

# Invisible Energy Made Visible: Croatia's 3.5 PJ Thermal Catalyst

Integrating industrial waste heat to decarbonise the national heating and cooling sector.

**3.5 PJ: The Untapped Annual Resource**

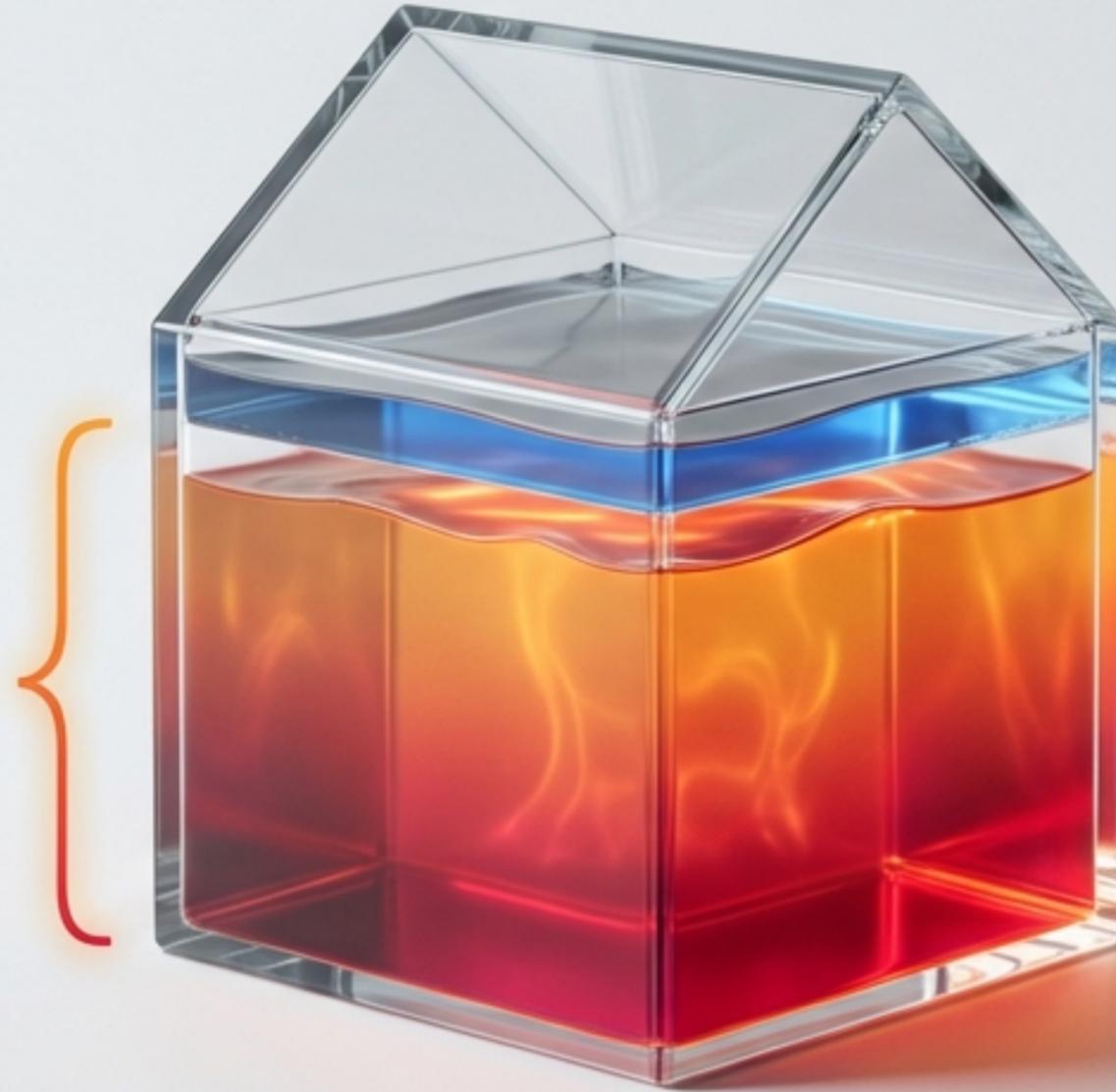


# Heating is Croatia's single greatest energy vulnerability

## The Imbalance

Nearly **80%** of residential energy is thermal.

