Gasgrid Finland and the Finnish gas sector: Scenarios 2040

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GASGRID

Foreword

Part 1

Foreword

Reading instructions for scenarios

What are scenarios?

Scenarios are comprehensive descriptions of possible and alternative future business environments. Scenarios have been built for the future of Gasgrid Finland's business environment. Scenarios describe the development of the external business environment and help to understand changes in the business environment, the cause-and-effect relationships of events and their impacts.

Why are scenarios made?

The aim of the scenario work has not been to predict the most probable future, but to develop Gasgrid Finland's strategic thinking, vision and interaction. The scenarios described may seem more or less likely to different people. However, the intention is not to select one scenario from among others by placing the scenarios in order of probability or preference, but to look at the set of scenarios as a whole. Future paths are often a combination of different scenarios.

The scenarios do not attempt to state what will certainly happen in the business environment, but are intended to strengthen the conditions for understanding current phenomena and their alternative development paths, and to improve responsiveness and readiness for change.

How were scenarios created?

Gasgrid Finland's scenarios were built using the inductive part-to-whole method. The multivariate method identified Gasgrid Finland’s operating environment and key uncertainties and related questions of destiny. The purpose of questions of destiny is to crystallise which issues about the operating environment should be better understood. Scenarios seek to find different answers to these questions.

Different development alternatives up to 2040 are defined for the uncertainties selected in the inductive method. The uncertainties and their development alternatives form the so-called future table. Different scenarios highlight different development alternatives. In addition to uncertainties, trends are taken into account in the scenarios, but they have roughly the same content in all scenarios.

The future table is used to create scenario structures, on the basis of which the scenarios are described. Scenarios are described as qualitative written stories, in addition to which they are concretised with descriptions of cause-and-effect relationships, illustrations and quantitative values.

In addition to Gasgrid Finland's personnel, a wide range of experts in the field have participated in the creation of the scenarios through stakeholder workshops and interviews. In the scenario work, Gasgrid Finland has been supported by the consulting company Capful, which specialises in scenario work.

Key uncertainties and questions of destiny in Gasgrid Finland's operating environment

Part 2

UNCERTAINTIES OF THE OPERATING ENVIRONMENT

Gasgrid Finland's scenarios 2040

Key uncertainties and questions of destiny for Gasgrid Finland

The uncertainties and questions of destiny addressed in the project are presented in the following slides through three themes

SUMMARY

SOCIETY AND SOCIAL ENVIRONMENT

EU energy and climate policy and the Energy Union

Finland's energy policy and vision of the role of gas

Economic development and the competitiveness of energy-intensive industries

Values and social ideology

GAS AND ENERGY MARKET

Geopolitical situation and relationship with Russia

Gas sources

Gas market development and European integration

Competitiveness and use of gas

GAS TRANSMISSION INFRASTRUCTURE AND TECHNOLOGIES

Future use of gas transmission infrastructure

Technologies related to gas transmission infrastructure and the use of gas

Key uncertainties and questions of destiny for Gasgrid Finland (1/3)

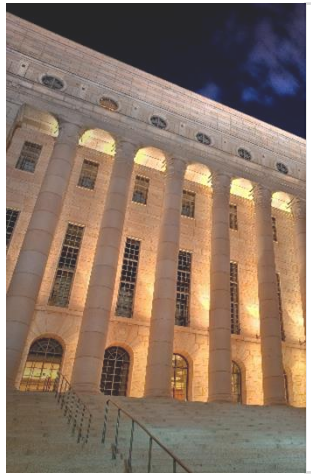
SOCIETY AND SOCIAL ENVIRONMENT

EU energy and climate policy and the Energy Union

- In what direction is the EU steering the energy market and what is the state of the Energy Union?
- How will the EU's role and power in relation to Member States evolve?
- Can the balance between energy production and demand be improved in the EU's internal energy market?

Economic development and industry competitiveness

- In which direction will the economy develop (for example, in terms of exports)? Is Finnish industry competitive?
- Will manufacturing move to or from Finland?
- How will energy-intensive industry be treated, for example, from a tax perspective?



Finland's energy policy and vision of the role of gas

- What will be the priorities of political guidance in the energy sector?
- What role will gas be allocated in society?
- How will taxation guide fuel choices?
- Will burning be prohibited and what can be burned?

Values and social ideology

- What factors will be emphasised in the decision-making of consumers, companies and society/politicians?
- How will climate change affect different decision-makers?
- How strongly will the consumer and business segments seek carbon neutrality?

Key uncertainties and questions of destiny for Gasgrid Finland (2/3)

Geopolitical situation and relationship with Russia

- How will natural gas and energy be used as a power tool?
- How will Russia's development affect the European gas market?
- How will Finland's relationship and position with neighbouring countries, and Russia in particular, develop?

Gas market development and European integration

- To what extent will the market integrate into Europe?
- Who will operate in the Finnish gas market and how will the competitive field in the Finnish gas market develop?
- Will new gas infrastructure be constructed?

Gas sources

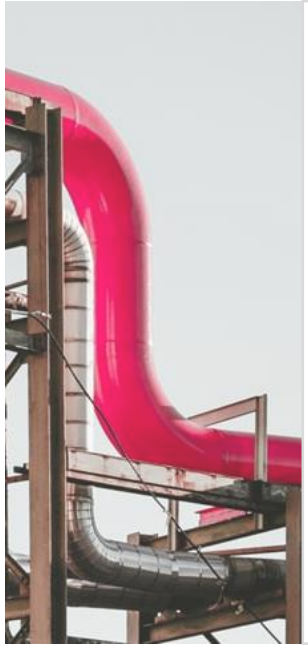
- From where will gas be imported to Finland and how much gas will be imported?
- What form will the imported and produced gas be in?
- Which forms of gas will be successful?

Competitiveness and use of gas

- How will the competitiveness of gas develop in relation to other fuels?
- What factors will affect the competitiveness and use of natural gas?
- How will the acceptability and image of natural gas develop?

Key uncertainties and questions of destiny for Gasgrid Finland (3/3)

GAS TRANSMISSION INFRASTRUCTURE AND TECHNOLOGIES



Future use of gas transmission infrastructure

- What will be the purpose of gas infrastructure and what will be the role of the gas system?
- What will be the characteristics of gas infrastructure?
- What will be the utilisation rate of gas infrastructure?

