DISTRICT ENERGY IN CITIES
A GLOBAL INITIATIVE TO UNLOCK THE POTENTIAL OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

Benjamin Hickman, Regional Technical Advisor, District Energy in Cities Initiative, UN Environment

Supported by:

Ministry of Foreign Affairs of Denmark DANIDA

KIGALI COOLING EFFICIENCY PROGRAM
IN FOCUS: DISTRICT COOLING

WEBINAR SERIES

• District Cooling in the Global South
• Cooling your home: should residential buildings use DC? Barriers and potential solutions
• District cooling – benefits to real estate developers and building owners
• District cooling – unlocking efficiencies, renewables and waste heat
• District cooling and the Kigali Amendment
• Developing a district cooling project: planning, procurement and financing
• Local government actions and policies to scale-up district cooling
IN FOCUS: DISTRICT COOLING

DISTRICT COOLING IN THE GLOBAL SOUTH
10th April 2019, 10am CEST

- Overview: Benjamin Hickman, UN Environment
- Dr. Alaa Olama, Head, Permanent Committee writing the Egyptian District Cooling Code
- Mr. Jianping Fu, Shenzhen Qianhai Energy Investment Development Co. Ltd
- Mr. Gaurang Patel, Deputy General Manager, Gujarat International Finance Tec (GIFT) City
- Mr. Ahmad Firdaus Mansor, Acting COO, TNB Engineering Sdn Bhd
- Audience Q&A
WE NEED TO FOCUS ON COOLING

AC growth from 1.2 billion today to 4.5 billion by 2050

Cooling could hit 12 GtCO$_2$e by 2050

Space cooling will consume 30% of electricity in buildings globally

Based on IEA’s 2050 baseline
THE GROWTH OF COOLING:
SCREENSHOT OF DELHI

- Space cooling already 25-30% of annual demand
- Half of annual network capacity increases is for space cooling

Data sourced from State Load Dispatch Centre
THE ROLE OF CITIES IN TACKLING COOLING

- Impacts of cooling felt in cities: grid stress, water, urban heat island, costs
- Can integrate multiple systems for increased efficiency
- Control over urban planning and municipal services
WHAT IS DISTRICT COOLING?
WHAT IS DISTRICT COOLING?
PLANT ROOM
THERMAL STORAGE
WHAT IS DISTRICT COOLING?
WHAT IS DISTRICT COOLING?
WHAT IS DISTRICT COOLING?
IT IS MORE THAN JUST COOLING BUILDINGS

- Connecting renewable electricity generation
- Waste incineration
- Connecting sources of "free cooling"
- Connecting commercial demand
- Connecting industrial demand
- Solar thermal connected to district heating
- Capturing waste heat from sewage and wastewater
- Absorption chiller capturing waste heat
- Combined heat and power (CHP) plant

Source: IEA
WHY DISTRICT COOLING IS IMPORTANT?

- CO$_2$ emissions decrease by 30-50%
- Reduce power demand for cooling by 30-50%
- Shift peak cooling demand to night
- Lower refrigerant emissions by up to 100%
- Lower cost of cooling to end-users
- Reduction in urban heat island impact
- Reduced potable water consumption for cooling
District cooling & trigeneration is proven globally and is growing across the Global South

Known district cooling systems in Global South:
- China
- Colombia
- Egypt
- India
- Indonesia
- Jordan
- Malaysia
- the Philippines
- the Seychelles
- Singapore
- Thailand

The Alpujarra District Cooling System, Colombia
For more information on the District Energy in Cities Initiative and to become a partner, please visit the website or contact:

**Benjamin Hickman**, Regional Technical Advisor, Europe & Asia, District Energy in Cities Initiative, UN Environment, [benjamin.hickman@un.org](mailto:benjamin.hickman@un.org)

[http://www.districtenergyinitiative.org](http://www.districtenergyinitiative.org)
District Cooling in the Global South

Cooling your home: should residential buildings use DC? Barriers and potential solutions

