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## VIABILITY OF DISTRICT HEATING NETWORKS IN TEMPERATE CLIMATES: BENEFITS AND BARRIERS OF COLD AND WARM TEMPERATURE NETWORKS

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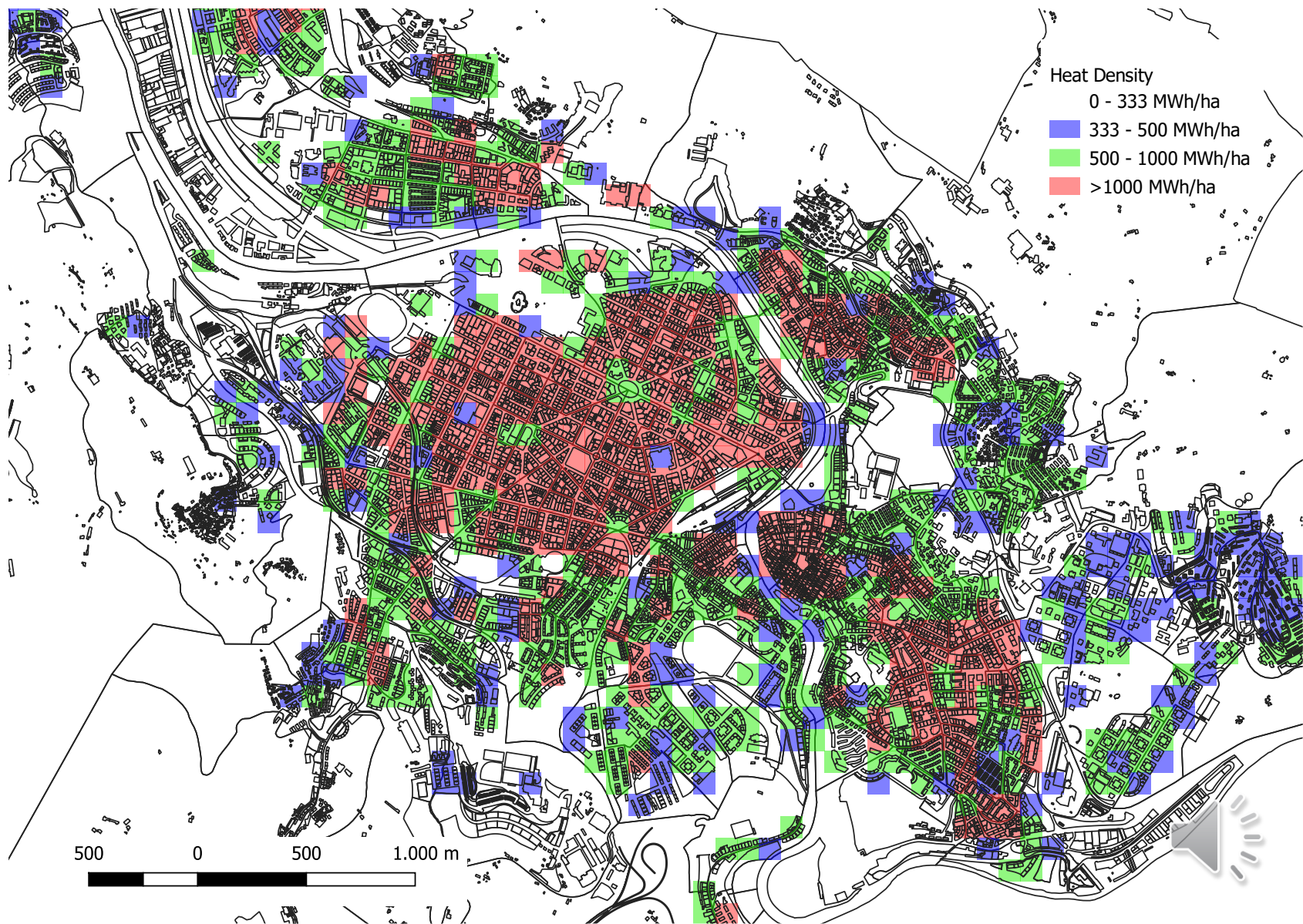


