



IDEA2018

Local Solutions,
Global Impact

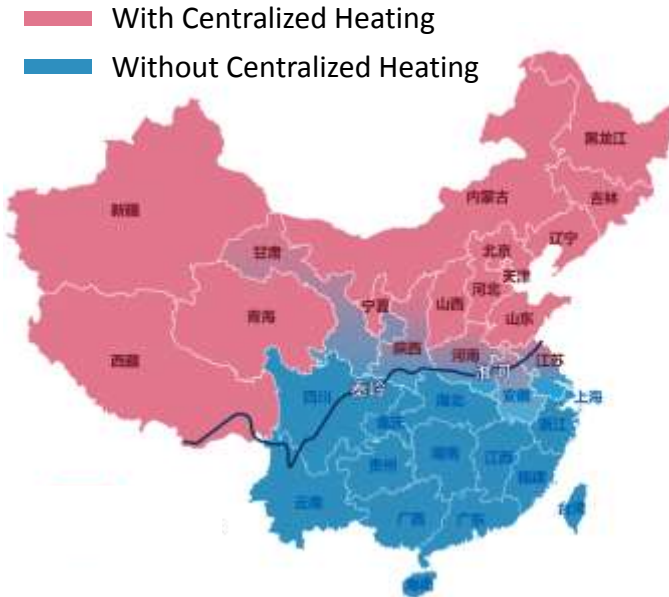
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China District Heating with Heat Recovery Solutions

Terry Deng

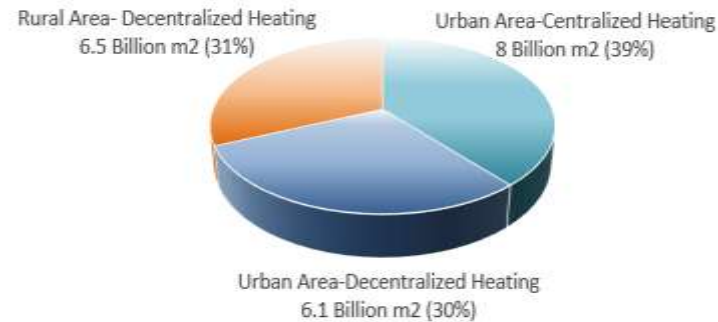
1. Overview of China Clean Heating Status and Plan
2. District Heating Solutions with Heat Recovery
3. Case Study: Power Plant Heat Recovery for District Heating
4. Summary

North China Clean Heating Status and 5-Year Plan



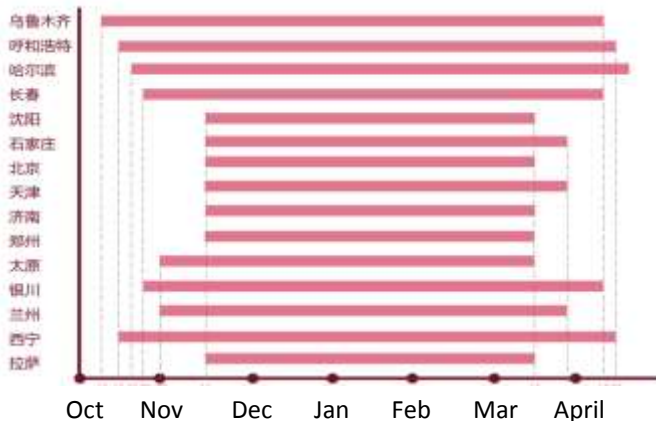
“North China Winter Clean Heating Plan (2017 to 2021)” was issued by China central government in Dec 2017

North China Building Heating Area (20.6 Billion m2 by end of 2016)

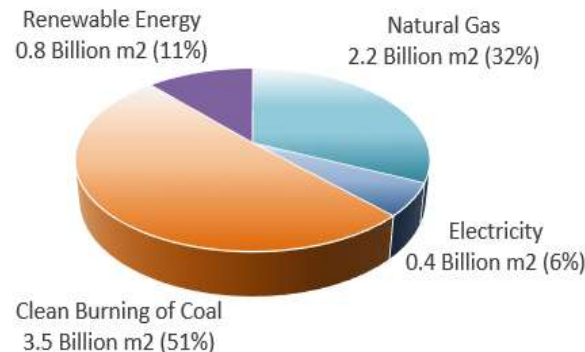


By end of 2016:

- North China heating area was 20.6 billion m2.
- District heating in North China reached around 8 billion m2.
- In North China, coal consumption for winter heating is around 400 million tons which account for 83% of winter heating energy.



