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Waste heat and cold: what can be counted under Article 14?

Lyons, L., Carlsson, J.

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JRC contribution

JRC is supporting ENER in the implementation of the recast Renewable Energy Directive and the Energy Efficiency Directive by preparing guidance documents on accounting for:

- **waste heat and cold**
- renewable cooling (helping supervise external study)
- efficient district heating and cooling
- renewable heating and cooling

RED and EED

Both RED and EED incentivise use of waste heat and cold

Waste heat or cold that is used *on* site plays an important role in achieving the objectives of the EED

Only heat or cold that is used *off* site counts towards Article 14 Comprehensive Assessments and RED Arts. 23 and 24 targets

Both Directives aim to respect the Energy Efficiency First principle by reining in both supply and demand

EED Assessments

Art. 14 focused originally on high-efficiency cogeneration and efficient DHC but RED Art. 15(7) made waste heat and cold a mandatory element (along with other renewable heat and cold)

Assessments must be updated every five years

EED definition of waste heat and cold

EED mentions waste heat and cold several times (Arts. 2, 7 and 14) but gives no clear definition

Mentions waste heat from power generation, which could be recovered through cogeneration, and waste heat from industry

“Useful temperature level of waste heat” and “useful waste heat” are also used but without additional explanation

RED definition of waste heat and cold

Waste heat and cold is "***unavoidable*** *heat or cold generated as* ***by-product*** *in industrial or power generation installations, or in the tertiary sector, which would be* ***dissipated*** *unused in air or water without access to a* ***district heating or cooling*** *system, where a* ***cogeneration*** *process has been used or will be used or where cogeneration is not feasible“*

- Article 2(9), recast RED

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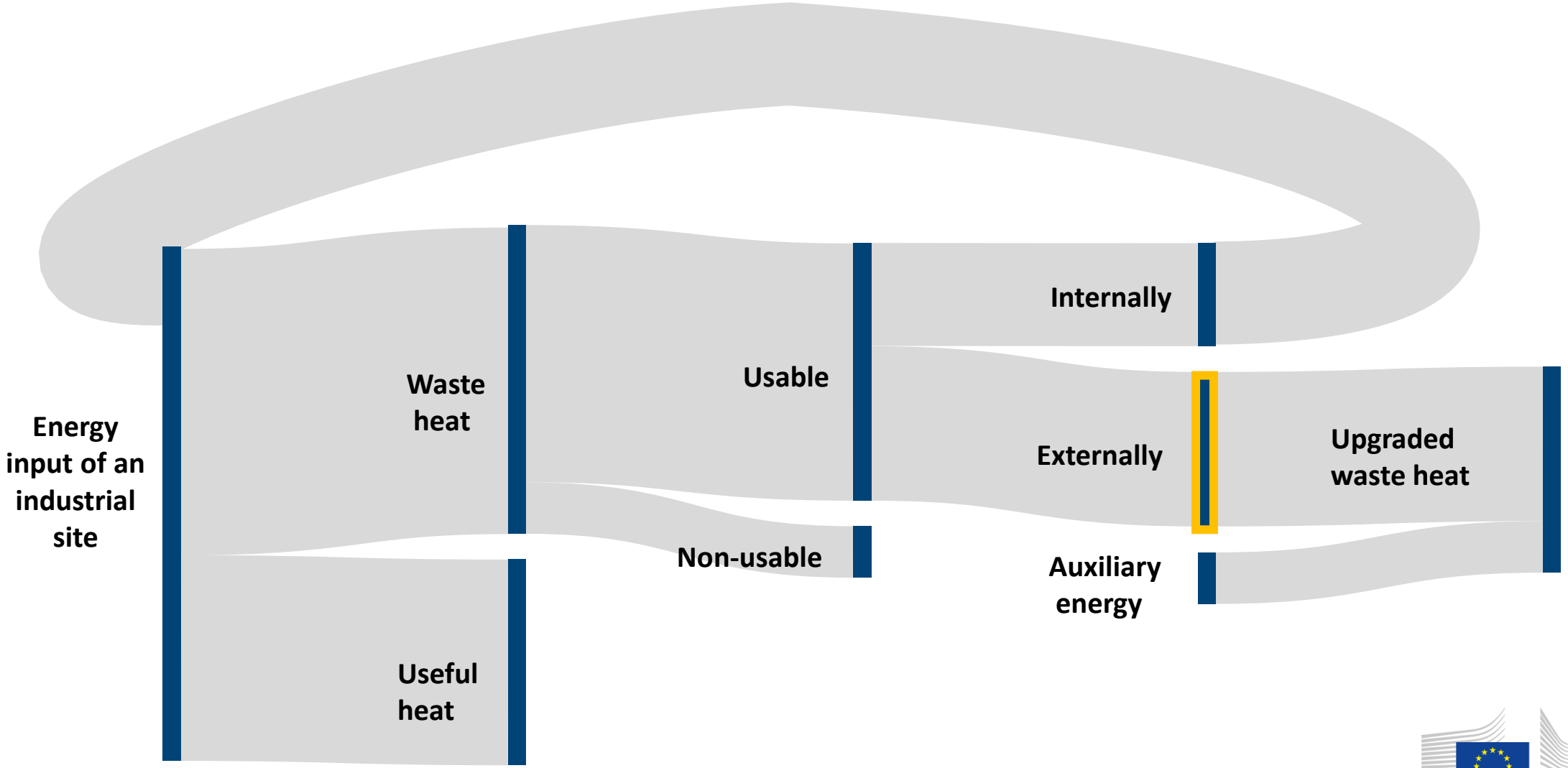
Energy process lifecycle under RED



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Eligibility of waste heat and cold for Assessments (and RED sectoral targets)

Sector		By-product		Energy efficiency		Use
Power generation	+	Waste	+	Unavoidable waste	+	Sale to a DHC network
Cogeneration						
WtE						
Industry		Intended production		Avoidable waste		On-site use
						Industrial symbiosis
Services						Any off-site use other than DHC
Residential						

What sources are out?

