Equitable Public Electric Vehicle Charging Infrastructure Expansion—From the Tribal Community Perspective

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Abstract

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Transportation electrification addresses climate goals but may exacerbate inequities for disadvantaged communities. Tribal communities' specific EVCI needs remain unexplored despite unique governance, cultural, and geographic circumstances. Existing Indigenous planning research focuses on transportation, energy, and infrastructure separately, lacking integrated frameworks for EVCI. Significant gaps exist in Tribal-specific investigation, sovereignty-respecting collaborative models, and appropriate decision-support tools.

This research develops a community-centric, data-driven scalable mapping tool (SMT) to support Tribes in planning EVCI expansion, conducted in partnership with the Tulalip Tribes. The study employs a mixed-methods approach integrating recognition justice and sociotechnical capacity assessment frameworks, utilizing technical questionnaire protocols for collecting geospatial infrastructure data and social survey protocols for gathering community-driven data on travel patterns and electric vehicle adoption preferences. The methodology implements a four-lens analytical framework (Can Go, Cannot Go, Should Go, and Type) that organizes data

inputs into a decision support system considering both technical feasibility and community priorities.

The research revealed that Tribal communities exist along a spectrum of EVCI readiness, from those with no existing charging infrastructure or limited electrical capacity to those already operating charging stations and pursuing federal grants for expansion. This spectrum presents critical challenges for funding mechanisms, which must be designed with sufficient flexibility to support communities regardless of their current infrastructural position. The analysis identified significant the need for educational programming to ensure Tribal members are aware of electric vehicle usage as well as infrastructure capacity building. These findings emphasize that effective EVCI implementation must recognize the diverse spectrum of tribal infrastructural capacity while simultaneously addressing educational needs and technical infrastructure gaps.

Table of Contents

Introduction....1
Background and Context....1
Research Problem and Objectives....3
Significance....6
Introduction to Indigenous Sovereignty and Indigenous Planning....7
Document Layout....10
Literature Review....11
Current State of Knowledge....12
Research Gaps....12
Transportation and Travel Behaviors....13
Energy....17
Infrastructure....22
Indigenous Planning Foundational Concepts....25
GIS Collaboration with Tribes....27
Theoretical Framework....29
Recognition Justice....29
Sociotechnical Capacity Assessment (STCA) for Technology Transitions....31
Key Concepts and Definitions....35
Methodology....36
Collection Methods....39
Technical Component: Questionnaire Protocol....39
Social Component: Survey Protocol....43
Basemap Protocol....44
Indigenous Data Sovereignty....45
Analytical Framework....46
Analysis and Findings....49
Data Presentation....52
Key Findings....57
Interpretation....59
Discussion....61
The Spectrum of Needs and Challenges....64
Limitations and Next Steps....68
Conclusion....70
Contributions to Planning....70
Future Research Directions....72
Works Cited....75
Appendix....80

List of Figures

Figure 01: Conceptual Diagram........8
Figure 02: Conceptual Diagram........13
Figure 03: Conceptual Diagram with Literature Review Findings........35
Figure 04: Questionnaire Protocol........41
Figure 05: Survey Protocol........43
Figure 06: Analytical Framework........47
Figure 07: Methodology Diagram........49
Figure 08: Tulalip Tribes Overview map........53
Figure 09: Tulalip Tribes O-D map........55
Figure 10: Tulalip Tribes Preliminary EVCI map........56
Figure 11: Tulalip Tribes Electric Access map........57
Figure 12: Tulalip Tribes Charge Model Preference........59

Introduction

This introduction establishes the foundation for developing a community-centric, data-driven scalable mapping tool to support Tribal communities in planning electric vehicle charging infrastructure (EVCI) expansion. The chapter begins by providing essential Background and Context on transportation electrification (TE) as a greenhouse gas reduction strategy, explaining the current EV landscape and charging infrastructure types, and highlighting the unique challenges facing Tribal communities in EVCI planning. The Research Problem and Objectives section identifies critical gaps in Indigenous planning scholarship regarding TE and outlines the study's primary goal of creating a mapping tool specifically for Tribal contexts, along with supporting sub-objectives focused on literature review and community engagement. The Significance section articulates how this research addresses the current under-exploration of TE in Tribal contexts while establishing foundational scholarship at the intersection with Indigenous planning. Finally, the Introduction to Indigenous Sovereignty and Indigenous Planning section provides an overview of relevant principles and how they inform this study's conceptual model.

Background and Context

Multiple national governments have identified TE as a critical strategy for reducing greenhouse gas (GHG) emissions (IEA, 2021). This approach is particularly relevant for Washington State, where the transportation sector accounts for a significant 39% of total greenhouse gas emissions (Washington State DoE, 2019). As the transition toward EVs gains momentum globally, research has emerged challenging the utilitarian distribution model guiding public EV charging infrastructure (EVCI) development on the basis that it may exacerbate existing inequities, particularly regarding access (Ding and Wu, 2024). Among systematically disadvantaged groups, Tribal communities in the United States represent a population whose specific needs and challenges remain largely unexplored in TE planning.

The development of EVCI presents a classic "chicken and egg" dilemma—potential EV adopters hesitate without sufficient charging options, while infrastructure investments lag without substantial EV adoption rates. This circular problem becomes even more pronounced in Tribal contexts, where planning decisions often occur without adequate consideration of their unique circumstances and priorities. These circumstances include distinct governance structures, cultural values emphasizing environmental stewardship, economic considerations such as limited funding sources and revenue-sharing arrangements, and geographic factors like remote locations and dispersed populations that create different infrastructure needs than those found in typical settler-state planning contexts.

Understanding the current EV landscape requires familiarity with both vehicle classifications and charging infrastructure types. EVs primarily fall into two categories: Battery Electric Vehicles (BEVs), which operate exclusively on rechargeable battery systems, and Plug-in Hybrid Electric Vehicles (PHEVs), which combine electric motors with conventional internal combustion engines and can be charged from external power sources.

The charging infrastructure supporting these vehicles consists of three distinct levels, each with different capabilities and applications:

- Level 1 Charging: Utilizing standard 110/120 volt household outlets, Level 1 represents the most basic charging option. While universally accessible, this method provides only 3-5 miles of range per hour of charging, making it suitable primarily for overnight charging in residential settings.

- Level 2 Charging: Operating at 240 volts (similar to electric clothes dryer connections), Level 2 chargers can be installed in both residential and public locations. With the ability to add approximately 25 miles of range per hour, these systems provide practical everyday charging solutions.

- Level 3 Charging (DC Fast Charging): These high-capacity systems, including Tesla's Supercharger network, employ direct current at 480+ volts and 100+ amps. Capable of fully charging a vehicle battery in 20-30 minutes, they serve primarily as commercial installations and support long-distance travel corridors.

Further complicating EVCI implementation is the fragmentation of connector standards across manufacturers and regions. This technological fragmentation creates additional planning challenges and highlights the need for accessible, context-specific guidance and decision-support tools, particularly for communities with limited technical expertise and financial resources. Yet despite these universal challenges, existing research and planning frameworks have largely overlooked how these complexities manifest within Tribal governance structures and community contexts.

Research Problem and Objectives

EVCI development represents an unprecedented domain within Indigenous planning scholarship. The field lacks documented investigation into the specific interests, needs, and challenges Tribal communities face regarding TE, resulting in literature, methodological, and empirical gaps. Most studies on collaborative planning between Indigenous communities and settler-state governments have focused on transportation and energy sectors separately, overlooking the integrated planning frameworks needed for emerging infrastructure like EVCI (Doyon et al., 2021;

McMaster et al., 2024). Although general best practices in collaborative planning can be applied, existing literature reveals significant gaps in understanding how traditional models can be adapted to respect Tribal sovereignty and cultural values, while methodological gaps persist in developing data collection and analysis approaches that prioritize Indigenous knowledge systems and community self-determination (Neecefer et al., 2015; Konstantinos & Parker, 2018). On the other hand, EVCI planning with Tribes remains underrepresented, resulting in both literature and empirical gaps that fail to address the unique intersection of transportation, energy, and infrastructure sectors in Indigenous contexts.

Transportation research has identified key challenges including funding limitations through programs like the Indian Reservation Roads (IRR) Program, demographic complexities requiring case-by-case analysis, and the critical need for government-to-government relationships that respect Tribal sovereignty rather than employing top-down prescriptive approaches (TRB, 2007; NAS, 2011; Shinstine et al., 2015). However, these studies focus primarily on access and livability concerns, lacking robust frameworks for emerging technologies like EVCI. Moreover, energy transition research demonstrates successful Indigenous-led models emphasizing cultural integration and self-determination, yet these findings have not been systematically applied to TE planning (Rakshit et al., 2019; Konstantinos & Parker, 2018). Therefore, examining collaborative EVCI planning while recognizing Indigenous sovereignty and integrating cultural values to inform policy decisions remains a critical yet underexplored aspect of infrastructure development in Tribal contexts. These knowledge gaps limit the ability to design contextually appropriate solutions with these sovereign nations. Initial communications with Tribal liaisons have revealed several critical barriers, including "educational needs, lack of comprehensive understanding of potential benefits, as well as lack of visual data-driven decision support tools," (CEI Grant Proposal).

Transportation patterns in Tribal communities often involve substantial travel distances that could benefit from electrification, particularly given that many Reservations are rural in nature with dispersed populations and limited public transportation options. A survey of Yakama Tribal employees, for instance, documented average daily commutes of 44 miles (CEI Grant Proposal). More notably, Tribal government personnel frequently undertake extensive driving for official duties, with forestry department employees routinely covering approximately 200 miles daily (CEI Grant Proposal). These significant travel requirements suggest that TE could offer meaningful economic and environmental benefits to Tribal communities—but only when implemented with careful consideration of their specific contexts, priorities, and sovereignty.

This research centers on developing a community-centric, data-driven scalable mapping tool (SMT) to support Tribes in planning EVCI expansion within their territories. This primary objective is complemented by two essential sub-objectives:

1. Conducting a comprehensive literature review examining potential impacts—both positive and negative—of EVCI development on Tribal communities and identifying appropriate mitigation strategies through policy and educational programming.

2. Designing and implementing culturally appropriate Tribal engagement activities to gather direct input from community members regarding their specific needs, concerns, and challenges related to public EVCI expansion.

While the resulting SMT is designed to serve as a resource for any federally recognized Tribe interested in TE, this research was conducted in partnership with the Tulalip Tribes through a collaborative relationship facilitated by Sparks Northwest. The Tulalip Tribes were already engaged in electrical infrastructure planning and energy planning initiatives when this project began, making the EVCI research directly aligned with existing tribal priorities and planning efforts. This collaborative approach ensured the resulting tool would reflect authentic community priorities rather than imposing external assumptions or standardized solutions inappropriate for sovereign Tribal contexts.

This project addresses the following primary research question: What are the EVCI expansion needs and challenges specific to Tribal communities?

This central inquiry is supported by several interconnected sub-questions:

1. How can these needs and challenges be most appropriately measured or assessed, particularly regarding Tribal concerns identified through literature review?
2. What methodologies enable effective geospatial representation of these concerns within the mapping tool framework?
3. Which identified concerns have supporting data available at the basemap scale for standardized inclusion?
4. Which concerns demonstrate significant case-by-case variation requiring customizable approaches?

Significance

TE offers several potential benefits that align with Tribal priorities for environmental stewardship and economic sovereignty. The transition to EVs could significantly reduce fuel expenditures and environmental impacts from air pollution and noise—outcomes that could strengthen both the ecological sustainability and economic resilience of Tribal nations over time. For Tribal government fleets that routinely cover extensive mileage, the economic advantages of reduced fuel and maintenance costs could yield particularly meaningful fiscal benefits, allowing redirection of resources toward other community priorities.

The current under exploration of TE in Tribal contexts, however, limits the realization of these potential benefits. This research addresses this gap by developing both educational resources and practical decision-support tools tailored specifically for Tribal governance systems. By operating within environmental, transportation, and energy justice frameworks, this project establishes foundational scholarship at the intersection of Indigenous planning and TE, creating pathways for future research and implementation that respect Tribal sovereignty and self-determination.

Introduction to Indigenous Sovereignty and Indigenous Planning

Engaging with Tribal communities necessitates recognition of the government-to-government (G2G) relationship and trust responsibility established between each federally recognized Tribe and non-tribal governments. Tribal sovereignty, the inherent authority of Tribes to govern themselves as distinct political entities with jurisdiction over their territories and citizens, forms the foundation of these relationships. This fundamental relationship must be respected throughout research processes, ensuring that interactions proceed as engagements between sovereign entities rather than defaulting to conventional researcher-subject dynamics. This respect of Tribal sovereignty forms the foundational principle guiding both the methodological approach and community engagement strategies employed throughout this project. This relationship, and this project's context, is illustrated in the figure below.

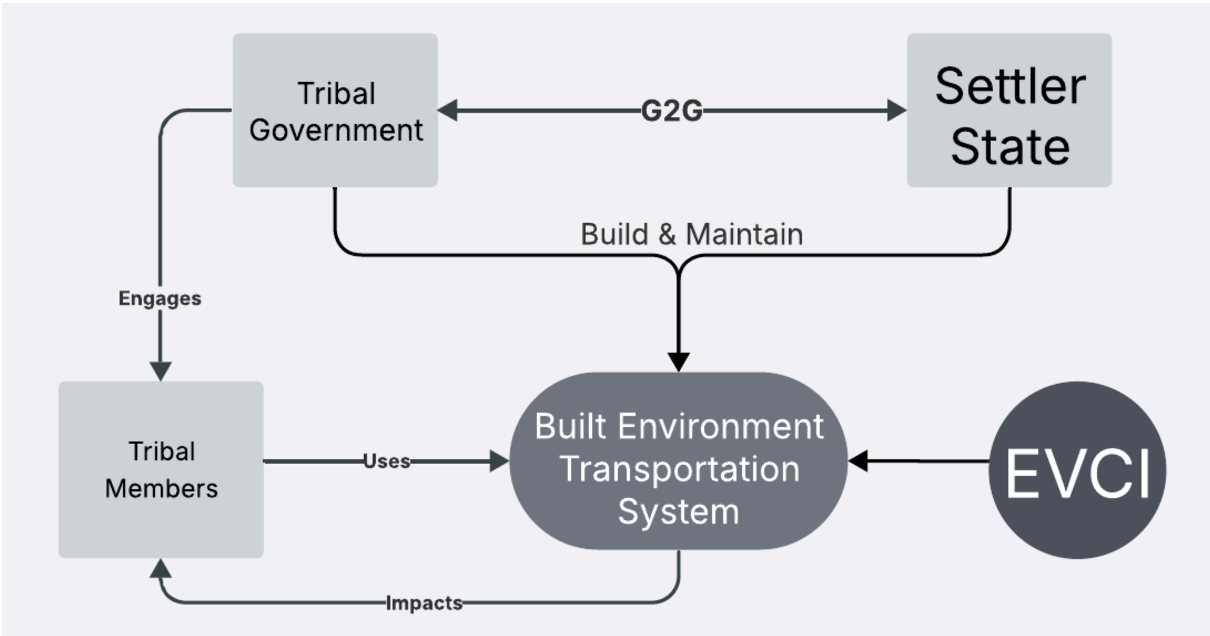


Figure 01: Conceptual Diagram

The diagram reveals how both Tribal and settler-state governmental entities jointly build and maintain the transportation system, shown as flowing from their collaborative effort. Meanwhile, Tribal governments maintain engagement with their members, who in turn use the transportation infrastructure. This usage creates a feedback loop as the transportation system ultimately impacts Tribal members, completing a cycle of influence and consequence. EVCI, then, can be conceptualized as being mapped onto this existing system, requiring a deep understanding of planning practices in relevant sectors from both the settler-state and Tribal perspectives. This need for deep understanding immediately raises critical questions about what information researchers can and should access when working within Tribal contexts, and how to approach knowledge gathering in ways that respect Tribal protocols and sovereignty.

A crucial understanding for this work are the levels of information disclosure in Indigenous planning, of which there are four: 1) *information conveyed,* 2) *in-house, operating information,*

3) *public information,* and 4) *public access*. All four levels step successively out from a *full understanding* and reflect deliberate in-group and out-group dynamics that protect cultural knowledge while enabling appropriate collaboration with external researchers. A *full understanding* can only come from being born and raised in-community, as this information requires a cultural clearance that researchers do not possess unless they are in-community themselves. This level represents the deepest form of cultural knowledge, accessible only to those within the in-group who have been socialized into the community's values, protocols, and ways of knowing.

The closest an out-group researcher can get is *information conveyed*, that which is transferred when working with in-community individuals. This cultural protocol ensures that sensitive information pertaining to topics like sacred sites, materials, or kin is shared only among those who have appropriate access to such knowledge. This boundary should be respected at all stages of research and points to the first best practice: that if information sought cannot be found even in direct engagement, it is not for you to know.

In-house, operating information is typically siloed across the departments of a Tribal government to ensure the full picture is not easily accessible to outsiders. This level often overlaps with the next as both follow the same logic of controlled accessibility by design. The next level, *public information* is available from sources like the Tribe's official website, social media pages, and newsletters, but can be difficult to access, often by intentional design. For instance, information on a particular Tribe's holidays likely does not exist as a comprehensive list on the front page of their website but might exist piecemeal across newsletters spanning a year.

Finally, *public access information* is both available and accessible, such as the Environmental Protection Agency (EPA) Tribal Consultations. With this understanding comes the second best practice: that every effort should be made by researchers to locate information from resources the Tribe has already made available (i.e., in-house, operating and public information) before engaging the Tribe directly (i.e., information conveyed). Following this practice not only respects the hierarchical nature of information disclosure but also builds trust by demonstrating that researchers have invested effort in understanding what communities have already chosen to share publicly.

Document Layout

The remainder of this document follows a structured organization:

The Literature Review section explores foundational concepts in Indigenous planning, establishes the theoretical framework guiding this research, and presents comprehensive findings addressing one of the project's central sub-objectives. This section begins by examining the current state of knowledge regarding EVCI planning with Tribes, conceptualizing the field as existing at the intersection of transportation, energy, and infrastructure planning domains.

The Methods section describes the data requirements identified through literature review, proposes collection methodologies appropriate to the nature of each variable, and outlines the analytical framework employed. This section details both the community engagement approaches and technical methodologies utilized in developing the scalable mapping tool.

