Buildings blocks for geothermal development, case examples from The Netherlands

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Keywords: State energy company, geothermal potential, public-private partnerships, development, PPS, Region of Amsterdam, Province of Noord-Brabant.

ABSTRACT

Energie Beheer Nederland (EBN), a state-owned company under the Ministry of Climate and Green Growth, plays a central role in the Dutch heat transition by actively supporting the development of geothermal energy. Through risk-sharing, knowledge dissemination, and mandatory participation (20–40%) in new projects, EBN enhances the professionalization and acceleration of geothermal deployment as a sustainable heat source. The national SCAN program, led by EBN and TNO, addresses geological uncertainties by acquiring and sharing subsurface data. In regions such as the Province of Noord-Brabant and the Amsterdam metropolitan area. Despite challenges such as insufficient subsurface data, risks of induced seismicity, and fragmented heat demand, targeted action plans and feasibility studies are helping to overcome these barriers. EBN supports in building regional consortiums with partners and facilitates this process by contributing technical expertise, co-financing exploration, and aligning geothermal development with broader climate and energy strategies. These region-specific strategies, grounded in collaboration, policy integration, and innovation, demonstrate how geothermal energy can play a structural role in achieving a climate-neutral heat supply. This paper shows how EBN serves as a strategic link between public interests and market development in these two regions.

1. INTRODUCTION

Energie Beheer Nederland (EBN) is a state-owned company playing a pivotal role in the Dutch energy transition. Established in 1975, EBN operates as a policy participation of the Ministry of Climate and Green Growth. Its core mission is to contribute to a reliable, affordable, and sustainable energy supply in the Netherlands. In doing so, EBN collaborates closely with both public and private partners to accelerate the transition towards a climate-neutral energy system. One of EBN's focus activities is the heat transition: EBN co-develops large-scale geothermal energy projects and promotes collective heating systems to reduce dependence on fossil fuels. The Netherlands have significant geothermal potential due to its favourable geological conditions. The direct use of heat is therefore a primary focus in geothermal developments deeper than 500 meters, with a projected potential of 55–125 PJ by 2050 (Rijksdienst voor Ondernemend Nederland, 2023).However, the development of geothermal projects faces various challenges, including high initial investment costs, geological uncertainties, and the need for long-term cooperation among public and private stakeholders. EBN addresses these challenges by participating as a non-operating partner in geothermal projects, sharing both knowledge and financial risks. Its involvement helps to strengthen project robustness and enhance investor confidence.

As of July 1, 2023, legislative changes mandate EBN's participation in all new geothermal licenses, with an ownership stake ranging from 20% to 40%. This compulsory involvement ensures that EBN contributes both financially and in terms of risk-sharing, without taking on operational responsibilities. The primary objectives are to accelerate project development, disseminate technical expertise, and promote the further professionalization of the geothermal sector.

In addition to co-investment, EBN contributes technical expertise and promotes transparency by collecting and sharing geological and operational data. Through the national SCAN program , EBN maps the Dutch subsurface in collaboration with TNO Geological Survey in areas where there is insufficient data availability for initiating a geothermal project. This data-driven approach reduces uncertainty and facilitates informed decision-making for future geothermal initiatives. As can be seen in figure 1, the main focus areas of the SCAN program are the Province of Noord-Brabant and the region of Amsterdam. Both areas are regions in which the interest from oil and gas in the past was limited which results in a lack of both well data and seismic data compared to other parts of the Netherlands (Ter Borgh et al (2024), Rehling et al. (2024)). More in-depth technical information about the regional exploration within the

Province of Noord-Brabant is described by De Vries, et al, (2025).