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# Background

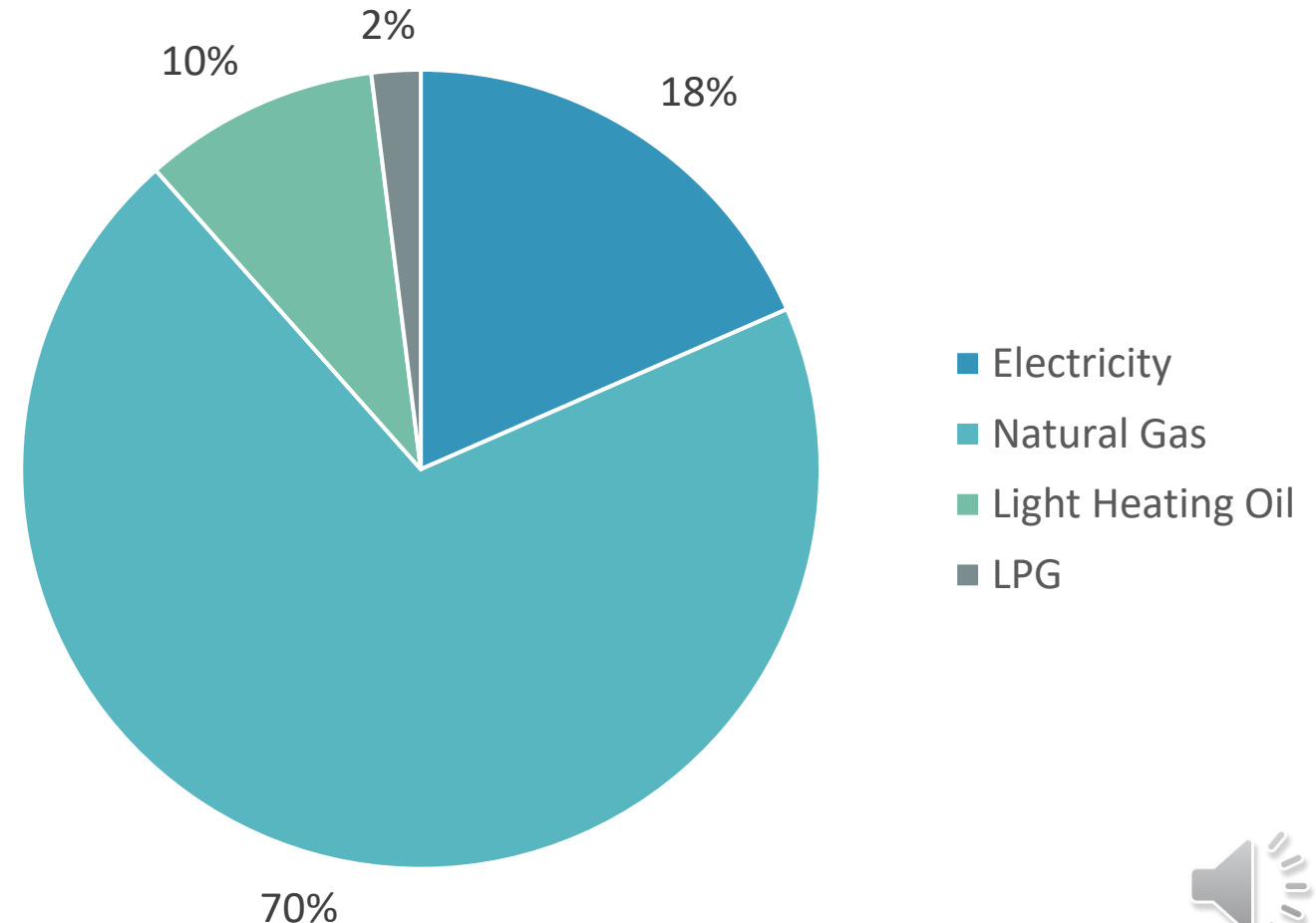
- Bilbao → city of 346 405 inhabitants located in northern Spain.
- Mild climate: 1 147 heating degree-days (13°C/17°C).
- Relatively low specific heat demands:  $\sim 60 \text{ kWh/m}^2_{\text{floor}}$
- High population density: 54 662 p/km<sup>2</sup> (population-weighted).
- High heat densities. Most of the city above 500 MWh/ha.



# Background

- Demand: 806 GWh
- Current heat supply: mostly based on fossil fuels and a small share of Joule electric heating.
- Less than 30% of the buildings have centralized heating systems.
- No District Heating system.
- Abundant industrial waste heat (~400 GWh) in the vicinity of the city and ambient heat from river, sea and WWTP (~600 GWh).

