



IDEA2018

Local Solutions,
Global Impact

109TH ANNUAL CONFERENCE & TRADE SHOW
June 11-14 | Vancouver Convention Centre | Vancouver, BC

China District Heating with Heat Recovery Solutions

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Outline

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

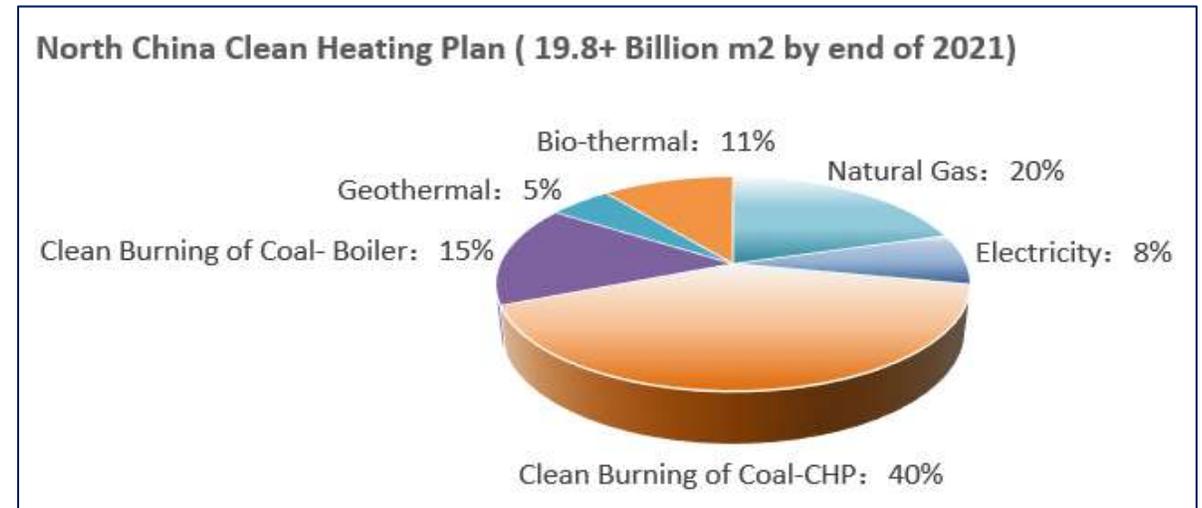
Target:

- 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



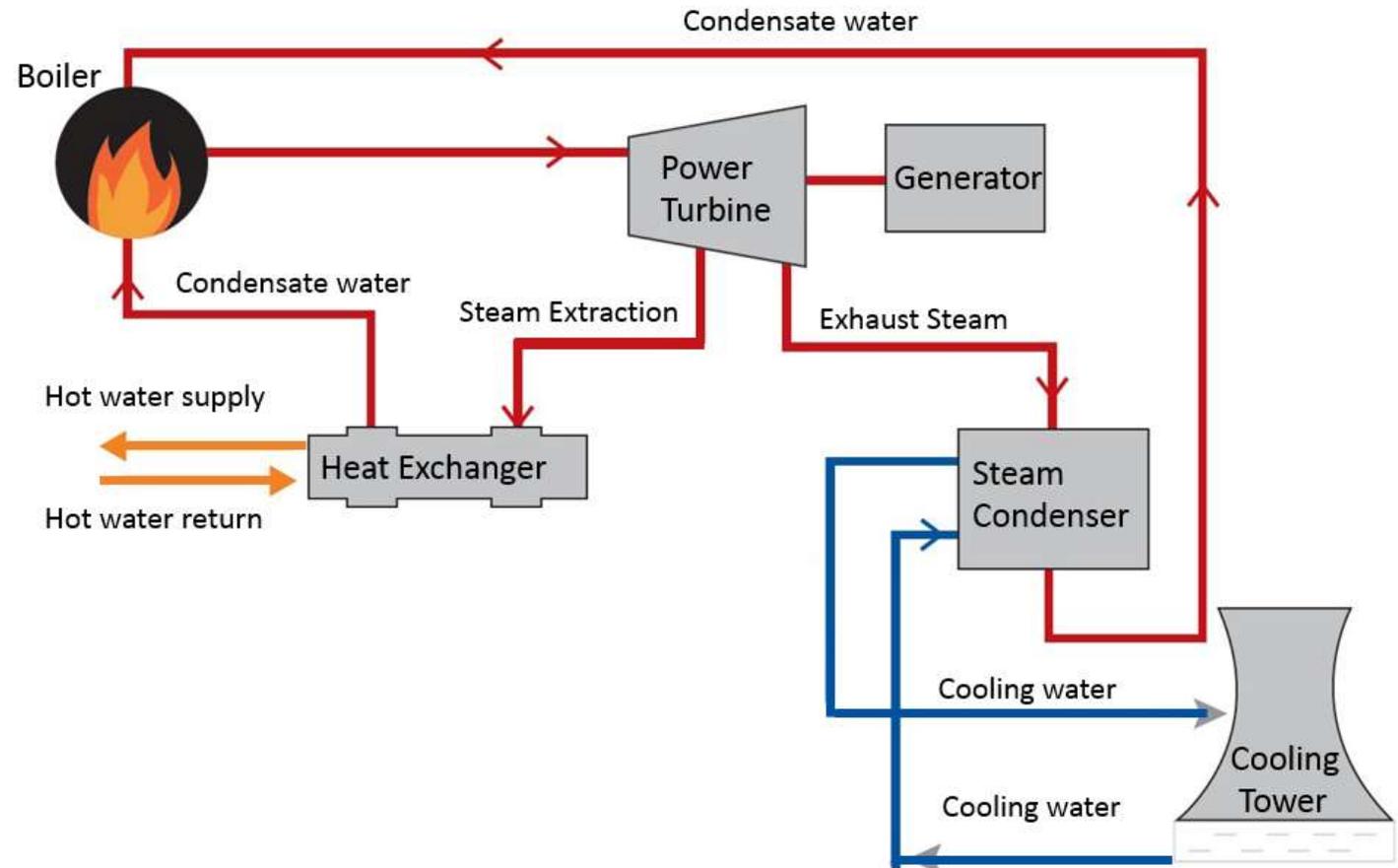
Clean Heating Solutions with Heat Recovery

