Why and how ? – on the way towards 4Generation district heating

Lessons Learned from LowTEMP and LowTEMP 2.0 Projects

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IMP PAN, Gdańsk

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Why 4Gen district heating ?

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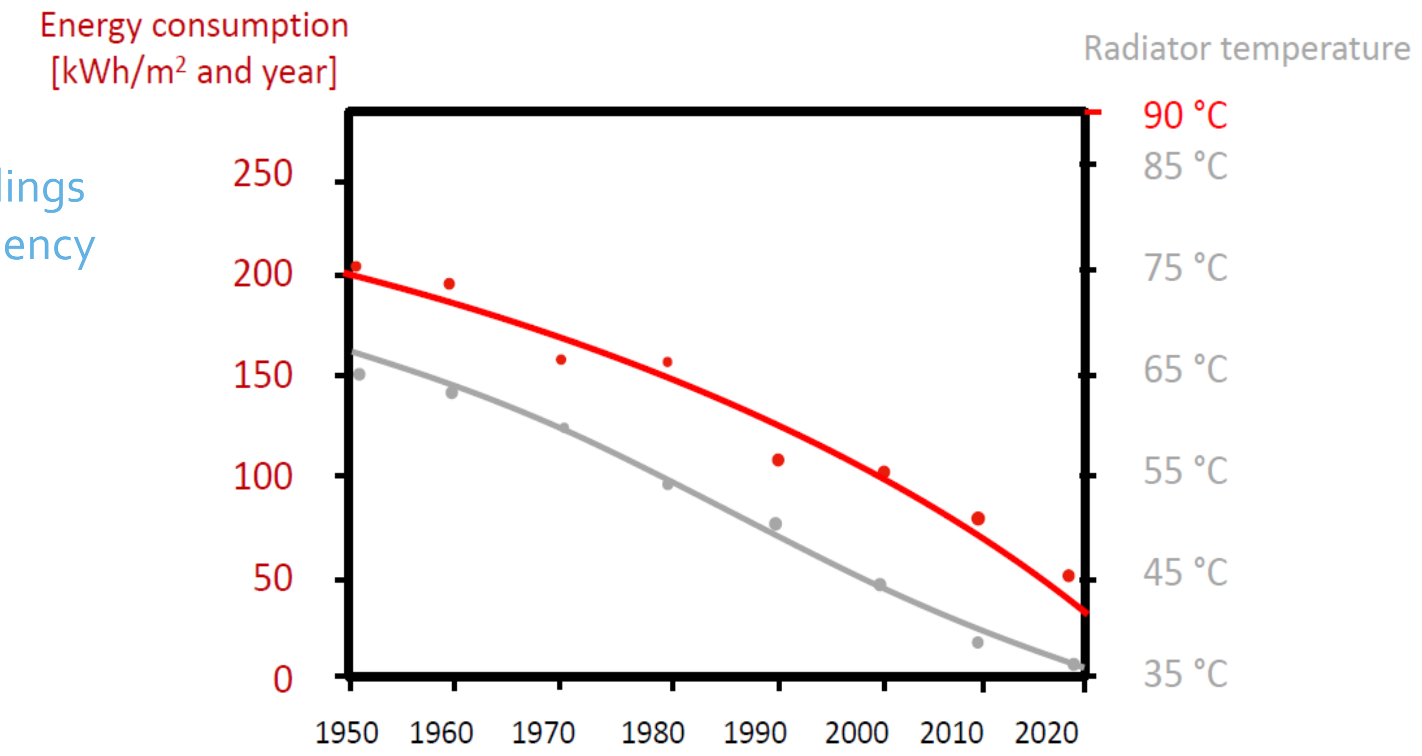
Energy consumption and forward temperatures in buildings in Sweden