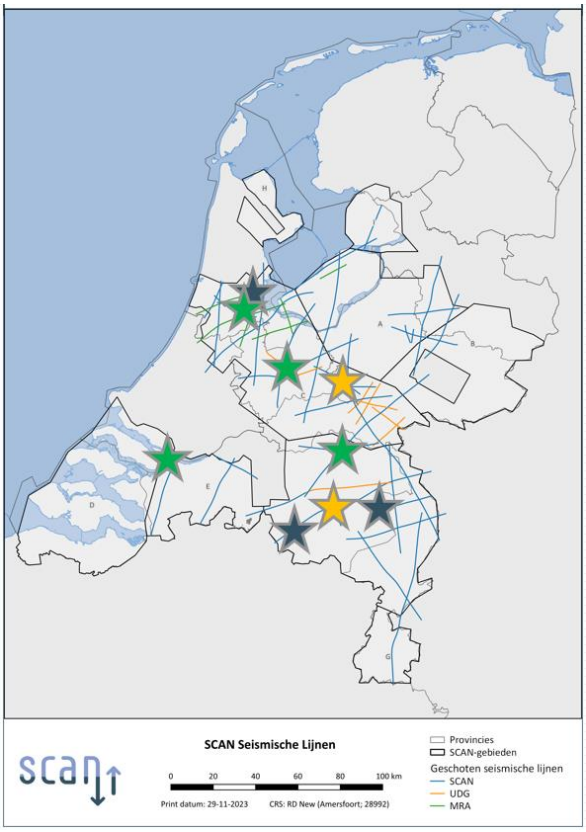

Figure 1. Activities of SCAN in the Netherlands. The blue lines are new SCAN seismic lines. A green star is a completed well, a yellow star is a well in progress and a blue star is a search area for a potential new well.

EBN's role also extends to policy support and collaboration with governmental and regional bodies. By participating in public-private partnerships, EBN ensures that geothermal development aligns with national climate goals and regional energy strategies. The company actively supports innovation, safety, and standardization in the geothermal sector to improve efficiency and reduce risks (Heijnen et al., 2025).

In summary, EBN functions as a knowledge partner, risk-sharing investor, and strategic advisor, working to unlock geothermal energy's potential as a reliable and sustainable heat source in the Dutch energy mix.

2. PROVINCE OF NOORD-BRABANT

In light of growing commitment to sustainable energy and the urgent need to decarbonize heat supply, geothermal energy has emerged as a critical component in the energy transition for the Netherlands. The Province of Noord-Brabant recognizes the potential of geothermal energy to meet low-carbon heat demand across several key sectors —namely the urban environment, greenhouse horticulture, and light industry. This recognition is formalized in the 2023–2027 provincial coalition agreement "Samen maken we Brabant" (Provincie Noord-Brabant, 2023), which prioritizes geothermal development within the regional climate strategy. This perspective is further detailed in the Implementation Agenda Energy 2024–2027 (Provincie Noord-Brabant, 2024), where the province outlines its focus on collective solutions—like geothermal energy—to help boost the use of renewable energy.

Nevertheless, actual progress in the development and deployment of geothermal energy within Noord-Brabant has been limited. The province currently trails behind both national averages and the ambitions articulated in earlier regional agreements such as the 2016 Green Deal Geothermal Brabant. Despite the presence of promising geological formations and substantial heat demand, geothermal projects have been slow to materialize, primarily due to a set of persistent barriers.

To address this lag, the Province of Noord-Brabant, in collaboration with EBN, Regional Energy Strategy (RES) regions, municipalities, and industry stakeholders, has developed an "Action Plan for Geothermal Energy in Noord-Brabant", aimed at accelerating geothermal development. This action plan builds on a shared vision for sustainable heat and identifies a roadmap to overcome institutional, financial, geological, and communicational obstacles. As can be seen in figure 2, the action plan consists of a steering committee, core team and working groups. Through the linked action plan, the members of the action plan are actively working to remove obstacles and take advantage of opportunities to speed up the development of geothermal energy in a responsible way.

2.1 The main objectives of the action plan

During the initial phase of the action plan, the main objectives were defined by all involved stakeholders, resulting in the identification of the following key goals:

- Increase awareness and understanding of geothermal energy among policymakers, citizens, and market actors
- Improve the availability and accessibility of geological and heat demand data to enable more informed decision-making.
- Mitigate financial risks through targeted instruments and risk-sharing mechanisms.
- Promote a supportive policy and investment environment for geothermal exploration and operation.
- Facilitate spatial alignment between subsurface geothermal potential and local heat demand.