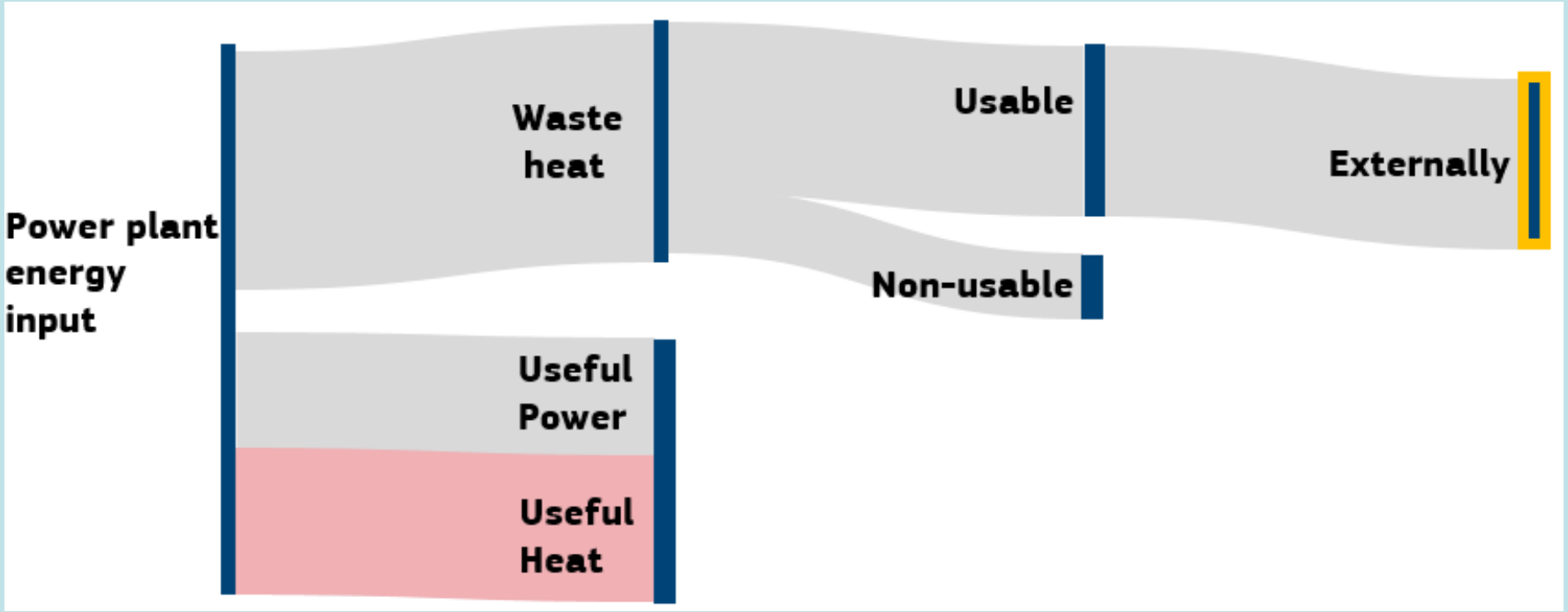
Heat that was generated with the main purpose of being directly used on or off site and is not a by-product of another process, irrespective of the energy input

Cogenerated heat from combined heat and power plants, because cogeneration is an energy efficiency measure by design (it reduces waste heat by using the energy of the input fuel in a more efficient way)

Heat that is or could be recovered internally on the same site

Cogeneration*

Usable heat from cogeneration plants cannot be considered waste heat



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What sources are in?

Thermal power plants that can supply, or be retrofitted to supply, waste heat with total thermal input exceeding 50 MW – condenser heat only

Cogeneration installations with total thermal input exceeding 20 MW – condenser heat only

Incineration plants – treated like power generation or cogeneration

Renewable energy installations with a total thermal input exceeding 20 MW generating heating or cooling using energy from renewable sources

Industrial installations with a total thermal input exceeding 20 MW that can provide waste heat – unavoidable only

Other sources, in particular from the tertiary sector (data centres, wastewater treatment, metro stations, etc.)

