Proceedings World Geothermal Congress 2026
Calgary, Canada, June 8 – 11, 2026

Mapping geothermal district heating and cooling market maturity across the EU

Katarzyna A. Kurek*, Jessica Maria Chicco and Adela Ramos Escudero
Czech University of Life Sciences*, University of Turin, TU Delft
*kurek@pef.czu.cz

Keywords: geothermal district heating and cooling; market maturity; public support; technical maturity; TRL; GIS mapping

ABSTRACT

We propose a practical framework to assess geothermal district heating and cooling (geoDHC) market maturity in Europe by combining (i) project-level technical maturity and (ii) national public-support maturity. Using 29 geoDHC installations in 13 EU countries reported in the COST Geothermal-DHC network and the SAPHEA project, we construct a Technical Maturity index (Technology Readiness Level, system scale, and 'human reach') and a Public Support index (regulatory intensity and support schemes for renewable DHC) derived from the EU RED II district heating and cooling assessment. Both indices are normalised to 0–10 and visualised through a maturity matrix and GIS maps. Results reveal strong 'pioneer' clusters where advanced deployments align with supportive frameworks (e.g., Germany, Poland, France, Slovakia), but also systematic mismatches: technology-leading contexts with policy gaps (e.g., Romania) and policy-driven contexts with limited population reach (e.g., the Netherlands). The approach is intended as a diagnostic tool to prioritise regulatory improvements and investment support for scaling geoDHC in the EU.

1 INTRODUCTION

Heating and cooling accounts for more than half of final energy use in the EU, with the majority still supplied by fossil fuels. GeoDHC can decarbonise urban heat at scale, yet deployment remains uneven across Europe. Existing assessments typically describe either technical readiness (e.g., TRL) or the enabling environment (laws, permitting, incentives) in isolation, which makes it hard to judge whether markets are 'ready' to scale geoDHC. This paper therefore asks: how do observed levels of technical maturity and public support in real geoDHC projects translate into geothermal market maturity?

We contribute a geoDHC-specific maturity metric and provide comparable cross-country benchmarking supported by GIS maps.

1.1 Research problem and research question

Research problem. GeoDHC scale-up is constrained by fragmented evidence: project catalogues describe technical readiness, while regulatory reviews describe enabling conditions, but they are rarely linked in a comparable way across countries. This makes it difficult for practitioners and policymakers to prioritise interventions that unlock deployment at scale.

Research question. By scaling up data from EU projects and EU reporting into harmonised indices, we ask:

- How technically mature are observed geoDHC systems across EU Member States (based on project-level evidence)?
- How strong is the national public-support environment for renewable DHC (regulation and support schemes)?
- Where do mismatches between technical maturity and public support indicate the highest leverage for action?

2 DATA AND METHODS

To scale up fragmented evidence into a comparable cross-country dataset, we compile a purposive sample of 29 geoDHC systems across 13 EU countries from EU project outputs (COST Geothermal-DHC results and the SAPHEA scenario catalogue), selected to cover diverse geologies, system configurations, and use contexts (urban DH networks, institutional systems, and industrial/agricultural applications). Public-support conditions are taken from Tractebel & Artelys' (2021) EU RED II district heating and cooling market and regulatory overview.

2.1 Indicators

Two composite indices are constructed and scaled to 0–10:

- Technical Maturity (installation-level, then country average): Technology Readiness Level (TRL 1–9), system scale/complexity (capacity, depth, network generation, resource type), and an estimated 'human reach' proxy (population/users served).
- Public Support (country-level): Regulation (ownership/operatorship, pricing regime, metering rules, and grid access on supply and demand side) and Support (presence of national schemes for RES in DHC, CHP, and DHC infrastructure).

The indices are combined in a Public Support–Technical Maturity matrix. Values are also mapped with national boundaries and overlaid with representative geoDHC project markers to highlight geographic patterns.

3 RESULTS

Country-level Technical Maturity (0–10) ranges from 6.0 to 8.3 across the 13 sampled EU Member States. Mapping Technical Maturity (Figure 1) shows higher average scores in Central and Eastern Europe (e.g., Hungary, Romania, Slovenia, Slovakia), consistent with deeper resources, substantial installed capacity and/or broad heat-network integration in the sampled cases. Public Support varies more widely (2.0 to 10.0): Figure 2 indicates that similarly mature technical contexts can face very different enabling conditions (e.g., the Netherlands and Spain combine strong policy packages with lower technical maturity in sampled systems, while Romania and Italy show the inverse pattern). Figure 3 summarises the joint positioning in the Public Support–Technical Maturity matrix.

