Technical aspects of the solar street lighting

System analysis

The CSEM UAE pre-study analyzed the different elements forming a solar street lighting pole:

Lighting
- Type of lighting: Induction, LED, Sodium (High or low pressure)…
- Luminous efficiency (Lumens per watt)
- Life time
- Behavior in hot climate

Battery
- Type of battery
- Maintenance-free
- Life time
- True Deep-Cycle Batteries

Solar panel
- Maximal efficiency for minimal area
- Low foot print can be realized by mono-crystalline and Polly crystalline technologies
- Poly crystalline being cheaper and having 25 years life is well suited for this application

Controller
- Maximal efficiency

Pole
- Solidity (resistance to weight and wind)
- Resistance to water and humidity

Sodium vapor lights	LED lamp	Induction lamp
Energy saving	Energy saving	Energy saving
Low life (18 000 hours)	High life (50 000 hours)	Very high life (100 000 hours)
Cheap	Costly	Costly
Bad visual quality (Yellow light)	Good visual quality (White light)	Good visual quality (White light)

CSEM-UAE Innovation Center LLC
www.csem-uae.com

Al Jazeera Al Hamra Area
PO Box 31208
Ras Al Khaimah, UAE

T +971 (7) 244 6929
F +971 (7) 244 6951
info@csem-uae.com

The result of this study leads to the use of **LED or Induction lamp** for a **high life system** with a **good visual quality**. Sodium vapor lights are cheaper, but the light quality is really too bad, especially for such an investment.

The rest of the system (pole, battery, Controller, Solar panel) can be quite equivalent for any system. The main difference will be given by the lighting, and especially:

- The **luminous efficiency**, i.e. the number of lumens provided by the lamp for a given wattage (that means for a given solar panel surface)
- The **life time** of the lamp
- The behavior in **hot climate** (UAE)

Induction lamp VS LED lamp

Our study mainly focused on the characteristics of the LED systems, and the induction lamp systems.
Both are in the same price range, but the technical characteristics differ, especially for a street lighting system placed in a hot climate environment.
The induction lamps technology is recent but growing quickly especially for the increasing worldwide demand in street lighting systems. LED lightings are widespread in many lighting systems since many years, but they are not really suited for street lighting.

- A LED street lamp will consist in a network of hundred of individual LEDs, usually distributed with a combination serial/parallel. If one LED fails, the serially-connected LEDs fail too, and the parallel-connected LEDs are affected by the current distribution, and shall become more sensitive to failure.

- On a design aspect, if some LEDs fails in the lamp, the design of the whole lamp is dramatically affected.

- LED needs heat sink, so they are not well-suited for hot climates like UAE, especially when the wind is low. They prone to failure under hot climates, and their efficiency decrease with temperature. Induction lamps have a very low heat output, and work perfectly with external temperatures up to 50°C.

- Induction lamps have a very high luminous efficiency (lumens delivered by watt), at least 30% higher than LEDs. This characteristic is crucial for a solar system, because the delivered power will be fixed (by the solar panel) and from this power, the induction lamp will enlighten 30% more than the LED lamp.

- The life time of induction lamps is twice longer than LED life time.

	LED Lamp	Induction Lamp
Power	From 0.5W to 1W, more than 100 LEDs needed for large wattage	From 15W to 300W
Luminous Efficiency	**< 60 Lumens per watt**	**> 80 Lumens per watt**
Color temperature	Narrow range (white Light LED)	Full range (2100K – 6500K)
Lumen depreciation	50% after 2000 hours	5% after 2000 hours
Life	**50 000 hours**	**100 000 hours**
Heat output	Very high, needs cooling device	Very low
Ambient temperature performance	**Reduced output above 25°C and then prone to failure**	**Maintains output up to more than 50°C**
Light fitting	More than 100 LED in the same large circuit board, Heat sink, microcontroller	Easy to accommodate
Liner light source	Dazzling glare and flicker	No glare, no flicker, good visual effect
Electro-Magnetic interference	No	Yes, if not properly shielded
Covered area	Focused (reduced area)	Spread (large area)

From all these considerations, and especially the behavior in hot climate, the life time and the luminous efficiency, we clearly propose to go for **induction lamps** systems.

