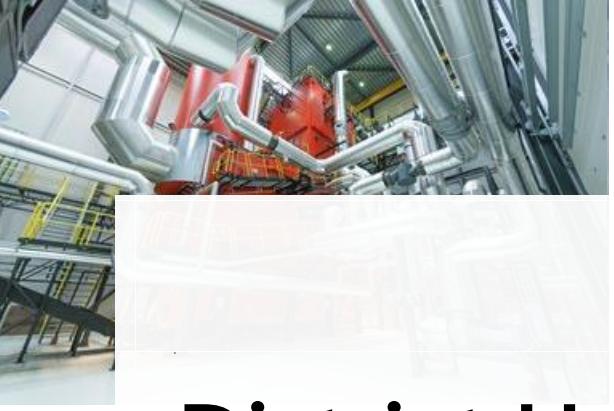



District Heating Denmark

Digitalization
– a modern way to energy efficiency

Zlatibor Serbia, May 2022





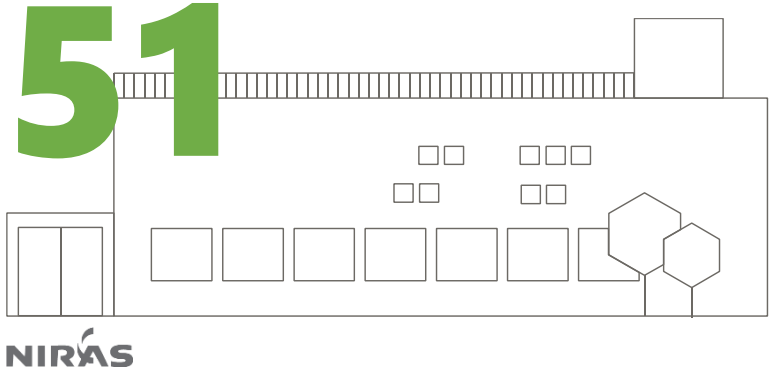


NIRAS

Worldwide Presence

Scandinavian consultant with universal values

51



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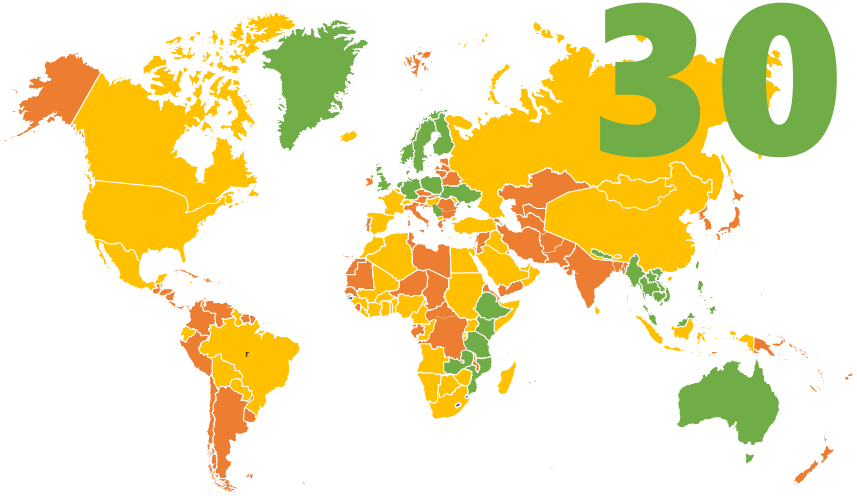
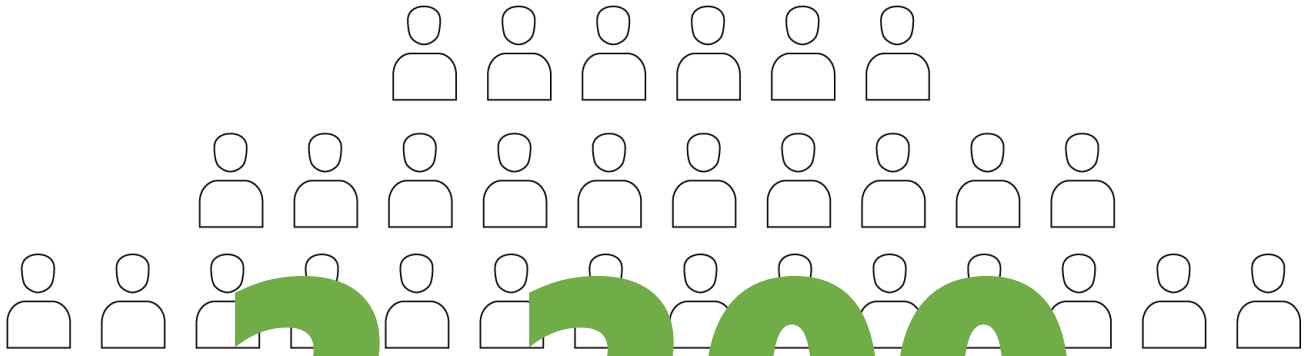




2,200

7,000

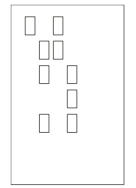
NIRAS

NIRAS

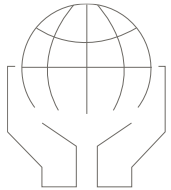
- Founded in 1912 (Alectia) / 1956 (NIRAS)
- Fusion 2017
- More than 100 years of professional expertise
- Projects in more than 108 countries

NIRAS ENERGY has more than 100 experts and projects in 20 countries

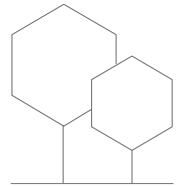
10 solid business units



Building

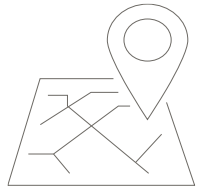


Development Consulting

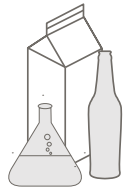


Environment & Nature

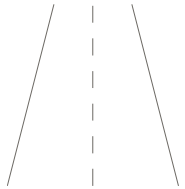
Energy



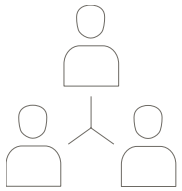
GIS, Geodata & Automation



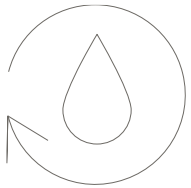
Process Industry



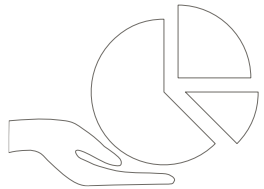
Infrastructure



Working Environment Consulting



Water & Utilities



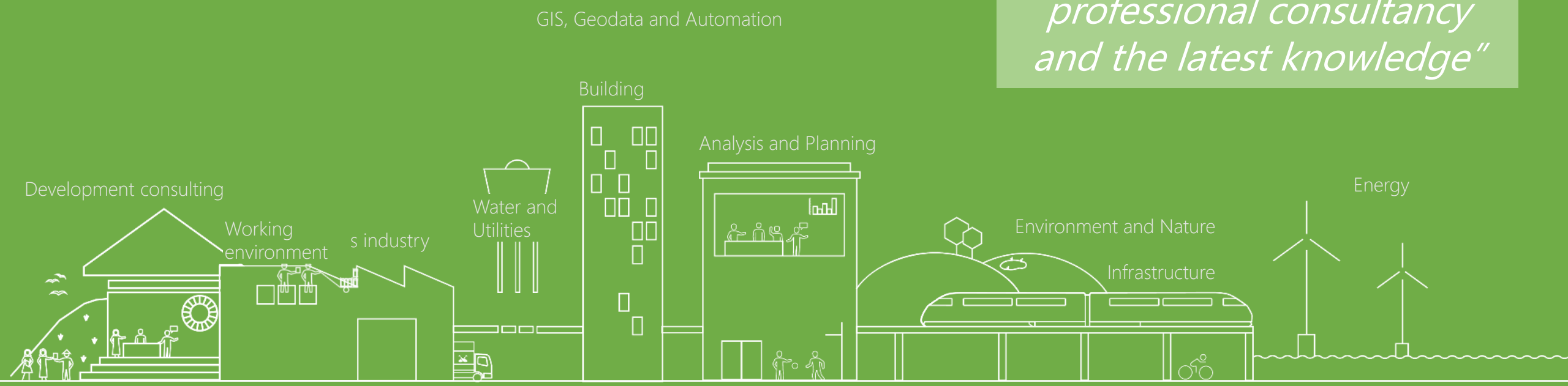
Analysis & Planning

NIRAS

Cooperating with NIRAS

A holistic and cross-disciplinary approach is in our DNA

"Cooperation across sectors, locations and countries provides our customers with access to the most professional consultancy and the latest knowledge"



NIRAS' key services within District Heating

- Strategic Energy Planning
- Energy Supply and Storage
- Digital optimization
- Renewables and solar energy
- Biomass
- Waste Energy
- Biogas
- Tendering and contracting
- Energy Savings
- Energy Efficiency
- CO2 and Sustainability
- Hydraulic modeling

