

## **Ph.D. Thesis Opening**

(Priority to candidates having achieved their M.Sc. thesis in csem-uae)

### **District Cooling for desert sea side cities**

#### **Background**

Conventional distributed air conditioning systems consume the biggest amount of electricity of the household energy consumption in commercial and residential building in UAE. Cooling is a must of living in a harsh climate almost all the year. Heating is not required except for domestic hot water use (shower, kitchen, etc).

Compared to vapor compression chilling which has low investment and low running electrical power cost, the low capacity solar cooling systems are not competitive to generate AC in buildings. The potential of centralized solar district cooling systems should be investigated.

Two master’s thesis student from the Department of Energy Technology, KTH, contributed to CSEM-UAE R&D

- 1- In 2010 (*Active energy efficiency technology solution for Al Hamra Mall in RAK - UAE*) : Concluded positively on the competitiveness of hybrid solar system of 5 MW cooling power if operating during the sunny hours with single effect chillers and 95°C vacuum tube collectors
  
- 2- In 2011 (*District cooling for Al Hamra Village in RAK-UAE*): Concluded negatively on the competitiveness of using solar or solar hybrid system of 40 MW cooling power if operating for 24 hours or only during sunny hours

Table below and following comments summarize the study’s outcomes

Item	Cost		
	Technology -1	Technology-2	Technology-3
<b>Chiller</b>	Low (single effect)	Medium (double effect)	High (triple effect)
<b>Solar Collector</b>	Low (Vacuum tube-105°C)	Medium (Fresnel Mirror-180°C)	High (Fresnel mirrors-270°C)
<b>Area</b>	High	Medium	Low
<b>Storage tank</b>	High	Medium	Low
<b>Others</b>	Medium	Medium	Medium

- Technology -1: System components (Single effect Chillers and Collectors) are commercially available but the effectiveness of a system integrated for few MW district Solar Cooling is to be proved
- Technology -2: Components (Double effect Chillers and Fresnel mirrors) are still under development with demonstrators and Prototypes available for each
- Technology -3: Components (Triple effect chiller) is under development only low cooling capacity and the solar concentrators (Trough type), which are commercially available, are complex and hard to install in a district region

## Purpose

The PhD proposal will consider the state of the art of each technology as the starting point and achieve the next step

- Technology -1  
Prove the effectiveness and competitiveness of a Solar or a Hybrid Solar cooling system in RAK-UAE
- Technology -2  
Develop and evaluate a low capacity but scalable prototype of solar cooling system with double effect chiller and Fresnel concentrators
- Technology -3  
Evaluate the effectiveness of low cost Fresnel type concentrators with triple effect chiller

## Objectives

- Technology-1
  - Select one of the applications where one of our local investors is informed and ready to support
  - Finalize the design, select the suppliers, make a proposal and supervise the implementation of a Hybrid Solar Cooling system
  - Characterize the installation over a year to prove the effectiveness of about 5 MW Hybrid Solar Cooling systems in GCC region
- Technology-2
  - Identify a double effect chiller supplier(s) to partner with and characterize a most promising component
  - Identify the best Fresnel mirror solution, fixed (like *csem-uae, Solar Island solution type*) or rotating (*very few suppliers in the market*) and characterize a module
  - Identify a scalable floating module for offshore concentrators and characterize it.
  - Implement a representative scalable prototype for 50 MW Solar District Cooling System
- Technology-3
  - Based on the state of art, simulate the feasibility and effectiveness using triple effect chillers with low cost high performance Linear Fresnel solar Concentrators (LFC)

## Expected outcomes

- 1- 5 MW Hybrid Solar Cooling system (Investment payback < 10 years)
- 2- Solar cooling scalable prototype with double effect absorption chiller and LFC
- 3- Evaluation of the competitiveness of triple effect absorption chillers with low cost/high performance LFC on or offshore.