Natural cooling resources for district cooling

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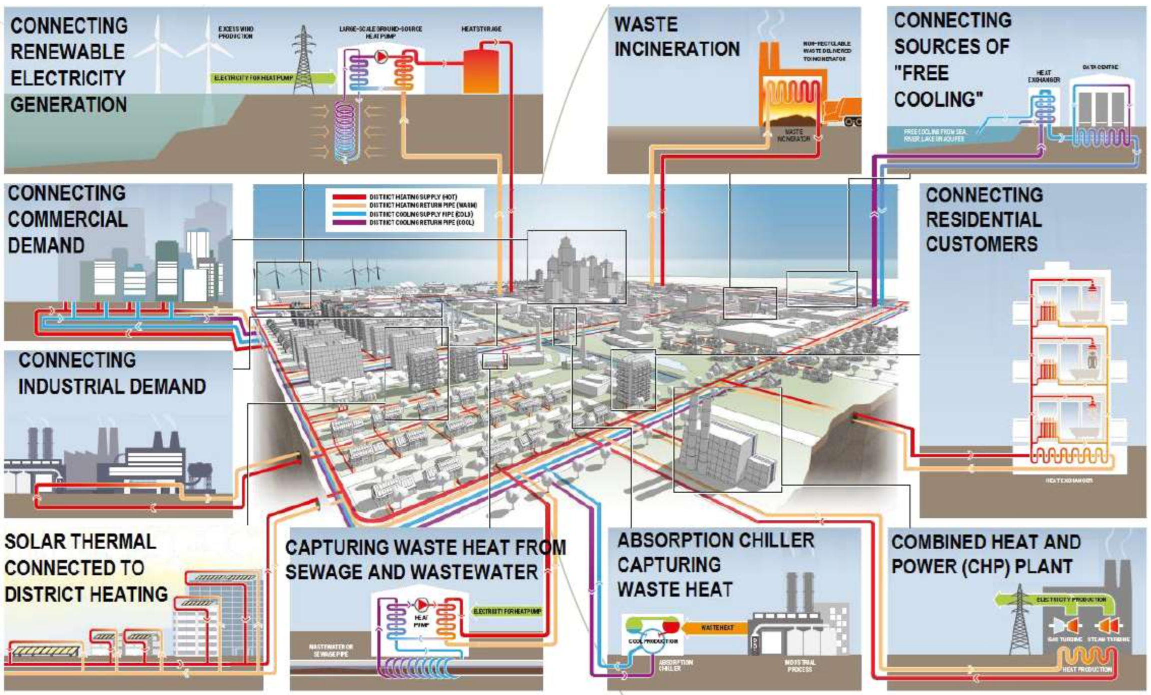
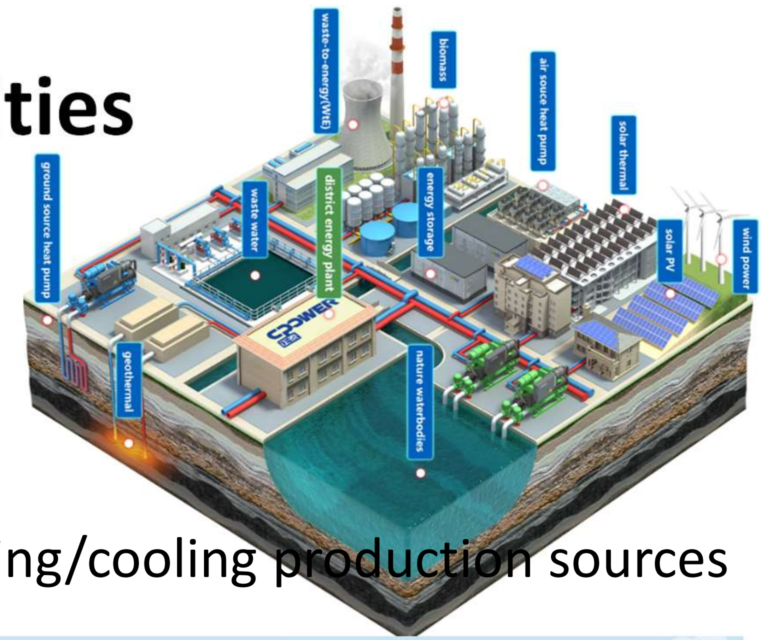
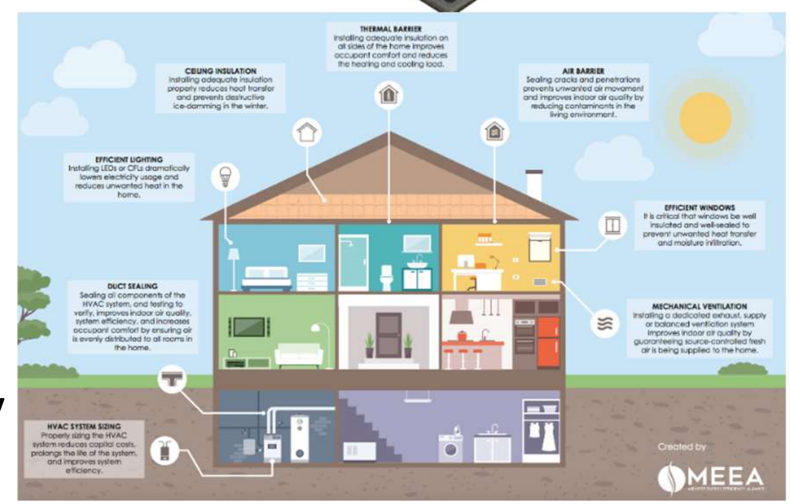
Introduction: Energy systems in cities