North China Clean Heating Area (6.9 Billion m2 by end of 2016)



By end of 2016:

- North China clean heating area reached 6.9 billion m2 which accounts for 33% of North China winter heating area.
- Clean burning of coal (Coal fired CHP plant) and natural gas provided clean heating for an area of 5.7 billion m2 which accounts for 83% of clean heating.

North China Clean Heating Status and 5-Year Plan

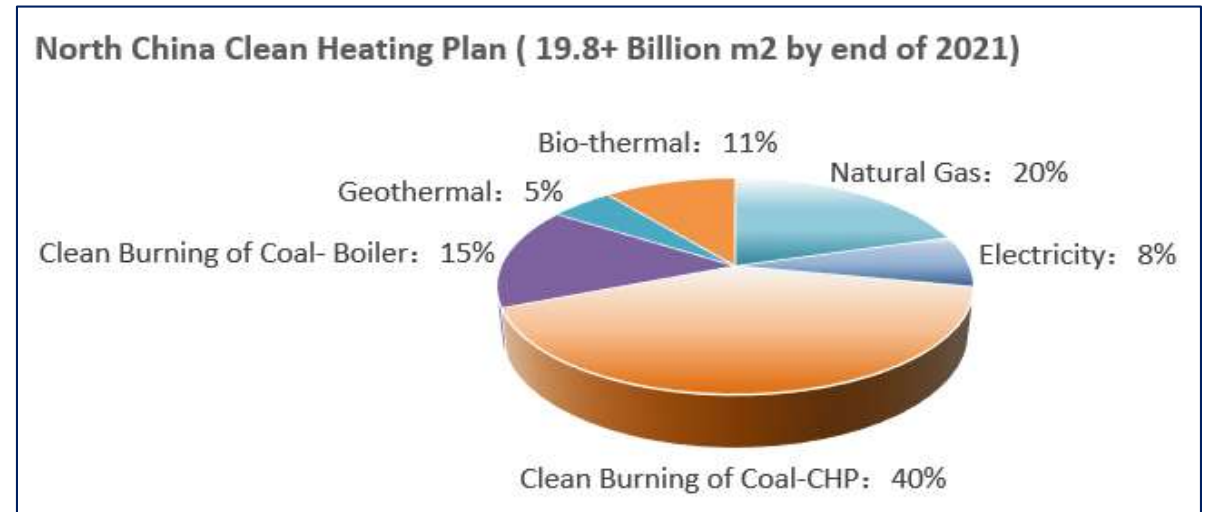
Target:

- By end of 2021, North China clean heating area reaches 19.8 billion m2 which accounts for 70% of winter heating in North China and substitute coal burning (furnace and boilers) of 150 million tons.

Measures to achieve clean heating for North China:

By end of 2021:

- Clean burning of coal: CHP plant provides heating for 8 billion m2 and low emission boilers provides heating for 3 billion m2.
- Natural gas: Increases heating for 1.8 billion m2 for “2+26” cities.
- Electricity (including heat pumps): Provides heating for 1.5 billion m2.
- Renewable energy: Provides heating for 3.3 billion m2 (Geothermal and Bio-thermal accounts for 30% and 63% respectively).



North China Clean Heating Plan by end of 2021 (Unit: billion m2)							
Natural Gas	Electricity	Clean Burning of Coal-CHP	Clean Burning of Coal-Boiler	Geothermal	Bio-thermal	Industrial Heat	Solar
4	1.5	8	3	1	2.1	0.2	0.05
20%	8%	40%	15%	5%	11%	1%	0%

