

# City Of Houston GBRC Education Session

Solar Presentation

#### NATURE'S FREE ELECTRICITY









### The Benefits of Solar Energy

Installing a solar electric system on home or building enables the owner or manager to:

•Generate utility cost saving while making a contribution to cleaning the environment.

 Generate some or all of their daily electrical energy demand on their own roof

•Exchanging daytime excess power for future energy needs (i.e. nighttime usage)

PV systems also help qualify a building for LEED certification





Only 3 hours of Sun can meet the world's energy needs for 1 year!



- A solar (photovoltaic-PV) cell is one that converts sunlight (photons) into electricity
- PV cells perform this conversion without any moving parts, noise, pollution, radiation, or maintenance.
- PV cells are made of a semiconductor material, typically silicon (sand?), which is processed to create a (+) positive charge layer and a (-) negative charge layer.







- As the sun rises higher and higher in the sky, the level of output increases
- At noon a solar system is producing at its optimum output







#### Solar Radiation in Average Peak Sun Hours/Day





3.0 - 3.5 hours
 3.5 - 4.0 hours
 4.0 - 4.5 hours
 4.5 - 5.0 hours
 5.0 - 5.5 hours
 5.5 - 6.0 hours
 6.0 - 6.5 hours



#### Solar System Production Based on Size

#### 10 KW Systems is designed to produce 10 KW/ Peak Sun Hour

#### **Houston**

#### 10 KW/Hour X 4.8 Avg. Peak Sun Hours = 48 KWh/day

#### Midland

10 KW/Hour X 6.0 Avg. Peak Sun Hours = 60 KWh/day



















- A Utility Meter
- **B** House Electrical Service Panel
- C AC Utility Safety Disconnect Switch
- F AC Service Disconnect

G - Inverters (quantity may vary from one to sixteen per Branch Circuit) Solar Arrays

- H Conduit from arrays to inverter area
- I EMU System Monitoring via Local Computer or router to internet



### What is Net Metering?



- Net metering means that when a PV system generates more electricity than needed, the excess goes to the utility grid and offsets the energy usage.
- This excess power can then be sold to the utility or traded for future credit on an individual's utility bill.
- Some utility companies have net metering programs, which further enhance the economics of PV.



#### **Solar System Features**

- The building remains connected to the electric utility at all times (Grid Tie).
- Any power needed beyond what the solar system produces is drawn from the utility.
- Due to the large volume of power consumed in commercial building these systems typically do not include battery backup.







#### How Does Solar Electric Work

Grid Tied Solar Systems

Energy is banked for later use by passing excess energy production back to the grid in reverse of the energy consumption accounting system (Net Metering).

On Grid systems are designed to meet a portion of the energy consumed by the loads.

On Grid systems allow the grid to meet the high current load demand, such as high rush, currents needed to start the air conditioner compressor, or other motor driven loads.

Any power needed beyond what the solar system produces is drawn from the utility.





#### Grid Tied Solar System Design

Home consumes 2000KWh/month

2000 KWh Per Month/ 30.4 Days Month = 65 KWh Day

65 KWh Per Day/ 4.8 sun Hrs Per day = 13.5 KW Per Hour

13.5 KW x 25% = 3.3 KW AC Solar System (\$17,000)

13.5 KW x 50% = 6.75 KW AC Solar System (\$34,000)

13.5 KW x 75% = 10.1 KW AC Solar System (\$51,000)



System AC Rating For 25% offset based on 2,00	00 KWh consumed per month.						
Current cost per KWh used for calculations	0.15						
Calculated Current daily consumption of electricity	65.57 KWh/day						
Peak PV required to perform offset	4.11 KW DC STC						
Peak PV required to perform offset	3.29 KW AC CEC						
Solar isolation for your area is	4.8 kW/meter sq^2/day						
Estimated system production rate (KWh/day)	<b>16.4</b> kWh						
Estimated system production rate (KWh /month)	500 kWh						
Estimated system production rate (KWh /year)	<b>6,000</b> kWh						
Value of monthly energy savings (year 1)	\$75.00 Average System						
Value of annual energy savings (year 1)	\$900.00						
Required area for solar array	<b>362</b> sq ft						
Number of panels in solar system	23						
Panel rating	175 Watts each						
Proposed solar panel manufacturer	Sharp, Kyocera, or Suntech						



#### How Does Solar Electric Work

#### • Grid Tied with Battery Back-up (Hybrid)

The Hybrid system takes advantage of the high efficiency of energy production of the On Grid system, but has a limited load demand battery storage bank to supply power to critical loads in the home like certain lights or a refrigerator.

Normally these critical loads do not include the air conditioning unit.

Hybrid systems are designed to supply critical loads without the benefit of a solar charge cycle period, referred to as the days of autonomy (3 days is typical).

