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FINANCING GEOTHERMAL PROJECTS IN EUROPE: AN OVERVIEW OF THE AVAILABLE INSTRUMENTS

ABSTRACT

The European geothermal sector is a dynamic and diverse industry. Geothermal projects can be used for power production, for district heating or concern a single building. The geothermal resource may be used directly, require the adjunction of a heat pump or the enhancement of a reservoir. This diversity in form, uses and challenges covers several similarities, including the fact that it is a capital-intensive technology.

In this article, after the presentation of the European geothermal market's state of play, we present the different financial instruments available in European for financing geothermal energy projects, and assess their relevance per market maturity.

KEYWORDS

Geothermal energy, European markets, financing, available financial instruments

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1. GEOTHERMAL STATE OF PLAY

1.1. Market report

The geothermal sector remains small at the European level and quite fragmented, being very dynamic in some states, less so in others. The availability of the resource in a given country's geology plays a role, but so does the existence of a suitable regulatory framework and sufficient political support.

State of the market in electricity

In electricity, Iceland, Italy and Turkey are by far the largest European players for geothermal. Italy, with 916 MW of capacity is the largest geothermal electricity producer in the EU. Iceland is well known for its extensive use of plentiful geothermal resources, which despites a small population allowed it to develop 663 MW of capacity. Both these countries mainly use "traditional geothermal" generation, from very high temperature fields. Turkey however, where geothermal development is much more recent, makes extensive use of EGS resources and dual cycle generation. It has 853 MW capacity in total.

State of the market for district heating

The use of geothermal for district heating is much more widespread than for electricity. GeoDH capacity in Europe amounts to 4.8 GW, including 1.7 GW in the EU. It is a fast-growing energy source, at 10% per year in the EU (3% over Europe as a whole) over the last

FIG. 15 // **NUMBER OF GEODH PLANTS IN OPERATION AND UNDER DEVELOPMENT / INVESTIGATION PER COUNTRY**

Fig. 1. Number of GeoDH plants in operation and in development in Europe by country
Source: EGEC 2016 Geothermal Market Report

Rys. 1. Liczba geotermalnych sieci ciepłowniczych w Europie – pracujących i w trakcie realizacji
Źródło: EGEC 2016 Geothermal Market Report

fast 5 years. Geothermal heat production for district heating amounted to 4.2 TWh in 2015 in the EU alone. The leading countries in terms of installed geothermal district heating are Iceland (2169 MW), Turkey (872 MW), France (493 MW) and Germany (301 MW) (Fig. 1). Poland, a country with a large share of H&C demand met through district heating, geothermal accounts for only 2% of district heating, and there have been few new developments in the 2012–2016 period.

State of the geothermal heat pump market

Across Europe, the total number of geothermal heat pumps (GSHP) amounts to 1.7 million units, with 1.3 for the EU alone. This market is dominated by Nordic countries, which total 44% of sales for 2015. Sweden is by far the biggest market for geothermal heat pumps (550,000 units installed, over 20,000 new units in 2015). Germany (over 300,000 units installed, 15,000 new) and France (200,000 units installed, 4,000 new) are also key markets, notably due to their size.

1.2. Trends

Geothermal for electricity

At the European level, geothermal for electricity has been growing at 10% per year (2% in the EU) over the last 5 years. Many investments are being developed with 26 plants planned in Europe, including 14 in the EU, most of which EGS. Over 100 plants are under investigation in the EU.

Geothermal projects for electricity are however being developed across the EU, carried by positive regulatory framework, financial support, notably from the EU, and the development of EGC technologies. France and Germany are among the main countries where this technology is being developed. Depending on the type of resources identified in the Sudetes region, such power production may be developed in Poland.

Geothermal for district heating

In the coming decade, the market for geothermal district heating will be structured by neighbourhood scale projects (EGEC 2016 Geothermal Market Report; www.egec.org) which are integrated within the communities and connected to smart thermal grids. The high number of plants under investigation (136 in the EU, 164 in Europe) testifies to the value of this technology for local uses. All European countries are expected to use geothermal district heating by 2020. A very large potential remains untapped as more than 25% of the EU population lives in an area directly suitable for geothermal district heating (GeoDH Report; www.geodh.eu).

