

VKG tänane tootmine ja arendusprojektid

Indrek Aarna, arendusjuht
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Teemad

1. VKG tutvustus
2. VKG tänane tootmine
3. VKG arendusprojektid
 - Biotoodete tehas
 - CO₂ kinnipüüdmise võimalused

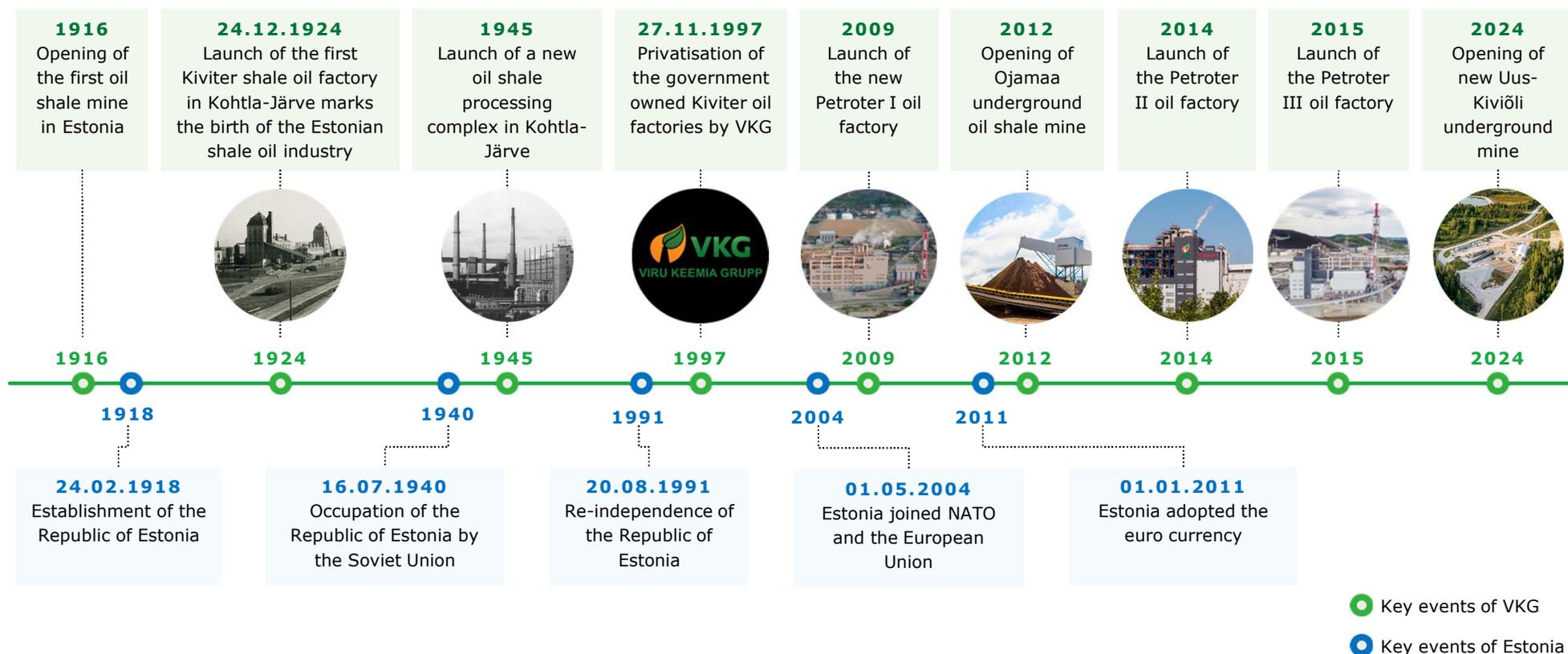


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VKG tutvustus



History of VKG and the Estonian shale oil industry





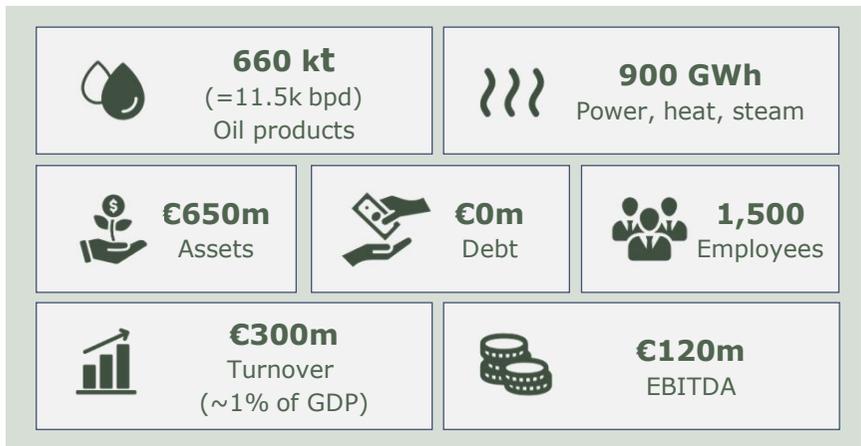
VKG represents 101 years of Estonian shale oil industry