District cooling – benefits to real estate developers and building owners

District cooling – unlocking efficiencies, renewables and waste heat

District cooling and the Kigali Amendment

Developing a district cooling project: planning, procurement and financing

Local government actions and policies to scale-up district cooling

http://www.districtenergyinitiative.org
政府对前海区域供冷的前期规划
The Government Pre-Planning Qianhai’s District Cooling System
目录

CONTENTS

01 前海概要 The General of Qianhai

02 前海区域供冷规划和建设运营情况 The Planning and Construction in Qianhai District Cooling System

03 前海区域供冷前期规划研究 The Planning Research for Qianhai District Cooling System

04 当地政策 Local Policies
前海概要  The General of Qianhai
The General of Qianhai

The Location of Qianhai

◆ 区域位置 Location Advantage

毗邻港澳，地处深圳市西部，30公里半径范围内拥有香港、深圳两大国际机场和香港港、深圳港大世界级集装箱枢纽港，区位优势绝佳。

Adjacent to Hong Kong and Macao

Outstanding overall transportation

◆ 前海战略定位 Strategic Positioning

- 深圳城市新中心 A new center area for Shenzhen
- 粤港澳大湾区核心 Core of Guangdong-Hong Kong-Macao Greater Bay Area

◆ 批复时间 Establishment Time

前海深港现代服务业合作区总体发展规划，于2010年8月26日获国务院批准。

The State Council approved the overall development plan for the Shenzhen-Hong Kong modern service industry cooperation zone in Qianhai on August 26, 2010.
综合规划要点  The Features of Master Plan

◆ 低碳生态之城
A City with Ecological Intelligence
广泛采用先进的节能、再生、环保等低碳技术，搭建多层次、组团式绿色生态体系，打造可持续发展的绿色低碳城区。

◆ 水滨个性之城
A Distinctive Waterfront City
以“护水、观水、亲水、乐水”为核心理念，打造集生态型、文化性、景观性、艺术性为一体的活力水城。

◆ 产城融合之城
A City with Vibrant Industries
建立科学高效的产业发展体系，突出主导产业特色与资源配置，打造具有国际竞争力的现代服务业区域中心。

◆ 高效便捷之城
A City with Efficiency and Convenience
以公共交通为主导，各类交通方式协调发展的交通发展模式。

◆ 紧凑集约之城
A City with Compactness
倡导土地混合利用，实施都市综合体开发模式，建设地上地下互联互通、均衡多远的立体城市空间。
前海概要 The General of Qianhai

产业类型 Industry Type

◆ 金融服务业 Financial Services
研究探讨深入推进深港金融合作，研究适当降低香港金融机构和金融业务准入门槛，支持金融改革创新项目在前海先行先试。

◆ 现代物流业 Modern Logistics Industry
促进深港两地现代物流业的深度合作，形成高端物流业的集聚区，打造亚太地区有重要影响的供应链管理中心和航运衍生服务基地。

◆ 信息服务业 Information Service Industry
统筹规划建设信息基础设施，发展软件和信息技术服务、信息内容服务，全面提升信息传输服务能力。

◆ 科技服务和其他专业服务 Science and Technology Services and Other Professional Services
在前海汇聚科技服务和其他专业服务资源，构建区域性科技创新服务中心和生产性专业服务基地。
01 前海概要 The General of Qianhai

前海规划建筑体量与业态 Qianhai Building Type and Size

- 前海占地: 14.92平方公里
- 建设规模: 2600-3000万㎡
- 容积率: 平均大于6.0
- 建筑业态: 以办公、商业、公寓、居住建筑为主，并配套相应市政公共设施。

- Land area: 14.92km²
- Construction size: 26-30 million m²
- Plot ratio: Greater than 6.0
- Building Type: Mainly in office, business, apartment, residential building, and supporting municipal public facilities
02

前海区域供冷规划和建设运营情况
The Planning and Construction in Qianhai District Cooling System
前海区域供冷规划和建设运营情况