Geothermal heat pumps

In terms of market dynamics, several countries are undergoing a rapid acceleration in the deployment of geothermal heat pumps. That is notably the case of Lithuania and Poland where units installed in 2015 account for 14% and 11.1% of the stock respectively.

Upcoming trends point the development of increasingly large systems, with borehole heat exchanger longer than 10km. Large installations are particularly suitable to meet the heating needs of the tertiary sector.

1.3. Regulations

Geothermal projects are defined by long project development times, uncertainty concerns regarding resource availability in the early phases of investment, and they are usually regulated across several frameworks (water, energy, mining, etc.). It requires many authorisations, and procedures are usually lengthy. A sound regulatory framework for the development of geothermal needs to be transparent, fair and avoid unnecessary burdens.

Type of measures

Among the measures that may apply to a project for geothermal district heating, or more precisely deep geothermal projects – including power:

— Water regulations: Depending on different criteria, geothermal projects may be covered by water regulation. For instance, in Hungary a geothermal project above 2,500 meters depth is considered a water extraction project.
  The application of water legislation to geothermal energy differs between open or closed-loop system. Article 11 of the Water Framework Directive gives member states the option to authorise the reinjection into the same aquifer of water used for geothermal purposes if it does not compromise the environmental objectives of the directive. National governments have the competency to decide as to whether reinjection of the geothermal fluids is required.
— Mining regulations: Depending on criteria varying at the national level (depth, size, etc.), geothermal projects may be covered by mining regulations.
— Permitting process (well, building of the plant/DH network, etc.): Typically, the European framework grants license for exploration for 4 years, followed by 30 years exploitation licenses. A key role of the licensing process is to avoid a double use of the resource.
— Environmental Impact Assessment, environmental permit: According to the Environmental Impact Assessment Directive, the national authority determines whether and which geothermal drilling projects should be subject to an environmental impact assessment. National or local regulations determine whether further environmental procedures are necessary, in compliance with EU requirements. This is notably the case when a project is proposed in a natural conservation area.
— Payment of royalties: Member States or regional or local authorities may impose the payment royalties to the operators of a geothermal project.

In cities, there is a diverse use of the underground (metro, parking, other networks) that make it more challenging to develop geothermal resources. Local heating and cooling plans are very rigid. Adding Geothermal DH in planning, requires information at an early stage

about resources. This is the case in Italy or Hungary where local authorities manage authorisation for GeoDH. Article 13 of the Current Renewable Energy Directive and the Article 14 of the Energy Efficiency Directive have had positive influence on policies geothermal district heating, by mandating MS & regional authorities to assess they DH resources or include RES-HC in the planning of city infrastructure.

Geothermal heat pumps are usually not concerned by the same regulations, and building level regulations, notably – at the European level – the Energy Performance of Building Directive, Ecodesign and Ecolabelling, are the most relevant.

2. FINANCING

Financing a geothermal energy project is often challenging because of the cost structure of geothermal projects that require large upfront investments while the viability of the project is unknown due to uncertainties on the quality of the resource before the well is drilled. Moreover, geothermal projects – notably for heating and cooling – are often undertaken by SMEs or public authorities, which have more limited finances or less capacity to take on debt.

2.1. Assessment of existing measures

Considering the different types of regulations that govern geothermal projects, the assessment of the different measures as a whole is a difficult task. However, as highlighted in the Geoelec final report: "*Geothermal developers overtly abhor opaque, complex and lengthy licensing procedures. Deficient licensing rules can undoubtedly cramp investment in the geothermal […] sector in Europe.*" (Geoelec Final Report, 2015).

The authorisation and licensing procedure of geothermal projects is tightly linked to the question of definition of geothermal energy. This has been settled in the Renewable Energy Directive where geothermal is defined as "*as energy stored in the form of heat beneath the surface of solid earth*." This definition plays a major role in the regulatory consistency and stability that allow predictability for geothermal project developers. This is notably crucial for developers of shallow or low enthalpy resources for district heating that may not meet criteria defined solely based on depth or temperature gradients.

As situations vary greatly from one European country to another, the geothermal regulatory framework is not homogeneous. Besides, within a national framework, the wide array of regulation applying to geothermal leads to a high probability that if some best practices may be applied in some aspects of authorisations and licensing for geothermal, barriers may remain, hindering deployment.

