Decarbonisation thru low temperature grids

Presented by

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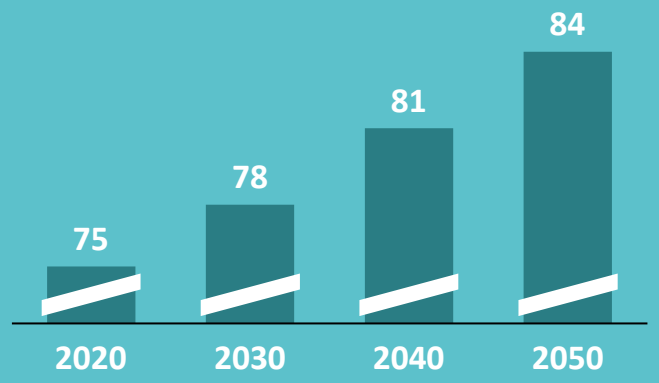
Urbanization has become a major cause of pollution with cities responsible for over 70% of greenhouse gases

Cities and communities are growing

Proportion of European citizens in urban areas (%)

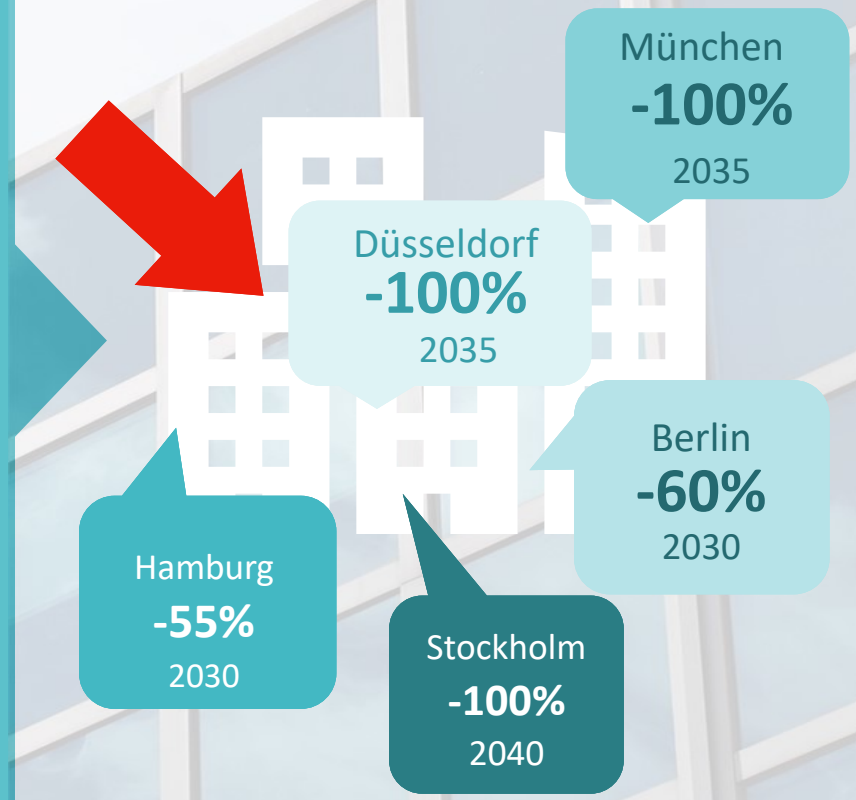


Today over 75% of the worlds population lives in cities.

All city dwellers need energy for transport, light, heating and cooling, generated by combustion.

Source: UN World Urbanization Prospects

Sustainability on top of municipal agendas



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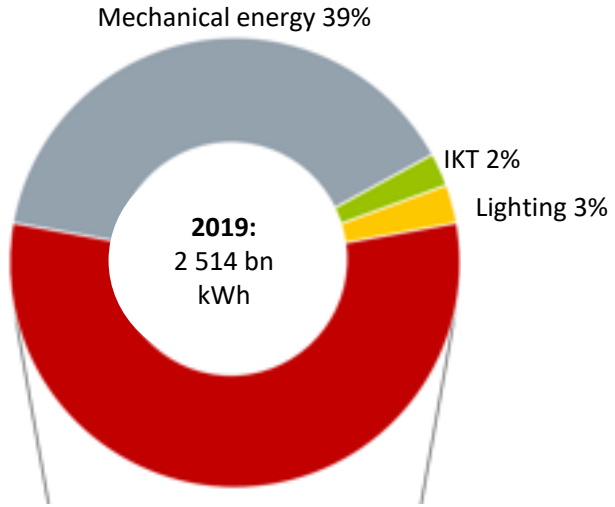
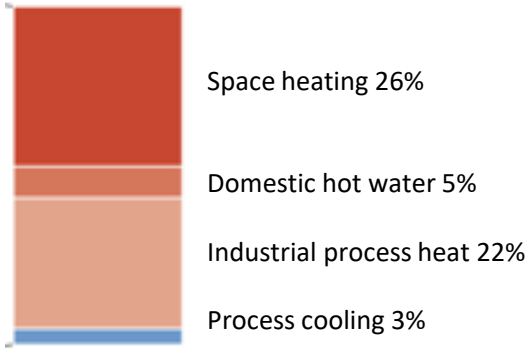
German energy consumption 2019



Heat/chill in total 56%=1399 bn kWh

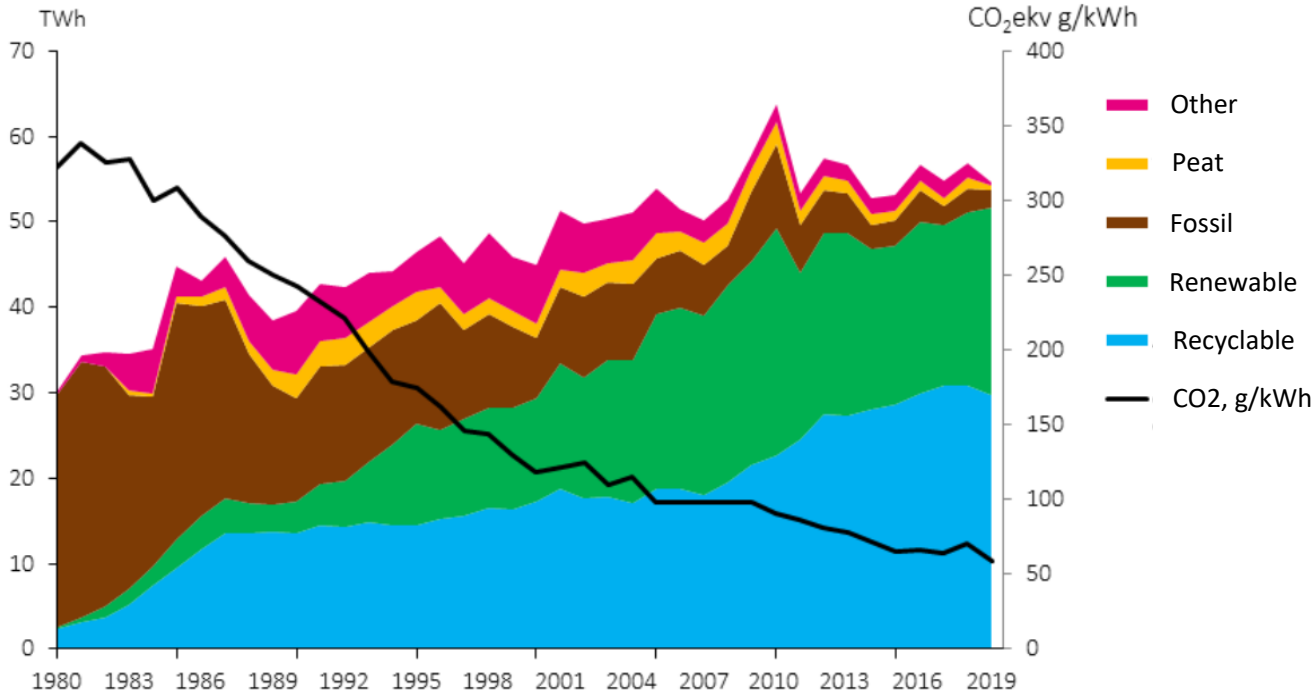


Development of district heating and carbon footprint

Low-temp grids

1st generation steam	2nd generation on-site construction	3rd generation off-site
Steam system, steam pipes in concrete ducts	Pressurized hot water system large on-site plant	Pre-insulated pipes off-site plant metering and monitoring
Temperature >200°C	>100°C	80-100°C
Efficiency		
Typical heat sources • Coal • Steam storage	**Typical heat sources** • Heat storage • CHP coal	**Typical heat sources** • Gas and biomass • Industrial waste heat • Waste incineration • CHP
1880-1930	**1930-1970**	**1970-**