- Space Heating: 69%
- Water Heating: 10%



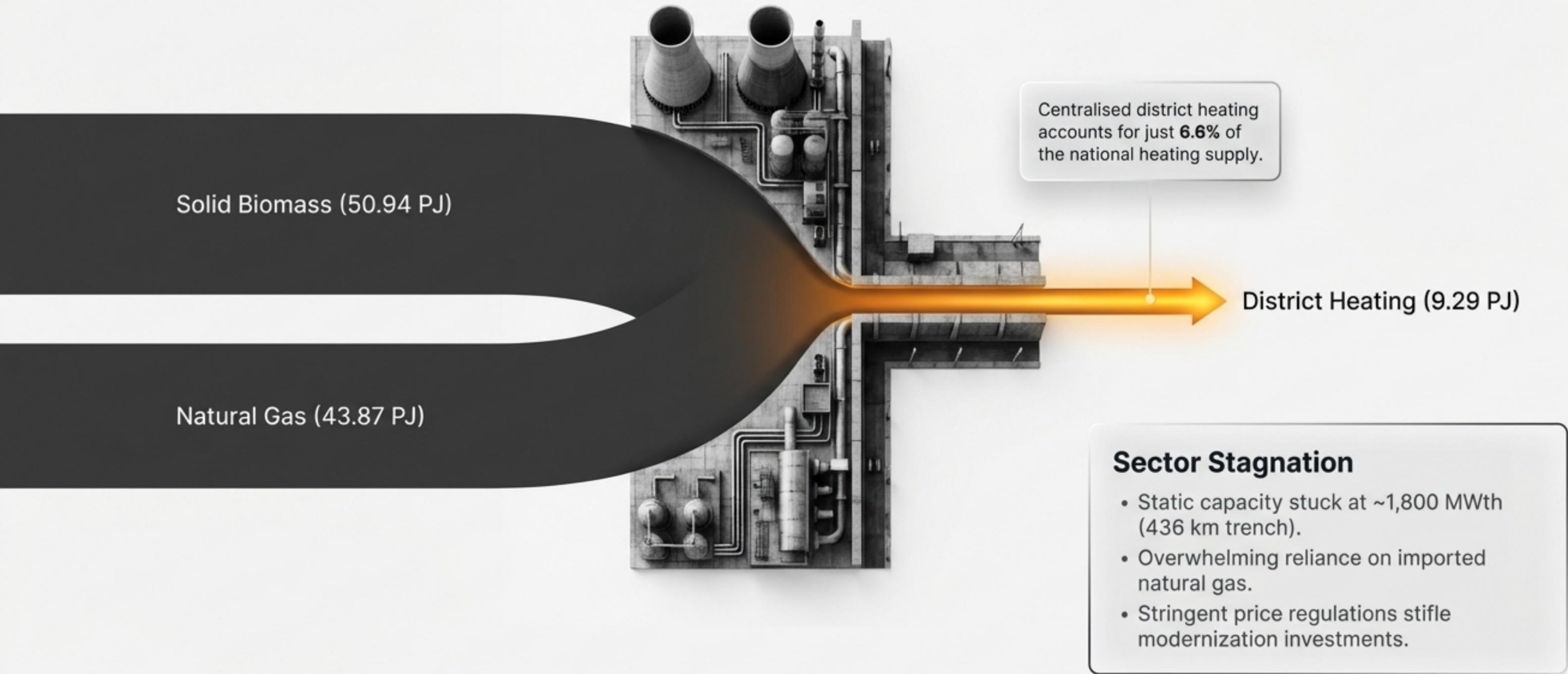
## The Macro Risk

Croatia's economy is highly exposed to imported fossil fuels to meet this thermal demand:

- Total Import Dependency: 54.5%
- Natural Gas Imports: 74.5%
- Oil Product Imports: 78.3%

**Takeaway: Decarbonising the residential sector must fundamentally be a strategy for decarbonising heat.**

# The incumbent thermal system is choked by a structural bottleneck



# The Governance Gap: EU mandates clash with a national policy void

**The Impending Catalyst:** Recast EED Article 25.6 mandates local heating and cooling plans for municipalities >45,000 inhabitants by September 2025.

