Prince Sultan University Solar PV Project

Riyadh, Saudi Arabia

January 2019

HAALA | Energy

هالة للطاقة المتجددة

جامعة الامير سلطان

PRINCE SULTAN UNIVERSITY

1998

There are 3 factors which together make a strong case for using solar in Saudi Arabia

HAALA | Energy
هالة للطاقة المتجددة

1 Abundant solar resource

2 Alignment of energy usage

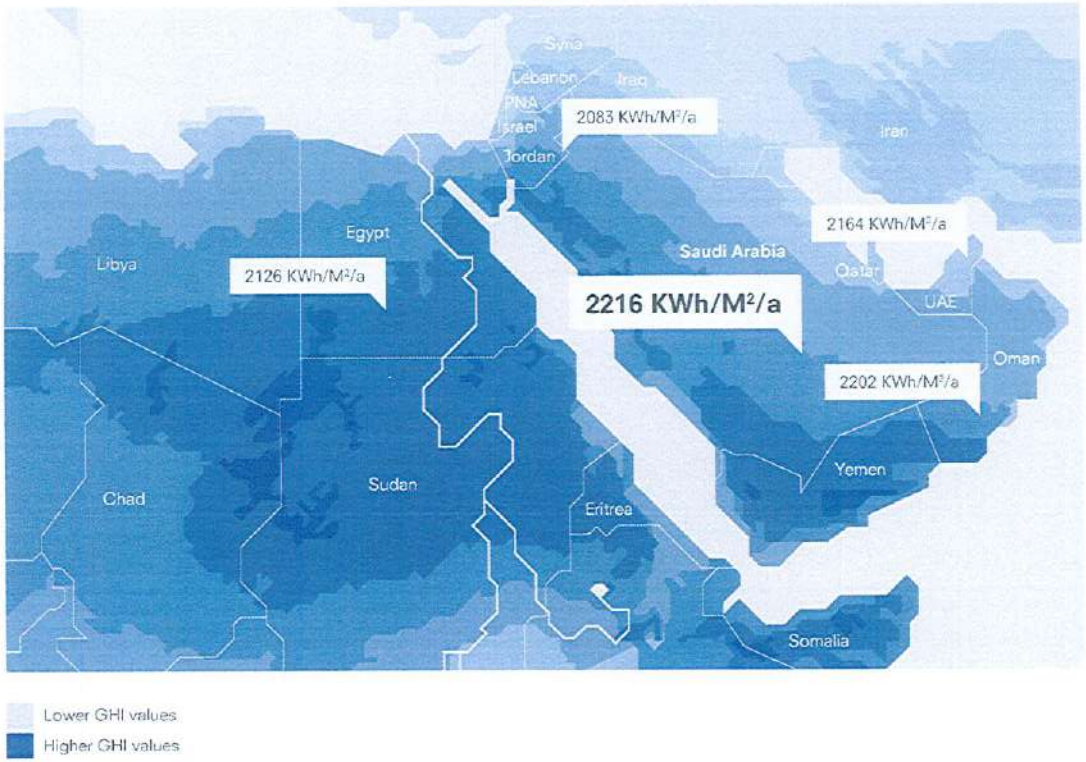
3 Cost effectiveness

Abundance of Solar Resource

HAALA | Energy
هالة للطاقة المتجددة

Average global horizontal irradiation (GHI) across key regional markets

Source: Solar GIS



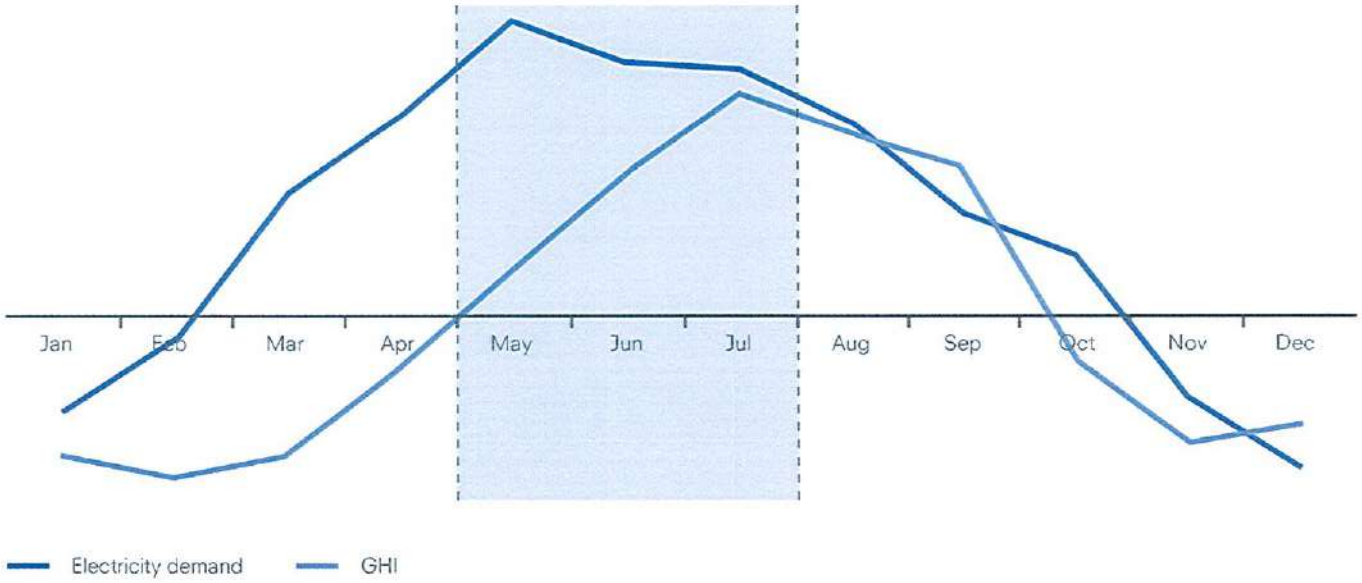
Country	Average GHI KWh/m²/yr
UK	972
Germany	1066
Portugal	1632
Spain	1659
Saudi Arabia	2216

