Preliminary study

Invest In Veitsiluoto - pipeline

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RAMBØLL

Bright ideas.
Sustainable change.

BACKGROUND

The goal of the preliminary study is to map out suitable biofuel and electric fuel production options for Veitsiluoto and Ajos.

The study takes into account the potential and limitations of the area.

The Veitsiluoto area has excellent opportunities for diverse production due to its location.

The area is located along the TEN-T[1] core network and the planned Meri-Lappi hydrogen trunk pipeline.

The proximity of the deep-water port of Ajos and the railway connection of the industrial area enable the export of production.

The use and production possibilities of bio and electric fuels, as well as their environmental friendliness, are taken into account in the preliminary study.

The placement option for Ajos is located in a groundwater area.

[1]) The Trans-European Transport Network (TEN-T) is a Europe-wide transport network. The goal of the TEN-T network is to create a safe and sustainable transportation system in the EU that promotes the seamless movement of goods and people. https://vayla.fi/en/transport-network/transport-system/ten-t

THE CONTENT OF THE REPORT

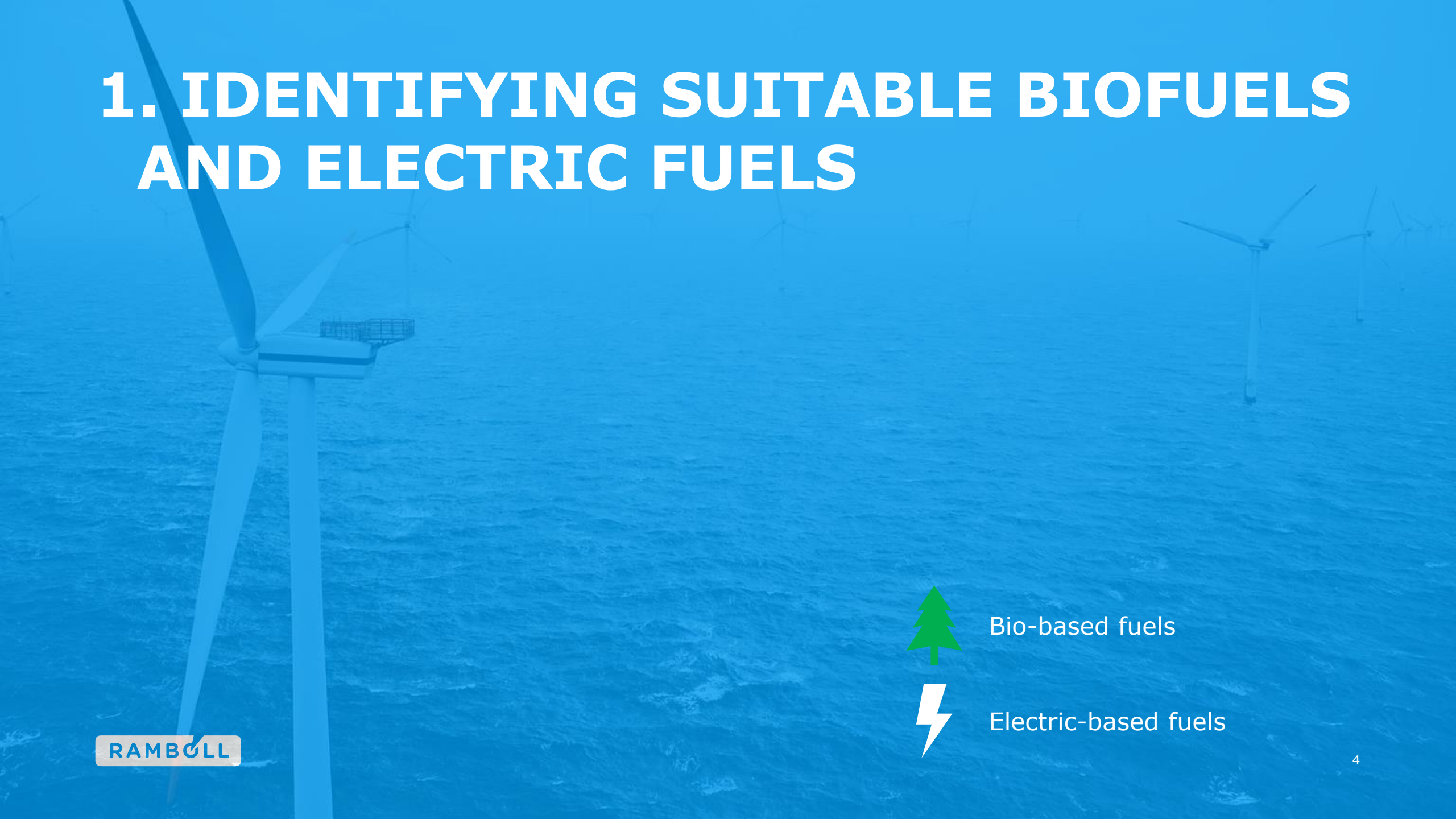
1. Identifying suitable biofuels and electric fuels

2. Identifying potential chemicals for different scenarios.

3. Scenario analysis

1. Chemical pipe Veitsiluoto-Ajos
2. Water pipe Veitsiluoto-Ajos
3. No pipe, storage in Ajos
4. District heating possibilities

1. IDENTIFYING SUITABLE BIOFUELS AND ELECTRIC FUELS



Bio-based fuels

Electric-based fuels

GENERAL INFORMATION ABOUT BIOFUELS AND ELECTRIC FUELS

- The most common biofuels have been on the market for several years, and their environmental impacts are relatively well known.
- Synthetic electric fuels are in the development stage. There are pilot plants, but commercial production is very small.
- Electric fuels are assumed to have the same environmental and safety impacts as the corresponding fossil fuel, as they are chemically almost identical.
- Typically, liquid chemicals cause soil contamination in the event of a leak, which almost always leads to remediation measures. The need for remediation is determined by the limit value specified by law.
- Even if a substance is not toxic to the environment, it can still be harmful to the environment.
- The production of electric fuels generates waste heat, which should be utilized, for example, as district heating.
- Assessing the market shares and development of future fuels is challenging. There is no certainty about which fuel will surpass others and over what time frame.

BIOFUEL – BIODIESEL / RENEWABLE DIESEL

- Biodiesel is typically produced from plant and animal oils and used as a fuel in transportation, mixed with fossil diesel.
- Renewable diesel is produced from waste-based renewable raw materials such as waste oils and by-products of the forestry industry. It is used in transportation as fuel, either mixed or on its own.
- Safety: Flammable liquid. Harmful and irritating to humans. It is comparable to the safety requirements of fossil diesel.
- Environmental impacts: Toxic to aquatic organisms. Potential risk of soil contamination. Commercial products vary for example in terms of biodegradability and ecotoxicity.
- Market outlook: The market exists and is expected to grow. The compulsory distribution volume in transport affects demand. Biodiesel is threatened by uncertainty over EU regulations on the use of plants as raw materials. The availability of raw materials for renewable diesel can become a barrier.
- Sunshine Kaidi New Energy Co. Ltd. has planned a biofuel refinery in Kemi, but the environmental and water management permitting process for the project has ended without a permit for the operation.

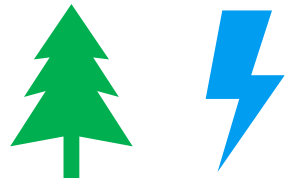
BIOFUEL – BIO-OIL / PYROLYSIS OIL

- Bio-oil is usually plant-based oil from agriculture or pine oil considered as a residue of the pulp industry
- Pyrolysis oil is made from wood by gasification and liquefaction, and it is used in small district heating boilers.
- Intended use: Energy production and in the future the possibility to further process into transportation fuel and as a raw material for the chemical industry.
- Safety: Bio-oil is classified as a corrosive substance and can cause eye and skin irritation.
- Environmental Impact: Bio-oil and pyrolysis oil are harmful to the environment if released but are not toxic. The environmental impacts of bio-oil may differ from traditional fossil oil products, for example, natural biodegradation.
- The current market is unclear, and market prospects are uncertain. The product replaces fossil oil, but the use of oil for heating is decreasing. Currently, there is little refining, and research is still ongoing. Small projects are planned around Finland.

BIOFUEL – BIOCHAR

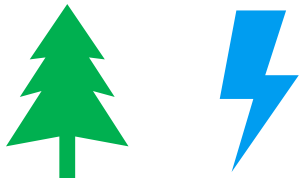
- Biochar is produced by dry distillation of wood (biomass) at temperatures of 350-800°C. By-products include waste heat, pyrolysis oil and gas, which can have beneficial uses.
- Intended use: There are several qualities and uses for biochar. Using biochar as a soil improver is the most environmentally viable option. It can also be used for water purification. Using biochar for heat production is not economically viable. Biochar can have business potential in carbon sequestration if it's buried in the ground.
- Safety: Not classified. No significant safety risks.
- Environmental impact: Not classified. No significant negative environmental impacts.
- Markets: The markets are small, but they exist. The popularity of the product is not yet clear, as there are not many projects, and its use is still in the research phase.

