

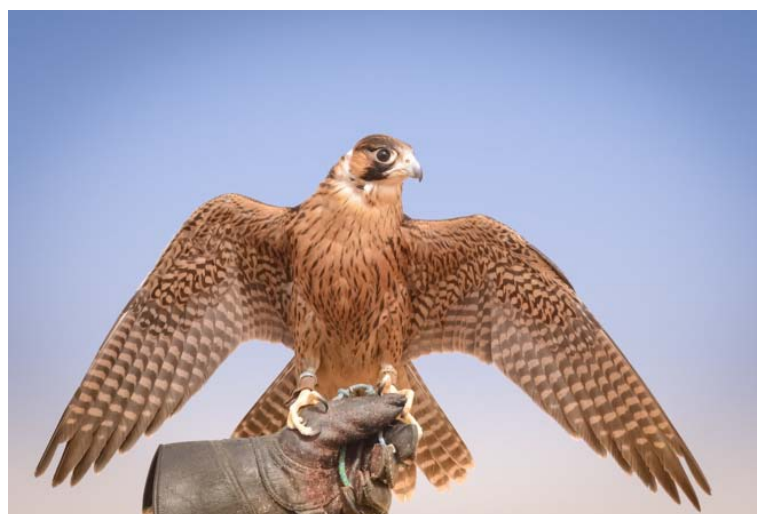


LAGI 2019
Abu Dhabi
Return to the Source



PROPOSAL

Nest calls upon primordial forces of earth, air, water, and light which manifest as jewel-like eggs from without and vibrant forests within. Bifacial photovoltaic modules which hold world records in efficiency form the eggs shells, collecting sunlight from all angles and **generating enough energy to cool 2,590 Masdar homes**. Visitors descend below a gleaming courtyard of white marble and ascend into realms of verdant life. Patterned after Peregrine Falcon eggs, strategically placed, clear glass panels will allow sunlight transmission in combination with light passing between solar cells to fuel three vibrant worlds, a rainforest, a cloud forest, and a floating forest with light levels balanced for each environment.

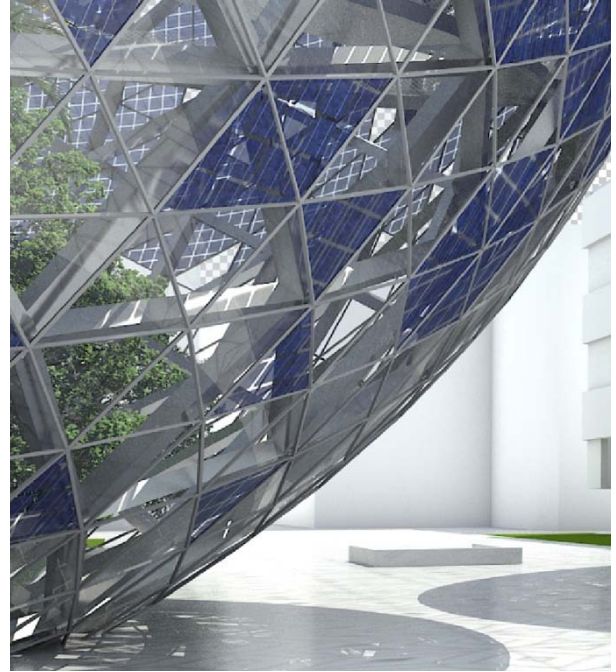


Featured as an emblem of the UAE and rooted in Bedouin culture, falcons are treasured members of many UAE families, the **Abu Dhabi Falcon Hospital alone treats over 11,000 raptors each year**. Paying homage to these much loved avians, Nest holds three eggs, a typical clutch. Three also links with the Three Pearl efficiency standard utilized in Masdar City and the UAE.

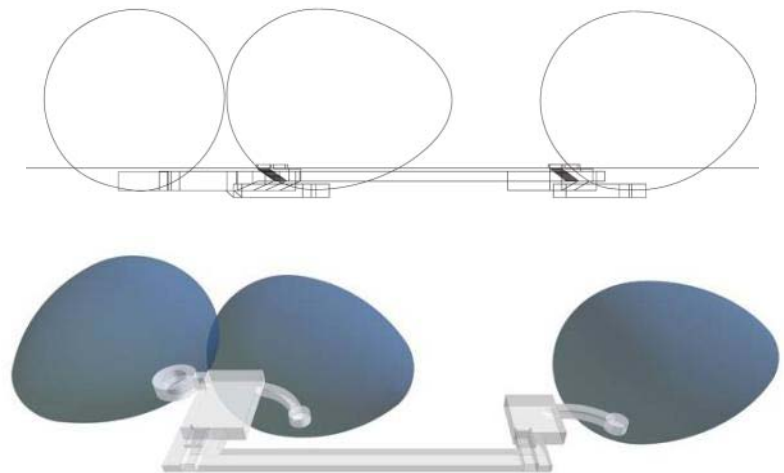


DESIGN

Evoking a hidden aerie, Nest holds orbs of life which provide a gateway into Masdar city and a sanctuary for visitors seeking a green oasis away from scorching summer heat. Clean unbroken lines rise from an expansive courtyard providing unobstructed fields of view highlighting the natural beauty of an ancient form, symbolic of life. White marble tiles reflect light onto solar modules increasing generation and helping cool the courtyard while aligning with the Masdar City Master Plan. Creation of enclosed spaces requires conditioning to account for the local climate, **Ground Sourced Geothermal** in combination with **Energy Recovery Ventilators (ERV)** have been selected to provide a carbon free and energy efficient solution entirely powered by solar.

