Energy Storage Day 2023

‘Innovaties in Energieopslag’

11-10-2023

Programma Energy Storage Day 2023

Programma:

1. Opening Energy Storage Day

2. Warmteopslag
Energy Nest – Carlijn Lahaye
Novar – Bas Bolomey | Theo Venema

3. Moleculenopslag
H2 Storage - André Molengraaf
Nobian - Louwrens op de Beek / Ellen Holmen

4. Techtalk
BCC-NL - Dirk van Asseldonk
Stedin – Angela Hulst
TNO – Joris Korenneef

5. Elektriciteitsopslag
Aquabattery - Janneke Tjon Pian Gi-Stuijfzand
Corre Energy - Corinne Faassen

6. Afronding

Energy Storage NL POWERED BY DUTCH TECHNOLOGY

Opening Energy Storage NL

Wie is Energy Storage NL?

- Energy Storage is de vertegenwoordiger van de **Nederlandse energieopslagsector**, onderdeel van FME.
- Uitgegroeid tot meer dan **170 leden**, denk aan **fabrikanten** (elektriciteits-, warme en moleculenopslag), **netbeheerders, energieleveranciers, kennisinstellingen**, **financiers**, etc.).

Belangenbehartiger

Energy Storage NL behartigt de belangen van haar leden bij de lokale, nationale, internationale overheid en bij aanverwante stakeholders (netbeheerders, ACM, etc.).

Netwerker

Energy Storage NL treedt op als verbinder, matchmaker en promotor zowel binnen als buiten de Nederlandse energieopslagsector.

Kenniscentrum

Energy Storage NL is de inhoudelijke expert op het gebied van energieopslag en conversietechnologie in Nederland.

Energy Storage NL POWERED BY DUTCH TECHNOLOGY

WAT DOET ENERGY STORAGE NL?

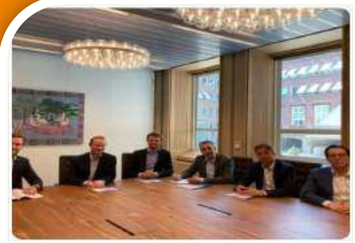
Belangenbehartiging

Kabinet wil honderden miljoenen investeren in energieopslag!

Verkiezingsinzet Energy Storage NL: opslag cruciaal voor duurzaam, betaalbaar en stabiel energiesysteem!

Energy Storage NL verwelkomt aanbevelingen EU-commissie rondom energieopslag

Tweede Kamer neemt Nationaal Actieplan Energieopslag in ontvangst



Routekaart Energieopslag zet belangrijke stap voor de energietransitie

ACM

ACM: korting op transporttarieven voor batterijen die congestie verminderen

Netwerk

Netwerkbijeenkomst ESNL: businesscase opslag centraal

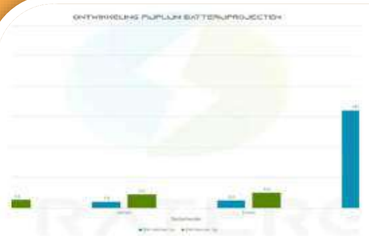
Energy Storage NL POWERED BY DUTCH TECHNOLOG

ESNL met meer dan 50 leden gegroeid in 2023

Leden Energy Storage NL praten mee over routekaart Energieopslag

Kijk het webinar grootschalige batterijsystemen en afnamenetcongestie terug

Energy Storage NL en Battery Competence Cluster – NL gaan samenwerken!



Jan-Willem Zwang duidt groei batterijaanvragen in online ledenbijeenkomst

Kenniscentrum

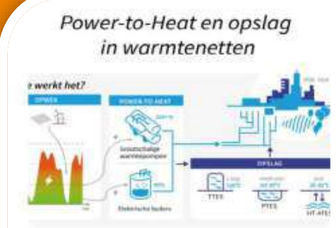
Grote batterijen kunnen Nederlandse samenleving €2 miljard per jaar besparen

PGS 37-1 Veiligheidskader voor Lithium-Ion opslagsystemen gepubliceerd

Energy Storage NL en Connectr werken aan landelijke proeftuin Energieopslag

Markt voor energieopslag groeit explosief!

Energy Storage NL start werkgroep moleculenopslag



Groot potentieel voor warmteopslag in warmtenetten

Thermal storage and Industrial heat

Vakbeurs Energie, 11 oktober 2023 Carlijn Lahaye

ENERGYNEST is a leading thermal storage provider: We are market tested and well backed

VAKBEURS ENERGIE
10-11-12 OKT. 2023 BRABANTHALLEN

Projects in execution with major industrial players

Partnering with major industrial suppliers and engineering companies

Majority shareholder, providing capital for fully financed, turnkey ThermalBattery™ project solutions

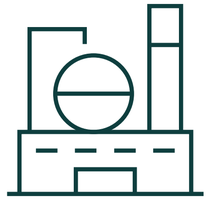
We are an award-winning scale-up company based on a strong thermal storage technology development

