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# Geothermal energy and the Visegrad group

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## Summary

While the calls for the utilisation of renewable wind and solar energy to reach decarbonisation targets are already clear and loud, geothermal energy does not receive the same amount of attention. However, studies on geothermal energy confirm that its potential in the process of decarbonisation is substantial. To correct the current lack of focus on geothermal, this paper will start by providing information about how geothermal energy works and what are its benefits and challenges. The second part of this paper will then provide a brief summary of the current state of knowledge regarding the potential and utilisation of geothermal energy in the Visegrad countries and present arguments on why more attention should be given to the utilisation of geothermal energy in V4.

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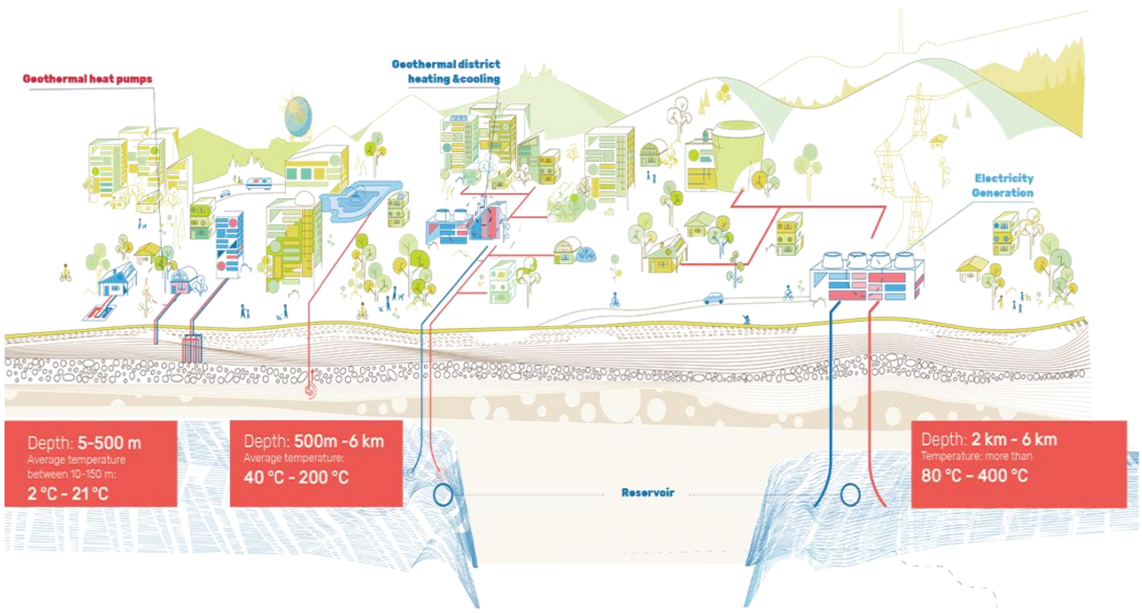
## *What is geothermal energy and what are the challenges in its utilisation*

In the simplest terms, geothermal energy can be explained as heat stored within the interior of the Earth that is brought to the surface by water or steam. Geothermal energy can be utilised in various ways and by using different types of technology. The three main ways of utilising geothermal energy are through the use of:

1. **heat-pumps** that utilise a constant underground temperature for warming or cooling the air and water in the buildings
2. **geothermal district heating & cooling systems** for larger areas or industrial use
3. **geothermal power plants** for producing electricity by turning the turbines with steam.

*Figure 1: Different types of geothermal energy, developed by the EGEC.*
Source: https://www.egec.org/about/



A commonly raised argument for disregarding geothermal projects is the limited availability of geothermal resources as localities that are suitable for utilising geothermal heat need to fulfil certain conditions. However, these limitations do not apply to all three ways of utilisation in the same way. Geothermal heat needed for the heat pumps used for the individual buildings is available almost everywhere.[1] Geothermal heat for district heat and cooling (H&C) and industrial use is generally available between 500m-6km deep wells. [2] Traditionally, these locations also have to fill other specific conditions, making only some locations suitable. Regarding geothermal heat for the production of electricity, high temperatures of underground sources are required as well as other specific conditions that can be found only in certain geological locations, making suitable locations for geothermal power plants limited.[2]