Calculating waste heat potential

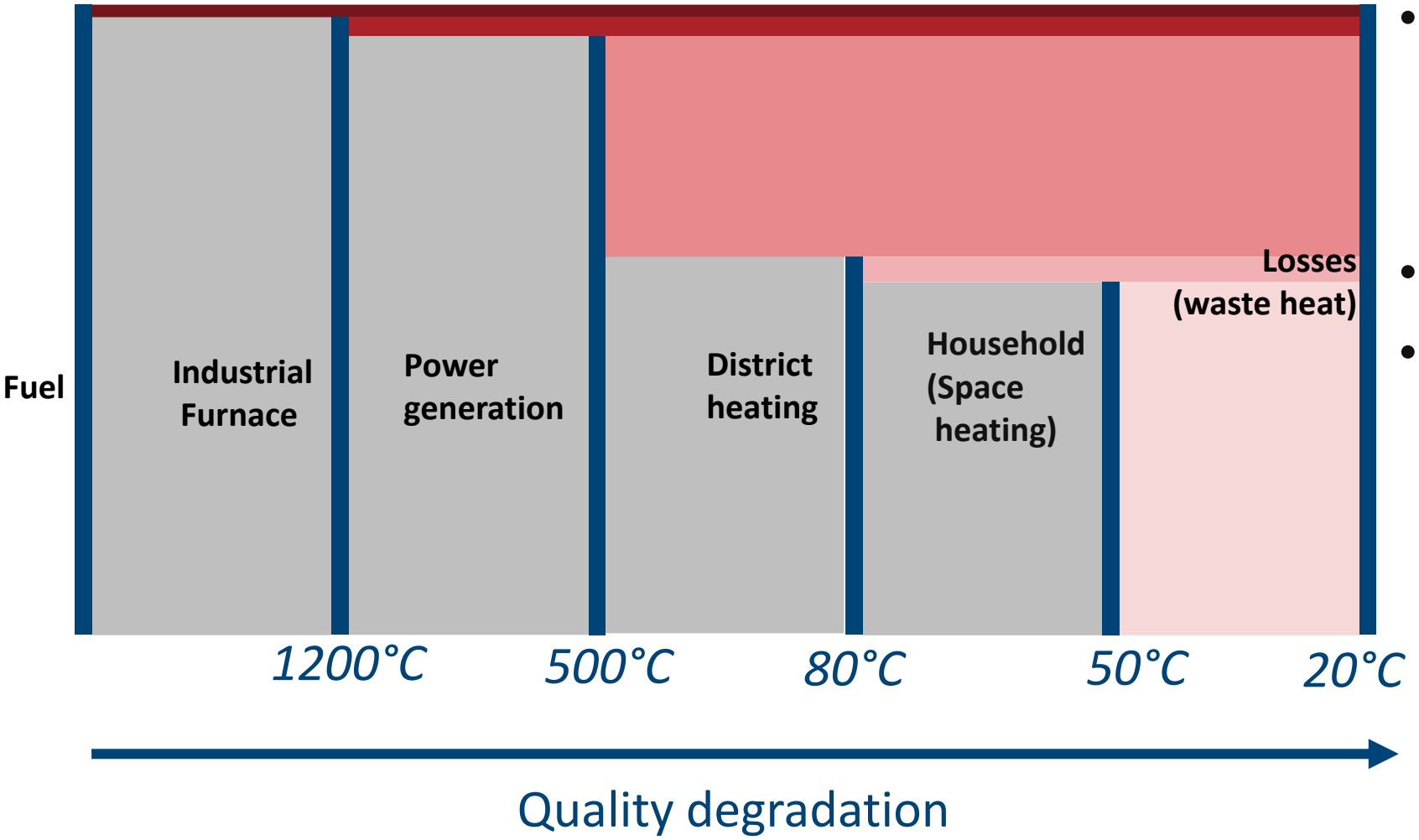
Assumptions can be made for the fraction of unavoidable waste heat from typical power plants, various industry sectors, data centres, etc. that is used off-site, *although*

both real-world examples of off-site use and estimates of recovery potential show that the temperature of waste heat and cold and the fraction of it that is used vary significantly by sector

so more detailed analysis would be required at site level, i.e. pinch analysis

sEEnergies project should be seen as an important source of reference values in this regard

Cascade effect: energy and temperature by end use



- The same 100 MWh can fire a furnace → produce power → end up in a district heating system → heat a household
- Deteriorates as it is used
- Each application has its own minimum temperature requirements

Thanks

Any questions?

You can find us at lorcan.lyons@ec.europa.eu and johan.carlsson@ec.europa.eu

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Extra slides

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RED Article 23

Member States have to increase the renewable share of heating and cooling by **1.3 percentage points** as an annual average for the periods 2021-2025 and 2026-2030 compared to 2020, expressed in final energy consumption

HOWEVER

- If the share is already greater than 60%, no further increase is required
- If the share is between 50% and 60%, only half of the increase is required

AND

Waste heat can only account for a maximum of 40% of the increase

The increase is an indicative 1.1 percentage points for Member States that don't use any waste heat and cold

