Action plan for development of clean and stable energy production in the Pyhäjoki economic area

Final report 24.10.2024

Content

1 Executive summary

The action plan to support clean and stable energy production and further processing possibilities at the Hanhikivi site is based on a prefeasibility study that explored alternative solutions for a possible major energy investment at the Hanhikivi site. The action plan identifies feasible regional objectives and a route map to achieve them, and provides a comprehensive review of the infrastructure and development measures conducted in the area and the actions required to activate them. The action plan also includes an opinion poll on the attitudes of the local population towards a possible major energy investment.

The action plan is a compilation of intent, objectives and actions. It brings together the current state of the area, the boundary conditions for development and the feasibility of various options. It describes the views of the municipality of Pyhäjoki and the surrounding economic area on the future investment.

The main regional objective is to attract a nuclear power plant investment to Hanhikivi. This is supported by the Hanhikivi regional plan for nuclear power, the infrastructure investments made in the area and the wide support for a nuclear power project. The area is best suited for nuclear power, but also for other major energy projects. There is wide support for the nuclear project, which will help to achieve the objectives. The municipality of Pyhäjoki plays a key role in attracting and welcoming investment to the region. This is facilitated by smooth cooperation and administrative processes. The strengths of the Hanhikivi site are its location, the state of zoning and permitting and the favourable public opinion. The strengths of Finnish public administration – the reliability and predictability of processes – strengthen the conditions for a potential investment. The Hanhikivi site is located close to key operators, ensuring that the potential for selling energy production to nearby operators is high.

The influence of the municipality of Pyhäjoki is so far largely based on regional marketing and communication. By highlighting the potential, opportunities and image of the Hanhikivi site and the capabilities of the municipality of Pyhäjoki, it is possible to communicate to investors that the area is suitable for a major project. The role of the municipality of Pyhäjoki as an enabler is an important part of the major project. Through the marketing of current opportunities and existing infrastructure, communication and lobbying, it is possible to promote awareness of the area and the realization of the investment. The communication plan supports the municipality and various actors in the wider economic area as the potential investment is initiated.

The development of the Hanhikivi site is a key part of the strategic development of the Pyhäjoki municipality. The other municipalities in the economic area also support the development of Hanhikivenniemi. Respondents to an opinion poll conducted in the area were in favour of a new major energy project: up to 70% of respondents were in favour of a new nuclear power project. According to residents, it would be important to attract new activities to the area.

The current clean energy production capacity in the municipality of Pyhäjoki is heavily reliant on wind power. There are many wind power investments in the region, as well as zoning for both offshore and onshore wind farms. In terms of industrial-scale solar

power plants, the only project currently in the region is the Leivinneva 150 MW solar power plant, which is under development[1]. In the Hanhikivi regional plan for nuclear power, a power line connection east from Hanhikivi to the existing 400 kV power lines has been planned, and Fingrid is ready to build the connection. The Hanhikivi site currently has a 5 MW distribution network connection[2]. A significant opportunity for clean energy production in the area is the Nordic Hydrogen Route, Gasgrid's hydrogen infrastructure project, with a planned route that runs through the coastal area of the Bothnian Bay, increasing the potential of Pyhäjoki and Hanhikivi for hydrogen projects[3].

The prefeasibility study identified areas for development that should be taken into account in the municipality of Pyhäjoki if the project goes ahead. One of the identified areas for development is the shortage of highly educated labour in the area. Attracting business investment to the area would bring more job opportunities and services to the area, improving the overall attractiveness of the area in order to attract highly educated labour. Although the municipality is already prepared to implement the major project, a large number of families with children moving into the area, for example, may in places create a need to develop municipal services. New businesses and private services, such as restaurants and accommodation services, will increase the number of jobs available in the area, improving the attractiveness of the area and the integration of families.

If realized, the major project will also increase the need to develop the transport infrastructure of the municipality of Pyhäjoki and its surrounding areas to meet the growth in passenger and freight traffic. The nearest railway station is located in Oulainen, to which some of the roads are currently in very poor condition. The works completed at the Hanhikivi site for the harbour area create opportunities to meet the growth pressures regarding freight traffic.

In the assessment of variables affecting the investment options for the Hanhikivi site, 12 variables were identified that could affect the four possible solutions for the development of the Hanhikivi site identified in the prefeasibility study. The first three solutions are based on nuclear power as the energy source and the fourth on renewable forms of production outside the Hanhikivi nuclear site. In addition, three of these options would involve the production of hydrogen and/or ammonia in the area. The assessed variables do not constitute an exhaustive list of all the possible variables that affect the investment options, and the main focus has been on the variables affecting nuclear projects. The analysis did not reveal any major barriers that a single variable could pose to the implementation of the solutions.

Two of the assessed variables were found to have no impact on the possible solutions. Five of the variables have a positive potential to influence the attractiveness of the solutions. These include a possible capacity mechanism, public subsidies for nuclear projects, the growing demand for electricity and hydrogen in northern Sweden, a positive nuclear trend and the significant offshore wind capacity that is planned near Pyhäjoki. Five of the variables have the potential to negatively affect the possible solutions or even prevent their realization in extreme cases – however, at this point it was not considered likely that any of the considered variables would prevent a major energy investment in the area. In any case, these negative variables, or threats, include the market price or demand for nuclear electricity and/or hydrogen, the lack of a capacity mechanism and public nuclear subsidies, the timeline of a hydrogen transmission network, the cancellation trend of green transition investments and a permit from the Radiation and Nuclear Safety Authority (STUK) to locate a hydrogen/ammonia plant near nuclear power production. For each variable, the likelihood of its occurrence, the timeframe for its clarification and the size of the impact on each possible solution were assessed.

[1] Motiva & Energy Authority. Solar power plants, https://aurinkosahkovoimalat.fi/
[2] AFRY Management Consulting Oy. 6.3.2024. Prefeasibility study for development of clean and stable energy production in the Pyhäjoki economic area. Final report, p. 97
[3] Gasgrid Finland. Nordic Hydrogen Route. https://gasgrid.fi/en/projects/nordic-hydrogen-route-en/

All three nuclear power scenarios are associated with a significant number of both negative and positive variables, but the third option, unlike the others, also involves uncertainty about the timeline of a hydrogen transmission pipeline in the area. When considering both the likelihood and the impact of the variable, if realized, the lack of a capacity mechanism or other additional revenue was estimated to be one of the most significant negative variables for the nuclear scenarios. Conversely, the biggest positive variables are the growing demand in northern Sweden and a possible positive nuclear trend at a national and European level.

Considerable variation and uncertainty can be seen in the timeframe for the clarification of variables, some of which may not become fully clear until the next decade. Clarity is likely to be achieved the fastest with regards to a potential positive nuclear trend and its implications, and the role of low-carbon hydrogen and ammonia. In addition, the proposal of the Swedish government in August 2024 concerning public subsidies for nuclear power may also accelerate similar developments in Finland in the next few years. Among the variables that are likely to become clear later are the capacity mechanism and the timeline of constructing a hydrogen pipeline in the area.

The attractiveness of both nuclear power and hydrogen and ammonia production involves a number of variables, the fate of which will be resolved at different stages over the coming years. The implementation of a nuclear power investment only at this point could therefore be seen as useful in terms of strategic flexibility, buying time for the variables affecting hydrogen and ammonia investments to become clear and postponing the decision on any further investments to the future. A possible small modular reactor (SMR) would further increase strategic flexibility by enabling a lower initial investment and increasing production capacity according to demand. However, SMR technology is still under development, and there are still major question marks over the timeline of commercialization and the cost level.

2 Introduction

This action plan to support clean and stable energy production and further processing possibilities at the Hanhikivi site describes the regional objectives and proposed measures, the public opinion, the municipality's current situation and potential, and a route map for the development of the site. The action plan has been prepared as part of the AKKE project funded by the Council of Oulu Region in 2024.

This report, the action plan to support clean and stable energy production and further processing possibilities at the Hanhikivi site, is based on a prefeasibility study (first phase of the project) carried out in 2023–24, which explored various alternative solutions for Hanhikivi. This action plan (second phase of the project) compiles and utilizes the prefeasibility study as part of the premises and grounds for the proposed measures.

This work defines the regional objectives, proposed measures and a route map for their implementation. The action plan describes the regional objectives, i.e. the direction in which the municipality of Pyhäjoki and regional actors want the region to develop. The route map assesses the variables affecting the investment options for the Hanhikivi site. The solutions are reflected against changes in the market and in the operating environment. The work also provides a comprehensive review of the infrastructure and development measures conducted in the area and the actions required to activate them.

As part of the action plan, an opinion poll has been carried out to examine the attitudes of local residents towards various alternatives. The poll has been conducted by phone to residents in the region. In addition to the opinion poll, views on the major investment have been gathered through an interview survey aimed at decision-makers and officials in Pyhäjoki.

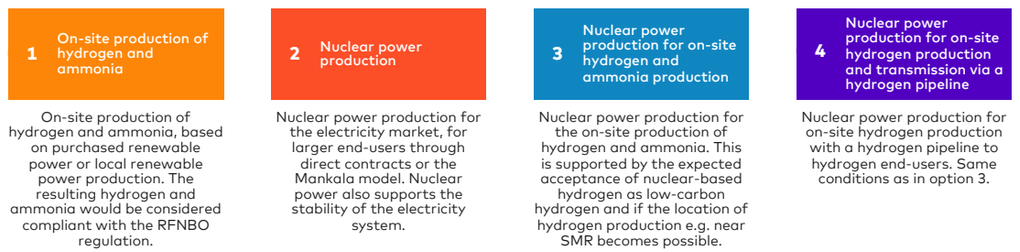

Figure 1 Alternative solutions for the Hanhikivi site (based on the prefeasibility study)

This action plan and its presentation material are intended for use in the marketing of new energy investments. Sections of the action plan may be selected for other materials, such as a regional marketing packages for those considering new major investments.

Basic project information: *The municipality of Pyhäjoki launched the project entitled Development of Clean and Stable Energy Production in the Pyhäjoki Economic Area in February 2023. The Council of Oulu Region has granted AKKE funding for the project. The project will run from 13 February 2023 to 31 December 2024 and it aims to explore various possibilities for energy production and further processing in Pyhäjoki. The project aims to find the best solutions in terms of technology, finances and timeline, using the infrastructure already constructed and the local operating environment. The work will also identify national and international operators in the energy industry and engage them in the development of the energy sector in the region.*

3 Regional objectives and proposed measures

The main regional objective is to attract a nuclear power plant investment to Hanhikivi. This is supported by the Hanhikivi regional plan for nuclear power, the infrastructure investments made in the area and the widespread support for a nuclear power project. The municipality of Pyhäjoki plays a key role in attracting and welcoming investment to the region. This is facilitated by smooth cooperation and administrative processes. Through the marketing of current opportunities and existing infrastructure, communication and lobbying, it is possible to promote awareness of the area and the realization of the investment. The communication plan supports the municipality and the various actors in the wider economic area as the potential investment is initiated.

3.1 Regional objectives

Key observations

- The main objective is to attract a nuclear power plant investment to Hanhikivi. This is supported by the Hanhikivi regional plan for nuclear power, the infrastructure investments made in the area and the widespread support for a nuclear power project. The area is also suitable for other major energy projects.
- For the municipality, the fact that the investment takes place is more important than what the investment consists of.
- There is wide support for a nuclear project, which will help to achieve the objectives.

The main regional objective is to attract a nuclear power plant investment to Hanhikivi. The main objective is widely accepted. This is supported by the Hanhikivi regional plan for nuclear power, the infrastructure investments made in the area and the widespread support for a nuclear power project. The area is also suitable for other major energy projects, but this would require an alteration of the plan. Nuclear power production for the electricity grid is the primary objective, but nuclear power production for hydrogen or ammonia plants in the area is also a possible option.

The Hanhikivi site is rare and special: in terms of zoning, it is the only place in Europe where nuclear power could be located. The infrastructure in Hanhikivi is well established and the readiness for deployment is therefore high. Both the Hanhikivi site and the municipality of Pyhäjoki and the economic region are well prepared for a major investment (services, cooperation structures). The legitimacy and political acceptance of green energy at the European level also support the investment.

The Hanhikivi site is ready for an investment in the energy sector, especially a nuclear power plant. The area is designed for nuclear power use and has an effective regional plan for nuclear power. The municipality's decision-makers and local residents are as much in favour of a nuclear investment as any other major energy project. Compared to other investments, the challenge of nuclear power projects is the long time required to get them started. Other projects supporting the green transition could be implemented in the area quicker or earlier than nuclear projects. The area could also be advertised as a green energy park. The environmental and social sustainability aspects of the investment are considered important, while recognizing that the development and construction work already carried out at the Hanhikivi site has transformed the natural environment of the area into a built environment.

An investment at the Hanhikivi site would increase the attractiveness and vitality of the economic area and entire province, as well as population retention. This would also help strengthen the municipal economy through the creation of employment effects, among other things. The direct and multiplier employment effects of the investment are expected to be significant. The size of the investment will affect the creation of employment effects. A single conventional nuclear power plant project will, in principle, generate the biggest employment effects. Other options may also generate similar effects, as the area could accommodate a number of similar smaller investments. For the municipality, the fact that the investment takes place is more important than what the investment consists of. For the municipality, it is important that the potential investment does not exclude other investments or the development of the area and that the project operator is committed to the development of the area.