Technologies related to gas transmission infrastructure and the use of gas

- How will the gas transmission infrastructure evolve and what gas will be transmitted in the pipeline?
- What kind of new gases will flow in the transmission network and how important will their share be?
- What technologies will support or counteract the use of gas?
- Will new technologies be introduced or will any technologies disappear?
- How and how quickly will P2X technologies become commercialised?

Summary of scenarios

Part 3

Summary of scenarios

Finland as a climate leader – the rise of hydrogen and electricity

- Finland emphasises green values and sustainability in its energy policy. Finland reaches its carbon-neutrality targets 2035.
- Companies actively pursue the emission reduction targets, with industry leading the way by improving their energy efficiency.
- In Finland, the most important criterion for economic growth is sustainability, and as the Z generation moves to decision-making positions, responsibility is emphasised in decisions.
- Society is characterised by strong electrification, and wind power can be used to meet the growing demand for electricity in Finland. The focus of sectoral integration is on the electrification of different sectors.
- The EU invests in gas and gas infrastructure through storage and electricity system balance. The attitudes of Finland and the EU towards gas diverge.
- Hydrogen production is based on electrolysis, and hydrogen travels locally in a separate infrastructure and is stored in local storage solutions.
- Local networks are connected into a national hydrogen network, and efforts are made to utilise gas infrastructure to expand the network where possible.
- Up to 10% by volume of hydrogen is transferred in the gas pipeline.

Finland as an island – security of supply with gases

- The EU becomes a global climate leader.
- Finland struggles with a weak economy and does not set more ambitious emissions targets than the EU, and even lags behind.
- Europe takes significant steps towards a hydrogen economy. Central European countries are more firmly attached to the hydrogen infrastructure and thus a more favourable platform for the developing hydrogen economy.
- In Finland, the taxation of fossil fuels is tightened from one government term to the next for fiscal reasons.
- For example, development aids to energy operators are significantly reduced.
- Gas-based CHP production is under threat and in the energy industry, gas has declined towards peak, reserve capacity and security of supply use.
- Declining gas use and tax increases, combined with the cost of maintaining gas infrastructure, increase the costs for the remaining gas users, highlighting the need for changes in pricing and regulatory models.
- New ways of leveraging gas infrastructure in Finland cannot be utilised due to industry's low willingness to invest.
- Electricity is quite inexpensive in Finland, as the amount of wind power has increased as it is profitable on market terms.

Towards carbon neutrality with determination – diverse gases

- In a unified EU, strong EU regulation creates and accelerates the emergence of a market for new gases. The effects of the coronavirus were small, and the economy took an upbeat turn after the dip.
- The energy system is based on zero-emission electricity, which increases the need for flexibility and storage capacity.
- At the political level, the choice has been made to build a bridge to an era of new gas, and policy and the tax system support the introduction of new gases and technologies.
- With the help of a long-term strategy, Finland has risen to the forefront of the development of the hydrogen industry and Power-to-Gas (P2G), relying on sectoral integration.
- The gas transmission infrastructure is an active and flexible entity that acts as a balancer and seasonal storage for the electricity system.
- There has been a shift from a natural gas-based portfolio to a diversified gas mix.
- Finland invests in the development of hydrogen infrastructure. Different technologies enable the production of hydrogen and methane outside the gas transmission network, and gas is also used for new purposes.
- The use of biogas increases.
- Gases play a strong role in Finnish traffic, especially in heavy transport, at sea and in local solutions.

Europe of conflicts – extension of traditional gas

- The time for the West, globalisation and EU domination is over. Democracy erodes in the face of authoritarian leaders.
- Russia and China are driven into conflict in the Arctic and Russia's interests in Europe become stronger.
- Resistance to the EU is on the rise and the EU only exists nominally. The EU's common climate goals are watered down.
- As national primacy increases, Finland also secures its back and wants to hold energy issues firmly in its grip. Energy self-sufficiency and security of supply are emphasised.
- The position of gas in Europe is strong and many countries are replacing coal with gas. In Finland, too, coal is replaced by gas in heat production.
- The role of traditional natural gas remains as it is today, albeit on a declining trend.
- Pilots in alternative heat production methods do not lead to significant investments. In industry, the use of gas continues as it is today, with the exception of the forest sector.
- The acceptability of gas use increases with the success of carbon dioxide capture (CCS and CCU).
- Sectoral integration between the electricity market and the gas sector is moderate, as large-scale exploitation of P2G technology remains costly.

Scenario 1
"Finland as a climate leader – the rise of hydrogen and electricity"

Part 4

GASGRID

SCENARIO 1: Finland as a climate leader – the rise of hydrogen and electricity

Climate model student Finland follows its own paths and the role of traditional gas decreases

Finland, which aims to be a climate model student, emphasises green values and sustainability in its energy policy. Public opinion and debate put pressure on greening energy policy. There is a consensus in Finland that climate action is society's number one priority. Green values are seen in companies as the right solution for business. The focus of economic growth has shifted to sustainable growth and, in addition to GDP, there are other indicators of society's well-being. Corporate social responsibility through changes in the value of customers grows, and the payment of dividends is no longer seen as the only task of companies. The coronavirus crisis provided tools to make massive solutions to combat climate change, and even at the individual level, larger lifestyle changes are seen as possible. Policy emphasises appreciation for scientific communities and experts. The addition of environmental themes in the Finnish education system is now realised in working life.

Gas is accepted as a short-term bridge fuel, but the use of natural gas is not seen to play a large role in the energy mix of a sustainable society. Domestic energy policy drives the use of traditional gas to a minimum even before 2035. In energy production, gas is strongly directed to peak use, with the goal of reducing all types of burning. Significant support measures are set for the carbon neutrality of industry, and the role of traditional gas is also reduced in industry.

Regions are strengthened in EU energy policy

Although the EU's and Finland's climate policy targets are parallel, the attitudes of the EU and Finland towards gas and their use of gas diverge. Where Finland seeks to phase out gas as part of a wider phase-out of burning, for example in Central Europe gas and methane are seen as a necessary part of the energy mix, including a substitute for coal and nuclear power. In Europe, significant investment is made in the use of gas and gas infrastructure, and the use of gas increases. Countries where gas plays a major role, for example in heating, strengthen their gas cooperation and integration.