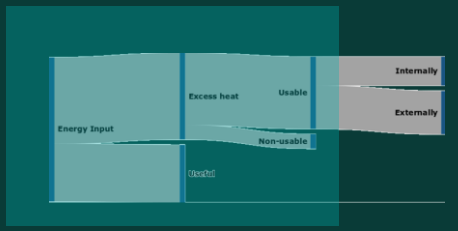
RED Art. 24

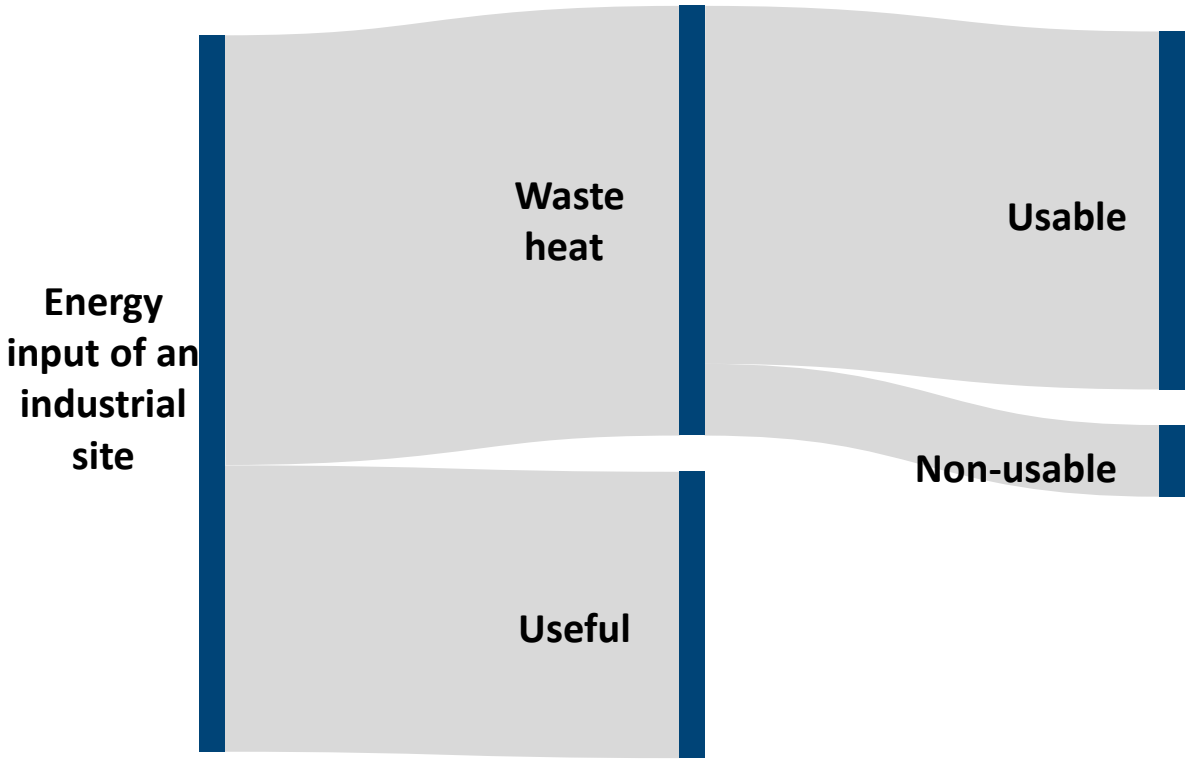
MS have to increase the renewable and waste share in district heating and cooling by at least **1 percentage point** as an annual average calculated for the period 2021 to 2025 and 2026 to 2030 compared to 2020, expressed in terms of final energy consumption

UNLESS

- Share of DHC is less than 2%
- Share of DHC increases above 2% by developing new efficient DHC (based on National Energy and Climate Plans)
- 90% of the DHC market is made up of efficient DHC, including based on high-efficiency cogeneration and for which a plan exists to become efficient by 31 December 2025, or small DH (<20 MW)

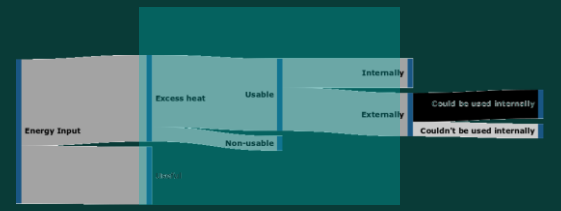
Waste heat (usable?)

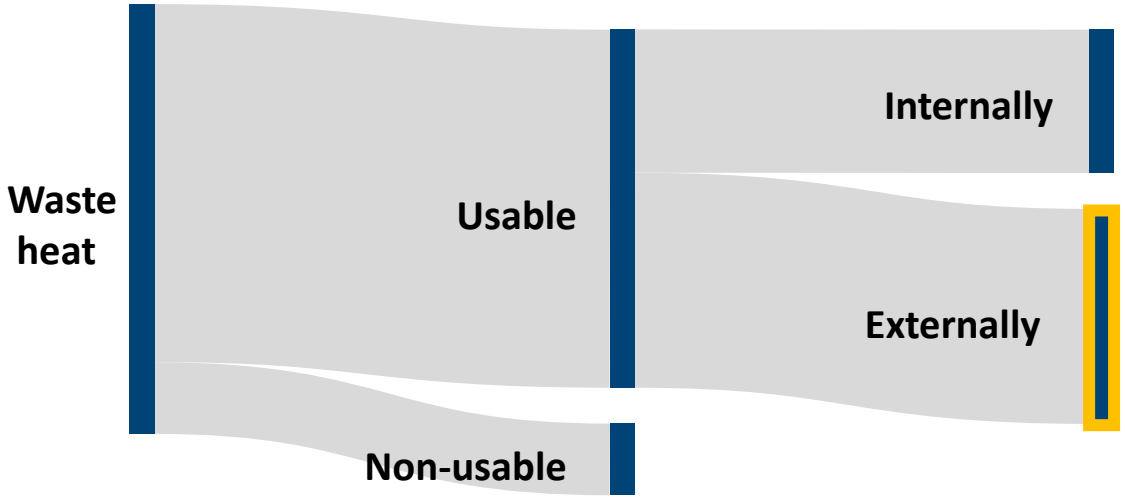




- **Usable**: Any tangible stream (gas or liquid) carrying energy at a temperature close to that required by a given application
- **Non-usable**: A diffuse form of energy that cannot be directly reused:
  - e.g. uninsulated pipe and other irreversible losses
- Both streams can be reduced through energy efficiency

Waste heat (internal or external?)