Energy input for production of district heating Sweden 1980-2019



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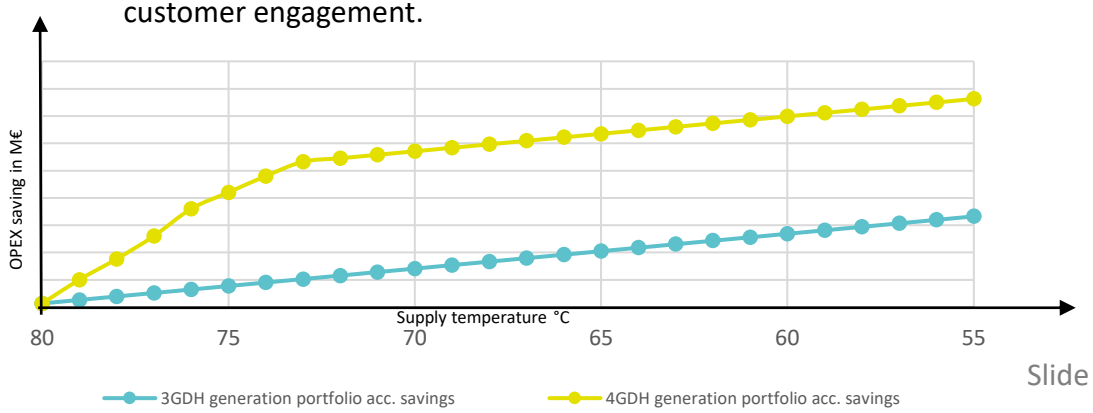
Low temp grids makes decarbonised heat competitive

- **Offer lower operational costs for producing & distributing heat**
  - Ability to utilize renewable and recycled heat from low-temperature sources including small scale prosumers.
  - Reduce the need for top up of competitive low temp sources and reduced heat losses in distribution.
- **Reduced environmental impact**
  - Recycled heat contributes to little or no environmental foot print.
  - Less combustion, less CO_2 and ideal circumstances for heat pumps.
- **Increased security of supply and customer engagement**
  - Decentralised and diversified production portfolio offers resilience.
  - Tailor-made and digitalised customer solutions including prosumption increases customer engagement.



How to prepare for low temp grids

- **Prepare customers for low temp**
  - Identify customers real heat requirement, consumption patterns and customer experience.
  - Improve existing building stock energy performance and domestic hot water requirements.

- **Smart grids to enable heat sources of tomorrow**
  - Grids to distribute large- & small scale heat- & chill production from prosumers and energy storages.
  - Online monitoring and grid optimization to cut peak load & temperatures.

- **Recycable heat is fundamental in future heat mix**
  - Invent and explore all local low temp and intermittent large scale heat sources.
  - Heterogenic generation mix of various temperatures, size, source and location.

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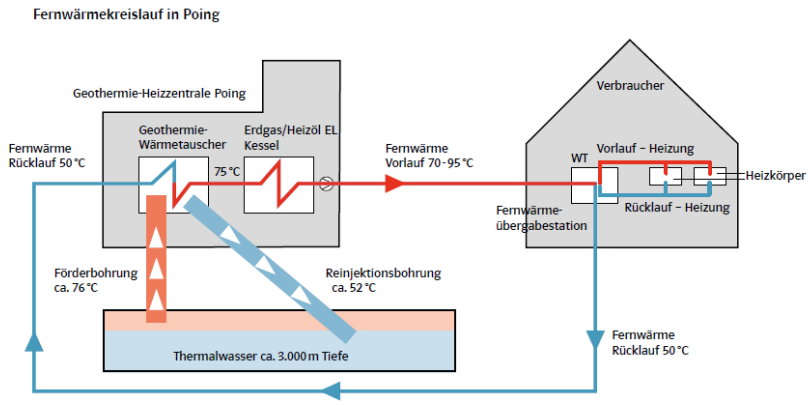
Optimisation of the return flow temperature for a geothermal solution

Background

Since September 2012 the district heating supply in Poing has been based on **geothermal energy**. The thermal water is fed via an underground pipeline from the production well at the western end of the town to the geothermal heating center (former CHP unit). There it transfers its heat in heat exchangers to the **district heating circuit**. The cooled thermal water is then returned to the re-injection well.



Project Description

The geothermal share of the annual heat generation should be kept as high as possible. The geothermal borehole is around 3 km deep. The potential heat capacity of the borehole is around 15 MW. **The idea is reduce use of the gas boilers as much as possible.**

For this reason, the heating curve of the district heating network of Bayernwerk was lowered, the supply temperature is approx. 76 °C . This is done with different actions.

One point was the connection of a whole new quarter with **reduced inlet temperature** and the supply of one building with **the return flow**. Another point was the **optimization of the heat substation** and secondary system of houses, which had too high return flow temperature.

A idea in the future is to integrate a **large scale heat pump** for an additional reduction of the return flow for an improvement of the geothermal boreholes.

Result

- At a pumping rate of around 100 liters per second, a geothermal output of up to 10 MW can be extracted. This corresponds to a theoretically recoverable heat quantity of about 80,000 MWh/a.

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Heat in the pulp & paper industry