Supplier selection

After a research on the web of the different solar street lighting suppliers, we visited some of those established in UAE. Some provide only components, and some provide also complete systems.

We opted for a complete solution due to the short timing, with a reliable company that has also stocks available in UAE.

The recommended supplier is **Green Energy Solar** / **PTL Solar**, established in Dubai since 5 years.

Poles selection

After checking different option with the installation of demo units of 40W and 80W (2x40W), and considering LUX measurements of different options, we propose poles of 80W (~9000 Lumens).

These poles consist in 8 meters poles with solar panels on top, two arms equipped with 40W induction lamps at 7 meters height, and an enclosure at the bottom including battery and controller.

Electrical components:

- Solar panels: *Sharp* - 2 x 130Wp
- Charge Controller*: Intelligent PWM* - 20A
- Battery: *SMF* - 3 x 105Ah / 12V
- Induction lamps: *GreenLite 40 Dual arm* - 2 x 40W (Light + Fixture + Ballast)

Non Electrical components:

- Galvanized Steel Pole 8m - Round tapered
- Battery Enclosure
- Panel mount
- Cable set
- Dual Light arms 1.5m with slight angle
- Installation and commissioning

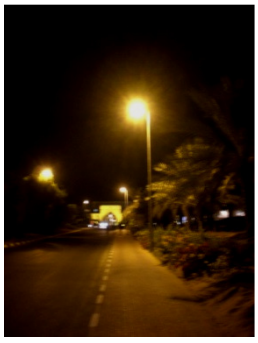
The operating profile of these poles is an automatic switch of the light on dusk and dawn. The autonomy of the lightings is set to allow 3 working nights without sunshine.

Technical specifications and luminaries testing reports are included in Annex V.

Induction lamps - photometric test (retrofit on an existing pole)

The 3 pictures below give an overview of the illumination given by the 80W induction lamp, installed on an existing pole of the Al Hamra Fort Hotel road.

Induction lamp (white)



Actual Sodium lamp (yellow)

Both lamps on same view

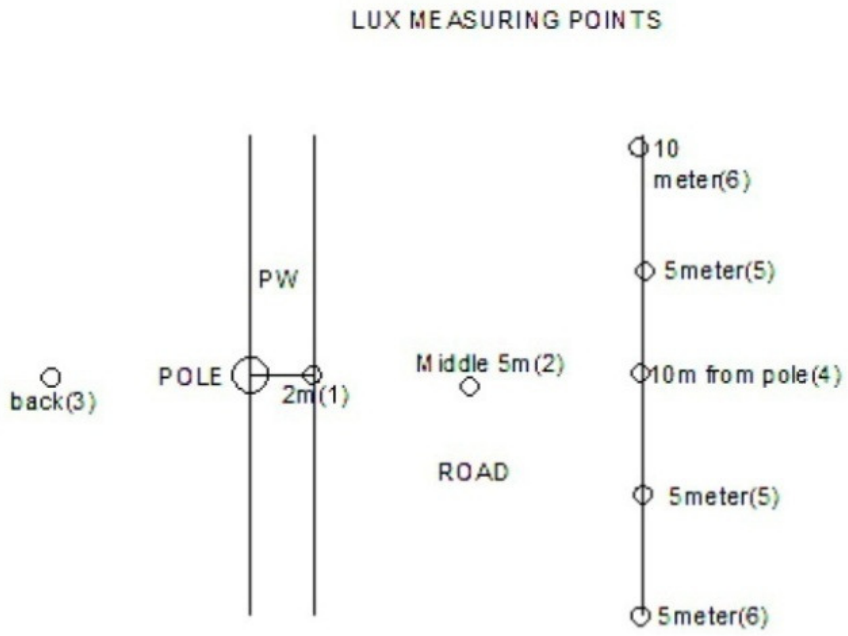
Note that Solar panels were not fixed at the top of the pole, as this installation was done only for a photometric test, whose results are presented below:

PHOTOMETRY STUDY AT 8 METER POLE HEIGHT FOR PROJECT OF CSEM-RAK

Pole Height: 8 meter
Location: CSEM UAE Innovative Centre LLC
Distance Between Two Poles: 55 meter
Generated by: Aminul Islam Date: 22/10/09, Time: 9.30pm