## Current State: The Void

No legal framework in place (Energy Cities 2024 EU Tracker).

National strategy for district heating postponed indefinitely.

High compliance risk; continued reliance on unregulated biomass and imported gas.



## Required State: The Catalyst

Transposed EED framework into national law.

Mandatory Local Heating & Cooling Plans activated.

Clear investment pathways mapped to hit NECP sub-target of 47.1% renewables in heating by 2030.

# The Discovery: 12 sites holding the key to thermal decarbonisation

## 3.5 PJ / annum

Technically recoverable excess heat available at >95°C.

**The Inefficiency:** Between 20% and 50% of total industrial energy input is currently lost as wasted heat.

**The Baseline:** This 3.5 PJ figure accounts for heat remaining even after current internal heat recovery within the plants is maximized.



# The Heat Grade Diagnostic: Prioritising high-grade integration

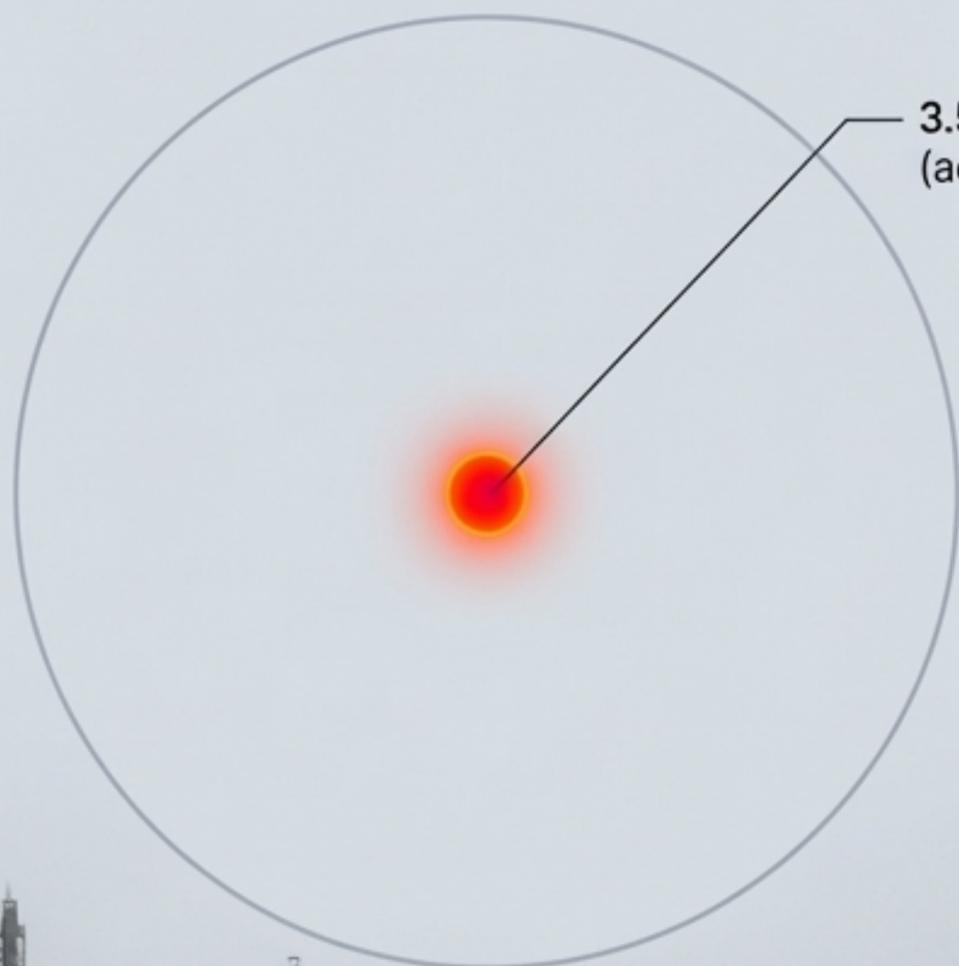
