Vermont Agency of Transportation Solar Plan

Rutland Airport

Prepared by: Good Company
For: Vermont Agency of Transportation

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Acronyms

ANR – Agency of Natural Resources

BGS – Vermont Buildings and General Services

CEP – Comprehensive Energy Plan

CPG – Certificate of Public Good

CPV – Concentrated Photovoltaic

DOT – Department of Transportation

EMF – Electromagnetic Field

EV – Electric Vehicle

FAA – Federal Aviation Administration

FEMA – Federal Emergency Management Agency

FHWA – Federal Highway Administration

FMV – Fair Market Value

GHG – Greenhouse Gas

GMP – Green Mountain Power

HSAT – Horizontal Single-Axis Tracking

ICE – Internal Combustion Engine

IRR – Internal Rate of Return

ITC – Investment Tax Credit

kW –Kilowatt

kWh – Kilowatt hour

LEAP – Long-Range Alternative Energy Planning

MACRS – Modified Accelerated Cost-Recovery System

MassDOT – Massachusetts Department of Transportation

MMBTU – one million British Thermal Units

MW – Megawatt

NLCD – National Land Cover Database

NREL – National Renewable Energy Laboratory

NPV – Net Present Value

ODOT – Oregon Department of Transportation

PPA – Power Purchase Agreement

PSB – Public Service Board

PV – photovoltaic

REC – Renewable Energy Certificate

RFP – Request for Proposal

ROW – Right-of-Way

RES – Renewable Energy Standard

RPS – Renewable Portfolio Standard

SAEP – State Agency Energy Plan

SAEIP – State Agency Energy Implementation Plan

SERF – State Energy Revolving Fund

SGHAT – Solar Glare Hazard Analysis Tool

SPEED – Sustainably Priced Energy Enterprise Development

SRMRF – State Resource Management Revolving Fund

UAP – Utility Accommodation Plan

USDOE – U.S. Department of Energy

VEC – Vermont Electric Cooperative

VEIC – Vermont Energy Investment Corporation

VELCO – Vermont Electric Power Company

VTrans – Vermont Agency of Transportation

Introduction

PLAN INTENT AND STRUCTURE

The Vermont Agency of Transportation Solar Development Plan provides an overview for the agency, potential partners, stakeholders, and the general public of why the agency should invest in solar photovoltaics (PV), and the process of developing solar PV projects on VTrans properties and highway right-of-way (ROW). The goal is to help the agency and others understand and navigate the processes towards a successful solar installation by providing step-by-step information regarding those processes and the resources that will assist in moving forward and avoiding project pitfalls. The energy industry and policy landscape is a dynamic one. Technologies, pricing, business models and incentives that make these types of projects possible regularly fluctuate; therefore, it is imperative to ensure that project elements outlined in this plan are still relevant and applicable to the project at hand.

The information presented within is based on:

- **Interviews** with VTrans staff and other state agency staff, Vermont partner and stakeholder organizations, other state departments of transportation (DOT) solar project staff, Federal Highways Administration (FHWA) staff, and solar specialists
- **Policy review**
- **Best practices review** of other transportation agencies efforts.

The plan is arranged by the following topics:

1. **Solar PV at VTrans:** This section provides an introduction as to the rationale for developing VTrans solar projects, particularly connecting solar development to Vermont and VTrans policies, greenhouse gas (GHG) and environmental benefits, energy landscape, economic benefits, and solar precedent at other state DOTs
2. **Key Considerations for Solar Projects:** This sections offers a primer on some of the main characteristics, concepts, and terminology needed to understand solar PV projects
3. **How to Implement Solar at VTrans:** This section is the heart of the plan. It outlines the step by step process to implement solar projects including: (1) assemble project team, (2) candidate site evaluation, (3) evaluate financial analysis and ownership model, (4) due diligence and project confirmation, and (5) implementation
4. **FHWA and request for proposal (RFP) procurement technical memos in Appendix:** These documents offer guidance on: (1) approaching right-of-way projects with the FHWA and (2) how to develop an RFP based on a Vermont specific context and solar PV contract language developed by DOTs in Massachusetts, New York, and Oregon.

Rationale for Solar PV at VTrans

OVERVIEW

The timing is right for VTrans to install solar generation at its properties and in the highway ROW. Project needs, policies, motivations, market conditions, and feasibility are aligned to make solar PV systems viable to deploy via VTrans internal operations as well as through partnerships with third-party solar developers. *(Note that the term partner or partnerships implies a cultural approach to working with people – not a legal sharing of a corporation.)*

The primary drivers for installing solar PV systems at VTrans include:

- **Agency cost reductions and financial feasibility:** Inadequate revenues from traditional sources such as fuel taxes limits the agency's ability to carry out its mission. In order to maintain the level of service to the public that depends on VTrans' system, operational cost avoidance and alternative revenue streams must be developed. Implementing solar projects can reduce agency operational costs and those cost reductions can be allocated to other essential agency activities. The current energy landscape of renewables in Vermont coupled with financial facets of solar PV projects, particularly pricing and project lifecycle, allow for projects to be feasible now that may not have just a few years ago. With the dramatic global scale up in solar panel production, prices have fallen dramatically since 2009, with marked drops on an annual basis. In 2015, prices dropped between 5-12% depending on the type of system (Lawrence Berkeley National Laboratory, 2016). Solar deployment costs are now financially competitive with, and under certain scenarios outperform, other power generation types fueled by coal and natural gas when compared based on a leveled cost (lifecycle) (Lazard, 2015). Solar power deployed for 11 years, now is price competitive with grid power in Vermont.
- **Resilience and continuity of service:** Distributed solar has the potential to provide the essential power for VTrans to continue operations when the electrical grid is down during and following disaster events to provide essential services for first responders and the rest of Vermont to reestablish normal life. Many things can disrupt the grid including: storms, extreme heat or cold that can cause rolling blackouts, cyberterrorism, etc.
- **Reduce the future effects of climate change:** In order to limit the magnitude of future climate change impacts, mitigation of GHGs from fossil fuel electricity generation is important. The differences between 1.5°C (current, 2.7°F), 2°C (3.6°F), and 4°C global temperature warming is dramatic and requires everyone to reduce their carbon footprint significantly and rapidly.
- **Policy alignment:** Policy directives at the agency, region, state, and federal levels require or encourage VTrans to participate in the shift to renewable energy sources in addition to clean transportation targets, particularly Vermont's 2050 energy goal.
- **Vermont's need for new clean electricity supply and VTrans energy use:** In the past few years, Vermont has deployed solar PV in substantial quantities. This growth has been spurred by the opportunity for a greater percentage of local, renewable power. In part, the closure of the Yankee nuclear plant left a vacancy and Vermont relies upon a majority of its electricity generation from outside its borders. Vermont state policy and initial net metering rules assisted in this growth of solar PV and will continue do so, albeit at a slower pace of implementation.

- **Solar projects at DOTs underway:** Vermont is one of eight state DOTs to develop solar for their operations. Arizona, Connecticut, Florida, Massachusetts, Minnesota, Ohio and Oregon all have developed rooftop and ground mount solar installations.
- **Reduced need for siting solar on agricultural land and scenic viewsheds:** Public opinion regarding siting solar on agricultural lands or scenic views could potentially be avoided by using VTrans properties or highway ROW sites that meet practical siting considerations.

AGENCY COST REDUCTIONS AND FINANCIAL FEASIBILITY

Case for VTrans Saving Money

- **Solar is already providing cost reductions.** For example, the 20 kilowatt (kW) project at Orange Garage is estimated to have saved the agency $3,500 in the first year of operation and will save over $130,000 over a 30-year lifespan. Likewise, the 60kW project at Rutland Airport is estimated to save over $11,000 in its first year and almost $400,000 over a 30-year life.
- **Simple payback periods:** The projects mentioned above have simple payback of 13 years and 10 years, respectively.
- **Net Present Value:** The 20-year and 30-year net present value (NPV) for Orange Garage are ($6,000) and $4,000 respectively (using a 5% discount rate) and for Rutland Airport are $9,000 and $41,000 respectively.
- **Utilizing VTrans staff for construction:** VTrans provided much of the installation labor required to install these systems, lowering first costs by over 25%. These systems would not provide the same value if a third party were used to install the systems.
- **Exploring business models:** While a VTrans owner-operator model has been successful for VTrans to date, consideration should be given to other business models that capture additional available financial incentives, reduce agency staff time, reduce project risk, and provide additional capital as needed. The business model that allows capture of the most incentives is one in which VTrans contracts with a third-party developer to build and own the system for a period of about 7 years. Around year 7, VTrans would purchase the system and take ownership from the developer at a depreciated cost. This model allows a project to capture incentives only available to private parties (Federal Tax Credit and asset depreciation) and the buyback allows the project to avoid debt financed interest charges as well as federal and state taxes on project income that would otherwise be assessed to the private party.

Solar Growth Factors

- **Cost of solar installation has decreased ~60% since 2009 for commercial solar** (see Figure 1) (NREL, 2015)
- **Solar PV efficiencies improving:** More power is being generated per surface area of panels
- **Solar PV panel lifespan system useful life:** Solar installations typically have warranty periods between 20-25 years although systems are capable and demonstrating that they can last 30-35 years thereby increasing a project's value of the equipment's lifecycle

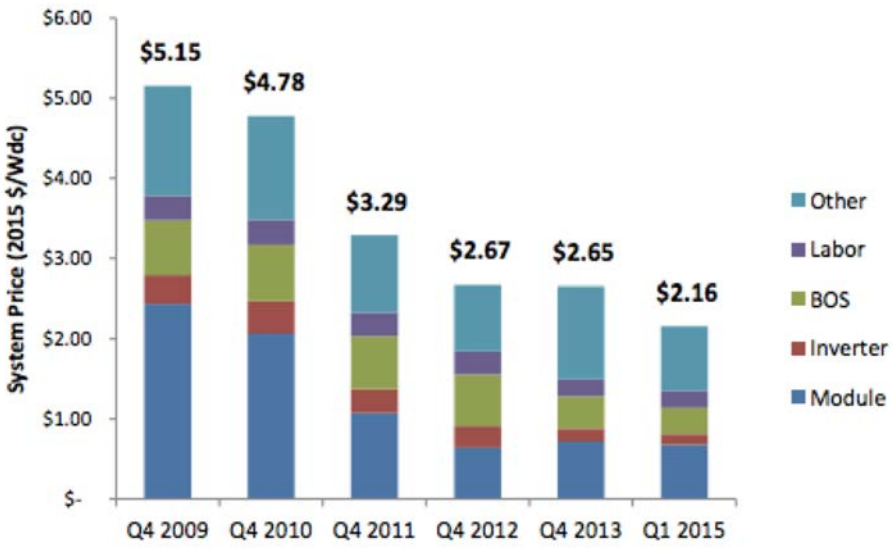

Figure 1 – Cost of Solar Installation 2009-2015

- **Incentives and business models:** Programs and models such as the Standard Offer program, net metering, power purchase agreements (PPAs), and Vermont's state agency loan programs (State Resource Management Revolving Fund – SRMRF and State Energy Revolving Fund – SERF) collectively provide multiple ownership pathways to solar deployment through different financing mechanisms.

RESILIENCE AND CONTINUITY OF SERVICE

Solar does not inherently permit resiliency in times that the electrical grid is down; however, measures to develop on-site storage or interconnectivity can allow for VTrans facilities, infrastructure, and equipment to be accessible and available in critical moments. Currently, net metering requirements involve adherence to IEEE 1547, which governs inverter specifications to a mandated grid-tied system to diminish the risk to utility crews in outage events. In order to allow for solar PV systems to be available during times of electrical grid outages requires additional equipment and functionality. Undoubtedly, increased equipment costs will increase overall project costs, but it is possible that VTrans may be able to access project funds from such organizations as the Federal Emergency Management Administration (FEMA).

- **Resilient infrastructure and systems:** Federal and state transportation agencies are directing considerable time and resources to developing both proactive and reactive strategies to managing extreme events. Proactive strategies include identifying the opportunity for new infrastructure or systems to include resilience or climate adaptation features that may increase resiliency, whereas reactive measures may include continuity or emergency response planning.
- **Solar potential for resilient energy system:** In the event of loss of power to the grid, whether that is due to an extreme weather event or another source of system outages, solar PV systems have the potential to maintain power to an organization or provide a public benefit and feed the grid power.

Micro grids are being deployed in greater numbers now to manage electricity systems at a localized level and ensure that electricity connection is maintained, which is critical for critical systems providers such as VTrans.

As an example, Rutland Airport can power its fuel pumping system with solar. This setup at Rutland required the Aviation Program Manager to first see the potential and value of backup power and then identify the method and equipment for it to work properly. In some cases, with more extensive onsite equipment or batteries, project costs will increase; however, the agency should also weigh the resiliency benefits and the importance of the project site in the aftermath of extreme events.

REDUCE THE FUTURE EFFECTS OF CLIMATE CHANGE

Opportunities for Reduction in Climate Change Impacts

- **Green regional grid:** The main approach to reducing the severity of climate change impacts is to continue and accelerate efforts to reduce GHG emissions. Vermont's electric grid is low carbon in comparison to other states, but does include significant generation from natural gas, a fossil fuel. Increasing renewable generation, particularly generation located within in the state boundaries, can decrease the grid's carbon intensity.

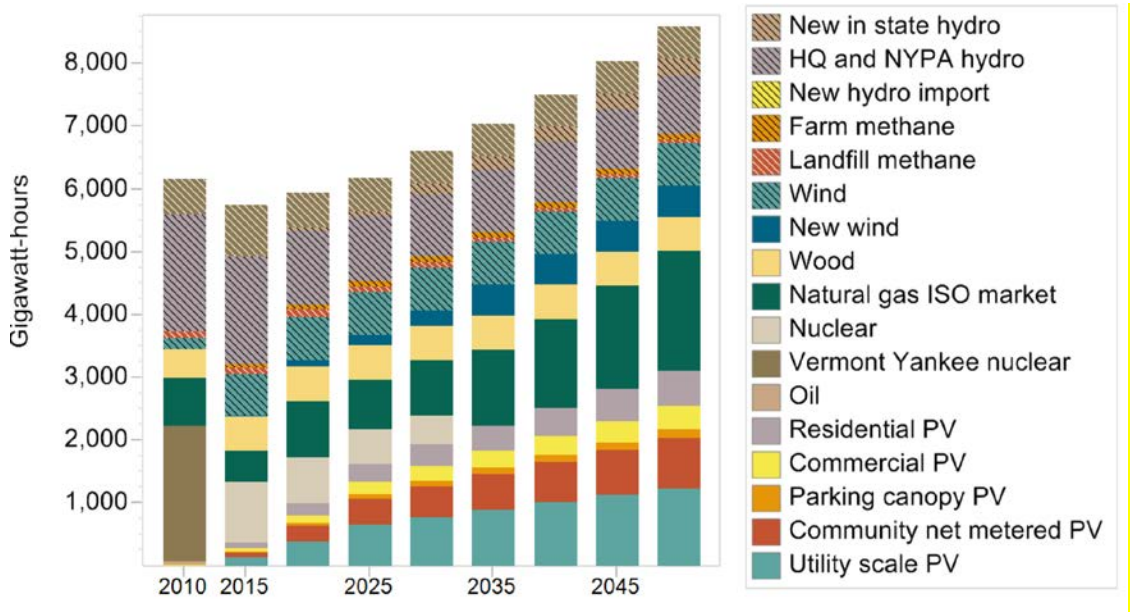

Figure 2 - VEIC Comprehensive Energy Plan 2010-2050
Source: VEIC, 2016

POLICY ALIGNMENT

Bold Targets and Opportunity for Transition

A solar development pathways effort spearheaded by Vermont Energy Investment Corporation is revealing opportunities to catalyze carbon free electricity in Vermont. The speculative study and stakeholder process is identifying the deployment and implications of ***reducing energy consumption by 20% by 2025, increasing solar electricity to 20% in Vermont by 2025 and ultimately supplying 90% of***

Vermont's total energy (electricity, thermal, transportation) with renewables by 2050 (Figure 2) (VEIC, 2016). What makes this target ambitious is that it is not simply renewable energy substituting for electricity production and use, but it also includes *transportation* and *thermal* energy demand and use.

Given the lower emissions of Vermont's electric grid, transportation GHGs play an even greater role, and in time, VTrans can participate in decarbonizing the regional grid in helping to transition to electric and zero emission vehicles. Further, 90% of transportation needs being met by electricity in 2050 reflects a revolutionary shift in the transportation landscape. Transportation currently represents about 40% of Vermont's GHG emissions and solar can be paired with electric vehicles (EVs) to reduce the GHG impact of traditional internal combustion engine (ICE) vehicles (ANR, 2016) (VEIC, 2016). VTrans' actions to meet this goal will enable to the agency to lead by example.

VTrans Goals and Policies:

VTrans is charting its course for solar PV deployment to meet state goals and its own internal mission and planning efforts. The following documents connect solar generation projects to efforts planned or underway:

- **Vermont State Agency Energy Plan (SAEP) (2016)**: Vermont's state agency goal in Buildings and General Service's State Agency Energy Plan is to: (1) reduce total energy consumption by 20% by 2025 and by 25% by 2030; (2) meet 35% of the remaining energy need from renewable sources by 2025, and 45% by 2030; and (3) reach a 40% reduction of greenhouse gas emissions below current levels by 2030 (VTrans SAEP)
- **State Agency Energy Implementation Plan (SAEIP) (2016)**: VTrans is responsible for preparing a biannual State Agency Energy Implementation Plan (SAEIP). The 2016 VTrans SAEIP uses VTrans energy data to better track energy use, GHG emissions and costs for the agency's transportation, heating and electricity sectors and makes several recommendations regarding efficiency and GHG emissions reduction measures. This solar plan is appended to the VTrans' SAEIP.
- **VTrans EV Charging Plan (2013):** The plan identifies the opportunity to connect solar PV generation to load served for variable daytime EV charging, which is a load that is anticipated to grow in the wake of the transition to transportation electrification
- **VTrans Fact Book and Annual Report (2015):** "*Goal 3 - Provide Vermonters energy efficient travel options: VTrans recognizes the transportation sector is a large contributor to greenhouse gas emissions, and seeks opportunities to improve efficiency of our operations by improving the energy efficiency of our buildings and better managing our energy consumption. Work continues to install solar panels at district garages and we are exploring installing additional solar capacity on VTrans-owned parcels throughout the state.*"
- **VTrans Climate Action Plan (2008):** The three focus areas of the plan are: (1) Reducing GHG Emissions from the Transportation Sector, (2) Protecting Vermont's Transportation Infrastructure from the Effects of Climate Change, and (3) Reducing VTrans' Operational Impacts on Climate Change.

(Note: referenced source documents are included in the appendix/bibliography.)

State Policy and Planning Frameworks

Vermont's energy landscape is changing rapidly as several policies and planning efforts are adopted and are actively amended. Here are the most relevant activities that relate to VTrans:

- **Vermont Comprehensive Energy Plan (CEP) (2016):** Mandated to be completed by the Department of Public Service Department (DPS) in compliance with 30 V.S.A. § 202, this plan charts the available means and methods for meeting state targets (e.g., energy efficiency, renewable energy). The plan is focused on achieving the following goals: (1) reduce total energy consumption per capita by 15% by 2025, and by more than one third by 2050; (2) meet 25% of the remaining energy need from renewable sources by 2025, 40% by 2035, and 90% by 2050; and (3) three end-use sector goals for 2025: 10% renewable transportation, 30% renewable buildings, and 67% renewable electric power
- **Vermont Renewable Portfolio Standard (RPS)/Renewable Energy Standard (RES):** The Vermont Legislature delivered Act 56 of 2015 that directed that electricity supplied to the state must be equal to 55% renewables by 2017 and 75% renewables by 2032. The RPS/RES requires that renewable energy certificates (RECs) be retired from projects of 5 MW or less that are connected to the utility.
- **Regional planning commission and Long-Range Energy Alternative Planning (LEAP) efforts:** Under 24 V.S.A. § 4302 Vermont's regional planning commissions are planning to identify their region's needs, opportunities, and implementation strategies to meet the state's renewable energy goals. Three regional planning commissions (Bennington County Regional Commission, Northwest Regional Planning Commission, and Two Rivers-Ottauquechee Regional Commission) have drafted plans, while the rest anticipate to complete those in 2017 or 2018. Act 174 (S.260), signed into law by the governor in June 2016, integrates local and energy standards into renewable energy project process so that municipalities and regional planning commissions and their representative communities have more involvement in renewable energy siting and project process.
- **Net metering rule:** Revisions to the net metering rule, to be commenced in January 2017, were announced late August 2016. The Public Service Board adjusted their directive in response to the significant amount of generation that came online in recent years. ***One of the most significant challenges to the new rule for VTrans is that it caps the individual customer capacity at 500kW.*** This aspect of the rule may be subject to change during rulemaking, particularly as government agencies advocate a rule that does not impede their efforts to meet state agency goals (PSB, 2016). VTrans could advocate for clearer definition of "customer" as it currently bundles entity types together including private, public, and non-profits. In the interim, VTrans should attempt to identify sites that are outside of the Green Mountain Power service territory (as most their installations are in this territory).
- **Solar siting:** Act 56 of 2015, Section 26g, created the Solar Siting Task Force to study the design, siting, and regulatory review of solar electric generation facilities and provide a proposed legislation with the rationale for each proposal." The final report, published in January 2016, outlined the relevant factors to consider. Components of this plan are referenced in greater detail in the siting selection section.
- **Standard Offer Program (feed-in-tariff):** Vermont's Sustainably Priced Energy Enterprise Development (SPEED) program offers incentives to primarily utility-scale projects (greater than 500kW capacity). The two SPEED projects selected in 2016 were for approximately 2MW systems each and received approximately $0.08 and $0.11 per kilowatt-hour (kWh), respectively.

EXPAND CLEAN ELECTRICITY SUPPLY

Vermont has undergone significant changes in its electricity generation resource mix in the past few years that in part reflect state level policy efforts combined with market mechanisms. Major elements of Vermont's electricity landscape include:

- **Nuclear closure:** Vermont Yankee Nuclear Plant permanently closed at the end of 2014
- **Reliance upon neighbors:** Vermont is now producing less than 40% of the electricity it consumes in the state. The rest is generated in Canada and other New England states.
- **Vermont renewables growth:** In-state renewable energy generation has increased over the past few years. This was illustrated in 2015, when Vermont's in-state net electricity generation was produced by its renewable energy sources, including hydroelectric, biomass, wind, and solar (U.S. Energy Information Administration, 2016).

Solar Connection to Vermont's Economy

- **Opportunity to reduce use of fossil fuels:** Two of the main areas for reducing fossil fuels lie in transportation and heating. Vehicle electrification and zero emission vehicle deployment, in addition to increased utilization of technologies such as ductless electric heat pumps, could increase electricity demand but this could be offset by onsite or grid renewables.
- **Opportunities to shift energy spending to local generation:** Vermonters spend $3.3 billion annually on energy for their homes and transportation. This represents a significant amount of money that could be retained in state if supplied by local generation (VEIC, 2016). The Vermont Energy Investment Corporation (VEIC) and the U.S. Department of Energy (USDOE) assessed the annual investment necessary to meet 90% renewable energy produced in state by 2050. They determined that an additional annual investment of approximately 1% would be needed to develop the necessary solar PV capacity. This additional capacity represents a net present value of $4 to 4.5 billion through 2050.
- **Local employment in solar sector:** More than 85 solar companies and 1,300 people are employed in the solar value chain in Vermont (SEIA, 2016). With the anticipated growth of solar in Vermont it can be expected that several good paying jobs will grow with the investment in additional generation capacity.