Typical regulatory barriers identified by the GeoDH project are:

— Closed markets to new entrants;

— Burdensome administrative procedures;

— Lack of suitable regulation to give geothermal projects a status.

Regarding geothermal heat pumps, the framework laid out in the Renewable Energy Directive for the calculation of the geothermal energy from heat pump accurately represents the value of this technology. This allowed a political reckoning of GSHP and the setting of relevant support framework in several European countries, including in Sweden or Germany. In the latter case however, a shift in the support framework (MAP) contributed to halving the number of new heat pumps installed between 2008 and 2015 (other factors also contributed). Another change in this framework introduced in 2015 led the number of new GSHP to grow from around 17,000 that year to over 20,000 in 2016. This highlights the responsiveness of consumers to support frameworks, and to changing general context. Well design measures are of paramount importance.

2.2. Next steps

To continue the dynamism of the geothermal sector and to foster growth in new areas and countries, there are several measures that could be implemented across Europe. As was stated, these measures need to be consistent to develop a stable, transparent and streamlined regulatory framework for developing geothermal projects.

This can notably mean:

— Regulations and measures that are aligned with the 2009 Renewable Energy Directive, and the definition of geothermal it enounces;
— Single licensing authority for geothermal (which is consistent with the European Commission proposal for a recast Renewable Energy Directive);
— Better information of the public about geothermal, better training of civil servants – notably in local authorities that regulate geothermal for heating and cooling;
— Rules for GeoDH as adapted to the local context as possible;
— Include geothermal in national, regional and local planning for energy (notably heating and cooling strategies);
— A policy framework that guarantees that geothermal projects do not lead to a degradation of the environment, and that gives geothermal priority over other uses (nuclear waste, CCS…) for the use of the underground;
— Good information and development involving local communities and citizens (for instance through crowdfunding (CrownFundRES Project, 2016) to increase involvement and ownership of the geothermal resource and facility, and to decrease the risks of protests.

For geothermal heat pumps, consumer information needs to be improved. Consumers are not sufficiently aware of renewable heating and cooling solution for individual heating systems, notably geothermal heat pumps, which reduces the capacity to make such choice (FrONT Project, Final Report, 2016). t. There, improving the training and awareness of professionals can also have a significant impact on support. Well-tailored incentive measures can also have a significant impact. However, considering the complexity of the heat pump market, these measures should be well designed not to incentivise inefficient

appliances (EGEC, *Geothermal, Air & Other Heat Pump technologies: market and efficiency*, 2017).

2.3. Summary

The geothermal market in Europe is undergoing a transition process. New investments, the development of new markets and the impact of innovative technologies support the growth of the sector and a change in the business models and organisations that allow these investments. This however requires suitable and consistent regulatory frameworks. The geothermal sector needs streamlined policies that result from a holistic approach to remove barriers that cause unnecessary frictions to project development. Moreover, due to the various uses that can be made of geothermal energy (electricity production, high or low temperature district heating, CHP, building heating, process heat for agriculture or industry…), and the tremendous differences between resources that can be utilised, there must not be a one size fits all approach to support, but flexible regulations that allow for diversity in projects. In that regard the definition of geothermal energy in Renewable Energy Directive is an important tool.

In the framework of sound policy support schemes aligned with the definition of the 2009 Renewable Energy Directive, state of the art environmental regulations, and integrating the specific challenges faced by geothermal projects, there can be a further deployment of geothermal energy in new markets and a diversification of uses and technologies.

3. TYPE OF MEASURES

There are different types of measures that ease the financing of a geothermal project.

For geothermal electricity, a possible approach is to provide feed in tariffs to power plants. These can be quite high in the case of demonstration projects, for instance in France they can be up to 0.28 EUR/kWh (JRC, 2015 Geothermal Energy Status Report). However, operational support is often not relevant for geothermal energy projects, whether electricity or heating and cooling, as they do not mitigate the risk for upfront investment. As was already noted, the key factor for financial uncertainty in geothermal project is not the price at which the energy can be sold, but the geothermal risk, that is the amount of energy – in terms of temperature, flow and sustainability of the reservoir – that can be recovered from a reservoir. A good measure reduces uncertainty in these areas.