Alignment of Energy Usage I

HAALA | Energy
هالة للطاقة المتجددة

Seasonal electricity demand and GHI profiles, indicative

Source: ECRA, OST, SolarGIS

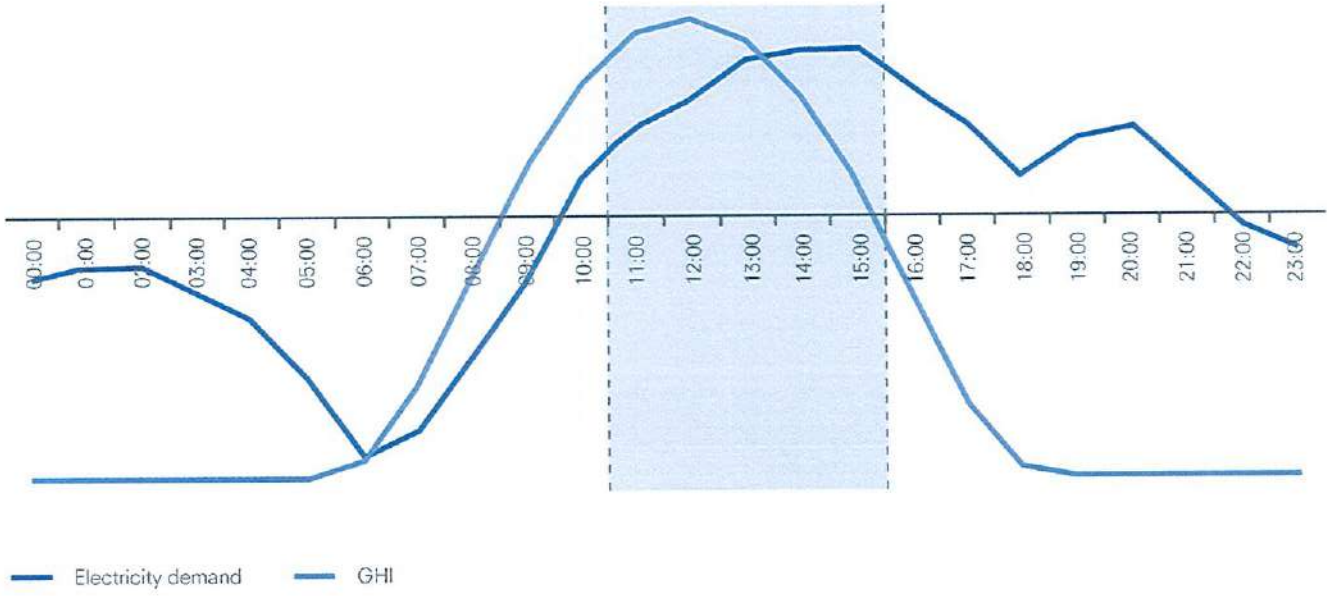


Alignment of Energy Usage II

HAALA | Energy
هالة للطاقة المتجددة

Daily electricity demand and GHI profiles, indicative

Source: ECRA, OST, SolarGIS

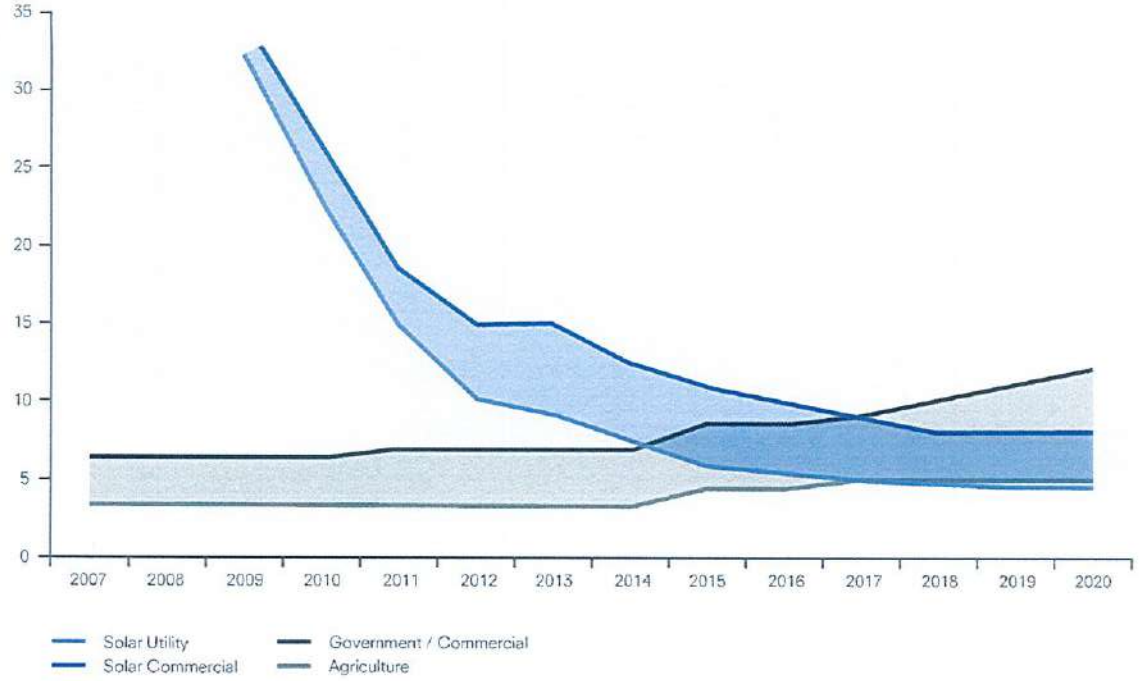


Cost Effectiveness

HAALA | Energy
هالة للطاقة المتجددة

Levelized cost of solar PV vs Saudi electricity tariffs, USD cents

Source: Lazard, SEC



HAALA | Energy
هالة للطاقة المتجددة

Technical

- Solar Photovoltaics (PV)
- Energy Storage
- Hybrid Systems / Microgrids

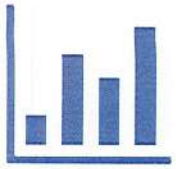
Geographical

- Saudi Arabia
- Other Gulf Countries (UAE, Qatar, Kuwait, Oman)
- Wider MENA Region (Jordan, Egypt, Algeria, Tunisia)

HAALA Energy develops turnkey solar PV peak-shaving solutions to reduce and control energy costs at the commercial and industrial scale