R&D&D → Planning and project development → Feasibility Studies → Concept Design → Detailed Design → Supervision → O&M

District heating in Denmark
- a 100 year's of experience

History

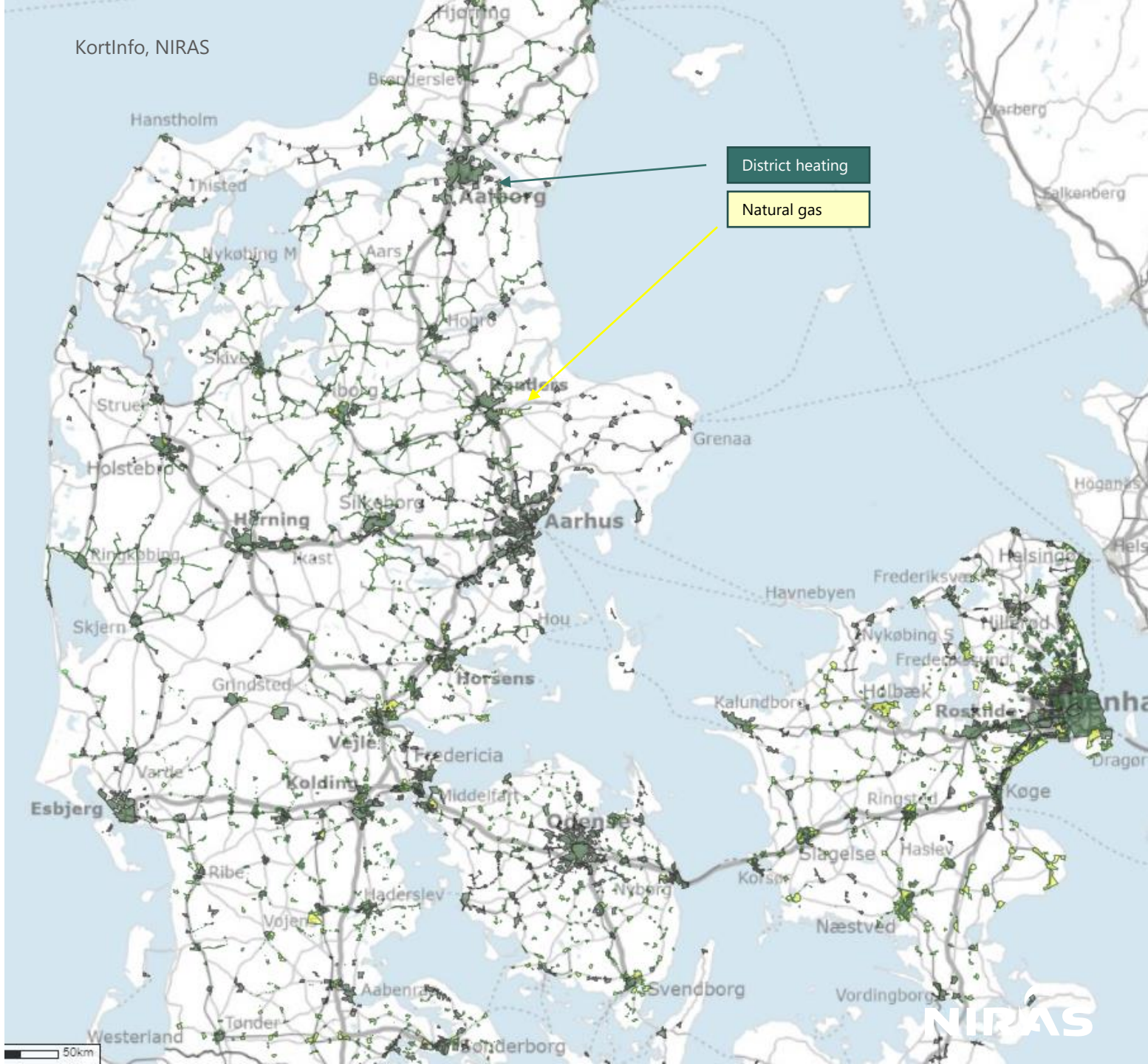
1903, the establishment of the first district heating plant in Copenhagen.

Used surplus heat from a waste incineration to heat the local hospital.

Denmark, today

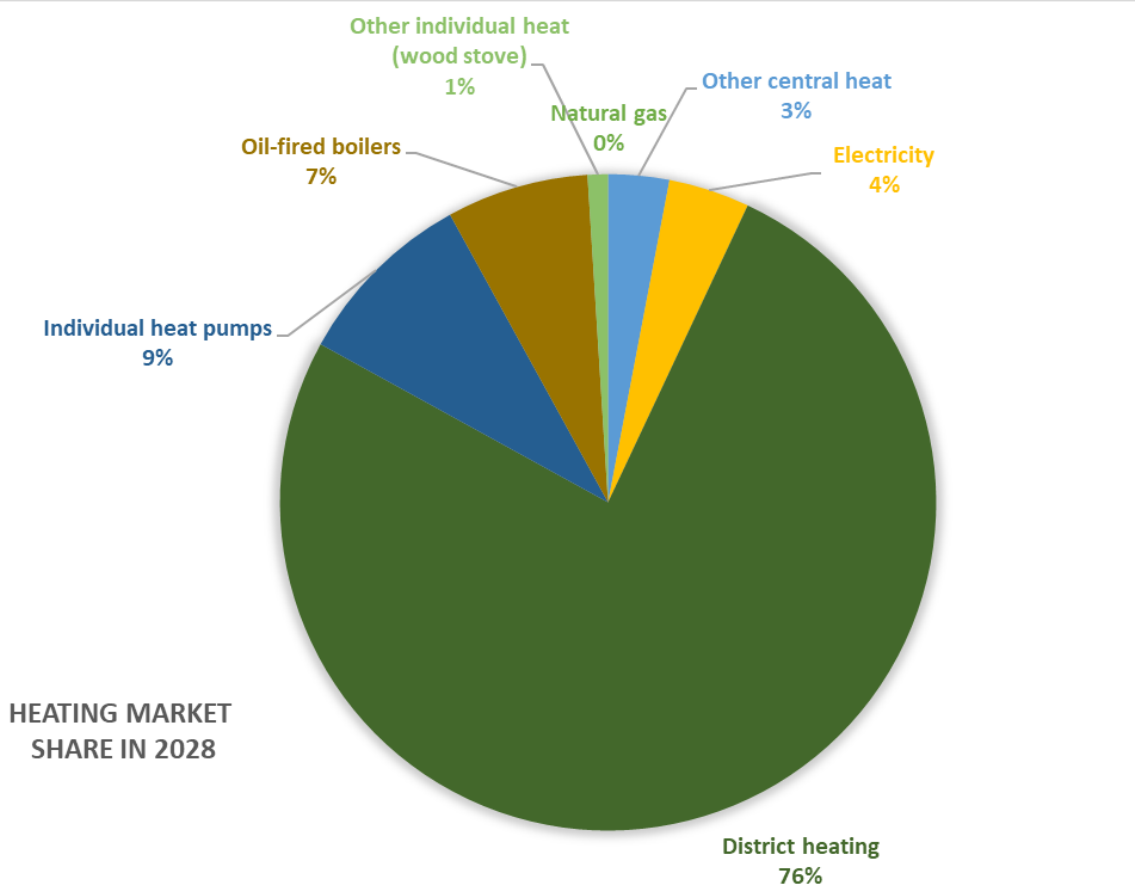
400 district heating plants.

Nearby 1,5 mio buildings are heated with district heating.