BIOMETHANOL / E-METHANOL



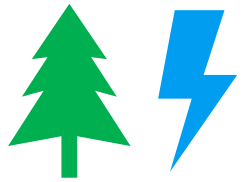
- Biomethanol is refined from biomass.
- E-Methanol is a liquid fuel, which is manufactured by combining green hydrogen and bio-based carbon dioxide.
- Intended use: Chemical industry and in the future as fuel for transportation.
- Safety: Methanol is a flammable, combustible liquid. Toxic to humans.
- Environmental Impact: Methanol is not classified as dangerous to the environment. Methanol that reaches the ground evaporates quickly from the surface. Methanol does not bind to soil, so it is very mobile and can therefore end up in groundwater.
- Markets in the chemical industry already exist. Methanol is predicted to be one of the fuels of the future for maritime and road transport.
    - ST1 is planning an e-methanol plant in Lappeenranta.
    - An e-methanol plant investment is planned for Ranua.

BIOETHANOL / E-ETHANOL



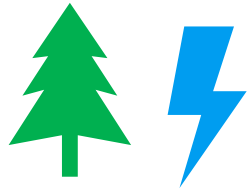
- Bioethanol is processed from biomass, such as plants or other organic waste.
- E-Ethanol is a liquid fuel produced by combining green hydrogen and bio-based carbon dioxide.
- Intended use: Chemical, chemical industry, transportation fuel
- Safety: Ethanol is a highly flammable, combustible liquid. It irritates humans on contact but is relatively safe as a chemical.
- Environmental effects: Ethanol is not classified as hazardous to the environment.
- The market for ethanol already exists. The amount of the distribution obligation in traffic affects demand. Ethanol is not seen as becoming a significant fuel.

ELECTRIC FUEL – SUSTAINABLE AVIATION FUEL (SAF)



- SAF (Sustainable Aviation Fuel), a renewable aviation fuel made from biomass and waste, is available.
- Synthetic aviation gasoline is made from green hydrogen, bio-based carbon dioxide and additives.
- The technology is in the research phase. No commercial plants are in operation. SAF is one of the future synthetic fuels.
- Intended use: Replaces jet fuel in air transport. Multiple different qualities.
- Safety: Assumed to correspond to the safety of fossil jet fuel. Jet fuel is a flammable liquid. It can be fatal if swallowed and if it enters the respiratory tract.
- Environmental effects: Assumed to correspond to the environmental effects of fossil jet fuel. It is toxic to aquatic organisms.
- The market is expected to grow strongly with the increase in air traffic and the tightening of emission reductions in air traffic.

ELECTRIC FUEL – DIMETHYL ETHER (DME)



- Possible to produce from biomass (BioDME)
  - BioDME fuel production pilot implemented in Sweden
- It can also be produced from hydrogen and carbon dioxide (DME)
- Gas at atmospheric pressure but can be compressed into a liquid.
- Intended use: Current use as a propellant. DME is one potential alternative to replace diesel and liquefied petroleum gas in the future.
- Safety: Extremely flammable. Gas-air mixtures are explosive. It is irritating to humans and may cause decreased consciousness.
- Environmental effects: Impacts not classified. No significant effects on the environment.
- Market: Small market. The future market is uncertain with the decline of internal combustion engines. On the other hand, even current diesel engines are suitable, with minor modifications, for using DME, especially in heavy-duty vehicles.

ELECTRIC FUEL - HYDROGEN

- Green hydrogen is produced from water and electricity. Hydrogen serves as a raw material for other electric fuels.
- A hydrogen plant should be located near an electricity and water connection.
- Transport and storage of hydrogen pose challenges when there is no transfer pipe. Liquefaction requires a lot of energy.
- Intended uses: Chemical industry, as a transportation fuel in the future, and in the steel industry.
- Safety: Hydrogen is a very highly flammable gas. High storage pressures increase the risks. Pure hydrogen gas is not poisonous. In high concentrations, it displaces oxygen and can cause suffocation in a confined space.
- Environmental impacts: No known harmful effects on the environment from hydrogen.
- Currently, there is no established market for hydrogen, usage is localized to certain plants. In the future, hydrogen is seen playing a big role in the energy system. To create a hydrogen market, the transport problem needs to be solved.
- You should further process or sell to the planned Meri-Lappi hydrogen pipe of Gasgrid when it is built unless some company wants to use it directly, for example, in transportation.

ELECTRIC FUEL – E-METHANE

- E-Methane is a gas that is produced by combining green hydrogen and bio-based carbon dioxide.
- Intended use: As a fuel in transportation, energy production, and the chemical industry.
- Safety: Risk of ignition and explosion. Comparable to the safety requirements of fossil natural gas and LNG. Safe handling methods are well known.
- Environment effects: A potent greenhouse gas when released into the air. Methane is not classified as hazardous to the environment.
- Market prospects for methane (natural gas) are good. Natural gas is a transition fuel, which has many uses. Fluctuations in the price of natural gas cause uncertainty.
- Several synthetic methane projects are planned in Finland.

ELECTRIC FUEL – AMMONIA

- Ammonia is produced by combining green hydrogen and nitrogen.
  - Nitrogen is obtained from the air, so production does not require an external source of carbon dioxide.
- Intended use: Chemical industry (mainly fertilizers). In the future, as a fuel in freight traffic.
- Safety: Ammonia is a colourless, highly irritating gas that can be easily liquefied into a colourless liquid. Ammonia is very irritating, toxic and corrosive. The danger is affected by the concentration in the air, and a gas cloud causing symptoms can travel hundreds of meters in the air. Ammonia is not highly flammable but can pose an explosion hazard with air.
- Environment effects: Based on aquatic toxicity, ammonia is classified as hazardous to the environment.
- Market: Use is quite concentrated, but the market still exists. Use will increase with the demand for fertilizers and fuels in shipping.

BY-PRODUCT – OXYGEN

- Oxygen is produced as a by-product of green hydrogen production.
  - About 8 kg of oxygen is produced per 1 kg of hydrogen.
  - Oxygen is also produced in the manufacture of E-Ammonia in the air gas plant.
- Intended use: Oxygen is used in industry e.g., in welding and cutting, to increase the oxygen content in combustion air in various combustion processes, in the pulp industry as a bleaching agent, in hospitals and in gas mixtures used for protective food packaging. It is also used in fish farming, in greenhouse irrigation water, and in the biological purification of wastewater. Oxygen is also used in the steel industry process (LD process/basic oxygen furnace).
- Safety: Oxygen is not flammable, but it sustains combustion and increases the intensity of a fire. It is not dangerous to humans.
- Environmental effects: Oxygen has not been found to have harmful effects on the environment.
- Market: Sales are mainly in small quantities in pressure cylinders or liquid cylinders. No clear commercial use has been found for the large amount of oxygen produced by hydrogen production.

RAW MATERIAL – CARBON DIOXIDE

- Intended use: Carbon dioxide is a raw material for several electric fuels. The amount of carbon dioxide needed depends on what substance you want to produce.
- Carbon dioxide can be captured directly from the atmosphere and combustion processes (power plants, waste-to-energy plants, pulp mills, steel mills). It can also be captured directly from fuels or biogas. The capture technology has not yet been commercialized, but the technology is mature.
- In general, the costs of capture are higher than transportation, making truck delivery a viable option.
- Safety: Carbon dioxide is not flammable and does not sustain combustion. Depending on the concentration, it can cause symptoms in humans, and in the worst case, it can displace oxygen and cause unconsciousness and death.
- Environmental effects: Based on current criteria, carbon dioxide is not classified as hazardous to the environment
- Market: The market already exists, mainly in the food and beverage industry.

COMPARISON MATRIX

	Bio-based							Electric-based						
	Bio-diesel	**Bio-oil**	**Bio-char**	**Bio-methanol**	**Bio-ethanol**	**Bio-SAF[1]**	**Bio-DME[2]**	**E-methanol**	**E-ethanol**	**SAF[1]**	**DME[2]**	**Hydro-gen**	**Methane**	**Ammonia**
Requires a carbon dioxide source								x	x	x	x		x	
Phase	Liquid	Liquid	Solid	Liquid	Liquid	Liquid	Gas	Liquid	Liquid	Liquid	Gas	Gas	Gas	Gas
Fuel in transportation	+++			++	+++	+++	+	++	+++	+++	+	+	++	+
Energy production		++											++	
Chemical industry			+	+++	++			+++	++			++	+++	+++
Fire hazard	xx	xx	x	xx	xx	xx	xxx	xx	xx	xx	xxx	xxx	xx	x
Toxicity to humans	x	x		xx	x		x	xx	x		x			xxx
Toxicity to aquatic organisms	x					x				x				xxx
Suitability to Scenario 1 (Chemical pipe)														
Suitability to Scenario 2 (Water pipe)														
Suitability to Scenario 3 (No pipe)														

Explanations:

+++	Chemical in established use
++	Small usage
+	Limited usage or in research phase
xxx	Significant safety risks and environmental impacts
xx	Toxic/Flammable
x	Minor harms