Results/Findings/Analysis presents the outcomes of the literature review and methodology sections, with particular attention to findings that inform the development of the scalable mapping tool. The SMT acts as the analytical framework and pulls together established data models on travel behavior and patterns to perform the analysis.

The Discussion section contextualizes these findings within broader scholarly and practical frameworks, drawing connections between specific results and their implications for Indigenous planning practice. In this, the limitations and next steps acknowledge methodological constraints and suggest directions for future research and implementation.

The Conclusion synthesizes key findings and articulates their implications for Indigenous planning, transportation policy, and environmental justice frameworks.

Literature Review

The purpose of this literature review is to establish and specify the literature and methodology gaps in collaborative planning between Indigenous communities and the settler-state, particularly the lack of Indigenous-centered planning frameworks and the absence of culturally appropriate methodological approaches for emerging infrastructure needs such as EVCI. Existing literature reveals significant gaps in understanding how traditional collaborative planning models can be adapted to respect Tribal sovereignty and cultural values, while methodological gaps persist in developing data collection and analysis approaches that prioritize Indigenous knowledge systems and community self-determination in infrastructure planning. The review first details the current state of energy transitions and EVCI in both the settler-state and Tribal contexts includes a survey of the foundational concepts related to Tribes and collaboration. Finally, the review closes with a summary of project relevancy, specifying the existing knowledge and gaps with respect to Tribal EVCI planning as well as the data implications for a key deliverable of this research project. These sections are intended to serve as a general framework for approaching Tribes in collaborative EVCI planning and, for this project, a profile of the Tribal partner will be included to illustrate its use. This review will inform the next steps involving workshop and survey engagement with Tribes by highlighting the data categories and potential models for representing community EVCI needs.

Current State of Knowledge

Research Gaps

EVCI planning with Tribes is underrepresented, resulting in both a literature and an empirical gap. Nevertheless, by conceptualizing the field of EVCI planning as existing at the triple point overlap of transportation, energy, and infrastructure, we can essentially extrapolate data and lessons to inform this novel field, overcoming theoretical, methodological, and conceptual gaps. Further, given the way EVCI interventions integrate into the current transportation system, understanding the current terrain of Tribal energy, transportation, and infrastructure planning is vital. To this end, the following presents case studies for each of the three sectors to provide a general description. The diagram below builds upon that in the Introduction section by visualizing the relevant sectors of EVCI planning.

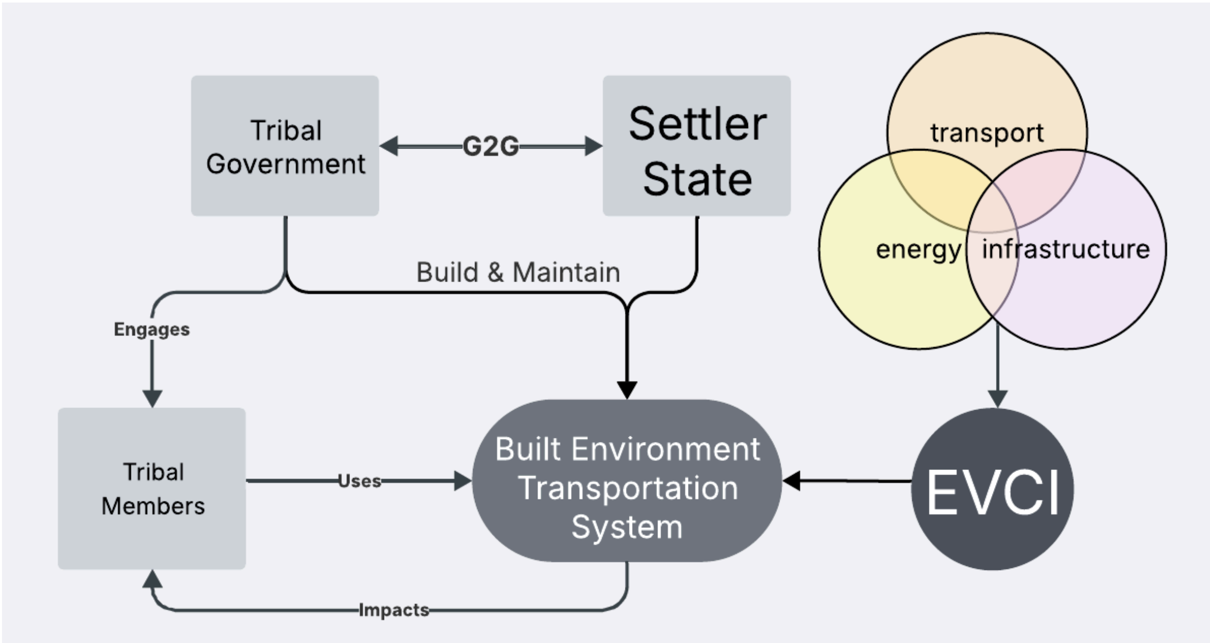


Figure 02: Conceptual Diagram

Transportation and Travel Behaviors

While EVCI planning with Tribes is still in its infancy with sparse research, general best practices in the broader field of collaborative planning can be applied. The literature is robust in the transportation sector, especially with the Federal Highway Administration (FHWA) and the Transportation Research Board (TRB) publishing project reports and peer-reviewed research on Tribal Transportation Programs (TTP). As both organizations work with Tribes across the country, the best practices distilled from their work are highly reliable.

Much of the literature on transportation planning in Tribal contexts does so from the perspective of livability. While definitions of livability for Tribes vary case-by-case, Shinestine et al. found that safety and access are two terms generally used by Tribes to characterize livability in this sense (2015). Recent research by Becker et al. (2022) with the Eastern Washington University's Small Urban, Rural, and Tribal Center on Mobility (SURTCOM) provides a quantitative assessment of resource accessibility on American Indian Reservations in the Western United States, examining key destinations including grocery stores, department stores, healthcare facilities, and transportation infrastructure. Their findings highlight significant disparities in access to essential resources, with 41 reservations completely lacking grocery stores within their boundaries and 28 reservations having ratios higher than 1,000 people per grocery store. Similarly, 80.3% of reservations lack department stores entirely, indicating severe limitations in access to essential goods (Becker et al., 2022). The concept of "livability" in transportation planning extends beyond mere access to include broader community well-being. Doyon et al. (2021) connect transportation to justice and self-determination, framing transportation factors as elements that can contribute to or detract from livability within tribal contexts. Their research introduces the concept of "sustainable self-determination," drawing on Indigenous perspectives and principles like the "Dish with One Spoon" wampum, which emphasizes relationality, sovereignty through relationality, and transdisciplinary co-production in addressing complex challenges (Doyon et al., 2021).

A 2007 National Cooperative Highway Research Program synthesis on Tribal Transportation programs found the two main influences for transportation demand are demographics and geography (TRB). The former determines the need for services and the latter determines how to administer those services including neighboring or overlapping jurisdictional cooperation. Ndembe et al. (2021) specifically focus on demographics as they relate to transportation needs, emphasizing that understanding Tribal community demographics is crucial for developing tailored transportation programs. As Tribal areas are often similar to rural contexts in terms of geography and demographic distribution, travel behavior is also similar with long commute distances favoring personal automobile mode choice (Ndembe et al., 2021; Shinstine et al., 2015).

Further, this inherent preference for personal automobile mode choice in rural travel behaviors has acute social impacts on youth, the elderly, and the differently abled populations as it renders them immobile if they cannot access a personal automobile (Shinstine et al., 2015), underscoring the role of demographics. Ndembe et al. found that it is often these sensitive sub-populations of Tribal memberships that drive demand for transit services (2015). While this can be thought of as a general rule of Tribal transportation behavior, the NCHRP synthesis does specify that demographics and geography vary significantly between Reservations (TRB, 2007) and each instance of collaboration should seek to highlight the particularities that may make or break the parallels with rural transportation behavior. In fact, Becker et. al. found that 80% of the 71 reservations are in rural contexts, seven percent in mostly urban areas, and 13% in mixed urban-rural areas (2022).

In addition to understanding the transportation behaviors common in Indian Country, it is important to consider transportation planning efforts. Research from the TRB and NAS have identified maintenance funding as a major concern for Tribes engaging in this sort of planning as funds for initial project development are often available in the construction phase but not for the built product's lifespan (2007; 2011). The document highlights that funding for tribal transportation projects primarily comes through the Indian Reservation Roads (IRR) Program, administered by FHWA, with the Tribal Transportation Allocation Methodology (TTAM) distributing these funds based on tribal needs and other factors (TRB, 2007). Such ongoing funding issues can be attributed to the limited economic development opportunities for Tribal Governments as taxation is not a reliable means of revenue generation. Instead, Tribal governments must develop other means that are much more involved and slow on return (i.e., enterprise developments like casinos, convenience stores and gas stations, and smoke shops).

The TRB and NAS reports also state that Tribes are sovereign nations and that the top-down prescriptive planning approach often employed by external collaborators does not respect this truth; direct interaction and partnership are the preferred modes of collaboration (2007; 2011). The TRB report emphasizes the importance of the government-to-government relationship between tribal governments and the U.S. federal government, rooted in treaties and historical agreements (2007). The Washington State DOT's relationship with 35 federally recognized Tribes serves as a national model for state/tribal planning, with their guidebook assisting Tribes in understanding and participating in transportation planning (NAS, 2011). This relationship necessitates consultation and recognition of tribal sovereignty, particularly as tribal lands face unique challenges related to their rural nature, geographic isolation, limited resources, and checkerboard land ownership patterns (Shinstine et al., 2015; TRB, 2007). Further, the NAS source calls out the need for culturally competent actors who are sensitive to the particular histories and practices of Tribal partners and able to employ that knowledge in a collaborative manner (2011). Successful examples like the Navajo Nation's comprehensive transportation program, which includes its own DOT and dedicated funding sources, demonstrate the potential for Tribes to exercise control over their transportation systems when properly supported (NAS, 2011).

Effective transportation planning in tribal communities requires coordination and collaboration between Tribal governments, federal agencies (eg. FHWA, BIA), state departments of transportation, and local governments (FHWA, 2009; NAS, 2011). This section of the review has identified best practices for Tribal transportation planning and the terms Tribes tend to think of transportation in. When approaching a Tribe in a transportation planning setting, maintain a direct relationship and avoid top-down practices. Also, understand that funding is a primary concern with projects in this sector and might drive the project. Transportation is thought of as an element of livability and this fractures along demographic lines that Tribal governments take care in addressing.

Energy

The work of Necefer et. al. (2015) investigates Tribal perspectives on energy production through a case study of the Navajo Nation. Building on this foundation, two additional case studies of energy transition projects in First Nation contexts in Canada were identified and reviewed to broaden the understanding of Indigenous energy transitions. The first case study, examined by Rakshit et al. (2019), focuses on the Poplar Hill First Nation in northern Ontario and explores the complexities of transitioning from off-grid diesel systems to grid connections while considering renewable energy options, highlighting the interdisciplinary challenges involving historical, geographic, cultural, technological, and regulatory factors. The second case study, analyzed by Konstantinos and Parker (2018), examines the transition to renewable electricity technologies across 144 Canadian remote Indigenous communities between 1980 and 2016, revealing a shift from utility-driven to community-driven approaches and demonstrating how Indigenous communities have evolved from passive technology recipients to active participants in transforming their electrical systems based on local sustainability agendas and self-governance goals. These two Canadian studies were reviewed using a framework informed by the Necefer Navajo Nation case study to increase the applicability of findings to the U.S. context and provide comparative insights into Indigenous-led energy transitions. This analytical lens has five dimensions through which the Canadian case studies will be presented: (1) Cultural and

Environmental Values in Energy Decision-Making, (2) Self-Determination and Energy Governance, (3) Complex Socio-Technical Systems, (4) Learning and Adaptation Processes, and (5) Policy Applications. Together, these three case studies provide a comprehensive foundation for understanding the diverse contexts, challenges, and approaches that characterize Indigenous energy transitions across North America.

Cultural and Environmental Values in Energy Decision-Making

Cultural and environmental values in energy decision-making refer to the integration of Indigenous worldviews, traditional ecological knowledge, and cultural priorities into energy system planning and implementation, recognizing that energy choices reflect deeper cultural relationships with land and natural resources. Rakshit et al. (2019) emphasize the necessity of this integration when designing local energy systems. A participant from the Poplar Hill First Nation case study articulated a profound cultural view: "our ancestors got energy from our natural surroundings, the new power is only a colonial way," revealing how energy transitions are perceived as cultural negotiations rather than merely technological shifts. Konstantinos and Parker's work involves remote Indigenous communities in Canada who rely on diesel-generated electricity, face significant environmental challenges, and poor quality services. Communities prioritize reducing "black carbon" emissions and preventing fuel spills that contaminate soils. These environmental concerns are key drivers for transitioning to renewable electricity technologies (RETs) (Konstantinos and Parker, 2018). Indigenous communities often reject energy solutions that negatively impact traditional land use. These Canadian cases where communities evaluate renewable technologies primarily through their compatibility with cultural values, align with Necefer et al.'s (2015) findings on the Navajo Nation, where concerns about land and water impacts led to opposition to certain energy projects.

Self-Determination and Energy Governance

Self-determination and energy governance refers to Indigenous communities' exercise of sovereignty and self-governance in controlling their energy systems, moving from external dependency to community-led ownership and decision-making over energy infrastructure and policies. This concept encompasses both the institutional arrangements that enable local control and the political processes through which communities assert authority over their energy futures. Konstantinos and Parker (2018) document a significant shift from a "utility driven phase" (1980-2000) dominated by government ownership to a "community driven phase" (2001-2016) centered on community-led solar projects. This evolution represents Indigenous communities' transition from passive recipients of technology to active participants shaping energy systems according to their sustainability visions. Rakshit et al. (2019) highlight Poplar Hill First Nation's development as an Independent Power Authority (IPA), demonstrating a desire to "own and operate their own local utility." This institutional arrangement enables local control and self-determination in energy management, freeing the community from external government regulations. This initiative emphasizes community consultations and operations, reflecting Necefer et al.'s (2015) call for decision frameworks that create community ownership over natural resources.

Complex Socio-Technical Systems

Complex socio-technical systems in Indigenous energy contexts refer to the intricate networks of technological, social, institutional, and political relationships that shape energy transitions, recognizing that successful energy development requires understanding and navigating multiple interconnected systems rather than focusing solely on technical solutions. Energy governance in Indigenous contexts involves complex "interdependencies between federal, provincial and local governments," (Konstantinos and Parker, 2018). Both Konstantinos and Parker (2018) and Rakshit et al. (2019) note how policies at different governmental levels create a complex regulatory landscape affecting RET deployment in remote communities. Rakshit et al. (2019) and McMaster et al. (2024) emphasize that "community appropriate sustainable energy solutions requires more than building renewable energy projects—it requires local socio-technical capacity to design, implement, and maintain renewable energy projects." This understanding aligns with Necefer et al.'s (2015) perspective on the interconnectedness of social and technical dimensions. The transition process involves dynamic "interactions between participating actors' structures, cultures, and practices" including utilities, Indigenous communities, and various government levels (Konstantinos and Parker, 2018). These relationships involve unpredictable negotiations influenced by divergent values, illustrating the social complexity in energy transitions.

Learning and Adaptation Processes

Learning and adaptation processes refer to the iterative mechanisms through which Indigenous communities experiment with, evaluate, and refine energy technologies and governance approaches over time, building local knowledge and capacity while adapting solutions to community-specific contexts and values. This concept recognizes that successful energy transitions require ongoing learning cycles rather than one-time technology transfers. Konstantinos and Parker (2018) describe an "evolution from an initial slow phase of community experimenting with different technologies and demonstration scale projects to a fast phase of increasingly larger scale solar applications" between 2001-2016. The authors also note the importance of "indigenous governments expressing their interest in local electricity systems' transformation through participation in energy charrettes, workshops and conferences." McMaster et al. (2024) further highlight "inter-local energy networks to enable knowledge sharing," creating vital learning mechanisms. This progression mirrors Necefer et al.'s (2015) understanding that successful energy development requires iterative learning.

Policy Applications

Policy applications in Indigenous energy contexts refer to the coordination of multiple governmental policies and programs to create supportive frameworks that respect Indigenous sovereignty, provide technical assistance, and enable community-led energy development. Effective policy approaches recognize the unique legal and cultural status of Indigenous communities while addressing the multi-jurisdictional complexity of energy governance. Konstantinos and Parker (2018) emphasize the critical need for "coordination of multiple provincial and federal policies and programs with RET related policies," echoing Necefer et al.'s (2015) call for improved decision frameworks involving all relevant stakeholders. Multiple sources also emphasize the value of technical support programs. Konstantinos and Parker (2018) note policies that "provided technical support" were crucial, while Rakshit et al. (2019) explicitly call for "energy support programmes in education and capacity building." Rakshit et al. (2019) clearly state that energy system transitions will fail if they negatively affect Indigenous "lifestyle, cultural values, and rights," referencing Section 35 of the Canadian Constitution regarding the duty to consult. This constitutional recognition of Indigenous rights has created a foundation for more respectful energy planning approaches.

These findings suggest that energy transitions can succeed when they prioritize Indigenous agency, integrate cultural perspectives, build local capacity, and create supportive policy environments that respect traditional relationships to land and resources. The shift from utility-driven to community-driven renewable energy models represents a significant transformation that aligns technological change with the broader goals of Indigenous sovereignty.

Infrastructure

Bottom-up Planning

The study by Miletić et al. (2022) highlights the need to include Native American voices in understanding infrastructure challenges, priorities, and opportunities to move towards more sustainable and resilient infrastructure systems. They argue that Indigenous perspectives must be considered. Their community-based participatory research approach in Southern California emphasized aligning community members' insider knowledge with academic and methodological expertise. This approach facilitated mutual respect and understanding between researchers and participants. Training native engineers was identified as a key priority, as they are best positioned to understand the infrastructure needs and opportunities within their own communities while respecting tribal sovereignty and decision-making.

In a similar vein, leveraging cultures, sovereignty, and care for the welfare of tribal communities is important for creating more sustainable infrastructure systems. Tribal sovereignty allows for innovation in sustainable infrastructure, but must not be compromised by any infrastructure system, as it is critical for building equitable infrastructure that maintains self-determination. In other words, Reservations can be viewed as spaces for innovation where different government regulations, coupled with a strong ethic for sustainable natural resource use, can creatively design the next generation of sustainable infrastructure systems.