规划建设10个供冷站
覆盖前海合作区12个开发单元
最大供冷能力40万RT

供冷建筑业态：办公、商业、酒店、地铁站等
服务建筑面积约1900万㎡
90公里供冷管网，片区之间管网连通

- 10个供冷站
- 覆盖12个开发单元
- 最大供冷能力：40万RT
- 服务建筑面积：1900万㎡
- 90公里供冷管网，片区之间管网连通

### Qianhai DCS Layout and Size

- 10 district cooling stations
- Covering 12 development units
- Maximum cooling capacity: 0.4 million USRT
- Service building types: office, commercial, hotel, metro station, etc.
- Service building area: 19 million m²
- 90 km cooling pipe network, and pipeline network interconnection in the area

<table>
<thead>
<tr>
<th>冷站</th>
<th>供冷规模</th>
<th>建筑面积 (㎡)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1#</td>
<td>3.00万RT 30,000 RT</td>
<td>7,500.00</td>
</tr>
<tr>
<td>2#</td>
<td>4.90万RT 49,000 RT</td>
<td>7,500.00</td>
</tr>
<tr>
<td>3#</td>
<td>3.00万RT 30,000 RT</td>
<td>7,500.00</td>
</tr>
<tr>
<td>4#</td>
<td>5.20万RT 52,000 RT</td>
<td>11,500.00</td>
</tr>
<tr>
<td>5#</td>
<td>5.50万RT 55,000 RT</td>
<td>11,500.00</td>
</tr>
<tr>
<td>6#</td>
<td>5.00万RT 50,000 RT</td>
<td>11,500.00</td>
</tr>
<tr>
<td>7#</td>
<td>5.50万RT 55,000 RT</td>
<td>11,500.00</td>
</tr>
<tr>
<td>8#</td>
<td>5.00万RT 50,000 RT</td>
<td>11,500.00</td>
</tr>
<tr>
<td>9#</td>
<td>3.00万RT 30,000 RT</td>
<td>7,500.00</td>
</tr>
<tr>
<td>10#</td>
<td>2.00万RT 20,000 RT</td>
<td>6,100.00</td>
</tr>
</tbody>
</table>
## 02 前海区域供冷规划和建设运营情况

### 项目建设进程

**Project Construction Process**

| 冷站冷却站 | 目前阶段 | 供冷时间
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1#</td>
<td>选址论证</td>
<td>/</td>
</tr>
<tr>
<td>2#</td>
<td>一期竣工，供冷中</td>
<td>2016.4</td>
</tr>
<tr>
<td>3#</td>
<td>完成工程可研</td>
<td>2021.7</td>
</tr>
<tr>
<td>4#</td>
<td>完成设计</td>
<td>2020.12</td>
</tr>
<tr>
<td>5#</td>
<td>桩基施工中</td>
<td>2021.4</td>
</tr>
<tr>
<td>6#</td>
<td>方案设计</td>
<td>2021.6</td>
</tr>
<tr>
<td>7#</td>
<td>论证中</td>
<td>/</td>
</tr>
<tr>
<td>8#</td>
<td>论证中</td>
<td>/</td>
</tr>
<tr>
<td>9#</td>
<td>论证中</td>
<td>/</td>
</tr>
<tr>
<td>10#</td>
<td>机电施工中</td>
<td>2019.5</td>
</tr>
</tbody>
</table>

- **1号冷站**: 正在进行选址论证
- **2号冷站**: 一期工程已竣工，2016年4月具备供冷条件
- **3号冷站**: 完成工程可研
- **4号冷站**: 完成设计
- **5号冷站**: 桩基施工中
- **6号冷站**: 方案设计
- **7号冷站**: 论证中
- **8号冷站**: 论证中
- **9号冷站**: 论证中
- **10号冷站**: 机电施工中
用户1: User 1
卓越前海壹号
接入面积：12.68万㎡
接入时间：2017年4月
Time: 2017.4

用户2: User 2
前海恒裕
接入面积：18.0万㎡
接入时间：2019年4月
Time: 2019.4

服务承诺：Service promise
全年365天，24小时不间断运行。
365*24hr online

用户反馈：Users feedback
Good services, Good comments!
前海区域供冷前期规划研究
The Planning Research for Qianhai District Cooling System
DCS Special Planning, which was authorized strength by Qianhai administration, and published in August 2014.

DCS special planning is formulated to implement the Comprehensive Planning of Qianhai. It includes five research papers.

