SWEHEAT & COOLING

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"Current status and future outlook of District Heating and District Cooling in China."

Bernt Andersson

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bernt.andersson@goldenforest.nu

Embracing Change

SweHeat & Cooling

District Heating

- Change of Heating Energy Supply, has highest priority in China, mainly depending on environmental reasons;
- Coal is inexpensive and Heating only Boilers utilising moving grate technology with very simple flue gas cleaning, is the most common solution for supply to existing District Heating systems;
- Total Production Cost for Gas fired Hot Water Boilers, including Natural Gas, O&M and Capital Cost is more then two times as expensive compared to burning Coal;
- District Heating Networks are almost all based on hot water technology and operated only during the winter and in 99% of cases only supply heat and no domestic hot water.
- As an example in Beijing Heating is provided from November 15 until March 15;

bernt.andersson@goldenforest.nu

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District Cooling

- Very limited development of District Cooling systems, first systems developed early 2000;
- Standard approach for cooling is split units for apartments and building or block level chilled water plants;
- Indoor design temperature is +26 C (77 F)
- For District Cooling systems a combination of compression chillers, absorption chillers and Ice Thermal Energy Storage are common;
- Almost all District Cooling plants with Ice Thermal Energy Storage have dual duty, single evaporator chillers and large heat exchangers between the glycol circuit and chilled water circuit for day time operation as well as heat exchangers between the Ice Thermal Energy Storage and the chilled water circuit;
- In almost all cases where both District Heating and District Cooling are developed the pipe network is two pipe system that are used for heat supply in winter and cooling supply in the summer;

bernt.andersson@goldenforest.nu

Considerable Climate Differences

Climate Zones	Mean Monthly Temperature	
	Coldest	Hottest
Severe Cold	≤ -10 °C	≤ 25 °C
Cold	-10–0 °C	18–28 °C
Temperate	0–13 °C	18–25 °C
Hot Summer and Cold Winter	0–10 °C	25–30 °C
Hot Summer and Warm Winter	> 10 °C	25–29 °C

Source: Berkely Labs

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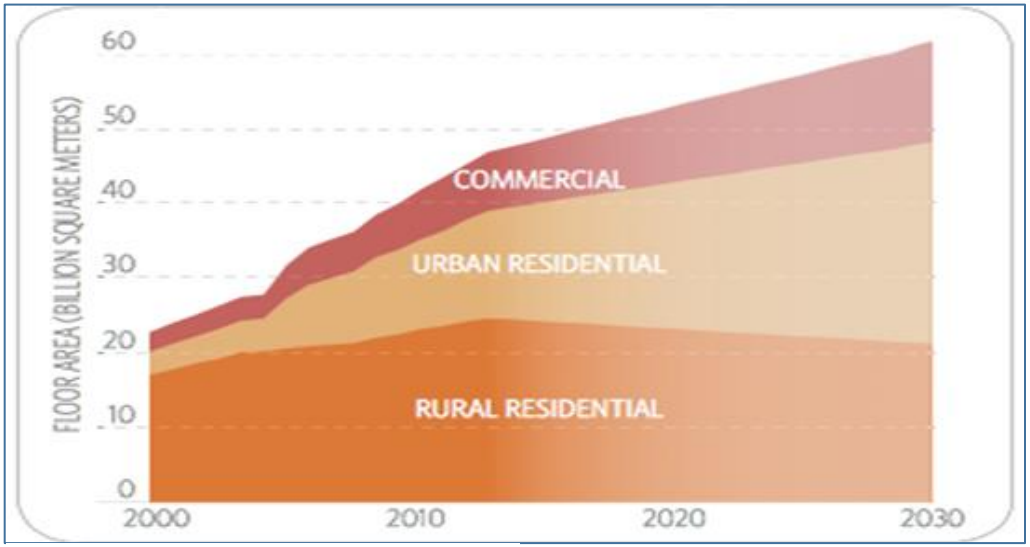
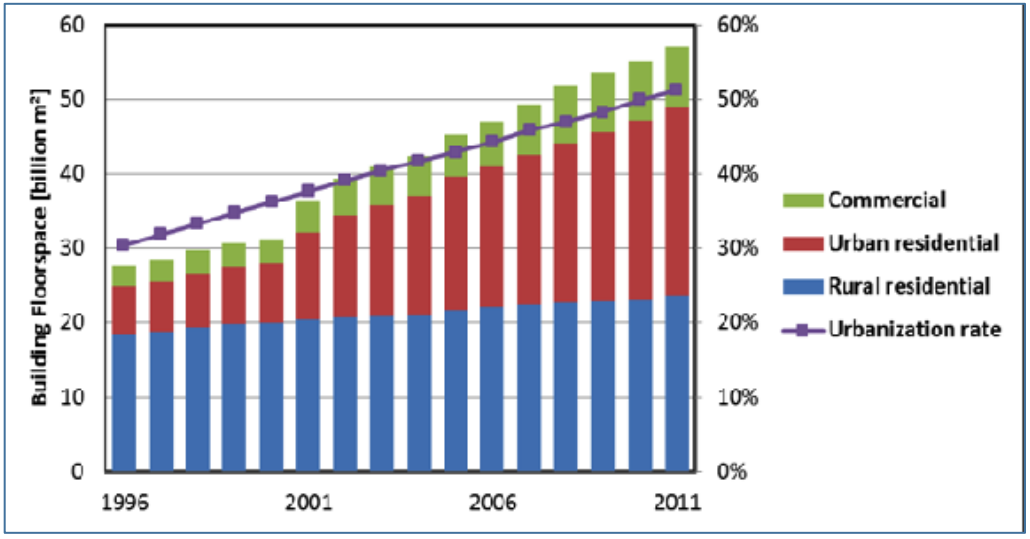
CONSIDERABLE GROWTH