INTRODUCTION TO VKG

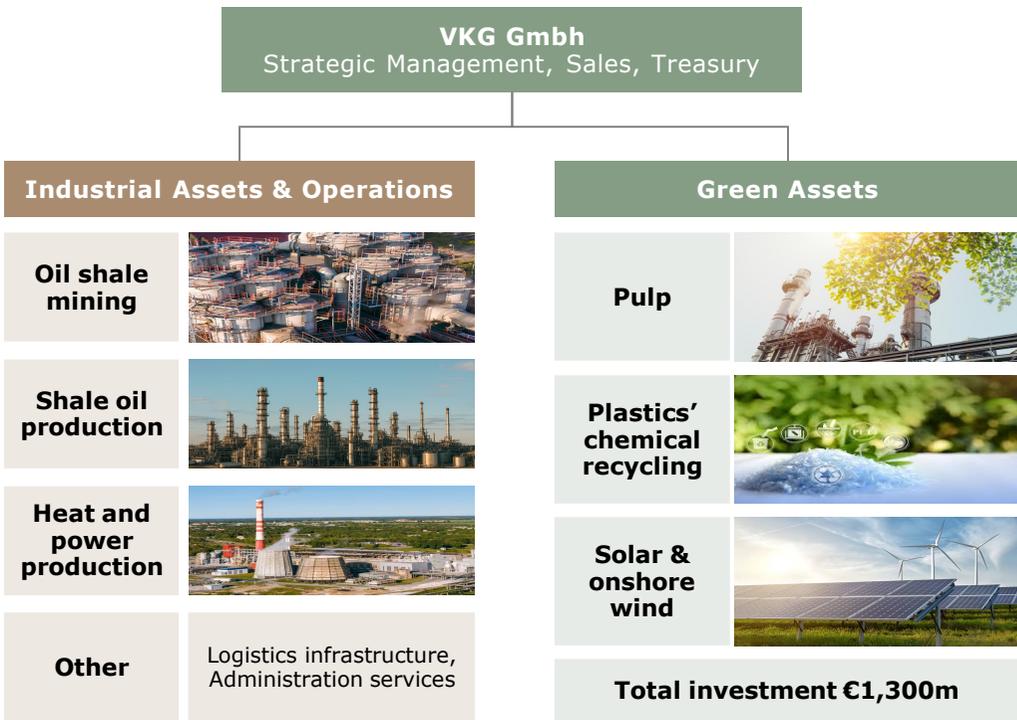
- VKG is one of the largest industrial manufacturing groups in Estonia
- Development and management of large-scale industrial operations in Estonia is our DNA
- In VKG's core business, the value chain consists of three levels: oil shale mining, shale oil production and energy production
- Our product goes mainly to the bunker fuel market, and our clients are global oil traders, e.g.



VKG IN NUMBERS (CONSOLIDATED 2025)