What We Do

HAALA | Energy
هالة للطاقة المتجددة



Analysis

Engineering & Design

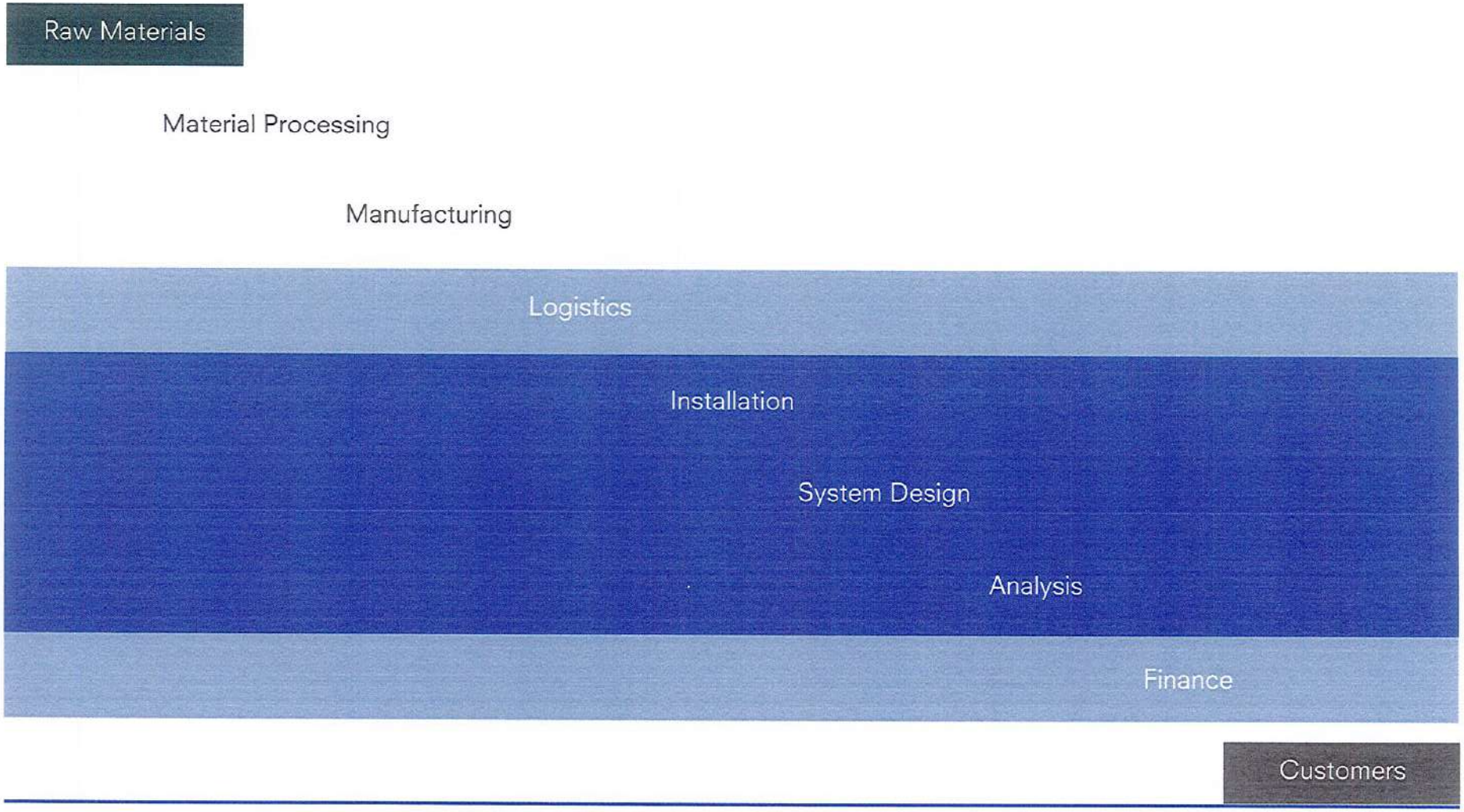
Procurement

Construction Management

Operation & Maintenance

The Solar PV Value Chain

HAALA | Energy
هالة للطاقة المتجددة



Context I

HAALA | Energy
هالة للطاقة المتجددة

- HAALA Energy was initially engaged in November 2017

- We studied the potential for developing Solar PV to power building 5 on the PSU campus