Presented by

Małgosia Rybak, Climate Change & Energy Director, Cepi

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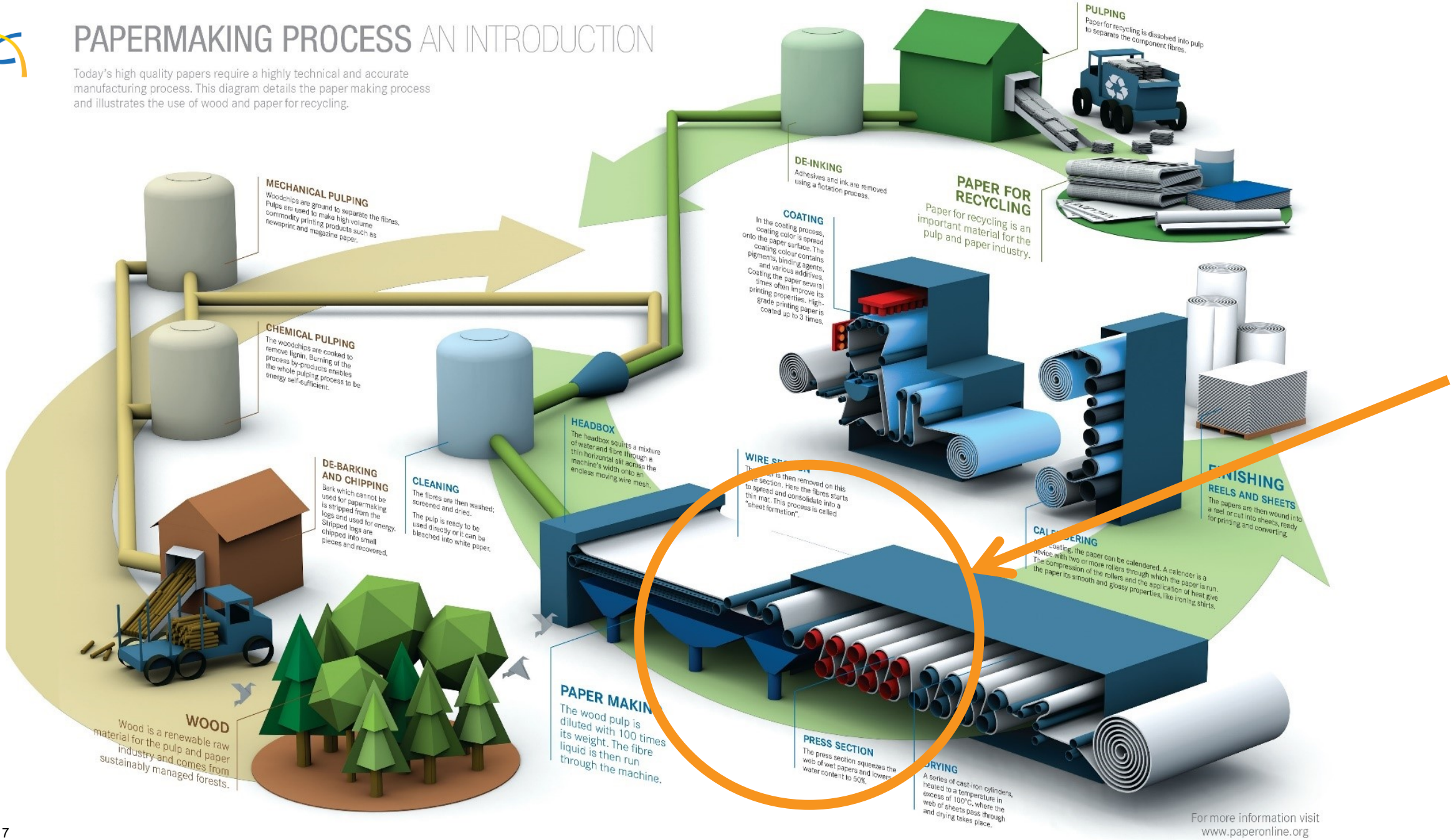
PAPERMAKING PROCESS AN INTRODUCTION

Today's high quality papers require a highly technical and accurate manufacturing process. This diagram details the paper making process and illustrates the use of wood and paper for recycling.



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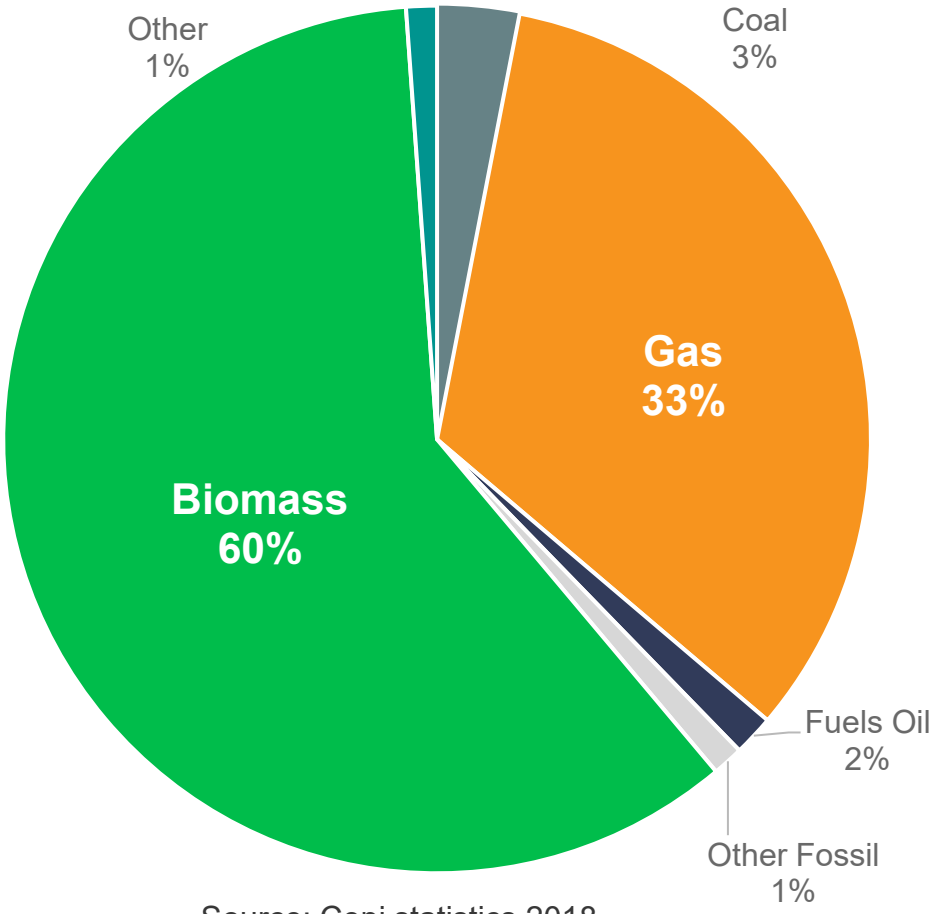
Energy mix in the pulp and paper industry

Combustion of fuels



Source: Cepi statistics 2018

Total: 319 TWh

269 TWh for steam production

50 TWh for electricity production

45 TWh net bought electricity

Around **70%** of the energy needs in pulp and papermaking is used to generate **heat** for drying processes

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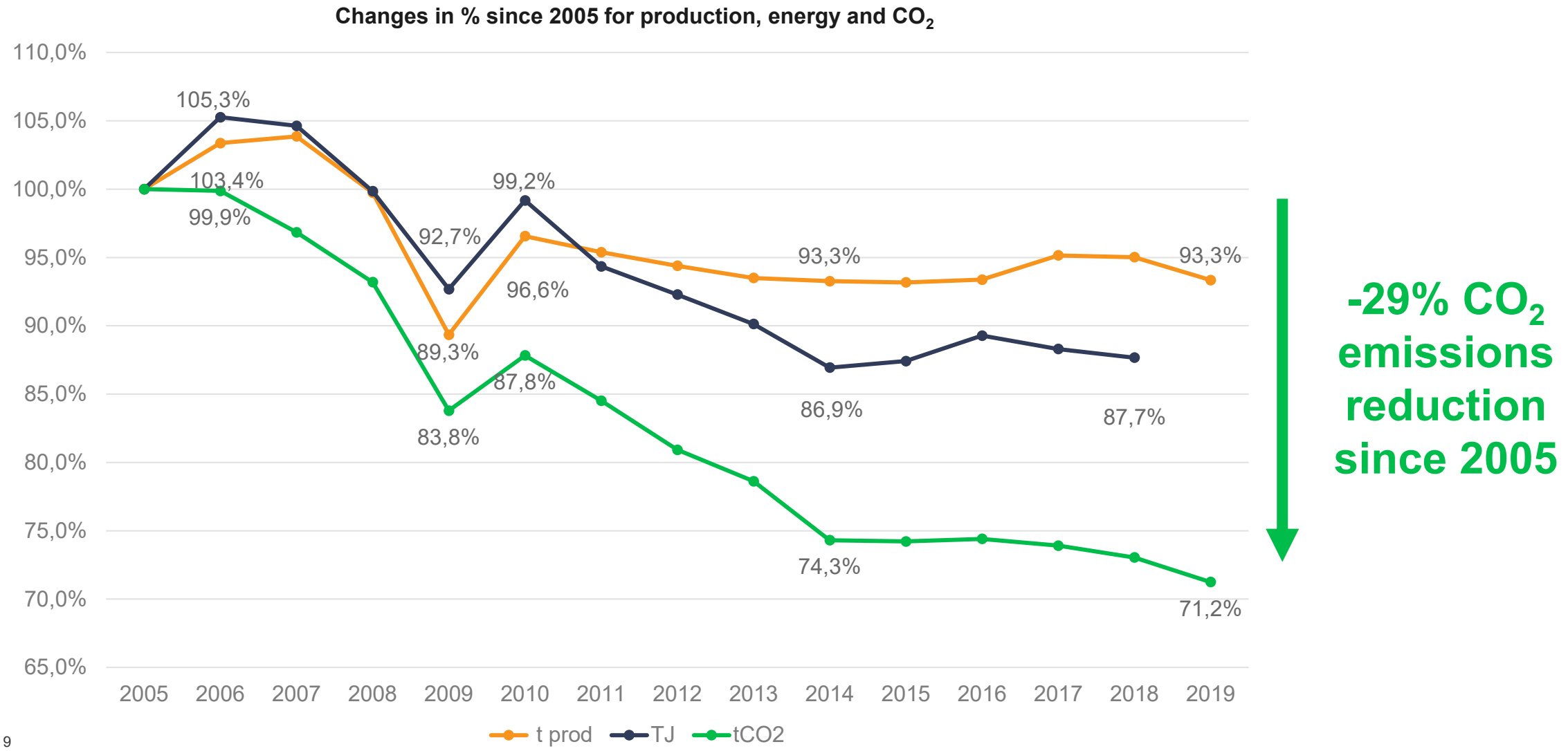
Decoupling economic growth from carbon emissions