Recent Bold Growth and Forecasted Growth in Solar PV Systems

- **Rise in solar rankings:** The pronounced deployment of solar in the last three years has raised Vermont's solar capacity per capita to seventh in the nation and 181 watts per person in capacity. As a comparison, Vermont had 51 watts per person in 2013 (Solar Industry, 2016; Environment America, 2015).
- **Reasons for growth:** Policies, market conditions, and subsequent private sector and community engagement have been responsible for the significant rise in Vermont's solar PV installations. Figure 3 shows the number of Certificate of Public Good (CPG) installations by kW size installed in Vermont over a 10-year period (through 2015). Per the report, the majority of systems under 500 kW are net metered and those above 500kW take advantage of the Standard Offer Program or utilize a utility Power Purchase Agreement (Solar Siting, 2016).

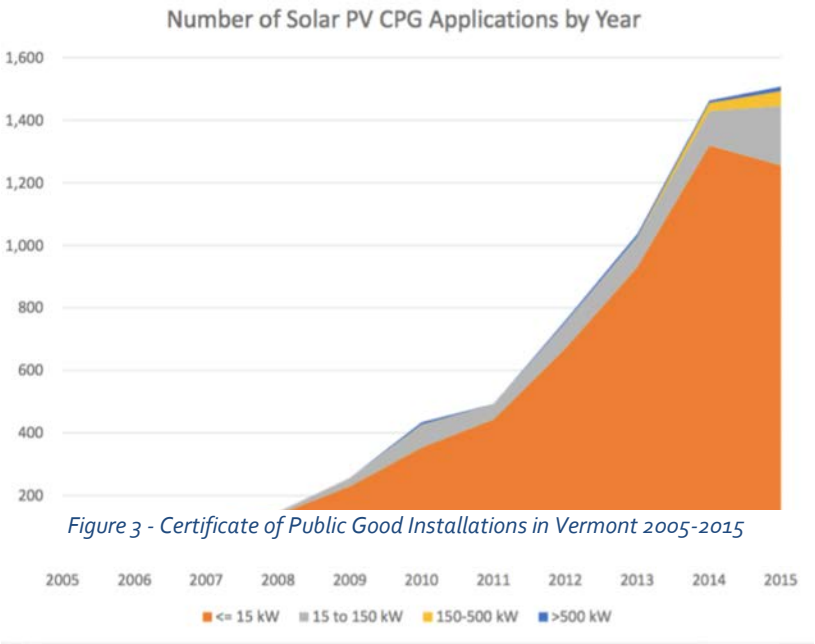

Figure 3 - Certificate of Public Good Installations in Vermont 2005-2015

- **Continued pace of growth:** VEIC and Vermont's CEP envisions an increasing pace of solar PV deployment – 10 times the current pace in the coming decade – with increasing solar PV efficiencies and ever-improving solar component pricing. At that rate of deployment, by 2025, greater than 20% of the total electricity supply will be from solar. The useful life of solar needs to be considered as well when projecting the amount of solar to be deployed. Given a useful life of approximately 30 years, a percentage of solar PV systems will need to be *replaced* prior to 2050 (CEP, 2016; VEIC, 2016).

Multi-Stakeholder Effort to Chart the Course Ahead

- **Energy implementation planning:** VEIC is coordinating a multi-stakeholder effort called *Vermont Solar Development Pathways* which is tasked with developing the plan of potential approaches for meeting the state's 2050 renewables target. VEIC is using the Long-range Energy Alternatives Planning (LEAP) integrated planning tool to assist the group and Regional Planning Commission (RPC) efforts. A draft plan is currently available and the final plan is anticipated to be completed by the end of 2016. Subsequent work will be focused on Vermont's regional implementation plans through 2018. Interviews with VEIC and RPCs indicated the opportunity for VTrans to reach out to RPCs in the near-term to coordinate opportunities for site selection and where VTrans can complement the regional planning for renewables installation.

VTRANS ENERGY USE

- **Total energy demand at VTrans:** The agency's electrical electricity consumption is comparatively low (~6%) in relation to agency total energy use (transportation fuels ~71%, heating ~20%) (SAEIP, 2016)
- **Electricity end uses:** In 2015, VTrans consumed 4.38 million kWhs in electricity. Approximately 66% of the agency's electricity consumption is utilized in buildings and 34% is directed to highway uses (e.g., traffic lights, signals, weather stations, weigh stations, street and park and ride lighting) (SAEIP, 2016)
- **Electricity costs:** For building electricity, VTrans is charged $0.17 per kWh (21% more than the residential rate) and the agency pays $0.25 per kWh for highway lighting (SAEIP, 2016)
- **Implementing energy efficiency measures:** LED replacements in buildings and roadway lighting will decrease electricity consumption
- **Electric vehicles:** In time, as more EVs are added to the agency's fleet, electricity demand will increase to meet this new end use. The agency should also consider how greater adoption of passenger vehicles and the siting of charging station at park and ride and rest area facilities will impact electricity demand.

Projects Already Developed

Project Location	Capacity Rating (kW)	Annual AC Energy Production (kWh)
Airports	60	~65,000
Rutland Airport	60	
Garages	~195	~220,000
Bennington	~15	16,000
Brandon	~15	16,000
Castleton	~15	16,000
Dummerston	~15	16,000
Lunenberg	~10	13,500
Mendon	~15	16,000
North Montpelier	~20	22,000
Orange	~20	22,000
Readsboro	~15	16,000
Rochester	~15	20,000
Royalton	~10	13,500
Tunbridge	~15	16,000
Wilmington	~15	16,000
Right-of-Way	75	~100,000
Fair Haven Welcome Center (AER)	75	
Total	**330 kW**	**385,000 kWh**

Opportunities for VTrans Projects

VTrans electricity use in 2015 was approximately 4.4 million kWh. VTrans previously set a 25% net metered renewable electricity goal or approximately 1.1 million kWh. VTrans will have 330 kW of installed solar PV capacity by the end of 2016, which is expected to generate approximately 385,000 kWh per year. This means that VTrans will be only 8.75% towards achieving its the 25%goal. If VTrans is limited to 500 kW per the draft net metering rules, VTrans could only install 170 kW in capacity or approximately 200,000 in annual kWh production if those systems were built in Green Mountain Power service territory. This would equate to 13% of VTrans' electricity being produced with net metered projects.

To meet the 25% target, an additional 610 kW of capacity that generates 715,000 kWh is needed. This capacity is equivalent to an additional seven projects like the system installed at Fair Haven Welcome Center or 36 additional 15kW garage projects. If they are fixed ground mount systems, an additional 4.25 acres of land will be required, however, if they are tracking ground mount systems an additional 5.5 acres will be needed.

PRECEDENT FOR SOLAR AT TRANSPORTATION DEPARTMENTS

The state-of-the-practice is still on the front edge of significant development; however, the last few years has seen a rising concentration of solar PV system installations at state DOTs across the country, particularly in the Northeast in Massachusetts and Connecticut.

The following is a list of state DOTs that have investigated and implemented solar projects and programs:

- ADOT – Arizona
- ConnDOT – Connecticut
- FDOT – Florida
- MassDOT – Massachusetts
- MnDOT – Minnesota
- ODOT – Ohio
- ODOT – Oregon

These state transportation agencies have conducted initial feasibility research or have released a solar RFP:

- CalTrans – California
- NDOR – Nebraska
- NJDOT – New Jersey
- NYSDOT – New York
- WSDOT – Washington

REDUCED NEED FOR SITING SOLAR ON AGRICULTURAL LAND AND SCENIC VIEWSHEDS

Vermont's legislature initiated a process for solar siting in response to stakeholder requests for directing future solar siting to areas that can be more beneficial to the grid but also that forego siting solar in locations that could have important future uses (e.g., agriculture) or that maintain the state's important scenic value. VTrans or ROW sites could be preferential to other private or public lands. Certainly it is important to acknowledge that highway ROW sites often provide a compelling viewshed or "window" onto Vermont's landscapes. Focusing on less visible sites and engaging local communities could help garner public support.

- **Meeting the challenge:** The challenges policy makers face are to meet: (1) the state's goals while implementing plans and policies that site solar in appropriate places; (2) energy load and demand; and (3) siting opportunities and constraints set forth by local and regional communities
- **Land use for solar siting:** Vermont's CEP and regional planning commissions are focused on the implications of land use for siting solar PV projects. Commissions are acutely aware of community concerns related to impeding scenic viewsheds and use of agricultural land. According to analysis in the CEP, it is estimated that between 8,000 and 13,000 acres of Vermont's total 6 million agricultural acres may be necessary to meet these targets, or about 0.2% (using an assumption of 7 acres per MW) (CEP, 2016).

Key Considerations for Solar Projects

Before engaging in a solar project, there are a few critical elements that need to be in place or clearly understood by agency staff. Without having a clear understanding of these project elements, a project either will not capture the full benefits or risk setback or failure. These initial considerations include:

- Understanding solar applications and options
- Agency capacity and commitment
- Incentives
- Business models and available project pathways

UNDERSTANDING SOLAR APPLICATIONS AND OPTIONS

How the Technology Works

System process: Solar photovoltaic panels are a distributed electricity generating technology converting direct and indirect sunlight into direct current (DC) electricity using solid-state semiconductors. Crystalline silicon (c-Si) are the predominant type of PV panel. An inverter then converts the direct current to alternating current (AC), at a voltage compatible with onsite or electrical grid systems.

VTrans draws from previous experience from owner operator and third-party PV solar systems at garages, maintenance facilities, airports, and a highway ROW rest areas. Small-scale, owner-operator projects (15 – 20 kW) have been and continue to be developed at several state maintenance garages. In 2016, VTrans developed an owner-operated 61kW project at Rutland State Airport. The same year VTrans also developed a project at the Fair Haven Welcome Center (75kW) in a public-private partnership with AllEarth Renewables.

Typical system components:

- PV panels
- Electrical equipment required to tie the system to the electric grid
  (NREL, 2016) (USDOE, 2016)

Balance of system components:

- Electrical connections such as wiring and switches
- Mounting structures
- Inverters
- Battery bank
- Solar tracker
- Ancillary equipment (e.g., security cameras, fences, roads).
- For a glossary of solar radiation resource terms, please see: http://rredc.nrel.gov/solar/glossary/gloss_s.html

Figure 4 illustrates the solar PV process from start to finish with options included such as better or electric vehicle charging.

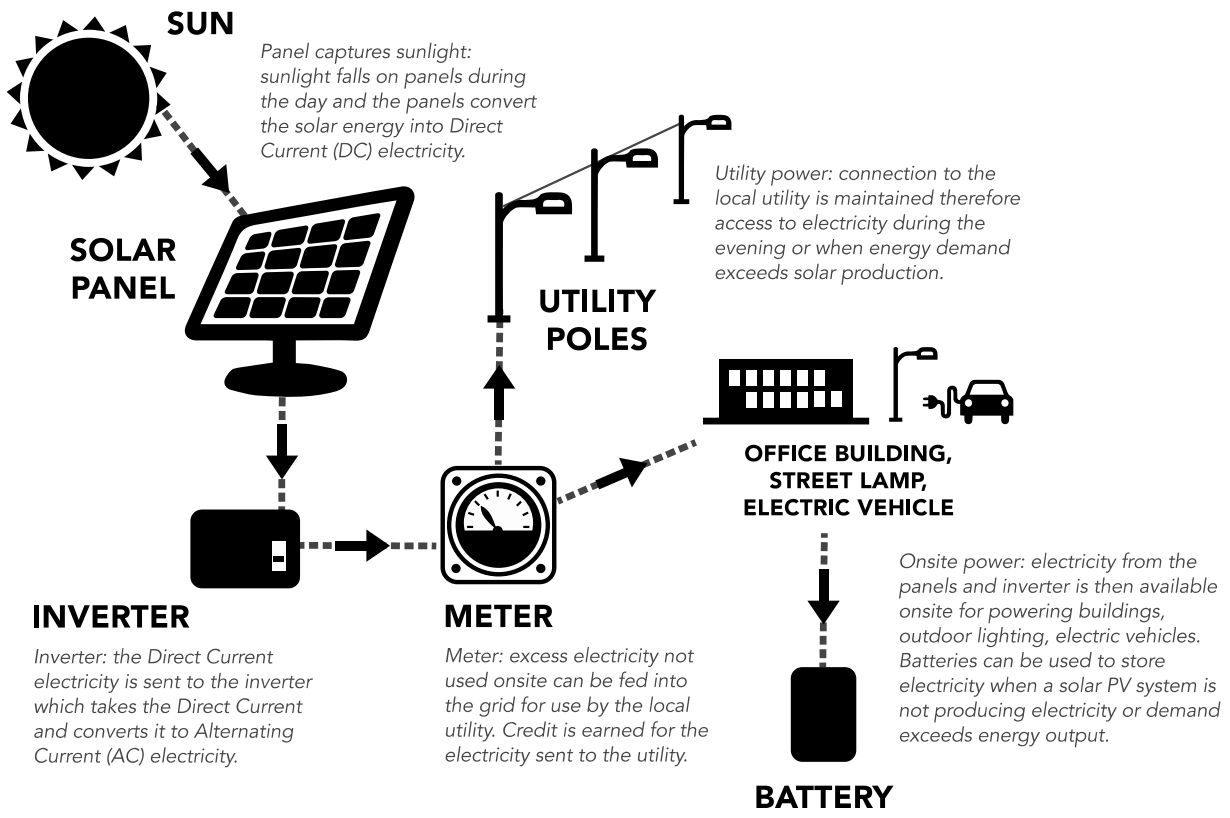

Figure 4 - The Solar PV Process

PV Design Options

Placement

- **Rooftop:** This type of PV solar system is attached to a building rooftop or roof structure (e.g., parking lot). The size of these systems is limited by the size of the roofing footprint. Rooftop solar can be attached to the roof with the use of a ballast to weigh the racking down, anchoring the racking using bolts attached to the structure members, or by gluing or sonically welding a mount to the affixed roof membrane. If thin film panels are used, these can be directly adhered to the roof membrane, although this limits the ability of the solar cells to be cooled, which will reduce productivity. Given new net metering rules, rooftop, particularly parking lot canopy sites, are given preferred status. A logical site for canopy installations would be park and ride facilities that could combine solar with EV charging stations. However, practical considerations of snow load and maintenance will most likely make these types of installations unlikely soon.
- **Ground mount:** These systems are installed on the ground either adjacent to buildings or on open sites. Most often they are mounted on driven piers, but in some cases, they are attached to ballast, such as eco-blocks when driving piers is not practical. The majority of future VTrans solar PV projects will be ground mount systems.

Mounting

- **Fixed-tilt systems:** These systems are stationary and fixed at an angle (e.g., 25°) and oriented to face south to capture the greatest amount of light from the sun over the course of a year. Fixed-tilt systems are the predominant type of PV deployment for ground mount and rooftop systems.
- **Single-axis tracking:** Instead of being fixed south, a horizontal single-axis tracking (HSAT) system allows the solar PV modules to follow the sun from east to west over the course of the day. The purpose of PV tracking systems is to optimize solar energy collection. A 2015 NREL report shared industry interviews that suggested "that single-axis trackers are now used nearly exclusively for large projects in climates where appropriate, such as in the Southwestern and Western United States." (NREL, 2015)
- **Dual-axis solar tracking:** These systems utilize a motor and GPS or a timer to track the sun over the course of a day. Before sunrise, the solar PV modules go into their "wake cycle" where they rotate into a position facing east and wait for the sun to rise at which point the modules begin tracking the sun. These systems can produce 45% more energy than fixed arrays because they maximize the amount of sunlight captured by the modules.

AGENCY CAPACITY AND COMMITMENT

Project Champion

A project champion is a critical component of launching VTrans solar projects. The project manager and the top leadership must be able to build a compelling vision to generate and maintain support within the agency and among stakeholders.
The project champion also needs a team of skilled agency staff and partners that provide the necessary support, technical expertise and resources. However, it is the project manager that is the point person responsible for overseeing, coordinating, and integrating disparate tasks and driving much of the schedule. If multiple projects are in process and VTrans is utilizing its staff for project management and process tasks, there will undoubtedly be limits on staff availability and the number of projects the agency can manage. Depending on the scale and timeframe for solar PV project deployments, the project manager could be directed to manage solar projects for a defined period and may not be a full-time FTE but might hold other responsibilities within in the agency.

Tasks a project manager may cover include:

- Site selection
- Oversight of the project budget
- Identification of funding opportunities including grants or private sector tax benefits
- Monitoring the project schedule and coordinating agency experts and consultants
- RFP procurement and third-party contractor communication

Ideally, the project manager possesses leadership and entrepreneurial talents capable of managing projects that navigate a significant level of learning and teaching, demonstrating a capability for communication, coordination and relentless problem solving.

Leadership Buy-In

The project manager should be empowered by the top leadership. Beyond the frontline project manager, it is critical to have the support of agency leadership from the top of the organization. Without this endorsement, the existing workload will compete for the time needed to answer the requests of the project manager. Leadership from the Secretary of Transportation and the Governor's office is a critical component and can direct agency efforts and engage stakeholder groups.

VTrans has the individual elements and skill sets to manage and implement solar projects; however, if VTrans is to set a course managing and developing a greater number of projects, a designated project manager will be essential to ensure success. Both Oregon DOT and MassDOT have exhibited successes with solar project managers. Allison Hamilton, ODOT's Solar Highway Project Manager, and Hongyan (Lily) Oliver, Environmental & Energy Analyst, both have contributed greatly to their respective programs.

Massachusetts, New York, and Oregon DOTs each mentioned in interviews this as a critical component.

Project Timeline

It is difficult to predict the amount of time that it may take to advance a project from conceptualization through implementation, as local circumstances will significantly vary. Projects will likely take between a few months to a full year or more for planning through commissioning. The time required depends on whether the project is a smaller, onsite solar PV system built with agency staff, or if the project is larger in scale (i.e., multiple sites being developed in parallel) and the project's stakeholders (e.g., developers, contractors, FHWA).

Project timelines are influenced by:

- Project team availability and resources
- Additional studies or modifications (e.g., interconnection study)
- Siting and permitting (e.g., environmental impact analysis)
- Federal and state policy
- RFP procurement process
- Construction seasons
- Business model and contracting pathway evaluation
- Timing of available financial incentives
- Financing

Program Costs

Agency program costs differ depending on whether the solar PV systems are built with existing agency financial and staff resources or via contracting with a 3rd party to develop, operate and maintain the system. A 3rd party would allow VTrans to avoid the upfront capital cost of the solar PV system, while an owner-operator approach would be simpler to develop. The difference in program costs is elaborated on in the ownership model section.

Regardless of the method used to deploy solar, there will be some programmatic costs the agency must fund. Some of these costs can be internalized by using staff time, while others can be contracted costs for professional or technical services. Often internal costs may not be as visible to tracking and determining a project's efficacy and financial viability. It may be possible to absorb these costs within existing programmatic budgets but it may also be necessary to secure funding from other sources such as federal grants or programmatic requests to cover program work.

INCENTIVES AND AGREEMENTS

Analyzing and selecting a financing structure that optimizes a project's financial performance and safeguards public resources requires knowledge of available federal, state, and utility financial incentives, the markets for electricity and renewable energy credits, and the regulatory constraints associated with certain financing structures. Gathering this information ensures that a proper financial assessment can be made by VTrans staff before committing to a project and/or business model.

Financial Incentives

Federal and state financial incentives are designed to help defray the upfront capital costs associated with a photovoltaic system and can be a key variable in determining a project's cost effectiveness. In some cases, pursuing a project without incentives may cost more than grid power.

This section outlines the financial incentives that can assist solar PV project's feasibility. General definitions are provided here but more specific context for their relevance to business models (agency owned and operated vs. contracted third-party with or without a system buy-back option) is described in greater detail the financial analysis section.

- **Assess and confirm *current* project incentives:** The landscape for renewable energy incentives regularly changes; therefore, it is important VTrans assess and confirm the availability and applicability of financial incentives for each project. For example, the Investment Tax Credit (ITC) was due to sunset in 2016 but in late 2015, Congress passed an extension of the ITC through 2022. This type of incentive (30% of solar project costs for a private entity) often drives the business model. As reduced solar panel pricing continues to make project feasibility possible without incentives, state and federal incentives may fade out. The table below outlines the incentives currently available for solar PV projects in Vermont. For future reference, it is recommended to use the Database of State Incentives for Renewables & Efficiency (DSIRE) as an initial point of reference and then confirm details with the named responsible office (e.g., Public Service Board for net metering) (DSIRE, 2016).
- **Incentives commonly benefit private entities:** Public agencies cannot generally take advantage of the full range of financial incentives (e.g., federal and state tax credits) available for investments in solar PV projects. Therefore, it is common for public agencies to contract with a private sector partner who can. However, there are means, as discussed in the next section, of contracting and models for different approaches whereby a public entity can take advantage of private entity incentives. The table below notes if incentives are available to public or private entities.