As shown in Figure 2 below, a significant part of the investment into a project happens before there is any decrease in the level of risk associated to this project. In practice, before a first exploratory well yields satisfying data – which entails million-euro scale investment – there are no guarantee to the amount of energy that can be sold.

Figure 3 does illustrate that at different stage of market or project maturity, different financial instruments are relevant to promote geothermal energy. An extensive exploration

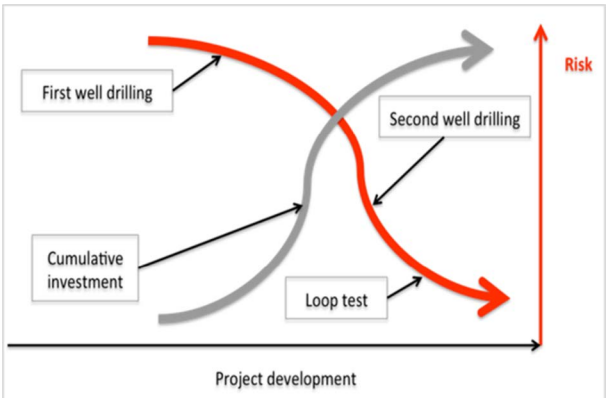

Fig. 2. Investment risk: a key challenge (representation of the level of risk of a geothermal project against cumulative investment)

Rys. 2. Ryzyko inwestycyjne: główne wyzwanie (przedstawiono poziom ryzyka w projekcie geotermalnym na tle całkowitej wartości inwestycji)

phase requires upfront support that, from a private sector perspective, entail significant risk and potential for investment failure. There seed or venture capital projects are well suited. In markets where the geothermal sector is small or emerging, it is unlikely that private financial market will be drawn to geothermal exploration by themselves, and there, public incentives are necessary. Ideal forms of support for exploration include grants or public exploration. In the case of Poland, the availability of public geological data coming from oil exploration in the previous decades is a positive starting point for identifying geothermal resources.

After the exploration phase, and before the operation of the facility, for which Feed-In Tariff (FiT) or Feed-In Premium (FiP) are a widespread solution, the drilling and construction phrase require specific financial instruments. On a private sector perspective, the financing must be suited to project with higher risk. In mature markets, private investors are able to pool risk among different projects, and they can utilise data on existing installations. Products such as mezzanine debt that have lower payback certainty, but higher returns can be a solution when there is sufficient information. Private insurance for project developers or for financing actors can also be a solution to decrease the cost of financing, or increase the availability of financing for geothermal project. However, the emergence of such private insurance scheme requires a large enough pool of project that risk can be adequately assessed.

A key factor in the maturity of a geothermal market is transforming uncertainty into risk. On a financial point of view, uncertainty is intangible, and investors or project developers cannot assess the probability of failure before they have committed enough funds to drilling at least a well that will provide the needed information. Once there are enough installations in a large enough market, the private sector can provide the tools that allows to do so. Until then, support from the public sector is needed to allow geothermal projects to emerge. A solution to this end is the development of geothermal risk insurance facilities, which have been successfully implemented in several countries.