3.2 Proposed measures

Key observations

- The municipality of Pyhäjoki plays a key role in attracting and welcoming investment to the region. The positive intent of the municipality is reflected in the smooth cooperation and administrative processes.
- Through the marketing of current opportunities and existing infrastructure, communication and lobbying, it is possible to promote awareness of the area and the realization of the investment.
- The communication plan supports the municipality and the various actors in the wider economic area as the potential investment is initiated.

The municipality of Pyhäjoki plays a key role in attracting investment to the region. The municipality ensures that the permit procedures and cooperation structures work in such a way that a new project can succeed in the area. The market, the seller and the buyer, are the ones who make the actual investment decision and provide a basis for the new project to be launched. The municipality also has a role to play in supporting the new company. Initiating a major energy investment involves identifying needs, identifying and including local operators, and securing a skilled workforce (especially engineering science). Issues concerning skilled labour are addressed in cooperation with the educational organizations in the region (upper secondary and higher education institutions).

Through the marketing of current opportunities and existing infrastructure, communication and lobbying, it is possible to promote awareness of the area and the realization of the investment. The first key step in marketing is to identify the parties who should be informed about the current state and potential of the area.

One of the most important marketing measures is the promotion of the region's strengths (infrastructure, municipal services and public opinion). In addition to the municipal services and the favourable opinion of residents, the marketing of the industrial areas near Hanhikivenniemi and their industrial plots is essential. One of the key communication measures is to provide information about the opportunities in the area. The first step is to identify the parties for whom it is essential to know about the current situation of the area. At the regional level, the municipality should focus on activating cooperation networks and providing information about the current situation and potential of the area. Communication should be targeted both at regional actors (e.g. the ELY Centre for North Ostrobothnia and the Council of Oulu Region) and at national decision-makers and key officials. Communication tools should be prepared in advance for a situation where a buyer expresses interest in a major energy investment option. The communication tools are concrete in nature and include measures and the parties responsible. Thirdly, communication supports lobbying. Bringing the lobbying interests of Pyhäjoki, North Ostrobothnia and Northern Finland together will reinforce the joint message.

Local residents, administration and decision-makers are all very much in favour of the investment. It is the role of the municipality to create a positive image and to highlight its capacity to promote the investment. It is worth highlighting a cooperation model that emphasizes the social acceptance of the investment and the municipality's capacity. In the nuclear sector in particular, the acceptance of the operations in the region is important.

4 Public opinion

The main regional objective is to attract a nuclear power plant investment to Hanhikivi. The development of the area is a key part of the strategic development of the municipality. The other municipalities in the economic area also support the development of Hanhikivenniemi. Respondents to an opinion poll in the area express very positive attitudes towards a potential major energy project. Up to 70% of respondents are in favour of a new nuclear power project. According to the poll, it would be important to attract new activities to the area.

4.1 Strategic intent of the municipality of Pyhäjoki

Key observations

- The development of Hanhikivi is a key part of the implementation and realization of the municipal strategy of Pyhäjoki.
- The municipality of Pyhäjoki has a high level of readiness and willingness to develop the area. This readiness is reflected both in the investments made and in the building of strong cooperation and lobbying relationships.
- The support of the region of North Ostrobothnia for the realization of the investment strengthens the intent of the municipality of Pyhäjoki.

The development of the Hanhikivi area is a key defining factor of the municipal operating environment in the municipal strategy[4] of Pyhäjoki. The situation with the Hanhikivi site has changed since the municipal strategy was prepared. For example, some of the strengths in the strategy have turned into weaknesses and some threats have materialized. Based on the items in the Pyhäjoki municipal strategy, the municipality still considers the development of the Hanhikivi site to be a major area of focus.

The municipality of Pyhäjoki has promoted the development of Hanhikivi from the very beginning. The municipality's intent to develop the area is reflected both in the effectiveness of cooperation and in the investments made. The municipality has improved the infrastructure and developed its own municipal services. The municipality of Pyhäjoki has the capacity to harness resources to develop the area and public services, e.g. by obtaining zoning expertise to support the expertise that the municipality already possesses. In addition to the investments made and planned, the municipality's intent is reflected in strong partnerships with neighbouring municipalities and other municipalities in the region, as well as in its lobbying on a regional level.

The municipality of Pyhäjoki has excellent readiness and partnerships with other municipalities in the economic area for promoting the investment. Inter-municipal cooperation structures work effectively. Regional cooperation is natural and has been carried out for a long time. The municipalities surrounding Pyhäjoki have an interest in joint lobbying in future national energy policies (e.g. hydrogen pipeline).

[4] "Pyhäjoella virtaa 2035". Municipal strategy of Pyhäjoki.

In terms of a possible major investment, inter-municipal cooperation in the Pyhäjoki economic area is important both in terms of attractiveness and the regional organization of housing and transport. Cooperation creates a wider range of housing and employment opportunities on a regional level. In addition, cooperation in the economic area strengthens the resilience of municipalities and businesses as they respond to changes in the operating environment, new service demand and investment needs, if a major new energy investment is made.

Based on interviews with officials and policymakers, the attitudes towards a potential major investment in the area are extremely positive. Attitudes towards the project are very open, examining the different options. Consideration of social and environmental sustainability is seen as important. The extremely strong political intent of the municipality of Pyhäjoki is supported by the positive attitude of the other municipalities in the region.

4.2 Views of local residents and decision-makers

Key observations

- Respondents to the opinion poll see a potential major energy project as very positive for the municipality.
- Up to 70% are in favour of a new nuclear power plant investment at the Hanhikivi site.
- Respondents see the investments already made in the area as a key strength.
- The most important themes for respondents in relation to the potential project: safety, (regional economic) productivity, environmental and resident-friendliness.

The purpose of the opinion poll was to document the attitudes of the regional administration and population towards a new major energy investment using qualitative and quantitative questions. The poll was carried out between 24 and 27 June 2024 and was answered by 210 residents. The poll was conducted by phone to residents of Pyhäjoki and the surrounding areas (a sample of postal code areas in Raahe).

As background information, respondents were asked to provide their age, municipality of residence, duration of living in the area and their knowledge of the topic. The respondents to the poll are older than the population of Pyhäjoki on average. 63% of the respondents are over the age of 65 (Figure 2). The corresponding percentage of the population of Pyhäjoki is about 30% (Statistics Finland).

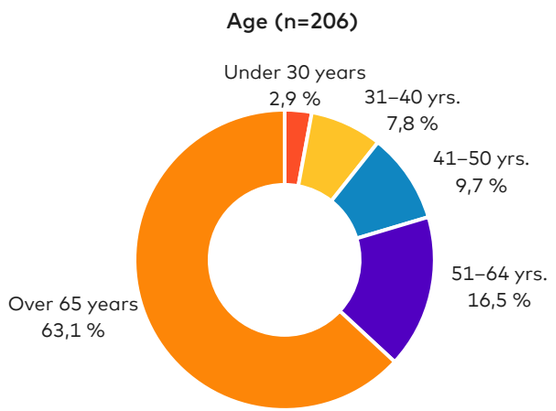

Figure 2 Age of opinion poll participants

Almost all the respondents to the poll are from Pyhäjoki and Raahe (Figure 3). Almost every respondent (98%) lives permanently in Pyhäjoki or Raahe. Only a few percent of respondents (2%) selected something other than Pyhäjoki or Raahe as their permanent municipality of residence. However, these respondents still lived in municipalities near Pyhäjoki. Not only are almost all the respondents from Pyhäjoki and Raahe, but they have also lived in the area for a very long time. Most of the

respondents have lived in the area for over 10 years or have been born in Pyhäjoki or Raahe.

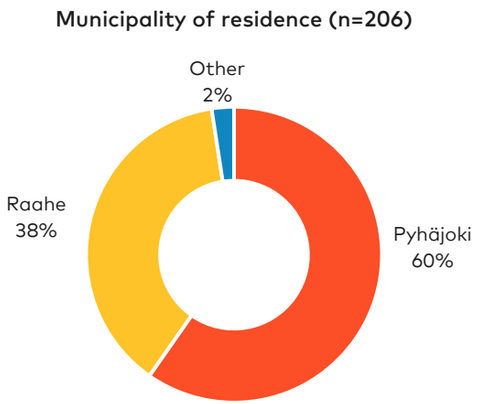

Figure 3 Municipality of residence of opinion poll participants

The majority of the respondents are very or somewhat familiar with the Hanhikivi site (Figure 4). One third of the respondents are very familiar with Hanhikivi and almost half are somewhat familiar with it. The energy sector is slightly less well known than Hanhikivi, but almost three out of four respondents are very or somewhat familiar with the energy sector. A quarter of the respondents are very familiar with the energy sector and just over half are somewhat familiar with it. The discussion in the region concerning major projects or potential investments in the energy sector may explain why the residents are familiar with the theme.

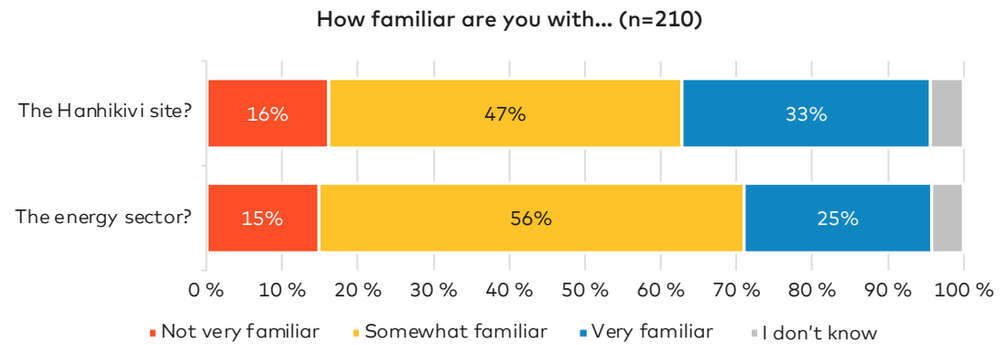

Figure 4 Opinion poll participants' familiarity with Hanhikivi site and the energy sector

Almost 40% of the respondents are strongly in favour of a new nuclear power project in the area. 70% of the respondents (options 5–7) express a positive attitude towards a new nuclear power project (Figure 5). Only one in ten is strongly opposed to a nuclear project. The share of "I don't know" responses is very low, less than 3.5%. This is partly explained by the public debate in the Pyhäjoki region on a nuclear power project, which has increased the awareness and knowledge of the residents, not only about the investment itself, but also its opportunities and constraints.

Just under 30% are strongly in favour of a new battery industry project in the area. 57% of the respondents (options 5–7) consider a new battery project to be a positive thing (Figure 5). The share of "I don't know" responses is higher than for the statement measuring attitudes towards a nuclear project. Residents are less aware of the risks and opportunities of projects in the battery industry than they are of similar aspects of nuclear power investments.

Just under 40% are strongly in favour of other major energy investments in the area. 71% of the respondents (options 5–7) are in favour of other projects besides those concerning nuclear power and the battery industry. The poll did not specify what these other projects might be.

For the most part, respondents have highly positive attitudes towards a potential major energy project. The percentage of respondents who gave the most positive rating (7, strongly in favour) is particularly high. Nuclear power divides opinions more than other major energy investments. Nuclear projects are also better known than other projects.

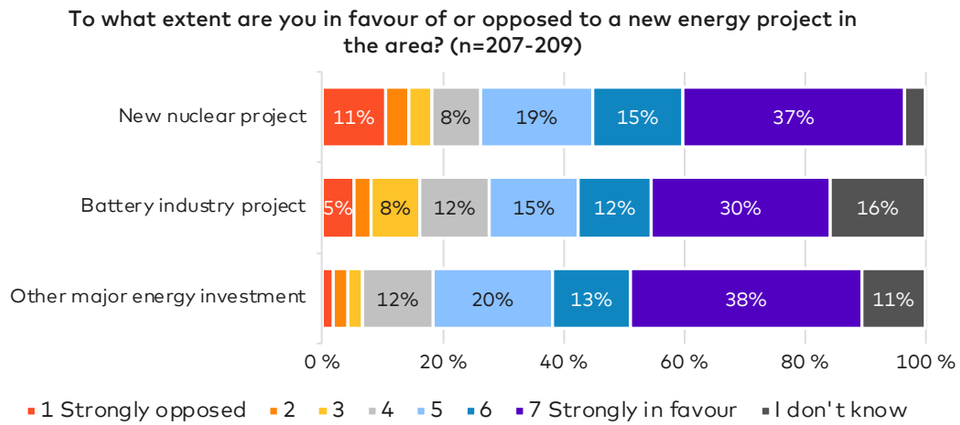

Figure 5 Opinion poll participants' attitudes towards a new energy project in the area

According to the opinion poll participants, it would be important to launch some kind of project in the area. In particular, respondents emphasized the utilization of the existing infrastructure and plan to make maximum use of the investments made.

According to the opinion poll, a new investment is expected to bring jobs, residents and expertise to the area, contributing to its vitality. The potential investment is seen to improve the economy of the municipality and the economic area. In addition to the local aspects of the project related to local needs, national and international future trends were highlighted in the responses. An energy investment was seen as meeting future needs both nationally and internationally.

From a local perspective, it is important that any major new energy investment is safe and is managed in a resident-friendly way. For residents, the environmental friendliness of the potential project is important. From the perspective of the economic area and the region, the project's productivity, environmental friendliness, high degree of domesticity (especially domestic management) and the absence or low risk of partners and funders are seen as important. The democratic nature of the societies of the project funders and partners is considered important. Some respondents had reservations about nuclear power and suggested alternative forms of energy production in the poll, such as hydrogen, wind, hydro, solar and peat energy.