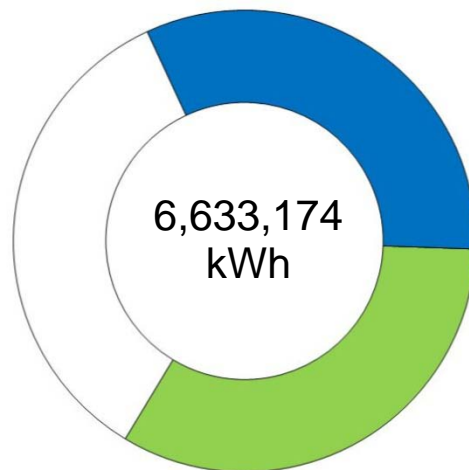


Constructed with a robust yet lightweight **omnitrangulated structure**. Eggs are open on the inside, a combination of frameless bi-facial solar modules and clear glass panels form the outer shells with flush glazing to limit soiling. A higher concentration of clear glass is integrated at street level to provide greater visibility into the eggs. **Two primary entrances** one on each side of the bisecting GRT Loop provide access to a sheltered pedestrian-way connecting all three eggs. *Visitor facilities and mechanical rooms are located below grade with inlaid glass incorporated into the courtyard's tile pattern to provide passive lighting.*

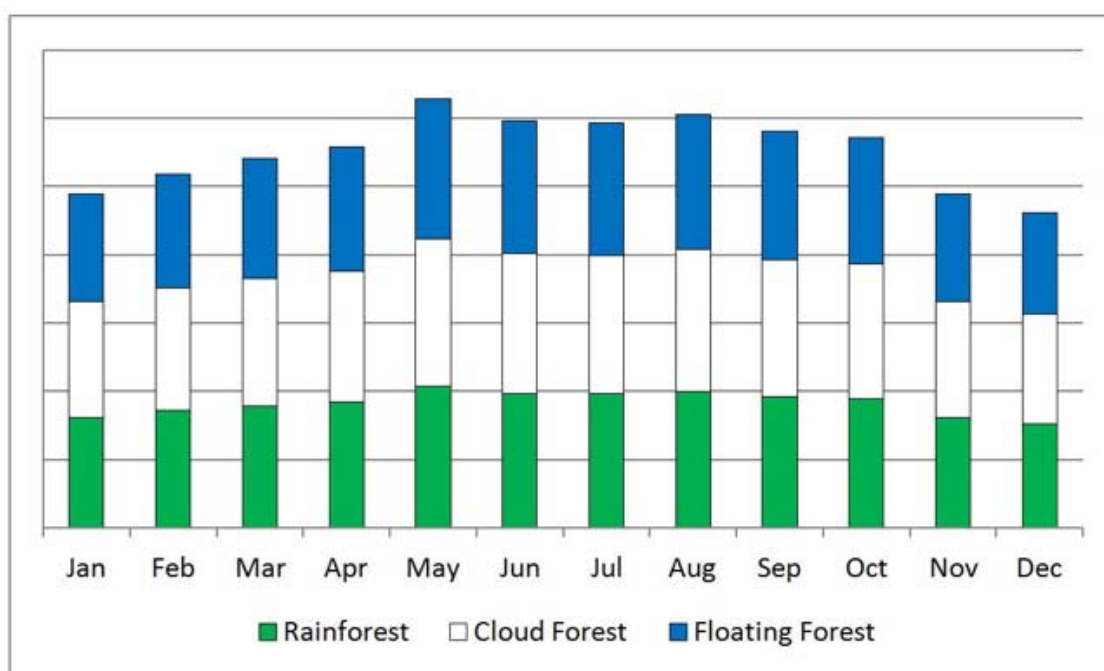


GENERATION

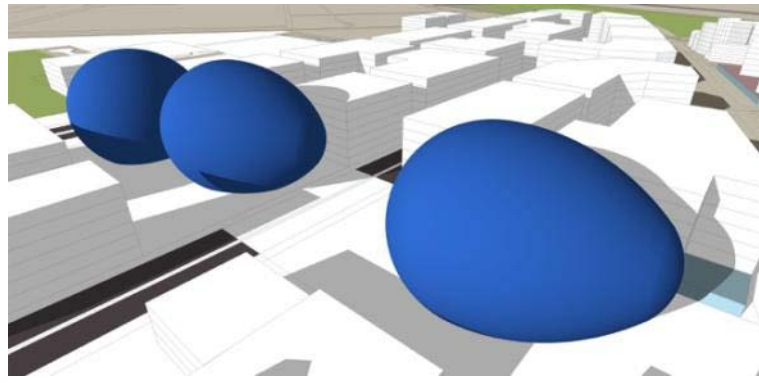
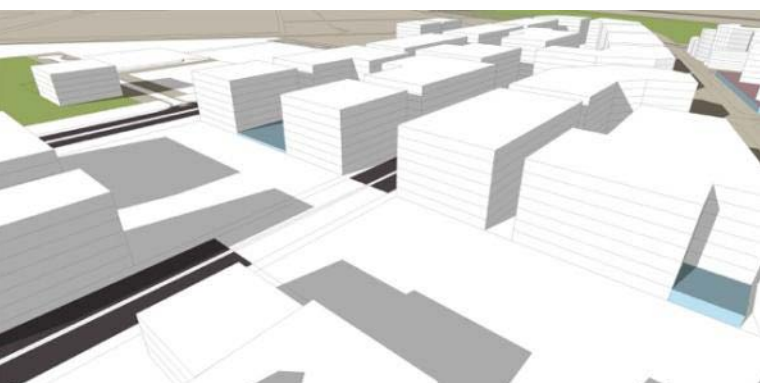
- **5,144.3 kW of DC Capacity**
- 11,063 solar modules, 465 watts each, 1500V DC
- 36 x 120kW String Inverters, 1500V DC, 400V AC