The maturity matrix (Figure 3) highlights four recurring patterns:

- High tech / high support ('pioneers'): aligned innovation and governance enabling scale-up (e.g., Germany, Poland, France, Slovakia, Czech Republic, Hungary).
- Low tech / high support ('policy-driven starters'): strong policy packages but limited population reach or network integration in sampled cases (e.g., the Netherlands; Spain).
- High tech / low support ('technology leaders with policy gaps'): mature systems exist but national support is fragmented or indirect (e.g., Romania; Italy; Denmark).
- Low tech / low support ('emerging'): foundational policy and deployment gaps (Portugal in this sample).

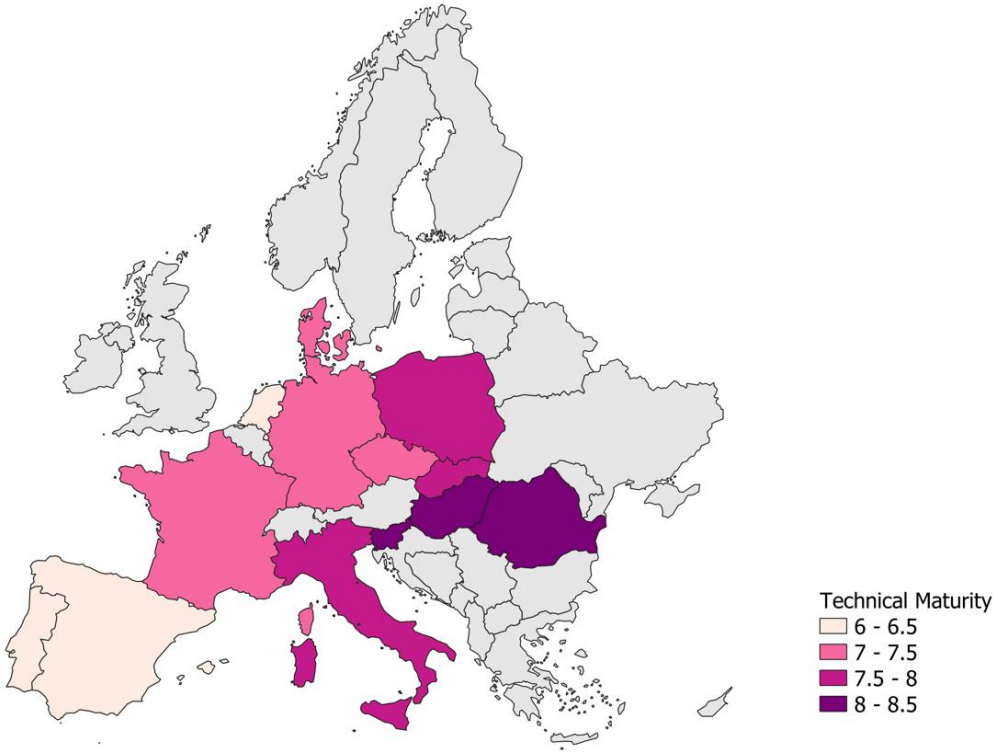


Figure 1. Composite Technical Maturity for geoDHC across sampled EU Member States (project-derived country averages). Own elaboration.

Figure 1 shows that Technical Maturity is highest in Central and South-Eastern Europe, with Hungary, Romania and Slovenia reaching the top tier (≈8.0–8.5), and Slovakia/Poland/Italy also scoring high (≈7.5–8.0). This pattern reflects countries where geoDHC projects are typically high-TRL and/or larger in delivered heat and end-user reach, indicating more proven, scalable system performance. In contrast, Spain and the Netherlands sit at the low end (≈6.0), suggesting that—within our sample—deployments are smaller in reach/scale or less representative of broad market roll-out, even where interest and pilots exist.