Typical Heat Recovery Applications For Clean Heating



Clean Heating Solutions with Heat Recovery

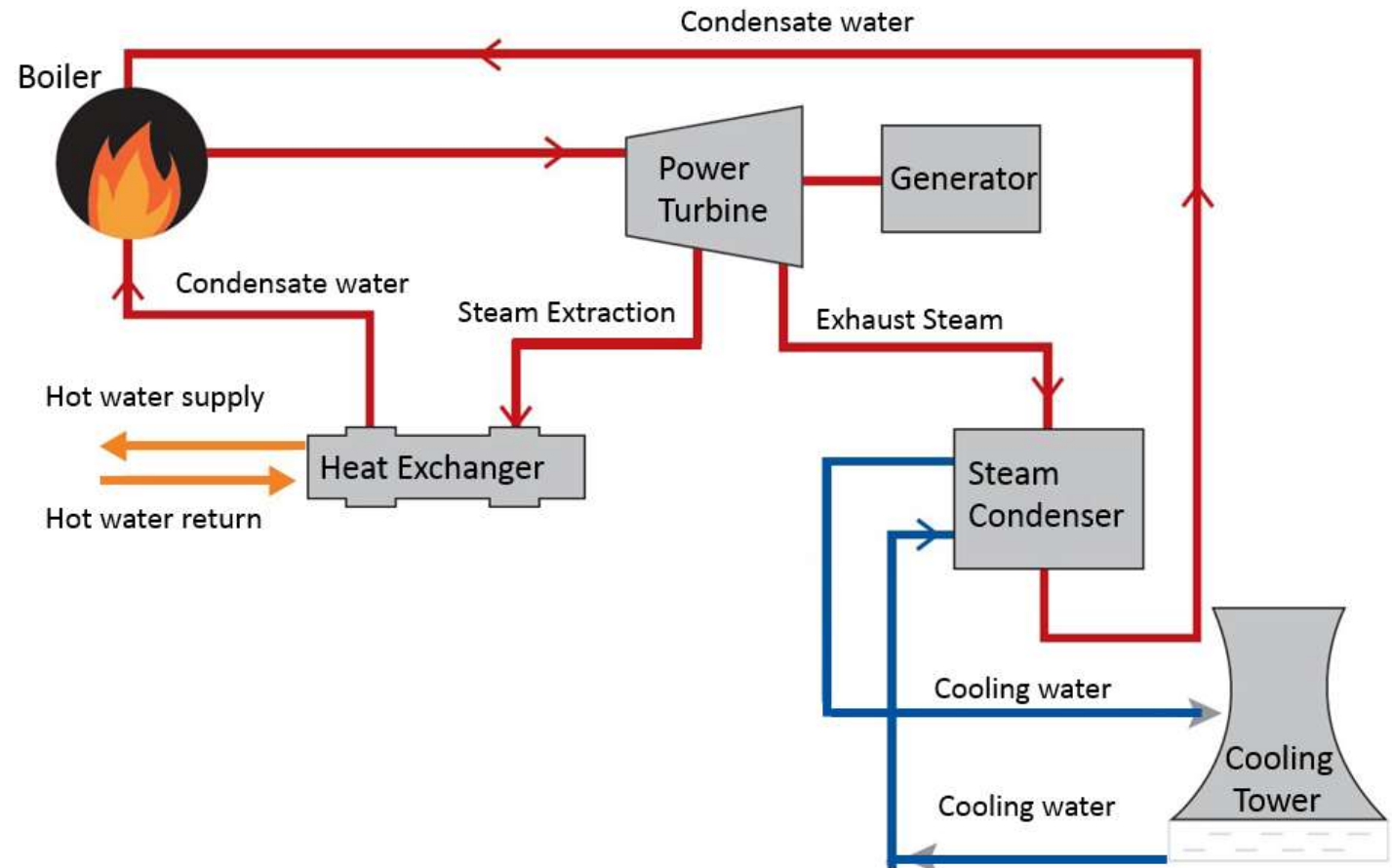
Typical Application 1: Coal fired CHP Exhaust Steam Heat Recovery for District Heating

Traditional CHP plant

- Condensing heat of exhaust steam from power turbine is rejected through cooling tower.
- Steam from power turbine is extracted for heating.