Society electrifies rapidly and strongly

Inexpensive electricity is significantly available due to extensive wind power investments and offshore wind power. The Nordic and Baltic countries have remained a kind of island in terms of electricity, as insufficient new transmission connections have been built to Central Europe. Electricity is inexpensive in the Nordic countries. Inexpensive electricity contributes to attracting foreign industry to Finland.

Electricity production and consumption are smartly optimised. Demand response services are highly developed and, for example, electric cars have been incorporated into smart flexibility capacity. The focus of sectoral integration is on the electrification of different sectors, and Finland is described as an electronic society.

Energy production is increasingly based on electricity (e.g. heat pumps), waste heat and geothermal energy. Small-scale nuclear power is piloted for integration into residential areas and large properties, especially in the Helsinki metropolitan area. Standardisation is expected to significantly reduce the construction costs of nuclear power, which increases the attractiveness of modular nuclear power as a future energy production form.

Waste heat from production facilities is utilised more widely and the overall energy efficiency of industry improves, which also reduces the need for gas in industry. The required gas is replaced by, for example, biomethane and hydrogen.

The traditional gas transmission infrastructure fluctuates between hydrogen and the security of supply role, separate hydrogen networks expand

Hydrogen is transmitted in the amount allowed by the gas network, but instead of gas and hydrogen blending solutions, hydrogen is directed to a separate infrastructure. Industry utilises power-to-hydrogen technology based on electrolysis. Hydrogen travels locally (point-to-point) in a separate infrastructure and is stored in industry's own storage solutions for short-term needs. Local networks are connected into a national hydrogen network, and efforts are made to utilise gas infrastructure to expand the network.

The role of the traditional gas transmission infrastructure in the sectoral integration of the energy system remains small. Consumers expect fully emission-free production, and the goal is to minimise the use of fossil fuels. The current form of the gas network mainly develops into a security of supply storage and a flexible element.

The role of gas as a traffic fuel for private drivers diminishes, as people are afraid to invest in alternative propulsion to electricity. LNG plays a role internationally as a fuel for maritime and heavy duty transport.

Scenario 1 plot description

Finland as a climate leader – the rise of hydrogen and electricity

2020-2024

- In Finland, the government and parliament agree that **climate action must be prioritised and the 2023 election results support this.** Support measures for the carbon neutrality of industry are considered. After the coronavirus crisis, the importance of knowledge in politics is emphasised, creating a foothold for climate action.
- In Finland, revitalisation policy after the **coronavirus crisis is strongly pursued on the terms of sustainability,** which leads to investments in e.g. energy efficiency of buildings and **emission-free solutions for industry**. Investors starting to favour **renewable energy investments.**
- **In Europe, traditional gas and methane continue to be seen as a key part of the energy mix,** and pilots seeking to exploit the future of gas infrastructure raise funding. Finland's and the EU's positions on gas begin to diverge when Finland tightens its position on burning.
- **Piloting hydrogen technology** is widely deployed, and a **national strategy** for the deployment of renewable hydrogen is developed.
- **Expertise and regulations related to hydrogen increase in Finland.** With regard to the use of hydrogen, there is a clear change in thinking in Finland.
- Hydrogen and biogas are defined as renewable energy at EU level (Green Gas Vision, completed in 2025). **Investment support focuses on upgrading gas infrastructure to carbon neutrality.**
- In Finland, wind power **radar problems and acceptability challenges are solved,** and large-scale offshore wind power projects are planned.
- **Old CHP plants are increasingly not being refurbished**, as uncertainty about the price of electricity and the acceptability of forest-based biofuels increase uncertainty about the profitability of production investments.
- **Circular economy thinking is strengthened,** and waste is primarily used for purposes other than incineration.
- **In Finland, point-to-point hydrogen networks and pilots are planned.**

2025-2029

- **The Nordic countries intensify their cooperation in EU energy policy** and move from information sharing to common visions and policies.
- **Nordic energy companies invest in wind power that has become cost-competitive on market terms**. Wind power is distributed throughout Finland and the growth in the total volume supports development.
- **The regional price of electricity in Finland fluctuates strongly as wind power production varies** according to the weather. Wind power is adjusted against hydropower.
- Wholesale heat production become electrified, and **district heating is utilised as a temporary form of electricity storage.** Heat is produced with low-cost electricity, for example by means of boilers and by utilising waste heat. **New geothermal heat production projects are planned in large cities. Utilisation of waste heat grows strongly**.
- Industry has bought the idea of electrification and carbon neutrality, and **investments are also seen in e.g. -optimising the energy efficiency of processes.**
- **Hydrogen-based fuels** (e.g. ammonia) are used more widely.
- **The use of LNG in heavy transport and maritime transport becomes more common** internationally.
- Criticism towards oil in Finland increases, which leads to **the generalisation of and investments in biooil**.
- Consumers increasingly **prioritise sustainable energy products and services**, which is also reflected in the choices of energy customers. Various **energy management service models for customers** begin to emerge in the energy sector.
- The **costs of Finnish companies' emissions trading are compensated**
- **No investments are made in natural gas networks or the district heating network,** and the networks remain unchanged. The national electricity network is heavily strengthened.
- **Local hydrogen networks are built on a pilot basis. Wider networks are discussed.**

2030-2034

- **The Finnish economy has returned to a path of economic growth**, but government debt has risen alarmingly high. The structure of the business sector has changed.
- **Additional construction of wind power continues**, and the role of hydrogen as a balancer for renewable energy is strengthened. The problems of hydrogen storage have not been fully solved, and seasonal variation remains a challenge for full utilisation.
- **Local hydrogen networks grow in number.** The good experiences of pilot experiments encourage to build more. A blend of hydrogen and gas is utilised where possible, but there is a growing shift from blends to a clean hydrogen strategy and a separate network.
- Discussions include the **connection of local networks into a national hydrogen network** and the use of gas infrastructure to expand the network. The development of a transmission infrastructure capable of 100% hydrogen transmission is planned.
- **The Nordic and Baltic countries have remained as an island in terms of electricity** and intensify their cooperation in EU energy policy as well
- The use of fossil fuels in energy production is being phased out, and in Finland **wind power accounts for more than 30% of total electricity production**. Tax revenues are collected from the energy sector, e.g. through the taxation of bio-based fuels**.**
- **The amount of low-cost electricity increases in the Nordic countries** and the market witnesses several hours when the price of electricity approaches zero
- **Heat production in large cities has shifted away from coal, and production has been replaced mainly by geothermal energy and the use of waste heat.** Gas maintains its position mainly in peak consumption – and as reserve capacity and through security of supply. The use of gas in industry has decreased significantly.
- **Small-scale energy production solutions increase in all customer groups** (heat pumps, electric boilers). Small producers of electricity sell out significantly more electricity.
- The role of artificial intelligence in data analytics and energy consumption forecasting grows. Industry optimises its energy consumption in real time.