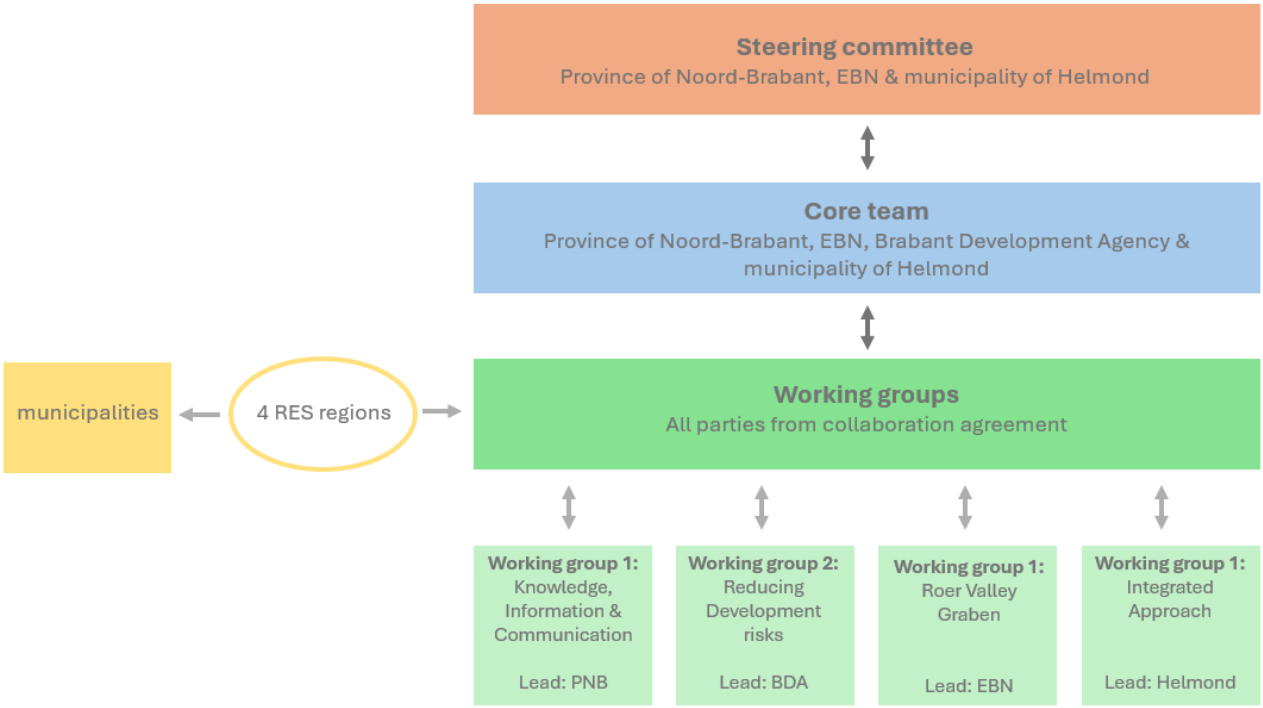

Figure 2. Governance of the "Action Plan for Geothermal Energy in Noord-Brabant", consisting of a steering committee, core team and working groups, working together with the 4 RES regions which are the linking pin with the all the municipalities in the province of Noord-Brabant

2.2 Key barriers & opportunities of geothermal development in the province of Noord-Brabant

Also, during the initial phase of the action plan, there all parties defined five key bottlenecks:

1. Uncertainty around risks of induced seismicity, particularly in the Roer Valley Graben, where the complex fault systems raise safety concerns.
2. Limited access to geological subsurface data, which hampers site identification and investment confidence.
3. High financial risks, especially in the early stages of geothermal exploration and drilling, where costs are high and the probability of failure remains significant.
4. Absence of integrated geothermal potential mapping, which prevents the effective matching of supply and demand in regional energy planning.
5. Lack of coordinated, scalable heat demand, particularly in regions where potential consumers (e.g. residential areas, greenhouse clusters) are fragmented or insufficiently organized to support a viable business case.