- It rejects a big amount of heat to the environment while supply heat with steam



Clean Heating Solutions with Heat Recovery

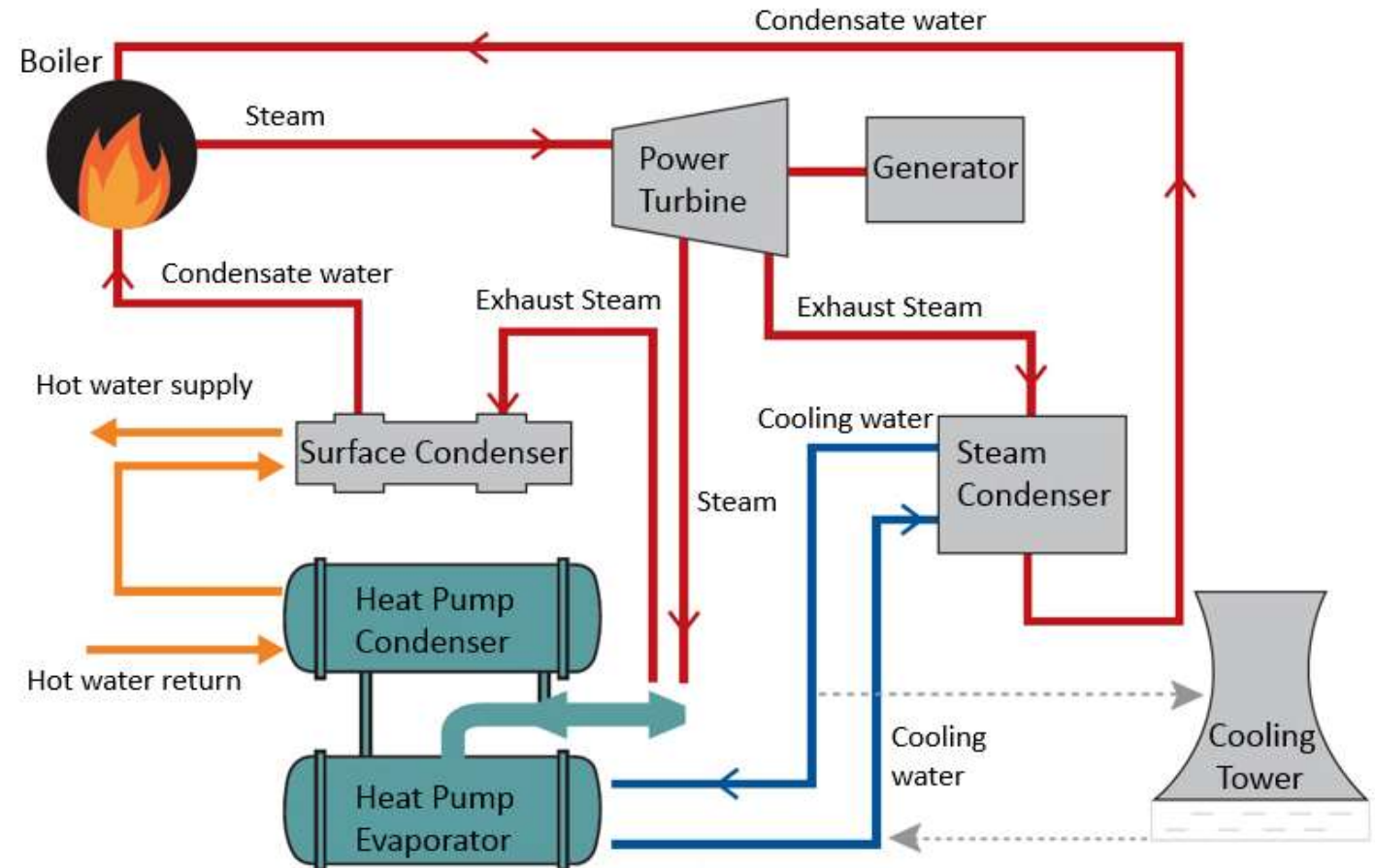
Typical Application 1: Coal fired CHP Exhaust Steam Heat Recovery for District Heating

CHP Heat Recovery

- Condensing heat of exhaust steam from power turbine is recovered by heat pump.
- Recovered heat is used for district heating.



- Increase CHP heating supply by more than 30%.