District energy systems for heating & cooling



Heating/cooling production sources



Building energy system

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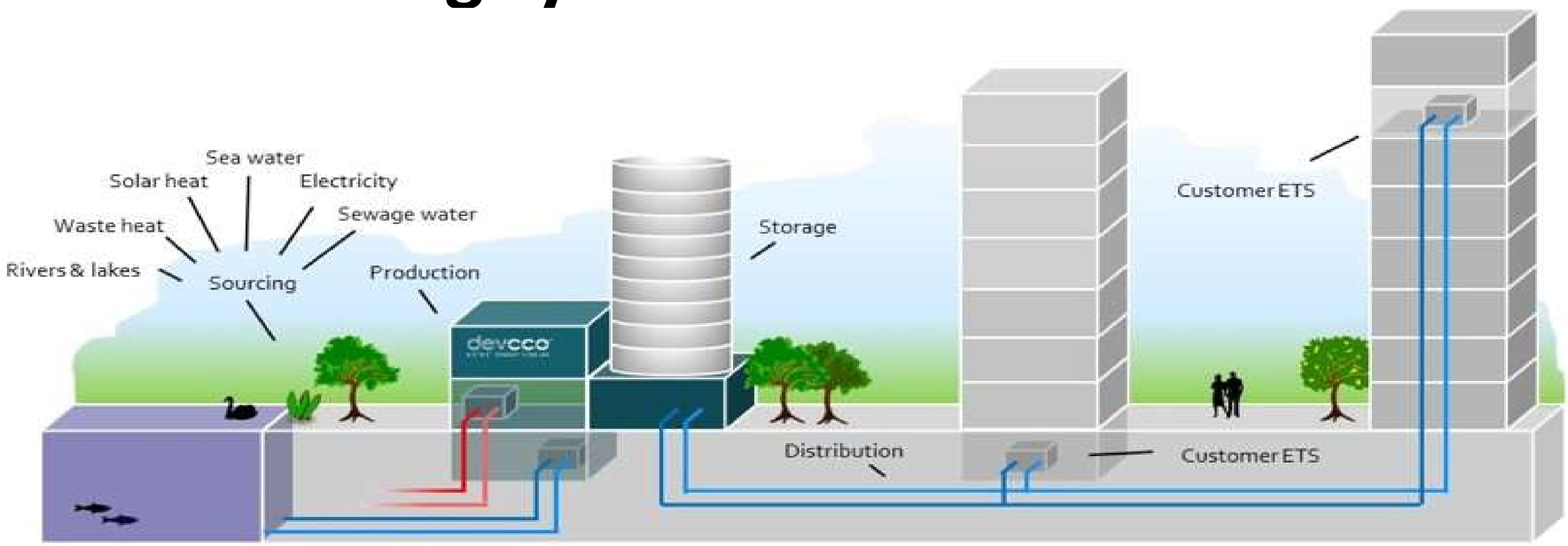
District cooling systems in cities



District cooling aims to use **<u>local energy sources</u>** that otherwise would be wasted or not used, in order to offer for the local market a **<u>competitive and high-energy-efficient alternative</u>** to the traditional cooling solutions.

