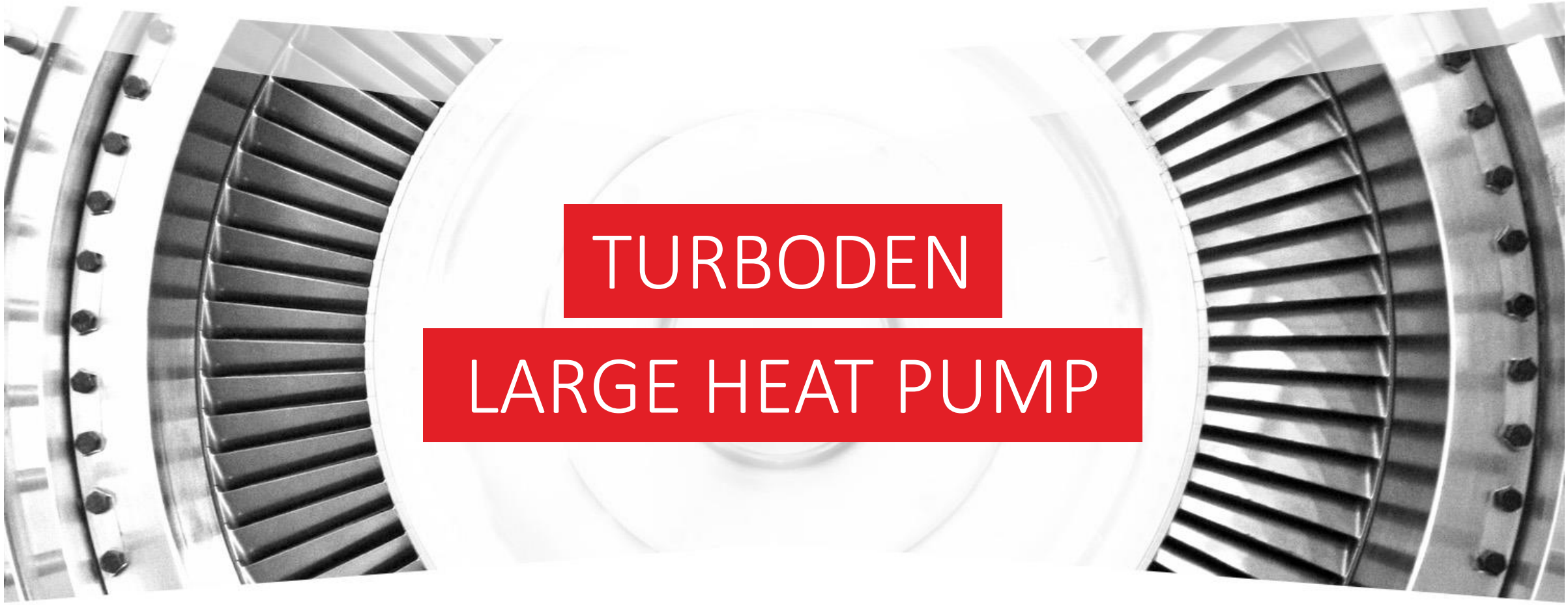
clean energy ahead®
TURBODEN

MOVE THE WORLD FORWARD MITSUBISHI HEAVY INDUSTRIES GROUP



TURBODEN
LARGE HEAT PUMP

Cod. 19-COM.P-7-rev.8

MORE HEAT OUT OF HEAT.

WHY HEAT PUMPS?

Because they play a key role in the electrification of heat in an increasingly decarbonised power grid. With heat pumps, we wish to play a broader role in the decarbonisation of district heating and energy-intensive industries.

TURBODEN LARGE HEAT PUMPS

Large Heat Pumps are utility-scale heating plants that allow to transfer large quantities of heat from a colder source, like groundwater or waste heat, to a higher temperature heat user, like a district heating network or an industrial process. Turboden specializes in large scale, electrical heat pumps, based on turbocompressor technology.

KEY POINTS

- Large-scale: output from 3 MWth to 30 MWth per unit
- High-temperature lift (ΔT up to 80°C and more)
- High-temperature output (including steam generation)
- Various fields of application: geothermal, biomass, waste heat in energy-intensive industries, waste to energy, power plants

FEATURES

Simplicity

- ✓ Remote monitoring and automatic operation
- ✓ Simple technical features
- ✓ Fast start-stop procedures

Flexibility

- ✓ Fully tailored solutions with optimised performance
- ✓ Experience with a number of different refrigerants
- ✓ Ease of integration