5 Current situation and potential of the municipality of Pyhäjoki

Based on the documentary analysis and the geographic data review, no significant obstacles or outright show-stoppers to the implementation of a major project emerged in the current situation and potential of the municipality. Based on the studies and interviews carried out, the municipality of Pyhäjoki and especially the Hanhikivi site are, in principle, well suited to the needs of a major energy production project (nuclear power, hydrogen/ammonia production).

5.1 Demographics and economic structure

Key observations and areas for development

- Need to invest in pull factors to attract a highly educated working-age population to the region
- Potential of industrial and business areas; attracting new operators to the area
- Attractiveness of the municipality of Pyhäjoki and resident engagement play an important role

Based on the documentary analysis, the demographics of the region are fairly typical for a small municipality with a population of 3,000 inhabitants in a sparsely populated area. The population trend is declining and the proportion of pensioners has been on an upward trend for at least 15 years (30.1% of the population in 2022, 23.3 % in the country as a whole). The level of education in the municipality is also below that of major growth centres. The proportion of people aged 15 and over with tertiary education in 2021 was 20.7% (33.0% in the country as a whole).[5]

The municipality of Pyhäjoki is located between two university cities (Oulu and Kokkola). There is potential to attract skilled labour from nearby cities to meet the needs of the region by enhancing the pull factors and providing more job opportunities. In order to attract international talent to the region, further efforts are needed, for example, to provide services in multiple languages. The interviews conducted in the municipality suggest that the municipality is well prepared to also meet the needs of a growing number of international talent.

The economic structure of the region is based e.g. on agriculture and the processing industry.[6] A major project developed in Hanhikivi would potentially change the economic structure of the municipality, as the project would become a major employer in the area. The project is also expected to indirectly generate new business activity in the municipality through subcontracting and private services, such as restaurants and accommodation. The business and industrial areas (Ollinmäki, Hanhikivi) planned for the municipality will act as enablers for this development (Figure 6). A commercial services area in Ollinmäki in the north has been designated by the town plan as a commercial building block, where a large retail unit may be located, thus providing more opportunities for developing commercial services in the area. In addition, the component master plan has zoned service and administration areas, which are still undeveloped, in the southern part of the Pyhäjoki town centre.

[5] Statistics Finland. https://stat.fi/index_en.html

[6] Pyhäjoki. https://www.pyhajoki.fi/tyo-elinkeinot-ja-yrittaminen/elinkeinot-ja-yrittaminen

Figure 6 Locations of Hanhikivi and Ollinmäki on a map

If realized, the Hanhikivi project would bring a large working-age population to the area. Based on previous studies, the number of people employed during the implementation stage of the nuclear power plant project could be up to 2,500 at most.[7] The employment of the spouses and offspring of those working on the major project will help retain and integrate skilled workers and their families into the Pyhäjoki municipality, allowing the project to produce potential secondary effects on the development of other economic and business activities.

A lack of private services (e.g. restaurants, shops) reduces the pull and attractiveness of the area. Restaurants that operated in the area in connection with the previous project have since closed down and left the area. The empty premises of the closed down restaurants will allow new restaurant entrepreneurs to come to the area.

Temporary accommodation services in Pyhäjoki are provided by e.g. Majoitusmaailma, Majoituspalvelu Forenom Oy and Akkukari Kiinteistöt Oy. There are no hotels or hostels in the municipality. The nearest ones can be found in Raahe, Kalajoki and Oulainen.[8]

5.2 Land use and zoning

Key observations

- Hanhikivi is zoned for a nuclear power project
- Plenty of zoned offshore and onshore wind farms
- Zoning has already aimed to take business and housing growth trends into account

From a land use and zoning perspective, the Pyhäjoki area has excellent potential for promoting energy projects. The Hanhikivi site is zoned as an area for energy production use (nuclear power) in the regional land use plan and the master plan, and there are several onshore and offshore wind farm projects in the municipality that are in the zoning, planning and production phases. The planning zone of the already zoned Maanahkiainen Offshore Wind Farm is approximately 3.9 km at the nearest and 17.3 km at the farthest to the west of Hanhikivi. The 1,400 MW Ebba Offshore Wind Farm project, which is currently in the zoning phase, is located approximately 20 km at the

[7] Hanhikivi 2020 report. 15.12.2010, p. 21

[8] Pyhäjoki. https://www.visitpyhajoki.fi/en/accommodation/

nearest and 34 km at the farthest from Hanhikivi, based on the indicative project framework[9].

In the zoning process, the municipality of Pyhäjoki has aimed to take into account the impact of an upcoming major project in the area using risk and growth scenarios. In addition to the Hanhikivi energy production facility, a large amount of business and industry has been zoned in the Ollinmäki business area (Figures 9 and 10). Taking the project into account in the current zoning will help accelerate and streamline the progress of the potential project, reducing the need for time-consuming additional zoning.

In terms of zoning, a possible need for additional zoning for housing can be seen as a potential development need if the project goes ahead. Currently, residential plots have been zoned in the area, for example in the Aatosvainio residential area of single-family housing, where 55 plots have been zoned, the majority of which are currently vacant (Figure 8). Vacant plots can also be found in other parts of Pyhäjoki. The increasing migratory pressure resulting from a major project may create a need to draw plans for more residential plots in the area.

Utilizing coastal plots to increase the attractiveness of the area is somewhat difficult, as the coastal areas are mostly owned by joint property management associations, which prevents their zoning.[10] The municipality has pending detailed shore plans for three areas (Ulko-Maunus, Syölätti, Tuhkasennokka), which will include planning for holiday home areas.[11]

Zoning in Pyhäjoki has considered the potentially growing need for commercial services, for example, through a commercial services area planned in Ollinmäki in the northern area of the town centre component master plan and service and administration areas in the southern area. The commercial services area in Ollinmäki in the north has been designated by the town plan as a commercial building block, where a large retail unit may be located. The area can accommodate up to 1,200 km² of grocery/food stores.[12]

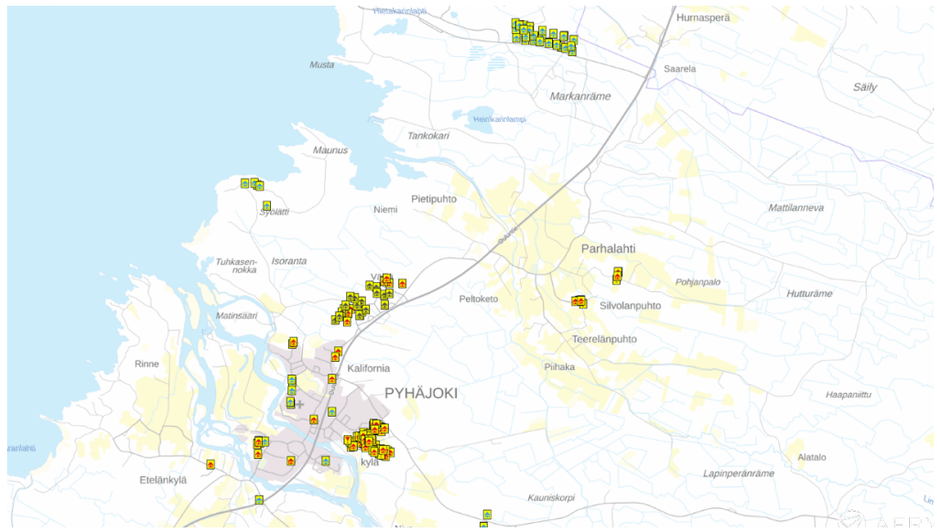

Figure 7 Plot supply in Pyhäjoki (source: JICT / InfoGIS)

[9] Renewables Finland. Wind power map. https://suomenuusiutuvat.fi/en/wind-power/projects-and-wind-turbines-in-finland/wind-power-map/
[10] Interview. Tapani Tuominen, Director of Economic Development and Vitality, Municipality of Pyhäjoki. 05/2024
[11] Pyhäjoki. https://www.pyhajoki.fi/asuminen-ja-ymparisto/kaavoitus-ja-maankaytto/vireilla-olevat-kaavat/ulko-maunuksen-syolatin-ja
[12] Pyhäjoki. https://www.pyhajoki.fi/asuminen-ja-ymparisto/kaavoitus-ja-maankaytto/voimassa-olevat-asemakaavat/ollinmaen-liikekorttelin

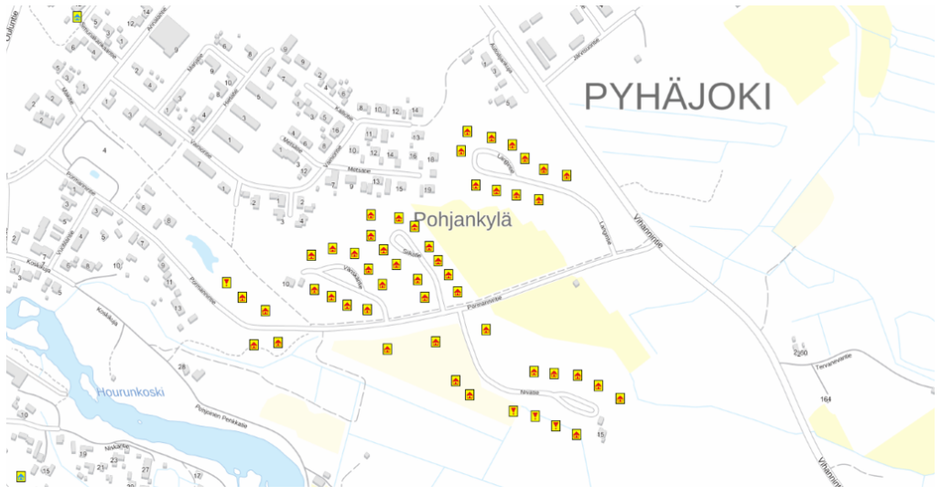

Figure 8 Aatosvainio residential area of single-family housing (source: JICT / InfoGIS)

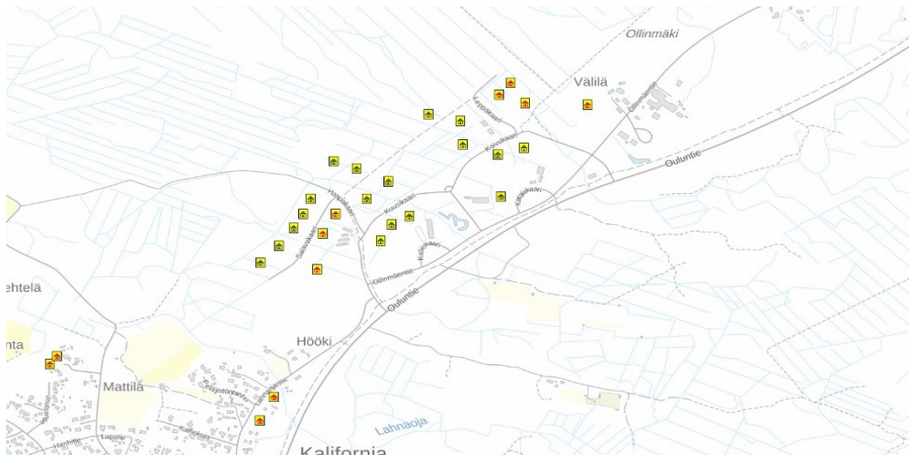

Figure 9 Ollinmäki business park (source: JICT / InfoGIS)

Figure 10 Hanhikivi business area (source: JICT / InfoGIS)

In addition to vacant plots, there were c. 30 apartments for sale[13] and c. 30 apartments for rent[14] in the Pyhäjoki municipality in August 2024. If the project goes ahead, there will be a growing need for rental apartments, so that the construction phase workers can also find regular rental housing options in the municipality.

The Hanhikivi site is currently allocated for a nuclear power project in the zoning. If a major project does go forward, for example for the production of hydrogen and/or ammonia, any changes that may be required should be taken into account in the zoning.

[13] Etuovi.com. https://www.etuovi.com/myytavat-asunnot/pyhajoki

[14] Vuokraovi.com. https://www.vuokraovi.com/vuokra-asunnot/Pyh%C3%A4joki

5.3 Public services

Key observations

- The municipality has a good capacity to respond to growth pressures in terms of services. Regional exercises have been carried out to prepare for growth scenarios.
- Clear, proactive communication can influence residents and decision-makers.

Based on the conducted interviews, the region has a good capacity to respond to population growth pressures, as a result of the previous project, and regional exercises concerning growth scenarios and population growth have been carried out. The multilingual and multi-channel delivery of services creates potential to increase the attractiveness of the region also for international talent.

In terms of municipal public services, clear and proactive communication can have a positive impact on residents and decision-makers both in the Pyhäjoki region and across the country. Clear communication is important in increasing municipal public services and the attractiveness of the municipality.

Pyhäjoki is part of the wellbeing services county of North Ostrobothnia. The hospitals in the county are the Oulu University Hospital (OYS), Oulaskangas Hospital (OAS) and Raahe Hospital (RAS), of which Raahe Hospital is the closest to Pyhäjoki. Health care in the municipality is provided by the Pyhäjoki health centre, a dental clinic, a child health clinic and the NeuvoRassi wellbeing service (guidance, advice, information on social services). The nearest private medical services can be found in Raahe and in Kalajoki. Youth activities in the municipality are provided by the parish youth room Sarpatti, 4H Pyhäjoki and the Pyhäjoki Motor Workshop.[15]

5.3.1 Schools and day-care centres

Key observations

- According to the municipality, the schools have the capacity to increase the number of pupils.
- The new Saari School was chosen as the School of the Year by the Trade Union of Education, OAJ.
- In early childhood education and care, buildings are in need of investments. There is a site for a new day-care centre. A major project would accelerate the investment decision.