Incentive	Amount	Public or Private Beneficiary	Details and Source
Investment Tax Credit (ITC)	30% of qualified project costs	Private	In late 2015, the ITC was extended to 2022 with the 30% project cost threshold available until 2019; and then the ITC tapers to 26% and then 22% from 2020-2022. Qualified expenditures include both equipment costs, direct (e.g., labor), and indirect installation costs (e.g. design fees). *Source: DSIRE, 2016.*
Modified Accelerated Cost-Recovery System (MACRS)	50% bonus depreciation	Private	MACRS is the method for calculating federal accelerated depreciation of business equipment. Under MACRS, a taxpayer can recover their capital investments through annual depreciation deductions over a specified number of years. Different business equipment types, or asset classes, have different depreciation schedules. Solar photovoltaic systems have a five-year MACRS depreciation schedule. To spur investment the federal government has temporarily modified the depreciation schedule for photovoltaic systems allowing taxpayers to take 100% of the depreciation deduction in the first year through 2011. For 2012, the bonus depreciation declines to a 50% depreciation deduction in the first year. Equipment installed prior to January 2018 a 50% bonus depreciation; installed during 2018 40% bonus depreciation; installed during 2019 30% bonus depreciation *Source: DSIRE, 2016.*
Net Metering – Site Adjustor Credit	Category I and II sites receive an additional $0.01 per kWh; Category III sites receive $0.01 less; and Category IV sites receive $0.03 less than residential rate	Public or private	The credit amount is a per kWh with a positive or negative adjustor to the residential rate. *Source: Vermont Public Service Board, 2016. Revised Rule 5.100 Pursuant to Act 99*

SPEED's Standard Offer Program	Per kWh is dependent on the offer provided by the project developer and whether it meets the bar	Contracted third party	The Standard Offer Program requires a proposal based on annual RFPs; this type of arrangement would most likely require a private entity developer. The PSB issues annual reports on the Standard Offer Program to the legislature every January. From 2016-2018, annual program capacity will be 7.5 MW, and beginning in 2019, annual program capacity will be 10 MW. The long-term contracts are 10 to 25 years for solar. The PSB sets avoided cost rates to be used as annual per-kWh cost caps for contracts. Contracts are selected competitively based on the proposed $/kWh structure. *Source: DSIRE, 2016;* *Vermont Electric Power Producers, 2016.*
State Resource Management Revolving Fund and State Energy Revolving Fund	Loan funds available. Repayments in form of value of energy saved and nominal interest rate.	Vermont public agency	These funds are available to solar projects but primarily serve energy conservation and efficiency projects for Vermont public agencies. SRMRF repayments will consist of 100% of the estimated annual value of energy saved or waste reduced and an administrative fee of 0.5% of the outstanding balance payable to Vermont Buildings and General Services (BGS). SERF repayments will consist of 100% of the estimated annual value of energy saved, waste reduced or power produced and a 2% interest rate payable to the Treasurer's Office and a 2% administrative fee payable to BGS. *Source: Vermont BGS*
Net Metering - Renewable Energy Credits — Renewable Energy Standard	$0.03 per kWh for first 10 years if transferred to utility; a negative (-$0.03) per kWh if RECs are retained		Projects that choose to retain their ability sell RECs bear a (-$0.03) reduction in their net metering rate for the duration of the project. Organizations may choose to hold the RECs for out-of-state sale or retire the RECs to meet internal renewable energy or climate goals. Guidance on Solar Marketing for Third-Party Solar Projects Selling RECs: Developed by the Vermont Attorney General's Office in partnership with the Department of Public Service. *Source: PSB, 2016.*
Renewable Energy System Sales Tax Exemption	6% is Vermont's current sales tax percentage on equipment	Private entity	Exemption for systems up to 500 kW in capacity. *Source: Vermont Legislature, 2016.*

For Vermont state agencies, the State Resource Management Revolving Fund and the State Energy Revolving Fund, overseen by Vermont's BGS Energy Manager, could be relevant sources of initial capital for VTrans owned and operated solar projects. These funds are primarily used for energy conservation but are available for renewables projects if they can demonstrate that the proposed solar project requires the funding to perform better than a third-party project. This program is ramping up in 2016 with the addition of three new employees.

Regulations and Policies Requiring Renewable Energy

In addition to offering voluntary financial incentives, states also use their authority to regulate the business practices of electric utilities to encourage the development of renewable energy. It is important to note that not all electric utilities are subject to the same state regulatory frameworks. Electric utilities are subject to an assortment of federal and state regulations from the setting of rates to the accommodation and composition of generating resources. Moreover, the applicability of these rules varies by utility ownership structure (investor-owned utility, municipally-owned utility, etc.). The complexity and variability of utility regulation can either facilitate (e.g., by requiring a utility to allow the interconnection of renewable energy systems) or impede project development (e.g., by restricting project ownership structures).

- **Vermont context:** Vermont primarily manages renewable energy policy through its Renewable Energy Standard and net metering rules that are overseen by Vermont's PSB
- **Navigating regulatory landscape:** Successfully understanding and negotiating this regulatory landscape requires the expertise of those well versed in the details of Vermont's regulatory frameworks. This expertise typically resides with staff at Vermont's BGS or state energy planning. Electric utilities often have individuals designated to facilitate renewable energy development who may also be of assistance. Thus, different utilities in a given state will often have different perspectives on and approaches to development of distributed renewable energy projects. Regardless of the type of utility it is important to consult with them early on about proposed projects as they will play a critical role in determining the success or failure of a project.

Renewable Energy Standard

Vermont's Renewable Energy Standard, also referred to as a Renewable Portfolio Standard (RPS) in other states, is a requirement that electric utilities include a minimum percentage of renewable electricity generation resources among the power resources serving their customers. This is a primary policy mechanism that states have adopted to encourage renewable energy. Vermont has enacted the nation's first integrated RES, which makes utilities responsible both for supplying renewable electricity and for supporting reductions in customers' fossil fuel use.

- **Vermont RES:** In 2015, Vermont enacted an RES which took the place of the previous renewable energy goals that had been developed under the Sustainably Priced Energy Enterprise Development program. Vermont's RES targets require utilities to obtain 55% of their annual electricity sales from renewable sources by January 2017. This requirement increases by 4% every three years until reaching 75% in January 2032.

Renewable Energy Certificates

As part of the RES, utilities demonstrate compliance with these requirements by acquiring renewable energy certificates (REC). RECs are tradable environmental commodities that represent the renewable attributes associated with the generation of electricity from renewable energy resources. The purchaser of an REC may retire it to claim the environmental attributes. When an REC is retired it can no longer be sold or transferred. In some markets, the sale of RECs can be a significant source of revenue used to offset project costs.

- **Vermont RECs:** Starting in 2017, RECs generated in Vermont can begin to be retired. As part of the RES, utilities are required to retire 1% of the RECs from their electricity sales in 2017 and 10% in 2032 with distributed generation RECs. For Vermont's new net metering rules, customers that transfer the RECs to the utility will be credited $0.03 per kWh for the first 10 years of production (PSB, 2016). If a net metering customer retains ownership of the RECs, the earned value of net metering credit is a negative -$0.03 per kWh for the duration of the project.
- **REC adjustor:** To date, net metering customers have found increased benefit of selling RECs outside Vermont to states trying to meet their RPS such as Connecticut and Massachusetts. RECs in these states may sell for $55-65 and generate $0.05-0.06 per kWh in additional value.
- **State agencies retire RECs via utility:** Per state guidance, the state would prefer that RECs be retired through the utility; therefore, state agencies will not report the individual benefit of renewables generation. The rationale for this is that the overall benefit and progress will be represented via the utilities at the state level while contributions will not be as visible at the individual agency level. RECs represent the environmental attribute, they are treated as an incentive to drive an increase renewable electricity generation and, in turn, a reduction in the average carbon intensity of the state's electricity generation.

Net Metering

Net metering rules require electric utilities to provide a utility bill credit for electricity generated by a grid-tied solar PV system in surplus of a customer's annual consumption. Net metering rules cover the rate, or price, at which the utility will purchase excess generation, the length of time and period for which bill credits are valid, and the maximum allowable PV system size.

- **Size:** Net metering rules limit the size, measured as system generating capacity, of a PV solar installation. These system limits can either be a fixed cap (e.g., a commercial system cannot exceed 500 kW) or a variable cap based on the customer's electricity consumption (e.g., the output of a system cannot exceed annual on-site consumption). PSB currently limits systems to 500 kW but prioritizes smaller scale systems of 15kW to 150kW or less. It is important to note that systems up to 500 kW will be located on preferred sites (explained in greater detail in Step 2). Therefore, VTrans is limited to either 150kW systems or identifying preferred sites for larger systems (>150kW).
- **Credits and site adjustor:** In the new net metering rules, PSB outlines tiers of payment depending on PV system size and the type of site (Categories I-IV – see table below) to incentivize certain types of solar projects. These per kWh adjustors are either higher or lower than the utility residential rate depending on the category. This difference in charge is referred to as the "site adjustor" in the PSB net metering rules. Category I and II sites earn a site adjustor incentive of an additional $0.01 per kWh while Category III and IV sites receive a reduced value of $0.01 and $0.03, respectively. These rates are above or below the residential rate, currently 14.8 cents per kWh. For instance, a Category II site would receive a residential rate of $0.148 plus the $0.01 for a total of $0.158 (before a REC adjustor of +/- $0.03).

- **Duration:** Net metering customers will receive the credit for 10 years and thereafter the customer will receive the retail rate. PSB rules also restrict how long a customer can maintain a balance of bill credits. A common arrangement is to allow a customer to carry forward unused credits to the next billing cycle for up to 12 months, after which the unused credits are forfeited.

The following table outlines the differences in net metering site categories:

Type of site	Site constraints or aspects
Category I – small scale *Site adjustor* – additional $0.01 per kWh	• capacity of 15 kW or less
Category II – preferred site *Site adjustor* – additional $0.01 per kWh	• capacity > 15 kW and ≤ 150 kW • new or existing structure whose primary use is not the generation of electricity or providing support for the placement of equipment that generates electricity • parking lot canopy • existing impervious land (as of July of the previous year of application) • brownfield site • sanitary landfill • gravel pit, quarry • site designated for renewables in municipal plan • National Priorities List site • same parcel or adjacent to customer using 50% or more electrical output
Category III – larger, preferred site *Site adjustor* – reduction of $0.01 per kWh	• >150 kW and ≤ 500 kW • not a hydro project • same list of preferred sites outlined in Category II
Category IV – mid-size, not preferred site *Site adjustor* – reduction of $0.03 per kWh	• capacity > 15 kW and ≤ 150 kW • does not meet criteria in Category II

BUSINESS MODELS AND AVAILABLE PROJECT PATHWAYS

Agency Owned and Operated	Third-Party: Public-Private Partnership (PPP)	Hybrid: Third-party to Agency Owned and Operated
• Net metered project financed, installed, and maintained by VTrans	• Net metered project financed by third party (PPA agreement) • Third party partnership to apply for SPEED's Standard Offer Program (Feed-in Tariff, PPA agreement) • Direct PPA with utility	• Net metered project agreement, finaced by third-party PPA agreement includes timeframe for purchase back by VTrans (e.g., 7 years)

Third Party Agreement Types

Public agencies have no tax burden and therefore cannot take advantage of tax-related financial incentives available for investments in PV solar systems. To leverage these incentives, it is common for public agencies to contract with a private sector firm that can. Under such an arrangement, the agency contracts with a private sector partner to design, finance, install, own and operate a PV solar installation on the agency's property. The public agency benefits from this structure by avoiding upfront capital investment and ongoing operating and maintenance responsibilities while securing a long-term, predictable price for electricity, often initially at a price lower than current utility rates. This benefit can be captured in a contract with the private party. The private sector partner or partners benefit by receiving revenue from electricity sales and by capturing the tax benefits and financial incentives made available from developing the project. Figure 5 outlines this relationship.

Source: NREL, Financing Solar Energy Projects: The Role of Local Government

Figure 5 - Third Party Agreement Diagram

There are two primary agreements an agency may enter into with a third-party.

- **Power Purchase Agreement**: A PPA is an agreement between the agency and the project developer (or a special purpose entity [SPE] that owns or leases the system) for the agency to purchase the electricity generated by the system for a specified period.
- **Site License Agreement (SLA):** A SLA is a separate land use agreement that grants the solar developer (or an SPE) the right to install and operate the system on agency property. It should be noted that these types of agreements are also referred to in the marketplace as "site lease agreements" although for tax purposes they are considered service agreements. For ROW projects, the characterization of a land-use agreement as a "lease" will trigger the fair market value provisions of FHWA's air-space lease rules and raise other potential legal complications (this is discussed in greater detail in Appendix A – FHWA technical memo).

Because of the interrelationship between the agreements, the SLA is commonly an exhibit within the PPA and the duration of the SLA will mirror the duration of the PPA.

Utility Agreements

- **Net metering and interconnection agreement:** This is a contract between the agency host and the electric utility serving the agency that allows the agency to connect the PV system with the utility's electric distribution network. The net metering agreement allows the agency host to "net" (count) the system's energy production against its utility bill at rates established by the utility and subject to the PSB's approval. As mentioned previously, updates to net metering rules are currently in draft form and will be finalized early 2017.
- **Certificate of Public Good:** Part of the process for becoming a net metered site requires the submittal of an application to the Vermont's PSB. Sites between 15 and 150kW require an application and systems greater than 139kW require an Agency of Natural Resources' (ANR) Section 248 form (PSB, 2016).

Implementing Solar at VTrans

PROCESS CHECKLIST

This section provides a step-by-step overview of the process of developing a solar PV project at VTrans.

- **Step 1 – Assemble project team:** Review the core capablities and competencies required for successful project development and secure commitments from internal and external partners who can provide this expertise as the program progresses
- **Step 2 – Candidate site evaluation**: Provide direction on how to evaluate candidate project sites and assist in determining *go/no go* early to rule in fewer sites for deep consideration
- **Step 3 – Evaluate financial analysis and ownership model:** Evaluate project aspects that could direct the project to one business model or another. Establish rough financial potential for all parties involved. If VTrans is procuring through a design build (DB) or engineer, procure and construct (EPC) method, release of the Request for Qualifications or Request for Proposal occurs now. If VTrans is procuring through a design-bid-build (DBB) method, then final design and permitting need to occur in advance of procurement.
- **Step 4 – Due diligence and project confirmation:** Evaluate each of the components of the feasibility study in more depth, including a more in-depth financial review (i.e. pro forma tool)
- **Step 5 – Implementation:** If the contract is DB or EPC, this step includes an in-depth discussion of the issues with the contractors and quality control on assumptions leading to a recalculation of the financial performance of the projects from both parties, and a final negotiation of agreement terms. Following that is construction and commissioning.

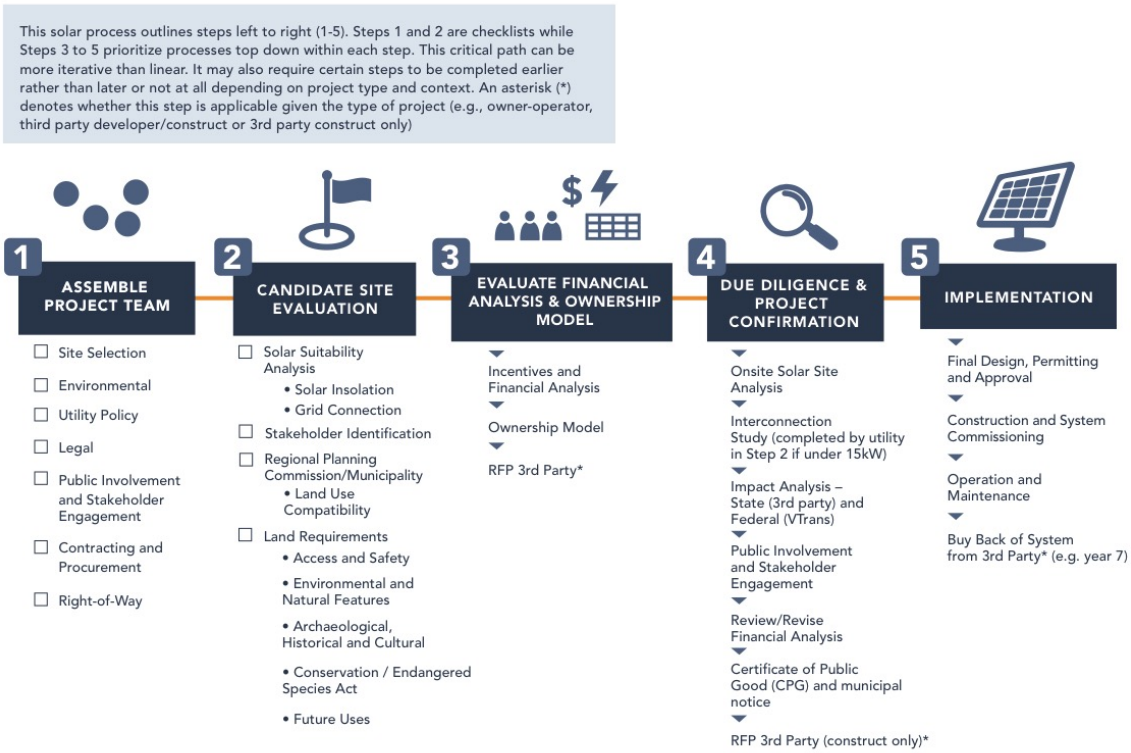

Figure 6 - Process Checklist

STEP 1: ASSEMBLE PROJECT TEAM

Note: As of the production of this Plan, VTrans has already assembled project teams for both owner-operator or third-party solar PV projects. This section provides overall guidance that may be useful for future projects.

Planning, design, financing, and construction of solar PV projects are complex tasks given the traditional procurement methods for a transportation department. Most agencies benefit from the advice and expertise of others within the agency as well as external partners that can share expertise and opportunities for avoiding project pitfalls. As a first step in program development, it is important to assess your technical assistance needs and begin connecting with other state and federal agencies to fill knowledge gaps, navigate project elements, and streamline the process and project timeline. Some agencies choose DB or EPC contractors with or without third-party financing to simplify the the need for staff to learn and develop programs. This simplification may be better overall for the department or the department may choose to retain more of the financial and environmental benefits of the project, which requires more learning and more hours.

Core Capabilities and Competencies

Below is an outline of the technical competencies required for successful project development (and suggestions for the sources of that expertise, internal and external to VTrans).

Technical Competency	Partners/Sources of Expertise
Site Selection	• VTrans Maintenance • VTrans Right of Way • VTrans Planning • VTrans Mapping Section • Vermont Agency of Natural Resources • Regional Planning Commission • Vermont Dept of Buildings and General Services • Local & regional economic development corporations and planners
Environmental Impact	• VTrans Environmental Section(s) • Vermont Agency of Natural Resources • FHWA Division Office – National Environmental Policy Act (NEPA) specialist *(Note: the Council on Environmental Quality (CEQ) has provided guidance on carbon footprinting the development and operation of a solar facility.)*
Utility Policy	• Department of Public ServicePublic Service Board • Electric utilities
Legal	• Vermont State Attorney General's Office
PV System Design and Engineering	• Solar developers • Electrical engineers for grid connection • Vermont Buildings and General Services
Public Involvement and Stakeholder Engagement	• VTrans Public Outreach staff • Solar advocacy groups • Public Information Officers
Contracting and Procurement Expertise	• Vermont Buildings and General Services • VTrans Contracting Experts FHWA
Right-of-Way	• VTrans Right of Way office • FHWA Division Office and FHWA Office of Planning, Environment, and Realty

STEP 2: CANDIDATE SITE EVALUATION

Note: VTrans has already begun this process for larger candidate sites. This section outlines a complete list of steps to assess the full range of site sizes and types. Given that VTrans is potentially limited to 500 kW of solar PV capacity in a single utility service territory and the clear majority of current solar is in Green Mountain Power (GMP). VTrans project team should make identifying sites outside of the GMP service territory a priority.

Solar Suitability Analysis

The first step is to conduct a preliminary screening of agency assets to generate the shortlist of sites worthy of further feasibility analysis. The preliminary screening should consider: space requirements, access to the electric grid, solar energy generation potential, and conflicting uses that would preclude site development. Each of these screening criteria is discussed below. Tools to screen include VTrans' Geographic Information System (GIS) system, Vermont Energy Atlas, and National Land Cover Database (NCLD).

Once internal screening is complete these sites can then be "ground-truthed." Limitations of the initial screen such as mapping layer information makes it essential that sites be evaluated prior to going further in the site selection process. The context sensitive site selection and environmental impact analysis will also dive more deeply into potential issues.

Identifying and prioritizing potential project sites is a multidisciplinary effort that will likely involve both internal and external experts or stakeholders. Agency of Natural Resources' Office of Planning is a vital means of identifying siting opportunities or challenges early in the planning process.. Also regional highway maintenance offices are an invaluable source of information related to actual site conditions and field staff in these offices should be consulted in the site selection and site review processes.

Solar insolation

After land and grid connection, solar resource and generational potential are the fundamental aspects in site selection as it directly defines the level of energy production and therefore project financial feasibility. A site's solar resource is measured by insolation, the amount of solar radiation received on a given surface area per unit of time (kWh/m2/day). The Solar Suitability GIS layer, Vermont Energy Atlas, and the National Renewable Energy Laboratory's solar resource maps and PV watts calculator provide information on solar potential.

Basic characteristics of a site's solar potential include:

- **Good southern exposure:** Systems should optimize their ability to capture more sunlight and be oriented south, particularly if they are ground mount systems.
- **No topographic or other shading:** Nearby hills, vegetation and the built environment can cast a shadow across a surface thereby impeding PV panels from generating electricity. Note: a shadow can reduce a string of panels' (not just the panel being shaded) productivity unless a bypass diode is used.
- **Limited site preparation:** Sites should also have limited vegetative coverage as extensive clearing and grubbing will add to site preparation and possible environmental mitigation costs.

- **Future array does not shade the ROW:** Shading of the ROW in patches provides a visual disturbance for drivers, but more importantly it will maintain a patch of ice while the surrounding ice may have melted from sunshine, causing a safety hazard.

Physical space for equipment

A site must also have the sufficient area to physically accommodate an installation. The amount of land required is primarily a function of the amount of generating capacity installed and the greater the capacity, the greater the area of land required. The rough scale of land required by solar PV system of differing solar capacities is the following:

- 5 MW: ~35 acres
- 1 MW: ~3-9 acres. Numbers differ based on type of solar placement (rooftop vs. ground mount) and design (fixed vs. tracking) (NREL, 2015; CEP 2016)
- 500 kW: ~3.5-4.5 acres (a fixed array could fit on a 3.5-acre site while a solar tracking array would require 4.5 acres)
- 250 kW: ~1.5-2 acres
- 50 kW rooftop: ~5,000 square feet

Potential locations adequate to accommodate a larger project may include:

- Rest areas
- Interchanges or cloverleaves
- Maintenance yards
- Former quarry or gravel sites
- Brownfield sites
- Inactive or abandoned weigh stations
- Park and ride areas
- Surplus property
- ROW beyond the clear zone or behind barrier

Current State of Screening of VTrans Sites: A multidisciplinary VTrans team has already undergone preliminary phase of screening candidate sites at VTrans properties and highway ROW sites (excluding the clear zone). VTrans evaluated sites greater than 20 acres in size. The VTrans mapping office performed a coarse screen of these sites. Initially, 124 sites demonstrated potential out of 375 sites. After ensuring that sites met a 5-acre threshold and qualitative screening considerations; 24 sites remained.

The screened list includes: Avery's Gore rest area, Boylan Airport, Caledonia City, Dorset garage, Elliot Parcel #6a, Essex garage site, Franklin City Airport, Hartford (Wiegel), Hartness Airport, Knapp Airport, Leicester stockpile area, Mendon traffic shop, Middlebury Airport, Middlesex garage, Morrisville-Stowe Airport, Morse Airport, Newport Airport, Old Burke garage, Readsboro garage, Redmond property, Royalton garage, Rutland Airport, Whipstock Hill.

Grid connection

A site with physical access to the local electrical grid is perhaps one of the most critical aspects of a project and generally one that can lead a project to fail. It is important to contact the utility's distributed generation department in the site's region to determine the level of interest and motivation to site a solar PV project in their utility area. It is vital to ascertain whether the site meets conditions such as proximity to substations, three-phase power lines, and proximity to higher voltage lines otherwise the project could prove financially infeasible. Green Mountain Power for example has developed a map showing sites in its region that have available capacity, are approaching capacity, or have little or no capacity. This layer of analysis can further assist in the site selection process (GMP, 2016).

Depending on information learned at this stage, it may be prudent to complete an interconnection study to safeguard future complications. If the PV system will be 15kW or less the utility will complete the interconnection study otherwise it is the responsibility of the project developer. If it is a larger system, the interconnection study can be completed as part of Step 4.

Consider sites that have the following characteristics:

- Near to substations and three-phase power lines
- Proximity to higher voltage lines
- Ability to support the grid (e.g., electricity load/demand is nearby, prioritize more urban rather than rural)

Vermont has 21 investor-owned, cooperative, and public providers of electricity. Interestingly, five electric utilities provide 94% of total state energy sales. Certain utilities and some locations within the state have recently deployed a number of solar projects that may be meeting local load demands and may not have the ability to site solar in their district. Vermont electric utilities are subject to increasing renewable energy to the grid but have an annual total cap of 15%; however, they are attentive to the potential array locations because that siting ultimately dictates how the generated electricity supports the grid and the efficiency of their electricity transmission. The table below summarizes retail sales (in MWh) for the top five providers of electricity in Vermont.