Heating market share in Denmark

Today's heating share



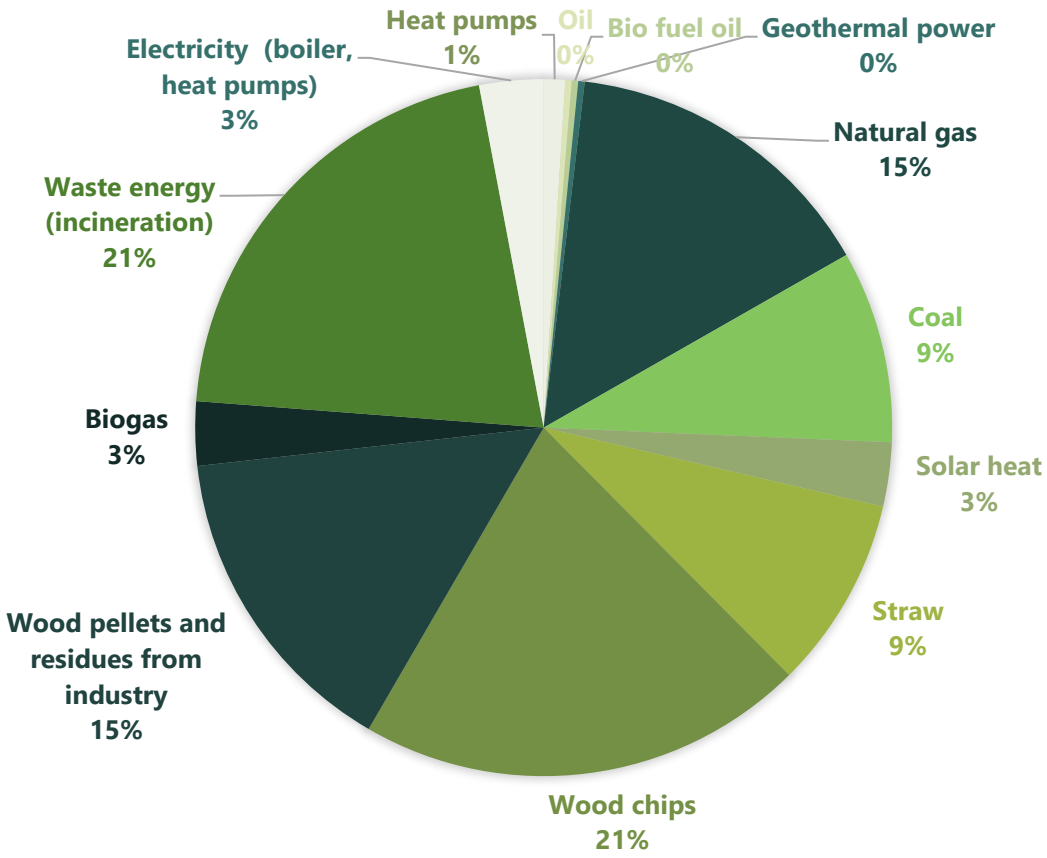
The governmental energy goal

Phasing out natural gas and individual gas boilers before 2028

- 400.000 consumers will be converted from natural gas
- 250.000 consumers convert to district heating within the next 6 years
- Future district heating market share increase to **75-80 %**

April 2022:
Denmark must be greener and more secure.
Independency of Russian gas.

Fuels in danish district heating sector



Source: Dansk Fjernvarme 2020

New technology

New fuels and technologies will be implemented at the Danish district heating plants in near future and will replace natural gas.

- More heat pumps and electric boilers
- Surplus heat from industry and data centers (Apple, Google, Face Book)
- Power2X
- Geothermal energy

- Optimization through digitization

DIGITALIZATION OF DISTRICT HEATING

Digitization

Development and implementation of new digital tools and processes are on the top agenda at NIRAS. With new technologies, we can deliver more value to our customers and to their business.

Prevalence of digitalization in the district heating sector

Production site
The district heating system in Denmark is based on an advanced SRO-system to control, regulate and monitoring the heating production.

Distribution site
The distribution of warm water in the network is controlled by Schneider TERMIS or Danfoss Leanheat and sensors placed in the pipes, network pumps and heat exhangers.

Heating consumption
The heat consumption is measured by heat meters.

Ready for more digitalization

Savings
Energy efficiency and financial savings for the district heating plant are the motivating factors for integrating more digitalization in order to keep a low district heating tariff and reduce CO2-emission.

Both component suppliers, software developers and district heating plants are investigating a lot efforts and resources in new and smarter IT technology.

Digitization secures tomorrow's heat demand

Why digitalization

- To do things better and smarter
- For energy efficiency and savings
- To keep the heating price low
- To reduce the heat production and CO2-emission
- To create a greener energy sector by using more different fuels and enable sector integration
- To secure it-systems and prevent cyber attacks
- Relevant for both small, medio-sized and bigger energy companies
- Also, the Danish Government supports the digitalization evolution. The Danish Digitization Agency has allocated 2 mio. EURO from 2023 to 2026 for a digital strategy in order to obtain a coherent green energy sector.

Savings in the district heating sector

2-4 per cent is the calculated financial savings for each district heating plant when integrating HEATman

(depending on the as-is situation of the individual plant and how much the district heating plant has optimized on the production, distribution and consumption site)

Digital Supported Smart District Heating

HEAT 4.0 aims to create the next generation digital platform for the district heating sector

- A high-tech platform that creates synergy between design, operation, production and maintenance of the entire district heating system by integrating the latest technologies and research knowledge into one unified product: HEAT 4.0.
- The result is a maximized economic effect for the district heating utilities, energy efficiency and CO2-reduction.
- The project is supported by the *Innovation Fund Denmark* with 3.4 mio. EURO and 1.4 mio. from the partners.

Innovation Fund Denmark

NIRAS

Holistic approach

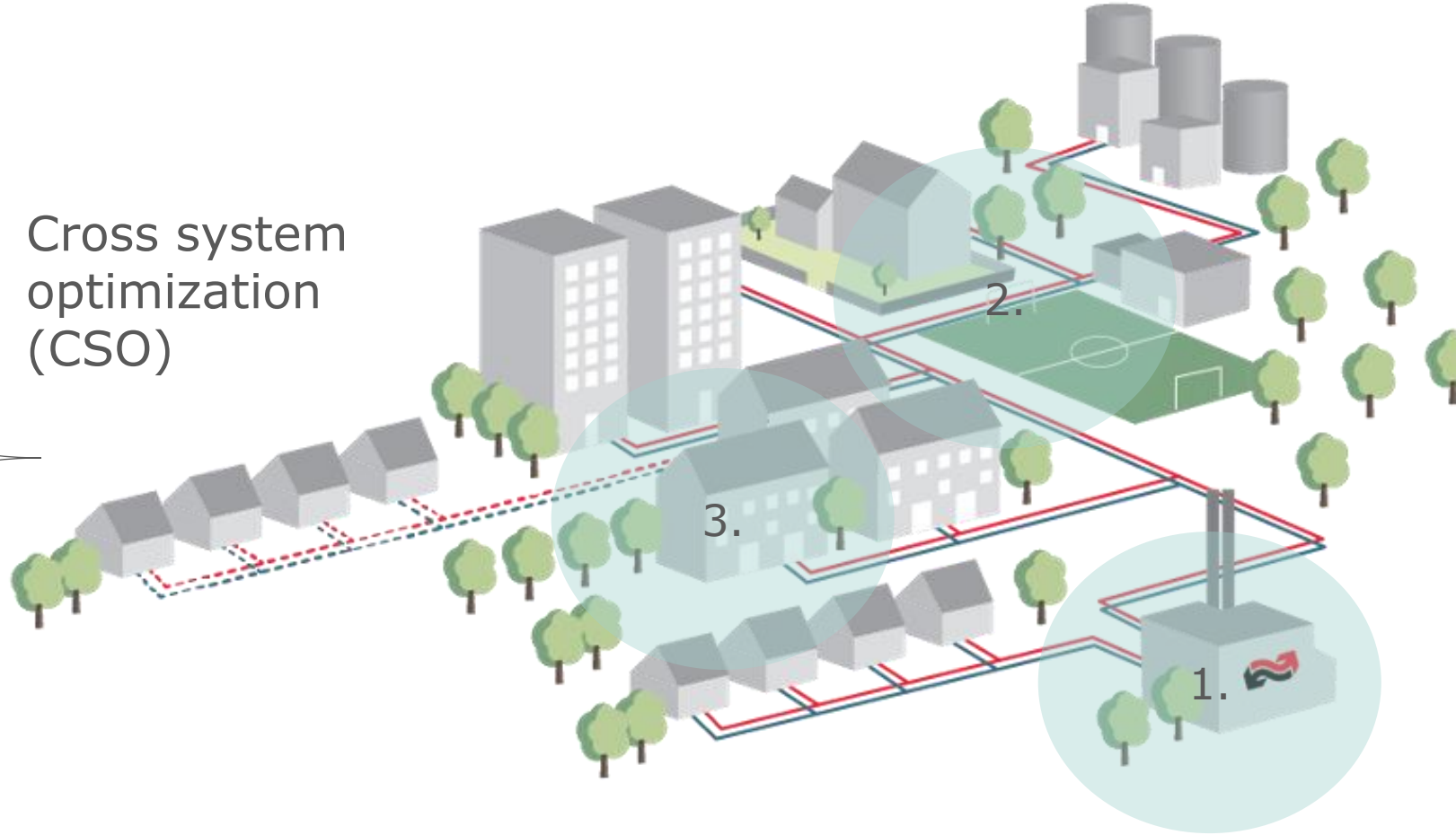
Digital improvements in the DH system

1. Production
Production utilities
Heat storage

2. Distribution
Network
Booster stations

3. Consumer (heating demand)
Building installations
Heating units

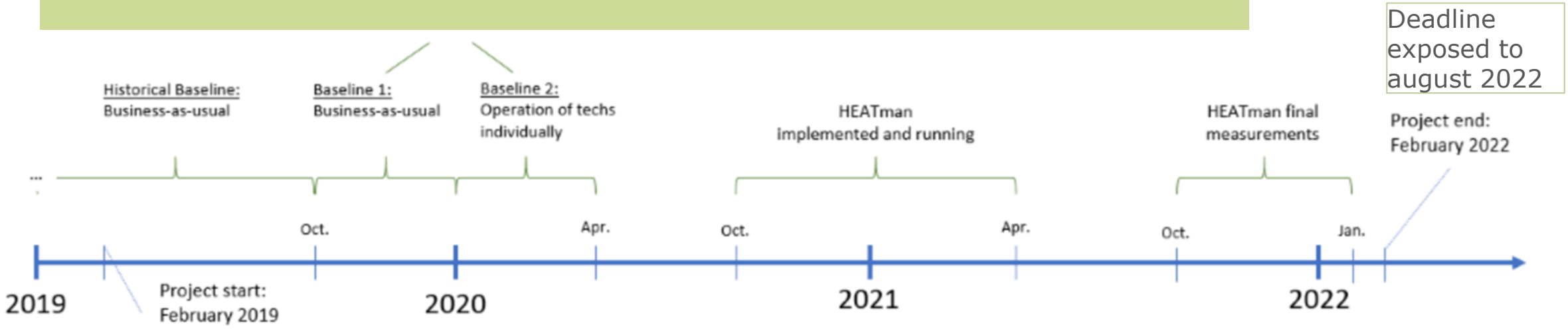
Cross system optimization (CSO)



