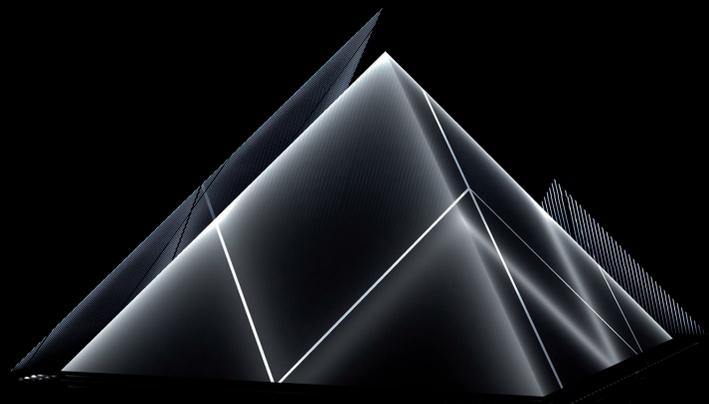


# LUNAR CUBIT

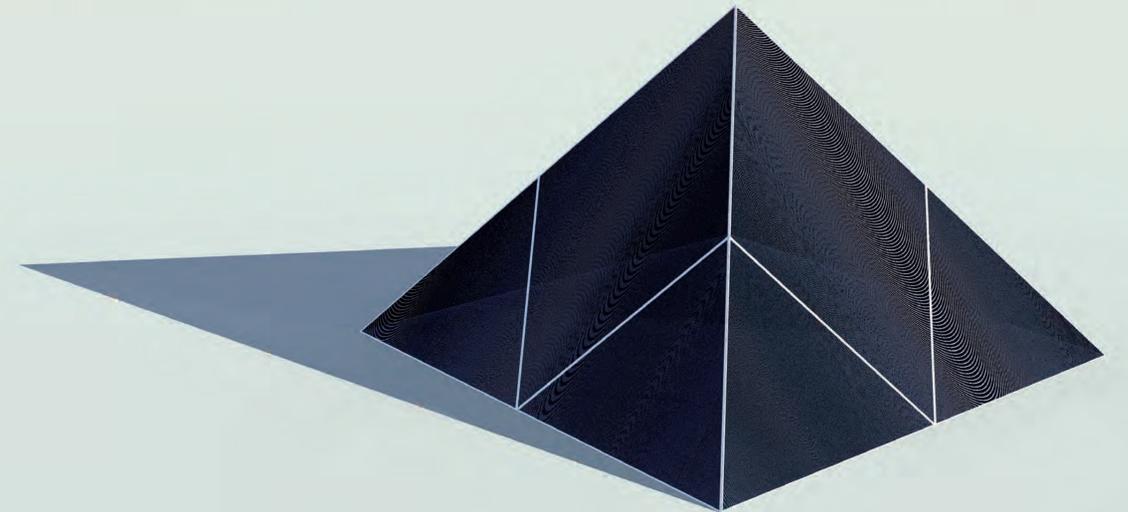
WINNER OF 2010 UAE DESIGN COMPETITION FOR  
ENERGY GENERATING PUBLIC ART

NIGHT



ILLUMINATES WITH LOW ENERGY LED LIGHTING

DAY



TRANSFORMING SUNLIGHT IN ELECTRICITY

Lunar Cubit is a site specific proposal to be constructed in Abu Dhabi just outside Masdar City, the world's first zero carbon metropolis once completed. Combining artistic vision with sustainable design and engineering, Lunar Cubit examines the nature of time through nightly contemplation of lunar phases and daily transformation of sunlight into electricity, powering up to 250 homes and at night illuminating inversely proportional to the lunar cycle. This work is open to the public, inviting a personal experience where one can literally reach out and touch a 1.74MW utility scale power plant, in the form of nine monolithic pyramids rising from the sands of Abu Dhabi.