- Various potential sites were studied including the rooftops of buildings 1 to 5 and the campus parking areas

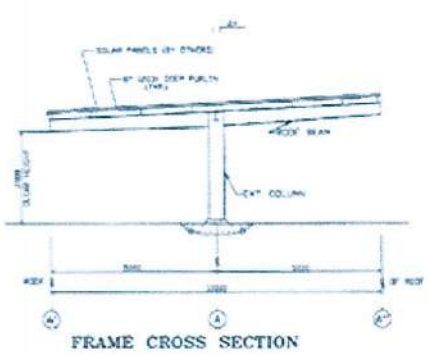
- The car-port solutions were most attractive because they offered the lowest installation and maintenance costs

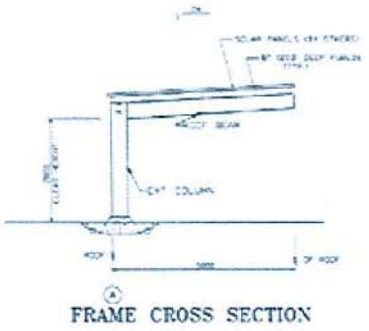
Context II

HAALA | Energy
هالة للطاقة المتجددة

- Given the cost-effectiveness of the car-port sections, Dr. Khaled requested some additional car-port options

- In December 2017 we provided two additional car-port options:
  - Option 2, same capacity as the original proposal but car-ports only
  - Option 3, a larger car-port system sized according to the limit of the net-metering regulation





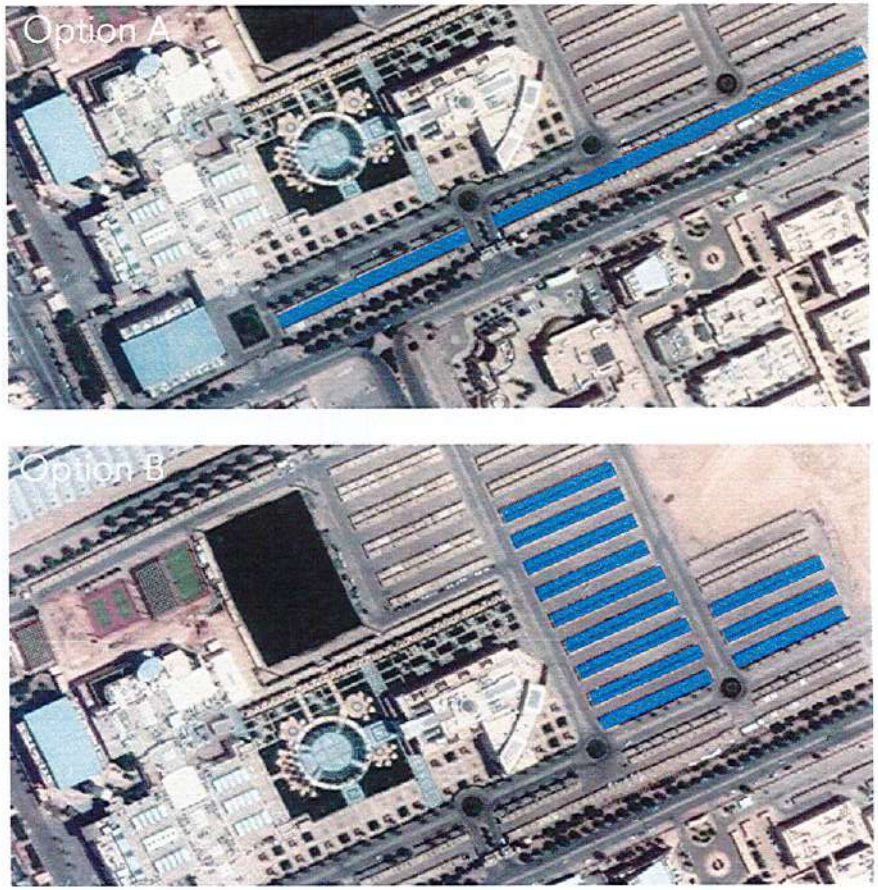
Proposed Systems 3.0

HAALA | Energy
هالة للطاقة المتجددة

- In September 2018 we updated our proposal based on the latest component pricing and a review of all previous options