Dependability

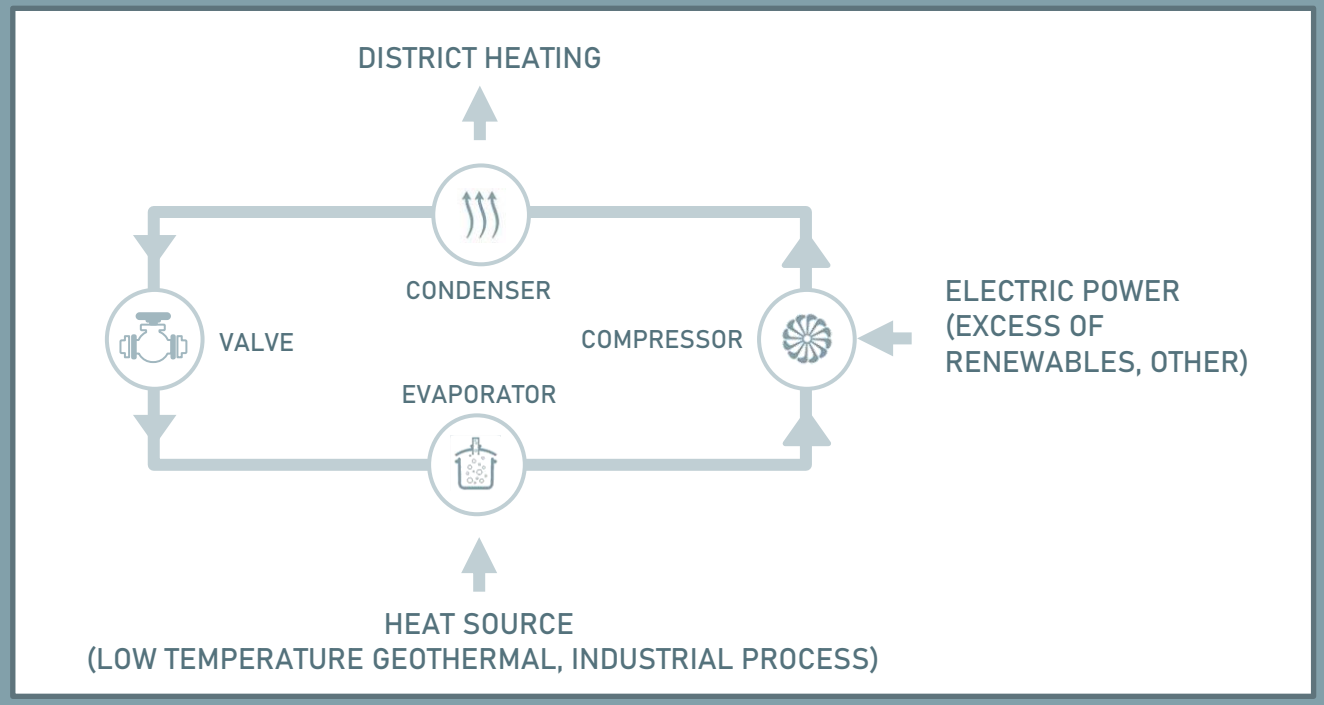
- ✓ Several proven technical solutions shared with sister ORC technology
- ✓ Global after sales service with 24/7 assistance
- ✓ Long design life

Sustainability

- ✓ Core system for renewable energy and energy efficiency
- ✓ Clean generation of higher-grade heat
- ✓ Non-toxic, low Global Warming Potential (GWP) refrigerants

APPLICATIONS – DISTRICT HEATING

DISTRICT HEATING | ENERGY EFFICIENCY IN INDUSTRIAL PROCESSES | HEATING & COOLING OF BUILDINGS | CHP PLANT PREHEATING



HEAT SOURCES

"FREE" HEAT:

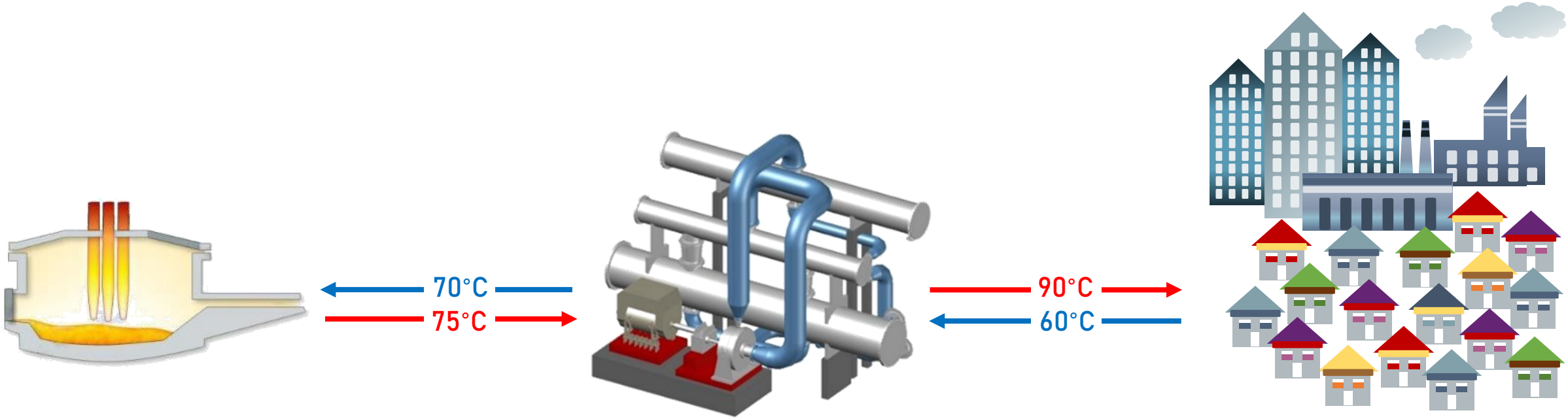
- Waste water
- River water
- Sea water (as low as 2-3°C)
- Groundwater

"INCOME GENERATOR" HEAT:

- Power plants waste heat
- Power plants flue gas cleaning
- Power plants heat from CO_2 capture
- Data centers cooling
- Cooling in industrial processes
- District cooling
- Seasonal solar heat storage

