Solar Energy Applications

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الطـاقة عالميـا

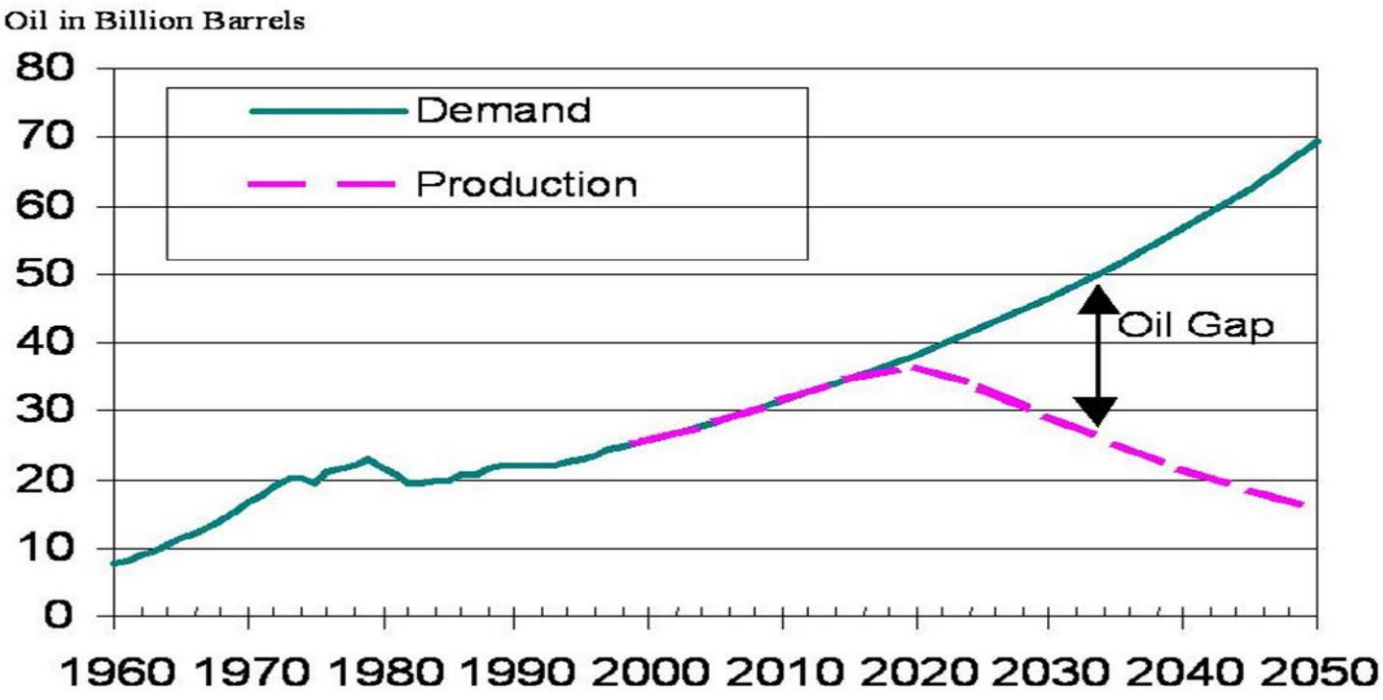
أهم عشـرة مشـاكل تواجه العـالم حتى عام 2050

- الطـاقة
- المياه
- الغـذاء
- البيئـــة
- الفقــر
- الإرهاب والحروب
- الأمــراض
- التعـليم
- الديمقراطية
- كثافة السـكان

2003 : 6.5 مليار نسمة

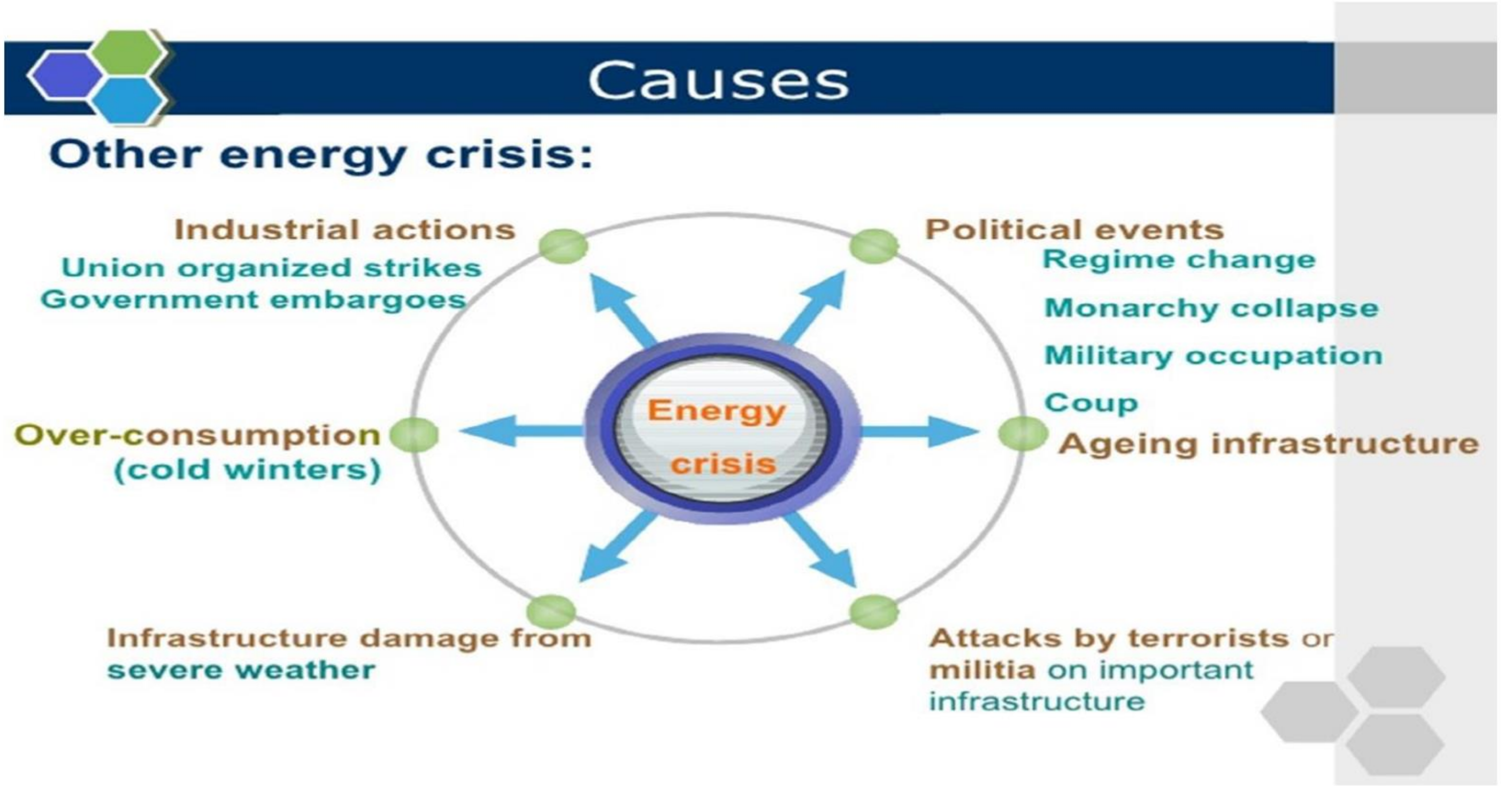
2050 : 8-10 مليار نسمة

Energy Crisis



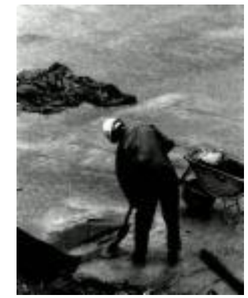
Gap between Energy Production & Demand

Energy Crisis



Causes of Energy Crisis

الطاقة عالميا



استكشافات

توترات سياسية

نوع الخام

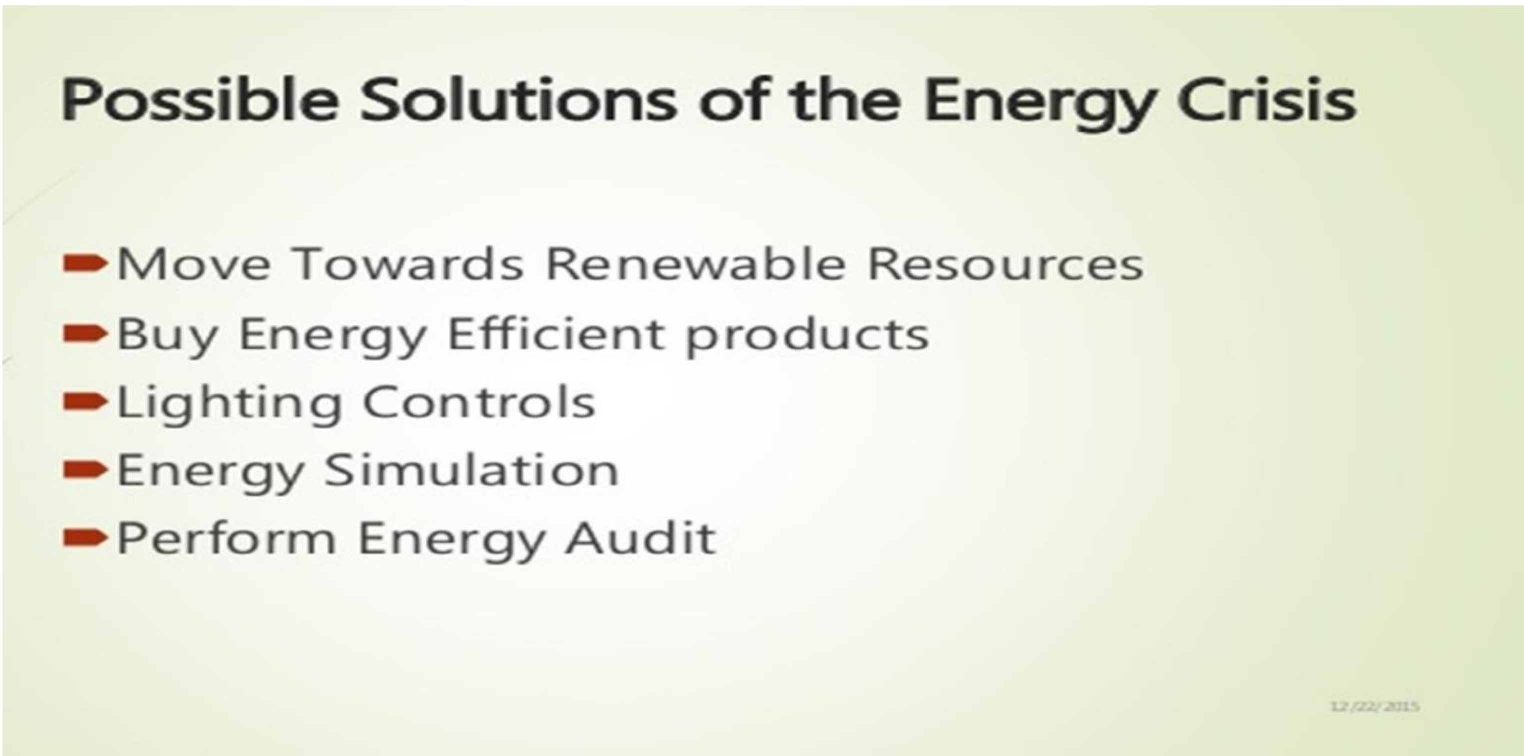
البترول

كوارث طبيعية

نمو الطلب

أسعار الصرف

Energy Crisis

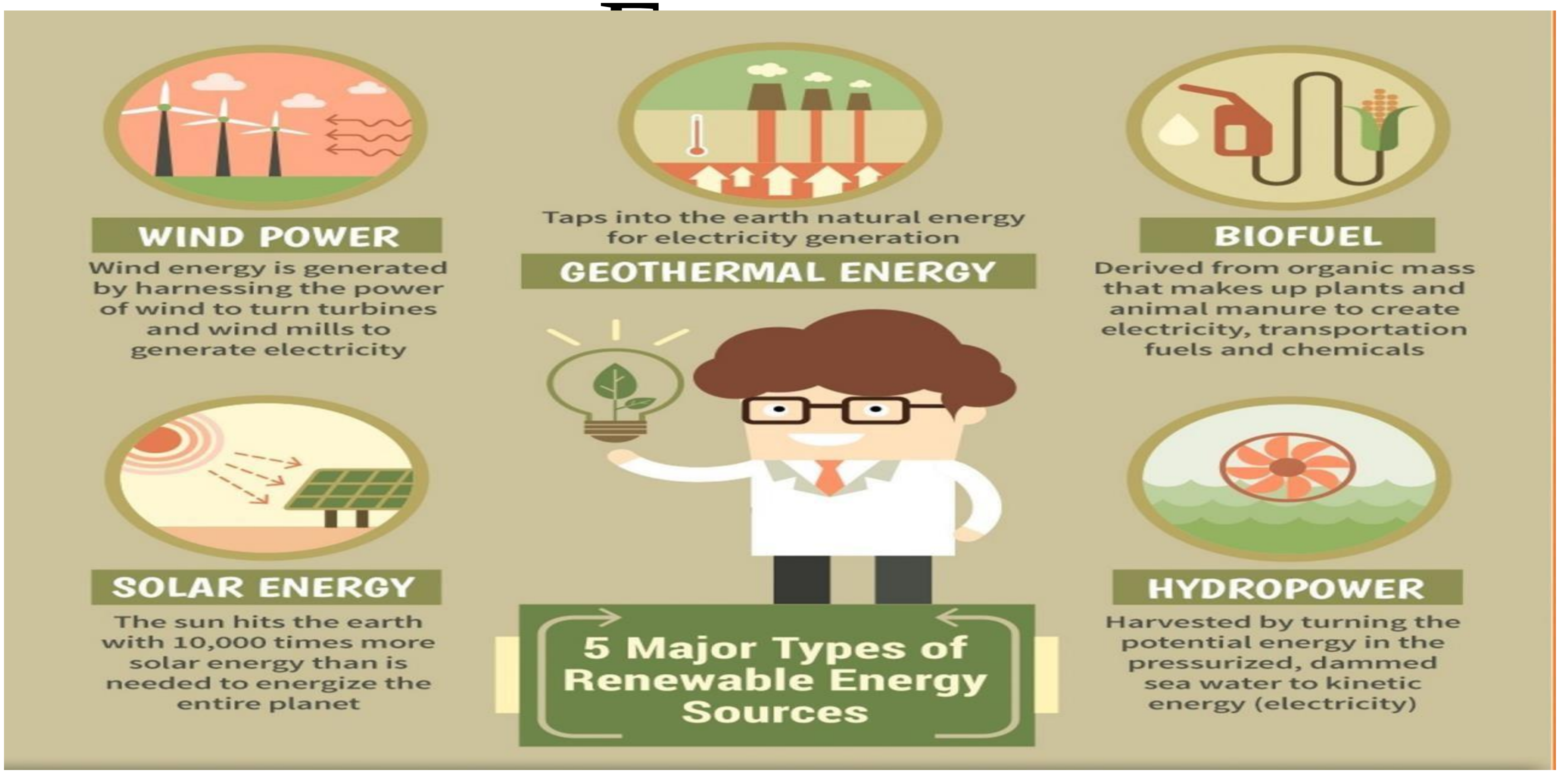


Possible Solutions of Energy Crisis

Energy

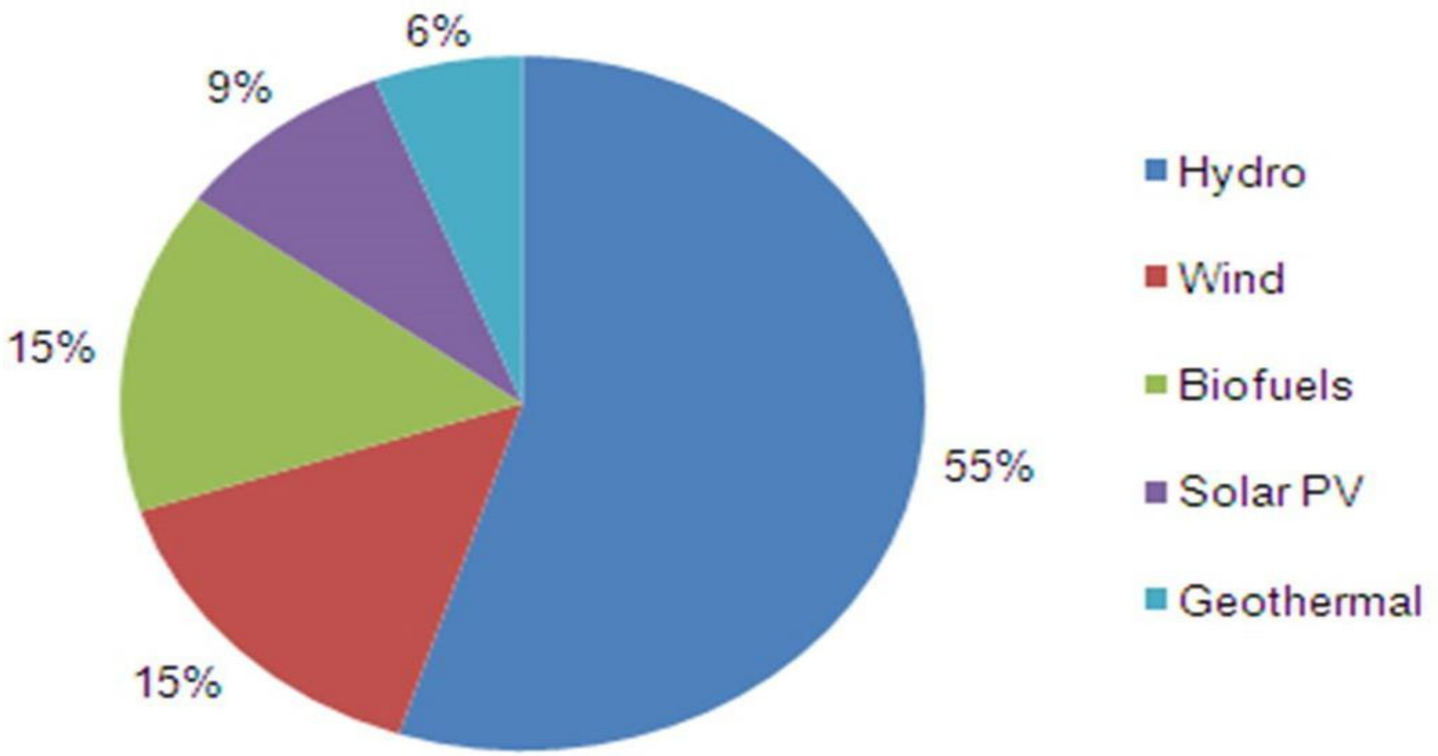
Renewable Energy Vs. Non-renewable Energy