Success criteria for HEAT 4.0

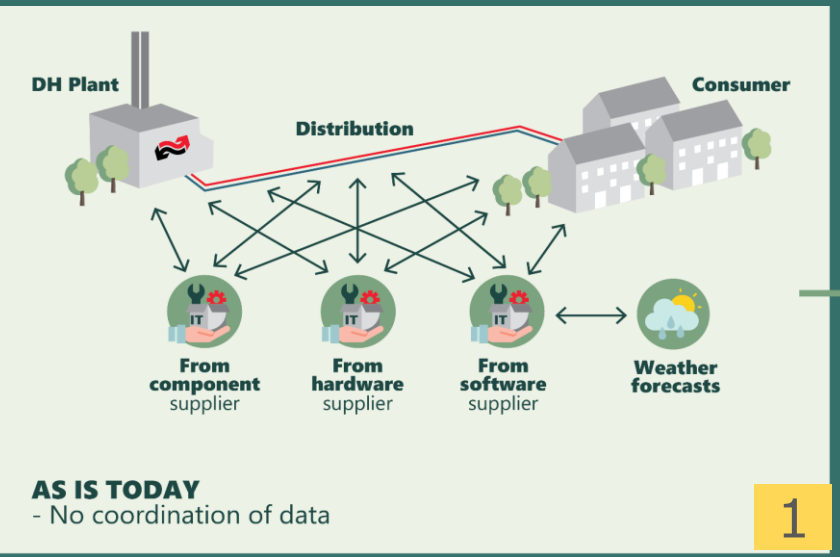
Digital improvements for production, distribution and heating consumption

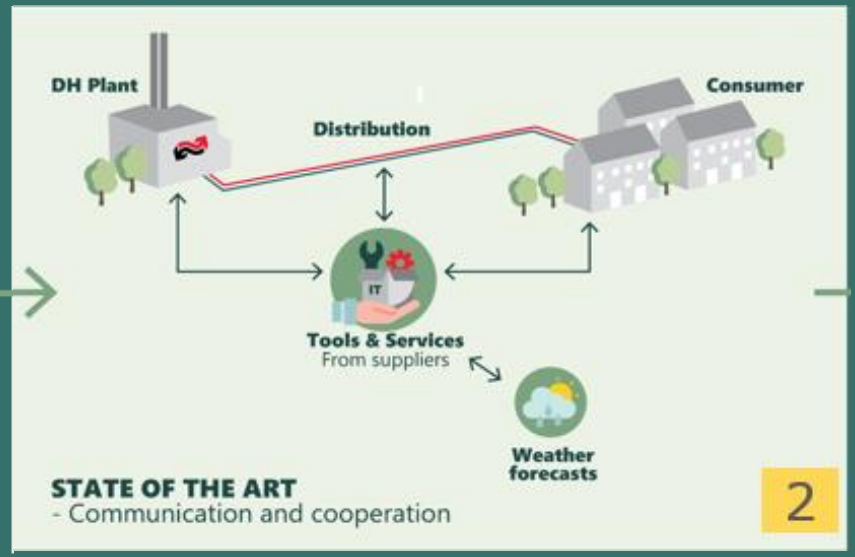
- Achieve energy savings in the heating network of minimum 2% in comparison to the baseline.
- At least 3 Danish district heating plants have installed a minimum of 2 tools from the HEATman platform.
- At least one foreign district heating plant has implemented parts of the concept.