Bilbao's current heat supply

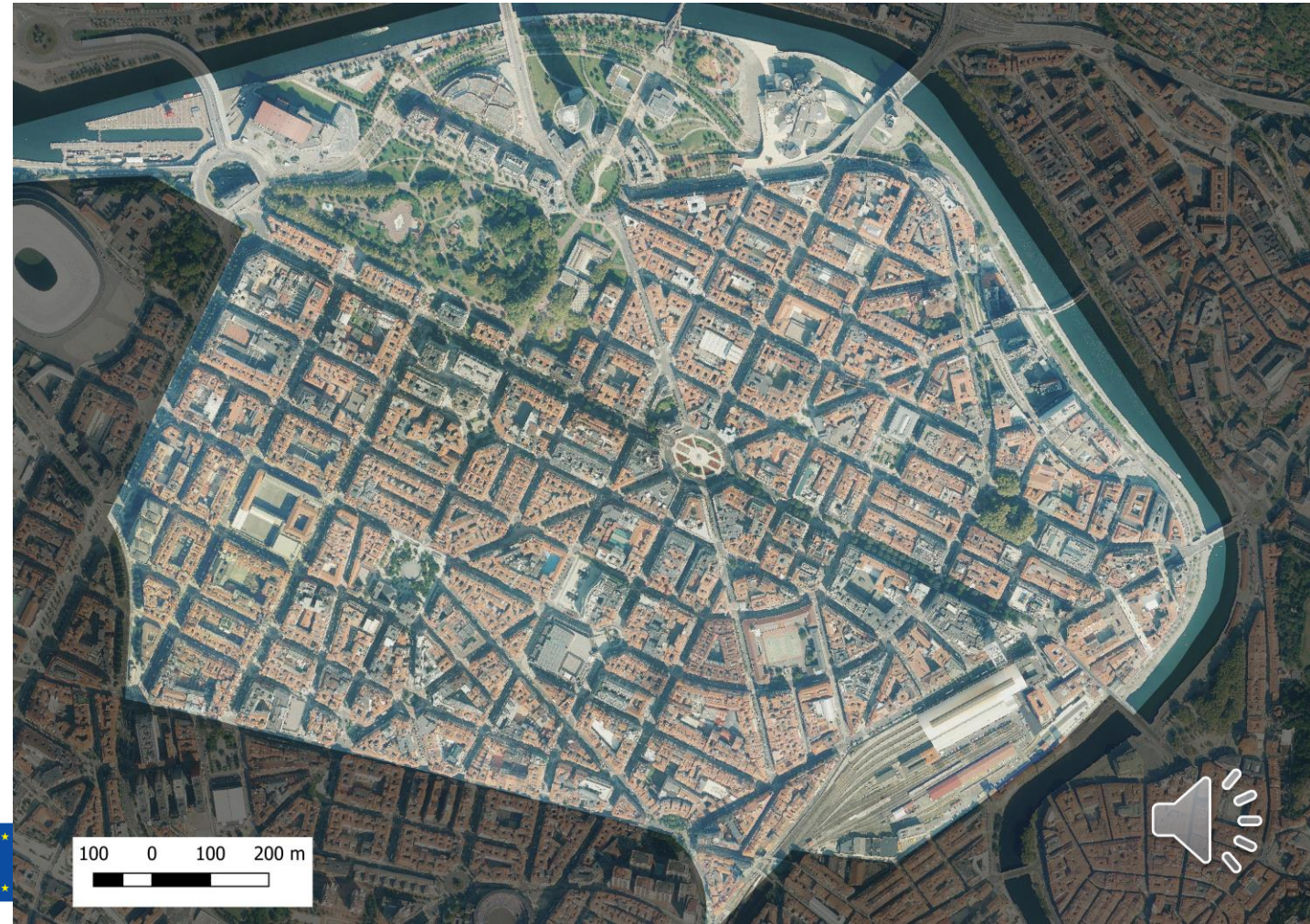


# Research questions

- Is a District Heating system feasible in such a mild climate?
- What are the benefits and costs for Ambient Temperature and Warm District Heating?

Case study in the District of Abando characterized by high heat demand and buildings with centralized heating systems.

Focus Presentation → **Network**



# Methodology

- Pipe network follows street network from OpenStreetMaps.
- Simple routing algorithm: shortest path from each consumer to production plant with Dijkstra's algorithm.
- Pipe sizing: based on algorithm by Tol & Svendsen, 2012.