2035-2040

- **Finland reaches its carbon neutrality targets 2035**, and Finland is considered a model student of climate action globally. Carbon neutrality has become Finland's new Nokia, and technology know-how is exported from Finland
- The emphasis on environmental themes in education is now realised in working life as the Z generation moves to decision-making positions. **The most important criteria for an increasing number of decisions are responsibility and environmental impact**
- At the EU level, Finland's and the Nordic countries' energy solutions are examined with interest and **criticism towards gas increases, albeit only in discussions.**
- **In Finland, the pressure to ban all burning grows** in public debate and politics. The forest industry has almost abandoned the use of gas, and the steel and chemical industries make extensive use of electricity and hydrogen in their own processes. Traditional gas consumption has decreased significantly and the utilisation rate of the traditional transmission network is low.
- **In the gas network, hydrogen is transferred up to the permitted 10% by volume**, which increases the amount of hydrogen in the total volume of energy.
- Hydrogen technology is in large-scale use and **industry has made extensive use of local hydrogen production.** Gas and hydrogen blending solutions have reduced significantly. **Large hydrogen transmission projects in Finland are progressing.**
- Wind power can meet the growth in demand for electricity in Finland (150 TWh)
- **The costs of Power-to-Gas technology have decreased**, and centralised P2G production has become more common during low electricity prices. P2G is used especially in industry, but **new applications have opened up in transport as fuel cells become more common.**
- The first **small-scale nuclear power pilot projects are launched in Finland**. The acceptability of nuclear power has increased due to the prioritisation of emission reductions, the cost trend seems favourable with the development of global standardisation.

Scenario 2
"Finland as an island – security of supply with gases"

Part 5

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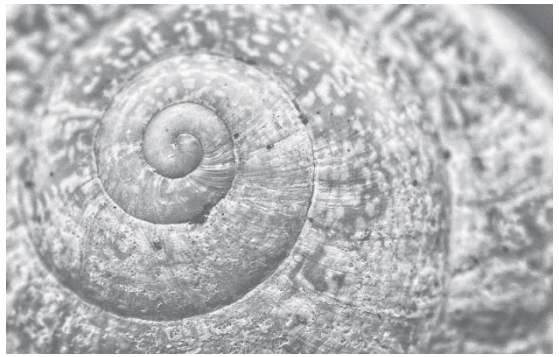
SCENARIO 2: Finland as an island – security of supply with gases



Climate policy tightens in Europe, Asia drives the global economy

In Europe, energy policy in the 2020s has been guided by the objectives of the Paris Climate Agreement, and this agreement has been followed by an even stricter follow-up agreement. The position of fossil fuels is difficult in Europe. The EU takes action on the objectives and the role of global climate leader is strengthened.

The decades of Asia and new silk roads are behind us. The focus of economic growth is found in Asia, which consumes about 50% of global energy. Growth in Asia also leads to growth in the European economy, but Finland is not part of this growth. As demand in Asia grows, e.g. Russia increasingly supplies gas to Asia. In Europe, the price of gas rises.

Finland's decision-making capacity weakens and national primacy is emphasised

Finland struggles with a weak economy and does not set more ambitious climate targets than the EU, and even lags behind them. Aging population tests the limits of the welfare state, and the services provided by the public sector are only a shadow of what was provided in earlier years. Healthcare is a continuous theme in politics.

In Finland, the taxation of fossil fuels, including gas, is tightened from one government term to the next. The increases are mainly driven by fiscal reasons. The increases are perceived to be easier to justify than, for example, increases in the taxation of transport fuels. National policy is short-term, and its stop-and-go nature is detrimental to businesses.

Domestic energy and climate policy emphasises national primacy due to the difficult economic situation. Achieving carbon neutrality targets forms a new, cross-cutting dividing line in politics. Political decision-making is hampered by the breakdown of traditional party positions. The formation of majority governments is difficult, and no agreement is reached on Finland's energy policy. For example, development aids to energy operators are significantly reduced.

The traditional and passive methane sector cannot renew itself and loses its attractiveness

Finland's energy policy increases uncertainty, in addition to which the utilisation of natural gas is expensive in Finland.

The gas sector is passive and does not want to admit how gas use can be reduced. Gas is used by a few large operators in industry and the energy sector. In the passivated society, market participants focus their activities on replacing natural gas, not on enabling the use of methane or new uses.

Gas-based CHP production is under threat, and in electricity and heat production, gas is replaced by other production methods, such as biofuels, geothermal energy, heat pumps and the use of waste heat.

In Finland, the forest industry has largely given up gas use by 2035, and gas use in the steel and chemical industries has continued on a declining trend. In the energy industry, gas has declined towards peak and reserve capacity use and as a safeguard for security of supply. Efforts are also made to revitalise the gas sector and the viability of gas infrastructure with biogas, and some liquefied biogas is imported from Europe. Gas remains a reserve fuel, but its attractiveness as a long-term control power-enabling fuel is lower.

Despite the growing volume of biogas, declining gas use and tax increases, combined with the cost of maintaining gas infrastructure, increase the costs for the remaining gas users, highlighting the need for changes in pricing and regulatory models. This further accelerates the conversion of gas to other forms of energy. Gas does not play a role in cross-sectoral integration. Sectoral integration focuses on the connection between the electricity network, industry and energy companies.

Electricity is quite inexpensive in Finland, because despite political dividing lines, the amount of environmentally friendly wind power has increased in Finland as it is profitable on market terms. The growth of wind power in Finland sometimes causes very strong price fluctuations.

Europe takes significant steps towards a hydrogen economy, the role of hydrogen is minor in Finland.