7:00h

7:30h

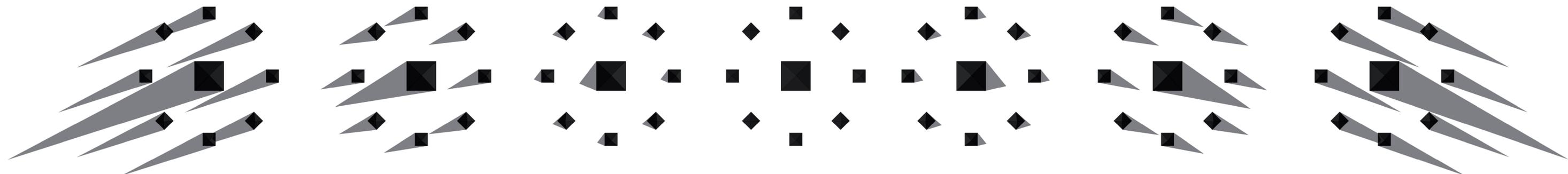
9:00h

12:00h

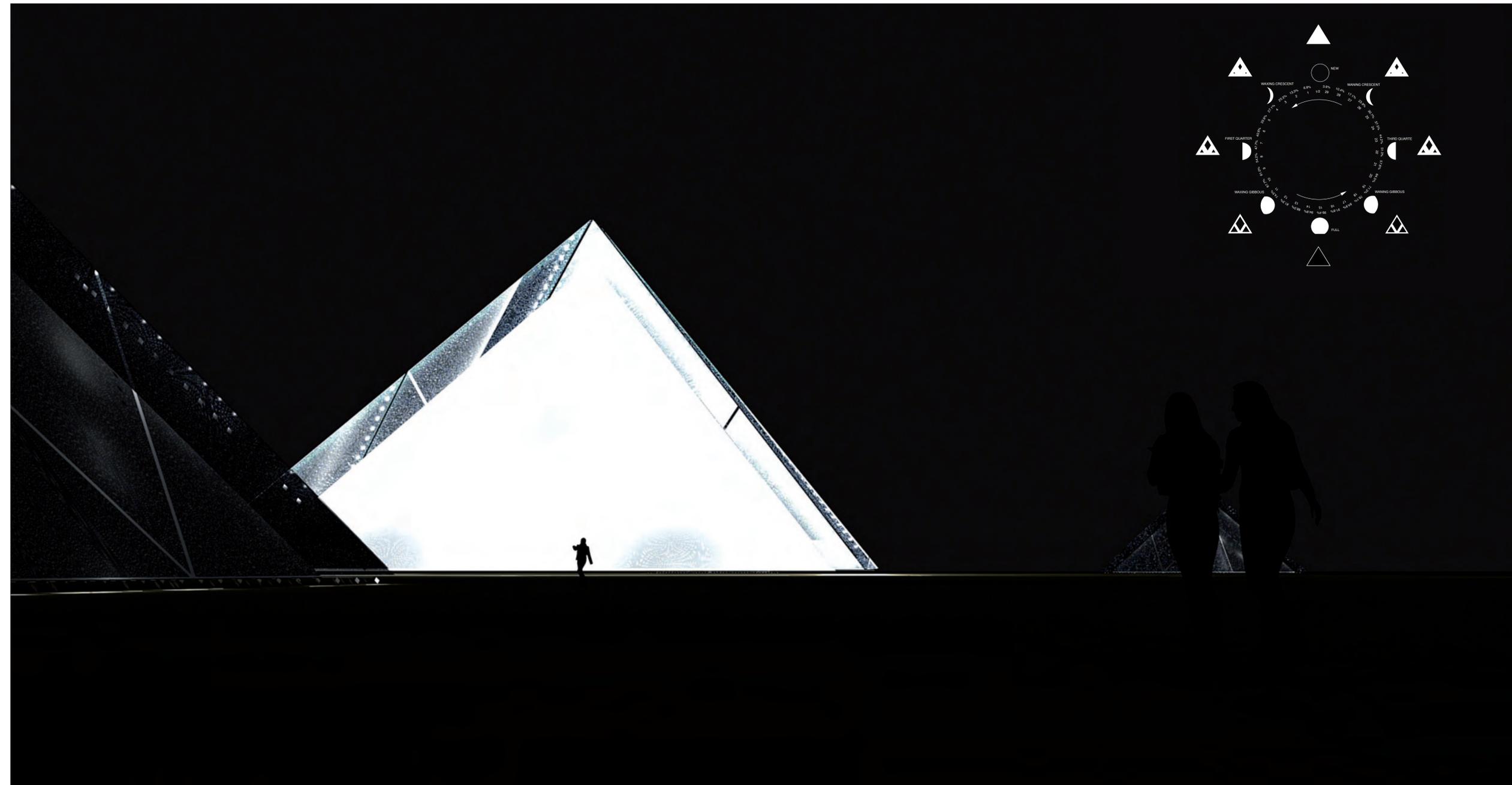
18:00h

19:00h

19:45h



# LUNAR CUBIT



Lunar Cubit represents nine pyramids made of solar panels that collect energy during the day and illuminate at night inversely proportional to the lunar cycle.

New Moon  Fully Illuminated  
 Full Moon  Totally Dark

With no moving parts, no exposed wires or hazardous elements this work invites personal interaction and meditation. Viewers are free to get as close as they like, even touch the pyramids and experience energy from the sun being transformed into electricity.

Linked to the site is a data monitoring system accessible anywhere in the world, providing real time data showing how much energy the pyramids are producing. Visitors can use their smart phone or view the data at a kiosk display located on site.