# Basic assumptions

## Warm District Heating

- SH demand → Maximum hourly demand.
- DHW demand → 37 kW/dwelling & 200 W/m<sup>2</sup> for service.
- Simultaneity factor only for DHW.
- $T_s = 80^{\circ}\text{C}$
- $T_r = 60^{\circ}\text{C}$  for SH and  $40^{\circ}\text{C}$  for DHW.
- Maximum pressure → 60, 100 and 160 mwc.

## Cold District Heating

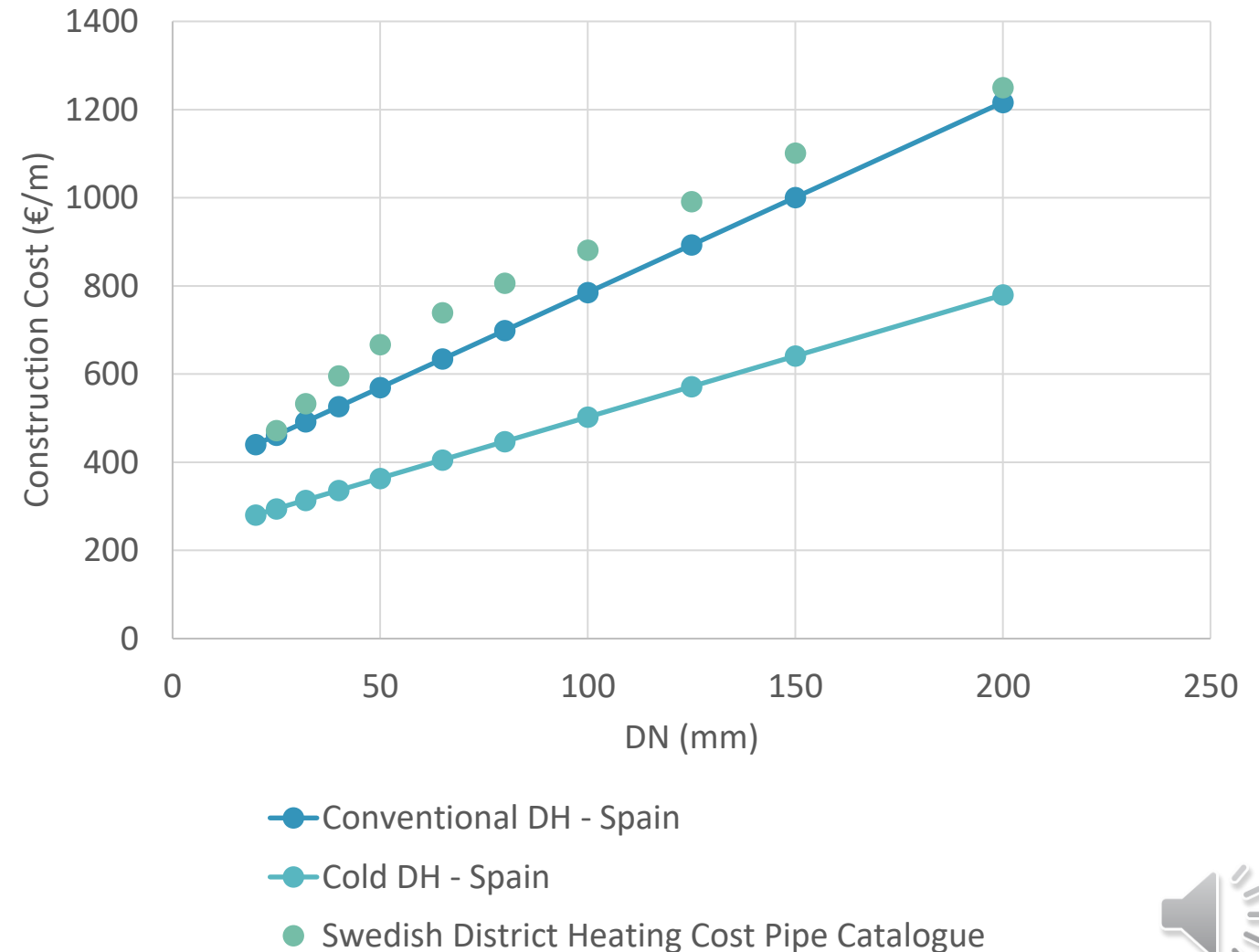
- SH demand → Maximum hourly demand.
- DHW demand → Daily demand in 8 hours.
- No Simultaneity.
- $\Delta T$  of  $10^{\circ}\text{C}$  for SH/DHW.
- Maximum pressure → 100 mwc.