Europe takes significant steps towards a hydrogen economy, and hydrogen is transmitted in Central Europe's gas transmission infrastructure up to 15%. Central European countries are more firmly attached to the hydrogen infrastructure and thus a more favourable platform for the developing hydrogen economy. Central European countries have also invested more than Finland in developing the hydrogen economy and infrastructure suitable for hydrogen. In Finland, there is not enough interest or willingness to invest in the construction of a parallel hydrogen infrastructure.

Finnish industrial operators seek to replace natural gas with hydrogen produced by electrolysis. Industrial operators use electricity and natural gas to produce hydrogen, depending on which is less expensive to them, and processes are hybridised.

New ways of leveraging gas infrastructure in Finland cannot be utilised, and the role of the traditional transmission pipeline starts to focus on security of supply as consumption decreases.

LNG is mainly used in industry and heavy transport.

Scenario 2 plot description

Finland as an island – security of supply with gases

2020-2024

- **The coronavirus epidemic remains in Finland for years.** The Finnish economy is sacrificed at the expense of health, and the economy faces a dark decade, which is compared in speeches to the recession of the 1990s.
- **Europe and the EU countries succeed in activating their economies** faster and more efficiently than Finland.
- **China overcomes the criticism brought by the coronavirus crisis, and the industrial giant continues to drive world growth.** In the aftermath of the coronavirus crisis, new investment opportunities also open up for China. The Belt and Road project progresses.
- **The weak economic situation reduces the available R&D funding in companies and institutions.** For example, many development projects related to energy technology, energy efficiency or energy production are postponed.
- **Gas fuel taxation is tightened for fiscal reasons.** Gas does not have a clear role in national energy policy and the short-term nature of the policy leads to investments being postponed. Gas has not been at the heart of the political debate and is still not receiving the attention required for the progress of new forms of gas.
- **The industry electricity tax (tax category 2) falls close to the European minimum.** At the same time, tax refunds on electricity tax and fossil fuels are abolished, which weakens the use of natural gas in industry.
- **Industry launches hydrogen experiments and pilot projects**. The aim is to replace natural gas.
- **The opening of the gas market has led to fragmentation**: the sector lacks a change leader who would be able to build a renewal story. The sector sinks into passivity, as gas is left in a secondary position in public debate, state plans and the activities of companies, and is undercut by electricity, for example.
- **OL3 is completed in 2021.** Electricity generation capacity increases.

2025-2029

- **The economy steamrolls climate targets in political decision-making and carbon neutrality targets are stretched.** However, the deadline for the use of coal takes effect as agreed and gas has a momentary extension.
- **Alternative forms of producing electricity and heat are not yet strongly visible**: the transition to new production forms is slow. In Europe, new energy solutions have not gained ground, either.
- **Next, methane emissions are pointed out in EU policy,** and the related regulations are significantly tightened, causing significant costs.
- **There is no real leader in the gas sector and the players are small.** It is difficult for the sector to make their voices heard in various forums.
- **Higher education institutions do not train gas expertise, which leads to a skills shortage.** Expertise in the natural gas sector is also reflected in the knowledge of other gases, and there is a clear gap in the Finnish field of expertise.
- **Several hydrogen production methods are available.** In Finland, these investments are mainly made by large industrial players. Hydrogen is treated with caution due to potential safety risks.
- **The activities of companies/entities using biogas are characterised by uncertainty** and this means that they do not get many investments. However, the state recognises the potential of biogas in maintaining the vitality of the gas sector. The aim is to keep the gas sector operational while waiting for the political vision to crystallise. **Various forms of support are granted to biogas to revitalise the market.**
- **Investments related to demand response** (next generation smart electricity meters) progress steadily, but partly on a delayed schedule.

2030-2034

- **Finnish economy and society begin to recover from the challenges posed by the coronavirus crisis.** The necessary investments in new technology start from behind, and Finland must utilise mainly existing technology.
- **The scale of heat pumps, waste heat and geothermal energy increases significantly.** These take market share away from gas.
- **Finland continues to increase taxation on natural gas**. **The competitiveness of natural gas declines** relative to other fuels, and the use of natural gas diminishes in all sectors. **LNG replaces the consumption of pipeline gas in peak use.**
- **Energy storage potential is sought outside the gas system.**
- **Finland's wind power capacity grows**. However, Finland is not on its way towards the strongest scenarios for electrification as, for example, the implementation of offshore wind power projects in the areas allocated to them in Finnish sea areas is expensive. However, Finnish energy companies form joint projects with the Nordic or Baltic energy sector.
- **Solar energy and P2G technology evolve**. n sunny countries, electricity is cheaper than wind power in the Nordic countries, and this opportunity starts to attract industry. Domestic wind power, which is widely available, also starts to push down the price of electricity.
- **Industry increasingly invests in its own hydrogen solutions** and, in particular, relocates its hydrogen-intensive production abroad.
- **As education decreases, the potential to direct industry and companies to the use of gases and new gases narrows.** The application of expertise to the new energy economy and thus to new export sectors also weakens.

2035-2040

- **The use of natural gas has declined**. The use is starting to be so marginal that it no longer attracts the attention of society's decision-makers. The focus of energy policy shifts to other issues.
- **Being a reserve fuel is not enough for the profitable use of gas** and the costs of maintaining the gas system increase.
- **The costs for the remaining gas transmission network users are at a very high level**. Security of supply users contribute to the maintenance costs, leading to new pricing models.
- Gas is used by a few large operators in industry and the energy sector. **The cyclicality of gas demand poses additional challenges** to the balance of the system.
- **Increasing amounts of biogas and liquefied biogas (LBG) are fed into the Finnish gas network.** LBG is also imported from other parts of Europe, where the gas market is much more viable than the Finnish market.
- Headlines talk about a factory investment that could have been located in Finland, but was decided to invest elsewhere. The decision was based, among other things, on the cheaper price of energy. **Unprofitable industrial plants are gradually shut down** in Finland.
- **China's massive economy swallows huge amounts of energy.** China has established energy relations globally in different directions to ensure the availability of fuels and energy. Sino-Russian relations are improving, but China will not place its "eggs in one basket".