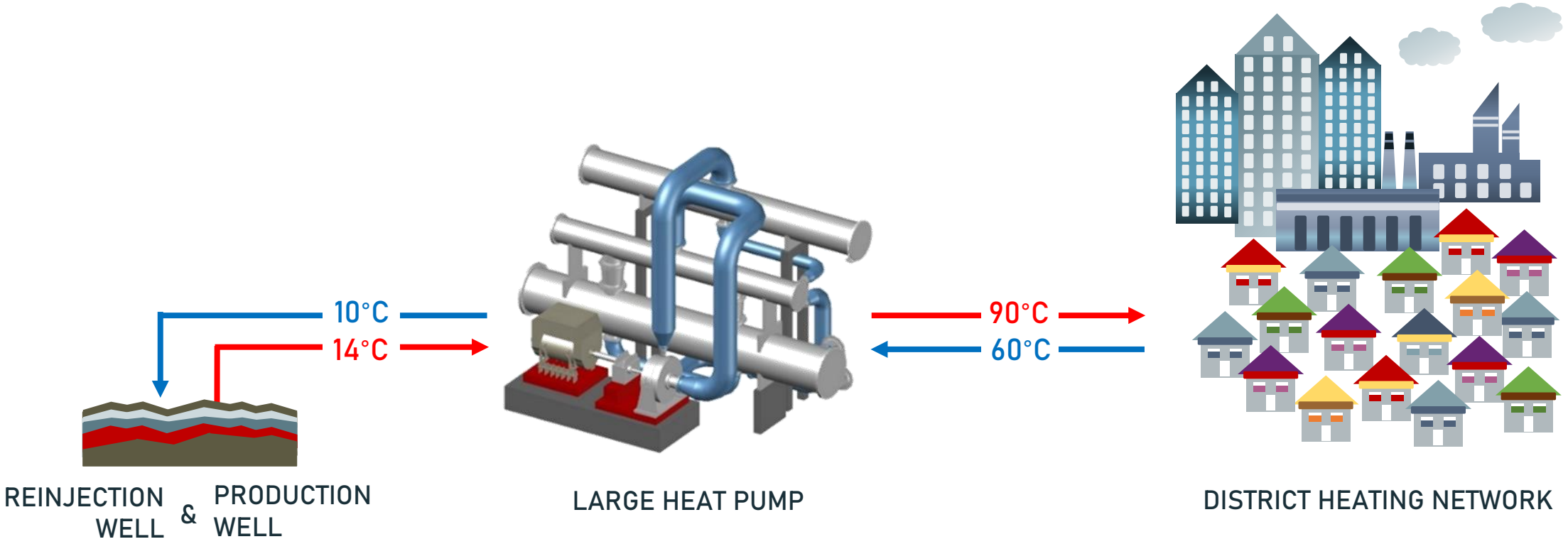
EXAMPLE: STEELWORKS

Heat from the cooling of the steelmaking process can be upgraded through a LHP and used for district heating instead of being wasted, i.e. dissipated through cooling towers.



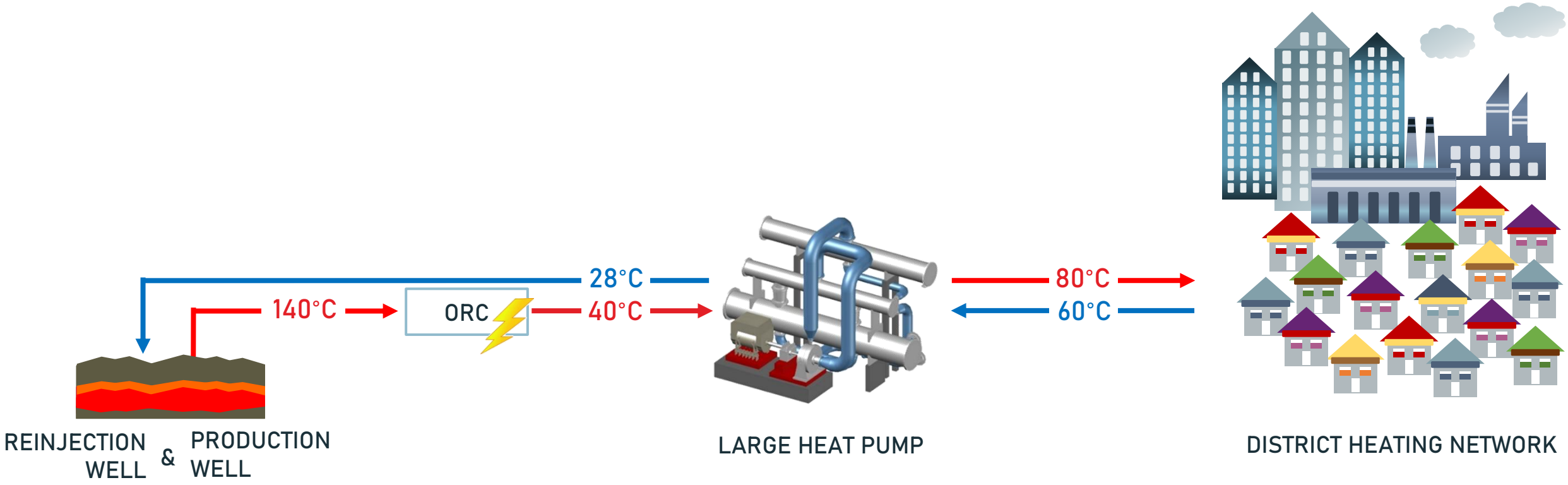
EXAMPLE: GROUND SOURCE PROJECTS

Even the energy contained in a shallow aquifer at low temperature can be used to feed a LHP and supply heat to a district energy network at higher temperature.