- **Annual Energy Generation 6,633,174 kWh**



Orientation was selected to maximize generation.



Height increases solar production by placing prime solar modules above shading from adjacent structures



TECHNOLOGY

Our team draws upon decades of experience across hundreds of megawatts in renewable energy with deep specialization in design, construction, and operation of photovoltaic plants plus manufacturing of solar modules. **Mono Crystalline Bifacial PERC** modules combined with **module level DC optimization** represent the vanguard of commercially available technology, offering superior performance, long-term reliability, and the lowest cost.

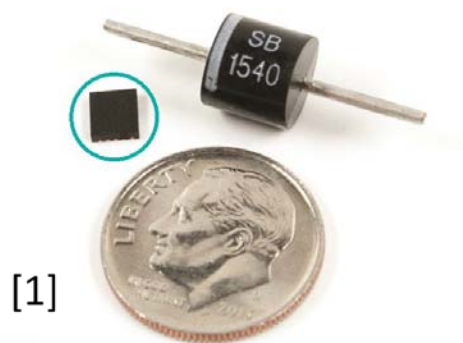
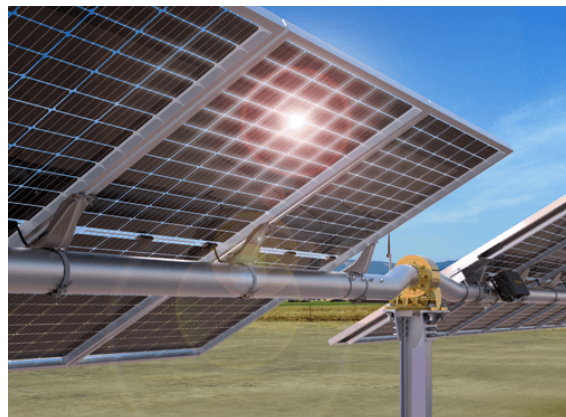
For example, phase 3 of the 800 MW Mohammed bin Rashid Al Maktoum Solar Park, which achieved the lowest price for solar-powered electricity in 2016, is expected to use bifacial technology in its final phase.

[0]