The Heat Grade Diagnostic Table

High-Grade ( $>95^{\circ}\text{C}$ )	Available Potential: 3.5 PJ	Sources: Petrochemical, Metals, Non-metallic minerals	Integration Readiness: HIGH (Direct injection into existing DHC networks)
Medium-Grade ( $55\text{--}95^{\circ}\text{C}$ )	Available Potential: 4.1 PJ	Sources: Food & Tobacco, Paper, Chemicals	Integration Readiness: MEDIUM (Suitable for modern/low-temp DHC)
Low-Grade ( $<55^{\circ}\text{C}$ )	Available Potential: 8.0 PJ	Sources: All sectors, wastewater	Integration Readiness: FUTURE (Requires large-scale heat pumps)

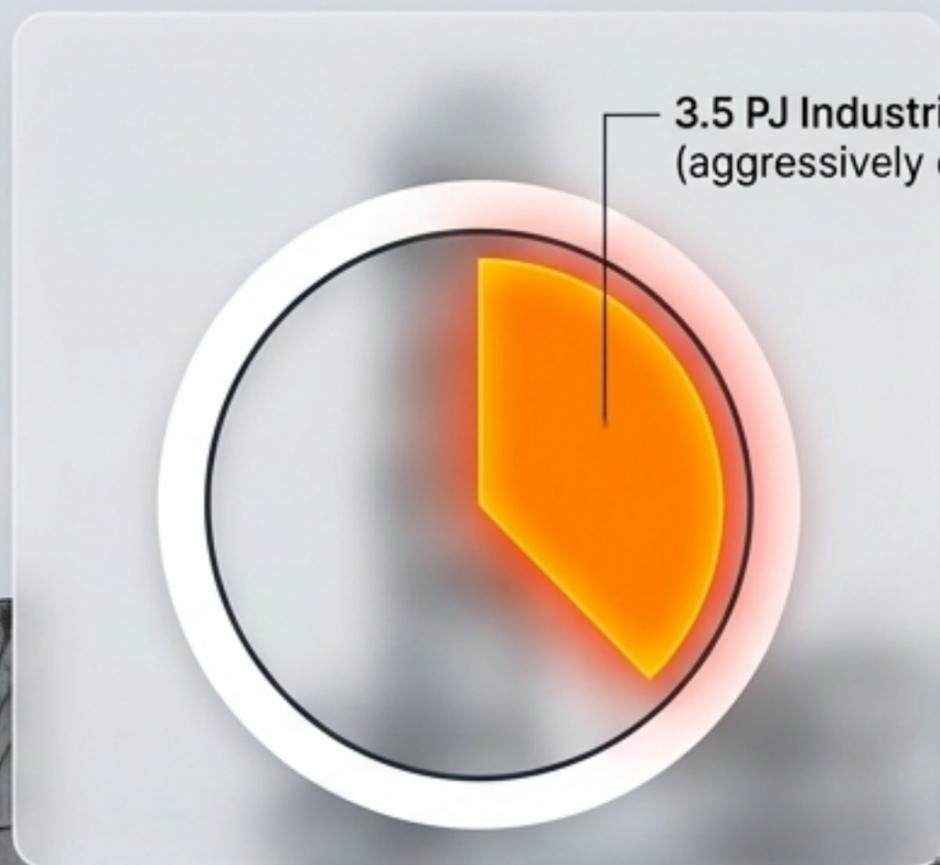
**Key Insight:** The petrochemical sector offers the greatest immediate potential, providing a highly reliable baseload due to 7,900 annual operating hours and stable  $220^{\circ}\text{C}$ – $255^{\circ}\text{C}$  flue gas temperatures.

