER 5. EXTERNAL FACTORS for LARGE-SCALE PV SOLAR IN MONTANA

In Montana, three types of large-scale solar developers invested in projects affected by differing external factors with varying levels of success. Ravalli Electric Co-operative completed their 50kW project in 2016, NorthWestern Energy is scheduled to begin construction on a 145kW project in 2019, and the Cypress Creek Renewables 3MW project failed in 2016. A total of 28 stakeholders were interviewed, and are operationalized as those whose level of involvement focused on the planning, implementation, or long-term maintenance for each case study. The conveners identified and defined which stakeholders were invited to be a part of the planning and implementation process, and consequently resulted in dissimilar stakeholders across the three types of projects. Four of these stakeholders were state-level solar resources representing the Montana Public Service Commission, Montana Department of Environmental Quality, regional and state renewable energy organizations. These interviews provided additional context for large-scale solar projects, and allowed a comparison of the opportunities and challenges between state level representatives and stakeholders.

The following result sections quantitatively and qualitatively describe external factors that emerged from this case study: 1) policy and administration, 2) economics, 3) local community, and 4) environmental effects. Each of these four external factors' opportunities and challenges are described and comparisons are made across projects. The final results section provides strategies related to external factors for future large-scale PV solar project success.

External Factor Review

Akin to project management and project design literature, few studies identify how electric co-operative, utility, and QF solar convener's external subthemes interact to create opportunities or challenges for a project. Studies found an expanse of external factor concepts proved to be tipping points for renewable energy development (Dincer, 1999; Jobert et al., 2007; Menegaki, 2008; Miller et al., 2015; Wüstenhagen et al., 2007). These concepts were 1) policy and administration, 2) economics, and 3) social-ecological. The following results identifies concepts acknowledged as opportunities and challenges during the projects, and how these results compared across the three projects.

External Factor Results

Stakeholders from the three projects were asked about their perceptions on external factors, and how to mitigate challenges influencing the success of their solar project. This study identified the external factors of 1) policy and administration, 2) economics, 3) environmental effects, and 4) local community as influencing the solar projects. Policy and administration, and economic considerations were intertwined and greatly affected each project's outcome.

Stakeholders identified policy and administration (opportunities 89%, challenges 86%); economics (opportunities 89%, challenges 82%); environmental effects (opportunities 71%, challenges 57%); and local community (opportunities 57%, challenges 36%) (Figure 17). The results indicated a need to closely examine external policy and administration, economics, environmental effects, and local community concepts for each convener. Specific quotes for external factors may be found in Appendix G.

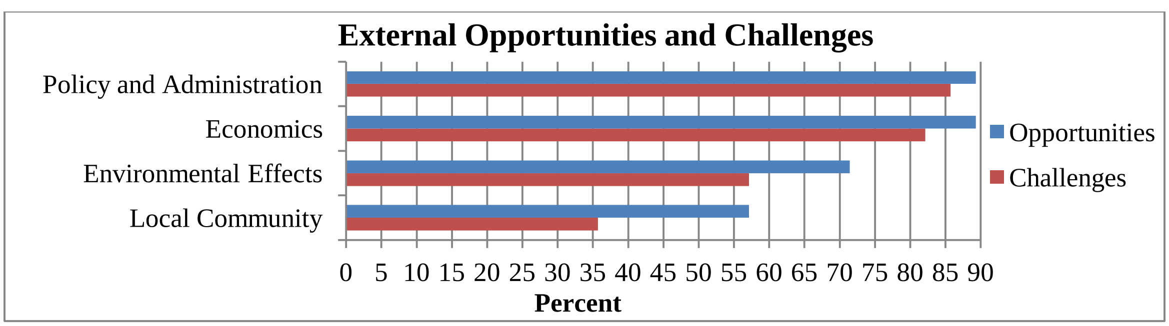

Figure 17. Distribution of interviews specifying external factor opportunities and challenges.

Policy and Administration

For each of the three projects, multiple policy and administration elements influenced the projects' outcome. Policy and administration considerations were separated into five elements to better identify variances in their distribution of opportunities and challenges. Interviewees identified 1) across scale, 2) convener, 3) local, 4) state, and 5) federal policy and administration as influential for solar project conveners. The 2015 Montana legislative instigated a, "…Montana wide stakeholder group convened to hear all the opinions and to identify the common ground, which is pretty rich in ability," to discuss solar policy in Montana.

Across Scale Policy and Administration

Across scale policy and administration is comprised of conversations held at all political scales between conveners, stakeholders, constituents, and political decision makers. The study's projects aid in the across scale policy discussion of the valuation of solar predominately for conveners, local authorities and advocates, and state representatives. This timing for political cooperation in Montana authenticates the urgent demand that, "…all of us need to bring our own perspectives to the table and I think there's great potential for this to influence policy makers, not only locally but potentially statewide," as far as the direction of electricity production in Montana.

The timing for the valuation of solar and other renewable energy in Montana is based on transitioning from fossil fuel electricity generated at the largest production site in Colstrip, MT. Multiple across scale policy challenges exist such as the energy supply transitions questions, "What sort of policy changes need to be made, who pays for any of the transmission development that would need to happen or upgrades to existing facilities, and is there a way to get everything lined up in order to step in when Colstrip One and Two are retired?" These critical challenges affect local and state policy and convener administration.

Local Policy

Interviewees identified local policy and administration as the most influential element with more flexibility than state policy to implement solar opportunities and mitigate challenges. Each project convener had a slightly different reason for why they were implementing solar in their community, but all found the process of complying with local building and electric permits, zoning process, and other community planning sideboards as a new and challenging experience.

Local policy opportunities from these projects are associated with, "Setting some parameters around acceptable development is a planning policy. Just providing certainty to the solar industry, landowners and planning commissions is really what we're talking about, and that's good for all of those parties." The NWE project demonstrated some communities are more progressive in exploring renewable energy development and are willing to troubleshoot associated challenges.

Challenges revealed in the case study concerning local policy and administration were identified as, "When you install solar you have to still comply with all the building permits, and electric permits, and zoning process, and all that administration." While all conveners made note of learning about the necessary requirements for the local zoning process, the challenges increased, "When you get onto these private landowner locations and you talk about 10 plus acres of solar development then that's where you start triggering those planning and zoning reviews."

In the case of CCR, "There are only four or five people [on the Zoning Board]. They are appointed by the County Commissioners, and the decision of the Zoning Board doesn't go to the

County Commission for final approval. That's the final decision." In the case of the controversial CCR project located in zoned residential, the Zoning Board could, and initially did, issue a special use permit for the solar development. The decision by the Zoning Board quickly turned into an ethical issue of the greatest good for the greatest number of local people when the project location at Fox Farm, "… was not in harmony with the area that they proposed… had a definite impact on property values." Many stakeholders felt that unfortunately, CCR's Portage Route and Fox Farm Solar project locations were not examined separately based on their individual merits or ability for conveners to work with neighbors to compromise on the project design.

State Policy and Convener Administration

State policy and convener administration are coupled in this section due to their inherent implications. The regional utility company and QF are tied to state contract terms and rates. Electric co-operatives are not restricted to the same state-level requirements, but do receive guidance from a state electric board.

A state and regional context is necessary to understand energy production and distribution planning for when Colstrip Units One and Two, the current predominant electricity sources in the northwest, close. Energy specialist stated,

> "That is going to dramatically shift the energy balance as it exists right now between Montana and west coast utilities: Puget Sound Energy, Avista, and Portland General Electric, the primary owner of the Colstrip power plants. So there's been a big effort by a variety of different agencies and entities, nonprofit organizations, renewal energy developers to try and find ways to replace that generation with new forms of Montana based generation that those west coast utilities would be interested in buying."

Many state policy planning challenges surround solar energy's development role during this transition. Since the contract term between NorthWestern Energy and QF developers was set at

15 years by the Public Service Commission, "…under current law, [QF] don't need to be identified in any sort of supply plan because the utility has an obligation to purchase them if they can be brought forward at the avoided cost rate for the utility. And that's also a challenge… that they don't really plan for these facilities." These results identify a substantial gap in current policy guidance and increased challenges for conveners to plan their energy production strategies. These terms and conditions directly influenced the CCR project's ability to take the time to mitigate stakeholder concerns.

Federal Policy

Federal policy provided few opportunities or challenges for the conveners with little variance across convener type. A positive aspect of federal policy was, "The federal tax credit of 30 percent investment tax credit is a really key piece of financing." Conveners were working within federal policy limitations and did not mention specific challenges but did mention the possibility of, "Federal legislation pending that would drastically alter the opportunities for qualifying facilities," as a future challenge.

Economic Considerations

Case study respondents reported three economic considerations influencing both opportunities and challenges of the solar projects: 1) economic development tool, 2) financing sources, and 3) ratepayer energy costs. Large-scale PV solar projects are considered an economic development tool because, "These projects are a new type of development for the county." Financing sources for each project were dependent on the convener type and therefore unique for each case study. Lastly, ratepayer energy costs are the, "…crediting rate [utility companies] want to give to the people participating in these community solar projects." Due to unique opportunities, challenges, and associations with the project conveners these three elements are further specified in the following sections.

Economic Development Tool

Some stakeholders consider solar as an economic development tool because it allows community growth in tandem with conservation, which is appealing to certain types of businesses and residents. The study identified the following economic development tool aspects: 1) local industry, 2) property values, 3) community values, 4) land use alternatives, and 5) community taxes. One interviewee integrates the role of local industry, property values, and community values as:

> "Millenials and boomers can live anywhere they want, and they want to live in a place that's dealing with these issues, that has clean air and clean water, recreation opportunities, and the quality of life that this work and solar contributes too. In that new reality, it puts us at an advantage for people to come here and live here, and for business to relocate here. If we have good planning and a good framework so we can grow that way and in a smart way with the respect to climate challenges, consumption, and conservation which I think we're moving down that road and have a good start."

Additional economic development opportunities are, "… they don't really create [boom-and-bust industry local infrastructure and service] stresses or costs to the community in a way that some other economic development does." Furthermore, solar development as a financial diversification strategy for land owners provides a land use alternative opportunity.

Economic development also poses challenges for communities. Concerns for property values and land use alternatives are closely linked to site consideration elements where, "It was kind of a battle on whether it hurt property values or not," at certain project locations. Additional challenges such as, "…the state of Montana allowed us to five year tax holiday," represents a loss of community taxes when incorporating these solar projects.

Overall, economic development tool had slightly more opportunities than challenges. The opportunities were related to local industry, community values, local land use alternatives, and community tax elements because, “[Solar projects are] a diversifying of the commercial activities in the county. It's diversifying its tax revenue, and diversifying local construction jobs and operation jobs.”

The majority of challenges; however, were predominately indicated by CCR respondents. In addition to the previously described challenges faced by all projects in the case study, CCR local industry challenges were, “…there is no long term jobs because once they're installed, they're pretty much maintenance free.” Specific to the CCR project, property value challenges arose when residents perceived, “[The solar project] would devalue their property.”

Financing Source

Another economic opportunity and challenge consideration was financing sources for the solar projects which incorporated: 1) customer financing, 2) grants, 3) utility financing, and 4) QF financing. Each of these financing sources produces an economy of scale where projects are maximizing energy production output with a proportionate saving in costs. Respondents revealed financing source opportunities and challenges were directly related to type of the convener.

Across conveners and financing sources was a generalized recognition of being grateful “… for that investment in clean, renewable energy, our jobs in the [project] area, community, and city.” These distinctive financial sources provided multiple facets to develop projects which otherwise could not be afforded. Other financial source opportunities identified by stakeholders was the feeling that conveners, “… had finances in pretty good order."

With solar, “There is a lot of fervor for people who want it, but they don't want to pay for it," or circumstances are such that they cannot afford it. Similarly, challenges associated with customer financing were, "It's sad to say most of the people from 60ish on up were the ones who could afford to do this because the younger ones, they weren't going to do it because of the long-term payout." In addition, grant funding sources are limited and often change due to political influences.