Visible from the sky, travelers flying into Abu Dhabi international airport will be welcomed with pyramids of light and easy access from the airport road will attract visitors, wanting to get a closer look at what they could see from the sky.

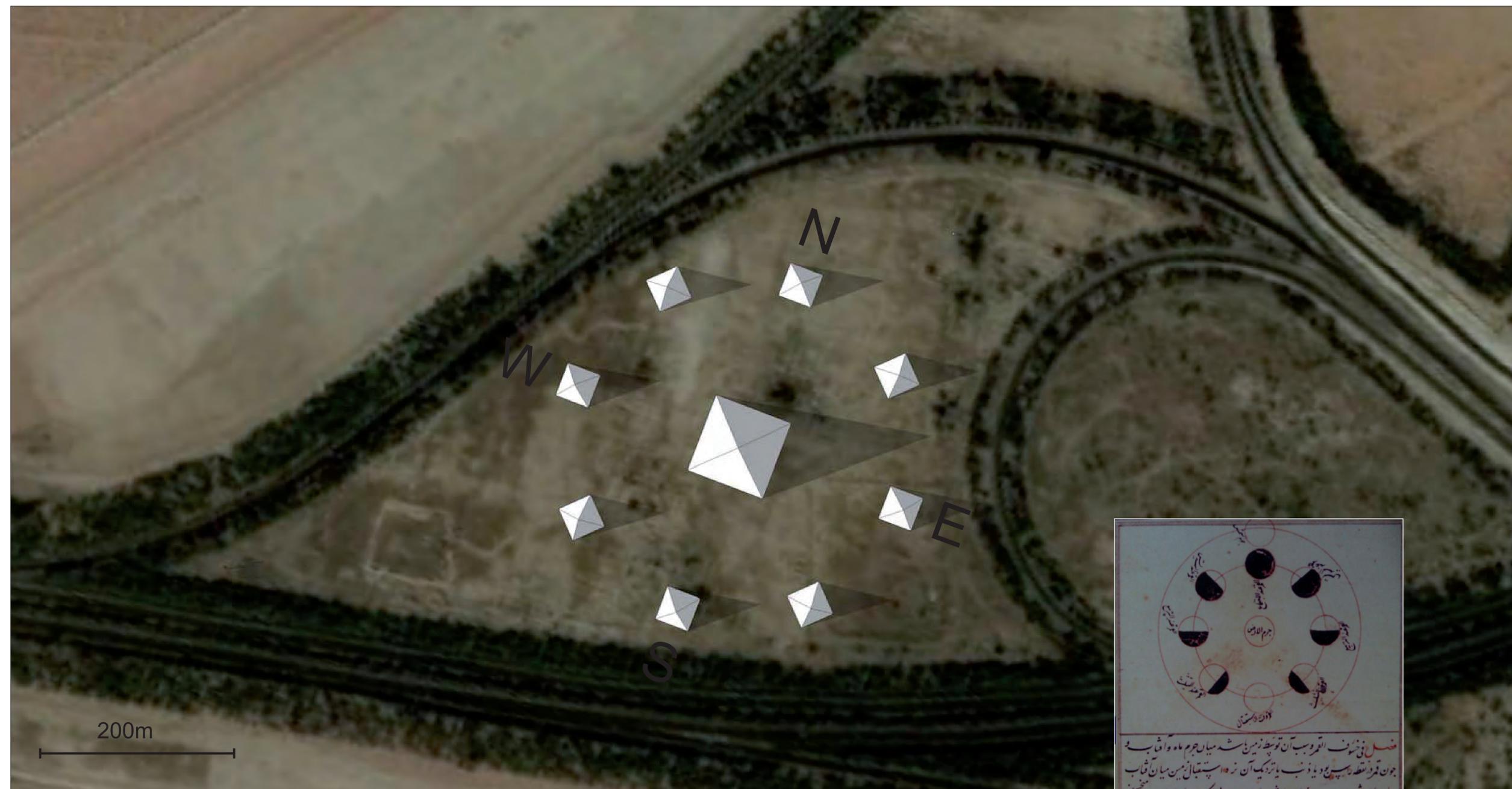
Honoring local customs, Lunar Cubit marks the lunar phases. Hilal is an Arabic term, meaning crescent moon, first developed in pre-Islamic Arabia. The very slight crescent moon that is first visible after a new moon. Muslims look for the hilal when determining the beginning and end of Islamic months. The need to determine the precise appearance of the hilal was one of the inducements for Muslim scholars to study astronomy and is an exciting link with this project.