# Basic assumptions

## Pipe Costs

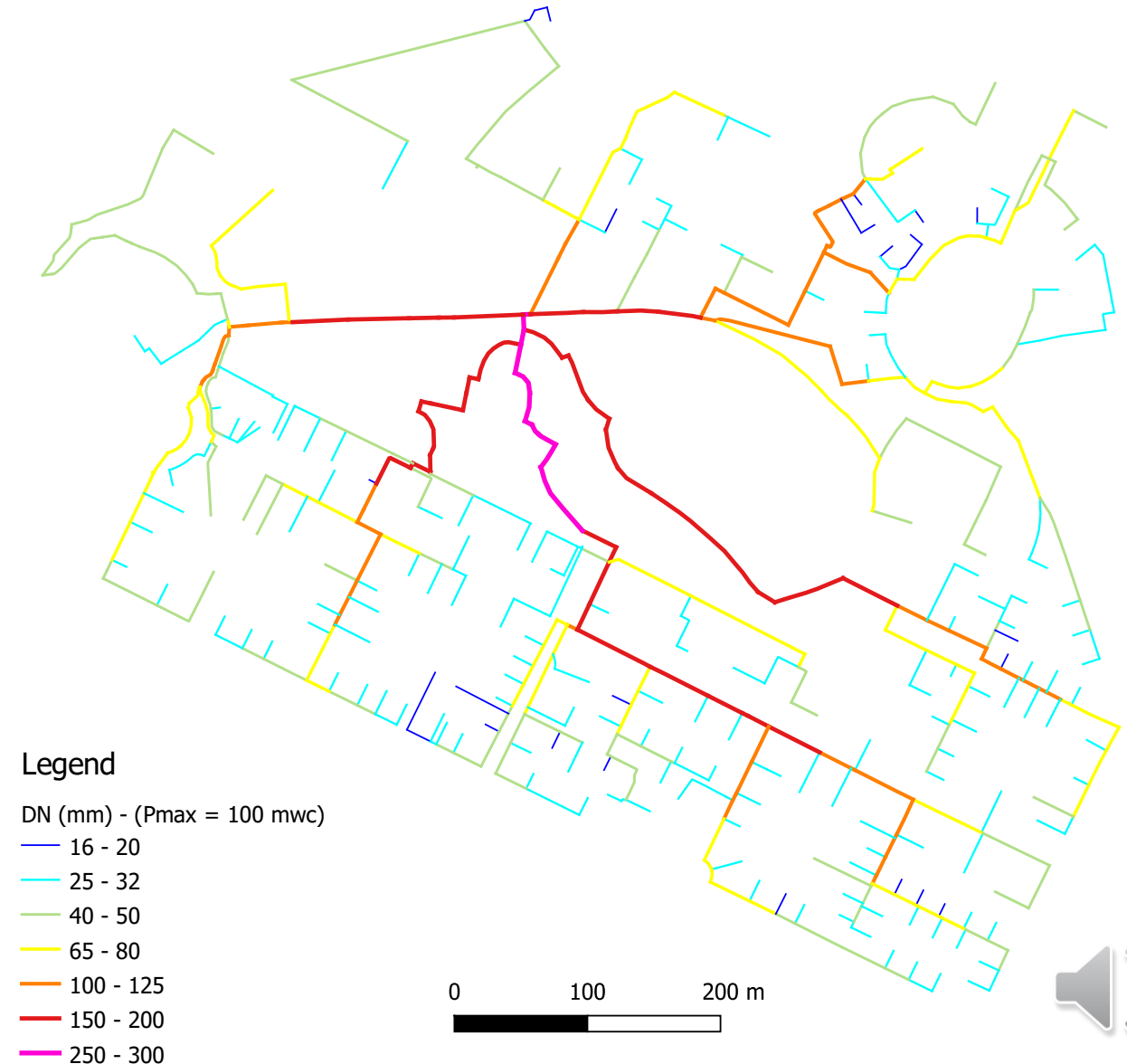
- Warm DH → According to sEEnergies project (data from ADHAC). Similar to the Swedish *Kulvertkostnadskatalog*.
- Cold DH → Estimated from 12 Fresh Water projects in Madrid.
- Cold DH with polyethylene pipes is ~36% cheaper than conventional DH.