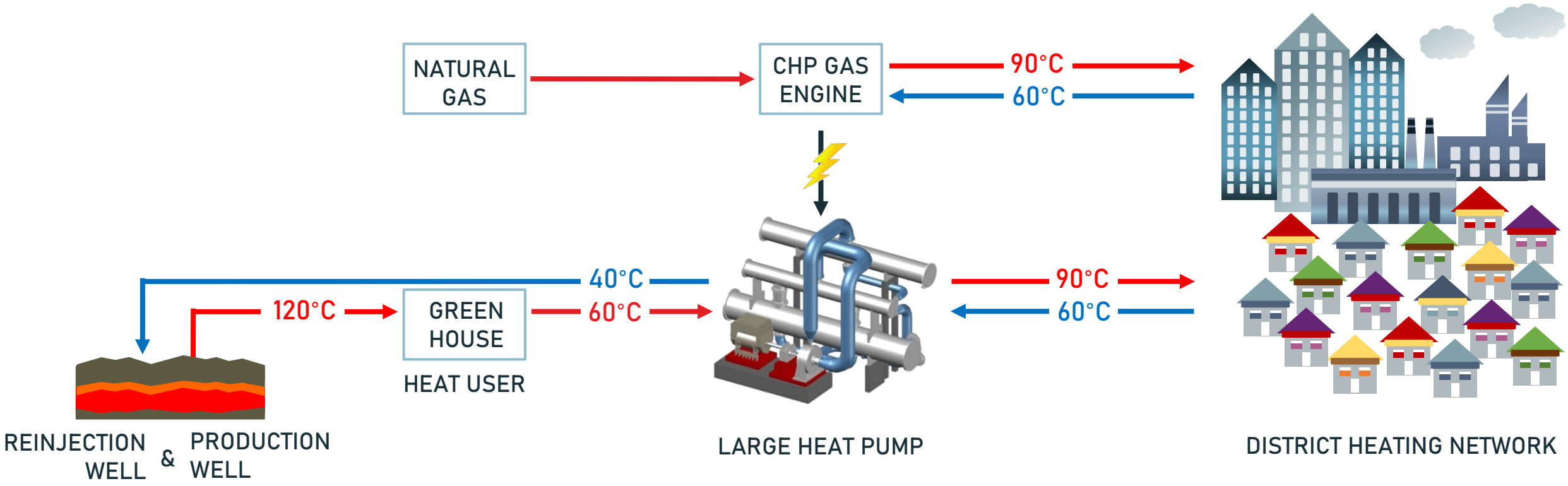
EXAMPLE: GEOTHERMAL WITH ORC

Deep geothermal at high enough temperature is used for power generation through a binary plant – a LHP can extract further energy at low temperature before reinjection and supply a district heating network at suitable temperature.

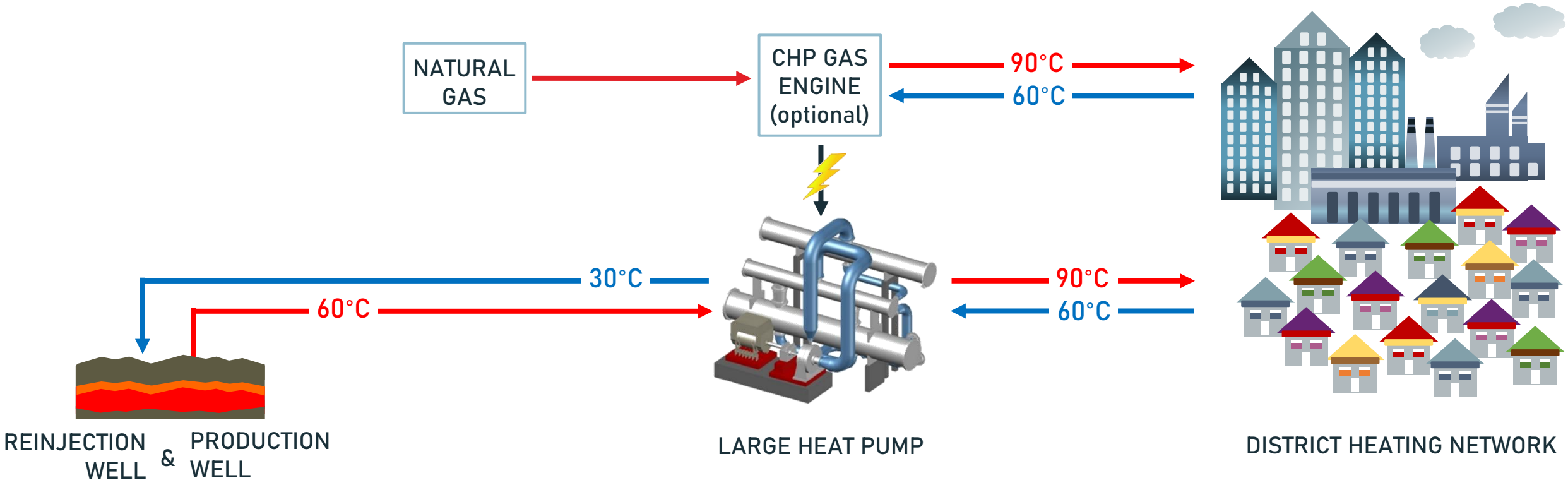


EXAMPLE: GEOTHERMAL AND GREENHOUSES

Deep geothermal can be used for heat supply to industrial users (e.g. large greenhouses), while a LHP can extract further energy at lower temperature before reinjection and supply a district heating network at suitable temperature.