LOOKING EAST TOWARD CENTER PYRAMID ON THE NIGHT OF A NEW MOON



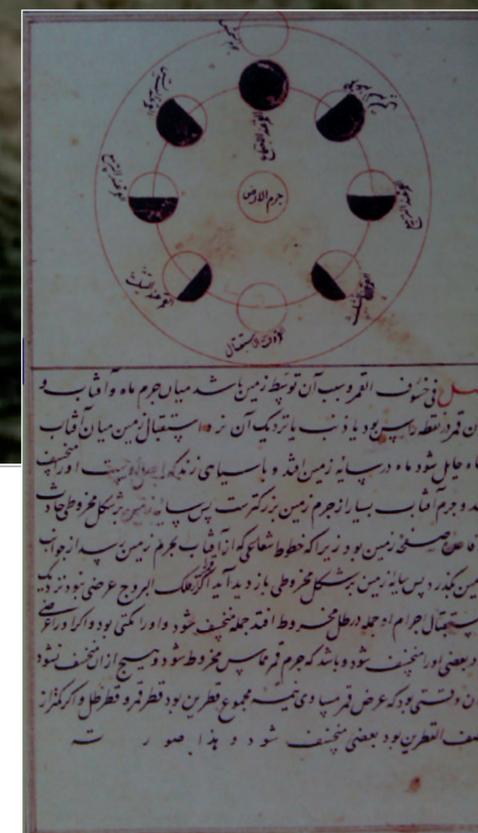
WAXING CRESCENT      FIRST QUARTER      WAXING GIBBOUS      FULL      WANING GIBBOUS      THIRD QUARTER      WANING CRESCENT      NEW

# LUNAR CUBIT



Designed with proportions matching the Great Pyramid at Giza and scaled using Royal Cubits, the earliest attested standard of measure; eight pyramids each 42 Royal Cubits high (~22meters) form a ring around a central pyramid 96 Royal Cubits high (~50 meters). Each of the eight smaller pyramids represents one of the eight lunar phases. Starting at North and rotating counter clockwise, following the orbit of the moon, they are; New, Waxing Crescent, First Quarter, Waxing Gibbous, Full, Waning Gibbous, Third Quarter, Waning Crescent. Each night the central pyramid will always illuminate inversely to the lunar cycle. Pyramids forming the ring also illuminate inversely but are lit only when their corresponding moon phase is active, orbiting around the central pyramid like the moon orbits around earth.

A cubit is the first recorded unit of length and was one of many different standards of measurement used through history. It was originally based on measuring by comparing to one's forearm length. Cubits were employed through Antiquity, the Middle-Ages up to the Early Modern Times, especially for measuring cords and textiles, but also for timbers, stone and volumes of grain. The Egyptian hieroglyph for the unit shows the symbol of a forearm, but it was rather longer than any actual forearms. The Egyptian cubit was not subdivided into centimeters or inches, but into palms and digits. The Egyptian cubit was subdivided into 7 'palms' of 4 'digits', making 28 parts in all, and was between 52.3 and 52.4cm in length.