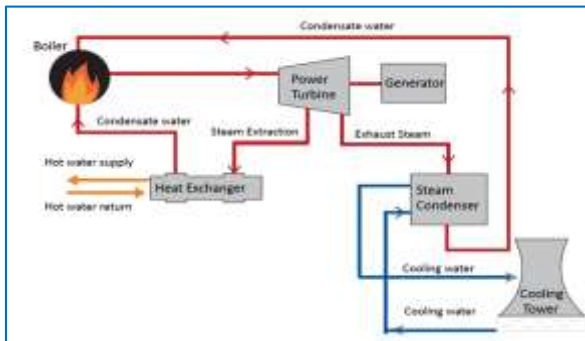


Clean Heating Solutions with Heat Recovery

Typical Application 1: Coal fired CHP Exhaust Steam Heat Recovery for District Heating

Heating supply capability of the CHP plant was improved by 33% percent with same amount of steam consumption before heating retrofit.

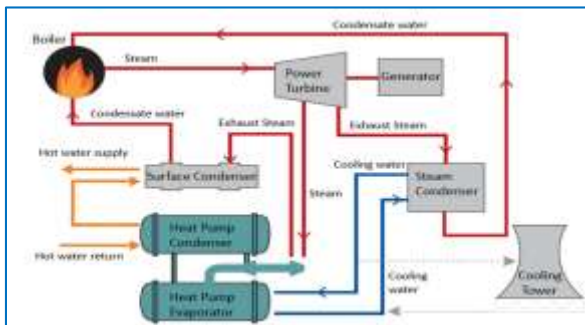
Traditional CHP Plant



Heating with Steam Extraction

Steam extraction parameter		Cooling water temperature		Heating loop temperature		Heating efficiency	Steam consumption	Heating Capacity
Pressure	Temperature	Inlet	Outlet	Return	Supply	COP	Ton/Hour	MW
MPa	°C	°C	°C	°C	°C			
0.98	300	25	17	60	100	1	68.9	50

CHP Plant with Heat Recovery



Heating with Steam Turbine Driven Heat Pump

Steam extraction parameter		Cooling water temperature		Heating loop temperature		Heating efficiency	Steam consumption	Heating Capacity
Pressure	Temperature	Inlet	Outlet	Return	Supply	COP	Ton/Hour	MW
MPa	°C	°C	°C	°C	°C			
0.98	300	25	17	60	100	4.35	68.9	66.5

Clean Heating Solutions with Heat Recovery

Typical Application 2: Energy Stations with Treated Sewage Water Heat Recovery



Heat Source:
10°C Treated Sewage Water



Heat Sink:
65°C Hot Water Supply
for Residential Heating



Clean Heating Solutions with Heat Recovery

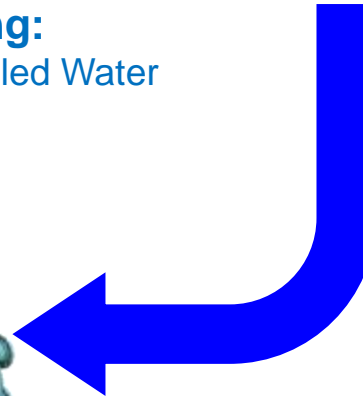
Typical Application 2: Energy Stations with Treated Sewage Water Heat Recovery



Summer:
Energy station provides
cooling and release heat to
the TSW



Cooling:
7°C Chilled Water



Clean Heating Solutions with Heat Recovery

Typical Application 2: Energy Stations with Treated Sewage Water Heat Recovery

Annual heating energy cost can be saved from 9.05 to 6.11 Million Yuan(33% cost reduction) with a heat pump of 11MW heating capacity.



CYK 2-stage Heat Pump

Heating with Heat Pump by TSW Heat Recovery								
Heating Capacity	Heating efficiency	Treated sewage water temperature		Heating loop temperature		Electricity Price	Heating hours	Annual Operation Cost
MW	COP	Inlet °C	Outlet °C	Return °C	Supply °C	RMB/Kwh	Hours	Million Yuan (RMB)
11	4.15	9	4	50	65	0.8	2880	6.11