The autonomy period is based on the load demand of the appliances to be operated and the length of time those appliances are to be in operation.





#### How Does Solar Electric Work

• Is an On Grid "Hybrid" system right for me?

These systems are best for applications in which backup power must be instantly available without interruption (ie. to power computers). They are also good for areas where power outages are a frequent occurrence, such as after a <u>hurricane</u>.

Batteries are an additional expense, require maintenance, only last 5-10 years, decrease system efficiency and result in a more complicated system.

Generators are usually the least expensive option for backup power production because they are the most reliable and cost effective source of extended backup power as long as they have fuel.



### Grid Tied "Hybrid" Solar System Design

#### Standby System

	AC	AC					ОР	ОР	WATT HOUR	System Load Requirement:
	VOLTS	AMPS	# UNITS	ITEM	WATTS	Total	Hr / D	HR / Wk	PER Day	8.2  KWh/day =
	120	1.67	3	ΤV	200	600	5	35	3,000	
	120	12.00	1	Microwave	1440	1440	0.25	1 75	360	252 KWh/month
	120	12.00					0.25	1.75	500	or 12.6% of 2000 KW/b/M
	120	0.29	12	Lights	35	420	3	21	1,260	
	240	29.31	0	2 ton AC Unit	7034	0	0	0	0	Home consumption
	120	9.17	0	Heater	1100	0	0	0	0	(\$13,000)
	120	12.00	1	W/achar	1440	1440	0.4	2.0	576	(\$43,000)
	120	12.00	I	washer	1440	1440	0.4	2.8	576	
-	120	45.83	0	Dryer	5500	0	0	0	0	Major System Elements
	120	0.83	0	MISC	100	0	0	0	0	14 ea. 175 Watt Solar Panels
										44 ea. 12 Volt Batteries
	120	0.83	3	FAN	100	300	5	35	1,500	
	120	1.67	1	FRIDGE	200	200	8	56	1,600	rea. 7.5 Kw inverter



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### Grid Tied "Hybrid" Solar System Design

#### Standby System With AC Unit

	AC	AC					ОР	ОР	WATT HOUR	WATT HOUR	System Load Requirement:
	VOLTS	AMPS	# UNITS	ITEM	WATT S	Total	Hr / D	HR / Wk	PER WEEK	PER Day	50 5 K\\/b/day =
	120	1.67	3	тν	200	600	5	35	21,000	3,000	30.3 KVII/uay –
	120	12.00	1	Microwave	1440	1440	0.25	1.75	2,520	360	1535 KWh/month
	120	0.29	12	Lights	35	420	3	21	8,820	1,260	or 76 7% of 2000 KWh/M
	240	29.31	1	2 ton AC Unit	7034	7034	6	42	295,428	42,204	Home consumption
	120	9.17	0	Heater	1100	0	0	0	0	0	
	120	12.00	1	Washer	1440	1440	0.4	2.8	4,032	576	(\$249,000)
-	120	45.83	0	Dryer	5500	0	0	0	0	0	
	120	0.83	0	MISC	100	0	0	0	0	0	Major System Elements
	120	0.83	3	FAN	100	300	5	35	10,500	1,500	84 ea. 175 Watt Solar Panel
	120	1.67	1	FRIDGE	200	200	8	56	11,200	1,600	272 ea. 12 Volt Batteries
				Water		_					1 ea. 40 KW Inverter
	240	15.00	0	Heater	3600	0	0	0	0	0	



### How Does Solar Electric Work

#### Off Grid Solar Systems

Off Grid systems are designed to meet 100% of the current demands of the attached appliances, and electrical loads

This RUSH current can be 3 to 7 times the energy required to operate the appliance.

In the Off Grid system the power storage capacity of the system needs to be large enough to meet ALL current demands of all appliances to be connected to the solar power production system.

If the current demand is not sufficient the connected loads will not function, or can be damaged.





### How Does Solar Electric Work

• Is an Off Grid system right for me?

Off-grid systems typically require a larger up-front investment than gridtie systems. This is, in large part, due to the greater demands on the system.

Batteries are an additional expense, require maintenance, only last 5-10 years, decrease system efficiency and result in a more complicated system.

Off Grid systems are typically used in remote applications in which utility power is not available, where running a line to the local utility grid is prohibitively expensive, or where a generator is not desirable.



