Photovoltaic Array

Recommended Action

Install a photovoltaic array on the roof. This will provide an alternative source for 60% of the facility's electrical energy and reduce CO_2 emissions.

Assessment Recommendation Summary				
Energy (MMBtu)	Energy (kWh)*	Cost Savings	Net Cost**	Payback (years)
6,472.9	1,898,208	$129,852	$530,836	4.1

*** Note: Implementation Cost includes incentives*

**1 kWh = 3,410 Btu*

Background

Photovoltaic arrays take energy from the sun, and convert it into useful electricity. They can last over 30 years, require minimal maintenance, and produce zero carbon emissions once they have been installed. Although the government has heavily incentivized photovoltaic's, incentives are changing continuously so review them in detail before purchasing a system.

Proposal

Place a photovoltaic array on the roof. A photovoltaic array will also reduce electricity costs and carbon emissions from electrical generation. Furthermore, take advantage of the RETC tax credit to its fullest extent for a net payback of 2.8 years.

For detailed calculations, see the Photovoltaic Array Calculation Methodology later in this report.

AR No. 4
Photovoltaic Array
Calculation Methodology

Recommended Action

Install a photovoltaic array on the roof. This will provide an alternative source for 60% of the facility's electrical energy and reduce CO_2 emissions associated with electrical generation.

Assessment Recommendation Summary				
Energy (MMBtu)	Energy (kWh)	Cost Savings	Implementation Cost	Payback (years)
6,472.9	1,898,208	$129,852	$1,396,287	10.8

**1 kWh = 3,410 Btu*

Estimated Incentive Summary				
RETC[1] Incentive	FITC[2] Tax Credit	ETO[3] Tax Credit	Net Cost	Net Payback (years)
$459,378	$281,073	$125,000	$530,836	4.1

[1] *Oregon Renewable Energy Tax Credit*
[2] *Federal Investment Tax Credit*
[3] *Energy Trust of Oregon Tax Credit*

Data Collected Summary

- To calculate electrical generation capacity, we estimated the roof space percentage available to be 80% of the total roof area of 202,800 ft^2. Changing this percentage will change the implementation and cost savings, but not the payback period
- The solar energy Production Capacity of 1.08kWh/Watts DC-year is provided by the Energy Trust of Oregon[1]
- The industry standard Solar Panel Rating of 12 Watts DC/ft2 and the estimates for labor cost were provided by a local electrician who specialized in photovoltaic systems and is based on the expected output of commercially available photovoltaic systems[2]
- The estimate for costs of solar panels, inverters, and the number of panels it takes to generate a kilowatt was provided by an industry database[3]

[1] From http://www.energytrust.org/TA/solar/charts.html
[2] From http://www.aesrenew.com/
[3] From http://www.solarbuzz.com/ModulePrices.htm

Savings Analysis

Annual Cost Savings are determined by comparing the photovoltaic system's expected production capacity with the incremental cost of energy.

CS = Cost Savings
= ES + DS
= $120,840 + $9,012
= $129,852

Where,

ES = Energy Savings
= IE x A x UE
= $0.06366/kWh x 162,240 ft^2 x 11.7 kWh/ft^2-year
= $120,840 per year

DS = Demand Savings
= ID x AP x 12 mo/yr
= $3.4608/kW x 217 kW x 12 mo/yr
= $9,012

Where,

IE = Incremental Energy Cost
= $0.06366/kWh

A = Available Area
= TA x PA
= 202,800 ft^2 x 80%
= 162,240 ft^2

UE = Usable Energy
= IL x PC x SP
= 90% x 1.08 kWh/Watts DC-year x 12 Watts DC/ft^2
= 11.7 kWh/ft^2-year

ID = Incremental Demand Cost
= $3.4608/kW

AP = Solar Panel Output
= UE x A x YH
= 11.7 kWh/ft^2-year x 162,240 ft^2 x 1 year / 8,760 hrs
= 217 kW

Where,

TA = Total Area
= 202,800 ft^2

PA = Percent area to be used
= 80%

IL = Inverter Efficiency
= 90%

PC = Production Capacity
= 1.08 kWh/Watts DC-year

SP = Solar Panel Rating
= 12 Watts DC/ft^2

YH = Years in an hour
= 1 year / 8,760 hr

Cost Analysis

We calculate implementation costs on a per kilowatt basis because the major costs in a photovoltaic array are related to how much power the array will generate.