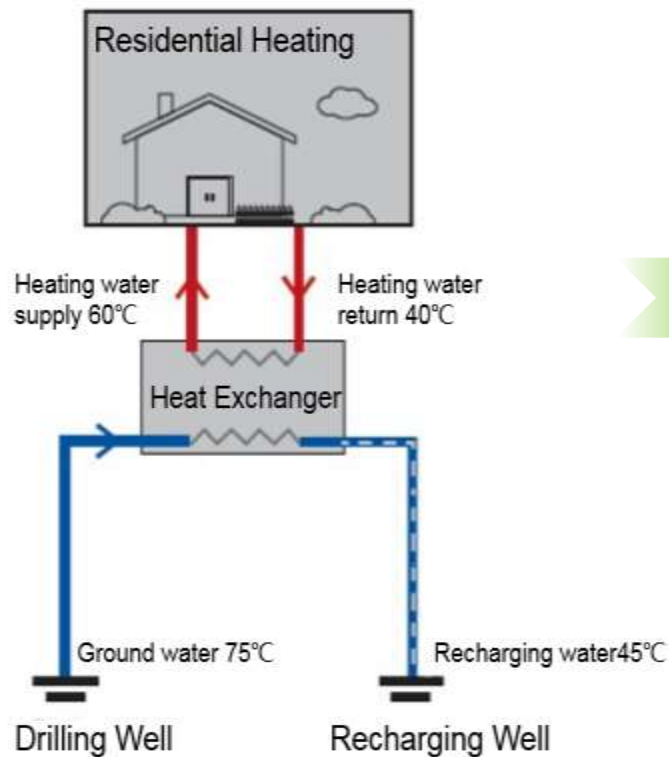
Gas Boiler

Heating with Gas Fired Boiler								
Heating Capacity	Heating value of gas	Treated sewage water temperature		Heating loop temperature		Gas price	Heating hours	Annual Operation Cost
MW	Kcal/M3	Inlet °C	Outlet °C	Return °C	Supply °C	RMB/M3	Hours	Million Yuan (RMB)
11	9000	9	4	50	65	3.0	2880	9.05

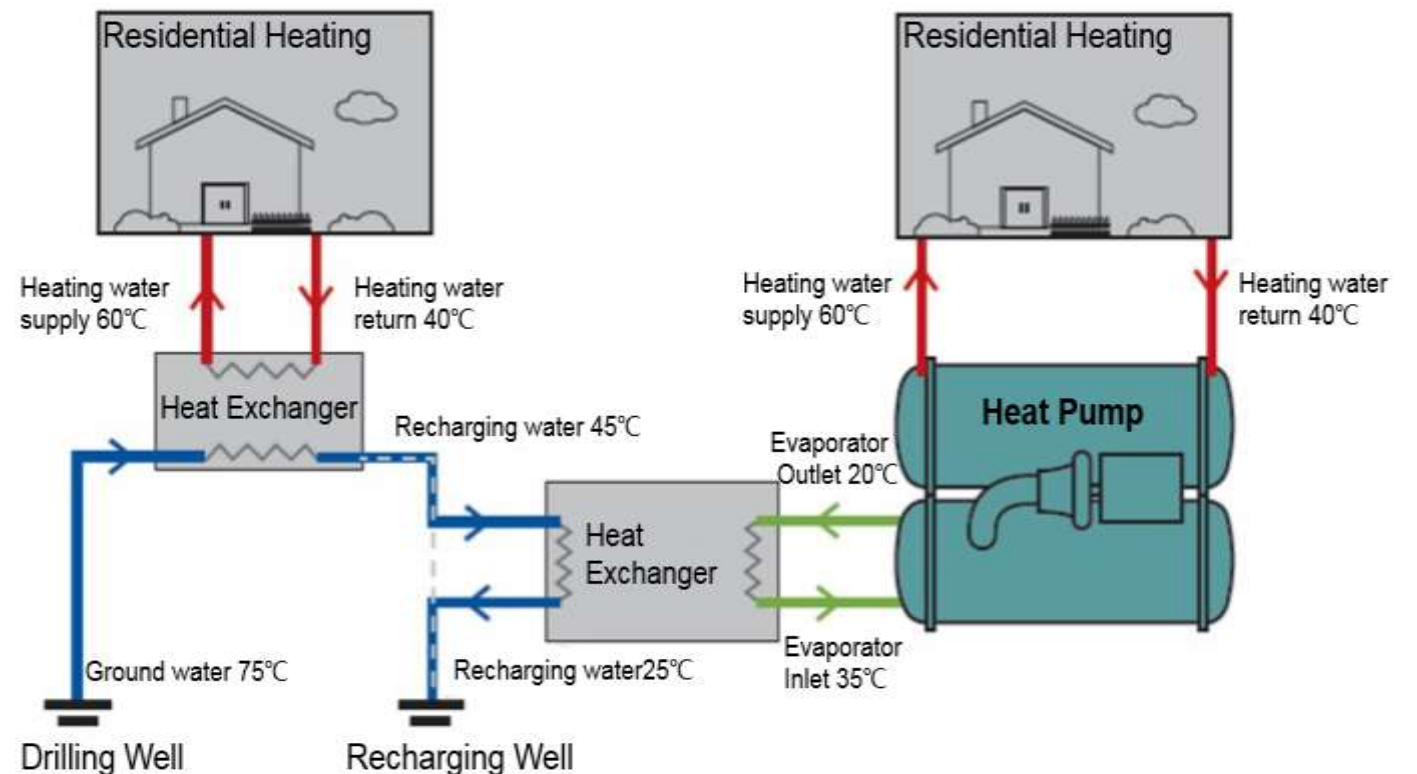
Clean Heating Solutions with Heat Recovery