Financing sources are convener specific, but also present similarities. REC presented customer financing and grants for project financial sources, whereas the NWE and CCR projects were financed by the specific convener. Members' desire to implement solar at the co-operative and a willingness to pay via customer financing were predominate opportunities for initiating the REC solar project. Convener financing was insufficient to fully cover project costs because, "… most of the people from 60ish on up were the ones who could afford to do this because the younger ones, they weren't going to do it because of the long-term payout." Co-operative staff initiated a grant and, "… received some money from USDA through their REAP program… about 25 percent of the project costs [were] covered that way." Challenges with these financial sources are quite substantial because, "…that funding source is limited, and so it would provide kind of a ceiling on the amount of sustainable growth of those types of projects."

NWE utility and CCR QF as financing sources were considered opportunities by respondents. Overall, stakeholders appreciated that these companies were willing to invest in projects. The NWE financed project faces budget allocation challenges that must be balanced with transmission line maintenance, investing in other renewable energy projects, producing reliable electricity, and meeting shareholder expectations. CCR would have financed their projects, but first had to agree to the current contract rates and terms set by the MT PSC to sell their energy to NWE for transmission to customers.

Ratepayer Energy Costs

Ratepayer energy costs are associated with the determination of energy prices, specifically how solar infrastructure and use of the transmission lines are valued. This study reinforced that large-scale solar projects are at a critical turning point due to ratepayer energy costs which determine, "…energy prices, as paid by a utility to a solar project developer, that are competitive for the ratepayers and allow for financing and a reasonable return for the developer…" coupled with the, "… determination that a solar project's energy output will meet the needs of the utility and its customer base and can be incorporated at a reasonable expense into the utility's existing transmission and distribution system." Both opportunities and challenges exist and are similar in each project.

Multiple opportunities are associated with ratepayer costs. One trend of costs associated with solar projects is conveners, "selling subscriptions for each of those projects to individual customers or even just ownership shares." Furthermore, "as far as offset, it helps our members about $2/ month roughly is what they are saving." Speculation about additional project opportunities are, "…you don't have any of these large facilities that have really gotten to the 20 or 25 year mark yet…modern science indicates you'll probably be able to continue to produce from that site and probably at a significantly lower cost because all of those startup costs were already paid for the first time around." One respondent summarized ratepayer energy cost challenges:

> "[Utilities] have fixed costs to maintain the poles and wires and those costs should be reflected in a fixed charge to their customers. So higher fixed charge lowers variable charge for the amount of energy consumed, but what that does is that it reduces the incentive to conserve energy or to produce your own solar energy. So I know that all the utilities really across the country are looking at those kinds of reforms because prospects of LED lighting, and conservation, and rooftop solar, and all those things are potentially damaging to their revenues and their bottom line and their business model."

Local Community

Within local community, community support and education about the solar project emerged as key concepts. Community support revolved around 1) communication, 2) coupling projects, 3) public health, and 4) equity. Education encompassed school, community, and international education. Local community was closely related to environmental effects, therefore similarities and differences across the projects are noted in the following section.

Stakeholders describe specific examples for community support opportunities as promoting projects that get, "… at that bigger social justice piece really of pollution and health." In some communities, members are willing to support energy development which helps reduce the long-term impacts for vulnerable populations such as elderly or low-income populous in the community. Education as a component of the projects was also an opportunity, "…for students and the next people who … inherit our world." These projects provide a unique opportunity to allow students and the general public to become more informed about solar applications.

An example of challenges related to community support that is closely linked to convener trust and credibility was ensuring, "… people in this town or any of the other towns are actually benefiting from this solar.... I don't know how many years it takes, but every day I'm like [all the business that they promised] didn't rush right in." In addition, state respondents noted the challenge of a community's initial exposure to large-scale arrays, "I think it is hard for people to understand [there is no noise, movement, and rarely any workers on site] until they actually see [an array], been up close to one."

Education challenges were compounded due to project goal expectations, "If we can wind up with a million dollars of really wonderful equipment, and if we under invest substantially in programming and in the people, the teachers really… then the whole project will fail. It will at least fail to meet expectations and it could fail outright." Furthermore, there were also concerns with, "… how the data that comes from [solar pilot projects] are all that helpful in the policy discussion."

Environmental Effects

The final external factor revealed in the case study was environmental effects. Opportunities and challenges acknowledged throughout the projects were 1) weather and seasonal variances, 2) air and water quality during energy production, 3) ecological trade-offs due to array footprints, and 4) impacts related to the lifecycle of solar panels. As one respondent expressed, "It's the three stools of sustainability: environment, economics, and equity. The environment is where it starts and everyone's best versed."

An example of an ecological footprint opportunity is, "The scalable nature of solar is probably more able to avoid dramatic environmental impacts than a dam or coal plant..." Opportunities for air and water quality, and lifecycle impacts were expressed as, "… you don't have to deal with, say groundwater pollution, or any other sort of pollution that may be left behind by other types of economic activities…. with these solar projects, you don't have that liability."

Respondents also identified environmental challenges. Weather and seasonality challenges were acknowledged as, "The only problem in Montana is … it can only supply enough power for five houses on a system, but December… only supplied enough power for maybe one house." The scalability of the arrays also produced ecological and lifecycle challenges such as, "… it's kind of nice to have [wildlife previously using a solar site]. And the more [energy development] that gets built out here, I don't know what it's going to do to [the wildlife]."

The study found environmental effects and local community support concepts were closely tied together. For example, challenges are associated with using agricultural lands for solar sites because of the loss of viable grazing land around solar panels, livestock damaging panels, and in another context, "… problematic for solar developers to start turning pragmatic land into solar farms."

Local community support included solar education, project interest, and equality of access to solar energy for varying populations were hypothesized to account for the failure of the CCR project. In contrast, the analysis showed these challenges were not emphasized by respondents. The majority of CCR respondents stated challenges in the implementation and maintenance phases where stakeholders did not, "…feel like people in this town, or any of the other towns, are actually benefiting from this solar."

In addition, demographics with economic ties to the gas and oil industry, and stakeholder stances on the project were also hypothesized as to why stakeholders did not support the CCR solar projects. Nearly all stakeholder who opposed the project stated, "I don't think [project opponents] are against solar," most opponents stated, "I actually have solar on my house, so I'm all for solar," or would not mind solar on their property especially if a company helped pay for it. Furthermore, all opponents noted the benefits of producing electricity through renewable energy resources.

The location of the NWE solar sites reduced a number of environmental effect challenges faced by the other conveners. The focus on using the project as education for not only the convener but also high schools, produced unique opportunities and challenges at developing a curriculum to meet this goal. The REC project also afforded a similar education opportunity.

Interestingly, the REC project incorporated international education, a concept not previously identified by other conveners. Student programs, from local to international, are encouraging students to focus on environmental issues and evaluate them, "…from the standpoint of how do you create sustainable renewable projects that you can do on the grassroots level that can actually have an impact in your home community?" The REC staff partnered with a University of Montana international student program which brings students to the solar site and communicates about the opportunities and challenges of the project. A respondent noted most students are astonished, "… at what they're doing with such a small space," because, "… a lot of these countries [are] overpopulated. They do not have a lot of space, and so it was really cool to see how [the space] was utilized, and it's also right next to the grid so you don't have to have too much transportation or battery storage."

This international education interest in the REC solar project was stated by stakeholders as valuable and should be investigated further. These opportunities were expressed as,

> "The value in that I think hearkens back to what I said earlier of building these networks. Maybe it's not the best option for us in the Bitterroot Valley in Ravalli, but this might be the springboard for a project that maybe happens in China, or India, or somewhere else. We don't know where that seed is going to go, but it's been such a valuable part for us to have as an educational opportunity and that is valuable…. It's an immediate global context, which is why I love it. Anything local is an immediate global context."

Strategies for Future Success

Respondents also stated what they perceived would increase the success of future large-scale solar projects. These strategies may be applied to any project, so were calculated as total percentages. Supportive policy factored (32%) while the importance of local government and community support was (21%), and using large-scale solar projects as an economic development was (14%) (Figure 18). While most respondents hoped state policy becomes more amenable to these solar projects, they recognize the need to move forward and focus on highly influential areas such as local community and government support which includes using these large-scale solar projects as an economic development tool.

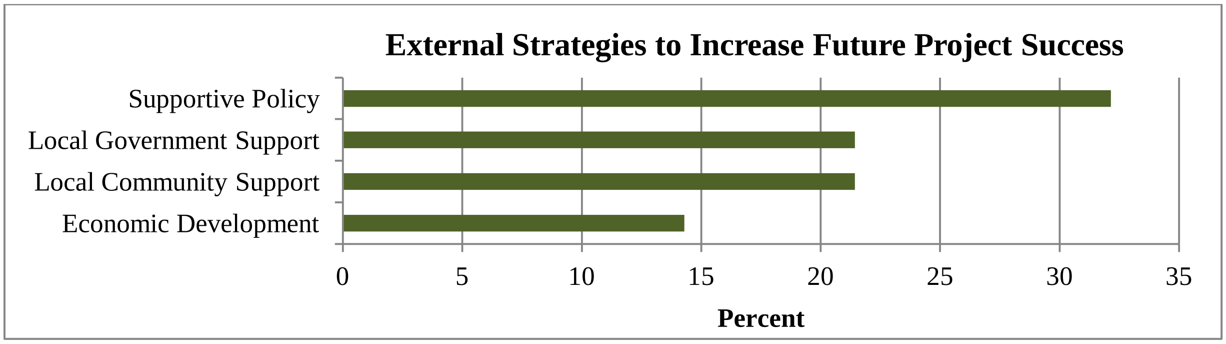

Figure 18. Distribution of interviews specifying external strategies to increase future solar project success.

External Factor Discussion

Of all the external factors revealed in this case study, 1) policy and administration, 2) financing source, and 3) local community support were the most influential to the success of the solar projects acknowledged by respondents across the case study projects and furthers previous research. This section delves into these three topics, while Chapter 6 discusses the remaining external factors found in this study.

Policy and Administration

State and federal policy is currently confining for large-scale PV solar projects, so adaptability and innovation through local government officials and convener administration becomes essential for successful renewable energy projects (Beier & Lovecraft, 2009; Miller et al., 2015; Omer, 2008). This study reinforced that solar projects need support from the majority of stakeholders who believe policy and administrative challenges are worth overcoming to promote solar projects (Beier & Lovecraft, 2009; Gunderson & Holling, 2002). The three projects revealed dissimilar opportunities and challenges when faced with local policy and convener administration.

NWE, the regional electricity company, is currently facing state and regional pressures to evaluate energy generation and distribution. Their operating plan balances providing reliable energy, updating transmission structures, planning for energy generation transitions, and balancing shareholder interests. These complex and simultaneous demands impact the development of new energy systems and are similar to findings from other energy studies (Miller et al., 2015). In conjunction with these demands, the company was encouraged through legislative pressures to also work with communities and local governments to gather data on how to value solar in their system. The willingness of the Missoula government partnering and working with the regional utility company suggests project compatibility with policy and administrative considerations (Omer, 2008).

The electric co-operative reflects a more facile relationship with state and local government requirements. The results from the co-operative complement other studies which insist energy projects must be compatible with governance and have more benefits than challenges (Beier & Lovecraft, 2009; Gunderson & Holling, 2002; Omer, 2008). REC presented itself as having the most apt administration for developing and operating new energy projects which were minimally impacted by other governance, and expands upon studies regarding the importance of institutional administration (Miller et al., 2015).

Lastly, the QF began their project with the greatest amount of project compatibility issues with state, local, and regional utility governance challenges. As suggested in literature on renewable energy development, the lack of strong policy compatibility for the CCR proposed projects decreased the convener's ability to implement the projects (Omer, 2008). The CCR proposals unfortunately faced policy incompatibilities at multiple scales. The zoning issue at the Fox Farm site instigated a local policy challenge which the majority of stakeholders perceived to outweigh the project's benefits. In addition, the deadline for the terms and rates contract between the QF and regional utility company was not conducive to allow for further negotiations or a rebuttal to the Zoning Board decision. While the Cypress Creek Renewables institutional administration may allow for more flexibility in their operating procedures and development sites they are currently bound in Montana to contracts with NorthWestern Energy.

Financing Source

The evaluation of three types of solar conveners in this case study emphasized project's financing sources were an important consideration to stakeholder support which is slightly different from other research suggesting project ownership increased the inclusivity of project support (Jobert et al., 2007; Smith, 2011; Wüstenhagen et al., 2007). This study agrees with studies that financial ownership of the solar project is important to community acceptance (Jobert et al., 2007; Wüstenhagen et al., 2007). The difference between project ownership and financing source is apparent in the electric co-operative and therefore needed to be distinguished.