Role of buildings energy efficiency



Source: e-on

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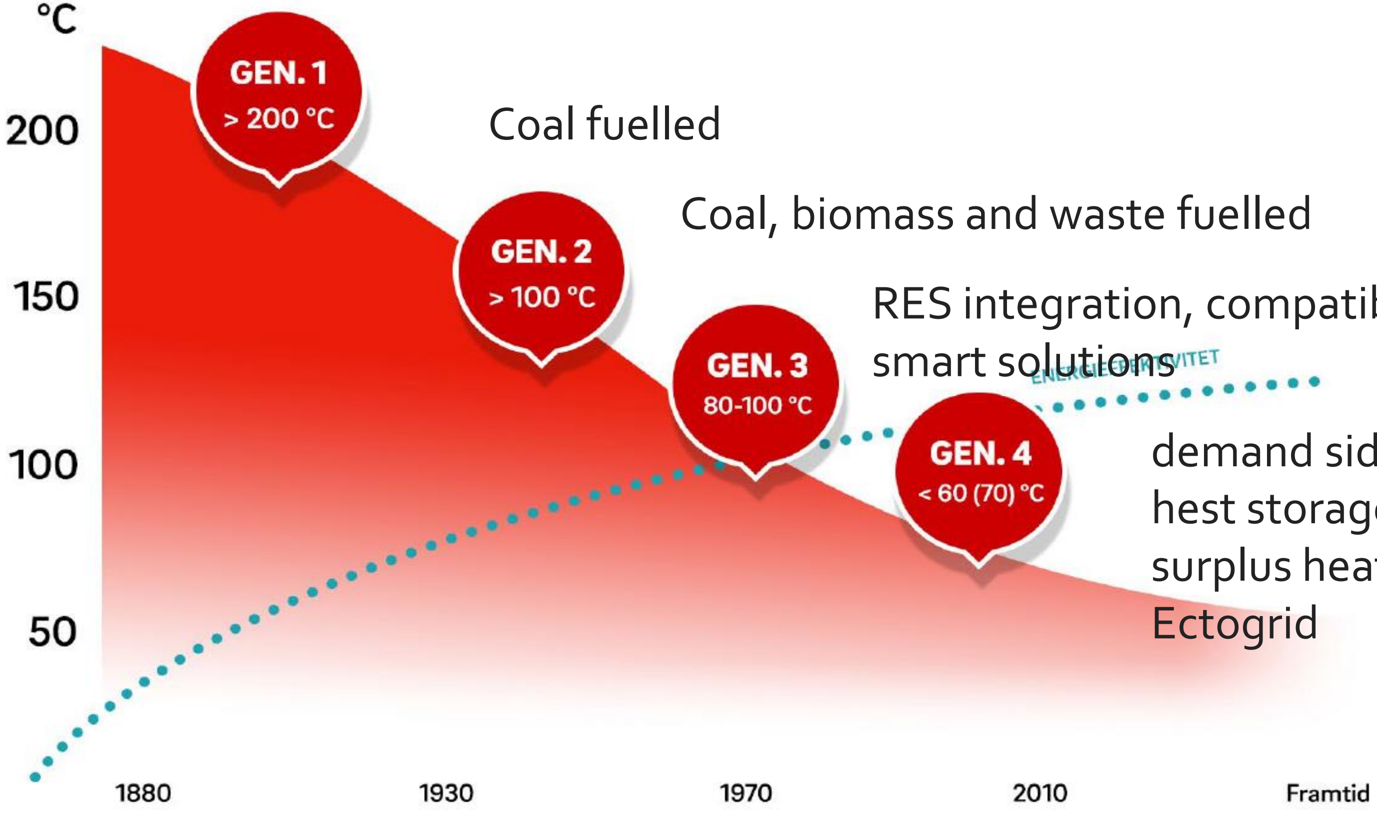
District heating generations



Coal fuelled

Coal, biomass and waste fuelled

RES integration, compatibility to cooling, smart solutions

demand side response,
hest storage systems
surplus heat integration
Ectogrid

e·on

LTDH advantage

- low temperatures reduce heat losses in DH pipes
- LTDH enables inclusion of RES e.g. thermal collectors, geothermal sources, ...
- enables use of low temperature waste (surplus heat)
- low temperatures reduce the thermal stress in pipes and prolong DH life
- low temperature of return flow heat enables its application for flue gas condensation

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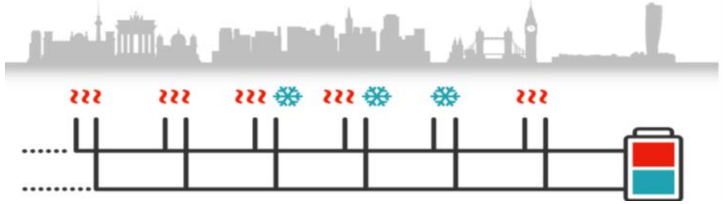
How ? - roadmap to LTDH

- New city districts with LTDH – Berlin Adlershof

Source: BSM – Beratungsgesellschaft für Stadterneuerung und Modernisierung mbH

Ectogrid – Lund



Source: e-on, http://ectogrid.com/

Source: Albertslund Kommune, Housing department, Denmark

- District with renovated houses - Albertslund
- District with nonrenovated houses