- Identify the internally and externally usable waste heat
- Very site specific but there are best practices by sector (e.g. BREFs under Industrial Emissions Directive 2010/75/EU))

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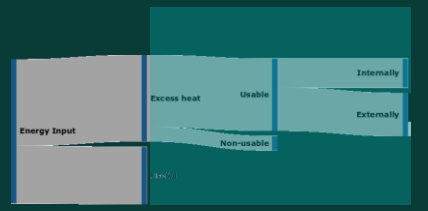
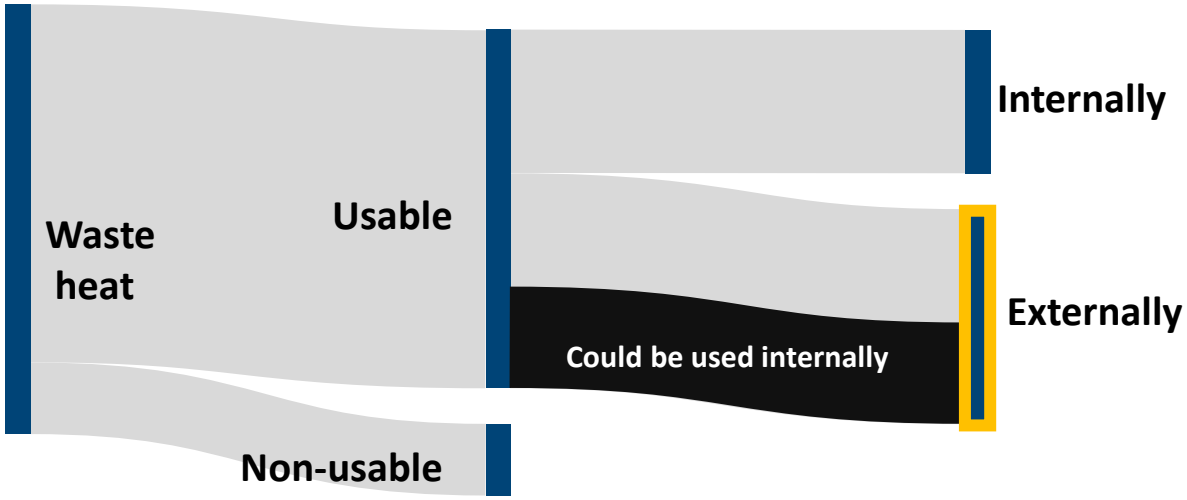
Unavoidable waste heat - external:





Identify the share of the externally usable heat stream that could not “reasonably” be recovered for internal use or avoided through improved efficiency

The only way for sites to prove that they have exhausted all reasonable energy efficiency and heat recovery options is through site-specific analysis (**pinch analysis**)

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Identify internally and externally recoverable heat

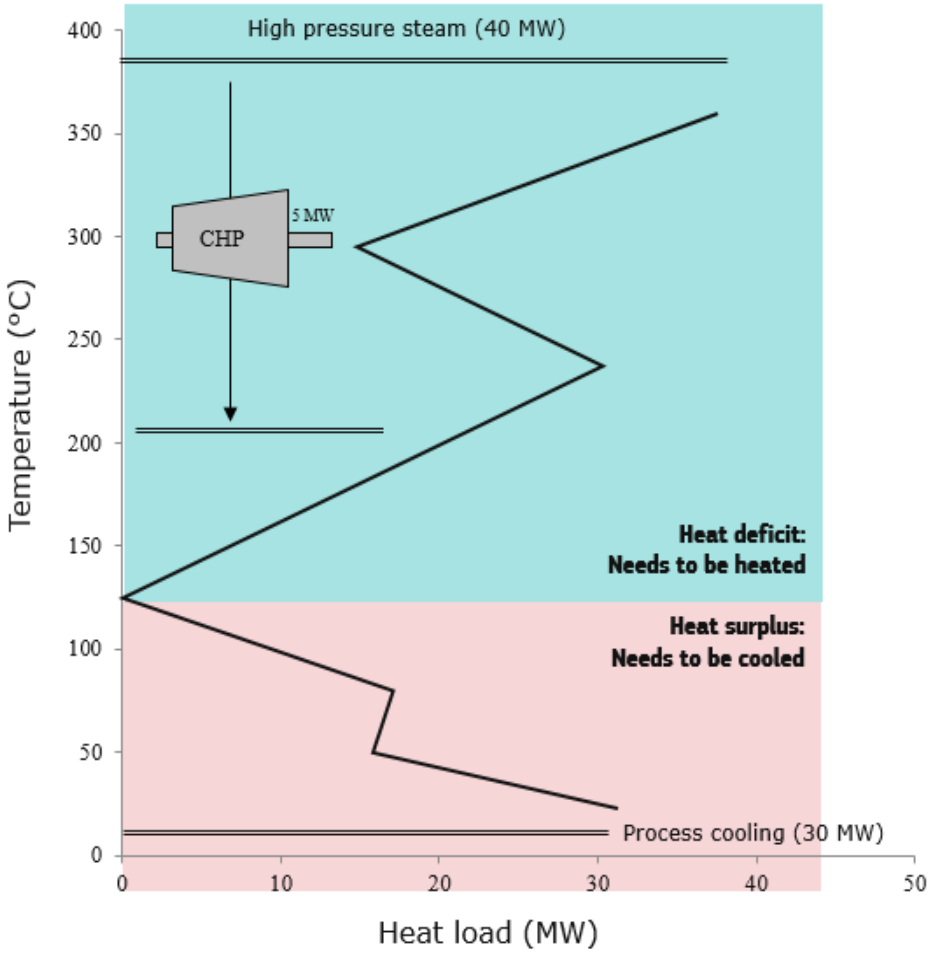
Pinch analysis is a long-standing robust methodology to quantify the avoidable and unavoidable shares of industrial waste heat, and:

- Potential for use of waste heat off site
- Potential for installation of heat engines (cogeneration)
- Potential for internal recovery using heat pumps

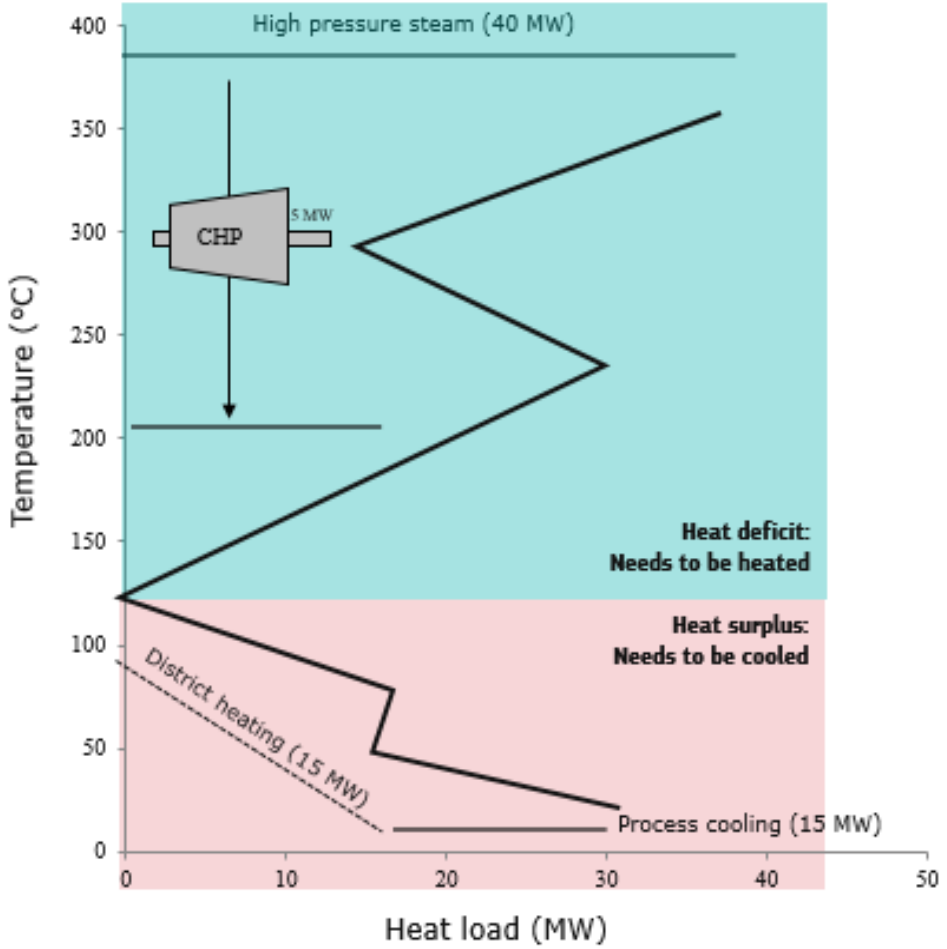
Proposal: Submit pinch analysis in order to claim use of industrial waste heat

Pinch analysis of an industrial site (heat load and temperature)

with cooling only



with cooling and off-site use



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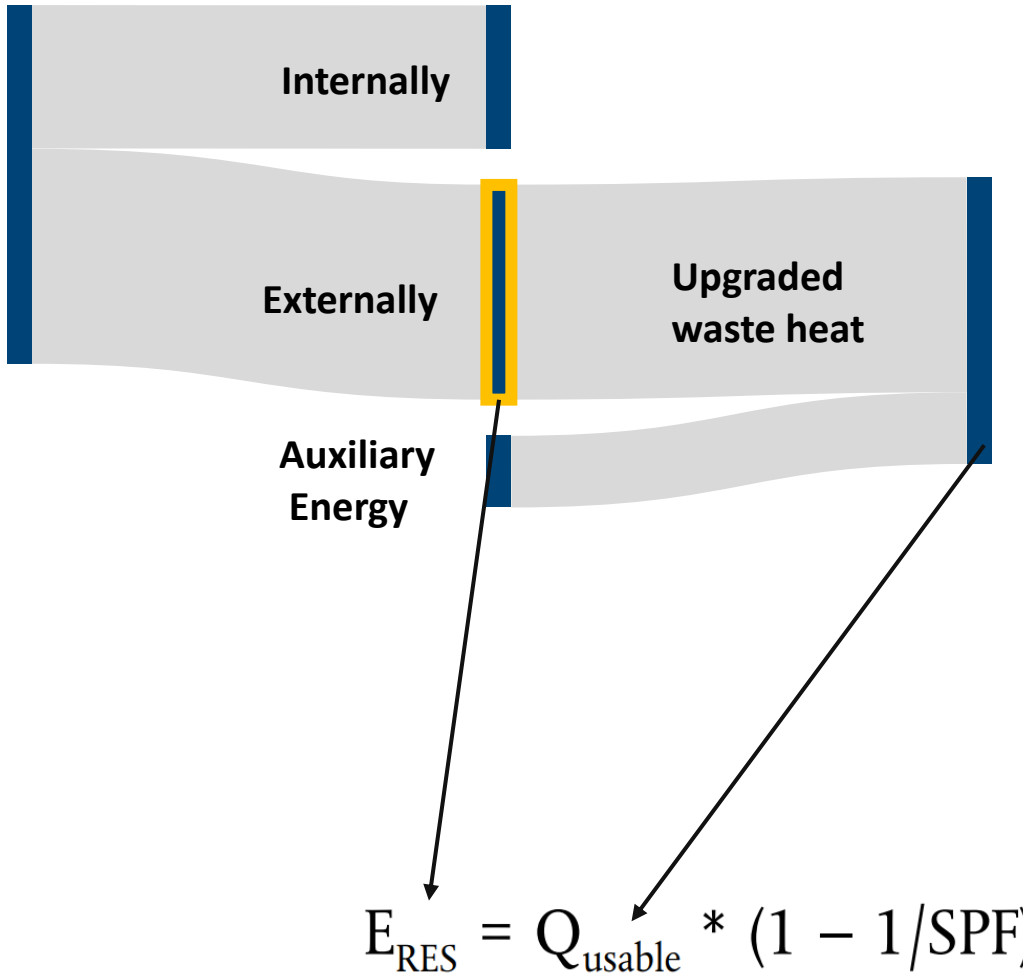
Upgrading waste heat