Renewable E



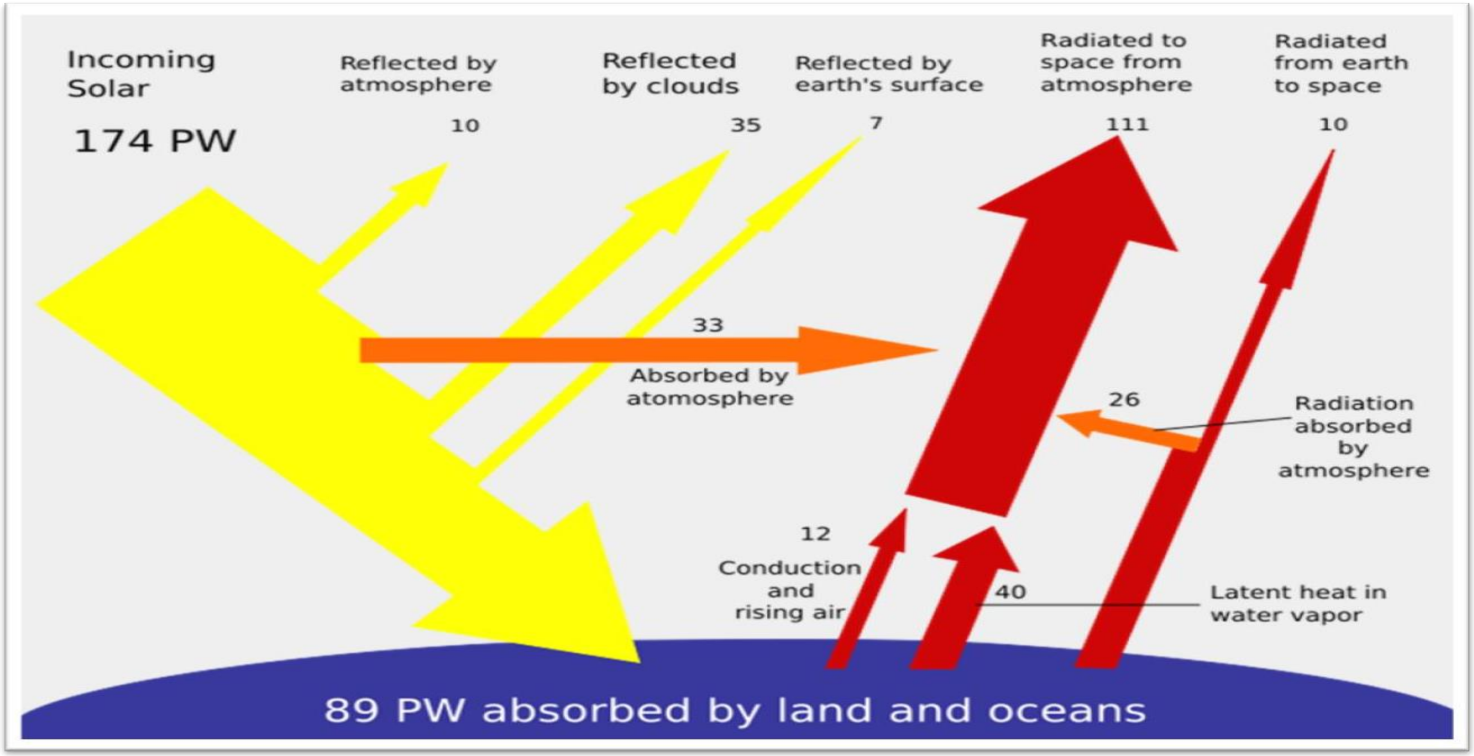
Renewable Energy Sources

Renewable Energy

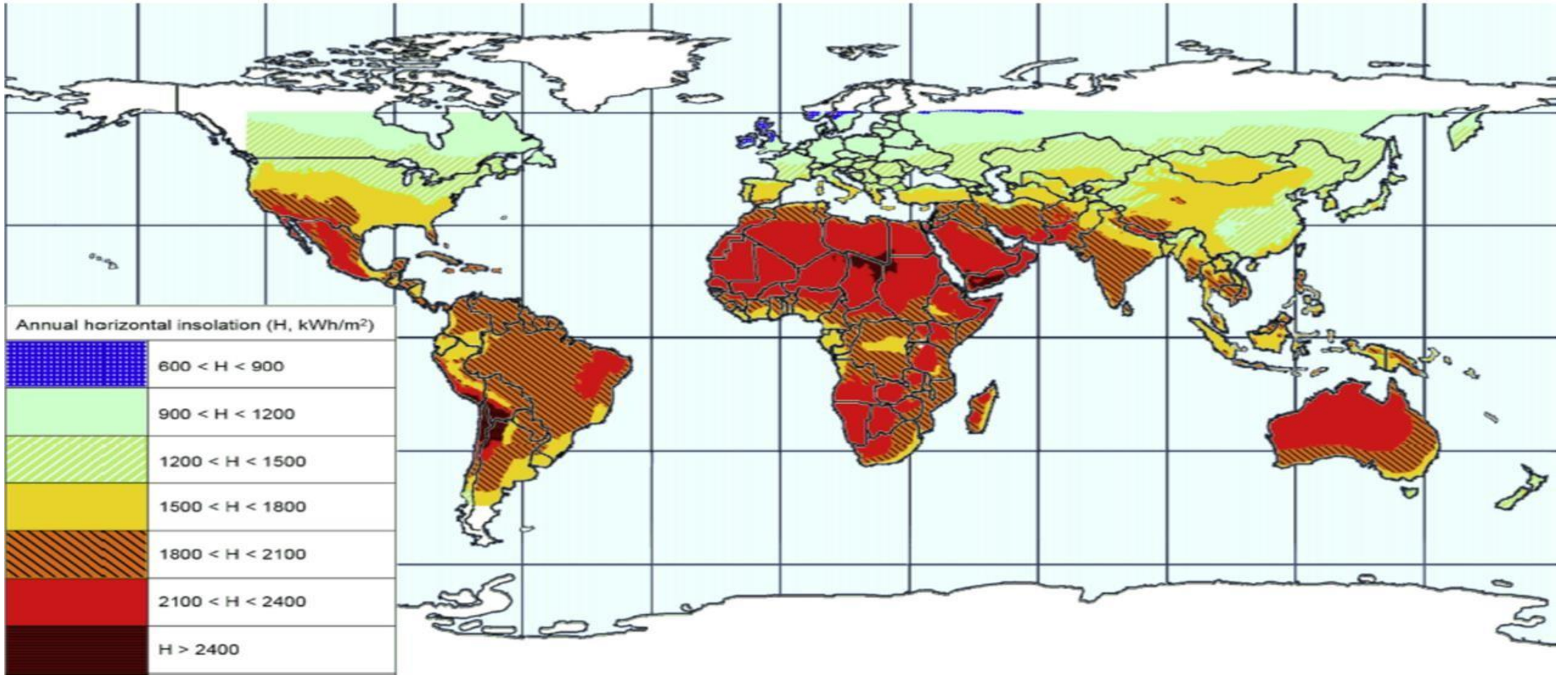


Globle Renewable Energy Share

Solar Energy & Application



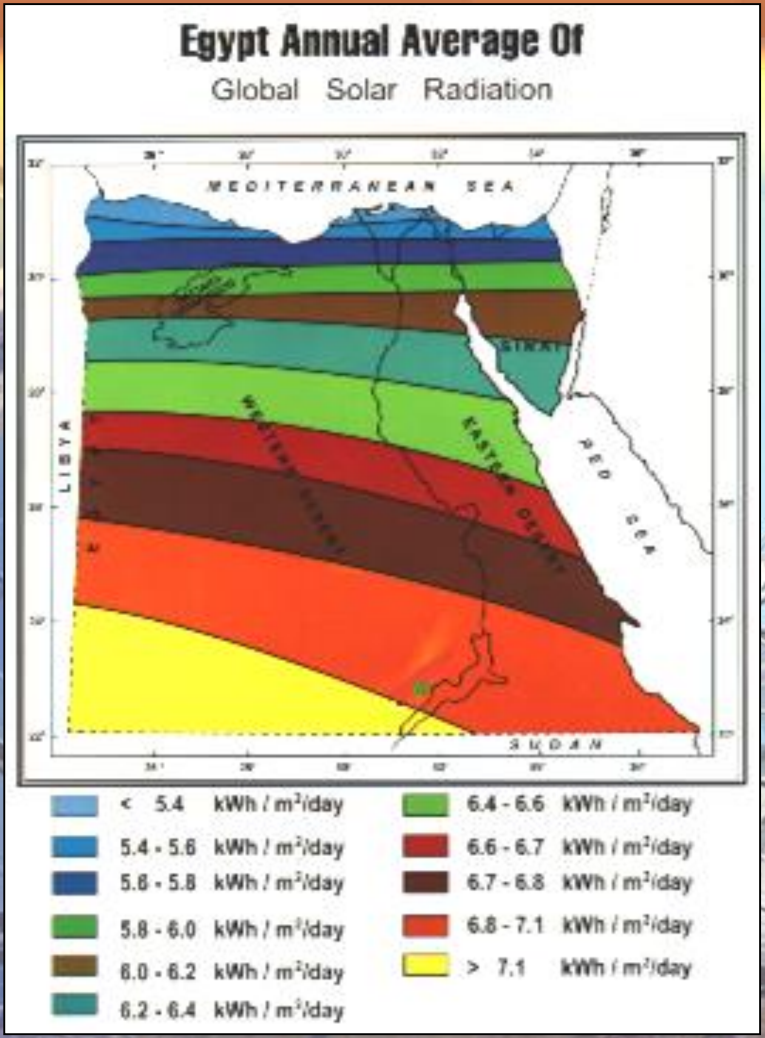
Solar Energy & Application



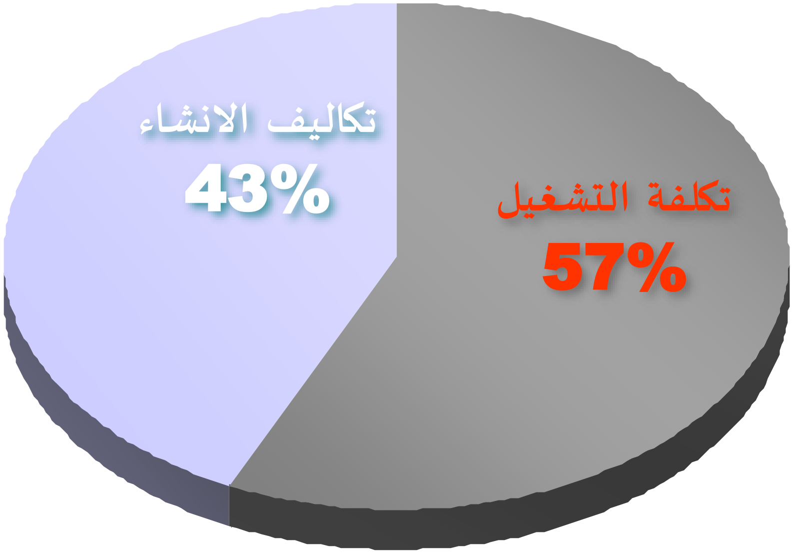
Annual cumulative global horizontal plane solar insolation

الأطلس الشمسى

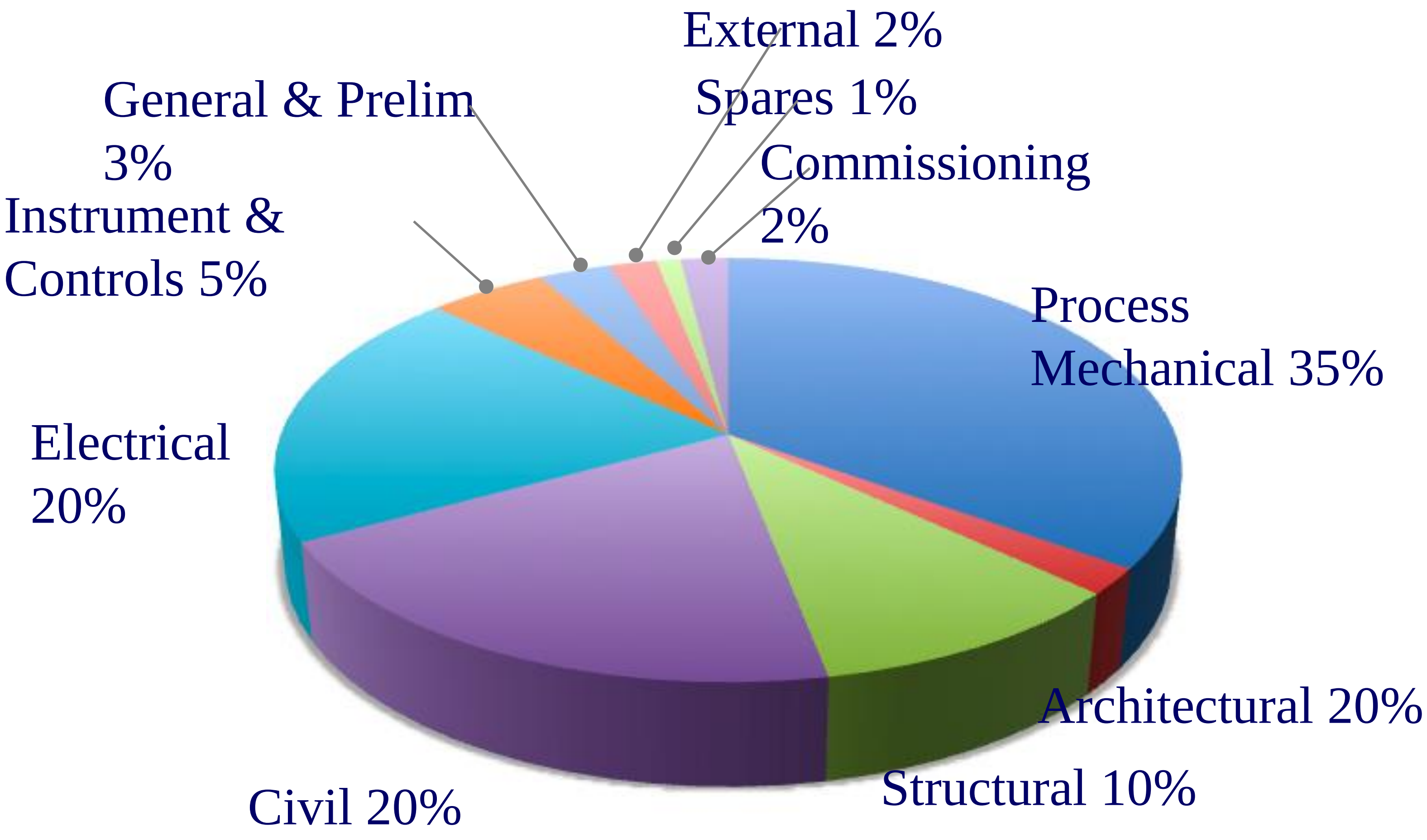
- تم اصدار اطلس شمسى شاملا تسجيلات على مدى سنوات لجميع مناطق الجمهورية ، متضمنا أيضا عام نمطي يتم فيه تمثيل البيانات المتوقعة لكل أيام العام مثل الاشعاع الشمسي وساعات سطوع الشمس.
- يتراوح متوسط الاشعاع الشمسي الكلي بين 1900 – 2600 ك.و.س/م2/السنة.
- كثافة الاشعاع الشمسي المباشر بين 2000 – 3200 ك.و.س/م2/السنة.
- يتراوح معدل سطوع الشمس بين 9 – 11 ساعة/يوم.