The second common argument against the utilisation of geothermal energy is the cost of such projects, as the initial costs for all three utilisation ways are generally higher than for the projects designed to use fossil fuels, solar or wind energy. The projects designed for providing geothermal electricity can also pose a financial risk due to the need for confirming the area's heat capacity by the initial drilling. On the other hand, the report on average levelized costs of energy shows that geothermal energy is 'at the lower end of the fossil-fuel cost range'.[3] A study from France concludes that the cost of geothermal district heating and cooling (GDH) is cheaper than gas.[4] Moreover, utilising geothermal heat pumps requires minimal maintenance and delivers higher energy efficiency than air-source heat pumps.[5,6] When compared with other renewable energy sources, geothermal energy is considered a competitive option.[7] Lastly, the operating costs of geothermal projects are generally lower, and this can result in some geothermal projects being the cheapest source of energy in the long term.[2,8]

As the technology connected to drilling and finding suitable locations is improving, the cost of geothermal projects and accompanying financial risks are expected to decrease. Moreover, the technological developments related to geothermal energy are making more locations suitable for all three uses. For instance, recent years have seen

[1] Joint Research Centre. *Geothermal Energy:Technology Development Report 2020.*; 2020. doi: 10.2760/16847
[2] EGEC. *Geothermal energy: the bedrock of energy transition.* https://www.egec.org/media-publications/new-egecs-brochure-geothermal-energy-the-bedrock-of-energy-transition/
[3] IRENA. *Renewable Power Generation Costs in 2020.*; 2021. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jun/IRENA_Power_Generation_Costs_2020.pdf
[4] Richter A. Yes, geothermal energy is cheaper (and cleaner) than gas - study from France. *Think Geoenergy*. https://www.thinkgeoenergy.com/yes-geothermal-energy-is-cheaper-and-cleaner-than-gas-so-a-study-for-france/. Published October 16, 2020.
[5] Gaur AS, Fitiwi DZ, Curtis J. Heat pumps and our low-carbon future: A comprehensive review. *Energy Research & Social Science*. 2021; doi:10.1016/J.ERSS.2020.101764
[6] Gheysari AF, Holländer HM, Maghoul P, Shalaby A. Sustainability, climate resiliency, and mitigation capacity of geothermal heat pump systems in cold regions. *Geothermics.* 2021; doi:10.1016/J.GEOTHERMICS.2020.101979
[7] IRENA, IDB, GGA. *Geothermal: The solution underneath.* 2021. https://www.globalgeothermalalliance.org/-/media/Files/IRENA/GGA/Publications/Geothermal---The-Solution-Underneath.pdf
[8] IRENA, *Geothermal Power.* https://www.irena.org/costs/Power-Generation-Costs/Geothermal-Power

improvement in the drilling technologies,[9] in the technologies used for localising existing resources,[10] as well as in the designs of the heat pumps and power plants.[11] Although the localities for the utilisation of geothermal energy continue to be dependent on certain conditions, the potential of geothermal energy in providing electricity and H&C is considerable[1], and with technological progress, new and cheaper possibilities for its utilisation are opening.

## Environmental and security wins

While specific challenges and trade-offs of geothermal energy have to be taken into consideration, its environmental and security benefits are clear and compelling. Geothermal heat is considered a renewable source of energy, as the higher temperatures produced under the Earth's surface are continuously supplied by Earth's core. Regarding land use, geothermal energy requires less land usage than power plants utilising fossil fuels or solar energy.[12] A common concern related to geothermal energy is its impact on underground water sources and the increased risk of seismic activity or landslides. However, the existing studies on potential environmental impacts of geothermal projects conclude that the probability of induced seismicity that would be noticeable or cause negative implications are 'low'.[13] Concerning contamination of groundwater, the potential of geothermal power plants to contaminate groundwater is also low when adequate measures are in place.[14] While certain precautions have to be made to answer these risks, the management measures to control them are well developed, and with the improvements in existing technologies, they can be further minimised.[4,11]

Geothermal energy can also significantly contribute to the decarbonisation process.[15] The range of produced air emissions depends on the type of technology used for utilising geothermal energy, but in all cases, the emissions from the use of geothermal heat are substantially lower than from burning fossil fuels.[4,11, 16] A comparison of gas emissions from different types of power plants during their lifecycle concludes that geothermal power plants generally produce $CO_2$ emissions lower by a 'factor of 10

[9] Richter A. Lower cost drilling technology to increase geothermal productivity. *Think Geoenergy. https://www.thinkgeoenergy.com/lower-cost-drilling-technology-to-increase-geothermal-productivity/* Published March 1, 2021.