Despite these challenges, additionally, the action plan identifies several opportunities for geothermal acceleration:

- Utilizing deep and shallow geothermal potential (500–1500 meters) to feed into existing and future district heating networks.
- Enhancing sustainability in greenhouse horticulture through locally available, renewable heat.
- Promoting regional cooperation and knowledge sharing between public authorities, research institutions, and energy developers.
- Aligning geothermal development with spatial planning instruments and climate-neutral heat strategies at the municipal and regional level.

To implement the action plan effectively, a dedicated governance structure has been established, consisting of four thematic working groups, each with a specific mandate:

1. Knowledge, Information & Communication:
   This group is tasked with increasing general and technical awareness of geothermal energy. Efforts include the development of accessible information materials, the organization of public engagement campaigns, and the creation of a centralized information platform where stakeholders can find reliable, up-to-date data on geothermal potential and projects.
2. Reducing Development Risks: Focuses on financial and technical risk mitigation. Key activities include exploring risk insurance, developing public-private financial instruments, and designing

support schemes tailored to Brabant's geothermal context.

3. Roer Valley Graben: Given the unique seismic and geological characteristics of this region, this group examines the safety implications of wells. It seeks to develop robust risk assessment frameworks and decision-making protocols, potentially informed by ongoing national research and seismic monitoring efforts.
4. Integrated Approach to Geothermal in the Energy Transition: This working group aims to create and refine geothermal opportunity maps that integrate geological data (from sources like SCAN and ThermoGIS) with spatial heat demand insights (e.g., RES Heat Strategies, local climate plans). These maps will support municipalities and heat companies in making strategic choices about geothermal investment and infrastructure planning.

Each working group is composed of relevant experts from public authorities, energy companies, scientific institutions, and consultancies. The governance model emphasizes transparency, shared learnings, and adaptability, recognizing the evolving nature of technologies and market dynamics.

The action plan represents a proactive and collaborative effort to unlock the region's geothermal potential. It balances technical analysis with policy, innovation, local engagement, and intergovernmental coordination. Through this structured and action-oriented approach, and the activities of the SCAN programme Noord-Brabant aims not only to close the gap with other Dutch provinces but also to position itself as a frontrunner in sustainable heat transition.

3. REGION OF AMSTERDAM

The Amsterdam region hosts two major district heating networks: Westpoort Warmte and Diemen-Almere. These systems currently serve approximately 50,000 and 140,000 home equivalents, respectively, and rely primarily on waste incineration and gas-fired power plants for their heat supply (see figure 3). Geothermal energy is recognized by the Municipality and by Vattenfall as a crucial component in the city's strategy to decarbonize its heating infrastructure. However, since geothermal sources alone may not always meet the high-temperature requirements of the existing networks, additional high-temperature heat pumps are expected to be necessary to deliver the needed performance. Unlocking geothermal energy as a dependable source of base-load heat is also central to supporting the expansion of both existing and new heat networks. The activities currently underway may lay the foundation for a transformative shift in the Amsterdam region's energy future.

3.1 Subsurface Data Limitations

Historically, the Amsterdam region has faced significant subsurface "data poverty" due to limited oil and gas exploration. Early seismic and well data suggested poor development of the Slochteren Formation (Fm)—one of the Netherlands' key geothermal reservoirs in this area.

To address this, legacy seismic data was reprocessed, and a regional 2D seismic survey was conducted in 2021 under the national SCAN program, cofinanced/extended with additional budget of the province. The results pointed to a possible "fault cut-out" bias, implying that the Slochteren Fm might be better developed than previously assumed.