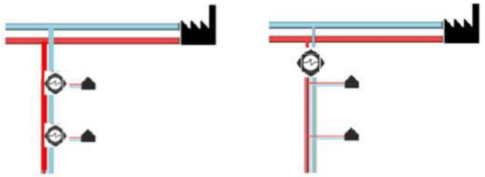
Source: Høje-Taastrup Fjernvarme a.m.b.a., Denmark

- Lowering temperature in whole DH grid – Łomża

Source: M. Dzierzgowski, IMP PAN PW

- Surplus heat utilization – Kalundborg, Gdansk

Source: Kalundborg Symbiosis



Source: D. Formela, IMP PAN

http://ectogrid.com/

- New districts

New city district with LTDH – Berlin Adlershof (BTB Berlin)

Project background

- 62 energy efficient buildings (15 W/m²), including 5 low energy and 3 plus energy buildings
- Implementation of a LTDH with bidirectional connection, allowing the owners to feed-in self-produced energy from thermal solar panels
- surplus thermal energy produced by the solar thermal system fed into the district heating network can be used later (2 year period of clearing)
- LTDH grid (60/40 °C) linked to the district **return flow**
- LTDH can save 65% in primary energy compared to decentral (individual) building heating systems

Source: BSM – Beratungsgesellschaft für Stadterneuerung und Modernisierung mbH

Source: Jan Gerbitz, ZEBAU, Germany

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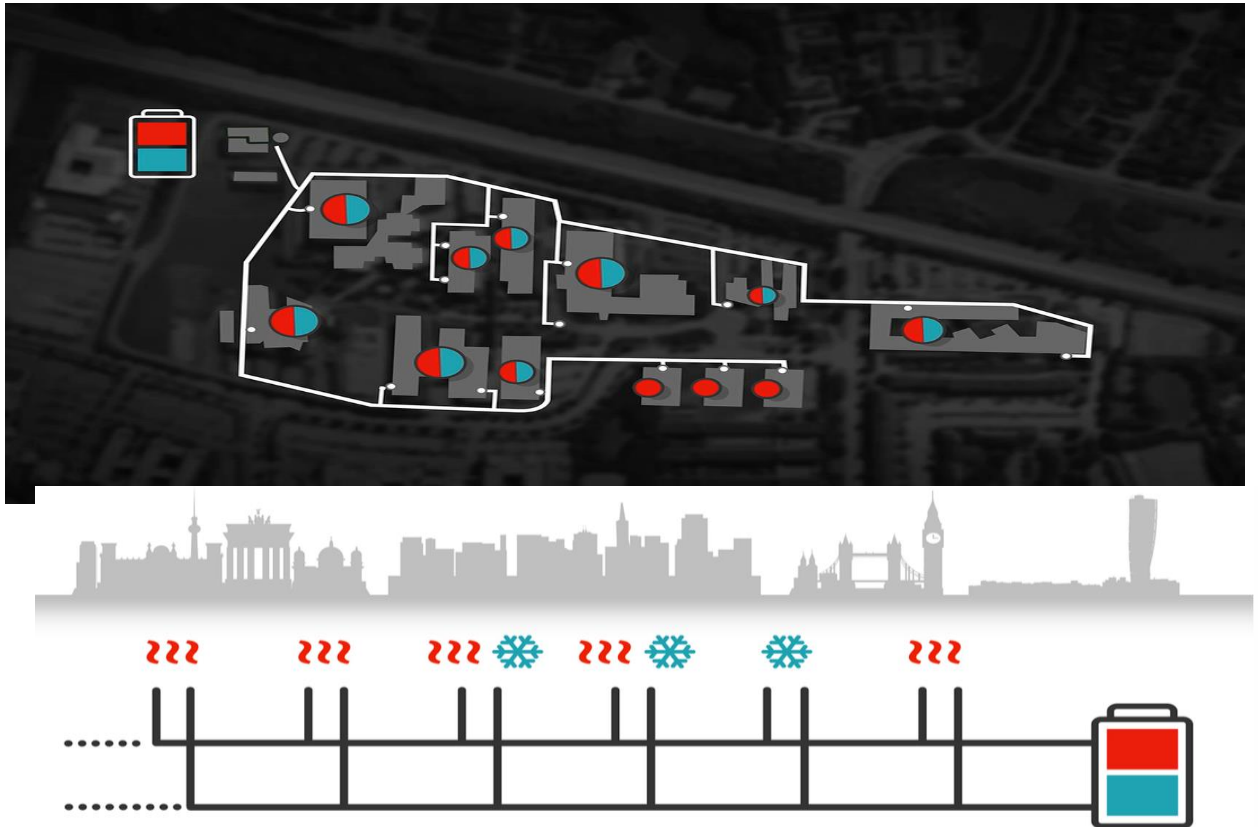
New city districts with LTDH – Ectogrid Lund