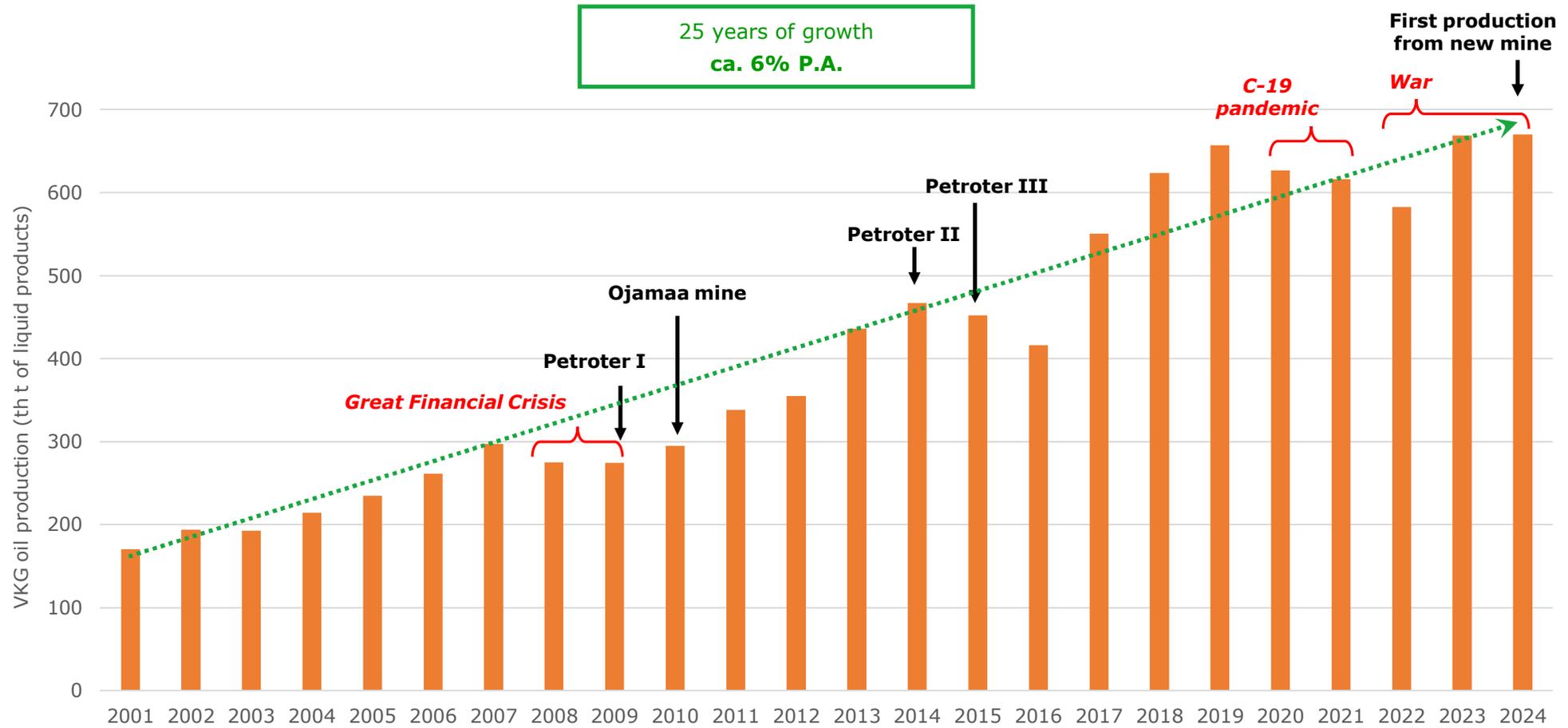
BUSINESS MODEL



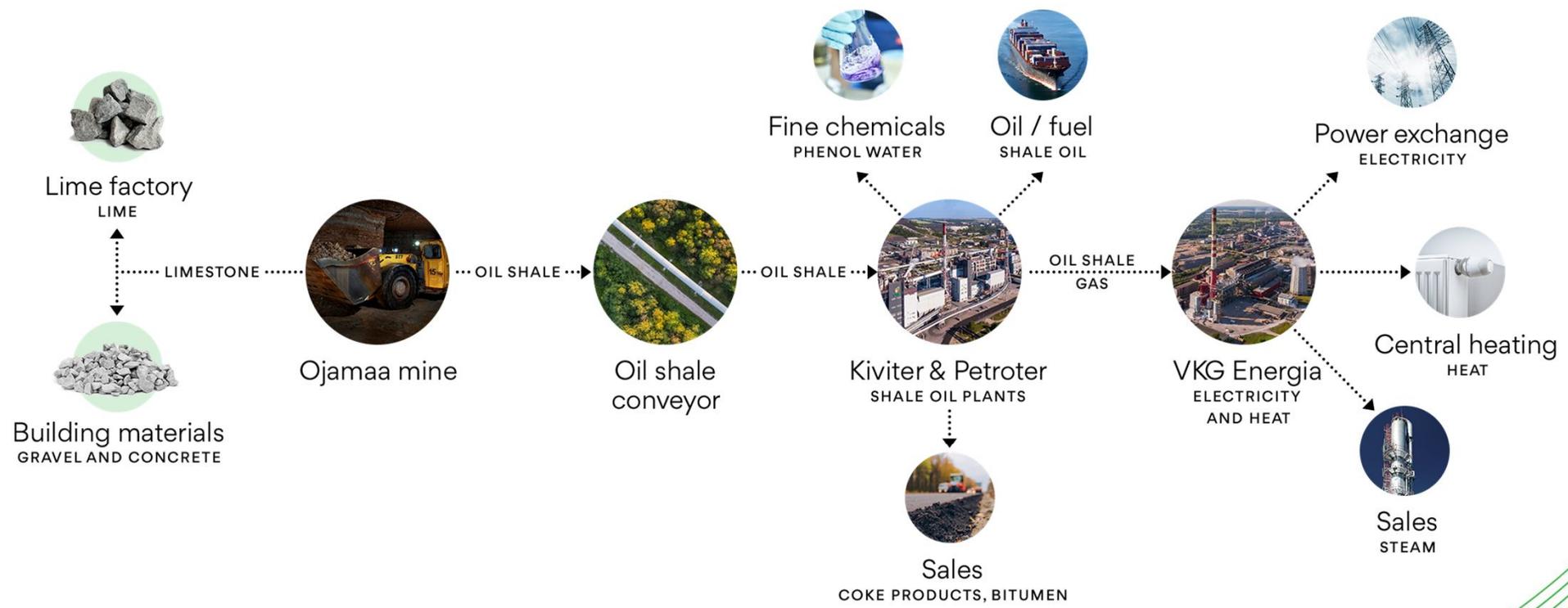
IN TRANSITION TO NON-FOSSIL



VKG outpaces Europe's manufacturing industry growth



VKG value chain

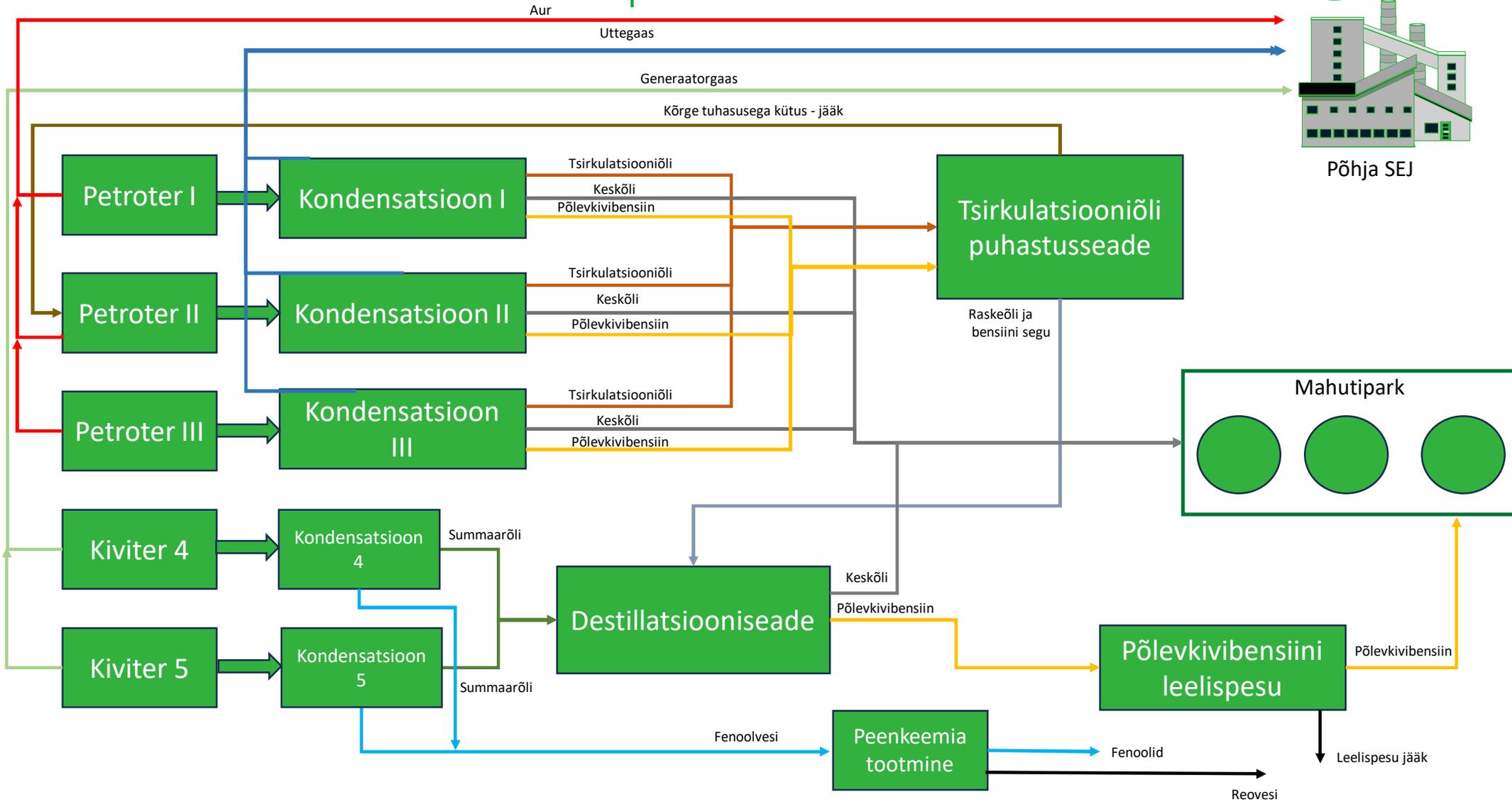


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VKG tänane tootmine



Põlevkiviõli tootmiskompleks



Petroter technology – pyrolysis

Petroter technology – condensation

VKG tänase tootmise arendamine

- Fookuses on Uus-Kiviõli kaevanduse käivitamine
- Uus-Kiviõli kaevandamisõiguste omandamine Enefit-ilt tagab toormekindluse vähemalt 2050. aastani
- VKG ei kavanda investeringuid õlitootmise laiendamisse
- VKG Oil tegeleb tootmise töökindluse ja efektiivsuse suurendamisega ning keskkonnajalajälje vähendamisega

3.1 VKG arendusprojektid:

- Biotoodete tehas



Estonian pulp mill project

500 ktpa BSKP/BHKP pulp mill, delivering high quality products

THE PULP MILL – SUMMARY



1st
most competitive
Nordic producer of
BSKP



500 ktpa
BSKP & BHKP
production volume



2030
Indicative startup
of the mill



€1.3bn
Indicative Capex



Project key facts

PULP MILL

- Requires 2.2 Mm³ of raw material (2/3 pulpwood and 1/3 sawmill chips), which accounts for 60% of currently exported pulpwood and chips volume
- Produces 0.5 mil tonnes of pulp (NBSK/BHKP) + biochemicals (by-products)
- 0.5 TWh of stable green electricity sales (8% of Estonian annual consumption)
- Creates 250 direct + 1 000 in-direct jobs in North-East Estonia
- Fully climate-neutral industry
- Potential to utilize residual heat for district heating (annual consumption of 0.5 TWh in the area whereas our production is 2.2 TWh)

FINANCIAL SNAPSHOT

- Indicative Capex € 1 270m
- Production volume 500 ktpa
- Indicative sales price 700-830 €/t

KEY STRENGTHS

- Growing demand for sustainable packaging
