

# How big is the market potential for electrified thermal energy?

Prepared for Kyoto Group



# Our analysis addresses 3 key questions regarding the market opportunity for electrified heat and thermal storage applications

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**Q.1** What is the size of the market for electrified industrial heat globally?

**Q.2** What is the size of other relevant heat market segments?

**Q.3** What is the cumulative investment needed to electrify heat markets?

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Power markets



Renewables



Storage



Electric vehicles



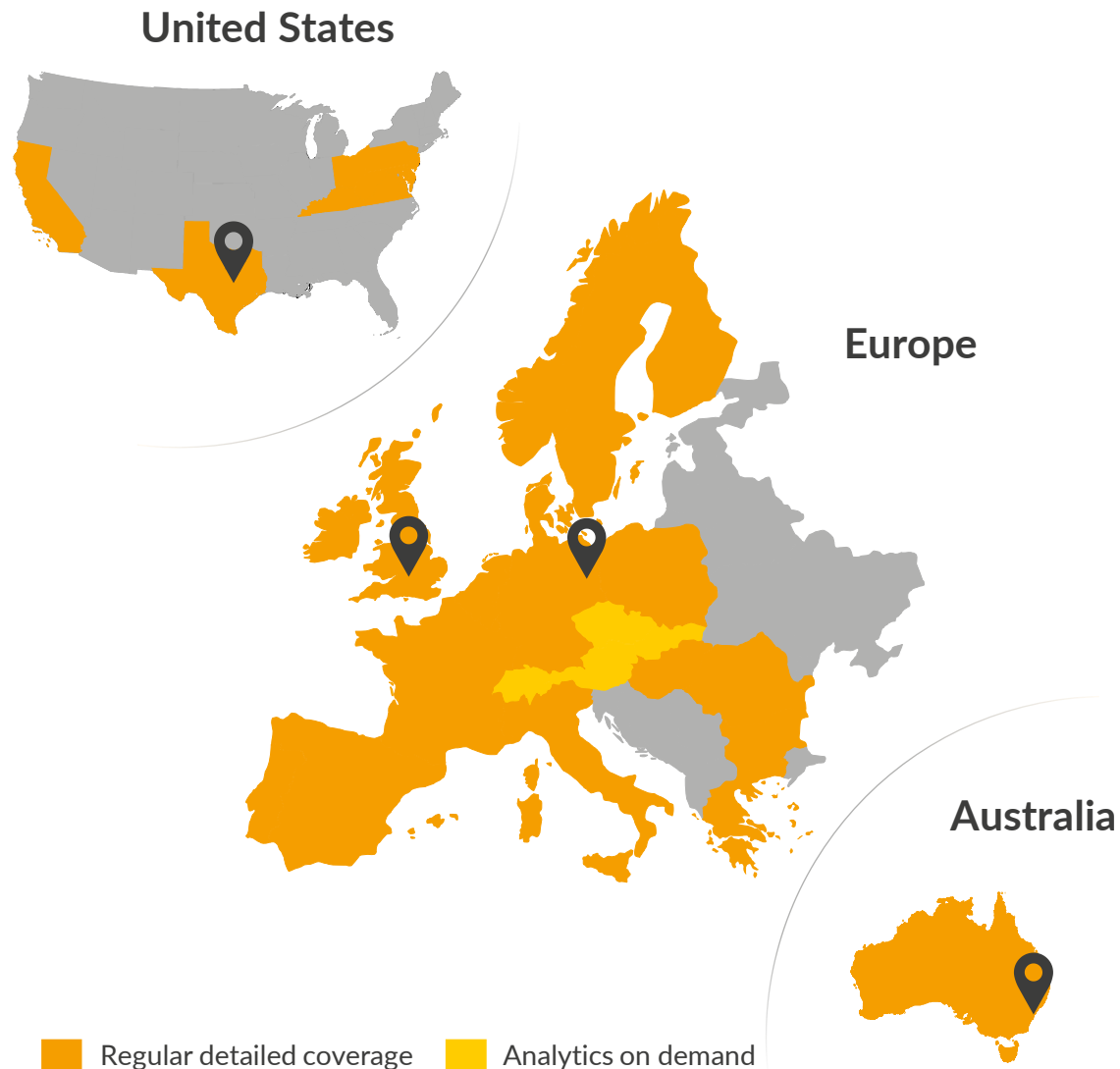
Hydrogen



Carbon



Natural gas



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transactions supported in 2020

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## Research & Publications

- Industry-standard market outlook reports and bankable price forecasts for power, gas, carbon and hydrogen markets
- Strategic insights into major policy questions and new business models
- Read and constantly challenged by 350+ subscribers from all industry sectors

## Commissioned Projects

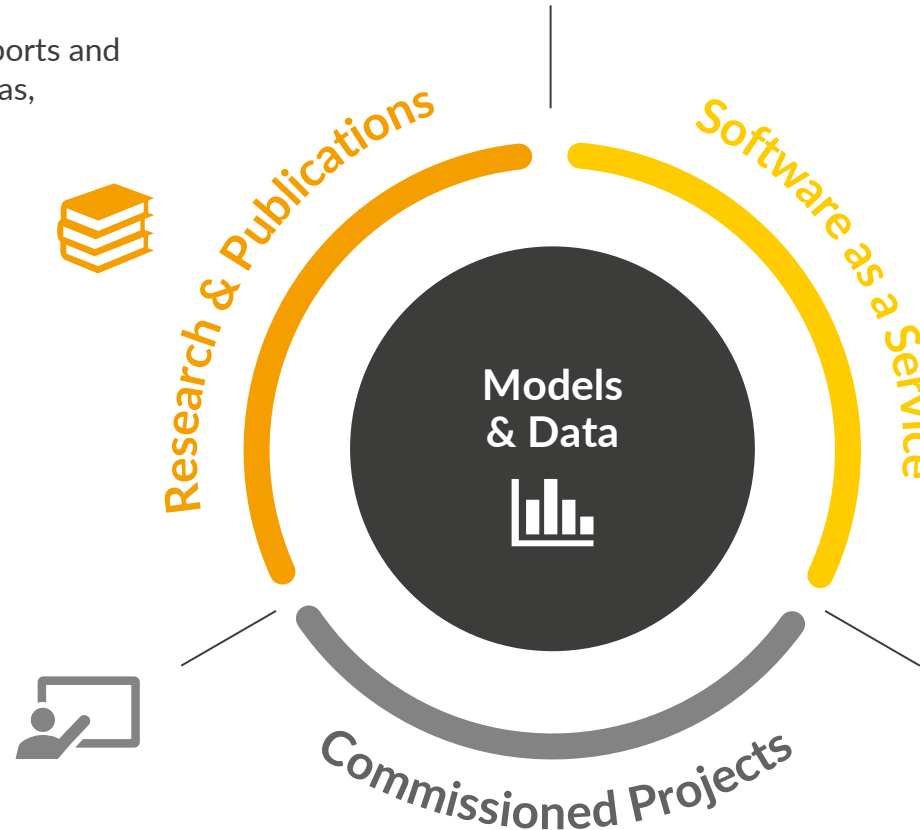
- Bespoke analysis, drawing upon our models and data
- Trusted advice for all major market participants proven in 500+ projects: transaction support, valuations, strategy & policy engagement