-29% CO_2 emissions reduction since 2005

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Many relevant technological innovations are emerging

and the industry invests in technologies for the CO_2 emission reduction

Improve energy efficiency (use less heat to produce paper)

Switch to renewable energy

Prevent waste heat

Internal reuse of heat

External use of heat

Slide provided by Cepi

New CHP in a paper mill in Italy

- **Technology**: Gas turbine cogeneration system
- **Description**: Replacing a gas turbine (7 MW electric), a boiler and a diathermic oil boiler with a new gas turbine cogeneration system
- **Emissions savings**:
  - Gas consumption and CO_2 emissions reduced by about 3,350 tonnes
  - The turbine could be powered in the future by a mix of methane and green hydrogen. Using 50% hydrogen, the CO_2 emissions reduction would reach 30,000 tonnes/year
- **Investment**: €7.3 million

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Solar thermal integration project in France

- **Technology**: Solar thermal
- **Description**: Building France's largest solar thermal installation producing heat, supplying the paper mill with hot water for its paper production process
- **Emissions savings**:
  - Reduce the consumption of fossil energy (about 3,900 MWh/ year of renewable heat produced)
  - Decrease of fossil use in steam boilers (equivalent to a reduction of CO_2 emissions of 1,000 t/year)
  - Improve steam management at the paper mill thanks to higher flexibility of steam production facilities
- **Investment**: €2.2 million

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Innovation for reducing waste heat

- Main sources of waste heat in the paper industry: dryer exhaust, effluent water
- Projects are focused on the development of innovative drying technologies that allow efficient heat recovery
- Technologies such as mechanical vapour recompression and other kinds of heat pumps may realise a significant reduction of energy required for steam production
- The integration of these technologies in the paper industry requires a complex individual case-dependent redesign of the production process and its energy supply

The regulatory framework needs to promote, re-risk, support and reward investments in energy efficiency

Slide provided by Cepi

Waste heat recovery in Poland

- **Technology:** Evaporator plant
- **Description:** The concept was to reduce steam consumption in the evaporation process. More water was removed at the evaporator stage. In addition, a reduced feed of water mixed with fuel into the recovery boiler increases heat generation from carbon-neutral fuel (black liquor)
- **Emissions savings:**
  - Use less heat in the evaporation process – about 300,000 GJ/year
  - Additional thermal green energy from the recovery boiler – about 190,000 GJ/year
  - Reduce coal consumption by 25,000 tonnes a year
- **Investment**: €6.5 million

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Heated water pipeline in Belgium

- **Technology:** Heated water pipeline

- **Description:**
  - A paper mill opened a pipeline with a car plant in Ghent, Belgium.
  - The pipeline takes hot water heated using renewable energy from biomass at the paper mill to the other manufacturing plant, where it is used to heat buildings and paint booths

- **Emissions savings**: emission reductions estimated at 15,000 t/y, cutting the Ghent plant's total CO_2 emissions by more than 40%

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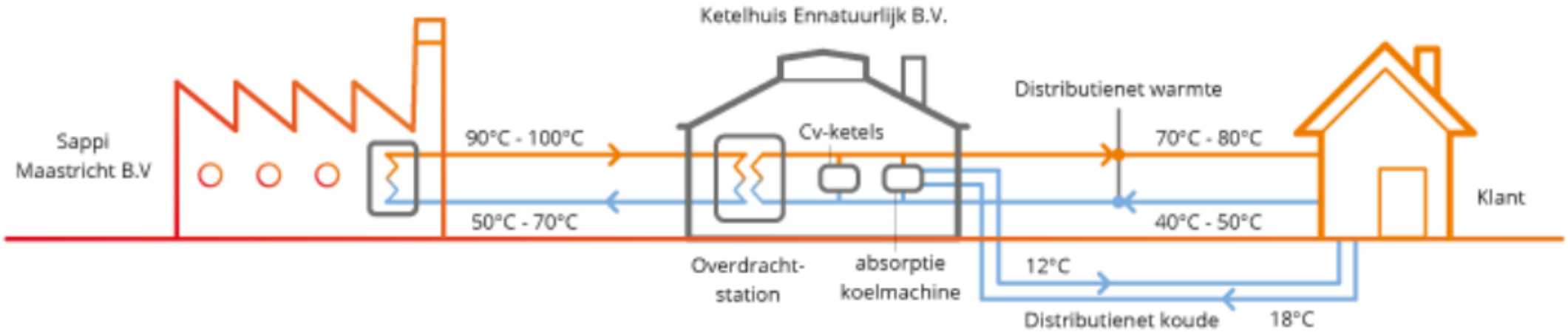
A paper mill heats a Dutch city

- A paper mill uses a Combined Heat and Power (CHP) plant in the Netherlands
- The mill delivers waste heat to several building complexes in the city of Maastricht
- Residual heat is used as a source of energy for heating and cooling of these buildings



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Decisions depend on a variety of factors

Availability, size and lay-out of energy conversion onsite	Energy infrastructure	Age of the equipment	Legislation, regulation and targets
Technologies available and under development	Regional support schemes	Location of the mills	Regional initiatives

Local cooperation and an integral systems approach are needed to design and achieve the most sustainable solutions