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.

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



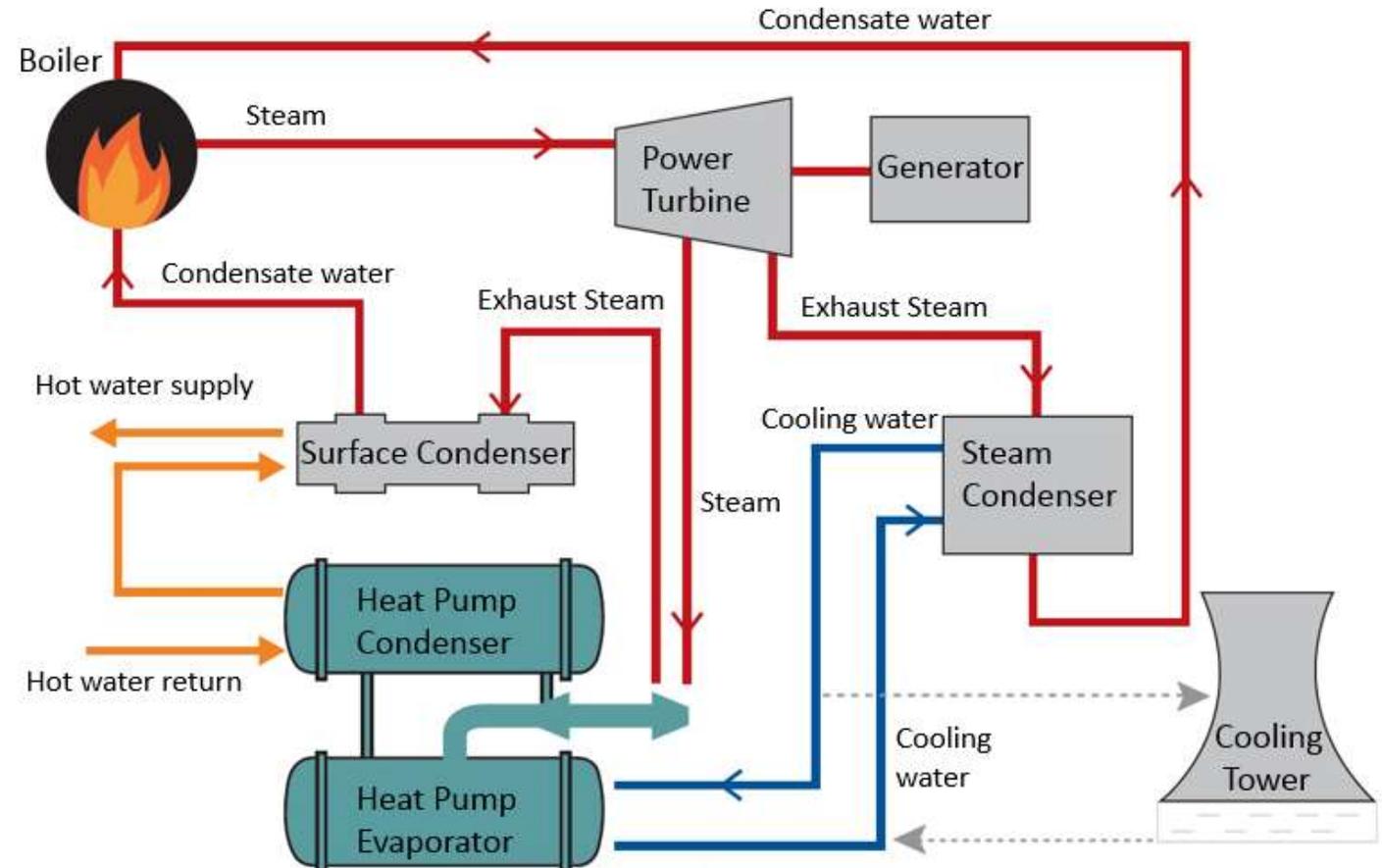
Clean Heating Solutions with Heat Recovery