REC used grants and members to fund their solar arrays, yet the co-operative retains management rights to the project. While using members to finance the project increases support and community acceptance of the project, the financing source may be very limited as was the case with REC. This finding supports research stating community acceptance and support for projects are increased due to the financers; however this study notes limitations not previously stated in other studies (Jober et al., 2007; McFadyen, & Warren 2010; Wüstenhagen et al., 2007).

NorthWestern Energy and Cypress Creek Renewables were both applauded for being their projects' financial source by stakeholders supporting or opposing the projects. Results from these projects differed from other studies which suggested project ownership increased project support. In this study perceptions of convener trust and credibility by stakeholders was not positively reflected by the majority of respondents in the results, and yet these conveners were commended for backing their respective solar projects and gained local support for their projects (Jobert et al., 2007; Wüstenhagen et al., 2007).

Local Community Support

Local community support was identified in previous research as the level of support for a specific renewable energy project in the community (Wüstenhagen et al., 2007). The results from the case study reinforce the concept of local community support as influential to the success of each solar project. In comparison, each project revealed different local community implications for social aspects, long-term considerations, and the distribution of trade-offs.

The stakeholders in the NWE pilot project generally perceived the Missoula community as accepting of new solar energy projects, but reiterated general social acceptance is not indicative of community acceptance for a specific project (Wolsink, 2006; Wüstenhagen et al., 2007). In this project, the working group acknowledged that the neighbors near the array sites might initiate pushback due to specific project concerns. Part of the NWE working group's strategy was to incorporate neighbors near the solar project after an initial plan was developed in order to ascertain if any public preferences were not accounted for and needed mitigation. This process is suggested in multiple publications to increase the likelihood of project success (Álvarez-Farizo & Hanley, 2002; Alsema et al., 2006; Schweizer-Ries, 2008; Sterling, 2015; Tsoutsos et al., 2005).

The NWE project's long-term implications are an interesting discussion piece. Multiple studies indicate weighing project's long-term expectations, longevity aspects, and community-based outcomes are necessary to minimize project ambiguities (Omer, 2008; Robinson, 2004). The NWE stakeholders provided contradictory responses as to expectations, longevity, and community outcomes of the project, because the project infers an inaccurate distribution of long-term trade-offs. Since the solar arrays are only a pilot project there is the possibility for the panels to be removed before their end-of-life, and therefore alter the distribution of trade-offs. Many of the respondents glazed over the lack of long-term expectations for the project, while some reported contention at not being able to address long-term implications, and yet others responded as if the project would last the life-time of the panels and provide positive local and non-local benefits. These perceptions and resulting omission of a long-term implication conclusion seemingly countered other studies, but may be a byproduct of the development being classified as a pilot project.

REC members accentuated previous studies that diffused generalized renewable energy project acceptance from acceptance for a specific project (Wolsink, 2006; Wüstenhagen et al., 2007). The general acceptance of renewable energy is apparent in the membership's dedication to using carbon-free electricity sources, and yet the majority of members were either strongly opposed or not willing to pay for the large-scale PV solar project. The REC conveners also incorporated strategies to take membership preferences into account and mitigate costs as suggested by studies promoting successful projects (Álvarez-Farizo & Hanley, 2002; Alsema et al., 2006; Tsoutsos et al., 2005).

The concept of identifying and weighing long-term expectations and outcomes of the large-scale solar project were also verified by the REC respondents (Omer, 2008; Robinson, 2004). Similar to the NWE project, the long-term expectations in the forms of next best alternative and future project expansions were dissimilar across stakeholders. Expectations were framed around membership desires and the ability for co-operative staff to implement cost efficient strategies to provide desirable outcomes for the entire co-operative. The majority of co-operative respondents indicated members who were willing to pay had already done so, and therefore the co-operative had met members' interest, and do not foresee additional development. Coinciding with membership expectations and trade-offs, some respondents agreed with past research that if members preference had considered other investment alternatives, such as energy efficiency projects, they would have maximized net benefits for co-operative members compared to the solar array (Álvarez-Farizo & Hanley, 2002; Miller & Richter, 2014).

The CCR project was a prime example of distinguishing between general renewable energy acceptance and that of a particular project (Wolsink, 2006; Wüstenhagen et al., 2007). While nearly all respondents opposing the project stated an affinity for renewable energy, specific site considerations discussed above proved insurmountable. Overall, the CCR convener strategy did not take into account enough social aspects, such as neighbor preferences or maximizing net community benefits, to have a successful project at the Fox Farm site. As research attests, this decreases the likelihood of project success (Alsema et al., 2006; Álvarez-Farizo & Hanley, 2002; Tsoutsos et al., 2005; Schweizer-Ries, 2008; Sterling, 2015). The untimely end to the project proposals may account for respondents not considering long-term implications of the project.

External Factor Implications for Conveners

External factor implications were derived from the findings for each convener. NorthWestern Energy provided opportunities as a good financial source and an economic development tool for communities, but incurred some policy and administration restrictions.

Ravalli Electric Co-operative had the least policy restrictions and good local community support, but does not have a sustainable financing source. Lastly, Cypress Creek Renewables had the best financial source, but had substantial policy and local support challenges. The following paragraphs further describe each convener's implications.

The scale of the pilot projects NorthWestern Energy is focusing on is driven by state level legislation; yet, are at a scale that does not constitute policy challenges. The projects provide an opportunity to work with local governments and explore solar implementation criteria such as required permits. As the financing source to the projects and willing to partner with a variety of entities, NorthWestern Energy is able to provide economic benefits to local communities focused on using solar as an economic development tool and encouraging community support through collaboration efforts. While some respondents encourage any level of solar development to be beneficial at offsetting environmental impacts of energy production, the scale of the pilot projects is minimal. The greater environmental and public health impact will be based on the outcome of these pilot projects, and how NorthWestern Energy evaluates solar projects and their valuation on the grid. If the pilot projects are deemed successful and are scaled-up, then they could provide greater environmental benefits. As another option, NorthWestern Energy could find other renewable energy sources such as wind, meet a greater number of their requirements, and are a more efficient and effective renewable energy source to pursue developing.

Ravalli Electric Co-operative proved to have the greatest flexibility as far as policy and administration due to not being held to state-level terms and contracts. The solar project scale, financed through members and grants, did not create challenges for contracts between the co-operative and Bonneville Power Administration. As part of the co-operative's objectives, they support products made in the USA and used a local installation contractor. While this project incorporated community support and even global education, the environmental trade-offs for developing this scale of solar array verses using pre-established, carbon-neutral sources is likely minimal. REC respondents acknowledge difficulties in developing larger arrays that would off-set trade-offs due to limited funding sources.

Cypress Creek Renewable conveners had the greatest policy and administrative challenges across scales. The current state legislative review on rates and terms with NorthWestern Energy is limiting future project expansion within Montana. At a local level, the convener is faced with various local policy and public support challenges at sites that are identified as easily conducive for project implementation under their current operating procedures. From an economic and ecological perspective, CCR has great potential as a financing source to implement projects which are at a scale to offset environmental impacts created by other electricity production sources. Yet, respondents in this study warn against choosing the easiest sites, and suggest due diligence to find previously degraded lands where solar arrays would not impede on community values and therefore minimize support.

External Factor Implications beyond the Case Study

External factor implications were also extrapolated for each type of convener. Regional utility companies overall have adequate policy and local support for solar projects, but have to finalize evaluations for ratepayer costs. Electric Co-operatives are not largely restricted by policy and administrative considerations and have positive local community support, but will likely still have financing source challenges. Finally, qualifying facilities can positively apply economic opportunities, but may run into local community and policy challenges. The sections below provide specific examples of these implications.

Regional utility companies' strong state and local political presence provides an influential opportunity not expressed by other types of conveners. Although this situation is inherently challenging due to the associated broad array of contingency interests, their position allows them to proactively direct the evolution of electricity production and valuation. If other regional utility companies proceed with NorthWestern Energy's example of creating community partnerships, they could expand their large-scale solar productions sites exponentially. If collectively these conveners find large-scale solar arrays as beneficial additions to their portfolio then substantial progress of decreasing environmental impacts can be made if previously degraded lands are used for array sites.

Even though most respondents perceived electric co-operatives as the most favorable convener for implementing solar arrays, there are inherent limitations if creative solutions are not applied. Electric co-operatives will likely face the least amount of policy and administrative challenges compared to the other conveners, but must have staff willing to relentlessly pursue creative options to fulfill membership desires, especially in the realm of financing sources. A part of this type of convener's attractiveness comes from its implementation of localized interest and benefits. While this level of community attentiveness is beneficial it is also limiting when the primary financing sources are local members in a rural community. If co-operative members have intentions to continuously promote solar projects which can offset other energy sources' negative environmental trade-offs, then creative options such as partnering with businesses or creating statewide co-operative projects are worth investigating.

Qualifying facilities are largely at the whims of state level contract terms, but have incredible opportunities to customize projects to adapt and fill specific community niches while obtaining production goals. QFs can seek out communities interested in promoting renewable energy or carbon-neutral goals, such as to meet the Chicago Climate Charter. As the financial source for their arrays, these conveners can seek out a plethora of options to mitigate local community and environmental impacts which may increase community support for their project. These opportunities include using previously degraded lands, promoting beneficial secondary uses at sites such as pollinator species, and partnering with conservative minded companies who are near a load center in need of additional energy and who have a site adequate for panels. An example of this is partnering with breweries or an industrial neighborhood within a city. While their sites are slightly dispersed, producing creative solar structures such as parking shelters or roadways could produce benefits for both the convener and site lessee. Other traditional options involve seeking previously degraded lands such as decommissioned mines or industrial sites. The convener's ability to creatively adapt to the current policy restrictions is imperative to future success of large-scale solar projects.

CHAPTER 6. THESIS DISCUSSION

This chapter explores the similarities and differences between the previous literature concepts and a conceptual framework developed from the results of this case study. The layout of this chapter first compares the previous concepts with the project management conceptual framework. Next, similarities and differences for each project are compared to previous literature. The process repeats for project design, and external factors. Project management, project design, and external factor considerations previously discussed in Chapters 4 and 5 are not repeated in this chapter. The last section in this chapter provides a comparative review of project management, project design, and external factor similarities and differences for each convener.

Project Management Conceptual Framework

This section reviews the previous literature concepts on project management then illustrates how a conceptual framework was developed based on results from this study. Under project management, one additional factor was found to influence stakeholder perceptions on the opportunities and challenges of large-scale solar projects (Figure 19). *Project goals*, encompassed by **stakeholder and public engagement**, was identified as a substantial factor because it helped dictate the direction of each project. With this being the only new factor, the conceptual framework for the project management incorporated **stakeholder and public engagement** with elements of *project goals, project planning initiation, project information accessibility, representation and inclusivity,* and *convener trust and credibility.* The second concept, **conflict resolution,** remained the same with the two elements of *mitigating impacts* and *compromise strategies*. In the next section comparing project management findings to previous studies, discussions on the similarities and differences of project information accessibility element (pg 81) and the two conflict resolution elements (pg 82) are not reiterated.

