**CACHE Modules on Energy in the Curriculum**

**Energy Topic: Solar Energy**

**Module Title:** Policies Related To Residential Solar Energy Usage

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**Key concepts:** Feed-in-tariff (FIT), Net metering, Power Purchase Agreement (PPA).

**Introduction:** Our previous module (Solar Panel Economics) provides information about the cost of installing solar panels in residential applications and the savings made due to it. Most of the residential solar panels are grid connected and once the panels are installed, it is also important for the installer to have information about the different policies that would benefit the installer. Though it differs from country to country and state to state, the policies are fundamentally based on at least one of the following: a) Feed-in-tariff b) Net metering c) Power Purchase Agreement. This module provides examples of these policies.

**Example Problems and Solution**

**a) Feed-in-Tariff**

**Problem Statement:** Gainesville Regional Utilities (GRU) offers a solar feed-in-tariff (FIT) for solar PV systems. For all systems 10kW or less, the rate is $0.21/kWh with a 20 year contract. If you install 10 panels of 140W, calculate whether you are eligible for this FIT. If yes, then find the FIT you would receive till the contract ends. Consider an illumination of 5hr per day.

**Solution:**

$Total output=\# of panels ×Output per panel=10×140=1400 W=1.4 kW $

 The size of installation is 1.4kW < 10kW.

Thus the system is eligible for FIT.

Assuming 5hr sunlight per day at maximum power, we have:

$$Output in kW-hr till the contract ends=1.4kW×5hr×365 days×20 years=51,000 kW-hr$$

$$FIT received=51,000 kW-hr ×\frac{\$0.21}{kW-hr}=\$10,731$$

Thus, we would receive an FIT of $10,731 for 10 panels of 140W.

**b) Net Metering**

**Problem Statement:** The State of New Jersey provides a net metering system wherein any excess electricity generated by a customer during a billing period is carried forward to the customer’s next bill as a full kW-hr credit (i.e. at the utility retail rate). At the end of a 12-month period, the utility purchases any remaining excess generation credits. If a system generates 1000 kW-hr electricity per month and uses 948 kW-hr of electricity per month, the find the amount the utility would have to pay for this energy at the end of a 12-month period. Assume a retail rate of $0.16/kW-hr for electricity.

**Solution:**

$$Excess electrcity generated per month=\left(1000-948\right)kW-hr=52 kW-hr$$

The system will receive 52 kW-hr credits per month.

$$Total credits generated at the end of 12-month period=52×12=624 credits$$

$$Amount paid by utility to the system=624×\$0.16=\$99.84$$

Thus, the given system would earn $99.84.

**c) Power Purchase Agreement**

**Problem Statement:** Consider a household consuming 948 kW-hr electricity per month. If the cost of electricity is $0.113/kW-hr, find whether a Power Purchase Agreement (PPA) of $0.12/kW-hr be beneficial. Assume an inflation of 4% per year for the cost of electricity. Take a 10 year contract period. (Refer Problem 2 of the module titled “Solar Panel Economics”).

**Solution:**

$$Annual consumption=12×948 kW-hr=11376 kW-hr$$

The cost of electricity per kW-hr will be given by the relation:

$$C\_{n}=C\_{1}(1+i)^{n-1}$$

*n = number of years*

*i = percent inflation in decimals*

*Cn = Cost of electricity at nth year*

*C1 = Cost of electricity at year 1*

 $Amount to be paid=C\_{n}×11376 kW-hr$

|  |  |  |
| --- | --- | --- |
| Year (n) | Cost Cn ($/kW-hr) | Amount to be paid ($) |
| 1 | 0.11300 | 1285.49 |
| 2 | 0.11752 | 1336.91 |
| 3 | 0.12222 | 1390.38 |
| 4 | 0.12711 | 1446.00 |
| 5 | 0.13219 | 1503.84 |
| 6 | 0.13748 | 1563.99 |
| 7 | 0.14298 | 1626.55 |
| 8 | 0.14870 | 1691.61 |
| 9 | 0.15465 | 1759.28 |
| 10 | 0.16083 | 1829.65 |
| Total |  | 15433.71 |

The household will have to pay $15433.71 after 10 years as electricity bill.

In case of PPA, the rate of $0.12/kW-hr would be fixed for the 10 year contract.

$$Total amount to be paid after 10 years through PPA=\frac{\$0.12}{kW-hr} ×11376 kW-hr ×10=\$13651.2$$

Thus PPA would be beneficial.

**Homework Problems**

**a) Feed-in-tariff**

**Problem Statement:** Assuming an illumination of 5 ¼ hrs of sunlight per day and a monthly consumption of 1402 kW-hr, calculate the number of panels required to suffice the average monthly consumption if 210W panels are used. How much would be the cost of panels if each panel costs $250? How much feed-in-tariff would the system receive at the end of a 20 year contract with the rate of $0.15/kW-hr? (Refer problem 1 of module titled Solar Panel Economics).

Formulae: To calculate the number of panels required, we would have to find the total output given by a single panel in kW-hr per month assuming an illumination of 5hrs per day.

$Total output per panel =Output in Watts per panel×10^{-3}×5.25\frac{hr}{day}×30days$ (Eq.1)

For an average monthly consumption of 1402 kW-hr,

$Number of panels required= \frac{Electricity Consumption}{Total output per panel}= \frac{1402}{Total output per panel}$ (Eq.2)

To find the total cost of panels we can use,

$Total cost of panels=Number of panels required ×Cost per panel$ (Eq.3)

**b) Net metering**

**Problem Statement:** Calculate how much a utility would have to pay for a system if the system adopts a net metering policy wherein any excess electricity generated by the customer during a billing period is carried forward to the customer’s next bill as a full kW-hr credit (i.e. at the utility retail rate). Assume 12 month billing period and utility rate of $0.13/kW-hr. The system has an output of electricity worth 1000 kW-hr per month for first eight months and 800 kW-hr per month for the remaining four. It consumes electricity worth 900 kW-hr per month for all the twelve months.

**c) Power Purchase Agreement**

**Problem Statement:** Consider the previous problem having 900 kW-hr per month consumption and $0.13/kW-hr utility rate. Find whether a Power Purchase Agreement (PPA) of $0.14/kW-hr be beneficial. Assume an inflation of 2% per year for the cost of electricity. Take a 10 year contract period.