

State of Oregon Solar Exploration Project SOLAR HIGHWAY LESSONS LEARNED

Prepared for the Oregon Department of Energy

Business Energy Tax Credit (BETC) Research, Development and Demonstration Briefing

Research, Development and Demonstration Project: This BETC demonstration project included costs typically inherent in a ground-mounted solar photovoltaic installation, plus additional costs resulting from the research and development aspects of the project. Considerations that made this solar project unique and, therefore, added to the cost, included:

Siting – *Siting a prototypical solar resource project on the transportation system requires addressing transportation system specific concerns and requirements, including transportation system specific permitting. Addressing those concerns and requirements requires additional analyses and may require additional investments to mitigate issues that arise.*

Siting concerns and requirements encountered in the development and construction of this demonstration project included:

- **Public Safety**

Public safety was of paramount concern in siting the solar photovoltaic project. Specific issues addressed in the demonstration project included:

- **Clear Zone** - Nothing immovable can be located inside a highway facility's "clear zone," or errant vehicle pathway. Solar installations must be located outside the clear zone or behind a barrier such as guardrail. The clear zone is site-specific and takes into account facility type, topography, and design speed, among other considerations. The Oregon Department of Transportation (ODOT) roadway design engineering section was consulted to determine appropriate clear zone boundaries.
- **Reflection** – Reflection or glint and its potential impact on traffic safety was a concern. That concern was addressed by describing how solar panels are designed to absorb sunlight and how the Federal Aeronautics Administration (FAA) considered such issues in allowing solar arrays to be sited at airports. The issue was also addressed by a study in England that evaluated changes in driver behavior by measuring brake light durations before and after a solar project was installed in the right-of-way.
- **Utility Permit** – Through review by ODOT, the Oregon Department of Justice (DOJ) and the Federal Highway

Administration (FHWA) it was determined that since the demonstration project supplies electricity for ODOT's own use, it was permitted on ODOT Right-of-Way (ROW) through the normal Oregon Administrative Rules Division 55 (OAR 734-055) Utility Permit process, which follows the Federal Utility Accommodation Plan. The Federal Utility Accommodation Plan is required of all states, and describes the process through which each state transportation agency works with utilities for siting, relocating, and maintaining utility infrastructure on State ROW. ODOT District offices issue and manage the permits as a normal course of business. Due to the prototypical nature of the solar installation, FHWA requested and completed review of the Permit before it was issued.

***Access** – Because interchanges otherwise have limited access, site access for construction, operations and maintenance will require new procedures and possibly additional facilities, such as graveled access roads. Such access will need to be thoughtfully developed, controlled and managed to avoid potential safety and security issues associated with access by the general public.*

Access concerns and requirements encountered in the development and construction of this demonstration project included:

- **Traffic Control**

A traffic control plan was submitted to the ODOT District office as a prerequisite to the Utility Permit. It was of great benefit to the interchange demonstration project that the EPC (Engineer, Procure and Construct) Contractor had extensive experience working on and alongside the Interstate highway. However, even with an approved traffic control plan, there was an instance where a subcontractor relocated a traffic control barrier in order to more easily exit the freeway. The EPC Contractor appointed an ODOT-certified Traffic Control Supervisor (TCS) to monitor the installation and operation of the traffic control system, in accordance with ODOT policy. Working together, ODOT District staff and the TCS corrected the problem and prevented any reoccurrence.

- **Maintenance Access**

Stipulations governing the access, ingress and egress of the site were incorporated into the Utility Permit, providing control over the time(s) and condition(s) under which access is permitted. This provides the access needed for maintenance functions while mitigating risk to the traveling public.

- **Gravel Access Road**

ODOT's existing point of maintenance ingress and egress from the Interstate highway has functioned adequately over many years. Therefore, the maintenance access point was maintained and only a small segment of gravel access road was constructed, entirely on site from

ODOT's existing access road to the array. By making use of ODOT's existing infrastructure, there was no increase in risk to the traveling public and project costs were minimized.