The first ectogrid™ at Medicon Village, Lund will connect 15 commercial and residential buildings with different heating and cooling demands of 1600 persons in more than 120 organizations working in life science; Medicon Village with yearly supply 3 GWh_{th} has the potential to balance as much as 11 GWh_{th}

http://ectogrid.com/



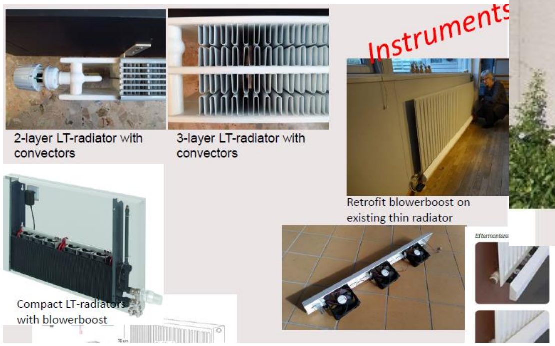
Source: e-on, Sweden

- Old renovated districts

Low temperature grid in renovated houses Albertslund

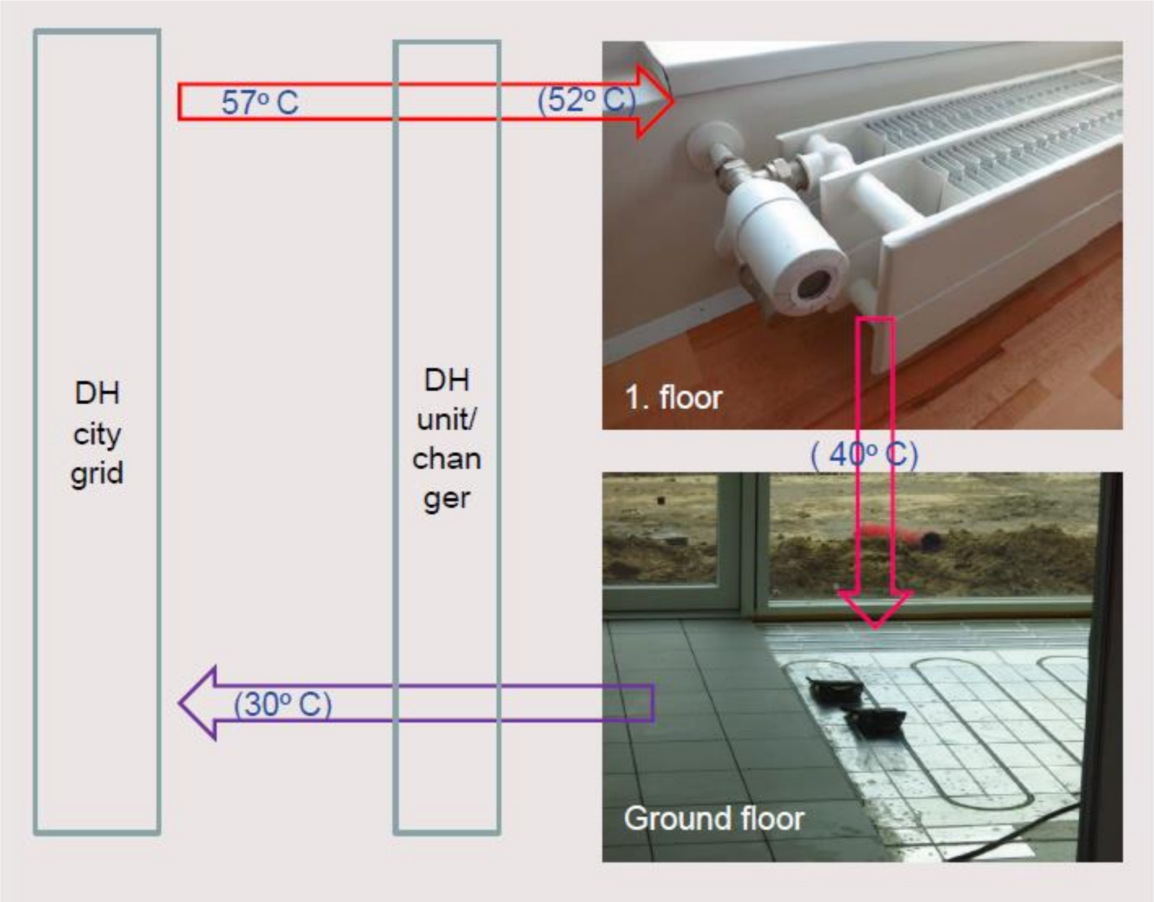
New measures: isolation of roof and walls