The research emphasizes that not only is integrating Native American perspectives important, but direct involvement of traditional knowledge and practice in infrastructure design is also critical for creating sustainable, resilient, and ethically fair infrastructure systems. More community-based participatory research is needed to understand how specific traditional knowledge and practices can lead to innovative, sustainable infrastructure systems. In contrast to top-down approaches, the study underscores the importance of asking tribal governments and communities what classes and expertise they need rather than prescribing solutions.

Eco-cultural Concerns and Tribal Involvement

Diver et al. (2024) emphasize the interconnectedness of ecological, cultural, and ceremonial relations with the Klamath watershed from the Karuk Tribe's perspective. The Tribe recast dam removal as a holistic eco-cultural revitalization initiative, going beyond just infrastructure removal or single-species restoration. This perspective reconfigures dam removal goals to include improving community health and well-being, enhancing spiritual elements of river restoration, responding to colonial legacies, and engaging tribal youth. For the Karuk community, dam removal was more than a fisheries restoration project; they hope the entire ecosystem will benefit, including the human communities living in relation with the river. Restoration focused on single-species management is seen as running counter to the interconnectivity centered in Karuk Traditional Ecological Knowledge (TEK) and has consequences for Karuk eco-cultural practices.

Karuk concepts of eco-cultural revitalization describe the social and political significance of dam removal for Indigenous-led river restoration, emphasizing the revitalization of human connections and responsibilities to the land, animals, plants, water, each other, and the spirit world. Salmon represents an integral part of their cultures, including unique ceremonies, and the dwindling salmon runs led to the loss of these ceremonies. This highlights the deep eco-cultural impacts that need to be considered from the project's beginning. The Karuk Tribe's World

Renewal ceremonies highlight their responsibilities for actively stewarding the place that sustains them, both physically and spiritually, through reciprocal relationships. Dam removal is seen as a transformative moment, facilitating spiritual alignment and enabling Karuk people to fulfill these obligations. The study underscores the importance of Karuk participation in eco-cultural revitalization activities through dam removal and river restoration, where they are "fixing the world" themselves in alignment with their World Renewal philosophy. Restorative justice requires creating on-the-ground experiences where Karuk community members can enact their culture and practice TEK by participating in river restoration.

Gosnell and Kelly (2010) discuss how improved social relations between Tribes and non-tribal entities, partly through local collaborative processes, were critical to the agreement for Klamath dam removal. They note a power shift taking place between tribal and non-tribal interests as Tribes gain access to decision-making processes regarding tribal trust resources and develop the capacity to participate in complex restoration strategies. That is, the Federal Energy Regulatory Commission (FERC) re-licensing process created a regulatory deadline that provided impetus for negotiation. This emphasizes that the ability of Indigenous peoples to effectively influence decisions around dam construction and management depends on the laws defining Indigenous rights, and it demonstrates the importance of a robust legal framework that protects the rights of all stakeholders and ensures environmental integrity, providing a forum for inclusive decision-making. The emergence of a forum for integrating multiple basin needs and the growth of a bottom-up, place-based approach to collaborative governance involving tribal and non-tribal groups was crucial. The authors suggest that the unified local leadership in the Klamath depended on changing power dynamics and a more even playing field, where farmers realized they needed to work more horizontally with tribal leaders.

Indigenous Planning Foundational Concepts

As mentioned in the Introduction, the official relationship between Tribes and settler-state governments is a G2G relationship established between each federally recognized Tribe and the U.S. Federal Government stemming from Tribes' inherent sovereignty. Because Tribal sovereignty is inherent rather than granted, Tribes retain the fundamental right of self-determination, meaning they choose how to exercise their sovereign powers and with whom to engage in collaborative relationships. This principle of self-determination extends to planning and development decisions, where Tribes maintain the authority to determine their priorities, select their partners, and define the terms of engagement with external entities, whether those are federal agencies, state governments, private companies, or research institutions. What this means for planning with Tribes is that no collaborative project should be pursued unless the Tribe has already expressed interest in the specified type of project, as doing otherwise would fail to respect their sovereign right to set their own agenda and make autonomous decisions about their lands, resources, and community development priorities.

Going further, the U.S. Constitution explicitly recognizes Tribal governments as one of four sovereigns, alongside federal, state, and foreign governments, establishing the legal foundation for G2G relationships between Tribes and the federal government. This relationship is further defined through Federal Indian Law, the body of documents and decisions that establishes the legal and political status of American Indians and Alaska Native Tribes, which continues to evolve today. The implementation of this sovereign relationship, however, has been shaped by shifting Federal Indian Policy across distinct historical eras that serve as markers of different policy approaches to the trust relationship between the U.S. and Tribes. The history between the U.S. settler-state and Tribes can be delineated as several distinct eras: Precontact, Colonial era, Treaty era, Land-dispossession era, Indian reorganization era, Termination era, and the current era of Tribal self-determination (D. Stevenson, Introduction to Indigenous Planning course, March, 2025). Sovereignty was only operationalized after the Land-dispossession era in the Indian reorganization era through the concept of self-governance, and was an attempt at mass standardization of Tribal government structures to align with U.S. governmental forms in hopes of simplifying the G2G relationship. This was followed by the termination era, in which the U.S. Federal Government sought to end the relationship between them and the Tribes entirely. The current era of Tribal self-determination recognizes the inherent incommensurability between the two parties because of the traumatic history brought on by settler-state action and fundamental differences in worldviews (D. Stevenson, Introduction to Indigenous Planning course, March, 2025).

In this current era, there are two concepts to consider: the Federal-Indian trust relationship and Plenary Power. The trust relationship includes all "legal duties, moral obligations, understandings and expectations that have arisen from the entire course of dealing between the federal government and the Tribes," (Canby, 2015; pg. 35) and ultimately requires the Federal Government to act in the interest of the Tribes' wellbeing and economic prosperity. This responsibility is carried out primarily through acts of Congress as they hold Plenary Power--the absolute, unlimited authority over all Indigenous peoples and governmental affairs. Given that there is no mandated Tribal representation within Congress, this system is ripe with contestation.

The final foundational concept is the complex property jurisdictional system, which comprises four land status types: Tribal trust lands, Tribal allotted lands, Tribal fee land, and Fee land (Hill & Tovey, 2023). What distinguishes the four typically includes who holds the title, the jurisdiction with regulatory rights, and the ability for land transfer. Tribal trust lands' titles are held by the Federal government, though the beneficiary title holder is a particular Tribal group, also acting as the regulator. These lands cannot be sold or transferred, though there are some rare exceptions. Tribal allotted lands' titles are similarly held by the Federal government, but the beneficiary title is held by individual members of the Tribe rather than the entire community. These lands can be sold or gifted with permission from the interest holder. Tribal fee lands are those where the Tribe holds the title and beneficiary title but may be taxed and regulated by the State and county in which it is situated, depending on their relationship. Tribes have full rights to sell or gift these lands as they are fee simple, and they can be converted to Tribal trust through a Bureau of Indian Affairs (BIA) process. Fee lands' titles are held in fee simple absolute with full rights to sell or gift and may be owned by non-Indians or Tribal members alike. The lands are contained by a Tribe's reservation boundaries but are taxed by the state or county if owned by non-Indians. This variety of land types can result in a mosaic of parcels comprising Indian Country (Hill & Tovey, 2023). This phenomenon is known as "checkerboarding" and carries several planning and research implications considered in the following section.

GIS Collaboration with Tribes

Indigenous Data Sovereignty in GIS Collaborations

GIS collaborations with Tribal Nations represent a critical intersection where issues of data sovereignty, land representation, and historical cartographic injustices converge. Western mapping practices have historically functioned as tools of colonial occupation, with Lucchesi (2020) observing that "cartography has served as a tool for colonial occupation of Indigenous lands world-wide... maps were used to clearly delineate arbitrary lines between where Indians were allowed to be and where they were not, and for which land belonged to which thieves."

This historical context necessitates approaching GIS collaborations with a fundamentally different framework than conventional community-based participatory research.

Despite this, many conventional participatory mapping projects have been critiqued as remaining "exploitative and deeply rooted in colonial epistemologies" where researchers "import Western styles of mapping into Indigenous communities, hand community members the pencil and ask them to draw their knowledge on a topographic base map, and then leave," (Lucchesi, 2020). These approaches often privilege researcher benefits over meaningful community outcomes and fail to integrate Indigenous epistemologies into the mapping process itself. Moving beyond these extractive practices demands methodological approaches that center community agency, respect cultural protocols, and ensure that mapping efforts contribute to community-defined goals rather than solely academic outputs.

Addressing these historical and contemporary cartography issues begins with recognizing Indigenous Data Sovereignty (IDS). As noted by Harding et al. (2012), Tribal sovereignty, predating European contact, differentiates Indigenous communities from other research partners, requiring recognition of "inherent rights to self-determination". This sovereignty extends directly to spatial data, where Indigenous peoples have the right to "own, control, and determine the use of data about themselves, their communities, and their territories" (Lucchesi, 2020). The implementation of IDS principles in GIS work requires shifting authority over information collection, storage, interpretation, and distribution to Tribal partners. However, implementing these sovereignty-respecting approaches is complicated by the fragmented spatial realities that characterize many Tribal territories today.

Checkerboarding Tribal Lands

The "checkerboarded reservation" phenomenon creates significant challenges for GIS implementation in Tribal contexts, resulting from historical land dispossession through policies like the Dawes Act of 1887. These policies created complex jurisdictional patterns where "up to four types of lands depending on the history of each tribe" exist within reservation boundaries, "each with their own rules, regulations, obligations, and procedures" (Hill & Tovey, 2023). While GIS technologies offer solutions, implementation requires honoring Tribal sovereignty through approaches including Tribal-led capacity development, formal data-sharing agreements, MOUs with neighboring jurisdictions, and integration of Indigenous mapping practices. As Lucchesi (2020) notes, "Knowledge about Indigenous Peoples is not the same as Indigenous knowledge, which is held by the people themselves," highlighting why relationship-building approaches are essential for successful implementation. This understanding of checkerboarded landscapes forms the foundation for the project's theoretical framework.

Theoretical Framework

Recognition Justice

Recognition justice provides a foundational framework for understanding distributional and regulatory justice in relation to Indigenous epistemologies and place-based approaches to nature. It emphasizes the need to recognize the historic and ongoing marginalization and exclusion of peoples, worldviews, and knowledges, requiring acknowledgment and respect for the right to self-determination while challenging dominant Western epistemological foundations in decision-making processes. The work of Doyon et al. (2021) is particularly significant, and although it focuses these discussions within the Canadian context, the principles have broader applications. This framework becomes essential when addressing EVCI planning in Tribal contexts, as it demands that infrastructure development acknowledge Indigenous sovereignty, knowledge systems, and self-determination rights rather than imposing external planning paradigms that perpetuate historical patterns of exclusion and misrecognition.

Doyon et al. (2021) argue that recognition justice is essential in transitions research not merely for normative reasons but also for instrumental purposes. Within their framework, transitions refer to sustainable transformations of socio-technical systems involving large-scale technological, economic, ecological, socio-cultural, and institutional developments, while transitions research encompasses the study of these processes with explicit attention to justice considerations, decolonial perspectives, and Indigenous epistemologies. When transitions fail to incorporate recognition justice, they erode political support and community buy-in, undermining the very foundations necessary for successful implementation. Their review revealed significant gaps in both theoretical discourse and practical applications of recognition justice, particularly in settler-colonial contexts, where Indigenous communities are present.

A critical insight from Doyon is the persistence of epistemological superiority in transitions research. Even when researchers claim to pursue more pluralistic understandings of transformation processes and acknowledge the value of Indigenous local knowledge, there remains a fundamental question that often goes unaddressed: "to whose benefit?" This questioning of research motivations highlights how recognition justice must challenge deep-seated assumptions about knowledge hierarchies and their implications (Doyon et. al., 2021). This emphasizes how Indigenous rights recognition is frequently filtered through colonial frames within decision-making institutions, which systematically limit and dispossess Indigenous communities. Colonial governance structures, particularly those operating in a top-down fashion, create barriers to authentic G2G relationships between Indigenous communities and settler states.

This structural impediment makes recognition justice difficult to achieve without fundamental changes to governance approaches (Doyon et. al., 2021).

A final contribution of Doyon et al. (2021) is their suggestion that environmental justice frameworks can support recognition-based justice by ensuring procedural justice mechanisms are in place. Procedural justice is the fairness and inclusivity of decision-making processes, particularly focusing on who has the authority to organize and facilitate processes, who is involved in setting the terms of engagement, and what epistemological and methodological assumptions guide the work. In the Canadian context specifically, engaging with reconciliation processes represents a primary form of recognition-based justice. However, the authors caution that procedural justice alone is insufficient, as the meaning and implementation of reconciliation remain contested in many contexts (Doyon et. al., 2021).

Sociotechnical Capacity Assessment (STCA) for Technology Transitions

Building on the foundation of recognition justice, sociotechnical capacity assessment (STCA) emerges as a practical framework for evaluating and developing the conditions necessary for successful technology transitions within Indigenous communities. McMaster et al. (2024) define community capacity as "the collective ability of a community to create and take advantage of opportunities to meet community energy needs, providing greater self-sufficiency and a course for self-determination for Indigenous communities." As part of this work, McMaster developed an STCA framework for rapid assessment of a community’s ability to implement new technology, which involved eight pillars:

Through a thematic content analysis of the literature review, the authors identified eight foundational pillars of socio-technical capacity, each of which provides guidance for the rapid assessment of a community's baseline socio-technical capacity:

1. Local energy champion(s): there are individual(s)/group(s) with an interest in leading the transition and they have sufficient resources like financing, logistics, and management;
2. Inter-local energy networks: access to a network of professional and technical knowledge about available and emerging energy technology through formal and informal community-to-community learning;
3. Community energy vision: a broadly shared vision for the community's energy future that is also understood as the pathway for long-term goals and aspirations;
4. Value creation: community energy systems are viewed as an opportunity to advance social, cultural, or economic opportunities;
5. Energy literacy: the community has a general knowledge of energy use, local sources, and alternate energy technologies as well as availability and access to literacy programs;
6. Embedded skills: existing energy-related skills within community to operate and maintain local energy systems and/or technologies, and transferable skillsets from other sectors like financial, managerial, and technical;
7. Skill development opportunities: training opportunities available and accessible, and interest in taking them are present in community; and
8. Next generation leaders: school curriculum has energy education embedded, and youth are actively engaged.

The eight pillars are not, individually, either social or technical and tend to reference a topic underwich both must be developed. For the purposes of this project, the STCA has been essentialized as the following:

1. Technical capacity - the physical infrastructure, built environment, and material resources required to implement technological systems
2. Social capacity - the community infrastructure, institutional relationships, and collective knowledge that enable technology adoption and sustained use

For Tribal EVCI planning specifically, this means simultaneously assessing both the physical electrical grid's capability to support charging stations and the community's social infrastructure of transportation patterns, cultural institutions, and governance readiness to participate in transportation electrification. Success depends on strengthening both infrastructures in parallel, recognizing that physical and social systems must evolve together rather than in isolation.

Addressing Common Tribal Concerns

The STCA framework offers several key strengths that make it particularly well-suited for Tribal contexts, which can be organized into four main areas: network-based resource pooling, capacity building for resilience, values-centered energy planning, and comprehensive baseline assessment. First, the emphasis on local energy champions and inter-local energy networks helps communities identify and potentially access funding through shared knowledge and resources. This network approach builds on proven strategies, as McMaster et al. (2024) demonstrate in their analysis of remote Alaskan communities, where resource pooling through collaborative networks enabled successful renewable energy integration despite geographic isolation and limited individual community resources. Second, by jointly optimizing social and technical aspects and building local capacity (including skills and knowledge), STCA fosters resilient outcomes where communities gain the ability to manage and sustain their energy systems long-term. Third, community energy must be pursued through a social lens, as energy practices are embedded in social systems shaped by local values and culture. STCA explicitly incorporates community values to ensure energy transitions align with local, community-centric objectives, addressing eco-cultural concerns by prioritizing values beyond purely technological or economic benefits. Finally, the framework provides conceptual guidance for assessing a community's baseline socio-technical capacity as a precursor to formal community energy planning and transition processes. This comprehensive approach considers the deeper and longer-term goals of energy transition, including energy sovereignty and self-determination.

The integration of recognition justice principles with sociotechnical capacity assessment creates a powerful framework for understanding and implementing just transitions in Indigenous contexts. Konstantinos and Parker (2018) highlight how remote Indigenous communities now seek active participation in transforming electrical systems based on local sustainability agendas, furthering their goals of economic development and self-governance. Their work is particularly significant because it demonstrates the evolution from passive technology recipients to active agents of change, revealing that sociotechnical capacity encompasses not only technical and managerial knowledge but also community leadership, institutional capacity, and the ability to align energy transitions with locally-defined sustainability goals and self-determination objectives.