## Software as a Service

- Out-of-the-box SaaS solutions, combining cutting-edge sophistication with unparalleled ease of use
- **Origin** provides cloud-based access to Aurora's market model, pre-populated with our data
- **Amun** automates asset-specific wind farm valuations for over 30 leading funds, developers and utilities

## Models & Data

- Market-leading long-term models for power, gas, hydrogen carbon, oil and coal markets
- Continuous model improvements to reflect policy and market developments



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Q.2

What is the size of other relevant heat market segments?

Q.3

What is the cumulative investment needed to electrify heat markets?

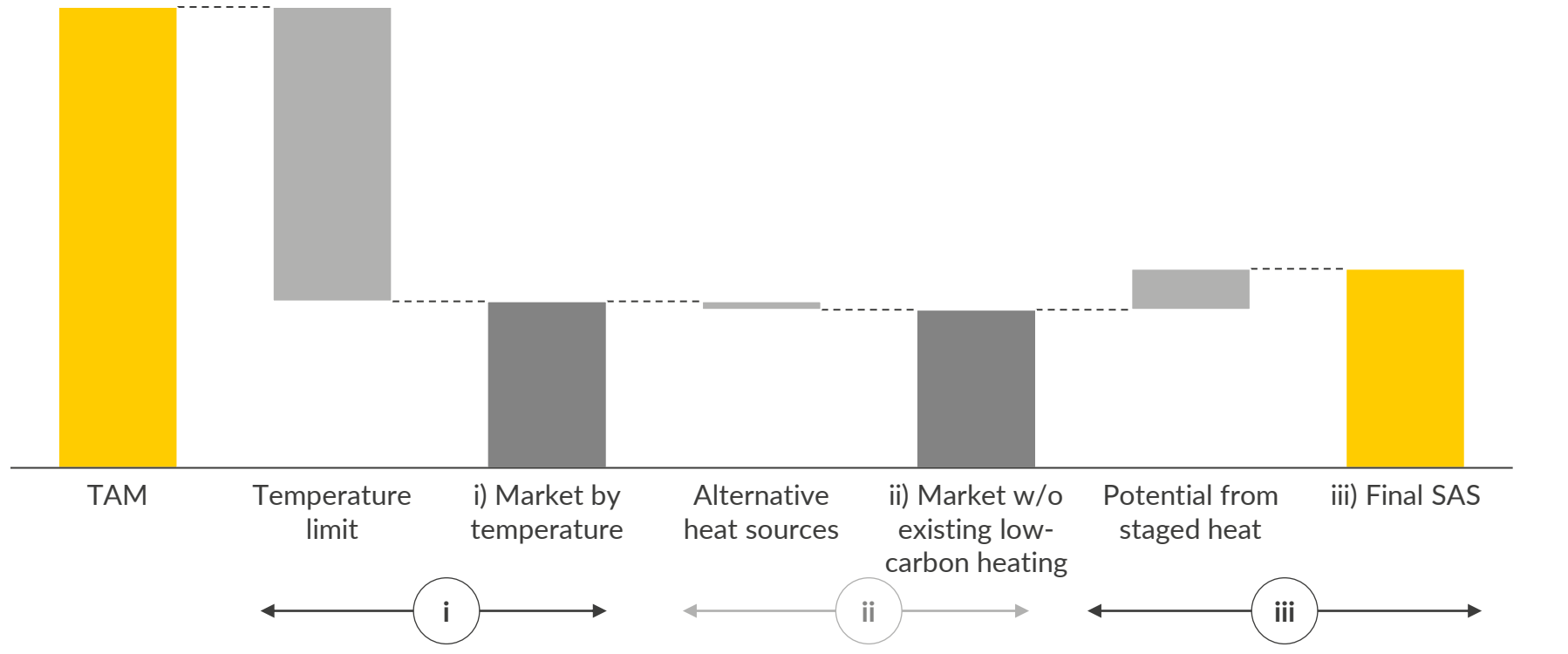
# We have assessed the market size for electrified industrial heat applications in three steps

## Total addressable market (TAM)

$$\text{TAM} = \text{Global heat demand} \ominus \text{heat demand outside industry}$$

## Serviceable addressable segments (SAS)

$$\text{SAS} = \text{TAM} \ominus \text{Heat demand outside relevant temperature range} \ominus \text{existing low-carbon heat} \oplus \text{heat demand for pre-heating}$$