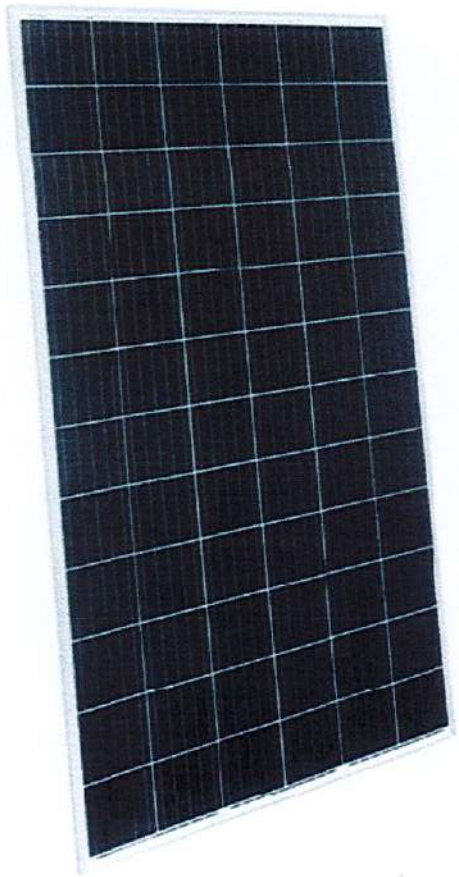
- The latest proposal consists of two options:
  - **Option A**, intended to provide most of the energy required in building 5 during the day at a reasonable cost, without impacting future development plans
  - **Option B**, intended to provide as much power as possible to the campus at the best possible price, while staying within the net-metering limit

	DC Capacity	Specific Yield (kWh/kWp)	Annual Yield	Cost
Option A	0.85 MWp	1,794	1,526 MWh	1.60 $/Wp
Option B	1.97 MWp	1,810	3,568 MWh	1.49 $/Wp



Specific Design Considerations I - Module

HAALA | Energy
هالة للطاقة المتجددة



Jinko Solar

*Building **Your Trust** in Solar*

Jinko Cheetah Mono PERC 72 380 Watt

KEY FEATURES

5 Busbar Solar Cell

5 busbar solar cell adopts new technology to improve the efficiency of modules , offers a better aesthetic appearance, making it perfect for rooftop installation.

High Efficiency

Higher module conversion efficiency (up to 19.67%) benefit from Passivated Emmiter Rear Contact (PERC) technology.

PID Resistance

Excellent Anti-PID performance guarantee limited power degradation for mass production.

Low-light Performance:

Advanced glass and surface texturing allow for excellent performance in low-light environment.

Severe Weather Resilience

Certified to withstand: wind load (2400 Pascal) and snow load (5400 Pascal).

Durability Against Extreme Environmental Conditions

High salt mist and ammonia resistance certified by TUV NORD.

Specific Design Considerations II - Inverters

HAALA | Energy
هالة للطاقة المتجددة

HUAWEI

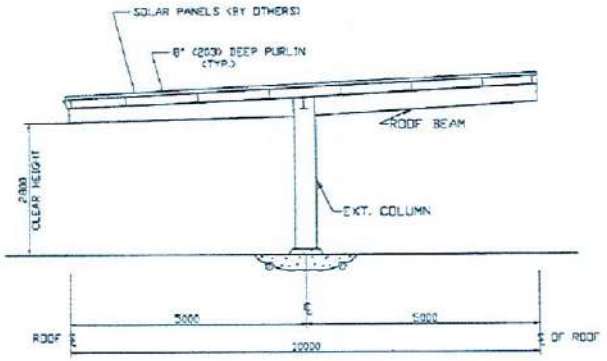
SUN2000-50KTL by Huawei

- String inverters optimize cost vs system resilience
- 8 string intelligent monitoring
- High efficiency inverter
- Natural cooling technology, no external fans
- IP65 weatherproof rating
- Extended 10 year warranty
- Largest manufacturer of string inverters worldwide