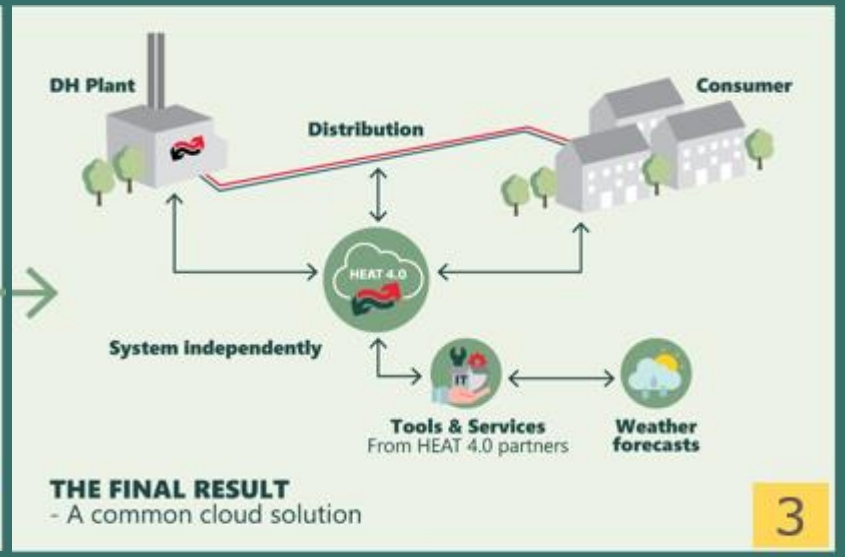


Digital Supported Smart District Heating

HEAT 4.0 – the digital infrastructure

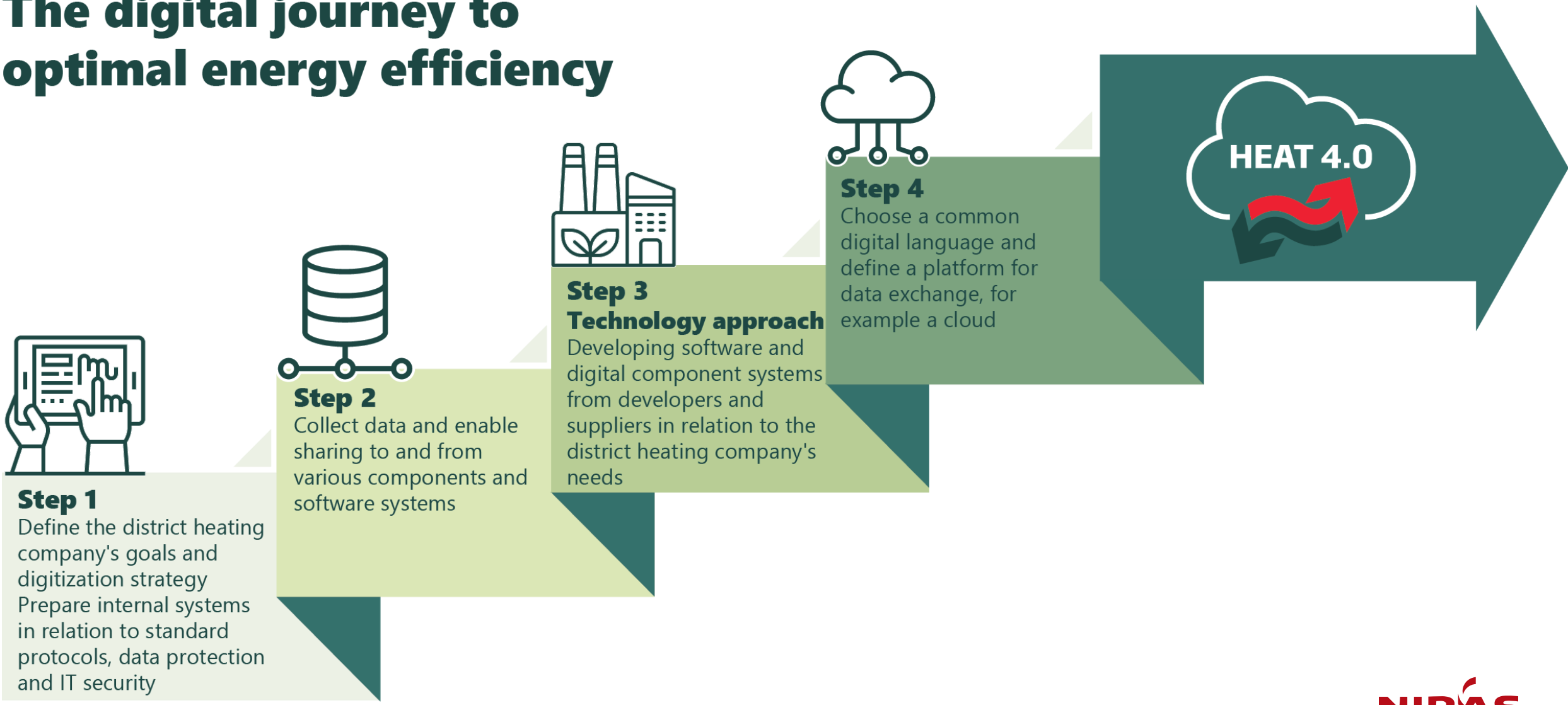






Practical approach for the district heating company

The digital journey to optimal energy efficiency

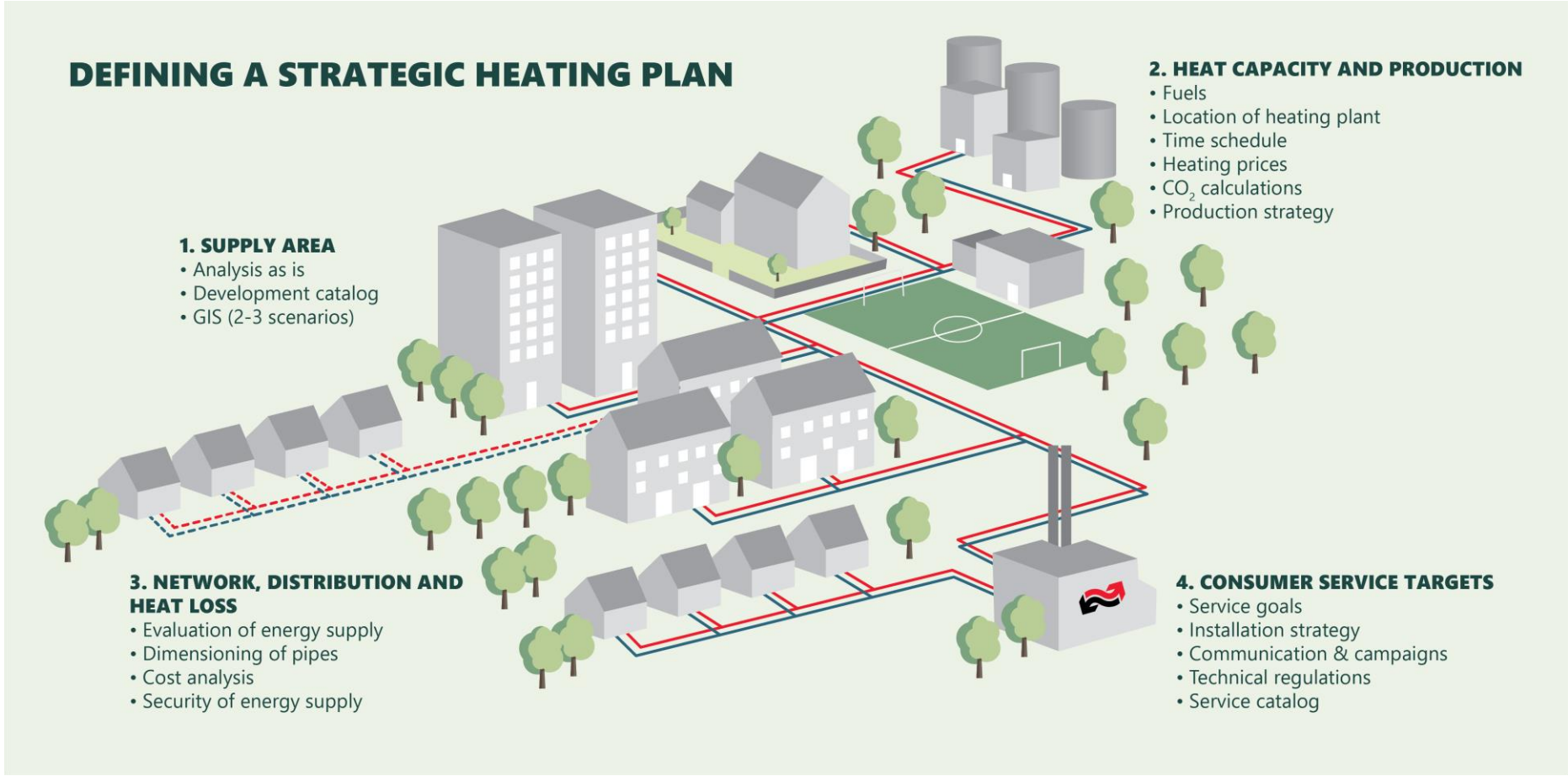


Step 1
Strategic Heating Plan

Four main elements

1. Heating supply area
2. Heat capacity and production utility
3. Distribution network
4. Consumer service targets

Finally, defining
a digitalization strategy



Step 2 Preparation of Systems and Data

- Prepare internal IT systems in relation to standard protocols, data protection and IT security.
- Enable collection of more data and provide the possibility to share data safety between different kinds of components and software programs.

District heating plants has tested the HEAT 4.0 tools

Results achieved

TREFOR Varme:

"There are economic and timewise savings, fewer problems with incorrect data through standardized technical integration and one integrator contact. The secured data exchange between several software systems enables especially smaller DH companies to digitize."

Brønderslev Forsyning:

"We have for some years successfully been working with data from Smart Meters to create added value for the company and the customers. The HEAT 4.0 project has given us new unique possibilities to step up in digitization and explore the use of more advanced technologies. Especially, the idea about the cloud-based Cross System Optimization has given us new valuable insights and provided us with more advanced tools to operate the entire utility more efficiently - from production to distribution and to end-consumers."

Step 3 Technology Approach

Developing and adjusting software programs, systems and component from different developers and suppliers in order to satisfy the energy company's IT requirements.

In the HEAT 4.0 project, 15 partners cooperate to find the best digital solutions.

The partners represent:

- District heating suppliers (components, software, hardware)
- Research institutes and universities
- District heating plants

HEAT 4.0 partners

DATA PROVIDERS DH CONSUMERS

KAMSTRUP:
- Provides data from smart meters

ENERGY INDUSTRY

LOGSTOR:
- Provides data from DH grid

ENFOR:
- Cross system optimization and T.O.

Desmi:
- Pump optimization in network

DH CONNECTION UNITS

DANFOSS ECL:
- Provides and controls data from units

TEST OF HEAT 4.0

Hillerød Forsyning:
- Test and implement components, software, algorithm

TreFor:
- Test and implement components, software, algorithm

Brønderslev Forsyning:
- Test and implement components, software, algorithm

Dansk Fjernvarme:
- Collect and verifies data from test plants (baseline)
- Screening tool

DH PRODUCTION OPTIMIZATION

Neogrid:
- Provides and analyse data from production

EMD:
- Provides and analyse data from production

RESEARCH DEVELOPMENT

Neogrid:
- Provides data from buildings and devices
- Analyse data
- Control ECL directly

LeanHeat:
- Provides data from buildings and device
- Analyse data
- Control ECL directly