This report mainly through the investigation of classical cases at home and abroad, and also through the systematic analysis of energy saving and economic comparison between the decentralized system and the district cooling system, concludes that the implementation of the district cooling system in the Qianhai is feasible.
The Planning Research for Qianhai District Cooling System

DCS Special Planning

Qianhai DCS Planning and Layout Scheme

Based on the analysis of building cooling load in the plot, this report plans and lays out the cooling stations and municipal cooling pipe network. It is concluded that 10 cooling stations and 90 km cooling pipe networks are planned in Qianhai, with a total cooling scale of about 400,000 RT.

Qianhai DCS Technical Standards and Design Guidelines

This report establishes technical standards for cooling stations and pipeline networks, as well as technical and design standards for user heat exchangers. It provides guidance for the design and construction of district cooling systems in Qianhai.
The Planning Research for Qianhai District Cooling System

DCS Special Planning

This report investigates the charging modes of different district cooling system cases, and through the establishment of price model and energy model, the pricing, price adjustment and investment benefit of district cooling system are analyzed, and the charging mode of "basic fee + usage fee" for the district cooling system in Qianhai is obtained.

Feasibility Study Report on Construction and Operation Plan

The report points out the role orientation of Qianhai Administration in policy coordination, municipal supporting, implementation unit selection, bidding and supervision, and formulates the evaluation and withdrawal mechanism of operation units.
05

当地政策  Local Policies
前海管理局颁布《前海区域集中供冷管理办法》，规定政府和用户定位、权利和责任、定价原则等。

《Management Measures for DCS》，Provision of government and user orientation, rights and responsibilities, pricing principles, etc.

**管理办法 Management Measures for DCS**

**主管单位：competent department**
前海管理局负责编制规划、建设审批、管网投资、监督等。
Qianhai administration draw up planning, construction approval, pipeline network investment, supervision, etc.

**实施单位：Implementation unit**
在本区域内规划有区域集中供冷系统的新建、改建、扩建项目，除住宅之外的项目均应当采用区域集中供冷系统。
DCS shall be used in all new, renovated and expanded projects except residential buildings, such as offices, hotels, commercial buildings, hospitals, schools and other public buildings.

**供冷范围：Users type**
制定区域供冷实施方案和建设计划，负责项目投资、建设及运营。
formulates DCS implementation plan and construction plan, and also is responsible for project investment, construction and operation.
监管机构：前海管理局
Supervision department: Qianhai administration

监管内容：主要从市场准入、退出、价格、质量、安全、社会监督等六个方面对集中供冷事业全生命周期进行监管。
Supervision content: mainly from market access, exit, price, quality, safety, social supervision to supervise the whole life cycle of centralized cooling enterprise.
Investment management

前海管理局为了降低用户的财务负担，主动承担以下部分区域供冷系统的投资：
1. 市政供冷管网；
2. 冷站站房。

In order to reduce the financial burden of users, Qianhai Administration took the initiative to undertake part of the investment in district cooling system:
1. Municipal cooling pipe networks;
2. Civil engineering of cooling stations.
感谢聆听，恳请指导！

Thank you!
India’s First District Cooling System: GIFT city
• GIFT – Gujarat International Finance Tec-city
• GIFT is India’s First IFSC (International Finance Service Centre) and Operational Smart City.
• GIFT city is a global financial and IT services Hub, a first of its kind in India, designed to be at par or above with globally benchmarked financial centres
• GIFT city is being developed on 886 acres of land comprising of a multi services SEZ with IFSC and a domestic finance centre.
• GIFT city has developed first phase of world class infrastructure facilities such as:
  - District cooling system
  - Under ground Utility tunnel
  - Automated waster collection system

www.giftgujarat.in
Master Planning of GIFT

Total built up area of GIFT city : 62 Mn. Sq.FT
Total Air-conditioning requirement : 2,70,000 TR
Electrical power requirement : 240 MW
(For Air conditioning only)
Load optimization by DCS

- Non DCS system: 2,70,000 TR, 240 MW
- DCS system: 1,80,000 TR, 150 MW

Air conditioning load (TR)

6 am  8 am  10 am  12 am  4pm  6pm  8pm  10 pm
Optimization of resources by DCS
District cooling in GIFT City - Key Challenges