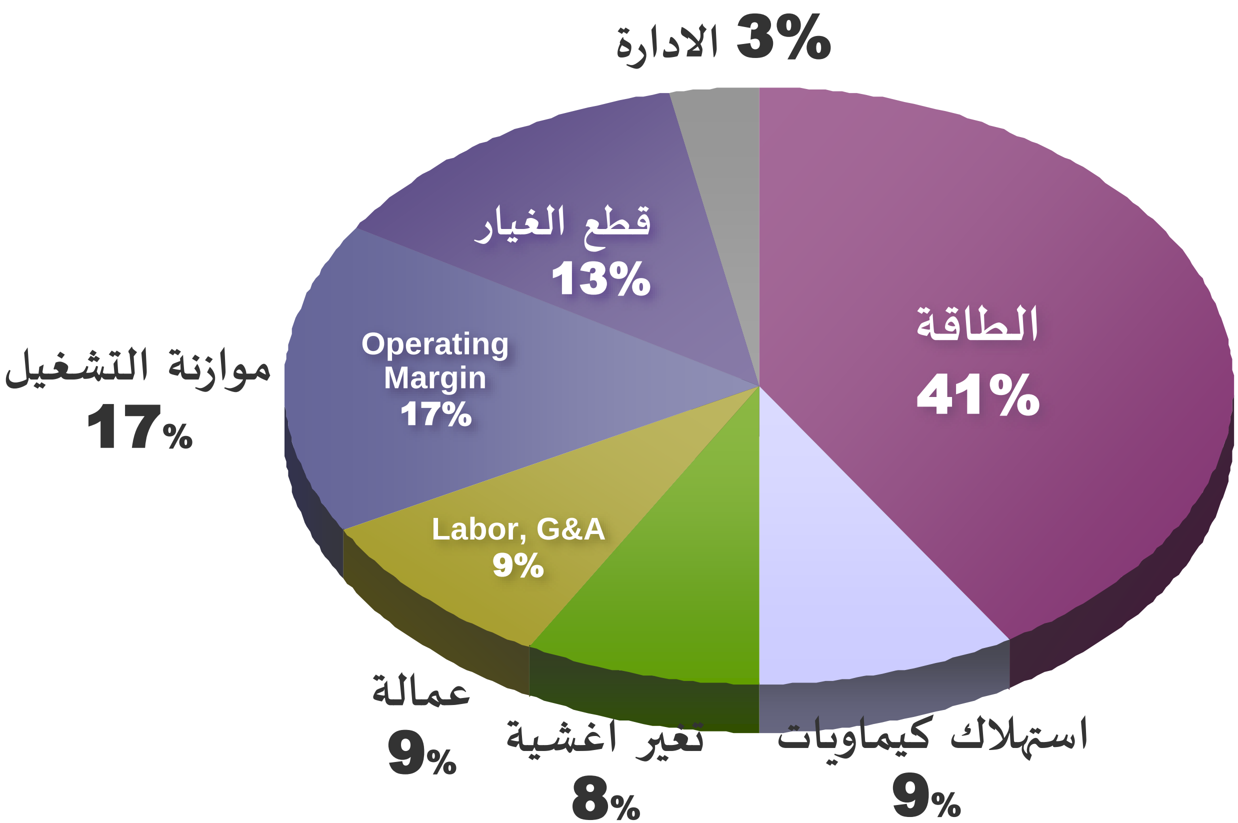
تكاليف إنشاء وتشغيل محطات التحلية بنظام التناضح العكسى


تكاليف الانشاء
43%
تكلفة التشغيل
57%

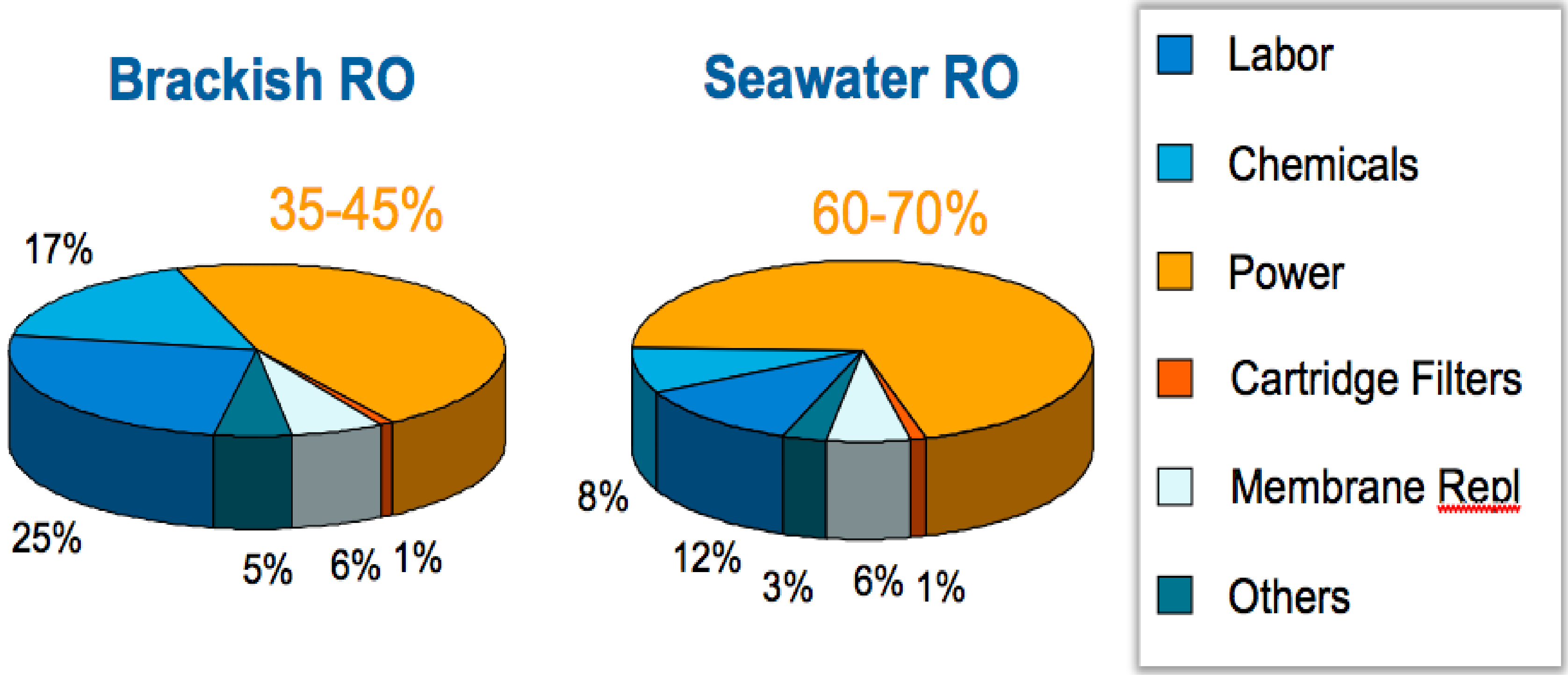
توزيع تكاليف إنشاء محطات التحلية



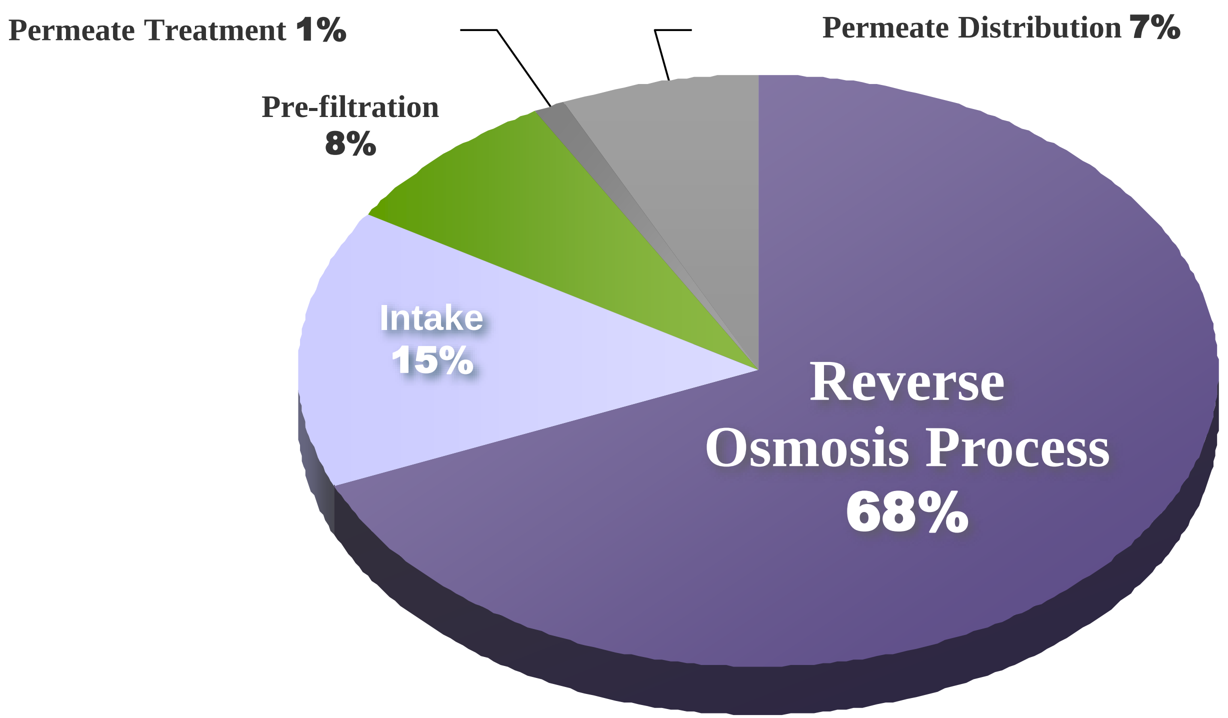
توزيع تكاليف التشغيل لمحطة تحلية المياه



توزيع تكاليف تشغيل محطات التحلية



توزيع إستهلاك الطاقة للمراحل المختلفة بمحطات التحلية



RO power consumption is approximately 20% (up to 45%) of total SWRO cost

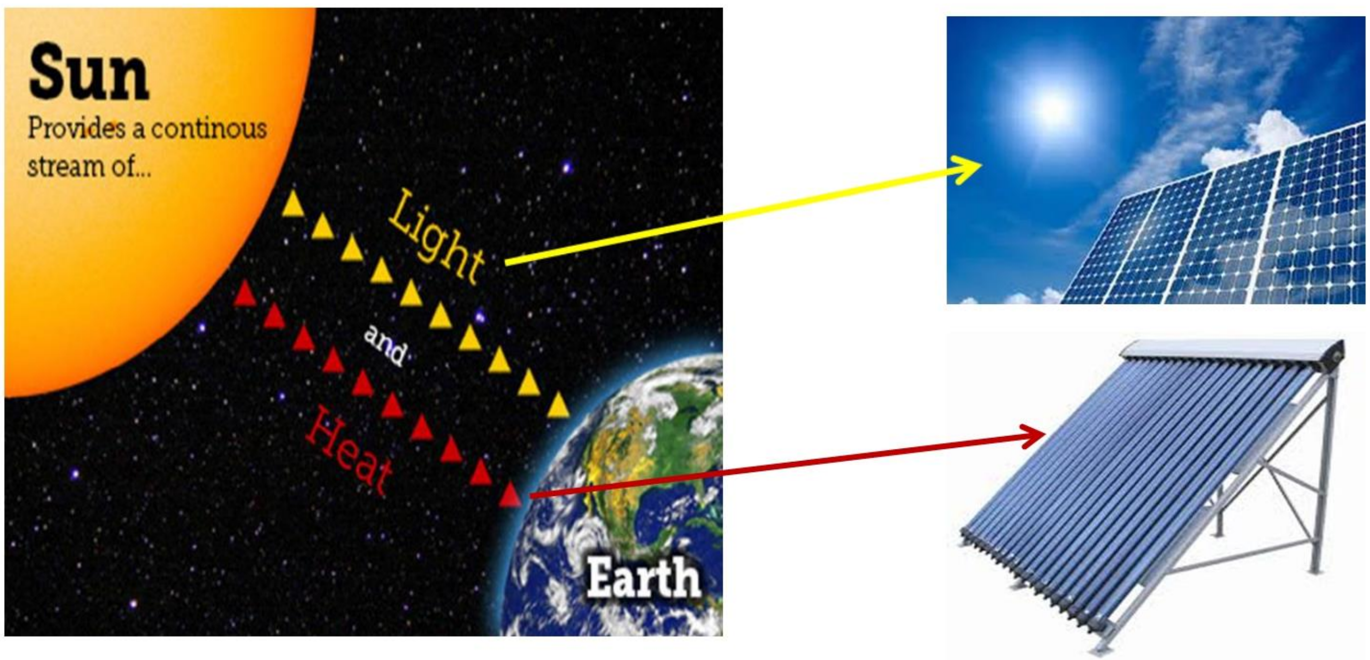
الأساليب الحديثة لتقليل تكاليف التشغيل بمحطات تحلية المياه

الإتجاه الأمثل لتقليل تكاليف الإنشاء والتشغيل

- الإهتمام بالبحوث والتطوير
- الإهتمام بالتدريب وتأهيل العاملين بمجال تحلية المياه
- تحسين الأداء بالمراحل المختلفة لمحطات التحلية
  - المعالجة الأولية
  - طلمبات الضغط العالى
  - موفرات الطاقة
  - الأغشية

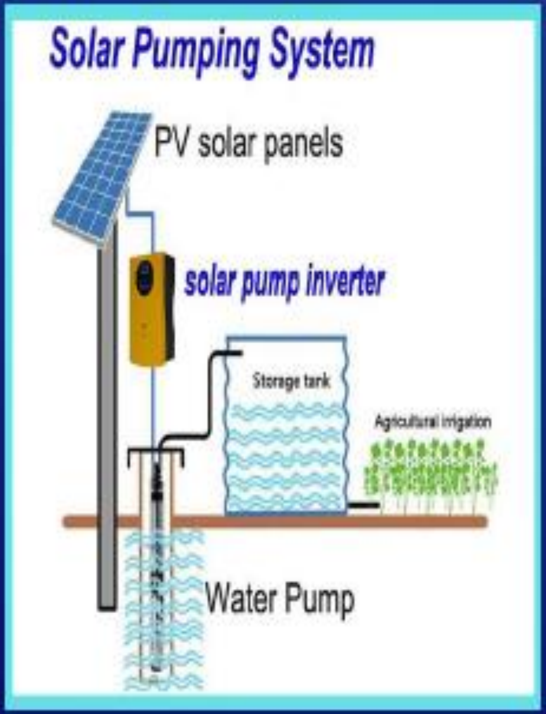
Solar Energy & Application

- Solar energy is radiant light and heat from the sun that is harnessed using a range of ever-evolving technologies.



SOLAR ENERGY

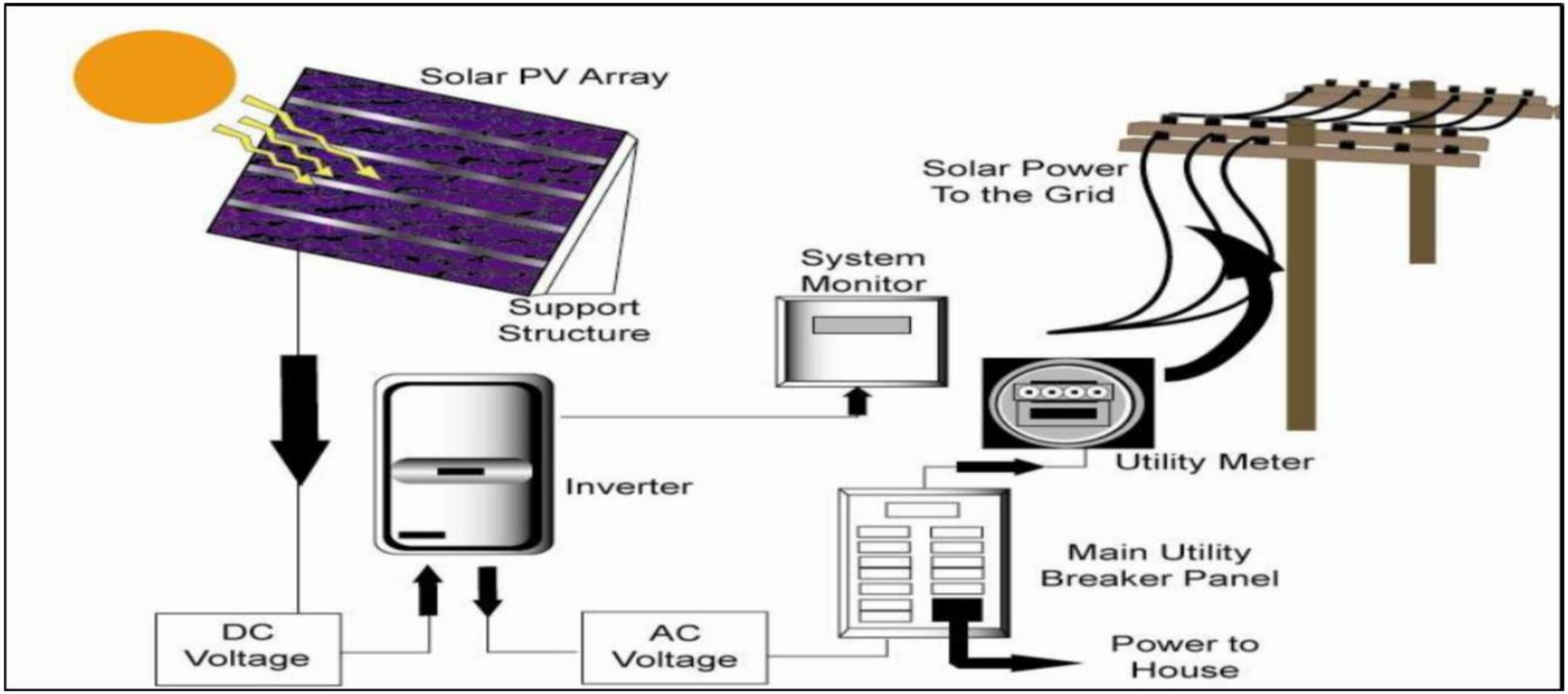
Types of solar systems



OFF Grid System

ON Grid System

Solar Photovoltaic Systems



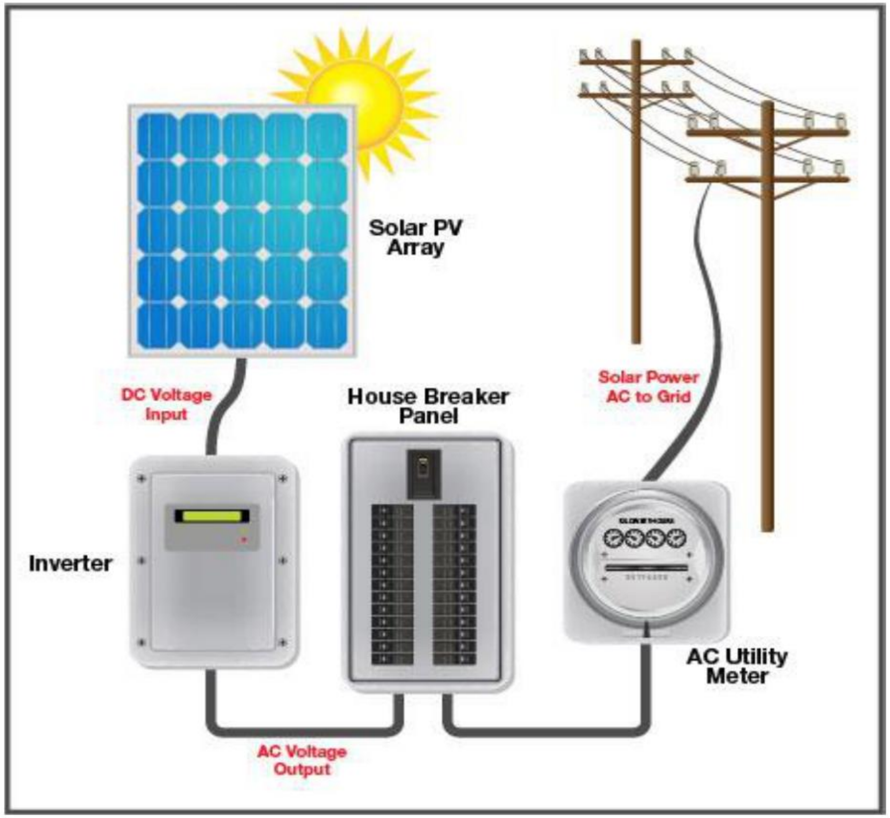
Grid-Tied PV System (ON-GRID)