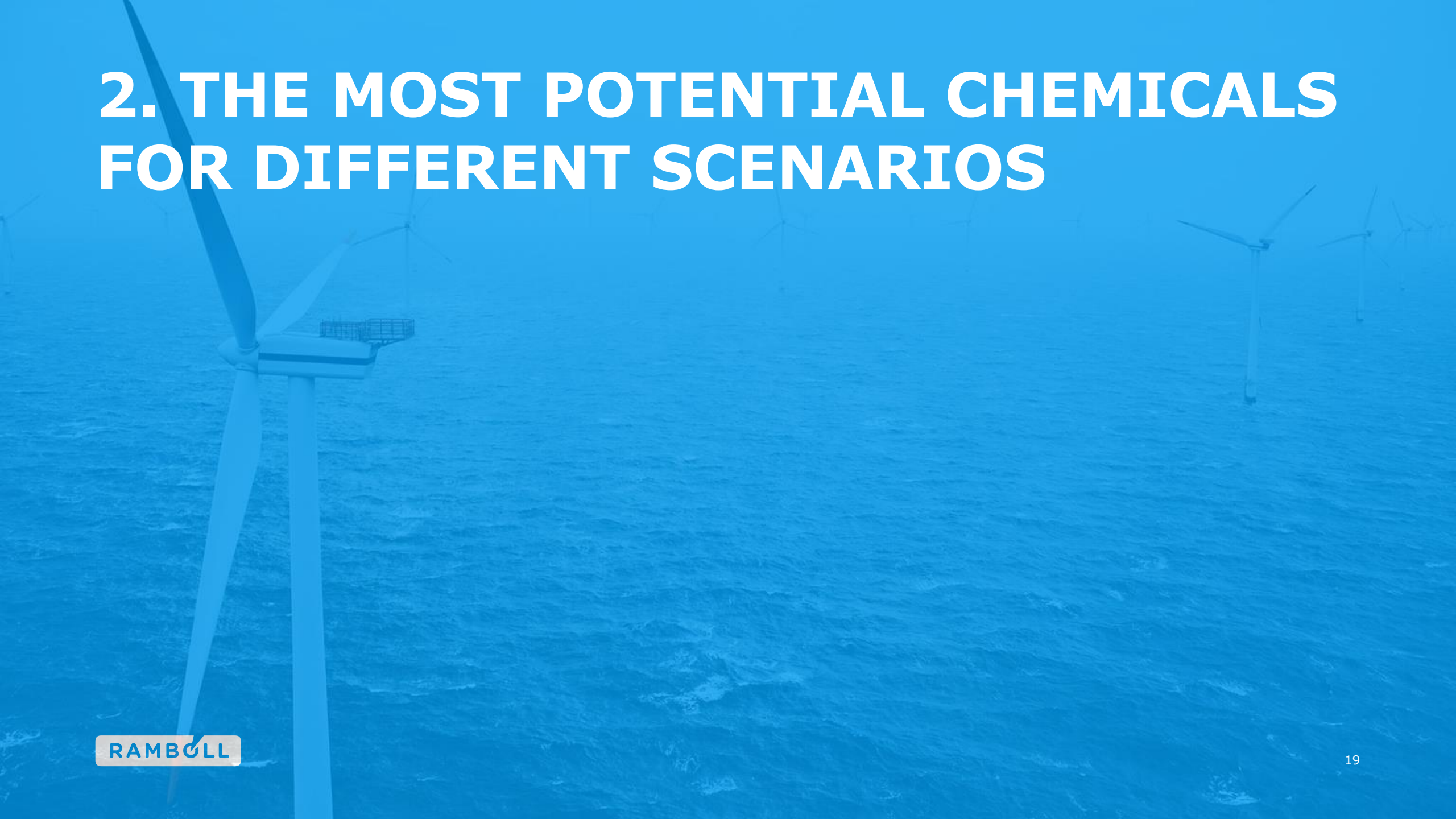
Not suitable

Partly suitable

Suitable

[1]) Renewable jet fuel, Sustainable Aviation Fuel (SAF)
[2]) Dimethyl ether (DME)

2. THE MOST POTENTIAL CHEMICALS FOR DIFFERENT SCENARIOS



EXAMINED SUBSTANCES AND THEIR SELECTION CRITERIA

E-Methane (gas)

+ Markets already exist in the 2020s. Several uses and usage will continue for decades.
+ Can be liquefied for transportation or fed into a gas pipeline as gas
+ Several pilots are planned in Finland
+ Handling is relatively safe.

- Requires a source of carbon dioxide

E-Ammonia

+ Markets already exist in the 2020s.
+ Predicted to be the fuel of the future for cargo ships
+ Does not require external carbon dioxide
+ Relatively easy to liquify

- Current uses in Finland are concentrated: Yara and mining/industry
- Very toxic to both humans and aquatic organisms, even in small concentrations
- Not recommended for placement near residential areas

E-Methanol (liquid)

+ Markets already exist in the 2020s. Predicted to be the fuel of the future.
+ Liquid form makes it easier to store
+ No significant environmental harms

- Toxic to humans if it leaches into groundwater.
- Current markets and applications are quite small in Finland.
- Requires a source of carbon dioxide.

CO_2 and O_2

+ Oxygen is a by-product of green hydrogen production
+ Carbon dioxide can be captured directly from the atmosphere and combustion processes

- Oxygen sales are mainly in small quantities
- CO_2 markets mainly exist in the food and beverage industry

AREAS IN VEITSILUOTO AND AJOS

REGIONAL INFLUENCING FACTORS

- Groundwater area
- Water permit for sea area utilization
- Area’s electrical connections
- Carbon dioxide capture and transport
- Ajos
  - Areas suitable for placement
  - Area’s zoning and zoning plans
  - Soil contamination
  - Other factors affecting placement
    - Nature conservation areas
- Veitsiluoto
  - Areas suitable for placement
  - Area’s zoning and zoning plans
  - Soil contamination
  - Other factors affecting placement
    - Nature conservation areas

GROUNDWATER AREA

- ”The distance (of the production plant) should also be sufficient from other industry, nature conservation areas, and other targets important for environmental protection.

  A production plant should not be located on an important groundwater area or other groundwater area suitable for water supply without a special justified reason.” (TUKES)

- Whether a production plant can be located in a groundwater area, the following factors should be taken into account on a case-by-case basis:

  1. the significance of the groundwater area in question for water supply (The water intake plant accounts for 8-10% of Kemi's drinking water)
  2. the type and extent of the operation and the quality and quantity of hazardous chemicals handled and stored there
  3. structural and operational solutions to prevent hazardous chemicals from migrating to groundwater
  4. the quality of the soil in the area and hydrogeological conditions in relation to the chemicals used
  5. need for transport and the effects of potential transport-related accidents and disasters

NEED FOR WATER PERMIT

- Facilities that take water exceeding 250 m3/day always require permission from the authorities (Water Act 3 chapters 2 and 3 §).
  - For example, a 130 MW electrolyser plant requires a water permit, as its water consumption is about 530 m3/day.
  - Also, building a pipe bridge from Veitsiluoto to Ajos may be part of the water permit.
- **Based on the high water demand, it can be assumed that each scenario requires a water permit.**
- The need for a permit is assessed by the ELY Centre. The municipal environmental protection authority can provide advice.
- The Regional State Administrative Agency is responsible for the processing and granting of the permit application.
- The average processing time for a water permit application is 9 months.
- Request can be made for prioritization as a green transition project in the processing of water management and environmental permit applications in 2023-2026.
- Further investigation: Can the plant be combined with the water permit for the Veitsiluoto factory area?
  - Investigate the conditions of the existing water permit and the possibility of increasing water intake as well as the discharge of waste heat into the sea.

AREA'S ELECTRICAL CONNECTIONS

- Ajos, Ajos Wind Oy's 110 kV power line
  - Onshore wind power, 13 pcs, 160 GWh
- Holstinharju, Fingrid 110 kV power line appr. 2,5 km away
- Veitsiluoto, Stora Enso 2 pcs 110 kV power lines 2,5 km away

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- Discussions in the area about the construction of a 400 kV power line, estimated construction time is 6-7 years
- The construction of 110 kV power lines takes an estimated 3-4 years
  - Cost estimate about 150 k€/km
- According to information provided by Fingrid, at the moment there is no free electricity connection capacity if the area is wanted to be built quickly
  - During 2023, Fingrid may be updating its design criteria to take into account the coordination of wind and solar power
  - At the end of next year, investments could generate tens of megawatts to the Isohaara-Simojoki power line.

- Fingrid Oyj is planning to renew the existing 3x110 kV Isohaara-Raasakka power line in its current location. The general planning of the project is already underway and construction is intended to be carried out during the years 2021-2023.
- The current 3x110 kV power line pylons include Fingrid's Isohaara–Raasakka, Metsä Fibre's Kemi and Stora Enso's Veitsiluoto plant's 110 kV lines. Fingrid is renewing Isohaara's power station and partly its related power lines. At the same time, Metsä Fibre and Stora Enso are also renewing their own power lines.
- The current 3x110 kV line structure has been decided to be renewed into two separate 2x110 kV pylon structures for operational and maintenance reasons. This ensures reliable power transmission also during fault and maintenance situations.