16TH CENTURY PERSIAN MANUSCRIPT „WONDERS OF CREATION“ AL QUAZWINI

The Islamic calendar or Muslim calendar or Hijri calendar is a lunar calendar consisting of 12 lunar months in a year of 354 or 355 days. It is used to date events in many Muslim countries (concurrently with the Gregorian calendar), and used by Muslims everywhere to determine the proper day on which to celebrate Islamic holy days and festivals. The first year was the year during which the emigration of the Islamic prophet Muhammad from Mecca to Medina, known as the Hijra, occurred. Each numbered year is designated either H for Hijra or AH for the Latin anno Hegirae (in the year of the Hijra).[1] A limited number of years before Hijra (BH) are used to date events related to Islam, such as the birth of Muhammad in 53 BH.[2] The current Islamic year is 1431 AH, from approximately 18 December 2009 (evening) to 6 December 2010 (evening).

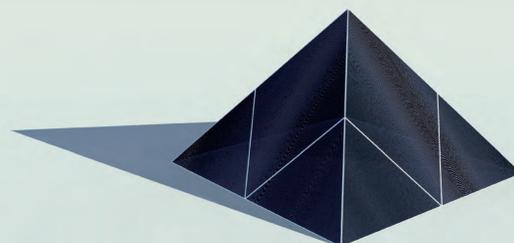
RATED CAPACITY 1.74 MW  
LUNAR CUBIT WILL  
GENERATE ENOUGH  
ELECTRICITY TO POWER  
250 HOMES

NIGHT



ILLUMINATES WITH LOW ENERGY LED LIGHTING

DAY



TRANSFORMING SUNLIGHT INTO ELECTRICITY

# LUNAR CUBIT



Made from Amorphous Silicon solar panels, this work is tailored to withstand the high temperatures of Abu Dhabi, with an operating range upto 85°C (185°F) Amorphous Silicon is also ideal for low light situations such as the north side of the pyramids.

Each outer pyramid has a DC rating of 131kw, totaling 1048kw for all eight. The center pyramid has a DC rating of 691kw. All nine have a combined DC rating of 1739kw - enough energy to power 250 homes for an entire year.

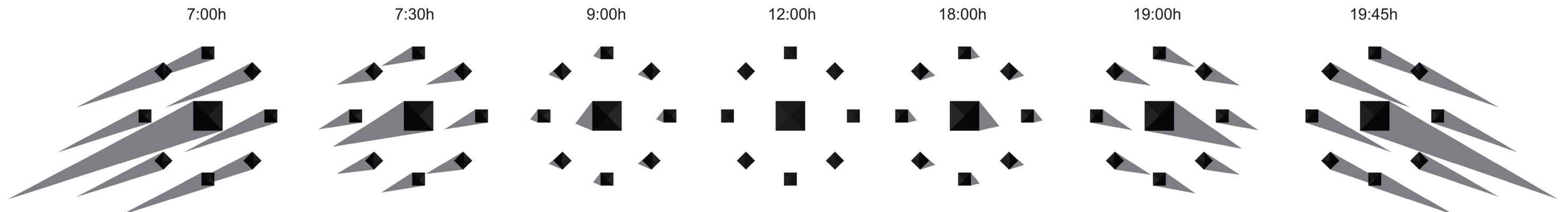
Expected output values were calculated using NREL TMY3 data and even though orientation for all the solar panels is not true south, the total loss in expected output is less than 25% from ideal.

Site three is located about 100km north of the Tropic of Cancer. The Tropic of Cancer is the circle of latitude on the earth that marks the apparent position of the sun at the time of the northern solstice. Also referred to as the Northern tropic, it is one of the two tropics (with the Tropic of Capricorn) that represent the extremes of the sun's path across the sky with the change of the seasons.

Because of the tilt of the earth's axis of rotation relative to the plane of its orbit around the sun, the sun is directly overhead on the Tropic of Cancer at the June solstice. It is the northernmost latitude at which the sun reaches 90 degrees above the horizon at its zenith, with the Northern Hemisphere tilted toward the sun to its maximum extent.