- Pulpwood and raw water availability
- Local community support
- Inline with EU climate policy goals
- Existing infrastructure in place (railway connection, highway access, freshwater supply)



Strong support from key stakeholders in Estonia

Agreements demonstrate strong national, local and industrial support for the project

<p>1</p> <h3>Estonian Government</h3>	<p>2</p> <h3>The Lügause local government</h3>	<p>3</p> <h3>State-owned forest company RMK</h3>	<p>4</p> <h3>Estonian Private Forest Union</h3>
<ul style="list-style-type: none">▪ MoU signed on October 1, 2025▪ Government policy to reduce the export of unprocessed wood and promote domestic industry	<ul style="list-style-type: none">▪ Spatial plan approved on May 29, 2025▪ Minimising adverse effects on the natural and human environment	<ul style="list-style-type: none">▪ 10-year wood supply agreement signed in 2025▪ In 2024 RMK stopped sale of unprocessed pulpwood for export	<ul style="list-style-type: none">▪ MoU signed on October 6, 2025▪ Supporting the establishment of a domestic processor capable of utilizing small-diameter pulpwood



Project located in Lügánuse - “VKG territory”

Well connected to main transportation hubs with access to abundant raw material and water supply. VKG has been present in the locality for over 100 years

PROJECT PULP MILL LOCATION



Source: VKG and public sources



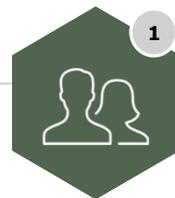


What VKG is looking for

A strategic partner to co-invest in the pulp mill project and lead the project in its next development phase

CELLULOSE INDUSTRY KNOW-HOW

VKG seeks a reputable strategic partner that would add relevant **cellulose know-how** to VKG's deep local industrial experience to drive the pulp mill project into the next phase of development (engineering)