Isolation of windows, toillets and new radiators



Source: Albertslund Kommune, Housing department, Denmark

Low temperature grid in renovated houses Albertslund



More than 50% reduction of heat bills enable to pay debts

Source: Albertslund Kommune, Housing department, Denmark

- Old non-renovated districts

Low temperature grid in non-renovated houses in Sønderby

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HØJE TAASTRUP fjernvarme amba

Before LTDH implementation

75 houses built in 1999 connected as one consumer through one district heating station with a heat exchanger

- all fitted with underfloor heating and a hot-water tank (boiler)
- heat losses in damaged pipelines were 41 - 48%

Source: Høje-Taastrup Fjernvarme a.m.b.a., Denmark

After LTDH implementation

- TwinPipe system, series 2, size 76 and smaller with Logstors alarm-system X4, provides a precise identification of error location
- supply temperature of 55 degrees is sent from the mixing arrangement
- Consumer supply temperature 45 - 50 degrees
- return temperature is lowered to 30 to 20 degrees
- Legionella problems decreased by low volume tanks
- LTDH lower heat loss (still 13 %)
- LTDH is sensitive to consumer habits (the bad ones)

LTDH is sustainable solution even for non-renovated houses with floor heating

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- Modernized DH grid

Lowering temperature in whole DH grid – Łomża/Poland

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- Verified heat demand: **73,71 MWt; 860** substations, length **160 km**
- **heat losses** of DH grid: **- 12,5 %**

Goal 2022 : to convert the whole existing DH into LTDH

Supply T: from **121 / 65^{o}C** in 2017 to **89 / 48 ^{o}C** in 2022

Decreased heat production from coal from **100** to **11,6 %** in 2022

Step 1: regulation of existing substations to comply with requirements of energy efficient LTDH

Results: decreased mass flow 55% ; increased temperature drop - 43,2% decrease of heat consumption in the buildings ~30%.

Step 2. Decrease Nominal Supply Temperature from 121,5 to 109,8 ^{o}C

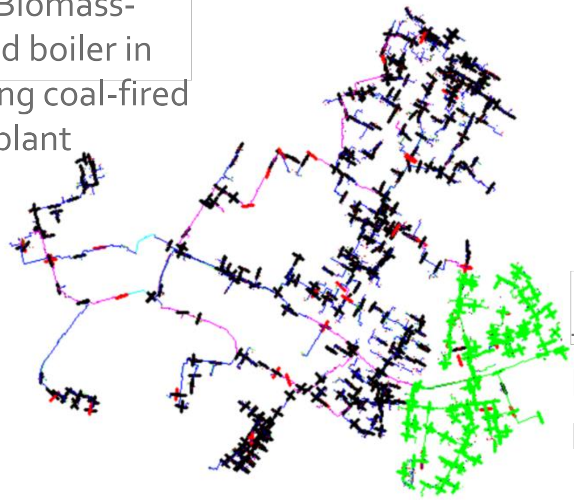
Result: decrease of seasonal DH heat losses from 12,6 to 10,6 %

Average seasonal DH return temperature: Tr = 45,1 ^{o}C

Step 3. 2019/2020, implementation of new biomass-fueled boiler and new gas-fired heat plant

Fuel: 52,0% Biomas, 36,4% Gas, 11,6 % Coal

Łomża City. Source: M. Dzierzgowski, IMP PAN, PW



- Surplus/waste heat

Brunnshög in Lund

Project background

- Lund is a fast-growing city with close to 120 000 inhabitants, Lund University, research facilities MAX IV and the European Spallation Source (ESS) resulting in huge amount of surplus heat
  - Science Village Scandinavia will cover 100 ha and in 2050 up to 40 000 people will live and work in Brunnshög
  - 65 °C supply line, 35 °C return line
  - construction commenced autumn 2017, first delivery planned on 2019
  - Details in following lecture