Specific Design Considerations III - Understructure

HAALA | Energy
هالة للطاقة المتجددة

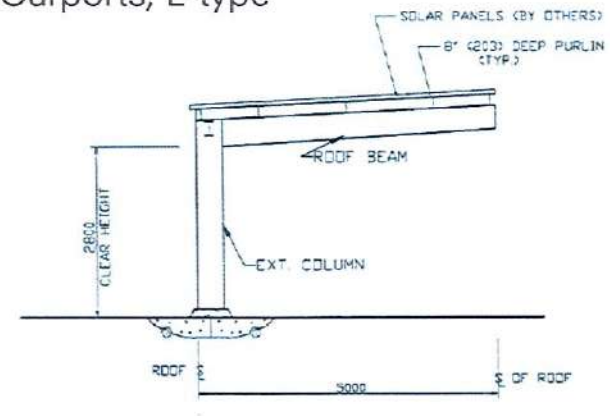
South Carports, T-type



Single & Double Cantilever Carport System

- Optimized panel layout to maximize capacity
- 5 Degree tilt angle to increase energy generation and allow for improved airflow beneath modules

North Carports, L-type



BUTLER®

Pricing

HAALA | Energy
هالة للطاقة المتجددة

System Price Breakdown		Option A	Option B
Solar PV Materials (modules, inverters, solar cable etc)	SAR	1,340,150	2,977,200
Balance of System (mounting structures, AC cabling, panel boards etc)	SAR	1,705,600	3,849,750
Construction, Testing & Commissioning	SAR	1,144,850	2,289,750
Consultants, Logistics & Other Expenses	SAR	362,550	775,100
HAALA Staff Costs, Overheads & Margin	SAR	565,350	1,130,700
Total	**SAR**	**5,118,500**	**11,022,500**
$/Wp price for comparison	$/Wp	1.60	1.49

Pricing

HAALA | Energy
هالة للطاقة المتجددة

System Price Breakdown		Option A	Option B
Solar PV Materials (modules, inverters, solar cable etc)	SAR	1,340,150	2,977,200
Balance of System (mounting structures, AC cabling, panel boards etc)	SAR	1,705,600	3,849,750
Construction, Testing & Commissioning	SAR	1,144,850	2,289,750
Consultants, Logistics & Other Expenses	SAR	362,550	775,100
HAALA Staff Costs, Overheads & Margin	SAR	565,350	1,130,700
Total	**SAR**	**5,118,500**	**11,022,500**
$/Wp price for comparison	$/Wp	1.60	1.49
- 1 year of operation and maintenance included -			
Option to extend operation and maintenance to 5 years	SAR	150,000	300,000
Estimated cleaning costs, using client's in-house staff	SAR	30,000 / year	75,000 / year
Estimated inverter overhaul cost, c. year 15	SAR	125,000	250,000

Return on Investment

HAALA | Energy
هالة للطاقة المتجددة

Key Financial Metrics		Option A (0.85MWp)	Option B (1.97 MWp)
CAPEX	SAR	5,118,500	11,022,500
OPEX	SAR	80,000	175,000
System Lifetime		30 Years	30 Years
Annual savings (average in first 5 years)	SAR	308,735	730,498
Total Savings (net)	SAR	13,322,109	32,549,162
IRR		9.21%	10.09%
NPV (5% discount rate)	SAR	3,410,808	9,133,637

Return on Investment

HAALA | Energy
هالة للطاقة المتجددة

Key Financial Metrics		Option A (0.85MWp)	Option B (1.97 MWp)
CAPEX	SAR	5,118,500	11,022,500
OPEX	SAR	80,000	175,000
System Lifetime		30 Years	30 Years
Annual savings (average in first 5 years)	SAR	308,735	730,498
Total Savings (net)	SAR	13,322,109	32,549,162
IRR		9.21%	10.09%
NPV (5% discount rate)	SAR	3,410,808	9,133,637