Interconnection – *Interconnection requirements will be far more challenging in the demonstration project where the utility interconnection point is the other side of an interchange of interstate highways. How and where that interconnection can most cost-effectively be completed will be a critical issue and documented in this research.*

Interconnection concerns and requirements encountered in the development and construction of this demonstration project included:

- **Highway Interchange Interconnection Issues**

The conductors that connect the photovoltaic array with the electric power grid cross two Interstate highways, I-5 and I-205. An economical means of connection was provided by mounting the electrical conduit to the underside of an existing bridge crossing I-205 and by installing the conduit beneath I-5 using directional boring. In addition to providing significant cost benefits, these two construction techniques achieved three additional aims: (1) eliminating risk to the traveling public, (2) preventing impacts to the flow of traffic, and (3) preventing damage to existing infrastructure.

Security – *Security of the investment is a practical concern. Roadside equipment is easily subject to theft and vandalism. The demonstration project will include development of specific procedures and measures to mitigate that risk. Such measures may include but not be limited to security fencing, continuous security monitoring, surveillance cameras and communications equipment, hardening installation (such as the use of one-way screws), embedding locator devices in equipment and other prototypical measures. In discussions with Christopher Dymond at ODOE, some of these measures tested could be broadly deployed at other high risk solar installations.*

Security concerns and requirements encountered in the development and construction of this demonstration project included:

- **Site Location and Configuration**

As the installation is in the center of a freeway interchange, pedestrian access severely limited. The freeway embankment slopes steeply upon leaving the paved facility, further discouraging vehicle and pedestrian access.

- **Fencing and Access Control**

The photovoltaic array and support equipment are located in a secure compound surrounded by a full height security fence, hardened with triple-strand barbed wire, razor wire coil and 3" barbed security tape. An

electronic security system monitors the perimeter fence and is capable of detecting when the fence is scaled, cut or damaged. Sensors monitor the opening and closing of the gate, and security cameras provide remote visual monitoring and motion detection within the compound.

- **24/7 Notification and Protocols**

ODOT maintenance personnel will be notified 24/7 if any breach of security is detected and similarly ODOT will notify PGE if it becomes aware of site security issues. Under the security protocols established, ODOT will notify State Police of site security issues.

- **Stop Theft Technology**

PGE has implemented the use of Stop Theft technology, a proprietary theft deterrent product that PGE has used widely to safeguard, identify and recover electronic equipment such as laptop computers, cameras and other moveable items. Placards are prominently displayed to further deter theft.

- **Tamper Resistant Hardware**

Tamper resistant bolts were used to make the removal of mounted hardware more difficult and time consuming.

- **ODOT Access**

If necessary to gain access inside the fence for security or any other reason, appropriate ODOT maintenance and district personnel have keys to the project site.

- **Lighting**

The interchange lighting served by the solar array also illuminates the demonstration project site. With that nighttime illumination, the nearly 145,000 vehicles passing by each day ensure a high level of public observation of the site.

- **Public Liability**

The Solar Power Purchase and Site License agreements clearly assign security responsibility for the solar project to PGE and there is no public liability for security of the solar array.

Maintenance – *There is the potential for significant maintenance costs given the proximity to the highway traffic. The array may be subject to oily road spray and airborne dust, resulting in efficiency losses. Flying rocks or other debris could damage the array. Assessing and mitigating those risks will be important.*

Maintenance concerns and requirements encountered in the development and construction of this demonstration project included:

- **Public Liability**
The Solar Power Purchase and Site License agreements clearly assign maintenance responsibility for the solar project to PGE and there is no public liability for maintenance. ODOT will continue to maintain the interchange area outside of the array just as it has in the past.
- **Set Back From Roadway**
The photovoltaic array is positioned as far from the roadway as possible to minimize the risk of roadway debris impacting the safety and functionality of the array.
- **Scheduled Maintenance**
Operation and Maintenance manuals for this project provide guidance on the proper processes and frequencies for inspecting, cleaning and maintaining the photovoltaic array, given the site and environmental conditions. This maintenance is performed by PGE on regularly scheduled basis.
- **Low Maintenance Construction**
Barring damage from external factors, the photovoltaic system should require very little maintenance during its service life. The compound, as well, incorporates low-maintenance construction options such as the use of a low growing grass species that eliminates the need for regular mowing and a stoutly constructed access road designed to minimize the need for repair.

