



The Heat Vault

A Quantitative Blueprint for Decarbonising
Slovakia's Thermal Sector Through Industrial
Waste Heat Recovery

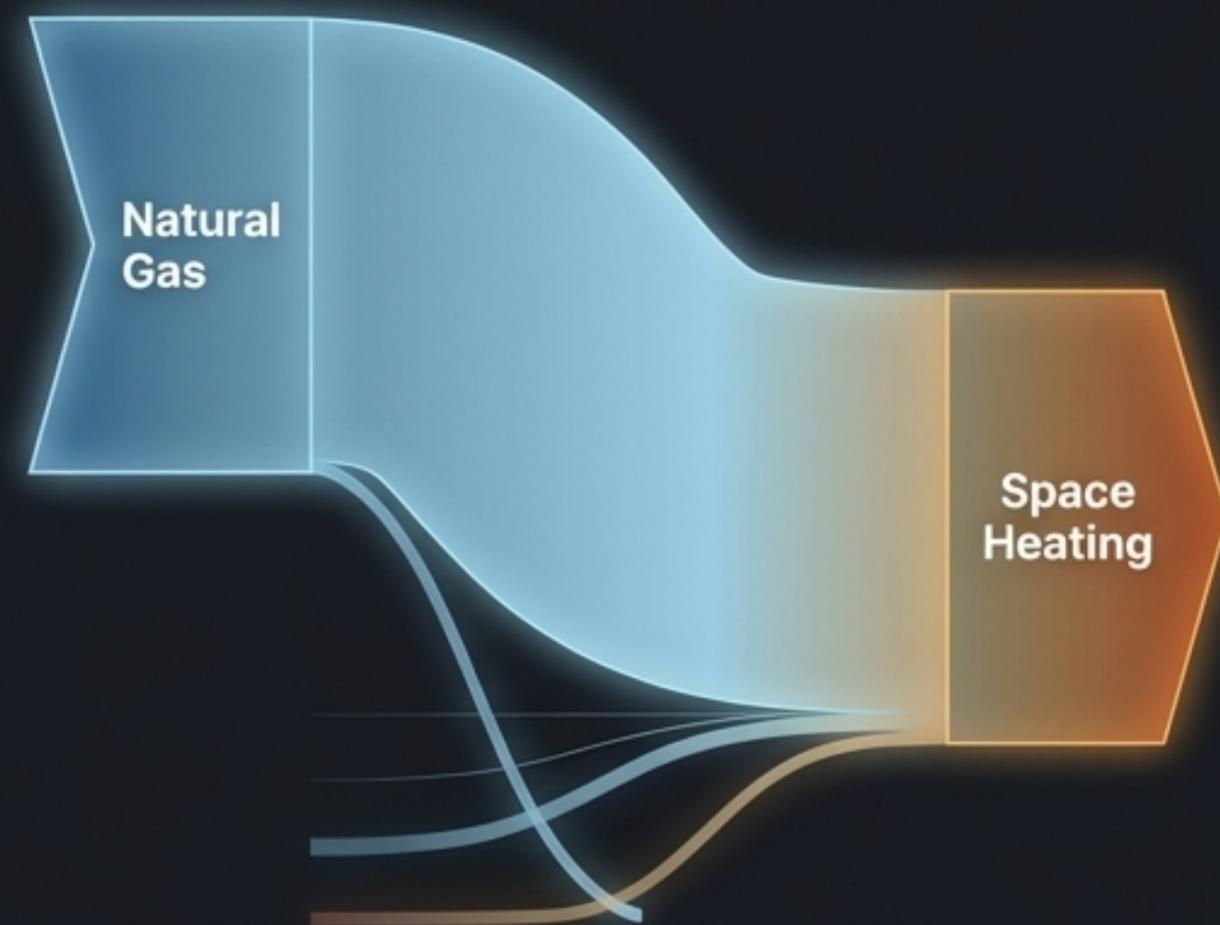
A Strategic Infrastructure Trapped in a Fossil-Fuel Dependency

53%

Proportion of residential heat demand supplied by District Heating (DHC).