Case study: Sea water for district cooling in El Alamein, Egypt

Introduction: El Alamein, Egypt

- The New El Alamein City is being built to be the modern “summer” capital for Egypt.
- Located about 110 km west of Alexandria, with easy access to the Cairo-Alamein highway, It is about 250 Km away from Cairo.
- The area is famous because of the WW 2 pivotal battle of Alamein that took place in the vicinity.

Introduction: El Alamein, Egypt

- The development area is located at the shoreline with direct access to the Mediterranean Sea
- The development consist of a mix between hotels, residential, and commercial buildings
- The project is on a “fast track” and construction is moving on in fast pace. Several high-rise buildings are at advanced stage of construction
- First cooling delivery by end of 2021 (temporary cooling solutions)
- Fully operational District Cooling system by 2025.

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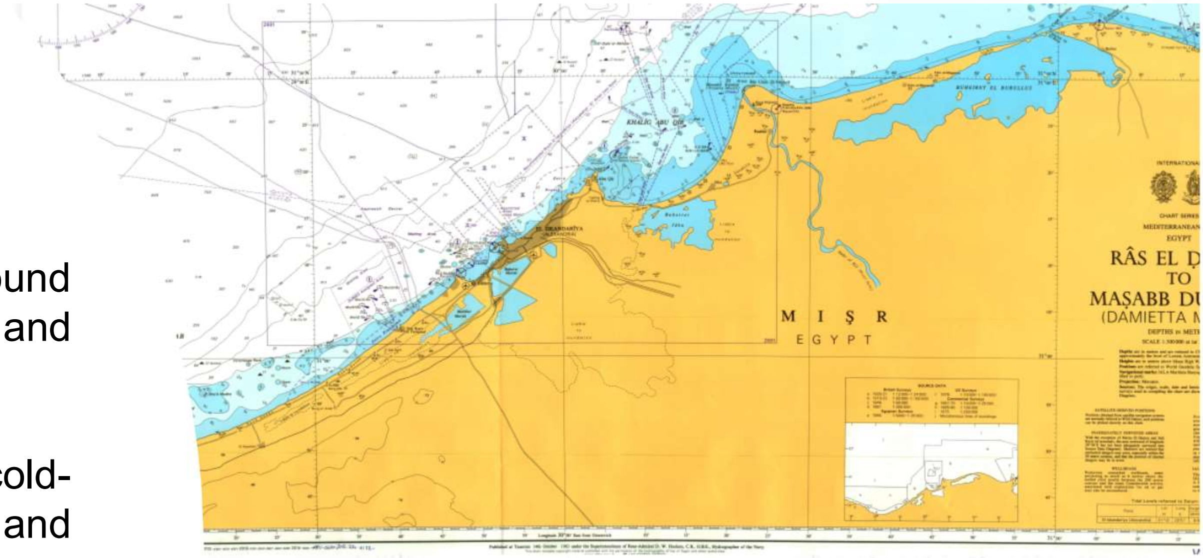
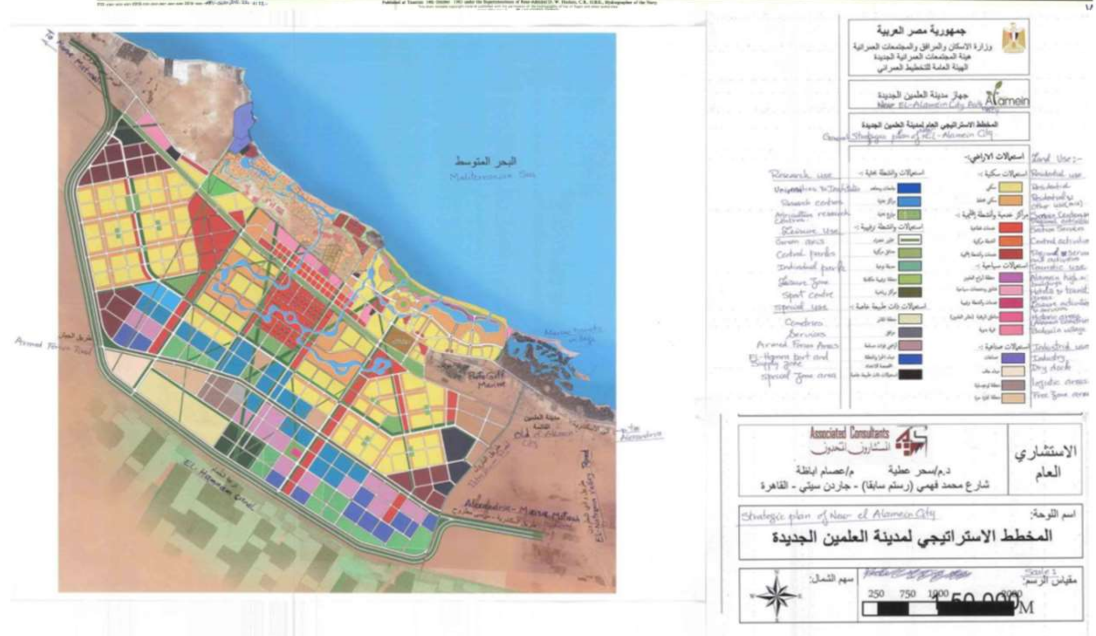
Site assessment