There are two schools providing basic education in Pyhäjoki, of which the newer Saari School, which opened in 2022, was selected as the School of the Year 2024 by the Trade Union of Education, OAJ.[16] The schools currently have good capacity and, based on interviews conducted in the municipality, capacity could be increased quickly by combining some of the current small groups. The schools have been designed to accommodate a larger population than currently lives in the municipality and the pupil forecast is currently declining. In addition to a comprehensive school, the municipality of Pyhäjoki has its own upper secondary school.

According to the interviews, the situation is worse for early childhood education and care. The municipality has two day-care centres, Kivitasku and Parhalahti, and pre-school education. The current buildings are in need of investments, according to the interviews. A site has been reserved for a new day-care centre, and the implementation of a major project is likely to accelerate the decision on a new day-care centre.

[15] Pyhäjoki. https://www.pyhajoki.fi/en/culture-and-leisure/youthwork/youth-facilities; https://www.pyhajoki.fi/hyvinvointi-ja-terveys-pohde/pohde-yhteystiedot

[16] Trade Union of Education OAJ. https://www.oaj.fi/ajankohtaista/uutiset-ja-tiedotteet/2024/vuoden-koulu-2024/

5.3.2 Leisure

Key observations

- The many outdoor recreation, sports and leisure opportunities in the region add to its attractiveness.
- Developing leisure activities also increase the potential for tourism growth.
- The library plays an important role in municipal services.

The municipality has many outdoor recreation and leisure opportunities, including beaches, marinas and fish harbours, exercise parks, nature trails, outdoor recreation and hiking destinations and playgrounds. There is also a sports hall, an indoor ice rink, a gym, two disc golf courses, a tennis court and a beach volley court in the area. During the Retkeilyreitistö project completed in 2023, over 200 km of walking and cross-country cycling trails and beaches were improved and marked.[17]

According to interviews, the municipal library and its exhibition space play an important role in the cultural life of local residents. Culture in Pyhäjoki is also produced by the art groups of the Raahe Adult Education Centre and the Ylivieska Music Institute. The Pauhasali Auditorium in the upper secondary school is used as a venue for plays and concerts.

5.4 Transport links and municipal infrastructure

Key observations

- Roads are in poor condition in some places.
- Construction and preparations for a harbour have been carried out in Hanhikivi.
- Lack of public transport. Poor public transport connections, e.g. to railway stations, airports, ports.

Based on the geographic data analysis conducted, the road network in the area is in poor condition in places. Road paving works have been carried out on national road 8 in 2024 to improve transport connections from Pyhäjoki to Raahe (Figure 11). In 2022, the average traffic volume on national road 8 between Pyhäjoki and Raahe was approximately 4,000 vehicles per day and between Pyhäjoki and Kalajoki approximately 3,000 vehicles per day.[18] National road 8 was also improved in 2016–2018 to respond to the increase in heavy traffic volumes. At the same time, pedestrian and bicycle routes in Pyhäjoki were also improved.[19]

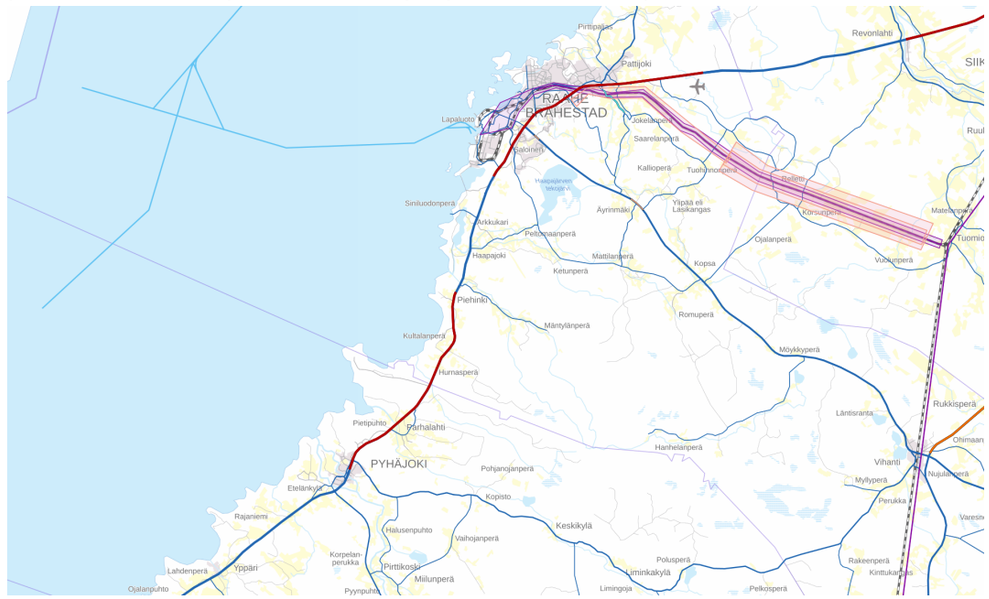

Figure 11 Road paving works (source: Finnish Transport Infrastructure Agency)

Some of the roads heading east from Pyhäjoki are in very poor condition. The nearest railway station to Pyhäjoki is in Oulainen (about 40 km to the east), which further

[17] Pyhäjoki. https://www.pyhajoki.fi/en/culture-and-leisure/sports/recreational-areas
[18] Finnish Transport Infrastructure Agency. Suomen Väylät. https://suomenvaylat.vayla.fi/?lang=en
[19] Finnish Transport Infrastructure Agency. https://vayla.fi/vt8pyhajoki

increases the urgency of repairing the eastbound routes. The traffic volumes on the road sections between Oulainen and Pyhäjoki in 2022 were roughly between 300 and 800 vehicles per day (Figure 12). For the time being, the municipality of Pyhäjoki lacks not only a railway network but also a direct port connection, which highlights the importance of the condition of the road network as freight and passenger transport increases.

Figure 12 Traffic volumes on roads in 2022, vehicles per day (source: Finnish Transport Infrastructure Agency)

Figure 13 Condition of road surfaces (source: Finnish Transport Infrastructure Agency)

For Pyhäjoki, the nearest railway connections can be found in Raahe (about 30 km) for freight traffic and in Vihanti (45 km) and Oulainen (40 km) for freight and passenger traffic. The nearest airports are in Oulu (100 km) and in Kokkola-Pietarsaari (120 km). The nearest ports are in Raahe (25 km), Kokkola (100 km), Oulu (100 km) and Kalajoki (50 km).

Underwater works have been previously completed for a harbour in Hanhikivi (waterway depth 8 m, width 80 m). The land constructions of the harbour have begun,

but are still in progress.[20] The harbour works, which have been started and partially completed, justify the development of the harbour area in the context of a major project, which will increase the capacity of freight traffic in particular to meet the growing needs of the area.

As a small municipality, the area has poor public transport connections, partly due to a lack of demand. There is a bus service from Pyhäjoki to Raahe and to Kalajoki. Public transport connections to, for example, railway stations, airports or ports in nearby municipalities would improve the attractiveness and accessibility of the area. If a major project is implemented, there may be a need to develop public transport connections, especially from residential areas to and from the Hanhikivi site.

There are roughly 31 kilometres of cycling routes near the Pyhäjoki population centre. The national cycling network runs through Pyhäjoki along national road 8. The international EuroVelo 10 cycling route also runs through the town centre of Pyhäjoki (Figure 14). In connection with the improvements to national road 8 in 2016–2018, a pedestrian and bicycle route was constructed next to the road in Pyhäjoki up to Hanhikivi. A pedestrian and bicycle route runs southwards along national road 8 as far as Viirre (c. 4.5 km).[21]

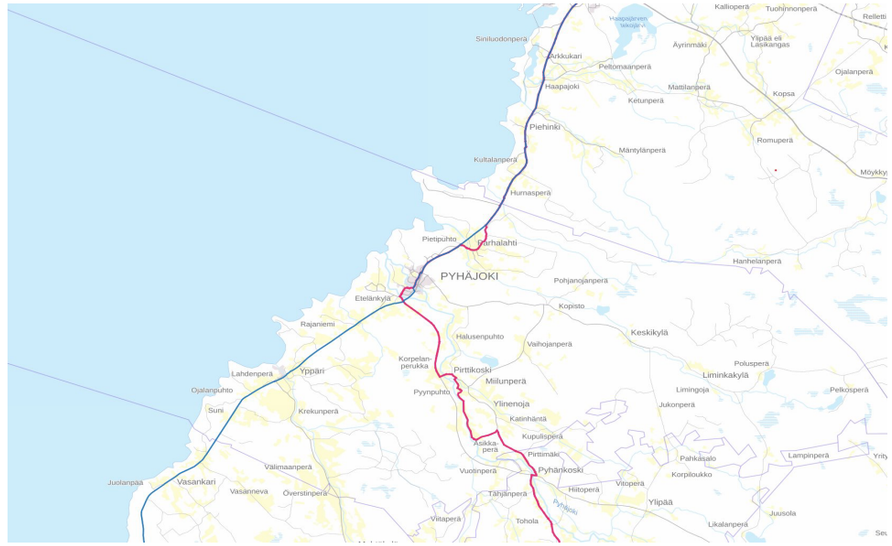

Figure 14 National cycling network and the EuroVelo route in Pyhäjoki (source: Finnish Transport Infrastructure Agency)

There are few groundwater areas in the Pyhäjoki area that are suitable for domestic water. Most of the water is imported from waterworks in neighbouring municipalities. The distribution areas for domestic water in Pyhäjoki are divided into three areas: the Pyhäjoki distribution area (Pyhäjoki-Yppäri-Pirttikoski-Parhalahti), the Kopisto distribution area, and the Liminkakylä-Keskikylä distribution area. A water connection (maximum freshwater intake capacity 1,200 t/day) has been built at the Hanhikivi site during the preparation of the site. There are about 40 km of general sewerage pipelines in the municipality, and wastewater treatment is carried out by three wastewater treatment plants (Lippi wastewater treatment plant, the old Yppäri treatment plant, the new Yppäri treatment plant).[22]

[20] AFRY Management Consulting Oy. 6.3.2024. Prefeasibility study for development of clean and stable energy production in the Pyhäjoki economic area. Final report, p. 97

[21] Finnish Transport Infrastructure Agency. https://vayla.fi/vt8pyhajoki

[22] Pyhäjokisuun Vesi Oy. http://www.pyhavesi.fi/

5.5 Industry and sub-supplier networks

Key observations

- Concrete and steel are likely to be the main materials needs of the major project. Cooperation with e.g. SSAB's Raahe steel mill and municipal/regional concrete mixing plants.
- Zoned industrial and business areas provide synergy benefits for the project (Hanhikivi, Ollinmäki).

The Pyhäjoki area is currently home to processing industry, such as wood and metal products. Steel and concrete form the biggest proportion of the raw material consumption of the nuclear power project. In terms of steel, possible cooperation with SSAB's Raahe mill could be a major advantage as they are a local supplier of steel. Cooperation with concrete mixing plants in the region (Ruskon Betoni Oy) increases synergy between regional operators.

The industrial and business areas planned for the area create potential for the formation of new project-specific supply chains within the municipality.

5.6 Energy and the environment

Key observations

- Wind power has a strong foothold in the municipality.
- There may be potential for more extensive use of solar power.
- There are several nature reserves in the immediate vicinity of Hanhikivi.

The Pyhäjoki area has made efforts to utilize both onshore and offshore wind power. Several wind farm projects have been zoned and planned in the area and there is already almost 340 MW of wind power capacity in the area. More than 2,000 MW of offshore wind capacity and around 50 MW of onshore wind capacity is at the planning/zoning stage.[23]

There are currently no industrial-scale solar power plants in the region. The 150 MW solar power plant in Leivinneva is under development.[24] In terms of solar irradiation, Pyhäjoki is at the same level with places such as Tampere, Lahti and Hämeenlinna (c. 1,000 kWh/m^2/a)[25], which also supports the more extensive use of solar power in the region, if suitable sites for production are available.

The abundance of zoned wind power production in the region creates potential for the Hanhikivi project to be implemented based on existing and planned wind power production in the area. This means that the production of hydrogen and/or ammonia, for example, at the Hanhikivi site could be carried out using wind power, thus avoiding the potential problem related to the definitions of renewable fuels of non-biological origin (RFNBO).