[10] Richter A. New exploration method to localise potential drilling sites for geothermal energy development. *Think Geoenergy. https://www.thinkgeoenergy.com/new-exploration-method-to-localise-potential-drilling-sites-for-geothermal-energy-development/.* Published November 14, 2019.

[11] Gumbau A. 'Closed-loop' technology brings promise of geothermal anywhere. *Euractiv*. https://www.euractiv.com/section/energy/news/closed-loop-technology-brings-promise-of-geothermal-anywhere/. Published October 25, 2021.

[12] Soltani M, Moradi Kashkooli F, Souri M, et al. Environmental, economic, and social impacts of geothermal energy systems. *Renewable and Sustainable Energy Reviews*. 2021. doi:10.1016/J.RSER.2021.110750

[13] Chen, S., Zhang, Q., Andrews-Speed, P., & Mclellan, B. Quantitative assessment of the environmental risks of geothermal energy: A review. *Journal of Environmental Management,* 2020; 276, 111287.

[14] Bošnjaković, M., Stojkov, M., & Jurjević, M. (2019). Environmental impact of geothermal power plants. *Tehnički vjesnik*, 2019; 26(5), 1515-1522.

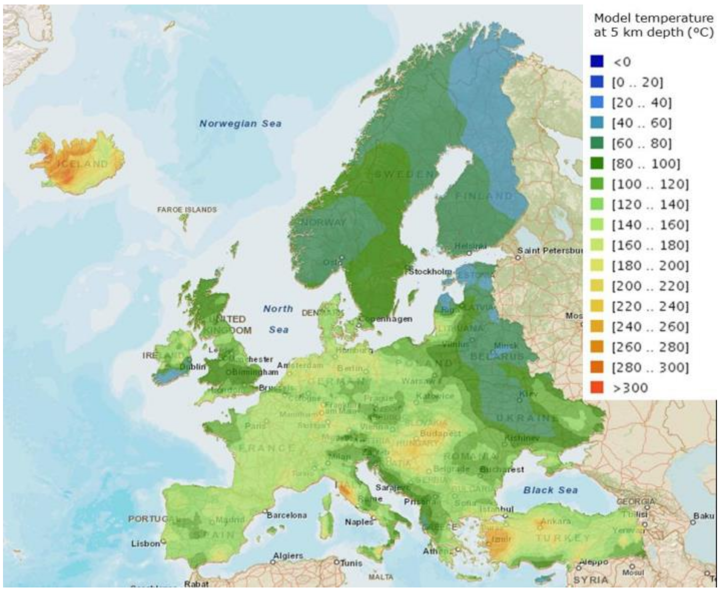
[15] Yousefi H, Abbaspour A, Seraj H. The Role of Geothermal Energy Development on CO2 Emission by 2030. *PROCEEDINGS, 44th Workshop on Geothermal Reservoir Engineering.* February 11-13, 2019. https://pangea.stanford.edu/ERE/pdf/IGAstandard/SGW/2019/Yousefi1.pdf

[16] Zhang R, Wang G, Shen X, et al. Is geothermal heating environmentally superior than coal fired heating in China? *Renewable and Sustainable Energy Reviews.* 2020; doi:10.1016/J.RSER.2020.110014

times against gas-fired and 20 times against oil and coal-powered generation'.[11(p2)] Moreover, the more recent designs of geothermal binary plants are built as closed systems and for this reason, they do not produce any emissions.[17] Lastly, geothermal energy has many different uses as it is the only renewable energy that can be used in the electricity, H&C and transport sectors.[2] Geothermal potential for decarbonising the H&C sector is especially intriguing as this type of energy is generally more available, and currently, heating of water and air is responsible for 79% of the total energy used by the EU households.[18]

In comparison to other renewable sources of energy, an unquestionable advantage of geothermal heat is that it is available 24 hours a day as it is not dependable on weather conditions and less susceptible to droughts or strong winds.[4] Moreover, geothermal heat is a dispatchable source of energy, meaning that its amount can be controlled and adjusted to the current needs of the energy networks without having negative effects on the electricity grids.[19] Adjustability and flexibility of geothermal energy supply are in some cases better than adjustability of natural gas plants, thus providing better services for the existing systems.[4] For this reason, geothermal energy can be utilised without causing disruptions to the system. The undisruptive and local nature of geothermal energy is also beneficial for the energy independence of the countries. By supporting geothermal projects, the energy security of the countries can improve significantly, as it reduces dependency on fossil fuels imports.