***Public Involvement** – A key objective is to enhance public understanding about the potential contribution of solar energy in meeting Oregon's energy needs and the opportunity for solar resource development in Oregon and specifically on Oregon's transportation system. Public support of solar resource development on the transportation system will be a determinative factor in future solar resource development on the system.*

Public involvement was a key element of the demonstration project:

- **Communications Plan**
A Communications Plan was developed by ODOT and PGE, and identified who is responsible for contacting and/or responding to media, press release protocols, Governor's Office liaise protocols and groundbreaking ceremony activities, etc. It specifies the need to liaison with local jurisdiction and state elected officials whose districts the project is in. These officials appreciated the orientation the project team provided.
- **Groundbreaking Ceremony**
An on-site Groundbreaking Ceremony was jointly hosted by ODOT and PGE. It included speeches by Oregon Governor Ted Kulongoski, PGE President and CEO Peggy Fowler, and Oregon Transportation Commission Chairwoman Gail Achterman. A press packet was prepared that included a Frequently Asked Questions piece, history of the project's development,

artist renderings of the array, pictures of the site, identification of all the Oregon companies involved in the project, and more. The groundbreaking event was a great success. Coverage was provided by the major Portland television and newspaper media, including the local ABC, NBC and CBS news stations; Oregon Public Broadcasting radio; the Portland Monthly Magazine, the Sustainable Industries Journal, The Oregonian, and more. The press was all very positive. Follow up interviews and media contacts continue to this day.

- **Green Media List**

To further engage the public, media releases and briefing papers were prepared and sent to a national audience which included mainstream media as well as specific “green media.” This action was determined to be successful based on the number of contacts the ODOT Project Director received (and continues to receive) from across the nation, as well as from international audiences. The public and media response has been overwhelmingly positive.

- **Oregon Solar Highway Website**

The Oregon Solar Highway website (www.oregonsolarhighway.com) has turned out to be one of ODOT’s most popular websites, getting around 250 hits per week. The count for November alone was 1,110 hits. The YouTube video of the groundbreaking ceremony holds the record for the most hits of any ODOT video, with 1,414 views through November (the runner up just barely broke 1,000 views). The Solar Highway photo set on Flickr has generated around 400 views. The photos are among ODOT’s most popular in terms of viewership. The website contains technical and historical information about the project, including fact sheets that discuss the carbon footprint of a solar panel, how long this project will take to become carbon neutral, how solar energy compares to grid energy in terms of carbon impacts, and more. The website provides information to solar energy providers about ODOT’s future plans as well. Based on emails received by ODOT’s Solar Highway Project Director, people from all over the globe have visited this website.

- **Site Signage**

There are two “motorist information” signs identifying the demonstration project. Approval for these non-standard signs was given by ODOT’s Sign Design Engineer. Due to the unusual nature of the project, ODOT determined that traffic safety would be improved by identifying the facility to the driving public. The signage identifies the site as an ODOT-PGE Solar Highway Demonstration Project.

System Performance Monitoring and Presentation – *Inherent in gaining public support will be affirming the value of the solar resource installation. System performance monitoring and presentation will lend substantive information as to the contribution of the system. Sharing that information with the public in terms it can understand will be important as will presenting it in easily accessible venues, such as web sites and public presentations. At*

the same time, this public focus will make it even more critical that the system performs well and having real-time monitoring of system component will facilitate managing system performance.

System performance monitoring and presentation opportunities encountered in development of the demonstration project included:

- **Data sharing for public benefit**

Both SunWay 1, LLC and ODOT wish to monitor and display, via the web, graphical representation of the energy generated by the demonstration project, both in real-time and cumulative. It was quite challenging to develop data sharing protocols acceptable to each parties' IT departments, while also considering cost, firewall and confidential information issues, hardware (conduit, fiber) and software sharing, and data formatting. It is expected that protocols developed for this first project will carry over to other projects sited in PGE territory.

Statutory or Regulatory Constraints – *Siting solar photovoltaic arrays in the rights-of-way will offer insights into statutory or regulatory issues that may inadvertently limit opportunities for renewable resource development. Net metering tariffs for example did not necessarily contemplate installations on a service area wide transportation system, rather than on a customer's specific site. Identifying statutory or regulatory constraints that preclude resource development and resolutions that would instead foster such development will have value.*

Regulatory constraints encountered during the development of the demonstration project included:

- **Utility Permit**

As noted earlier, ODOT, DOJ, and FHWA determined that the appropriate permitting for the project was through the Utility Permit process because the electricity will be for ODOT's own use on the transportation system. This "nexus," tying the solar installation to ODOT's need for electricity, complies with constitutional constraints on the use of highway funds and with the utility permitting process. The Solar Power Purchase and Site License Agreements include provisions enabling PGE to assume ownership of the project, but it was also critical to demonstrate that electricity produced by the project would continue to be for ODOT's own use, while benefiting PGE's ratepayers to meet regulatory requirements associated with a generating plant owned by PGE. These complex legal and regulatory requirements were carefully considered and thoughtfully addressed through the permitting process.