In the Hanhikivi regional plan for nuclear power, a power line connection east from Hanhikivi to the current 400 kV power lines has been planned for the area[26], and Fingrid has the capacity to build the connection. An electricity distribution network connection (5 MW capacity) has already been built in Hanhikivi in connection with the previous nuclear power project[27]. A new 400 kV electricity transmission link (Aurora Line) between Finland and Sweden will be completed in 2025 and will increase transmission capacity from Finland to Sweden by about 900 MW and from Sweden to

[23] Renewables Finland. Wind power map. https://suomenuusiutuvat.fi/en/wind-power/projects-and-wind-turbines-in-finland/wind-power-map/
[24] Motiva & Energy Authority. Solar power plants, https://aurinkosahkovoimalat.fi/
[25] Global Solar Atlas. https://globalsolaratlas.info/map
[26] Council of Oulu Region. https://www.pohjois-pohjanmaa.fi/kehittaminen/maakuntakaava/hanhikiven-ydinvoimamaakuntakaava-lainvoimainen/
[27] AFRY Management Consulting Oy. 6.3.2024. Prefeasibility study for development of clean and stable energy production in the Pyhäjoki economic area. Final report, p. 97

Finland by about 800 MW. The new transmission link will run from Pyhänselkä in Muhos via Keminmaa to Messaure in Sweden.[28]

From the perspective of Finland as a whole, the area is on average well suited for the utilization of conventional geothermal energy. For deep geothermal energy, the Pyhäjoki area does not appear to have particular potential based on the documentary analysis.[29]

There are few groundwater areas in the Pyhäjoki area. There are several privately owned nature reserves near Hanhikivi. There are also Natura 2000 areas in the immediate vicinity of the site.[30] The nature reserves must be taken into account when planning a major project. However, the EIAs carried out for the earlier nuclear power project and the related supporting functions in the area did not reveal any actual barriers to the implementation of a nuclear power project in Hanhikivi. Although new projects will have to conduct their own EIAs, the previous EIA decisions give new operators some reassurance as to the suitability of the area for a major energy project.

5.7 Other infrastructure projects

Key observations

- The Gasgrid hydrogen pipeline (Nordic Hydrogen Route) is proposed to run through the Pyhäjoki area. Greater potential for hydrogen projects.
- Fingrid has the capacity to implement 400 kV power lines. Basic planning, zoning and permit procedures are ready for 2x400 kV + 2x110 kV connections to the transmission grid.

Gasgrid aims to build hydrogen infrastructure in the Bothnian Bay region by 2030. The intended route runs through the coastal areas of the Bothnian Bay.[31] The development of hydrogen infrastructure in the region increases the potential for investment in hydrogen production in Pyhäjoki and Hanhikivi.

Fingrid's capacity to implement a 400 kV power line connection in the Hanhikivi site will serve as an enabler for the nuclear power project, as the current lack of transmission connections will not form an obstacle to the implementation of the nuclear power project.

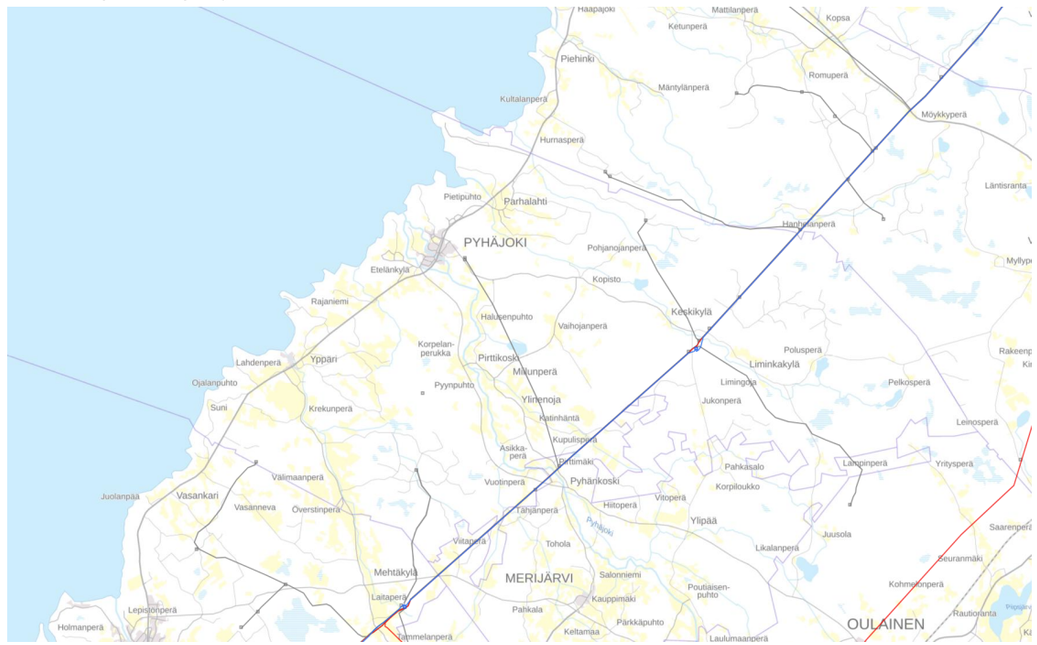

Figure 15 Electricity grid on a map (source: Fingrid)

[28] Fingrid Oyj. https://www.fingrid.fi/en/grid/construction/aurora-line/
[29] Geological Survey of Finland GTK. https://gtkdata.gtk.fi/Maankamara/index.html
[30] Paikkatietoikkuna. https://kartta.paikkatietoikkuna.fi/?lang=en
[31] Gasgrid Finland Oy. Nordic Hydrogen Route. https://gasgrid.fi/en/projects/nordic-hydrogen-route-en/

5.8 Summary of the advantages and areas for development in the area in terms of energy investment

Key observations

- A lot of groundwork and infrastructure construction has been done in Hanhikivi for a nuclear power project.
- Previous permits and EIAs provide a good starting point for a new project; although the permits and EIAs cannot be used as such as a basis for the new project, the permits granted can be expected to provide some reassurance to the new operator.
- Due to the previous project, the municipality of Pyhäjoki has, to some extent, proven its capacity as an enabler and a facilitator of a major project.
- The municipality of Pyhäjoki has worked actively to enable clean energy production in the area, as shown e.g. by the zoning decisions for Hanhikivi and the wind farms.
- The Pyhäjoki area has a low availability of highly educated labour.
- The transport infrastructure needs to be developed.

The primary advantage of the Pyhäjoki area for energy investment is the Hanhikivi site itself. Earthworks and preparations have already been carried out in an area of about 115 ha. In addition, infrastructure has been developed for a project, including roads, a freshwater connection (max. 1,200 t/day), and a distribution network connection (5 MW capacity). The site is zoned for energy production use and supporting functions (more specifically for nuclear power). Underwater works have been completed for a harbour on the site (waterway depth 8 m, width 80 m). The work already completed on the site could lead to cost savings of up to 15% on a new nuclear power project investment, according to the prefeasibility study. The site has been specifically prepared for nuclear power use, which means that the groundwork may not be able to be utilized to the same extent in other major projects and the maximum benefits of the measures taken cannot be derived.[32]

The permits granted previously for the site and the nuclear project (environmental permit, water permit for the harbour and cooling water and chemical permit) and the environmental impact assessment (EIA) carried out for the project cannot be utilized as such in the implementation of a new project. However, the fact that these permits have been granted may give new investors and developers some reassurance as to the project going ahead. However, it should be remembered that permits are assessed at a given point in time. The state of the environment, for example, may have changed since the permits currently in force were issued.

From the point of view of an energy investment, the capacity of the municipality to act as an enabler of a major project should also be seen as an advantage for Pyhäjoki. Due to the previous project, the municipality has a certain understanding of and readiness for a major project and the growth trend it will generate in the population. The municipality has made efforts to develop the services in the area from the perspective of a major project and, for example, local schools have the capacity to increase the number of pupils. Public opinion in Pyhäjoki and the surrounding municipalities is favourable to the implementation of a nuclear power project in the municipality, and the municipality has actively sought to enable clean energy production in the area, for example through zoning.

Areas for development in the region include the shortage of skilled labour and the poor condition of transport infrastructure. The implementation of the major project in itself can be expected to increase the attractiveness of the region among the highly educated population through the creation of new jobs. The region's weaknesses,

[32] AFRY Management Consulting Oy. 6.3.2024. Prefeasibility study for development of clean and stable energy production in the Pyhäjoki economic area. Final report, p. 9

particularly in terms of regional attractiveness, are the lack of private services (shops, restaurants, etc.) and the lack of public transport connections.

For now, the transport connections in the region are limited to the road network. Parts of the road network are in poor condition. On national road 8, paving works have been carried out on sections in poor condition in 2024. Especially the smaller regional and connecting roads to the east are in very poor condition in some parts. The works carried out at the Hanhikivi site for a harbour create a potential to shift the growth pressure in freight traffic, in particular, away from road traffic capacity.

Table 1 Key opportunities and areas for development in the Pyhäjoki area identified in the documentary analysis

Topic	Opportunity	Area for development
Demographics	Expertise in nearby regions (university cities)	Increasing regional attractiveness and employee retention
Schools and day-care centres	Schools have the capacity to increase number of pupils	Investment needs in early childhood education and care
Services (public and private)	Plenty of recreational, outdoor and sports services	Increasing the attractiveness of the area by increasing and promoting services, lack of e.g. restaurant services
Hanhikivi site	Preparation and construction work already done on the site for a nuclear project	Project-specific infrastructure needs
Economic structure / industry	Zoned industrial/business areas (Ollinmäki, Hanhikivi)	Attracting industrial investment and private services to the area
Sub-supplier networks	SSAB's Raahe mill, concrete mixing plants in Pyhäjoki and neighbouring municipalities	Project-specific special needs
Land use / zoning	Hanhikivi site: zoning for energy production use	Adequate zoning of residential areas as projects go ahead, possibly updating the plan for the Hanhikivi site
Energy infrastructure	Several wind power projects in the region, possible future hydrogen infrastructure, Hanhikivi planning area	Basic planning for electricity transmission connections (2x400 kV and 2x110 kV), but no implementation; zoning and permit procedures are complete
Transport connections	Underwater works for Hanhikivi harbour completed	Regional and connecting roads to the east: in poor or very poor condition in places
Environment	Previous permits and EIAs: reassurance for the preparation of similar projects	Taking the protected areas near Hanhikivi into account

Table 2 Readiness of the Pyhäjoki area in the current situation and at the start of the major investment

Topic	Current situation	Priority (1–3) at the start of major investment	Comments
Demographics	●	1	The region has a limited supply of highly educated labour to meet the needs of a major project. Developing cooperation with the nearest university cities (Oulu, Kokkola) is important. A major investment can be expected to increase the attractiveness of the region also for the highly educated population.
Schools and day-care centres	◑	2	Investments in early childhood education and care buildings are required, especially at the start of the major project. A site for a new day-care centre exists. Based on the interviews, a major project would accelerate the decision to invest, and there is good capacity to improve the situation.
Services (public and private)	●	1	Private service providers (e.g. restaurants) disappeared after the previous project failed. Attracting entrepreneurs to the area is expected to be easier following a major investment. The development of private services and the available municipal services will facilitate the better retention of labour in the region.
Hanhikivi site and environment	◑	2	There are nature reserves near Hanhikivi. It is important that these areas are taken into account in the planning and implementation of a major investment. Separate EIA studies must be carried out for new projects. However, previous EIA decisions give new operators some reassurance as to the suitability of the site, particularly for a major energy project.
Economic structure / industry / sub-supplier networks	●	3	A major investment is likely to bring new operators and sub-supplier networks to the region.
Land use / zoning	●	1 / 3	Depending on the nature of the major investment, the zoning of the area may need to be changed. The Hanhikivi site is zoned as an area for energy production use (nuclear power) in the regional and master plan.
Energy infrastructure	●	2	New electricity transmission connections to the grid to meet the needs of a major energy investment. Fingrid has the capacity to implement a 400 kV connection, timeline c. 4 years from the decision.
Transport connections	◑	1	Poor public transport connections in the area; more public transport connections to neighbouring municipalities and to the Hanhikivi site will be needed if the investment goes forward. Well-functioning public transport will also improve the attractiveness and accessibility of the area. Road conditions east of Pyhäjoki / to the nearest railway station are very poor in places. The municipality has limited opportunities to influence road repair in the short term.

6 Route map: Assessment of variables affecting investment options in Hanhikivi

This chapter assesses twelve variables that could affect the four possible solutions for the development of the Hanhikivi site that were identified in the prefeasibility study. A possible capacity mechanism, public subsidies for nuclear projects, the growing demand for electricity and hydrogen in northern Sweden, a positive nuclear trend and the significant offshore wind capacity that is planned near Pyhäjoki can have a positive impact on the realization of the project. However, threats include the low value or demand for nuclear electricity and/or hydrogen, the lack of a capacity mechanism and public nuclear subsidies, the timetable for the construction of a hydrogen transmission network, the cancellation trend of green transition investments, and the permit from the Radiation and Nuclear Safety Authority (STUK) to locate a hydrogen/ammonia plant near nuclear power production. The analysis did not reveal any major obstacles that a single variable could pose to the implementation of the solutions.

6.1 Current situation and potential of the Hanhikivi site, description of options

Key observations

- The prefeasibility study identified four possible solutions for utilizing the Hanhikivi site.
- Three of these options use nuclear energy and one uses renewable energy as the energy source.
- Each option will result in the production of electricity, hydrogen or ammonia for the market, classified as either green (RFNBO) or low-carbon, depending on the production method.[33]

The prefeasibility study identified four feasible solutions for the utilization of the Hanhikivi site, namely:

1) **Nuclear power production for the electricity market:** Nuclear power production for the electricity market and/or for larger end-users through direct contracts or the Mankala model. Nuclear power also contributes to the stability of the electricity system.

[33] Green hydrogen refers to hydrogen produced from renewable energy sources. Blue hydrogen is hydrogen that is produced from fossil fuels, but the carbon emissions are not released into the atmosphere but captured and stored. RFNBO = Renewable Fuels of Non-Biological Origin. Green hydrogen fulfils the EU's RFNBO criteria, which will increase its demand and value, partly because the EU is obliging companies to use RFNBO fuels to an increasing extent.