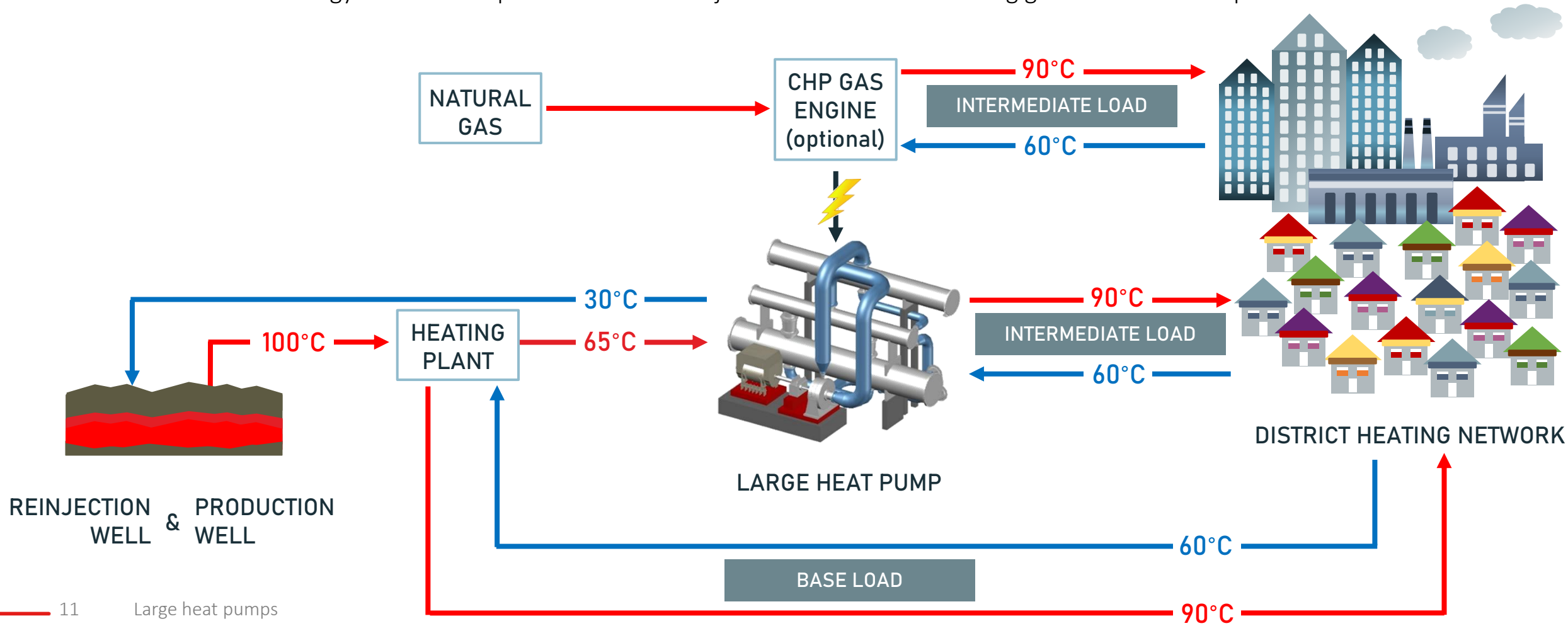


EXAMPLE: GEOTHERMAL DISTRICT HEATING



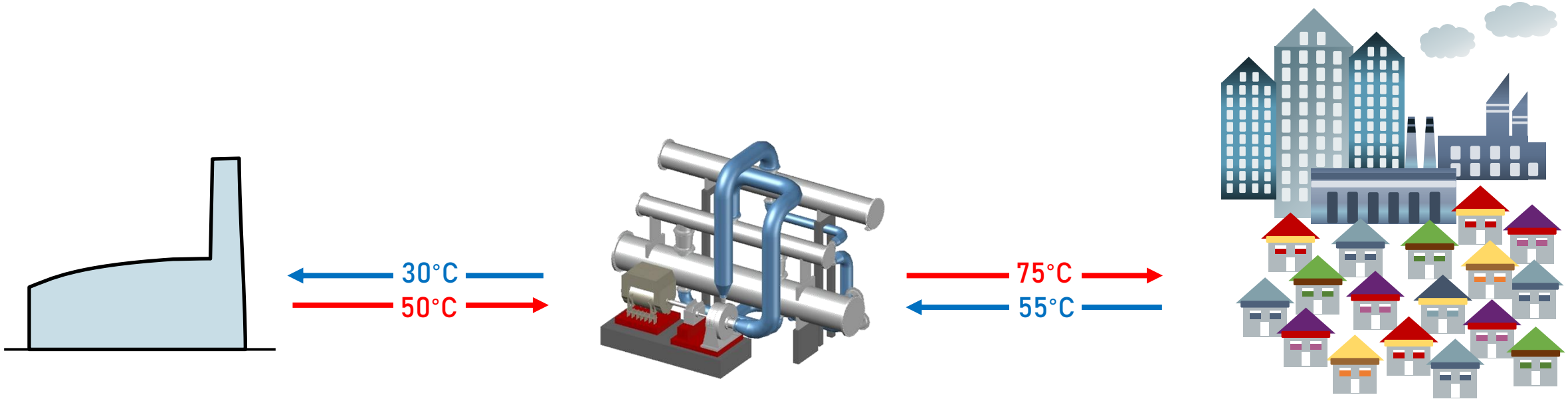
EXAMPLE: GEOTHERMAL DISTRICT HEATING

Deep geothermal can be used to supply heat to a district heating network through direct exchange in a heating plant, while a LHP can extract further energy at lower temperature before reinjection and feed the heating grid at suitable temperature.



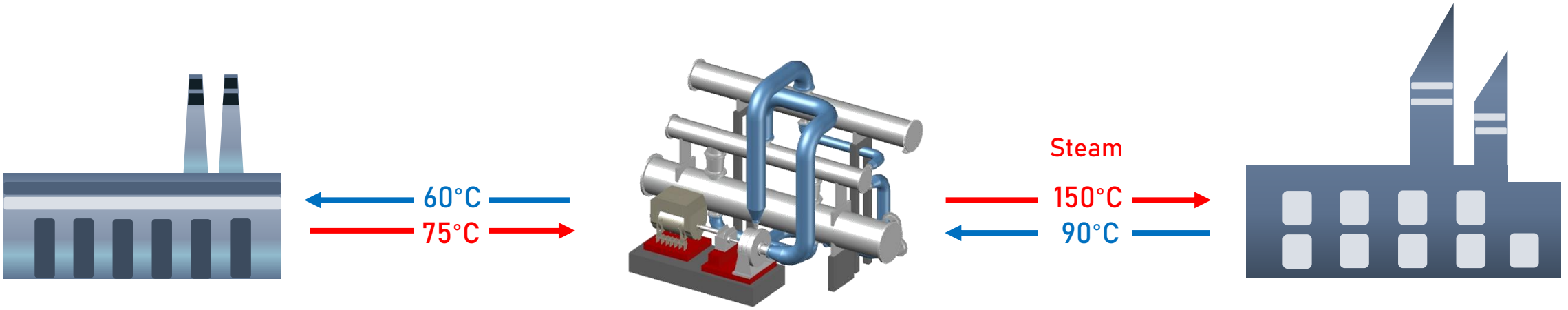
CASE STUDY: WASTE TO ENERGY PLANT

Pollutant abatement in flue gas through quenching and recovery of condensation heat: projects of this kind are becoming common in Northern Europe (e.g. Scandinavia) and there is a high potential for replication.