Measuring Point (in Fig)	**Distance from Post**	**LUX (GRENLite™ 40W)**	**LUX (GRENLite™ 80W)**	**Lux (Existing Lights Metal Halide 250 W)**
1.	Distance from Post 2 meter	29.7	46	27
2.	Distance from Post 4.5 meter	15.5	25	13.6
3.	Back of Post 3 meter	12	20	2
4.	Opposite Side of Pole and Road	5.2	13.8	6.4
5.	Opposite Side of Pole and Road 5 meter ahead	4.5	12	4.8
6.	Opposite Side of Pole and Road 10 Meter Ahead	3.1	6.8	3.8

Note: **Measuring points are located in the map below**



From these photometric tests, we propose the following:

- All the roads will be equipped with the dual 40W induction lamps (80W) for a spread lighting of the roads.

- These poles will be places alternatively on both sides of the street, with a different spacing depending on the required illumination level for each road.

- All roads have a width of around 7.5 meters, and poles will be placed on external sides at around 2.5 meters. As the lamp arms will be 1.5 meters, the distance of the opposite footpath will be roughly 10 meters from the lamp, which will have an illumination of 14 Lux that is ideal for pedestrian ways.

- The spacing between poles will be 20 meters in highly bright areas where pedestrians are subject to walk, which is the case for:
  - Al Hamra Fort Hotel road
  - Al Hamra Palace Hotel road
  - America's cup island roads

- The spacing between poles will be 25 meters in bright areas where pedestrians are not subject to walk, which is the case for:
  - Marina main drive

- For each pole, the solar panel will be place on top and oriented in the south direction.

The number of poles has been defined regarding the spacing and the road length:

- **Al Hamra Fort Hotel road**
  Length: 1000m
  Spacing: 20m
  50 solar street lighting systems

- **Al Hamra Palace Hotel road**
  Length: 810m
  Spacing: 20m
  41 solar street lighting systems

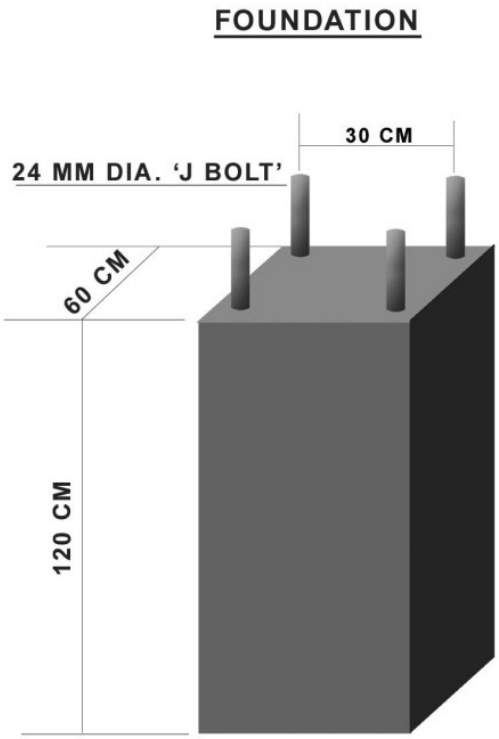
- **America's cup island roads** (from the bridge to both teams sites)
  Length: 630m
  Spacing: 20m
  32 solar street lighting systems

- **Marina main drive**
  Length: 3000m
  Spacing: 25m
  120 solar street lighting systems

Pre-Requiste to installation

Al Hamra Real Estate will be in charge of the following support (see quotations)

- Civil Work and Base Foundations for pole



- Crane & Man Lift for installation of Solar Lights
- Necessary Work Permit to perform scope of work (Day & Night)

Schedule

The proposed schedule for the project is described below, from project acceptance to commissioning.

• Weeks 2-3	• Week 4	• Week 5	• Week 6
Installation of lightings **Marina main drive**	Installation of lightings **Al Hamra Island roads**	Installation of lightings **Al Hamra Fort Hotel road**	Installation of lightings **Al Hamra Palace Hotel road**

This schedule can be freely changed by the priorities defined by Al Hamra Real Estate.