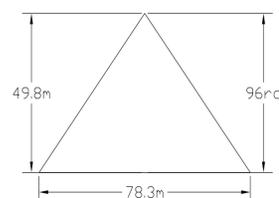
The tropics are two of the five major degree measures or major circles of latitude that mark maps of the Earth, besides the Arctic and Antarctic Circles and the Equator.

## SHADE STUDY - SUMMER SOLSTICE JUNE 21, 2010

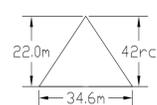


# LUNAR CUBIT

## PYRAMIDS



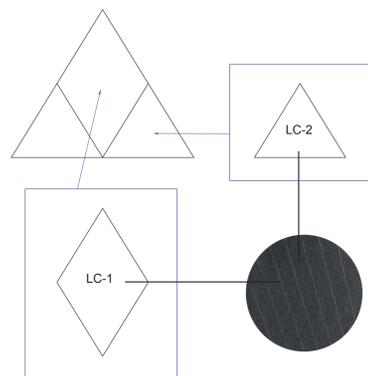
RATED POWER  
691 KW DC  
SURFACE AREA  
10 000m<sup>2</sup>



RATED POWER  
131 KW DC  
SURFACE AREA  
1894m<sup>2</sup>

Built on a concrete foundation with a steel support structure that carries an extruded aluminum facade, engineered by Schüco, a world leader in building integrated photovoltaics (BIPV)

## SOLAR PANELS



AMORPHOUS SILICON (a-Si) THIN FILM

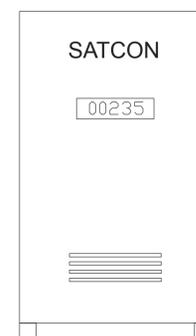
HIGH PERFORMANCE  
LOW LIGHT

THERMAL OPERATING  
RANGE - 40°C TO 85°C

25 YEAR POWER  
OUTPUT WARRANTY

SUNTECH Thin Film solar panels, LC-1 and LC-2 create a beautiful seamless facade while providing 1.74MW of rated power. For this application Amorphous Silicon modules will outperform crystalline modules and unlike many other thin films, are 100% safe for the environment.

## INVERTER



POWERGATE® PLUS 500KW  
96.52% EFFICIENCY

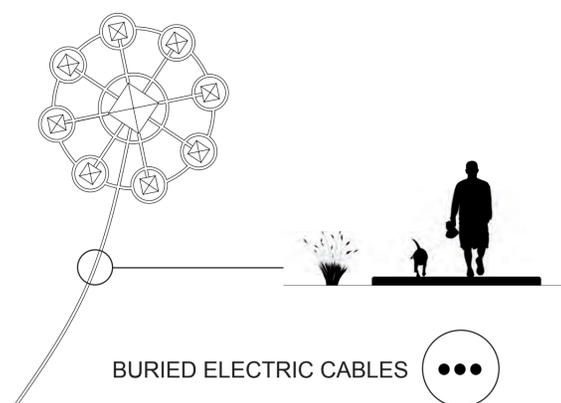
SATCON SOLSTICE FOR  
MAXIMUM ENERGY HARVEST

THERMAL OPERATING  
RANGE - 40°C TO 85°C

5 YEAR WARRANTY

SatCon is an industry leader offering the highest quality product to convert DC energy to AC. Four PowerGate®Plus 500kw inverters will be co-located inside the central pyramid where AC power is stepped up to transmission voltage for Utility Grid interconnection.

## ENVIRONMENTAL IMPACT



Disruption to local ecosystems will be minimized by building pedestrian paths with natural stone over land disturbed during initial construction. Accessibility and power transmission linked together reducing the footprint impacted by Lunar Cubit.

## DATA MONITORING



Locus Energy will provide a state of the art data monitoring system providing real time revenue grade data accessible anywhere in the world. This interactive feature expands Lunar Cubit beyond its geographic boundaries, inviting national and international participation.