# The 'Aha' Synthesis: A highly concentrated urban catalyst

Total National Heat Demand (103.6 PJ)



District Heating Demand (9.29 PJ)



**Synthesis:** IWH is not a silver bullet for the entire nation. It is a highly potent, targeted catalyst. 3.5 PJ of high-grade waste heat can satisfy 37.7% of all current district heating supplied in Croatia.

# The Proximity Factor: Why District Heating is the essential integration vector



## The Mechanism

Practical utilisation of large-scale point-source heat for thousands of individual buildings is physically impossible without an aggregation network.

District Heating and Cooling (DHC) serves as this necessary integration vector.

## The Proximity Rule

The sEnergies methodology establishes a 10km radius as the threshold for economic viability.

Major industrial sites in Croatia are historically co-located with urban workforce centres, making pipeline infrastructure highly plausible.

# The Economic Flywheel: Unlocking €700 million in annual system savings

Introduce **zero-marginal-cost Industrial Waste Heat (IWH)**.

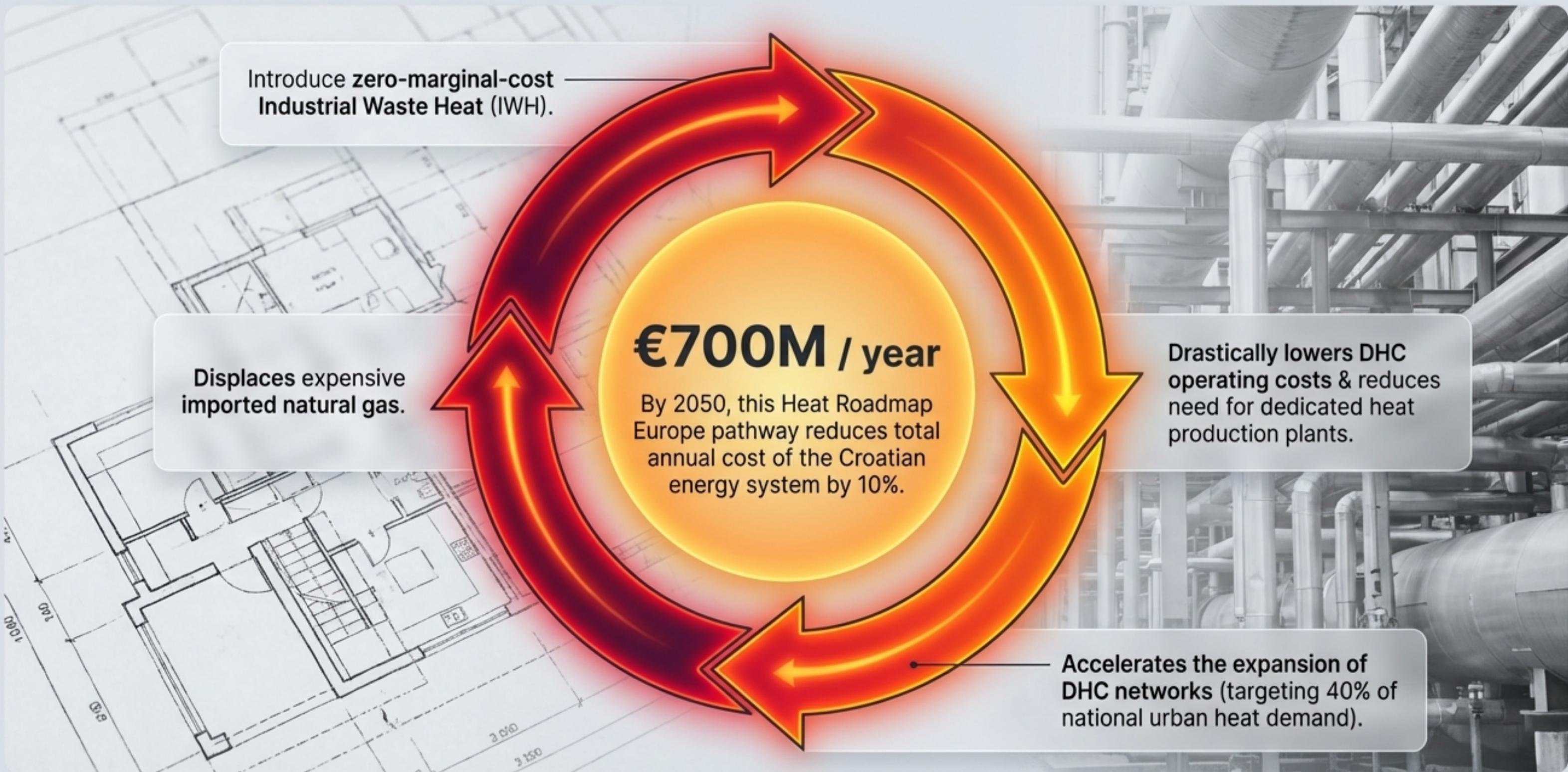
**Displaces expensive imported natural gas.**