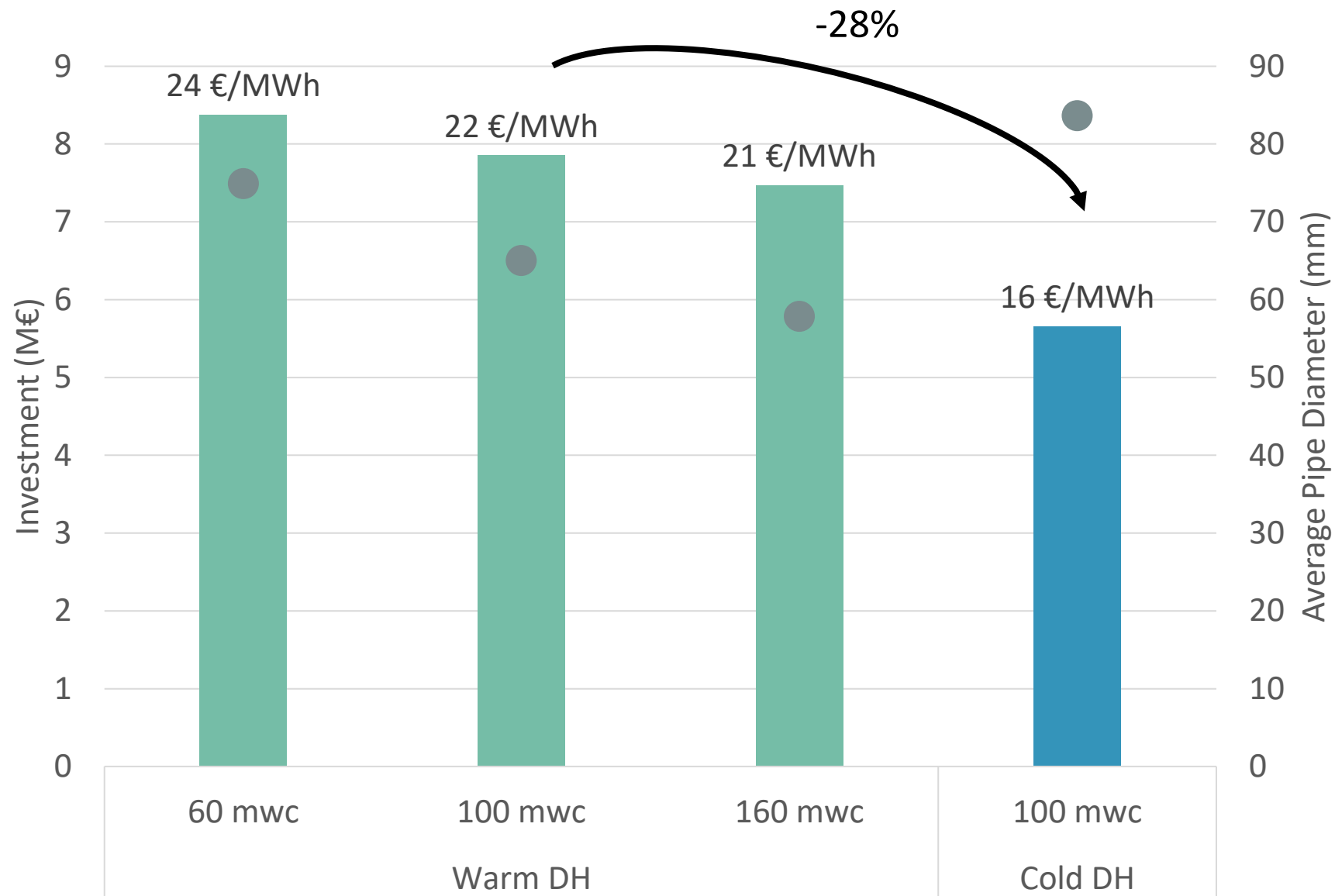
# Results

- Total Pipe Length: 12 376 m
- Total heat demand → 28 GWh
- Centralized heat demand → 24 GWh
- Total Linear Heat Density → 2.3 MWh/m – 8,2 GJ/m
- Centralized LHD → 1,9 MWh/m – 7 GJ/m

Warm DH (100 mwc)