Slide provided by Cepi

Waste-to-Energy contributions in heating and cooling systems

Presented by

Fabio Poretti, Technical & Scientific Officer, CEWEP

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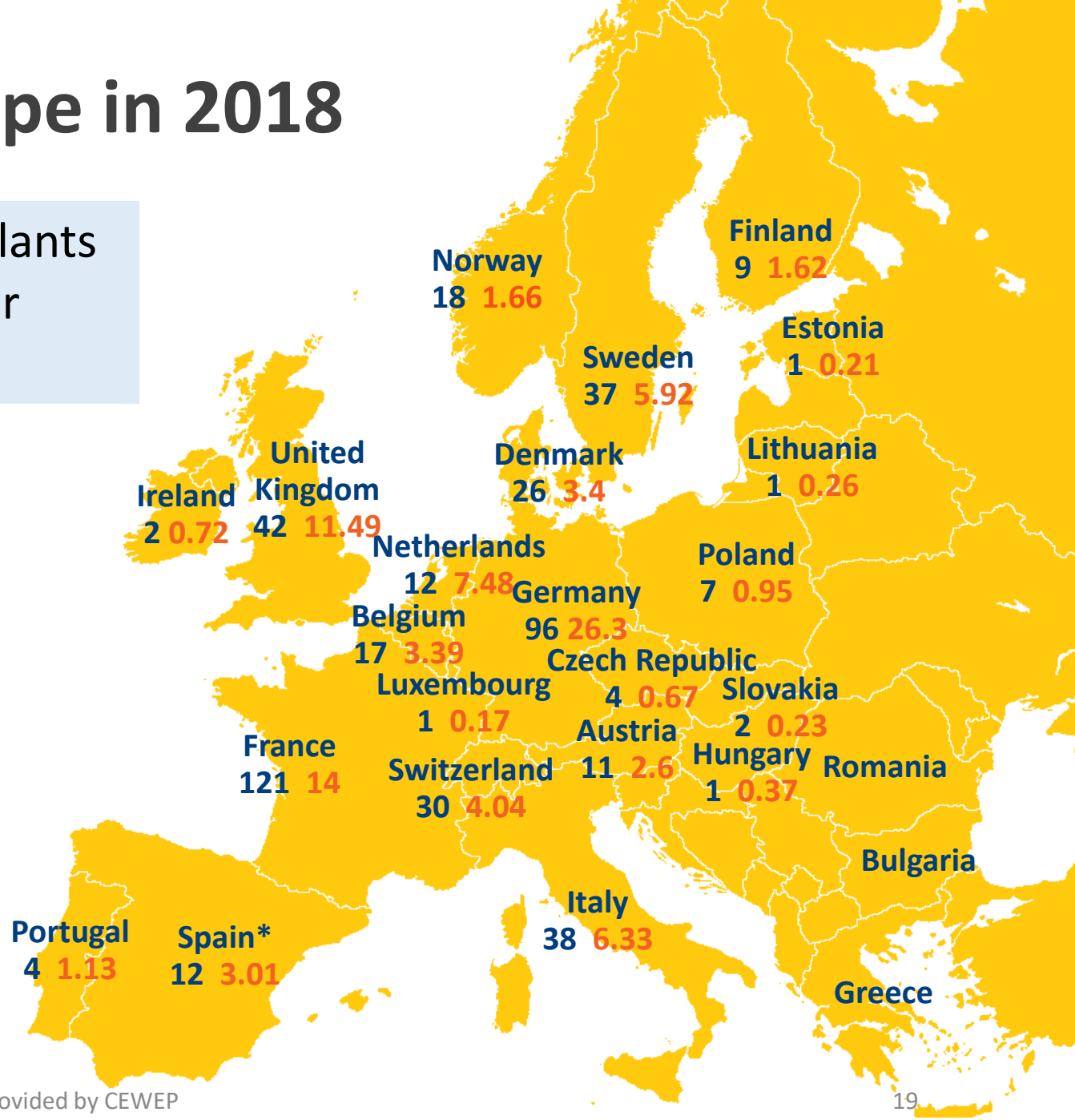
Waste-to-Energy in Europe in 2018

Waste-to-Energy (**WtE**): waste incineration plants with energy recovery of municipal and similar commercial and industrial waste

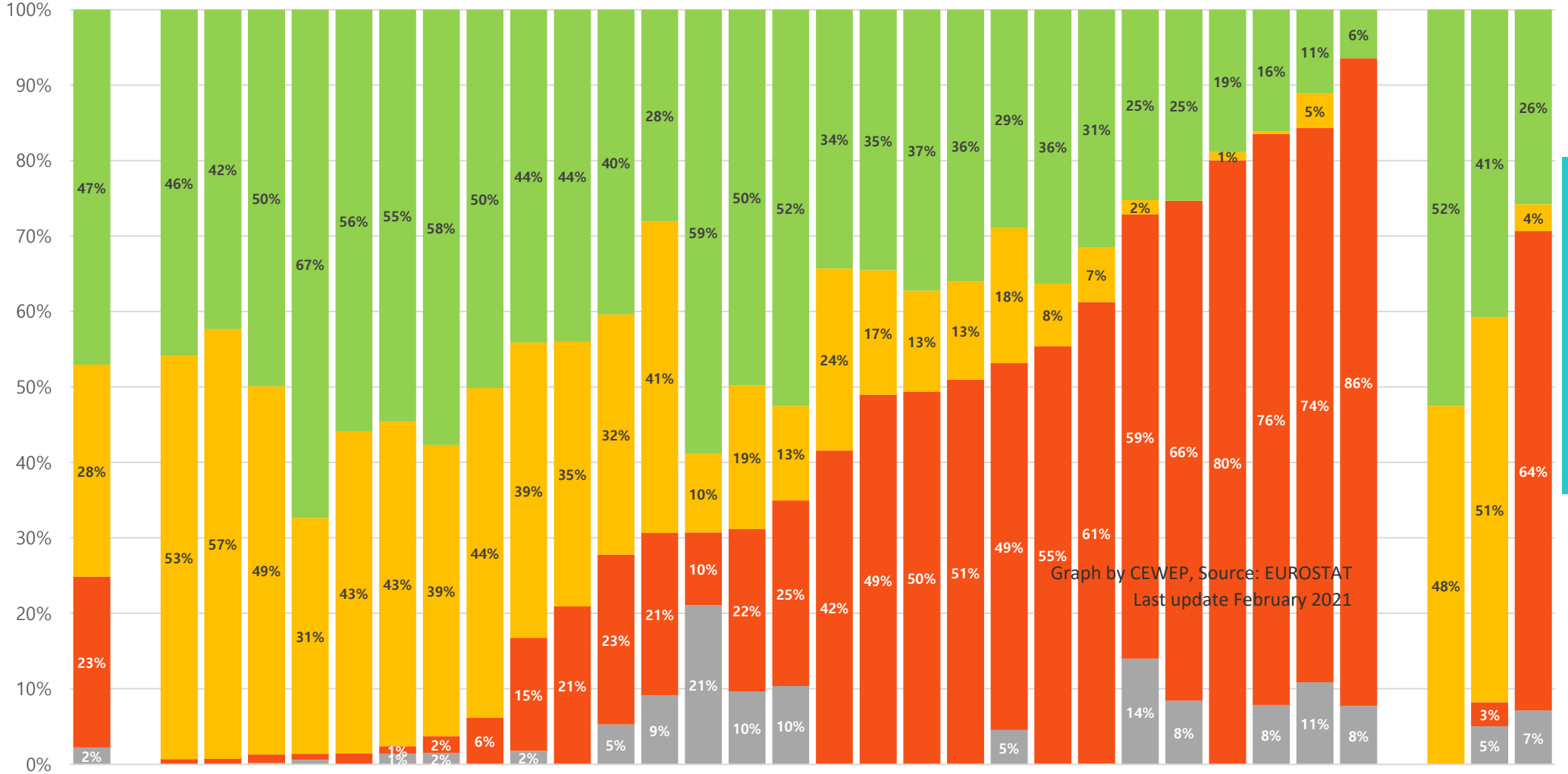
- WtE Plants operating in Europe (not including hazardous waste incineration plants) : **492**
- **Residual, no-recyclable** waste thermally treated in European WtE plants (in million tonnes): **96**



Data supplied by CEWEP members and national sources

*** Includes plant in Andorra and SAICA plant**

Municipal waste treatment in 2018



Percentages are calculated based on the municipal waste reported as generated in the country

*: 2017 data (last available)