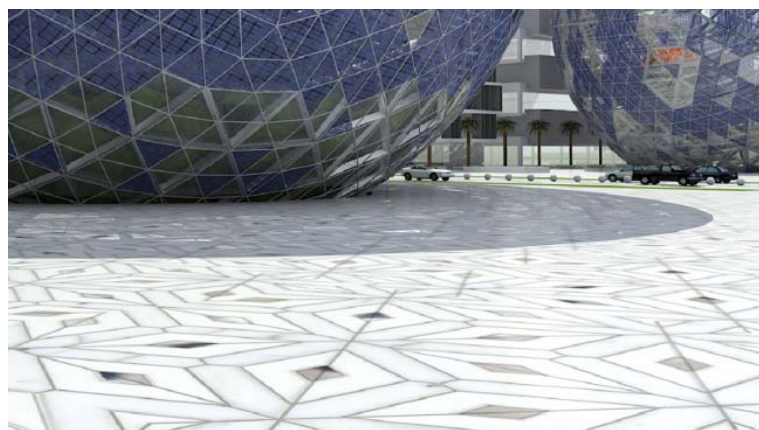
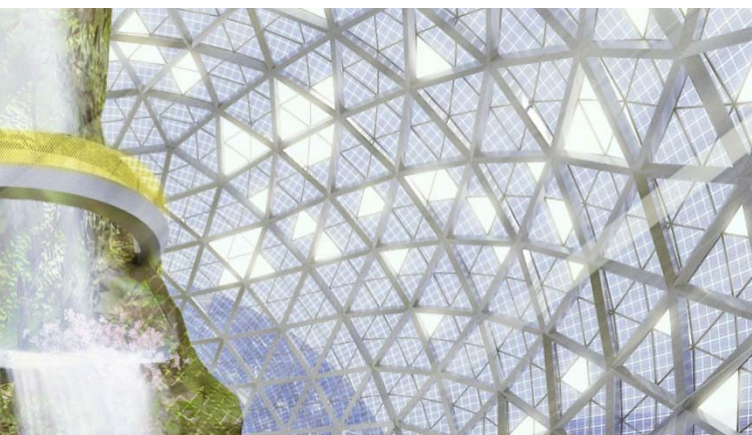
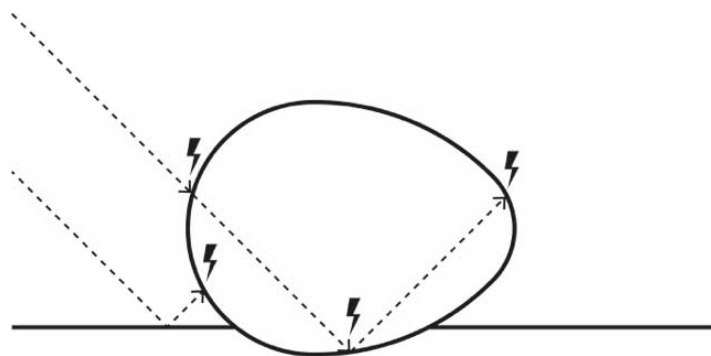
Solar modules connect in long chains called a string. If any links in the chain are impacted it impacts all links. **DC optimization** eliminates this “miss-match” loss. While multiple global vendors provide DC optimization, we have selected **Maxim** which provides multiple optimizers that are integrated into each solar module, providing superior performance.

PERC Bifacial Technology has roughly 71% more power per meter² than the local First Solar CdTe 10MW solar array.

Reflected light off white surfaces when combined with bifacial technology can **increase solar production over 20%**



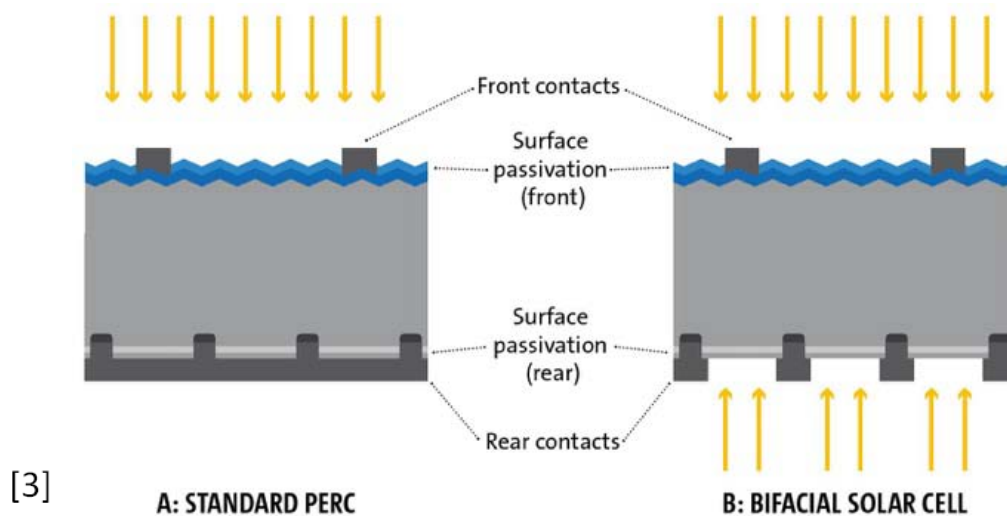
[1]



Longi a world leader in bifacial technology has set world records in cell efficiency and is our preferred technology.