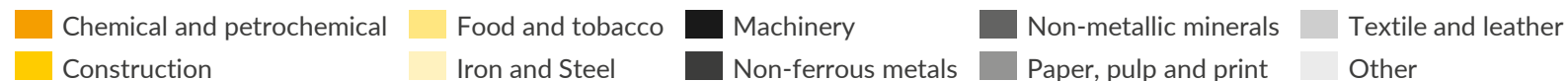
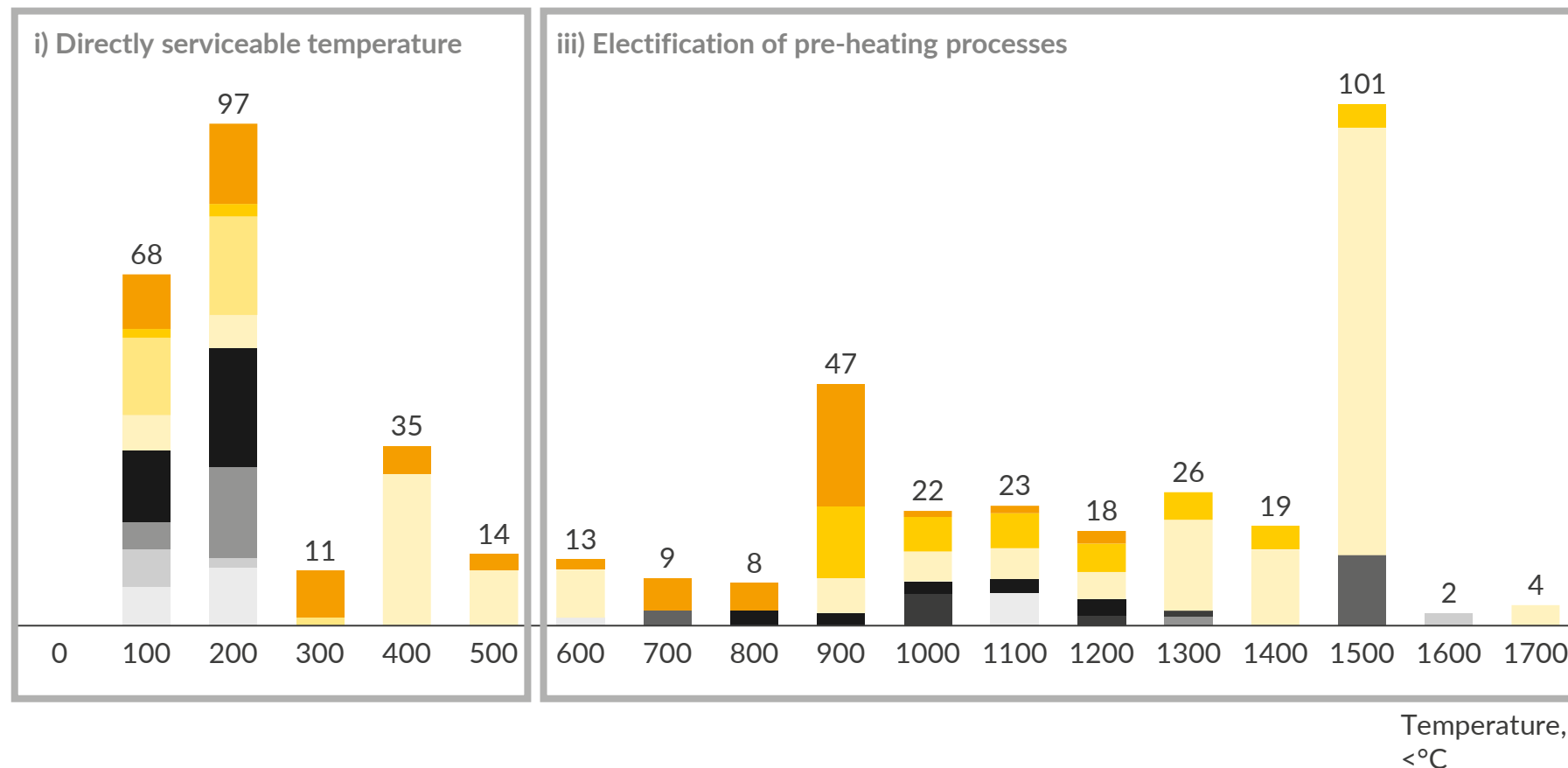
## Method

- We estimated the heat market size based on UN data
- To determine SAS, we applied three steps:
  - i. Limits by directly serviceable temperature range
  - ii. Discount to consider existing alternative low-carbon heating technologies
  - iii. Upside from staged heat in high-temperature industry processes

# The market size of different industrial heat segments is determined by the temperature requirements of each segment

Heat demand per temperature and industry segment in Germany

TWh

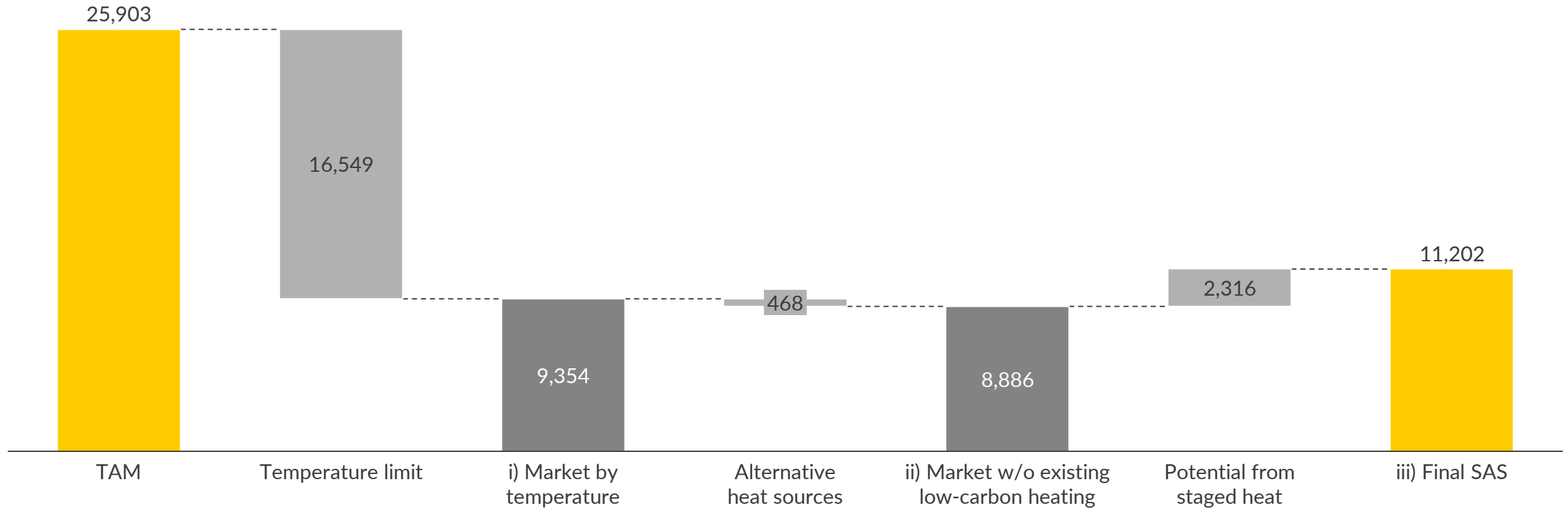


## Methodological notes

- A significant proportion of industrial heat is required at temperatures above 500°C
- Iron and Steel makes up a significant proportion of total industrial heat demand, largely above 1000°C
- This is the key factor leading to a lower Serviceable market than the Total market for electrified heating applications
- Staged heating leads to potential for accessing higher temperature demands – although a share of pre-heating is already provided via waste heat
- c. 5% resistance-based heating in industry process heat could be deducted from SAS

# Focusing on the directly applicable temperature range and the potential for staged heating leads to a SAS of c. 11,200 TWh