- Not In-Kind district cooling, capacity around 45,000 TR, final market assessment and technical configuration under evaluation
- Utilization of Mediterranean Sea as cold-water source as the admiralty map and initial seabed surveys indicates access to cold water at the development shoreline
- Production of cold water using a combination of sea water and chillers to optimize the production towards a low-GWP refrigerant, and high efficiency district cooling





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Technical solutions for district cooling

- Cooling production system (DC plant): hybrid system with a combination of absorptive chillers, seawater cooling (SWAC) and electric chillers.

- Buildings: centralized cooling system with fan coils and/or air handling units

- Chilled water transition pipelines

- Seawater intake and return pipelines

- Heat exchanger/substations on the customer side

Technical solutions: cooling production

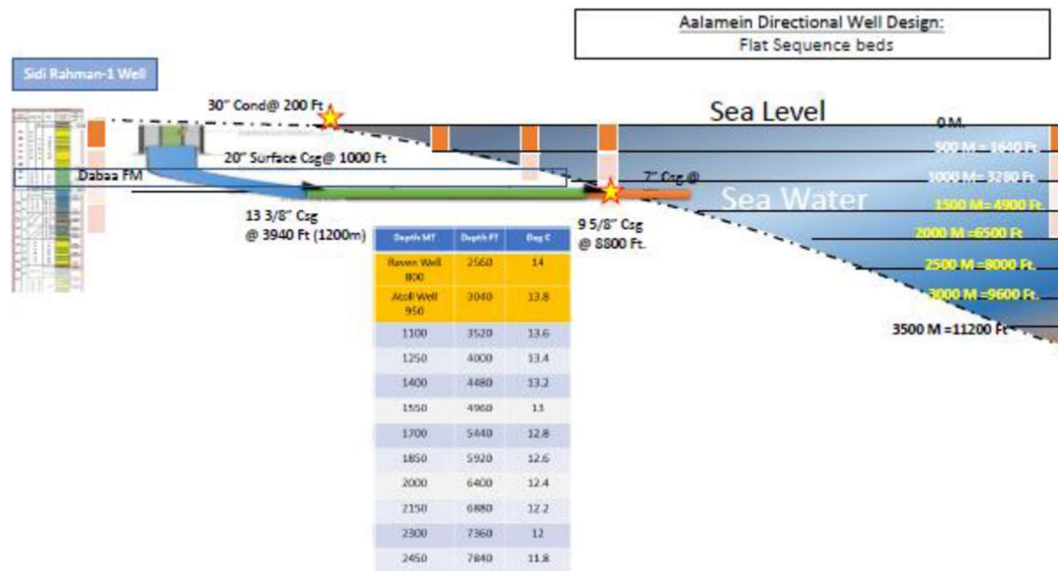
	Distributed Chillers	100% SWAC	100% absorption chillers + electric chillers	20% SWAC + 80% absorption chillers + electric chillers
The initial cost of the AC system in Millions for Towers only	1338	1413	975	996
The initial cost of the AC system in Millions for Towers and The Heritage City	1848	2165	1350	1328
The operation and maintenance cost of the AC system in Millions EGP for Towers only	335	29	152	38
The operation and maintenance cost of the AC system in Millions EGP for Towers and The Heritage City	460	44	213	51
Operation Tarrif (EGP/TR.hr)	5.1	4	4.6	4.1
Operation Tarrif (EGP/sq m.month)	35.2	27.8	31.6	28.4
Electric Power required for Towers only	34.7 MW	5 MW	10 MW	7 MW
Land Areas required for Towers only	Machine rooms within each towers cluster	1.2 acre including wells	1.5 acre	0.6 acre including wells

- DC grid supply & return temperature: 6/16 degree C

Technical solutions: Seawater cooling (SWAC)

- The seawater temperature drops quickly from the surface down to a depth of approximately 200 m. At greater depths, the decline in temperature is much slower.