Key Concepts and Definitions

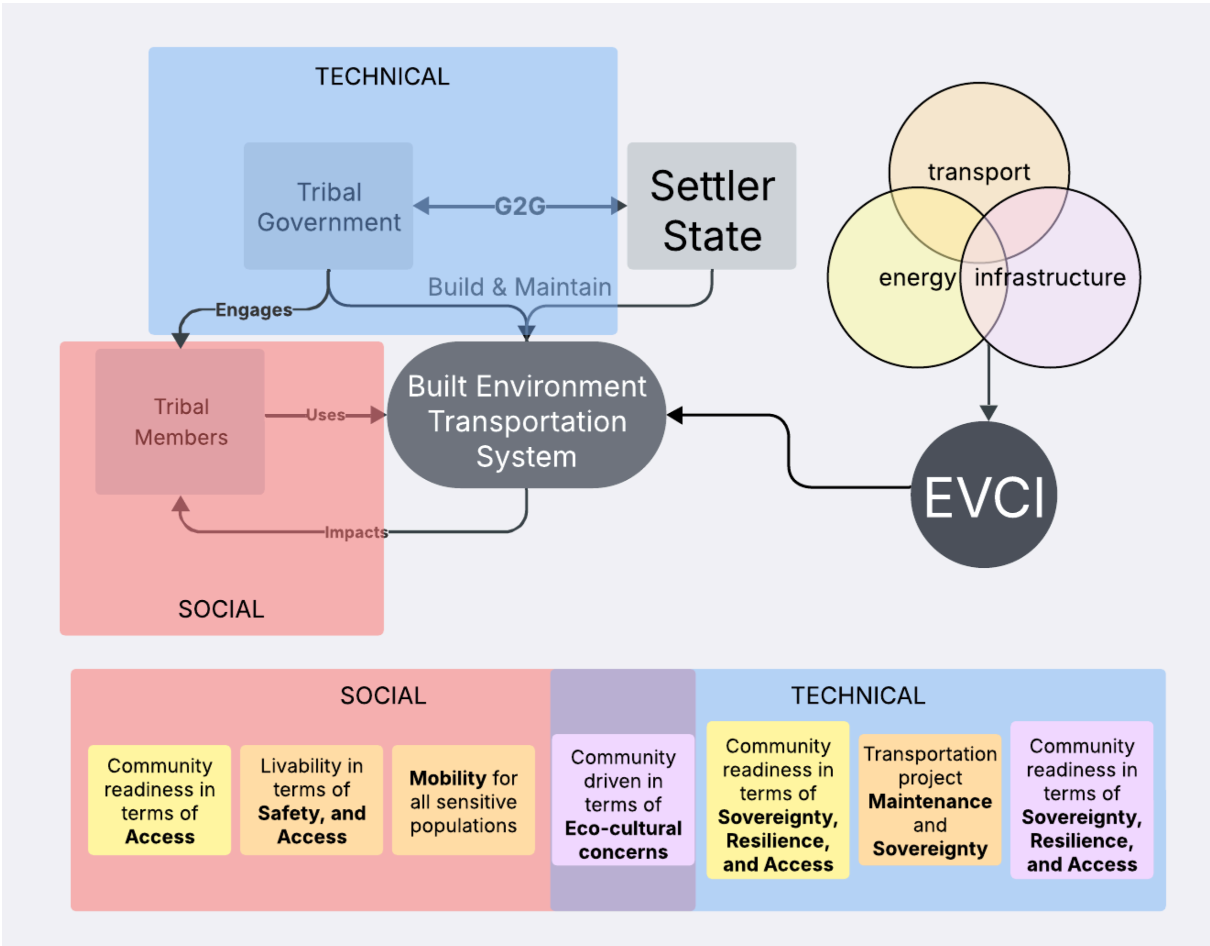


Figure 03: Conceptual Diagram with Literature Review Findings

This diagram illustrates the relational dynamics between Tribes and the settler-state in EVCI planning and is supplemented by the findings of this literature review. The framework distinguishes between the social and technical domains of the STCA theoretical framework while highlighting their interconnections. In the social domain, Tribal members engage with Tribal governments, which maintain G2G relationships with state entities. These technical and governmental relationships facilitate the development and maintenance of transportation systems that Tribal members ultimately use and are impacted by. EVCI exists at the nexus of transportation, energy, and infrastructure, requiring integrated planning approaches. The bottom portion identifies key considerations across the three sectors: social concerns, including community access readiness, safety-oriented livability, and demographic mobility needs; technical aspects encompassing sovereignty, resilience, access readiness, and maintenance funding; and socio-technical integration centered on eco-cultural concerns. This conceptual model provides a foundation for analyzing collaborative EVCI planning initiatives that respect Tribal sovereignty while addressing both community and infrastructure requirements.

These findings will inform the methodology section, first identifying the data needed for analysis and then guiding the collection methods to be used. The STCA framework is the north star in this process, ensuring that the relationships detailed in the conceptual framework and the related concepts are addressed throughout.

Methodology

As mentioned, this research was conducted in partnership with the Tulalip Tribes through a collaborative relationship facilitated by Spark Northwest as they were already engaged in electrical infrastructure planning and energy planning initiatives with EV goals when this project began. Specifically, the Tribe had explicit goals for EV integration in their transportation planning as stated in their 2024 Comprehensive Plan update, which includes Goal T7 explicitly stating alternate energy use in the transport sector to reduce emissions. The associated policies specify EV adaptation as a means for achieving this goal, and the 2022-2026 Tulalip Transportation Improvement Plan includes a project to install EV charging stations and parking spaces at the Administration Building on the reservation. The survey and questionnaire tools described below were administered with Tribal members and Tribal government representatives, respectively, with data collection occurring at the Tulalip Tribes' Earth Day event and through email correspondence with appointed Tribal contacts and Sparks Northwest. This collaborative approach was essential not only for ensuring culturally appropriate research methods but also for developing findings that would be directly useful to the Tulalip Tribes' ongoing infrastructure planning and community development efforts. The findings will be shared back with the Tribe through community checking processes to ensure conclusions are agreeable with Tribal leadership, and the research will continue to explore further engagement through the materials developed, potentially including ArcGIS story maps for broader community engagement.

Our approach began with the data needs identified in the literature review, distinguishing between basemap data (generalizable across Tribal contexts) and case-by-case data (requiring customized collection). The development of a comprehensive EVCI assessment relies fundamentally on GIS data collection that serves as the spatial foundation for the SMT. This GIS data collection encompasses multiple infrastructure categories, including transportation networks, energy systems, population centers, and Tribal locations of interest, each requiring different data sources and collection methodologies. While the basemap data consists of reliably available datasets such as U.S. energy transmission lines, North American road networks, and federally recognized Tribal reservation boundaries that can be systematically collected through secondary sources and integrated into a geodatabase on ArcGIS for upload to the SMT; the case-by-case data presents more complex collection challenges, as it includes community-specific information about travel behaviors, charging preferences, and local infrastructure conditions that cannot be obtained through existing databases. The case-by-case data was further categorized as social or technical. To address these data gaps and ensure the SMT provides actionable insights that honor Indigenous data sovereignty, we employed two complementary methodological approaches: a technical questionnaire protocol for collecting geospatial infrastructure data and verifying existing datasets, and a social survey protocol for gathering community-driven data on travel patterns and electric vehicle adoption preferences. The table below summarizes all data needs according to the basemap/case-by-case and social/technical categories described. This chapter then continues to describe the survey and questionnaire collection methods and the protocols developed before closing with a description of the analytical framework and the datasets collected for this project.

Table 01: Data Needs

Tribal concern	Concept	Subconcept	Variable	Scale	Collection
Community driven	Eco-cultural Impacts	Culturally sensitive areas	Undevelopable areas	Case-by-case	At discretion
Community readiness	Access	EV education	Electric capacity	Case-by-case	Survey
Community readiness	Geography	Roadway network	Segments	Case-by-case	Questionnaire
Community readiness	Sovereignty	Production	Macro or Micro grid	Case-by-case	Questionnaire
Livability	Safety	Natural Hazard	Undevelopable areas	Case-by-case	Questionnaire
Livability	Access	Tribal Locations of interest	Tribal HQ locations	Basemap	Basemap
Livability	Access	Tribal Locations of interest	Reservation boundaries	Basemap	Basemap
Livability	Access	Tribal Locations of interest	Trip Origins	Case-by-case	Survey
Livability	Access	Tribal Locations of interest	Trip Destinations	Case-by-case	Survey
Mobility	Behavior	Trip Characteristics	Mode	Case-by-case	Survey
Mobility	Behavior	EV education	Knowledge	Case-by-case	Survey
Mobility	Behavior	Trip Characteristics	Length of stay	Case-by-case	Survey
Mobility	Behavior	Trip Characteristics	Trip distance	Case-by-case	Survey
Mobility	Behavior	Trip Characteristics	Frequency	Case-by-case	Survey

Mobility	Geography	Transit	Tribal Transit	Case-by-case	Questionnaire
Mobility	Behavior	Transit	Non-Tribal transit	Basemap	Basemap

Collection Methods

The survey and questionnaire, forming the social and the technical arms respectively, served distinct methodological purposes. This distinction stems from their inherent epistemological differences, where surveys tend to be inductive and questionnaires deductive. The questionnaire collected data on the current roadway and energy infrastructure to assess geospatial data capabilities against the framework that the SMT employs from Tribal Government sources. Further, the questionnaire elicits specific case-by-case data on a particular Tribe's Reservation neighborhood origins (or equivalent), common Reservation destinations, and preliminary EVCI sites to populate answer fields in the survey. In contrast, the survey was designed to collect data on Tribal members' travel behaviors, transportation preferences, and EV awareness. This bottom-up approach enabled the discovery of patterns and insights that might not have been anticipated beforehand, particularly important given the case-by-case variations in Tribal contexts and the need to understand community-specific needs. This methodological distinction was crucial because it allowed the research to generate contextual knowledge from community members while simultaneously evaluating technical readiness, creating a comprehensive socio-technical capacity assessment that honored Indigenous data sovereignty while providing actionable infrastructure planning insights.

Technical Component: Questionnaire Protocol

The technical questionnaire targeted Tribal planning staff, GIS specialists, and infrastructure departments who possessed institutional knowledge about their community's existing data systems and infrastructure planning documents. These individuals were selected because they had access to technical documentation, comprehensive plans, and data repositories that may not have been publicly available, and could provide authoritative information about data availability and collection protocols within their Tribal government. The questionnaire consisted of approximately ten questions organized into general understanding, GIS layers assessment, and basemap layer calibration sections, with an estimated completion time of 45-60 minutes, depending on the complexity of follow-up responses. Initially, the research team completed the questionnaire using publicly available information and secondary sources to establish a baseline assessment, after which it was shared with Tribal collaborators for verification, correction, and supplementation with any additional information they chose to provide at their discretion, ensuring Tribal sovereignty over sensitive data. The questionnaire systematically addressed four critical infrastructure categories that formed the foundation for EVCI analysis: transportation infrastructure encompassing roadway network characteristics including jurisdictional boundaries, pavement conditions, and surface materials that affected installation feasibility; energy infrastructure covering both national grid connections and micro-grid systems, production facilities, substations, and transmission line capacities that determined charging infrastructure viability; population centers requiring geographic delineation systems and demographic data particularly for vulnerable populations including youth, elderly, and economically disadvantaged communities; and Tribal locations of interest such as community centers, healthcare facilities, and commercial establishments that served as key trip origins and destinations for understanding community mobility patterns and optimal charging station placement.

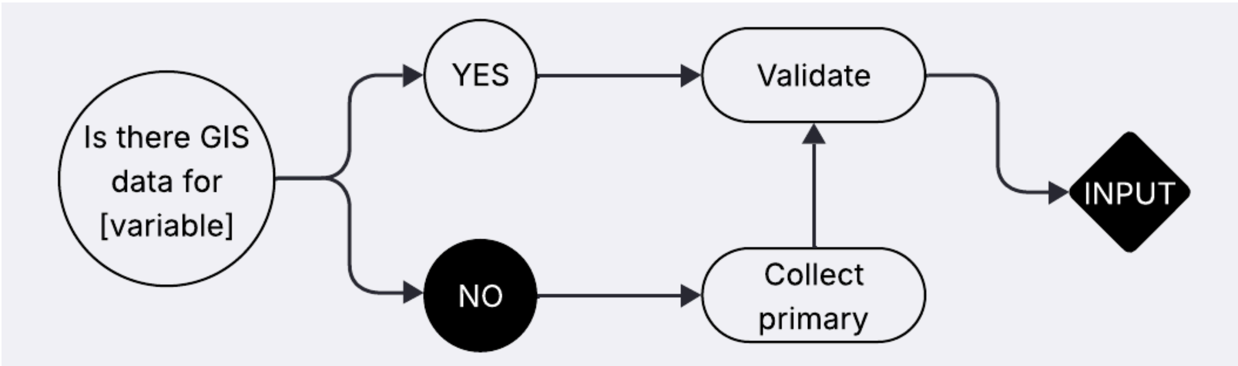


Figure 04: Questionnaire Protocol

As mentioned, the questionnaire was a framework for background research into the Tribe and determining their unique origin/destination locations on their Reservation, any preliminary EVCI locations, and then populating specific answer fields in the survey. This protocol was based on two foundational practices for Indigenous planning on levels of information disclosure, as detailed in the introduction chapter. The questionnaire, included as an appendix, provides guidelines for conducting the necessary background research.

Geospatial Data Collection

A critical component of the protocol involved identifying and collecting geospatial information for four key infrastructure categories. The first category, roadway networks, encompassed jurisdiction boundaries, roadway conditions, and surface materials that would affect EVCI installation feasibility. Energy infrastructure formed the second category, covering grid connectivity, whether through national or micro-grid systems, production facilities, transmission lines, and service areas that would determine charging capacity and power availability. The third category focused on population centers, requiring geographic delineation systems and neighborhood boundaries to understand community demographics and settlement patterns. Finally, Tribal locations of interest comprised community centers, government buildings, healthcare facilities, and other points of community significance that served as key destinations and activity nodes for Tribal members.

For each infrastructure category, the protocol employed a decision-tree approach to systematically determine data availability and establish appropriate collection methods. When data already existed within Tribal GIS systems, researchers requested permission to incorporate these existing layers directly into the analysis, respecting Tribal data sovereignty and existing institutional knowledge. In cases where data existed in federal or state repositories but required verification or customization for the specific Tribal context, researchers prepared draft layers that were then shared with Tribal partners for review, correction, and validation. When no relevant data existed for a particular category, researchers documented these gaps as recommendations for future capacity-building initiatives, ensuring that data limitations were transparent and could inform subsequent planning efforts.

Location Dataset Development

The collection of origin and destination locations proved particularly important for the SMT analysis. Researchers followed a structured process to develop this dataset through the embedded instructions of the Google Form titled "Location Dataset Collection". The form first codes the location inputs as neighborhood origin, reservation destination, or preliminary EVCI site. For each categorized location, researchers provided the locally recognized name and the precise latitude/longitude coordinates. The resulting sheet was used to populate answer options for questions 2, 4, 7, and 19 of the survey.

Social Component: Survey Protocol

The social component engaged Tribal members to develop a comprehensive understanding of community travel patterns and EV awareness. This engagement process focused on documenting travel behaviors, including the frequency and duration of trips made by community members, which provided essential baseline data for infrastructure planning. The component also captured detailed trip characteristics, specifically examining common origins and destinations within the Reservation, as well as the transportation modes currently used by Tribal members. Additionally, the survey assessed EV awareness levels and community attitudes toward EV adoption, exploring both barriers and motivations that might influence future uptake. This information proved instrumental in determining optimal locations where charging infrastructure would best serve existing community needs and align with stated preferences, ensuring that technical solutions responded to actual usage patterns rather than theoretical projections.

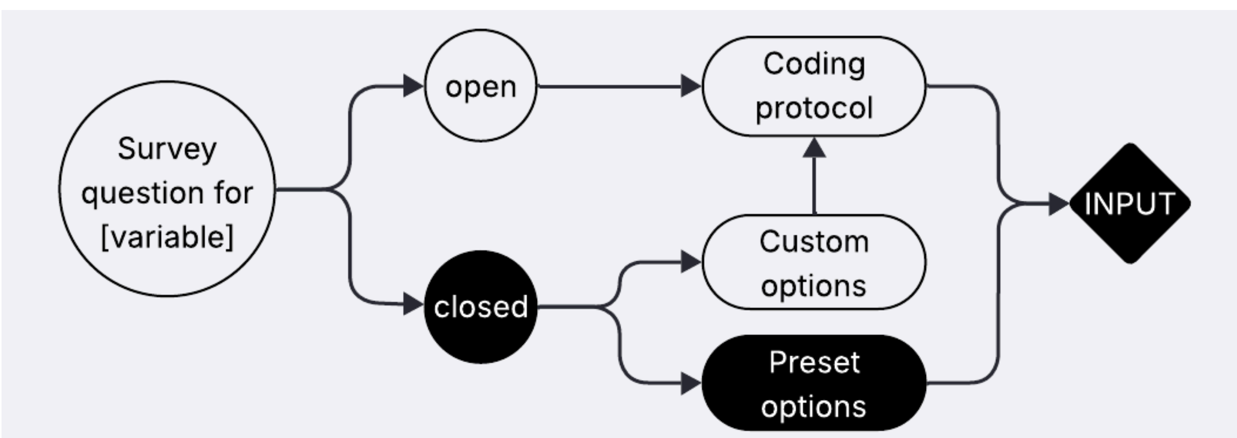


Figure 05: Survey Protocol

The survey employs both open and closed questions with standardized options where appropriate and includes branching logic to create different question paths based on Tribal members' residency status (on or off-reservation) and other travel behaviors.

The approach utilized snowball sampling and intercept survey techniques, which are particularly well-suited for Tribal communities where trust networks and community connections are essential for participation. Initial survey respondents from key community access points (Tribal government offices, community centers, cultural events) will be asked to refer other Tribal members who might participate, creating expanding networks of respondents. This method acknowledges the importance of relationship-based research in Indigenous contexts while efficiently reaching community members who might otherwise be missed. In this project, we have worked with Tribal partners to administer the survey at cultural events in particular and have been able to offer awards for participation. Our goal was to achieve 15-20 responses per engagement event, and hoped that subsequent referrals and dissemination by the Tribal government would bring in more.

The survey instrument was designed as a practical tool for Tribal governments to deploy, adapt, and own beyond this initial implementation (and is available as an appendix). Rather than an extractive research approach, this methodology creates a flexible framework that each Tribal government can customize to their specific context, population, and priorities. The underlying goal is to provide Tribal governments with a ready-to-use instrument that supports their sovereignty in planning decisions while minimizing the resource burden of developing assessment tools from scratch. To ensure accessibility, the survey can be made available in multiple formats (digital and paper), but is freely accessible and administrable through Google Forms.

Basemap Protocol

For the datasets reliably available for every Tribal context in the U.S., they were collected digitally and stored as a geodatabase on ArcGIS to be uploaded with the SMT. The geodatabase contained information on the U.S. energy transmission lines[1], the North American Roads[2], and Federally Recognized Tribe Reservation lands[3].

Indigenous Data Sovereignty

This research honors Indigenous Data Sovereignty (IDS) principles, recognizing Tribes' right to maintain, control, protect, and develop their cultural heritage, traditional knowledge, and data. Any information pertaining Tribes and their members is sensitive when considering the historical treatment of Tribes by the settler-state. To this end, the approach employs a "black box" model for Tribal data, where it remains under Tribal control while still informing the mapping tool. Building upon the earlier discussion on levels of information disclosure, this section specifies the practices followed and mechanisms built-in to the research design to ensure our IDS commitment is not just words on a page.