Market size globally,  
TWh/year



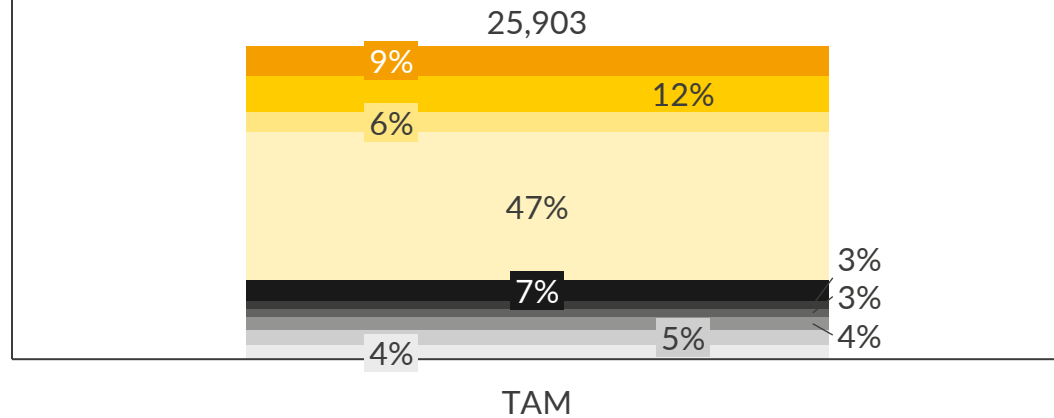


# An electrified system that can deliver heat up to 500°C can serve c. 45% of all industrial heat demand

## Total addressable heat market (TAM)

$$\text{TAM} = \text{Global heat demand} - \text{heat demand outside industry}$$

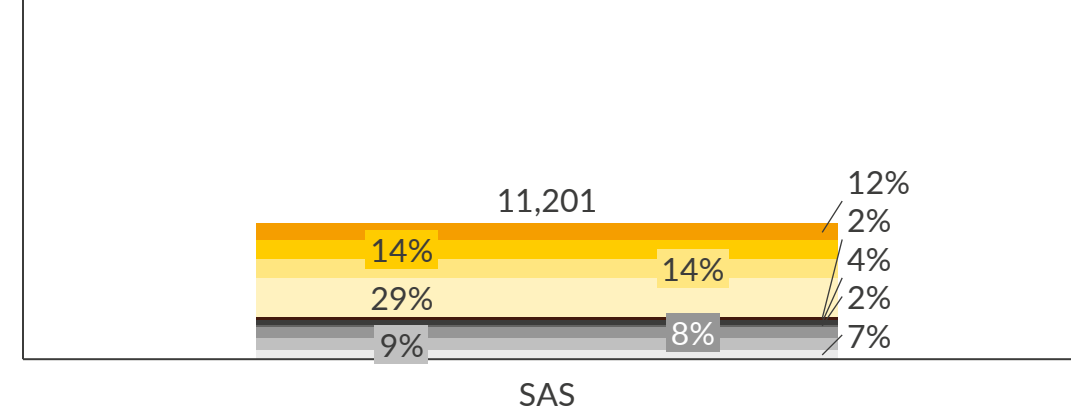
Heat demand, TWh/year



## Serviceable addressable segments (SAS)

$$\text{SAS} = \text{TAM} - \text{Heat demand outside relevant temperature range} - \text{existing low-carbon heat} + \text{heat demand for pre-heating}$$

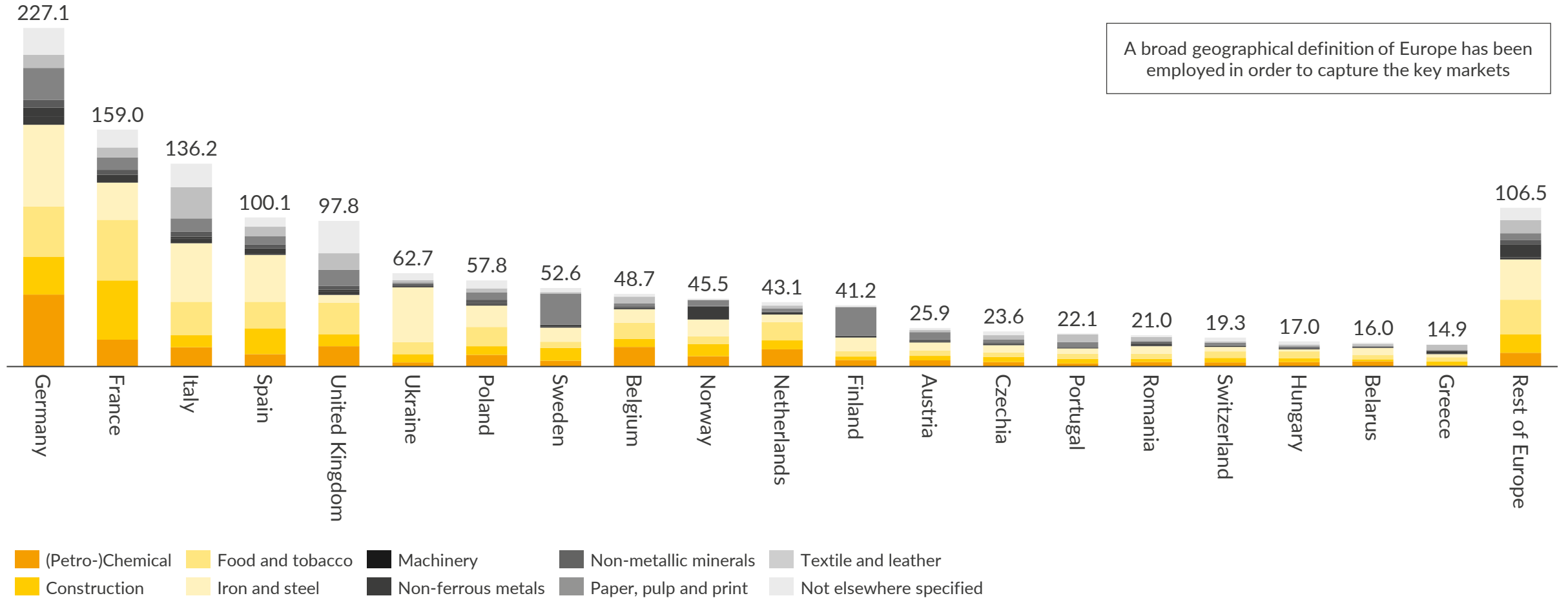
Heat demand, TWh/year



- Chemical and petrochemical
- Food and tobacco
- Machinery
- Non-metallic minerals
- Textile and leather
- Construction
- Iron and steel
- Non-ferrous metals
- Paper, pulp and print
- Not elsewhere specified

# Germany is by far the highest source of industrial heat demand in Europe

European SAS break down  
TWh/year



# Our analysis addresses 3 key questions regarding the market opportunity for electrified heat and thermal storage applications