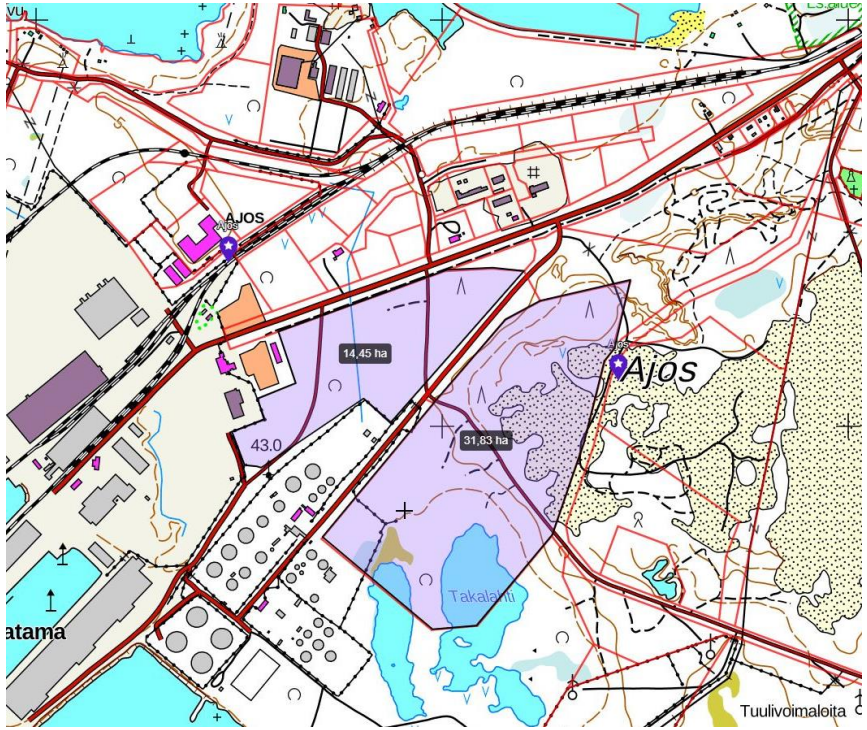
CARBON DIOXIDE CAPTURE AND TRANSPORT

- Experience with carbon dioxide pipeline transport exists in the oil and gas industry.
- Potential industrial sources of carbon dioxide:
  - Metsä Fibre's Pajusalmi pulp mill
  - It is not expected that Infinited Fiber Company's textile fiber factory, which is to be completed in Veitsiluoto in 2025, will produce carbon dioxide, except for emissions from Nevel's steam production.
  - SMA Mineral has a CCUS pilot project, which, once implemented, will produce 1.5 million tonnes of carbon dioxide. It is unclear which factory this project is associated with.
  - The collection and further use of carbon dioxide from Outokumpu should be investigated separately.
  - Kemi Water and Energy's (32 MW+18 MW) bio-boilers have the potential to capture carbon dioxide. The amounts of carbon dioxide from bio-boilers are so small that it is not economically viable to transfer it via pipeline.
- The amounts of carbon dioxide from potential large industrial sources should be mapped separately.
- Carbon dioxide can be liquefied or pressurized, enabling truck, rail, and ship transport.
- Truck transport of carbon dioxide is possible in every scenario.
  - Ajos and Veitsiluoto are suitable for interim storage.
- In the event of a leak, it can cause a risk of suffocation in humans at high concentrations.
  - Carbon dioxide is not hazardous to the environment nor flammable.

AJOS

AREAS SUITABLE FOR PLACEMENT

- In Ajos, there are two identified areas, suitable for the production, refinement, and storage of electric fuels.
  - Northern area 14,5 ha
  - Southern area 31,8 ha
- The southern area is partially situated on groundwater areas.
- According to preliminary information, the Tank Oil Oy and Neste Oil Oy storage facilities that pose a major-accident hazard as defined by the Seveso II Directive 96/82/EC are located in the southwest[1]. These may result in the inclusion of the plant in the Seveso directive.
  - The possibilities of placing chemical containers on the port shore in the soil dumping area need to be examined separately. When considering placing them in the soil dumping area, the Seveso II directive and other risks arising from the chemicals in the area should be taken into account.



Potential placement area for the factory/storage

1) https://projektit.ramboll.fi/YVA/keminsatama/aineistot/Kemin-Satama-oas-asemakaava-8-6-2010.pdf

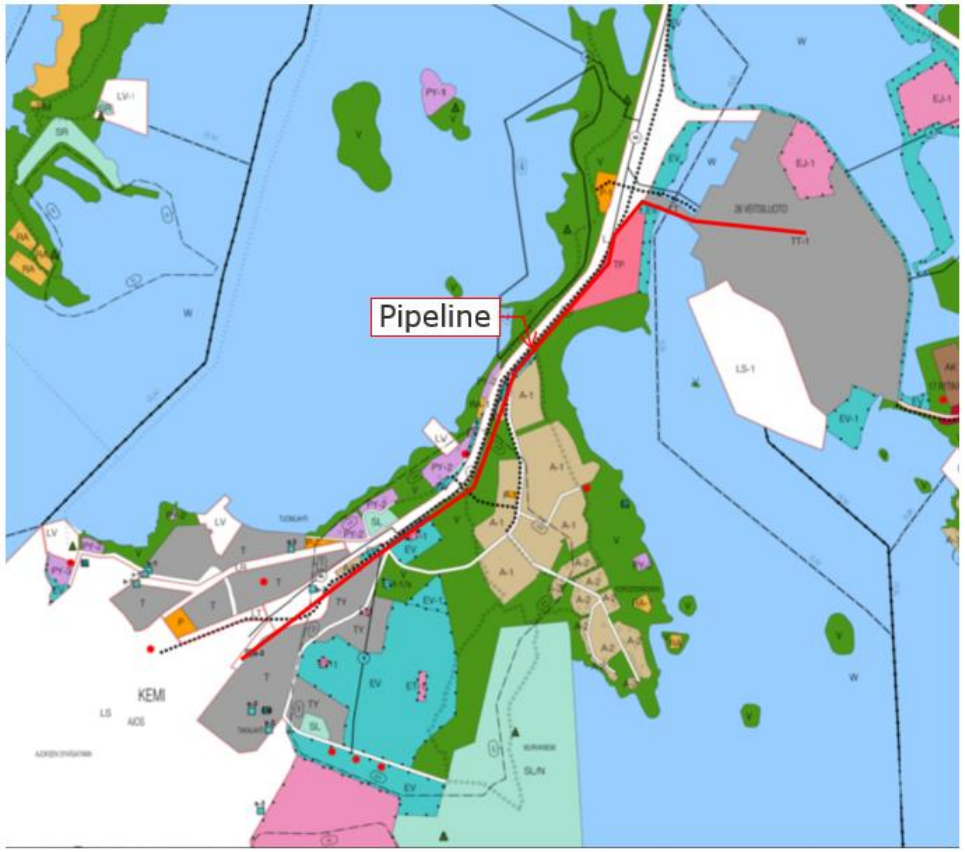
PLANNING

- In the local detailed plan, the southern area of the example placement site in Ajos is marked as T/Kem (Grey), meaning an industrial or storage building area, where a significant plant manufacturing or storing dangerous chemicals can be placed.
- It's important to note that the production plant cannot be located on a major groundwater area or other groundwater area suitable for water supply without a specific justified reason.
- No site plan has been released for the northern area. There are no public planning targets for Ajos or Veitsiluoto area in the 2023 planning report[2].

EV	Protective green area	V	Recreation area	W	Water area
T/kem	Industrial and storage area	TY-1	Industrial building block area	ET	Community technical maintenance area

[2]) https://www.kemi.fi/asuminen-ja-ymparisto/rakentaminen-ja-ymparisto/kaavoitus/vireilla/

PLANNING - PIPELINE



In the general plan, the areas through which the preliminary pipeline runs are marked as

- Industrial area, in which the environment sets special requirements (TY),
- protective green areas (EV),
- recreation areas (V),
- employment area (TP) and
- Area for buildings and plants serving communal technical maintenance (ET).

Near the pipe, there is also an area reserved for residential buildings (A-1).

V	Recreation area	T	Industrial and storage area	A-1	Urban functions area
TY	Industrial area	LS-1	Port area	EV	Protective green areas
EJ-1	Waste treatment area	TT-1	Industrial operations area with significant environmental effects	TP	Employment area

PLANNING - PIPELINE

In the local detailed plan, the areas through which the preliminary pipeline runs are marked as

- transport areas (LT, white) and
- recreation areas (VL, green).

Taking into account the safety zones for chemical/hydrogen pipelines, the pipes transferring large quantities of chemicals do not fit into the area.

Safety distances have not been defined for certain chemicals. For example, for natural gas pipelines, the safety distance ranges from a few meters to several tens of meters, which makes the existing pipelines and cables on the edge of the road a hindrance, and there is no room for the necessary safety distances.

There are no sensitive targets in the immediate vicinity of the pipeline, but the distances are very tight. The nearest residential area is about 100 meters away. They do not prevent the construction of the pipeline, but they may complicate construction.

EV	Protective green area	V	Recreation area	W	Water area
T/kem	Industrial and storage area	TY-1	Industrial building block area	ET	Community technical maintenance area