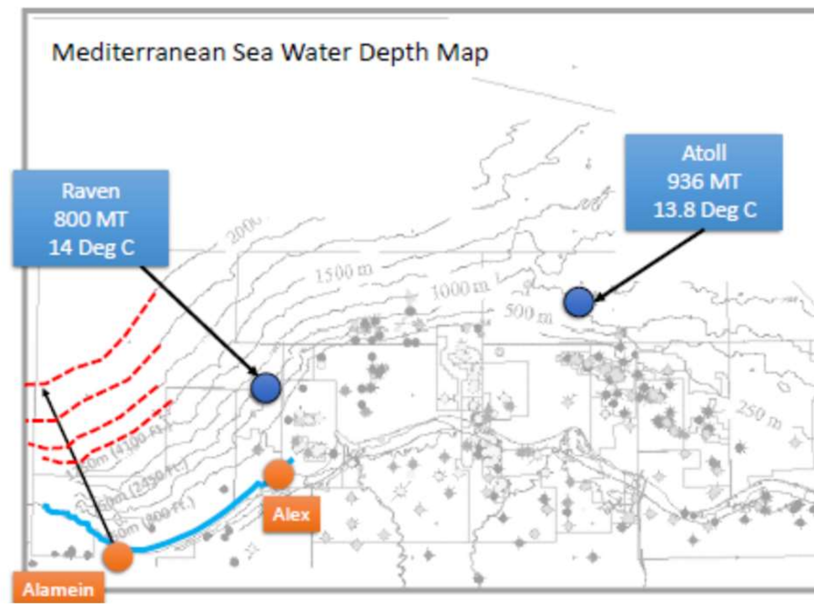
- In the north side of El Alamein, the seabed has a relatively flat slope and, at a distance of 25 km from the shoreline, the depth is around 1,000 m, where the water temperature is approximately 13-14˚C.



Depth MT	Depth FT	Deg C
Raven Well 800	2560	14
Atoll Well 950	3040	13.8
1100	3520	13.6
1250	4000	13.4
1400	4480	13.2
1550	4960	13
1700	5440	12.8
1850	5920	12.6
2000	6400	12.4
2150	6880	12.2
2300	7360	12
2450	7840	11.8

Technical solutions: Seawater cooling (SWAC)

- Shore crossing is achieved by means of micro tunneling and extends to a depth of approximately 10 m.
- Seawater intake is located at 850 m depth (14°C) with a required offshore pipe length of 2,500 m.