DH OPTIMIZATION BUILDINGS

DTU: develops algorithm
AU: develops algorithm
ENFOR: develops algorithm

SCIENCE / COMMERCIAL CLOUD

Center Danmark:
- Tools and cloud solution

HEAT 4.0

INTEGRATOR

NIRAS:
Project owner and project leader

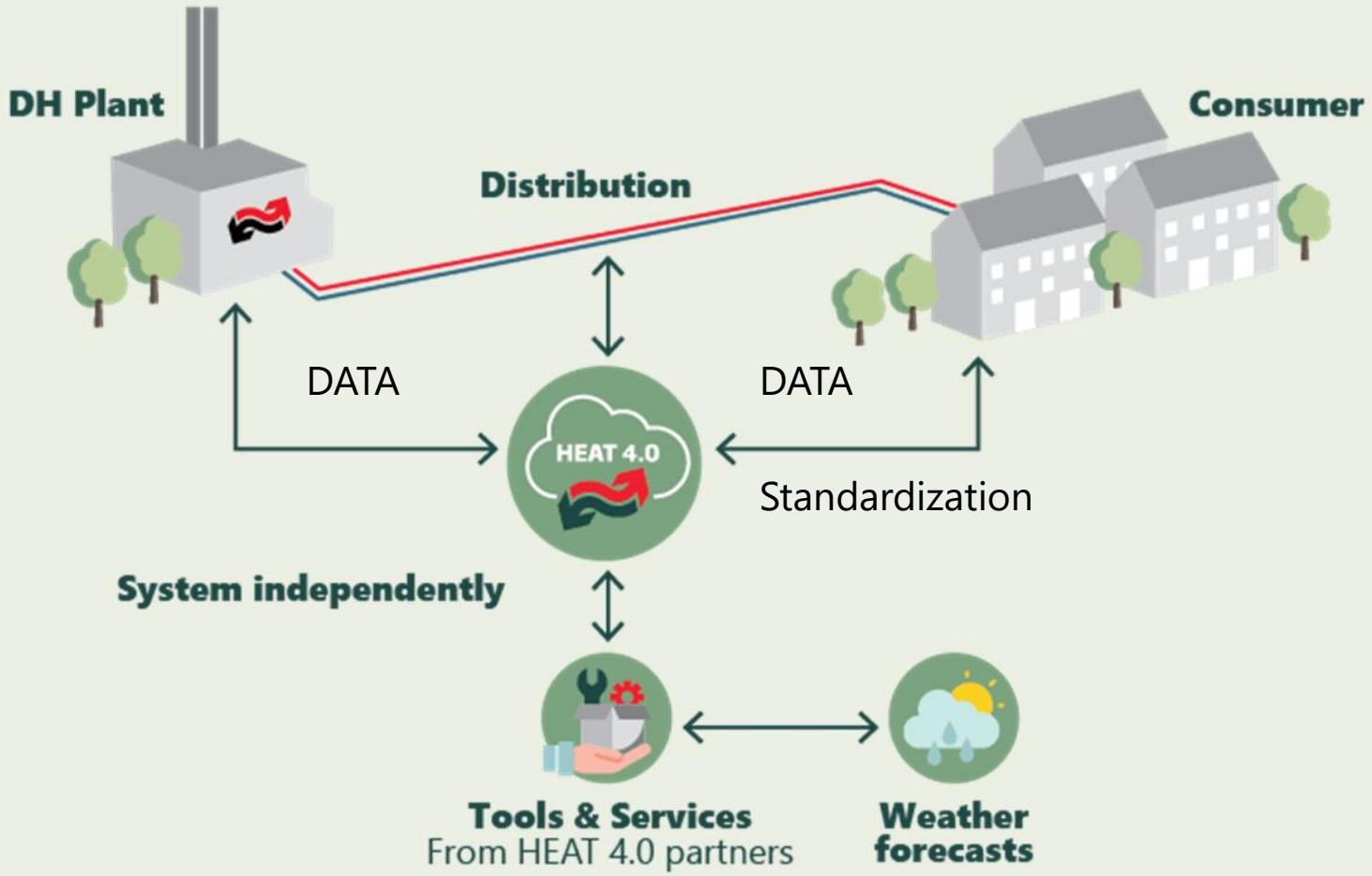
IT tools in HEAT 4.0

EMD International	Production	energyPro (energy system modelling) energyTrade (production planning)
Enfor	Distribution og udsigter for vejr og forbrug	Heat Solutions™ is an integrated portfolio of forecasting and optimization solutions for the district heating sector. It consists of MetFor™, which delivers locally-calibrated weather forecasts, HeatFor™ which provides heat demand forecasts and HeatTO™, which provides temperature optimization of the supply temperature.
NIRAS	Distribution	TERMIS for hydrodynamic modelling of DH networks and temperature optimisation and control.
Leanheat/Danfoss	Buildings	Leanheat Building
Neogrid	Buildings	PreHEAT for District Heating
Kamstrup	Building	e-metring at customers
End to end alternative	All components	PreHEAT for District Heating is a integrated end-to-end solution for the optimisation of whole DH systems.

Step 4
A cloud solution

- The communication to / from the heating company takes place via a limited number of 'languages' and via a common component - a 'cloud'. This can be internal or external.
- Individual software systems and components are not connected directly to each other or the heating company's server, but to the 'cloud', which facilitates smart data handling.

The digital infrastructure of District Heating



The uniqueness about HEAT 4.0

- One common data driven solution
- Avalaible for all suppliers, developers and district heating companies
- An agile and flexible IT architecture
- A common communication platform
- Utilization of standardized language
- System-independent
- Foreign software can be integrated
- Makes data avalaible in a secure way
- Makes digital interconnection of data and IT architecture across systems possible
- Improves management capabilities for optimal production and operation.
- Create synergy for the entire district heating system, ie. between production, distribution and consumption and between design, operation and maintenance.

Possible savings by data-driven operation of DH Systems

- **Large savings by improved weather, heat load, and temperature forecasting**
- **10 – 30 pct savings by predictive control of heat pumps**
- **5 – 20 pct savings by integrating forecasts in smart house controllers**
- **Up to 20 pct savings by using network and houses for flexible energy storage**
- **10 – 40 pct improvements of electricity and heat load forecasts**
- **Up to 20 pct savings by optimal operation and bidding**

- **Thanks to HEAT4.0, many data-driven solutions now exists. Solutions can run in the HEATman Cloud, at commercial companies, - or in a combination.**

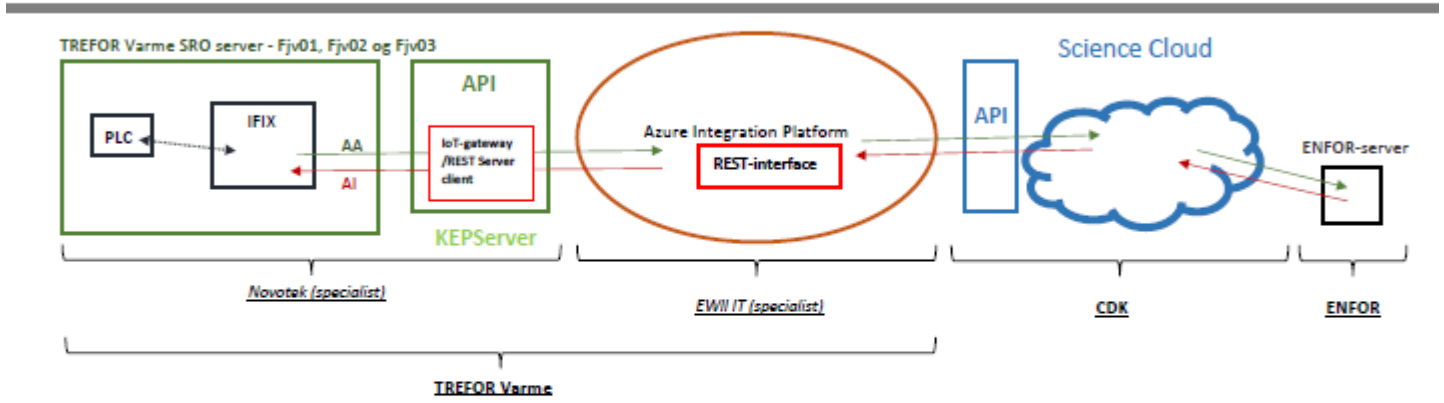
2-4 per cent is the calculated extra financial savings for each district heating plant when integrating HEATman

HEATman - Results

Communication setup (HEATman)

Frbu/ 21-01-2022

Simpel princip diagram



Krav:
- **Frekvens max 5 min.**
- **2-vejs kommunikation**

AA - Frem tags
AI - Returtags
Intern (TREFOR)

AI – Data fra ENFOR retur til Science Cloud / SRO

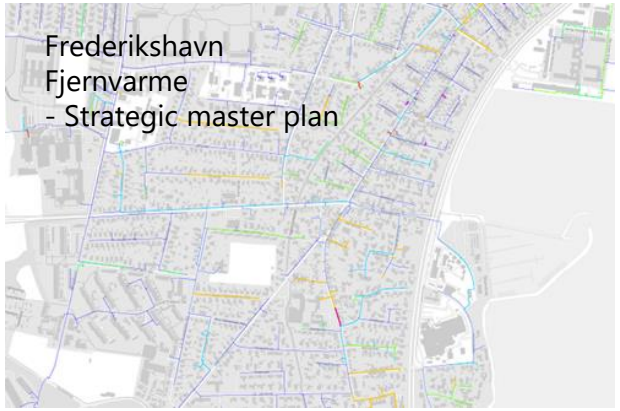
Fremløbstemperatur [°C] – (24 datatags)
Alivecounter [-]

AA – Data fra SRO til Science Cloud / ENFOR

Varmeeffekt [MW]
Fremløbstemperatur [°C]
Returtemperatur [°C]
Flow [m³/h]
Udetemperatur [°C]
Alivecounter [-]
Setpunktstemperatur [°C]

TREFOR Varme

References



NIRAS

Gren Tartu, Estonia

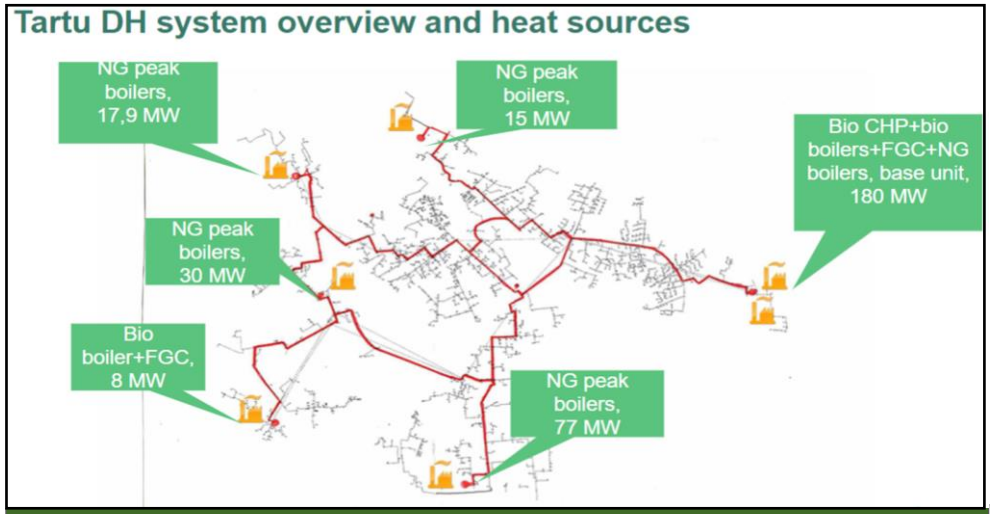
CASE

The company operates in 10 countries, with some 8,000 energy sector professionals.