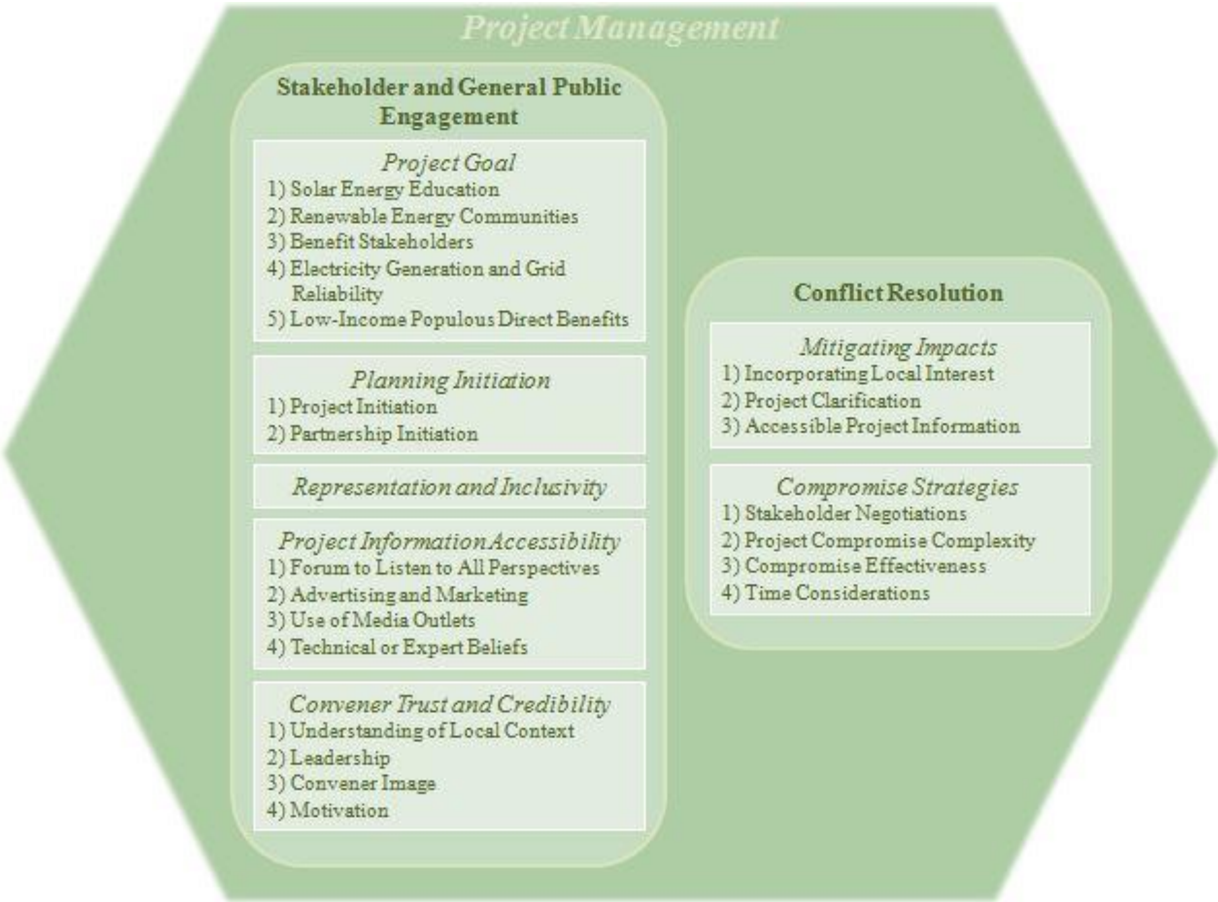

Figure 19. Project management conceptual framework for large-scale PV solar projects.

Stakeholder and Public Engagement

Project planning initiation for renewable energy developments are cited in literature as needing to incorporate community values and expectations for local community, economic, and long-term community outcomes through the use of social networks and community communication to maximize local benefits and minimize costs (Robinson, 2004; Schweizer-Ries, 2008; Van der Schoor et al., 2016; Walker & Devine-Wright, 2007). Respondents from this case study identified project planning initiation as a critical first step. Results from this study confirmed the initial scoping of a project needs to incorporate or be willing to assess social components described in other studies (Alsema et al., 2006; Tsoutsos et al., 2005). Respondents throughout this study emphasized the need to initiate partnerships or social networks in the form of stakeholders early on during the planning process to increase adaptive capacity and address local community, economic and long-term outcomes.

As discussed in previous sections, the formation of these stakeholders ranged from collaboration groups to largely unstructured stakeholder groups. REC and NWE projects initiated both a scoping period and partnerships that provided an inclusive representation of community interests. Statements from CCR respondents reinforce the concept to incorporate local networks and experts representing a broad array of community values and expectations to increase adaptive capacity.

In addition to planning initiation, the establishment of *project goals* was reinforced in all projects. Project goals were differentiated from the planning process because they set precedence for how the plan would be implemented. At this time, solar energy education, renewable energy communities, grid reliability, recipient benefits, and low income populous direct benefits were the goals established across the projects. Additional research is necessary to discern if these goals are communicated across a greater landscape and the amount of progress other conveners have made in these goals.

The establishment of project goals was largely dependent on *representation and inclusivity*. Extensive research insists inclusivity and representation for all interests in a project is critical to project success (Devine-Wright, 2011; Cruikshank & Susskind, 1987; Margerum, 2011). The NWE project specifically used a collaborative approach with diverse stakeholders and a deliberative process to solve community preference and site consideration challenges while developing consensus seeking results, which supports collaborative based research

(Margerum, 2011; McKinney, 2011). Both the NWE and REC conveners used an inclusive, informative, and deliberative approach to initiate the project and then resorted to a bureaucratic leadership to implement final decisions, as emphasized by other collaborative research (Imperial et al., 2016; Margerum, 2011; Mckinney, 2011).

The CCR project portrayed a lack of stakeholder inclusivity with similar results to a previous study where a minimal collaborative management strategy decreased the likelihood of project success because a systematic process for stakeholder involvement in the monitoring, evaluation, and long-term decisions making process was not in place (Scarlett, 2013). The likelihood of project success for CCR may have been greater if they incorporated processes where informed and deliberative participation was encouraged. This process creates equal opportunities to share views and information, clarify interests, and subsequently seek solutions to incorporate as many interests as possible (Mckinney, 2011). Overall, the CCR conveners largely used a bureaucratic management style which attempted to incorporate some local leadership and interests, but retained an internal decision making process as described in previous research (Imperial et al., 2016).

The final stakeholder and public engagement element was *convener trust and credibility*. This element is noted as important to the outcome of renewable energy projects in past research and was hypothesized as critical to project success in this case study (Jobert et al., 2007; Ruggiero et al., 2014). As the results indicated, all projects in the case study portrayed convener trust and credibility as less influential and viewed as a challenge that could be overcome, therefore contrary to previous research.

Project Design Conceptual Framework

This section reviews previous research concepts on project design and then illustrates how a conceptual framework was developed based on results from this case study. Literature sources focusing on project design described site considerations and scale in relation to the placement of a project; and technological components such as effective renewable energy source, energy output, and storage as critical to RE energy project success (Angelis-Dimakis et al., 2011; Dincer, 2000; Paine et al., 1996; Shahan, 2013; Wyborn & Bixler, 2013). Overall, project design concepts of **spatial components** reflecting *site considerations* and *scale*, and **technological components** of *effective renewable energy source, storage,* and *energy output* were previously identified.

The project design conceptual framework integrated one additional concept (Figure 20). Under **technological components**, *data management* was noted in the case study as highly influential to the project. Data from the project would be used for a variety of purposes such as student projects related to solar data, and informing conveners and other stakeholders of production and use information. This concept is important for both the actual project and future renewable energy projects. The resulting conceptual framework revealed the same **spatial components** of *site considerations* and *scale*, and a slight change to **technological components** with *data management, effective renewable energy source, storage,* and *energy output.* Discussions in the following section about how previous project design results compare to results from this study do not reiterate project site considerations (pg 84).

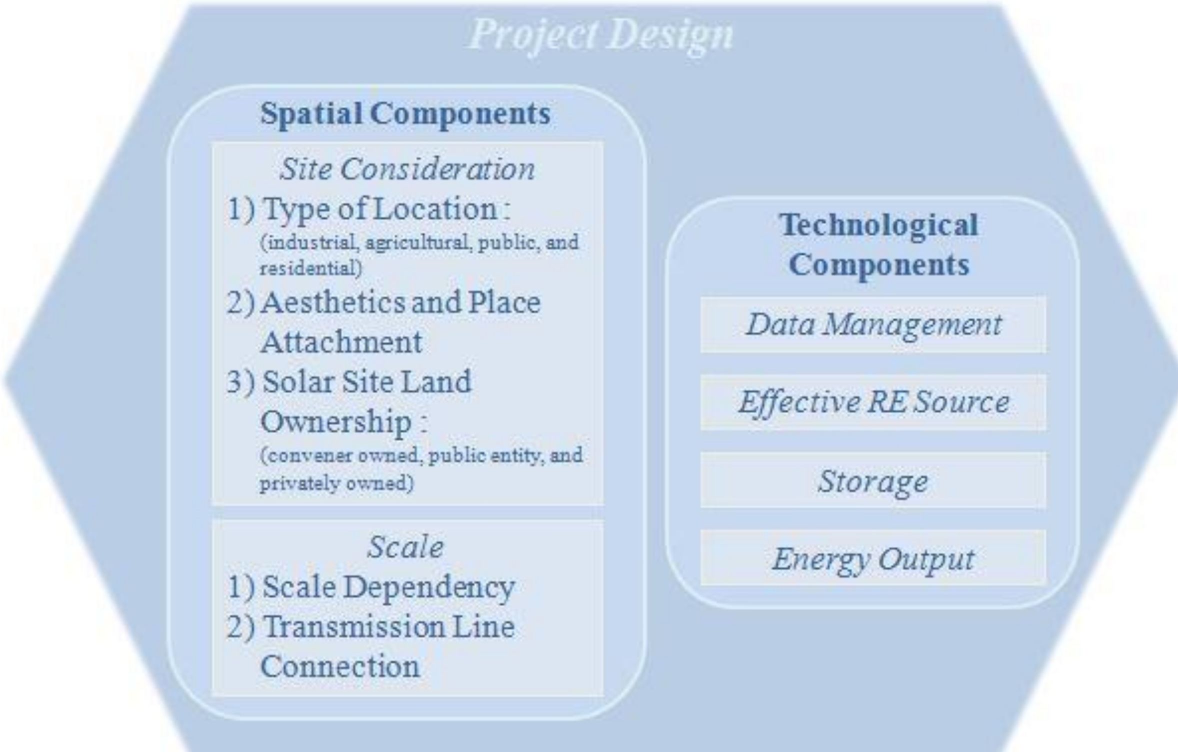

Figure 20. Project design conceptual framework for large-scale PV solar.

Spatial Components

A range of studies indicated scale such as the size of the project, scale dependency for electricity generation, and accessibility to the grid were pertinent to the success of projects (Cash et al., 2006; Gibson et al., 2000; Margerum, 2011; Wyborn & Bixler, 2013). Opportunities for scale were prevalent across the case study projects possibly from conveners doing due diligence during the planning phase to mitigate transmission accessibility challenges, and evaluating local electricity consumption and generation needs at potential sites.

Due to the scalability of solar arrays and access to transformer sites, the NWE working group used an innovative technique to disperse arrays across multiple sites. This adaptability allowed the project to meet spatial restrictions, provide adequate energy, and easily connect to the grid. For the REC project, the size and therefore generation capacity was not regarded as large enough to decrease electricity demands as other sources, but was ultimately an economical challenge. CCR respondents noted the size of the Fox Farm solar proposal was not appropriate, but this challenge is better represented as a type of location or zoning issue since the site was in a residentially zoned area.

Technological Components

Predominate technological concepts influencing each PV solar project were *effective renewable energy source*, *storage*, and *energy output* (Dincer, 1999; Green, 2005; Mulvaney, 2013). These concepts closely relate to state and federal policy concepts because the case study projects are working within current state and federal policy frameworks, and were not focused on new technology. Initially, NWE collaborators suggested innovative solar technologies such as solar roadways, but were guided by NorthWestern Energy representatives to stay within current, on-the-market PV solar systems. The working group adapted this idea to a novel solar fence design at one of the locations which will aid in furthering discussions about energy output and the effectiveness of this solar array design. REC staff noted they are using the project to monitor the array's energy output due to seasonal and environmental factors. The overall energy output at the site is realistically undersized for co-operative needs and only produces electricity for about 1-5 homes per year, depending on the season. Again, this was less of a technological challenge as it was an economic, financing source hurdle. Similar to previous studies, state level respondents noted the addition of storage to QF arrays could increase their functionality, yet this was not a pertinent point of discussion for CCR respondents (Shahan, 2013).

External Factor Conceptual Framework

This section reviews the previous literature on external factors then notes the development of a conceptual framework based on this case study's results. Previous literature on renewable or solar energy projects offers an assortment of concepts that interact to create opportunities or challenges for projects. Studies found an expanse of external factors proved to be thresholds for renewable energy development (Dincer, 1999; Jobert et al., 2007; Menegaki, 2008; Miller et al., 2015; Wüstenhagen et al., 2007). These include local community and environmental concepts which influence local support through a perception of how trade-offs are distributed for long-term effects, compatibility with a project; and weighing economic opportunities verse ecological impacts (Alsema & Nieuwlaar, 2000; Álvarez-Farizo & Hanley, 2002; Beeton & Galvin, 2017; Foxon et al., 2005; Hain et al., 2005; Omer, 2008; Van Der Schoor et al., 2016; Warren & McFadyen, 2010; Wei et al., 2010; Wolsink, 2006).