**€700M / year**

By 2050, this Heat Roadmap Europe pathway reduces total annual cost of the Croatian energy system by 10%.

**Drastically lowers DHC operating costs & reduces need for dedicated heat production plants.**

**Accelerates the expansion of DHC networks (targeting 40% of national urban heat demand).**



# The Strategic Blueprint: A synergistic policy package



## Crucial Interdependence

These are not a menu of options. Mandating local plans is ineffective without a national strategy, and DHC expansion requires the low-cost economics of waste heat to succeed.

# Phase 1: Establish a National Heat Planning Framework

## 1. Immediate Action:

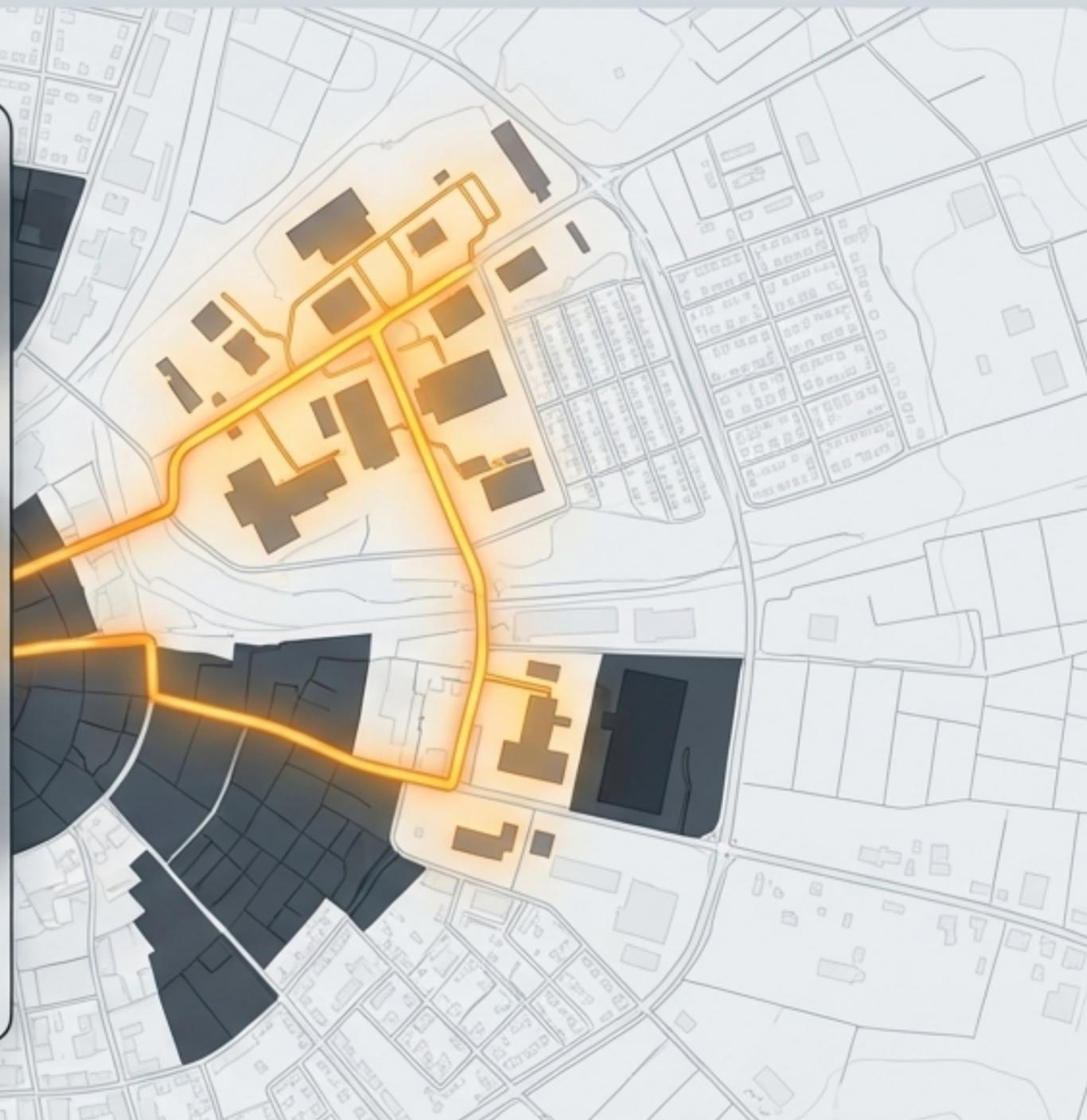
Fully transpose Article 25.6 of the Recast EED into national law.