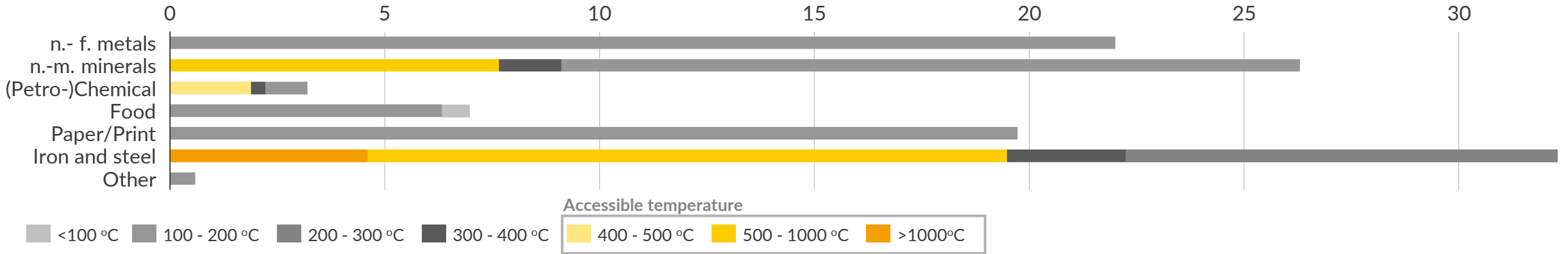
Q.1 What is the size of the market for electrified industrial heat globally?

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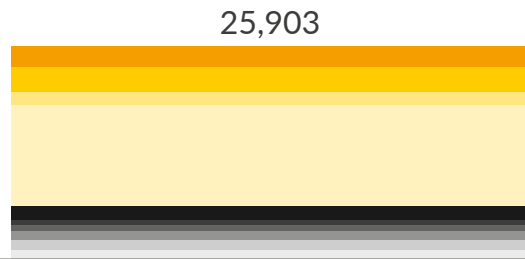
Q.3 What is the cumulative investment needed to electrify heat markets?