- **Net Metering Artificially Restricts the Most Promising Sites**

Because of Oregon Public Utility Commission rules, customers, including ODOT, can only offset load aggregated by meter and feeder,

across contiguously owned property, and on the same rate schedule. Net metering is also limited to 2 megawatts per site. These restrictions will result in more, smaller projects; a greater timeline to develop renewable energy resources (or a "solar highway" system); and higher cost per kilowatt installed. Development of an "Administrative Net Metering" tariff or process – allowing an agency to offset all its load in a given utility's service area by utilizing the most promising ROW locations to their full capacity – would greatly facilitate development of the Solar Highway, and would result in lower costs to the public.

- **Legal Issues**

Legal issues associated with the demonstration project were significant hurdles if only because neither DOJ transaction attorneys nor Special Assistant Attorneys General had expertise in Solar Power Purchase and Site License Agreements. There was an inherent learning curve associated with these agreements and the application of related state transportation law. An intervening declaratory ruling process initiated at the Oregon Public Utility Commission required further review of the application of net metering and energy supplier laws and rules and how the application of those rules might adversely affect ODOT's interests in the demonstration project and future solar resource development. All issues associated with the demonstration project were resolved affirmatively.

Technology Transfer – Technology transfer will address a critical potential audience in future solar resource development on the transportation system. Such technology transfer will identify transportation systems issues and how those issues were resolved in a context that will facilitate resource development not only within the Oregon Department of Transportation, but also by other local Oregon jurisdictions and, through FHWA, jurisdictions throughout the nation.

Technology transfer has been and will continue to be achieved. It has been facilitated by recognition of Oregon's demonstration project as the first solar highway project in the nation. The project has been cited for its leadership role by FHWA and the American Association of State Highway and Transportation Officials (AASHTO).

- **FHWA Office of Real Estate Services**

ODOT worked closely with FHWA Oregon Division on the Solar Highway Demonstration Project. In the summer of 2008, an article written by Virginia Tsu, FHWA Oregon Division, was published in the FHWA Office of Real Estate Services Newsletter titled *Focus On The Future: Accommodation of Renewable Energy Resources in the Right-of-Way*. The article acknowledged Oregon's leadership role and fostered technology transfer through FHWA offices with key regulatory responsibilities for solar installations on the transportation system throughout the nation.

- **American Association of State Highway and Transportation Officials (AASHTO)**

The September 5, 2008 AASHTO Weekly Journal featured the Solar Highway Demonstration Project in an article titled *Oregon to Light Interchange Using Solar Power*. This publication is widely read by transportation officials throughout the nation.

- **2009 AASHTO Strategic Plan**

The incoming president of AASHTO identified three critical focus areas, reauthorization of the Federal Highway Fund, a strategic freight movement plan, and sustainability. The Plan prominently featured the Oregon Solar Highway Demonstration Project as part of its strategic vision for sustainability.

- **Portland Chapter of the International Women's Transportation Seminar (WTS)**

The Portland Chapter of WTS selected the Solar Highway Demonstration project as the 2008 Transportation Project of the Year, presenting the award to Allison Hamilton, ODOT Solar Highway Project Director, with the statement *"Seldom do we see projects as transformative as this year's selection, the Oregon Department of Transportation's Solar Highway Project."*

Technology transfer has been and will continue to be supported by ODOT through briefings to other transportation agencies, including the California DOT, Massachusetts DOT, Ohio DOT, West Virginia (DOT and Sierra Club), New York Transit Authority, and Italy and Australia, where solar highway projects are being considered. Additionally, interest has been expressed by the federal Transportation Research Board and from a congressional member of the Senate Energy Committee. These interests will extend the reach of the technology transfer nationally.

The project has also disseminated information through recognition by its peers. In addition to the WTS Project of the Year award, the Oregon Solar Highway was a finalist for the Oregon Sustainability Award; nominated for the AASHTO Environmental Excellence Award, and nominated for the Innovations in American Government Award from Harvard's Kennedy School of Government.