## MATERIAL



ALUMINUM EXTRUSION

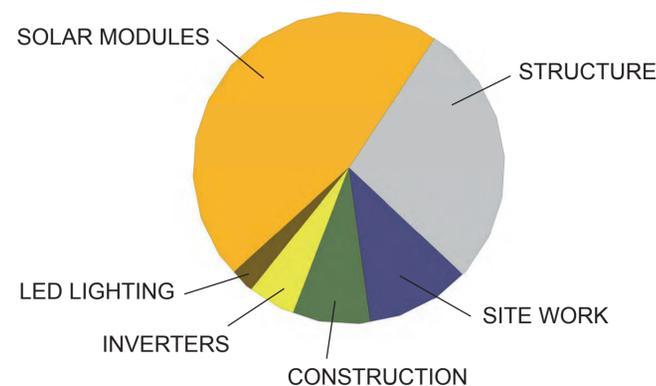
ANNEALED GLASS  
AMORPHOUS SILICON

STEEL

CONCRETE  
NATURAL STONE

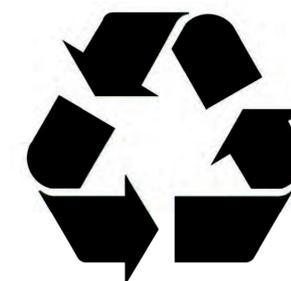
Constructed with safe, reliable, non-toxic materials that perform well over long periods of time; creates no run-off, no emissions nor any other by-product beyond renewable energy. No moving parts to break or be serviced.

## EMBODIED ENERGY



Using frameless thin film solar panels the estimated time to recover their embodied energy is less than two years. Total embodied energy for Lunar Cubit will be recovered in under five years.

## LIFE CYCLE ANALYSIS



Decommissioning of Amorphous Silicon solar panels after their 25 year warranty is safe and simple. Using non-soldered junctions, they are 100% clean fill, safe as a pile of sand. Inverters will be recycled.

# LUNAR CUBIT

Lunar Cubit is a site specific proposal to be constructed in Abu Dhabi just outside Masdar City, the world's first zero carbon metropolis once completed. Combining artistic vision with sustainable design and engineering, Lunar Cubit examines the nature of time through nightly contemplation of lunar phases and daily transformation of sunlight into electricity, powering up to 250 homes. Inspired by astronomy, quantum physics and the photoelectric effect, for which Einstein received the Nobel Prize in 1921, this work is open to the public, inviting a personal experience where one can literally reach out and touch a 1.74MW utility scale power plant, in the form of nine monolithic pyramids rising from the sands of Abu Dhabi.

Lunar means relating to or involving the moon and cubit is the name given to the oldest recorded units of length; employed though antiquity, the oldest cubit being the royal cubit, dating back to the Step Pyramid of Djoser circa 2,700 B.C.

Lunar Cubit is a timekeeper, a monthly calendar, allowing viewers to measure time through the eight lunar phases represented by a ring of eight pyramids encircling one central pyramid. All nine are proportional to the Great Pyramid of Cheops in Giza and scaled using the royal cubit but they're not made from stone; they're made of glass and amorphous silicon, giving them the appearance of onyx polished to a mirror finish. Supported from within, the façade of the pyramids is neatly seamless, like the face of a skyscraper, crisp against the heavens, reaching from base to tip, unbroken except for two silver streaks like rays of light scribing each face into two equal triangles and one diamond. Using frameless solar panels reduces embodied energy by nearly 30%, reducing time to be energy positive from seven years to five years. Around the pyramids flow natural stone paths in a repeating pattern that mirrors buried electrical cables, conducting electrons from the outer pyramids to the central pyramid where inside they are transformed into AC energy and transmitted to the Utility Grid. Co-locating walking paths and conduit runs minimizes the footprint of disturbed land during the construction allowing the maximum amount of natural ecosystem to remain untouched.

Nine pyramids resting on tan sand; encircled by distant trees; antiquity gilded with technology. Visitors are encouraged to walk amongst these clean power plants, beacons of science, rising to meet a hail of photons from 149 million kilometers away, traveling at the speed of light, to smash into electrons, jarring them free from their molecular bonds and channeling them into electricity. Day passes; a crown of shadows slides silently across the shrubs and sand as the sun rises and falls, moving across the sky and eventually disappearing below the horizon. Two pyramids begin to glow, rising in luminosity as twilight fades and the sky grows dark. Lunar Cubit illuminates inversely proportional to the lunar cycle and tonight is a new moon; white LED's shine through thousands of tiny bands that are the cellular structure of amorphous silicon solar panels; creating a diffused glow that rises to become a solid pyramid of white light.