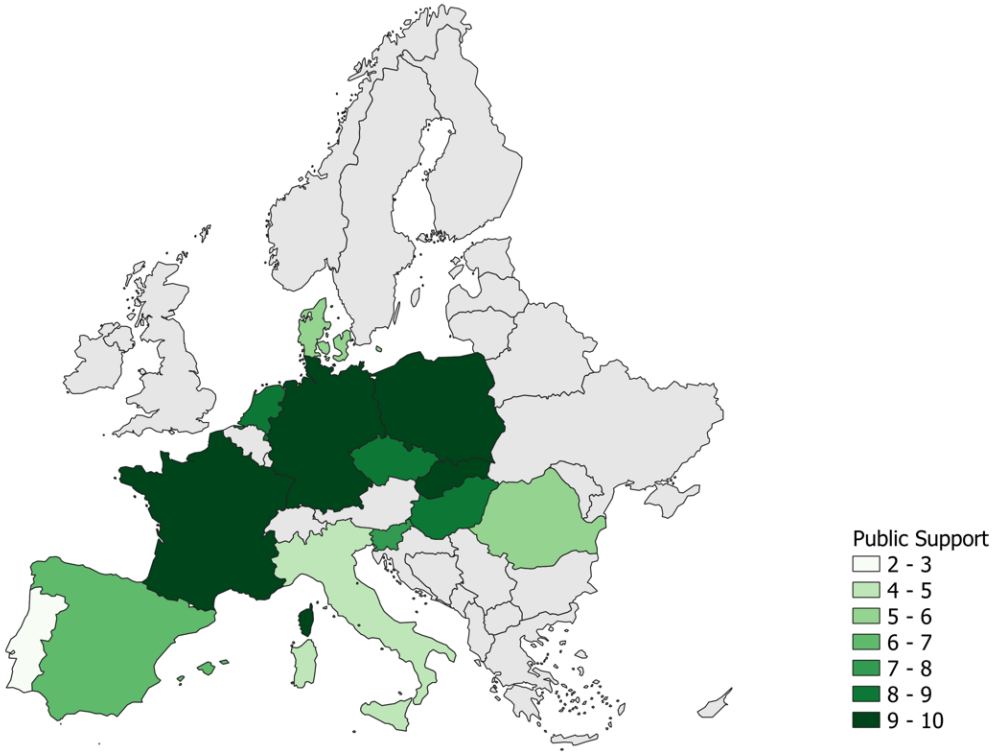


Figure 2. Composite Public Support for geoDHC across sampled EU Member States (regulation + support). Own elaboration.

Figure 2 indicates a clear gradient in the enabling environment: Poland and Germany score at the top (≈10), followed by France and Slovakia (≈9.6), pointing to a combination of strong regulatory frameworks and/or robust support schemes for renewable DHC. Czechia and the Netherlands also perform strongly (≈8.8), while Portugal is lowest (≈2.0) and Italy remains relatively weak (≈4.8). Importantly, the map reveals policy–deployment mismatches: for example, Romania combines very high technical maturity with only moderate public support (≈5.1), whereas the Netherlands shows strong public support despite low technical maturity, suggesting different leverage points for accelerating geoDHC (targeting support design vs. market-building measures).