IC = Implementation Cost
= AP x (NC + PC + LC)
= 217 kW x ($721/kW + $892.5/kW + $4,821/kW)
= $1,396,287

Where,

NC = Inverter Cost
= $721/kW

PC = Panel and Mounting Cost
= $4,821/kW

LC = Labor Cost
= T x CW x PW
= 2 hr/Panel x $85/hr x 5.25 Panels/kW
= $892.5/kW

Where,

T = Time for Installation
= 2 hr/Panel

CW = Crew Wage
= $85/hr

PW = Number of panels per kW
= 5.25 Panels/kW

Before incentives, savings will pay for implementation cost in approximately 10.8 years.

Incentive Summary

You may be eligible for the Oregon Business Energy Tax Credit (BETC). For photovoltaic arrays meeting efficiency and longevity standards, the tax credit is 50% of eligible project costs. This credit is claimed over five years (10%, 10%, 10%, 10%, 10%), or over one year for projects with implementation costs of less than $20,000. The BETC has a pass-through option in which the tax credits can be sold to another company in exchange for a lump sum worth 33.5% of the implementation cost. For simplicity, we use the pass-through method below.

The BETC is calculated with two maximum values, one of which is an absolute tax credit maximum (MT). The other is based on the amount of power expected to be generated and is called the Maximum Eligible Cost (ME). The tax credit maximum is set at $20,000,000. The Maximum Eligible Cost rate is set by the Oregon Department of Energy (ODOE) and changes based on the amount of renewable energy being produced in Oregon. There is also an application fee (AF) based on the project's implementation cost (IC). This fee is the lesser of 0.6% of the expected implementation cost or $35,000.

BETCAF = Oregon Business Energy Tax Credit After Application Fee
= BETC - AF
= $467,756 - $8,378
= $459,378

Where,

BETC = Oregon Business Energy Tax Credit

=	The lesser of 33.5% x EC	or	MT
=	The lesser of 0.335 x $1,396,287	or	$20,000,000
=	The lesser of $467,756	or	$20,000,000
=	$467,756		

AF = Application Fee

=	The lesser of (0.6% x IC)	or	$35,000
=	The lesser of (0.006 x $1,396,287)	or	$35,000
=	The lesser of $8,378	or	$35,000
=	$8,378		

Where,

EC = Eligible Cost

=	The lesser of IC	or	ME
=	The lesser of $1,396,287	or	$1,790,250
=	$1,396,287		

MT = Maximum Tax Credit
= $20,000,000

Where,
ME = Maximum Eligible Cost
= ODOE x AP x 1000 W/kW
= $8.25/W x 217 kW x 1000 W/kW
= $1,790,250

Where,
ODOE = Oregon Department of Energy Maximum Eligible Cost Rate
= $8.25/W

You may also be eligible for the Federal Investment Tax Credit. This provides for 30% of implementation costs for photovoltaic projects, although this is reduced to 10% for projects that apply for the incentive after December, 2008.

FITC = Federal Investment Tax Credit
= 30% x (IC - BETC)
= 0.3 x ($1,396,287-$459,378)
= $281,073

In Oregon, renewable energy systems are exempt from property tax.

You may also be eligible for Energy Trust of Oregon (ETO) Commercial Incentives for new solar electric systems. Incentive amounts are based on the rated power capacity (AP) of the solar array in watts and a rate (ETOR) set by ETO. There is an absolute maximum (MI) on the incentive set at $125,000.

ETO = Energy Trust of Oregon Incentive
= The lesser of CETO or MI
= The lesser of $271,250 or $125,000
= $125,000

Where,
CETO = Calculated Energy Trust of Oregon Incentive
= ETOR x AP x 1000 W/kW
= $1.25/W x 217 kW x 1000 W/kW
= $271,250

MI = Maximum Incentive
= $125,000

Where,

ETOR = Energy Trust of Oregon Incentive Rate
= $1.25/W

The following table summarizes incentives and net costs.

Incentive Summary	
Description	Cost
Pre-incentive Cost	**$1,396,287**
Business Energy Tax Credit	($459,378)
Federal Investment Tax Credit	($281,073)
Energy Trust of Oregon incentive	($125,000)
Net Cost After Incentives	**$530,836**

After incentives, savings will pay for implementation in 4.1 years.

Note: If you take full advantage of the BETC tax credit, savings will pay for implementation in 2.8 years. Also, the cost savings, incentives, and implementation costs depend on average wattage, which is dependent on total size. This means that the payback period per square foot will be constant. Therefore, the controlling factors for determining the square footage of a photovoltaic array are available roof space, electrical demand and the amount of money you want to invest.