Different Types of Inverter

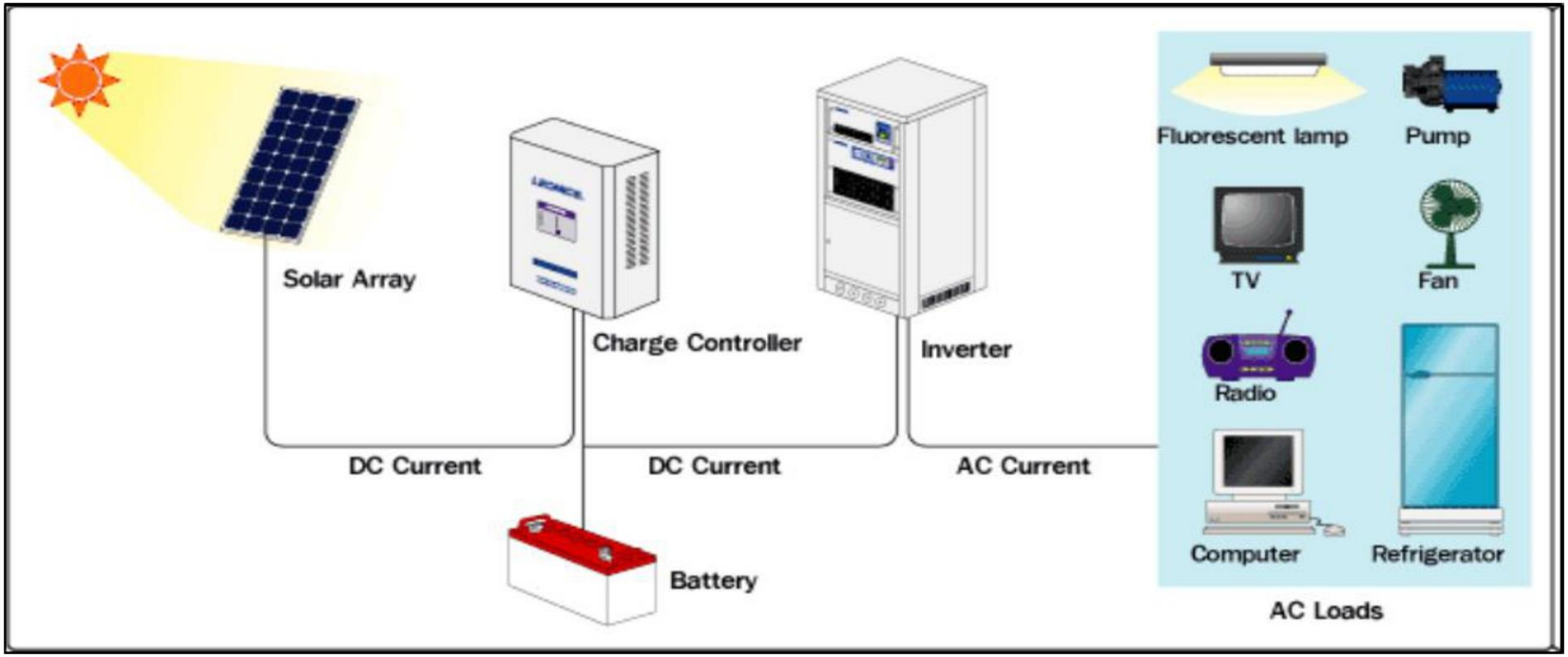
- **2. Grid Tie Inverter:**

A grid-tie inverter has a different function than the off-grid inverter. It not only converts DC current into an alternating current suitable for injecting into an electrical power grid.

To inject electrical power efficiently and safely into the grid, grid-tie inverters must accurately match the voltage sampling and synchronization and phase of the grid sine wave AC waveform.



Solar Photovoltaic Systems

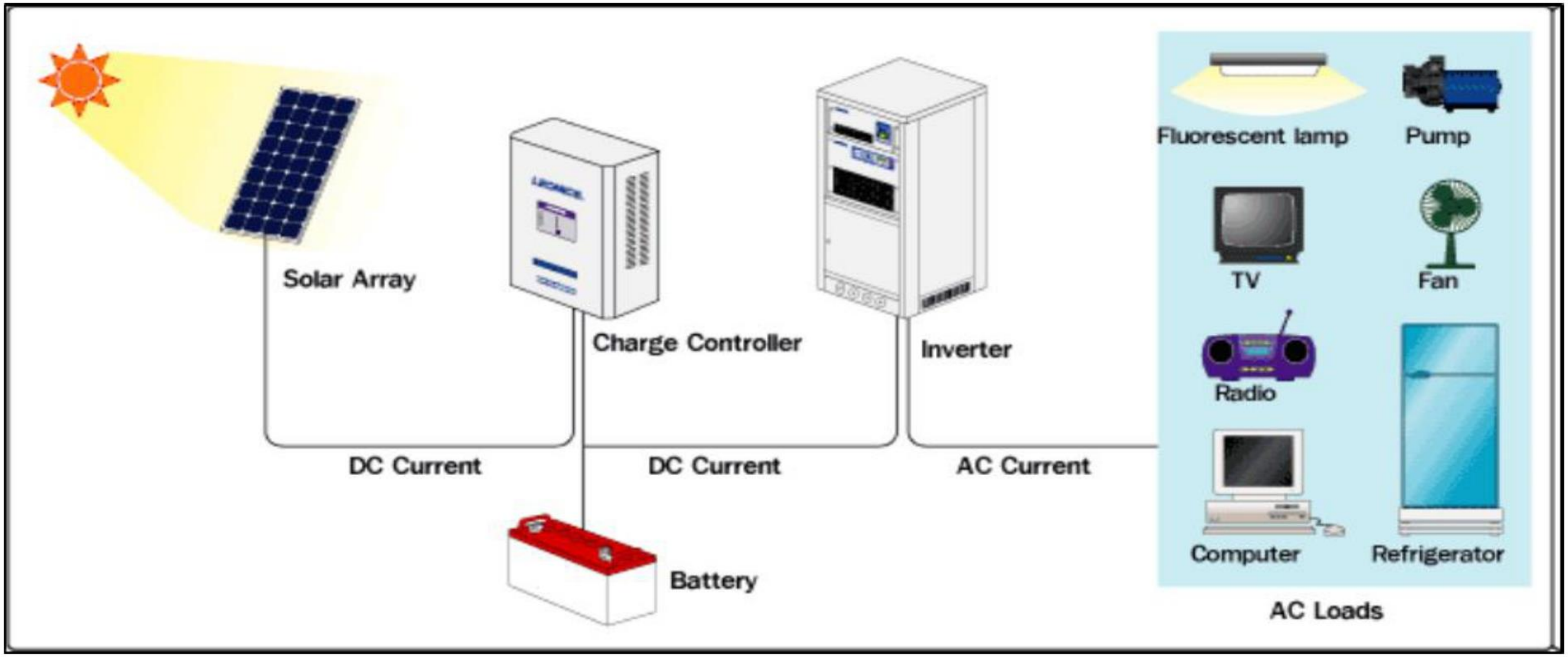


Stand Alone PV System (OFF-Grid)

Street lighting system

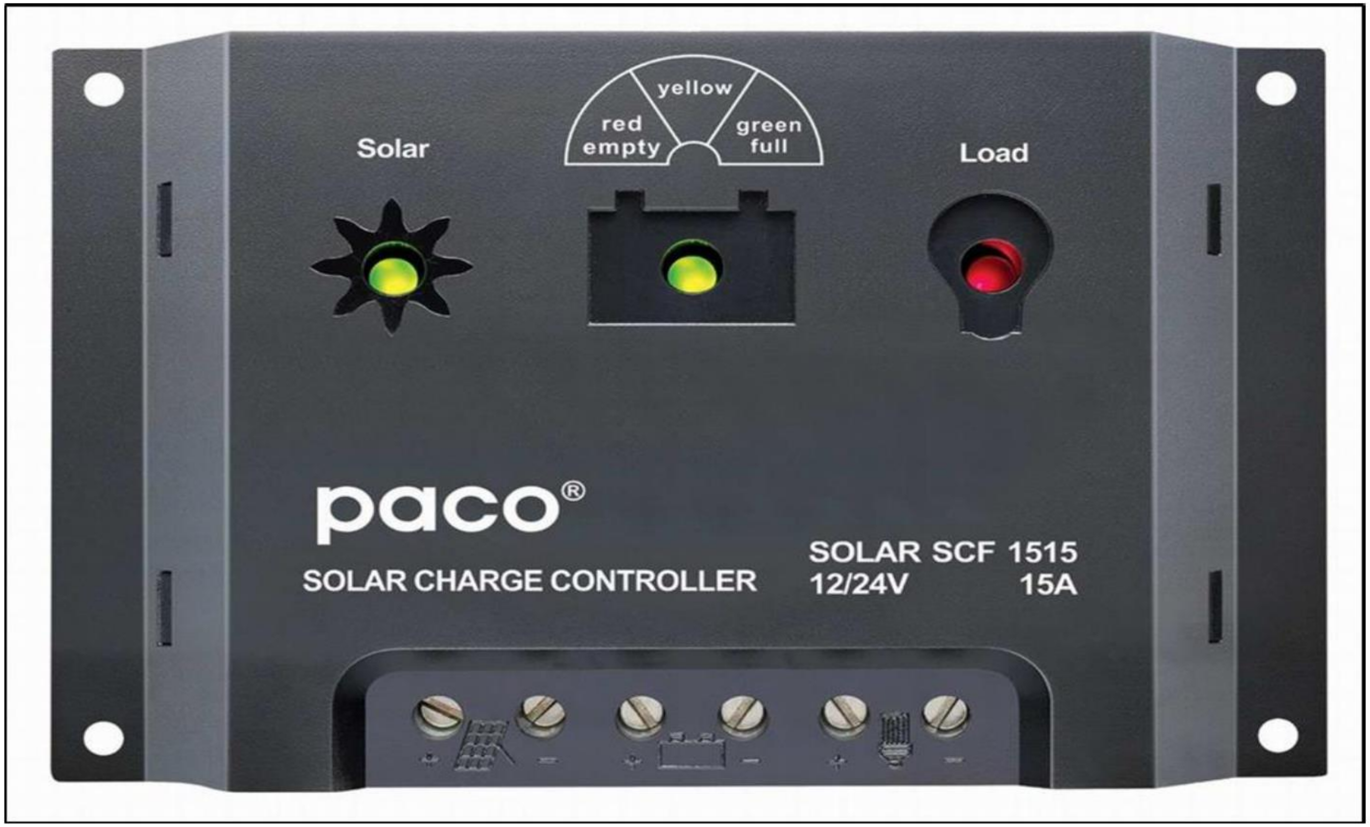
Hybrid solar system

Solar Photovoltaic Systems



Stand Alone PV System (OFF-Grid)

Charge Controller Types



Charge Controller Types

Charge Controller Types

Inverter

- The Solar Inverter is an essential device in any solar power system. Its basic function of the inverter is to change the variable Direct Current output of the solar panels into Alternating Current.

- The converted Alternating Current power is used for running your appliances like the TV, Refrigerator, Microwave, etc.

Off-Grid Inverter

Off-Grid Inverter

Batteries

- A battery is a device that is able to store electrical energy in the form of chemical energy, and convert that energy into electricity.

- **Advantages:**

- Backup for night and cloudy days.

- **Disadvantages:**

- Decreases the efficiency of PV system.
- Only 80% of energy stored retainable.
- Adds to the expense of the system.
- Finite Lifetime ~ 5 – 10 years.
- Added floor space, maintenance and safety concerns.

الطــاقة الشمسية

تطبيقات الطــاقة الشمســية
سخانات المياه الشمسية

التطبيقات (≤ 80°م):-

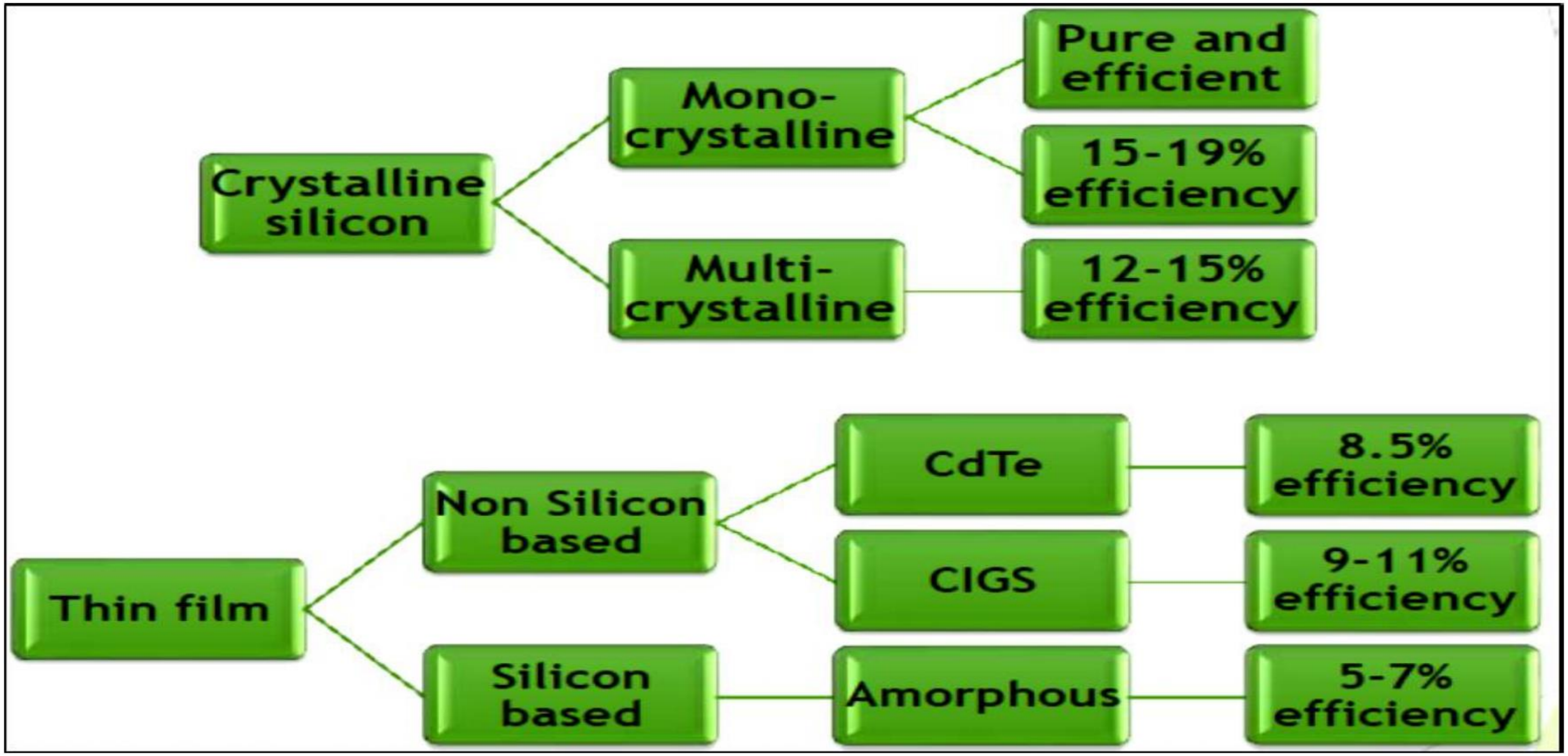
-المنازل

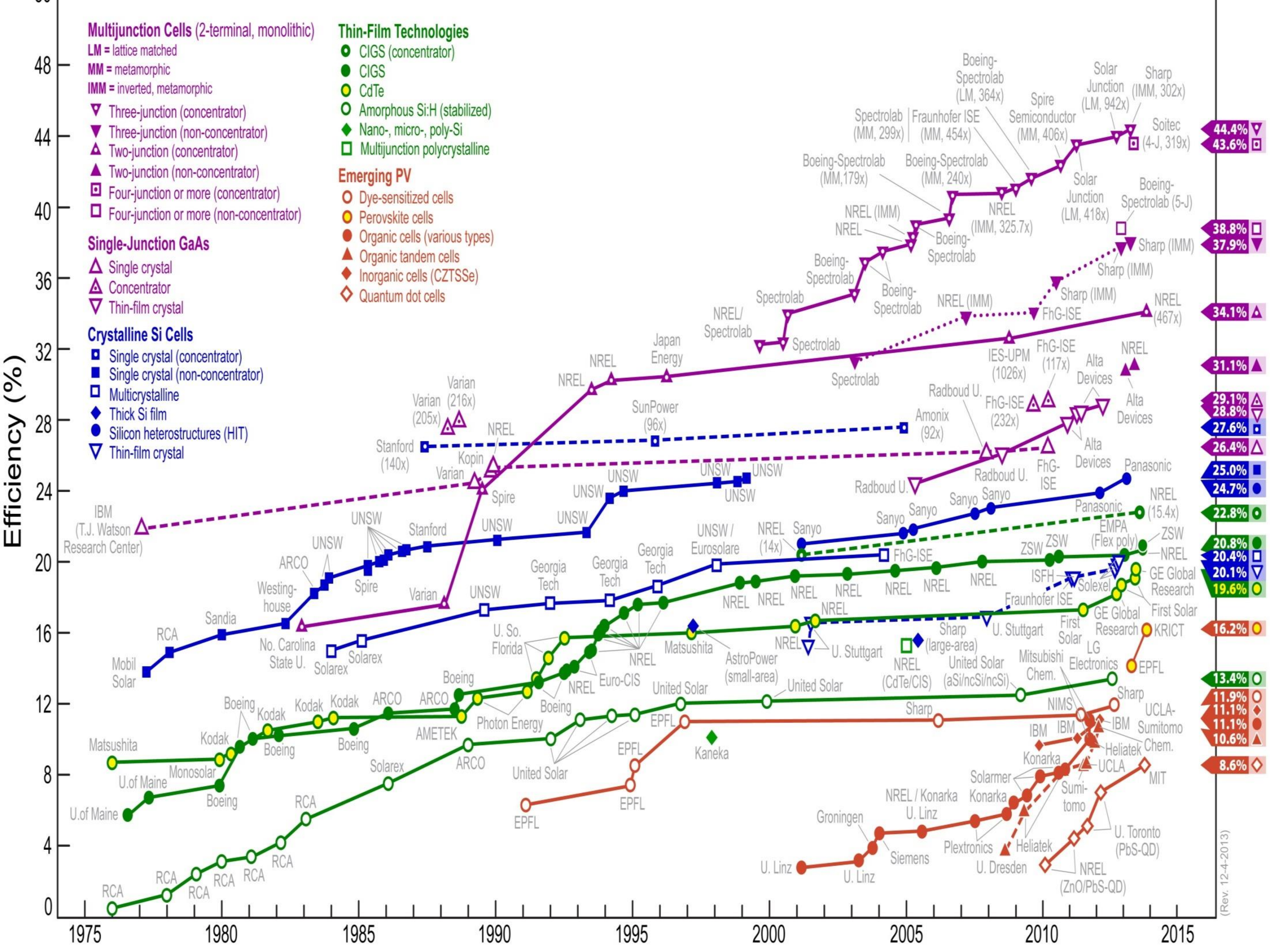
-الفنادق

-بعض المصانع


PHOTOVOLTAIC CABLE INSTALLATION GUIDE
General Cable
INSTALLATION TYPE
1
2
2
3
4
4
5
6
7

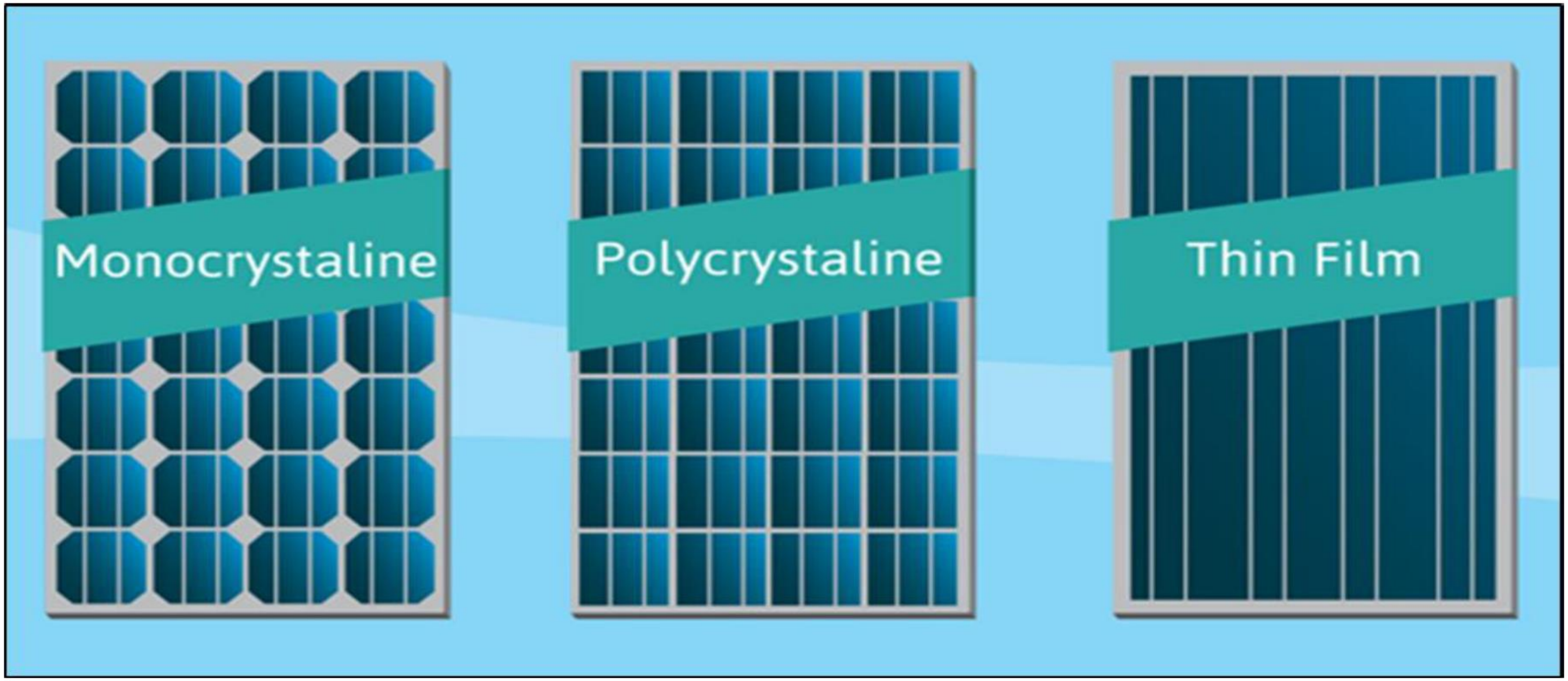
Solar Cells Different Types



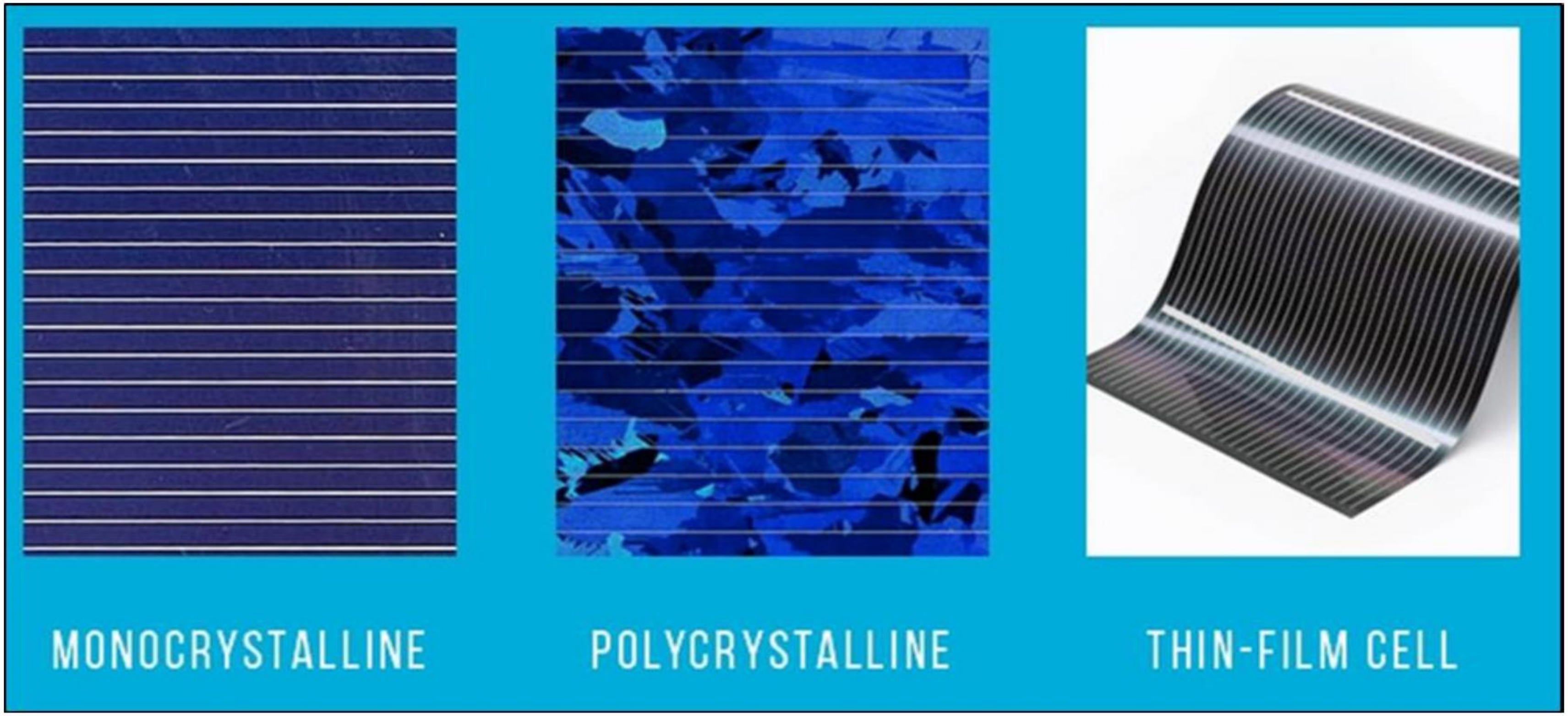


Multijunction Cells (2-terminal, monolithic)
LM = lattice matched
MM = metamorphic
IMM = inverted, metamorphic
Three-junction (concentrator)
Three-junction (non-concentrator)
Two-junction (concentrator)
Two-junction (non-concentrator)
Four-junction or more (concentrator)
Four-junction or more (non-concentrator)
Single-Junction GaAs
Single crystal
Concentrator
Thin-film crystal
Crystalline Si Cells
Single crystal (concentrator)
Single crystal (non-concentrator)
Multicrystalline
Thick Si film
Silicon heterostructures (HIT)
Thin-film crystal
Thin-Film Technologies
CIGS (concentrator)
CIGS
CdTe
Amorphous Si:H (stabilized)
Nano-, micro-, poly-Si
Multijunction polycrystalline
Emerging PV
Dye-sensitized cells
Perovskite cells
Organic cells (various types)
Organic tandem cells
Inorganic cells (CZTSSe)
Quantum dot cells
Efficiency (%)
44.4%
43.6%
38.8%
37.9%
34.1%
31.1%
29.1%
28.8%
27.6%
26.4%
25.0%
24.7%
22.8%
20.8%
20.4%
20.1%
19.6%
16.2%
13.4%
11.9%
11.1%
11.1%
10.6%
8.6%
1975
1980
1985
1990
1995
2000
2005
2010
2015
(Rev. 12-4-2013)
Boeing-Spectrolab (LM, 364x)
Spectrolab (MM, 299x)
Fraunhofer ISE (MM, 454x)
Spire Semiconductor (MM, 406x)
Solar Junction (LM, 942x)
Sharp (IMM, 302x)
Soitec (4-J, 319x)
Boeing-Spectrolab (MM,179x)
Boeing-Spectrolab (MM, 240x)
NREL (IMM, 325.7x)
Solar Junction (LM, 418x)
Boeing-Spectrolab (5-J)
Sharp (IMM)
NREL (IMM)
NREL (467x)
FhG-ISE
IES-UPM (1026x)
FhG-ISE (117x)
FhG-ISE (232x)
Alta Devices
Radboud U.
Amonix (92x)
SunPower (96x)
Stanford (140x)
Varian (205x)
Varian (216x)
Japan Energy
IBM (T.J. Watson Research Center)
Panasonic
NREL (15.4x)
EMPA (Flex poly)
ZSW
GE Global Research
First Solar
KRICT
EPFL
Mobil Solar
Westinghouse
No. Carolina State U.
UNSW / Eurosolare
Georgia Tech
Matsushita
AstroPower (small-area)
NREL (CdTe/CIS)
Sharp (large-area)
U. Stuttgart
Fraunhofer ISE
United Solar (aSi/ncSi/ncSi)
Mitsubishi Chem.
LG Electronics
UCLA-Sumitomo Chem.
Heliatek
Konarka
Solarmer
NREL / Konarka
U. Linz
Groningen
Siemens
Plextronics
U. Dresden
U. Toronto (PbS-QD)
NREL (ZnO/PbS-QD)
MIT
Kaneka
Photon Energy
AMETEK
U. So. Florida
Euro-CIS
Solarex
U.of Maine
Monosolar

Solar Cells Different Types



Solar Cells Different Types



Solar Cells Different Types

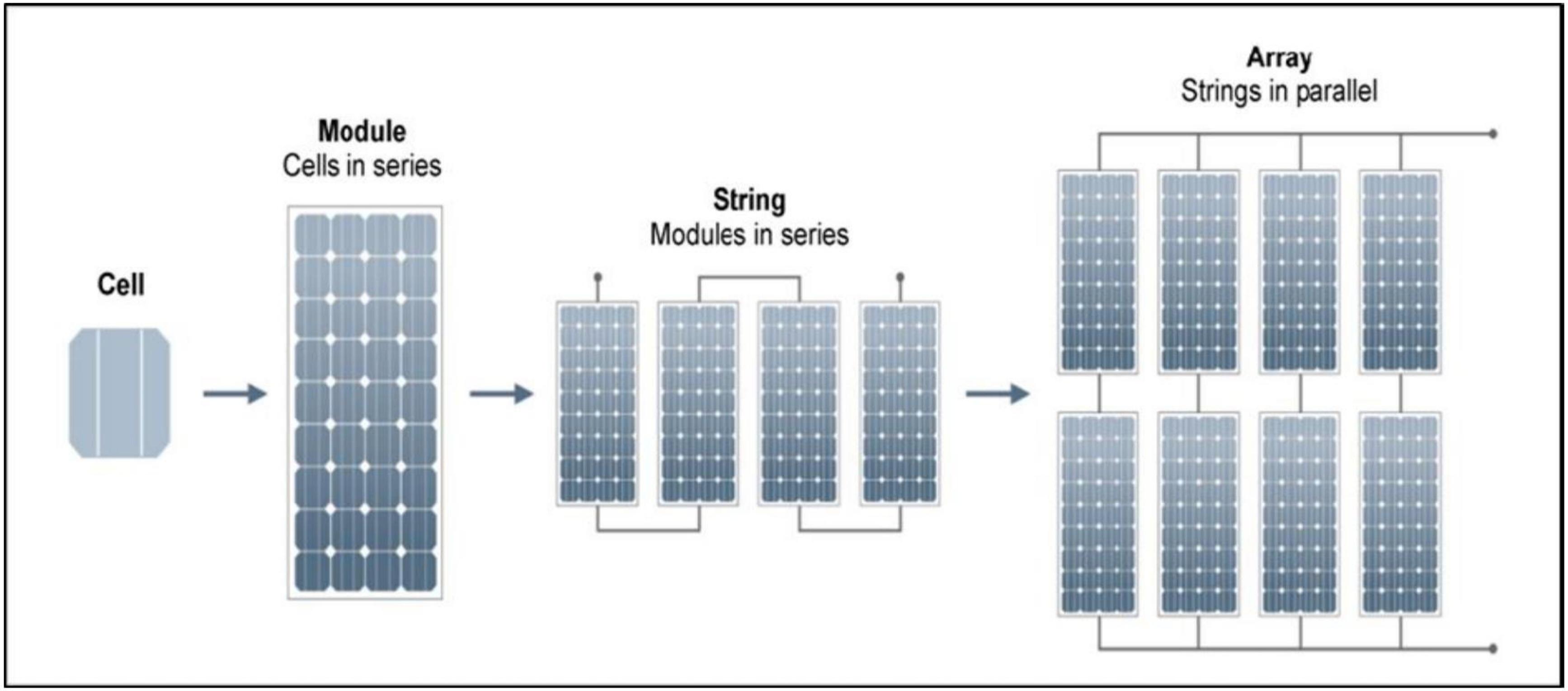
Crystalline	Thin Films
	
Types of Crystalline panels ◆ Single Crystalline (15%) ◆ Multi-Crystalline (14%) (% of sunlight converted to electricity)	**Types of Thin Film panels** ◆ Amorphous Silicon (5-7%) ◆ Copper Indium Diselenide (10%) ◆ Cadmium Telluride (7%) (% of sunlight converted to electricity)
Positive factors ◆ Efficient ◆ Requires less space ◆ Long track record	**Positive factors** ◆ Less expensive ◆ Very versatile ◆ More shade tolerant ◆ Less temperature sensitive
Negative factors ◆ Costly ◆ Limited applications ◆ Shade intolerant ◆ Temperature sensitive	**Negative factors** ◆ Shorter track record ◆ Lower efficiency ◆ Requires more space

Solar Cells Different Types

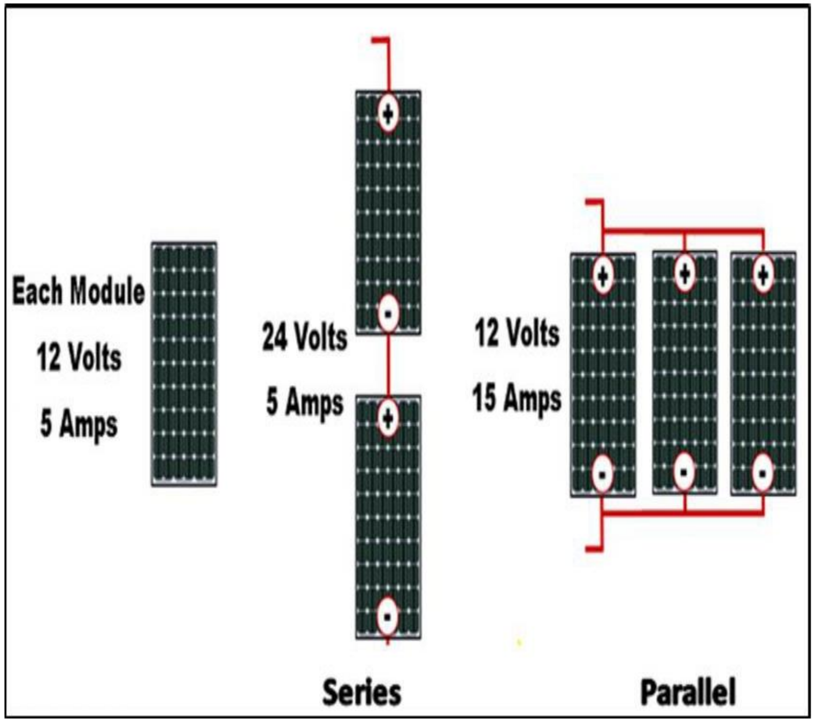
PV Panel Technology Summary

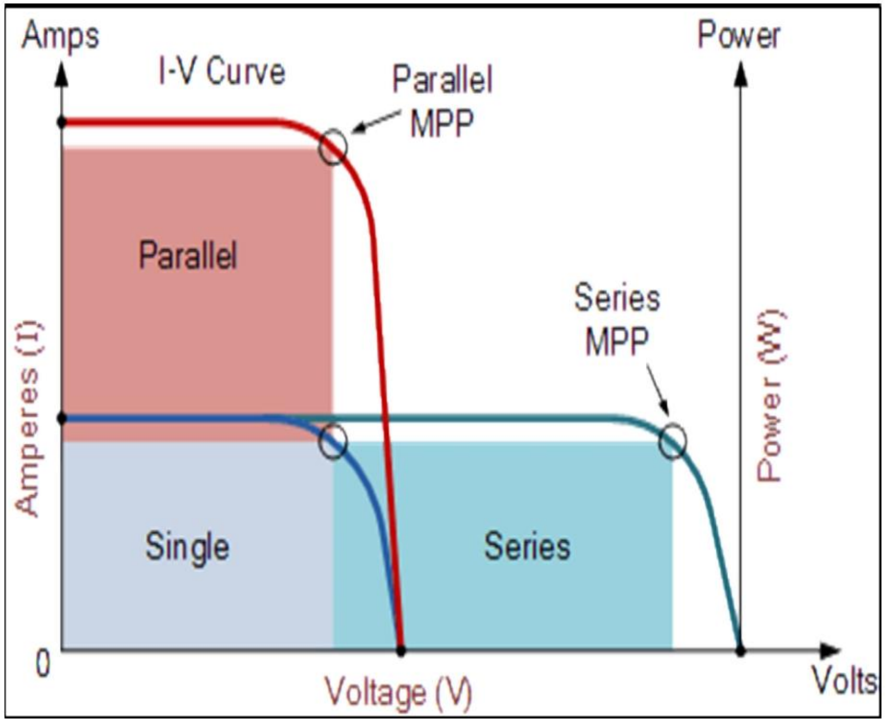
Technology	Description	Module Efficiency (Commercial)	Cell Efficiency (Laboratory)	Sample Companies Employing Technologies
Crystalline Silicon	The orignal approach; grow silicon crystal structures in a variety of ways. Represents almost 90% of total market. Appearance dark blue to black but other colors possible with changes to anti-reflective coatings.			
Single Crystal	Grown in Cylinders and wire- or laser-sliced into circular wafers as thin as 200 microns. Cells are circular and modules are inherently flat black or charcoal.	14 - 15%	25%	BP Solar GE/AstroPower Sanyo Sharp SunWorld
Multi-Crystalline	Cast in blocks or drawn through a die to create a "ribbon" and wire-sliced or cut into rectangular wafers. Cells are typically vibrant blue.	12 - 14%	19%	BP Solar Evergreen Solar Kyocera Solar Schott Solar Sharp SunWorld
Thin-Film Materials	Near single-atom vapor or electro-deposition on low-cost materials (glass, stainless steel, or plastic). Modules can be flexible. Appearance dark charcoal to near black; can also be semi-transparent.			
Amorphous Silicon (a-Si)	Cell and module production part of same process. Widely used in consumer products and on flexible substrates.	5 - 7%	13%	BP Solar Kaneka Solar TerraSolar United Solar Ovonic
Copper Indium Diselenide (CIS)	Alternative semiconductor material under commercialization.	8 - 10%	19%	Global Solar Shell Solar
Cadmium Telluride (CdTe)	Alternative semiconductor material under commercialization.	7 - 9%	17%	BP Solar First Solar

Solar Cells Connections



Solar Cells Connections





Characteristics of Solar Photovoltaic Cells

Standard Test Conditions (STC) against Nominal Operating Cell Temperature (NOCT):

Standard Test Conditions are the laboratory conditions under which all PV modules are tested. STC means:

1- An irradiance of 1000 watts per square meter (W/m2), which simulates peak sunshine on a surface.

2- Temperature of the cell 25°C.

However, these are idealized conditions which don't reflect the real site conditions under which a PV module will operate.

Characteristics of Solar Photovoltaic Cells

Standard Test Conditions (STC) against Nominal Operating Cell Temperature (NOCT):

The conditions at Nominal Operating Cell Temperature aim to simulate reality more closely:

1- The irradiance is 800 watts per square meter (W/m2), which takes into account the fact that PV modules don't always face the sun.

2- Solar panels heat up considerably during operation, so the temperature considered is 45 (+/- 3) °C.

3-Temperature of ambient air of 20°C is considered.

This means that solar panels will always have higher ratings at STC compared with NOTC.

Characteristics of Solar Photovoltaic Cells

MECHANICAL DATA	
Solar cells	Multicrystalline 156 × 156 mm (6 inches)
Cell orientation	60 cells (6 × 10)
Module dimensions	1650 × 992 × 35 mm(65.0 x 39.1 x 1.4 inches)
Weight	18.6 kg (41 lb)
Glass	3.2 mm(0.13 inches),High Transmission, AR Coated Tempered Glass
Backsheet	White(PD05.08); Black(PD05.05)
Frame	Black Anodized Aluminium Alloy
J-Box	IP 65 or IP 67 rated
Cables	Photovoltaic Technology cable 4.0mm^2 (0.006 inches^2), 1000mm(39.4inches)
Connector	UTX Amphenol
Fire Type	Type 1 or 2

Characteristics of Solar Photovoltaic Cells

ELECTRICAL DATA (STC)

Peak Power Watts-P_{MAX} (Wp)	250	255	260	265
Power Output Tolerance-P_{MAX} (W)	0 ~ +5			
Maximum Power Voltage-V_{MPP} (V)	30.3	30.5	30.6	30.8
Maximum Power Current-I_{MPP} (A)	8.27	8.37	8.50	8.61
Open Circuit Voltage-V_{OC} (V)	38.0	38.1	38.2	38.3
Short Circuit Current-I_{SC} (A)	8.79	8.88	9.00	9.10
Module Efficiency η_m (%)	15.3	15.6	15.9	16.2

STC: Irradiance 1000 W/m², Cell Temperature 25°C, Air Mass AM1.5.

Characteristics of Solar Photovoltaic Cells

ELECTRICAL DATA (NOCT)

Maximum Power-P_{MAX} (Wp)	186	189	193	197
Maximum Power Voltage-V_{MPP} (V)	28.1	28.2	28.4	28.6
Maximum Power Current-I_{MPP} (A)	6.63	6.71	6.81	6.89
Open Circuit Voltage-V_{OC} (V)	35.3	35.3	35.4	35.5
Short Circuit Current-I_{SC} (A)	7.10	7.17	7.27	7.35

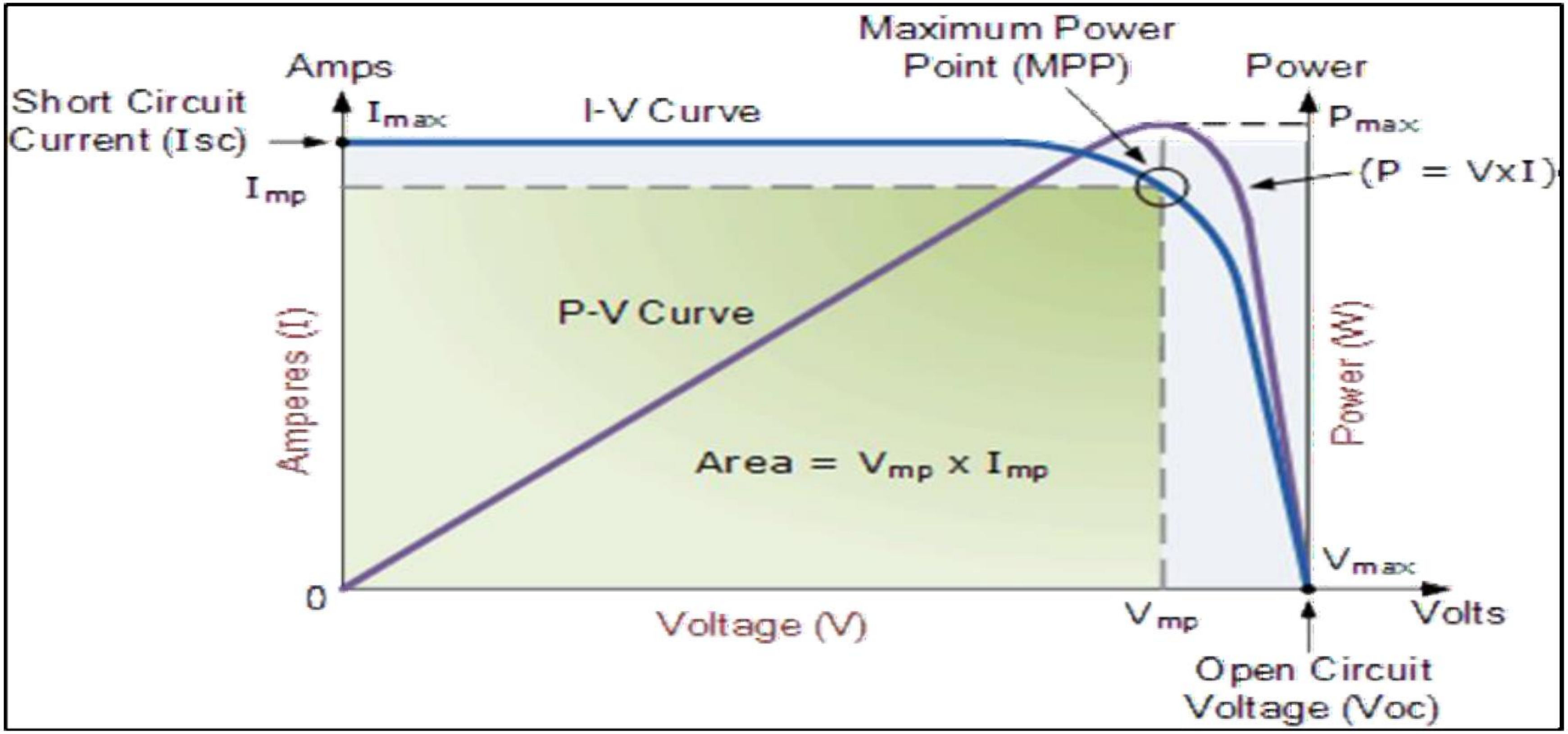
NOCT: Irradiance at 800 W/m², Ambient Temperature 20°C, Wind Speed 1 m/s.

Characteristics of Solar Photovoltaic Cells

TEMPERATURE RATINGS	
Nominal Operating Cell Temperature (NOCT)	44°C (±2°C)
Temperature Coefficient of P_{MAX}	- 0.41%/°C
Temperature Coefficient of V_{OC}	- 0.32%/°C
Temperature Coefficient of I_{SC}	0.05%/°C

MAXIMUM RATINGS	
Operational Temperature	-40~+85°C
Maximum System Voltage	1000V DC(IEC) 1000V DC (UL)
Max Series Fuse Rating	15A

Solar Cell I-V Characteristic Curves



Design example – PV array

Panel specifications(example)	
Power output (Wp)	100
V_{MPP} (V)	16
I_{MPP} (A)	6.25
V_{OC} (V)	20
I_{SC} (A)	7

?

Design example – 4 PV array

$$Minimum\,W_p = \frac{644.5Wh}{4.5h/day} = 143.2W$$

$$Number\ of\ panels = \frac{143.2W}{100W_p} = 1.4 \approx 2\,panels$$

Design example – 4 PV configuration

Parallel

$$Maximum\ current\ I_{max} = 7A \times 2 = 14A$$

Series

$$Maximum\ voltage\ V_{max} = 20V \times 2 = 40V$$

Open circuit voltage

Design example – 5 Inverter

Power from one panel

$$\text{Minimum Nominal Power Rating} = 2 \times 100W = 200W$$

Number of panels

Design example – 5 Inverter

$$\text{Minimum Nominal Power Rating} = 2 \times 100W = 200W$$

Inverter specifications(example)	
Rated power (W)	300
Maximum DC voltage (V)	50
Maximum DC current (A)	8
MPPT	Yes

$> V_{Max}$

$< I_{Max}$

Panels in Series

Wiring Sizing

- **Wiring System:**

Solar cables and wires are seen as the arteries and veins of any solar PV system. Mostly, the electricity generated by PV solar panels is used at another place. Solar cables and wires are required to transport this electricity.

Wire size selection based on two criteria:

- ✓ Ampacity
- ✓ Voltage drop

Wiring Sizing

- **Ampacity: current carrying ability of a wire without degrading**

  The larger the wire, the greater its capacity to carry current

  Wire size given in terms of American Wire Gauge (AWG)

  The higher the gauge number, the smaller the wire

- **Voltage drop: the loss of voltage due to a wire's resistance and length**

  Function of wire gauge, length of wire, and current flow in the wire.

Wiring Sizing

- **Must comply with National Electrical Code NEC**
- **Ampacity:**
  - ✓ NEC Table 310.15(B)(16)
  - ✓ Isc X 1.25 (over irradiance) X 1.25 (3 hours continuous use)
- **Physical Size:**
  - ✓ Will it fit in the breaker
  - ✓ Conduit fill consideration
- **Temperature:**
  - ✓ NEC Table 310.15(B)(2)(b)
  - ✓ Within acceptable operating temperatures of terminals to which it's connected
- **Voltage Drop:**
  - ✓ Long distance runs requires larger cable to reduce losing voltage.

Wiring Types

- **Wire Types Used in PV**
- **USE-2:**
  - ✓ UV (sunlight) resistant; used in wet or dry location.
  - ✓ Can not be used in conduit UNLESS also marked RHW-2 and/or XHHW-2.
  - ✓ Typically used from modules to combiner box in grounded systems.
- **PV Wire:**
  - ✓ Similar to USE-2, but with thicker insulation; available up to 2KV.
  - ✓ Required for ungrounded systems.
- **THWN-2 or XHHW-2:**
  - ✓ Used in wet or dry locations; Not sunlight resistant, must be in conduit.
  - ✓ Typically used from combiner box to DC load center or disconnect.
- **THW:**
  - ✓ Dry location only.
  - ✓ Typically used for battery cables.

Maximum Allowable Ampacity

Copper

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C through 90°C (140°F through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

Conductor Size (AWG or KCMIL)	60°C/140°F TW & UF	75°C/167°F RHW, THHW, THW, THWN, XHHW, USE, ZW	90°C/194°F TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, XHH, XHHW, XHHW-2, USE-2 & ZW
18	--	--	14
16	--	--	18
14*	15	20	25
12*	20	25	30
10*	30	35	40
8	40	50	55
6	55	65	75
4	70	85	95
3	85	100	115
2	95	115	130
1	110	130	145
1/0	125	150	170
2/0	145	175	195
3/0	165	200	225
4/0	195	230	260
250	215	255	290
300	240	285	320
350	260	310	350
400	280	335	380
500	320	380	430
600	350	420	475
700	385	460	520
750	400	475	535
800	410	490	555
900	435	520	585
1000	455	545	615

American Wire Gauge (AWG)

American Wire Gauge (AWG) to mm^2

AWG	mm^2	AWG	mm^2
30	0.05	2	35
28	0.08	1	50
26	0.14	1/0	50
24	0.25	2/0	70
22	0.34	3/0	95
20	0.50	4/0	120
19	0.75	250	150
18	1.0	300	150
16	1.5	350	185
14	2.5	400	185
12	4	450	240
10	6	500	240
8	10	600	300
6	16	750	400
4	25		

Wiring Sizing

- **PV Source Wire (Module to Combiner Box)**
- **Maximum Panel Current:**

  9.09A Isc X 1.25 (over-irradiance) = 11.36A
- **Continuous Current:**

  11.36A X 1.25 (3 hour continuous) = 14.2A
- **Using USE-2 Wire from PV module to combiner box**
- **Terminal Temperature Rate:**

  Breaker rater for 75°C

  Must use 75°C rating, even though wire is rated for 90°C

  Breaker accepts 18-6AWG
- **Temperature Compensation:**

  Ambient temperature of 38°C

Wiring Sizing

- **PV Output Wire (Combiner Box to DC Load Center)**
- **Combined Current:**

  9.09 X 1.56= 14.2A X 2 strings = 28.4A
- **Using THWN-2 Wire from combiner box to DC Load Center in conduit**

  4 current carrying wires and ground
- **Temperature Compensation:**

  Ambient temperature of 38°C
- **Terminal Temperature Range:**

  Breaker rater for 75°C

  Must use 75°C rating, even though wire is rated for 90°C

  Breaker accepts 18-6AWG

Wiring Sizing

- **Battery to Inverter Cables**
- **Calculate the highest current possible:**

  Inverter Wattage ÷ Battery Bank Lowest Voltage

  3500W ÷ 20V = 175A
- **Using THW Wire for Dry Location**

  2 wires in conduit
- **Temperature Compensation:**

  Cool equipment room temperature of 22°C

Voltage Drop

- **Calculate Voltage Drop from Battery to Inverter**

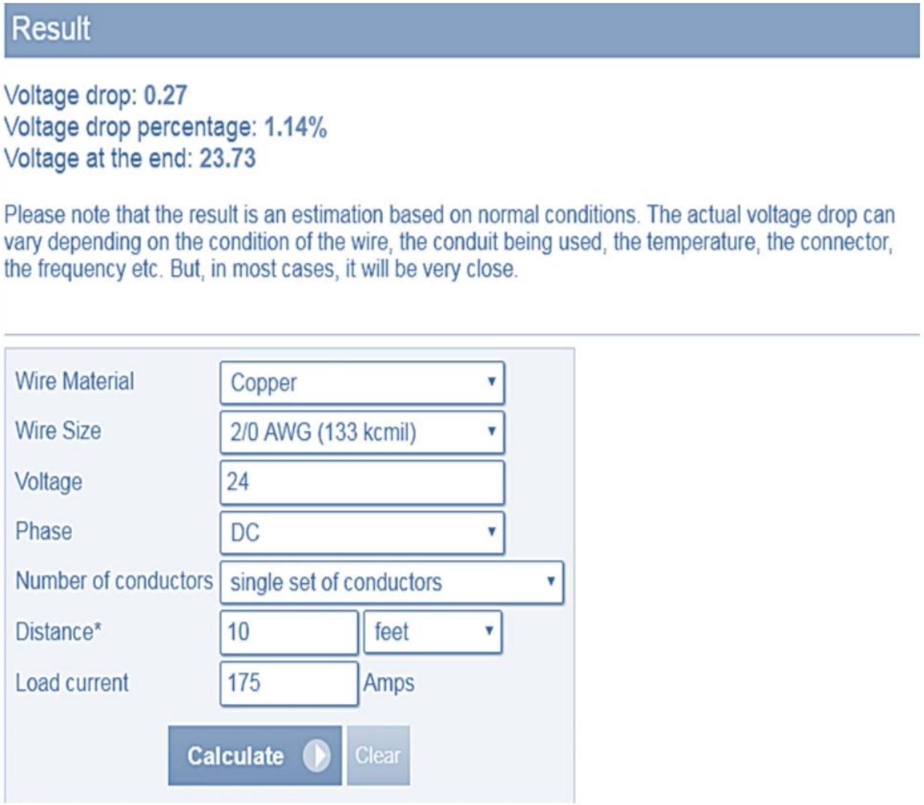
  175A

  24V system

  ≤ 2% voltage drop recommended

- **Use Voltage Drop Calculator:**

  https://www.calculator.net/voltage-drop-calculator.html



Wiring Sizing

- **Inverter Output Wires**
- **Calculate the Continuous current:**

  Inverter Wattage ÷ VAC

  3500W ÷ 120V = 29.2A
- **Check NEC Tables**

  2 current carrying wires in conduit
- **Temperature Compensation:**

  Cool equipment room temperature of 22°C

Wiring Sizing

- **Summary**
- **PV Source Wires:**

  Minimum required USE-2 of 14 AWG
- **PV Output Wires:**

  Minimum required THWN-2 of 6 AWG
- **Battery to Inverter Cables:**

  Minimum required THW of 2/0 AWG
- **Inverter Output Wires:**

  Minimum required wire of 10 AWG

مواصفات الاسلاك والكابلات سواء DC & AC

1- يجب استخدام الكابلات الخاصة بتطبيقات الطاقة الشمسية وأن تكون معزولة بعزل حراري و مائي طبقاً للمواصفات الفنية وأن تكون حاصلة على شهادة TUV & UL.
جميع كابلات الطاقة الشمسية مصنوعة من شعيرات النحاس المقصدر Tinned Copperعالي الجودة.
3- مساحة مقطع الكابلات والاسلاك مناسبة لشدة التيار بها مع الاخذ فى الاعتبار معامل امان
4- أن تتحمل درجات الحرارة العالية لتصل الى 70درجة مئوية وذو عمر افتراضى كبير.
5- استخدام ال Cable tray للكابلات والاسلاك المتواجدة بالخارج.
7- إستخدام الترامل والكوس المناسبة للاسلاك والكابلات وترقيمها تبعا لكل مصفوفة
6- استخدام وصلات MC4 معتمدة وحاصلة على شهادة TUV على أن يكون كل لوح به 2 وصلة.

مساحة مقطع كابلات DC =
$$\frac{1.4*2*\text{المسافة بين الالواح والانفرتر* التيار الكلى * }0.01724}{\text{الأنخفاض المسموح به للجهد *الجهد الكلى}}$$

مساحة مقطع كابلات AC (للفازة الواحدة) =
$$\frac{1.4*1.73*\text{المسافة بين الالواح والانفرتر* التيار الكلى*}0.01724}{\text{الأنخفاض المسموح به للجهد *الجهد الكلى}}$$

لوحة التجميع والحمايات

- في حال ان عدد السلاسل علي التوازي اكثر من أثنين يجب تجميعها فى لوحة التجميع واستخدام البارات النحاس للتجميع.
- عمل جلندات لمداخل ومخارج كابلات لوحة التجميع.
- يجب تركيب قاطع تيار مستمر عمومي DC Circuit Breakerبين الألواح الشمسية و الأنفرتر
  * امبير القاطع العمومي = 1.56 * Isc * *اجمالي عدد الخطوط علي التوازي في المنظومة
- تركيب قاطع تيار مستمر فرعى لكل String لامكانية فصله اثناء الصيانة والاختبار دون التأثير على باقى المنظومة.
- يمكن الاستغناء عن القواطع الفرعية بإستخدام Inline MC4وهو عبارة عن فيوز يتم وضعه في السلك نفسه من خلال استخدام وصلات MC4.
- استخدام DC fuse protectionبقدرة مناسبة لجهد وتيار كل string

- تركيب DC Surge protection device للحماية من الصعق نتيجة لزيادة الجهد.
- تركيب قاطع AC عند خرج الانفرتر وقبل الأحمال بسعة قطع مناسبة مع الأخذ فى الاعتبار التيار المسحوب عند القدرة القصوى Surge Power للانفرتر.

تأريض المنظومة

- استخدام قضيب من النحاس النقى بطول لا يقل عن 1.5 متر .
- يتم في البئر الأرضي وضع حول القضان المواد المحسنة لخواص توصيل التربة مثل الفحم و الملح.
- يتم قياس مقاومه الأرضى بحيث لا تتعدى 2 اوم. و إذا تم عمل نظام تأريض ولم نصل للمقاومة المطلوبة فيتم زيادة عدد القضبان المستخدمة
- يتم التوصيل بين بئر التأريض و النظام الشمسي عن طريق سلك من نحاس معزول بمادة بلاستيكية باللون الاخضر مع الاصفر
- يتم توصيل الإطار المعدني للألواح مع بعض بواسطة ربط اسلاك التأريض بصواميل وبشكل محكم الى إطار الالواح.
- يتم استخدام سلك ذو قطر لأ يقل عن 4 مم2 للتوصيل بين الألواح و بعضها
- بعد ربط و توصيل جميع الألواح بعضها ببعض يتم عمل سلك أرضي من بارة تجميع الارضى الي قضيب التأريض مباشرة و يتم تنفيذ هذا السلك بقطاع لأ يقل عن 16مم2 في حالة ان طوله لأ يزيد عن 25 متر, اما في حال ان المسافة بين الألواح و قضيب الأرضي اكبر من 25 متر و اقل من 50 متر فيتم تنفييذ السلك بقطر 25 مم2.
- يتم تأريض جميع مكونات المنظومة دون استثناء وربطها بالبئر الارضى

Auxiliary Components

- **Monitoring:**

Monitoring Equipment components are usually connected to a concurrent Inverter manufacturer, and they view and relay system energy information analytics to an in-product console or web connected device through their proprietary software. Monitoring Equipment components may be integrated into an Inverter, or in some instances – be connected to another component of a photovoltaic array.

Racking & Mounting System

- **Fixed Roof Mounting:**

Fixed roof mounting has all the advantages of fixed ground mounting but with reduced ease of maintenance traded off against immunity to tampering and/or vandalism. One additional issue is the possible need for roof penetrations to accommodate mounting hardware.

Racking & Mounting System

- **Wall Mounting:**

South facing building walls can be taken advantage of as module mounting surfaces. Modules arrays can be parallel to the wall, tilted away from the wall, or configured as an overhanging canopy.

Racking & Mounting System

- **Top of Pole Mounting:**

Top of pole mounting is another fixed array mounting method. Arrays remain stationary even through the arrangement looks similar to a tracker. Top of pole mounts often allow for seasonal tilt adjustments which may help to optimize harvests particularly during winter conditions.

اختيار الموقع المناسب وعمل دراسة الجدوى لإنشاء محطة طاقة شمسية On-Grid

1- المساحة المناسبة والكافية لانشاء المحطة الشمسية بالقدرة المسموح بها حيث أن توليد 1 ك.وات يحتاج مساحة فى حدود 8 متر مربع أو أقل ع حسب قدرة اللوح المستخدم.

2- أن يكون المكان المخصص لإنشاء المحطة الشمسية بعيد عن الظلال.

3- توافر بيان بالاستهلاك السنوى للموقع المراد انشاء المحطة به وذلك لحساب القدرة المسموح بها من قبل شركة الكهرباء.

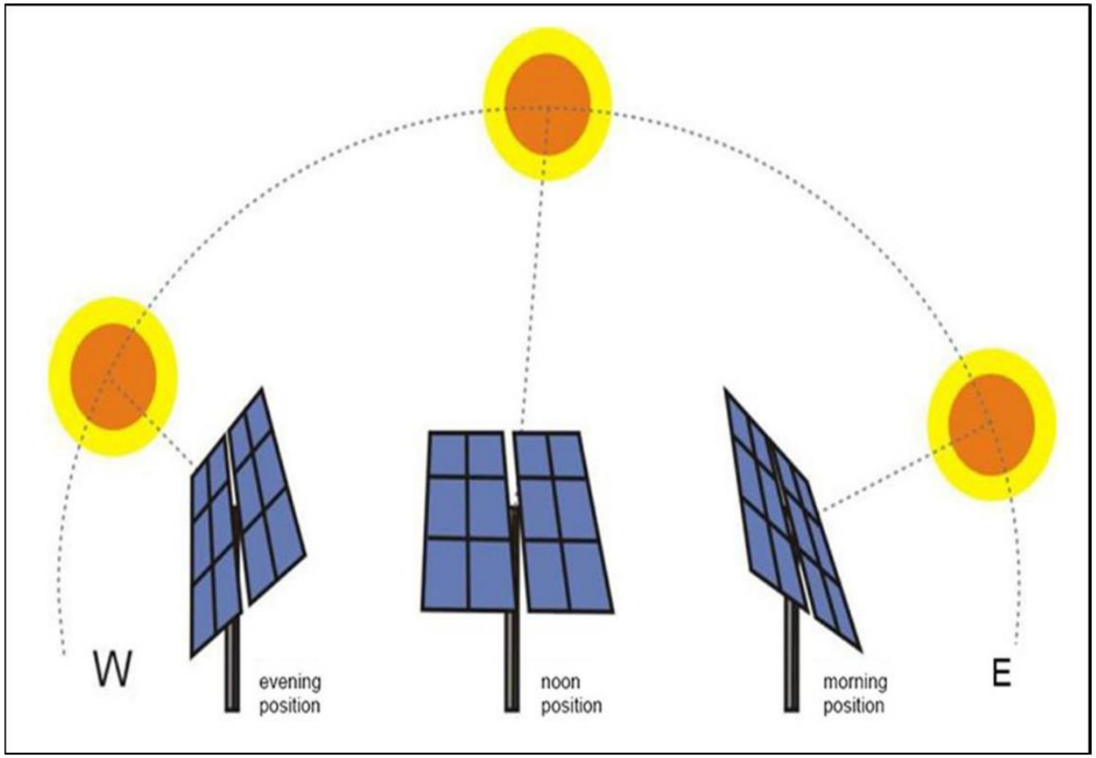
4- عدم مخالفة الموقع لقانون البناء الموحد.

5- تحمل المبانى لاحمال محطة الطاقة الشمسية من ألواح وشاسيهات.

Solar Cell Orientation & Angles

Azimuth Orientation:

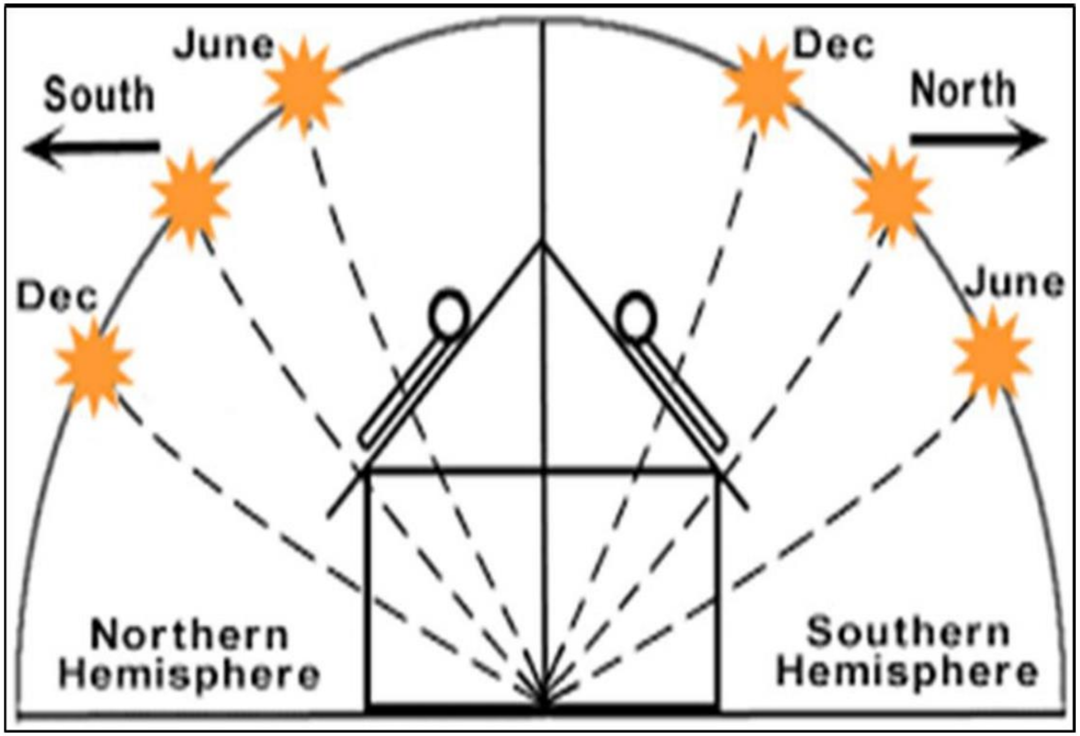
Azimuth – This is the compass angle of the sun as it moves through the sky from East to West over the course of the day. Generally, azimuth is calculated as an angle from true south.



Solar Cell Orientation & Angles

Zenith Orientation:

Zenith – This is the angle of the sun looking up from ground level or the horizon. Solar zenith angle at midday is different depending on the season.



Self-Shading

Example:

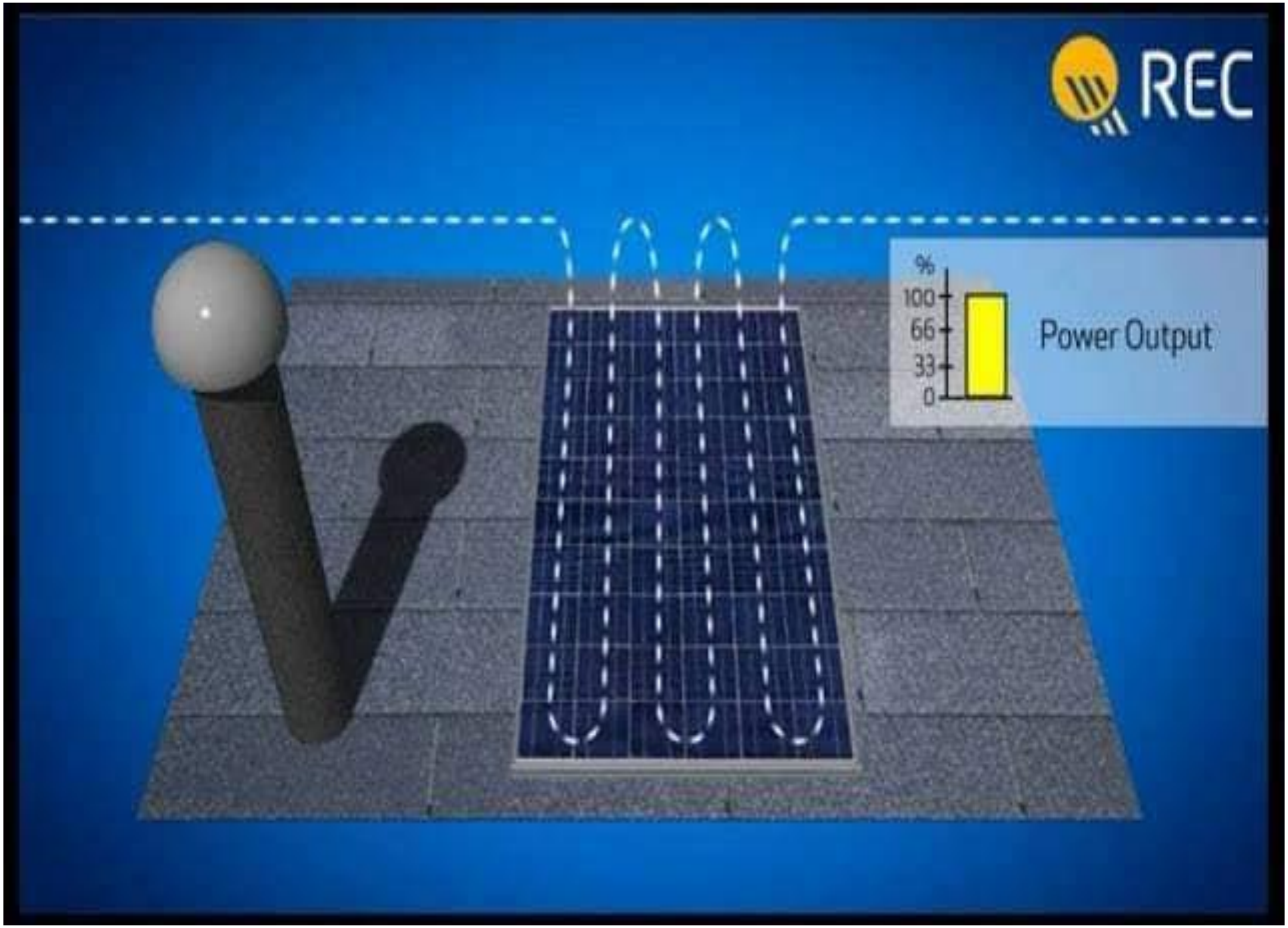
For 21, Dec, the tilt angle = 45^{o} and the panel tilted length = 2 (m). Calculate the minimum and maximum inter-row spacing needed.

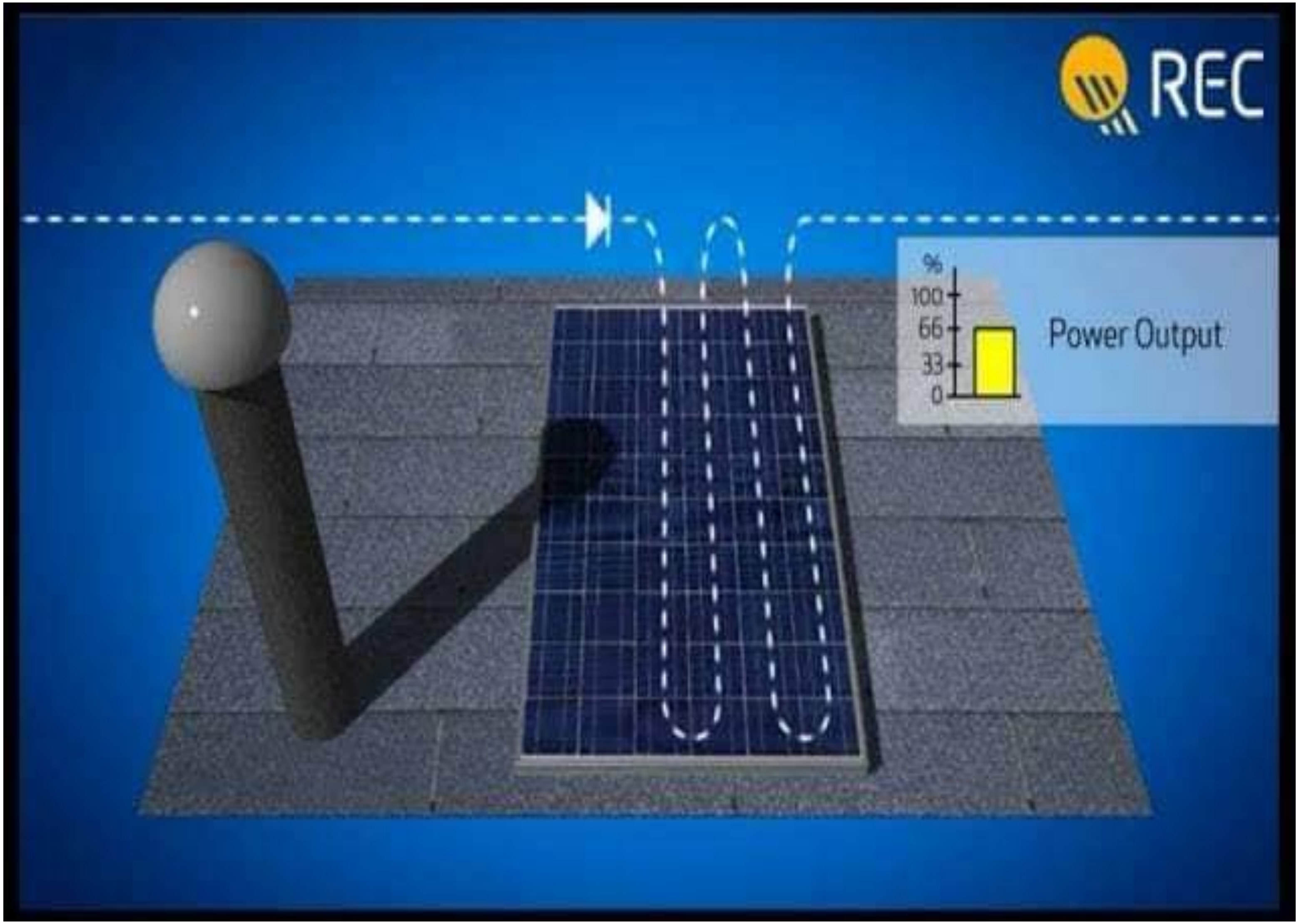
$$h = 2 * \sin(45) = 1.41\ (m)$$

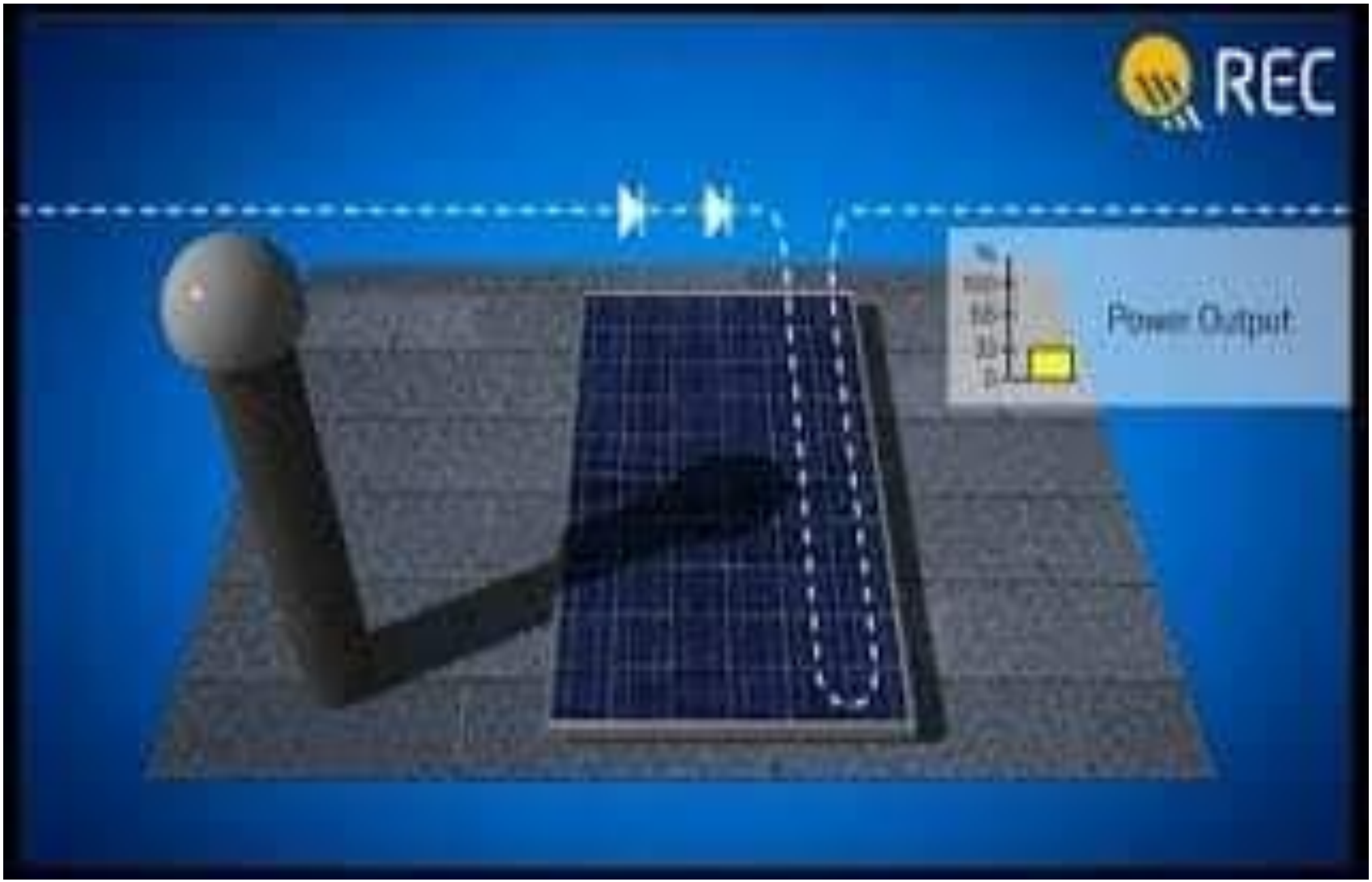
$$maximum\ spacing\ D' = \frac{1.41}{\tan(36.49)} = 1.91\ (m)$$

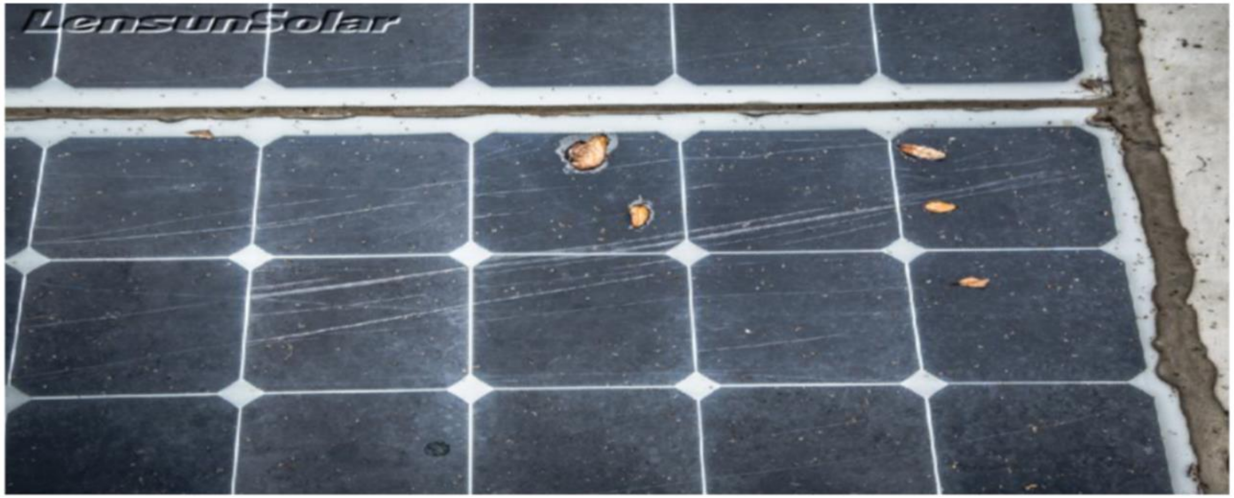
$$minimum\ spacing\ D\ @\ 9\ am\ (\psi = 137.2)$$

$$D = 1.91 * \cos(180 - 137.2) = 1.4\ (m)$$


REC
%
100
66
33
0
Power Output


REC
%
100
66
33
0
Power Output


REC
Power Output


LensunSolar

- After designing RO plant with energy load 4.179 kWh/day and 1m3/day.
- PV solar system will two panels each is 545 watt monocrystalline panel.
- With battery bank 12 batteries each of 500 AH, 2V can be used.
- Total cost will be 46000 LE.

- **Thus, the cost of Power to desalinate is 7 L.E/m3.**

- Costs are relatively reasonable compared to the costs of other alternative sources such as diesel, which is higher or wind energy in the absence of the national grid.

- Plant Performance

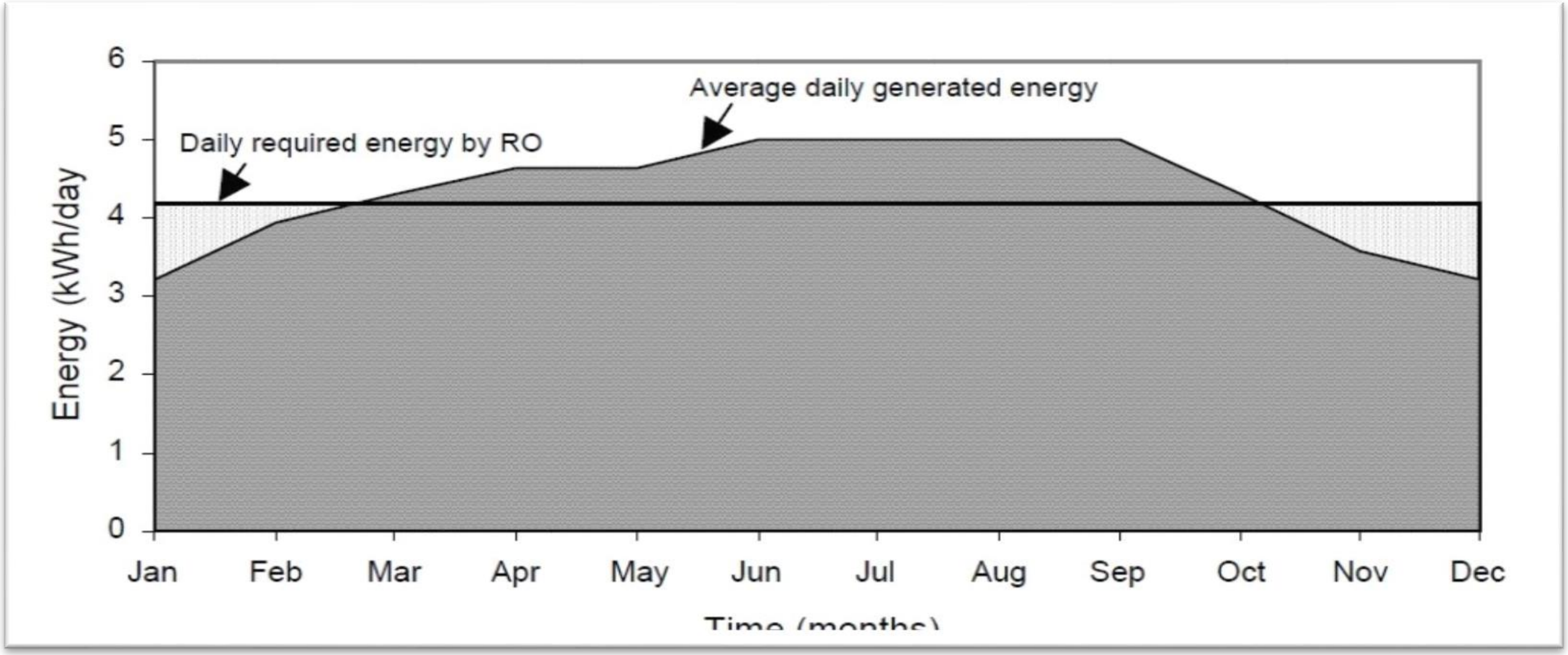


Figure 3 The average daily generated energy versus that required by the RO unit at different months

- Plant Performance

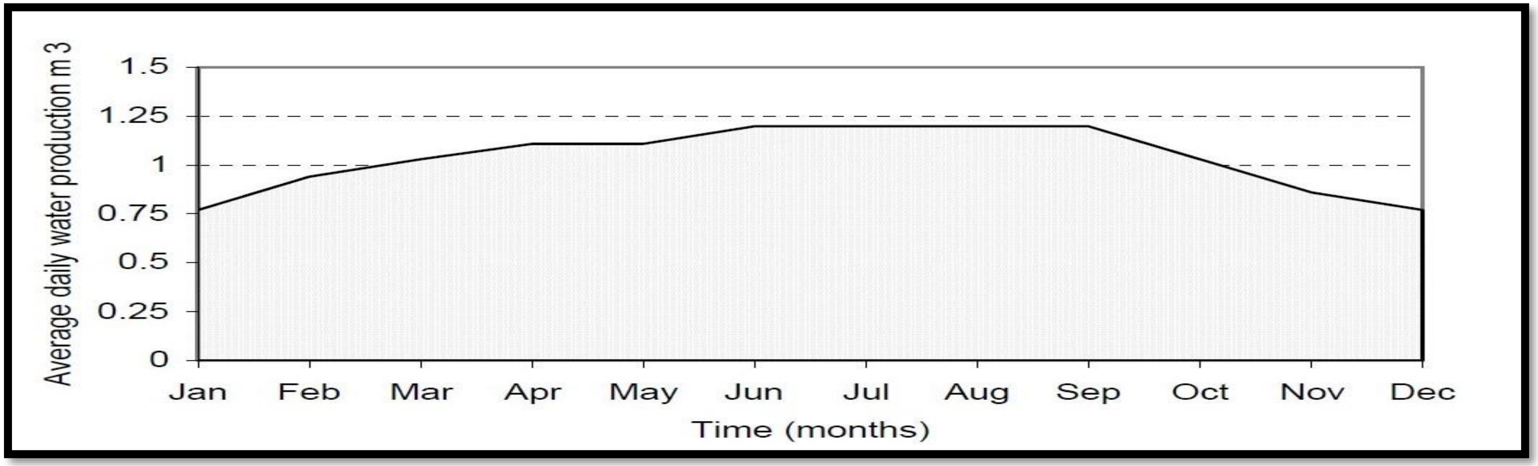
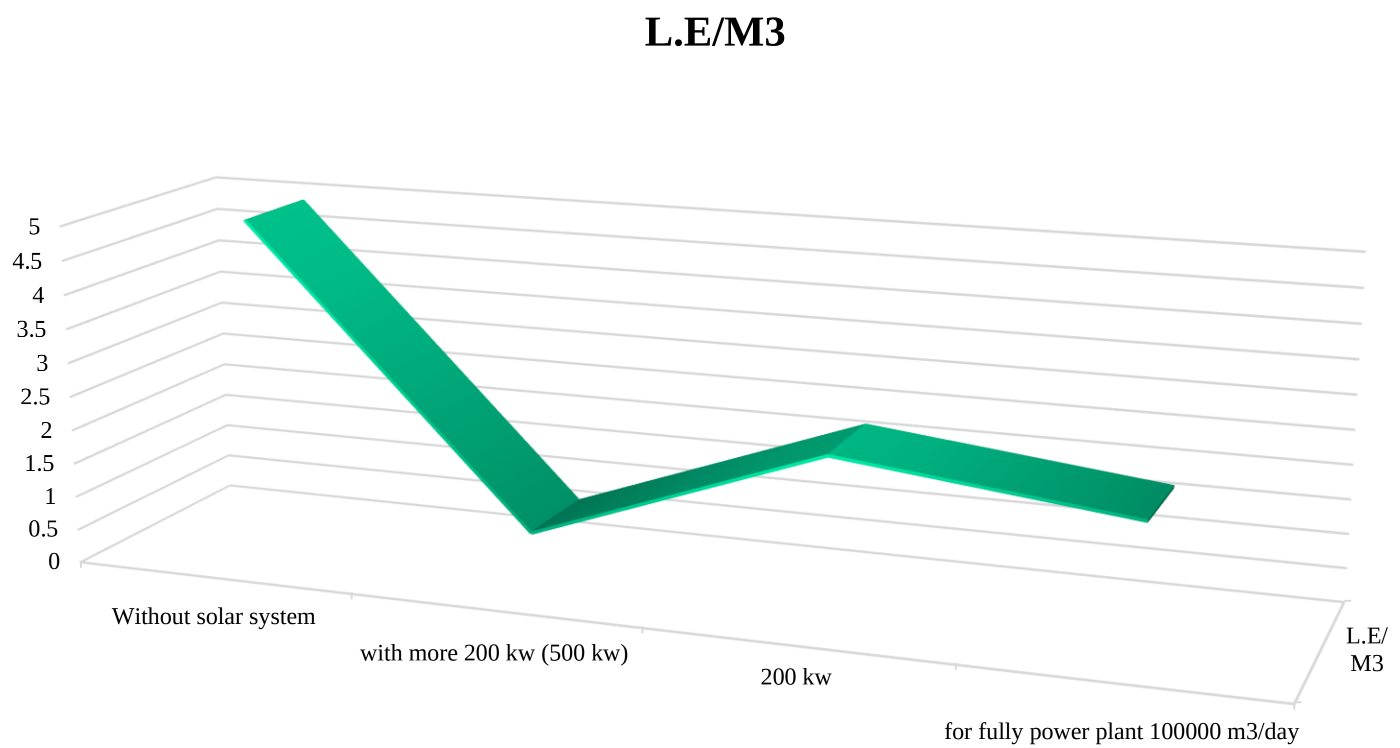


Figure 4 introduces the expected water production during different months

-the cost of Power to desalinate is 7 L.E/m3.

- The national grid's availability, opinions disagree, thus we turn to the on-grid solar system, it is the subject of our next study in Sina, in a sadr reverse desalination plant driven by an on-grid solar system.


L.E/M3
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Without solar system
with more 200 kw (500 kw)
200 kw
for fully power plant 100000 m3/day
L.E/
M3


شكراً

Thank you for your attention