How To Use Solar Energy Conversion Equipment Effectively To Reduce House's Power Energy Bill

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Abstract

Access to affordable electricity price is one of the major factors that causing socio-economic problems in the island of Puerto Rico. At the present, most of the clients require the service from the only Power Company provided by the government of PR "Autoridad de Energia Electrica" (AEE). Saying this, the possible opportunities to find a better price for the same utility is limited. At this moment, the use of alternative energy is the only option provided to the client. Inside this alternative energy program, we have the solar energy system that can even be installed in distant area in which the local electrical power cannot afford it.

Introduction

The present energy demand is increasing day by day in Puerto Rico due to various reasons such as the aspiration for improved living standard and general economic and industrial growth. The power generation system is principally depended on imported petroleum oil and natural gas. To reduce the dependency on this type of energy source, the present power generation system must be diversified by using renewable energies with environment protection and can be an alternative energy solution to solving energy problems in the rural areas.

Background

- Provide details on how the solar energy could be converted into electrical power that could be use on customer's houses.
- Provide information on how the sun will be a very important source of energy without have to spend too much money for its acquisition benefits.
- Equipment and electrical diagrams will also provide for visual interpretation.

Problem

This research will try to explain the possible benefits on the implementation of solar systems to help the community to understand how this type of equipment could help on their regular living styles without affecting their power energy consumption bills that typically are highly costs provided from traditional source of power production.

Methodology

The process of solar home system design is shown in the below Block Diagram. The process is started with the site screening. It means that it must be located in a place where there is enough sunlight. Then first stage is load estimation and after that battery sizing. Then other components of the system such as charge controller unit and voltage converter (if needed) are selected. In this way, the whole system design is processed.

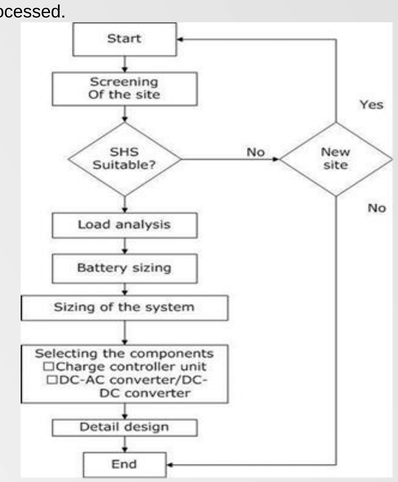

Figure #1 Block Diagram of Solar Home System Design

The average overall monthly household income for family was $1,160 (Hourly rate of $7.25, working 40 hours weekly).

Methodology (Cont.)

Solar Home System Design

Basic Components:

1) Module (Solar Array)
2) Battery
3) Charge Controller
4) Inverter (AC/DC Load)

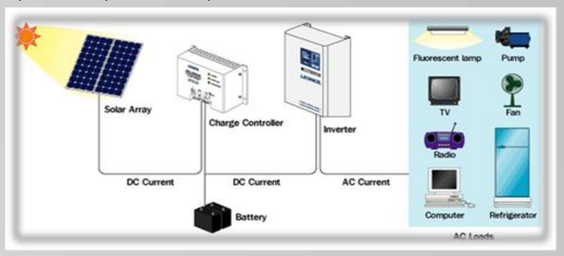

Figure #2: Design of Solar Home Systems

Results and Discussion

Load Determination

Customer Power consumption - Load Analysis for one-month period for a family of 4 members.

Electric Equipment	Potency Consumption (kW)	Daily Use (h)	Electrical Consumption per day (kWh)	Monthly Use (h)	Electrical Consumption per month (kWh)
Ceramic Top Stove	12	2	2.4	60	72
Refrigerator	0.89	24	21.36	720	640.8
Washing Machine	0.33	1	0.33	30	9.9
Oven	0.79	5	3.95	150	118.5
TV	0.156	8	1.248	240	37.44
Lights	0.24	6	1.44	180	43.2
Internet / Laptop Computer	0.17	6	1.02	180	30.6
Microwave	1.2	3	3.6	90	108
A/C	1.35	4	5.4	120	162
Fans	0.06	8	0.48	240	14.4
Total			41.228		1,236.84

Table 1: Electrical Power Consumption on Electric Equipment

Solution:

The daily energy needed for the given family = 41.228 kWh
The monthly energy needed for the given family = 1,236.84 kWh
The yearly energy needed for the given family = 14,842.08 kWh

A small size 12 volts Home System Design

Let, Load determination for 41,228 Wh/Day design a 12 volts solar home system.

Here 85W per module (Isc = 7.9A, Imp = 7.00A & nominal voltage=12), 2,000 Ah battery (DOD = 60%, Efficiency=80%) will use.