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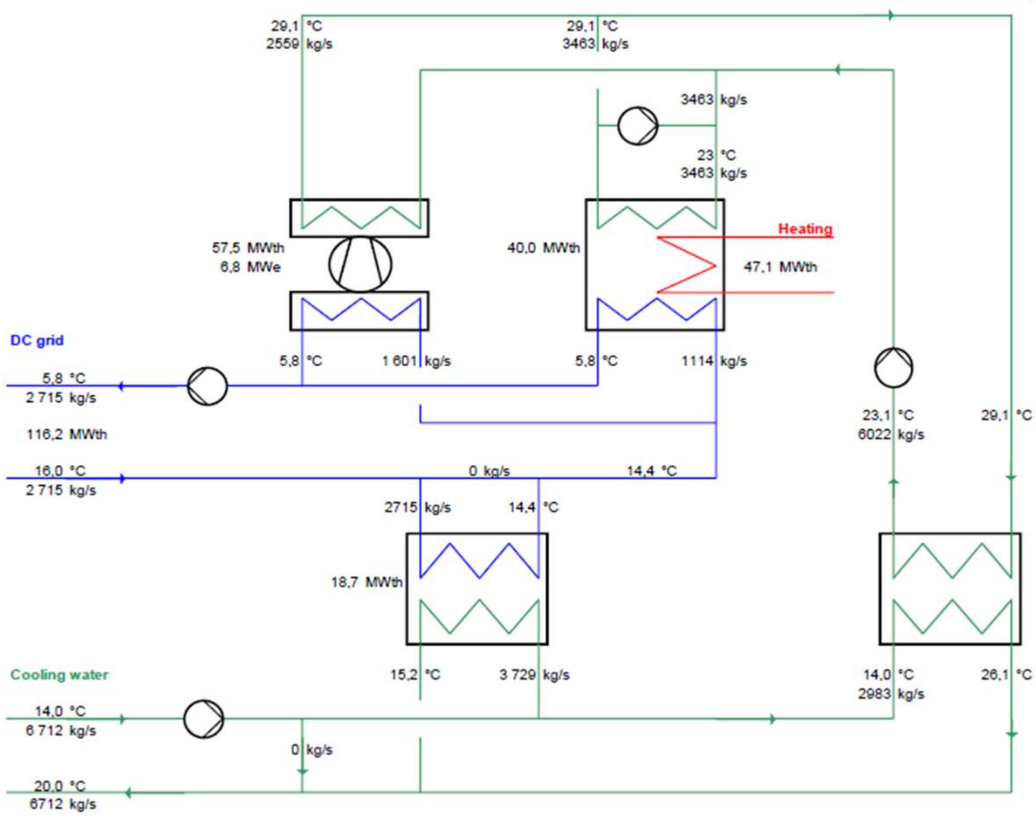
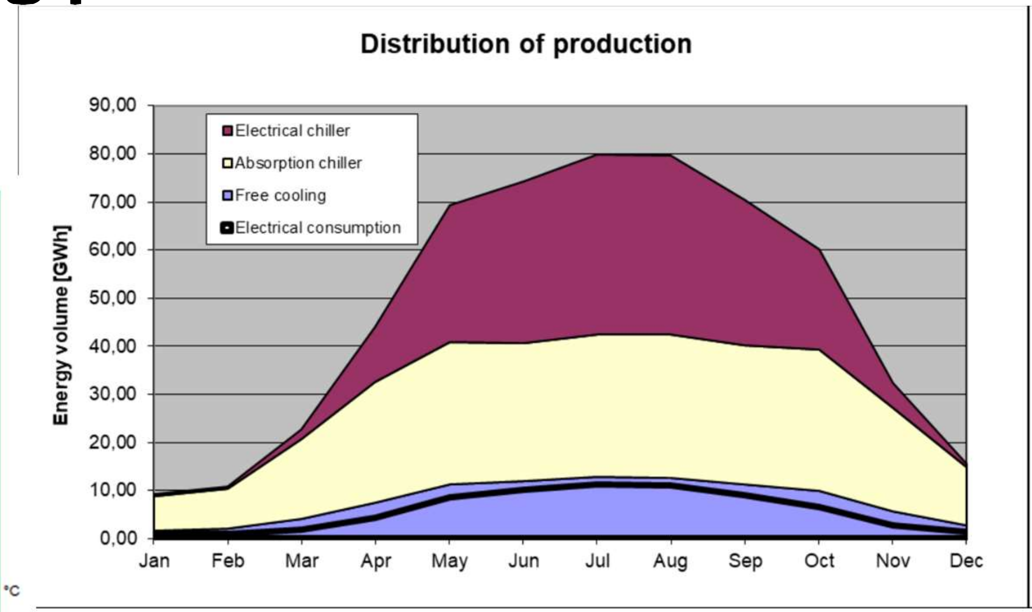
2600	8320	11.6