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.

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- Increase CHP heating supply by more than 30%.

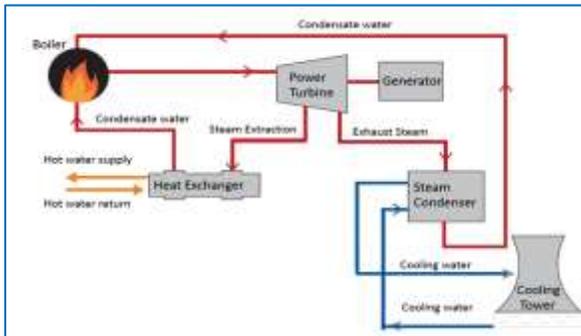


Clean Heating Solutions with Heat Recovery

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.

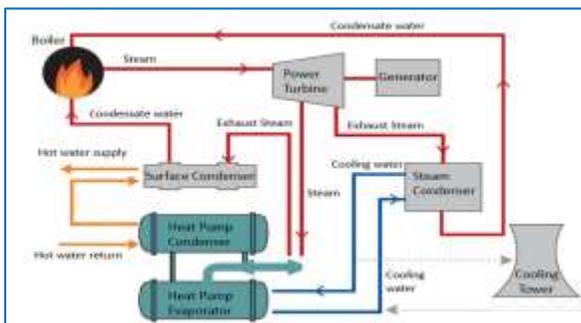
Traditional CHP Plant



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

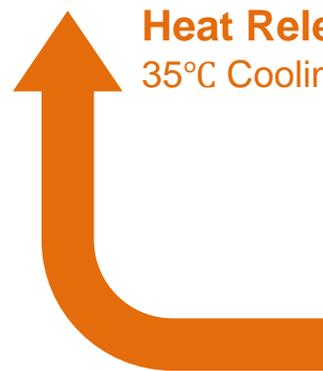