CASE STUDY: INDUSTRIAL PARK

The Large Heat Pump generates large quantities of steam exploiting a colder energy source that would otherwise be wasted, eventually dissipated by cooling towers. Hence, a neighbouring industrial process can benefit from this new higher-grade source of heat.



APPLICATIONS – INDUSTRIAL PROCESSES

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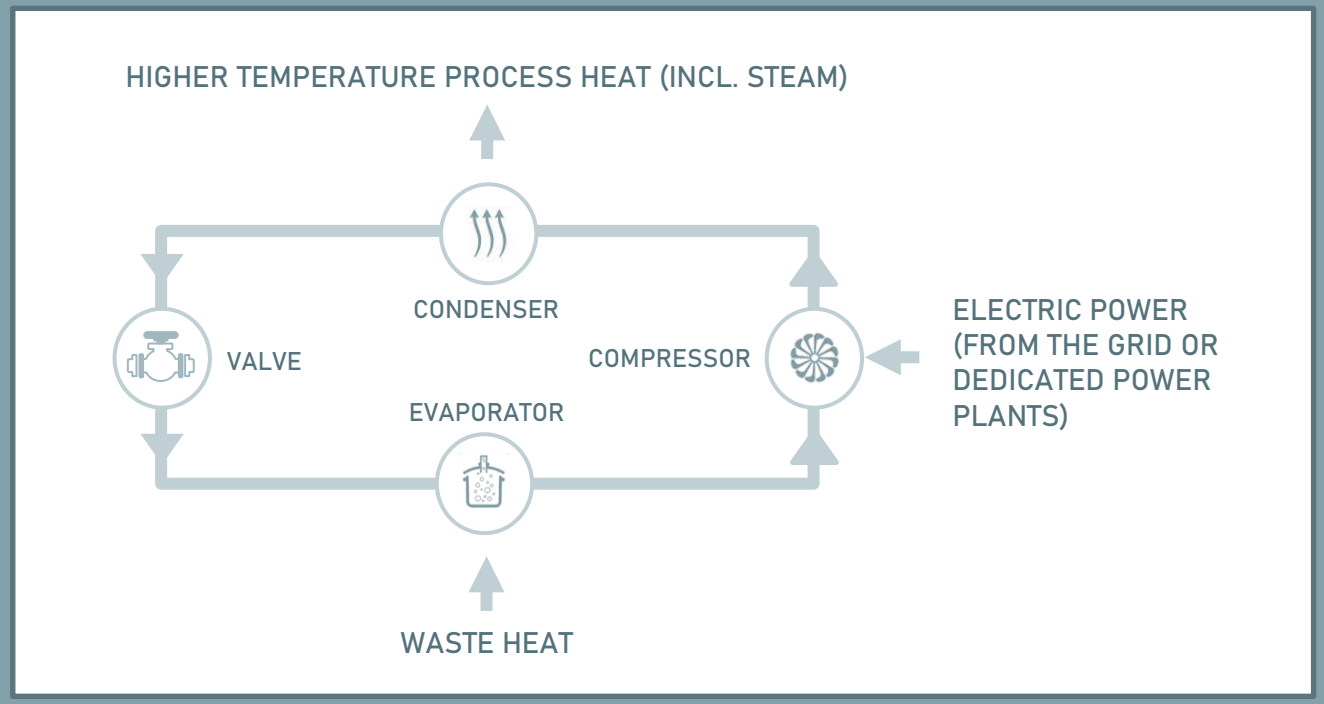
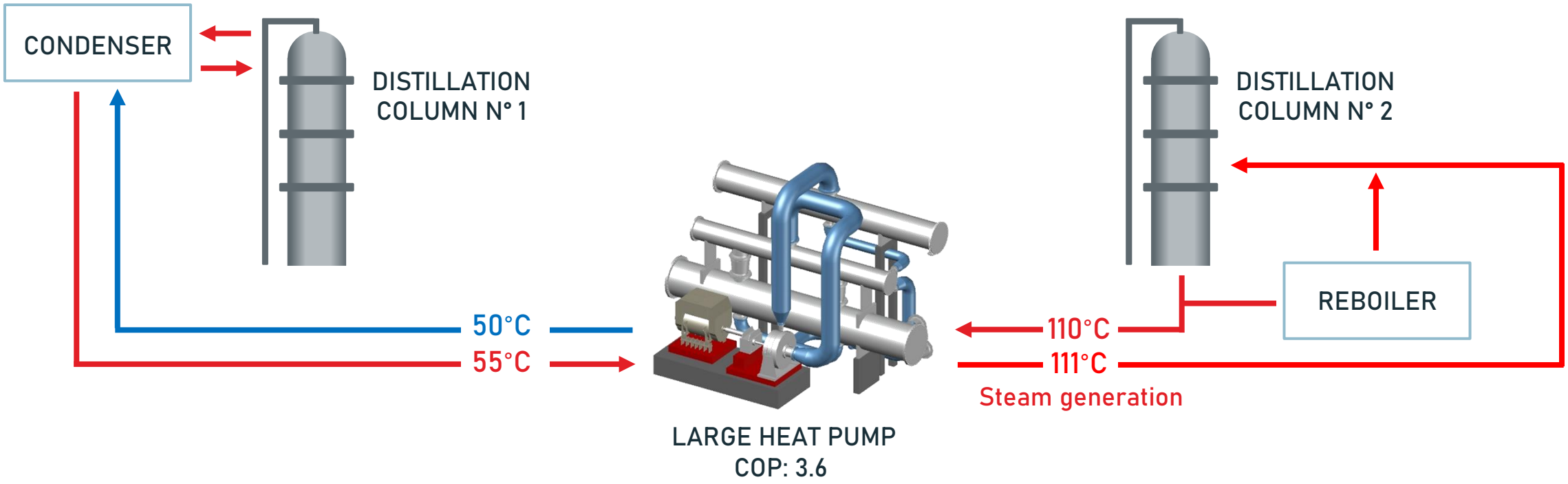