AREA’S ELECTRICAL CONNECTIONS

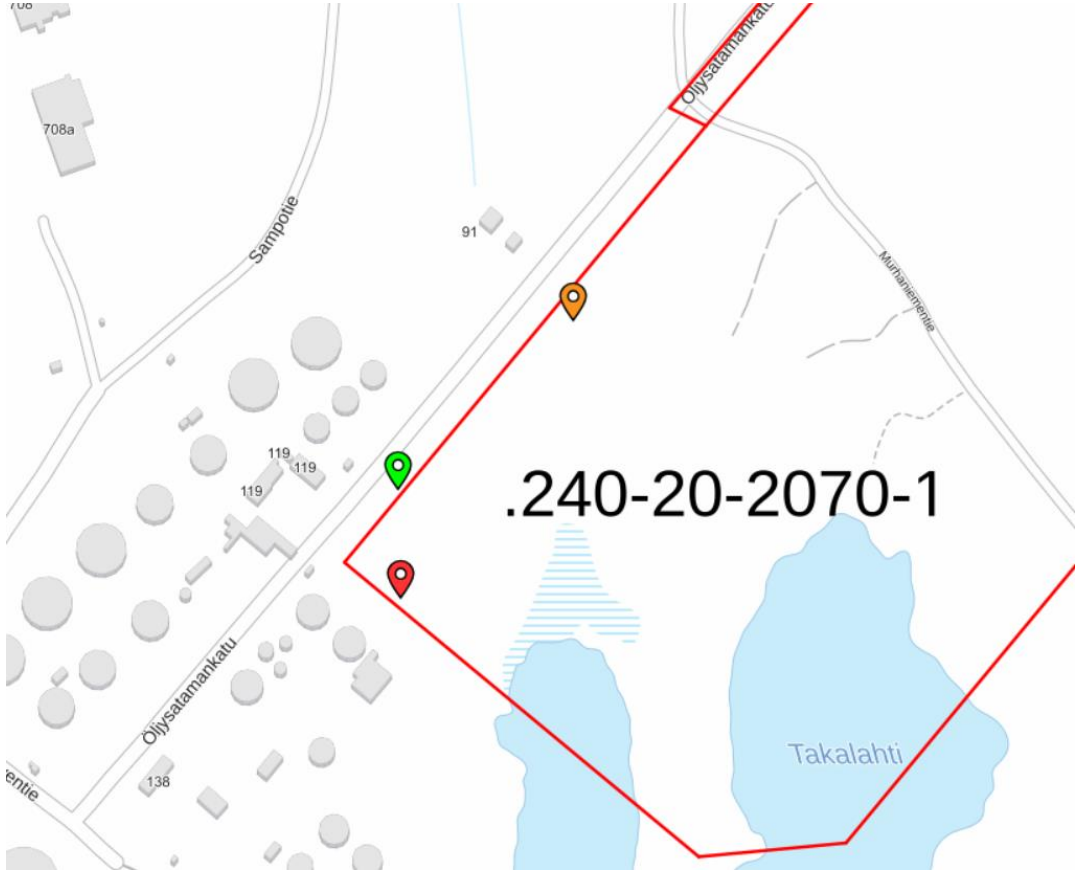
A 110kV power line runs through Ajos in the direction of the road.

If a chemical pipeline is being planned, we recommend discussions with Tukes and Fingrid about placing the chemical pipeline near the Isohaara-Simojoki power line.

SOIL INVESTIGATION OF PLACEMENT AREAS - SOIL CONTAMINATION

Soil contamination has occurred in the southern area of the Ajos example placement area, which has been remediated.

1. The soil contamination was caused by Teboil's oil storage (marked in orange). The soil was remediated in 2017, achieving a site-specific target value.
2. SEO's additive tank (marked in green) had a chemical accident in 2006. The soil was remediated up to a level below the threshold values of the time.
3. The soil contamination was caused by ST1 Oy's oil storage (marked in red). The soil was remediated in 2016 below the upper threshold value of Decree 214/2007.



Presented locations of contamined sites in Ajos

OTHER FACTORS AFFECTING PLACEMENT

- The planned area is near the **Ajos port** (marked in blue)
  - The port area also has a free storage/customs warehouse and storage areas for temperature-controlled containers and hazardous substances
  - In front of the port is a wind park owned by Ikea and operated by OX2, which has **13 wind turbines** (marked in black)
    - The ice fall warning distance of wind turbines should be considered during construction.

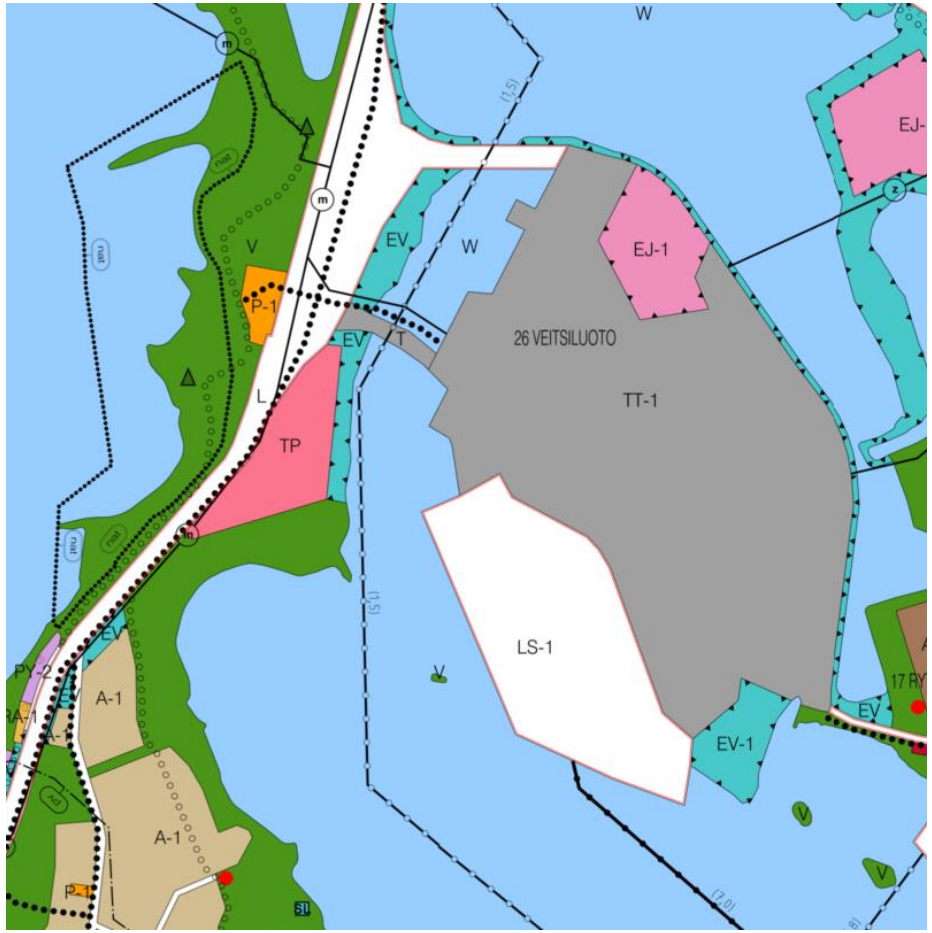
OTHER FACTORS AFFECTING PLACEMENT

- There are **ancient remains** in the area (marked with red dots)
  - In the west, another cultural heritage site: Point of Struve's chain
  - The southernmost fixed ancient monument: two stone structures, the eastern one of which is a stone wall with at least three overlapping layers of stones
  - In the southeast, another cultural heritage site: Tall old spruces with thick trunks. A story is associated with the spruce located in the Murhaniemi nature reserve, where it served as a lookout spruce.
  - In the north on the left, a fixed ancient monument: 30 pits, where prisoners of war were likely buried
  - In the north on the left, another cultural heritage site: The cemetery and memorial of the prisoner of war camp no. 9 during the Continuation War
- Near the pipeline is **a Natura 2000 Conservation Area** (green), which must be considered when designing the pipeline
- As the project progresses, an archaeological survey (for example protection areas) is recommended for the area.

VEITSILUOTO

PLANNING VEITSILUOTO

- In the general plan, the example placement site of the Veitsiluoto factory area is marked as TT-1 (grey).
- The detailed plan alterations for Veitsiluoto came into effect at the beginning of 2023. In the new detailed plan, the Veitsiluoto area is marked as a T/Kem area, i.e., an area for industrial or storage buildings where a significant plant that manufactures or stores dangerous chemicals can be located.



V	Recreation area	T	Industrial and storage area	A-1	Urban functions area
TY	Industrial area	LS-1	Port area	EV	Protective green areas
EJ-1	Waste treatment area	TT-1	Industrial operations area with significant environmental effects	TP	Employment area

SOIL INVESTIGATION OF PLACEMENT AREAS - SOIL CONTAMINATION

Areas in Veitsiluoto have been used for activities that can lead to soil contamination.

1. Stora Enso's sawmill (marked in yellow)

   The site is currently in operation and potentially harmful activities may have occurred here. Studies of soil contamination have been conducted in this area.

2. Stora Enso’s drying kiln (marked in red)

   The area around the kiln has soil contamination resulting from activities of the old sawmill. Activity that may contaminate the soil has ended. The need for soil remediation has been identified. A decision about the remediation of the site was made in spring 2023.

The base data originates from the MATTI database. The base data of the investigation did not involve information about PIMA studies carried out or soil remediation procedures.

In general, the building control authority requires separate soil investigations and a foundation method statement from the building plot (especially regarding the foundations) in connection with a building permit application. This means that previous soil studies from the area may not necessarily be directly usable.

Presented locations of contamined sites in Veitsiluoto

OTHER FACTORS AFFECTING PLACEMENT

There are no **ancient remains** (marked with red dots) in the Veitsiluoto factory area.