133.01 PJ

Total natural gas primary energy input into the national system.



The Slovak Republic possesses one of Europe's most deeply penetrated district heating networks. Yet, this vital infrastructure remains a bastion of fossil fuel incumbency. With widespread gasification reaching over 90% of the population, the system faces a deep-rooted economic and infrastructural lock-in, jeopardising national and EU climate targets.

The Anatomy of DHC Emissions

	Combined Heat and Power (CHP)	Heat-Only Boilers	Total Production
Natural Gas	15.0 PJ	10.0 PJ	25.0 PJ
Coal & Coal Products	7.5 PJ	3.0 PJ	10.5 PJ
Solid Biomass	1.0 PJ	2.5 PJ	3.5 PJ
Other	~1.0 PJ	~0.23 PJ	~1.23 PJ

88% Fossil Baseline

Natural gas and coal collectively constitute over 88% (35.5 PJ) of the primary energy inputs for the centralized district heating network. Solid biomass, the primary renewable, contributes a mere 3.5 PJ.

The Regulatory Trap Stifling Network Modernisation

Well-intentioned consumer price protections inadvertently function as a cost-plus trap. This suppression of ROI disincentivises capital investment in efficiency upgrades or cleaner heat sources, locking consumers into an aging, high-carbon, and insecure energy supply.

Entrenched Monopoly

20% higher RES threshold required for disconnection blocks alternative competitors.

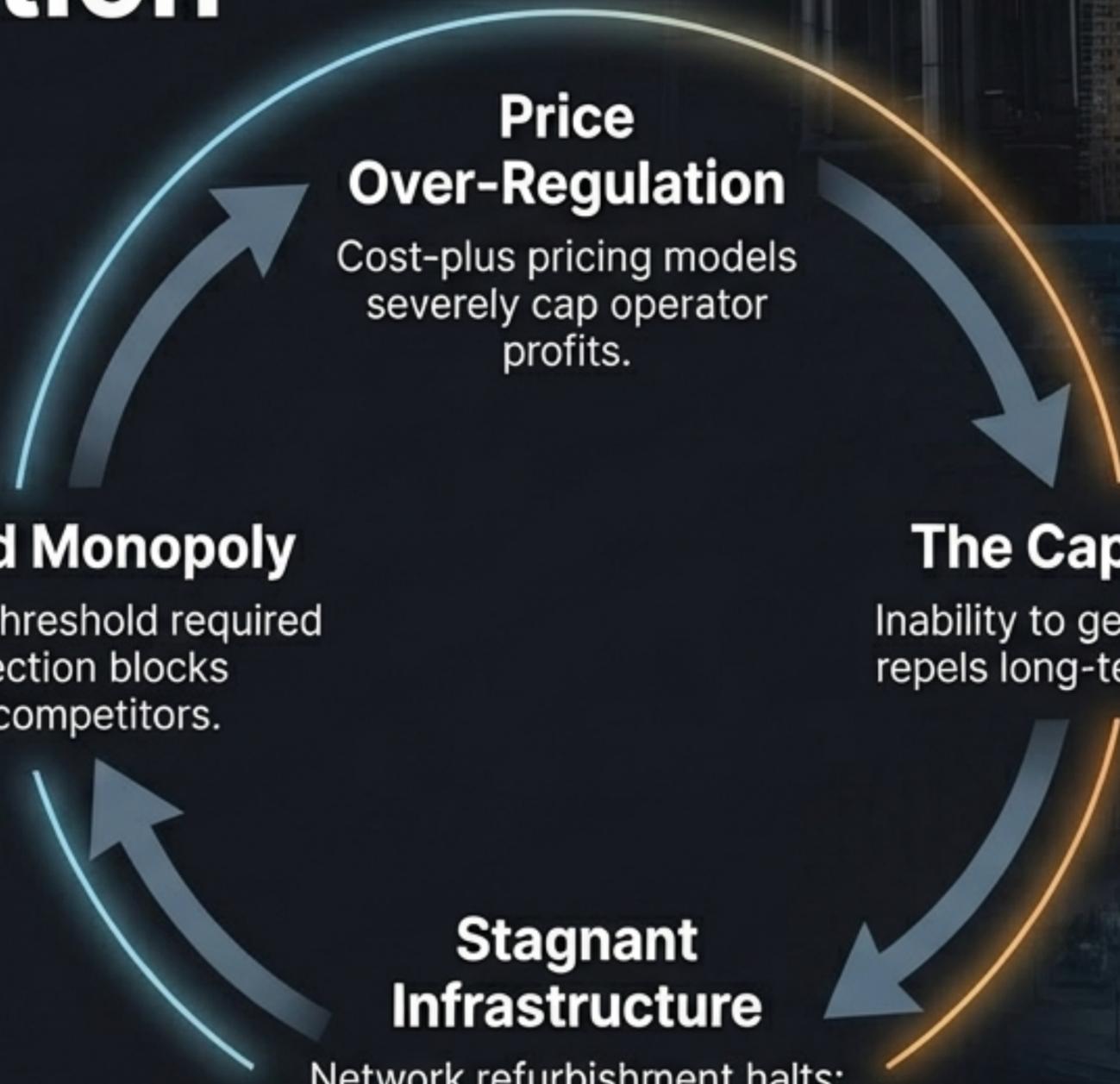
Price Over-Regulation
Cost-plus pricing models severely cap operator profits.