# Heat storage systems could be used to recover c. 2,500 TWh of waste heat globally

Fraction of heat demand available for waste heat  
% of heat demand



Global heat demand  
TWh/year



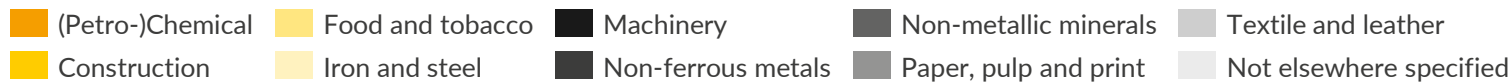
TAM

Resulting global waste heat supply  
TWh/year



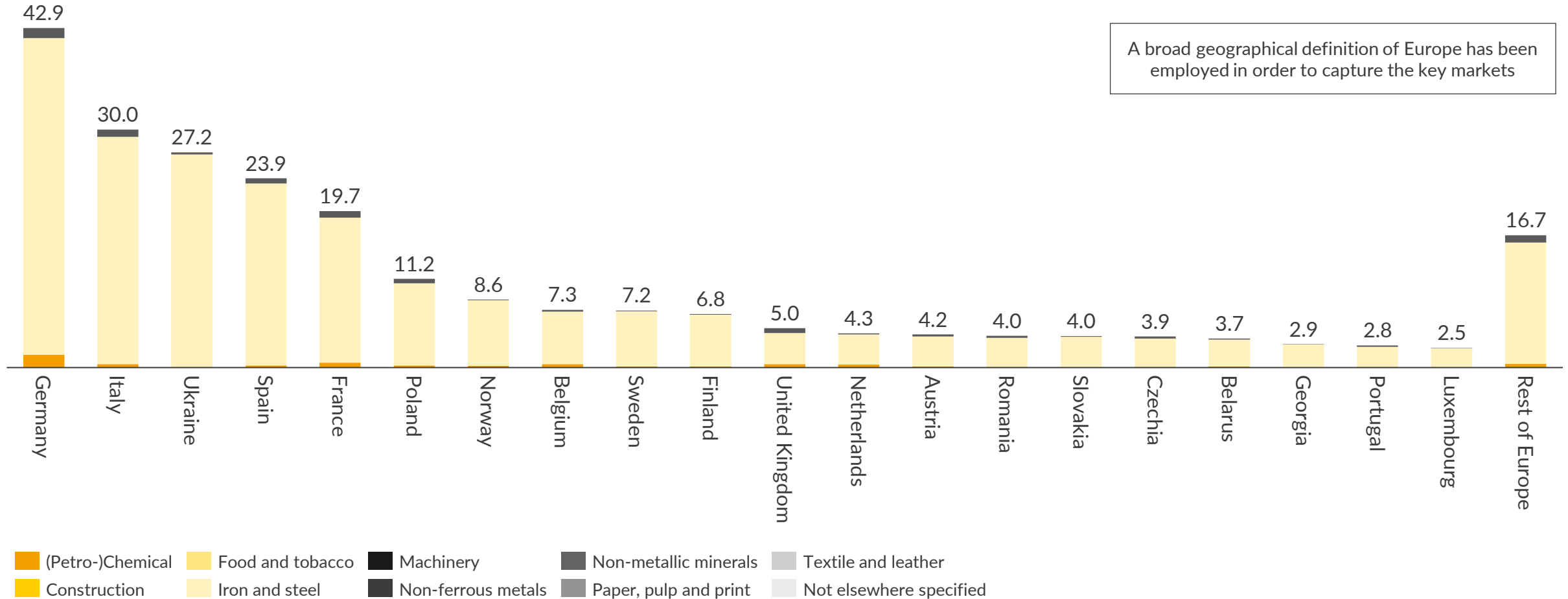
Potential WH

Accessible WH



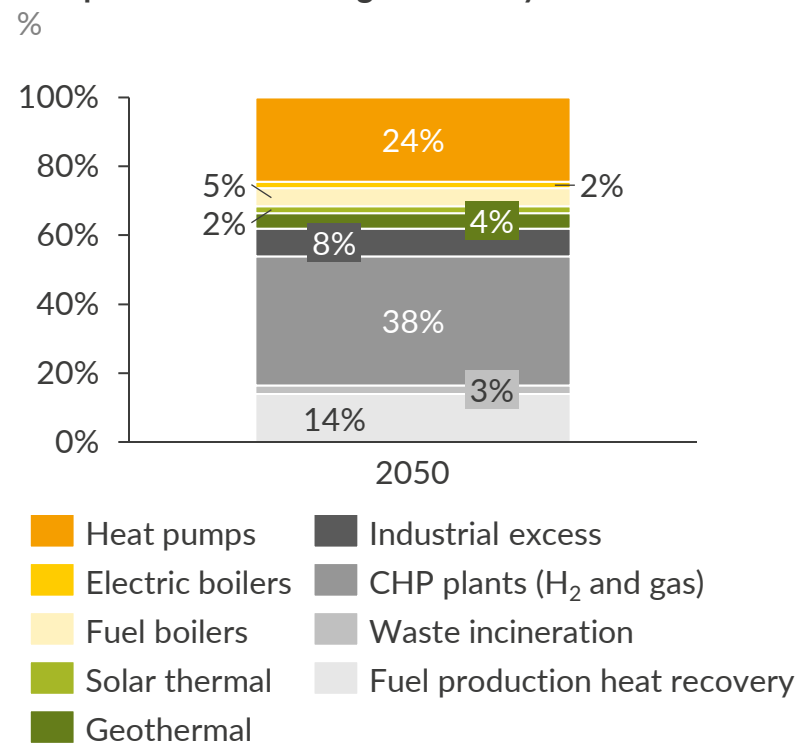
# Germany is by far the highest source of waste heat in Europe

Resulting European waste heat potential  
TWh/year



# Up to 69% of global district heating demand could be electrified, reflecting a market of c. 2,460TWh

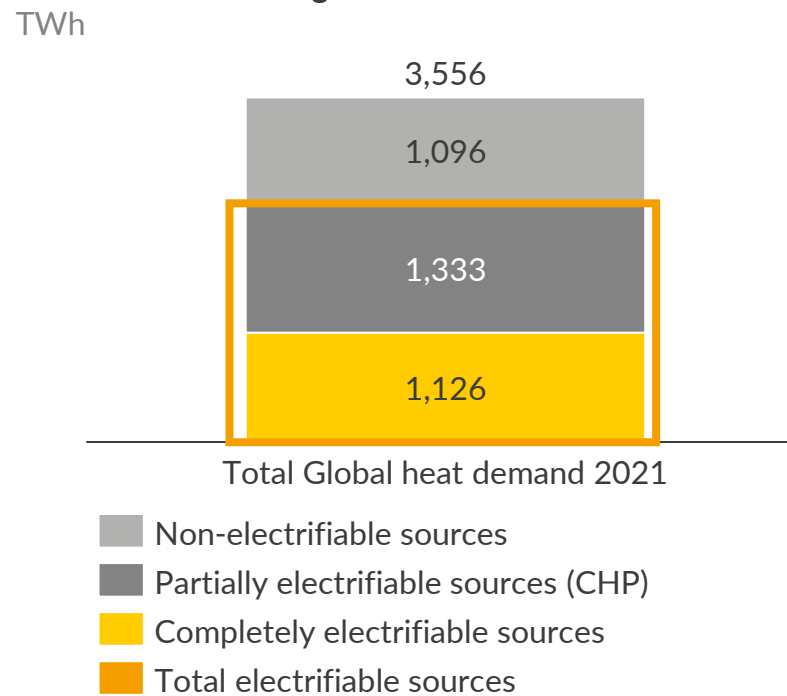
European district heating demand by source %



## District heating can be electrified up to 31 + 38 % by 2050

- 31% of the district heating demand in Europe in 2050 would be either already electrified (Heat pumps and electric boilers) or electrifiable (fuel boilers)
- An additional 38% of CHP could be electrified

Global district heating demand TWh

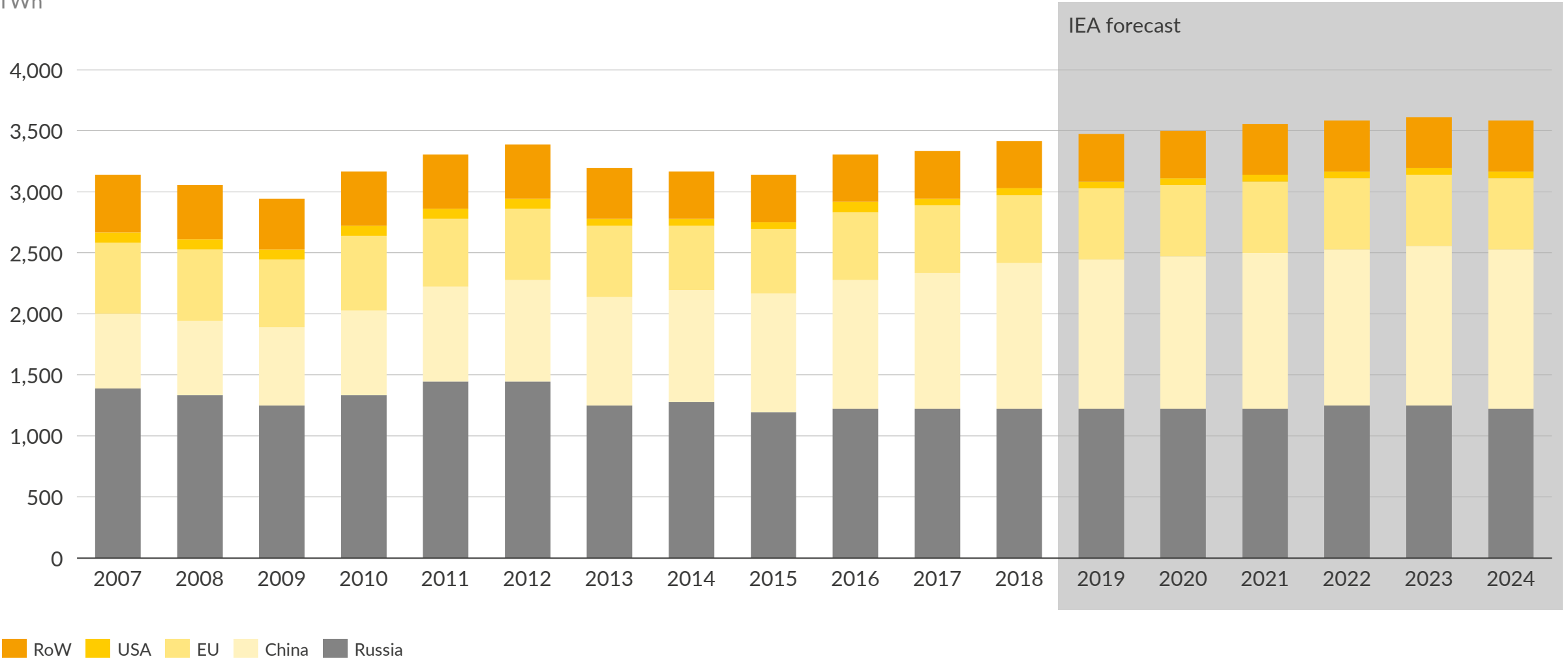


## The size of the current market that can be electrified is between 1 and 2.5 PWh

- The analysis presented here represents an upper bound of the size of the district heating market
- Overall demand growth for district heating may stagnate due to efficiency improvements, but Heat Roadmap Europe sees the potential for district heating to increase from 12% to 50% in terms of the proportion of total heat delivered
- The total market for low-carbon DH is up to 2.5 PWh, which is addressable by electric applications and CHP plants
- Key uncertainties moving forward are regarding the role of large scale heat pumps, combined heat and power (CHP) from gas and coal with carbon capture and storage (CCS) and hydrogen.