# Off Grid Solar System Design

AC	AC					ОР	ОР	WATT HOUR	
VOLTS	AMPS	# UNITS	ITEM	WATTS	Total	Hr / D	HR / Wk	PER DAY	System Load Dequirement
120	1.67	2	ΤV	200	400	5	35	2,000	System Load Requirement.
120	12.00	1	Microwave	1440	1440	0.25	1.75	360	29 KWh/day =
120	0.29	12	Lights	35	420	3	21	1,260	886 KWh/month
240	6.10	1	AC Unit	1465	1465	6	42	8,790	
120	9.17	0	Heater	1100	0	2	14	0	(\$138,000)
120	12.00	1	Washer	1440	1440	0.4	2.8	576	
120	45.83	1	Dryer	5500	5500	2	14	11,000	Major System Elements
120	0.83	5	MISC	100	500	0.75	5.25	375	45 ea. 175 Watt Solar Panels
120	0.83	2	FAN	100	200	5	35	1,000	144 ea. 12 Volt Batteries
120	1.67	1	FRIDGE	200	200	8	56	1,600	1 ea. 25 KW Inverter
240	15.00		Water Heater	3600	0	3	21	0	



### **Solar System Features**



- Up to 25 years manufactures warranty for energy output only
- Solar system typically produce power in excess of 30 yrs
- Solar collectors are typically mounted on the roof



### **Solar System Features**

- Solar collector can be mounted on the ground or special structures
- Solar collector are made of a hail resistant material to prevent damage
- Solar Systems can be designed to withstand winds in excess of 125 mph





Crystalline – Glass Module

Mono-crystalline - (12-15 watt per SF) Poly-crystalline - (10-11 watt per SF)





#### Amorphous PVS Laminates

- Thin and lightweight
- Flexible and unbreakable
- Shorter energy payback time
- More electricity per rated power (kWh/KW)
- Easy to integrate with the roof
- Low installation cost
- Aesthetically pleasing
- Outperforms crystalline 8-12%
- Low high heat degradation
- High performance in low light





Amorphous - (5-8 watt per SF)

- PVS (standing seam metal roof)
- PVR (Integrated with composition shingles)
- SIT (Integrated with single-ply roofing membrane)





#### <u>Special Rooftop SIT Systems</u>

No racking or roof penetrations required Light weight; Less than 2 lb/Sq ft. Waterproof, Class A fire rated, UL certified







#### Cylindrical Module Enhances Light Collection

- Direct light: same cross-section at all angles
- Diffuse light: enhanced collection from all angles
- Reflected light: from the roof



High energy yield in horizontal orientation









#### **Available Rebates and Tax Incentives**

- Businesses that purchase solar equipment receive a tax credit worth 30% of the overall system cost. There are no caps (limits) for commercial/business tax credits.
- Texas allows a corporation to deduct the cost of a solar energy device from the franchise tax in one of two ways:

(1)the total cost of the system may be deducted from the company's taxable capital; or,

(2)10% of the system's cost may be deducted from the company's income. Both taxable capital and a company's income are taxed under the franchise tax, which is Texas's equivalent to a corporate tax.



#### **Available Rebates and Tax Incentives**

 The Texas property tax code allows an exemption of the amount of the appraised property value that arises from the installation or construction of a solar or wind-powered energy device that is primarily for the production and distribution of thermal, mechanical, or electrical energy for on-site use, or devices used to store that energy.

 Renewable Energy Credits (RECs) can be sold based on the production of these systems



### **Typical Installation cost**

Small Commercial based solar electric systems typically cost between \$15,000 and \$250,000 installed (3.1KW to 43.7KW).

Large Commercial based solar electric systems can cost between \$250,000 and \$5,000,000 installed (50KW to 1MW).

The multiple variables that influence the cost of these systems include but are not limited to:

amount of utility grid power to be offset
selected type of system
mounting options

### The Benefits of Solar Hot Water Heating

Installing a solar hot water heating system in residential applications enables a home owner to:

•Reduce their energy cost associated with hot water heating by as much as 85% (typically only for electric applications)

Heat potable water and swimming pool water

Establish as reduced predictable energy budget







# How Does Solar Hot Water Work

The basic components of a solar hot water heater:

Solar collector
Heat exchangers
Water and/or glycol pumps
Storage and preheat tanks

Can be added to existing tanks.



### **Solar System Features**



- The systems typically pay for themselves in 4 to 7 years of utility savings.
- Up to 12 years manufactures warranty
- Solar system typically produce heat efficiently in excess of 20 yrs

 Solar collectors are typically mounted on the roof

















#### How Does Solar Pool Heating Work

The basic components of a solar pool heater:

- Solar collector
- Automatic control
- •Diverter valve
- Associated piping

Simply added to the existing pool pump, timer and filter.





#### **Solar System Features**



- Up to 12 years manufactures warranty
- Solar system typically produce heat efficiently in excess of 20 yrs
- Solar collectors are typically mounted on the roof



#### **Solar System Features**

- Solar collector can be mounted on the ground or special structures
- Solar collector are made of a hail resistant material to prevent damage
- Solar Systems can be designed to withstand winds in excess of 175 mph







# Thank you! We look forward to working with you.

# **Questions and Answers**

This concludes the American Institute of Architects Continuing Education Systems Program

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