Scenario 3
"Europe of conflicts – extension of traditional gas"

Part 6

GASGRID

SCENARIO 3: Europe of conflicts – extension of traditional gas

Geopolitical tensions and the strong rise of nationality

The West was wrong in believing in the world conquest of liberal democracy based on capitalism. The time for the West, globalisation and EU domination is over. An increasing number of countries are now ruled by authoritarian leaders trampling on democracy. Geopolitical tensions grow, for example, due to the scarcity of natural resources. In the midst of conflicts, the role of states and state capitalism is emphasised

The prosperity, democracy and freedom promised by the EU disappear as the chronic cycle of debts of states and citizens comes to an end in a long economic recession and living standards in EU countries decline. Among the disappointed citizens of EU countries emerges strong resistance to the EU and a national awakening. Following the successful exits from the EU by Great Britain and a couple of other countries, the European idea is no longer attractive. Nationalism has become mainstream. The EU only exists nominally. It looks on as the United States, Russia and China pursue geopolitics, which undermines the growth of all. EU-led climate issues are also watered down and investments in climate change mitigation remain local.

The energy transformation is not successful, leading to an extension of fossil fuels in Europe

The position of gas remains strong in Europe, for example, when France closes its nuclear power plants.-Many energy companies in Europe have switched from burning coal to gas, especially in electricity generation. After the end of the use of nuclear power, Germany is forced to realise that the energy transformation cannot be implemented. The use of coal and lignite is continued, but in Germany coal is also largely replaced by cheap natural gas.

Russia seeks to strengthen its grip on the conflict-ridden Europe

Russia and China are driven into conflict in the Arctic and Russia's interests in Europe become stronger. At the same time, the United States, for example, seeks to strengthen its grip on Europe with low-cost LNG. The volume of imported LNG from the Middle East, Africa and Asia also grows. Russia, which can still be described as a hydrocarbon society, embarks on price competition to secure its gas relations with Europe.

In the EU, finding common ground on energy and climate policy is challenging. Conflicts within the EU increase and interests diverge, for example on economic issues. Climate issues are overtaken by conflicts and nation-state-centricity, and emissions targets remain targets. EU integration becomes weaker and decision-making capacity becomes more national.

Finland protects itself from international threats and strives to preserve jobs and support domestic production. Finland also wants to hold energy issues firmly in its grip, with an emphasis on energy self-sufficiency and security of supply. The price of energy is the most important criterion for choosing the form of production. Finland's national energy and climate policy emphasises security of supply. Although environmental and climate issues have been relegated to the background, the goal is a considered shift to more sustainable fuels.

Natural gas flows in Finland and the Baltic region

The Finnish and Baltic markets have become integrated, but the integration of the gas market is not expanding beyond the Baltics. Finland's ability to receive LNG has been increased, for example, by expanding LNG and LBG terminals, which reduces Finland's dependence on Russia. However, significant volumes of Russian pipeline gas and LNG flow to Finland and the Baltic countries from the world market.

The role of traditional natural gas remains as it is today, albeit on a declining consumption trend. In Finland, the largest users of coal in the energy sector switch from coal mainly to gas in heat production. Biogas replaces natural gas in a systematic manner. Waste heat is utilised in heat production, but pilots in geothermal heat production methods do not result in significant investments in new heat production methods. In industry, the use of gas decreases significantly in the forest sector, but continues as it is in other industries.

The use of gases is accepted as part of the energy mix. Central European countries such as Germany have been the drivers of CCS technology, for which demand has arisen at the request of certain consumer sectors. Finland also discusses participation in CO2 storage: if emission targets were tightened again, CCS technology could be combined with bioenergy, which would result in negative emissions.

Gas transmission infrastructure retains its basic purpose

Sectoral integration between the electricity market and the gas sector is moderate, as large-scale exploitation of P2G technology remains costly. Gas is favoured for its low price and availability.

The active use of natural gas and gas transmission infrastructure, as well as strong state support for biogas, support the development of the refuelling network for gas cars. There are about 50,000–100,000 gas cars in Finland. For example, public transport in growth centres utilises gas vehicles.

Scenario 3 plot description

Europe of conflicts – extension of traditional gas

2020-2024

- Global mechanisms are being tested **as countries pursue their own interests in the midst of the pandemic.** Global leadership is lacking and for some countries, the pandemic proves to be particularly devastating.
- **The prolonged coronavirus crisis tests the global economy.** There is an economic downturn and recession ahead. Industry and companies go bankrupt and energy consumption falls globally.
- **The choices made during the pandemic strain relations between countries**. As the crisis subsides, countries focus on accusations and trust in cooperation is weakened. The EU is accused of failing to take control of the situation in the early and late stages of the crisis.
- In Finland, the unity of the beginning of the crisis is but a memory, and the aftermath of the coronavirus crisis becomes the subject of plenary sessions. **Dividing lines between parties are strengthened.**
- **The EU's grip on energy governance is beginning to slip.** The Green Deal and new climate bills do not find their way into national legislation. The Finnish government says it considers climate targets important but tackling the consequences of the coronavirus crisis as a priority.
- **Trump is re-elected.** Trump continues on his path; he denies climate change and seeks to keep the wheels of the country's coal, oil and gas industries spinning.
- **In the EU, energy investments are postponed due to the uncertain economic situation** and there is little renewal of energy systems. The price of oil rises from its worst hole but remains low for a long time. **The recession in the global economy also temporarily lowers the price of natural gas and LNG**.
- **In the Finnish parliamentary elections in 2023, parties that do not have climate change as a top priority succeed.** The political debate on climate change is easily silenced by invoking the need to rebuild Finland.
- **In the 2024 European parliamentary elections, EU-critical parties win.** The new idea of nationality inspires citizens more than the worn European idea.

2025-2029

- **The global multilateral system is in crisis and the influence of traditional institutions declines.** Instead of mutual agreement, states seek to pursue their own interests through bilateral agreements.
- **In Europe, the economic crisis is followed by growing dispersion, conflicts within the EU increase and interests diverge.** The gap between Northern Europe and the indebted Southern Europe widens. Confusion is also caused by countries where state leadership seeks to concentrate power on themselves, contrary to EU principles.
- **In the long economic recession, living standards in EU countries decline**. Hiccups in the internal market make EU citizens question the benefits of the EU and its existence.
- **Nationalism becomes mainstream**. Following the example set by Great Britain, one or more countries hit by the economic crisis have also withdrawn from the EU – and this may continue.
- **Finding common ground on energy and climate policy is also missing.** In a contentious EU, emissions trading is relaxed, and the steering power of emissions trading is weakened.
- **Russia is going through difficult times due to low fuel prices.** The postponement of more sustainable forms of energy is positive news for the country, but demand has weakened along with the global economy. Russia develops its relations with the contentious Europe and, through bilateral agreements, strengthens the position of gas in Europe.
- **Finland's politics and climate policy emphasise "Finland first" and security of supply**. In practice, this means e.g. that Finland wishes to become a competitive country for energy-intensive industry.
- Despite the change in the political climate, **the largest users of coal in the energy sector in Finland stick to their promises to give up coal**. Heat production shifts from coal mainly to natural gas, electricity, waste heat and biofuels by 2029. Biogas is utilised in a systematic manner.
- **In Finland, biofuels and peat are used to heat smaller cities.** Nationalist thinking has also increased biogas production and biogas plants are connected to the gas network.