A particular concern that came out of the literature review was eco-cultural impacts. Such impacts tend to involve a Tribe's sacred land or natural resources. Initially, the concern was addressed by a generic variable for "undevelopable areas" to be collected through the questionnaire process. This was revised in the aforementioned alteration of the questionnaire methodology with a new protocol for the SMT predicated on the first best practice. While the initial motivation to exclude culturally sensitive sites from the analysis was an attempt to

1 https://services2.arcgis.com/FiaPA4ga0iQKduv3/arcgis/rest/services/US_Electric_Power_Transmission_Lines/FeatureServer/0

2 https://services.arcgis.com/xOi1kZaI0eWDREZv/arcgis/rest/services/NTAD_North_American_Roads/FeatureServer/0

3 https://gisnation-sdi.hub.arcgis.com/datasets/fedmaps::federal-american-indian-reservations/explore?location=17.602393%2C-99.374432%2C4.03&showTable=true

proactively address eco-cultural concerns documented in the literature, it was quickly discovered that the necessary process for accomplishing this would be antithetical to the first best practice. The solution was quite simple: remove the use of any culturally sensitive information from the analysis. The SMT can then be programmed to output a list of all potential EVCI sites based on the social and technical factors discussed, which the Tribal government then applies its own exclusion criteria to.

Analytical Framework

This section describes the data needed for the SMT to run an EVCI analysis. This analysis involves fou considerations:

1. Can Go: Areas where EVCI development is physically and legally possible
2. Cannot Go: Areas where EVCI development is prohibited or impractical
3. Should Go: Priority areas for EVCI development based on community needs
4. Type: Appropriate EVCI technology and capacity for specific locations

This framework organizes data inputs into a decision support system that considers technical feasibility and community priorities, aligning with established best practices for systematic EVCI planning by the U.S. Department of Energy. Their guidance on planning electric vehicle charging infrastructure uses a structured stepwise process that emphasizes regulatory analysis and systematic planning (U.S. Department of Energy, n.d.). The DOE framework directly supports the Can Go and Cannot Go lenses by requiring planners to "identify relevant plans, policies, and regulations" that could impact EV infrastructure development, followed by identifying "changes needed to facilitate EV infrastructure development" (U.S. Department of Energy, n.d.). This regulatory review process ensures that EVCI deployment decisions account for existing legal and policy constraints that determine where infrastructure is permissible or prohibited. While the

DOE guidance focuses primarily on the regulatory and planning process foundations, it establishes the critical groundwork for the comprehensive site evaluation approach that includes technical feasibility assessment and community needs prioritization, supporting the Should Go and Type lenses.

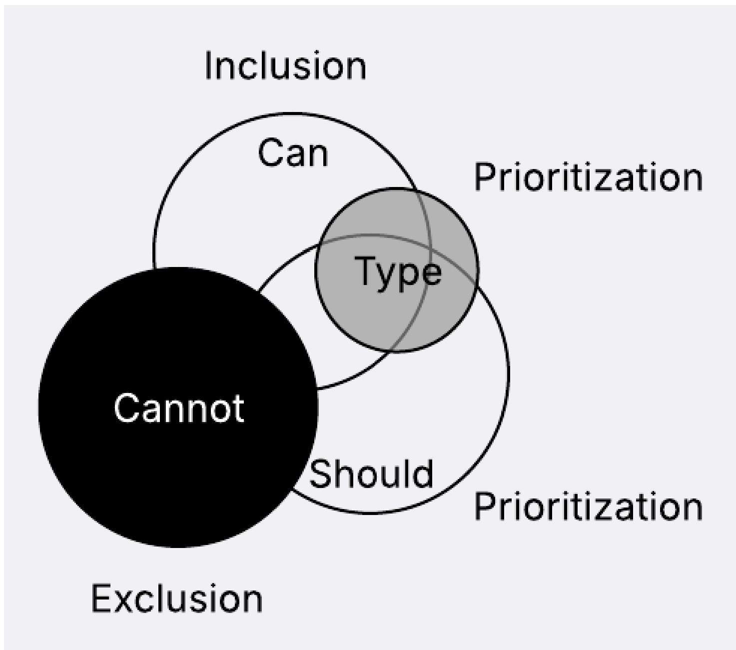


Figure 06: Analytical Framework

The diagram above visualizes the criteria discussed as four lenses where each one serves to include, exclude, or prioritize a location based on the corresponding variable in the table below.

Table 02: Variable Roles

Variable	Role in SMT
Undevelopable areas	Where can EVCI not go?
Electric capacity	What type of EVCI?
Segments	Where can EVCI go?
Macro or Micro grid	What type of EVCI?
Energy type	What type of EVCI?

Capacity	What type of EVCI?
Production facility	Where can EVCI go?
Substations	Where can EVCI go?
Transmission lines	Where can EVCI go?
Undevelopable areas	Where can EVCI not go?
Tribal HQ locations	Where should EVCI go?
Reservation boundaries	Where should EVCI go?
Trip Origins	Where should EVCI go?
Trip Destinations	Where should EVCI go?
Mode	What type of EVCI?
Knowledge	What type of EVCI?
Length of stay	What type of EVCI?
Trip distance	What type of EVCI?
Frequency	What type of EVCI?
Tribal Transit	What type of EVCI?
Non-Tribal transit	What type of EVCI?

The SMT functions primarily to map the community-driven or social aspects of this overall analysis, which come primarily from the survey. This methodology, its datasets, and their analysis in the SMT are modeled in the figure below.

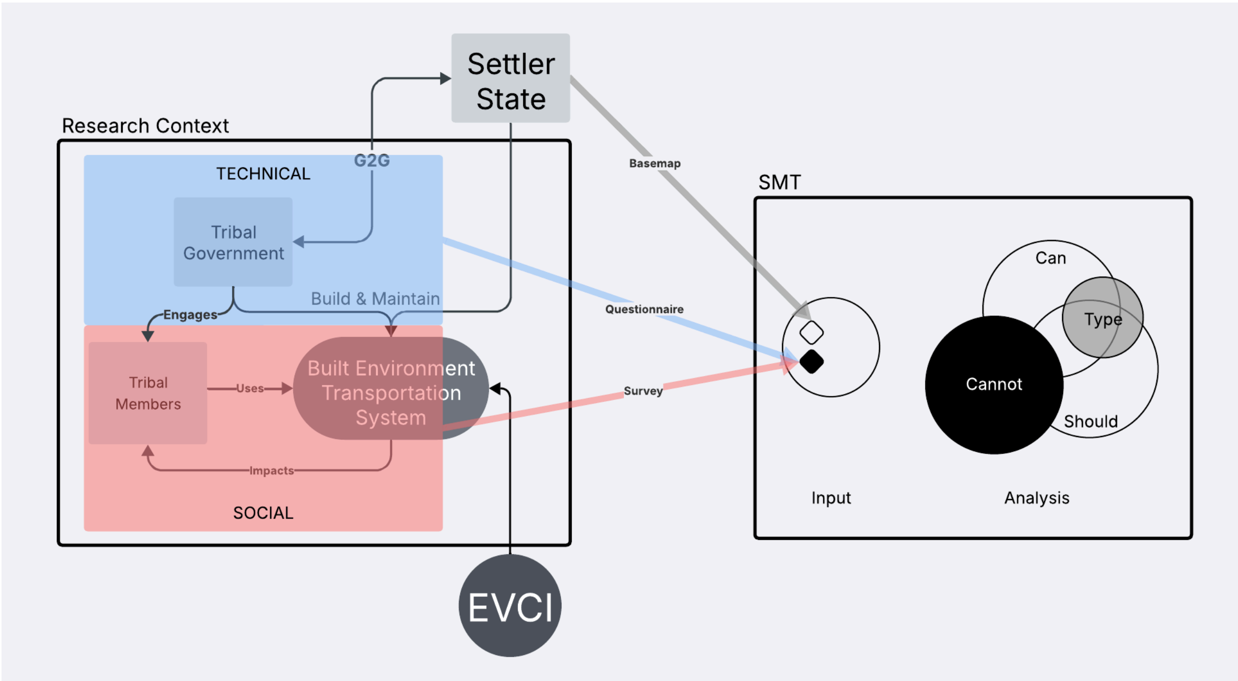


Figure 07: Methodology Diagram

The diagram, most importantly, illustrates the "black box" model used when handling data collected through the questionnaire and survey protocols. This is used with basemap data in the inclusion/exclusion/prioritization analysis for each location according to the process detailed in the next chapter.

Analysis and Findings

The analysis described herein formed the structure that is the first version of the SMT. It began with the survey administered at the Tulalip Tribes' Earth Day event. Survey data was analyzed to understand community transportation patterns, EV adoption potential, and charging infrastructure preferences, which then informed SMT analysis. The survey collected 20 responses, with 11 respondents identifying as living on the Reservation and nine living off-Reservation, providing insights into both on-reservation mobility patterns and commuting behaviors of Tribal members residing in surrounding communities. Of the nine on-Reservation, most (six) tend to travel off-Reservation, and all who tend to travel within the Reservation hail from different neighborhood origins. Of the 11 off-Reservation origin respondents, none reported a one-way trip distance greater than 50 miles and they tend to make these trips multiple times a week. The demographic analysis revealed a diverse respondent pool that provided insights into different community perspectives on electric vehicle adoption and charging needs across various age groups and household compositions.

When examining current transportation patterns, the survey found that personal automobiles were the primary means of travel for most respondents. When asked what their ideal mode of transportation would be, only three respondents switched from personal automobile preferring public transit options. This mode choice and preference support EV adoption in the future as a GHG reduction strategy. Length of stay and trip frequency data showed that respondents tend to travel to their selected destinations multiple times a week and stay for more than one hour. This data will be used again in the Type lens of analysis to follow.

Regarding EV adoption potential, only eight of the twenty indicated interest in purchasing one and most (six) are looking beyond the two-year timeframe for doing so. Responses indicated varying levels of openness to electric vehicles, with interest levels appearing to correlate with factors such as environmental concerns, cost considerations, and perceived convenience of charging access, highlighting the chicken-and-egg dynamic between infrastructure development and adoption that often characterizes early EV market development.

With the basic survey analysis done, the SMT analysis began with the placement of every destination location identified for the Tulalip Tribes on a map and performed two scoring visualizations, constituting the Should Go lens. The first was based on a score each location received, measuring how often it was selected in the survey, or its popularity. This involved response data from Q4 and Q7, pooling all respondents with on-Reservation travel behavior, which asked respondents to select their top three Reservation destinations, unranked. The second selection was a list of preliminary EVCI locations from the Tribal Government. Q19 of the survey asked respondents to rank the preliminary EVCI locations directly according to their preferences. This data was used to give each location a weighted score based on the number of times it received a certain number rank (1 = 3, 2 = 2, 3 = 1). These simple popularity scores are presented in the Top O-D and Preliminary EVCI maps.

Should Go locations were then put through the more technical Can Go and Type lenses. The Can Go lens used information on the voltage of nearby electric transmission lines from the questionnaire protocol, which identified that the current geodatabase sources for roadways and transmission lines have limited data on the Tulalip Tribes' Reservation; specifically, none on the roadway, and only a few segments of a transmission line. While likely a result of data privacy efforts, this does point to an important pivot of the Can Go lens: looking at energy access to point out infrastructure expansion that would necessarily predate EVCI development. Without full technical data, the analysis was largely of access; but, for the locations within the service area of the transmission line data, the voltage demand capacity at the closest substation was used to determine the maximum number of DC fast charger stations versus Level 2 chargers the site could support.

The Type lens determined if current travel frequencies and durations of stay could only support DC fast charger models or if slower, more accessible, and adoptable models would work in this current pattern. Essentially, if a traveller is at a destination for a short time, they can only use a

DC fast charger. If that short duration is common for stays at that location, then the DC fast charger model would be the best fit. But, if a location is seeing many infrequent though lengthy stays, and few of these quick visits, it could thrive with even level 3 chargers. This analysis may only be worthy of action in the extreme cases described, but identifying locations with many quick visits across a range of frequencies as potentially only able to support DC models is useful for strategic planning. To perform the analysis, all onDes responses were pivoted as columns with onDesFreq and onDesLen as rows nested in that order, and values set to the count of responses. Then, locations could be viewed by the possible frequency length pairs. Locations seeing primarily quick visits were coded as true for DC_dom. Ultimately, through the Can Go and Type lenses, the locations can be presented in terms of alignment between their charger capacity and likely charger demand. The results of this analysis are available in the Electric Access map.

Data Presentation

The analysis outputted three maps with one general overview map for reference. The overview map shows all neighborhood origin and Reservation destination locations on the Reservation and the extent of electric and roadway infrastructure geospatial data. The O-D map displays the same origin-destination locations with opacity diminished for less popular locations. This map is accompanied by histogram presentations of the same location popularity data. The Top Preliminary EVCI map does the same presentation for preliminary EVCI locations specifically. Finally, the Electric Access map displays all Reservation destinations and lowers the opacity of those without access to the transmission line. Taken together, these maps can triangulate ideal EVCI locations, combining the multiple lenses of analysis for a comprehensive approach.

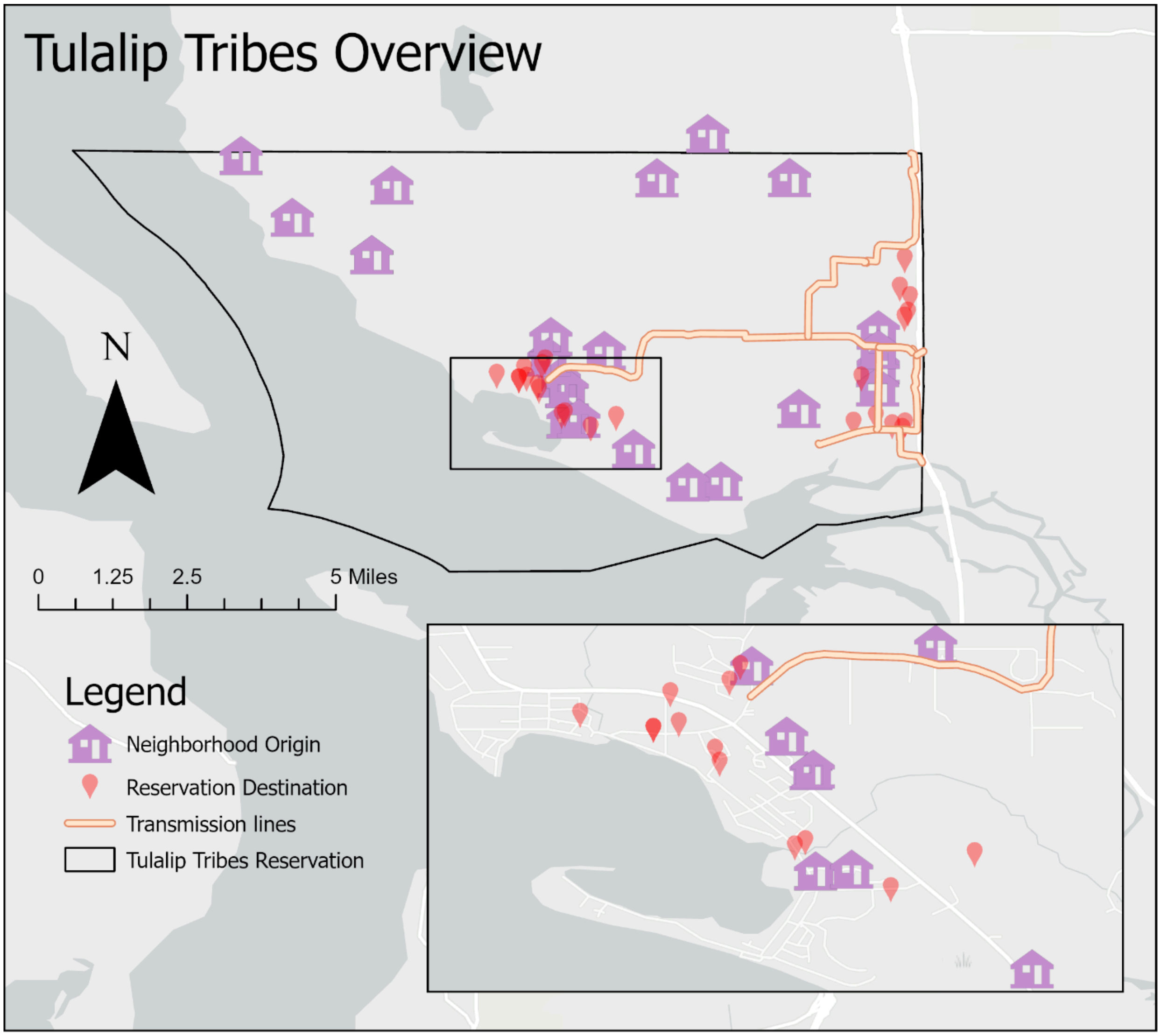
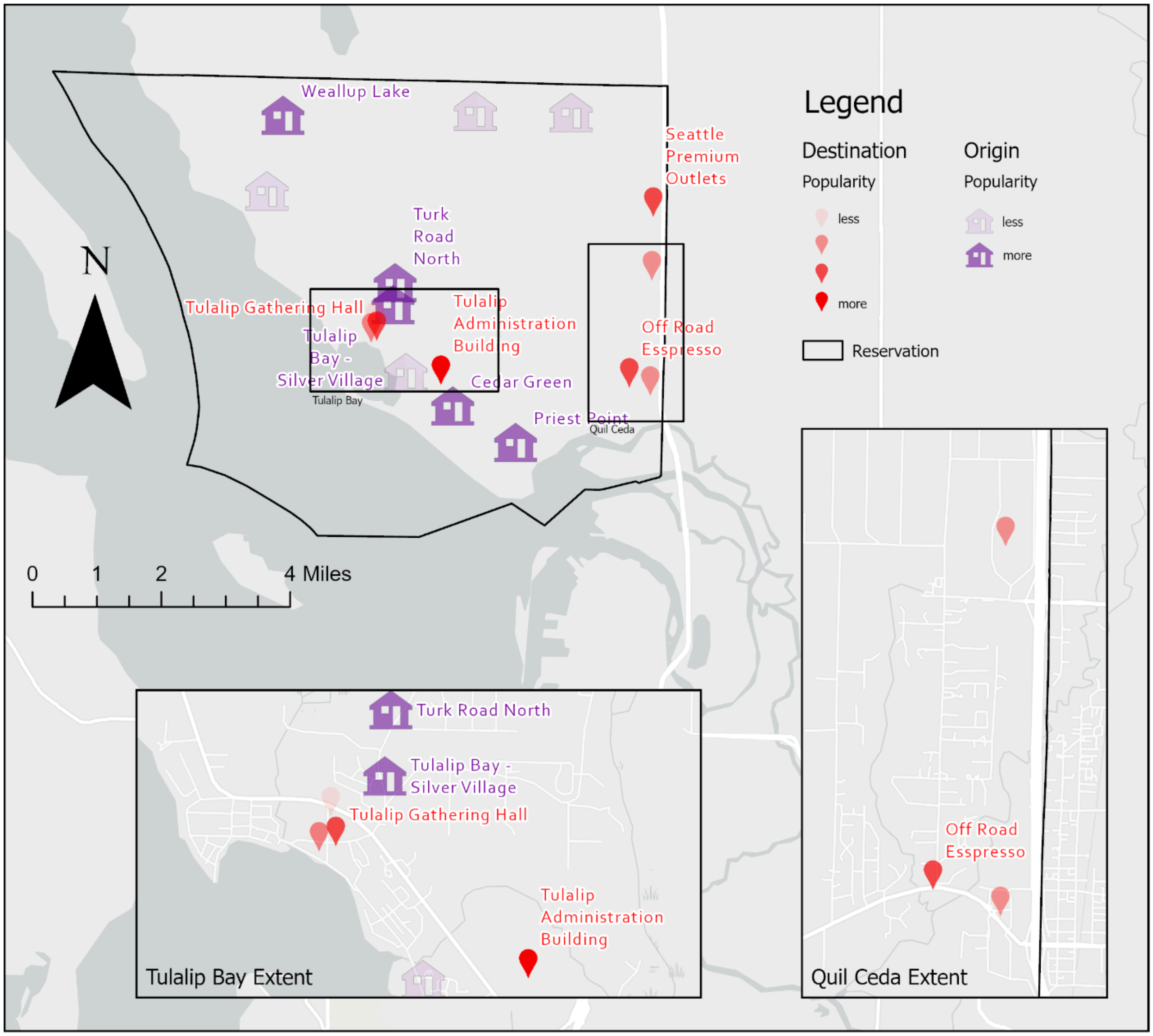
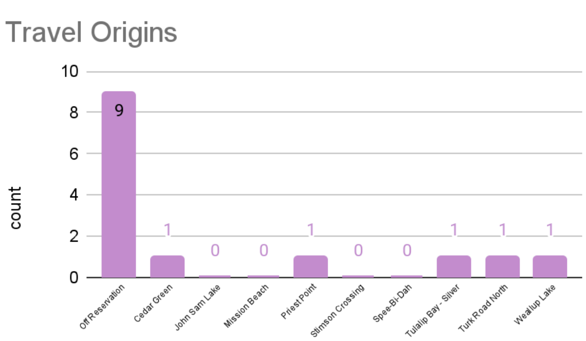