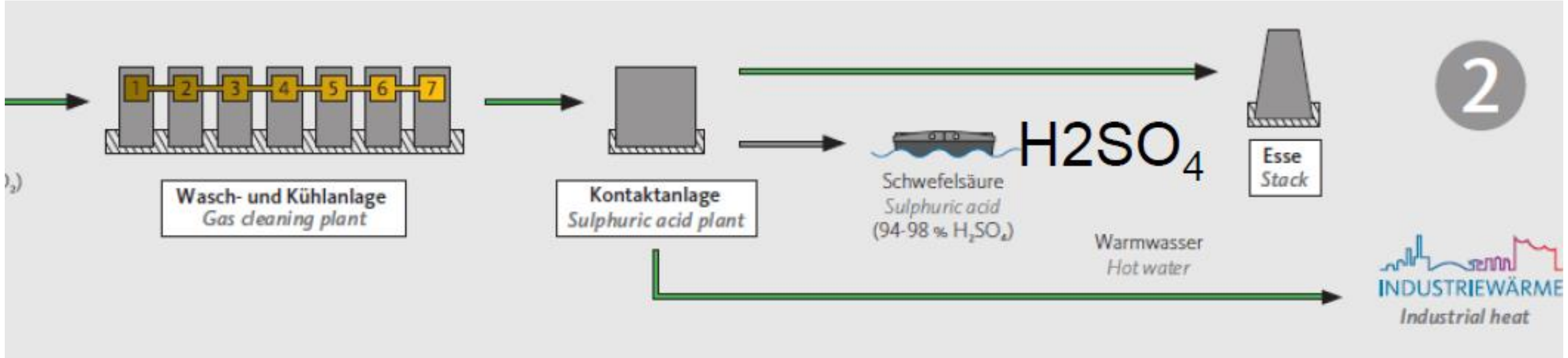
Vision image of Brunnshög I. Source: Kraftringen Energi AB

Surplus heat from Aurubis cooper factory in Hamburg

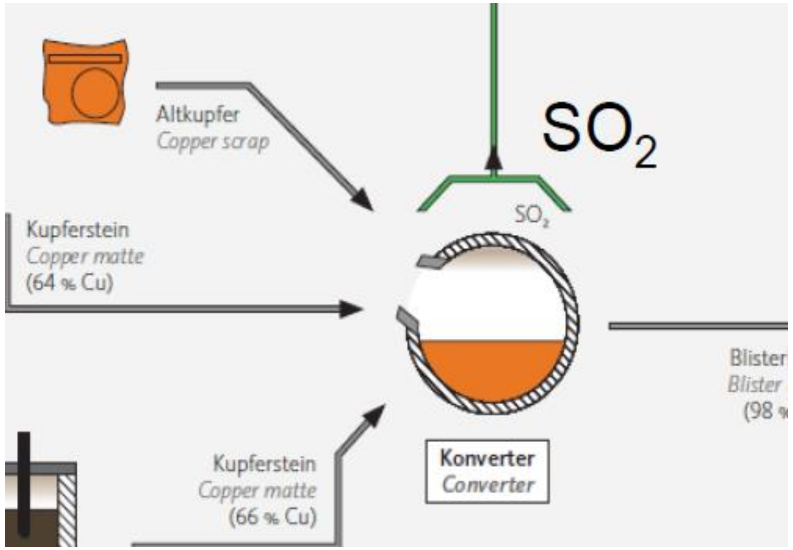
Aurubis AG, headquartered in Hamburg is the world's leading provider of non-ferrous metals, especially the largest copper producer in Europe

SO2 released during melting cupper matte is cleaned and turned to sulfuric acid in exothermic process – realising heat

- **three** production lines
- each provides **18 MW**th - sufficient to supply HafenCity East;
- 2 other lines will also be implemented in the future
- CO_2 emission in HafenCity East will limited every year by **4,500 t**



Source: Aurubis AG



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Surplus heat utilization in onside LTDH grid