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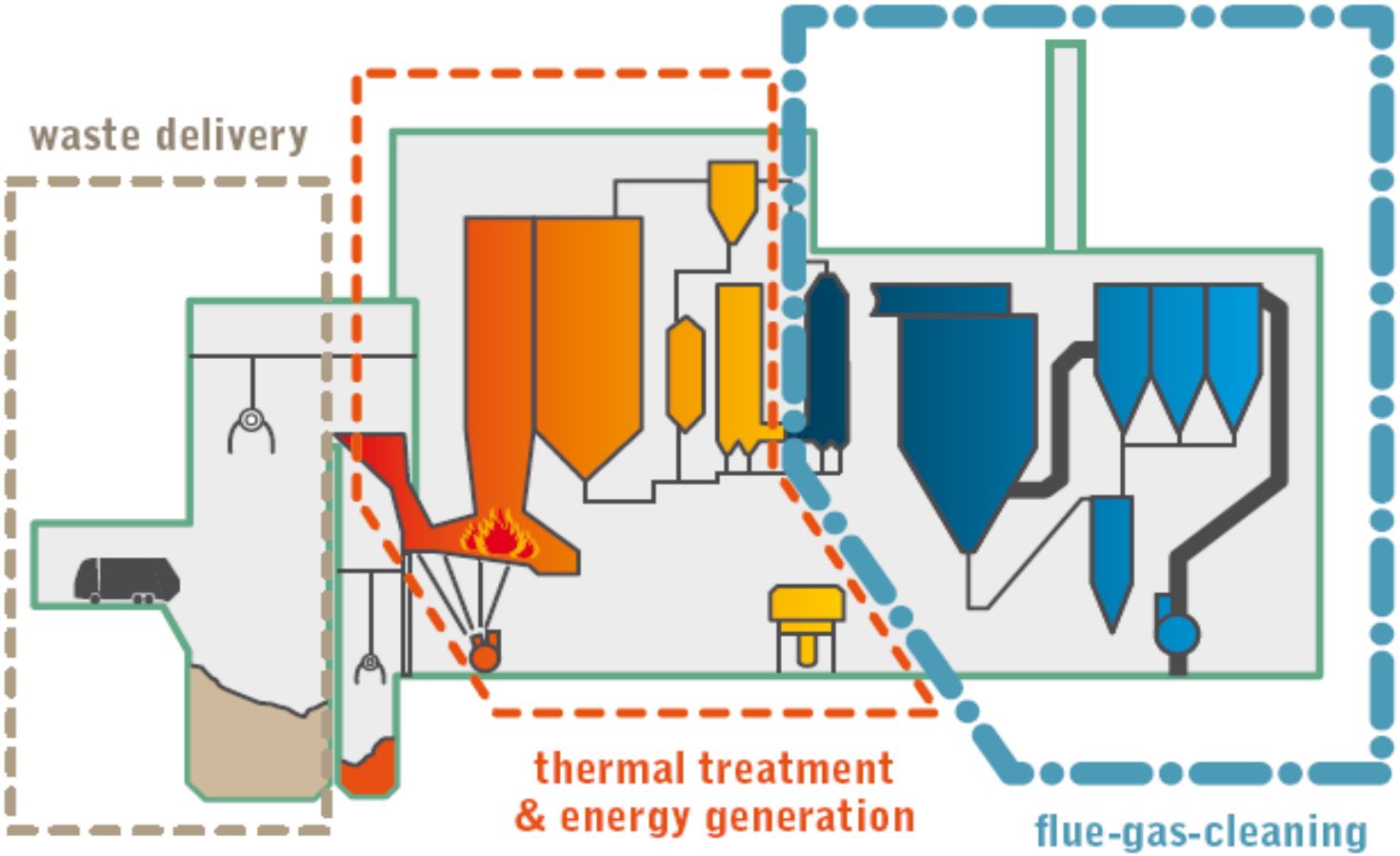
How does a Waste-to-Energy plant work?



- WtE is one of the **most strictly-regulated industrial sectors**
- very strict existing legal requirements on emission limits, monitoring and energy performances.

WtE turns non-recyclable waste in an environmentally safe way into secure, local, and sustainable energy.

Slide provided by CEWEP

Waste-to-Energy has a double role: **Sustainable waste management** and **Energy&Climate**

- Primary task: WtE provides a hygienic service
- As byproducts WtE:

1) **Substitutes fossil fuels and reduce their dependence on imports:**

Between **11 and 53 million tonnes of fossil fuels** (gas, oil, hard coal and lignite) can be substituted annually, which would emit **26 - 52 million tonnes of CO2**

2) **Helps to divert waste from landfills and saves methane emissions**
→ methane is much more potent than CO2

3) **Recovers valuable raw materials from bottom ash** (metals and inerts)
→ Circular Economy and further $CO2_{eq}$ savings

Slide provided by CEWEP

What about air quality?

Multiple studies have found **no evidence of a negative impact** of WtE on health or the environment

- Connecting the WtE plant to a District Heating network in urban areas…

City of Umeå, Sweden in 1960s and 2000s

Waste-to-Energy as an effective CHP and renewable Heating&Cooling technology

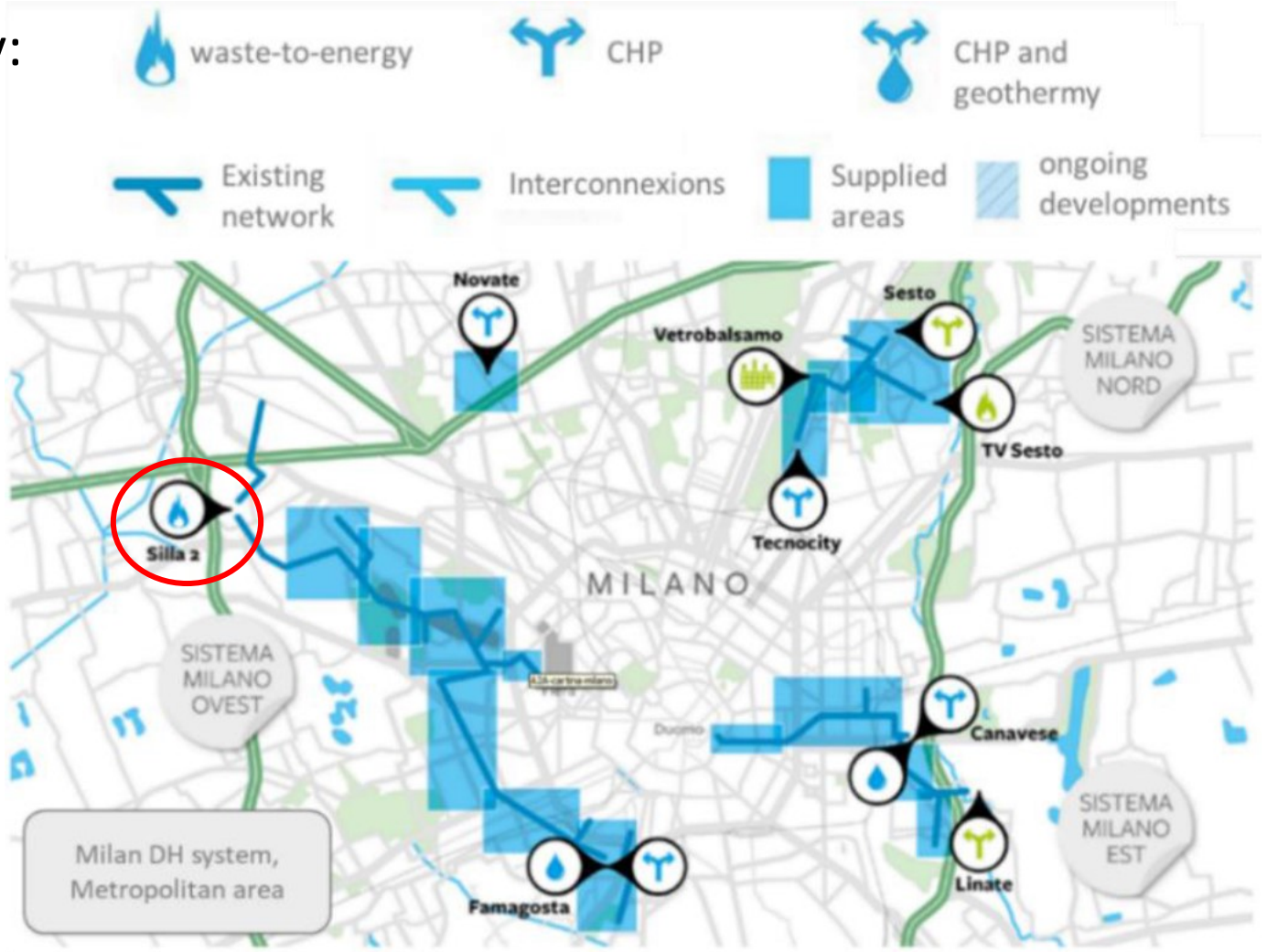
- **2/3 of Europe's WtE plants are Combined Heat & Power** (CHP) producers.
- **10%** of Europe's energy to **District Heating** comes from WtE;
  → On a local level WtE supplies sometimes more than 50% of the heat demand
  (EU average is much lower as not all Member States have WtE plants)
- WtE can rely on **programmability and flexibility** of energy production,
  delivering energy vectors through various forms (electricity, heat, steam)
  + many other possibilities of sector coupling and industrial symbiosis.
- Waste is a very heterogeneous type of fuel but, on average, around **55% of the energy produced by a WtE facility is renewable** (biodegradable/organic fraction of residual waste)
- Recent **Report** by the **European Commission – JRC** (2021):
  Integrating renewable and waste heat and cold sources into district heating and cooling systems *- Case studies analysis, replicable key success factors and potential policy implications*