- Considerable increase of Commercial and Urban residential floor space;
- Tripling the floor area in 30 years in a country with close to 1,500 million people is in itself an achievement;



Source: Climate Policy Initiative

- From 1995 to 2000 the increase of building space were growing steadily;
- From year 2000 and on, the development "changed gears" and became more rapid;



Source: United States Department of Energy

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Distributed Energy, District Heating & District Cooling Development Trends

- **Distributed Energy Installations**, (Tri-generation), the problem with these installations is the limitation on delivery of produced electricity to the National Grid when internal electrical consumption is low!
  - One solution could be to combine the electrical generation with Heat Pumps;
- **District Cooling,** utilising Thermal Energy Storage in most cases Ice technology;
  - Extremely important not to oversize production plants and networks and to schedule investments to follow the expansion of buildings and their occupation;
- **Utilisation of existing Power Plants** only producing electricity to also produce heating and via long transmission lines transfer the heat energy to City centres;
  - Key is high flow velocities to reduce pipe sizes and thereby the investment, require capability to perform pressure transient analysis;
- **Hot water thermal energy storage**;
  - When price of produced energy becomes substantially different during the day, for example CHP in combination with natural gas fired Heating Only Boilers for peak heat demand, or in combination with electrical boilers;
- **Pool Operation**, Increased requirement for optimisation of energy production as a number of plants with different production costs supply heat energy to the same district system, pool operation;
  - Advanced SCADA and planning programs required;

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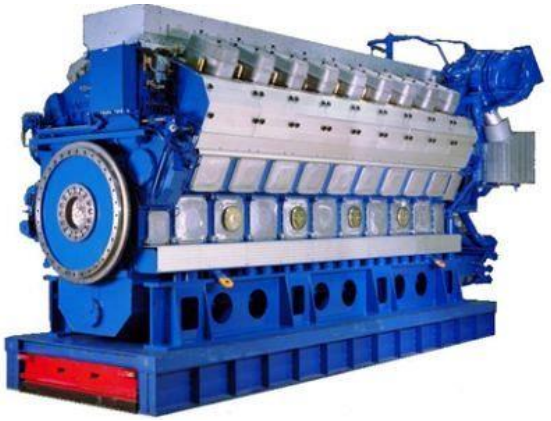
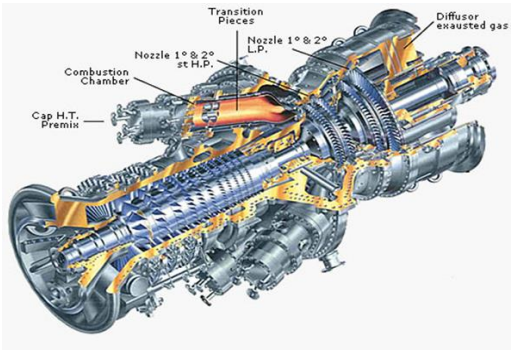
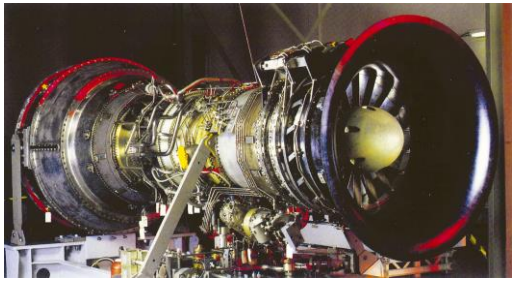
Alternative Technologies Prime Movers

Prime Movers for Tri-generation concepts

- Spark ignited Gas Engines
- Gas Turbines
- Steam Turbines operating in back pressure mode