Entity	Type of provider	All sectors	Residential	Commercial	Industrial
Green Mountain Power Corp	Investor-Owned	4,281,682	1,551,471	1,572,378	1,157,833
Vermont Electric Cooperative, Inc	Cooperative	446,870	222,366	122,807	101,697
City of Burlington Electric - (VT)	Public	338,421	83,592	185,019	69,810
Town of Stowe- (VT)	Public	74,414	22,636	41,526	10,252
Washington Electric Coop - (VT)	Cooperative	69,993	62,002	4,524	3,467
Total sales, top five providers		5,211,380	1,942,067	1,926,254	1,343,059
Percent of total state sales		94	92	95	95

Source: U.S. Energy Information Administration, Form EIA-861, "Annual Electric Power Industry Report."

Figure 7 shows the electric utility boundaries in the state of Vermont.

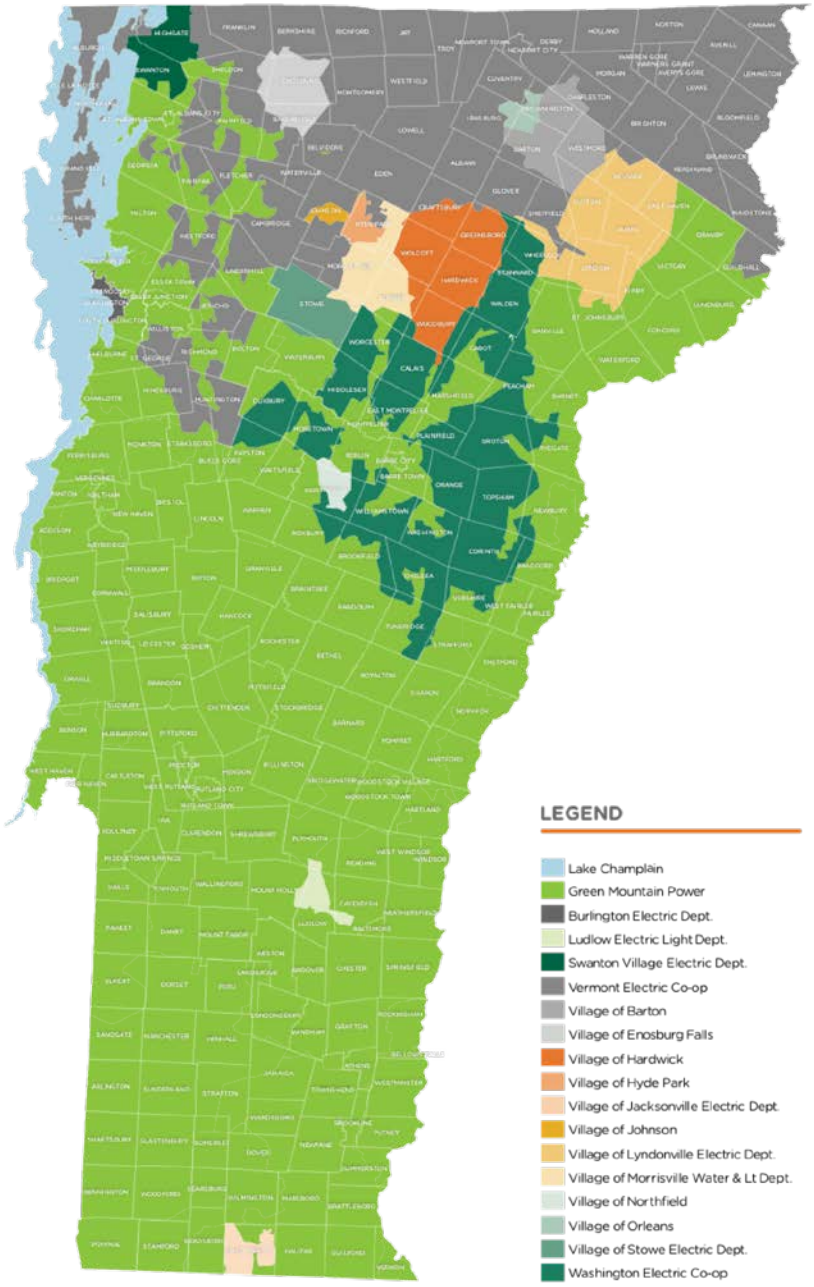

Figure 7 - Vermont's Electric Utilities Boundaries

Stakeholder Identification

As part of the initial candidate site screening VTrans can begin to identify which stakeholders may play an important role in the project. This step can help determine which stakeholders are relevant to the site and anticipating whom to engage, which can serve as the basis for building community support and satisfaction. Each stakeholder group will have different perspectives and questions about a potential project. While compiling the list of groups to communicate with, project managers should try to

discover and anticipate these perspectives in order to craft the core messages. Project managers should also consider project benefits framed around community values and priorities including environmental benefits, energy independence, job creation and economic development.

The target audiences and stakeholders list should include:

- Adjacent neighbors and property owners
- Nearby businesses
- Local officials and jurisdictional partners
- Regional planning commission planners
- Impacted transportation users
- Nonprofit and environmental interest groups
- Internal agency staff

As part of Vermont's solar siting efforts, stakeholders have weighed in on several siting considerations including:

- **Same aesthetic standards as other development:** Some on the PSB board mentioned that solar projects should not be viewed as more or less strict than other development or land use
- **Inadequate screening for aesthetics:** Some believe that there is not adequate screening to minimize aesthetic impacts. Vermont's PSB has responded by identifying preferred sites as well as including information in the CPG application for screening, environmental impact, and local planning considerations. The 30 V.S.A. § 248(s) criteria aids in the site selection process and the opportunity for community stakeholder comment and participation.
- **Communicate with communities earlier in the project review process:** Communities are asking for greater engagement with solar developers and would like to be notified of solar projects earlier so that they can respond to concerns. The PSB has collected feedback that some developers are not being respectful and responsive to neighbor concerns
  (Solar Siting Report, 2016).

Regional Planning Commission and Municipalities

Sites that meet the conditions and constraints dictated in RPC implementation plans will likely encounter fewer obstacles at the local level. Part of compliance with the PSB and obtaining a Certificate of Public Good is to ensure that the solar project meets municipal bylaws and ordinances. Ground-mounted solar PV systems require contacting the municipality to understand the municipality's applicable screening requirements. Per the PSB, screening "means reasonable aesthetic mitigation measures to harmonize a facility with its surroundings and includes landscaping, vegetation, fencing, and topographic features" (PSB, 2016).

Municipal officials and RPCs can be good barometers of local sentiment for such projects. At this stage, it may also may be deemed worthwhile to gauge local neighbors' interest and support of a project if there are adjacent properties to the site, what the setback would be, and the distances from the nearest property owners and highways. Project details such as setback are performed in the CPG application and use the guidelines outlined in 30 V.S.A. § 248(s) (PSB, 2016).

It will need to be determined if the project will be consistent with existing land use regulations at the municipal or RPC level by contacting local jurisdiction planners. An assessment should be done to

determine whether the project will have an impact on surrounding land uses. Interviews indicated that this is one of the primary aspects that should be considered.

Further investigation is needed to discover whether the development at the proposed site would displace any residential, commercial or community structures, adversely impact access to community services, and if these potential impacts would be disproportionately borne by minority and low-income populations. Potential socioeconomic impacts can be determined by analyzing census block-level demographic data of populations in the immediate vicinity of the project.

Solar PV systems arrays sited in the highway ROW are a novel type of land use and local codes may not have specific standards to address them. If several projects are deemed viable in the highway ROW based on candidate site evaluation, it may be useful to consider working at a statewide level with local jurisdictions to adopt uniform review and approval standards and procedures for solar projects in the highway ROW.

Land use compatibility

The preliminary screening should also consider current and future site incongruities and future uses that would provide cultural value to the community. Major natural features such as lakes and vistas should be considered as well for their community viewshed value. Many interviews indicated a preference for maintaining beautiful views and not obstructing them with PV solar systems. The solar siting report Vermont's legislature requested and Act 174 along with RPC solar siting planning will help shape community expectation.

It is important to consider whether a project would result in changes in the character of scenic resources. This evaluation should be conducted by a VTrans landscape architect and include an inventory of existing visual features from the perspective of viewers and an analysis of how proposed project elements may impact these features. Vegetative buffers are a common mitigation but must not grow tall enough to shade the panels. Fences may also be used to mitigate visual effects.

Opportunity – Regional Energy Planning: Interviews with VEIC and RPCs welcomed VTrans to coordinate together to determine if VTrans sites could meet mutually beneficial goals. Given that RPCs will be conducting this work between 2016-2018, this exchange could serve as a forum for identifying good candidate sites and receiving initial feedback on the validity of VTrans sites already screened for considerations such as community support and need (local load demand).

Regional energy planning

VEIC is currently providing guidance to each RPC to develop an energy approach and siting. As part of the *Vermont Solar Development Pathways* process (mentioned in the previous section), RPCs are developing plans within 2016-2018 timeframe that will consider specific sites. Bennington, Two Rivers-Ottauquechee, and Northwest are the three RPCs that piloted this work and have draft reports available as of the summer of 2016. This planning is meant to identify sites that best meet the utility and community needs for solar, prioritizing sites that meet certain characteristics (e.g., brownfields, greyfields, sites close to load that do not obstruct views per Act 174 standards).

Net metering rules

Solar PV projects in the past few years have not always been sited in areas that best meet the electric grid and community's needs. In order to be more selective and identify higher quality sites, Vermont's PSB developed eligibility site prioritization for net metering and receipt of Certificate of Public Good. The net metering rules outline four categories of sites. Category I and II sites avoid sensitive environmental, agricultural, and scenic areas and instead utilize rooftops, brownfields, greyfields, and other elements of the built environment.

Land Requirements

Environmental and major natural features

Preliminary screening should also seek to rule out locations with obvious sensitive environmental resources such as wetlands and threatened and endangered species. Also, tree cover and shading may not show up well in the GIS screen and need to be physically inspected. The intention at this stage of site evaluation is not to make a definitive determination about potential impacts, but to avoid sites that pose obvious risks of complex and costly environmental reviews. Note that tree cutting is more of an expense, habitat, and aesthetic concern than a climate change concern. Generally, solar displaces more emissions per surface area of land than trees sequester in wood and soil (Good Company, West Linn 2010).

Consult with VTrans and ANR water and wetlands specialists to determine if water resources are present within the project area and evaluate potential impacts. Water resources include groundwater, rivers, lakes, streams and wetlands. The specialist should also help identify if any stormwater management or erosion control measures will be necessary. Stormwater facilities will need to comply with TS4 general permitting guidelines (to be released at the end of 2016) and this guidance will affect future stormwater facilities. This review should include examination of wetland maps and if necessary a delineation study. Interviews indicated that stormwater is most likely one of the more critical environmental siting aspects to consider for VTrans properties. Also note that there are a wide range of interpretations of whether or not solar arrays constitute impermeable surfaces, given that they do shade the earth, but shed the water to the ground to percolate.

Investigate whether the project would impact public parks, recreation areas, wildlife refuges or other DOT Section 4(f) resources. Additionally, determine if any portion of the site was acquired or developed with Land and Water Conservation Act funds (i.e., is the site a Section 6(f) resource). If impacts to park lands are unavoidable, the project may be subject to the additional scrutiny of a Section 4(f) or Section 6(f) evaluation.

Consult with a licensed geotechnical engineer to determine if the site presents any geologic hazards; if the area is noted for a history of instability, a formal geotechnical evaluation may be required. While ground-mounted photovoltaic systems can be constructed on steeper slopes or in areas with hard subsurface layers such granite or basalt, negotiating these site conditions can add costs. The highest quality sites will have relatively little slope (less than 5%) and feature cohesive soils. Other land limitations to consider during the preliminary screening include natural hazard zones, such as flood and landslide areas.

Conservation and Endangered Species Act

Consult with VTrans environmental staff and ANR to identify any habitat or wildlife concerns including the presence of any sensitive, threatened or endangered species, both flora and fauna, in the project area. This should include an on-site survey and a review of natural resources databases. Our interviews with subject matter experts indicated that generally no significant concern with flora and fauna is to be expected, though site specific reviews will identify possible issues.

Future use

Covenants, easements and agreements not included in the screen require a check with VTrans staff and local agencies. Sites may be allocated and reserved for future projects (e.g., park and ride, widening, maintenance facility expansion) or may be of interest to the local community for transit or recreation. Primary agricultural soils should be considered as well. This will not likely be a major factor for highway transportation properties as most ROWs have degraded and compacted soils, or are set aside as stormwater facilities.

Archaeological, historical, and cultural aspects

Work with agency cultural resources specialists to determine the likely existence of any archeological resources. Interviews indicated that there have been a couple of solar sites in question that did have archeological value and were therefore removed from the list.

Access and Safety

Traffic and highway safety are of paramount consideration. Site access for construction, operations, and maintenance may require additional facilities, such as graveled access roads. As always, if the project is in the highway ROW, safety controls must be used during construction and will add to the project costs. Such access must be thoughtfully developed and controlled to avoid potential safety and security issues associated with access by the general public. Ideally site access would not be directly from the highway itself but from other roadways or existing access breaks. The clear zone should be avoided generally, unless a proper barrier is already installed to protect motorists. It is important to note that if panels are closer to traffic, shadows from the panel should be considered.

Solar glare

Glare is a common phenomenon that originates from the reflection of a light source (usually the sun) off any reflective service (e.g., windows, chrome automobile bumpers, water, vegetation). This glare (or "glint") can serve as a potential hazard or distraction for motorists and nearby residents. The solar glare associated with each PV design will be different, but generally is not a concern since they are designed to absorb light energy. The reflectivity of a surface, or albedo, varies with the type of material that covers it. These solar panels have a reflectivity of around 30% – like the reflectivity of current site surface materials such as dry sand at 45%, needle-leaf coniferous trees at 20%, grass-type vegetation at 25% and broadleaf deciduous trees at 10%. The solar panels therefore do not noticeably alter the site's current amount of reflected, indirect sunlight. Often, only sites that are much higher in elevation will experience direct reflection from the incident angle; therefore, being aware of surrounding topography and potential neighbors and stakeholders is important. That said, there is some glint, but most importantly, neighbors, local permitting offices and aviation officials generally need to be reassured of the intensity of the glare and when it will be noticeable.

- **Factors:** Panel tilt, height, orientation, and reflectivity all must be taken into consideration with respect to solar glare to neighboring structures, ground, and air traffic
- **Solutions:** The application of anti-reflective coatings and textured glass can reduce reflectivity
- **Analysis:** NREL developed the Solar Glare Hazard Analysis Tool (SGHAT), a web-based platform for solar glare analysis, which can be helpful to ascertain to what extent a PV solar array will exhibit solar glare. For airport sites, the Federal Aviation Administration (FAA), requires an ocular study.

Future Site Selection

Once VTrans deploys solar PV systems on its best candidate sites, the agency will need to reevaluate sites that did not merit the final list and determine whether they are fatally flawed or if the site challenges can be overcome.

Considerations for future screening and siting include:

- **Expand the inventory to include sites not initially part of the initial screen**: When VTrans initially performed the screen, it did not have a full inventory of what sites are owned
- **Sites may need more significant preparation or alteration:** Certain changes may need to occur on VTrans properties to accommodate solar project such as cutting down trees, reducing slope, or prioritizing solar rather than another current or future use
- **Identify smaller sites (< 5 acres) with onsite load:** The initial screen prioritized larger sites that could facilitate larger scale solar projects. Smaller sites, including rooftop sites could prove useful particularly for agency owned and operated projects.
- **Rooftop installations:** Consider rooftop installations (e.g., park-and-ride, maintenance facilities) that could be coupled with EV charging stations.

STEP 3: EVALUATE FINANCIAL ANALYSIS AND OWNERSHIP MODEL

Following the initial screen of candidate sites, VTrans should determine the preferable business and ownership model. The initial step in assisting in this decision-making process is the review of a preliminary financial analysis. Ownership models need to be evaluated and a review of incentives and initial financial analysis should be conducted to help determine the best project approach. It is not essential that this step conclude with a final decision between agency or third-party ownership because there are some sites that could be developed with either business model (particularly PV systems between 15-60kW in size). However, if VTrans does not have the capacity to direct staff time to project development tasks then it is worthwhile to initiate the procurement phase once an ownership model is selected or hire a contractor to complete this work.

Preliminary Financial Analysis

Note: Solar panel pricing and efficiency are factors that have changed dramatically in recent years and continue to do so. It is important that these aspects be evaluated at the front end of the project, particularly if project parameters are being assessed beyond a couple of years of this plan's publication.

Review incentives

First, review the incentives currently available for solar PV projects in Vermont, including both state and federal opportunities. The list represented in the background section should have most if not all of the

incentives available. Incentives can change year to year so it is important to check the current standing of the incentive and the availability to public and private entities.

Conduct a simple financial analysis

While solar developers typically possess the expertise to optimize a project's financial structure to take advantage of the range of incentives, it is incumbent upon the agency to conduct its own due diligence to evaluate project alternatives and price out systems. During development of this plan, an Excel-based pro forma analysis tool was created to allow VTrans staff to conduct a simple financial analysis on solar PV projects and compare the value of solar PV systems across different potential business models. This Excel spreadsheet is titled, *VTrans PV Solar Pro Forma*. The business models compared in the tool include:

- VTrans Owner-Operator
- Third-Party Developed with a 20-Year Contract with VTrans
- Third-Party Developed with a VTrans system buyback at Year 7

An initial financial analysis will prove helpful in determining the best ownership model for the project. The pro forma utilizes a dashboard (*Inputs Results* worksheet) to facilitate the gathering of relevant data inputs for each business model.

The inputs to the financial analysis include:

General system information:

- PV system capacity (AC kW system nameplate)
- Annual system output (kWh)
- Annual degradation rate of solar panels (e.g., 0.5%)
- Useful life of PV solar system (e.g., between 20 and 33 years)
- Cost of electricity ($/kWh)

Project first costs:

The tool allows the user to enter either a simple cost ($/installed kW of capacity), or detailed project costs. The tool automatically provides a first cost benchmark for ground-mounted, fixed array systems based on the installed system capacity from the 2016 Vermont Cost of Solar Study by the Clean Energy States Alliance. The benchmark values may be used prior to acquiring actual system cost data. Regardless of how costs are entered they should include:

- Generation equipment
- Balance of system
- Interconnection
- Development costs and fees
- Reserves and financing costs

Operations and Maintenance (O&M) Costs:

The tool allows the user to enter either a simple cost ($/installed kW of capacity), or detailed project costs. Regardless of how costs are entered they should include:

- Annual fixed O&M costs

- O&M and cost escalation rate
- Contributions to a decommissioning fund
- Inverter life and replacement cost. The tool automatically estimates inverter replacement costs based on a 2015 National Renewable Energy Laboratory report titled, *U.S. Photovoltaic Prices and Cost Breakdowns: Q1 2015 Benchmarks for Residential, Commercial, and Utility-Scale Systems*.

Tax assumptions and incentives:

- Federal and tax rates (for applicable third-party party ownership models)
- Federal ITC (for applicable third-party party ownership models)
- Grants or additional cash incentives
- REC pricing and escalation rate (as applicable)

Financing assumptions and discount rate:

- Percentage of debt funding (as applicable)
- Loan interest rate (as applicable)
- Loan period (as applicable)
- Discount rate used to calculate the system net present value

Figure 8 shows a screenshot of the *PV Solar Pro Forma Inputs* table.

Inputs

Category	Owner Operator Net Metered	3rd Party Developer 20-Year Contract	3rd Party Developer w/Year 7 Buyback		
System Info	Value	value	value	Unit	Instructions
System Size - Installed Capacity	61	61	61	kW DC	
Site Category	Category II	Category II	Category II	category designation	
Annual System Output - Year 1	1,100	1,100	1,100	kWh / kW AC	
Annual System Output - Year 1	67,100	67,100	67,100	kWh / year 1	
Annual Degradation Rate	0.5%	0.5%	0.5%	annual % decrease	
Useful Life of System	30	20	30	years	
Cumulative System Output	1,867,058	1,278,255	1,867,058	kWh / useful life	
Cost of Electricity	value	value	value	unit	
Annual Onsite Load	40,260	40,260	40,260	kWh / year	
Cost of Grid Power / Blended Residential Rate	$ 0.1480	$ 0.1480	$ 0.1480	$ / kWh	
Grid/Blended Cost Escalation Rate	1.3%	1.3%	1.3%	annual % increase	

Figure 8 - PV Solar Pro Forma Inputs

Once data is input into the tool, the tool provides a summary of results which include:

- **Costs and Payback**
    - **First costs of project development:** These costs include general equipment and labor, balance of system, in connection costs and studies, and other project development costs and fees
    - **O&M costs:** These costs include site maintenance, panel cleaning, system maintenance, contributions to a decommissioning fund, and inverter replacement costs
    - **Simple payback for the system**
    - **Levelized cost of electricity**: This metric ($/kWh) considers the first costs and O&M costs divided by the total system output over the useful life of the system

- **Net present value at year 7, 10, 20, and 30**
- **Internal rate of return for owner-operator scenario**
- **Summary of project values, split for VTrans and third-party, which include**:
    - Electricity– Year 1 and cumulative
    - REC value
    - Federal tax credit
    - Depreciation
    - Avoided external labor
    - Site license

Figure 9 shows a screen shot the *PV Solar Pro Forma* Results Table.

Results

Category	Owner Operator Net Metered	3rd Party Developer Net Metered 20-Year Contract		3rd Party Developer Net Metered w/Year 7 Buyback	
Costs and Payback	VTrans	VTrans	3rd Party	VTrans	3rd Party
Project First Costs ($)	($132,000)	$ -	($178,059)	$ -	($178,059)
Buyback Cost - Year 7 ($)				($68,671)	$ 68,671
O&M Costs ($ / project life)	($44,853)	$ -	$27,584	($36,254)	($8,600)
Simple Payback (years post VTrans investment)	10.5			4.9	
Levelized Cost of Energy ($ / kWh)	$ 0.09		$ 0.12		
Net Present Value (NPV)					
Year 7	($59,631)	$5,915	$7,637	($46,503)	$8,617
Year 10	($35,694)	$8,156	$8,442	($22,566)	
Year 20	$8,993	$11,926	$5,708	$22,453	
Year 30	$41,709	$14,777	$22,791	$55,751	
Internal Rate of Return (IRR)					
Year 7	-10.0%				
Year 10	-1.2%				
Year 20	5.8%				
Year 30	7.7%				
Summary of Project Values ($)					
Electricity - Year 1	$ 10,602	$ 998	$ 9,603	$ (4)	$ 10,606
Electricity - Useful Life	$ 397,718	$ 19,626	$ 226,618	$ 318,766	$ 78,952
Renewable Energy Certificates (year 10)	$ 19,677		$ 19,677	$ 5,797	$ 13,880
Federal Tax Credits			$ 50,213		$ 50,213
Depreciation			$ 65,468		$ 59,176
Estimate of Avoided External Labor Cost	$ 48,119				

Figure 9 - PV Solar Pro Forma Results

This tool was created to address specific questions and scenarios voiced by VTrans staff and other stakeholders. The model is fully transparent, offering clear, detailed background calculations for each business model on separate worksheets.