HEAT SOURCES

- Cooling in industrial processes
- Power plants waste heat
- Other waste heat
- Waste water
- Ground source

EXAMPLE: CHEMICAL PLANT

The low-grade heat that needs to be dissipated to cool a distillation column (N.1) can feed a LHP and therefore be used to displace other sources of higher-temperature heat in another distillation column (N.2).



- COP tends to be lower due to higher lift, hence more challenging.
- May require special (more costly) materials.
- Year-round (potentially >8,000 hrs_{eq} /y) waste heat valorisation thanks to internal re-use.

OVER 40 YEARS OF A VIABLE SUSTAINABILITY

40 YEARS viable sustainability

SINCE 1980

Turboden is an Italian firm and a global leader in the design, manufacture, and maintenance of **Organic Rankine Cycle (ORC) systems**, highly suitable for distributed generation, which produce electric and thermal power exploiting multiple sources.

Thanks to its long experience in the energy efficiency sector, today Turboden expands its solutions offering with **large heat pumps** and **gas expanders**.

MILESTONES

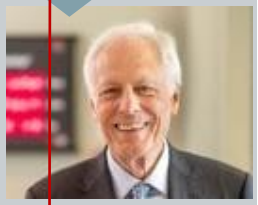
‘60-’70

Prof. Mario Gaia makes experience in the field of ORC within his research group at Politecnico di Milano.

1976

1st ORC prototype.

1980



Prof. Mario Gaia founds Turboden.

1998

1st ORC biomass plant.

‘90-2000

Turboden enters geothermal, waste heat recovery and solar markets.

2000-2009

Turboden becomes leader in Europe with its biomass plants.

2013

MITSUBISHI HEAVY INDUSTRIES, LTD.

MHI acquires the majority of Turboden.

2019

Turboden launches new products, LHP and EXP.

2020

40th ANNIVERSARY

	1990	2000	2010	2020
ORC SIZES AVAILABLE	300 kW	1 - 2 - 4 MW	5 - 8 - 10 MW	20 MW
ORC PLANTS INSTALLED	1	100	220	390+

GLOBAL AND PROVEN EXPERIENCE

A worldwide presence in **50** countries with **400+** plants

19 million hours

cumulative operation time

25 thousand GWh

electrical energy generated

98+ %

average availability

Last update: April 2022

WHY TURBODEN

MITSUBISHI HEAVY INDUSTRIES GROUP

- Turboden fully embraces the values, philosophy and vision of its parent company MHI
- Turboden leverages the financial stability of its parent company and the technical support to satisfy customer needs

CAPABILITIES & EXPERIENCE

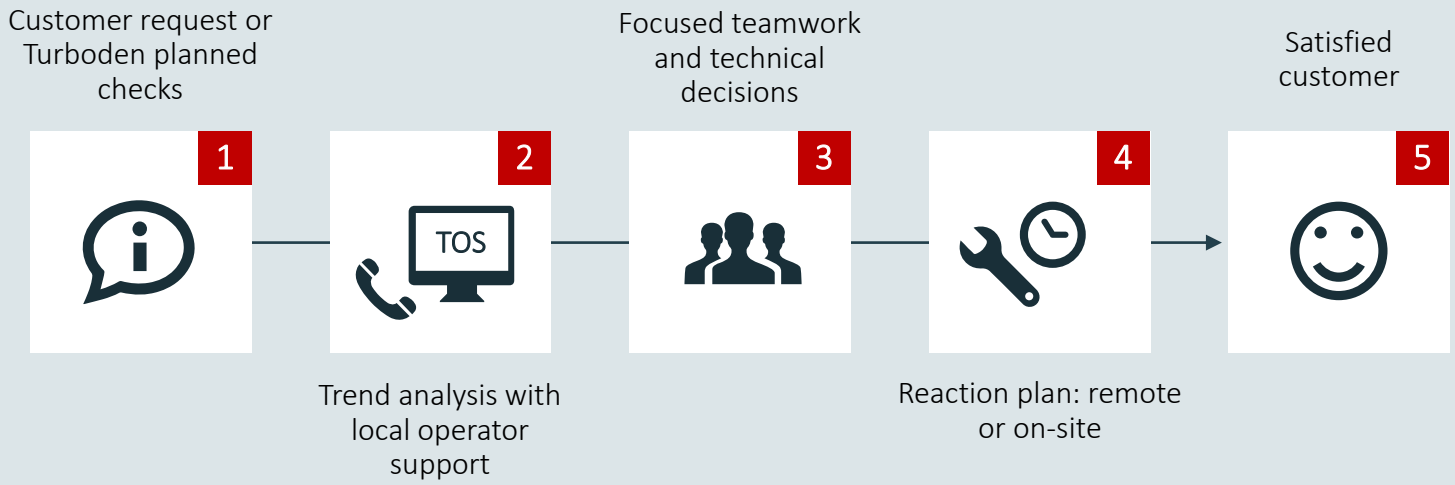
- With 40 years of experience, Turboden holds the know-how of the ORC technology
- Excellence in R&D and turbine design
- Total capacity of 750+ MWe, 400+ plants, 50 countries
- Global presence

CUSTOMER ORIENTATION

- Always dedicated to the success projects of the customers
- Prompt assistance and customized after-sales service
- Ready to provide optimized solutions for the clients
- High availability
- High customer satisfaction

DEDICATED AFTER-SALES SERVICE

Qualified staff is exclusively dedicated to the customer assistance, both from remote and on-site, with the aim of optimizing the management of the plants. The customer can choose the most suitable service package thanks to the wide range of services offered.