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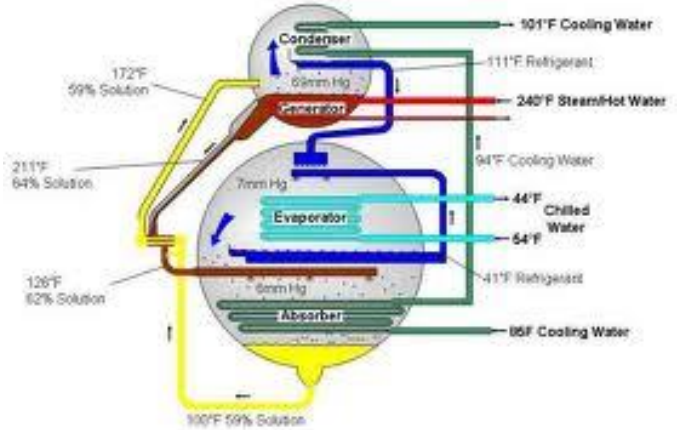
Lithium Bromide Absorption Chillers

Absorption Chillers are an important component of a Tri-generation installation



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Heat Pump/Chillers complement the generation of Heating & Cooling

Heat Pump/Chiller heat sources and heat sinks

- The heat source for the heat pumps:
  - Treated Sewage Water, TSE;
  - Sea, Lake, River Water;
  - Industrial low temperature waste energy;
- The heat sink in the summer, is the same as in winter is utilised as a heat source, complemented by cooling towers;

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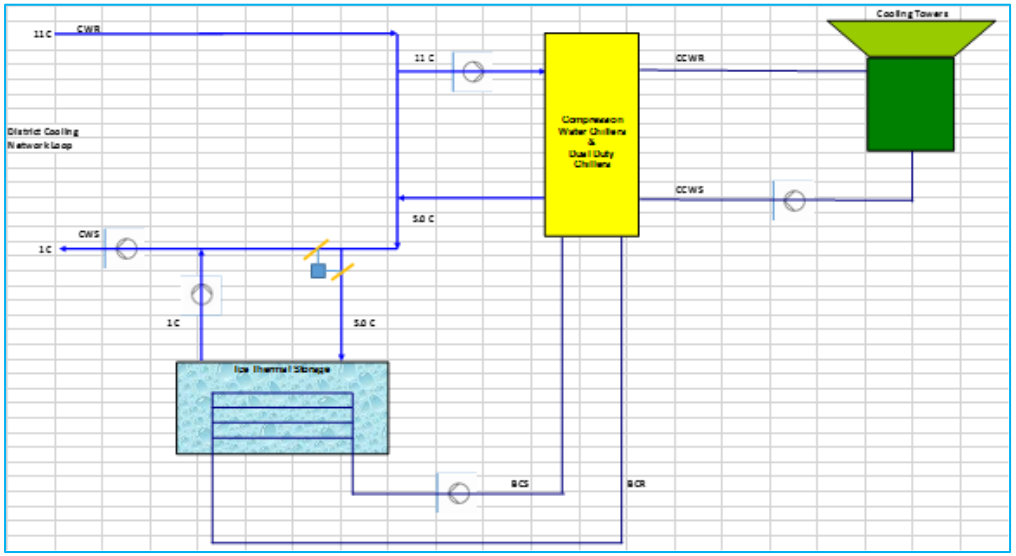
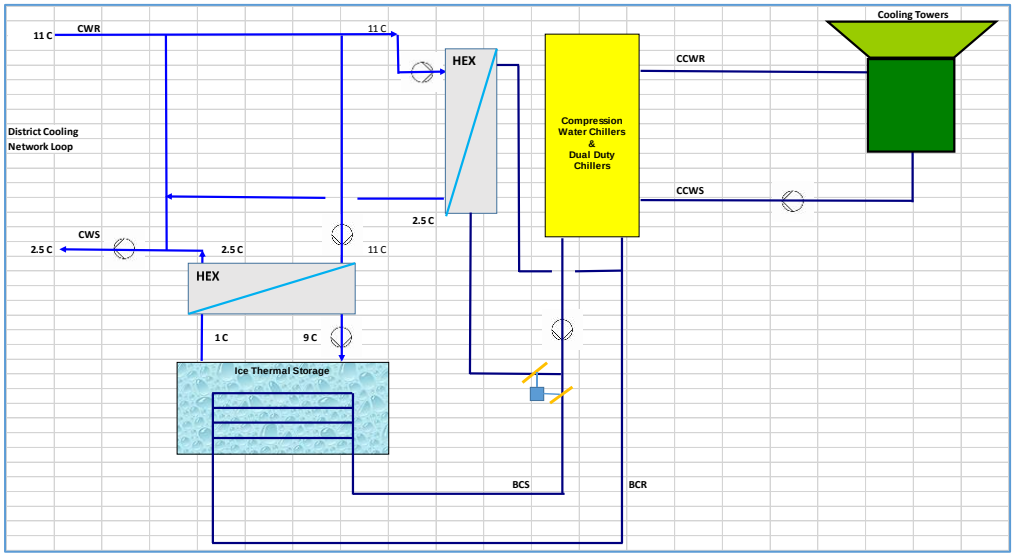
Compression Chillers with Ice Thermal Energy Storage Concepts

- Dual duty chillers with two evaporators where the chilled water evaporator is connected in series with the directly connected Thermal Energy storage;
- Provide the highest COP at the same time as utilising low night time electricity;