2030-2034

- **There is no globally recognisable value leader or visionary.** The decline of the EU and the whimsicality of the United States are seen as an indication of the failure of the Western social system, and there is a demand on the global stage for alternative social models.
- **China seeks to strengthen its grip on the Arctic,** as the country is forced to look for new sources of energy and food to sustain its growing economy. The region is also valuable for Russia dependent on hydrocarbon culture, and the countries drift into conflict in the region. As a result of the conflict, China announces that it will reduce gas imports from Russia. Russia's interests towards Europe are strengthened.
- **EU integration becomes even weaker and decision-making capacity becomes national.** Climate issues are undercut by conflicts and nationalism.
- **Germany states that the energy transformation is not possible.** The use of coal and lignite is continued, but in Germany coal is also largely replaced by cheap natural gas. **As part of the energy transformation, Germany has developed CCS technology**, which is believed to make its breakthrough, albeit with a delay.
- To reduce its dependence on Russia, **Germany and other Central European countries intensify their relations with the United States, the Middle East and Africa,** which increase LNG imports into Europe.
- **Finland's national energy and climate policy emphasises security of supply.** Finland protects itself from international threats and strives to secure domestic jobs and support domestic production. With regard to gas, the aim is to secure gas sources and, on the other hand, to foster relations with Russia. The capacity of Finnish LNG terminals is expanded, and additional support is provided for domestic biogas.
- In Finland, the demand for wood grows in selected industrial sectors, which leads to an increase in its price as a fuel. **The aim is to direct wood to uses where it has a higher value,** and burning wood is also replaced by gas.

2035-2040

- **There is a shift from nationalism and protectionism to a world** where bilateral relations are paramount, and competition globally is fierce. **The United States, China and Russia seek to pursue geopolitics in their own interests.** The fragmented EU is not able to match the world's powers. Globally, the fruits of growth and competition are unevenly distributed.
- **Natural gas flows to EU countries via pipelines and sea routes.** Russia seeks to price its gas cheaply so that it can compete against LNG.
- The economic downturn has also been reflected in technological development, and many **technologies previously predicted as revolutionary, such as P2G, have been dormant**. P2G technology development projects are promoted, but large-scale use is still a long way off.
- **At the same time, under German leadership, CCS technology is becoming more widespread, with demand at the request of certain consumer sectors.** There is also discussion on carbon storage in Finland, but so far, the initiatives are just talk. If emission targets are revived, Finland can combine CCS technology with bioenergy, which would result in negative emissions.
- **The use of gases is widely accepted.** The potential of biogas is also widely exploited.
- **France seeks to gradually reduce its nuclear power.** Initial targets to reduce the use of nuclear power by 50% by 2035 are postponed, but France phases out its nuclear power plants.

Scenario 4
"Towards carbon neutrality with determination – diverse gases"

Part 7

GASGRID

SCENARIO 4: Towards carbon neutrality with determination – diverse gases

Background: politics enable the transformation of the gas sector

Technological development and the attitudes of society become favourable for gas both in Finland and in Europe. Politics and regulations support the introduction of new gases and technologies and seek to strengthen their role. At the political level, the choice has been made to build a bridge to the era of new gas. Change is also driven by companies and research institutes that strive for sustainability and invest in new technology. Carbon-negative gases in particular have achieved national approval, and the use of clean gases, like bioenergy, is intended to benefit the national economy.

The EU is strong and united. Strong EU regulation creates and accelerates the emergence of a market for new gases. Finnish legislation is in line with EU legislation. Political decisions of the EU and Finland are supported by favourable economic development.

The role of traditional natural gas as a bridge fuel is accepted in Finland in the 2020s, but the role of traditional gas remains small as we move towards the end of the 2030s.

The gas transmission infrastructure is an active balancer for the energy system

In the Nordic and Baltic countries, the energy system is based on zero-emission electricity. Renewable electricity increases the system's volatility and therefore the need for flexibility and storage capacity. The electricity transmission network is expanded in the region, and the connection of the Nordic electricity market with Central Europe is strengthened. Gas is also used as a quick-start flexibility capacity to offset peaks and expensive electricity prices.

Gas infrastructure is an active and flexible entity, which has contributed to a significant increase in renewable energy and progress in sectoral integration. The gas system acts as a balancer and seasonal storage for the electricity system together with district heating and cooling networks as well as industry. P2G technology is integrated into energy networks, which increases the flexibility of the electrifying energy system. Energy storage using P2G technology takes place as synthetic methane and hydrogen.

Finland is a leading country in new gases

General political ambition is high for new technologies and zero emissions. With the help of a long-term strategy, Finland has risen to the forefront of the development of the hydrogen industry and Power-to-Gas. Development projects have brought new jobs to Finland, especially in export industry. The tax system also supports the conversion of carbon-neutral electricity into gases.

The versatile gas hybrid invests in the development of new gases

The Finnish gas market is characterised by a versatile gas hybrid, and gases play a role in a more sustainable energy mix. There has been a shift from a natural gas-based portfolio to a diversified gas mix that includes synthetic methane, biomethane, biogas, hydrogen and natural gas. Diverse gas sources have contributed to the reduction of the importance of Russian gas.

Finland invests in the development of hydrogen infrastructure and the state supports investments in hydrogen and synthetic methane technology. In Finland, local applications are made for gas customers to utilise hydrogen.

Hydrogen is evaluated for its usability and durability. Hydrogen is produced from natural gas and renewable energy through a combination of steam reforming and CCU technology, pyrolysis and electrolysis. Hydrogen is further methanised to synthetic methane for energy system storage and flexibility purposes. Industry utilises pure hydrogen, but hydrogen is also blended into the pipeline gas within the limits allowed by the infrastructure.