Clean Heating Solutions with Heat Recovery

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



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



Heat Release:
35°C Cooling Water

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 |



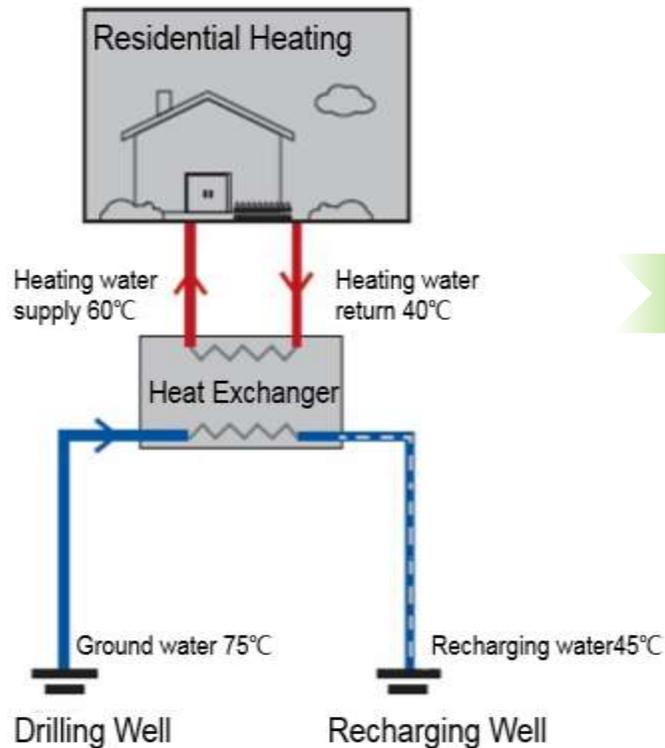
Gas Boiler

| 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 |

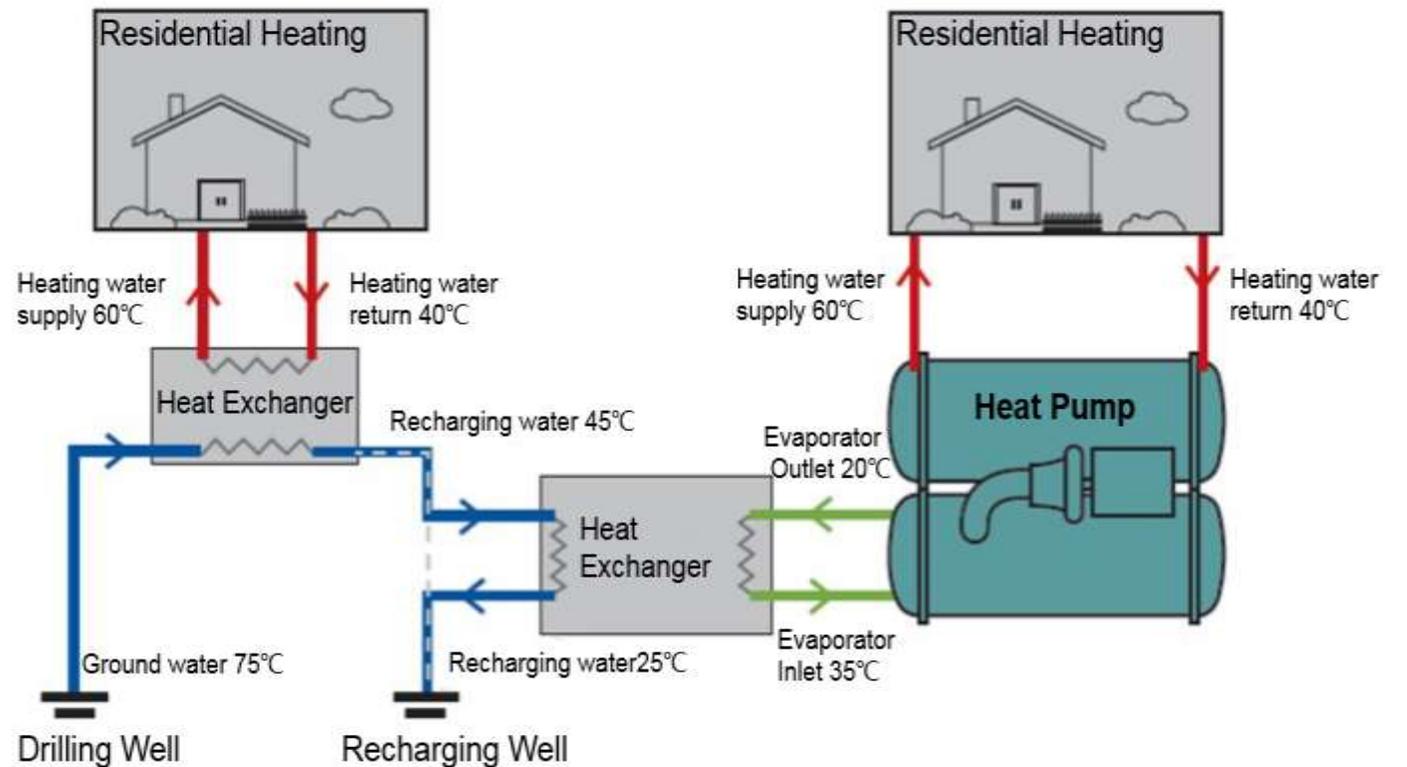
Clean Heating Solutions with Heat Recovery