$$E_{RES} = Q_{usable} * (1 - 1/SPF)$$

- In some cases a waste heat stream can be used after being upgraded (e.g. via heat pumps)
- The amount of auxiliary energy used should not be counted

Heat pump equations apply per Annex VII of RED

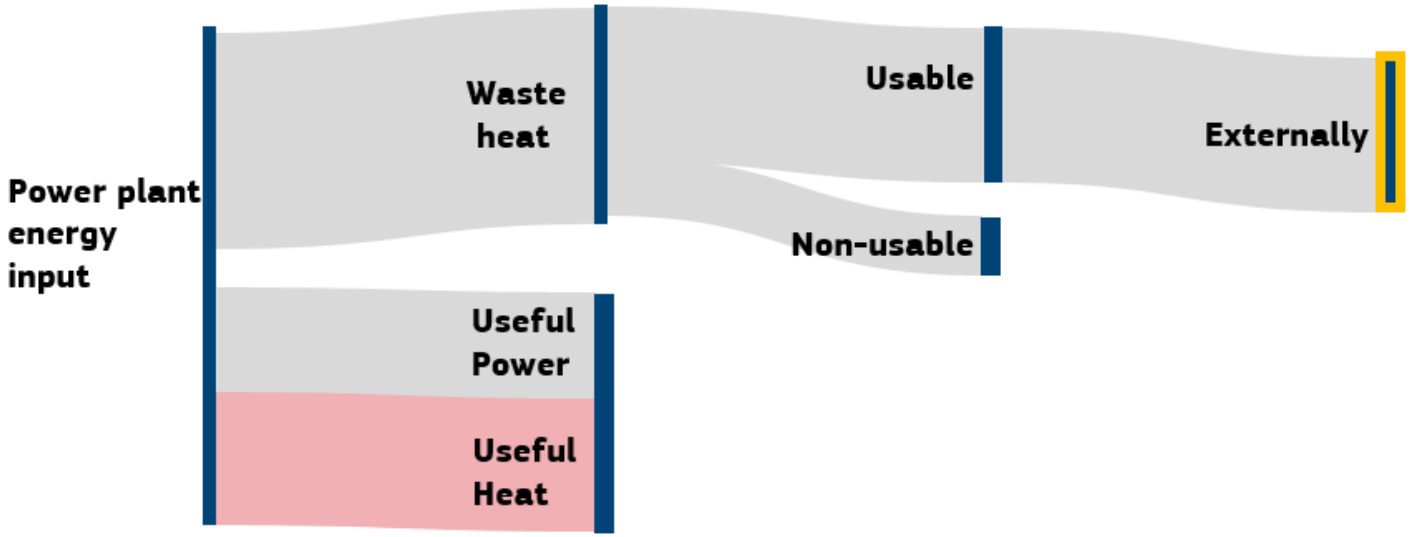
Energy efficiency versus waste heat

A more efficient process:

- Increases useful energy
- Reduces waste heat
- **BUT** does not utilise it

→ Contributes to the energy efficiency target but not to the renewable energy target