2) **Nuclear power production for on-site hydrogen and ammonia production:** Nuclear power production for on-site hydrogen and ammonia production. Requires a permit from the Radiation and Nuclear Safety Authority (STUK) for locating a hydrogen/ammonia production plant on the same site as nuclear power. Hydrogen and ammonia produced by nuclear power is likely to be classified as low-carbon and not green. Under this option, hydrogen and ammonia would be transported, for example, in liquefied form by truck or sea.

3) **Nuclear power and hydrogen production with hydrogen transported via a pipeline:** Nuclear power production for on-site hydrogen production. Hydrogen is transported via a hydrogen pipeline. Also requires a permit from STUK. Hydrogen and ammonia are likely to be classified as low-carbon and not green. Requires hydrogen pipelines to be constructed in Finland.

4) **Hydrogen and ammonia production with renewable energy:** On-site production of hydrogen and ammonia, based on purchased renewable power or local[34] renewable power production. The resulting hydrogen and ammonia would be considered RFNBO compliant and green, unlike that produced by nuclear power.

The potential nuclear power project therefore constitutes, in principle, a conventional large nuclear power plant. However, if nuclear power production were to be based on SMR (small modular reactor) technology, there would be room for several such plants at the site, the exact number depending on the selected model. Total production capacity could then range from 300 MW to more than 2,000 MW. SMR technology offers flexibility by reducing the initial investment, and would also deliver a faster return on investment. This technology also allows the investment to be scaled up and units to be built one by one as demand evolves. However, SMR technology is still under development, with some models more advanced than others. A potential plant could reach the operational phase in the early 2030s at the earliest.

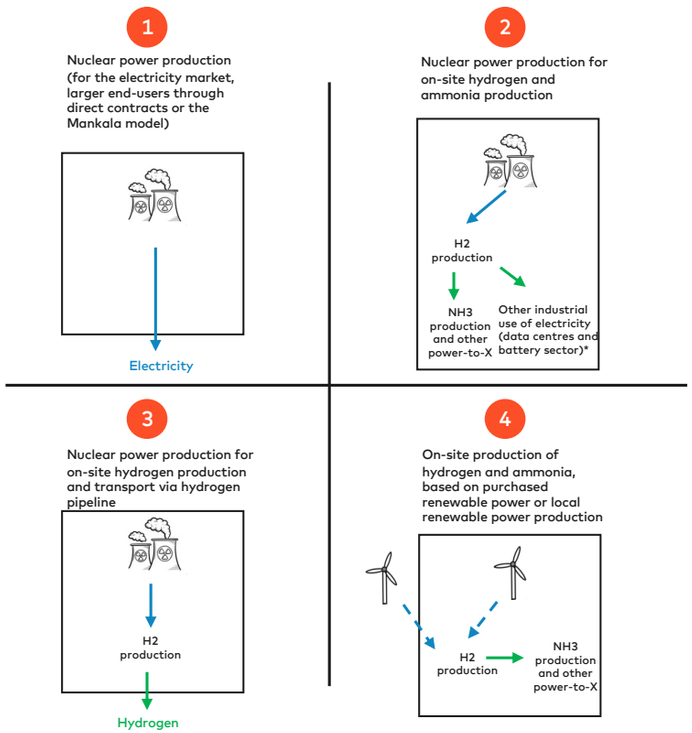

*Figure 16 Options for the utilization of the Hanhikivi site identified in the prefeasibility study**

[34] For the sake of clarification, local renewable production does not, however, refer to e.g. offshore wind power directly at the Hanhikivi site.

* The study identified data centres and the battery sector as potential options, but these were not examined in the prefeasibility study and are therefore not discussed in more detail in the route map section of this action plan.

6.2 Description of identified variables (drivers, constraints/threats)

Key observations

- The study analysed more than ten different variables that, if realized, could affect the attractiveness or feasibility of the possible solutions.
- The variables are divided into negative (constraints/threats) and positive (drivers).
- For each variable, the likelihood of its occurrence, the timeframe for its clarification and the size of the impact if it were to occur were assessed.

During the task, the variables selected by the client that could have a positive or a negative impact on the possible solutions identified in the prefeasibility study were analysed. The options concerning nuclear power have played the main role in the study and therefore most of the variables concern solutions 1, 2 and 3. The list of variables should therefore not be seen as an exhaustive sample of all the variables affecting the possible solutions.

Positive variables are referred to in this chapter as drivers and negative variables as constraints, threats or show-stoppers. It is worth noting that, despite their name, show-stoppers are not automatically barriers to options when they occur, but most of them only complicate or delay the realization of the scenarios.

The assessment aimed to identify how the relative attractiveness of the options identified in the prefeasibility study might change under different variables. In addition, the likelihood of each of these variables becoming a reality was analysed, as well as an estimate of the timeframe in which the fate of each variable would become clear or be clarified.

Five potential drivers and five potential constraints or threats that, if realized, would affect the attractiveness or even the feasibility of the possible solutions are presented below. For two of the variables, it was determined that they will not cause problems.

These are the technical challenges of hydrogen transmission (challenges may arise from the cost level, but the technical capability exists) and the ability of Fingrid to provide a 400 kV connection to the Hanhikivi site (Fingrid has the capability to do this and the implementation would take about 4 years from the decision, which is a short time compared to the rest of the project schedule).

The potential drivers and the potentially negative variables, i.e. constraints or threats, analysed in the study are presented in the table below.

Table 3 Drivers and constraints/threats

Drivers	Constraints/threats
» **Possible capacity mechanism.** A possible additional mechanism for the electricity market, through which electricity producers would also receive revenue from the existence of capacity, and not only from the sale of electricity. » **Public subsidies for nuclear power.** In some countries, public subsidies for nuclear power have also been envisaged as a means of ensuring the viability of nuclear power. These subsidies require EU approval. » **Growing demand for electricity/hydrogen in northern Sweden.** Strong growth in electricity demand has been predicted for	» **Low value and demand for nuclear electricity/hydrogen/ammonia (low-carbon classification).** Nuclear hydrogen and its derivatives are currently defined as low-carbon in EU regulation. Low-carbon hydrogen competes with green hydrogen produced from renewables and blue hydrogen which utilizes carbon capture. The value and demand for low-carbon hydrogen is therefore uncertain for the time being. » **Lack of capacity mechanism / public subsidies for nuclear power.** The viability of conventional nuclear power, especially considering the project risks, may be put to the test

northern Sweden, and it is uncertain whether the energy needs of local industry will be met in the future, which may increase demand from Finland. » **Positive nuclear trend.** Possible positive views in society towards nuclear power. » **Large amount of offshore wind power planned near Pyhäjoki.** Two large offshore wind farms are planned at sea about 10 and 25 km from Hanhikivi, which could be useful for the 4th scenario. An EIA has already been conducted for the project named Maanahkiainen, 10 km away, and its estimated capacity is 500 MW. Another farm 25 km away has also been zoned and has an estimated capacity of 1,400 MW.	without additional sources of revenue, such as a capacity mechanism or public subsidies for nuclear power. » **Construction and timeframe of a hydrogen transmission network.** Gasgrid is responsible for planning a large-scale hydrogen transmission network in Finland. The hydrogen transmission network is an absolute constraint to the realization of the third option, the pipeline transportation of nuclear hydrogen, but there is uncertainty about its timetable, in particular. » **The cancellation trend of green transition investments.** Possible cancellations or delays of green energy projects. » **Permit from STUK to locate a hydrogen/ammonia plant near nuclear power production.** A permit from the Radiation and Nuclear Safety Authority to locate a hydrogen and/or ammonia plant in the same site as nuclear power is a constraint to the implementation of options 2 and 3.

6.3 Assessment of variables in relation to the development options for the site

Key observations

- The likelihood of the variables and their impact if they were to occur vary. The overall impact assessments for each scenario are visualized in a summary table at the end of the chapter.
- All three nuclear power scenarios involve a substantial number of both negative and positive variables, but the third option, unlike the others, also involves uncertainty about the timetable of the hydrogen pipeline in the area.
- The lack of a capacity mechanism or other additional revenue is the most significant negative variable for the nuclear scenarios, while the growing demand in northern Sweden and a possible positive nuclear trend are the biggest positive variables.

Tables 4 and 5 summarize the likelihood of the variables and their impact if they were to occur.

Table 4 Likelihood of positive variables and their impact on the possible solutions

Positive variable	Likelihood and impact on possible solutions
Capacity mechanism	A capacity mechanism could increase the viability of nuclear power; however, its realization seems uncertain under the current regulatory framework. Requires a political decision at both EU and national level. Under the current EU calculation method, Finland does not have a problem in the long term that needs a capacity mechanism as a solution. The question marks are therefore the regulation, benefits and timetable.

Public subsidies for nuclear power projects	Public subsidies for nuclear power projects are under consideration in Finland and there is a significant possibility that Finland will follow Sweden's lead. In August 2024, the Swedish government proposed, based on its study, that Swedish nuclear power projects will be supported by the state through loans and electricity price guarantees (CfD)[35]. The subsidies require EU approval and a major change in Finland's energy policy. The Czech subsidy plans were approved by the EU in May 2024.[36] EU's von der Leyen has also expressed her openness to them.[37] A positive subsidy decision would improve the viability of nuclear power to some extent, but it depends on the size of the subsidies whether it would make a decisive difference.
Growing demand for electricity and hydrogen in northern Sweden	Electricity/hydrogen production in Pyhäjoki could benefit from the growing demand in northern Sweden. The potential demand for energy from Finland could also be increased by the wind power opposition in northern Sweden and the new electricity transmission connections under construction between the two countries. Up to 70 TWh/a of additional demand could be generated in northern Sweden by 2050. The substantial growth in demand seems likely, but attitudes towards wind power could also change quite quickly.
Positive nuclear trend	Both in Finland (e.g. Fortum and Helen[38], survey by Finnish Energy[39]) and in Europe[40], there has been extensive pro-nuclear debate recently. This suggests that the appreciation of nuclear power is unlikely to decline in the next few years but may even increase significantly. This may contribute to obtaining permits and to the appreciation and demand for nuclear electricity/hydrogen.
Large amount of offshore wind power planned near Pyhäjoki	The two offshore wind farms planned some 10-25 km from Hanhikivi could, if realized, provide a cost-effective way to produce RFNBO hydrogen or ammonia with a direct connection to the wind plant. However, Fingrid estimated in June 2024 that Finnish grid electricity could also soon be used to produce RFNBO-compliant green hydrogen/ammonia, which could reduce the significance of nearby wind power. The farms may also be delayed, for example, if it appears that the growth of electricity demand does not follow the growth in production in Finland.

Table 5 Likelihood of negative variables and their impact on the possible solutions

Threat/constraint	Likelihood and impact on possible solutions
Low value and demand for nuclear electricity/ hydrogen/ammonia (low-carbon classification)	Low-carbon hydrogen and its derivatives compete with green and blue hydrogen. Green hydrogen has the advantage of meeting the RFNBO targets set by the EU for companies, which cannot be met by using low-carbon hydrogen. On the other hand, the steady hydrogen production enabled by nuclear power eliminates the need for hydrogen storage, which is very expensive and challenging. Blue hydrogen, on the other hand, can be cheaper than nuclear hydrogen, but the carbon capture it requires is neither simple nor free, and requires an appropriate value chain and infrastructure. There are therefore many factors that affect the competitiveness of nuclear energy and its derivatives, and time will tell where their value will settle in the energy market. If value and demand are low, the negative impact on the viability of nuclear projects is obvious.
Lack of capacity mechanism / public	The viability of a conventional nuclear power plant (especially considering the risks) will be put to the test without additional revenues from a capacity mechanism or public subsidies. However, the realization of both sources of additional revenue in Finland is highly uncertain for now. This

[35] https://www.world-nuclear-news.org/Articles/Financing-model-proposed-for-new-Swedish-reactors
[36] https://world-nuclear-news.org/Articles/EU-sets-out-terms-for-allowing-Czech-nuclear-state
[37] https://www.euronews.com/my-europe/2023/09/26/european-commission-is-willing-to-consider-subsidies-for-nuclear-technology-says-von-der-l
[38] https://www.hs.fi/talous/art-2000010409294.html
[39] https://energia.fi/en/press-releases/popularity-of-nuclear-power-continues-strong-in-finland/
[40] https://www.eunews.it/en/2024/03/21/declaration-for-nuclear-power-in-brussels-von-der-leyen-backbone-by-2050-with-renewables/

subsidies for nuclear power	variable is therefore quite a significant threat to the nuclear scenarios. On the other hand, the Swedish government's historic proposal in August 2024 to support Swedish nuclear power projects from public funds may increase the likelihood of similar development in Finland.
Construction and, above all, timeframe of a hydrogen transmission network	Gasgrid is responsible for planning a large-scale hydrogen transmission network in Finland. Gasgrid aims to have the hydrogen network in Finland in operation by 2030. The projects are currently at the preliminary planning stage, meaning that final policies and investment decisions have not yet been made, so there is still considerable uncertainty about the timing and likelihood of implementation. A hydrogen transmission network will be needed if there is insufficient local demand for hydrogen. Hydrogen could potentially be transported along the transmission network to several end-users connected to the network, or even for export, depending on the extent of the transmission network. Hanhikivi is geographically located within the Nordic Hydrogen Route project, which has been approved for the EU's Projects-of-Common-Interest list and is therefore eligible for public support through the Connecting Europe Facility, thus increasing the likelihood of project realization.
Cancellations/delays of green transition investments	There are some signs that industrial investments are not keeping up with the pace of growth in energy production. This may affect energy demand at least temporarily, reducing the viability of power generation projects.
Permit from STUK to locate a hydrogen/ammonia plant near nuclear power production	A permit from STUK is a constraint to the implementation of options 2 and 3. According to a new regulation issued by STUK in February 2024, the protection area and the contingency area are defined on a case-by-case basis, whereas before they were automatically 5 km and 20 km respectively. This may facilitate the location of nuclear power and other production at the site, but obtaining a permit will not be known until it is applied for. Obtaining the permit will largely depend on the distance, the size of the hydrogen/ammonia plant and the external threat it poses to the nuclear power plant. STUK estimates that if the content of the application is mainly in order, the assessment of the protection area will be carried out within 6 months of submission of the application. Any requests for further clarification will, of course, extend the processing time.