- Cabal voltage drop maximum 5%
- Maximum power loss 5%
- Inverter efficiency 90%

Battery size

DC Wh/day = 41,228 Wh÷ (0.9*0.95) =48,219.88Wh
Daily load = 48,219.88 Wh ÷ 12V =4,018.32Ah Battery efficiency = 80%
DOD (Depth of Discharge) = 60%
If autonomy of battery 3 day
Therefore, Amp-hour for battery = (4,018.32*3) ÷ (0.6*0.8) = 25,114.5Ah
Each battery is 2,000Ah.
Number of batteries required = 25,114.5 ÷ 2000 = 12.56 ≈ 13
Therefore, 13 batteries are needed.

Results and Discussion (Cont.)

Selection of Charge Controller

Functional parameters of solar home system charge controller

- Maximum current receives from PV panel
- Ability of maximum power supply on the load
- Mark its low /high voltage level
- Electric protection from thunder
- Good regulation
- Protection from reverse polarity
- Adjust with system voltage

Selection of System Wiring

From PV module up to system component electric wiring is needed.
Voltage drop occurs in internal resistance of the wire.

- Wires are not making defect to the system.
- Centralized 12volt-DC or 24 Volt-DC systems must be required.

Array sizing

Module nominal voltage = 12V
Daily avg. pick insulation = 6 hours
Daily PV module output = Module nominal voltage x Imp x Daily avg. pick insulation = 12*7.00*6= 506 Wh/day
Summarizing 15% loss PV Array Sizing= 506*0.15 =75.6Wh
DC watt-hours Available = 506-75.60Wh = 430.4Wh
Therefore, no. of module = Daily consumption / DC watt-hours Available = 41,228 /430.4 = 95.78 ≈ 96

Inverter size

Size of the inverter = 14,842.08 / (.9) *1.25 = 20,614W ≈ 21,000W
Therefore, 21 kW inverter is needed.
Cost of Solar Power System (Approx. 15,000 kW-h)

Item No.	Description of items	Quantity	Unit Price ($)	Price ($)
1	Solar Panel (440W)	36	380	13,680
2	Battery	13	400	5,200
3	Charge Controller	1	500	500
4	Wire	1	430	430
5	Inverter	1	3,150	3,150
6	Panel Mounting	1	1,250	1,250
7	Miscellaneous	1	245	245
8	Maintenance Cost (Labor & Others)	1	3,067	3,067
Total				27,522

Table #2: Cost of Solar Power System

Cost of Power from AEE (14,842.08 kW-h)

Per Unit Cost of power from AEE ≈ $0.27 / kWh
Per year cost of power from AEE= 14,842.08 kWh x $0.27 / kWh = $4,007.36
Total cost for 20 Years (without considering any maintenance cost) = $4,007.36×20 = $80,147.20

Comparison Between Solar Home System and Power from AEE

Comparison	Solar Home System	Powered from AEE
Cost	Total cost for 20 Years = $27,522	Total cost for 20 Years (without considering any maintenance cost) = $80,147.20
Load Shedding	No	Yes
Cost Variation Due Time	No	Yes
Utility Bills	Low	High
Backup Capability	Around 4 day	No
Source of Production	Sunlight (No greenhouse gases)	Coil, Gas, Water, Oil, etc.

Table #3: Comparison Between Solar Home System and Power from AEE

Results and Discussion (Cont.)

Identifying Direct Costs

Direct costs items are usually classified into two types:

A. Capital costs
B. Operating and maintenance costs

Advantage of Solar Home System

1) Save Money on Electric Bills Immediately
2) Protect Yourself Against Rising Energy Costs
3) Reduce Your Carbon Footprint
4) Conserve Our Natural Resources
5) Work Toward Energy Independence
6) Increase Your Home Value
7) Reduce Utility Bill
8) Minimal Environmental Impact

Limitation of Solar Home System

- Limited number of supplier & lack of experience in the solar technology market, resulting the high price of Solar Home System. Therefore, it is necessary to increase technology market.
- During Rainy season sometimes, sunlight isn't available..
- Initial costing is high that's why some middle-class family can't afford it.
- If Solar panel is damaged, then must change the panel.

Conclusion

The growing rate of Solar Home System (SHS) is around the middle-class family & the poorest are still unable to afford it. One thing we can suggest increasing their research & development sector for having more new ideas. Some strategies could include:

- Offer small system, so that initial investment amount is reduced.
- Cross subsidies may make SHS more accessible to the poor people.
- Installing SHS in school, college, health facilities market may increase working hour.
- At the present there are limited number of supplier & lack of experience in the solar technology market, resulting the high price of SHS. The components are not always available or difficult to source. So, if it is necessary to increase technology market.

Battery recycling process is compulsory project for each organization to ensure the health and environmental issue. Moreover, at the top end of the organization tree, approved specification, guidelines & technology should be updated frequently to run with modern energy world. In the bottom of the organization tree the need increases their technical training to ensure the proper maintenance service.
we can hope that by increasing their service they will put a real impact on the national power generation and the future perspective of the SHS organization should concern about their quality.

Future Work

New research will be conducted on a near future to found more information associated to additional providers and more updated solar technology that could be applicable on this Solar Home System (SHS) for better price and quality.

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