- Dual duty chillers with single evaporator, large heat exchangers between the glycol circuit and chilled water circuit for day time operation as well as heat exchangers between the Ice Thermal Storage and the chilled water circuit;
- Result in a considerably lower COP;



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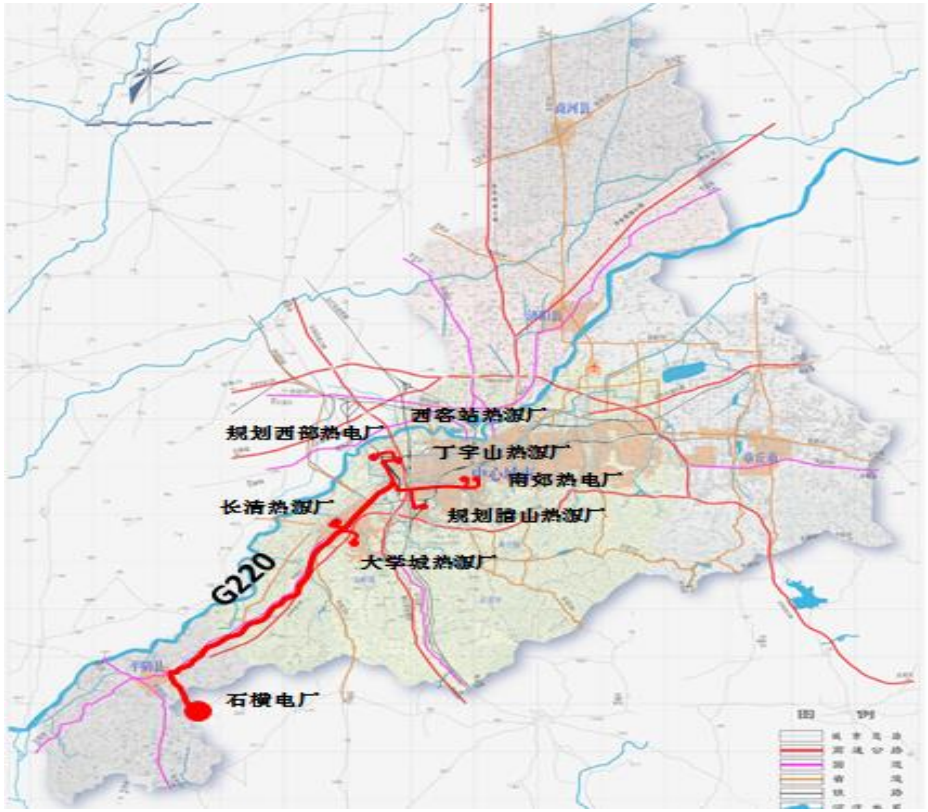
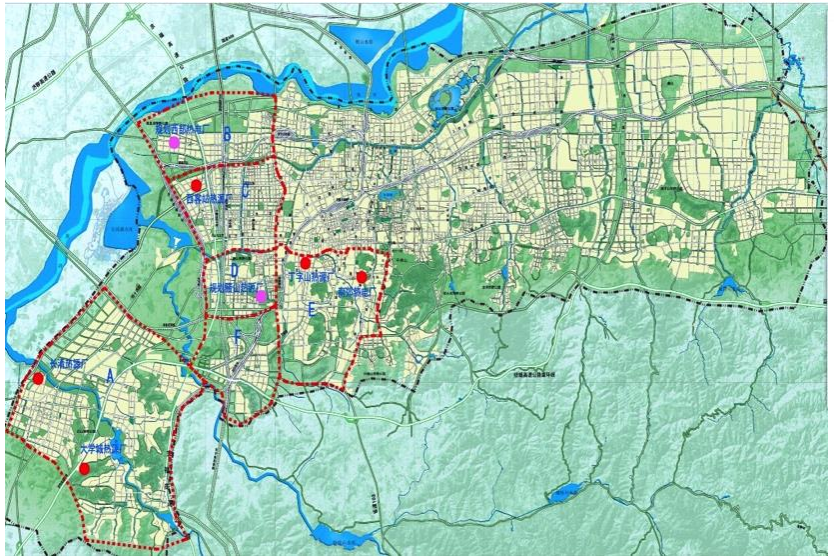
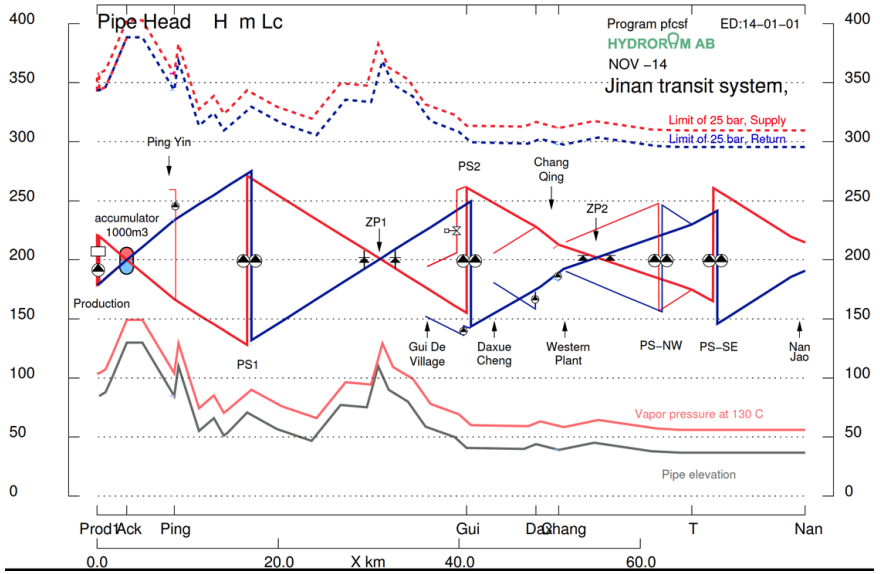
Jinan 120 km Transmission line