*Figure 2: The geographical distribution of heat within the Earth's crust, developed by GeoELEC.*




Source: https://ec.europa.eu/jrc/en/news/new-report-analyses-geothermal-energy-sector

## Geothermal energy in the V4 and its current utilisation

Countries such as Iceland, US or Turkey are known as the places where geothermal resources are plentiful. Although the countries of V4 have fewer geothermal resources, the locations that can be utilised for both geothermal heat as well as power generation are found in all V4 members. For instance,

[17] Geothermal Technologies Office. Geothermal Power Plants — Meeting Clean Air Standards. *Department of Energy*. Accessed November 9, 2021. https://www.energy.gov/eere/geothermal/geothermal-power-plants-meeting-clean-air-standards

[18] European Commission. Heating and cooling . Energy. Published 2019. Accessed November 9, 2021. https://ec.europa.eu/energy/topics/energy-efficiency/heating-and-cooling_en

[19] IRENA. Geothermal energy. 2021. https://www.irena.org/geothermal

parts of Hungary and Slovakia are located in the area of the Pannonian Basin, which is a locality that is known as a geothermal anomaly in Europe, with higher average temperatures.[20] Currently, **Hungary** is the only country of V4 that has a geothermal power plant connected to the grid.[21] Within the V4, **Hungary** also has the highest number of identified localities for utilisation of geothermal energy and the richest resources.[20] Since 2010, 20 areas have been assessed as a pre-requisite for concessional tendering concerning geothermal electricity generation.[22(p3)] In **Slovakia**, the construction of the first geothermal power plant will start in 2022. [23] The research focused on **Slovakia** also identified other locations that fulfil the conditions for geothermal electricity production, with the best conditions in Trebisov depression and Mukatchevo Basin.[24]

Although the available research shows that the potential of Czechia and Poland for producing geothermal electricity is weaker, locations for potential future employment were also identified. In **Czechia**, two projects have been for a long time planned in northern Bohemia, and improvements in Enhanced Geothermal Systems can open more options.[25] In **Poland**, the most abundant resources are found in Podhale Basin and in the central part of the Polish Lowlands.[26] This list of locations includes resources available at different depths, and it is definitely not an exhaustive one, as, with technological progress, new areas can be discovered or become financially viable.

The potential of the Visegrad group to utilise low-temperature geothermal energy for their heating needs is even more significant as V4 countries share a feature of the district heating system as a dominant way of production and distribution of heat in the residential sector. [27] These infrastructures are currently predominately fuelled by fossil fuels and are often in need of reconstruction. For example, DH in Slovakia supplies heat for 1/3 of the population, and as more than half of the existing boilers are older than 20 years, these systems are in need of replacement.[28 (p138)]

[20] Nádor A, Sebess-Zilahi L, Rotár-Szalkai Á, Gulyás Á, Markovic T. New methods of geothermal potential assessment in the Pannonian basin. Netherlands Journal of Geosciences. 2019;98. doi:10.1017/NJG.2019.7

[21] Richter A. First geothermal heat and power plant of Hungary connected to gridhttps://www.thinkgeoenergy.com/first-geothermal-heat-and-power-plant-of-hungary-starts-operation/ Published November 17, 2017.

[22] Nádor A, Kujbus A, Tóth A. Geothermal Energy Use, Country Update for Hungary. Published online 2019. https://europeangeothermalcongress.eu/wp-content/uploads/2019/07/CUR-14-Hungary.pdf

[23] First geothermal power plant in Slovakia, *Slovak Spectator*. Published March 31, 2021. https://spectator.sme.sk/c/22629052/first-geothermal-power-plant-in-slovakia.html

[24] Majcin D, Král M, Bilčík D, Šujan M, Vranovská A. Deep geothermal sources for electricity production in Slovakia: thermal conditions. *Contributions to Geophysics and Geodesy.* 2017;47(1):1-22. doi:10.1515/CONGEO-2017-0001

[25] Dědeček P, Šafanda J, Tym A. Geothermal Energy Use, Country Update for Czech Republic. Published online 2019. https://europeangeothermalcongress.eu/wp-content/uploads/2019/07/CUR-08-Czech-Republic.pdf