## 2. Support Structure:

Create a national competence centre (one-stop-shop) to provide municipalities with technical guidance, standardised methodologies, and modelling tools.

## 3. Data Infrastructure:

Institutionalise the Interreg CE-HEAT project's digital waste heat cadastres into a permanent, publicly accessible national thermal atlas (modelled on PETA 4) to georeference heat demand and supply.



# Phase 2: Adopt the Heat Roadmap Europe Strategy



## The Urban Target:

Formally adopt the goal of expanding district heating and cooling networks to supply 40% of the national heat demand across all economically viable urban areas.

**Impact:** Provides the long-term certainty required to drive €22 billion in infrastructure investment over the coming decades.



## The Rural Complement:

Deploy high-efficiency individual electric heat pumps in rural and low-density suburban areas where DHC is technically infeasible.

# Phase 3: Create a Commercial Market for Waste Heat

## The Hurdle:

Industrial operators currently have zero incentive to invest in heat capture equipment.

## Push Mechanism

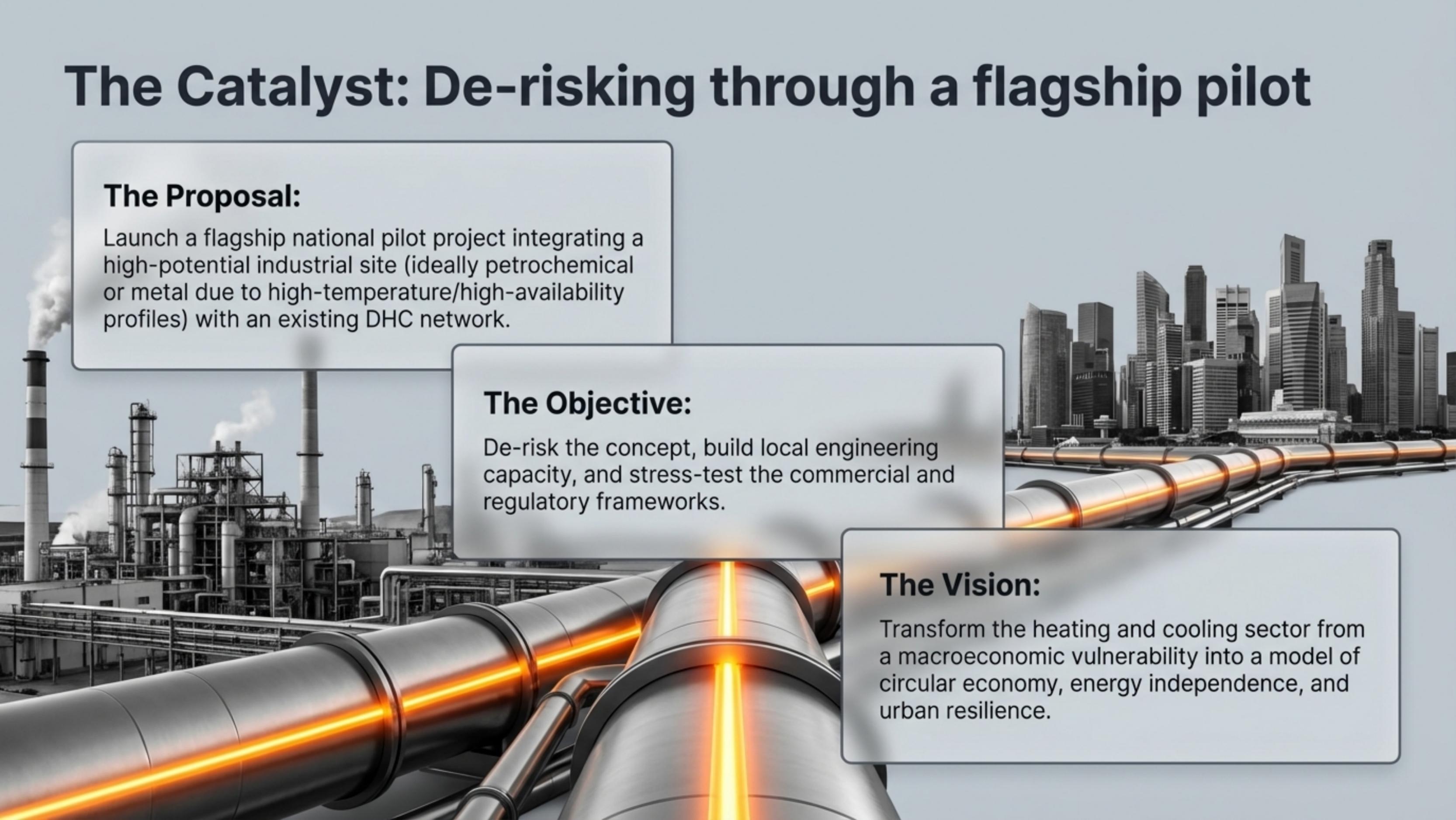
Introduce an environmental fee or carbon tax on vented industrial heat above specific temperature thresholds.



## Pull Mechanisms - The Business Case

- 1. CAPEX Support:** Direct grants or accelerated depreciation for heat recovery equipment and pipelines.
- 2. Revenue Certainty:** Regulated tariff structures or long-term off-take agreements to guarantee predictable returns.
- 3. Regulatory Clearing:** Remove complex permitting barriers for heat pipelines and correct unfavourable tax treatments.

# The Catalyst: De-risking through a flagship pilot



## The Proposal:

Launch a flagship national pilot project integrating a high-potential industrial site (ideally petrochemical or metal due to high-temperature/high-availability profiles) with an existing DHC network.

## The Objective:

De-risk the concept, build local engineering capacity, and stress-test the commercial and regulatory frameworks.

## The Vision:

Transform the heating and cooling sector from a macroeconomic vulnerability into a model of circular economy, energy independence, and urban resilience.



**The strategic integration of industrial waste heat is the most logical, cost-effective step to secure Croatia's decarbonised future.**