Hydraulic optimisation & pressure transient analysis absolutely required to maximise the utilisation of the investment







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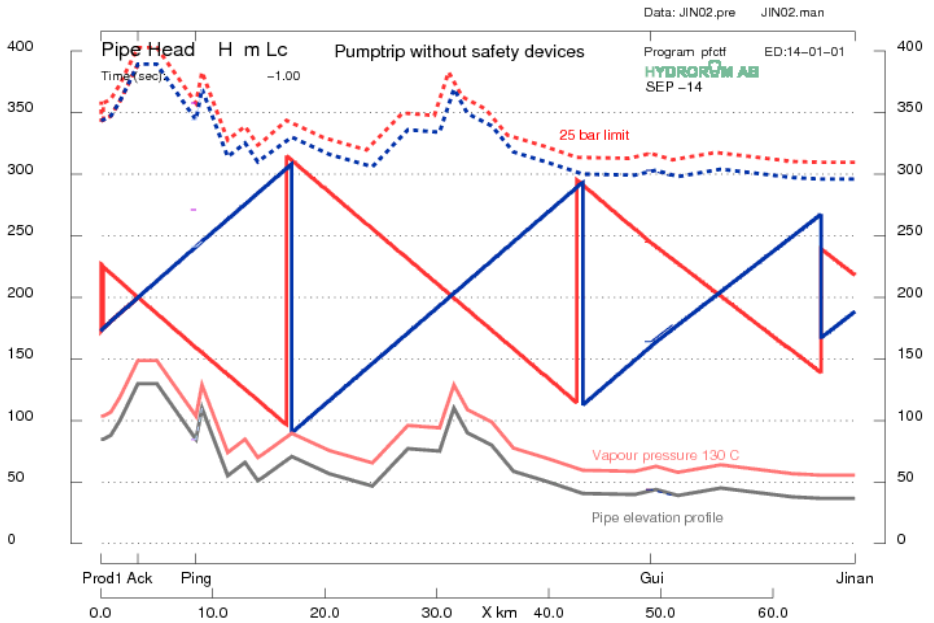
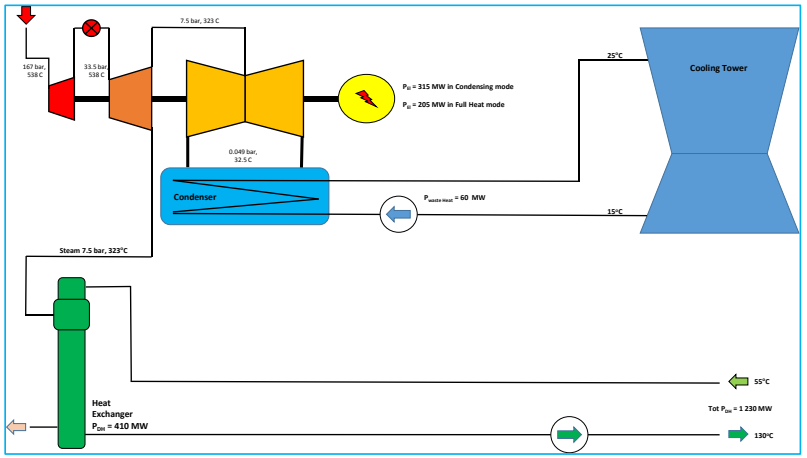
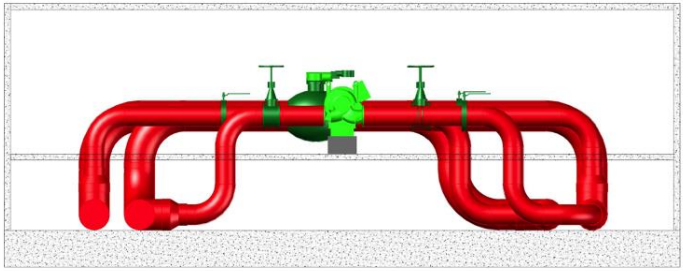
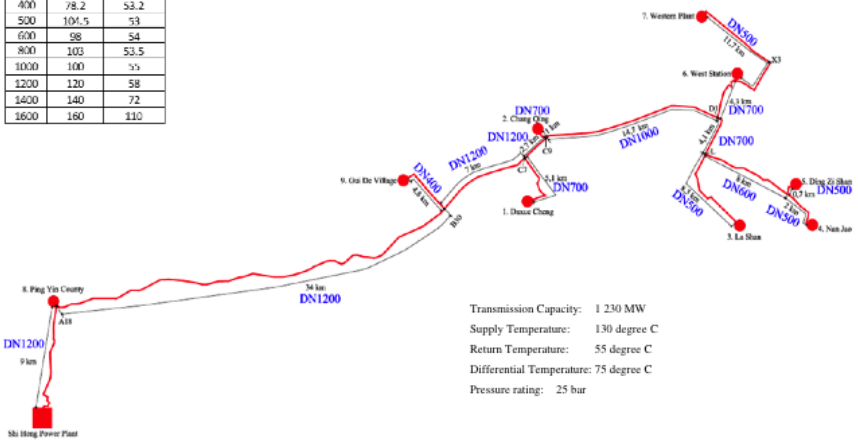