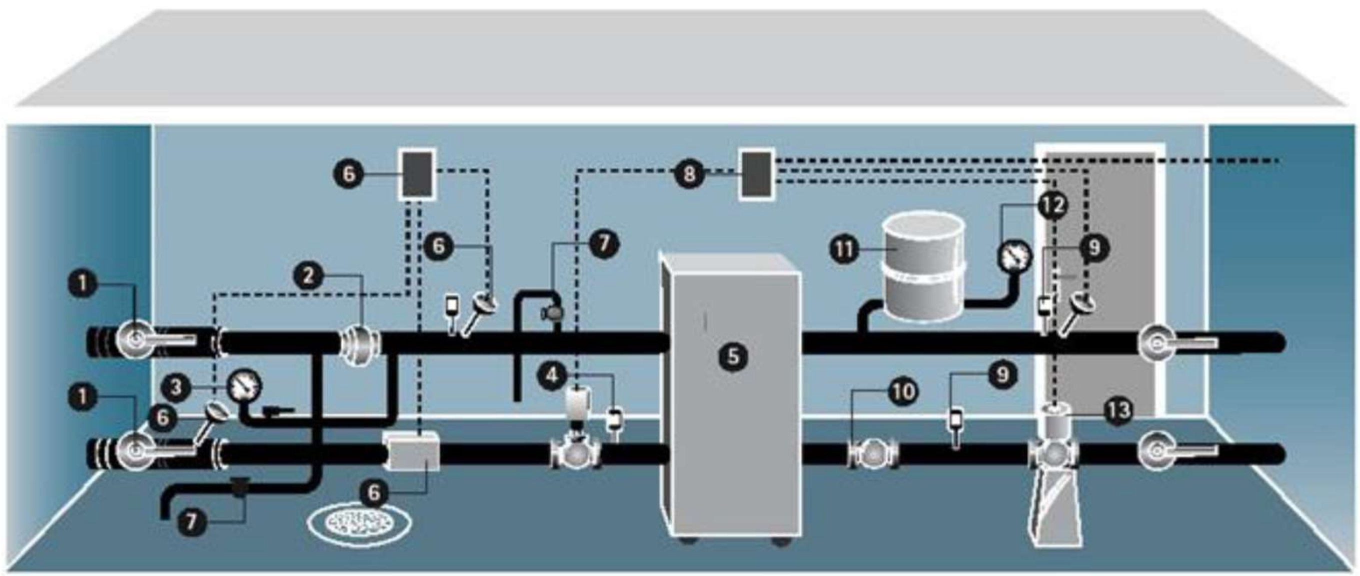
Technical solutions: cooling production





Technical solutions: heat exchanger in customer side

TECHNICAL DESCRIPTION OF A SUBSTATION



DISTRICT COOLING NETWORK

1. SERVICE VALVE
2. FILTER
3. PRESSURE GAUGE
4. THERMOMETER
5. CHILLED WATER EXCHANGER
6. INSTRUMENTATION
7. VENTILATION, DRAINING

SECONDARY SYSTEM CIRCUIT

8. CONTROL CENTRE
9. THERMOMETER
10. FILTER
11. EXPANSION VESSEL
12. PRESSURE GAUGE
13. CIRCULATION PUMP

Economic feasibility analysis

Key figures	PA09	
Net present value of the project (NPV)	246 758	k$
Internal rate of return (IRR)	22,4%	
Pay-Back (year)	2 028	
NPV / PV Investments (incl. conn. fees)	2,0	
NPV / PV Investments (excl. conn. fees)	2,0	
NPV / Customer capacity demand	1 407	
PV Income	490 791	k$
PV Costs	121 677	k$
PV Investments (incl. conn. fees)	122 355	k$
PV Investments (excl. conn. fees)	122 355	k$

Economic feasibility analysis: pricing strategy

The project indicates a technical, commercial financially feasible structure with an average tariff of around 6,8 L.E/TRh.

TARIFF STRUCTURE		
Connection Fee	0	USD/TR
Capacity Fee	739	USD/TR
Consumption Fee	0,07	USD/TRh
Average Fee	0,43	USD/TRh
Average Fee Local Currency	6,78	L.E/TRh

According to an investigation in the region, the tariff used in DC as following:

- The connection fee varies from 70 USD/TR up to 2,000 USD/TR.
- The capacity fee varies from 200 USD/TR year up to 500 USD/TR year.
- The consumption charge varies depending on local cost for water and electricity.

Environmental benefits

• Reduce refrigerant emissions by 99%.

• Save 139,500 tons of carbon dioxide equivalent annually, lowering CO_2 emissions by 40%.

• Cut peak power demand by 52 MW.

Case study: Sewage/waste water heat pump for district heating & cooling in Zhengzhou, China