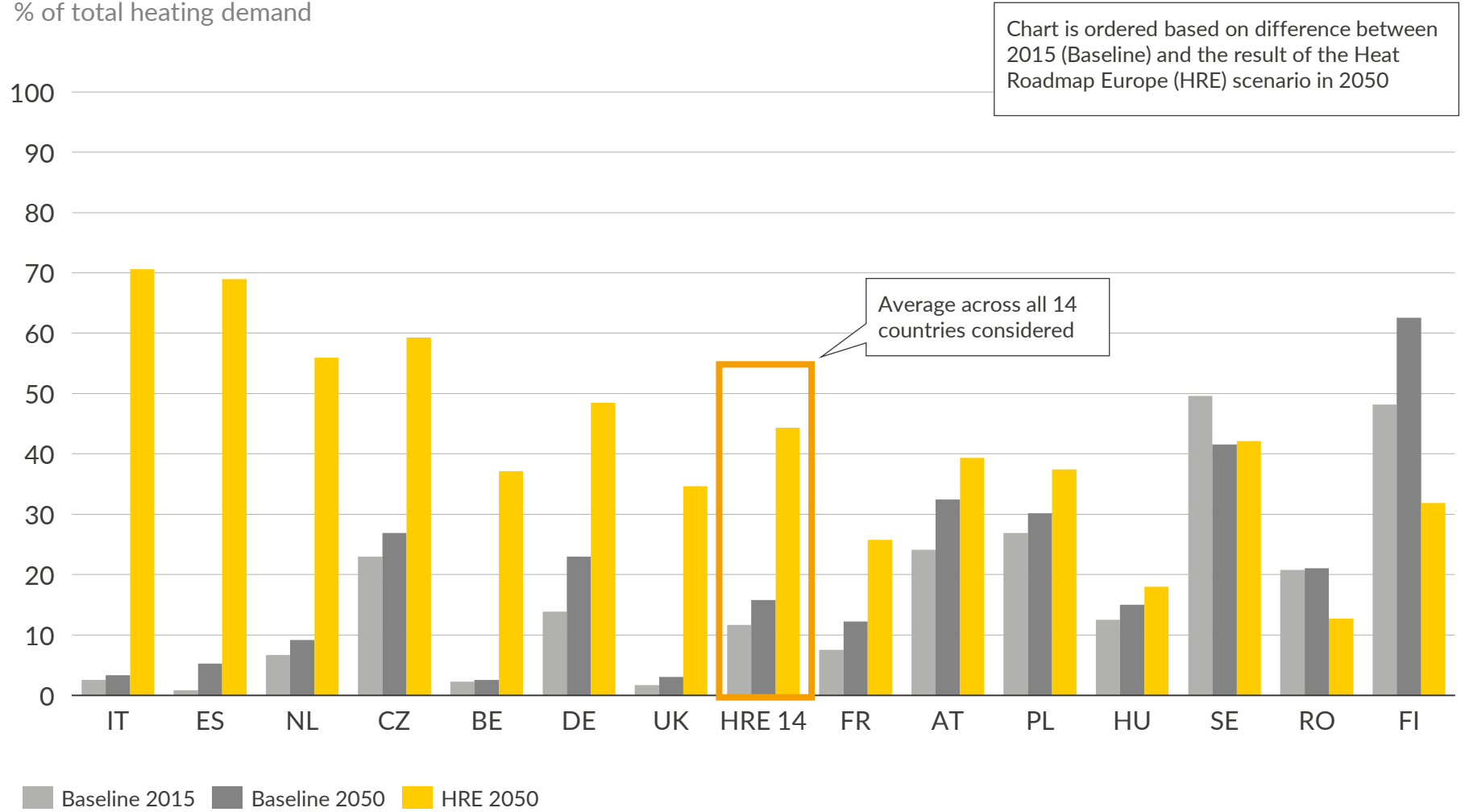
# Demand for district heating comes mainly from Russia and China, with China being the main growth area

Heat demand from district heating  
TWh



# There is great potential for expansion of district heating networks, however it will only be realised if there is a significant policy shift

Modelled heat demand from district heating  
% of total heating demand



- Baseline 2015 represents historical data from 2015
- Baseline 2050 represents the proportion of district heating demand if no change in policy is enacted
- HRE 2050 represents the proportion of district heating that could be expanded in order to remain in line with Paris targets
- The chart shown here indicates that the countries that exhibit the biggest growth potential are Italy, Spain, the Netherlands, the Czech Republic, Belgium, Germany, and the UK
- In some countries (such as Romania or Finland) the penetration of district heating is lower in the HRE scenario, due to economic reasons



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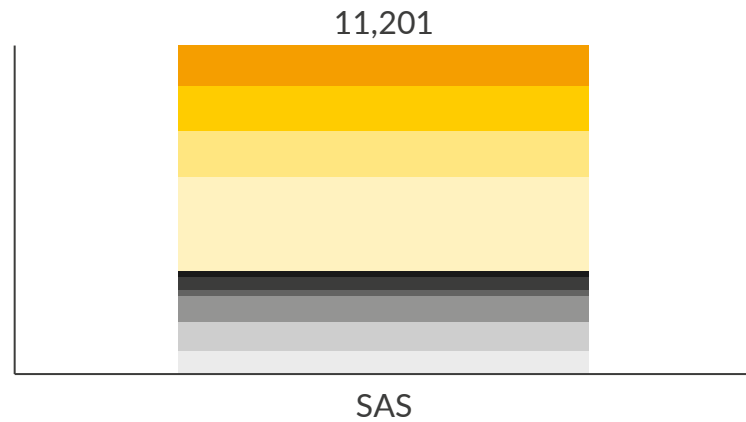
Q.3 What is the cumulative investment needed to electrify heat markets?