These variables therefore affect the four possible solutions for the site in different ways. Their scenario-specific likelihood, timeframe and impact are visualized in Figure 17. The impact and likelihood of occurrence are illustrated by green spheres for positive variables and red spheres for negative variables. The number of spheres indicates the impact of the variable if it were to occur, and the brightness of the spheres indicates the likelihood of occurrence. The clock symbol estimates the timeframe in which the fate of the variable could become clearer.

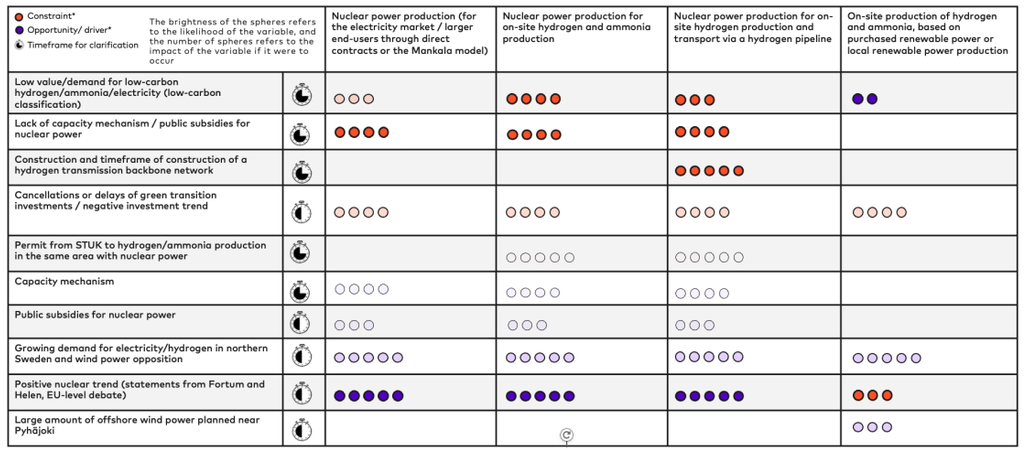

Figure 17 Likelihood and impact of variables on possible solutions

Most of the variables relate to one of three nuclear scenarios. The most important threats identified for the nuclear scenarios are the low value/demand for nuclear

commodities, i.e. electricity, hydrogen or ammonia, and the lack of a capacity mechanism and public subsidies for nuclear power. The demand for nuclear commodities is significantly affected e.g. by EU regulation, which currently defines, for example, nuclear hydrogen as low-carbon and not green as in the case of renewable energy sources. The viability of conventional nuclear power, on the other hand, is put to the test, especially considering the risks of the project, if no additional revenues are generated for the projects, for example through a capacity mechanism or public subsidies for nuclear power. However, it is useful to examine viability on a case-by-case and project-by-project basis.

The biggest potential drivers include the positive nuclear trend in Finland and across the EU, of which there are already some noteworthy signs (e.g. the above-mentioned statements by Helen, Fortum and EU's von der Leyen). Such a trend could reduce the risks associated with nuclear power projects, for example in terms of the timetable and permits, and promote nuclear-friendly regulation, increasing the value and demand for nuclear commodities.

In addition, the growing demand for electricity and hydrogen in northern Sweden and the concurrent local wind power opposition there may increase the demand for both nuclear and renewable electricity, hydrogen and ammonia from Finland. The demand for electricity is expected to grow in the future as industrial and other actors become even more electrified. In the Nordic market, northern Sweden is expected to use more and more electricity as investments in green steel are realized. It should also be noted that although Finland is typically expected to be self-sufficient in electricity on an annual level in the future, it should be noted that Finland may still be highly dependent on imported electricity in shorter periods.

As shown by Figure 17, there are significant variables, both negative and positive, associated with the nuclear power scenarios. The third scenario differs from the others in that it includes as an additional variable that causes uncertainty, namely, the construction of the hydrogen pipeline and, above all, the timeframe for its construction. The fourth possible solution, the production of hydrogen and ammonia using renewable energy, also involves a number of variables. The most significant potential drivers for this option are the potential growth in demand in northern Sweden and the large amount of offshore wind planned near Pyhäjoki. There is also a lot of existing onshore wind power around Pyhäjoki, but it is not seen to provide a significant benefit for the fourth scenario.

It is important to remember that this is not an exhaustive list of the variables affecting the possible solutions, but a selected sample of them. Therefore, the above table cannot be used to directly interpret the relative level of risk or opportunity of the possible solutions, because not all possible variables have been taken into account. For example, the analysis is quite focused on nuclear power for the reasons mentioned above, so all the variables related to the fourth scenario, in particular, are not taken into account in the analysis. For the same reason, it is not reasonable to add up the variables, i.e. it is not advisable to assess the combined effect directly based on the figure, as this is a qualitative assessment.

6.4 Variables on a timeline and assessment of ways forward

Key observations

- There is a clear variation in the timeframe for the clarification of the variables, and some may not become fully clear until the following decade. There is also considerable doubt and uncertainty as to the timeframe of all the variables.
- The potential positive nuclear trend and its implications are likely to be clarified the fastest of all the variables, as well as the role of low-carbon hydrogen and ammonia.
- Variables that are likely to become clear later include the capacity mechanism and the more precise timetable for the construction of the hydrogen pipeline.

A large nuclear power plant has already been prepared for the Hanhikivi site under a previous project, and the municipality's interests have always focused on option 1 as the most likely solution, i.e. the construction of a conventional nuclear power plant only. The starting point for this assessment has therefore been to determine the potential of the site in terms of nuclear power and, in addition, to analyse the attractiveness of complementary or alternative solutions.

Tables 6 and 7 contain a brief estimate of the timetable for each variable and municipality's influence over them.

Table 6 Estimated timetable for the positive variables and the municipality's influence over them

Positive variable	*Timetable and municipality's influence*
Capacity mechanism	If realized, will take at least 5 years. Likely to utilize the Swedish study, scheduled for completion in spring 2025. Pyhäjoki has little influence over this.
Public subsidies for nuclear power projects	If realized, will take at least a few years. The Swedish government's proposal on public subsidies in August 2024 may also accelerate progress in Finland. There is a distinct possibility that Finland will follow Sweden's lead. The subsidies would still require EU approval after a decision at national level. In the case of the Czech Republic, it took two years to obtain approval, but the time would probably be shorter next time for similar subsidies. Pyhäjoki has little influence over this.
Growing demand for electricity and hydrogen in northern Sweden	The exact amount of growth in demand should be confirmed in the coming years as investment decisions are taken. Local opinion towards wind power in northern Sweden, which may increase demand, can change rapidly. Aurora Line 1 is scheduled for completion in 2025 and Aurora Line 2 in 2031. Demand and supply are interdependent, so planning for new electricity or hydrogen production may also contribute to demand-side investments. If energy is available anyway, there is no similar pressure to accept wind power. Thus, the energy production projects in Pyhäjoki have at least a theoretical potential to influence demand growth in northern Sweden.
Positive nuclear trend	The role and appreciation of nuclear power as part of the energy system will become clearer in the coming years. Pyhäjoki has the opportunity to contribute to a positive debate on nuclear power.
Large amount of offshore wind power planned near Pyhäjoki	Both Maanahkiainen (500 MW) and the Pyhäjoki-Raahi offshore wind project (1,400 MW) aim to be operational in 2032. The provision of high and stable electricity demand, such as hydrogen production, in the area may increase the likelihood that these projects will be implemented. The projects in Pyhäjoki therefore have at least a theoretical opportunity to make an impact.

Table 7 Estimated timetable for the negative variables and the municipality's influence over them

Threat/constraint	*Timetable and municipality's influence*
Low value and demand for nuclear electricity/hydrogen/ammonia (low-carbon classification)	The EU's new *Low Carbon Delegated Act*, set to be completed by the end of 2024, will clarify the role and value of nuclear hydrogen. Pyhäjoki has little influence over this.
Lack of capacity mechanism / public subsidies for nuclear power	If realized, will take at least a few years. The Swedish studies completed in August 2024 and spring 2025 should also give some indication of the direction Finland will take. Pyhäjoki has little influence over this.

Construction of the hydrogen transmission network	Gasgrid aims to have the hydrogen network in Finland in operation by 2030. The projects are currently at the preliminary planning stage, meaning that final policies and investment decisions have not yet been made, so there is still considerable uncertainty about the timing and likelihood of implementation. Pyhäjoki has limited influence over this.
Cancellations/delays of green transition investments, or demand-side investments	The situation should become clearer over the next few years as a result of companies' investment decisions. For now, it is too early to say. Pyhäjoki has limited influence over this.
Permit from STUK to locate a hydrogen/ammonia plant near nuclear power production	Permits are processed on a case-by-case basis. Appropriate and thorough safety planning is likely to improve the likelihood of obtaining a permit. There is no single valid answer to locating plants in the same area, but STUK's decision will require more details on the characteristics of the plants and the factors affecting safety. However, STUK has stated that there may be some other activities on the power plant site, but so that these do not pose a threat to the safety of the nuclear power plant or to safety and emergency arrangements. On the other hand, the threats posed by the nuclear power plant to the hydrogen/ammonia plant must also be taken into account. Requirements concerning the site of a nuclear facility and external threats are set out in STUK Regulation Y/1/2018 Section 14, Regulatory Guides on nuclear safety and security (YVL) B.7 and A.2.

Some variables may be clarified in the next couple of years, while others will become clearer closer to 2030 or even beyond. For the most part, the ability of the municipality of Pyhäjoki to influence the variables is estimated to be low, but by engaging in positive debate on nuclear power, for example, the municipality can help advance the role of nuclear power. The provision of electricity demand, for example in the form of hydrogen production, could in theory contribute to the realization of electricity generation projects such as offshore wind power (option 4). Similarly, the provision of electricity and hydrogen production could potentially contribute to the realization of electricity and/or hydrogen consuming projects, for example in northern Sweden (options 1, 2 and 3).

For most variables, it is extremely difficult to estimate the resolution time with a relevant degree of accuracy. Figure 18 visualizes the timeframe of the variables by placing them roughly on a timeline. The longer the bar, the greater the doubt or uncertainty associated with the timetable. Although the visualization has been done to the nearest year, it should be noted that the bars are based on a rough estimate and the fate of the variables may also become clear outside the estimated time window.

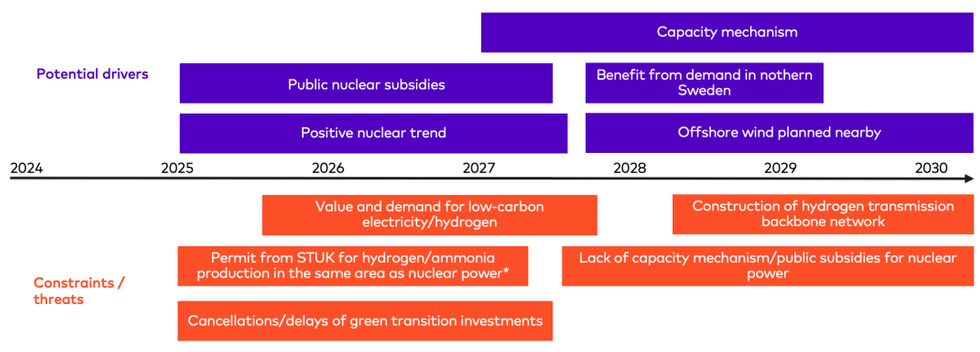

Figure 18 Estimated timeframe for the clarification of variables

The attractiveness of both nuclear power and hydrogen and ammonia production involves a number of variables, the fate of which will be resolved at various stages over the coming years. The implementation of option 1 could therefore be seen as

useful in terms of strategic flexibility, buying time to examine the variables affecting investment in hydrogen and ammonia and postponing the decision on possible additional investments (hydrogen/ammonia production) to the future. Possible SMR nuclear power would further increase strategic flexibility by allowing for a lower initial investment. However, there are still major question marks over the timing of SMR commercialization and the cost level. It is estimated that an SMR facility could become operational in the early 2030s at the earliest. Of course, waiting too long could also lead to the diversion of key energy generation or demand-side projects to other places.

The variables relating to the attractiveness of hydrogen and ammonia investments include the construction of the hydrogen network and the timeframe for its construction, as well as the role and value of low-carbon hydrogen/ammonia. Thus, the further forward we go, the more attractive the other options may become. On the other hand, it is possible that if negative variables do materialize, the attractiveness of the options will decline. In any case, waiting will provide valuable information. Some major variables may become much clearer already over the next couple of years. For example, the EU's new Low Carbon Delegated Act, to be completed by the end of 2024, will clarify the role and value of nuclear hydrogen.