Previous research identifies policy and administration, economics, and social-ecological components affecting renewable energy projects. **Policy and administration** included *multi-scale governance* and *compatibility* concepts. Under **social and ecological**, *local community support, environmental effects, long-term implications,* and *distribution of trade-offs* were identified as important concepts. Lastly, **economics** identified *project economic effects* and *project ownership* as instrumental to RE projects.

This study found the preceding external theories largely explained stakeholder perceptions associated with each type of large-scale solar project; however, slight variances were noted by respondents in this study (Figure 21). Instead of a social and ecological category, respondents discerned **local community** and **environmental effects** as instrumental concepts, and did not indicate how trade-offs were distributed or long-term implications. Furthermore, respondents stated more specific **policy and administration,** and **economics** concepts then previous literature due to divergent implications. For example, *multi-scale governance* was identified by respondents as *across scales, convener, local, state,* and *federal,* while compatibility was not implied as a concept specific to itself. Similarly, respondents noted the economic effects elements of *economic development tool, financing sources,* and *ratepayer costs.* While these concepts were noted in each of the three projects in this case study, there were different implications for each project. Similar to the previous sections, comparison discussions for policy and administration elements (pg. 107), financing source element (pg. 109), and local community support element (pg. 110) previously discussed in Chapter 5 are not reiterated.

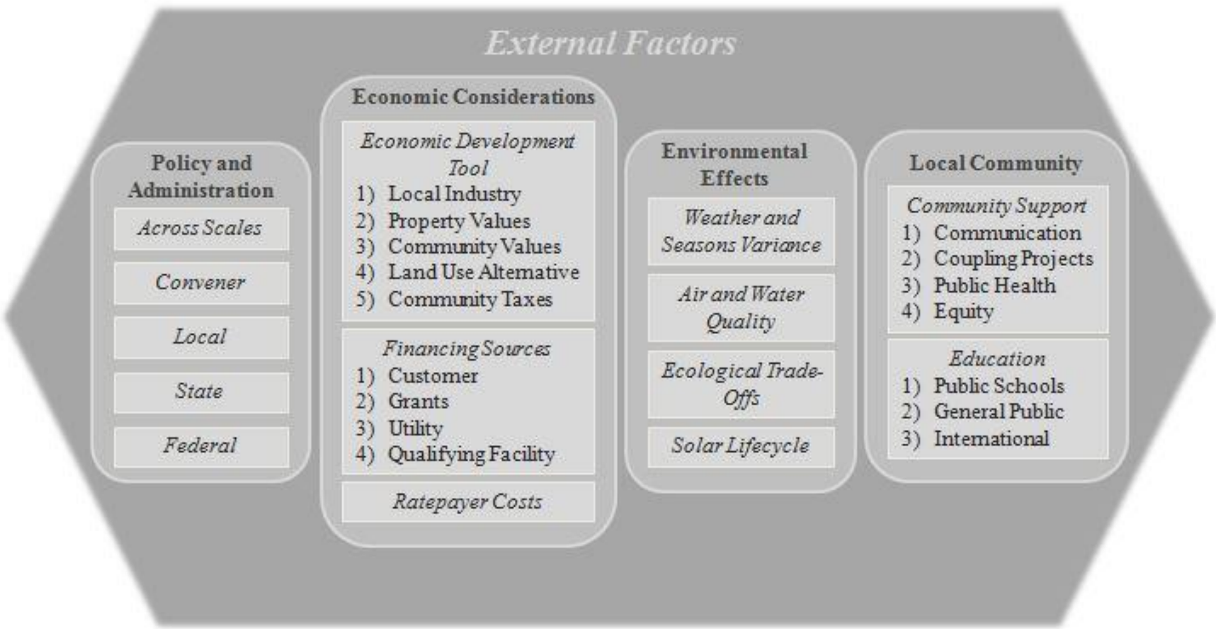

Figure 21. External factors conceptual framework for large-scale PV solar.

Economics

The use of solar as an *economic development tool* for communities was not previously emphasized by other studies on renewable energy. Respondents, especially in the NWE project, emphasized the potential of developing enough solar and complimentary carbon-neutral programs to promote their community as upholding the Chicago Climate Charter, whereas most other studies focused solely on weighing economic benefits, such as local construction jobs (Olson-Hazboun et al., 2016). Respondents committed to upholding the Charter's agreements realize many businesses and residents are seeking communities that are promoting carbon-neutral growth. In some communities, the addition of solar as a development tool is a practical component to their plan.

The incorporation of solar as a tool in a community's economic development plan is not without challenges. CCR respondents insisted on proof that the development of previous solar projects had indeed brought in other industries, and as another aspect did not decrease property values. The latter is more closely related to the type of location such as residential zoning, and geographical location challenges as in the case of the Fox Farm site being at the bottom of a large, open bowl. Furthermore, REC respondents implied an impasse regarding the overall benefits of the project because they were already supplying carbon-neutral energy. Additional research investigating the use of large-scale solar projects as an economic development tool is beneficial and timely, especially for communities seeking to understand how they can uphold the Chicago Climate Charter.

Local Community and Environmental Effects

"The environment is where it starts and everyone's best versed," was eloquently stated by a respondent. Overall, respondents from each case study acknowledged opportunities and challenges associated to past research, and were able to overcome these challenges during the case study projects. For example, CCR project respondents provided specific examples about the need to disturb an ecosystem to build a solar farm, verses skeptics remarks that the energy was not necessary for local consumption. The basis of the skepticism may be slightly misleading due to technological factors, but the example does contribute to research indicating environmental benefits of renewable energy is context dependent at local levels (Jobert et al., 2007). An initial hypothesis stated the CCR projects may have been terminated due to perceived negative environmental effects related to the projects' size, or scale. Respondents acknowledged negative environmental impacts, but related they were tied to place attachment and aesthetics more than the size.

Additional studies conceded project size was a notable challenge if the project did not create enough electricity to actually decrease pollution (Angelis-Dimakis et al., 2011; Kalogirou, 2004; Lewis, 2013). Various REC, CCR, and state-level respondents reflected this challenge and offered next best alternative strategies ranging from establishing financing partnerships to increase array sizes, to focusing on energy conservation projects and foregoing redundant renewable energy production efforts. The NWE respondents retained a more positive perspective about their project even though it did not decrease a large amount of pollution. Complementing other studies, every respondent from the case study encouraged any application of renewable energy helps against negative impacts associated with fossil fuel sources (Shahan, 2013).

Complete Conceptual Framework

This section reviews the similarities and differences between the previous research concepts and the conceptual framework for results in this case study. The importance of project management, project design, and external factors and their relative concepts of stakeholder and general public engagement, conflict resolution, spatial components, technological components, policy and administration, and economic considerations, local community, and environmental effects confirmed previous literature findings. The greatest dissimilarity between the previous research and this case study were how specific concepts iterated across the projects revealed vastly different opportunity and challenge implications for each project. Overall, this study found previous theories on project management, project design, and external factor concepts were relevant to this case study; however, a few dissimilarities under external factors exist.

Policy and administration concepts from this case study identified *across scales, convener*, *local*, *state*, and *federal* as important concepts instead of lumping all of the concepts under a singular multi-scale governance concept. This study found an emphasis on **local community** and **environmental effects** were important to the solar projects instead of the previous literature concept encompassing a number of social-ecological considerations. Lastly, in this research the economics category revealed the importance of *economic development tools, financing sources,* and *ratepayer costs* as instrumental to the opportunities and challenges to various conveners of solar projects (Figure 22).

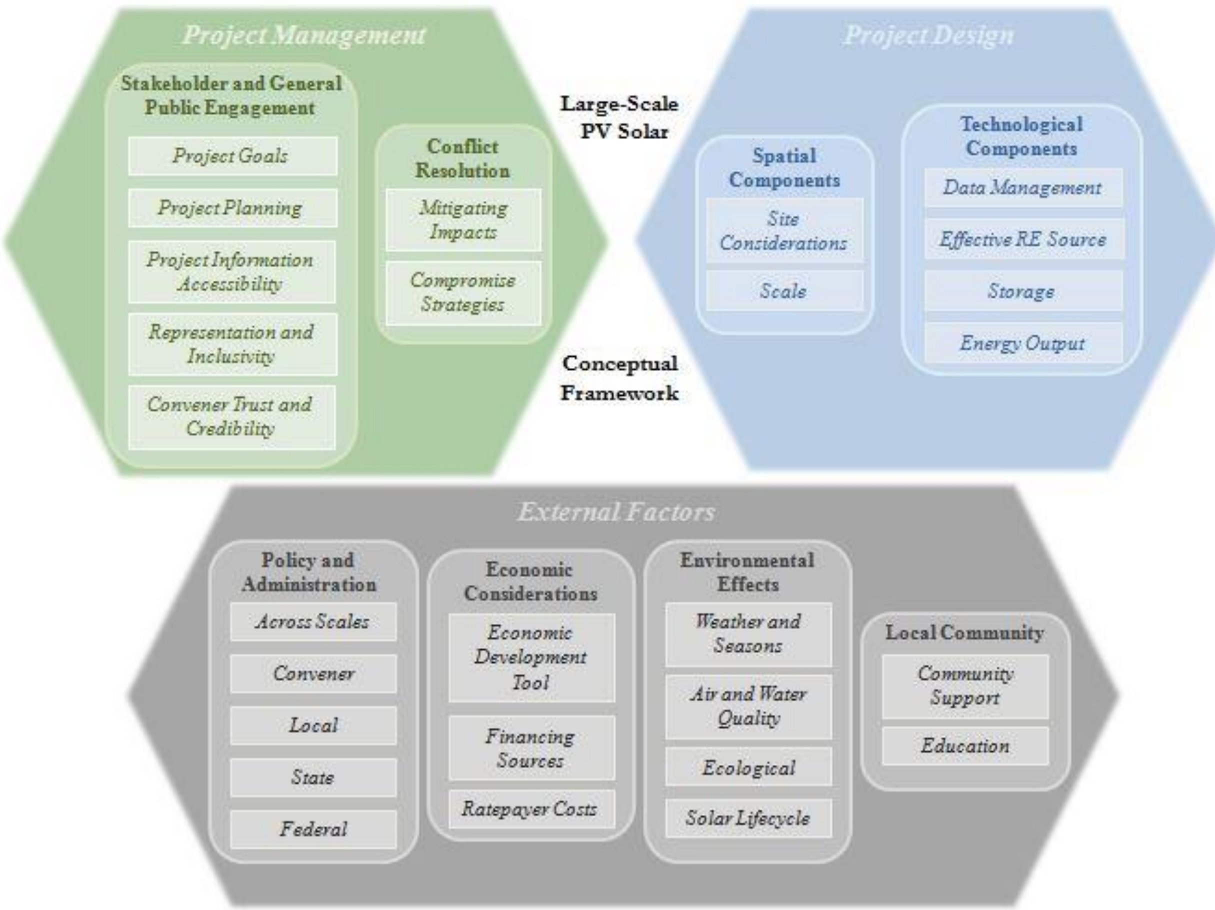

Figure 22. Conceptual framework for large-scale PV solar project opportunities and challenges.

Project management, project design and external factors are interrelated and influence one another across scales. External factors at national, state, and local scales affect project management decisions which shape the project design of the large-scale PV solar project, and may retrospectively influence other external factors. For example, local weather and seasonal variations at the site may influence stakeholders to set a project goal of education about project design factors. For instance, the installation of NWE solar fence at a school offered a chance for stakeholders to learn how efficient this design is for energy output and how acceptable it is to the local community. Another example is how federal decisions to not engage in the Paris Climate Agreement followed by less strict clean energy requirements resulted in local governments taking on the challenge to fulfill a more localized Chicago Climate Charter by recognizing solar is an economic development tool for cities. This influenced partnership planning initiation by incorporating diverse stakeholders who offered alternative site considerations.

Convener Similarities and Differences

The electric co-operative, regional utility company, and qualifying facility in this study largely exhibited similarities for project management, project design, and external factors, but also revealed unique aspects particular to their type of convener. The findings of this study discerned different levels of opportunity and challenge concepts for each type of convener (Figure 23). In essence, each of the three conveners from this study fulfill a niche in large-scale PV solar development.