Figure 08: Tulalip Tribes Overview map

Table 03: Tulalip Tribes Locations

Neighborhood-origins	Reservation destinations	**Preliminary EVCI locations**
Cable Tower	Tulalip Administration Building	Tulalip Administration Building
Cedar Green	Beda?Cheh	Tulalip Gathering Hall
Everett Property	Tulalip Dental Clinic	Tulalip Health Clinic
John Sam Lake	Tulalip Dining Hall/Community Dining Hall (Old Mission School)	Tulalip Public Justic Center
Maplewood	Tulalip Gathering Hall	Beda?Cheh
Mission Beach	Tulalip Health Clinic	Hibub Cultural Center & Natural History Preserve
Priest Point	Tulalip Public Justice Center	
Shaker Church	Tulalip Market	
Stimson Crossing	Tulalip Pharmacy	
Spee-Bi-Dah	Tulalip Tribes Public Works	
Sunny Shores	Tulalip Resort	
Tulalip Bay - 28th Drive NW	Tulalip Tribal Senior Center	
Tulalip Bay - Battle Creek	Tulalip Worship Center	
Tulalip Bay - Beatty Estate	Boys & Girls Club	
Tulalip Bay - Mission Highlands	Don Hatch Youth Center	
Tulalip Bay - Silver Village	Hibub Cultural Center & Natural History Preserve	
Tulalip Bay - Y Site	St. Anne's Catholic Church	
Tulare Beach	Cabelas	
Turk Road North	The Home Depot	
Quil Ceda II	Seattle Premium Outlets	
Quil Ceda North	Off Road Esspresso, and/or adjacent businesses such as Salish Sky Vapor or Tacos El Rey	
Quil Ceda South	Quil Ceda Creek Casino	
Quil Ceda Meadows	Walmart Super Center	
Weallup Lake	Marysville Tulalip Campus	
TOTAL: 24	TOTAL: 24	TOTAL: 6





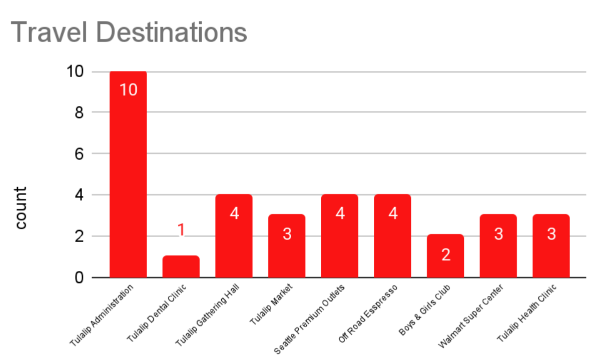


Figure 09: Tulalip Tribes O-D map

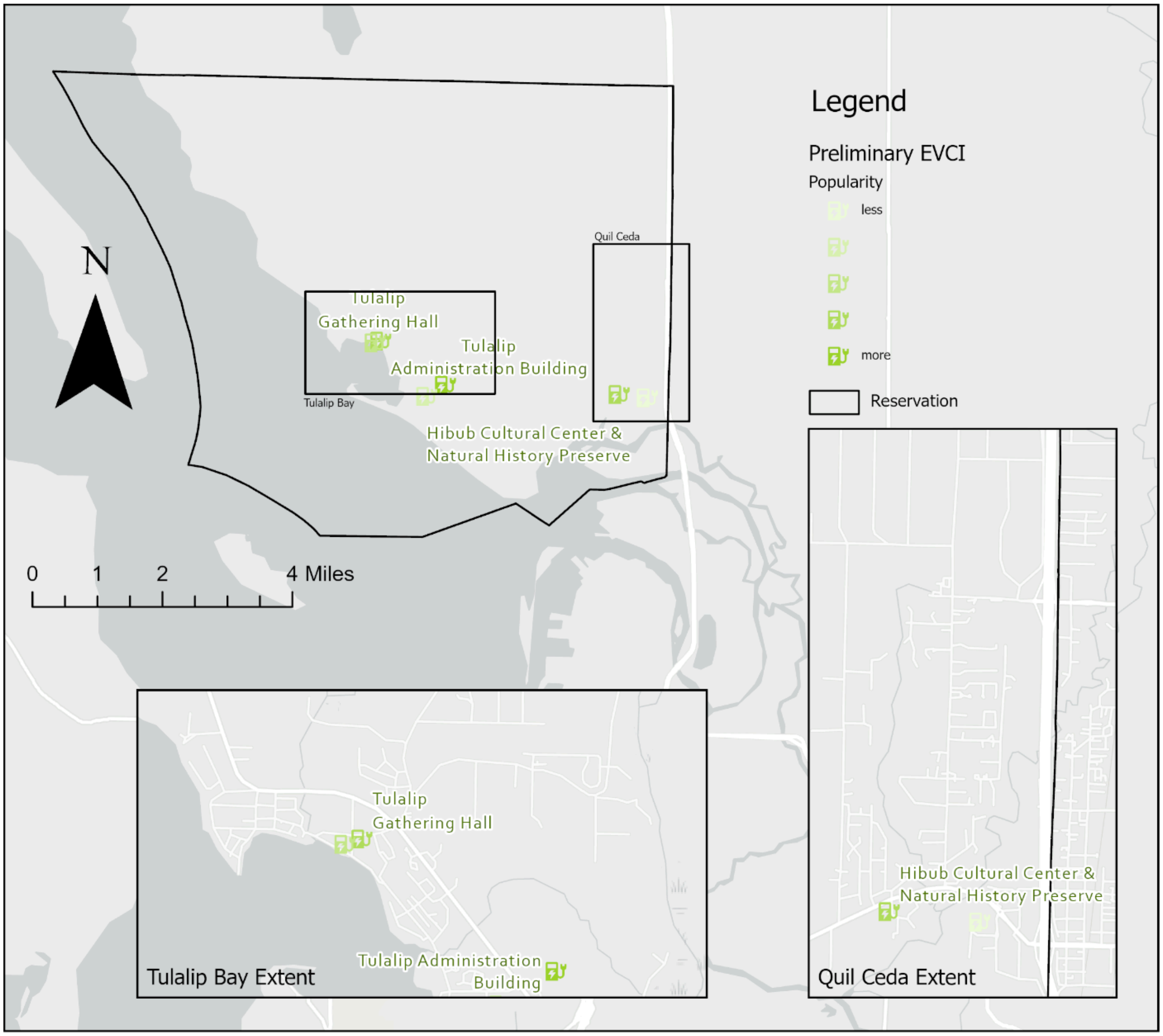


Figure 10: Tulalip Tribes Preliminary EVCI map

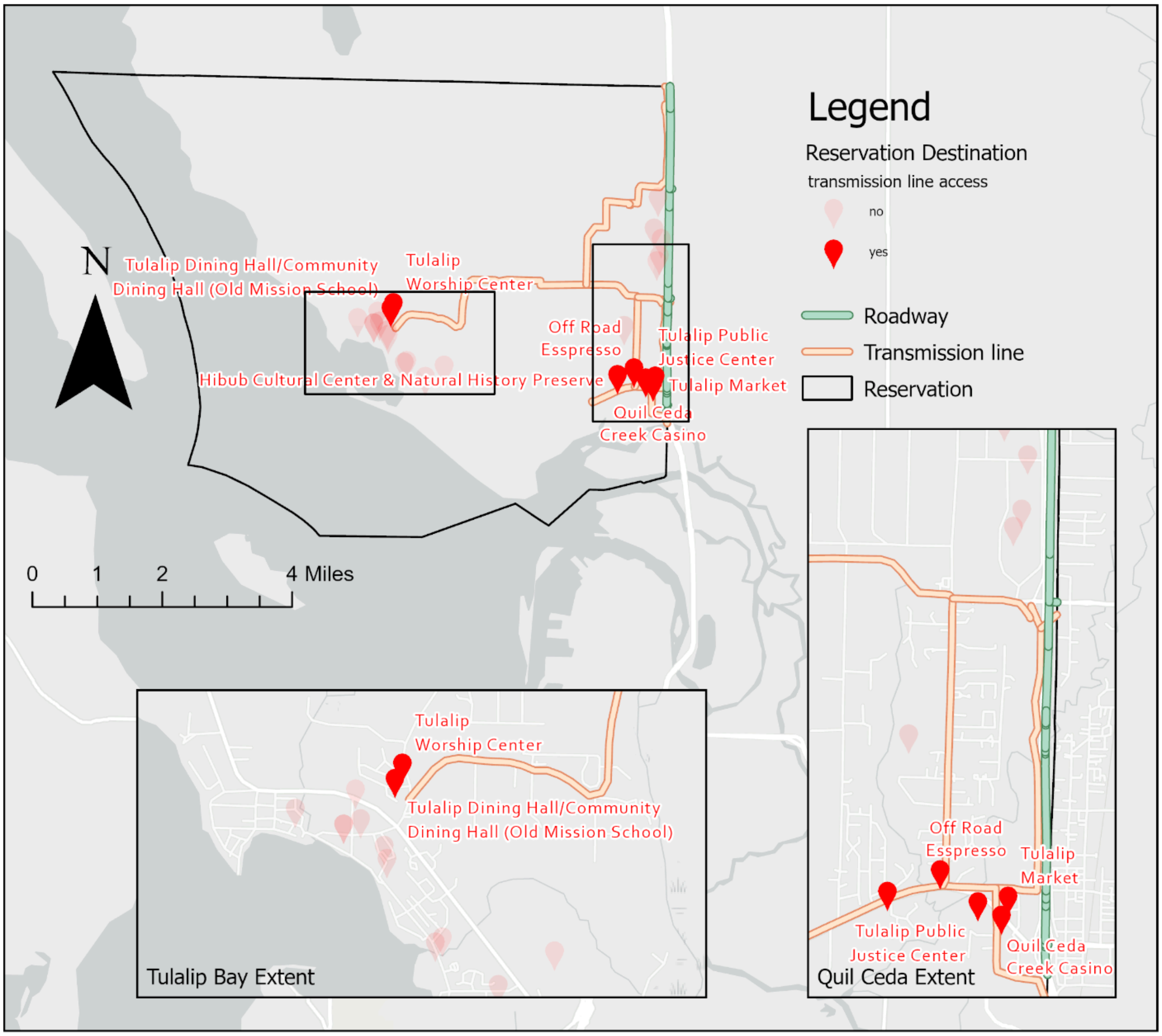


Figure 11: Tulalip Tribes Electric Access map

Key Findings

The geospatial process of this analysis provided key insights, bringing together the location popularity and site infrastructure access and capacity assessments. The O-D map revealed the Tulalip Administrative Building to be the most popular destination by a wide margin, with the Tulalip Gathering Hall, Seattle Premium Outlets, and Off Road Espresso (and/or adjacent businesses) being secondary. Other destinations were not as popular. The most common origin was off-Reservation. This aligned with the findings of Q17 and 20-22, which determined the charging model (public near origins, private near origins, or public near destinations) respondents would prefer. Generally, respondents preferred private charging overall by a slight margin, and public charging near origin was slightly more preferred than near destination. This finding came when aggregating from two response groups after being split by whether or not they were considering an EV purchase (Q15). Those who are considering are asked directly which of the three models they prefer and those who are not are asked which, if any, would change their mind. Looking at those two groups separately reveals a similar preference for private charging models with no clear second.

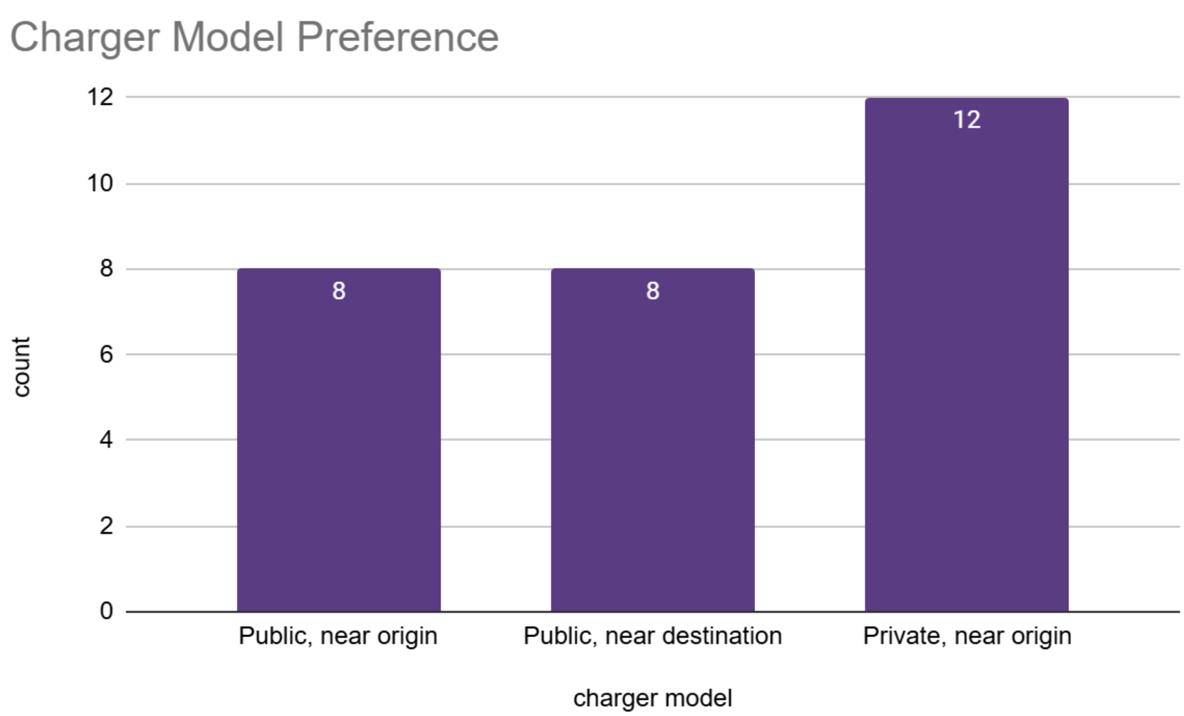


Figure 12: Tulalip Tribes Charge Model Preference

The direct ranking of preliminary EV charger locations in the Top Preliminary EVCI map supported the findings of the O-D map. The Tulalip Tribes Administrative building was the top choice with the Gathering Hall, Hibub Cultural Center, and Tulalip Health Clinic taking second. The difference in popularity that sets the Administrative Building apart is evident in both selections, with the second group of locations only slightly distinguished from less popular ones. This triangulation does support the Administrative Building as a key location for EVCI development.

The Type analysis found no locations where only DC fast chargers would be supported based on current trip stay durations and frequencies so this did not impact the analysis. Access was the biggest driver for the Can Go lens with most destinations not being within a feasible distance of the transmission line.

Interpretation

Of the four lenses comprising it, the Should Go was the most robust analysis. Compared to the binary determinations that technical factors like electricity access provide, rich and complex social data gives ground for more meaningful prioritization. Technical feasibility assessments, while essential, often yield straightforward yes-or-no answers: either adequate electrical infrastructure exists at a location or it doesn't, either zoning permits commercial charging or it doesn't. These binary outcomes, though critical for implementation, offer limited insight into the relative importance or community value of different potential sites.

The Can Go lens was constrained by insufficient transmission line data, highlighting why electrical infrastructure assessment needs to be an optional parameter. Voltage demand capacity measurements at substations allowed for effective determination of maximum charger capacity where data existed. This lens successfully identified the limited geodatabase coverage for Reservation roadways and transmission lines, pivoting the analysis toward energy access as a prerequisite for infrastructure expansion.

The Type lens examined travel duration and frequency patterns to determine appropriate charger types based on location usage. The onDesFreq and onDesLen metrics created a matrix view of location usage, revealing that no locations currently demonstrate usage patterns limiting them to only DC fast chargers. Most locations could support various charger levels based on current visitation patterns. Current usage patterns support mixed charger deployment at most locations, with preference data showing a slight community favor toward private charging options.