COVERAGE

2 service subsidiaries and 5 international service partner companies.

ASSISTANCE

Turboden 24/7, the call center service h24, 7 days per week.

CUSTOMISED SERVICES

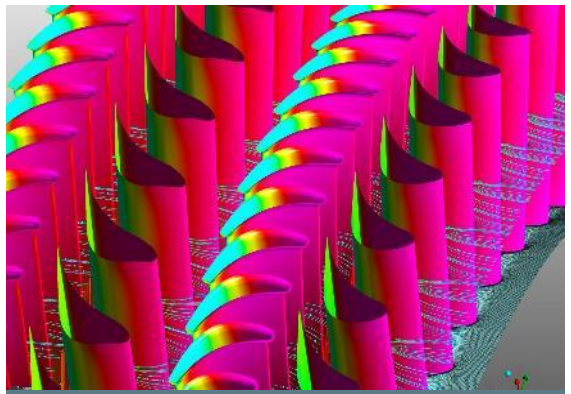
- single contact for requests for support
- staff dedicated to on-site and remote technical support
- assistance of an international network of companies able to provide technical support
- wide range of services provided
- prompt assistance and customized after-sales services
- remote technical support using innovative tools (TOS – Turboden Online Service)
- dedicated spare parts warehouse

R&D – THE INNOVATION

TURBOMACHINES

Over 60 different axial turbines, from 2 to 6 stages reaching up to 20 MW of power and in some cases exceeding isentropic efficiency 90%.

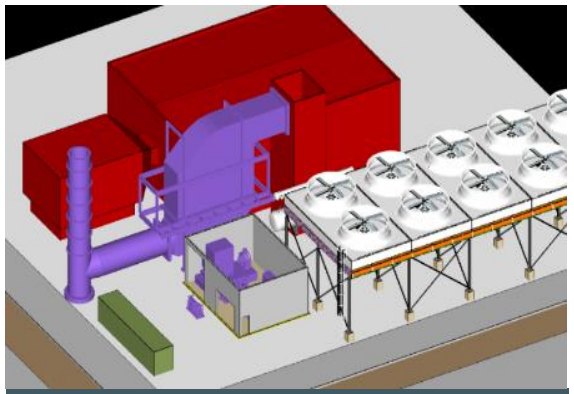
The new compressor shares a number of technical features and solutions with Turboden turbine.



WORKING FLUIDS

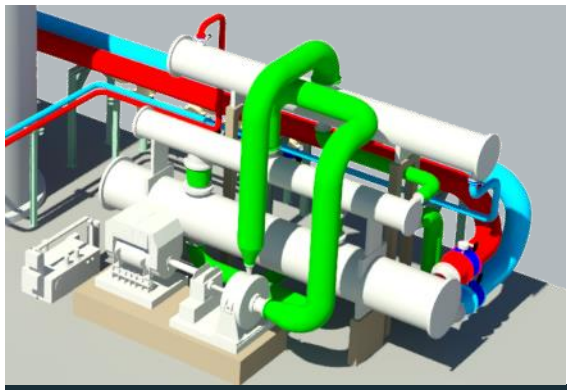
A deep understanding of fluid properties, thermal stability and flammability permits the usage of over 10 different working fluids.

Some of the working fluids are used with temperatures > 300°C in ORC systems.



DIRECT EXCHANGE

Pioneer in the development of systems with Direct Exchange between hot gas (the primary heat source) and the ORC working fluids, reducing the investment cost and improving the ORC performances.



NEW PRODUCTS

Pioneer in the development of innovative solutions in the ORC space, now extending its reach to related technologies like Large Heat Pumps and Gas Expanders.

AN EXTENSIVE NETWORK OF INSTITUTIONAL RELATIONS

ANIMA
Federazione delle Associazioni Nazionali dell'Industria Meccanica Varia ed Affine

Associazione Industriale Bresciana

Bioenergy EUROPE

CanGEA
CANADIAN GEOTHERMAL ENERGY ASSOCIATION

CIUZ
Camera di Commercio ItaliaUzbekistan

COGEN EUROPE

CONFINDUSTRIA

EGEC GEOTHERMAL

ehpa
european heat pump association

ELETTRICITÀ FUTURA
imprese elettriche italiane

Energy Efficiency
Financial Institutions Group

EUROHEAT & POWER

European Bank
for Reconstruction and Development

European Commission

European Investment Bank
The EU bank

European Parliament

FIRE

GAK
Geothermal Association of Kenya

Geothermal Resources Council
GRC

IGU
INTERNATIONAL GAS UNION
UNION INTERNATIONALE DU GAZ

ISWA
International Solid Waste Association

ITA
ITALIAN TRADE AGENCY
ICE – AGENZIA

ITALCOGEN
Associazione dei costruttori e distributori di impianti di cogenerazione

LE2C
LOMBARDY ENERGY CLEANTECH CLUSTER

Life

MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE

Ministero dello Sviluppo Economico

sace simest
gruppo cdp

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP

TURKISH COGEN AND CLEAN ENERGY TECHN. ASSOCIATION

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FIND OUT MORE

OUR EXPERIENCE. YOUR POWER.