Typical Application 3: Geothermal Recharge Water Heat Recovery for Residential Heating

Ground Water Heating



Ground Water Heating with Heat Recovery



Clean Heating Solutions with Heat Recovery

Typical Application 3: Geothermal Recharge Water Heat Recovery for Residential Heating

Annual heating energy cost can be saved from 6.58 to 3.36 Million Yuan(49% cost reduction) with a heat pump of 8 MW heating capacity.



YK single-stage Heat Pump

Heating with Heat Pump by Geothermal Heat Recovery								
Heating Capacity	Heating efficiency	Ground water temperature		Heating loop temperature		Electricity Price	Heating hours	Annual Operation Cost
MW	COP	Inlet °C	Outlet °C	Return °C	Supply °C	RMB/Kwh	Hours	Million Yuan (RMB)
8	5.48	35	20	40	60	0.8	2880	3.36



Gas Boiler

Heating with Gas Fired Boiler								
Heating Capacity	Heating value of gas	Treated sewage water temperature		Heating loop temperature		Gas price	Heating hours	Annual Operation Cost
MW	Kcal/M3	Inlet °C	Outlet °C	Return °C	Supply °C	RMB/M3	Hours	Million Yuan (RMB)
8	9000	9	4	40	60	3.0	2880	6.58

Case Study

China Resources Group Tangshan Fengrun Power Plant Heat Recovery Project

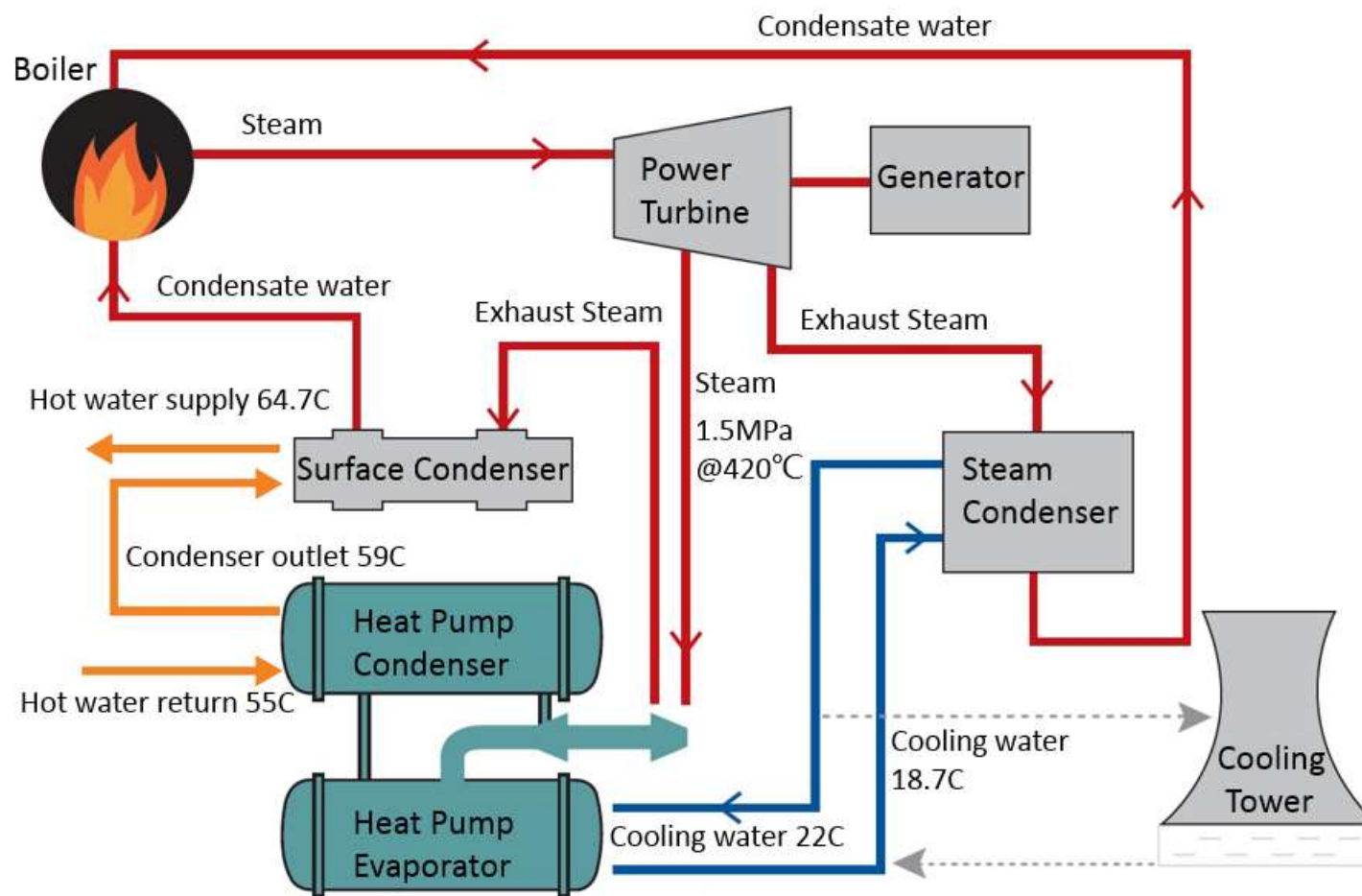


Case Study:

China Resources Group Tangshan Fengrun CHP Plant Heat Recovery Project



YORK™ YDST Double Extension Shaft
Steam Turbine Driven Heat Pump



Case Study:

China Resources Group Tangshan Fengrun CHP Plant Heat Recovery Project