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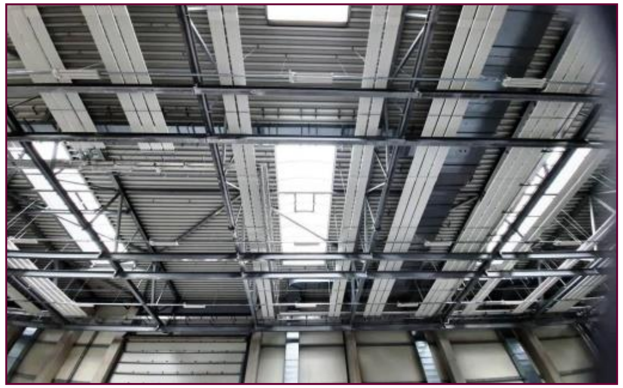
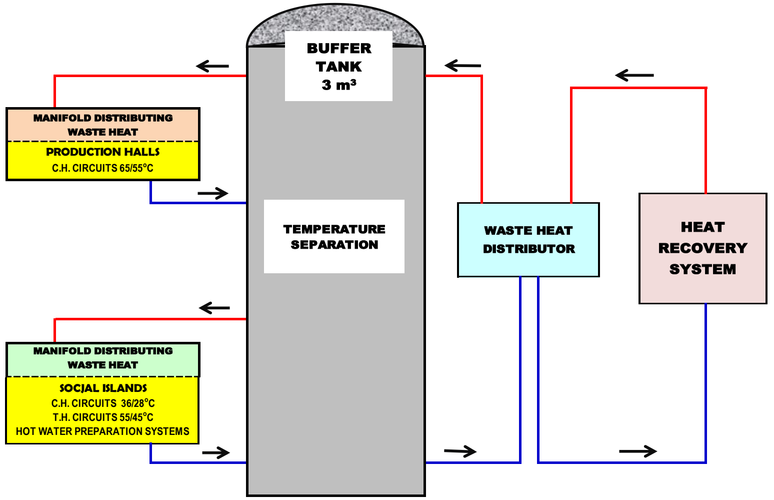
Surplus heat from products cooled after soldering in furnace (630 kW_{th} at 70°C) used for

- space heating (radiant heaters at 65/55°C, and floor heating - 36/28°C),
- ventilation with recuperation (55/45°C)
- domestic hot water preparation. (45÷50°C)

Up to 40 % of the surplus heat is used for heating purposes; the rest is dissipated by fan air cooler placed at the roof.



Radiant heaters



Floor heating

Sources: Foto: Zehnder, H. Raab

Source: D. Formela, T. Zurek – IMP PAN Gdansk

Surplus heat utilization in onside LTDH grid

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Use of waste heat potential

The amount of waste heat generated in soldering furnaces (on average - with furnaces operating at the level of 70% of nominal power)	**7 076 MWh/year**
The level of waste heat utilization	**39 %**


Source: D. Formela, T. Żurek – IMP PAN Gdansk

Energy and economic efficiency of the project and ecological effects

The analysis carried out in relation to the alternative variant including the supply of heat for the production halls and office and social facilities based on a gas boiler room

No	Name	Value	Units
1	**Avoided amount of additional energy consumption as a result of the project**	**2 362**	**MWh/year**
2	**Avoided amount of additional purchase of an energy carrier (natural gas)**	**246 982**	**m^3/year**
3	**Avoided additional purchase costs of an energy carrier (natural gas)**	**388,12** **88,13**	**thousand PLN** **thousand €**
4	**Ecological effects** **Avoided CO_2 emissions**	**tons of CO_2/year**	**471**
5	**Project cost**	**2 000,00** **454,13**	**thousand PLN** **thousand €**
6	**Simple period back time (SPBT)**	**5,15**	**years**

- Surplus/waste heat at low temperature

Long distance ultralow temperature heat transfer

Source: Kalundborg Symbiosis

Kalundborg City:
Densely populated industrial sites; thus, a substantial amount of surplus (waste) heat

Heat transfer – long distance

Is it economically feasible to transfer heat (~ 20 C) 20 km away ?

Solution:
Uninsulated pipes with central heat pump at final destination

Estimated payback time around 12 years

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- Surplus/waste heat at high temperature

10 kWe ORC system utilizing surplus heat from drying

- Localized: Skawina k/Krakowa
- Cooperation: IMP PAN and ENKI Ltd in frame of Biostrateg Project
- Start: July 2021
- Heat source: drying process

BIOSTRATEG

Polygeneration ORC system – medium power 100 kWe

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Technical data:

Supplied heat power : ~500 kW

Electric power: ~100 kWe

Fuel: gas/biomass

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Energa

The National Centre for Research and Development

STRATEGIC PROGRAMME OF THE NATIONAL CENTRE FOR RESEARCH AND DEVELOPMENT

The research task financed within the framework of the Strategic Research and Development Programme entitled 'Advanced Technologies for Energy Generation' carried by The National Centre for Research and Development and electric power holding company ENERGA SA in Poland