The Capital Void

Inability to generate returns repels long-term financiers.

Stagnant Infrastructure

Network refurbishment halts; distribution pipes age (15-30 years old), leading to massive thermal losses.



The 2025 European Mandate Cliff

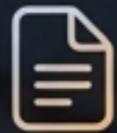
Present Day

September 2025

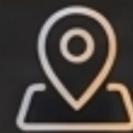
Energy supply plans obligatory but disconnected from spatial planning.

The Recast EU Energy Efficiency Directive (EED) deadline.

Core Requirements



Mandatory comprehensive heating and cooling plans for municipalities over 45,000 population.



Detailed mapping of local heating and cooling potentials



Strict trajectories aligned with climate neutrality.

The Implementation Deficit

Slovak municipalities currently lack the technical staff, financial resources, and granular spatial data required to execute these sophisticated plans. Without immediate state intervention, the national decarbonisation strategy risks total local failure.

The Hidden Asset: Slovakia's Industrial Thermal Engine

100 PJ

Total industrial final energy consumption (2023).

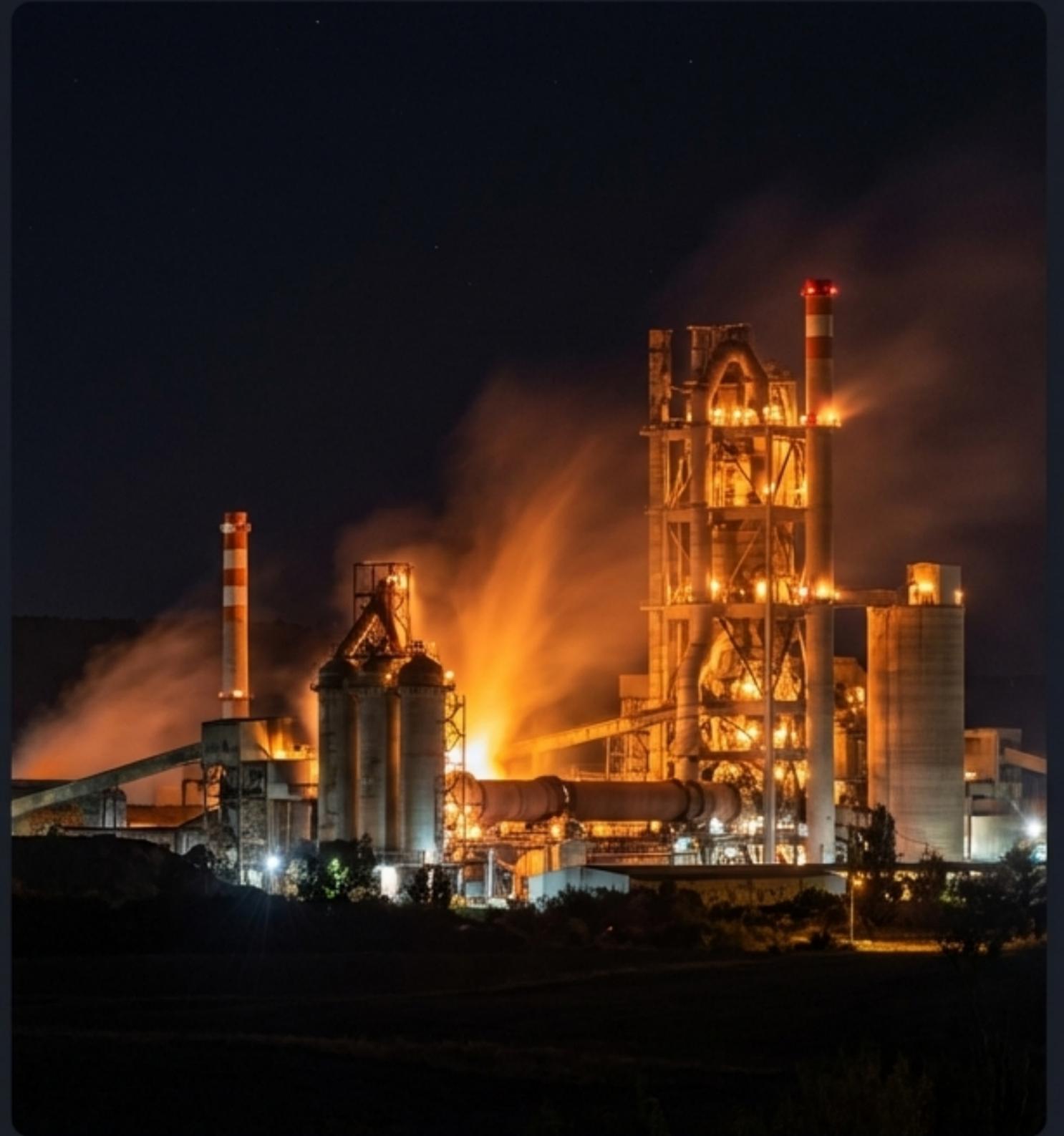
4 - 9 PJ

Technical potential of recoverable high-temperature (>95°C) waste heat per year.

9 - 18 PJ

Technical potential of low-temperature (>25°C) waste heat per year.

Slovakia's heavy industrial base—spanning iron and steel, chemical processing, non-metallic minerals, and pulp and paper—generates a vast, continuous stream of high-temperature thermal energy. Currently, this energy is vented into the atmosphere as a discarded byproduct.



The Geographic Advantage of Legacy Planning

Technical potential is irrelevant without proximity. Fortunately, mid-20th-century centralised planning in Slovakia deliberately co-located heavy industrial facilities with newly planned urban settlements and district heating systems.

Key Insight

This legacy creates an exceptional synergy. The most significant cost barrier to waste heat recovery—long-distance transmission infrastructure—is practically eliminated. The resource is already precisely where the demand is.



