Oregon Department of Transportation
Solar Power Report for 800 Airport Road, Salem, Facility

Report #1
+ Supplement

For Energy Trust of Oregon
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Supplement: January 28, 2008

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Background:
The Oregon Department of Transportation wishes to evaluate several of its buildings for solar electric potential. This short report evaluates a portion of the 800 Airport Road Facility solar potential and other considerations.

Description: The 800 Airport Road Facility is a large facility housing laboratories. The roof is flat with multiple levels for housing mechanical equipment. The building's axis is oriented 25° East of South. Shown to the right is a satellite photo of the building (with proper orientation).

Energy Observations: Electricity consumption records were obtained from Portland General Electric. The facility consumes an average of 1,011,120 kilowatt-hours per year (based on last two years), or about 84,600 kWh per month. There is a slight up-tick in summer months, which indicates air-conditioning-driven peaks in those months. Otherwise the monthly load is very stable and varies between 70,000 and 100,000 kWh per month.

Solar Recommendations: The roof consists of multiple levels, which break up the continuity of the roof for solar. The "higher level" roofs create shaded areas to the north

of these sections which are inappropriate for solar. (See photo on left, which shows lower level roof from one of the upper level roofs.) Also, there are small arrays of "stacks" for exhaust which are approximately 5 feet high, which also have shaded areas to their north, thus ruling these areas out. (See photo here showing two of these stacks.)

As a result, the roof is broken up into multiple areas, separated from one another by shaded areas or at different levels, which are suitable for solar arrays in excess of 1 kilowatt each (100 square feet per kilowatt). See the diagram next page, which identifies each of these sections, including the gross square footage in each section, which will be explored in more detail in a subsequent report.

Of particular immediate interest, however, are awnings covering the loading dock areas on the western-most section of the south side of the building. There are two awnings, one 84 feet long and the other 56 feet long, which can hold photovoltaic arrays of 10 feet high (leaning against the wall of the building). On these two awnings, an approximate 13 kW array can be installed, which will produce 13,600 kilowatt-hours per year. A sketch mockup of the location of these awning arrays is shown here.

Other advantages of installing in this awning area: 1) arrays located on these awnings will be visible from street level (for visibility and public information); 2) located near numerous electrical panels inside the loading dock area for interconnection; 3) easy for installers to access; 4) in a protected area, and 5) provide a small platform for ODOT employees to become involved with and obtain experience in installing such systems before moving on to larger installations.

A system of 13 kW size will cost approximately $120,000 for installation. If owned by a taxable third party (at least for the first 5 years), most of this cost (80-90%) can be written off with a combination of tax credits (state and federal), incentives (Energy Trust) and Accelerated Depreciation. Annual energy savings is estimated to be approximately $950 per year.

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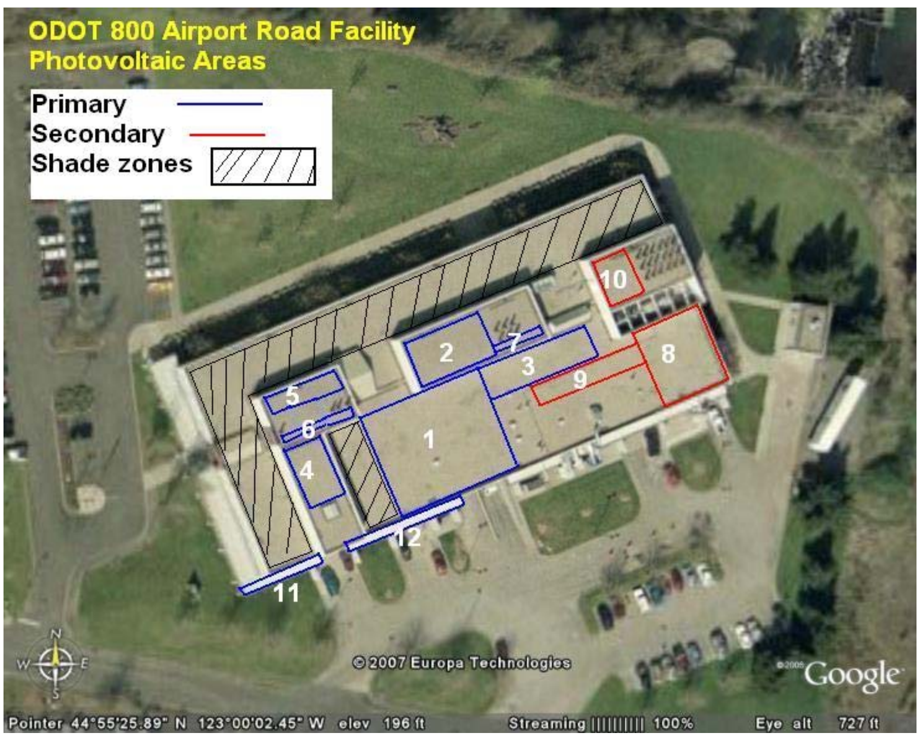
Additional observations and data:

In further analyzing the building roof, the "penthouse" structures stand 10 feet above the base roofline. These structures produce shadows in winter at noon of more than 25 feet in length. For this reason, shade zones have been identified and shown in the image following that are unsuitable for solar photovoltaic arrays.