Passive Emitter Rear Contact (PERC) solar cells have dominated the solar market in recent years and launched the growth of bifacial. *By making slight alterations a manufacturer can produce a cell with two sides at minimal extra cost.*

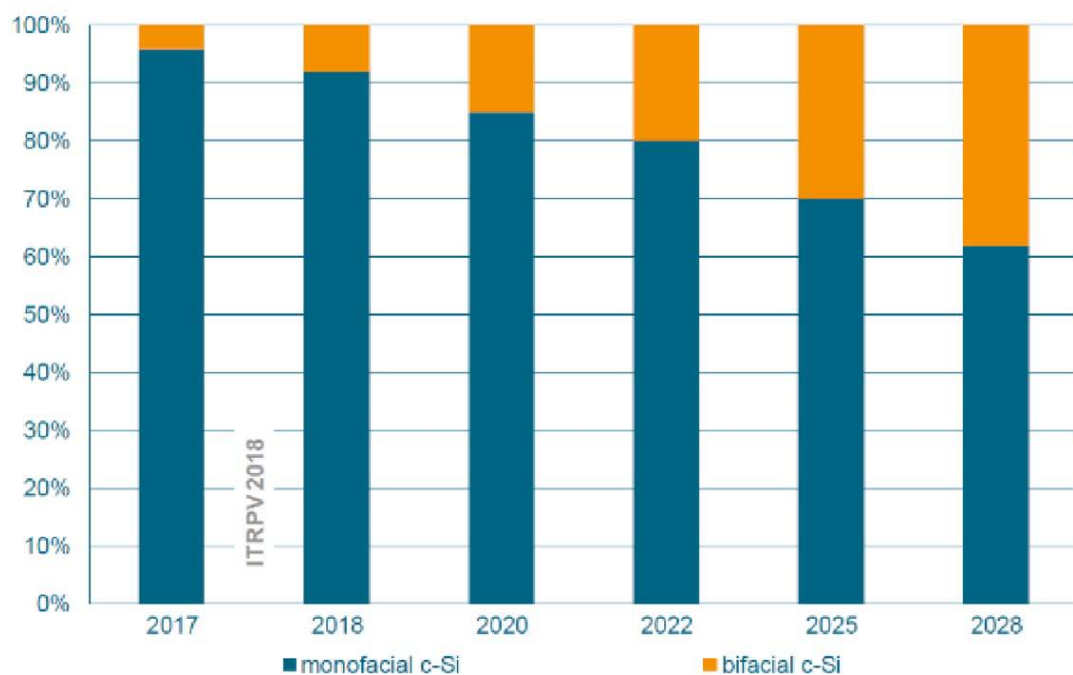
[2]



Bifacial market share is expected to grow rapidly.

Bifacial cell technology

World market share [%]



[4]

BANKABLE

Longi is the **7th largest global module manufacturer**, if Longi is unable to provide modules when Nest is constructed many other top manufacturers offer bifacial technology.

- Longi Glass/Glass Modules carry a standard **30 year power warranty**;
- SMA Sunny Tripower 60kW Inverters carry an extended warranty for 15 years.

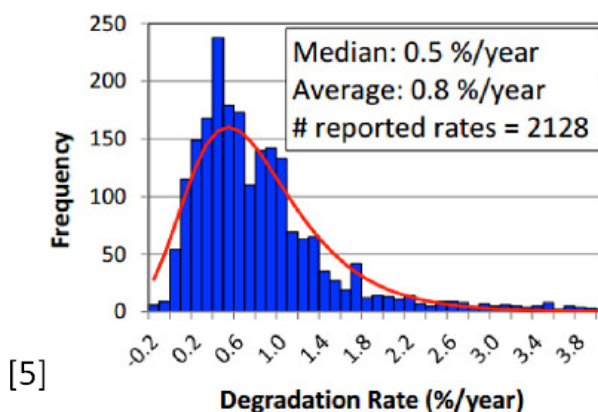
Tier 1 Solar Module Manufactures as of Q1 2019

Annual Module Capacity		Annual Module Capacity	
Firm/Brand	MW/year	Firm/Brand	MW/year
Jinko*	10,000	Sumec/Phono Solar*	2,000
Canadian Solar*	8,700	Jinneng	2,000
Risen Energy*	8,600	REC Group*	1,500
JA Solar*	8,500	Waaree	1,500
Hanwha Q-Cells*	8,000	HT-SAAE*	1,500
Trina Solar*	8,000	Adani/Mundra*	1,200
Longi*	7,500	Vikram Solar*	1,100
GCL*	5,400	ET Solar	1,000
Talesun	4,800	Neo Solar Power/URE	1,000
Seraphim*	4,000	Lightway	1,000
Suntech*	3,900	Boviet*	800
Renesola	3,500	Hansol Technics	600
ZNShine*	3,200	S-Energy	530
First Solar*	2,900	AU Optronics	500
Chint/Astronergy*	2,500	Shinsung	300
LG Electronics*	2,500	Heliene*	250
BYD*	2,400	Sharp	210
Eging	2,100	Total	113,490

* Indicates Module Manufacturers for which Technical Due Diligence Report (PQP) is available from PV Evolution Labs