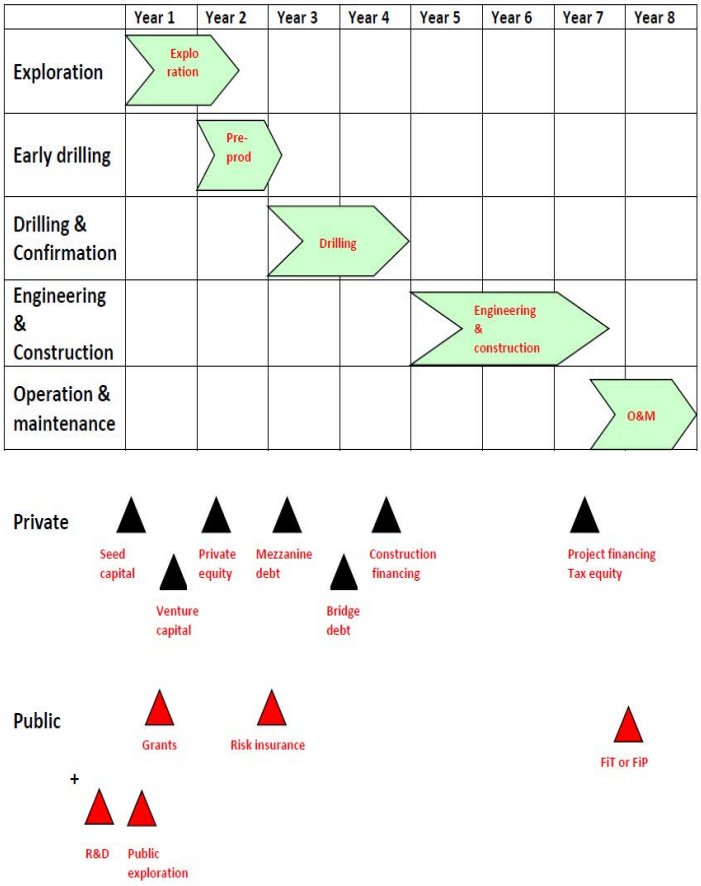

Fig. 3. Mechanisms for funding geothermal energy projects at different stages of projects development (elaborated by EGEC)

Rys. 3. Mechanizmy finansowania na różnych etapach projektów geotermalnych (opracowanie EGEC)

3.1. Assessment of existing measures

Existing public-sector measures to promote geothermal energy can be divided in four categories: RD&I, risk insurance, support to electricity, support to heating.

Research, Development & Innovation: a major actor in awarding support to RD&I in the geothermal sector have been the European Union. For the 2014–2020 programming period, the Horizon2020 facility – the EU's main vehicle for supporting RD&I projects – has allocated EUR 3.8 billion to projects in the "secure, clean and efficient energy" programme, of which EUR 664.3 million in 201–2017. For geothermal energy, projects to improve the

integration of geothermal in retrofitted buildings, the efficiency of borehole heat exchanges (BHE), further develop EGS or more generally improve the market uptake of geothermal and other RES technologies. The European Commission estimates that, as a whole, investment in RD&I relating to Energy Union priorities (which includes renewable energy, and thus, geothermal) amounted to EUR 22.9 billion (European Commission, *Accelerating Clean Energy Innovation*, 2016, Com(2016) 763). The European Commission notably lists among its priorities for investment in RD&I the decarbonization of the building stock, for which geothermal energy is a viable solution for a large share of the European population, and strengthening the EU leadership in renewables, for which it is crucial to maintain a strong European know how to meet Europe's needs.

- **Public risk insurance**: the countries that have implemented a public risk insurance mechanism for geothermal projects in Europe include: France, Germany, Iceland, The Netherlands and Switzerland;
- **Support for electricity**: feed in tariffs are available for geothermal electricity in several European countries, with limitation in some cases. However, due to a shift away from feed in tariffs across the EU, support for geothermal electricity is increasingly awarded through feed in premiums.

Support for heating and cooling: geothermal for heating and cooling can be delivered through district heating (in which case some sort of feed in tariff or premium can be considered) or directly in a building. Many different solutions exist, from CHP to low temperature systems using heat pumps. Existing measures include (FrONT, *Integrated Support Schemes for RHC, Assessment Report*, 2016):

- Investment grants (e.g.:France's Fond chaleur renouvelable, Poland's National Fund for Environmental Protection and Water Management),
- Operational aid (e.g.: Feed in tariffs such as Italy's ContoTermico),
- Tax incentives: reduced VAT (France), tax breaks…,
- Zero interest loans (e.g.: Spain with PAREER programme),
- Carbon tax: Finland, Sweden, Denmark, France.

The RE-Shaping project notably underlines that "*the success of some schemes will depend on the existing infrastructure, for example, the realization of renewable-based centralized heating systems can only be fully achieved if district heating grids exist*" and that stability is important for support to renewables in heating and cooling – including geothermal – to function.

Financial instruments: whether at the European Union or national level, or provided by private institutions, specific financial instruments are increasingly important in the financing of renewable energy projects, including for heating and cooling. They can take different forms, from financial risk guarantee (e.g. European Fund for Strategic Investment), subsidized loans (e.g. National Fund for Environmental Protection and Water Management) to capacity building (e.g. ELENA). The main characteristic of such mechanisms is that a small amount of public funding is used to leverage private financing into a project (typically ratios between 15 to 20 are sought).