Significant Model Variables

There are a number of model inputs that have a very significant effect on the model outputs, such as net present value. These include the following:

- **Solar PV system electrical output:** One of the most critical aspects to any electricity generation pro forma is the quantity of electricity produced over the life of the system. For solar PV - electrical output depends on the geographic location of the system; type of PV modules; PV module

degradation rate; mounting specifications; system losses due to shading, dust and snow; and the overall efficiency of the system at converting light to electricity. Ideally system output will be will be based on a solar site analysis or the guaranteed generation from a third-party developer.

- **Useful life of system:** Typically, a financial analysis for solar PV systems is based on the warrantied period for key system components. It is well understood that solar PV modules last much longer than their warranties. The financial analysis should be considered conservatively based on warranties (20 to 25 years), but should also be considered for more optimistic scenarios (25 to 33 years).
- **Costs of grid and solar PV electricity:** In a third-party scenario, it is important to thoroughly understand the how the cost of the system electricity (purchased by VTrans) compares to current and projected retail market rates for electricity.
- **Electricity cost escalators:** Most financial models will include a cost escalator for assessing both the value of grid electricity as well as for pricing the system electricity. Changes in these assumptions can have significant effects on the projected value of the solar PV electricity and the net present value of the system. When working with a third-party its critical to understand what assumptions they used to develop their cost proposals.
- **NPV discount rates:** Like escalation rates, the NPV discount rate used will have significant effects on the project's NPV. The discount rate should be set equal to the expected annual return from available alternative investments to the solar PV system. The discount rate used by an organization represents their available alternative investment options.
- **Net Metering and Public Policy:** Changes in public policy governing incentives and net metering or solar power rates are a significant risk in any pro forma. This can be addressed during contracting with a third-party by tying the economic benefit to VTrans to utility rate schedules in a way that ensures that VTrans will never pay over market prices for power.

Case Study Example of VTrans Pro Forma Tool

Existing VTrans solar PV installations at Orange Garage and Rutland Airport provided relevant data inputs to compare business models. The results of these comparisons are shown in following subsections.

General conclusions from pilot analyses:

- In scenarios where VTrans is installing systems, how the cost of VTrans labor (primarily staff time to construct) is or is not attributed to total project costs can significantly change the value of the system.
- The useful life of the system is a very significant variable in financial modeling. The longer the project can continue to generate electricity and revenue the better it will perform from a financial perspective.
- The third-party developer with buyback at year 7 model provides the greatest ability to capture all financial incentives between VTrans and the third party. These incentives include:
    - Federal tax credits
    - Depreciation
    - Avoided taxes during (year 8 – end of system useful life)
    - Avoided interest on debt financing (year 8 – end of system useful life)

Case Study 1: Orange Garage

Summary of data inputs and assumptions:

- The solar PV installation at Orange Garage is a 20 kW DC, fixed, ground-mounted system. The system is expected to generate approximately 22,000 kWh in its first year of operation; have a degradation rate of 0.5% annually; and have system losses of 11% (soiling, snow, system losses etc.).
- The system first costs are roughly $53,000 for the *owner-operator* scenario and about $72,000 for the *3rd party* scenarios. The difference between the two values is a savings in external labor costs because of VTrans' work forces completing the site work and array assembly.
- Annual operations and maintenance (O&M) costs are assumed to be equal across all systems at $19 / kW and are assumed to escalate at 2% annually.
- The system lifespan is assumed to be 30 years for the *owner-operator* model; 20 years for the *third-party 20-Year Contract*, and 30 years for the *third-party with buyback*.
- Onsite load is assumed to be 60% of system output in year 1.
- Electricity is valued at the Vermont average residential price of electricity for June of 2016, or $0.148 / kWh. This rate is assumed to escalate at 1.3% annually, which is consistent with average annual increases in Vermont over the previous five years. In addition to this base value, a $0.01 / kWh site adjustor credit is applied as well as a $0.03/kWh REC credit that is applied for the first 10 years of operation. These credits are static values over the 10-year period and no escalation is applied.
- The *third-party* scenarios assume that VTrans will avoid electricity costs equal to 10% of the value of electricity (not including the value of the site adjustor or REC credits).
- The *owner-operator, third-party*, and *third-party with buyback* scenarios assume no debt financing is used by VTrans to pay first costs and buyback costs. The *third-party* scenarios assume the 3rd party developer will debt finance 45% of first costs. The *third-party*, 20-Year Contract scenario assumes a loan period of 18 years at an interest rate of 5%, while the *third-party with buyback* scenario assumes a loan period of 7 years at an interest rate of 4%.
- A discount rate of 5% is used equally across all scenarios for calculation of NPV.

Summary of results:

- See Figure 10 below for a summary of the pro forma tool outputs for Orange Garage.
- VTrans avoided approximately $20,000 in external labor costs by completing site preparation, installation, and project management tasks internally, or about 27% of expected first costs for this size and type of system. *Note: If the cost of VTrans labor was included in the model the outputs would not look as favorable for the owner-operator business model.*
- The value of Year 1 electricity is estimated at $3,500; and the cumulative electricity value over a 30-year timeframe is $130,000. If the system were to only operate for 20 years, as in the 20-year contract scenario the cumulative value of the electricity would be reduced to $80,000.
- Based on NPV at a 5% discount rate the favored business model is *owner operator* for this sized system; at Year 20 the system has an NPV of -$6,000 and an NPV of $4,000 at 30 years (@5% discount rate). Based on *third-party* NPV values, this sized system does not support the involvement of a third-party. Based on this analysis the NPV is likely too low to attract an external, private firm.
- Simple payback is approximately 13 years.

Category	Owner Operator Net Metered	3rd Party Developer Net Metered 20-Year Contract		3rd Party Developer Net Metered w/Year 7 Buyback	
Costs and Payback	VTrans	VTrans	3rd Party	VTrans	3rd Party
Project First Costs ($)	($52,777)	$ -	($72,046)	$ -	($72,046)
Buyback Cost - Year 7 ($)				($27,785)	$ 27,785
O&M Costs ($ / project life)	($14,706)	$ -	($9,044)	($11,886)	($2,820)
Simple Payback (years post VTrans investment)	12.8			6.0	
Cost of Energy ($ / kWh)	$ 0.12		$ 0.09		
Net Present Value (NPV)					
Year 7	($28,597)	$1,939	$139	($16,867)	($1,270)
Year 10	($20,749)	$2,674	($476)	($9,019)	
Year 20	($6,326)	$3,910	($3,483)	$5,524	
Year 30	$4,261	$4,845	$2,045	$16,320	
Internal Rate of Return (IRR)					
Year 7	-13.8%				
Year 10	-4.5%				
Year 20	3.4%				
Year 30	5.7%				
Summary of Project Values ($)					
Electricity - Year 1	$ 3,476	$ 327	$ 3,149	$ 327	$ 3,149
Electricity - Useful Life	$ 130,399	$ 6,435	$ 74,301	$ 106,999	$ 23,401
Renewable Energy Certificates (year 10)	$ 6,452		$ 6,452	$ 1,901	$ 4,551
Federal Tax Credits			$ 20,317		$ 20,317
Depreciation			$ 26,267		$ 23,944
Estimate of Avoided External Labor Cost	$ 19,389				
System Performance					
Useful Life Assumption (years)	30	20		30	
Year 1 Output (kWh)	22,000	22,000		22,000	
Cumulative Useful Life Output (kWh)	612,150	419,100		612,150	

Figure 10 - Case Study 1 Pro Forma Results for Orange Garage

Case Study 2: Rutland Airport

Summary of data inputs and assumptions:

- The solar PV installation at Rutland Airport is a 61 kW DC, fixed, ground-mounted system. The system is expected to generate approximately 67,000 kWh in its first year of operation with a degradation rate of 0.5% annually, and system losses of 11% (soiling, snow, system losses etc.).
- The system first costs are approximately $132,000 for the *owner-operator* scenario and about $179,000 for the *third-party* scenario. The difference between the two values is in savings of external labor costs because of VTrans' work forces completing the site work and array assembly.
- Annual operations and maintenance (O&M) costs are assumed to be equal across all systems at $19/kW and are assumed to escalate at 2% annually.
- The system lifespan is assumed to be 30 years for the *owner-operator* model; 20 years for the *third-party under a 20-year contract*; and 30 years for the *third-party with buyback*.
- Onsite load is assumed to be 60% of system output in Year 1.
- Electricity is valued at the Vermont average residential price of electricity for June of 2016, or $0.148/kWh. This rate is assumed to escalate at 1.3% annually, which is consistent with average annual increases in Vermont over the previous 5 years. In addition to this base value, a $0.01 per kWh site adjustor credit is applied as well as a $0.03 per kWh REC adjustor credit that is applied for the first 10 years of operation. These credits are static values over the 10-year period and no escalation is applied.
- The *3rd party* scenarios assume that VTrans will avoid electricity costs equal to 10% of the value of electricity (not including the value of the site or REC adjustors).
- The *owner-operator*, *third-party*, and *third-party with buyback* scenarios assume no debt financing is used by VTrans to pay first costs and buyback costs. The 3rd party scenarios assume the 3rd party developer will debt finance 45% of first costs. The 3rd party, 20-year contract scenario assumes a loan period of 18 years at an interest rate of 5%, while the buyback scenario assumes a loan period of seven years at an interest rate of 4%.
- A discount rate of 5% is used equally across all scenarios for NPV calculations.

Summary of Results:

- See the Figure 11 for a summary of the Pro Forma Tool outputs for Rutland Airport.
- VTrans avoided approximately $48,000 in external labor costs by completing site preparation, installation, and project management tasks internally, or about 27% of expected first costs for this size and type of system. *Note: If the cost of VTrans labor were included in the model the outputs would not look as favorable for the owner-operator business model.*
- The value of Year 1 electricity is estimated at $11,000; and the cumulative electricity value over a 30-year timeframe is $400,000. If the system were to only operate for 20 years, as in the 20-year contract scenario the cumulative value of the electricity would be reduced to $250,000.
- Due to the difference in first costs between the *owner operator* and *third-party* scenarios, the cost of electricity per kWh is $0.11 per kWh and $0.08 per kWh respectively.
- Simple payback for the *owner operator* scenario is about 10 years and the simple payback for the *third-party with buyback* is about five years after the year seven buyback.
- Based on 20-year and 30-year NPV (@ 5% discount rate) the favored business models are the *buyback* and *owner operator* business models.

- The *buyback* model performs best because this model can capture financial incentives only available to the private sector including the Federal Tax Credit and asset depreciation, while at the same time avoiding some debt interest payments, as well as federal and state taxes that would otherwise be incurred by the private party from year 8 onward.
- The *owner-operator* model is highly sensitive to how the internal cost of VTrans labor is valued. In the results presented here, VTrans and volunteer labor for site preparation, system installation, and project management are valued at 0. If these labor costs were to be included in first cost, it would significantly change the NPVs.
- The *third-party*, 20-year contract NPV performs favorably compared the *owner-operator* model if a value of VTrans labor is included in the first costs for the *owner-operator* scenario.

Category	Owner Operator Net Metered	3rd Party Developer Net Metered 20-Year Contract		3rd Party Developer Net Metered w/Year 7 Buyback	
Costs and Payback	VTrans	VTrans	3rd Party	VTrans	3rd Party
Project First Costs ($)	($132,000)	$ -	($178,059)	$ -	($178,059)
Buyback Cost - Year 7 ($)				($68,671)	$ 68,671
O&M Costs ($ / project life)	($44,853)	$ -	($27,584)	($36,254)	($8,600)
Simple Payback (years post VTrans investment)	10.5			4.9	
Cost of Energy ($ / kWh)	$ 0.11		$ 0.08		
Net Present Value (NPV)					
Year 7	($59,631)	$5,915	$7,637	($40,564)	$4,596
Year 10	($35,694)	$8,156	$8,442	($16,627)	
Year 20	$8,993	$11,926	$5,708	$28,392	
Year 30	$41,709	$14,777	$22,791	$61,689	
Internal Rate of Return (IRR)					
Year 7	-10.0%				
Year 10	-1.2%				
Year 20	5.8%				
Year 30	7.7%				
Summary of Project Values ($)					
Electricity - Year 1	$ 10,602	$ 998	$ 9,603	$ 998	$ 9,603
Electricity - Useful Life	$ 397,718	$ 19,626	$ 226,618	$ 326,346	$ 71,372
Renewable Energy Certificates (year 10)	$ 19,677		$ 19,677	$ 5,797	$ 13,880
Federal Tax Credits			$ 50,213		$ 50,213
Depreciation			$ 65,468		$ 59,176
Estimate of Avoided External Labor Cost	$ 48,119				
System Performance					
Useful Life Assumption (years)	30	20		30	
Year 1 Output (kWh)	67,100	67,100		67,100	
Cumulative Useful Life Output (kWh)	1,867,058	1,278,255		1,867,058	

Figure 11 - Case Study 2 Pro Forma Results for Rutland Airport

Ownership Model Evaluation

Three general pathways are available to VTrans to finance, build, and operate PV solar systems. First, VTrans can capitalize, construct, and operate a project internally. Secondly, VTrans can contract with a private sector partner, a solar developer or special purpose entity (SPE), to finance, build, and operate the solar project with VTrans contracting for benefits with the SPE. Lastly, VTrans could develop a hybrid model whereby it would contract a developer to capitalize, build and operate the solar project for a defined time (e.g., seven years) after which VTrans could exercise an option to purchase the system and operate it for the duration of the system's remaining useful life.

Note that a PV solar system is likely to continue to perform at a discounted rate after the major component's warranties expire. Warranties are typically for a period of 20 to 25 years, while NREL suggests that a system's useful life maybe closer to 30 to 35 years. A solar PV system's useful life will likely be affected by the life of the system's inverters. Inverters are a relatively expensive and required component replacement in a PV system. The inverters typically have a life of 10 to 15 years, so the timing of failure, particularly after the second inverter replacement will likely inform the system's useful life.

Agency Owned and Operated	Contract with Third Party Developer and Operator	Hybrid: Third-party to Agency Owned and Operated
• Net metered project financed, installed, and maintained by VTrans	• Direct PPA with utility • Net metered project financed by third partydeveloper and operator • Third party to apply for SPEED's Standard Offer Program (Feed-in Tariff, PPA agreement)	• Net metered project agreement, finaced by third-party PPA agreement includes timeframe for purchase back by VTrans (e.g., 7 years)

We recommend that VTrans continue to internally build PV solar, net-metered projects for smaller sites and applications (<20kW) that can utilize available VTrans staff time, financial resources, and leverage state funding. Larger projects, which can help VTrans meet its 25% net metering goals, will most likely require the assistance of a third-party developer to finance and build. Undoubtedly, there are occasions for owner-operator projects at a larger scale (e.g., Rutland airport) and third-party projects at smaller scales (e.g., AllEarth Renewables micro projects at garages). Determination of the pathway will largely depend on the availability of agency funds, staff time for management and construction, and the number of projects in the pipeline that VTrans can manage in parallel.

Each of these pathways could be developed with unique contracting or business model structures depending on the outcome desired. Third-party financing offers several different possibilities.

The table below compares these models while a deeper evaluation of the financial implications of these models is shared in the next section.

Model	Advantages + Opportunities	Disadvantages + Challenges
Agency Owned and Operated	• Allows for greater project control as VTrans has oversight into all of the project management and project parameters • Can leverage staff downtime to build and construct solar projects • Can leverage state and agency funding and budget sources to finance projects • Ability to clearly define financial viability for agency. There is a greater transparency on financial information and knowing whether the agency is getting a good deal.	• Cannot capture federal investment tax credit (30% of project costs) and MACRS depreciation benefits • May be limited by net metering rules and requirement for onsite load (e.g., 50% of load to be met onsite) • Limited by the amount of VTrans capital that can be allocated to invest in solar projects. This may encumber the number or scale of projects VTrans can deploy. • Requires maintenance to be completed by VTrans staff which incurs an internal cost and potentially staffing priority conflicts. Maintenance includes cleaning, dust removal of inverters, change out of inverters, and maintaining security.
Contract with Third Party Developer and Operator	• Does not require initial capital for project investment • Allows public agency to leverage benefit from tax credits via private 3rd party partner • Can share some project management responsibilities (e.g., permitting) • Can transfer operation and maintenance responsbiilities to developer • Provides the opportunity for a path to ownership, i.e. PV system could be purchased after agreed upon timeframe (~5-7 years) • Can assess feed-in-tariff via the Standard Offer Program	• Reliant upon outside party to determine financial viability and allows for some level of uncertainty as to whether VTrans is getting the best deal it could • For Standard Offer Program requires putting together a team and responding to a RFP to meet guidelines • For Standard Offer Program requires a VTrans site that meets the needs of a larger scale system

Procurement

Note: This section contains only the General Guidance of a more thorough RFP technical memo: "Considerations for an RFP for Solar Facility Construction or for Development and Financing Services," which can be found in Appendix B.

At this stage of the project, VTrans has the option of initiating the procurement process if it is interested in leveraging assistance from a third-party developer and operator. Typically DOTs release an RFP following internal due diligence, environmental impact screening/analysis, and appropriate public process (the process outlined in Step 4). These steps are often performed internally to expedite the project procurement and implementation phases. One of the main reasons to complete this due diligence before releasing the RFP is to ensure that the contract parameters (i.e., locking in a financing rate and incentive sunsets) are conducive to third-party developers. Other DOTs with experience developing solar PV projects, mentioned the need to build the project within six months of the contract agreement with a third-party developer.

Programmatic versus site-based RFPs: Generally, our research found that developing a programmatic RFP for multiple sites simplifies the RFP process but can lead to a more complicated project development process from overpricing and an increased number of change orders. The site-specific conditions for rooftop and ground mount vary across locations. Ideally, VTrans screens all potential sites first to determine which ones are viable from the agency's perspective and puts them out to bid one by one. This allows the comparison of bids to be more accurate and reliable.

Combine public RFP with recruitment of best-in-class vendors: A public RFP process does not ensure that best-in-class parties will participate. A public RFP assumes that highly qualified vendors will see the RFP, which is rarely the case. The RFP should be paired with directly contacting best-in-class vendors to call their attention to the RFP. Reaching out to vendors after the RFP will help determine why or why not they chose to participate and will likely improve future RFPs.

Construction only: For VTrans owned and operated projects that do not need private financial incentives to make the projects financially viable, a low-bid method may be acceptable if the vendor is found to have proven abilities. Make sure that components and warranties are comparable or specify the components you prefer.

Choosing a developer: If possible, avoid a low bid approach and pursue a Best Value Scoring methodology such as Oregon DOT's. If you must use a low-bid methodology, take the time to include careful specifications and/or consider requiring the proof of qualifications, experience/references, and design ability to deliver at the scale you need. Note that it is difficult for agency staff to discern a developer's abilities until the design review or design stage. Qualifications were less of a differentiator of actual abilities for most DOT procurements. This detail reinforces the concept of a paid consultation on the design or to design the facility first with an escape clause before you negotiate for construction and/or financing value.

Defining the value of incentives: If there is uncertainty about the value of financial incentives near the time the RFP is released, consider defining the values for the proposers as opposed to asking them to define the values. This will allow for an easier apples-to-apples comparison of different proposals.

Project confirmation: After award, confer with the construction firm to validate the existing design or advise on design changes. Clearly define the roles of the developer and that of VTrans. We recommend that this time is paid for as a consulting fee at a fixed rate to keep VTrans in a stronger negotiation position as the contracted party is not taking risk or uncompensated cost. After this consultation is settled, negotiate terms. A fair negotiation requires financial transparency and VTrans must insist on sharing financials in both directions.

Buyback versus decommissioning: Some DOTs have been concerned with decommissioning the facility at the end of the contracted or warranted life. Oregon DOT negotiated for the panels to be taken back by the manufacturer for an upfront fee for proper recovery and/or disposal. Oregon found that the salvage value of the system is similar to the cost of decommissioning, but this will vary by site. That said, solar facilities continue to perform well beyond the warranty but their productivity of the panels slowly degrades. It is recommended that VTrans consider buyback after year 7 or after the warrantied period of the components and contrast that to decommissioning costs and risks.

FHWA approval may not be needed if Solar is covered under the Utility Accommodation Plan (UAP): If the solar PV renewable energy facility qualifies as a public utility per VTrans' UAP (which it does in the March 2016 revision), then VTrans can approve the project using the process described in the UAP, without referral to FHWA. In this case VTrans "will charge compensation for the installation of renewable energy facilities based on Chapter 8, Property Management, of the Right of Way Manual. VTrans may also receive in-kind energy supplies or other services, subject to negotiation."

Fair market value (FMV) exceptions: While receiving fair market value for a lease is a good way to capture value, a lease is not required per FHWA's guidance: "The regulations do provide an exception to charging fair market rent if the state DOT shows, and the FHWA approves, that such an exception is in the overall public interest for social, environmental, or economic purposes. This exception may be appropriate for activities that positively address climate change, contribute to improvements in air quality, and similar environmental initiatives." (Source: FHWA, http://www.fhwa.dot.gov/real_estate/right-of-way/policy_and_guidance/guidutil.cfm) This allows for a more flexible agreement.

Fair market value determination and precedence: If the division FHWA office does not grant an exemption then use of FMV rent is required. FHWA recommends using VTrans staff appraisers to acquire the necessary information to determine FMV. FHWA acknowledged that FMV implies that there is a market of parties that want to use the area, but that this is not always the case. FHWA has heard that in other states, airspace leases have been valued from between $100 to $400 per acre per year. MassDOT, in its RFP, included a site lease fee of $17,500 per mega-watt (MW) of installed capacity. If the area required for each MW is 7 acres, this rate equates to $2,500 per acre per year. It is interesting to note that while MassDOT charges this lease fee, they also require developers to include the fee in the power purchase agreement (PPA) rate schedule. Therefore, while MassDOT does include a lease fee, they ultimately pay for it via their PPA with the developer. Oregon DOT also includes a land lease with their developer, but the annual payment is minimal. As another point comparison for assessing FMV, FHWA also mentioned the use of cell tower leases as the "closest allowable alternate use."

Include performance requirements for the 3rd party and for VTrans: It is important to define performance requirements and consequences for not achieving them. For example, the project developer may have to submit a traffic control plan to the VTrans project manager or define the financial consequences and payments to the developer should VTrans determine it has to repurpose a site mid-contract.

System warranty periods: As previously mentioned, assumptions about the useful life of the system will have significant effects on the value of the system. To capture as much of this value as possible, while managing risk, Oregon DOT sought out and purchased key system components that had longer than industry average warranty periods and/or had demonstrated extended useful lives in field applications. By approaching component technical specifications and purchases in this way, they could develop contractual agreements that extend the systems life beyond warranty periods.

As VTrans moves towards releasing a public RFP, we recommend reviewing these Oregon DOT Resources:

- ORS184.423 for Values-Based Procurement – Appendix C
- Proposed Solar Projects Inverter Minimum Requirements…- Appendix D
- Solar Best Value Panel Selection Process – Appendix E

While Mass DOT and NYDOT have issued procurements, their context and business models are different enough that we think they have limited utility to VTrans.