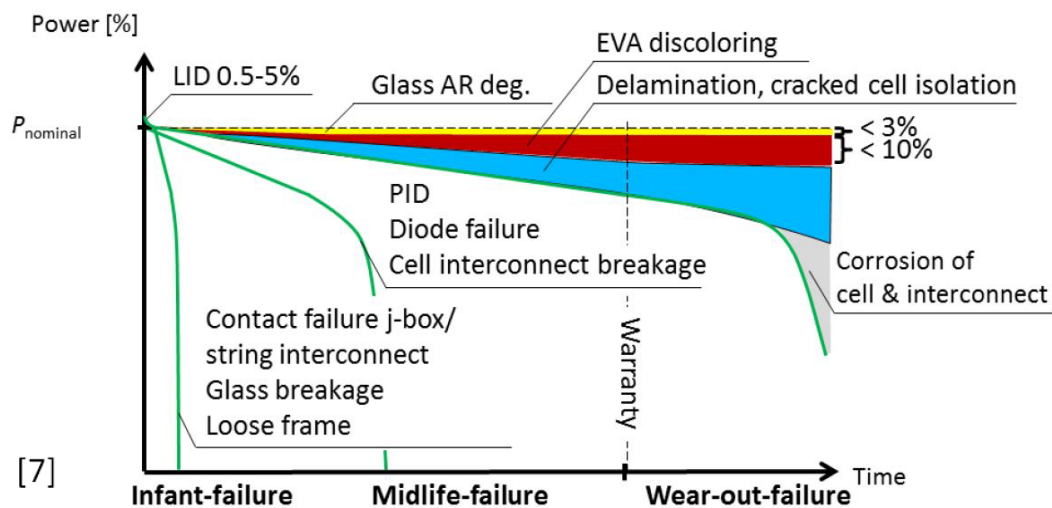
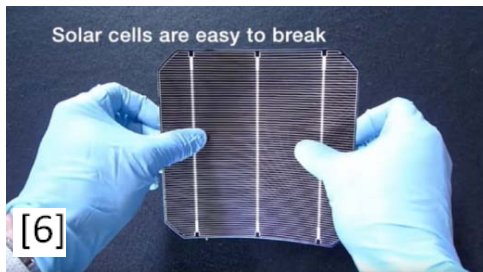
DURABILITY

Long-term reliability is critical to a successful design. Crystalline solar technology has decades of documented performance data. *Not all technologies have performed well* and **annual degradation** (amount of lost DC capacity each year) varies significantly. **Carefully selecting raw materials, validating the design through durability testing and managing the manufacturing process drives superior long-term performance.**

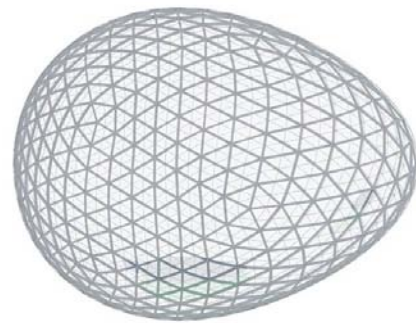


Module design plays a key role. Crystalline cells are fragile and when bent or impacted they shatter, this damage is invisible to the naked eye in a laminated module because the cell fragments are held together by the laminate however over time pieces can separate and the cell/module

loses power or fails completely. For this reason we are not using "flexible" crystalline modules. Another source of failure is water entering the module through polymer laminates and is why we have selected a **glass/glass design which offers maximum durability and superior warranties**.



Climate change has increased severe weather including high winds which can cause serious damage to solar fields. Our design uses an **omnitriangulated structure** that is both **lightweight and extremely strong**. Our design with fully captured modules is rated for winds in excess of 200km/h.



SOILING

Soiling is a major factor in the MENA region. **Soiling rates in excess of 10% per month** have been measured. Our design minimizes horizontal surfaces and uses frameless modules to reduced dust collecting on edges and flat surfaces.



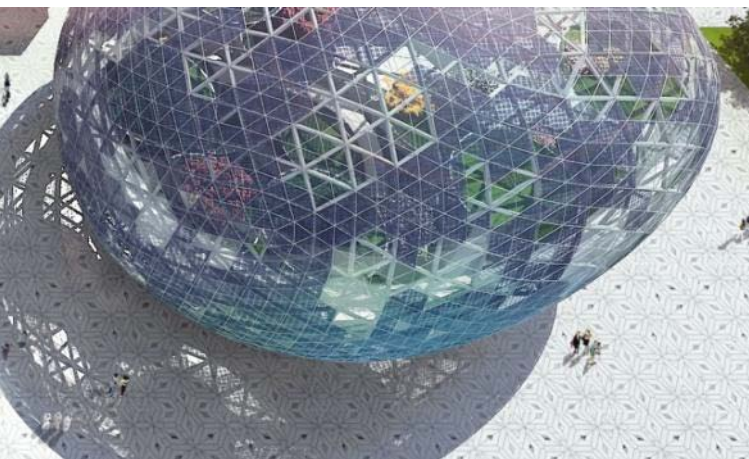
Even with a vertical orientation soiling is inevitable so planning/budgeting for cleaning is important.