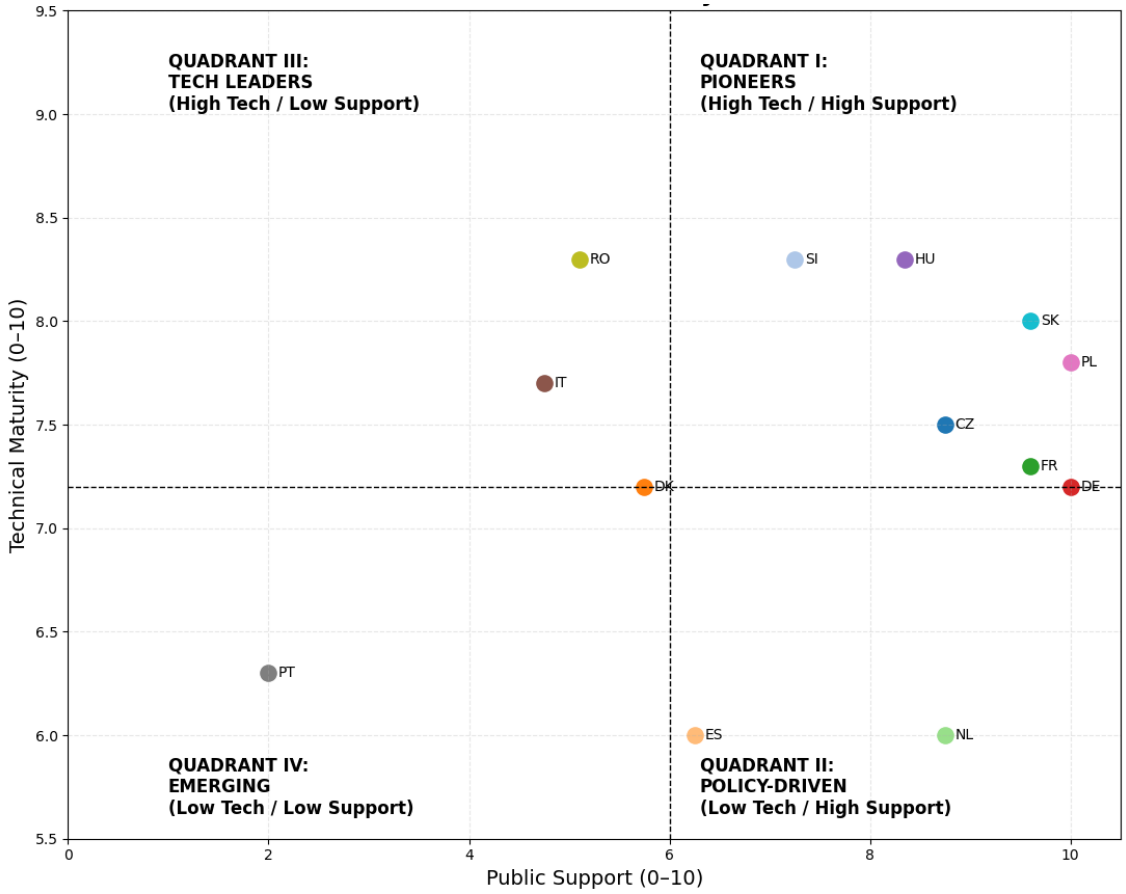


Figure 3. GeoDHC market maturity matrix: Public Support versus Technical Maturity (country averages). Own elaboration.

Figure 3 combines both indices into a single diagnostic view and reveals four distinct readiness patterns. An upper-right cluster of "pioneers" (e.g., Germany, Poland, France, Slovakia, Czech Republic, Hungary and Slovenia) shows aligned high Public Support and high Technical Maturity, indicating environments where supportive rules/schemes reinforce proven, scalable geoDHC delivery. The lower-right "policy-driven starters" (notably the Netherlands and Spain) combine strong public support with comparatively lower technical maturity, suggesting that the enabling framework is in place but deployments in the sample remain smaller in scale/reach or earlier in the roll-out pathway. Conversely, the upper-left "technology leaders with policy gaps" (Romania and Italy; Denmark near the boundary) show high technical maturity despite weaker/fragmented public support, implying that accelerating scale-up will depend more on permitting, market rules and targeted risk-mitigation than on technology readiness. Finally, Portugal appears in the lower-left "emerging" quadrant, where both pillars are low, pointing to a need for foundational policy support alongside project pipeline development.

4 DISCUSSION AND IMPLICATIONS

The combined framework is designed to be actionable. 'Pioneer' countries provide benchmarks for how clear rules, support schemes and advanced deployments reinforce each other. Mismatched quadrants indicate where targeted interventions may deliver the highest marginal benefit: (i) in technology-leading contexts, improve permitting, market rules and risk-mitigation instruments to unlock private investment; (ii) in policy-driven contexts, focus on project pipelines, urban integration and business models that increase network-connected heat demand ('human reach').

A key limitation is the absence of a dedicated financial maturity pillar due to inconsistent EU-wide data; however, part of this dimension is indirectly represented through the support index. Future work should add comparable indicators for risk sharing, cost of capital, and realised investment volumes.

5 CONCLUSIONS

We introduced a geoDHC-specific market maturity metric that jointly considers technical maturity and public support. Applied to 29 installations across 13 EU countries, the approach reveals both clusters of aligned readiness and structural mismatches that can constrain scale-up. The maturity matrix and GIS visualisations

offer a compact diagnostic tool for EU and national stakeholders to prioritise regulatory improvements, investment support, and cross-country learning.

Acknowledgements

The study received no funding.

REFERENCES

Boissavy, C.: Status of geothermal district heating in Europe, Proceedings, European Geothermal Congress 2016, Strasbourg, France (2016).

EGEC – European Geothermal Energy Council: Market report 2022: Geothermal energy in Europe (2022).

European Commission: An EU strategy for energy system integration (COM/2020/299 final) (2020).

European Commission: REPowerEU: Joint European action for more affordable, secure and sustainable energy (COM/2022/108 final) (2022).

Geothermal-DHC: Results, COST Action CA18219 (2019–2024).

IEA: Renewable heat policies: Global status and recommendations (2021).

Mazzucato, M.: The entrepreneurial state: Debunking public vs. private sector myths, Anthem Press (2015).

Rogge, K.S., and Reichardt, K.: Policy mixes for sustainability transitions, Research Policy, 45 (2016), 1620–1635.

Tractebel & Artelys: Overview of District Heating and Cooling Markets and Regulatory Frameworks under the Revised Renewable Energy Directive (RED II) (2021).

Kurek, K. A., Chicco, J. M., & Ramos Escudero, A.: Zenodo repository for maturity scoring data (2025). https://doi.org/10.5281/zenodo.17220350