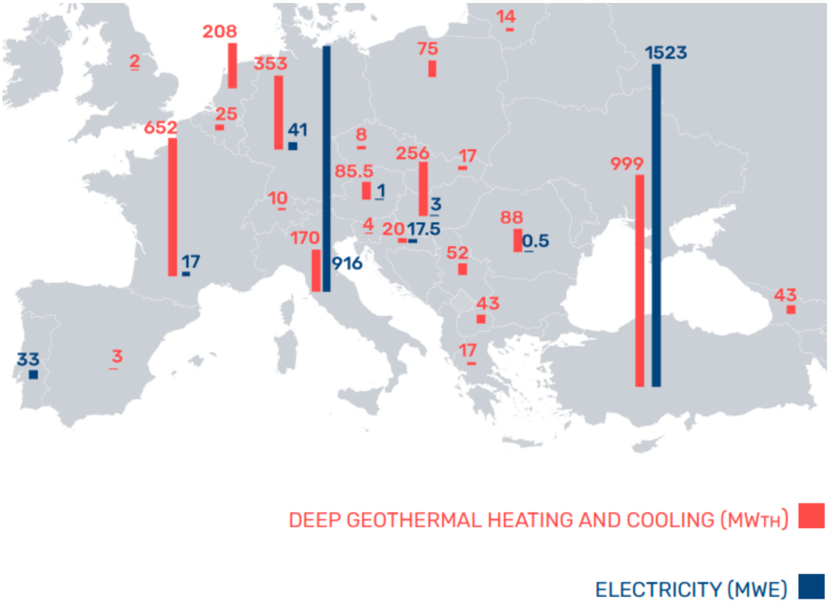
[26] Sowizdzal A. Geothermal energy resources in Poland – Overview of the current state of knowledge. *Renewable and Sustainable Energy Reviews.* 2018;82:4020-4027. doi:10.1016/J.RSER.2017.10.070

[27] Váhovský Jakub, Abraham Milan. Evaluation of District Heating Systems Status in Countries of Visegrad Group. *Advances in Thermal Processes and Energy Transformation*. 2018;1:70-73. https://www.iea.org/publications/freepublications/

[28] International Energy Agency. ENERGY POLICIES OF IEA COUNTRIES Slovak Republic 2018 Review. Published online 2018. https://www.connaissancedesenergies.org/sites/default/files/pdf-actualites/energy_policies_of_iea_countries_slovak_republic_2018_review.pdf

A study of geothermal district heating in Europe from 2014 shows 'a respective potential' for such projects in all V4 countries. [29] [(p19)] The study calculates that in **Czechia**, about 10% of the population could be reached with GDH at the depth to up to 2km, which is a depth already achievable with existing technologies from 2014.[28] Currently, the Czech city of Litoměřice is planning to transform its heating and electricity systems with geothermal energy and as a part of the project, the deepest geothermal borehole in Central Europe was drilled in this town in 2020.[30] In **Hungary**, 23 cities utilise GDH.[21] Hungary's potential with GDH is, however, much higher as around 90% of its population could be reached with this system.[27] In **Poland**, six GDH are currently operating[31], but again, the potential of utilising GDH is higher as at least 10% of the population could be reached with GDH.[27] Four **Slovak** cities currently utilise GDH to different extents. [32] The already mentioned study estimates that at least 50% of the population can be reached with GDH.[27] Interestingly, one of the regions where the potential for GDH is substantial is the Nitriansky region, currently known for its coal-mining business (Ibid.).

*Figure 3: Installed capacity for electricity and district heating in 2019 (MW), developed by EGEC.*




Source: https://www.egec.org/wp-content/uploads/2020/06/MR19_KeyFindings_new-cover.pdf

## Why geothermal energy deserves more attention in the V4

Returning to the benefits of geothermal energy that were described above, the Visegrad countries share certain conditions that make utilisation of geothermal heat even more advantageous for them. Starting with the potential of geothermal energy to

[29] GeoDH. Developing Geothermal District Heating in Europe.; 2014. http://geodh.eu/wp-content/uploads/2012/07/GeoDH-Report-2014_web.pdf

[30] Klusak J. Litoměřice: Two decades of working towards a just transition in the Czech Republic. *Mpower*. https://municipalpower.org/articles/litomerice-two-decades-of-working-towards-a-just-transition-in-the-czech-republic/. Accessed November 10, 2021.