The analysis revealed crucial infrastructure gaps requiring attention before EVCI deployment can scale effectively. Limited geodatabase information for roadways and transmission lines presents both a challenge and opportunity for comprehensive planning beyond EVCI deployment. Integration across lenses yielded comprehensive insights beyond what any single method could provide. Through this triangulation, the Administrative Building emerged as the clear priority location, demonstrating consistency in both popularity metrics and technical suitability. Secondary locations (Gathering Hall, Hibub Cultural Center, Health Clinic) showed comparable suitability but with less distinct differentiation from other potential sites. This hierarchy suggests a phased deployment approach beginning with the high-confidence Administrative Building location before extending to the less-differentiated secondary tier.

The O-D map revealed concentrated travel patterns with the Administrative Building as a central hub, suggesting an initial hub-and-spoke deployment model focused on the most popular destination before expanding based on popularity and infrastructure proximity. Further, social preferences aligned reasonably well with technical feasibility, particularly for the Administrative Building, suggesting implementation will face fewer trade-offs between community desires and technical constraints at priority locations. The Can Go lens identified infrastructure gaps that should be addressed as prerequisites to EVCI deployment, including expanded transmission line coverage and improved geodatabase information.

Discussion

In addition to the SMT analysis, the survey also collected data on variables related to EV adoption, like amenity preference and purchase concerns. Purchase cost emerged as the most significant barrier to electric vehicle adoption, with 15 respondents identifying it as a concern among other options. This aligns with the broader findings on travel factor ranking, where cost was again the dominant factor influencing transportation decisions. When examining amenity preferences, restaurants/food locations stood out as the most frequented destination type (8 respondents), followed by shopping and restrooms (6 respondents each). This suggests that charging infrastructure placed at food service locations would align well with existing travel patterns.

The SMT analysis identified the Tulalip Administrative Building as the highest priority location for EVCI deployment by a significant margin. Secondary priority locations included the Tulalip Gathering Hall, Seattle Premium Outlets, Off Road Espresso (and/or adjacent businesses), though with less distinct differentiation from other potential sites. Notably absent from the high-preference categories were health service facilities, which received lower popularity and EVCI location preference in the survey. This finding contrasts with expectations from the literature, where Becker et al. establish that IHS facilities serve as anchor institutions providing essential medical services and significantly improving overall resource accessibility for reservation populations. The analysis revealed significant infrastructure gaps, particularly regarding transmission line data across the Reservation, with geodatabase sources containing limited information beyond the main transmission line for the first few miles of the main road.

The Can Go and Cannot Go lenses, while providing essential technical baseline assessments, presented several analytical limitations that constrained their utility for meaningful prioritization. The Can Go analysis was significantly hampered by data availability issues, particularly the lack of comprehensive transmission line data and absence of detailed roadway network information, which limited the precision of infrastructure assessments and connectivity analyses. Without complete electrical grid mapping, the analysis could only provide rough approximations of power availability rather than detailed capacity assessments that would enable fine-grained comparisons between potential sites. The absence of roadway network data similarly constrained the evaluation of site accessibility and traffic flow patterns that would be crucial for understanding charging station utilization potential. The Cannot Go analysis faced a different challenge entirely—the absence of any clearly undevelopable areas on the reservation meant there were effectively no locations that warranted outright exclusion from consideration. This created an overly restrictive analytical framework that may have prematurely eliminated sites where creative solutions or policy modifications could have enabled development, while simultaneously failing to provide the filtering function that such an assessment typically serves in site selection processes. The binary nature of these technical assessments also obscured important trade-offs between technical optimization and community priorities, potentially favoring locations that appeared technically straightforward based on limited data but might prove socially or strategically suboptimal for serving Tribal community needs. These data limitations and methodological constraints ultimately reinforced the importance of the social and strategic lenses in providing the nuanced analysis necessary for meaningful EVCI site prioritization.

Spatially, the O-D mapping showed concentrated travel patterns with the Administrative Building functioning as a central hub, suggesting a phased, hub-and-spoke deployment model beginning with this high-confidence location. The analysis also underscored the importance of improving infrastructure data collection, particularly for transmission lines, as a prerequisite to scaled EVCI implementation. The observed travel patterns, particularly the significant off-reservation to on-reservation movement, require careful interpretation considering potential demographic bias in survey responses. Analysis suggests that many respondents were Tribal government employees commuting to work at Tribal facilities, with at least 25% of responses coming from Tribal staff members. This employment-based travel pattern may not fully represent the broader community's transportation needs and could overemphasize work-related charging requirements at the expense of other trip purposes such as healthcare, shopping, or cultural activities. The concentration of Tribal employee responses highlights the importance of expanding future surveys to capture more diverse community perspectives, including elders, youth, and residents with varying employment situations. This demographic consideration is crucial for ensuring that EVCI deployment serves the full spectrum of community travel needs rather than primarily addressing work-commute patterns.

The research also identified potential environmental considerations for EVCI development, particularly regarding impacts to nearby sacred sites. While EVCI infrastructure does not inherently pose operational risks to sacred sites, generally presenting lower ongoing environmental risks than traditional gas or oil infrastructure, construction-phase impacts warrant careful attention. Construction runoff and soil disturbance during installation could potentially affect sensitive cultural areas. Moreover, EVCI deployment may introduce infrastructure to locations where fuel-related development has not previously occurred, requiring enhanced cultural resource assessments during site selection. Future EVCI planning should incorporate comprehensive cultural impact evaluations and establish protocols for protecting sacred sites during both construction and operational phases.

The Type lens analysis determined that no locations currently exhibit usage patterns that would limit them to DC fast chargers only. Instead, most locations could support various charger levels based on visitation patterns, with private charging near origins being slightly preferred over public options (aligning with the survey data).

The Spectrum of Needs and Challenges

The spatial component of this project, combined with the range of social variables measured through the survey, provides a comprehensive answer to our research question: What are the EVCI expansion needs and challenges specific to Tribal communities?

The analysis revealed that effective EVCI planning must recognize that Tribal communities exist at different points along a spectrum of infrastructural readiness and capacity, from those with no existing charging infrastructure or limited electrical capacity to those already operating charging stations and actively pursuing federal grants for expansion. This spectrum of Tribal readiness presents a critical challenge for funding mechanisms, which must be designed with sufficient flexibility to support communities regardless of their current position along this continuum. Tribes with robust existing infrastructure and established planning processes may be well-positioned to compete for large-scale federal grants requiring detailed technical specifications, matching funds, and rapid implementation timelines, while communities with limited infrastructure or early-stage planning capacity may struggle to access the same funding opportunities despite having equally valid charging needs. The funding landscape must therefore incorporate a range of support mechanisms that can meet Tribes where they are—from capacity-building grants that support initial feasibility studies and planning processes for communities just beginning their EVCI journey, to implementation funding for Tribes ready to install charging stations, to expansion grants for those seeking to scale existing programs. Without this nuanced approach to funding that acknowledges the diverse spectrum of Tribal infrastructural capacity and readiness, current grant programs risk creating inequitable access to EVCI development opportunities, potentially leaving behind communities that face the greatest infrastructure challenges while rewarding those already positioned for success. The analysis demonstrates how a Tribe's position on this spectrum directly influences both their charging infrastructure needs and their ability to access and effectively utilize available funding resources.

Our findings reveal that successful EVCI implementation in Tribal communities requires addressing both community-specific charging preferences and location-specific technical considerations. The data shows that community members have distinct preferences for charging locations (primarily near homes rather than destinations) and frequently visit specific amenity types (especially food service locations).

The identified barriers to EV adoption, particularly cost concerns, suggest that EVCI planning must include considerations for affordability and accessibility. By addressing these concerns early in the planning process, this approach helps mitigate the "chicken-and-egg" dilemma of whether charging infrastructure or EV adoption should come first.

The research also highlights unique challenges for Tribal EVCI implementation, including:

1. Infrastructure data gaps, particularly regarding transmission line information
2. Balancing traditional community travel patterns with new technology needs
3. Addressing data sovereignty concerns while collecting necessary planning information

While more empirical research is needed to cover the inherent depth and breadth of any topic in the field of Indigenous planning, this research provides a valuable starting point for any project interested in EVCI and community-driven decision-making in general. The methodology developed here demonstrates how community input can be strategically incorporated into infrastructure planning processes. By centering community preferences and needs in the site selection process, this approach helps ensure that infrastructure investments reflect local priorities and use patterns.

The unexpectedly low prioritization of health service facilities in the survey warrants attention in future EVCI planning efforts. While the literature establishes healthcare facilities as essential community infrastructure, their minimal representation in travel preferences suggests that healthcare-related charging needs may require separate analysis from discretionary travel patterns. Future research should explicitly examine medical trip charging requirements, as these non-discretionary journeys may have infrastructure needs different from those of visits to restaurants or shopping destinations.

While the project was specifically geared towards Tribal EVCI planning, much of the processes used and developed in the research methodology and analysis can be transferred to site selection in other areas of planning where community input is a primary concern. The multi-layered spatial analysis approach, combined with weighted community preference factors, offers a replicable framework for other infrastructure planning efforts. While unsurprising that the Cannot Go lens of the criteria did very little to drive the analysis, given the lack of data availability, it might have done so regardless. Given that EVCI is constructed additively to the current transportation system and existing facilities may have their own resiliency requirements, natural hazard impact area for site exclusion is likely not appropriate at this stage in the analysis. This insight aligns with findings from Miletić et al. (2022), who note that Native American communities in Southern California have already incorporated considerations for specific local environmental risks, such as high winds and wildfires, into their sustainable infrastructure planning through the integration of traditional knowledge and practices. Nevertheless, the SMT's inclusion of the Cannot Go lens as a binary exclusion parameter will still enable extreme cases to be identified.

The findings also highlight the importance of considering both technical and social factors in infrastructure planning, bringing to mind the concept of checkerboarding. Such jurisdictional complexities are likely too chaotic for a tool to solve but, through successive iterations with other Tribal collaborators, the tool could cultivate the community necessary to address this issue. Tribal data sovereignty concerns necessitate careful management of geospatial information, where reporting obligations may result in fragmented public representation while comprehensive datasets remain securely maintained by Tribal authorities to protect sensitive cultural and environmental knowledge (Hill & Tovey, 2023).

These methodological considerations underscore the complexity of collecting representative data in Tribal communities while respecting cultural protocols and data sovereignty concerns. The apparent response bias toward Tribal employees, while providing valuable insights into government facility charging needs, also demonstrates the challenge of achieving broad community representation in infrastructure planning surveys. Future EVCI research must balance the need for comprehensive travel data with culturally appropriate data collection methods that encourage participation across all community demographics and trip purposes.

Limitations and Next Steps

This study faced several methodological and data-related limitations that should be addressed in future research:

1. **Limited Sample Size**: The survey response numbers (20 respondents) provide valuable insights but may not fully represent the diversity of community perspectives.
2. **Lack of Temporal Data**: The analysis focuses on current travel patterns without accounting for how EV adoption might change these patterns over time.
3. **GIS Data**: Discrepancies between GIS datasets and actual conditions create challenges for accurate planning.

The survey's limited examination of trip types and distances represents a significant analytical gap. While basic trip length questions were included for the off-reservation travel group, the survey did not systematically collect data on trip purposes (commuting, shopping, medical visits, etc.) or correlate these with distance requirements. This limitation is particularly relevant for larger reservations like the Yakima Nation, where trip type categorization could reveal distinct charging infrastructure needs. For instance, daily commuting patterns may require different charging solutions than occasional long-distance medical trips. Future research should integrate comprehensive trip type analysis with distance data to develop more targeted EVCI deployment strategies that address specific travel purposes and their associated infrastructure requirements.

The survey methodology also faced limitations related to question formatting and potential response bias, particularly around EV purchase considerations. The binary nature of some questions may have limited nuanced responses, and the survey did not systematically follow up "no" responses with direct questions about underlying reasons for not considering EV purchase. Particularly, Q15 asked if respondents were currently considering an EV purchase but only had options for yes or no and failed to capture whether individuals already own one. This approach may have missed important barriers or concerns that could inform EVCI planning. Additionally, the phrasing of questions about EV adoption may have inadvertently introduced assumptions about respondent familiarity with EVs. Future surveys should employ more open-ended follow-up questions and avoid making assumptions about baseline knowledge before collecting preference data.

Moving forward, efforts should prioritize enhanced data collection, particularly expanding transmission line information across the Reservation and validating existing datasets through direct review by Tribal staff, comparison with alternative sources, and ground-truthing where necessary. The SMT methodology should be refined to incorporate additional variables relevant to EVCI planning, with improved scoring processes and exploration of alternative weighting mechanisms that better reflect community priorities. Deeper stakeholder engagement through expanded surveys and focused discussions with specific user groups (elders, youth, workers) will strengthen the community-driven aspect of the planning process. Implementation should follow a phased approach beginning with the Administrative Building, including detailed electrical capacity assessments and Tribal-specific maintenance protocols. Cross-jurisdictional coordination will be essential, requiring discussions with neighboring jurisdictions about regional EVCI planning while developing protocols that protect Tribal data sovereignty. Finally, ongoing technology assessment should evaluate emerging charging technologies for compatibility with Tribal needs, consider renewable energy integration, and explore opportunities for local workforce development in EVCI installation and maintenance. These interconnected steps will help ensure that EVCI deployment respects both the technical requirements and cultural contexts unique to Tribal communities.

Conclusion

This research developed and implemented a community-centric, data-driven SMT to support the Tulalip Tribes in planning EVCI expansion. Through a collaborative partnership that honored Indigenous data sovereignty principles, this study addressed the critical research question: What are the EVCI expansion needs and challenges specific to Tribal communities?

A critical finding was the identification of significant infrastructure data gaps, particularly regarding transmission line information across the Reservation. The analysis revealed limited geodatabase coverage beyond main transmission lines for the first few miles of the main road, highlighting the need for enhanced data collection as a prerequisite to scaled EVCI implementation. The Can Go and Cannot Go technical lenses, while providing essential baseline assessments, were constrained by data availability issues that limited the precision of infrastructure assessments and connectivity analyses.

Contributions to Planning

This research makes several significant contributions to the emerging field of Indigenous TE planning. First, it establishes foundational scholarship at the intersection of Indigenous planning and TE, addressing a critical gap in the literature where EVCI planning with Tribes has been largely unexplored despite the unique intersection of transportation, energy, and infrastructure sectors in Indigenous contexts.

Methodologically, the study introduces a novel application of the STCA framework specifically adapted for Tribal EVCI planning contexts. The integration of recognition justice principles with sociotechnical capacity assessment creates a powerful analytical framework that simultaneously evaluates physical electrical grid capabilities and community social infrastructure readiness. This approach moves beyond conventional technical feasibility assessments to incorporate Indigenous sovereignty, knowledge systems, and self-determination rights into infrastructure planning processes. Additionally, the development of the four-lens analytical framework (Can Go, Cannot Go, Should Go, and Type) represents a significant methodological advancement for community-driven infrastructure planning. This framework organizes data inputs into a decision support system that considers both technical feasibility and community priorities, aligning with established best practices for systematic EVCI planning while centering Indigenous values and governance structures.

Perhaps most significantly, this work challenges the utilitarian distribution model guiding public EV charging infrastructure development by demonstrating that standardized approaches may exacerbate existing inequities when applied without consideration of unique cultural, geographic, and governance contexts. The research provides empirical evidence for the need to develop funding mechanisms that acknowledge the diverse spectrum of Tribal infrastructural capacity and readiness, from capacity-building grants supporting initial feasibility studies to implementation funding for communities ready to install charging stations.

Future Research Directions

This research has demonstrated that Tribal communities exist along a spectrum of EVCI readiness, as illustrated in the conceptual framework showing the progression from communities with zero EVCI infrastructure to those actively applying for grants to expand existing systems. This spectrum reveals both social and technical dimensions that must be addressed through continued research and development efforts.

The analysis revealed that the needs and challenges for Tribal EVCI development span this entire spectrum, with communities potentially finding themselves anywhere from requiring basic electrical infrastructure development before EVCI becomes feasible, to being ready for immediate charging station deployment. This spectrum necessitates different types of support and research approaches depending on where a particular Tribal community is positioned in their infrastructure development journey.

The social dimension, highlighted in the framework, emphasizes the critical importance of EV education programming that must begin early in any EVCI development process. The research findings showed that only a quarter of survey respondents reported moderate or better EV knowledge, with most gaining this awareness through personal research rather than community programming. This gap suggests that future research should focus on developing culturally appropriate EV education curricula that can be implemented across Tribal communities regardless of their current position on the infrastructure readiness spectrum.

On the technical dimension, the framework identifies infrastructure capacity development and interjurisdictional agreements as foundational requirements. The Tulalip case study demonstrated significant data gaps, particularly regarding transmission line information, which constrained the technical analysis and highlighted the need for enhanced data collection methodologies. Future research should prioritize developing standardized approaches for infrastructure assessment that can accommodate the varying levels of existing data availability across Tribal communities.

The research also identified the need for methodological refinements to the scalable mapping tool approach. Future iterations should incorporate additional variables beyond those tested in the Tulalip case, particularly around trip type analysis. As noted during the discussion, the current methodology would benefit from distinguishing between different trip purposes—commuting, healthcare, shopping, and cultural activities—as these may have fundamentally different charging infrastructure requirements. The bias toward Tribal employee responses in this study, representing at least 25% of participants, suggests that work-related travel patterns may be overrepresented, indicating the need for broader community engagement strategies in future research.

Longitudinal studies represent another critical research direction, particularly given the temporal aspects of EV adoption and infrastructure development. The chicken-and-egg dilemma between charging infrastructure availability and EV adoption rates suggests that future research should track how these dynamics evolve over time within Tribal communities. This temporal analysis could inform adaptive management strategies and help validate the initial planning assumptions embedded in the SMT framework.

The economic development perspective emerged as particularly important with the observation that many Tribes initially explore EVCI development through their existing business enterprises—casinos, convenience stores, and gas stations—as amenities for current customers. Future research should investigate this economic development approach more systematically, exploring how EVCI can be integrated into broader Tribal economic strategies rather than being viewed solely as a public amenity.

Finally, the funding mechanism research is perhaps the most critical future research direction. The current study demonstrated that funding programs must be sensitive to the diverse spectrum of Tribal infrastructure readiness, accommodating communities that may need to develop transmission capacity before implementing EVCI. Future research should evaluate the effectiveness of flexible funding approaches that can support capacity-building grants for initial feasibility studies, implementation funding for communities ready to install charging stations, and expansion grants for those seeking to scale existing programs.