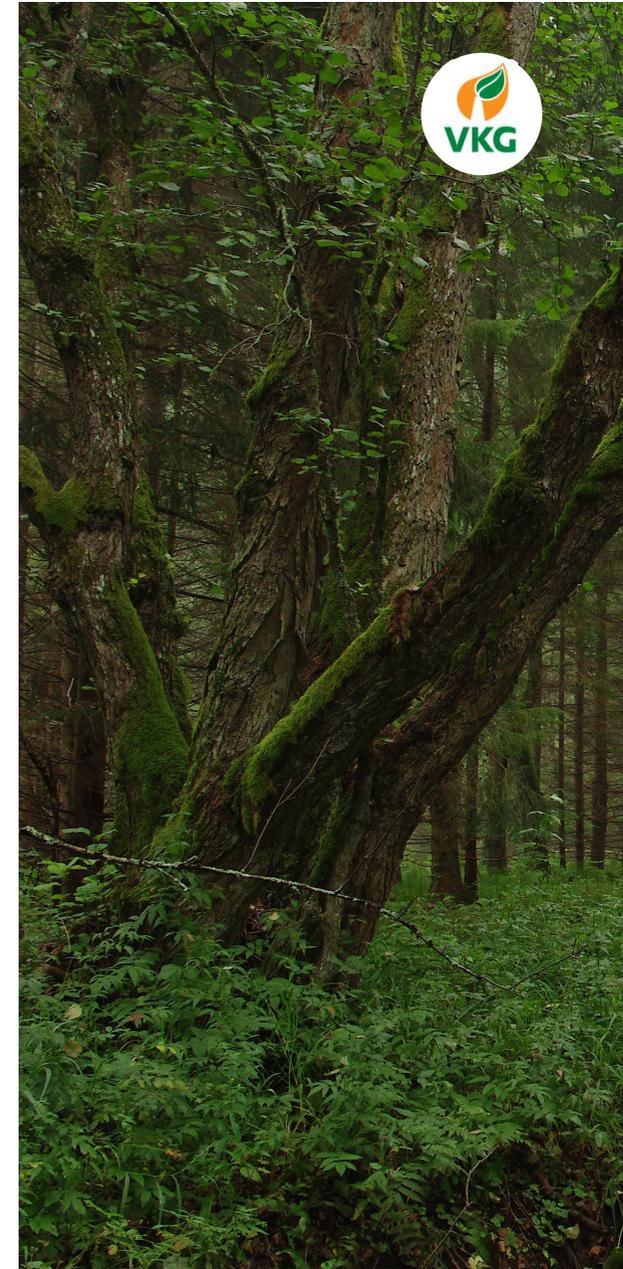
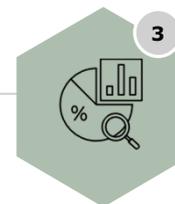
CAPITAL INVESTMENT

VKG seeks to raise capital for the next phase of the project (engineering)



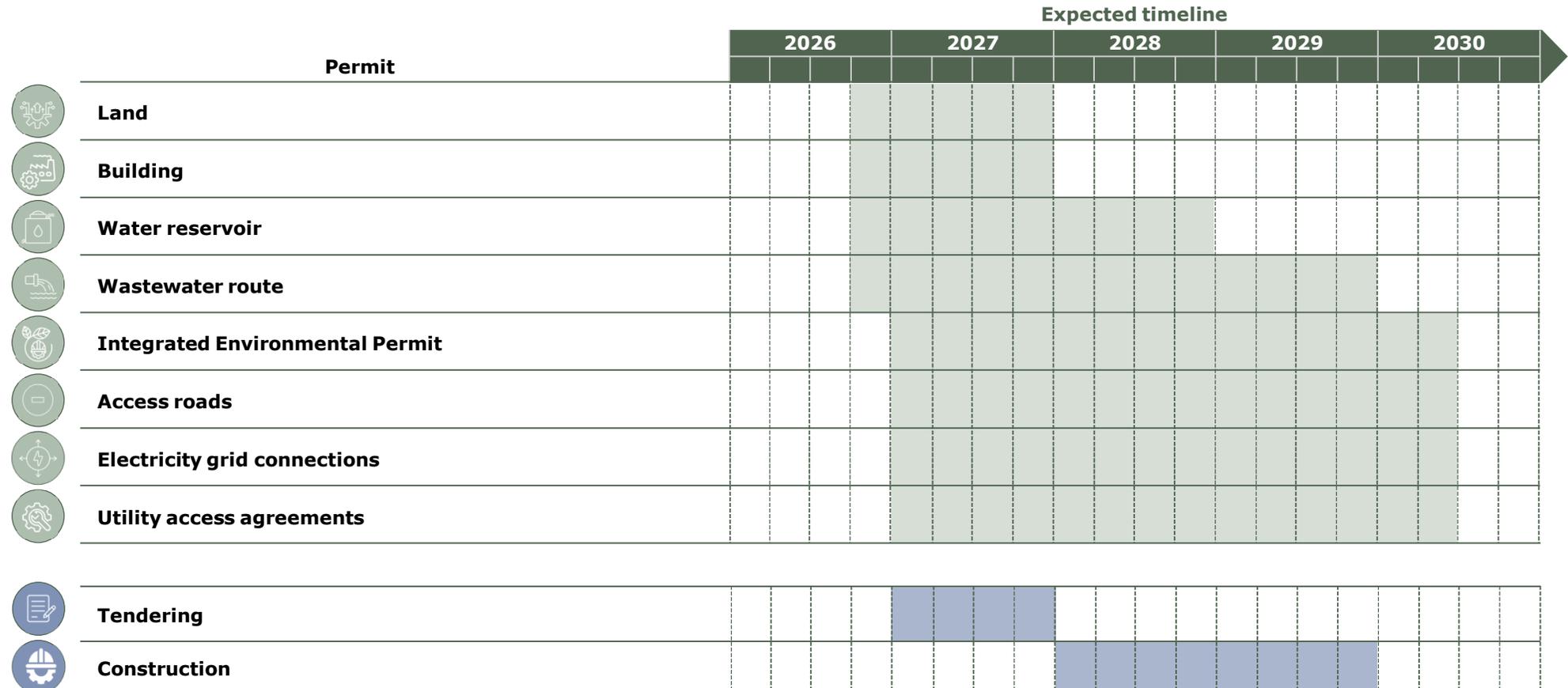
ENGINEERING PROJECT SUPPORT

VKG seeks an industrial partner who would **provide technical support and pulp industry expertise** in developing, constructing, and operating the pulp mill project