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 |
| | | Inlet | Outlet | Return | Supply | | | |
| MW | COP | °C | °C | °C | °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 |
| | | Inlet | Outlet | Return | Supply | | | |
| MW | Kcal/M3 | °C | °C | °C | °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

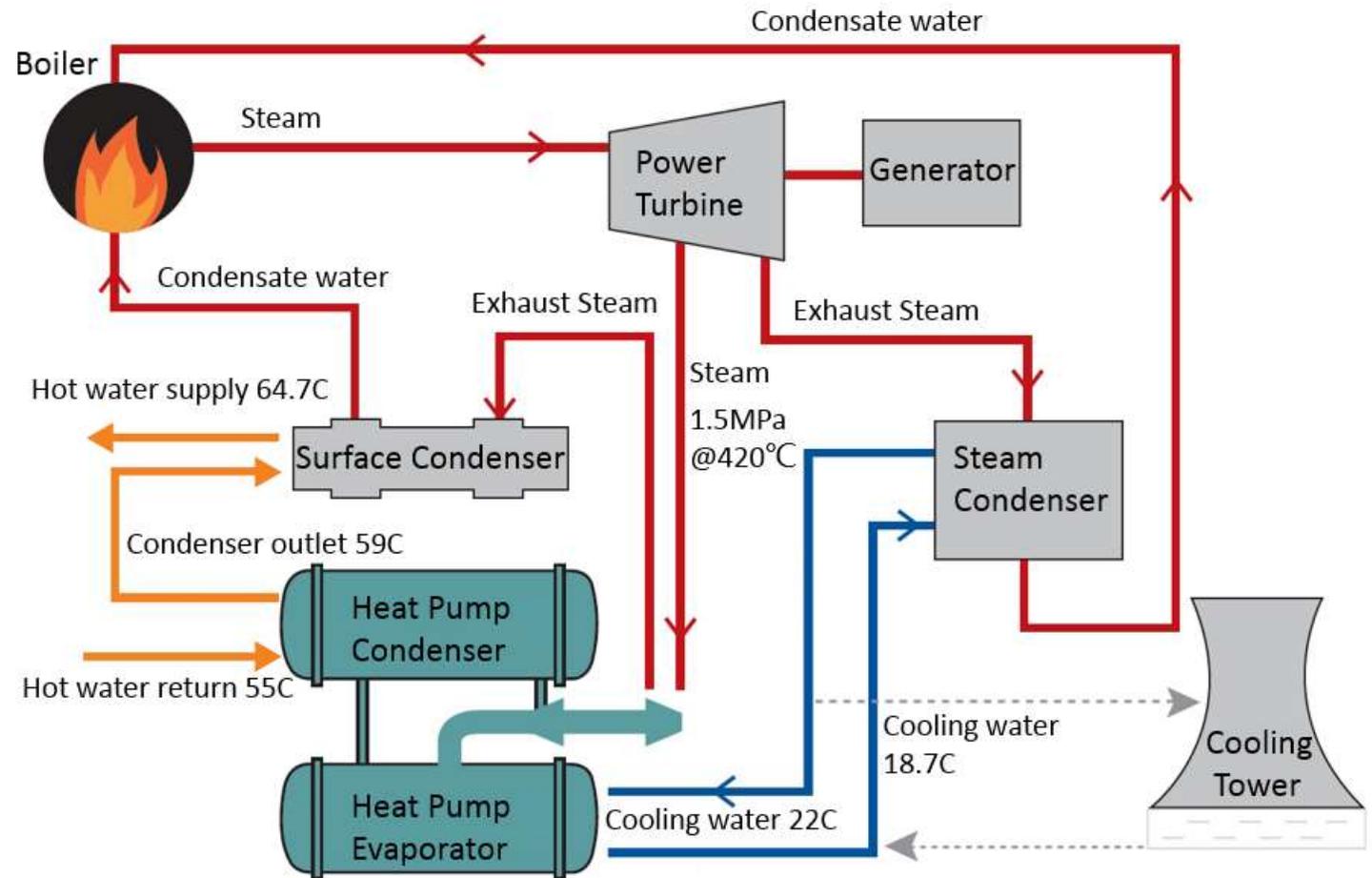


Case Study:

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.