STEP 4: DUE DILIGENCE

After potential project concerns and ownership pathways have been better understood and determined, it is prudent to engage a deeper level of analysis. This step should address potential issues that could be detrimental to a project's feasibility. The purpose of this step is to determine whether the project has the merit to continue in the project pipeline. Support for conducting this due diligence may be available from experts within Vermont including Vermont's BGS Energy Manager and Vermont ANR's Director of Planning. In Step 2, the VTrans project manager should have reached out to ANR to get guidance on site selection. At this stage, ANR's planning office can pull in necessary ANR programs to review proposals and identify necessary permits.

Site-specific technical design and site development considerations include:

- Onsite solar site and design evaluation
- Interconnection study
- Impact analysis – state and federal
- Public involvement and stakeholder engagement
- Review and revision of financial analysis if stakeholder information or requests alter the project
- Submission to Public Service Board for Certificate of Public Good and subsequent municipal notice of CPG
- Equipment purchase through VTrans staff or third-party construct only RFP

Onsite Solar Site and Design Evaluation

Solar Site Analysis

A solar site analysis is an on-site evaluation of the available solar resource conducted by a solar energy professional. The information gathered during the site visit will be used during the design process to optimize system size, configuration, and performance. The information is also used to fine tune energy production estimates which feed into the project financial analysis.

During the survey the assessor measures and analyzes site conditions including:

- **Solar access:** A site's solar access is the amount of solar resource available after shading losses are accounted for. The evaluator will also consider any loss of insolation due to less than optimal tilt and orientation. The site evaluator will use a specialized site analysis instrument to take a series of measurements at various positions across the site to identify potential shading obstructions to produce a metric called a Total Solar Resource Fraction (TSRF). Some financial incentives require that projects meet a minimum threshold and the higher the ratio the better. The minimum TSRF appropriate for any given location will be a function of project costs, utility rates and total insolation, but as a rule of thumb projects should have a TSRF not less than 75%.
- **Proximity and access to electric grid infrastructure**: The site analysis should also include documentation of potential points of grid interconnection and the characteristics of the adjacent distribution system. This is necessary to determine what type of interconnection equipment may be required and what, if any, hardware upgrades on the utility side of the point of interconnection may be required. Vermont's BGS Energy Manager mentioned identifying the owner of utility poles, because that may not be straightforward and could prove to be a barrier. MassDOT and ODOT both have experienced project timeline setbacks or project failure due to grid interconnection issues.
- **Physical properties**: On-site analysis should also note the approximate acreage with suitable solar orientation and slope. This information will be used to preliminarily determine the size and configuration of an array. Information about slope and soil type can be used to ascertain the appropriate type of mounting and racking system for the installation. Examples of physical properties include total area, grade, orientation, and soil type.
- **Additional factors**: Other factors that should be considered during the on-site evaluation include site access for construction and maintenance equipment and safety and security requirements.

PV System Design and Siting Implications

Developing a project also requires internal or external expertise or experience in the design and engineering of PV solar systems. This work may be performed before requesting bids in the design-bid-

build model, or may be bundled into a more comprehensive contract involving financing and design-build from one private sector firm.

- **External expertise:** For some projects, working with a reputable solar developer will ensure that the system is built to maximize energy and financial performance. Many solar contractors are design-build firms and as such will also be familiar with relevant electrical, safety and building codes, local utility regulations, current financial incentives, and system installation and commissioning, as well as operation and maintenance requirements.
- **In-house expertise:** VTrans has already completed owner-operator solar PV projects and maintains the responsibility of site preparation, installation of solar PV modules and operation and maintenance of the system.

A 2016 "Vermont Cost of Solar Study" by Clean Energy States Alliance contributes good context for siting.

- **Ground mount eases code compliance:** Given Vermont's older building stock, it is more difficult to meet code compliance. Rooftop solar PV can lead to higher installed costs. Typically, these costs are due to mounting requirements required for wind shear. Also dead loads which require increased roof structure often associated with ballasted systems. Membrane roofs with weld mounts avoid the extra weight and provide the wind shear strength required.
- **Low cost:** Vermont's rural land value is lower than that of other New England states and therefore more reasonable to site solar projects. However, as noted in the siting section, rural sites need to be matched to energy load and consider viewsheds and future use.

Interconnection Study

Depending on conversations with utility representatives in Step 2, an interconnection study may be necessary. For larger scale projects, MassDOT asked developers to include a $50,000-line item in the financial proposals to cover interconnection application costs for the sites specified in their proposal. The amount of staff time or consultant time should be evaluated prior to engaging this study. MassDOT and Oregon DOT both experienced significant costs related to interconnection. To better assess interconnection costs, MassDOT completed interconnection studies for a couple of sites that ultimately were ruled out due to costs. For one of its projects, Oregon DOT needed to connect its solar PV project across the highway which required a robot to burrow underneath the highway to provide a conduit access to proper connection.

To meet current net metering rules for solar PV systems under 150kW must follow applicable electrical safety, power quality, and interconnection requirements established by the National Electrical Code (NEC), the Institute of Electrical and Electronics Engineers (IEEE), and Underwriters Laboratories (UL) including:

- Utility-accessible, lockable disconnect switch (unless the system is inverter-based and the utility waives the requirement in writing)
- Initial system testing at installation and once every two years to confirm function of anti-islanding controls.

For sites greater than 150kW, the PSB has developed interconnection standards and documents outlining the relationship between customer and utility but other arrangements can be made:

- Feasibility study agreement
- System impact study agreement
- Facilities study agreement
- Interconnection agreement
- Technical requirements
- Operator protocols

Interconnection guidelines provided by Vermont Electric Cooperative include:

- IEEE 1547 recommendations
- Voltage quality
- Conductor ampacity, device ratings and interrupter phase pick up
- Available service
- Load to generation ratio
- Distribution bus
- Integration with area EPS grounding
- Circuit ties
- Transformer size

(Source: Vermont Electric Cooperative, 2016)

Impact Analysis

This series of activities may be completed by VTrans staff, a third-party contractor or solar developer personnel depending on the scale and scope of effort (i.e. a single project vs. programmatic series of projects).

The conduct of this screening follows VTrans' established policies and procedures for complying with federal, state, and local environmental and land use laws. The following lists outline the permits and aspects that need to be considered to comply with state and federal regulations:

State Permitting

- Storm Water Discharge Permit
- Compliance with MS4 GP-3-9014
- Compliance with TS4 (new statewide transportation stormwater permit for state roads under the Clean Water Act; GP to be issued at the end of 2016)
- State Wetland Permit (10 V.S.A. Ch 37, Section 905 [7-9] [1986]) – Satisfies Sec. 401 WQ Cert.)
- 1272 Order (10 V.S.A. Ch 47, Section 1272)
- Historic Preservation & Archaeological (22 V.S.A. Ch 14)
- Agency of Agriculture
- Threatened and Endangered Species Permit (10 V.S.A. Ch 123)
- NPDES Construction General Permit (40 C.F.R. Part 122.26 – Title 10, V.S.A. Ch 47) –>/= 1 acre
- VTrans EPSC Plan Pursuant to PDD Directive

Federal Permitting

- CEQ, Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews (CEQ, 2016)
- NEPA Documentation via FHWA (23 C.F.R. Part 771.117)
- NEPA Documentation via FAA

- Section 106 Evaluation (16 U.S.C. National Historic Preservation Act)
- Section 4(f) Evaluation (23 U.S.C. 138 Preservation of Parklands & 49 U.S.C. 303)
- Section 6(f) Evaluation (16 U.S.C. Ch 1, Section 4601-4 Land & Water Conservation Fund)
- USDA Green Mountain National Forest Authorization under FHWA MOU
- 401 Water Quality Certificate (33 U.S.C. Ch 26, Clean Water Act, Section 401)
- 404 Corps of Engineers Permit (33 U.S.C. 1344 Clean Water Act, Section 404)
- Floodplain Management - FEMA (Floodway and Floodplain) & Executive Order 11988
- Wetland Protection (Executive Order 11990)
- Environmental Justice (Executive Order 12898)
- Fish & Wildlife Coordination Act (16 U.S.C. Part 661 – 666)
- Endangered Species Act (16 U.S.C. Section 1531 – 1534) – USF&W Service Section 7 consultation

FHWA's NEPA regulations and other FHWA project guidelines and considerations are included in the FHWA technical memo in Appendix A.

Public Involvement and Stakeholder Engagement

Stakeholder engagement is probably one of the most critical aspects of bringing a larger solar PV project to a successful completion. It is also one of the main reasons to name and task a project manager with the responsibility of managing and communicating, to ensure that a project's many tasks are tracked and brought to completion. VTrans is currently developing a Public Involvement Process for construction and maintenance projects. That document will be completed in 2016 and much of the information it contains will be relevant to solar project implementation.

Since larger solar PV projects tend to have high public visibility, it is critical to have a communications plan in place. The plan should be developed at the outset and include strategies for engaging community stakeholders and identifying and responding to their concerns. The plan should also include a marketing component to inform and educate the public at-large and key influencers about the project.

Agency public involvement and public relations specialists can be useful resources in developing a communications plan and working with stakeholders, including local elected officials and appointed officials. Public relations contractors can supplement the work of agency staff by providing third-party facilitation, conducting stakeholder interviews, planning and coordinating events or preparing public information and outreach materials. Working with an outside consultant may also be preferable because it allows project managers to focus on project delivery.

A thoughtful plan for public involvement is needed to reach out to, inform, and gather input from project stakeholders. A communications plan could also publicize the project to the broader public. The depth of the plan will depend in large degree on the location and size of the project.

The plan should contain several components including:

- identification of stakeholders and their issues or concerns
- clear and compelling project description and case statement
- description of planned outreach strategies and activities.

The public involvement and communications plan should also detail planned outreach actions to reach the target audiences. It is important to remember that different outreach methods will reach different

audiences. It is also important to keep in mind that different audiences will respond differently to different messengers; sometimes it is more compelling for the message to come from a civic or business leader.

Outreach might include a combination of unilateral, bilateral and multiparty communication tools. One-way, unilateral approaches like websites, press releases and direct mail are useful for reaching a broad audience with minimal effort. Two-way, bilateral approaches like one-on-one in-person meetings and phone calls are more time consuming but provide an intimate setting that more readily allows for candid exchanges. Multiparty events like community meetings or online forums can reach broad audiences and can help with project transparency. However, if not managed carefully these approaches can devolve and simply turn into an opportunity for critics to vent frustrations. The most effective multiparty events encourage small group interactions like open houses that last several hours or project site tours.

Despite broad-based public support for alternative energy, solar energy projects are not immune from critique by stakeholders. If not addressed, these critiques can wind up resulting in costly delays or even derail a project. There are, however, a number of techniques that can be deployed to respond. The best approach is to proactively mobilize project supporters to share their outlook with other community members.

Once project advocates have been identified, recruited and mobilized, the focus should shift to responding to project critics. Outreach should begin with active listening, preferably in a one-on-one or small group setting. Often the critique has less to do with the project and more to do with an individuals' own desire to be consulted on matters affecting their community or neighborhood. Sometimes, there is a festering old issue unrelated to the project that has not been resolved to their satisfaction. Any misperceptions and misinformation should be corrected with clear and concise informational pieces (e.g. factsheets, websites, frequently asked questions). Finally, project managers might consider project modifications or mitigations to address real or perceived threats to community interests.

Examples of topics of stakeholder interest may include:

- site preparation necessary and expected length of noise
- visual impacts
- enough solar potential in Vermont
- electric and magnetic fields (EMFs)
- tree removal – are trees being removed? If trees are removed for a solar array, doesn't that interfere with the gain of clean energy?
- whether panels contain hazardous materials
- life expectancy of panels
- use of electricity generated
- economic and financial considerations.

Review and Revise Financial Analysis

Using the guidance provided in Step 3, it is worth determining if project parameters affect financial pro forma inputs and how these may improve or impair project viability. Depending on the project details included in the initial financial analysis this step should not take too much time to complete.

Certificate of Public Good

For sites between 15kW and 150kW in capacity, the PSB's CPG application requires the following components be addressed:

- **Proximity of solar PV system:** to floodway, shoreline, stream, wetland, historic site or district, rare and irreplaceable natural area, necessary wildlife habitat or area where an endangered species is present.
- **Visible and aesthetic impact:** need to describe why the solar project will not have "an undue adverse effect on aesthetics and the scenic and natural beauty of the area". Beyond describing the facility's location and its proximity to adjoining properties and roadways, the net metering customer must also describe the visibility from those locations and share measures to minimize the visible impact (PSB, 2016).

For systems with capacities greater than 50 kW the following is required:

- **Site plan**
    - a map, drawn to scale, including compass orientation, legend, title, and date
    - inset showing the location of the system within the town
    - proposed facility location(s), all construction features, and dimensions of all proposed improvements
    - state and municipal highways and setback distances from those highways to the system
    - property boundaries and setback distances from those boundaries to the system
    - locations of any proposed utility lines
    - description of any areas where vegetation is to be cleared or altered and a description of any proposed direct or indirect alterations or impacts to wetlands and other natural resources protected under 30 V.S.A. § 248(b)(5), including the limits of earth disturbance and the total acreage disturbed
    - locations and specific descriptions of proposed screening, landscaping, ground cover, fencing, exterior lighting, and signs; location of any proposed access driveway, roadway, or parking area (PSB, 2016 – direct quotation).

- **Ground-mounted systems set back information:**
    - distance from each state or municipal highway, measured from the edge of the traveled way
    - distance from each property boundary that is not a state or municipal highway
    - distance from the nearest residence
    - copy of the complete text of any applicable screening requirements contained in a municipal bylaw adopted under 24 V.S.A. § 4414(15) or a municipal ordinance adopted under 24 V.S.A. § 2291(28); narrative description explaining how the proposed system will comply with such screening requirements or how complying with such requirements would prohibit or have the effect of prohibiting the installation of the facility or have the effect of interfering with the facility's intended functional use or how the screening requirements are more restrictive than requirements for commercial development and therefore are inapplicable. If the municipality has not adopted any screening requirements, please state this fact (PSB, 2016 – direct quotation).

For projects greater than 150kW in capacity the following is required:

- **Notice requirements the legislative bodies and neighboring properties:** Before filing a § 219a application the following entities need to be contacted 45 days before:
    - legislative bodies, municipal and regional planning commissions in the communities where the project will be located
    - Agency of Natural Resources
    - Commissioner of the Department of Public Service and its Director for Public Advocacy
    - landowners of record of property adjoining the project sites
    - Public Service Board
    - serving electric company (PSB, 2016).

RFP for Third Party Construct

If VTrans chooses to conduct the majority of the project internally except for project construction, then this is the point at which VTrans could release a RFP to complete that construction.

STEP 5 IMPLEMENTATION

Assemble Project Delivery Team

Depending on the complexity of the project, VTrans may want to assemble a project delivery team. For more extensive projects, the project developer should put a project delivery team in place. The delivery team is the set of professionals responsible for the design, engineering, procurement, and construction tasks for the project.

VTrans or the solar developer may contract out for these services or may complete these in house. When contracting out, the developer may utilize an engineer-procure-construct firm or consortium that specializes in delivering solar projects or they may assemble the team on an ad hoc basis.

If a third party is completing the project, it is in VTrans' best interest to ensure a high quality project. VTrans may request that the developer provide evidence of their own or their subcontractors' qualifications, licensing, insurance certification, and evidence of compliance with applicable state or federal requirements. If state or federal dollars, other than tax incentives, are used to fund a portion of the project existing subcontractor approval rules may apply.

Final Design, Permitting and Approval

The next step is to finalize design and engineering plans and these final plans should include schematics and drawings showing the placement of all equipment and ancillary project elements and include the stamp and seal of a licensed professional engineer. If applicable, the final plans should also include a traffic control plan that addresses temporary construction and project maintenance related site access.

At this stage the project developer, whether VTrans or a third party should also begin to seek out the necessary approvals and permits. Commonly required approvals and permits include:

- Electrical and or construction permit from local jurisdiction
- Land use approvals and design review permits
- Utility interconnection approval
- Construction stormwater permit
- Utility accommodation permit or air-space lease

The project agreements should include a provision that allows VTrans to review and comment on design and construction submittals, prior to the commencement of any construction work.

Construction and System Commissioning

After VTrans has approved the final plans and concurs that all permitting requirements have been satisfied, the agency may issue a notice to proceed authorizing the developer to commence construction. If VTrans is completing this project internally, the agency will need to coordinate equipment purchasing via a local vendor (e.g., Green Mountain Electric), coordinate staff time to build the project, and hire a certified electrician to complete the necessary interconnection. During construction, VTrans will need to coordinate the timing of the work so that it does not interfere with critical transportation functions or that critical deadlines are not missed.

The construction phase activities include:

- Materials procurement
- Mobilization
- Site preparation
- Constructing foundations and support structures
- Assembling and mounting PV modules
- Installing power inverters and electrical systems
- Erecting security fencing and installing security systems
- Restoring impacted areas.

Once construction is complete, the developer, or their designee, will commission the system. Commissioning is the developer's final quality check to make certain the system is structurally sound and free of any deficiencies in materials or workmanship. It also confirms that the system's electrical installation is compliant with applicable electrical codes and standards and properly labeled. Finally, commissioning determines if the system performs as expected by activating the system and verifying it operates within acceptable limits. During the review, VTrans should be notified of any issues raised during commissioning and the steps taken to resolve those issues. When the project developer is satisfied that the system is operable and that they have substantially completed it, they should issue a final commissioning report to VTrans.

Once the developer has finalized the project commissioning, and the electric utility authorizes it, the system can commence operation and begin delivering energy to the electric grid. When these tasks are complete the developer should submit a letter certifying the final completion of the project.

Operation and Maintenance

Maintenance and monitoring are also the responsibility of the solar developer or VTrans. The maintenance requirements for grid-connected solar PV systems are minimal and typically limited to an annual inspection. VTrans may request that the developer provide copies of these annual on-site inspections. During this inspection, the developer, or their designee, will:

- Check electrical systems for signs of damage or corrosion
- Examine the solar PV array and mounting system for structural integrity
- Take readings of electric system to ensure they are with normal operating ranges

- Clean the array to remove any accumulation of dust, dirt or other debris
- Perform any site maintenance that may need to be completed
- Make contributions to the decommissioning fund and prepare for inverter replacement costs.

Buy Back of System from Third Party

If VTrans chooses to develop a project with a third party and the agency decides that it would like to purchase the solar PV system (described earlier as a hybrid model), an agreed upon price will need to be determined. This timeframe may or may not be identified in the contract. Vermont's BGS has indicated that they have developed agreements to purchase the solar PV system at year seven. This approach allows the third-party developer to get the federal tax incentives as well as accelerated depreciation of the system. Undoubtedly the developer will perform its own due diligence and calculations to determine the value of the system at the time of purchase but VTrans should conduct its own analysis to determine if it is getting a good deal. The financial pro forma includes an option for valuing the system at year seven and shows both the financial aspects for VTrans. Consult this pro forma to determine the anticipated cost to VTrans and whether that is a fair assessment of value.

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Appendix A

FHWA GUIDANCE AND REQUIREMENTS FOR DEVELOPING RENEWABLE ENERGY FACILITIES IN THE LIMITED-ACCESS HIGHWAY RIGHTS-OF-WAY

FHWA Requirements for Renewable Energy in the Right-of-Way

Subject: FHWA Guidance and Requirements for Developing Renewable Energy Facilities in the Limited-Access Highway Rights-of-Way
To: Gina Campoli, Environmental Policy Manager, VTrans
From: Aaron Toneys, Senior Associate; Josh Proudfoot, Principal, Good Company
Date: September 26, 2016

Purpose

Vermont Agency of Transportation (VTrans) is in the process of developing a Solar Development Plan as part of State Agency Energy Implementation Plan (SAEIP) and is expected to select sites for solar photovoltaic (PV) facilities in the future. While the specific locations of these sites are not yet known, it is anticipated that some sites will be located on land purchased with Federal Title 23 Funds and under the jurisdiction of the Federal Highway Administration (FHWA). These require that all standard management principles apply to the project such as: ensuring that the transportation purpose is not compromised in the present or future; safety and other standards of control of access are abided (23 CFR 620.203h); that NEPA is followed (http://www.fhwa.dot.gov/real_estate/publications/row/page05.cfm); and that the fair market value is calculated and expected as an assumption.

FHWA determines the approach to specific design guidelines for projects at the Division Office level with guidance from the head quarter's program offices. Generally, they strive for alignment, however, it is possible for a division office to rule differently than other division offices. This being the case, VTrans asked Good Company to conduct interviews and summarize existing guidance on the topic to support development of VTrans Solar Plan and to allow the agency to understand and plan for specific FHWA requirements during the site selection process.

Approach

Interviews were conducted with the Vermont FHWA Division office, Oregon, Massachusetts, New York, and Connecticut DOT. The FHWA headquarters office answered questions via email and directed us towards best available written resources on the topic. A review of these resources within the Vermont context, combined with interviews conducted provide the basis for the following summary of findings and conclusions.

FHWA Guidance – Summary of Available Resources

The following guidance was provided by FHWA on initiating solar PV projects that require FHWA approvals. FHWA first suggests that VTrans staff becomes familiar with the resources summarized at http://www.fhwa.dot.gov/real_estate/right-of-way/corridor_management/alternative_uses.cfm. The website includes a variety of context and guidance documents including:

- **Renewable Energy Generation in the Highway Right-of-Way Briefing Book:** The briefing book provides a high-level overview of Renewable energy highway projects,

including potential business models and funding sources, and applicable federal and state regulatory requirements.

- **Alternative Uses of Highway Right-of-Way Report (January 2012):** FHWA published this report to assist State DOTs and local agencies to evaluate the feasibility of accommodating renewable energy technologies in the ROW. The report includes a program checklist consisting of questions that DOTs might consider in contemplating a program to accommodate renewable energy or alternative fuel facilities
- **Alternative Uses of Highway ROW Webinar (August 2012):** FHWA hosted a webinar on accommodating renewable energy technologies and alternative fuel facilities in the highway ROW. The webinar includes presentations from three states that have implemented renewable energy projects in the ROW including Oregon DOT's solar highway projects.
- **Guidance on Utilization of Highway Right-of-Way (March 2009):** In response to an increasing number of proposals to use the highway system ROW to accommodate renewable energy facilities, in FHWA issued guidance to clarify the applicability of Federal laws and regulations to such proposals.
- **Program Guide on Utility Relocation and Accommodation on Federal-Aid Highway Projects (January 2003):** FHWA developed this program guide to assist individuals administering Federal-aid highway programs that involve: use of Federal-aid highway funds for the relocation and adjustment of utility facilities, and the accommodation of utility facilities and private lines on Federal-aid highway ROW.

A second website provided by FHWA's Office of Real Estate http://www.fhwa.dot.gov/real_estate/right-of-way/policy_and_guidance/guidutil_a.cfm offers an additional guidance document:

- **Longitudinal Accommodation of Utilities in the Interstate System Right-of-Way:** The purpose of this guidance is to discuss the FHWA's interests regarding the longitudinal accommodation of utility facilities within the right-of-way of the Interstate System. This document identifies the existing laws, regulations, policies and guidance applicable to the longitudinal installation and accommodation of public and private utility facilities and clarifies their application on a case-by-case basis.