Pathway to full project permitting

Clear plan to obtain all the remaining required permits



Source: VKG and public sources

3.2 VKG arendusprojektid:

- CO₂ kinnipüüdmine



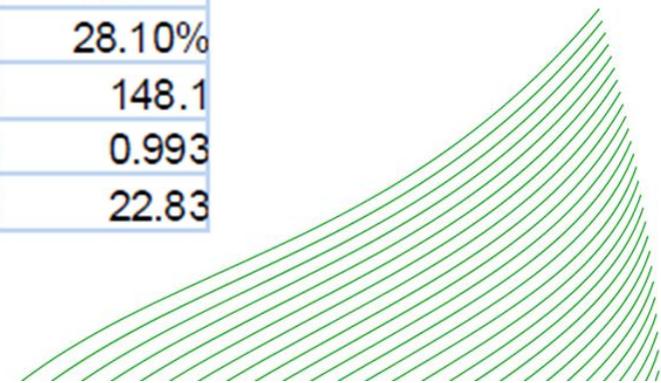
CO₂ emissions

CO₂ emissions sources:

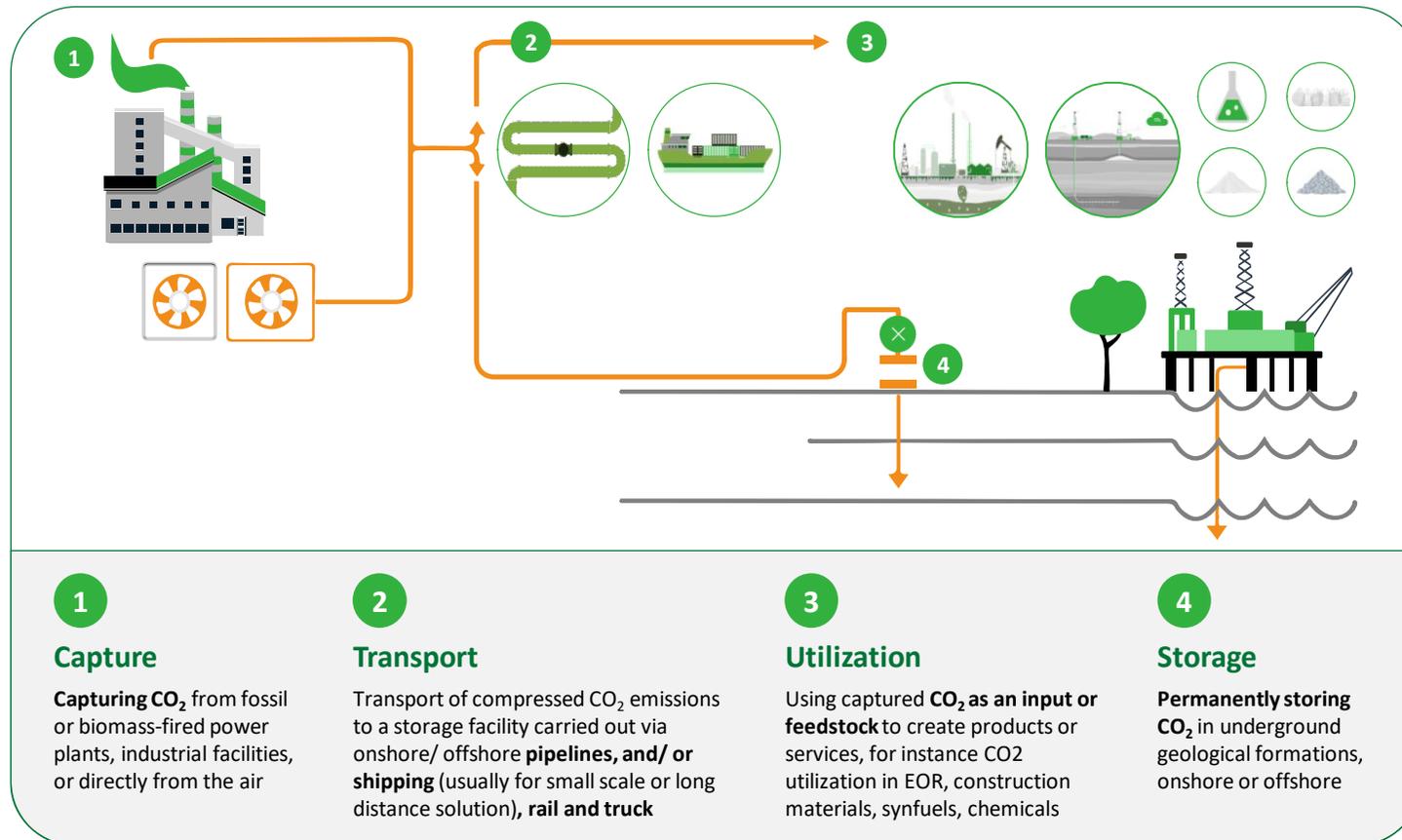
- Petroter oil production plants each emits annually ca 230 th tonnes
- VKG power plants combusts pyrolysis gas and emits annually ca 600 th tonnes