- Flexibility in Plant design
- Optimization of piping network
- Physical infrastructure for current and future scenarios
- Planning in line with City development
- Optimization of Plant energy consumption
- Demand Assessment
- User satisfaction

DCS IN GIFT
Distribution of DCS Plant
Phase -1 Development of DCS at GIFT

- DCS Plant Capacity – 10,000 TR
- DCS Chilled water network (Operational): 4 km
- No of Building connected : 08

www.giftgujarat.in
District cooling plant @ GIFT

Chillers in Plant room

Secondary Pump

TES tank

www.giftgujarat.in
Step toward Sustainable Development

- High COP Chillers
- High temperature difference chilled (9°C) water system
- VFD for chilled water pump
- VFD for cooling tower fan
- Pre insulated chilled water pipe to minimize temperature loss
- Eco friendly refrigerant R-134a
- Use of STP recycled water for cooling tower

District energy Help in reducing Heat Island Effect.

- Low Energy Consumption
  - Reduce CO2 emission by 940 ton per Day
- Low Water consumption
  - Save Water by 18 MLD
- Use of recycle water
  - Reduce use of Natural resources
- Minimum impact of refrigerant on environment
  - Reduce Environmental damage
THANK YOU

Gaurang Patel
Dy. General Manager, GIFT, Gujarat. Email: gaurang.patel@giftgujarat.in, gppatel14@gmail.com

www.giftgujarat.in
In Focus: District Cooling | District Cooling in the Global South
Egypt's Experience

WEBINAR

10 April 2019

By: Dr Alaa Olama
In Focus: District Cooling | District Cooling in the Global South
Egypt’s Experience

Contents:
- What is District Cooling. 2 slides
- District Cooling is not for the developed world only. 3 slides
- District Cooling and the cooling density problem. 1 slide
  Market distorts perception of district cooling.
- District Cooling and the magic of diversity of use. 3 slides
- Case Study: The DC and H of the Smart Village- 24,000 TR. 11 slides
What is District Cooling
What is a district Cooling and Heating System.

DISTRICT COOLING SERVES MULTIPLE BUILDINGS IN A LOCAL AREA

Note: Water is chilled in the district cooling plant and supplied to customer buildings through the network of pipes. The chilled water is fed into the building’s own cooling system through the heat exchanger, and then fed back to the cooling plant in a closed loop where it is chilled again and redistributed.

Source: Adapted with kind permission from Euroheat & Power, ECOHEATCOOL Work package 5, Possibilities with more district cooling in Europe, Brussels, 2006-2006
In Focus: District Cooling | District Cooling in the Global South
Egypt’s Experience
District Cooling is not for the developed world only.
In Focus: District Cooling | District Cooling in the Global South
Egypt’s Experience

**GCC Peak Cooling Demand**

*In Millions of RT*

<table>
<thead>
<tr>
<th>Country</th>
<th>2010</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahrain</td>
<td>36</td>
<td>52</td>
</tr>
<tr>
<td>Oman</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Qatar</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Kuwait</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>UAE</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Note: RT = refrigeration tons.
Sources: MEED; GWI; national statistics; World Bank; Booz & Company analysis and forecast.
In Focus: District Cooling | District Cooling in the Global South
Egypt's Experience

- Current and Future of DC&H in the Middle East

GCC FORECAST COOLING REQUIREMENTS, 2030
(IN MILLIONS OF RT)

Sources: MEED; GWI; national statistics; World Bank; Booz & Company analysis and forecast
District Cooling and the cooling density problem.

