Clean Cooling
the new “Frontier Market” for UAE & the GCC region

9-10 April 2018
Dubai - UAE

Next Generation District Cooling Network— A High-Level Overview

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The Network is funded by

Organised by

In Partnership with

EU-GCC Cleanenergy.Net
The Key Points

• Typical GCC district cooling overview; general & technology perspective.

• The current approach to optimize operational efficiency within the GCC region; to achieve national energy efficiency KPI’s related to district cooling sector.

• The next generation district cooling network; intelligent and life-cycle cost effective.

• The future of district cooling technology and management strategy; forward thinking approach towards generation, distribution, and storage attributes.

• District cooling research work in the EU and GCC region; EU Horizon 2020 projects and regional cooling research focus.

• Concluding remarks; potential Day 2 (Workshop) discussion topic.
District Cooling Overview – The GCC Perspective
Opportunity, Market, Challenges

- Over 60% of the electrical energy generated in the GCC is consumed for cooling and ventilation systems by commercial and residential buildings.
- GCC peak Cooling demand is expected to grow 3 times; **100 million RT** by **2030**.
- The GCC countries are in the process of **regulating** its district cooling sector; thus implementing policies to improve system energy efficiency.
- Maximum target; Increase penetration of district cooling up to **40%** by 2030 (*Dubai*).
- District cooling is the most efficient cooling technologies for bulk cooling; regional study **0.92 KW/Ton**
- District cooling sector **challenges**; technology stagnation, no life-cycle cost consideration, consumer protection mechanism, portable water scarcity, capacity planning, misalignment in benefit allocation and others.
Impact of District Cooling – The Energy Efficiency Perspective

GCC Peak Electricity Demand: 150 GW*
Peak Demand Cooling Share: 70%
District Cooling Market Share: 15%

A 10 – 20 % improvement in District Cooling Shall reduce the peak by 1.5 GW – 3 GW

* Assumed Value
Typical District Cooling Technology – The GCC Perspective

Typical District Cooling Technology

- Conventional Chiller Components
  - No Life Cycle Cost Consideration
- Fixed Speed Chillers
- Shell and Tube Heat Exchanger
- Forced Drafts Cooling Towers
- Fixed and/or Portable Make-up Water
- Fixed and/or Variable Speed Pumps
Regional District Cooling Research for Operational Optimization

A mechanism to identify and rank potential energy savings in a district cooling facility.

Optimized control of district cooling plant facility; with and without thermal energy storage.

Compressor semi-empirical and engineering models for centrifugal compressors

A novel dehumidification process to reduce the moisture in the inlet air to the cooling tower.

Treated sewage effluent (TSE) used instead of fresh water for condenser cooling

Optimal Measures Combined Savings: 5 – 9* %

* On-going research work
Next Generation District Cooling Network – Key Features

- Combined CHP system
- Chiller components predictive controller
- Improved system planning
- Advanced thermal storage integration
- Symbiotic relationship w.r.t. waste heat
- Artificial intelligent meters
- Integration to a thermal grid network
- New Business Models
- Improved system planning
- DC management strategy
- Intelligent and life-cycle cost effective
- Advanced thermal storage integration
- Symbiotic relationship w.r.t. waste heat
- Artificial intelligent meters
- Integration to a thermal grid network
- New Business Models
- Improved system planning
- DC management strategy
- Intelligent and life-cycle cost effective
A Tri-generation Facility

- Vapor Absorption Machine (VAM) and an electrical chiller (Vapor Compression (VC)) for meeting balance cooling demand.
- Utilization of triple-effect absorption chillers.
- Compared to electric district cooling tri-generation saves 60% primary energy, and 60% emissions.
- Waste heat symbiosis potential within the cluster/ vicinity.

![Diagram of A Tri-generation Facility]

### Key facts

<table>
<thead>
<tr>
<th></th>
<th>VAM</th>
<th>VC</th>
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<tbody>
<tr>
<td>Gas engine capacity</td>
<td>347 kW</td>
<td>410 kW</td>
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<tr>
<td>( n_{el} ) gas engine</td>
<td>0.40</td>
<td>0.70</td>
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<tr>
<td>COP</td>
<td>0.7</td>
<td>4.0</td>
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<tr>
<td>Chilled water temp.</td>
<td>7°C</td>
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<tr>
<td>Fuel</td>
<td>Natural Gas</td>
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### Achieved savings

- Energy total p.a.: 660,000 kWh
- Energy costs p.a.: 220,000 EUR
- \( CO_2 \): 1,700 t/a

### Economics

- Investment: 690,000 EUR
- Payback: 3.2 years
Next Generation District Cooling Ongoing Research

Intelligent Thermal Networks

• Intelligent thermal networks that reduce energy transportation losses.
• Reversible heat pumps and chillers; providing necessary cooling for buildings
• Integrate effectively with multiple energy generation sources; assuring optimized energy exploitation.
• The thermal capacity design and development of control strategies; thermal balance between generation, storage & utilization.
• The networks reduce primary energy consumption for space heating and cooling by 50% compared to actual standards.
**Next Generation District Cooling Ongoing Research**

**Tool for Better System Monitoring**

- Predicting the short-term weather conditions and forthcoming need for heating and cooling.
- Forecasting the anticipated energy demand based on weather data and energy consumption data.
- Deployment of autonomous sensors supplied by energy harvesting.
- Weather prediction & energy demand prediction.
- AI meters for real-time monitoring of energy storage.
- Life Cycle Assessment.
- Insulation materials.
- An automated decision support system for optimal energy distribution.
- Development of smart monitoring and energy storage management tools.

- Solutions of minimizing heat losses via pipe design and innovative insulation materials & life cycle assessment.
- Central monitoring: a web-based platform accessible for mobile devices and PCs permitting the users to monitor the network’s operation and its properties.
- A central control platform for a 24/7 monitoring of DHCS.
- Real-time energy consumption data gathering via artificial intelligent meters including autonomous sensing capabilities.

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Conclusion / Day 2 Theme to Discuss

• District cooling technology stagnation; next generation system requires to be intelligent and life-cycle cost effective.

• Addressing the current challenges ; where the regional district cooling sector stands?

• How the region can benefit from Horizon 2020 research projects such as “FLEXYNETS” and “InDeal”; EU-GCC forum role?

• A thermal grid and/or thermal trading platform is the future of district cooling?

• Business models for next generation district cooling and heating network.

• Disruption with the district cooling sector; A required transition for future energy network integration.
References

- Booz & Company 2012, Unlocking the potential of district cooling; The need for GCC governments to take action.
- EU Horizon 2020 research project: [http://www.flexynets.eu](http://www.flexynets.eu)
- EU Horizon 2020 research project: [http://www.indeal-project.eu](http://www.indeal-project.eu)
Questions

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