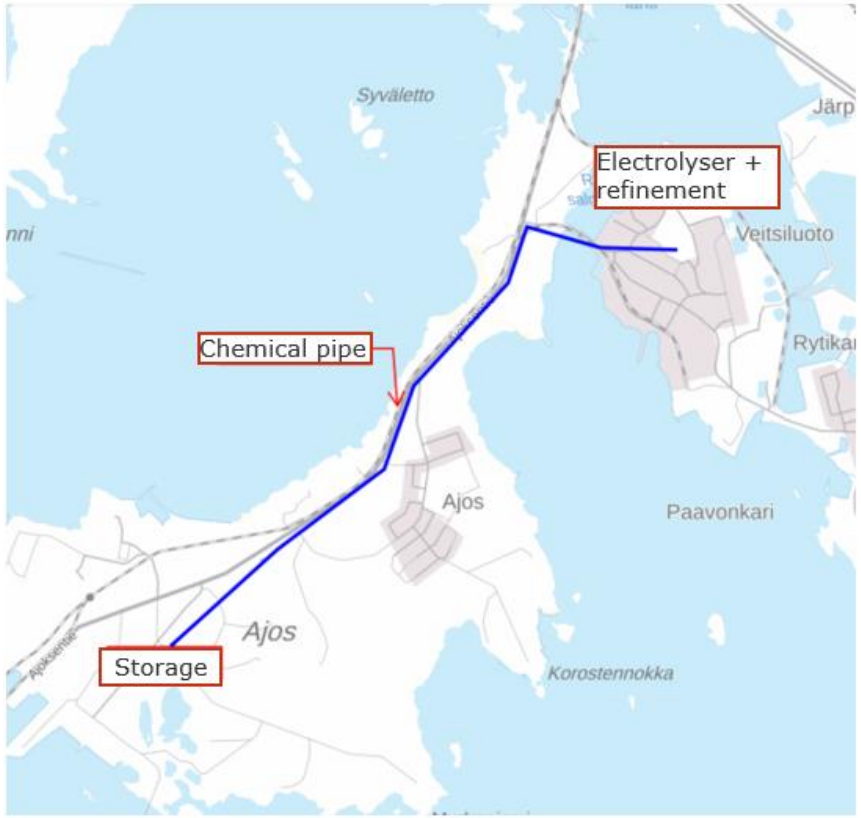
There are no nature conservation areas in Veitsiluoto area. Natura 2000 area is marked in grey in the picture.

SCENARIO 1
CHEMICAL PIPE
VEITSILUOTO-AJOS

SCENARIO 1
CHEMICAL PIPE OR HYDROGEN PIPE

A chemical pipeline can be used to transfer finished or to-be-refined chemicals between Ajos and Veitsiluoto.

- A chemical pipeline to Ajos is essential if there is no space/opportunity for storage in Veitsiluoto or if production volumes are large.
- There are sensitive targets fairly close to the route (e.g., a sand field at 30 meters, residential houses about 100 meters). This should be taken into account for safety impacts and placement.
- The effect of the power line running along the edge of the road on the placement of the chemical pipeline needs to be investigated.
- Crossing a body of water increases the cost of the pipeline and depending on the chemical, it may involve applying for water permits.
- The Ajos groundwater area complicates the obtaining of permits for an ammonia pipeline and may increase the costs associated with precautionary measures.



SCENARIO 1
CHEMICAL PIPE OR HYDROGEN PIPE

- Hydrogen pipe is essential if there is no space for refining plant or storage in Veitsiluoto
- The importance could increase if a separate branch could be obtained from the Gasgrid pipeline to Ajos port. This is seen as positive as it would enable the construction of a larger refining plant in Ajos.

SCENARIO 1
CHEMICAL PIPE VEITSILUOTO-AJOS

Methane (gas)

- There is a lot of experience in transporting methane in pipes, as it is identical to natural gas pipelines.
- There is no danger to the environment in the event of a leak, as methane is not classified as hazardous for the environment.

Methanol (liquid)

- There is no danger to the environment in the event of a leak, as methanol is not considered hazardous for the environment.
- Methanol is very mobile in the soil and can therefore enter the groundwater in the event of leaks. Methanol is toxic to humans. The Ajos groundwater area can complicate licensing.

Ammonia

- Long-distance transfer of ammonia via a pipe is not common.
- In the event of leaks, ammonia is harmful to humans, aquatic organisms, and the environment.
- The Ajos groundwater area complicates ammonia licensing and can raise the costs of precautions.
- Housing is quite close to the pipe route, which raises safety risks in the event of a leak.

SCENARIO 1
CHEMICAL PIPE VEITSILUOTO-AJOS

Hydrogen

- Hydrogen pipes are already in use today, but only a few large transmission pipes are in use in Europe.
- In the event of a leak, hydrogen does not cause harm to the environment or to humans.

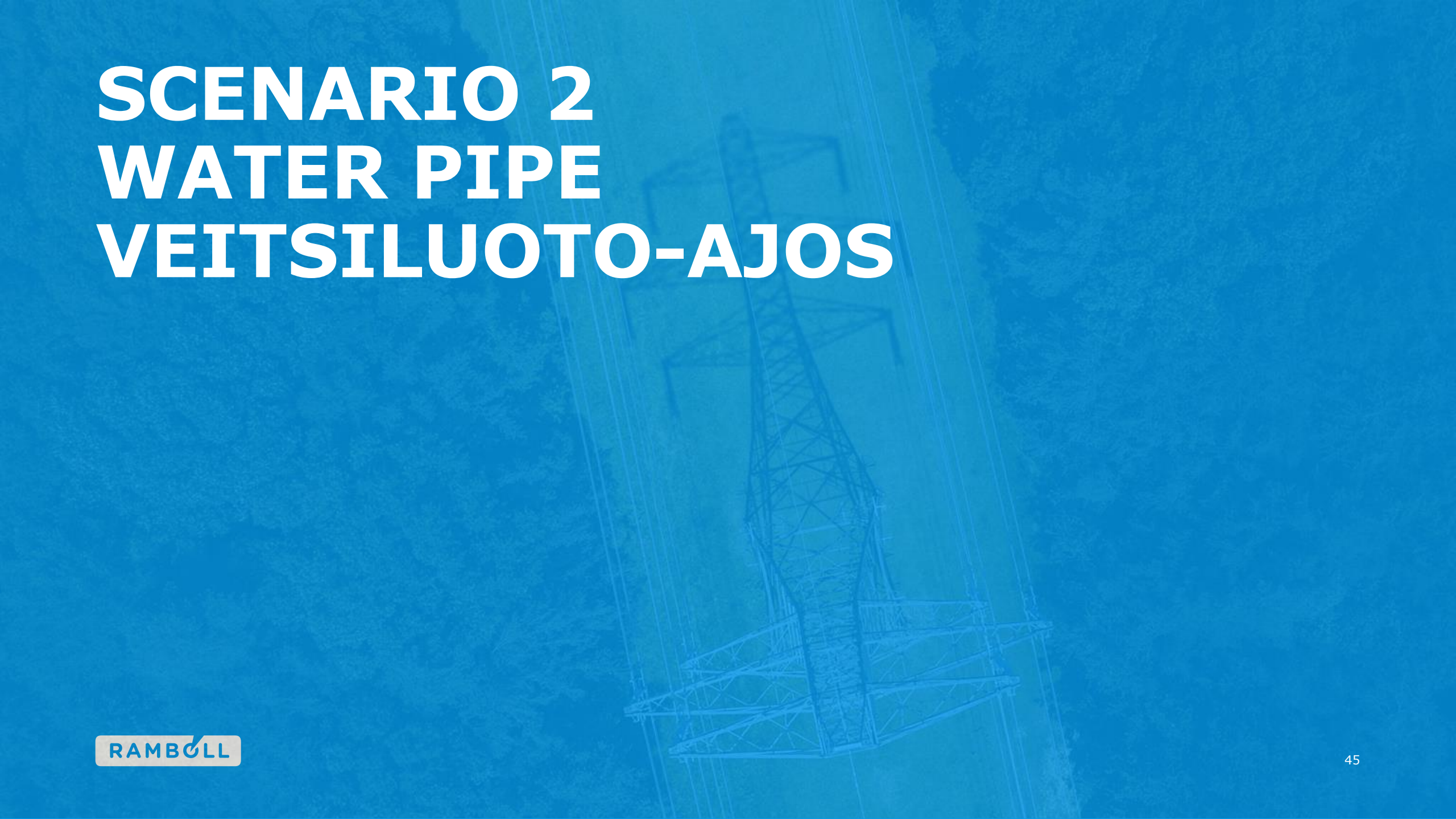
Oxygen (by-product)

- In the event of a leak, oxygen does not cause harm to the environment or to humans.
- A paying end-use must be found for the pipeline transportation of oxygen.

Carbon dioxide (raw material)

- In the event of a leak, carbon dioxide does not cause harm to the environment. However, it is dangerous for humans in high concentrations due to the risk of suffocation.
- There is experience in the pipeline transportation of carbon dioxide, but the source and amounts determine the mode of transportation.