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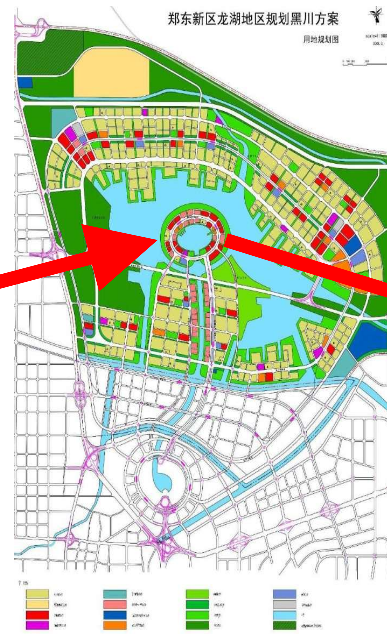
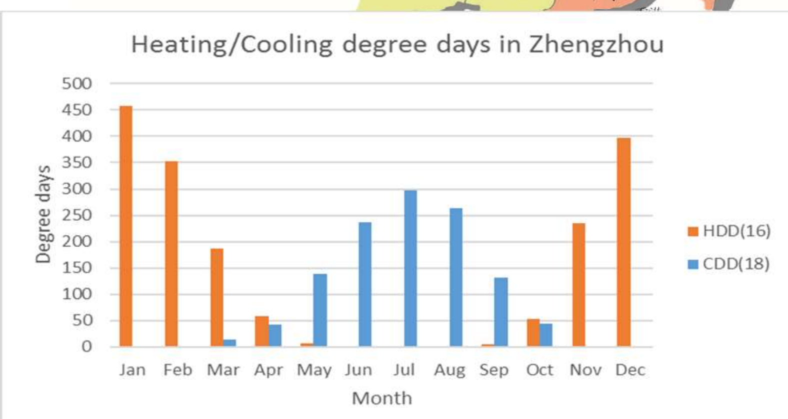
Introduction: Zhengzhou, China





- Located in Longhu District, Zhengzhou
- Cover 3.1 million sq. m of commercial buildings
- Use waste heat from treated waste water
- Providing district heating and cooling

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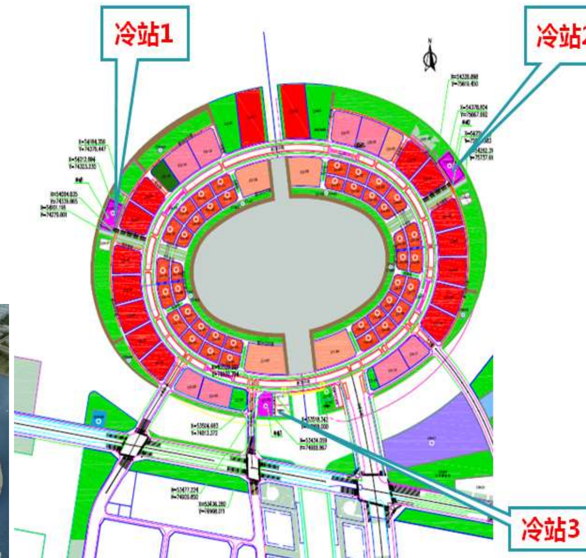
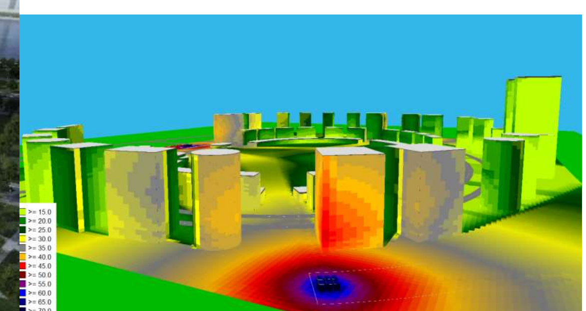
Environmental benefits

- Reduce refrigerant emissions by 99%.

- Save 139,500 tons of carbon dioxide equivalent annually, lowering CO_2 emissions by 40%.

- Cut peak power demand by 52 MW.





Key facts of the project

Key partners

Municipality, waste water treatment factory, private company

Local government role

Land for DES plants and pipeline, 100% construction fee coverage (Turn-key or EPC), 20 years of concession for heating & cooling in the region

Private company

Operation & Management

Profit structure

Heating price is regulated by local government, cooling price is set to be 15% off standalone system

Key facts of the project

Challenges

- Lower carbon footprint
- Balance of reliability and efficiency of energy system
- Support of green finance

Key success factors

- District energy planning is critical
- Support from local government for franchise rights and security of connections
- Communication channel between DES supplier and end-users

Future prospect

- Application of renewable energy
- Application of smart energy technologies
- Net-zero energy of the region

Conclusion: how to use natural cooling resources for district cooling

- Location of the end-users
- Temperature of the natural cooling resources
- Environmental impacts assessment to the water body
- How fast the heat released to the water body (river, sea etc.) can evaporate to achieve heat balance
- Different types of use: direct cooling, indirect cooling, cooling as replacement of cooling towers
- Consider to combine different kinds of cooling resources

Thank you very much!

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