However, it is also important to acknowledge the important variables related to the attractiveness of option 1 and their potential impact on the viability of nuclear power. While the fate of some of the variables may become clear in the near future, others may take a long time to be resolved. In accordance with the timeline above, a good example of such a variable is the realization of a possible capacity mechanism. Indeed, there are question marks over the viability of nuclear power construction, especially considering the risks associated with large-scale nuclear projects. The municipality may also have some influence over some of these variables, but the key is to at least monitor their development and status and maintain a picture of the situation that is as up to date as possible.

6.5 Assessment of investment options

Key observations

- A single conventional nuclear power plant project would, in principle, generate the greatest employment effects and would therefore be the best option for the municipality. But other options (such as new technologies, data centres, etc.) are also very viable and could potentially accumulate similar impacts, as the Hanhikivi site can accommodate several similar (smaller) investments.
- If the aim is to maximize the value of the investment and ensure a smooth investment and construction process without unnecessary and costly delays, all the nuclear power options (1–3) are interesting, as this investment has already been prepared in terms of zoning and other infrastructure and the readiness for the investment also appears good in terms of permitting.
- If the investment options are examined from the point of view of ensuring municipal vitality, securing any major energy investment in the area would be important – regardless of the sector.
- Option 3 (nuclear power production for on-site hydrogen production and transmission via a hydrogen pipeline) is the least likely of all and this investment would take the longest to complete.
- Option 4 (on-site production of hydrogen and ammonia based on purchased renewable energy or local renewable energy production) does not exclude small modular reactor (SMR) projects and therefore provides flexibility for possible further investments in Hanhikivi.

If the investment options are assessed and ranked in terms of the variables discussed earlier in this chapter, it appears clear that option 3 (nuclear power production for on-site hydrogen production and transmission via a hydrogen pipeline) is the least likely of all and this investment would take the longest to complete. This is due to the uncertainty of the construction timetable of the hydrogen network and the long implementation period of the nuclear project. Of course, the long construction times of the nuclear project also apply to options 1 (nuclear power production for the electricity market, for larger end-users through direct contracts or the Mankala model) and 2 (nuclear power production for on-site hydrogen and ammonia production). However, construction and permitting involves uncertainties also in other types of energy investments. In addition, option 1 involves uncertainty about the rate of growth in electricity demand in the Nordic countries.

An additional uncertainty for all the nuclear options (options 1–3) is the fate of the capacity mechanism. On the other hand, option 4 (on-site production of hydrogen and ammonia production based on purchased renewable energy or local renewable energy production) seems to have the least identified obstacles at present and would therefore be perhaps the easiest option to implement in the area. Option 4 also does not exclude small modular reactor (SMR) projects and therefore provides flexibility for possible further investments in the Hanhikivi area.

From a potential investor's point of view, the focus is on maximizing the value of the investment and ensuring a smooth investment and construction process without unnecessary and costly delays. From this perspective, all the nuclear options (1–3) are interesting, as this investment has already been prepared in terms of zoning and other infrastructure and the capacity for this investment also appears good in terms of permits.

If the investment options are examined from the point of view of ensuring municipal vitality, securing any major energy investment in the area would be important – regardless of the sector. From this perspective, it would make sense to focus on an investment that would create as many new jobs as possible in the region and provide long-term and stable security for the municipality, both in terms of new taxpayers and permanent industry.

In this way, the size of the investment directly affects the ranking of the investment options. For example, the regional plan[41] estimates that the employment effects of the Hanhikivi nuclear power plant would be between 3,000 and 4,000 person-years during construction and the permanent employment effect during operation would be between 400 and 500 jobs. This can be compared, for example, with the Microsoft data centre to be constructed in Vihti, where the effects are estimated[42] at 1,000 person-years during construction and around 200 employees during operation. Naturally, there are plans to expand to a total of four data centres in Vihti in the future, so the final employment impact would be significantly higher – although synergy benefits are generated and the total number of jobs is not directly multiplied by four.

In other words, a single conventional nuclear power plant project would, in principle, generate the greatest employment effects and would therefore be the best option for the municipality. But other options (such as new technologies, data centres, etc.) are also very viable and could potentially accumulate similar impacts, as the Hanhikivi area can accommodate several similar (smaller) investments. From an employment point of view, the municipality should facilitate any projects that clearly increase employment and it would therefore be justified to focus on attracting any new industrial demand to the area, so as not to overly limit or exclude potential alternatives.

[41] https://ym.fi/documents/1410903/38439968/Hanhikivi_maakuntakaava_selostus_suomi-A3BD3CF8_3EA4_421C_8682_A11C0B11BBD0-32161.pdf/3f61e9ee-ed98-5d77-1deb-59b36d6950fa/Hanhikivi_maakuntakaava_selostus_suomi-A3BD3CF8_3EA4_421C_8682_A11C0B11BBD0-32161.pdf?t=1603262004012

[42] https://www.vihdinuutiset.fi/paikalliset/5869827 and https://www.vihdinuutiset.fi/paikalliset/7351683

7 Conclusions and recommendations

The Hanhikivi site is ready for a new major energy investment. The use of the site for nuclear power production is supported by the existing regional plan for nuclear power, the positive attitude of residents towards nuclear power and the infrastructure development measures carried out in the area. According to an opinion poll aimed at local residents, up to 70% are in favour of a new nuclear power project. If a major project goes ahead, the municipality of Pyhäjoki should focus on the potential of different investment options and joint implementation, as well as on the strategic assessment of the investment options. Lobbying for Northern Finland should be enhanced. In terms of the action plan, strategic communication should be strengthened.

Recommendations

1. The municipality of Pyhäjoki should strengthen the assessment of different investment options and the opportunities for joint implementation.
2. Energy-intensive industrial activities should be pursued in the area, which will support the conditions for new nuclear power investment to the area.
3. The municipality of Pyhäjoki, the region of North Ostrobothnia and Northern Finland should strengthen lobbying to promote the conditions for nuclear power in order to attract investment to the area.
4. Once the action plan is complete, comprehensive strategic communication of the contents of the action plan and the results of the study should be aimed at those considering major investments and the media.

The Hanhikivi site is well prepared for a large-scale energy investment. A nuclear power plant investment is pursued for the site as a first priority. The use of the site for nuclear power production is supported by the existing regional plan for nuclear power, the support of the population (70%) for nuclear investment and the infrastructure development measures carried out in the area. Nuclear power production for the electricity grid is the primary objective, but nuclear power production for hydrogen or ammonia plants in the area is also a possible alternative. The challenge with these options is the long lead times of nuclear projects. Hydrogen or ammonia production in the area would not exclude SMR projects and would therefore be a more flexible solution than conventional nuclear projects. The identification of ways forward and the assessment of different investment options increases the strategic flexibility of investment decision-making.

In terms of the variables related to the various possible solutions, no obvious barriers have been identified that would prevent a major investment in the area. The attractiveness of the different options could be positively influenced by a potential capacity mechanism, public subsidies for nuclear projects, the growing demand for electricity and hydrogen in northern Sweden, a positive nuclear trend and the significant offshore wind capacity planned near Pyhäjoki. Five variables have the potential to negatively influence the possible solutions - at this point it was not considered likely that any of the variables analysed would prevent a major energy investment in the region. The identified threats include the low market price or demand for nuclear electricity and/or hydrogen, the lack of a capacity mechanism and

nuclear subsidies, the timetable for the construction of the hydrogen transmission network, the trend of cancelling green transition investments and the permit from STUK to locate a hydrogen/ammonia plant near nuclear power production.

A conventional nuclear project is the best option for the vitality of the region. All the nuclear options examined during the assignment (options 1-3) are linked to the fate of the capacity mechanism. For a potential investor, the focus is on getting the maximum value for the investment and ensuring a smooth investment and construction process without unnecessary and costly delays. If the investment options are examined from the point of view of ensuring municipal vitality, securing any major energy investment in the area would be important - regardless of the sector. In this way, the size of the investment directly affects the ranking of the investment options. In other words, a single conventional nuclear power plant project would, in principle, generate the greatest employment effects and would therefore be the best option for the municipality.

Recommendation 1: The municipality of Pyhäjoki should strengthen the assessment of different investment options and the opportunities for joint implementation.

Recommendation 2: Energy-intensive industrial activities should be pursued in the area, which will support the conditions for new nuclear power investment to the area.

The municipality of Pyhäjoki is ready to develop the area. This is evident from interviews with officials in Pyhäjoki and policy-makers, as well as the opinion poll. The interviews and the opinion poll have shown that the opinion and attitude in the municipality of Pyhäjoki and its surrounding areas towards both the nuclear power project and other large-scale energy projects is positive, and that the region has become mentally prepared to move forward with a major international project during the earlier nuclear power project. Investments suitable for the Hanhikivi site, in particular potential nuclear investments, are seen as very positive and desirable.

Public opinion is favourable. 70% of respondents are in favour of a new nuclear power project. According to the poll, it would be important to attract new activities into the area. The support and acceptance of local residents towards a potential investment supports the decision-making of organizations considering investment. The region recognizes that the decision to sell is up to the seller to decide and that the municipality can only have an indirect effect on it. The indirect influence of the municipality includes promoting and describing the current state of the Hanhikivi site; the political and administrative environment of the municipality, the region and the province; social acceptance; and the municipality's willingness to cooperate.

The infrastructure of the Hanhikivi site and the wider Pyhäjoki municipality is complete. The zoning and permitting provide an advantage for those planning the investment. Municipal services are in good condition and can be developed rapidly. Attracting a new energy investment to the area is partly a regional and partly a Pyhäjoki issue: for example, improving the condition of routes and the availability of skilled labour are challenges that need to be addressed regionally. As a result of the previous project, the zoning of the area and the sizing of public services have been designed with the aim of taking the growth scenarios of the project into account.

Recommendation 3: The municipality of Pyhäjoki, the region of North Ostrobothnia and Northern Finland should strengthen lobbying to promote the conditions for nuclear power in order to attract investment to the area.

Recommendation 4: Once the action plan is complete, comprehensive strategic communication of the contents of the action plan and the results of the study should be aimed at those considering major investments and the media.

The time to develop the Hanhikivi site is now. The action plan will give a strategic boost to the development of the site, which is necessary to increase its attractiveness. The key question is whether Hanhikivi will make it onto the list of operators considering major investments. Inter-municipal and regional cooperation in the provision of services works well in the Pyhäjoki economic area. Strengthening cooperation in lobbying will strengthen the ability of the economic area to attract the investment to Hanhikivi. The contents of this action plan form the basis of communication with those considering major investments and the media.

The study identified areas for development that the municipality of Pyhäjoki should take into account if the project goes ahead. One such area for development is the shortage of highly educated labour in the area. Attracting business investment to the area would bring more job opportunities and services to the area, improving the overall attractiveness of the area in order to attract highly educated labour. If implemented, the major project will also increase the need to develop the transport infrastructure of the municipality of Pyhäjoki and its surrounding areas to meet the growth in passenger and freight traffic volumes.

Annex 1: Methodology and data

The action plan has been implemented using a mixed method approach. Data has been collected through interviews with experts and key stakeholders, an opinion poll of local residents conducted by phone, and workshops where the findings of the study were validated and further developed. The formation of the action plan is illustrated in the figure below.

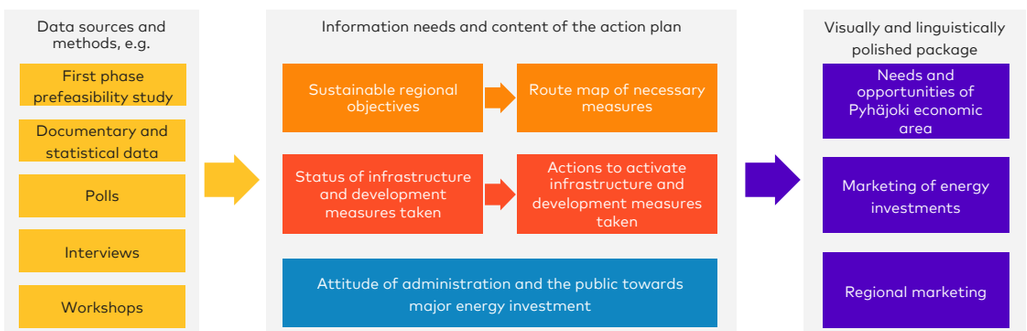

Figure 19 Approach to constructing the action plan

The work is based on the prefeasibility study carried out by Afry and other background material. The conclusions of the prefeasibility study have been discussed as part of the starting points for the proposed measures. Documentary material has been supplemented by interviews with experts and decision-makers. A background analysis and an analysis of the current state of the measures taken have been utilized in workshops organized for operators in the region. The first workshop was dedicated to working on the regional objectives, while the second focused on a route map for the various implementation options. A third workshop was organized for the project's steering group to validate the main entries in the action plan. A total of 40 experts, officials and policy-makers have participated in the data collection for the study.

Conducted as an independent professional survey, the opinion poll has produced a picture of the attitude of the administration and the public towards a major energy investment. The opinion poll was carried out by phone to residents of Pyhäjoki and the surrounding areas (a sample of postal code areas in Raahe) between 24 and 27 June 2024. It was answered by a total of 210 local residents.

The work has been carried out by Owal Group Oy in cooperation with AFRY Management Consulting Oy.

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