In the other flat roof areas, as was mentioned in Part 1 of this report, there are a number of roof obstructions, mostly in the form of HVAC equipment, ventilators, and miscellaneous stacks. In that each of these casts a shadow, areas to the north of each piece of equipment or stack is unsuitable for PV installation.

In the image above, the roof has been divided into Areas, each of which would contain a photovoltaic array. The blue zones are primary areas, where there are no or few obstructions. The red areas are secondary, where there are more obstructions and PV arrays in this area may be "broken up". The potential size of each array is provided in the Summary Table on the next page, along with its dimensions. The more separate that the arrays are, there is more likelihood of increased price because of additional conduit runs, racking setups, etc.

ODOT Materials Lab Building Summary

The Table below documents the areas the square footage of area suitable for solar PV arrays, the potential kW capacity of the solar array in the area, the predicted annual kilowatt-hour output, and the contribution to annual electricity loads. [Note that the areas described here are approximations for estimating purposes only.]

Building	PV Area	Length E-W	Width N-S	Area for Solar	kW capacity each Area	Total Building PV kW	Building PV Energy kWh per year	Percent of Annual Building Power
Mat Lab Rooftop	1	89	72	6,408	64			
"	2	53	34	1,804	18			
"	3	72	24	1,728	17			
"	4	26	45	1,170	12			
"	5	56	14	784	8			
"	6	56	9	504	5			
"	7	36	8	288	3			
"	8	52	53	2,756	27			
"	9	73	12	876	8			
"	10	25	36	900	9	171	Rooftop: 181,745	18%
Awning	11	56	10	560	5			
"	12	84	10	840	8	13	Awnings: 13,600	1.3%
BUILDING TOTAL						184	195,345	19.3%

Note: On flat roofs, modules are considered to have a 10 degree tilt, with minimal shading between rows of modules. 1 kW of modules per 100 ft2 of flat roof area is assumed.

Electrical Considerations:

The building has numerous breaker cabinets on the south side of the building in the loading dock area (near PV Area #12, except at ground level). These breakers serve numerous different voltages and phase configurations including 480/277, 120/240, 120/208. A number of spare breaker positions were identified. Given the size of the potential PV system, however, one or several new sub-panels are likely to be needed. Size of the electrical service from PGE will also need to be reviewed, but is likely plenty adequate for a 200 kW PV system.

Structural Considerations:

As is usual, the structure of the building roofs where solar arrays will be placed needs to be reviewed by a licensed structural engineer to confirm it is adequate for any proposed configuration of flat-roof mounting (see Section below on flat roof mounting options).

PV System Mounting Options and Considerations for Flat Roofs

With flat roofs, there are several options for mounting, including rack mount, ballasted tray, structural tray, or roof tile/membrane system. This section discusses these four mounting methods, any of which may be suitable for the ODOT Mat Lab:

There are four options for mounting the solar modules on a flat roof:

1. Rack mount bolted into the roof: In this configuration, the modules are mounted on a rack, then the rack is bolted into the roof structure. Usually this is done in curbs or “sleepers” that are laid in rows on top of the roof and then roofed over by a roofing contractor. The module racks are then lag bolted into the “roofed” curbs at the top and bottom of the module array rack. This configuration is shown in the picture in Figure 1.

Figure 1: Bolted Rack Mount

2. Ballasted tray system: In this system the photovoltaic modules are mounted in a frame which is bolted into a “pan” which is filled with weighted ballast. The ballast is typically of concrete block. In the ballasted system, no roof penetrations are necessary, but the roof has to be structurally capable of the additional weight of the ballasted trays. For all buildings, a structural

engineering study is required to confirm if the roof will withstand the additional weight that a ballasted system would impose. Figure 2 is an example of a ballasted tray system.

Figure 2: Ballasted Tray System

3. Structural tray system: The third type of system relies on the modules being placed in a structural tray system, in which the rows of trays are linked by metal struts for wind anchoring and stability. These systems do not require any additional ballasting, because the structure, as tied together, will not uplift in design wind speeds. See Figures 3 & 4.

Figure 3 & 4: Structural Tray Systems

4. Roof tile system: The fourth type of system is the roof tile system for flat roofs. This system sits flat on the roof and covers over the existing roofing. This system is lightweight and the modules interlock to maintain the system on the roof. This system adds protection and life to the underlying roofing. See Figure 5.

Figure 5: Roof Tile System