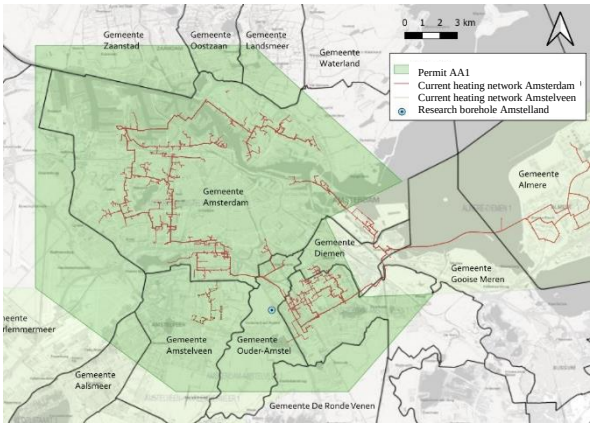

Figure 3. Map of the Amsterdam region with location of geothermal license and heating network.

In late 2023, the first research borehole, Amstelland-01 (AMS-01), was drilled to investigate the formation's potential. Encouragingly, the Slochteren Fm was found to be over 100 meters thick, with good permeability and temperatures reaching up to 82°C—conditions favourable for geothermal energy production fitting the heat demand in the area. The technical details can be seen in figure 4.

3.2 Upcoming Data Acquisition Initiatives

Initial geological assessments indicate strong potential for the direct use of hydrothermal resources. As a result, several new data acquisition campaigns are planned for 2025 and 2026:

- Amsterdam-01 Research Well (Q3 2025): This SCAN research well will assess the Slochteren Fm approximately 10 km northwest of AMS-01, in a geologically distinct domain. The objective is to evaluate the potential for the Diemen-Almere network and understand how burial history affects reservoir quality.
- 3D Seismic Survey – Amsterdam (Q3 2025): Covering 90 km², this survey will deliver detailed imaging of subsurface structures, aiding in well planning and site selection for geothermal doublets across the city.

Thickness	112 mAH
Facies	Clean (eolian?) sandstone
Porosity	Average 18%, up to 26%
Permeabiity	High core permeabilities
Production	Produced and re-injected 1000m3
Temperature	82°C, around 5ºC higher than pre-drill best estimate.
Flow	90% of flow taken by 2 zones of 10m thickness each.

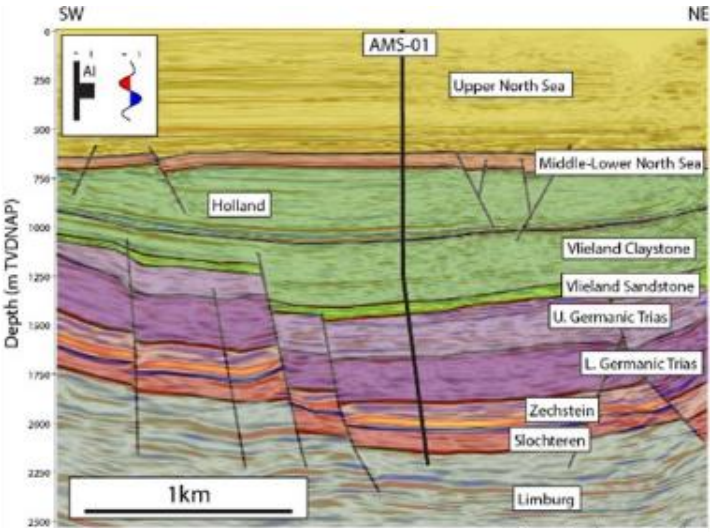

Figure 4. Results table and seismic line with stratigraphic zonation Amstelland-1 SCAN well

- 2D Seismic Survey – Aalsmeer Area (2026): Up to 100 line-km of regional seismic lines will be acquired in the flower-growing hub of Aalsmeer, to define the broader structural trends of the Slochteren Fm.
- Additional Surveys (2026): Depending on the results from ADA-01, further seismic efforts may include a 3D survey in Almere and 2D lines in Amsterdam West and North.

3.3 Collaborative Public-Private Partnerships

Amsterdam-Amstelveen Area: In August 2024, the Municipality of Amsterdam and Vattenfall, holders of the geothermal exploration license indicated in figure 3, partnered with EBN to explore geothermal development in the license area. This collaboration aims to ensure a sustainable, affordable, and reliable heat supply for the region.