- Worldwide, more than 2.5 million customers, 150+ power, heating and cooling plants

- Global energy production in 2019:
  76.3 electricity (TWh)
  26.4 heat (TWh)
  59% of electricity production CO_2 free

In Tartu, Fortum Tartu generates and distributes district energy – power, heating and cooling - to residential, commercial and industrial customers with a peak of 270MWe and 200 MWt. Using biomass, natural gas and flue gas from the CHP – 10 plants in total.



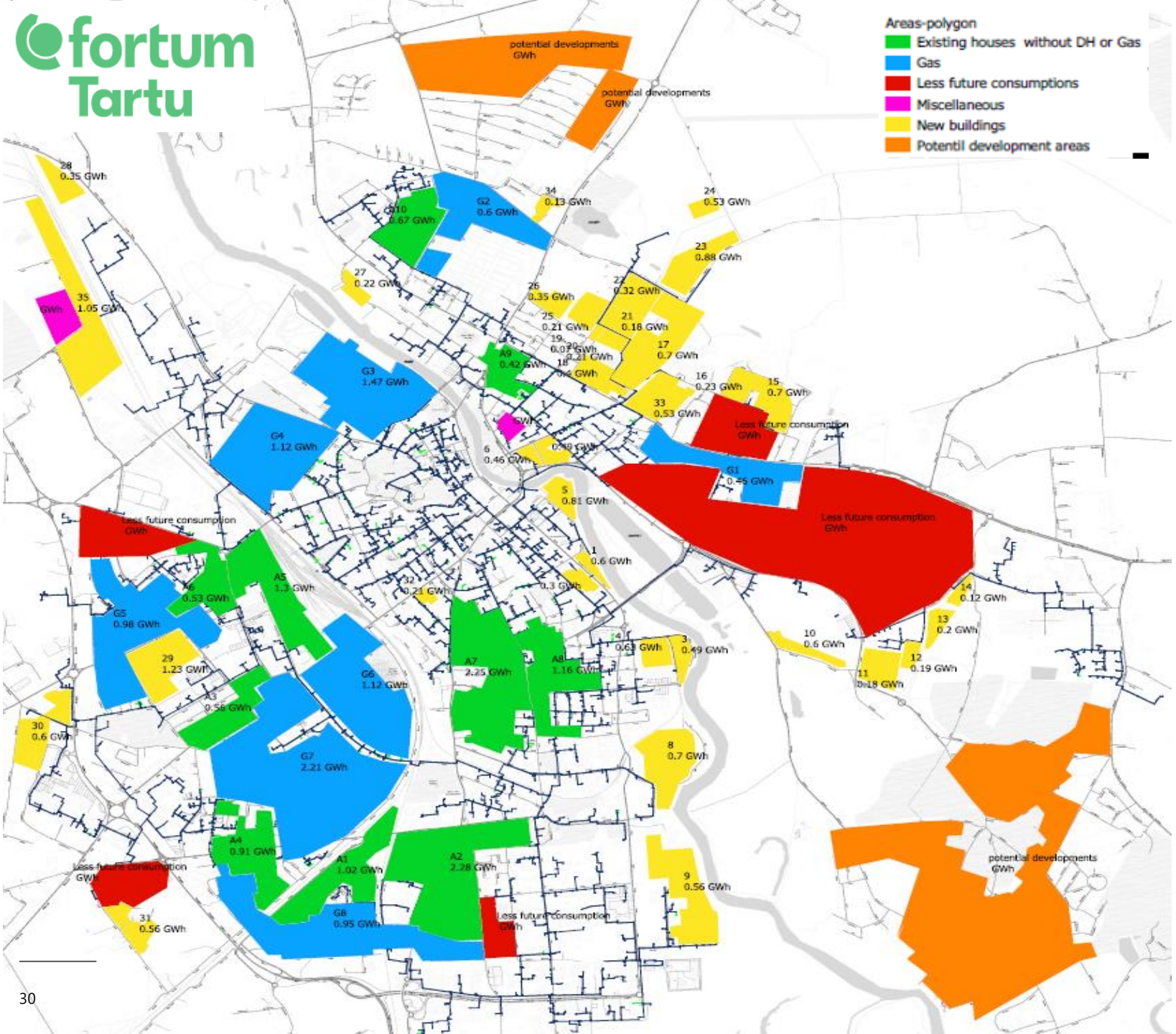
FACTs and FIGURES	
Establishment of first DH plant	1967
DH market share	App. Population in city: 93.000 DH Consumers: 46.000
Heating capacity	DH: 328 MWt/1,115 MMBTU DC: 13 MWt/3,705 Tons
Km DH network	DH: 173,5 km/110 miles DC: 1,8 km/1,1 miles

Fortum Tartu

Primary tasks

- **Masterplan development**
  Plans for the future heat supply
- **energyPRO analysis**
  Techno-/economic analysis (detailed technical and financial analysis)
- **Production planning and operation strategy**
  Optimizing the production according to heat demand, electricity prices and specific conditions (storage, production units, etc.)
- **Feasibility study and investment analysis for future production capacity and storage opportunities**
  - Testing different storage opportunities (daily, seasonal etc.) and size
  - Analysis based on annual production costs, investment and energy conversion.
- **Comparison of different scenarios and sensitivity analysis**
- **Trigeneration**
  The energy system of Tartu includes:
  - Combined heat and power (CHP production)
  - Heat only production (boilers, heat pumps)
  - Cooling (heat pumps, compressor chillers)
- **CO2 emission analysis**
  - CO2 reduction and comparison

fortum Tartu



Future demands

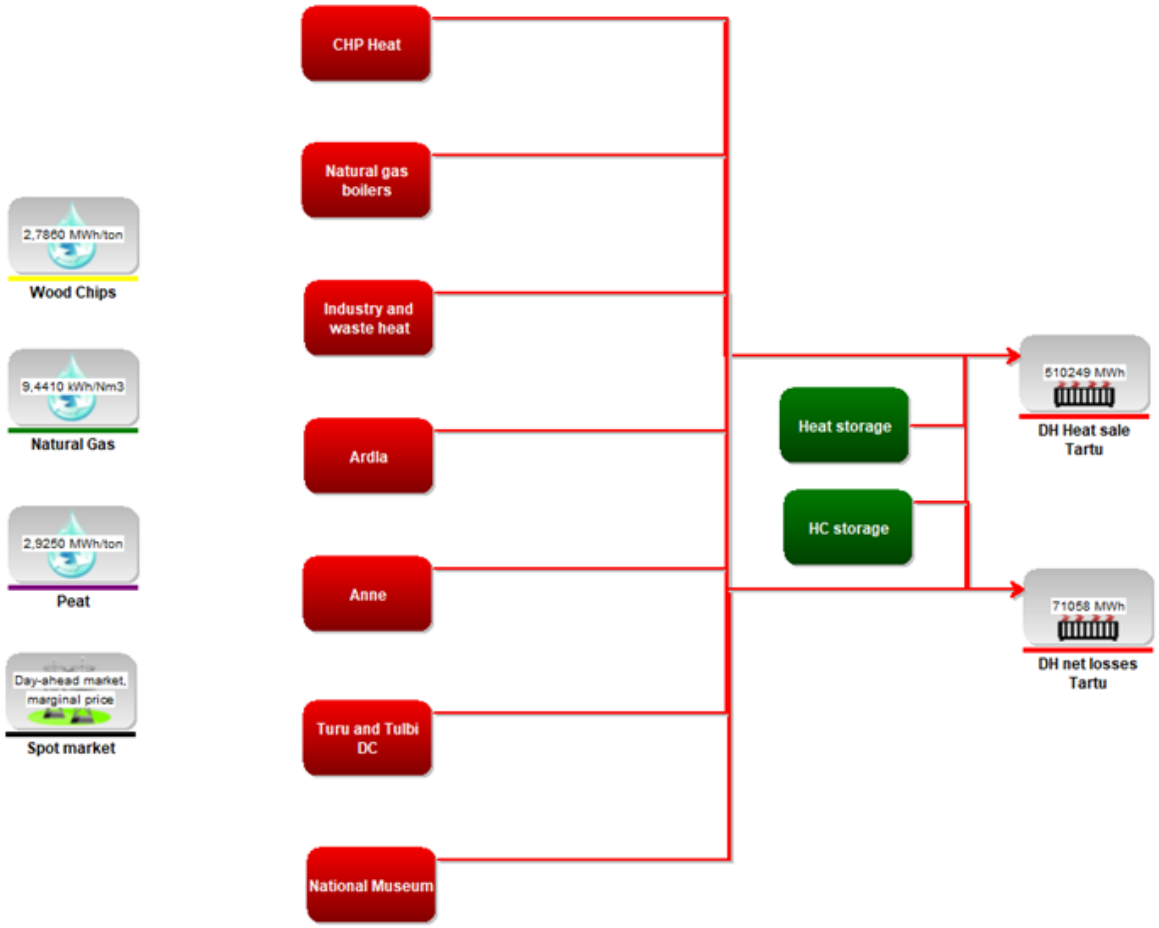
1. Conversion from gas
2. Conversion from other fuels
3. New buildings
4. City expansion

Project description

Strategic Feasibility study to enhance the design of the large-scale district energy power, cooling and heating system for future demand.