# Results



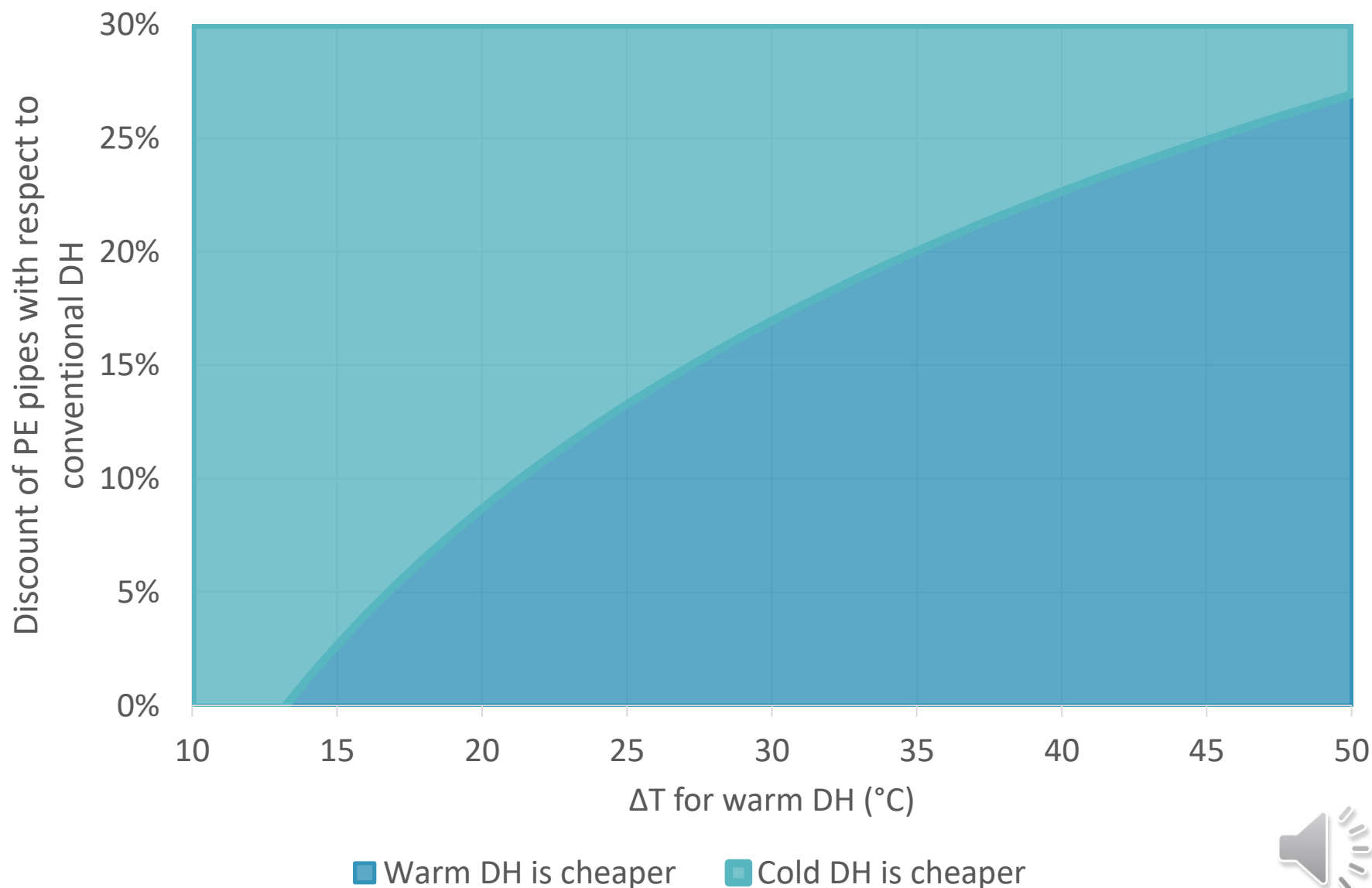
Specific Cost →  
20 years @ 3%



# Results

Generally Cold  
DH  $\rightarrow$   $\downarrow$  cost if PE  
pipes are cheap  
enough.

For  $\uparrow \Delta T \rightarrow$  the  
discount of PE  
pipes will need to  
be  $\uparrow$  for  $\downarrow$  cost of  
cold DH



# Conclusions

- Network-wise → DH is feasible with relatively low specific piping costs (16 – 24 €/MWh) in line with top-down analysis.
- Cold DH → Generally lower construction costs although more difficult when warm DH has a good  $\Delta T$ .



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# THANK YOU VERY MUCH FOR YOUR ATTENTION

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