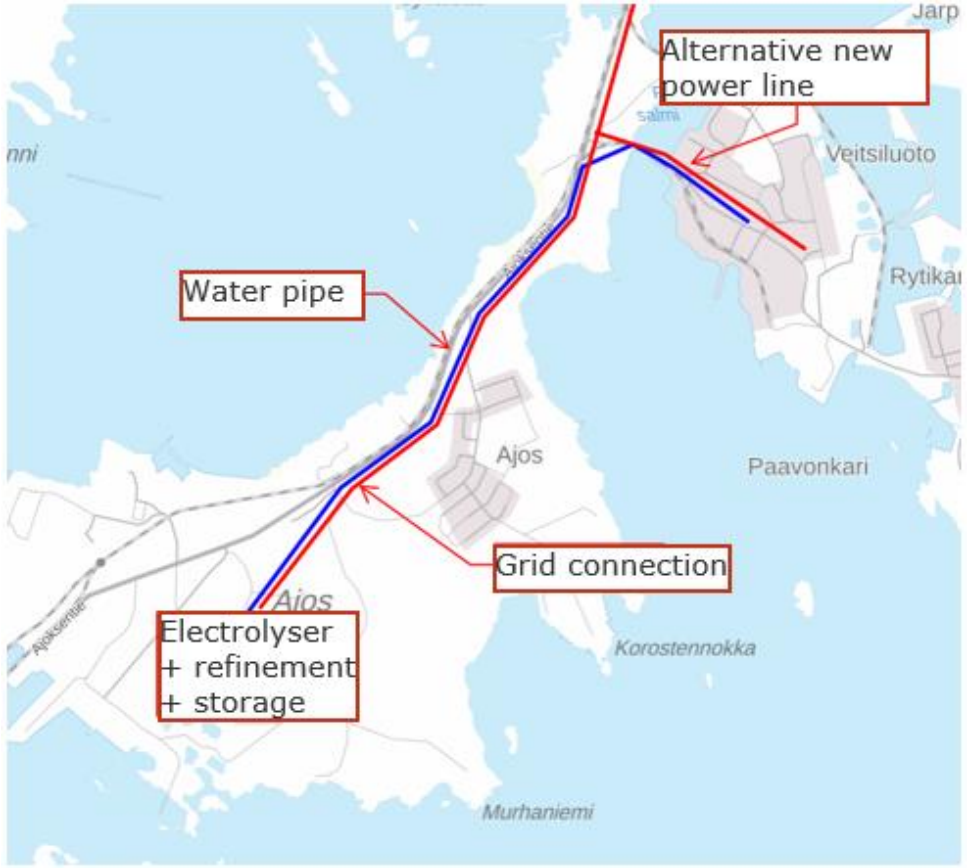
SCENARIO 2
WATER PIPE
VEITSILUOTO-AJOS



SCENARIO 2
WATER PIPE TO AJOS

In Ajos, a water pipeline can be used to transfer fresh water to the chemical production or refining process between Ajos and Veitsiluoto.

- The construction and licensing of a water pipeline is more straightforward, faster and cheaper due to the safety of water.
- An alternative solution is to take seawater from the Kemi port area. This would require a desalination plant and a water permit. It is recommended to map the possible locations of the water intake station in the area.
- A production facility in Ajos requires an electrical grid connection. There is no information available on the free connection capacity or expansion plans for the electrical connection in Ajos.
- In this scenario, no new investments are made in Veitsiluoto.



SCENARIO 2
WATER PIPE VEITSILUOTO-AJOS

Methane (gas)

- There is no danger to the environment in the event of a leak, as methane is not classified as hazardous for the environment.

Methanol (liquid)

- Methanol is not considered hazardous for the environment.
- Methanol is very mobile in the soil and can therefore enter the groundwater in the event of leaks. Methanol is toxic to humans. The Ajos groundwater area can complicate licensing.

Ammonia

- In the event of leaks, ammonia is harmful to humans, aquatic organisms, and the environment.
- The Ajos groundwater area complicates ammonia production plant licensing and can raise the costs of precautions.
- In scenario 2 the ammonia is not located near housing, and thus the affects in the event of a leak do not reach housing.

SCENARIO 2
WATER PIPE VEITSILUOTO-AJOS

Hydrogen

- In the event of a leak, hydrogen does not cause harm to the environment or humans.
- In this scenario, there is no need to transport hydrogen, as production and consumption take place in the same area.
- Hydrogen can be transported pressurized or liquified in transferable containers or fuelled directly into a ship in its liquid form.

Oxygen (by-product)

- In the event of a leak, oxygen does not cause harm to the environment or to humans.

Carbon dioxide (raw material)

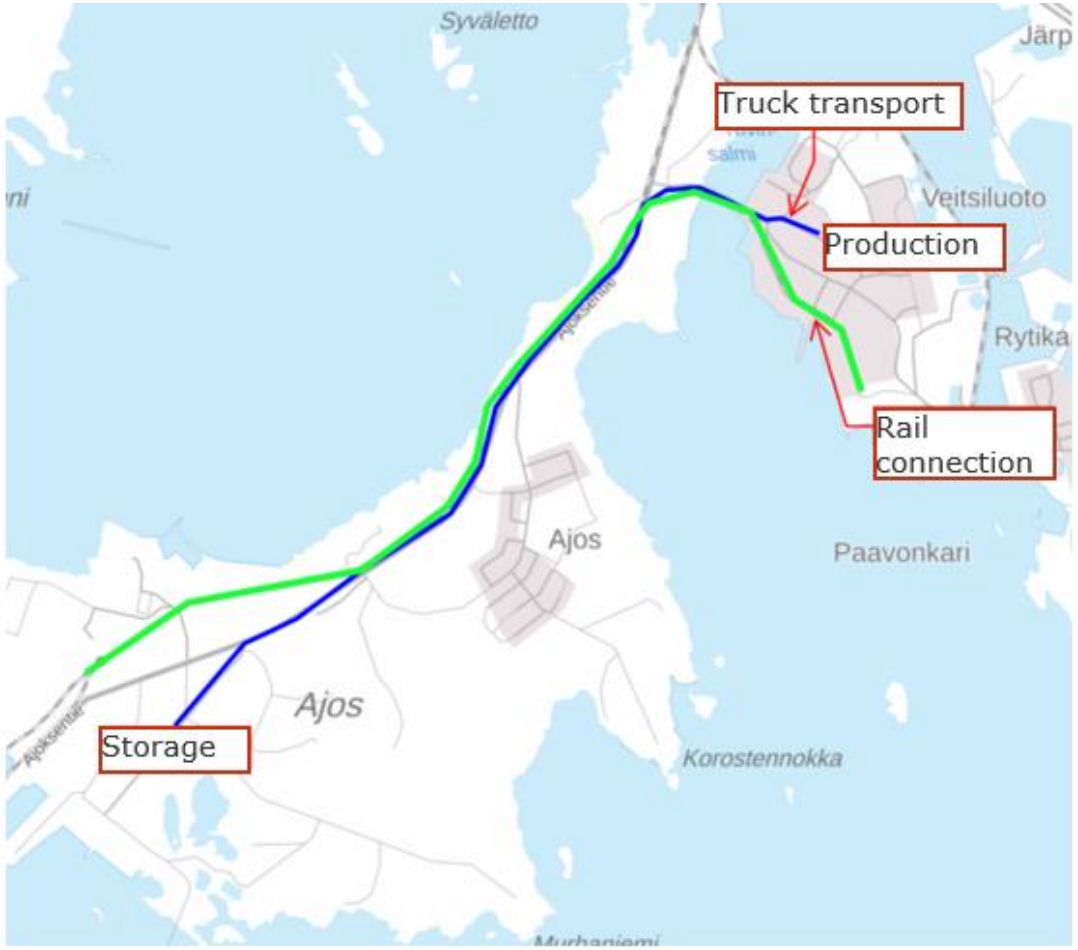
- In the event of a leak, carbon dioxide does not cause harm to the environment. However, it is dangerous for humans in high concentrations due to the risk of suffocation.
- Carbon dioxide can be transported in trucks, ships or via a pipeline.

SCENARIO 3
NO PIPE,
STORAGE IN AJOS

SCENARIO 3
NO PIPE

With the chemical production or refining processes located in Ajos and Veitsiluoto, the chemicals transfer between units is managed with other logistical means.

- Permitting is lighter, as the pipeline is not needed. It only requires permitting for the production plant and the warehouse.
- There are no direct impacts on implementation in the groundwater and Natura areas. However, the impact of traffic in the EIA[1] procedure must be considered.
- Rail connection and truck transport allow deliveries elsewhere in Finland.
- The pipeline has high investment costs but low operating costs. Vehicles require a small investment but have high operating costs.
- The economic benefit of the pipeline is only realized when there is a lot of production. The pipeline is not profitable for a small plant.



[1]) Environmental impact assessment

SCENARIO 3
NO PIPE

Methane (gas)

- Transportation of methane and methanol by train and truck is common.
- In case of a leak, there is no danger to the environment, as methane or methanol is not classified as hazardous for the environment.

Methanol (liquid)

- Methanol is not classified as hazardous for the environment.
- A storage in the Ajos groundwater area can complicate licensing. Methanol is very mobile in the soil and, thus, can end up in groundwater in leakage situations. Methanol is toxic to humans.

Ammonia

- Transportation of ammonia by train and truck is common.
- In leakage situations, ammonia is harmful to humans, aquatic organisms, and the environment.
- The Ajos groundwater area complicates licensing for an ammonia storage and may increase the costs of precautionary measures.

SCENARIO 3
NO PIPE

Oxygen (by-product)

- In the event of a leak, oxygen does not cause harm to the environment or to humans.

Carbon dioxide (raw material)

- In the event of a leak, carbon dioxide does not cause harm to the environment. However, it is dangerous for humans in high concentrations due to the risk of suffocation.
- Carbon dioxide can be transported in trucks or ships.