- Municipality of Amsterdam brings local knowledge, supports spatial planning and social integration, and facilitates the identification of surface sites.
- Vattenfall contributes as the heat offtake partner, with expertise in district heating and project management for large-scale infrastructure.
- EBN, as a state-owned energy company, provides funding, technical expertise, and safeguards public interests, including best practices in subsurface exploration and development.
- Province of Noord-Holland and Eneco initially held stakes but have since stepped back, confident in the partnership's capacity to cover public interests.

The immediate goal is to assess feasibility for a geothermal capacity of 30–45 MW in the Amstelland area to support the Diemen-Almere network. The Amstelland 3D seismic survey, co-financed by the partnership, the province (EUR 2 million subsidy), and the SCAN4 program, will be central to this effort.

The feasibility phase runs through the second half of 2026. A public tender for a geothermal operator is planned in the second half of 2025. Combined results from this survey and ADA-01 will determine the medium-term development ambition of 60–90 MW, with longer-term plans dependent on both subsurface and surface developments.

Aalsmeer Area: Situated 8–15 km southwest of AMS-01, the Aalsmeer region encompasses five smaller geothermal licenses operated by Gaia Energy in collaboration with EBN. A formal partnership is expected by Q2 2025, focusing on feasibility studies to supply heat to the region's large greenhouses.

Working closely with the Municipality of Haarlemmermeer, the partnership is preparing a 2D seismic survey and subsidy application to the Province of Noord-Holland. The subsidy could cover up to 50% of costs, contingent upon public release of data and feasibility results.

3.4 Feasibility Studies: Toward first heat before 2030

AMS-01 and the emerging geothermal partnerships have accelerated pre-feasibility studies that will define the roadmap for significant geothermal deployment by 2030 as in the Province of Noord-Brabant. EBN is committed to ensuring these studies are comprehensive and aligned with public interests, focusing on:

1. Geological Characterization - A robust geological understanding is foundational. This includes mapping the Slochteren Fm using seismic and well logs (e.g., AMS-01), assessing reservoir thickness, porosity, permeability, and temperature. Hydrogeological modelling will evaluate flow dynamics and thermal sustainability to inform long-term production potential.

2. Site Selection - Sites are evaluated based on subsurface potential, heat demand proximity, and surface suitability. Key factors include reservoir depth and quality, access to district heating infrastructure, land use planning, and social and environmental considerations. Coordination with local authorities ensures spatial integration and public support.
3. Technical Concept Development - This phase defines the system design: well configurations, surface facilities, and integration with existing heat networks. Concepts include doublet spacing, heat pump requirements, and thermal output modelling. Compliance with mining regulations and safety standards is embedded in the design process.
4. Business Case Development – Assessing economic viability, risks, and benefits.
5. Governance Framework – Clarifying partner roles during development and operation.
6. Stakeholder Engagement – Ensuring community alignment and transparent planning.

These efforts form the backbone of a potential paradigm shift in Amsterdam's heating system. By focusing on feasibility, innovation, and inclusive collaboration, the Amsterdam region is positioning itself as a leader in sustainable urban energy transition, alongside other major European capitals.

4. CONCLUSIONS

Collectively, these regional initiatives reflect a growing recognition of geothermal energy as a scalable, low-carbon solution. EBN plays a central role in enabling this development by actively de-risking projects, co-investing as a non-operating partner, and contributing technical and geological expertise. In both Noord-Brabant and the Amsterdam region, EBN facilitates the integration of geothermal energy into regional heating strategies by ensuring access to reliable subsurface data (e.g., through the SCAN program), advising on risk management, and promoting standardization. EBN's mandatory participation helps ensure that public interests are protected, project development is accelerated, and the invest climate is improved. Through this multidimensional approach, EBN strengthens the institutional and technical foundations needed for geothermal energy to become an important component of the Netherlands' heat transition.

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Acknowledgements

We would like to express our sincere gratitude to our partners in both regions for their dedicated cooperation and effort. Their contributions have been essential to accelerating the heat transition. A special word of thanks goes to the Municipality of Amsterdam, Vattenfall, and the Province of Noord-Brabant for their partnership.