Accompanying the center pyramid is a corresponding outer pyramid, clearly marking the lunar phase like a number on the face of a clock. Inverted illumination creates a dance, an ebb and flow like the tides; pyramids of light reaching out to a hidden new moon and as the moon begins to shine, the pyramids recede, allowing moon light to fill the landscape. On the night of a full moon, only moonlight will trace a crown of silvery shadows across the desert floor until the following evening when the pyramids again begin to glow and the moon begins to fade; light forever rising and falling as the moon spins around earth, as the earth spins around the sun as the solar system spins around a massive black hole.

Located 5 kilometers from Abu Dhabi international airport, Lunar Cubit is visible from the air and creates a landmark, a destination for travelers to visit, relax and meditate. Nine pyramids form a ring matching near-by road structures, forming a symbol of infinity. Lunar cubit serves as a reference, a familiar sight like Big Ben or the Empire States Building, safe, comfortable and timeless as the sun and moon.

Generating electricity for 250 homes, is a perfect complement to Masdar City, a symbol of imagination and sustainability. Harnessing the power of the internet to reach a wider audience, Lunar Cubit utilizes data monitoring, connecting the system's output and usage to a website that anyone can visit and see live information; how much energy is being generated, how much is being used by the LED lighting, what are the weather conditions and details about the site.

Follow this link for a demonstration

<http://datareadings.com/client/moduleSystem/Kiosk/site/bin/kiosk.cfm?k=ZcZPe0TD>

Art and renewable power generation are expanding frontiers. Our world is changing and the pace of change is accelerating rapidly. Lunar Cubit is a portal between past and future, combining art and energy, welcoming us to step into the future.

## Lunar Cubit – Team Bios

Robert Flottemesch  
Artist - Sr. Engineer

Robert Flottemesch is an artist working with renewable energy and a Sr. Engineer at Hudson Valley Clean Energy, New York State's largest solar integrator; headquartered in New York's first zero-net energy commercial building. Pioneering the hybridization of art with renewable energy, he expands social awareness and understanding. Mr. Flottemesch is NABCEP certified in Photovoltaics and extensively trained in Building Science. He holds a B.A. in Contemporary Art from Bard College.

Johanna Ballhaus  
Landscape Design

Johanna Ballhaus currently lives and works as a self-employed landscape designer in the Hudson Valley, NY, USA. Managing and designing projects for a developer in New York and a builder in New Paltz, NY, she emphasizes a distinct design language with low environmental impact that mediates the qualities of the natural heritage and the beauty of clear structuring of open spaces. Mrs. Ballhaus' prior experience spans between NYC and Berlin, Germany where she has managed residential projects and international competitions. Her Diploma in Landscape-Planning is from the Technical University, Berlin, Germany.

Adrian P. De Luca  
VP, Sales and Marketing

Mr. De Luca is a founding team member of Locus Energy, which provides web-based operations and management software to the distributed renewable energy market. At Locus, he is responsible for product management as well as strategic planning and business development. He has 10 years experience in information technology marketing and sales. Prior to Locus, Mr. De Luca was the vice president of marketing at GridPoint, where he was instrumental in launching the company's innovative renewable integration products. He has a B.A. in Economics from Pomona College.

Jen DeNike  
Artist

Jen DeNike is an artist who lives and works in New York City. Her work has been shown internationally including: Museum of Modern Art, Kunst Werke, P.S.I/MOMA, Julia Stoschek Collection, Brooklyn Museum, Shanghai Zendai Museum Of Modern Art, CCS Hessel Museum, MOCA Miami, Site Gallery England, Tensta Konsthall Sweden, EMPAC. She received her MFA from Bard College in 2002. Her work is in the permanent collection of the Museum of Modern Art. Forthcoming solo exhibitions this fall include: THE COMPANY Los Angeles, DUVE Berlin, and Claudia Groeflin Zurich.