Large-Scale PV Solar Implementation Considerations			Utility	Co-op	QF
Project Management	Stakeholder and Public Engagement	*Project Goals*	**O**c	**OC**	o**C**
		Representation and Inclusivity	**O**c	**O**c	o**C**
		Planning Initiation	**O**c	o**C**	o**C**
		Information Accessibility	**O**c	oc	o**C**
		Convener Trust and Credibility	oc	**O**c	o**C**
	Conflict Resolution	*Mitigation of Impacts*	**O**c	**O**c	o**C**
		Compromise Strategies	**OC**	**O**c	o**C**
Project Design	Spatial Components	*Site Consideration*	**OC**	**O**c	o**C**
		Scale	o**C**	o**C**	**O**c
	Technological Components	*Data Management*	**O**c	**O**c	oc
		Effective RE Source	oc	oc	oc
		Storage	**O**c	oc	o**C**
		Energy Output	oc	oc	**O**c
External Factors	Policy and Administration	*Across Scale*	**O**c	oc	o**C**
		Convener	**O**c	**O**c	**OC**
		Local	oc	oc	o**C**
		State	**OC**	oc	o**C**
		Federal	oc	oc	oc
	Economic Considerations	*Economic Development Tool*	**O**c	oc	oc
		Financing Sources	**O**c	o**C**	**O**c
		Ratepayer Costs	o**C**	o**C**	oc
	Environmental Effects	*Weather and Seasonal Variances*	o**C**	o**C**	oc
		Air and Water Quality	**O**c	**O**c	**O**c
		Ecological Trade-Offs	oc	oc	o**C**
		Solar Lifecycle	oc	oc	oc
	Local Community	*Local Community Support*	**O**c	oc	o**C**
		Education	**O**c	**O**c	**O**c

o = few opportunities, ***O*** *= many opportunities, c = few challenges,* ***C*** *= many challenges*

Figure 23. Opportunities and challenges for each factor by type of convener.

Overall, the regional utility company had the greatest amount of project management and external factor opportunities, and similar amount, although unique, project design opportunities and challenges. NorthWestern Energy, the regional utility company, portrayed the most opportunities and fewest challenges for project management concepts. NWE initiated partnerships with diverse stakeholders who could accomplish project goals. As a convener, the regional utility company had marginal trust and credibility among stakeholders and faced many challenges with compromise strategies due to working through new processes such as leasing lands from a public entity. Under project design, NWE had many opportunities for site considerations due to partnering with public high schools, data management, and storage through the application of a battery unit. The remaining project design concepts reflected fewer opportunities and challenges due to the smaller scale of the pilot project. External factors also resulted in the most opportunities and fewest challenges by the regional utility company convener. NWE had many state and across scale policy opportunities with the small pilot project, but also many state level policy challenges associated with figuring out ratepayer costs of solar integration. Environmental effects and local community were similar between all case studies, although the location of the pilot project in Missoula incurs more challenges due to decreased electricity production during winter months when there is an inversion.

Overall, the electric co-operative had the second greatest amount of project management opportunities, a similar amount of project design opportunities and challenges as the other conveners, and generally few external factor opportunities or challenges. As an electric co-operative, REC nearly had as many project management opportunities as NWE. The co-operative is membership driven so includes all member interests during conflict resolution measures increasing convener trust and convener opportunities. The greatest challenges REC faced in project management was initiating project partnerships when the goal of incorporating solar arrays at the co-operative was limited to a small percent of members. For project management, REC had similar opportunities as NWE, but did not incorporate a storage element into their design. Their greatest challenge was the lack of scale to their arrays only created enough electricity for one household during the winter months when over 70 individuals partnered to finance the arrays. The co-operative had fairly few overwhelming external factor opportunities or challenges. The greatest challenges came from their limited financing source through members and grants, and similarly to NWE evaluating ratepayer costs for solar production and use.

Lastly, the qualifying facility had the greatest amount of project management and external factor challenges, and a similar amount of project design opportunities and challenges. Cypress Creek Renewables had minimal stakeholder representation which resulted in largely challenges under all project management concepts and relating local community support. The qualifying facility's greatest project design opportunities revolve around the scale of the arrays and amount of energy output. These opportunities were counteracted by many policy challenges and ecological trade-offs.

CHAPTER 7. THESIS CONCLUSION

Outcomes and Implications

This thesis provides an understanding of how stakeholders in the three projects perceived project management, project design, and external factors during the planning, implementation, and long-term maintenance phases of their solar projects. Their insight suggested similarities and differences to previous literature when developing renewable and solar energy projects, and therefore expands the current literature base for large-scale PV solar implementation. These outcomes provide a foundational understanding for specific opportunities and challenges associated with large-scale solar projects by co-operatives, regional utility companies, and qualifying facility conveners in Montana. The implication of this research can help inform the Montana legislature, large-scale PV solar providers, and stakeholder groups about influential elements, and how stakeholders influenced the acceptance or rejection of projects.

Overall, large-scale PV solar projects revealed similar opportunity and challenge concepts, regardless of the type of convener, but have moderate differences concerning opportunity or challenge implications of these concepts. In addition, relationships between project management, project design, and external factors are intertwined and influence each other. For example, financing sources, an economic concept, are a challenge for electric co-operative conveners, but they may be influenced by creative project management opportunities such as seeking creative partnerships with a group of businesses to fund the project. Another example is under the current policy and administration structure, stakeholders and conveners may work together on project design concepts to minimize policy challenges and maximize project compatibility.

Certain results in this study may be generalized beyond the specific context of the three conveners initiating large-scale PV solar projects in Montana. Furthermore, the project scope can be broadened to large-scale renewable energy project. The findings in this paper lead to the following propositions to increase both the literature base and the likelihood of success for these projects:

1) As a commodity, conveners need to promote their projects through marketing strategies to shift stakeholder and public behavior to support projects.
2) The identification and incorporation of local interests and goals is valuable for conveners to integrate throughout the planning and implementation phases.
3) Site considerations of type of location, aesthetics, and place attachment are critical to assess and should align with community values and interests.
4) Establishing creative partnerships, such as local governments interested in renewable energy sources as an economic development tool, helps identify local project leaders familiar with the local community context and able to assist navigating through the project planning and implementation processes.
5) No singular type of convener provides the greatest opportunities; rather each convener is fulfilling a niche taking advantage of specific project management, project design, and external concepts applicable to their organizational structure.

This study illustrates that even with state and federal policy challenges, Montana large-scale PV solar conveners are pursuing a diversified approach to expanding solar energy. While stakeholders perceived an array of challenges associated with these projects, nearly all concerns associated with each convener may be mediated with conflict resolution strategies. The virtually singular, monumental challenge which could impede future PV solar projects in Montana is a decreasing finance source. As reflected in this study, these sources may be from a convener, grants, members, or alternative financing sources. This challenge may be remediated through unrelenting marketing which would continue to encourage diverse entities to invest in these projects.

As with all research, there are limitations to this study. This research only includes three projects, all influenced slightly differently by project management, project design, and external factors due to having dissimilar conveners. More specifically, the study only focuses on one electric co-operative, qualifying facility, and regional utility company in Montana. Additional research could pursue case studies for each of these conveners, within or outside of Montana, to substantiate how the concepts in this study translate across the convener base. Another limitation of this study previously noted the inclusion of a limited stakeholder base. The inclusion of additional stakeholders, such as the missing QF convener in this case study, may produce a greater array of elements not reflected in this study. Lastly, this study forms a basis for additional research to identify trends based on project management, project design, and external factors for conveners implementing large-scale PV solar or other renewable energy sources.

APPENDICES

Appendix A

Missoula County

Population	Population Density: People per Square Mile	Median Household Income	Poverty Rate	Education Level: High School Degree or Greater	Education Level: Bachelor's Degree or Greater
116,130	42.1	$46,164	15.8%	95.3%	40.7%

Ravalli County

Population	Population Density: People per Square Mile	Median Household Income	Poverty Rate	Education Level: High School Degree or Greater	Education Level: Bachelor's Degree or Greater
42,088	16.8	$39,480	14.9%	91.9%	24.4%

Cascade County

Population	Population Density: People per Square Mile	Median Household Income	Poverty Rate	Education Level: High School Degree or Greater	Education Level: Bachelor's Degree or Greater
81,755	30.1	$45,205	14.40%	91.30%	25.50%

Information from US Census Bureau (Census, 2016).

Appendix B

Interview Guide

NorthWestern Energy PV Solar Pilot Project in Missoula

1) Can you please tell me a little about your background and how you became involved in the PV solar project?

    a. How long you have lived in (or interacted with) the community, what is your role in the PV solar project, what influenced you to participate in this project?

    b. Did you support or not support the project? Please explain why.

2) What do you perceive were the greatest opportunities for how the project was managed?

    a. What do you perceive were the greatest challenges for how the project was managed, and how were these challenges overcome?

3) What do you perceive were the greatest technological or siting opportunities of the PV solar project?

    a. What do you perceive were the greatest technological or siting challenges, and how were these challenges overcome?

4) What do you perceive were the greatest policy opportunities (such as: company, institutional, local or state government policy) of the PV solar project?

    a. What do you perceive were the greatest policy challenges, and how were these challenges overcome?

5) What do you perceive were the greatest financial opportunities of the PV solar project?

    a. What do you perceive were the greatest financial challenges, and how were these challenges overcome?

6) What do you perceive were the greatest local community opportunities of the PV solar project?

    a. What do you perceive were the greatest local community challenges, and how were these challenges overcome?

7) What do you perceive were the greatest natural-environment opportunities of the PV solar project?

    a. What do you perceive were the greatest natural-environment challenges, and how were these challenges overcome?

8) Should PV solar opportunities be increased, maintained, or reduced in this community? Please explain to what degree and why.

9) Is there anything else about the project we have not discussed that you would like to tell me about?

10) Is there anyone else with expertise about this PV solar project who you think I should talk to about these topics?

Appendix C

Interview Guide

Ravalli Electric Cooperative: Valley Solar Project

The data for this research will be collected through voluntary participation. Your responses are confidential and you will have access to the study once the research is complete. All questions are specific to the Valley Solar project.

1) Can you please tell me a little about your background and how you became involved in the Valley Solar project?

   a. How long you have lived in (or interacted with) the community, what is your role in the solar project, what influenced you to participate in the project?

   b. Do you support or not support the solar project? Please explain why.

2) What do you believe were the greatest opportunities for how the project was managed?

   a. What do you believe were the greatest challenges for how the project was managed, and how were these challenges overcome?

3) What do you believe were the greatest technological or siting opportunities of the solar project?

   a. What do you believe were the greatest technological or siting challenges, and how were these challenges overcome?

4) What do you believe were the greatest policy opportunities (such as: company, institutional, local, state, or federal policy) of the solar project?

   a. What do you believe were the greatest policy challenges, and how were these challenges overcome?

5) What do you believe were the greatest financial opportunities of the solar project?

   a. What do you believe were the greatest financial challenges, and how were these challenges overcome?

6) What do you believe were the greatest local community opportunities of the solar project?

   a. What do you believe were the greatest local community challenges, and how were these challenges overcome?

7) What do you believe were the greatest natural-environment opportunities (such as: ecosystems, air, water, etc.) of the solar project?

a. What do you believe were the greatest natural-environment challenges, and how were these challenges overcome?

8) Should solar opportunities be increased, maintained, or reduced in this community? Please explain to what degree and why.

9) Is there anything else about the project we have not discussed that you would like to tell me about?

10) Is there anyone else with expertise about this solar project who you think I should talk to about these topics, or share the findings with?

Appendix D

Interview Guide

Cypress Creek Renewables: Proposed Fox Solar & Portage Solar Projects

The data for this research will be collected through voluntary participation. Your responses are confidential and you will have access to the study once the research is complete. All questions are specific to the previously proposed Fox and Portage Solar projects.

1) Can you please tell me a little about your background and how you became involved in the Cypress Creek Renewables Fox and Portage Solar project proposals in Great Falls?

    a. How long you have lived in (or interacted with) the community, what is your role in the solar projects, and what influenced you to participate in the projects?

    b. Do you support or not support the proposed solar projects? Please explain why.