Research Task No. 4

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Dotychczasowe realizacje układów ORC projekty B+R

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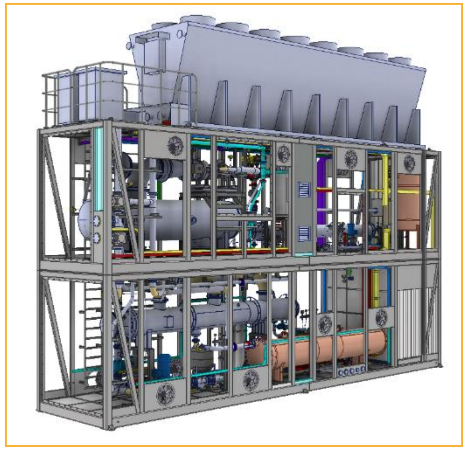
Prototypowa instalacja ORC – 300 kWe



Microturbines and compressors up to 300 kW

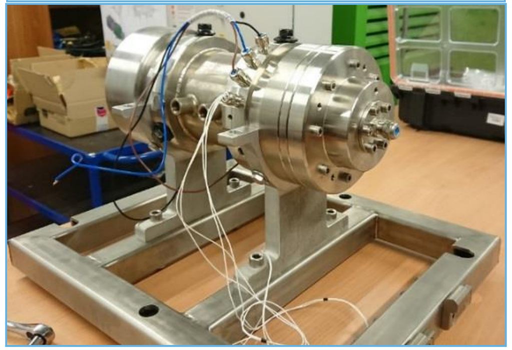
Turbina ORC o mocy 300kW

Turbina ORC o mocy 30kW

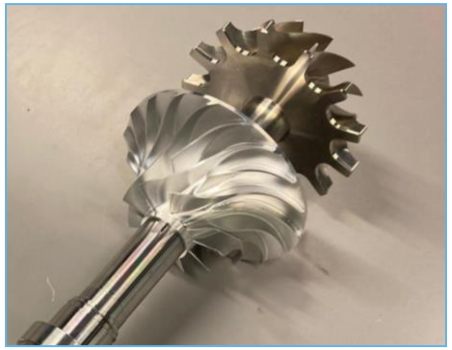
Turbina ORC o mocy 15kW

Turbina ORC o mocy 10kW

Sprężarka o mocy 10kW



Turbina gazowa o mocy 30kW

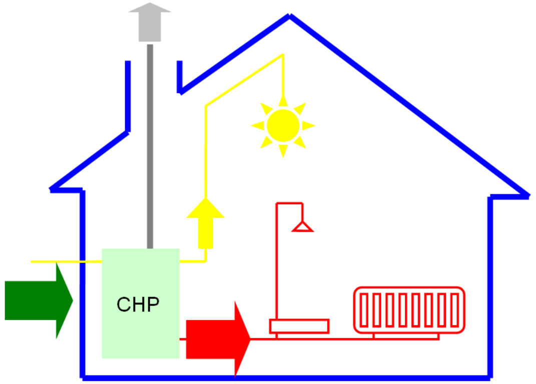


Microturbines and compressors up to 300 kW

ORC CHP system (2,5 kWe/25 kWt for single family house

Project

Prototype



Technical data:

Dimensions: 160x74x74(175) cm

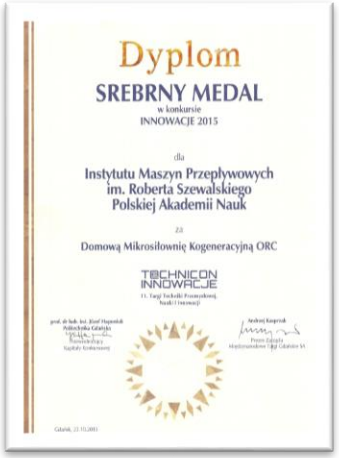
Thermal power: 25 kWt

Electrical power: 2,5 kWe

Fuel: biomass (pellet)

modelowe kompleksy agroenergetyczne

Financed by National Centre for Science and Development – project POIG.01.01.02-00-016/08 „Model agroenergetic systems as example of distributed cogeneration based on lccal and renewable energy sources"



Patented solution

Thanks for attention

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Figure 3: XXXXXXXXX, © Photograher, Organisation (depending on type of copyright)

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