Jinan transit system,
Hydroram AB Sept -14

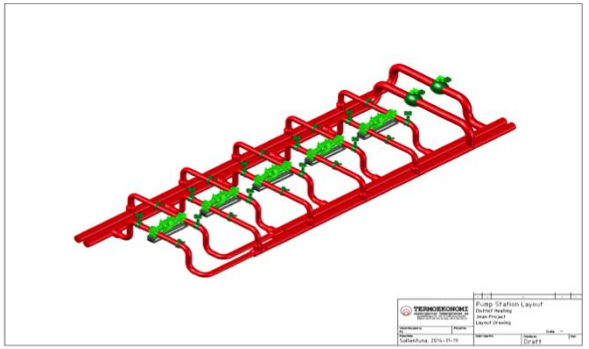




DN	Insulation, mm	
	Supply	Return
300	79.5	40.5
350	77.7	53.5
400	78.2	53.2
500	104.5	53
600	98	54
800	103	53.5
1000	100	55
1200	120	58
1400	140	72
1600	160	110



Transmission Capacity: 1 230 MW
Supply Temperature: 130 degree C
Return Temperature: 55 degree C
Differential Temperature: 75 degree C
Pressure rating: 25 bar



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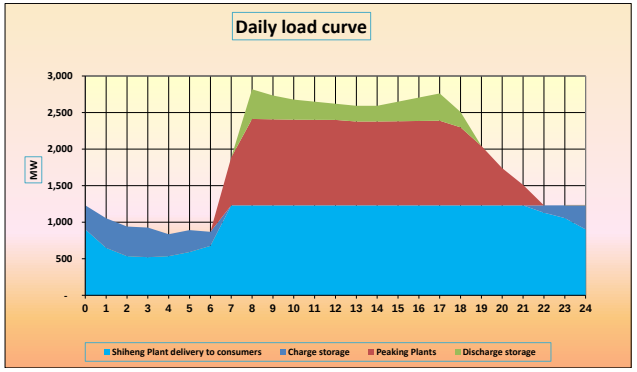
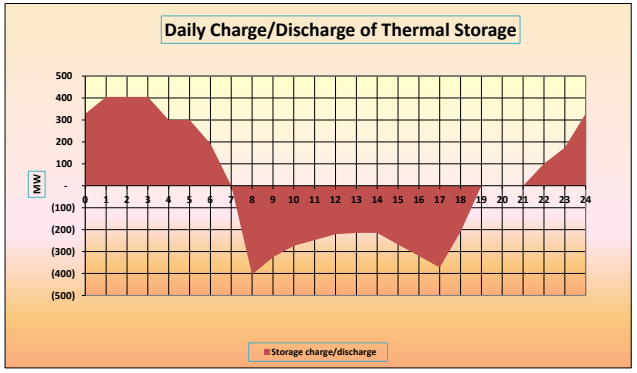
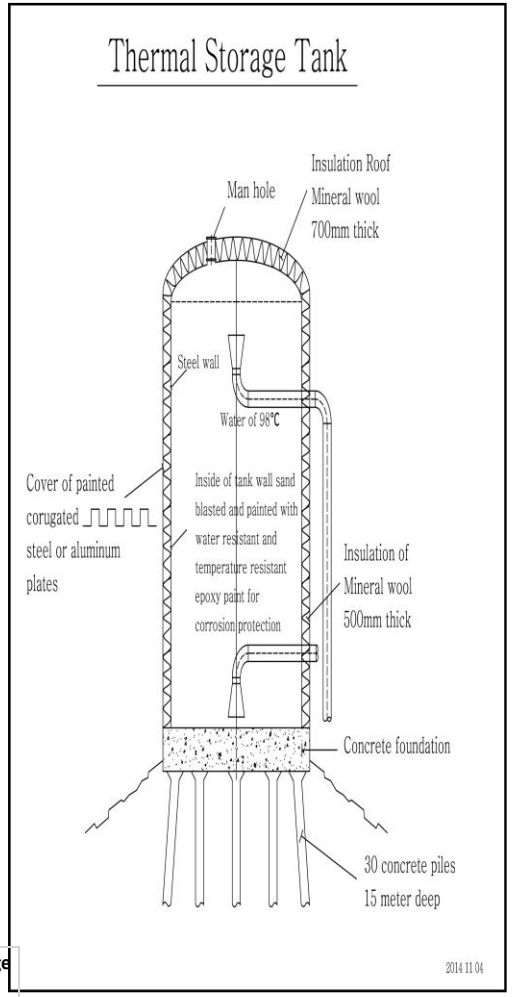
Thermal Storage for Increasing Base Load Energy Supply