OPERATIONS & MAINTENANCE

Unrestricted lift access is provided around each egg and sturdy glass/glass construction allows for easy cleaning without damaging modules. Water is precious, limited, and costly so any used for cleaning flows to the base of each structure where it is collected in cisterns for reuse to water plants.

String Inverters minimize lost energy during equipment failure and allow for rapid repair utilizing onsite spares. In the event of the original module or inverter manufacturer departing the market, many alternate options are available for glass/glass bifacial technology and string inverters.



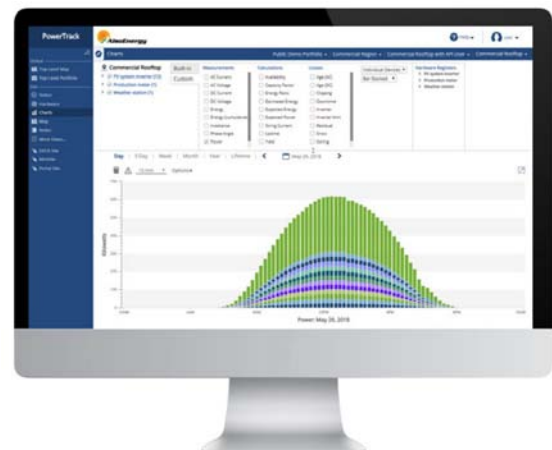
ENVIRONMENTAL IMPACT

Construction of Nest will occur on land previously developed to varying degrees. Any native species found onsite will be relocated as appropriate. The Floating Forest will be an opportunity to highlight specific native flora. Locally and regionally sourced building materials shall be prioritized. While ensuring premium quality solar modules are procured to enable long-term durability and limit overall lifetime embodied energy the module construction shall be lead-free. Elimination of aluminum frames greatly reduces embodied energy. Pumped hydro provides a clean

storage solution with no end-of-life complications and no operating environmental risk. Glass surfaces pose some risk to avian species, promoting falconry near Nest will discourage other avians from flying too close. All energy required to maintain interior ecosystems shall be generated onsite. Being within walking distance for Masdar residents and served by public transit will help mitigate the carbon footprint of visitors. Design minimizes soiling and reduces water usage, any water needed for washing is repurposed.



A **Data Monitoring Platform** will track environmental benefits from carbon offsets in addition to providing insight into system performance for the O&M team.

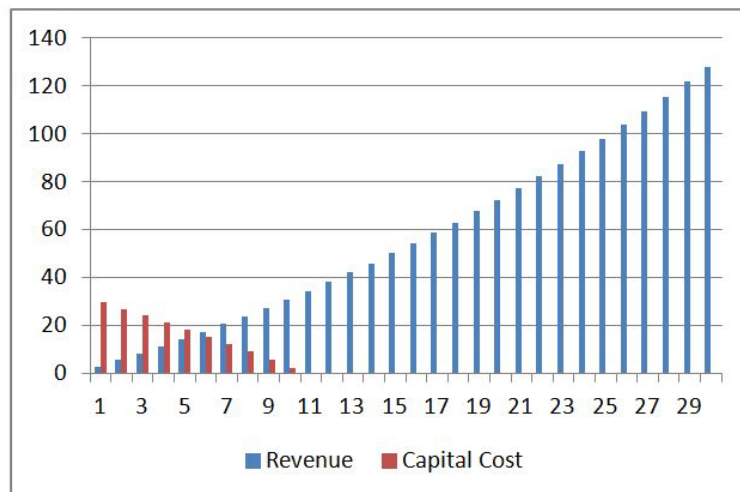


Energy Offset \$\$/kWh	0.06
Energy (kWh)	6633174
Modules W	465
Total Module Count	11063
Total Size	5144295
Module Cost \$\$/W	\$ 0.50
Inverter Cost \$\$/W	\$ 0.09
Structure Cost \$\$/W	\$ 2.00
BOS	\$ 1.00
Labor	\$ 1.00
O&M \$\$/W	\$ 0.12
Annual Escalator	3.0%
Total Inverter	\$ 462,987
Total Module	\$ 2,572,148
Total Structure	\$ 10,288,590
BOS	\$ 5,144,295
Labor	\$ 5,144,295
Biomass	\$ 6,000,000
Total \$\$/W	\$ 5.76
Total Capital Cost	\$ 29,612,314
Total O&M Year 1	\$ 617,315
Total Annual Energy Savings	\$ 397,990
Total Event Revenue	\$ 720,000
Revenue per Event	\$ 15,000
Events Annually	48
Annual Visitors	54750
Visitor Per Day	150
Revenue Per Visitor	\$ 40
Visitor Revenue	\$ 2,190,000
Total Annual Revenue	\$ 3,307,990

Lifetime Gross Margin = \$128MM

With low energy rates in the UAE the return on investment from Nest is driven primarily through visitors and hosting events. Economic benefits from increased tourism, higher occupancy of surrounding residences, scientific engagement with the biodiversity, child education and general the well being of Emirates/Expats was not considered in this analysis but we feel this work holds great potential in all of the above categories.