2) What do you believe were the greatest opportunities for how the projects were managed?

    a. What do you believe were the greatest challenges for how the projects were managed, and how were these challenges overcome?

3) What do you believe were the greatest technological or siting opportunities of the proposed solar projects?

    a. What do you believe were the greatest technological or siting challenges, and how were these challenges overcome?

4) What do you believe were the greatest policy opportunities (such as: company, institutional, local, state, or federal policy) of the proposed solar projects?

    a. What do you believe were the greatest policy challenges, and how were these challenges overcome?

5) What do you believe were the greatest financial opportunities of the proposed solar projects?

    a. What do you believe were the greatest financial challenges, and how were these challenges overcome?

6) What do you believe were the greatest local community opportunities of the proposed solar projects?

    a. What do you believe were the greatest local community challenges, and how were these challenges overcome?

7) What do you believe were the greatest natural-environment opportunities (such as: ecosystems, air, water, etc.) of the proposed solar projects?

    a. What do you believe were the greatest natural-environment challenges, and how were these challenges overcome?

8) Should solar opportunities be increased, maintained, or reduced in this community? Please explain to what degree and why.

9) If the economy of scale was sufficient, could Cypress Creek Renewables sell directly to a Montanan consumer and forgo interactions with the PSC and regional utility company?

10) Is there anything else about the proposed projects we have not discussed that you would like to tell me about?

11) Is there anyone else with expertise about these proposed solar projects who you think I should talk to about these topics, or share the findings with?

Appendix E

Project Management

Stakeholder and Public Engagement Quotes

Project Management Element	Opportunity/ Challenge	Quote	Project
Project Goals	Opportunity	"Support the expansion of community scale renewable energy projects."	REC
		"We have to change what we're doing and it has to start somewhere, so why not at the schools. The key will be to making sure that not only the students are involved, but you get the parents involved, and you get the parents companies involved and you just start the dominoes."	NWE
		"We recognize that the energy landscape is changing and that we must be willing to consider alternatives. However, we also understand our responsibility to provide a reliable grid network to support all customers."	NWE
	Challenge	"We just committed to uphold the Paris Climate Agreement, and sign the Chicago Climate Charter, and are trying to figure out what that looks like on the ground.... What does 100% renewable energy for the community of Missoula look like? ....We are in the background stages; we have more questions than anything right now before we can even develop that."	NWE
		"We have an all requirements contract with the Bonneville Power Administration where we're 89% hydro, and then 11% of that is nuclear, with some solar and wind from the Columbia, so we have no carbon footprint."	REC
		"The only benefit on either one of them, was the private individuals on each project, besides Cypress Creek, the owners of the land. Other than that, I just didn't get a feeling there was a benefit to anybody else."	CCR

Figure E1. Project goal quotes by opportunity and challenge.

Project Management	Opportunity/ Challenge	Quote	Project
Planning Initiation	Opportunity	"I believe with all my heart that Missoula is one of the places to do a project. And so I contacted … and we invited the local NorthWestern Energy rep to a meeting to make that case; which he had already been warned that we would calling."	NWE
		"They actually started out with 25 kilowatts and then had enough customer demand that they expanded to 50 total kilowatts."	REC
		"Anytime we do a project... we do need to get our facts, figures, and we go through it really hard and make sure we're making the right decision."	REC
	Challenge	"264 respondents said they would buy 813 panels if we offered community solar….When it was all said and done for the project, only 71 members participated."	REC
		"I have no idea what's going on now and I'm a little bit disappointed that it kind of just died and we're no longer being updated, or asked about it, or informed about it even."	NWE

Figure E2. Planning initiation quotes by opportunity and challenge.

Project Management	Opportunity/ Challenge	Quote	Project
Representation and Inclusivity	Opportunity	"What these consumer owned utilities have going for them is their board is governed by their elected board members. So when the board makes a decision the staff kind of falls in line."	REC
		"As an industry bringing a project to a community, I think they did reach out to the right people and make sure most of those people who might have good ideas were there."	NWE
		"I think that right now it's been good that we've brought a variety of partners together, but I think there's potential as the project is rolled out, and whether it's a five year project or beyond, to continue to bring people together…"	NWE
	Challenge	"You only looked at 30 homes and ... within a mile and a half of this there's like 200 homes and there's like 130 other property owners and it's just like a lot of people that they hadn't even looked at. But they went to … the smallest basic number of people that they could possibly alert."	CCR
		"Conflicting perspectives regarding the resource value and the ability to manage ongoing operation and maintenance activities."	NWE

Figure E3. Representation and inclusivity quotes by opportunity and challenge.

Project Management	Opportunity/ Challenge	Quote	Project
Project Information Accessibility	Opportunity	"… outreach with community meetings and we'll do some mailings to the residents around the proposed sites and invite them to a meeting to learn about it, to see what we're considering as initial design and to provide us with feedback. So that'd be step one. I think at the time NorthWestern Energy actually seeks permits for construction that it will also have to go through Development Services and there's a public hearing process that occurs there, so that would be another opportunity not only for those in the immediate area but for the community at large to respond to the proposal."	NWE
		"Every month in the Rural Montanan we did a countdown. We'd get four pages in the Rural Montanan, so we had, you know, 'Watch, there are only 50 panels left.' 'There's 28 panels left, get them while you can.' And tried to keep the process up."	REC
		"There is the outreach component to this... marketing if you will, of what happens at these places to the rest of the communities so they know what's going on.... We need the Missoulian and the Independent to cover these kind of things. We need to set up some competitions. We need to get them in front of city council for presentations, and all that kind of stuff."	NWE
	Challenge	"I also feel because NorthWestern is not a co-operative, that there's a barrier for me in wondering how to communicate with them and how to get news from them.... And so I think a barrier for me is wondering how to engage with a for-profit provider."	NWE
		"I asked them for maybe some references to some of their past projects, and what type of business had followed that solar project into the cities. And I got no response.… I would think that after I did a project like that, I would somehow post that so people would see what a great asset it was that I did that project."	CCR
		"And then the bad science element of it. People said, 'Oh these things are going to be 20' high!' No they aren't, they are going to be like 6-8' high."	CCR

Figure E4. Project information accessibility quotes by opportunity and challenge.

Project Management	Opportunity/ Challenge	Quote	Project
Convener Trust and Credibility	Opportunity	"There is so much history in this area. This [Lewis and Clark Portage] solar farm and educational site, was going to be part of [the] educating attempt for the [Lewis and Clark Portage] heritage area."	CCR
		"I just think it's exciting to have anything going on. Especially when the utility has decided that it's going to take its own money. It's a big step, and I applaud them for that."	NWE
		"I'm really grateful that [REC is] so open to making this an educational model, and I think that in and of itself shows value to the local community, but also to the global community and that was something that maybe we wouldn't know if we didn't have these programs.... It's challenging locally, but it's having an impact [globally]."	REC
	Challenge	"Examples they brought in they were like, 'Well, you know, in Virginia. It's within a quarter mile of these homes and nobody even knows it's there.'…Where here we're trying to put this out in the middle of a … big, huge, flat bowl where everybody sees it."	CCR
		"At first when we started this project there was a handful that said they absolutely didn't want to pay for, so that was one of our main challenges to try to get through to make sure they understood that they weren't paying for it."	REC
		"This year it was a very opposite session more so in the sense that I felt the co-operative employees had lost that gusto... 'We have to start somewhere attitude' that they had the previous year, and it was much more like, 'Yeah, I don't know if it's worth it.'....I think it was still really valuable for [students] to see that sometimes things don't always work out, but you're not going to know if you don't try."	REC

Figure E5. Convener trust and credibility quotes by opportunity and challenge.

Conflict Resolution Quotes

Project Management	**Opportunity/ Challenge**	**Quote**	**Project**
Mitigating Impacts	Opportunity	"That's why [the Board of Directors] went out with the survey because they had been approached… about doing a project.”	REC
		"One of the provisions that I came up with to soften the objections from the historical people was to have some panels telling the historic story on the edge of the solar farm.... In other words, I took advantage of a disadvantage."	CCR
		"You could say yay or nay, or you could refuse to participate like a lot of members did."	REC
		"It's totally understandable as we're going through this that there are times when it's sort of like, ‘Well this would be that easiest path.’… And then it's sort of everybody else's responsibility to come back and say let's remember what the point of doing this is, and provide options."	NWE
	Challenge	“I would've felt a lot better if they had [contractors] from Great Falls and they said we know the area, but that wasn't the case.”	CCR
		“I think what really worked against them is when one of the guys came in here and talked about...We have more energy right now than we need as a county, than we need as to state. He's basically like, 'We don't need this. Even if we have incredible population growth, we don't need it. We have all these hydroelectric dams that are running at a percentage of capacity, and we're still fine.' And I think that's where a lot of people went, ‘Well, Geez, I thought there was a reason for this.’”	CCR
		“We don't know what that process is going to be moving forward. It feels like it's faded, and maybe it hasn't for them, but how would we know?”	NWE

Figure E6. Mitigating impacts quotes by opportunity and challenge.

Project Management	Opportunity/ Challenge	Quote	Project
Compromise Strategy	Opportunity	"So the group … agreed that would be a reasonable outcome because if we continued to focus and fixate on components we would never get the project done."	NWE
		"The members that wanted it, we were an entity that could step up, even though it was a small number, work with them and get the project up and get it running."	REC
		"They've come to a best benefits option which would not only provide energy which is the goal, but also would provide public visibility, and … education for the students and for the public."	NWE
		"I think [CCR] were just saying we will cut our losses because we are just going to face the same uphill battle, and we will just settle for the Black Eagle solar development because it's an industrial area."	CCR
	Challenge	"One of the challenges that we have and that we work with a lot of these utilities… is that they're predominantly hydro-power. And so some of the questions you get from the naysayers is, 'Well, why build solar when we've got this great hydro resource that's low, that's zero carbon already?'…. There are the local investments… economic development, there's the diversity of electric supply, the scalable nature of solar is probably more able to avoid dramatic environmental impacts that a dam or coal plant will have."	REC
		"It shouldn't take two years to figure this project out."	NWE

Figure E7. Compromise strategy quotes by opportunity and challenge.

Appendix F

Project Design

Spatial Component Quotes

Project Design	Opportunity/ Challenge	Quote	Project
Site Consideration	Opportunity	"We have many farmers in Cascade County that would welcome a solar farm on their place just for the additional income, and it would be out of sight, out of mind."	CCR
		"As far as added benefit, you drive up and down the valley from Hamilton to Missoula one way or another you are going to see it so it's visible to everybody. For the people that own it, they can say, 'Hey I have a piece of that.' For us as a co-op, its right in the middle of the community and its better to look at that than weeds."	REC
		"A solar farm is only about eight feet high and it's quiet, it's secure. You don't have any pollution, you don't have any noise. It's everything you'd want in a neighbor, I would think."	CCR
	Challenge	"In general, it's just not really viable to graze livestock around solar panels and you know, they rub on the array, bump the wiring and all that. So it becomes essentially unused land, but if you can find some little use of the plot like planting pollinator friendly species, and putting some bee hives around that."	CCR
		"NorthWestern is going to put it up, it's going to run, it's accomplished what it's goal is. The challenge will be is it visibly sustainable as an education effort for the schools and the community."	NWE
		"It would have been built in a residential area of Great Falls that would be easily visible from my home."	CCR

Figure F1. Site consideration quotes by opportunity and challenge.

Project Design	Opportunity/ Challenge	Quote	Project
Type of Location	Opportunity	"We have many farmers in Cascade County that would welcome a solar farm on place just for the additional income, and it would be out of sight, out of mind."	CCR
		"So looking for marginal lands, or potentially brown-fields, or former industrial sites. I think those kinds of locations make a lot of sense for solar. And of course the beauty's in the eyes of beholder."	CCR
	Challenge	"In general, it's just not really viable to graze livestock around solar panels and you know, the rub on the array, bump the wiring and all that. So it becomes essentially unused land, but if you can find some little use of the plot like planting pollinator friendly species, and putting some bee hives around that."	CCR
		"The concern that I had, and a lot of the neighbors, is they built homes and invested in that property with the idea that it was a residential zoned area, which it was. And so that was kind of the big problem at least from my perspective and I would think most of the people in the area. I think that most people had no problem with the solar."	CCR
		"I think that's kind of a city by city thing."	CCR

Figure F2. Type of location quotes by opportunity and challenge.