Some WtE Success Stories from JRC Report – MILANO

- Overall heat requirement of the City: around **12,000 GWh/year**

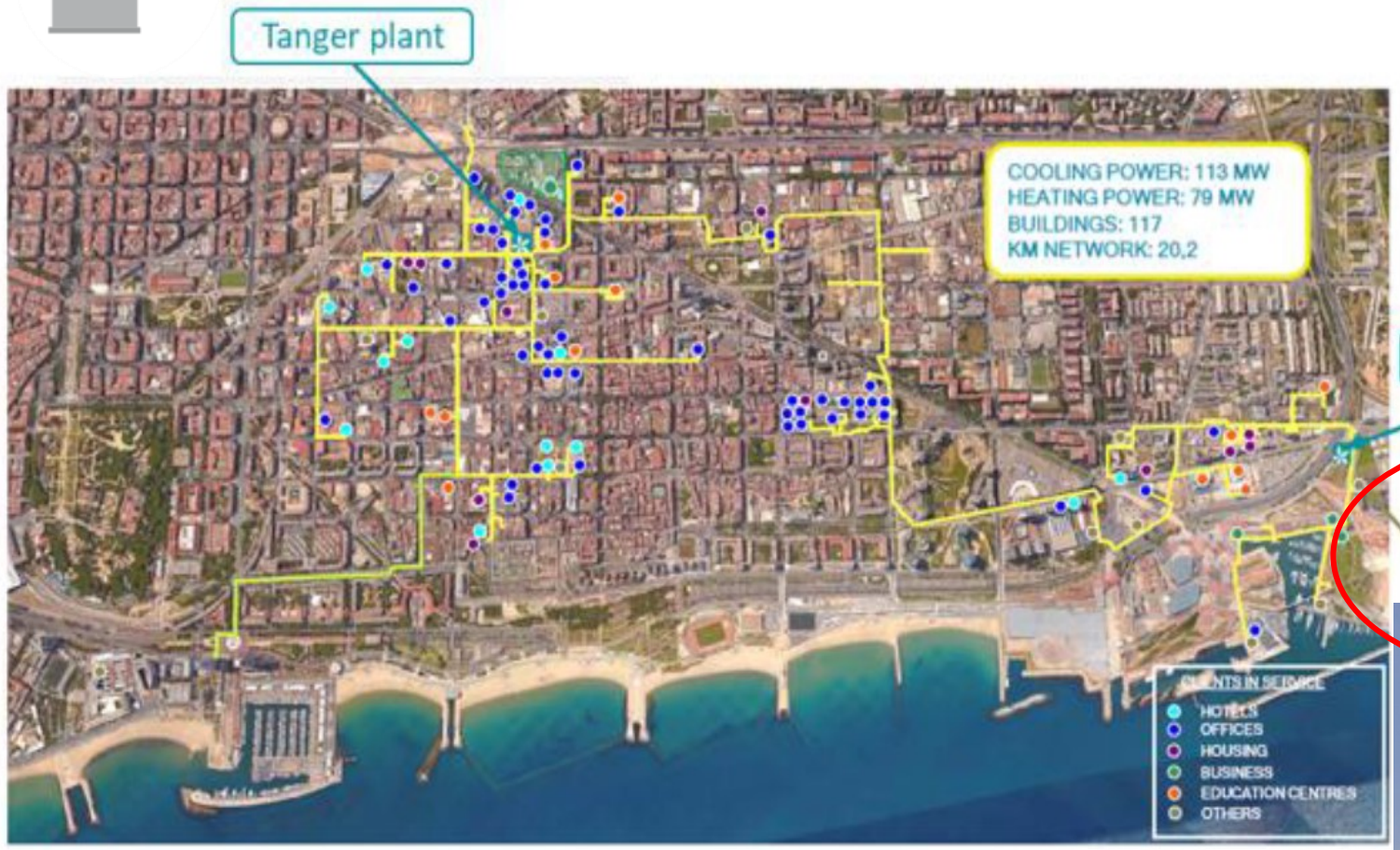
→ about 10% covered by DH.

The plant produces **375 GWh of heat** and **345 GWh of electricity** per year from **540'000 t** of residual waste.



Milan district heating network (source: A2A)

Some WtE Success Stories from JRC Report – BARCELONA



Map of Districlima DHC system, and type of connected buildings (source: Districlima)

Tersa WtE plant:
4 steam/water exchangers of 5 MW each

The main demand of **Districlima DHC** system is cooling.

The WtE plant produces **195 GWh of electricity** and **125'000 t of steam** per year from **350'000 t** of residual waste for heating and cooling.

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A Local WtE Success Story – BRUXELLES