- The mostly used TES concept for hot water based District Heating systems are atmospheric pressure "open" water tanks that are, in addition to storing Energy, used as expansion tanks for the local district heating system.
- The water volume in the tank is heated up at night by circulating hot water into the top of the tank and discharging cold water from the bottom of the tank and in the day time when the heat demand goes up the process is reversed so that cold water is circulated into the bottom of the tank and hot water is discharged from the top of the tank.
- The maximum temperature in the tank will be just over 98 degree C and as the return temperature in the local systems are 50 degree C or below, depending on time of heating season, the differential temperature that the tank can operate with is at least 48 degree C.
- The TES will further reduce the amount of locally produced heat from burning coal or natural gas in the urban area and will increase the boiler efficiency for especially coal fired boilers.





Energy storage	Volume	Effective Heigth	Diameter	Charge/Discharge Capacity
MWh	cubic meter	meter	m	MW
780	14,000	30	24.4	**100**
520	10,000	30	20.6	**65**
260	5,000	30	14.6	**35**
215	4,000	30	13.0	**35**
100	2,000	30	9.2	**25**

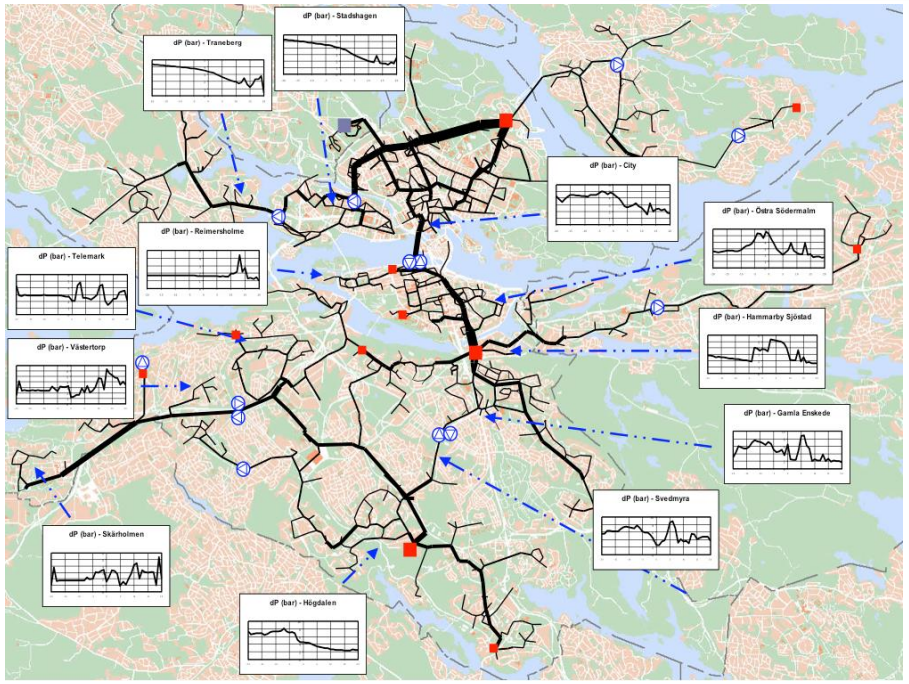


bernt.andersson@goldenforest.nu

Pool Operation of District Systems, Stockholn

Stockholm Southern Section

- 26 different heat sources all with different production costs and a variation of fuel resources, Household Waste, Bio-mass, Heat Pumps, Combined Heat and Power Plants, Heating Only Boiler Plants etc.;
- 16 pump stations where some are reversible (can pump in two directions);
- All sources feeding into an integrated pool operated network;
- Great requirements to have full control of the total system and forecasting of heating loads;
- Weekly, daily and hourly load forecasts are required to optimise the operation to achieve the lowest production cost and the best financial result for the Utility Company;



Peak Load:	**4 700 MW**
Annual DH Supply:	**11,7 TWh**
Consumers:	**16,000**
Elevation difference:	**110 m**
Pipe length:	**1 710 km**
Pressure level:	**16 bar**
Temp. level:	**120/60**
Network volume:	**161 000 m^3**