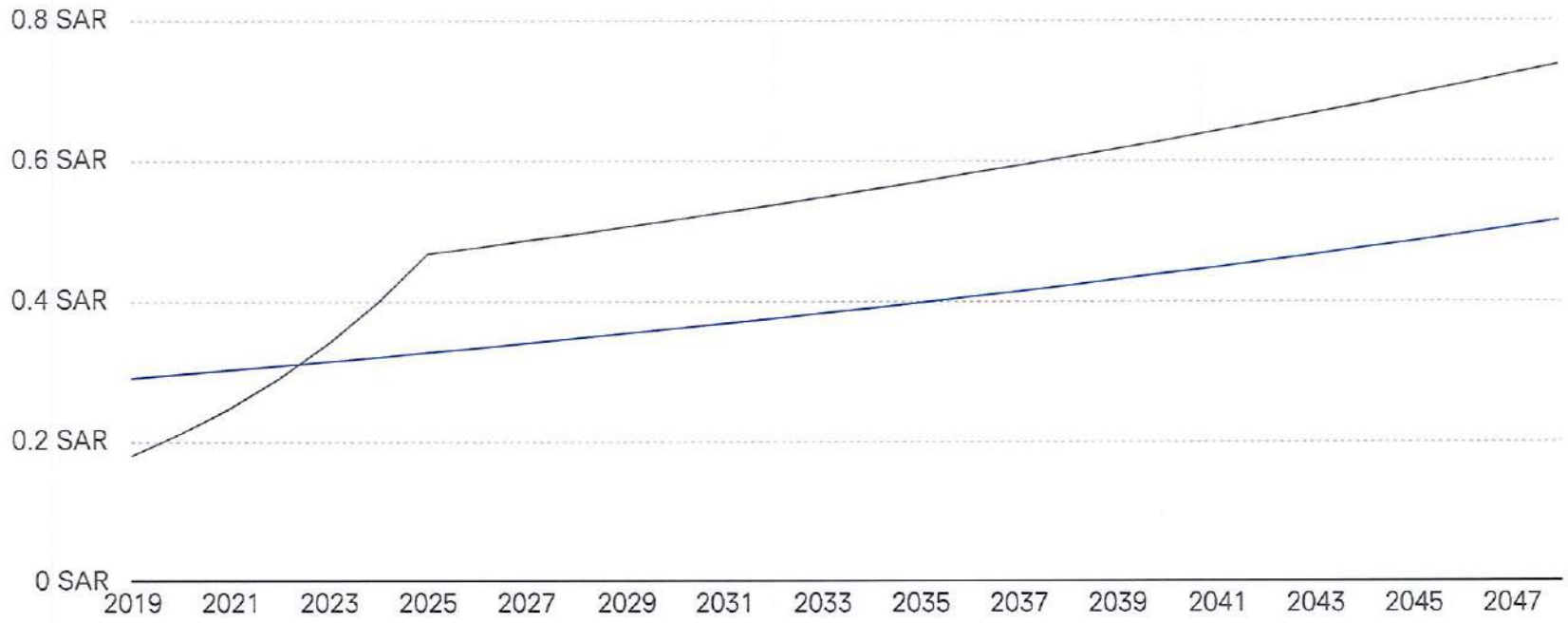
Levelized Cost of Energy (LCOE)			
Current (SEC)	SAR / kWh	0.18	0.18
Projected (SEC 30 year average)	SAR / kWh	0.52	0.52
Solar PV	SAR / kWh	0.20	0.18

Financed Solution

HAALA | Energy
هالة للطاقة المتجددة

- It may be possible to finance the project with third-party investors and operate under a lease agreement. PSU would buy the energy generated, rather than the system

- Zero Capex requirement
- Tariff would be higher than today's SEC tariff, but likely lower than future SEC rates



Upfront vs Financed Solution (Option B)

HAALA | Energy
هالة للطاقة المتجددة

Key Financial Metrics		Option A Upfront	Option B Upfront	Financed
CAPEX	SAR	5,118,500	11,022,500	-
OPEX	SAR	80,000	175,000	1,035,000
System Lifetime		30 Years	30 Years	30 Years
Annual savings (average in first 5 years)	SAR	308,735	730,498	(170,715)
Total Savings (net)	SAR	13,322,109	32,549,162	12,952,553
IRR		9.21%	10.09%	-
NPV (5% discount rate)	SAR	3,410,808	9,133,637	-

Levelized Cost of Energy (LCOE)				
Current (SEC)	SAR / kWh	0.18	0.18	0.18
Projected (SEC 30 year average)	SAR / kWh	0.52	0.52	0.52
Solar PV	SAR / kWh	0.20	0.18	0.29