Hydrogen

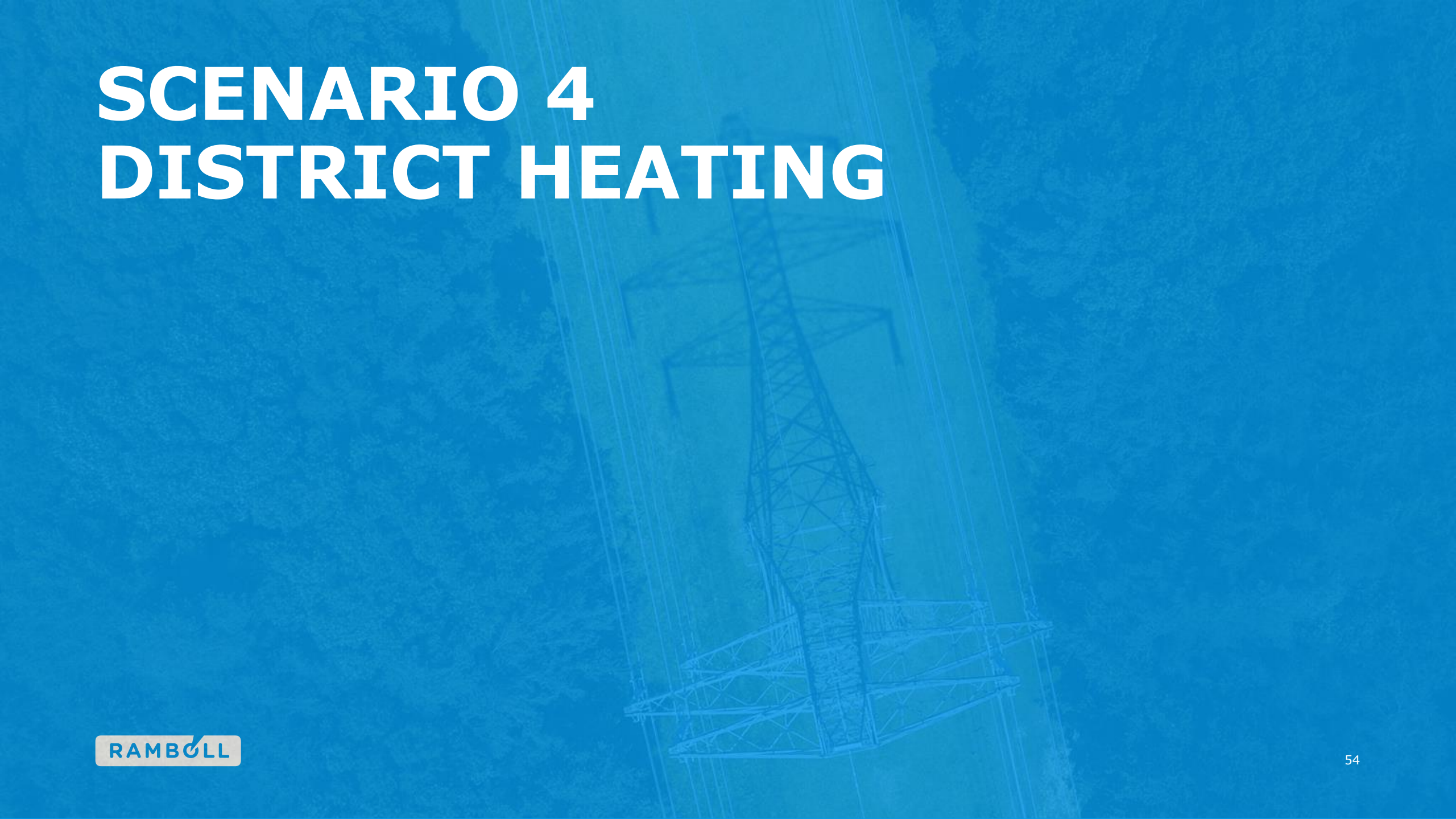
- In the event of a leak, hydrogen does not cause harm to the environment or humans.
- In this scenario, there is no need to transport hydrogen, as production and consumption take place in the same area.
- There is no need to transport hydrogen if electric fuels are produced.
- Hydrogen can be transported pressurized or liquified in transferable containers or tanks by truck or train.

SCENARIO COMPARISON

	Methane	Methanol	Ammonia	Hydrogen	Oxygen (by-product)	Carbon dioxide (raw material)
Scenario 1 Chemical pipe	• Not hazardous to the environment • Lot of experience in pipeline transportation	• Not hazardous to the environment • Can migrate to groundwater during leakage	• During leakage harmful to humans and organisms • Pipe transportation is rare • Groundwater area and housing complicate licensing	• Not hazardous to the environment • Hydrogen pipeline transmission not yet common	• Not hazardous to the environment • Requires end-user at the end of the pipe	• Not hazardous to the environment • During leakage causes a risk of suffocation • Many methods of transportation, also pipe
Scenario 2 Water pipe	• Not hazardous to the environment	• Not hazardous to the environment • Can migrate to groundwater during leakage, can complicate licensing	• During leakage harmful to humans and organisms • Groundwater area complicates production plant and storage licensing	• No hydrogen transportation • If necessary, can be transported by truck or by liquid fuelling of a ship	• Not hazardous to the environment • Can be liquified and transported by cars	• Not hazardous to the environment • During leakage causes a risk of suffocation • Many methods of transportation
Scenario 3 No pipe	• Not hazardous to the environment	• Not hazardous to the environment • Can migrate to groundwater during storage leakage, can complicate licensing	• During leakage harmful to humans and organisms • Storage in groundwater area complicates licensing	• No hydrogen transportation • If necessary, can be transported by truck or train	• Not hazardous to the environment • Can be liquified and transported by cars	• Not hazardous to the environment • During leakage causes a risk of suffocation • Many methods of transportation

Not suitable
Partly suitable
Suitable
Not relevant in the scenario

SCENARIO 4
DISTRICT HEATING



DISTRICT HEATING PRODUCTION – WASTE HEAT POTENTIAL

Utilization of waste heat generated as a by-product of chemical production in the district heating network.

- The waste heat produced by the electrolysis equipment is of low grade (40-70 °C). It needs to be raised to a temperature of 80-90 °C with a heat pump if it is transferred to the district heating network.
- In hydrogen production, the efficiency of electrolysis is about 60-90% depending on the technology, so waste heat is always generated. For example, about 22 MW of usable heat is generated from a 130 MW plant.
- Waste heat is also often produced at high temperatures from refining processes. The amount and temperature of waste heat vary in different chemical syntheses.
- In the production of electric fuels, all heat is generated from electricity.
- In the production of biofuels, the amount of heat varies between chemicals. For example, the production of biochar generates a lot of waste heat.

POTENTIAL USES/APPLICATIONS

Low-grade waste heat can generally be used, for example:

- In the district heating network
- For heating greenhouses
- For heating fish farms
- In drying
- For keeping road areas thawed in winter
- For keeping port basins thawed in winter
- For heating tanks

In Ajos, there are no clear targets where waste heat could be used.

Operators located in Ajos:

- Neste and Baltic Tank. Fuel storage.
- Lappiporras Oy
- Palsatech. A geoservice company
- Several storage operators at the Port of Kemi

CONNECTING TO DISTRICT HEATING NETWORK

- The Rytikari regional network is located about 1 km from Veitsiluoto
  - Nevel Oy is responsible for production
    - 34 MW electric boiler
    - 11 MW bio-boiler to be completed Q4/2023
  - Veitsiluoto operators are ready to increase capacity as heat demand increases
    - 20 MW bio-boiler planned
  - The fuel plant in Veitsiluoto will therefore have the possibility to provide heat to the Rytikari network and other operators in Veitsiluoto

CONNECTING TO DISTRICT HEATING NETWORK

- Connecting larger power
  - The nearest suitable connection point to Kemi Energia network (the intersection of Valtakatu and Etelänväylä) is about 6 km from Veitsiluoto (northern point)
  - The estimated cost of connection pipeline would be between 4,1 and 5,1 M€
- Connecting lower power
  - Nearest connection point is 3 km from Veitsiluoto (southern point)

CONNECTING TO DISTRICT HEATING NETWORK

- There is no district heating network in Ajos.
- Investing in the network and utilizing waste heat would require several simultaneous subscribers.
  - Building a 4 km district heating pipeline to the residential area in Ajos would cost approximately 2,6-3,2 M€ (eastern point).
  - Building a 6 km district heating pipeline to the Ajos port would cost approximately 5 M€ (western point).
- In Kemi's port, there might be a use for low-grade waste heat if the production facility is in Ajos.
  - For example, for heating warehouses, keeping roads thawed, or keeping the port basin thawed.
  - This would require the construction of a regional network and cooperation from multiple players.

IN CONCLUSION

Most common biofuels have been on the market for several years and their environmental impacts are relatively well known, but due to the current global situation, the availability and costs of bio and wood materials vary a lot.

The market shares of synthetic electric fuels are constantly evolving and forming. Electric fuels are chemically almost identical to fossil fuels. Currently, hydrogen does not have an established market, but in the future, hydrogen is seen to have a very large role in the energy system, especially when further processed into synthetic fuels.

The establishment of a new chemical production or storage facility in Ajos requires consideration of the area's Seveso directive permit, ancient remains, groundwater area and nature conservation areas. In the Veitsiluoto area, it is possible to take advantage of synergies brought by other industries in the production of chemicals.

A chemical pipeline can be used to transport finished or to-be-processed chemicals between Ajos and Veitsiluoto. E-methane, hydrogen, oxygen, and carbon dioxide are environmentally friendly chemicals suitable for pipeline transfer. E-methanol and ammonia are hazardous to humans and to the environment in pipeline leakage situations, especially in the Ajos groundwater area.

A water pipe can be used to transport fresh water to the chemical production or refining process between Ajos and Veitsiluoto. The water pipe can be used between e-methane, e-methanol, oxygen and carbon dioxide production plants.

If the chemical production and refining processes are located in Ajos and Veitsiluoto, the transportation of chemicals between units can be managed by truck or by train. Chemicals transported via other logistical means can be e-methane, e-methanol, ammonia, oxygen, and carbon dioxide. Transport between different production units require more detailed profitability evaluations.

The utilization of waste heat generated as a by-product of chemical production in the district heating network depends on the temperature and volume of waste heat. The quality of the heat produced determines the additional investments needed in order for the district heat to be used in Kemi's district heating network.

Bright ideas. Sustainable change.