Flue gas composition:

		Petroter 1	Petroter 2	Petroter 3	Avg
O₂	%	1.70%	1.80%	1.60%	1.70%
CO₂	%	19.20%	18.50%	19.70%	19.13%
H₂O	%	27.50%	27.60%	29.20%	28.10%
FG Temp	C	147	147.5	149.8	148.1
Duct pressure	bara	0.992	0.992	0.995	0.993
Vol flow	Nm³/s	19.98	24.29	24.23	22.83



Carbon capture, utilization and storage opportunities



1 Capture

Capturing CO₂ from fossil or biomass-fired power plants, industrial facilities, or directly from the air

2 Transport

Transport of compressed CO₂ emissions to a storage facility carried out via onshore/ offshore **pipelines, and/ or shipping** (usually for small scale or long distance solution), **rail and truck**

3 Utilization

Using captured CO₂ as an **input or feedstock** to create products or services, for instance CO₂ utilization in EOR, construction materials, syngases, chemicals

4 Storage

Permanently storing CO₂ in underground geological formations, onshore or offshore

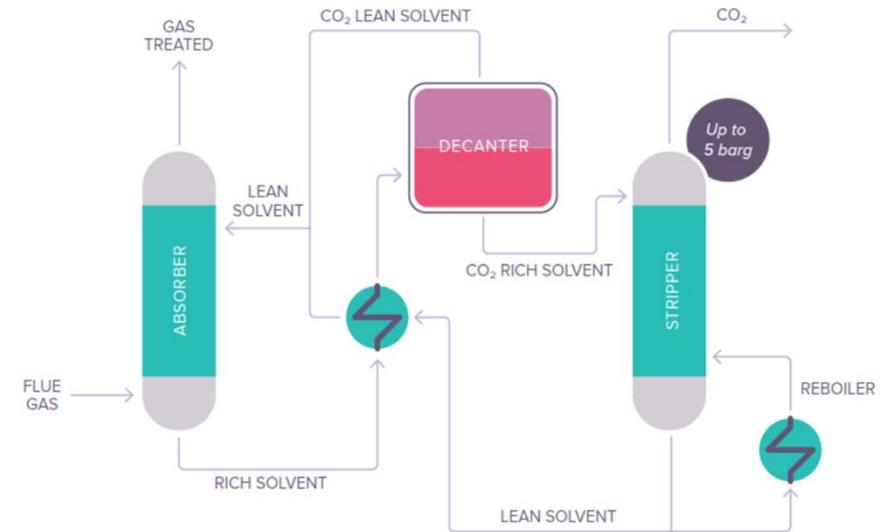
Carbon can be captured directly from the air (DAC) or at point sources, for instance, at power generation or industrial facilities that use either fossil fuels or biomass for fuel

If not being used on-site, the captured CO₂ is compressed and transported by pipeline, ship, rail or truck to be used in a range of applications, or injected into deep geological formations

1. CO₂ not from point source is referred to as DAC (Direct Air Capture)

Amiinilahustega suitsugaaside pesemise lahendus

- Hetkel enim kasutatud lahendus;
- Suitsugaasid peavad olema väga puhtad (madalad NO_x, SO_x ja tolmu sisaldused) või tuleb täiendavalt paigaldada suitsugaaside eelpuhastuse seadmed (*pre-treatment*);
- Tööpõhimõte:
 - Suitsugaasid tuleb jahutada 40-50°C-ni (Petorterte suitsugaaside temperatuur on ca 150°C).
 - Edasi suunatakse suitsugaasid absorptsioonikolonni, kus neid pestakse amiinilahusega, kus CO₂ seotakse amiinidega:
$$\text{RNH}_2 + \text{CO}_2 \leftrightarrow \text{RNHCOO}^- + \text{H}^+$$
 - Kolonni ülaosast väljuvatest suitsugaasidest on 90-95%-i CO₂ eraldatud;
 - Sõltuvalt suitsugaaside puhtusest ja amiinide lagunemisastmest võivad lahkuvad gaasid sisaldada mittesoovitavaidprodukte (erinevad lämmastikuühendid ja amiinid). Sõltuvalt ühendite sisaldusest võib olla vajadus nende gaaside täiendava puhastuse järele (*post-treatment*).
 - Kolonni allosast väljub CO₂-ga rikastatud amiinilahus, mida on vaja CO₂ eraldamiseks (desorptsiooniks) soojendada 100-120°C-ni. CO₂ eraldamine toimub teises kolonnis, mille ülevalt eraldub puhas CO₂
 - Kolonni allosast väljub regenereeritud amiinilahus, mis suunatakse peale jahutamist uuesti esimesse kolonni.
- Erinevad firmad kasutavad oma patenteeritud amiinilahust;
- Eraldatud puhta CO₂ voo edasine käitlemine sõltub selle kasutuse või utiliseerimise lahendusest. Enamasti CO₂ transpordiks ja kasutuseks gaas komprimeeritakse või veeldatakse.