[31] Kruszewski M. Country Update – Poland . International Geothermal Association. Published August 23, 2018. https://www.geothermal-energy.org/country-update-poland/

[32] Fričovský B, Černák R, Marcin D, et al. Geothermal Energy Use, Country Update for Slovakia. Published online 2019:11-14. http://europeangeothermalcongress.eu/wp-content/uploads/2019/07/CUR-25-Slovakia.pdf

contribute towards the decarbonisation process, all countries of V4 have currently insufficient measures in place to reach the targets set up by the Paris Agreement, with Czechia and Poland planning to continue burning coal after 2030.[33] Although utilising geothermal potential cannot resolve this issue fully, diversifying countries' energy mixes with low-carbon energy that is produced locally and without negative effects on the electricity grids is paramount for the energy transition in the V4.

Another challenge shared by the V4 countries is energy security. Despite the improvements in energy security during recent years, all V4 countries continue to be heavily dependent on the import of natural resources to sustain their energy needs.[34] Although the dependency of the V4 countries differs in extent, all countries of the V4 require large quantities of imported natural gas for their heating needs (Ibid.). Furthermore, different levels of energy poverty continue to be an issue in V4 countries.[35] The local nature of geothermal energy with its non-fluctuating price could aid in both of these issues. With the expected closings of coal mines in the countries, projects that can contribute to generating new employment will also be needed. In this regard, the geothermal industry is considered a job creator, with the possibility to create 350 000 direct and indirect jobs by 2030.[2]

Lastly, the recent discoveries of large amounts of lithium in a geothermal fluid can become 'a game-changer' for the geothermal industry.[36] Lithium is currently mined only in Australia and South America, and the process of its mining has serious negative environmental impacts.[37] Extracting lithium from geothermal fluids would not only have minimal environmental impacts but it would also be done locally. With the shift towards electro mobility, demand for lithium is expected to rise significantly. Therefore, although the amounts of lithium will differ in extent, the potential availability of lithium will attract new investors in geothermal energy projects. This new development can be especially significant for the members of the V4, as the automotive sector continues to be an important part of the V4's economies.[38]

## Conclusion

The main purpose of this paper was to highlight the need for paying more attention to geothermal energy in the Visegrad group. The first part of this paper discussed the different ways of utilisation, current challenges as well as benefits of utilising geothermal

[33] Kochanek E. The Energy Transition in the Visegrad Group Countries. *Energies 2021, Vol 14,* 2021;14(8):2212. doi:10.3390/EN14082212

[34] Godzisz K, Dzikuć M. Energy Security Of The Visegrad Group Countries In The Context Of Low-Carbon Development. In: *ECONOMIC SAFETY OF THE ENVIRONMENT*. Polish Academy of Sciences; 2020:148-160. https://www.researchgate.net/publication/349081208

[35] Brodny J, Tutak M. The comparative assessment of sustainable energy security in the Visegrad countries. A 10-year perspective. *Journal of Cleaner Production*. 2021; doi:10.1016/J.JCLEPRO.2021.128427

[36] Taylor K. 'Game-changer' for geothermal energy as UK plant unlocks vast supply of lithium. *Euractiv*. https://www.euractiv.com/section/energy/news/game-changer-for-geothermal-energy-as-uk-plant-unlocks-vast-supply-of-lithium/. Published 2021.

[37] Richter A. Record levels of lithium in geothermal water at United Downs project. *ThinkGeoenergy*. https://www.thinkgeoenergy.com/record-levels-of-lithium-in-geothermal-water-at-united-downs-project/. Published August 12, 2021.

[38] Dębkowska Katarzyna, Ambroziak Łukasz, Czernicki Łukasz, Kłosiewicz-Górecka Urszula, Kutwa Krzysztof, Ważniewski Piotr. *The Automotive Industry in the Visegrad Group Countries*.; 2019. https://pie.net.pl/wp-content/uploads/2019/08/PIE-Raport_Automotive.pdf

energy for electricity and heat production. Although geothermal energy continues to be limited to specific locations and financing the initial phase of geothermal projects can still pose risks, its environmental and security benefits are substantial. Geothermal energy can contribute towards the decarbonisation process as well as improve energy security in the countries. As shown in this paper, the Visegrad group has a large potential for utilising geothermal energy, especially in district heating systems. Nevertheless, this potential is not fully realized. Taking into consideration the current circumstances of the V4 regarding the decarbonisation process, energy security and the importance of the automobile industry for their economies, geothermal energy should become a much stronger topic of interest in this group.

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