Electrolysis-based technology enables the production of hydrogen and methane also in areas outside the gas transmission network, and gas is also used for new purposes. Carbon dioxide recovered by CCU technology is reused in, for example, chemical products and the production of clean gases.

The integration of the gas market continues, and the markets of Finland, Estonia, Latvia and Lithuania have become integrated, also with Poland. The EU consists of regional hydrogen markets and the plans to build a single common market for green hydrogen.

Biogas and LNG (and LBG) find their place in the energy sector

The use of biogas and biomethane increases as the biogas certificate and the guarantee of gas origin expand to cover the integrated market. The market is also activated by the fuel blending obligation and the distribution obligation. The use of biogas has increased, especially in transport.

The number of gas cars (passenger traffic and heavy traffic) increases considerably, and the gas refuelling network also covers Northern Finland. Gas comes close to consumers, which also increases the acceptability of gas. The importance of LNG and LGB, especially in heavy traffic and shipping, is considerable.

Scenario 4 plot description

Towards carbon neutrality with determination – diverse gases

2020-2024

- **The coronavirus crisis is turned into a unifying factor at EU level** and is overcome with joint solutions. The EU's economy faces a blow in the crisis, but the crisis is overcome quickly.
- **Finland has set a vision and concrete measures for renewable gas**: the aim is to actively develop the sector and adapt it to future needs. Finland wants to be a pioneer also in the gas sector.
- **In Finland, the vision for the energy system and gas is supported, for example, by tax decisions** (incl. fuels and electricity), and a genuine reform of the tax system is carried out.
- **Finland sets up a coordination group for systemic sectoral integration**, representing different energy sectors. The development of the Finnish energy system is done in genuine cooperation, taking into account systemic efficiency.
- **Support programmes are set for gas product development,** and pilot projects for synthetic gases are launched. Blending obligations have been imposed on fuels, which sets the market outlook for profitable production.
- **Zero tax is imposed on biogas** for the next 5–10 years, after which a distribution obligation is imposed on biogas. The EU changes its regulations, and emission regulation and measurements assess lifecycle emissions, which is an advantageous solution for biogas.
- Industry (e.g. chemical industry) uses blue hydrogen increasingly in its processes. **Investments are made in industrial hydrogen projects and pilots**.
- **The gas sector works actively to renew its reputation** and instils faith in the future.
- **The gas sector is developed in the EU in a strong "New Green Deal" spirit**. The EU focuses on product development and gas infrastructure by investing more than EUR 3 billion in renewable gas development projects.

2025-2029

- **EU integration is strengthening**, which can be seen, for example, in the development of the internal market.
- **At EU level, there is an active debate on whether P2G technology is energy storage or energy production**. Synthetic gases produced using renewable energy are defined as renewable energy.
- **In Finland, changes in energy and capacity pricing support the shift towards a renewable energy system** (eg control power).
- **The biogas certificate system expands to cover the Baltic and Finnish markets.** The volumes of biogas flowing into Finland are increasing and biogas is being sought especially as a way to reduce traffic emissions. Natural gas is also being replaced to a small extent by liquefied biogas in industry.
- **Several new gas car models will enter the market and the gas car market will grow** under the leadership of Central Europe. The refueling network for gas cars also covers northern Finland.
- **Obstacles to the construction of offshore wind power are being removed in Finland.**
- **Many large-scale plant pilots involved in the production of synthetic gas are underway**.
- Industry is investing in local hydrogen solutions and hybridizing its processes with hydrogen.
- **CCU technology is becoming more common in industrial plants**. For example, the chemical industry is investing in technology.
- Investment decisions for new electrolysers (plants consisting of ~ 2-3 MW modules) will be made after 2025.
- **The new technologies will be sufficiently competitive and affordable in the late 2020s**. Favorable policies and regulations have contributed to the development.

2030-2034

- **EU cooperation intensifies and the Union actively negotiates** with new Member States, and the EU's global importance grows.
- **The dominance of EU energy policy has levelled off** and activities are characterised by cooperation.
- **The amount of renewable energy** in the EU and Finnish energy systems **grows strongly**.
- The EU's target of 100 GW of offshore wind power by 2030, **in line with the offshore wind power strategy, is achieved**. The increase in wind power increases the need for storage and flexible solutions. In Finland, the share of wind power in energy production grows significantly.
- **Finland is more strongly integrated into Central Europe in terms of electricity transmission connections.** A common wholesale electricity market has emerged in Europe.
- The integration of the Finnish and Baltic gas markets continues **to Poland**.
- **The role of alternative gases** (hydrogen, biogas, LBG, synthetic gases) **strengthen in Finland.** Traditional gas for industrial use is an expensive option with taxation and support forms, which has led to a new way of using gases. **10% of Finland's gas consumption is hydrogen / synthetic gas**.
- **The transport sector uses more than 4 TWh of biogas.** Biogas cars can be found in the public sector, in professional use as well as in passenger car use.
- In the steel industry, the production of "green" steel on a larger scale is in use. In the chemical industry, hydrogen is produced to a significant extent by electricity.
- **The competitiveness of gaseous stocks has improved over alternative solutions.** For example, the use of electric batteries is focused on small-scale use and passenger cars. The construction of artificial pools is not desirable.

2035-2040

- **EU debates feature federalist themes,** and EU politicians representing a stronger EU strengthen their grip on the EU parliament.
- **The Finnish and Nordic energy systems are increasingly based on electricity and renewable electricity**, such as wind power.
- **The networks of the energy system are increasingly integrated into an entity:** the gas network, the district heating network and the cooling network act as balancers for the energy system.
- **Gas storage based on P2G technology has been introduced**. More investments are made in electrolysers and P2G technology.
- **25% of Finland's pipeline gas is hydrogen / synthetic methane**. However, hydrogen is mainly directed in local use and infrastructure. Industry continues to make extensive use of hydrogen and natural gas blending solutions.
- **CCU technology is widely used in industry,** and the recovered carbon dioxide is used, for example, as part of chemical products.
- **There are more than 100,000 gas cars** in Finland that utilise natural gas and biogas. The biogas refuelling network has developed strongly to support increased gas traffic.
- **However, gases have increased most in heavy transport and maritime transport**
- Traditional use of natural gas is at a low level in both energy production and industry in Finland.

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