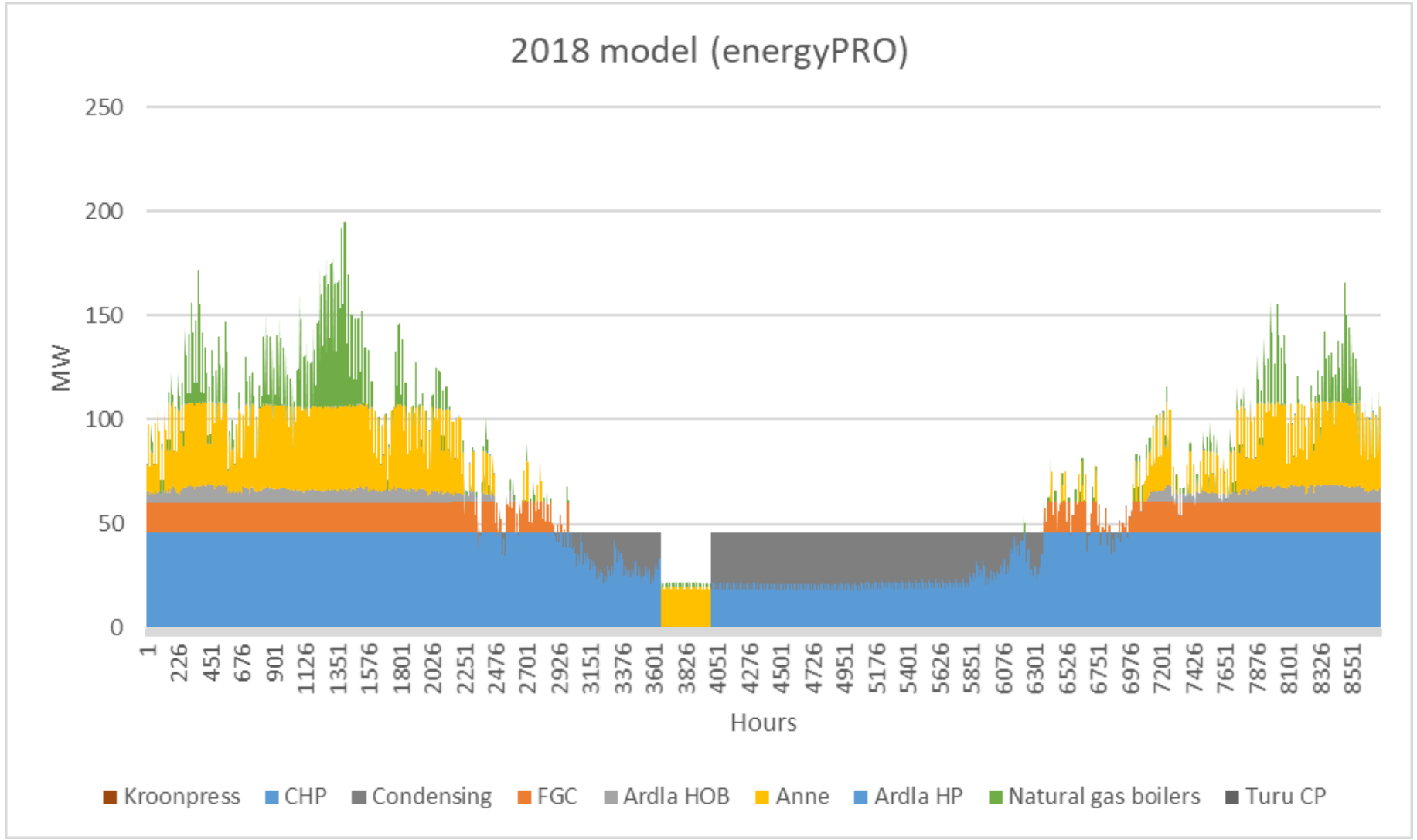
Optimizing the utilization of biomass and waste energy sources to improve profitability and lower emission using state-of-the-art modeling software solutions for hydraulic analysis as well as energy and cost-benefit modeling, energy technology including thermal energy storage.

Production facility, Tartu



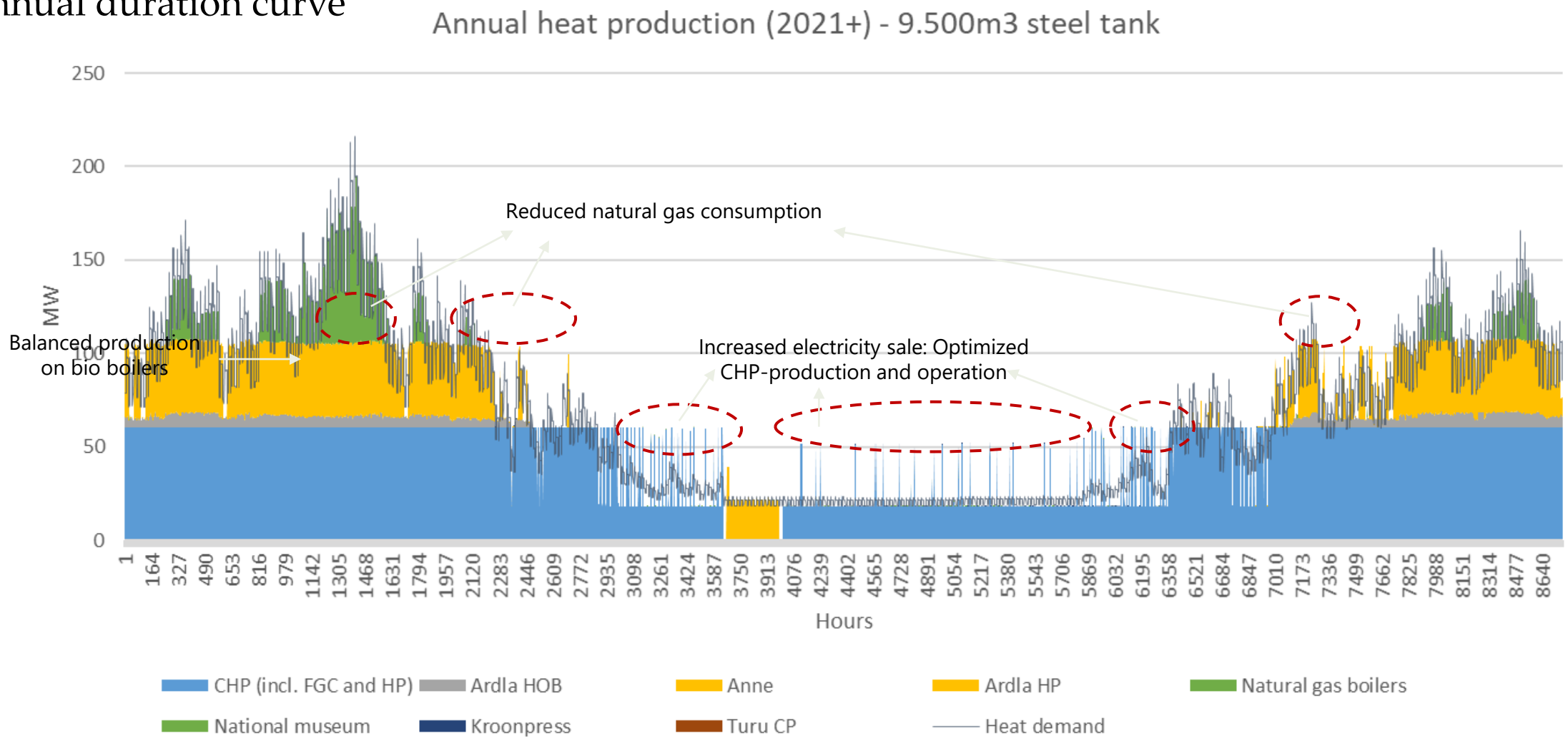
Tartu: Production fuels and peak loads

Annual duration curve



Tartu: Production fuels and peak loads (explained)

Annual duration curve



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HEAD OF DEPARTMENT

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Realising your sustainable potential
NIRAS Energy
Thank you for your attention!
NIRAS