This guidance is intended to be a compliment to the aforementioned document, *Program Guide on Utility Relocation and Accommodation on Federal-Aid Highway Projects*. These materials were reviewed and utilized in preparation of this memo. FHWA went on to recommend reviewing the associate Federal Regulations, which list the minimum requirements for the review of proposed alternative uses of the highway right-of-way.

- 23 CFR 710.405 on Right of Way Use Agreements (formerly Air Rights lease)
- 23 CFR 710.409 Disposal of excess property
- 23 CFR 710.635 Utility accommodation
- 23 USC 111 Use and Access of Interstate ROW

FHWA Requirements for Renewable Energy in the Right-of-Way

One staff member of the Office of Real Estate in FHWA - headquarters recommended preparing information related to these regulations in advance of meeting with division FHWA officials.

Summary of Federal Regulations and Related Issues

There are a variety of potential issues that stem from Federal Regulations that may or may not be relevant during development of a solar PV facility at a specific site in Vermont. Site-by-site differences have the potential to be significant within the context of Federal Regulations and therefore there is no single path to success that is evenly applicable to all circumstances.

The following sections summarize the potential issues, which include:

- Utility Accommodation
- Interstate Access
- Use and Occupancy Permit
- National Environmental Policy Act (NEPA)
- Transportation Planning

Utility Accommodation Policy

Federal Highway Administration (FHWA), in its *Renewable Energy Generation in the Highway Right-of-Way Briefing Book*, states that it has determined that use of highway right-of-way (ROW) for public utility facilities (eg, solar PV facility) is in the public interest and therefore the state DOT may approve installation of the facility in accordance with the state's Utility's Accommodation Plan and with approval from the Vermont Division Office of FHWA. However, if the solar PV facility is determined to be a private utility serving proprietary interests and not have public benefit, the facility would need approval under a Federal ROW Use Agreement (23 CFR 710 Subpart D).

Determination of Public or Private Utility Facilities

Accommodation of a facility as a public utility is determined by how a State views the facility under its own laws and regulations, as well as by that facility meeting the definition established in 23 CFR 645.207. Solar PV facilities clearly meet the definition of "utility" in Federal and State law. FHWA Guidance on Utilization of Highway Rights-of-Way Attachment issued March 27, 2009 states:

> *The definition of "utility" in 23 CFR 645.207 is broad enough to include solar and wind generated energy facilities. Solar panels and wind turbines constitute a "facility or system" for producing, transmitting, and distributing electricity and/or heat."*

Vermont Public Service Board's definition of Utility is also broad enough to include solar facilities.

> *"(D) Utility: any person subject to the general jurisdiction of the Board and owning or operating any public service business or any facility used in the manufacture, transmission or distribution of a utility service."*

FHWA Requirements for Renewable Energy in the Right-of-Way

Likewise, Vermont's *2012 Location and Design Standards, Chapter 2, Location and Design Standards ("Utility Accommodation Plan")* were revised in March 2016 to specifically to include and accommodate renewable energy facilities in a section titled, *Renewable Energy Generation/Transmission on Non-Limited and Limited Access Highways.* Renewable energy facilities clearly defined in the UAP to include "solar structures".

Once the facility is clearly defined as a utility, the next question is whether the facility qualifies as a public or private utility per the state's Utility Accommodation Plan (UAP). The following table, taken from FHWA's *Renewable Energy Generation in the Highway Right-of-Way,* provides additional details on the means of accommodation and permitting process for "Public" as well as "Private utilities." The distinction between a public or private use will determine which approval process is required.

Figure 1: FHWA's *Renewable Energy Generation in the Highway Right-of-Way - FHWA-FHWA-HEP-16-052.*
http://www.fhwa.dot.gov/real_estate/publications/row/renewablerow.pdf

	Accommodation	Approval Process
Public Utility	UAP	If the renewable energy facility qualifies as a utility per the state's UAP then a DOT can approve the installation in accordance with the process outlined in the UAP without referral to the FHWA. If the type of facility is not included in the UAP, then the FHWA Division Office must review and approve the facility.
Private Utility	ROW Use Agreement (23 CFR 710 Subpart D)	The Federal ROW Use Agreement requirements apply to projects in which Federal funds or assistance will be used in any phase of project development. The regulations require agencies to charge current fair market value or rent for the use of the ROW if the property was obtained with Title 23 funds. They also provide an exception to charging fair market rent if the DOT shows and the FHWA approves that such an exception is in the overall public interest for social, environmental, or economic purposes.

As previously stated, VTrans' March 2016 revisions to its UAP clearly describe the process required to accommodate renewable energy facilities on highways, both limited and non-limited access. These revisions have been approved by FHWA and therefore it seems likely that VTrans will be able to approve solar PV installations with approval from the Vermont Division Office of FHWA. The only caveat to this finding is that the revisions to the UAP do not clearly define or distinguish between the potential scenarios and business models in which a facility would be considered a "public" versus "private" utility.

FHWA defines these terms as follows:

- ***Public utility:*** *A facility is "public" if it directly or indirectly serves the public. A small utility company servicing a small community or limited number of neighborhoods would*

normally be considered a "public" use, if it is generally available to any occupants within the service area.

- ***Private utility:*** *A facility is "private" if it serves a limited proprietary use; for example a telecommunications company that proposes to place a line within the highway ROW to serve a select group of users on a lease arrangement basis would normally be considered "private."*

23 CFR 645.207 is significant in this context because it contains the Federal Highway Administrator's finding that *"it is in the public interest for utility facilities to be accommodated on the right-of-way of Federal-aid or direct Federal highway projects provided certain conditions are met."*[1] In addition, VTrans existing and planned solar facilities are in the "public interest" in that they save the agency (i.e., the public) money via net-metering; send surplus renewable energy to be used by general consumers on the electricity grid; are installed to meet State goals related to renewable energy; create in-State job opportunities in manufacturing and construction; and more broadly are intended to mitigate the negative effects of climate change.

Fair Market Value Lease Value for Private Utilities

As described in Figure 1, if a facility is determined to be a "private" utility – regulations require agencies charge current fair market value or rent for the use of the right of way if the property was obtained with Title 23 funds. A private utility is described in FHWA's That said - the property, if defined as a "private utility", may be exempt from the fair market rent requirements if the DOT shows the facility *"is in the overall public interest for social, environmental, or economic purposes"*.

In FHWA's document titled Guidance on Utilization of the Highway Right of Way – Longitudinal Accommodation of Utilities in the Interstate System Right-of-Way states the following:

> *"This exception may be appropriate for activities that positively address climate change, contribute to improvements in air quality, and similar environmental initiatives."*

VTrans installation of these facilities is mandated by state law, the Vermont Comprehensive Energy Plan and requirements that Vermont state agencies reduce greenhouse gases and increase the use of renewables in their operations. Because the VTrans facilities may be net metered in the future or the agency may be supporting solar development through other power purchase arrangements - a further public benefit is derived from pollution free power being sent to the electricity grid for general consumption by other utility customers. An economic public benefit will be realized through lower energy cost for VTrans, a public agency. Further "economic" and "social" benefit would be realized through partnerships and construction contract with local firms for job creation.

[1] See FHWA's Program Guide – Utility Relocation and Accommodations on Federal-Aid Highway Projects in the Policy, Public Interest Finding section. Accessed online at http://www.fhwa.dot.gov/reports/utilguid/if03014.pdf.

FHWA Requirements for Renewable Energy in the Right-of-Way

If the division FHWA office requires use of FMV or rent for use of the ROW is required. FHWA recommends using VTrans staff appraisers to acquire the necessary information to determine fair market value. FHWA acknowledged that fair market value implies that there is a market of parties that want to use the area, but that this isn't always the case.

FHWA has heard that many states have an airspace lease of varying amounts from $100/year to $400 per acre per year. MassDOT included a site lease fee of $17,500 per mega-watt (MW) of installed capacity. If the area required for each MW is 7 acres, this rate equates to $2,500 per acre per year. Its interesting to note that while MassDOT charges this lease fee they also require developers to include the fee in the power purchase agreement (PPA) rate schedule. Therefore, while MassDOT includes a lease fee – they ultimately pay for it via their PPA with the developer. FHWA also mentioned the use of cell tower leases as the "closest allowable alternate use".

Oregon DOT staff suggested that the FMV requirement may satisfied through the value of a portion of the renewable energy certificates (RECs), retired on behalf of VTrans by the developer, in specified in project's contractual documents. They made clear that current guidance does not address the number or value of RECs that would be needed to constitute FMV.

Compensation requirements are described in the March 2016 revisions to VTrans UAP as:

> *"VTrans will charge compensation for the installation of renewable energy facilities based on Chapter 8, Property Management, of the Right of Way Manual. VTrans may also receive in-kind energy supplies or other services, subject to negotiation."*

Use and Occupancy Agreement

A Use and Occupancy Agreement (or permit) is required for renewable energy facilities sited in the highway right of way (ROW) per CFR 645.213. The terms of the agreement define the responsibilities and authorities of the parties involved, typically the DOT and the utility (or other 3rd party developer). The agreement must reference State DOT standards, and describe the type, size and location of facility; include drawings showing the facility, ROW lines, control of access limits, and approved access points; descriptions of liability and responsibilities related to future adjustments; and corrective action to be taken for non-compliance with agreement.

The March 2016 revisions to VTrans UAP (approved by FHWA) describe these requirements for use and occupancy agreement and the process by which related requirements are satisfied.

Control of Access to the Interstate

The FHWA retains all approval rights to the control of access to the Interstate system (23 CFR 620.203h). A DOT is required to obtain FHWA written approval when access to the Interstate

system is added or modified. Both temporary and permanent modification on of access control for transportation on and non- transportation on purposes require FHWA approval.

The March 2016 revisions to VTrans UAP (approved by FHWA) describe these access requirements and limitations and the process by which the access is granted. In addition, it describes the traffic control plan requirements for the site.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act applies to development of any project that received Federal funds or if Federal permits are required. If FHWA approval of the ROW Use and Occupancy Agreement is required – NEPA procedures must be followed. Based on experience from other states with solar PV installations, environmental studies may include issues related to water quality, air quality, visual impacts (such as glint and glare studies), aesthetics, biological or cultural impacts, and hazardous materials.

NEPA requirements are dependent on the potential scale and significance of environmental impacts at the project site. If the environmental impacts are not found to be individually or cumulatively significant the project may be documented as a Categorical Exclusion (CE). In the case where sensitive environments or resources will be impacted – the NEPA requirements will require more extensive study and documentation. To avoid these issues, projects sites should be selected to avoid areas near sensitive environments. Likewise, sites should also be selected so as to avoid sensitive cultural areas – historic sites, public parks, recreation areas, etc.

Responsibility for conducting such analysis varied across solar PV projects between the agency and utility or developer. In the Oregon demonstration project, ODOT was responsible for the environmental analysis and for the costs of mitigating or rehabilitating the impacts. In contrast, in both California and Massachusetts, the developers are responsible for complying with the state's environmental protection regulations. During the interview with Oregon DOT staff, they made a point of recommending that the developers be responsible for environmental compliance, but that the agency provide support and access to related existing agency resources and information related to specific sites.

Long-Range Transportation Planning

As VTrans considers specific sites for solar PV projects should integrate those considerations into state, regional, and corridor-level transportation planning. Solar PV lease agreements are typically between 20 - 25 years, and the useful life of a solar PV facility can be greater than 30 years. These time horizons are consistent with long-range transportation planning. Potential sites for installation of solar PV facilities should be compared with LRTP or introduced during planning processes to determine whether proposed facilities conflict with future expansion of the transportation system or policy direction of the State or metropolitan region.

Summary of DOT Interviews and Related Resources

Connecticut

Connecticut's installed solar PV installations, to date, have been limited to installation at concessionaire facilities via concessionaire agreements. All installations are less than 2 kW. These installations were part of a rest area renovation projects and the State of Connecticut mandated a quality of solar installation as part of the renovation contract. This process did not provide CDOT staff with any relevant experience with FHWA approvals.

Massachusetts

MassDOT did not report any significant issues identified by FHWA related to solar PV installations. The primary issues mentioned included aesthetics and glare, but both of these issues were resolved through a public involvement process. Massachusetts early projects were permitted through ROW Use Agreements. MassDOT does charge developers an annual site lease fee in addition to receiving electricity rates less than retail energy prices. The site lease fee of $17,500 per installed megawatt (MW) of capacity. MassDOT offered to share the method used to arrive at the value with VTrans staff. MassDOT provided a range of resources related to development and release of their RFP. Specifically Exhibit C6 – Financial Proposal Term Sheet is relevant to inclusion of FMV. MassDOT recommends early information sharing and frequent conversations with division FHWA staff as project sites are identified.

New York

NYDOT did not report any significant issues to date related to Federal regulations. That said – NYDOT is still early in the process of selecting a developer and final site selection. To support the process to date, NYDOT staff prepared an informational packet that addressed all concerns and requirements identified by FHWA in their guidance documents and related Federal regulations. This informational packet was used during discussions between the NYDOT commissioner and FHWA division administrator. NYDOT noted the importance of having a mandate for renewable energy from the governor during these discussions.

Oregon

Oregon DOT worked closely with the district FHWA office that was supportive of the innovative nature of the solar highway project. The primary issues mentioned by ODOT staff included visual impacts, aesthetics, and tree removal. ODOT staff provided a range of documents that could prove useful as VTrans develops its solar program. In 2008, Oregon completed the first Solar Highway project in America, installing a solar photovoltaic project in the right-of-way to supply electricity to light the interchange at I-5 and I-205. That project was permitted under Oregon's Utility Accommodation Plan approved by the Federal Highway Administration (FHWA). That plan was developed in accordance with rules adopted by FHWA under 23 CFR 645 Subpart B, Accommodation of Utilities. These include:

- Option Agreement for Solar Site License
- Generic Solar Site License Agreement

FHWA Requirements for Renewable Energy in the Right-of-Way

- Minimum Invertor Requirements
- Oregon's Best Value Selection Process
- FHWA UAP Conformance Briefing

Summary of Findings

The key findings are summarized as follows:

- The revisions made to VTrans Utility Accommodation Plan in March 2016 to include renewable energy facilities is a significant step in solar program development.
- These updates will allow VTrans to approve solar PV installations, in accordance with the UAP, but must be approved by the local FHWA Division Office.
    - VTrans could further revise the UAP to clearly distinguish facility types and business models that are considered "public" versus "private" utilities.
- Fair market value rent requirements in ROW Use Agreements are only applicable to sites that were purchased with Federal Title 23 funds AND seek to host a private utility serving solely propriety interests. In this scenario Federal ROW Use Agreements provide an exception to charging FMV rent if the facility is found to be in the overall public interest for social, environmental, or economic purposes.
- During interviews, other state DOT's reported a number of site-specific concerns related to Federal regulation including access, security, clear zone, aesthetics, and other visual impacts. While concerns were identified, the DOT's made clear that many concerns are site-specific or the result of learning during the development and installation of a first projects. These concerns diminished after experience with solar PV installations increased and related systems and shared understanding are established.
    - The interviewees all suggested that consulting FHWA's division office early and often in will allow for early identification and solution for site-specific and programmatic concerns.
- Site-specific concerns are difficult to fully predict at the site screening stage, but it is best to avoid sites that have known environmental issues, limited access, or other potential safety or security issues.
- Solar PV site selection and the related planning process should be integrated with the development of Long Range Transportation Plans.

Appendix B

TECHNICAL MEMO: CONSIDERATIONS FOR AN RFP FOR SOLAR FACILITY CONSTRUCTION OR FOR DEVELOPMENT AND FINANCING SERVICES

Tech memo: Considerations for an RFP for Solar Facility Construction or for Development and Financing Services

Intro: This document lists the considerations that were introduced by VTrans solar staff and by the key personnel on their teams. Other state DOTs that have procured solar have done so in their own unique way. Many of the conditions that are driving solar development by these other DOTs are not applicable to VTrans. The relevant lessons learned from other DOTs are listed below as of October 2016.

General Guidance

Programmatic versus site-based RFPs: Generally, our research found that developing a programmatic RFP for multiple sites simplifies the RFP process but can lead to a more complicated project development process from overpricing and an increased number of change orders. The site specific conditions for rooftop and ground mount vary across locations. Ideally, VTrans screens all potential sites first to determine which ones are viable from the agency's perspective and puts them out to bid one by one. This allows the comparison of bids to be more accurate and reliable.

Combine public RFP with recruitment of best-in-class vendors: A public RFP process does not ensure that best-in-class parties will participate. A public RFP assumes that highly qualified vendors will see the RFP, which is rarely the case. The RFP should be paired with directly contacting best-in-class vendors to call their attention to the RFP. Reaching out to vendors after the RFP will help determine why or why not they chose to participate and will likely improve future RFPs.

Construction only: For VTrans owned and operated projects that do not need private financial incentives to make the projects financially viable, a low-bid method may be acceptable if the vendor is found to have proven abilities. Make sure that components and warranties are comparable or specify the components you prefer.

Choosing a developer: If possible, avoid a low bid approach and pursue a Best Value Scoring methodology such as Oregon DOT's. If you must use a low-bid methodology, take the time to include careful specifications and/or consider requiring the proof of qualifications, experience/references, and design ability to deliver at the scale you need. Note that it is difficult for agency staff to discern a developer's abilities until the design review or design stage. Qualifications were less of a differentiator of actual abilities for most DOT procurements. This detail reinforces the concept of a paid consultation on the design or to

design the facility first with an escape clause before you negotiate for construction and/or financing value.

Defining the value of incentives: If there is uncertainty about the value of financial incentives near the time the RFP is released, consider defining the values for the proposers as opposed to asking them to define the values. This will allow for an easier apples-to-apples comparison of different proposals.

Project confirmation: After award, confer with the construction firm to validate the existing design or advise on design changes. Clearly define the roles of the developer and that of VTrans. We recommend that this time is paid for as a consulting fee at a fixed rate to keep VTrans in a stronger negotiation position as the contracted party is not taking risk or uncompensated cost. After this consultation is settled, negotiate terms. A fair negotiation requires financial transparency and VTrans must insist on sharing financials in both directions.

Buyback versus decommissioning: Some DOTs have been concerned with decommissioning the facility at the end of the contracted or warranted life. Oregon DOT negotiated for the panels to be taken back by the manufacturer for an upfront fee for proper recovery and/or disposal. Oregon found that the salvage value of the system is similar to the cost of decommissioning, but this will vary by site. That said, solar facilities continue to perform well beyond the warranty but their productivity of the panels slowly degrades. It is recommended that VTrans consider buyback after year 7 or after the warrantied period of the components and contrast that to decommissioning costs and risks.

FHWA approval may not be needed if Solar is covered under the Utility Accommodation Plan (UAP): If the solar PV renewable energy facility qualifies as a public utility per VTrans' UAP (which it does in the March 2016 revision), then VTrans can approve the project using the process described in the UAP, without referral to FHWA. In this case VTrans "will charge compensation for the installation of renewable energy facilities based on Chapter 8, Property Management, of the Right of Way Manual. VTrans may also receive in-kind energy supplies or other services, subject to negotiation."

Fair market value (FMV) exceptions: While receiving fair market value for a lease is a good way to capture value, a lease is not required per FHWA's guidance: "The regulations do provide an exception to charging fair market rent if the state DOT shows, and the FHWA approves, that such an exception is in the overall public interest for social, environmental, or economic purposes. This exception may be appropriate for activities that positively address climate change, contribute to improvements in air quality, and similar environmental initiatives." (Source: http://www.fhwa.dot.gov/real_estate/right-of-way/policy_and_guidance/guidutil_a.cfm) This allows for a more flexible agreement.

Fair market value determination and precedence: If the division FHWA office does not grant an exemption then use of FMV rent is required. FHWA recommends using VTrans staff

appraisers to acquire the necessary information to determine FMV. FHWA acknowledged that FMV implies that there is a market of parties that want to use the area, but that this is not always the case. FHWA has heard that in other states, airspace leases have been valued from between $100 to $400 per acre per year. MassDOT, in its RFP, included a site lease fee of $17,500 per mega-watt (MW) of installed capacity. If the area required for each MW is 7 acres, this rate equates to $2,500 per acre per year. It is interesting to note that while MassDOT charges this lease fee, they also require developers to include the fee in the power purchase agreement (PPA) rate schedule. Therefore, while MassDOT does include a lease fee, they ultimately pay for it via their PPA with the developer. Oregon DOT also includes a land lease with their developer, but the annual payment is minimal. As another point comparison for assessing FMV, FHWA also mentioned the use of cell tower leases as the "closest allowable alternate use."

Include performance requirements for the 3rd party and for VTrans: It is important to define performance requirements and consequences for not achieving them. For example, the project developer may have to submit a traffic control plan to the VTrans project manager or define the financial consequences and payments to the developer should VTrans determine it has to repurpose a site mid-contract.

System warranty periods: As previously mentioned, assumptions about the useful life of the system will have significant effects on the value of the system. To capture as much of this value as possible, while managing risk, Oregon DOT sought out and purchased key system components that had longer than industry average warranty periods and/or had demonstrated extended useful lives in field applications. By approaching component technical specifications and purchases in this way, they were able to develop contractual agreements that extend the systems life beyond warranty periods.

VTrans Declarations to Bidders:

1. Program goals in this order
   1.1. Reduce agency's electricity costs
   1.2. Provide resilience for the local grid or VTrans operations through back-up power in a regional or local loss of power service
   1.3. Reduce the future effects of climate change
   1.4. Support state policies encouraging distributed generation; renewable power generation *in Vermont, for Vermont*; demonstrate leadership to other Departments of Transportation; and reduce the need for use of scenic viewsheds and agricultural land for solar
   1.5. For 3rd party projects, develop a contractual relationship, but negotiate and work together as a partnership
2. Program goals for larger projects

2.1. Leverage financing and incentives that are only available to the private sector to improve VTrans' benefits which serves the public, while providing a fair deal to the developers and investors
2.2. Reduce VTrans' development effort in identifying sites, obtaining permits and performing federal and transportation-specific due diligence and delivery (e.g., future transportation or stormwater needs, archaeology etc.)
2.3. Transfer of ownership to VTrans after sufficient return on investment is made by developer or investor

3. Expectations of the potential development partner
   3.1. ROW conditions versus rooftop (limited locations) or ground mount
   3.2. Quality control of site due diligence and solar production potential which should be paid as a consulting fee, including the determination of a project go or no go. If the project is a no go, VTrans will pay for the consultation, not the bidding effort. The quality control phase could be negotiated on a time and materials basis with a not to exceed limit, or it could be a pre-determined lump sum. If the project is a go, the consulting fee will be paid to the solar partner out of the income streams of the facility or on a consulting basis as described above.
   3.3. If a viable financial deal exists, develop engineering plans as needed as part of the development of the project
   3.4. Community engagement – if needed. The consultant or development team should coordinate with VTrans by attending meetings. VTrans should have a good sense of what the impacts will be already from the site screening, but should engage the public early enough to determine public acceptance. The research and screening should include things such as: land use, town plan, conservation issues, as well as having conversations with local and regional planners.
   3.5. Utility negotiations and permitting
   3.6. Agency of Natural Resources coordination and permitting
   3.7. Special permitting, bonds, insurances and controls for this site and DOT work
4. Project specific goals
   4.1. Site unique conditions – these determine Balance of Systems (BOS) cost and productivity
      4.1.1. Rack considerations may include: driven pier to avoid storm water concerns, ballast due to a rocky site. Consider ground surface to avoid creating impervious surface.
      4.1.2. Height above ground of bottom of arrays to provide access below for maintenance – also to prevent problems like animals climbing arrays
      4.1.3. Barriers for safety
      4.1.4. Security needs
      4.1.5. Vegetation for viewshed
      4.1.6. Neighbor accommodations
5. Equipment requirements, if any
   5.1. Buy America – what percentage or components must be made in the U.S. given funding sources?