Energy Performance Contracting: energy performance contracting can be used for geothermal projects, notably when they are included in a wider programme that includes energy efficiency improvements. This is particularly suitable for instance for a project to improve energy efficiency and switch the heating and cooling system of a large building. With EPC, a company (ESCO) finances the project, which is then paid back periodically according to the terms of the contract (e.g. 10% of the total every year over 10 years). Following a European Commission Guidance (http://europa.eu/rapid/press-release_IP-17-3268_en.htm) issued in September 2017, public authorities are now able to use EPCs to undertake renewable or energy efficiency investments without them being accounted as debt. This is quite significant for local authorities facing debt limitation but with clear prospect to decrease their energy expenditures by investing in geothermal energy projects.

3.2. Next steps

For further developing geothermal, particularly in heating and cooling, a stable and balanced policy framework is a requirement. Due to the varying climatic condition across Europe, and the different factors that affect the cost of installations (availability of skilled contractors, quality of resources, cost of financing, scale…), the market for geothermal heating and cooling is quite fragmented. Moreover, projects in this sector often face harsh competition from subsidized conventional fossil energy sources, notably the so-called "social tariffs" for natural gas or electricity – which often remains quite a carbon intensive energy carrier across Europe. Operational subsidies or tax breaks at different steps of the value chain of fossil energy sources should be phased out to ensure a level playing field with renewables. Meanwhile, emerging energy sources such as, in the case of Poland, geothermal, cannot be expected to stand on their own and a relevant support framework should be set.

CONCLUSIONS

Considering the small number of geothermal projects in operation in Poland, with a suitable infrastructure and significant geological potential, the support framework should emphasise the mitigation of the geological risk and the development of expertise in the industry. Awareness raising for district heating operators and consumers as to the specific challenges and benefits of geothermal energy is also necessary, as the Front project has identified that lack of awareness is a major barrier in the development and the financing of RES projects for heating and cooling.

Initiating a geothermal risk insurance platform is a prerequisite to draw the private sector to the financing of geothermal project at a cost that does not prevent project development. Such platform could be national, which allows for an approach more suited to specific conditions. However, a European facility allows for a wider pool of projects, meaning a decreased risk at portfolio level – the projects are less likely to fail at the same time as they are set in different geological, political and economic settings.

Beyond such facility, investment grants such as the ones proposed by the National Fund for Environmental Protection and Water Management in Poland allow to develop so-called "flagship projects" that showcase the possible benefits from the use of geothermal resources. It is important that such a facility is prolonged until there is a sufficient depth of the geothermal market in Poland that allow project developers to build on past experience, and local authorities and district heating operators to be familiar with this energy resource.

In emerging markets, where "conventional" or fossil energy sources are still dominant, it is much too early to phase out grant based support to geothermal projects. If such projects can indeed be a factor of profitability and lower costs, this is unlikely to happen without some sort of public support.

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Iceland Liechtenstein Norway grants

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FINANSOWANIE PROJEKTÓW GEOTERMALNYCH W EUROPIE: PRZEGLĄD DOSTĘPNYCH INSTRUMENTÓW

STRESZCZENIE

Europejski sektor energii geotermalnej jest dynamicznie zróżnicowanym przemysłem. Projekty geotermalne mogą dotyczyć generowania energii elektrycznej, ogrzewania sieciowego lub pojedynczego budynku. Zasoby geotermalne mogą być wykorzystywane bezpośrednio, w niektórych przypadkach wymagają włączenia pompy ciepła lub też zastosowania metody zwiększenia produkcji wody z jej zbiornika. Ta różnorodność form, zastosowań i wyzwań obejmuje kilka podobieństw, w tym faktu, że jest to technologia wymagająca dużych nakładów kapitałowych. W artykule, po przedstawieniu aktualnej sytuacji na rynku energii geotermalnej, przedstawiono różne dostępne w Europie instrumenty dla finansowania projektów z zakresu energii geotermalnej i oceniono ich przydatność dla rynków o różnych etapach rozwoju.

SŁOWA KLUCZOWE

Energia geotermalna, rynki europejskie, finansowanie, dostępne instrumenty finansowe

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