- Two YORK™ YDST steam turbine driven heat pumps was installed to recover “waste” heat from the power plant cooling water (22°C) and produce hot water of 64.7°C.
- 42 megawatts heat can be recovered from power plant cooling water which is capable to provide 840 thousands m2 heating area in Tangshan city.
- 14.8 thousand tons of coal consumption and 39 thousand tons of CO₂ emissions can be saved per each heating season.



Performance of Steam Turbine Driven Centrifugal Heat Pump (YORK YDST)								
Heat Pump Condenser Heating Capacity	Heat Pump Surface Condenser Heating Capacity	Heat Recovery Capacity	Turbine Shaft Power	Evaporator Water Inlet/Out	Condenser Water Inlet/Out	Surface Condenser Water Inlet/Out	Heating COP	Steam Consumption
MW	MW	MW	MW	°C	°C	°C	COP	T/h
26.5	37.5	21	5.5	22/18.7	55/58.9	58.9/64.7	4.74	56

Summary

- China central government made strong commitment/policies to promote clean heating for North China in next 5 years with plan to grow clean heating from 6.9 billion m² in 2016 to 19.8 billion m² in 2021.
- Heating by coal fired CHP which is considered as one way of clean burning of coal is planned to grow from 3.5 billion m² in 2016 to 8.0 billion m² in 2021 which accounts for 40% North China clean heating plan in 2021.
- Heat pumps are used for district heating with heat recovery applications including CHP, TSW, Geothermal and achieved 30% to 50% energy cost saving.