Market distorts perception of district cooling.
In Focus: District Cooling | District Cooling in the Global South
Egypt’s Experience

The Market Distorts Perceptions of District Cooling

**COOLING COSTS WITH ACTUAL POWER COSTS**

- Conventional cooling more economically effective
- District cooling more economically effective

**COOLING COSTS WITH APPLICABLE POWER TARIFFS**

- Perceived economic benefits

Source: Booz & Company
District Cooling and the magic of diversity of use
Figure 3-1 Typical daily cooling loads demand profiles, mixed use, in a high ambient temperature country
Figure 3-3 Typical daily cooling load demand profile showing average daily load.
Figure 3-4 Typical daily cooling loads demand profiles for several applications, superimposed
(by kind permission of www.araner.com)
Case Study: The DC and H of the Smart Village- 24,000 TR
Case Study: The DC and H of the Smart Village- 24,000 TR.
General.
The system location: Giza, Egypt. The Desert Road to Alexandria – toll station Cairo end.
A modern IT administrative park.
District cooling plant: Two plants.
Refrigeration capacity: \(42,240 + 17,600 = 60,000\ kW\).
\((12,000 + 5,000 = 17,000\ TR)\).
Expected Final Refrigeration Capacity: 85,500 kW.
\((24,000\ TR)\).
End-users buildings served: 62 buildings.
End-users buildings after all building are completed: 85 building.
District heating source: Absorption unit-Qt: 6.
Capacity of each, absorption unit-in heating mode: 2,800 kW (800 TR.)
District heating water temperature, in/out: 55/60 °C.

Chiller Plant Details.

Type of chillers: Natural Gas fired absorption chillers and vapour compression centrifugal chillers.
Cooling of chillers: Water-cooled.
Number of chillers: Absorption chillers, 12.
   Centrifugal chillers, 2.
Nominal Capacity of Chiller: Absorption 4,200 kW (1,000 TR each).
   Centrifugal 8,800 kW (2,500 TR each).
Refrigerants: Absorption chillers, water (LiBr-H\(_2\)O solution).
   Centrifugal chillers, HFC 134a.
Chillers arrangement: Parallel counter flow.
District Cooling System.
- Build, Own and Operate: 20 years.
- Yearly total energy supplied (chilled water), TR hrs./year: 22,000,000.
- Chilled water design ΔT: 7.7°C (14.0 F).
- Chilled water supply/return °C: 5.6/13.3

Pumping details.
- Number of primary pumps, CHW.: 14.
- Capacity of each-CHW primary pump: 90 kW.
- Type of CHW pump: horizontal split case.
- Number of secondary pumps, CHW: 9.
- Capacity of each-CHW secondary pump: 200 kW.
- Type: horizontal split case.
- Drive: Variable speed.
- Tertiary pumps capacity: depends on building size.
- Number of condenser pumps: 14.
- Capacity of each-CW pump: 200 kW.
- Type of CW pump: horizontal split case.
Cooling towers details.
Position: On top of separate building.
Number cooling towers: 14.
Number of cell per cooling tower: 2.
Capacity of cooling tower – absorption unit: 6400 kW (1800 TR.)
Capacity of cooling tower – centrifugal unit: 12,700 kW (3600 TR.)
Type: Induced draft – axial fans.
Cooling tower pump – absorption unit: 1050 m³/hr.
Cooling tower ΔP: 40 m.
Cooling tower ΔT: 5.6 °C.
Cooling tower design CW temperature in/out: 35/29.4 °C.
Chilled water distribution system.

Type: 4 pipes system (2 chilled water, 2 hot water). Directly buried, pre-insulated piping system made of carbon steel pipes, insulated and wrapped in factory by sprayed polyurethane foam and wrapped with P.E. layer.


Piping network length (cold & hot): 51,000 m.

Sizes of pipes, at station, main headers: 48 in.

Sizes of pipes, CHW, at station end: 32 in.

Sizes of pipes, Hot water, at station end: 18 in.

Number of pipes main branches: 4 (A, B, C1 & C2).

Piping material: Carbon steel.

Piping and insulation, CHW: Pre-insulated, sprayed at factory – 1 inch thick with P.E. Jacket.

Piping and insulation, Hot water: Pre-insulated, sprayed at factory – 2 inch thick with PE Jacket.

Joining: Electric arc - welding.

Testing of pipes: Liquid plug system and water pressure & X-ray at Golden welds.

Cathodic protection: N/A.

Leak detection: N/A.

Number of manholes and manoeuvring rooms: 100 +
Consumer Interface
Direct connection.
Energy meter reading: at TES.
Tariff penalty for low ΔT: N/A.
Thank You. Dr Alaa A. Olama,

alaaolama@gmail.com