5.2. Buy Vermont – If there are no federal funds, what percentage of dollar value, specific components, investor or labor must be local? Note that many of the components are unlikely to be made in Vermont. Construction, racking, site development and other balance of system components such as fencing, or vegetation could all be in-state contractors.

6. Operations and Maintenance
   6.1. Ensure that facility contacts of all parties will remain clear due to retirement and turnover
   6.2. What is in the maintenance regime and what is out? Consider snow removal, summer washing, inverter dust removal, replacement of panels, wire or damaged connections, vandalism, and animal impacts (chewing on wires – nesting)
   6.3. Ground surface – grass, gravel, paved. Some owners have sheep grazing below. Consider this carefully. It will be most of the maintenance in most years. Include in this maintenance of storm water facilities if needed.
   6.4. Decommissioning or buyback
7. Legal
   7.1. Need for complete financial transparency of the deal in larger 3rd party projects
   7.2. Negotiate based on the net benefits and consider an option to buy the project back after 7 years
   7.3. Need to research the payment of a patent royalty to a party that holds patent rights to "solar along highways." (Note that this implies behind barrier or beyond the clear zone). Most DOTs paid it as a "nuisance fee." Nearly every legal team found this patent to exist, but would likely be unenforceable if challenged. No DOT has challenged the patent holder.
   7.4. Termination fees – Be prepared in case a situation develops in which VTrans needs the land back. VTrans should include a schedule where you would pay the 3rd party in the event of having to close the facility early for transportation needs. The schedule should be based on 3 phases: 1) Development, 2) Post tax credit/depreciation, and 3) Production after year 5 or 7. Consider a clause that allows VTrans to condemn the site if needed for other transportation purposes with a defined calculation formula, specific to the project, based on individual years through year 7, and then a prorated sum for each year going forward. Consider operations and maintenance costs, deconstruction costs and salvage value in this valuation formula. Note, if you have a buyback option, lost revenue may be a moot point.
   7.5. Protect the asset from liens on the developer from their suppliers

CORPORATE AND KEY PERSON QUALIFICATIONS AND EXPERIENCE

1. For the lead firm and its partners
   1.1. Years in business and parent companies

1.2. Experience working with federal money and conditions
1.3. Performance bonding capacity for the system over time, not just construction
1.4. DOT experience
1.5. Host and other part-owners' references
1.6. Utility references
1.7. Financing references
1.8. Construction references

2. Key persons committed to this project and their references

TECHNICAL PROPOSAL - POWER SYSTEM DESIGN AND RATIONALE:

1. Design QC improvements and/or conceptual design
2. Capacity (AC kW system nameplate)
3. DC-to-AC ratio (DC array system size versus inverter rated nameplate)
4. Azimuth (orientation)
5. Tilt – balance of solar productivity versus more panels for the area, need to be high enough for under array maintenance and vegetation growth, also can affect snow cover
6. Solar panel quantity, type, manufacturer, wattage, and warranty
7. Inverter quantity, manufacturer, model, and replacement schedule
8. Energy storage information for net-metered projects that serve VTrans load and/or any projects where resiliency is of substantial importance
9. Racking type, mounting, and tracking types (as applicable) – driven piers versus ballast, finishes, rooftop mounting piers
10. Site specific Balance of System - Security or safety equipment required. Grid connection, interpretive signage, ground covering, and parking, etc.
11. Energy production modeling – annual expected production with declared range of uncertainty

BUSINESS MODEL AND FINANCIAL PROPOSAL:

1. Assumptions – useful life, escalation rates, panel degradation rate
2. Capital provided and incentives
3. Debt source, interest rate and all fees for transparency and negotiation, not for assuming the debt through a contractual instrument
4. Equipment costs and labor to follow technical proposal. Include second set of inverters. Note that energy storage for net metered may warrant exclusion of average costs since it brings a separate benefit from the reduced cost energy.
5. Site specific variables and costs. Note that grid connection is often a critical cost. Also include permitting - utility, ANR, and public coordination and public engagement costs.
6. Operations and maintenance costs, if part of the deal. Include insurance.

7. Developers fees or project management time.
8. Projected income sources and total value. Include ranges of uncertainty
   8.1. ITC
   8.2. MACRS - Depreciation
   8.3. FIT/Standard offer
   8.4. Savings through net metering and wholesale power sales
   8.5. Sale of Renewable Energy Credits
   8.6. Levelized cost of energy per kWh
9. Suggested distribution of profits/benefits by all project parties – not just parties inside the special purpose entity
10. Performance guarantees with or without partners failing
11. Decommissioning fees or VTrans buyback option
12. Termination fees, if any

Appendix C

ORS184.423 FOR VALUES-BASED PROCUREMENT

184.423 Findings and goals regarding sustainability. The Legislative Assembly finds and declares the following goals for the State of Oregon regarding sustainability:!

(1) In conducting internal operations, state agencies shall, in cooperation with the Oregon Department of Administrative Services, seek to achieve the following objectives:!

(a) State purchases should be made so as to serve the broad, long term financial interests of Oregonians, including ensuring that environmental, economic and societal improvements are made so as to enhance environmental, economic and societal well-being.!

(b) Investments in facilities, equipment and durable goods should reflect the highest feasible efficiency and lowest life cycle costs.!

(c) Investments and expenditures should help promote improvements in the efficient use of energy, water and resources.!

(d) State operations should be located in diverse locations, including rural and distressed communities.!

(e) State operations and purchases should help maintain vital and active downtown and main street communities.!

(f) State purchases should help support opportunities for economically distressed communities and historically underemployed people.!

(g) State operations should reflect partnerships with communities and businesses.!

(h) State operations should help reduce adverse impacts on native habitats and species and help restore ecological processes.!

(i) State operations should be conducted in ways that significantly increase the efficient use of energy, water and resources.!

(j) State operations and purchases should reflect the efficient use and reuse of resources and reduction of contaminants released into the environment.!

(2) In supporting sustainable communities, state agencies shall seek to enable and encourage local communities to achieve the following objectives:!

(a) Resilient local economies that provide a diversity of economic opportunities for all citizens.!

(b) Workers supported by lifelong education to ensure a globally competitive workforce.!

(c) An independent and productive citizenry.!

(d) Youth supported by strong families and communities.!

(e) Downtowns and main street communities that are active and vital.!

(f) Development that wisely and efficiently uses infrastructure investments and natural resources.!

(g) Affordable housing available for citizens in community centers.!

(h) Healthy urban and rural watersheds, including habitats for fish and wildlife.!

(i) Clean and sufficient water for all uses.!

(j) Efficient use and reuse of resources and minimization of harmful emissions to the environment.!

(3) Intensification of efforts to increase the economic stability of communities designated as economically distressed. [2001 c.918 §4]!

Appendix D

PROPOSED SOLAR PROJECTS - INVERTER MINIMUM REQUIREMENTS, QUESTIONS AND SITE SPECIFICS

Proposed Solar Projects
Inverter Minimum Requirements, Questions and Site Specifics

Overview:

XXX requests proposals to supply and deliver inverters to three solar photovoltaic sites within a 20 mile radius of Portland, Oregon. The inverters will be installed by others. The inverters must be compatible with XXX photovoltaic modules that XXX is procuring separately and that will be provided for ground mount installation at each of the three locations.

The three facilities and site locations are: XXX

Evaluation of Proposals:

XXX are seeking best value for least cost. Each proposal will be evaluated based upon the degree to which the manufacturer demonstrates compliance with the "Technical Criteria" and "Corporate Criteria" listed below, and based upon its "Price." A complete proposal will address all criteria.

Technical Criteria:

The proposal shall include written information, data and specification sheets that demonstrate the manufacturer's degree of compliance with the following technical criteria:

1.! Inverter efficiency must be 97.0% or better for the CEC-weighted efficiency.

2.! Offer must include at least a 10 year warranty at no additional cost and offer an optional 20 year extended warranty. 20 year extended warranty is preferred.

3.! Integrated DC disconnects must be load-break rated.

4.! Must be capable of maximum power point tracking at full power down to 295VDC input with no de-rating of power output capacity.

5.! Ambient temperature rated for -30C to 50C.

6.! Enclosure shall be rated NEMA 4 to prevent wind driven rain from entering the inverter.

7.! Preference is for sourcing of products within 500 miles or less to support Oregon sustainability policies and LEED certification guidelines.

8.! DC sub-combiner must be located in a dedicated section with separate door.

9.! Integrated data monitoring system must be an available option and connections to utility communications should be located away from high voltage areas, such as bus work. Ethernet modbus connections preferred.

10.! Integrated sub-combiner fusing with current monitoring must be available as an option.

11.! Manufacturer must provide same day or next day service and parts. Local service provider preferred.

12.! Manufacturer must provide measured db sound ratings for each side of the proposed inverters from distances of 3 feet, 10 feet and 50 feet and if available offer a "low noise" option along with the cost and net db sound ratings associated with that option for each side of the proposed inverters from distances of 3, 10 and 50 feet.

13.! Manufacturer must provide measured EMF levels for each side of the proposed inverters from distances of 3, 10 and 50 feet and if available offer a "low EMF" option along with the cost and net EMF levels associated with that option for each side of the proposed inverters from distances of 3, 10 and 50 feet.

14.! Provide a Material Safety Data Sheet ("MSDS") as defined in Occupational Safety and Health Administration ("OSHA") for any goods or materials incorporated into the PV Inverters that may release, or otherwise result in exposure to, a hazardous chemical under normal conditions of use or that would require personnel to take special precautions in either recycling, demolishing or serving an emergency (such as vandalism breakage, fire or vehicular accident) involving the PV Inverters.

15.! Are your inverters made in an ISO 9001:2000 certified facility?

16.! Provide your proposed delivery schedule as part of the proposal and identify the kW ratings of the inverters and quantity for each site.

17.! Identify and provide technical specification or data sheets on the proposed inverters, model and type.

Corporate Criteria

The proposal shall include written information in response to the following corporate criteria:

1. Describe your firm's 1) qualifications to perform work under the contract, 2) your core business, 3) years in operation producing inverters, 4) number of employees, 5) address of headquarters, 6) ownership structure.

2. Identify up to three (3) projects including its name, location and owner references that used PV inverters similar to those proposed for this project.

3.! Describe your company's financial capacity including: 1) capacity to support this project, 2) capacity to support warranty on the inverters and extended warrantees.

4.! Identify the actual plant that will produce the inverters for XXX. Identify the location of your facility that is nearest to XXX, Oregon and that will handle any warranty or service issues relative to this project.

5.! Provide copy of proposed warranty terms and conditions, standard and extended.

6.! Describe annual maintenance requirements or recommendations from the date of commissioning through the assumed 25 year project life. As a minimum, address repair, replacement, inspections, testing and cleaning.

7.! Provide evidence that the proposed inverters will be able to withstand all adverse environmental conditions in XXX, Oregon.

8.! Describe your company's sustainability policy by addressing: 1) recycling of PV Module materials after their useful life; 2) whether the inverter are manufactured free of materials that could become hazardous wastes if the inverter are destroyed or no longer used or useful, and if not, specify the materials and the special handling requirements to dispose of such materials; 3) manufacturing locations of PV Module components, 4) relevance of triple bottom line in company practices.

9.! What specific actions has your company taken in Oregon to further Oregon's commitment to sustainability policies? Examples are not limited to, but may include, diverse workforce training and employment in sustainable and renewable energy fields; public service commitments and community service involvement and related public benefit actions.

10.! What specific actions has your company taken and does it take to train and support Oregon trade allies certified by the Energy Trust of Oregon to install your solar panels? Which of those certified Oregon trade allies have you trained and do you support? Identify which of those certified Oregon trade allies meet the provisions of Section 4.7 below.

11.! XXX encourage the use of Diverse Suppliers. Diverse Suppliers include: small businesses, small disadvantaged businesses, minority and women business enterprises and veteran owned business. Please submit information regarding your company's utilization of Diverse Suppliers.

12.! Identify whether your business has one or more of the following special designations by completing and submitting with your response.

- a.! Small Business Enterprise (SBE)
- b.! Small Business Disadvantaged Enterprise (SBDE)
    - i.! Minority Business Enterprise (MBE)
    - ii.! Woman-owned business Enterprise (WBE)

SUPPLIERS BID PROPOSAL PRICE PAGE
INVERTERS FOR XXX SOLAR PROJECTS

							10 Year Warranty		20 Year Warranty	
Sites	Module Type	Watts DC	# of Inverter	Need Date	Inverter Size	# of Inverters	Price/ Inverter	Total Price	Price/ Inverter	Total Price

Notes:
Prices are to be FOB delivered to each site, inclusive of transportation.
Offered prices shall be firm for 120 calendar days from date of proposal.
Provide Service Representative rates.
Provide recommended spare parts list and prices.

Company	Signed
Address	Name
	Title
Telephone	Date

Appendix E

SOLAR BEST VALUE PANEL SELECTION PROCESS

3. Best Value Selection Process

_____ seeks to procure PV Modules that provide _____ the best value over the assumed 25-year life of the project. The Selection Process consists of a two step review by _____ and its advisors of each written Proposal that _____ receives. Step one is a pass/fail review against the pass/fail criteria listed in this RFP. Step two is a scoring determination, based upon the Evaluation Factors listed in this RFP, for each Evaluation Criteria.

Step One Review

In order for Respondent to be considered for Step two, it must pass each Step one criteria. Step one criteria consist of:

- Pass/Fail Commercial Requirements
- Pass/Fail Technical Requirements

The Respondent shall be responsible for providing a written Proposal that adequately and completely addresses the pass/fail requirements identified in Sections 4.1 and 4.2 of this RFP. _____ may request additional from a Respondent if necessary to complete its review.

Step Two Evaluation

Step two Evaluation Criteria will be scored based upon the information provided in Respondent's proposal vis-à-vis each Evaluation Factor listed in Sections 4.3 through 4.9 of this RFP. Section 12 indicates the maximum number of points that are available for each criterion. Evaluation Criteria consists of:

- Corporate Qualifications and Financial Capacity
- Commitment to Delivery Schedule
- Technical Characteristics of Proposed PV Modules
- Commitment to Oregon's Sustainability Policies
- Acceptance of Material/Equipment Terms and Conditions
- Price

4. Proposal Contents

This section outlines the proposal content required to be submitted by Respondent. _____ reserves the right to conduct any further due diligence it deems necessary.

Respondent shall organize its proposal as outlined below. A complete proposal will address each of the following areas:

4.1 Pass/Fail Commercial Requirements

Objective: _____ desires to ensure that the successful Respondent is qualified and financially capable of fulfilling its obligations under the Contract over the 25-year assumed life of the PV Modules.

To be eligible for consideration, Respondent must meet certain requirements. Respondent shall demonstrate that it meets each one of the items outlined below.

4.1.a Pre-Qualified by _____: Respondent must be pre-qualified by _____ in order to submit a proposal. The pre-qualification process has been completed and all pre-qualified Respondents have received this RFP e-mailed directly to them by _____. Responses from any party other than a pre-qualified Respondent will not be considered.

4.1.b Minimum Creditworthiness: Respondent must provide their DUNS number and current financial statements.

4.1.c Price: Respondent must submit the Bid Form (Attachment No. 3) in response to this RFP.

4.2 Pass/Fail Technical Requirements

Objective: _____ desires to maximize the solar generated electrical power at each site. The minimum requirements must be met. PV Modules of higher rated capacity may be proposed at any or all of the sites.

To be eligible for consideration, Respondent must propose to supply PV Modules that meet certain minimum technical requirements. The minimum technical requirements that must be met are identified in the following table.

Table #1: Minimum Technical Requirements

Size

at the above minimum technical requirements will be met as follows:

4.2.a Identify the quantity of proposed PV Modules included in the bid price in order to produce at least the minimum rated DC electrical power at each site in the above table.

4.2.b Provide specification or technical data sheet identifying the rated DC power capacity of each proposed PV Module.

4.2.c Provide specification or technical data sheet identifying the type of solar cells in each PV Module.

4.2.d Identify the area/layout required by the proposed PV Modules in order to produce the minimum rated DC electrical power at each site. PV Module array layout and orientation is constrained at each site. Attachment No. 2 includes the conceptual drawings on which this RFP is based and within which the required area/layout should comply. The RFP conceptual drawings are based upon the minimum rated capacity of each PV Module as indicated in the above table.

Constraint: The square footage required by the proposed PV Modules should not exceed the square footage shown in the conceptual drawings included in this RFP. In the event that Respondent proposes PV Modules that require or suggest revision to the RFP conceptual layouts, the Respondent shall submit, as part of its proposal, drawings that show the revisions, how the PV Modules would fit within the available area, and what the total rated DC electrical power would be at the site.

4.3 Corporate Qualifications and Financial Capacity

Objective: Demonstrated corporate qualifications and financial capacity that best assures _____ of successful performance under the Contract.

4.3.a Describe your firm's 1) qualifications to perform work under the Contract; 2) your core business; 3) years in operation producing PV Modules; 4) number of employees; 5) address of headquarters; 6) ownership structure.

4.3.b Identify up to three (3) projects that used PV Modules similar to those proposed for this project. Include the project name, location, owner references, and manufacturing location for the PV Modules used in each project.

4.3.c Describe your company's financial capacity including: 1) capacity to support this project; 2) capacity to support a 25-year warranty on the PV Modules; 3) corporate growth and profitability over the last five years; 4) projected corporate growth and profitability over the next five years.

4.3.d Identify the actual plant that will produce the modules for _____. Identify the location of your facility that is nearest to Portland, Oregon and that will handle any warranty or service issues relative to this project.

4.3.e Identify how many years your company has been commercially manufacturing 1) PV Modules in general; and 2) the proposed PV Modules for this project specifically.

4.4 Commitment to Delivery Schedule

Objective: Delivery of PV Modules to each site in accordance with _____'s current schedule. Respondent is advised that timely delivery of the PV Modules to each site is critical to the success of the project. Respondent must demonstrate in its proposal that it will meet each of the delivery dates indicated in the above table, or propose alternative dates.

Respondent will be required to manufacture the required quantity of PV Modules and drop ship them FOB to each of three sites within a 20 mile radius of Portland, Oregon, in accordance with the agreed-upon schedule. _____'s current schedule would require Respondent to manufacture and deliver PV Modules to each site as follows:

_____'s Current Schedule

Site

4.5 Technical Characteristics of Proposed PV Modules

Objective: To obtain PV Modules that will generate the most electrical energy and best performance over the assumed 25-year life.

4.5.a Identify and provide technical specification or data sheets on the proposed PV Module (or Modules), model and type.

4.5.b Identify the 1) number of PV Modules proposed for each of the three sites and the 2) solar DC power in kilowatts that can be generated at each site based upon the DC power rating of each PV Module ("Quantity x Rated DC Power per PV Module").

4.5.c Provide any available independent test data that confirms the actual yield (kWh/kW) of the proposed PV Modules.

4.5.d For the proposed PV Modules, provide technical data including of: 1) power tolerance; 2) 25-year performance warranty (percentage of original nameplate capacity at 25 years); 3) evidence of UL 1703, IEC 61730, IEC 61215 and ISO 9001 compliance; 4) environmental protections built into the solar laminate and solar module construction.

4.5.e Provide copy of proposed warranty terms and conditions, standard and extended. _____ requires a 25-year warranty on the PV Modules.

4.5.f Describe annual maintenance requirements or recommendations from the date of commissioning through the assumed 25-year project life. As a minimum, address repair, replacement, inspections, testing and cleaning.

4.5.g Provide evidence that the proposed PV Modules will be able to withstand all adverse environmental conditions in Portland, Oregon, including snow, rain, ice, freeze/thaw cycles, seismic events and expansion/contraction due to heat cycling.

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4.6 Commitment to Oregon's Sustainability Policies

Objective: To best support and promote Oregon's leadership and commitment to sustainability.

4.6.a Describe your company's sustainability policy by addressing: 1) recycling of PV Module materials after their useful life; 2) whether the modules are manufactured free of materials that could become hazardous wastes if the modules are destroyed or no longer used or useful, and if not, specify the materials and the special handling requirements to dispose of such materials; 3) manufacturing locations of PV Module components; 4) relevance of triple bottom line in company practices.

4.6.b What specific actions has your company taken in Oregon to further Oregon's commitment to sustainability policies? Examples are not limited to, but may include diverse workforce training and employment in sustainable and renewable energy fields; public service commitments and community service involvement and related public benefit actions.

4.6.c What specific actions has your company taken and does it take to train and support Oregon trade allies certified by the Energy Trust of Oregon to install your solar panels? Which of those certified Oregon trade allies have you trained and do you support? Identify which of those certified Oregon trade allies meet the provisions of Section 4.7 below.

4.6.d Provide a Material Safety Data Sheet ("MSDS") as defined in Occupational Safety and Health Administration ("OSHA") for any goods or materials incorporated into the PV Modules that may release, or otherwise result in exposure to, a hazardous chemical under normal conditions of use or that would require personnel to take special precautions in either recycling, demolishing or serving an emergency (such as vandalism breakage, fire or vehicular accident) involving the PV Modules.

4.6.e Are your modules made in an ISO 9001:2000 certified facility?

4.7 Commitment to Diverse Suppliers

4.7.a _____ has a subcontracting plan to encourage the use of Diverse Suppliers. Diverse Suppliers include: small businesses, small disadvantaged businesses, minority and women business enterprises and veteran owned business. Please submit information regarding your company's utilization of Diverse Suppliers.

4.7.b Identify whether your business has one or more of the following special designations by completing and submitting with your response Attachment 6 - _____ Self-Certification Questionnaire.

- Small Business Enterprise (SBE)
- Small Business Disadvantaged Enterprise (SBDE)
    1. Minority Business Enterprise (MBE)
    2. Woman-owned business Enterprise (WBE)

4.8 Price

Objective: _____ seeks best value for least cost.

Respondent must completely fill out the attached Bid Form (Attachment No. 3). Respondent's price must remain firm for 120 days from the due date for proposals, unless otherwise agreed in writing by _____.

4.9 Terms and Conditions

Note that bidders may take exception to the Material/Equipment Terms and Conditions in Attachment No. 4, but do so at their own risk. If exceptions are taken, a redline version of _____'s terms and conditions must be submitted with your bid.

Objective: _____ to receive the terms and conditions in Attachment No. 4.

Proposal Schedule

Request for Proposal Issuance Date:

er execution of contract

Delivery of PV Modules:

6. Pre-bid Conference: No pre-bid conference or pre-bid site visit is scheduled.

7. Proposal Submittal Deadline

Proposals are due no later than 2:00 PM PDT on November 13, 2009. _____ will, at its sole discretion, decide whether to review any Proposal received after the due date and time. All Proposals must be delivered to: