مؤتمر عجمان الدولي الخامس للبيئة

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A Comparison between a Stand-Alone and Grid-Connected Roof Mounted PV Solar System under Abu Dhabi Net Metering Scheme Using HOMER

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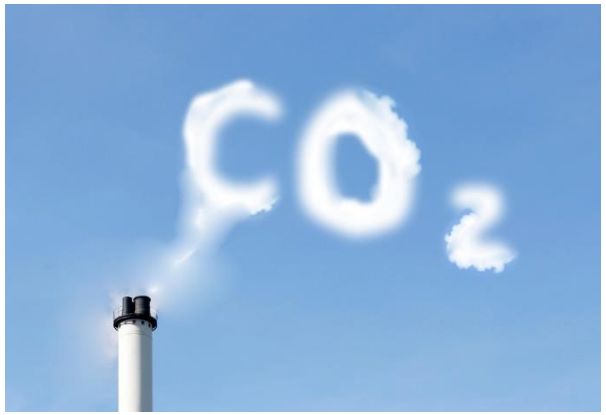
Introduction

- **UAE electric power consumption per capita ≈11,264 kWh per person (2014)**

- **UAE mainly relies on Fossil fuels in energy production**

- **The Carbon footprint of electricity production was almost 26.6 million tons of Co_2 Equivalent (2014)**



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Introduction

- **Abu Dhabi consumed 62,979 (GWh) of electricity in 2016**
- **Only 30,867 MWh produced from renewable resources.**
- **The need to expand the power generation from clean renewable resources is of high importance.**

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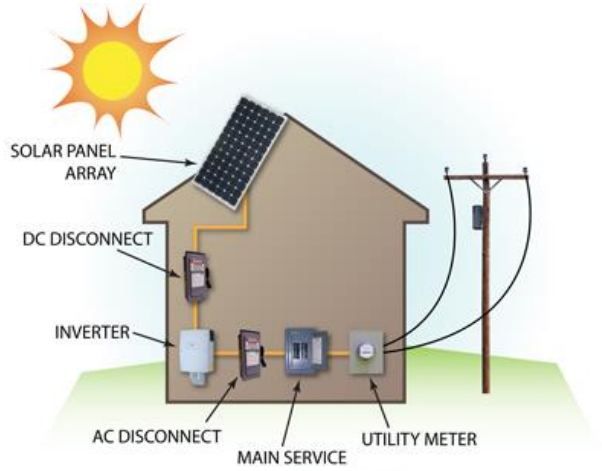
Introduction-Solar Energy

- **Solar energy is clean & free with no environmental impacts**
- **Heavily available in UAE**
- **Cost has become much lower in the past few years**
- **A 10 kW PV system can cost 75,000-100,000 AED including PV cells, invertor, wiring, installation (Grid connected)**



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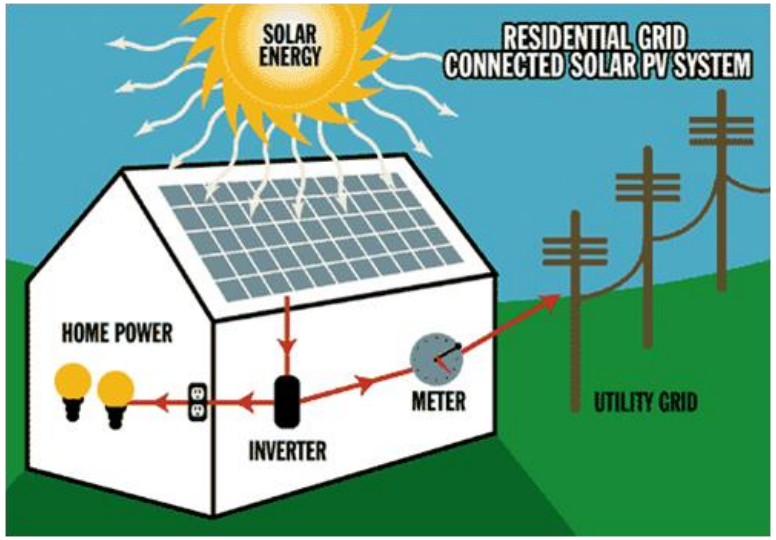
Background

- PV cells captures light from the sunlight and convert it into electricity
- The excess energy can be stored in batteries for night use and emergency
- The excess energy can also be fed into the utility grid

(if allowed)



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Background

- **Feed in tariffs: benefits for electricity generated from renewable resources by the consumer**

  (Germany, Spain , Denmark)

- **Net metering: consumers are charged for their monthly or annually net purchases from the grid**

  (Dubai, Abu Dhabi)

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Background-HOMER

- **Modelling renewable energy systems can be very hard**
- **Many complex variables & constrains**
- **HOMER (Hybrid Optimization of Multiple Energy Resources) can model renewable vs. traditional systems**
- **HOMER solves the complexity of Micro-grid systems cost and reliability**

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Methodology

- **The objective is to measure the feasibility of a roof mounted PV system for a certain mixed-use building while connected to Abu Dhabi electrical grid by:**

A. **Selecting a building**

B. **Electrical energy daily demand calculation using Carrier HAP**

C. **PV system design and simulation using HOMER for 2 scenarios: 1. stand alone, 2. Grid-conneced**

D. **Results & Conclusions**

The building

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- *Community centre*
- *520 m² of Area*
- *Multiple office rooms*
- *Gym*
- *Indoor lounge/dining area*
- *External dining area (Alfresco)*
- *Library*
- *Kitchen and toilets*
- *Cathedral type ceiling*

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Building energy demand

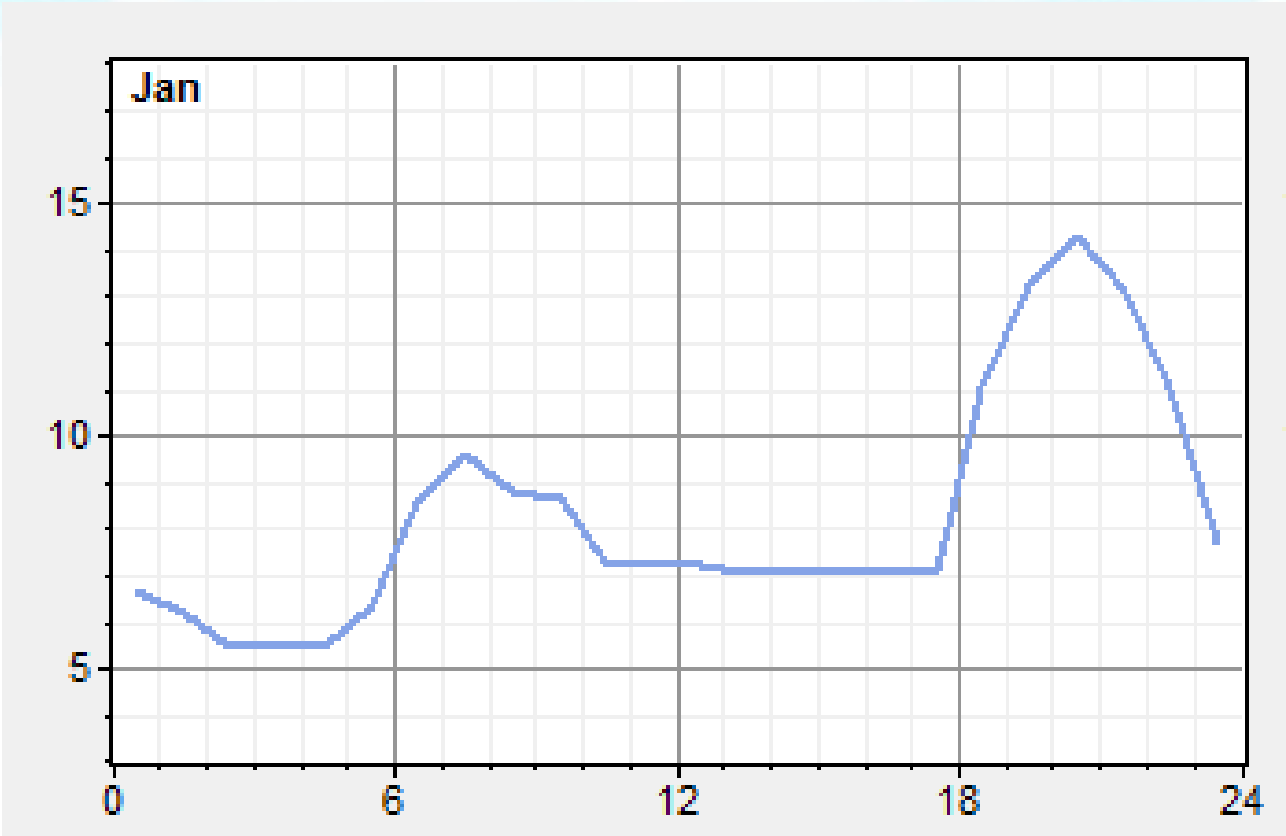
- **Daily electrical demand was found using Carrier HAP (Hourly Analysis Program)**
- **The building was selected to be cooled by outside water (District cooling)**
- **The electrical energy demand consists of:**

A. **HVAC equipment such as pumps and fans**

B. **Indoor lighting**

C. **Receptacle equipment: TV's, computers**

Building energy demand



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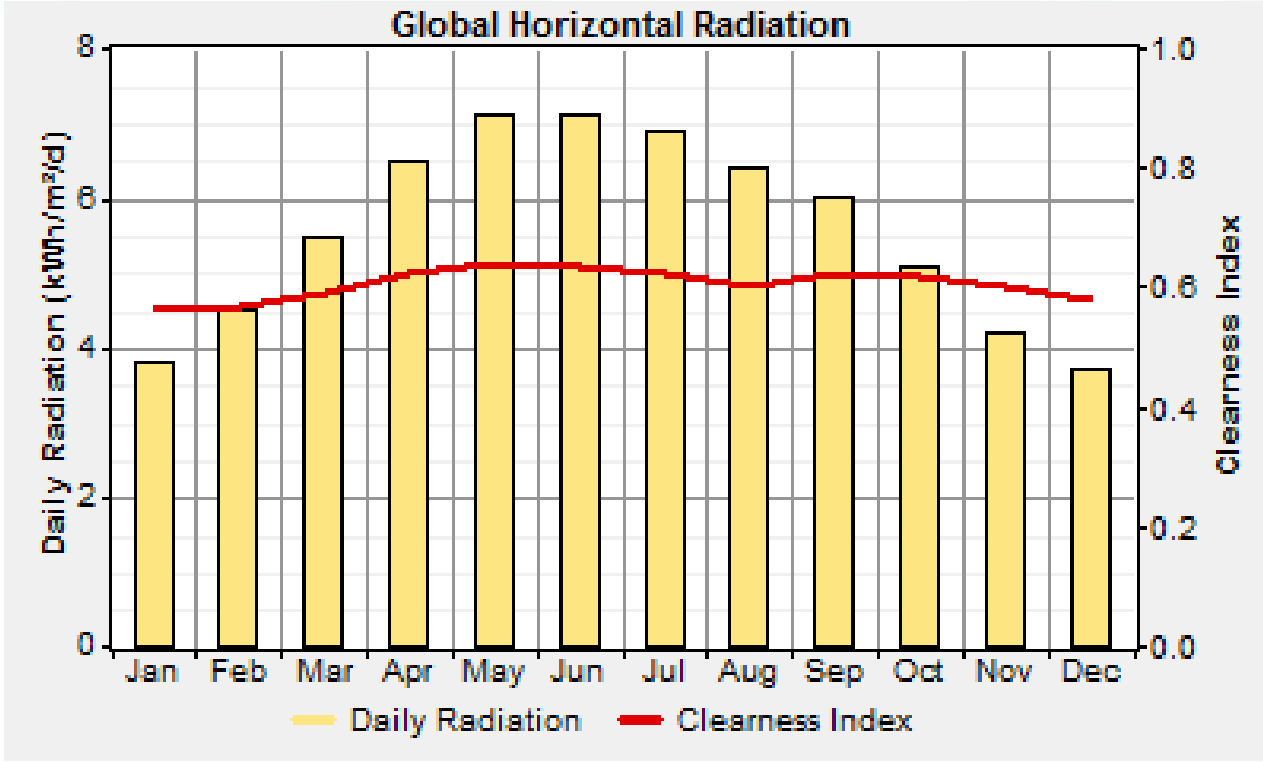
Solar Radiation Data

Abu Dhabi national center of Meteorology



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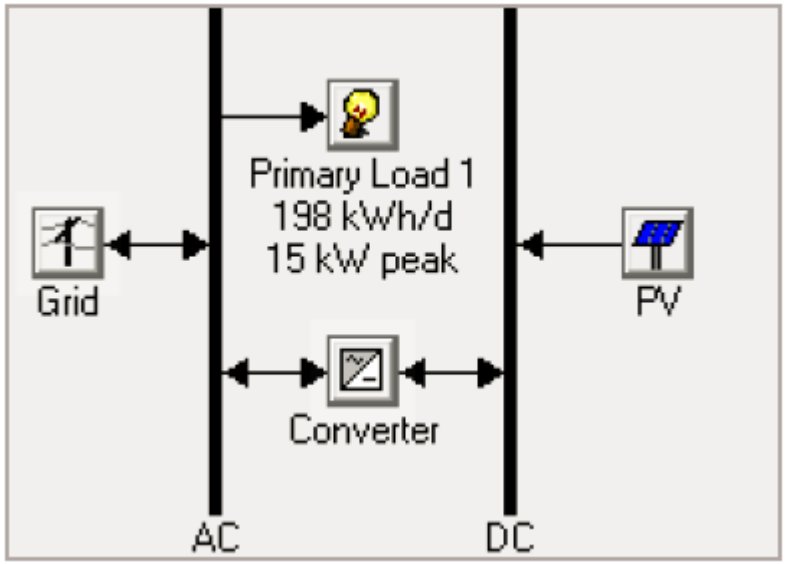
HOMER Simulation-Grid-connected System

- **PV cells** (Polycrystalline Silicon solar cells)
- **Convertor/invertor**
- **Electrical AC load**
- **Grid connection**
- **Solar radiation**

(Abu Dhabi national center of Meteorology)

- **No batteries**
- **Electricity price 0.08 $/kWh**
- **Life 25 years**



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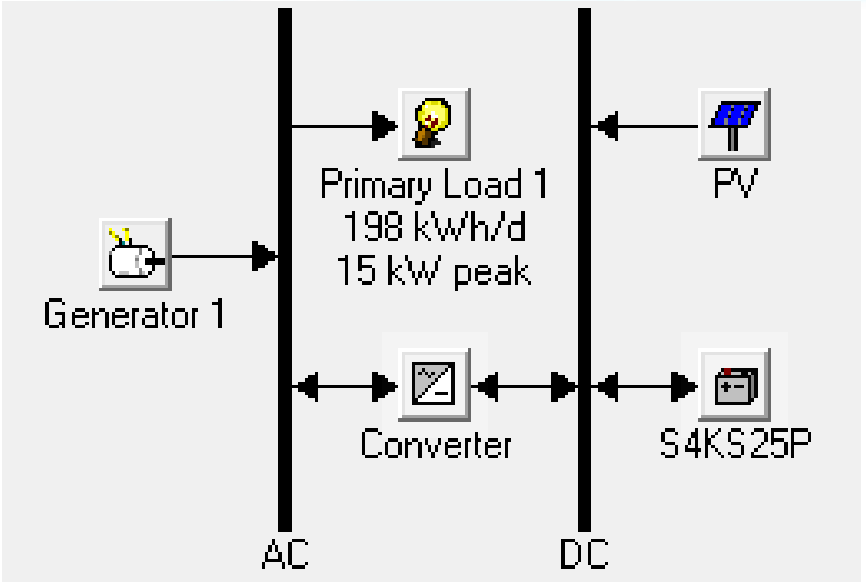
HOMER Simulation-Stand-alone System

- **PV cells** (Polycrystalline Silicon solar cells)
- **Convertor/invertor**
- **Electrical AC load**
- **No grid connection**
- **Solar radiation**

(Abu Dhabi national center of Meteorology)

- **Batteries**
- **Diesel Generator**
- **Diesel Price 1 $/Liter**
- **Life 25 years**



Results-Technical

Grid-connected	Stand-alone
25 kW Solar Cells	50 kW Solar Cells
25 kW invertor	50 kW invertor
No Batteries	100 batteries (4V, 1,900 Ah. 7.6 kWh)
No Generator	25 kW diesel generator
Approx. Area 250 m^2	Approx. Area 500 m^2

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Results-Financial

	Grid Connected	Stand-alone
Initial cost ($)	41,250	176,250
NPC ($)	98,544	319,037
LCOE ($/kWh)	0.107	0.345
Renewable fraction (%)	50.7 %	93.3 %
Excess electricity (%)	0 %	11.6 %
Payback Period (years)	7.1	30.5

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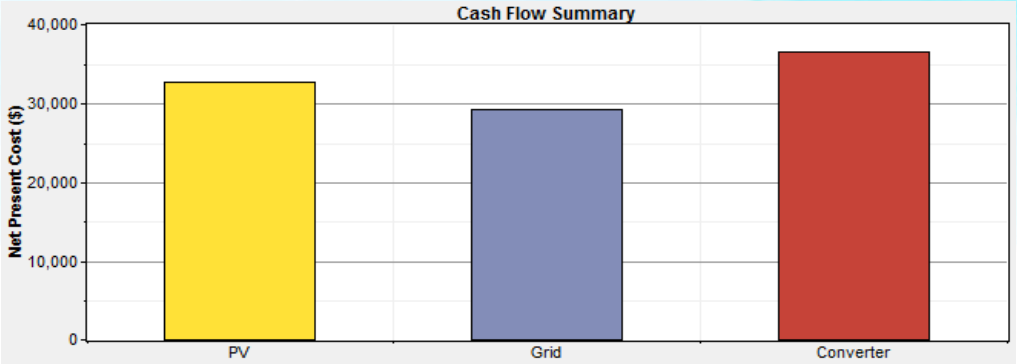
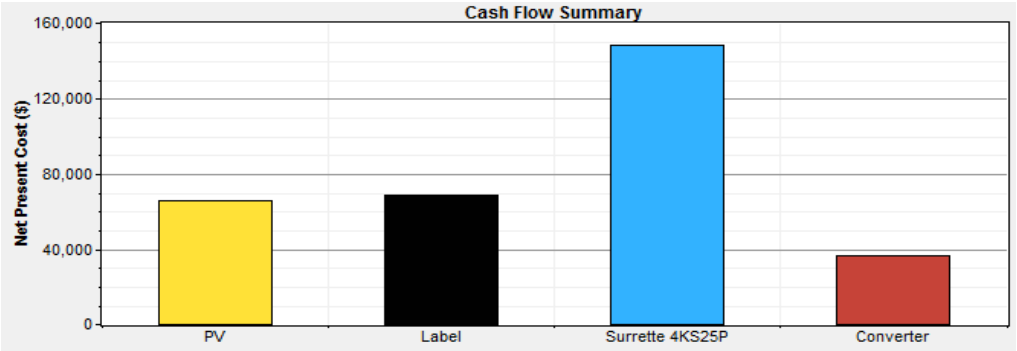
Results

- **Grid-connected**



Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
PV	20,000	0	12,783	0	0	32,783
Grid	0	0	29,304	0	0	29,304
Converter	21,250	8,867	7,990	0	-1,650	36,456
System	41,250	8,867	50,077	0	-1,650	98,544

- **Stand-alone**



Component	Capital ($)	Replacement ($)	O&M ($)	Fuel ($)	Salvage ($)	Total ($)
PV	40,000	0	25,567	0	0	65,567
Generator 1	35,000	0	6,302	30,871	-3,155	69,018
Surrette 4KS25P	80,000	59,516	25,567	0	-17,087	147,996
Converter	21,250	8,867	7,990	0	-1,650	36,456
System	176,250	68,383	65,425	30,871	-21,892	319,037

Results-Environmental

Pollutant (kg/year)	No PV System	Grid-connected	Stand-alone
Carbon dioxide (CO_2)	45,674	18,110	6,359
Carbon monoxide (CO)	0	0	15.7
Unburned hydrocarbons (UHCs)	0	0	1.74
Particulate matter	0	0	1.18
Sulfur dioxide (SO_2)	198	78.5	12.8
Nitrogen oxides (NO, NO_2, N_2O)	96.8	38.4	140

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Conclusions

- **Grid-connection can reduce the cost of PV systems while performing good in terms of renewable energy fraction**
- **Grid-connection can be very helpful to the country economy if applied on a large scale**
- **Grid-connected system works good in terms of initial costs, LCOE, O&M, payback period and emitted pollutants**
- **Stand-alone systems work good in terms of environmental aspects but fails in financial sides, as a results, it can be used at distant locations with no grid at a low scale.**

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Thank You