With rock-solid, state-of-the-art technology and a sound long term strategy for O&M, Nest is a viable enterprise and holds great potential.



Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Energy Offset	\$	0.4	\$0.4	\$0.4	\$0.4	\$0.4	\$0.5	\$0.5	\$0.5	\$0.5	\$0.5	\$0.5	\$0.6	\$0.6	\$0.6	\$0.6	\$0.6	\$0.7	\$0.7	\$0.7	\$0.7	\$0.7	\$0.7	\$0.8	\$0.8	\$0.8	\$0.8	\$0.9	\$0.9	\$0.9	\$0.9
Event Revenue	\$	0.7	\$0.7	\$0.8	\$0.8	\$0.8	\$0.8	\$0.9	\$0.9	\$0.9	\$0.9	\$1.0	\$1.0	\$1.0	\$1.1	\$1.1	\$1.1	\$1.2	\$1.2	\$1.2	\$1.3	\$1.3	\$1.3	\$1.4	\$1.4	\$1.5	\$1.5	\$1.6	\$1.6	\$1.6	\$1.7
Visitor Revenue	\$	2.2	\$2.3	\$2.3	\$2.4	\$2.5	\$2.5	\$2.6	\$2.7	\$2.8	\$2.9	\$2.9	\$3.0	\$3.1	\$3.2	\$3.3	\$3.4	\$3.5	\$3.6	\$3.7	\$3.8	\$4.0	\$4.1	\$4.2	\$4.3	\$4.5	\$4.6	\$4.7	\$4.9	\$5.0	\$5.2
Total Revenue	\$	3.3	\$3.4	\$3.5	\$3.6	\$3.7	\$3.8	\$3.9	\$4.1	\$4.2	\$4.3	\$4.4	\$4.6	\$4.7	\$4.9	\$5.0	\$5.2	\$5.3	\$5.5	\$5.6	\$5.8	\$6.0	\$6.2	\$6.3	\$6.5	\$6.7	\$6.9	\$7.1	\$7.3	\$7.6	\$7.8
O&M Cost	\$	0.6	\$0.6	\$0.7	\$0.7	\$0.7	\$0.7	\$0.7	\$0.8	\$0.8	\$0.8	\$0.8	\$0.9	\$0.9	\$0.9	\$0.9	\$1.0	\$1.0	\$1.0	\$1.1	\$1.1	\$1.1	\$1.1	\$1.2	\$1.2	\$1.3	\$1.3	\$1.4	\$1.4	\$1.5	
Net Revenue	\$	2.7	\$2.8	\$2.9	\$2.9	\$3.0	\$3.1	\$3.2	\$3.3	\$3.4	\$3.5	\$3.6	\$3.7	\$3.8	\$4.0	\$4.1	\$4.2	\$4.3	\$4.4	\$4.6	\$4.7	\$4.9	\$5.0	\$5.2	\$5.3	\$5.5	\$5.6	\$5.8	\$6.0	\$6.2	\$6.3
Lifetime GM	\$	128.0																													
Total Capital Cost	\$	29.6																													
Simple Payback	<10 Years																														

EMBODIED ENERGY

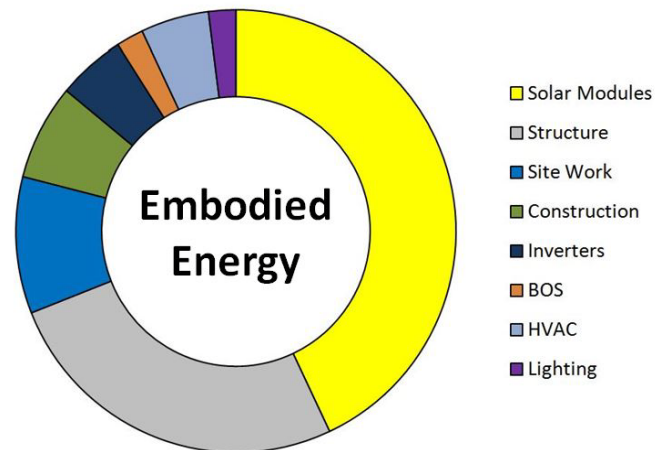
Frameless modules significantly reduces embodied energy and they will recover their embodied energy in less than two years.
Total embodied energy for Nest will be recovered in less than five years.

Dimensions:

- Eggs are 40 meters above grade;
- Above grade surface area 10,886 meters²
- Total surface area 32,659 meters²
- Total Active Area 27,216 meters²

Major Materials:

- Glass & Crystalline Silicon;
- Steel;
- Aluminium Extrusion;
- Concrete & Natural Stone;
- Biomass.



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