The complexity of EVCI planning in Indigenous contexts demands continued research that respects Tribal sovereignty while addressing urgent infrastructure needs. This foundational work establishes a framework for community-driven infrastructure planning that can be adapted and refined through ongoing collaboration between Tribal communities, researchers, and policymakers. As Tribal communities increasingly assert leadership in renewable energy and sustainable infrastructure development, EVCI represents both an opportunity and a challenge. Success will require continued commitment to collaborative approaches that center Indigenous knowledge, respect Tribal governance structures, and recognize that sustainable infrastructure development must align with community-defined goals and values. This research provides a foundation for that ongoing work while acknowledging that much remains to be learned through continued partnership and engagement with Tribal communities nationwide.

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Appendix

Questionnaire Template

At this point, it is assumed that a Tribe with explicit interest in this research project has been engaged. The most important question to ask ourselves as researchers is whether we are aware of the specific protocols of the Tribe and have a Tribal liaison with that knowledge who can provide guidance. Without this awareness and relationship, the project should not continue as this questionnaire and related resources require an ongoing collaborative relationship that adheres to the Tribe's protocols.

The protocol for use of this questionnaire involves an exhaustive review of the suggested sources to collect the relevant information. Once the questionnaire is completed to the degree allowed at the public information level of information disclosure, it can be shared with the Tribal liaison to fill gaps and check accuracy. This questionnaire is a framework for that review to determine the Tribe's unique origin/destination locations on their Reservation and any preliminary EVCI plans. Additionally, it includes a list of the case-by-case GIS layers needed for the end analysis. Reliable processes and sources for collection are provided as well.

General Understanding

1. Has the Tribe already engaged Tribal Members, in any form, on the topic of EVs?
    - Yes
    - No
    a. If yes, please provide a description:

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2. Does the Tribe produce its own energy or draw from the national grid?
    - Micro-grid
    - National grid
    a. If the Tribe has microgrid development plans, please provide a description of the capacity and service area:

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    b. Is the Tribe currently exploring new energy production development (i.e., new energy type and/or facilities)?
        - Yes
        - No

3. Are there specific segments of the Reservation roadway network that, for reasons related to the roadway condition, cover, or jurisdiction, pose a potential barrier to EVCI development?

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4. Does the Tribe have a geographic delineation system for population centers on its Reservation (e.g., neighborhoods or council districts)? Reliable sources for this information, in order of validity, include:
    I. The Housing element of Tribal Comprehensive Plans
    II. Housing or Neighborhood Master Plans
    III. The Planning office's webpage on the Tribe's official website
    IV. Recent Tribal Census Block Groups from the U.S. Census
    V. Google maps
        a. This information is used to populate the Survey (Question 2).
5. Does the Tribe keep a list of Reservation buildings and places that are common community destinations (e.g., community centers, IHS facilities, grocery or convenience stores. etc.)? Reliable sources for this information, in order of validity, include:
    I. Tribal Comprehensive Plans
    II. Event advertisements on the Tribe's official social media or in newsletters
    III. Official Tribal Visitor guides
    IV. Google maps
        a. This information will be used to populate the Survey (Question 4).
6. Has the Tribe already identified potential locations for EVCI development? Reliable sources for this information, in order of validity, include:
    I. Energy, Infrastructure, and Transportation elements of Tribal Comprehensive Plans and Master Plans for any of the sectors
    II. Tribal Climate Action Plans
        a. This information will be used to populate the Survey (Question 18).

GIS Layers

1. Below is a list of case-by-case GIS data layers necessary for the scalable mapping tool. First see if the Tribe has already made available any of the layers. Otherwise, for roadway network and energy production, use the “Basemap Layer Calibration” tool in the package to generate GIS layers for their context. Instructions for this are provided in the following section. For the population centers and locations of interest, follow the process in the Dataset Construction Instruction section. Undevelopable areas vary significantly case-by-case and natural hazard areas are not reliably available at the granular scale needed for the development of tools and processes similar to those for the other layers. Instead, research relevant natural hazard GIS data at the local level and trust that the Tribe will communicate any concerns they have related to those or conservation areas.
    - ☐ Undevelopable or protected areas, such as
        - ☐ Natural hazard prone areas (eg. flooding, wildfire, earthquake, etc.)
        - ☐ Conservation areas
    - ☐ Roadway network
    - ☐ Energy infrastructure
        - ☐ Transmission lines
        - ☐ Capacity/Voltage
    - ☐ Population centers (as identified in Question 4 of the previous section)
    - ☐ Locations of interest (as identified in Questions 5 and 6 of the previous section)
        - ☐ Reservation POIs
        - ☐ Preliminary EVCI locations

2. For any data layers not maintained, is the Tribe planning to collect data at some point in the future?

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a. Are there any barriers the Tribe is facing in doing this work?

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b. What resources would be helpful to the Tribe to do this work?

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Survey Template

NOTICE: By taking this survey, I agree that I am 18 years of age or older

Hello! And thank you for your interest in helping [your Tribal government] understand your needs related to electric vehicle charging infrastructure (EVCI). EVCI simply refers to the EV charging stations and the electric infrastructure necessary to operate them. [your Tribal government] is interested in developing public EVCI and is engaging Tribal members, like you, to ensure the placement is driven by community needs. To assess community needs the survey will ask about your current travel behaviors, trip characteristics, and familiarity with EVs. You will be asked between 13 and 18 questions, depending on how you respond to certain questions that include follow-up options, and will take about 15-20 minutes to complete. All information you provide will be stored by [your Tribal government] and will not be shared with any external agencies or groups.

[Opportunity to provide reward or incentive for completion]

1. Do you live *on* or *off* of your Tribe's Reservation? Please select one:
    a. On
    b. Off
    - If you selected "On," please proceed to the next question; if you selected "Off," please skip to Question 7.

2. (On-Res Branch) If you live *on* your Tribe's Reservation, which of the following areas best describes the origin of your trip? Please select one:
    a. [Tribal Government list of Reservation neighborhoods or Tribal council districts]

3. (On-Res Branch) If you live *on* your Tribe's Reservation, do you tend to travel *within* the Reservation or *off* Reservation? Please select one:
    a. Within
    b. Off
    - If you selected "Within," please proceed to the next question; if you selected "Off," please skip to Question 10.

4. (On-Res Branch, travel within) If you typically travel *within* your Tribe's Reservation, which of the following Reservation locations do you travel to? Please select your top three (unranked):
    a. Destination A
        i. [Tribal Government list of Reservation POIs]
    b. Destination B
        i. [Tribal Government list of Reservation POIs]
    c. Destination C
        i. [Tribal Government list of Reservation POIs]

5. (On-Res Branch, travel within) Roughly how long do you spend there? Please select the option that best describes your stay duration for each of the top three destinations selected:
    a. Destination A
        i. less than 30 minutes
        ii. 30 minutes to 1 hour
        iii. 1 to 4 hours
        iv. 4 to 8 hours
        v. More than 8 hours
    b. Destination B
        i. less than 30 minutes
        ii. 30 minutes to 1 hour
        iii. 1 to 4 hours
        iv. 4 to 8 hours
        v. More than 8 hours
    c. Destination C
        i. less than 30 minutes
        ii. 30 minutes to 1 hour
        iii. 1 to 4 hours
        iv. 4 to 8 hours
        v. More than 8 hours

6. (On-Res Branch, travel within) For the top three destinations selected, how often do you travel to each one? Please select the option that best describes the frequency for each:
    a. Destination A
        i. 1-2 times per year
        ii. Once a month
        iii. Once a week
        iv. Multiple times a week
    b. Destination B
        i. 1-2 times per year
        ii. Once a month
        iii. Once a week
        iv. Multiple times a week
    c. Destination C
        i. 1-2 times per year
        ii. Once a month
        iii. Once a week
        iv. Multiple times a week

- Please skip to <u>Question 10</u> to continue.

7. (Off-Res Branch) If you live *off* your Tribe's Reservation, which of the following Reservation locations do you typically travel to? Please select all that apply:
    a. [Tribal Government list of Reservation POIs]

8. (Off-Res Branch) If you live *off* your Tribe's Reservation, roughly how far is the trip (one-way) in miles? Please select the range that best describes the distance:
    a. less than 25 miles
    b. 25-50 miles
    c. 50-75 miles
    d. 75-100 miles
    e. greater than 100 miles

9. (Off-Res Branch) If you live *off* of your Tribe's Reservation, how often do you travel to the Reservation? Please select the option that best describes the frequency of these trips:
    a. 1-2 times per year
    b. Once a month
    c. Once a week
    d. Multiple times a week
    - Please proceed to the next question to continue.

10. When you travel, what form of transportation do you use? Please select one:
    a. Private automobile (fossil-fueled, electric, and hybrid)
    b. Shared automobile (carpool, rideshare)
    c. Taxi service (like Uber or Lyft)
    d. Public transit (bus, tram, light rail)
    e. Tribal Transit
    f. Bicycle
    g. Walk or Roll
    h. Other (please specify)

    ____

11. How important are the following factors in your transportation choices? Please rate from 1-5, with 5 being most important:

Factor	Rank (1-5)
Cost	
Convenience	
Environmental Impact	
Reliability	
Travel Time	

12. What would be your *ideal* form of transportation? Please select one:
    a. Private automobile (fossil-fueled, electric, and hybrid)
    b. Shared automobile (carpool, rideshare)
    c. Taxi service (like Uber or Lyft)
    d. Public transit (bus, tram, light rail)
    e. Tribal Transit
    f. Bicycle
    g. Walk or Roll
    h. Other (please specify)

    ____

13. How knowledgeable are you about electric vehicle use? Please select one:
    a. Not at all
    b. Slightly
    c. Neutral
    d. Moderately
    e. Extremely
    - If you responded Moderately or Extremely, please proceed to the next question; if you responded Neutral, Slightly, or Not at all, please skip to <u>Question 15.</u>

14. If you responded Moderately or Extremely, where did you obtain this knowledge? Please select one:
    a. Tribal community event
    b. Friends or peers in the community
    c. Coworkers
    d. Personal research
    e. Other (please specify)

    ____

15. Are you currently considering an electric vehicle (battery EV or plug-in hybrid)? Please select one:
    a. Yes
    b. No
    c. I already own one
    - If you selected "Yes" please proceed to the next question; if you selected "No" please skip to <u>Question 20</u>; if you selected "I already own one" please skip to <u>Question 19.</u>

16. (Considering EV branch) If you are currently considering an electric vehicle, how soon do you anticipate acquiring it? Please select one:
    a. Within the next year
    b. Within 1-2 years
    c. Within 3-4 years
    d. Not immediately

17. (Considering EV branch) If you are currently considering an electric vehicle, which model would you prefer? Please select one:
    a. Private charging at residence
    b. Public charging near residence
    c. Public charging near destinations

18. (Considering EV branch) If you are currently considering an electric vehicle, what amenities would you want nearby while charging your vehicle? Please select all that apply:
    a. Restaurants/food options
    b. Shopping
    c. Restrooms
    d. Wi-Fi access
    e. Cultural/educational displays
    f. Recreation areas
    g. Other (please specify)
    - Please proceed to the next question to continue.

19. (Locate EV branch) If you are currently considering an electric vehicle and the Tribe installed charging stations, where would be most convenient for you? Please select your top three:
    a. [Tribal Government list of preliminary locations for EV charging]
    - Please skip to <u>Question 23</u> to continue.

20. (Not considering EV branch) If you are NOT currently considering an electric vehicle, would access to a public charging station near your *residence* (e.g., neighborhood station) change this? Please select one:
    a. Yes
    b. No

21. (Not considering EV branch) If you are NOT currently considering an electric vehicle, would access to a public charging station near your *destination(s)* change this? Please select one:
    a. Yes
    b. No

22. (Not considering EV branch) If you are NOT currently considering an electric vehicle, would the availability of a *private home charging station* (in the carport or garage) change this? Please select one option:
    a. Yes
    b. No
    - Please proceed to the next question to continue.

23. What concerns do you have about electric vehicles? Please select all that apply:
    a. Purchase cost
    b. Driving range/battery life
    c. Charging availability
    d. Charging time
    e. Vehicle performance in rural/remote areas
    f. Maintenance costs
    g. Other (please specify)

    ____

    ____

    ____

    h. No concerns

24. Would you be interested in attending a meeting or workshop to learn more about electric vehicles? Please select one:
    a. Yes
    b. No

User Guide

NO.	Branch	Question	Answer Prompt & Choices	Notes
1	Main	Do you live on or off of your Tribe's Reservation?	Please select one: - ON - OFF	(If ON, proceed to Question 2 If OFF, skip to Question 7)
2	On Res.	If you live on your Tribe's Reservation, which of the following areas best describes the origin of your trip?	Please select one: [Tribal Government list of Reservation neighborhoods or Tribal council districts].	Whatever the Tribe's system for residential spatial distribution categorization should be used. How well do Tribal members recognize the neighborhood or district names used?
3	On Res.	If you live on your Tribe's Reservation, do you tend to travel within the Reservation or off Reservation?	Please select one: - WITHIN - OFF	If the Reservation has significant checkerboarding, might need to add clarification (ie. if starting on Res. but has to go off in transit but ultimately ends on Res). (If WITHIN, proceed to Question 5 If OFF, skip to Question 10)
4	On Res., travel within	If you typically travel within your Tribe's Reservation, which of the following Reservation locations do you travel to?	Please select your top three (unranked): [Tribal Government list of Reservation POIs]	Reservation destinations like community or cultural centers, government buildings, commerce, etc. Answer choices listed three times, each under a "Destination [A/B/C]" header.

				How well do Tribal members recognize the POI destination names?
5	On Res., travel within	Roughly how long do you spend there?	Please select the option that best describes your stay duration for each of the top three destinations selected: - less than 30 minutes - 30 minutes to 1 hour - 1 to 4 hours - 4 to 8 hours - More than 8 hours	Answer choices listed three times, each under a "Destination [A/B/C]" to correspond to the previously selected destinations.
6	On Res., travel within	For the top three destinations selected, how often do you travel to each one?	Please select the option that best describes the frequency for each: - 1-2 times per year - Once a month - Once a week - Multiple times a week	Answer choices listed three times, each under a "Destination [A/B/C]" to correspond to the previously selected destinations. (Skip to Question 10 to continue)
7	Off Res.	If you live off your Tribe's Reservation, which of the following Reservation locations do you typically travel to?	Please select all that apply: [Tribal Government list of Reservation POIs]	Reservation destinations like community or cultural centers, government buildings, commerce, etc.
8	Off Res.	If you live off your Tribe's Reservation, roughly how far is the trip (one-way) in miles?	Please select the range that best describes the distance: - less than 25 miles - 25-50 miles - 50-75 miles - 75-100 miles - greater than 100 miles	
9	Off Res.	If you live off of your Tribe's Reservation, how often do you travel to the Reservation?	Please select the option that best describes the frequency of these trips: - 1-2 times per	

			year - Once a month - Once a week - Multiple times a week	
10	Main	When you travel, what form of transportation do you use?	Please select one: - Private automobile (fossil-fueled, electric, and hybrid) - Shared automobile (carpool, rideshare) - Taxi service (like Uber or Lyft) - Public transit (bus, tram, light rail) - Tribal Transit - Bicycle - Walk or Roll - Other (please specify)	
11	Main	How important are the following factors in your transportation choices?	Please rate from 1-5, with 5 being most important: - Cost - Convenience - Environmental impact - Reliability - Travel time	
12	Main	What would be your ideal form of transportation?	Please select one: - Private automobile (fossil-fueled, electric, and hybrid) - Shared automobile (carpool, rideshare) - Taxi service (like	

			Uber or Lyft) - Public transit (bus, tram, light rail) - Tribal Transit - Bicycle - Walk or Roll - Other (please specify)	
13	Main	How knowledgeable are you of electric vehicle use?	Please select one: - Not at all - Slightly - Neutral - Moderately - Extremely	(If you responded Moderately or Extremely, please proceed to the next question; if you responded Neutral, Slightly, or Not at all, please skip to Question 15.)
14	EV Knowledge	If you responded Moderately or Extremely, where did you obtain this knowledge?	Please select one: - Tribal community event - Friends or peers in the community - Coworkers - Personal research - Other (please specify)	
15	Main	Are you currently considering an electric vehicle (battery EV or plug-in hybrid)?	Please select one: - Yes - No - I already own one	(If you selected Yes, please proceed to the next question; if you selected No, please skip to Question 20; if you selected I already own one, please skip to Question 19.)
16	Considering EV	If you are currently considering an electric vehicle, how soon do you anticipate acquiring it?	Please select one: - Within the next year - Within 1-2 years - Within 3-4 years - Not immediately	
17	Considering EV	If you are currently considering an electric vehicle, which model would you prefer?	Please select one: - Private charging at residence - Public charging	

			near residence - Public charging near destinations	
18	Considering EV	If you are currently considering an electric vehicle, what amenities would you want nearby while charging your vehicle?	Please select all that apply: - Restaurants/food options - Shopping - Restrooms - Wi-Fi access - Cultural/educational displays - Recreation areas - Other (please specify)	(Proceed to next question to continue)
19	Considering EV	If you are currently considering an electric vehicle and the Tribe installed charging stations, where would be most convenient for you?	- Please select your top three: - [Tribal Government list of preliminary locations for EV charging]	If your Tribe has already identified potential locations, this question can help identify the locations that should be prioritized according to community perception. (Please skip to Question 23 to continue.)
20	Not considering EV	If you are not currently considering an electric vehicle, would access to a public charging station near your residence (eg. neighborhood station) change this?	Please select one: - Yes - No	
21	Not considering EV	If you are not currently considering an electric vehicle, would access to a public charging station near your destination(s) change this?	Please select one: - Yes - No	
22	Not considering EV	If you are not currently considering an electric vehicle, would the availability of a private home charging station (in the carport or garage) change this?	Please select one: - Yes - No	
23	Main	What concerns do you have about electric vehicles?	Please select all that apply: - Purchase cost - Driving	

			range/battery life - Charging availability - Charging time - Vehicle performance in rural/remote areas - Maintenance costs - Other (please specify) - No concerns	
24	Main	Would you be interested in attending a meeting or workshop to learn more about electric vehicles?	Please select one: - Yes - No	