Example: Cogeneration



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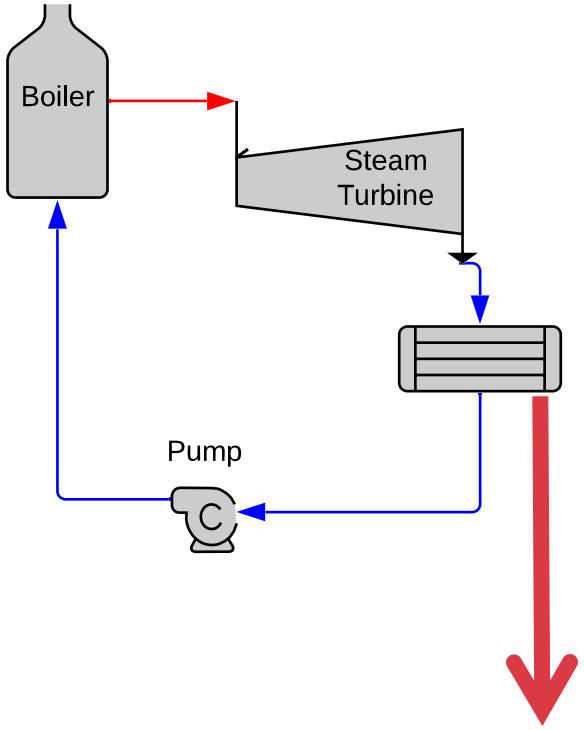
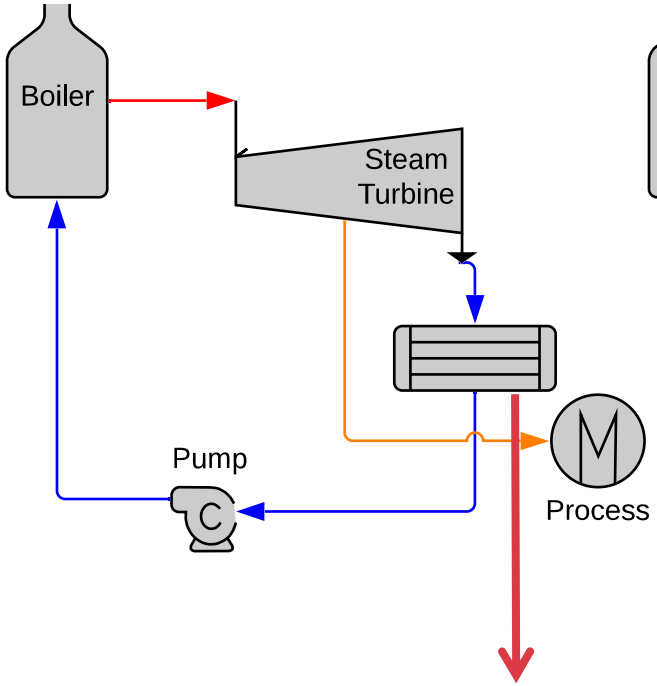
Steam-based cogeneration applications

Power plant



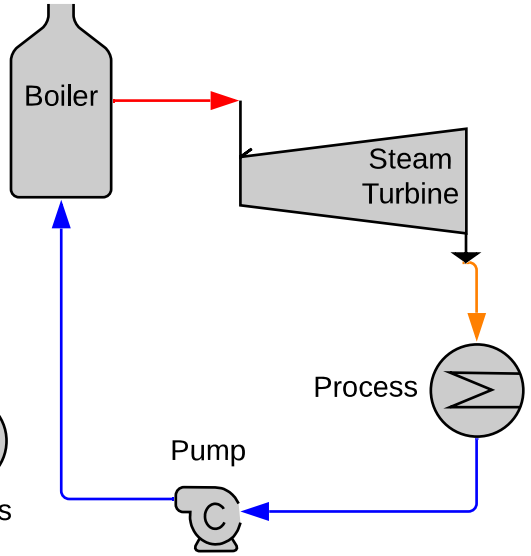
Waste heat from condenser

Cogeneration District heat



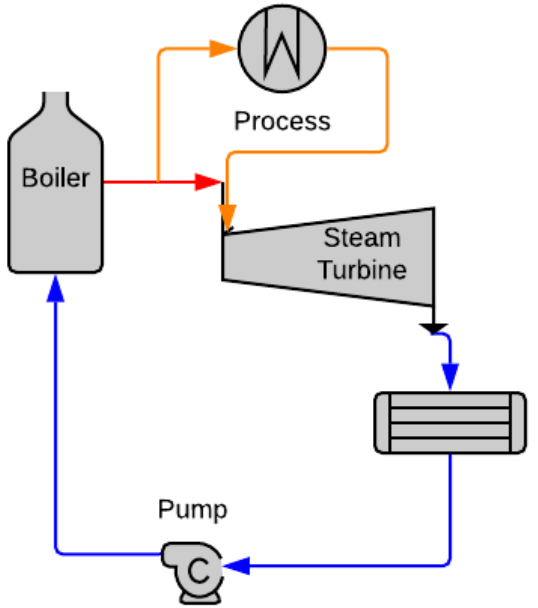
Waste heat from condenser is reduced

Cogeneration Industrial application (topping)



Zero waste heat; all heat is useful

Cogeneration Industrial application (bottoming)



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Waste heat merit order

Site-specific cost optimisation should be carried out but the following rules of thumb apply:

Internal (heat recovery)

- Energy efficiency measures
- Use heat directly (piping or ducting, usually within the same process)
- On-site heat transfer using a heat exchanger
- Use an absorption or adsorption chiller for cooling on site
- Upgrading heat for use on site using a heat pump
- Generating electricity, i.e. cogeneration through Organic Rankin Cycle

External (waste heat)

- Exporting for direct use off site
- Exporting for use off site and upgrade it via a heat pump

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Waste heat calculation approach under RED by sector and source

Industry

- Anything that can be proven not to be “reasonably” recoverable

Power generation

- Output of condenser or gas turbine

Services

- Active cooling or refrigeration systems (e.g. heat pumps)
- Passive cooling (e.g. data centres, power conversion)
- Other combustion activities (e.g. cremation)
- Wastewater treatment plants and pipes (but not sewage pipes)
- Metro stations, etc.

Pinch analysis

Justification also needed but calculation more straightforward (internal recovery usually not applicable)

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The case of cooling

- Active cooling (from heat pumps)
  - uses electricity or heat and
  - uses ambient energy or renewable body
- Passive cooling (without heat pump)
  - **using a renewable resource (ambient)** as a medium to remove excess heat
- Both **emit waste heat**, i.e. have an exhaust stream higher than the ambient temperature

Conclusions – waste heat under the RED

- JRC is helping to clarify how to count it
- Straightforward, apart from industrial waste heat where pinch analysis may be needed
- Cascading heat reuse is not compatible with energy balances or overall RES target but we can consider waste heat renewable for H&C sub-targets
- Default values may be used for Art. 14 Assessments