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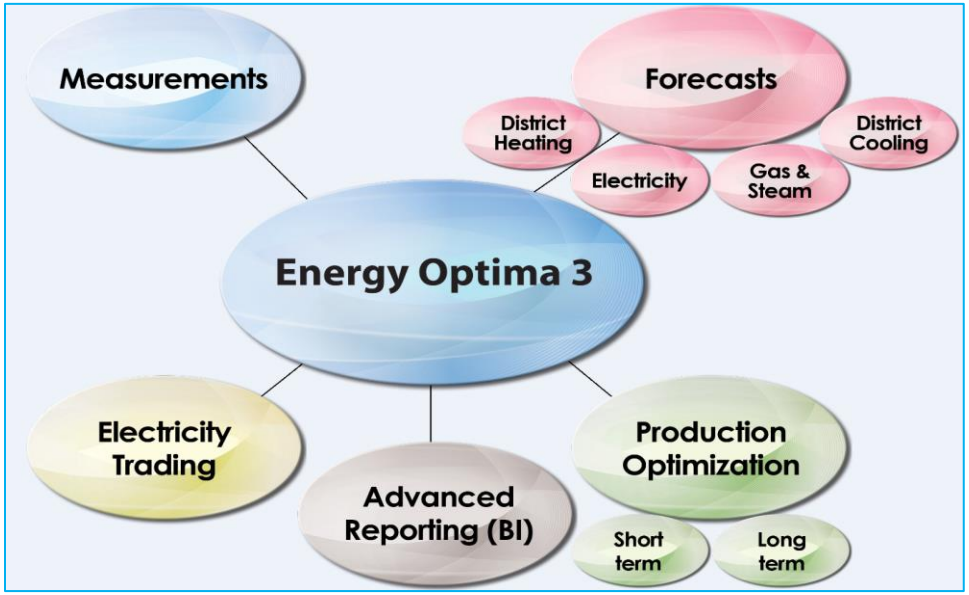
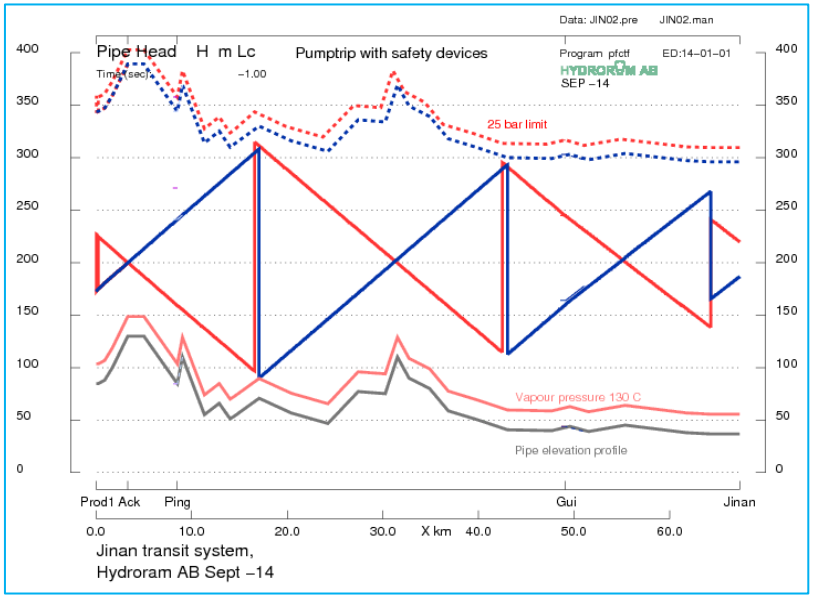
Optimization Tools



PFC: Software for hydraulic modelling, dynamic modelling and transient analysis.



Short-term planning
(Day, week ahead)

- Optimize start and stop of production units
- Maximise Lowest cost fuel usage
- Economical load dispatch between units (boiler, turbines etc.)
- Handling the electricity and gas purchasing
- Common ground for the planning in the load dispatch organisation

Long-term planning

- Investment calculation:
  - New or changed production system
- Yearly budget
- Fuel contracts
- Electricity contracts
- Revision planning

bernt.andersson@goldenforest.nu

Final Comments

- Tri-Generation, distributed energy;
- District Cooling;
- Long transmission lines;
- Thermal Energy Storage;
- Pool Operation;

- China is an extremely challenging market for foreign Companies;
- It take a long time to get established, minimum 3 and more likely 5 years or more before one can expect to see positive financial results;
- In most cases (depending on business type) a strong Chinese JV-Partner with good political contacts is absolutely required to be successful;
- Contract processes are different to what we are used to. Many times contract periods for heating and cooling supply are only 5 years and tariff can be changed annually by the regulator;
- China has many potential opportunities, the problem is to determine where to spend your time and money;
- Recruiting and retaining qualified staff;
- Hard work, flexibility and never give up is as always the formula for success;

bernt.andersson@goldenforest.nu


Thank you!
bernt.andersson@goldenforest.nu