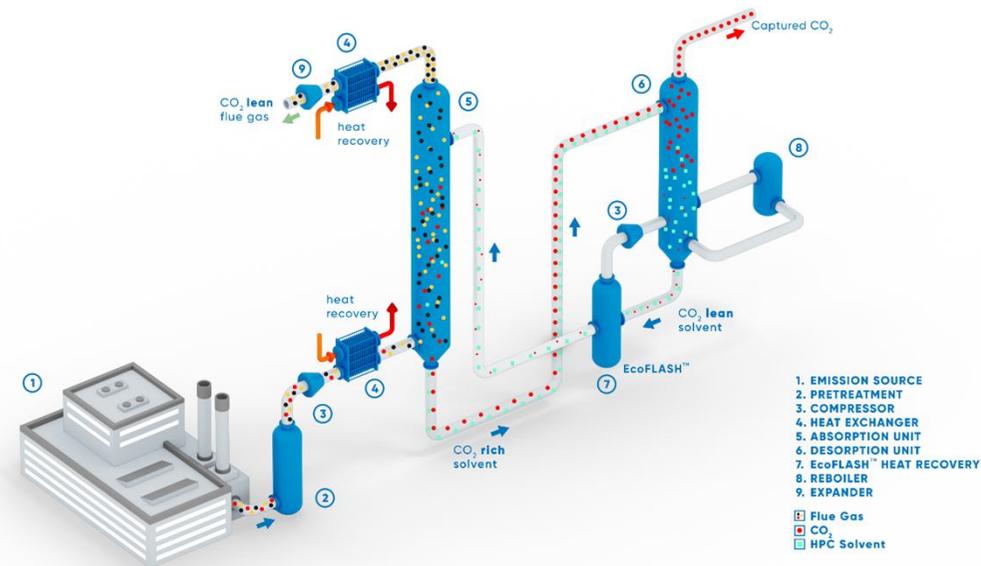


Tehnoloogiapakkujad:

- Shell/Technip Energies (NED/FRA)
- BASF (GER)
- Linde Engineering (GER)
- Axens (FRA)
- Andritz (AUT)
- GEA (GER)
- Mitsubishi Heavy Industries (JPN)
- Fluor (NED)
- SLB Capturi (NOR)
- Tonexus (CHN)
- Air Liquide (FRA)

Kuuma kaaliumkarbonaadi lahusega (HPC) suitsugaaside pesemise lahendus

- Esimeste tööstuslike tehasteni arendatud lahendus.
- Suitsugaasid ei pea olema nii puhtad kui amiinipesu lahendusi korral, kuid Petroter tehaste suitsugaaside jaoks on vaja kindlasti eeltötlust.
- Tööpõhimõte:
 - Suitsugaasid tuleb komprimeerida rõhule 20-30 baari (Petroter suitsugaaside korral 5,3 baarini) ja jahutada 80-100°C-ni.
 - Kõrgel rõhul suitsugaasid suunatakse absorptsioonikoloni, kus CO₂ seotakse kaaliumkarbonaadiga:
$$K_2CO_3 + CO_2 + H_2O \leftrightarrow 2KHCO_3$$
 - Koloni ülaosast väljuvad puhastatud suitsugaasid, mis protsessi tulemusel soojenevad ja millest on võimalik soojusvahetis jääsoojus eraldada. Kõrgel rõhul olevad puhastatud suitsugaasid saab lasta läbi turbiini ja toota elektrit.
 - Koloni allasast väljuv lahus suunatakse desorptsioonikoloni, kus toimub alandatud rõhul (1-3 baari) ja madalrõhulise auru abil CO₂ desorptsioon.
 - Puhas CO₂ eraldub koloni ülaosast ja ei vaja täiendavat puhastamist. Koloni allasast väljub kaaliumkarbonaadilahus, mis soojendatakse ja suunatakse tagasi absorptsioonikoloni.
- Eraldatud puhta CO₂ voo edasine käitlemine sõltub selle kasutuse või utiliseerimise lahendusest. Enamasti CO₂ transpordiks ja kasutuseks gaas komprimeeritakse või veeldatakse.



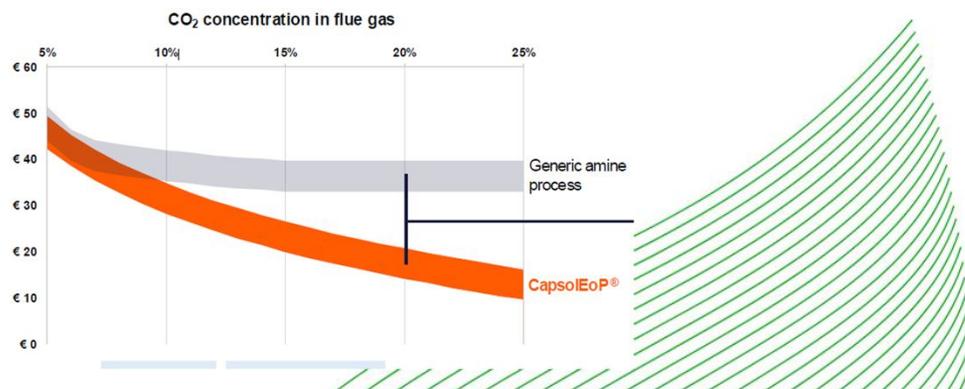
Tehnoloogiapakkujad:

- Capsol Technologies (NOR)
- Andritz (AUT)
- Catacarb (USA)

Absorptsiooni põhiste lahenduste võrdlus

Näitaja	Amiinilahusega absorptsioon	Kuuma kaaliumkarbonaadi lahusega absorptsioon
Tehnoloogilise valmisoleku tase	TRL 9	TRL 8
Suitsugaaside puhtus	Kõrge	Keskmine
Energiakulu	Kõrge	Keskmine
Lahuse keskkonnamõju	Kõrge	Madal
CAPEX	ca 100 €/t _{CO2}	ca 100 €/t _{CO2}

Kuna HPC tehnoloogia muutub efektiivsemaks kõrge CO₂ kontsentratsiooniga suitsugaaside puhastamisel ja Petroter tehaste suitsugaasides on CO₂ sisaldus ca 20%, siis **peaks VKG eelistama HPC tehnoloogiat.**



Thank you!