District heating capacity **20 GW_{th}**

Water Temperature: 110°C
Heating line: 6km of piping

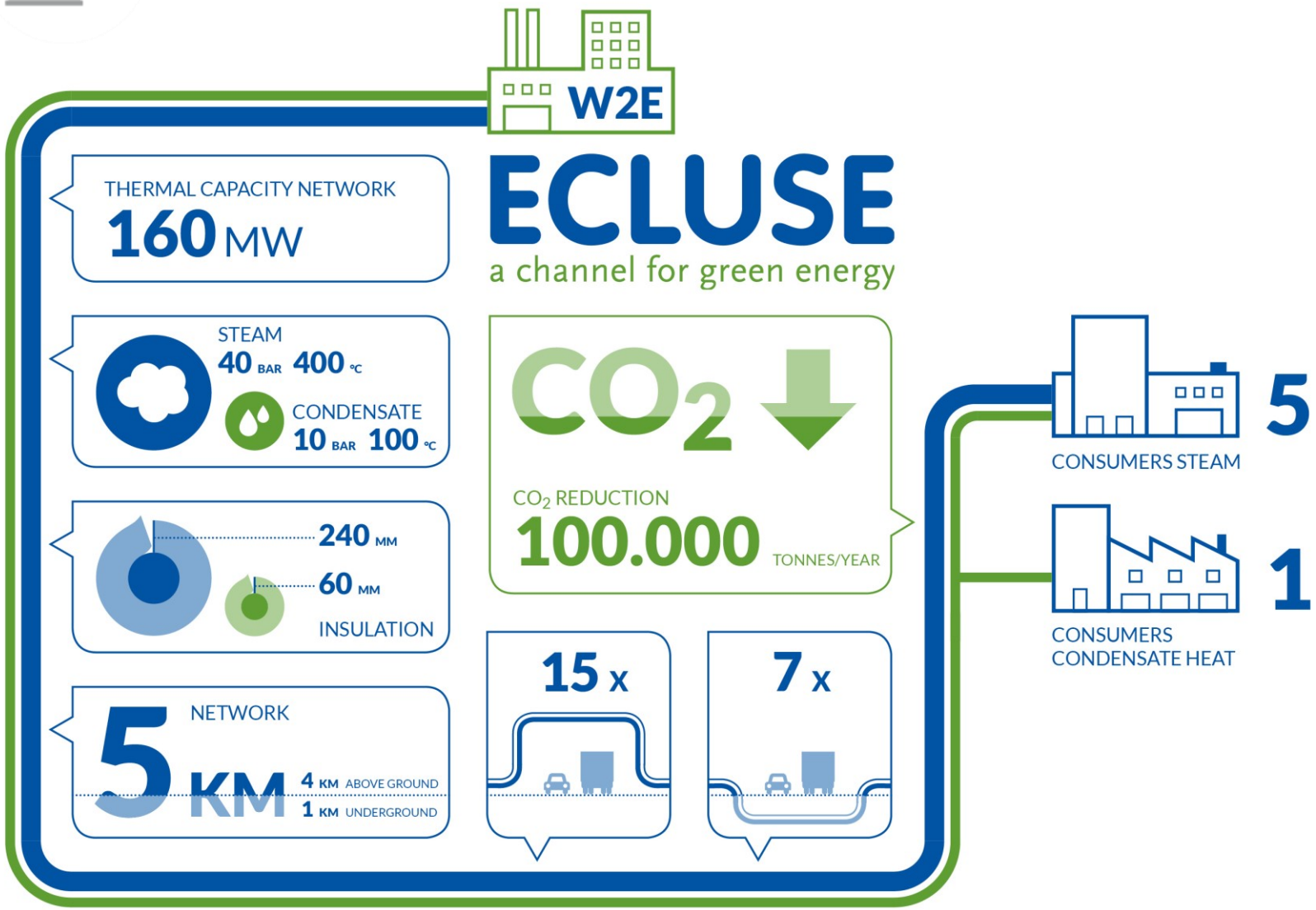
Brussels Energie WtE Plant

Heat Supply to **DOCKS Shopping Center** + Connection with the **greenhouses of the Royal Domain**

Un nouveau système de chauffage pour les serres de Laeken

Video Link

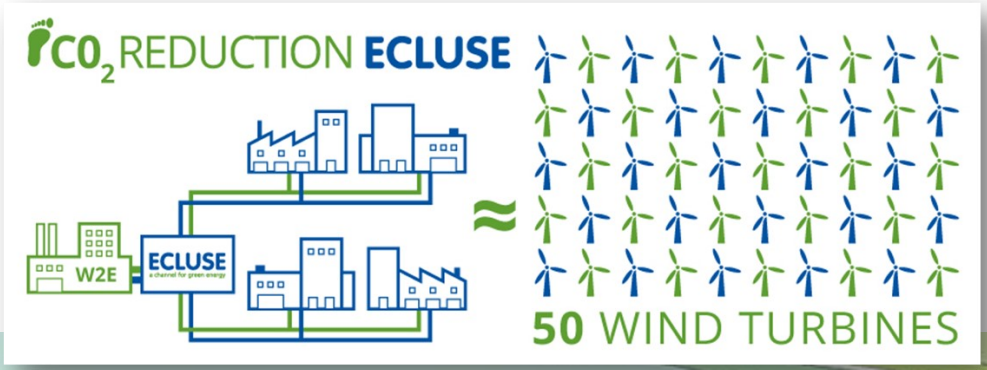
Belgium: Industrial symbiosis in the port of Antwerp

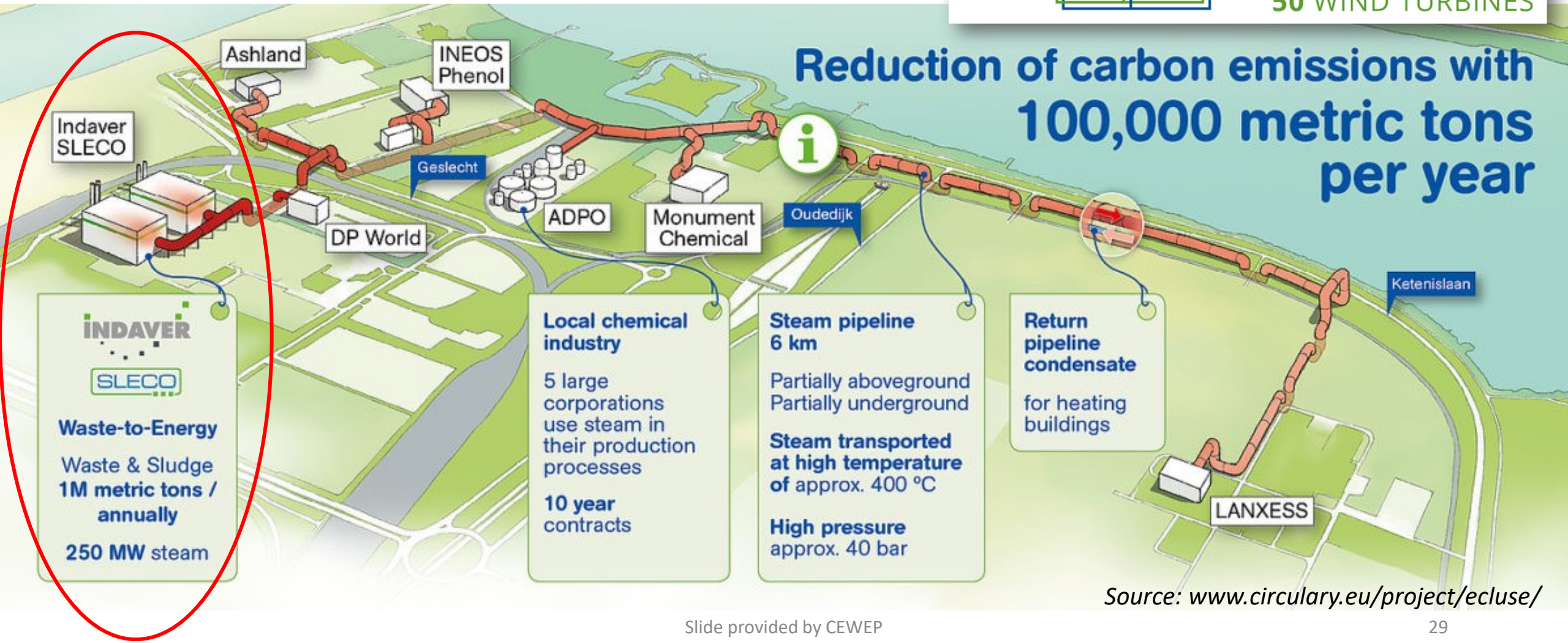


- **Energy cluster: steam from Waste-to-Energy to chemical companies**
- Sustainable and reliable energy supply for industry
- Important pillar in energy and competitiveness policy of the Flemish government

Source: www.ecluse.be

Belgium: Industrial symbiosis in the port of Antwerp





Source: www.circulary.eu/project/ecluse/

WtE: other examples of innovative sustainable energy use

- **Twence Waste-to-Energy plant** in the Netherlands captures CO_2 and transforms it into sodium bicarbonate $NaHCO_3$. It is used in the plant's flue gas cleaning system, saving precious raw materials while reducing its carbon emissions.

- **AVR plant in the Netherlands** captures CO2 and supplies it to the local greenhouses.
- **SUEZ Waste-to-Energy plant in Toulouse**, France, provides heating for nearby greenhouses growing 6,000 tonnes of tomatoes each year.

- In **Linköping, Sweden, Waste-to-Energy produces cooling** for the district cooling network.

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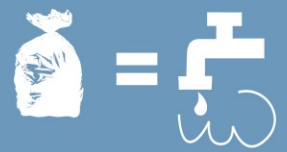
Back-up slide

WASTE-TO-ENERGY IN DAILY LIFE

With 10 kg of residual waste

you can shower
7 times
5 minutes each



With 10 kg of residual waste

you can power your laptop
for 3 hours per day
for 2 months

With 10 kg of residual waste

enough heat can be
produced to warm your
home for at least 8 hours

Slide provided by CEWEP