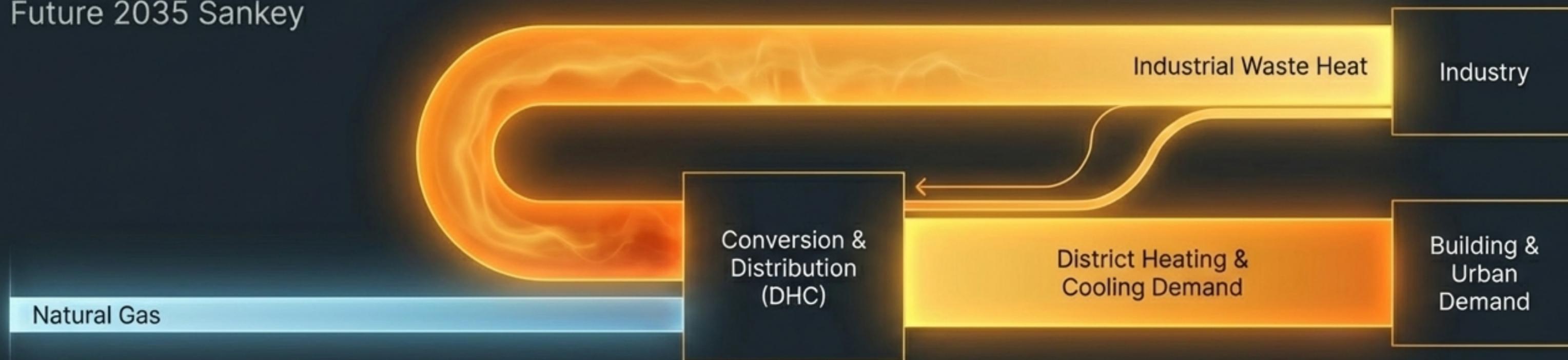
Bridging the Gap: Supply Meets Demand



This is not a marginal resource. Geographically viable industrial waste heat can satisfy up to 20% of the total heat supplied by the national DHC system. It is the single most cost-effective lever for near-term thermal decarbonisation.

The 2035 Vision: A Circular Energy Economy

Future 2035 Sankey



Strategic Enablers

Displacement

Direct reduction in imported primary fossil fuels.

Efficiency

Lowers overall primary energy required to meet final heat demand.

EU Compliance

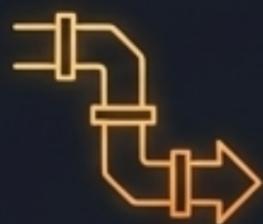
Provides a direct pathway for legacy DH networks to reach the EU's 50% 'efficient DHC' benchmark, unlocking massive structural funding.

The Strategic Blueprint: Regulatory Reform

Policy Transformation Matrix

	The Current Regime	The Heat Vault Blueprint
Permitting	Industrial heat venting is unregulated.	"Waste Heat First" principle. Mandatory feasibility studies for >20 MW facilities and right of first refusal for DH operators.
Price Regulation	Cost-plus pricing limiting ROI.	Performance-based models. Enhanced ROI tied directly to efficiency KPIs and waste heat integration.
Local Planning	Unfunded, abstract mandates.	State-funded competence centres empowering municipalities with strict zoning authority.
Data Governance	Fragmented, anomalous reporting.	A centralised, publicly accessible national thermal energy database managed by SIEA.

The Strategic Blueprint: Investment & Infrastructure



Synergy Infrastructure

Prioritise EU structural and Modernisation funds strictly for 'last-mile' transmission pipelines connecting industrial heat sources to existing urban DH sinks. Deploy public loan guarantees to de-risk capital.

Heat Transformation Tech

Create dedicated subsidy programmes and tax incentives for large-scale, high-efficiency industrial heat pumps. This upgrades vast volumes of low-temperature (<math><100^{\circ}\text{C}</math>) waste heat to DH-compatible temperatures.

Standardised PPP Frameworks

Develop national legal templates for Public-Private Partnerships. Align the municipal planning authority with private sector technical execution to share costs, risks, and revenues equitably.

A nighttime aerial view of a city, likely Bratislava, Slovakia. The foreground shows illuminated buildings and streets. In the background, a large industrial facility with multiple smokestacks and structures is visible against the dark sky. The city lights create a warm, golden glow.

Turning Industrial Liability into Urban Resilience

The transition from a linear model of energy consumption to a circular one—where industrial waste becomes urban warmth—is not merely a technical possibility. It is a strategic imperative.

By systematically harnessing industrial waste heat, the Slovak Republic can insulate its vital district heating networks, displace up to 23% of fossil fuel imports, and make a profound leap towards its 2050 climate targets.