Project Design	Opportunity/ Challenge	Quote	Project
Aesthetics and Place Attachment	Opportunity	“A solar farm is only about eight feet high and it's quiet, it's secure. You don't have any pollution, you don't have any noise. It's everything you'd want in a neighbor, I would think.”	CCR
		“As far as added benefit, you drive up and down the valley… It’s visible to everybody. For the people that own it, they can say, ‘Hey I have a piece of that.’ For us as a co-op, its right in the middle of the community and its better to look at than weeds.”	REC
		“But the people already living near a substation didn't object to a substation. When they bought their property next to it they didn't say, ‘Wow NorthWestern Energy, remove that substation before I buy a half a million dollar home here.’”	CCR
	Challenge	“I look out my bedroom window in the morning and there's six horses out there grazing across the prairie. Well, big deal. That's kind of nice. To look at 30 some acres of shiny metal and stuff looking back at you, that's not why we moved out here.”	CCR
		"NorthWestern is going to put it up, it's going to run, it's accomplished what its goal is. The challenge will be is it visibly sustainable as an education effort for the schools and the community.”	NWE
		“Once people learn about the potential value of encouraging that type of development, it no longer becomes an eyesore it becomes kind of just a part of your community, a part of the electric system.”	CCR

Figure F3. Aesthetic and place attachment quotes by opportunity and challenge.

Project Design	Opportunity/ Challenge	Quote	Project
Solar Site Land Ownership	Opportunity	“Especially people that didn't own their property or the orientation of their house didn't work and couldn't have solar. The other benefit was is it wasn't on their property, and we maintain it for 25 years.”	REC
		“The advantage of this site was it was close to a substation and the property owner was willing to lease the property.”	CCR
	Challenge	“The people that owned the Fox project at one time they were local people here. And since they have moved to Kalispell area. We kind of got the feeling, kind of get the sense that it really didn't matter to them what happened to that property.”	CCR
		“It would have been built in a residential area of Great Falls that would be easily visible from my home.”	CCR

Figure F4. Land ownership quotes by opportunity and challenge.

Project Design	Opportunity/ Challenge	Quote	Project
Scale	Opportunity	"We go to the substation all the time, so as far as maintenance, checking it and security, it's all right there."	REC
		"As far as added benefit, you drive up and down the valley from Hamilton to Missoula one way or another you are going to see it, so it's visible to everybody. For the people that own it, they can say, 'Hey I have a piece of that.' For us as a co-op, its right in the middle of the community and its better to look at that than weeds."	REC
		"[Conveners] are looking to be near a substation... The other thing is just being near a load center. Being near a source of electricity demand can decrease what's called line loss. If you have to run electricity down 400 miles of transmission lines, there's a little bit of electricity lost due to heat as it goes through the line. Verses if you're one mile from where it's consumed you don't have that line loss."	CCR
		"At the time we needed another way to feed our west side over there when there were power outages and to help make our power more reliable. So that's why we purchased the property to begin with..."	REC
	Challenge	"The solar generation output for December showing it generated only 1,471 kWh. In July; however, it generated 9,484 kWh. While the idea of solar energy is great, it is not quite proving to be a reliable and significant source of power throughout the year."	REC
		"Transmission capacity, i.e. the ability of a transmission line to accept increased energy loads, varies across a utility's grid and may face limitations due to conductor, pole, and support system characteristics, the viability and expense of a proposed solar project may vary greatly with location."	CCR
		"The developer might have a hunch that there is available distribution system capacity at this location, and so they put in an application with NorthWestern Energy and then through the course of the interconnection review they discover that they're going to have to put in a whole new substation and that just blows the economics out of the water and the whole project flops."	CCR

Figure F5. Scale quotes by opportunity and challenge.

Technological Component Quotes

Project Design	**Opportunity/ Challenge**	**Quote**	**Project**
Technological Components	Opportunity	"There [are] some interesting and innovative ways that we can construct solar that might serve multiple purposes. For example, not only electrical generation, but maybe a shade feature or fencing, or a boundary."	NWE
		"I think those smaller projects, distributed scale utility investments in solar, have the potential to serve the purpose of providing other ancillary services, or in combination with other grid enhancements could potentially provide more stability on the distribution grid."	CCR
		"The other thing we are doing is to get accurate numbers. We are monitoring it for the 25 years. Currently we get daily readings. I have 5 minute data for the panels since they were installed."	REC
	Challenge	"In two years, whatever they purchased will start to become, I don't want to say obsolete, but they will become not as productive because there'll be something new on the market. So yes, they will learn something. Now the question is can they extrapolate that to a new technology. And I assume through some engineering calculation they probably could do that."	NWE
		"I keep going back to the education opportunity of it, and so it's not clear to me how the data that comes from the production of systems like this are all that helpful in the policy discussion."	NWE
		"You would think in the pilot they would've gone for the more innovative. I understand why they would want the stuff that's been on the market that's easily serviceable.... But somebody has to do the innovative part. Somebody has to make the mistakes, learn from them, correct them, and then move on."	NWE

Figure F5. Technological component quotes by opportunity and challenge.

Appendix G External factors

Policy and Administration Quotes

External Factor	Opportunity/ Challenge	Quote	Project
Policy and Administration	Opportunity	"Setting some parameters around acceptable development is a planning policy. Just providing certainty to the solar industry, landowners and planning commissions is really what we're talking about, and that's good for all of those parties."	CCR
		"The other constraint is these utilities have their power supply contracts with BPA and they impose some limits on the size of resources they can develop. So 200 kilowatts is one benchmark, and if they go above that they have to amend some points in their contract. It's not a deal breaker, but it makes the process a little more complicated."	REC
	Challenge	"What are the constraints limiting more renewable resources from getting to a west coast customers... what sort of policy changes need to be made, who pays for any of the transmission development that would need to happen or upgrades to existing facilities, and is there a way to get everything lined up in order to step in when Colstrip One and Two are retired? So that sort of the big picture context, the big picture conversation."	NWE
		"When you install solar you have to still comply with all the building permits, and electric permits, and zoning process, and all that administration."	NWE
		"One, the determination of energy prices, as paid by a utility to a solar project developer, that are competitive for the ratepayers and allow for financing and a reasonable return for the developer; and two a determination that a solar project's energy output will meet the needs of the utility and its customer base and can be incorporated at reasonable expense into the utility's existing transmission and distribution system."	CCR

Figure G1. Policy and administration quotes by opportunity and challenge.

Economic Consideration Quotes

External Factor	Opportunity/ Challenge	Quote	Project
Economic Development Tool	Opportunity	“Millenial's and boomers can live anywhere they want, and they want to live in a place that's dealing with these issues, that has clean air and clean water, recreation opportunities, and the quality of life that this work and solar contributes too. In that new reality, it puts us at an advantage for people to come here and live here, and for business to relocate here. If we have good planning and a good framework so we can grow that way and in a smart way with the respect to climate challenges, consumption, and conservation which I think we’re moving down that road and have a good start.”	NWE
		“In some ways these projects, you build them and they just sit there and generate revenue and clean energy and they don't really create [boom-and-bust industry local infrastructure and service] stresses or costs to the community in a way that some other economic development does. And people don't always think about that.”	CCR
		“That was the monetary advantage to the dairy: to lose the grazing, but pick up the solar farm it more than offset it.”	CCR
	Challenge	“So the downside on the tax situation because we own it versus somebody else the state of Montana allowed us to five year tax holiday…we're still going to be paid on a hundred percent of the valuation of it, which we did not factor into the cost of that. So that's where all sudden your payback period went from 25 years up to about 40 years.”	REC
		“It was kind of a battle on whether it hurt property values or not, but if you were familiar with the site, not that it will ever get built on, but it would be one of the nicest building developments in Great Falls.”	CCR
		“You can state every study you want and say, well it doesn't affect your property value. Well if you have the opportunity to not look at a solar field versus looking at solar field, then you're going to buy a house without it, with a nice view.”	CCR

Figure G2. Economic development tool quotes by opportunity and challenge.

External Factor	Opportunity/ Challenge	Quote	Project
Financing Sources	Opportunity	"I am grateful to NorthWestern Energy for that investment in clean, renewable energy, our jobs in the Missoula area, community, and city."	NWE
		"[The] co-operative projects received some money from USDA through their REAP program, and I think all of them got about 25 percent of the project costs covered that way."	REC
		"... they would lease [the land] for 30 years with a 10 year extension possible or probable.... I think they had finances in pretty good order."	CCR
	Challenge	"It's sad to say most of the people from 60ish on up were the ones who could afford to do this because the younger ones, they weren't going to do it because of the long-term payout."	REC
		"There is a lot of fervor for people who want it, but they don't want to pay for it."	REC
		"[Grant] funding [sources are] limited, and so it would provide kind of a ceiling on the amount of sustainable growth of those types of projects."	REC

Figure G3. Financing source quotes by opportunity and challenge.

External Factor	Opportunity/ Challenge	Quote	Project
Ratepayer Energy Costs	Opportunity	"As far as offset, it helps our members about $2/ month roughly is what they are saving."	REC
		"Most of them have gone in a direction where they're selling subscriptions for each of those projects to individual customers or even just ownership shares."	REC
	Challenge	"The determination of energy prices, as paid by a utility to a solar project developer, that are competitive for the ratepayers and allow for financing and a reasonable return for the developer; and … a determination that a solar project's energy output will meet the needs of the utility and its customer base and can be incorporated at reasonable expense into the utility's existing transmission and distribution system."	NWE
		"A lot of utilities are pushing for changes to their rate designs which raised the base rate and lower the energy rate… that's a dynamic that certainly could negatively affect the prospects for community solar that is virtually net metered."	REC
		"If you're going to spend that same amount of money, you're much better off to dump it into more insulation, more energy efficient items."	REC

Figure G4. Ratepayer energy cost quotes by opportunity and challenge.

Local Community Quotes

External Factor	Opportunity/ Challenge	Quote	Project
Local Community	Opportunity	"That education piece, not only for students and the next people who not only inherit our world... I hope, just by that exposure and that education and then general community education which is going to be part of it, but it's less developed at this point and we have a lot of work to do there."	NWE
		"It gets at that bigger social justice piece really of pollution and health. If they're already spending a huge amount of their income on energy and it becomes more because there is now a summer spike in energy because of air conditioning or something like that, then they're not going to get other things for their basic health and services. It puts vulnerable folks into even more vulnerable positions."	NWE
		"Once people learn about the potential value of encouraging that type of development, it no longer becomes an eyesore it becomes kind of just a part of your community, a part of the electric system."	CCR
	Challenge	"If we can wind up with a million dollars of really wonderful equipment, and if we under invest substantially in programming and in the people, the teachers really, we will be the leaders of these laboratories as we talked about. Then the whole project will fail. It will at least fail to meet expectations and it could fail outright."	NWE
		"I keep going back to the education opportunity of it, and so it's not clear to me how the data that comes from the production of systems like this are all that helpful in the policy discussion."	NWE
		"I don't feel like people in this town or any of the other towns are actually benefiting from this solar.... I don't know how many years it takes, but every day I'm like [all the business that they promised] didn't rush right in."	CCR

Figure G5. Local community quotes by opportunity and challenge.

Environmental Effects Community Quotes

External Factor	Opportunity/ Challenge	Quote	Project
Environmental Effects	Opportunity	"...they don't produce air pollution or water pollution or any kind of pollution while they are in operation, but it also means when the project has to be a retired, you don't have to deal with say groundwater pollution or any other sort of pollution that may be left behind by other types of economic activities…. with these solar projects, you don't have that liability."	CCR
		"The scalable nature of solar is probably more able to avoid dramatic environmental impacts than a dam or coal plant..."	REC
	Challenge	"While many argue that this is 'green' energy, other resources must be used to produce these products. Therefore, 'are they truly green'?"	CCR
		"The only problem in Montana is … it can only supply enough power for five houses on a system, but December… only supplied enough power for maybe one house."	REC
		"Right now there's a fox down there and he's checking all the gopher holes. That's kind of neat to see…. We've got a nice little group of [Hungarian partridges] and grouse right in here, and it's kind of nice to have that. And the more [energy development] that gets built out here, I don't know what it's going to do to [the wildlife]."	CCR

Figure G6. Environmental effects quotes by opportunity and challenge.

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