# Cumulative investment to electrify industrial heat using Heatcube is c.€1tn, with iron and steel representing about 29% of the total

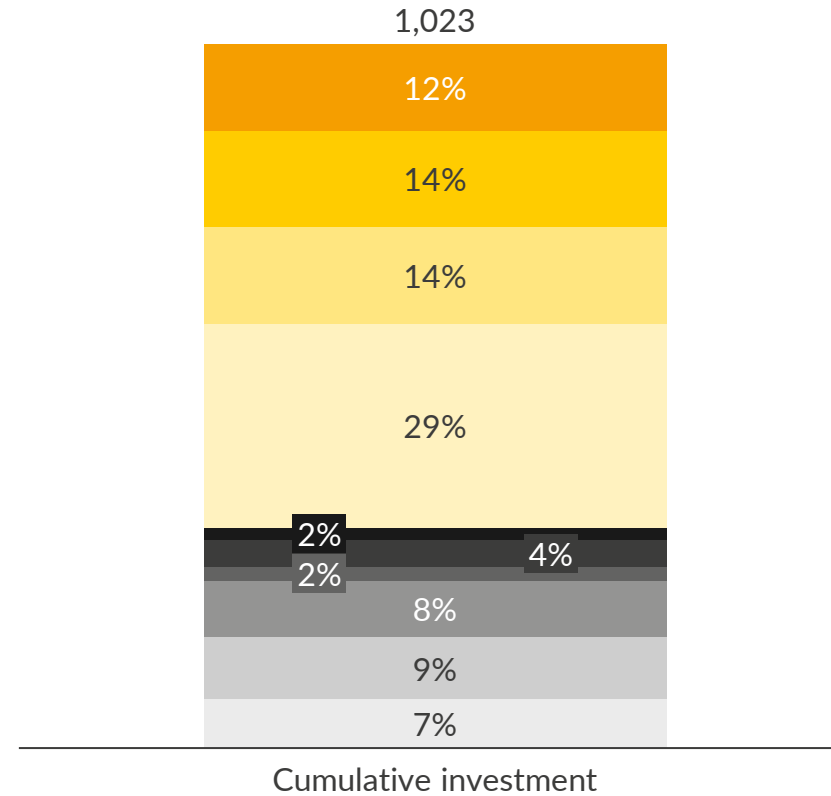
## Technology Assumptions

Unit capacity	12 MW charge; 5 MW discharge
Storage capacity	60 MWh
CAPEX	2 mEUR
=> Annual heat output	21.9 GWh

## Global heat demand TWh/year



## Cumulative investment to electrify SAS bn EUR



- Chemical and petrochemical
- Food and tobacco
- Machinery
- Non-metallic minerals
- Textile and leather
- Construction
- Iron and steel
- Non-ferrous metals
- Paper, pulp and print
- Not elsewhere specified

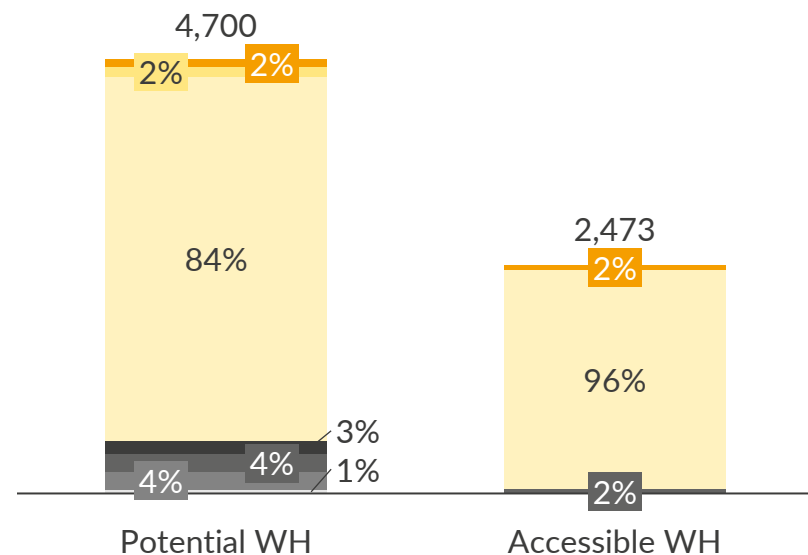
## Comments

- We assume that Heatcube is cycled once per day – leading to a total of 21.9 GWh of heat output per 60 MWh unit
- CAPEX is assumed to be consistent over countries and industry applications
- Cumulative investment represents the market at saturation.

# Electrification with Heatcube of other heat markets could imply additional cumulative investment of €450bn globally

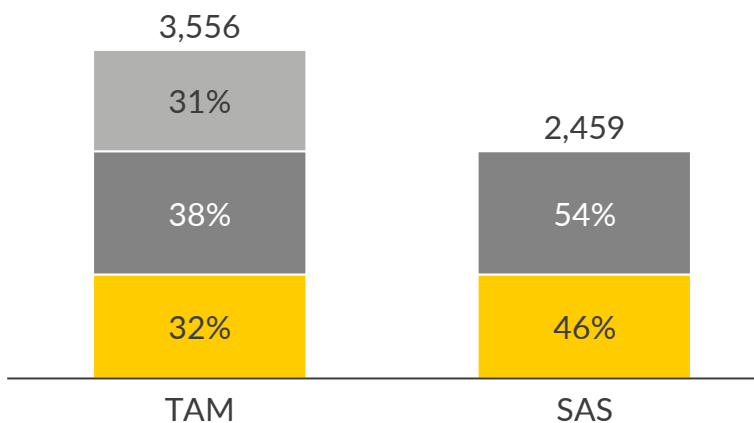
Global waste heat supply

TWh



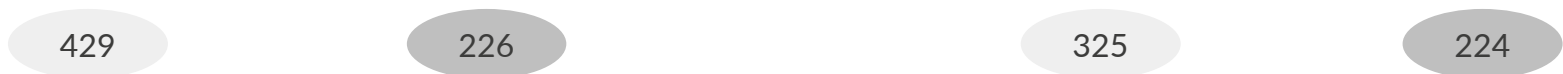
Global district heating demand

TWh



Cumulative investment to electrify

bn EUR



- Chemical and petrochemical
- Construction
- Food and tobacco
- Iron and steel
- Machinery
- Non-ferrous metals
- Non-metallic minerals
- Paper, pulp and print
- Textile and leather
- Not elsewhere specified

- Non-electrifiable sources
- Partially electrifiable sources (CHP)
- Total electrifiable sources

- Accessible waste heat supply is c. 2.5PWh, with iron and steel industry being the dominant sector
- Up to 70% of the district heating demand could be satisfied by electrical sources, which could be an additional 2.5PWh market globally for electrified heat applications

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