- Founded in 2011
- Offices in Norway, Spain, Germany and the Netherlands
- 40 employees
- Received biggest single investment to date into a thermal energy storage company: EUR 110m by Infracapital (M&G)
- Established ThermalBattery™ module fabrication hub in Rotterdam offering favorable logistics for EU and global deliveries
- First commercial order in 2019 with 3 projects up-to-date: 1 in operation, 1 in commissioning and 1 in execution

Current energy reality creates demand for new green, secure heat offers for industry

Energy costs are volatile and are expected to remain elevated in the coming years

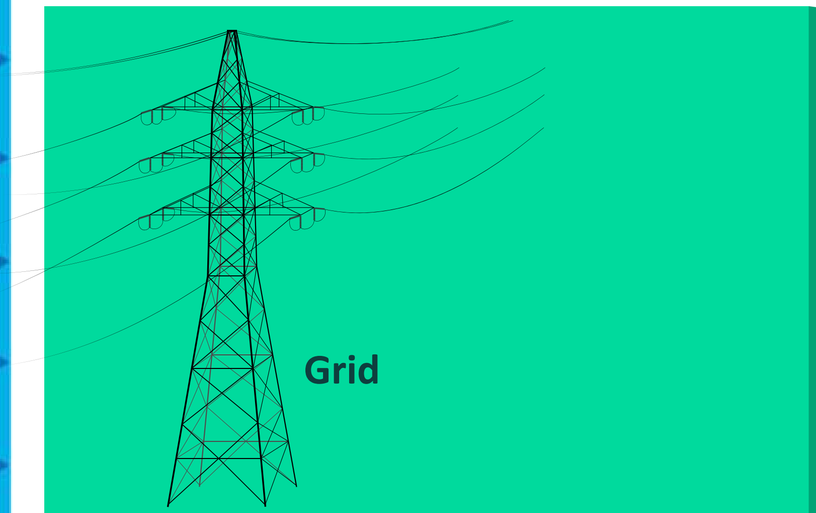
Pressure to decarbonise, with customers, investors, governments demanding real action

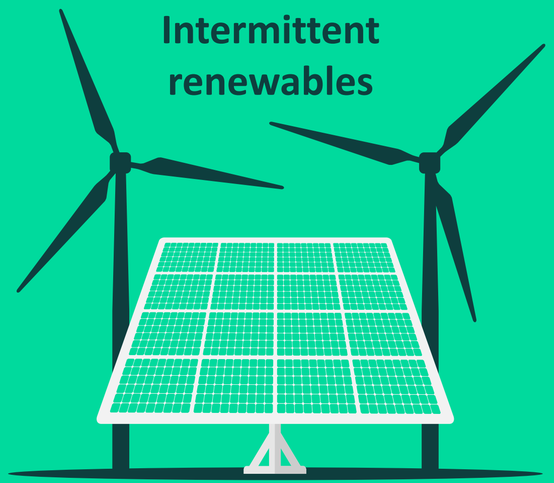


Reliable operation and production continue to be essential

Energy and efficiency solutions need to be future-proof, cost-competitive, and no regrets

Electrification of industry: We provide industrial steam from renewable electricity





Timeshift

- ENERGYNEST ThermalBattery™ is charged when electricity is cheap
- Steam is discharged on demand
- Steam is available 24/7

Flex services ThermalBattery™

1. Day Ahead market

The Day Ahead market ensures a stable revenue stream as it is highly liquid and predictable due to bids being placed well in advance. This predictability offers a significant level of certainty for energy arbitrage, as price volatility is anticipated well ahead of time

2. Intraday market

The Intraday market is a more volatile market than the Day Ahead market. This comes with higher profits, but also a higher margin of error.

3. aFRR market

The aFRR market provides stable revenue. As this market transitions into a 4-hour market, longer duration storages will keep an advantage over small storage batteries. The ThermalBattery™ can be used for downward regulation of the grid (absorb surplus electricity) or upward regulation (use less electricity than scheduled).

ENERGYNEST creates value in different applications

Electrification

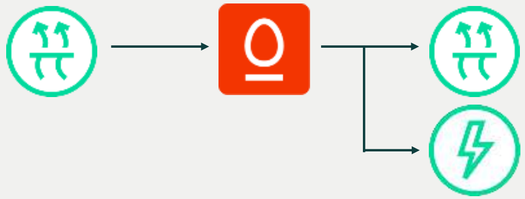
Power-2-heat for industry

- Provision of high grade “green” steam to manufac-turing or batch processes.
- Flexibly to exploit low-cost electricity to achieve competitive cost.

Chemicals, Paper & Pulp, Food & Beverages, etc.

Waste heat recovery

Capture and time-shift heat

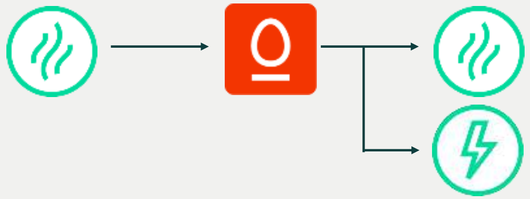


- Effectively recover variable waste heat sources in energy-intensive industries.
- Time-shift delivery and balance energy supply.

Metallurgy, Chemicals, Cements, Petrochemical, etc.

Steam grid balancing

Tailor steam supply to demand

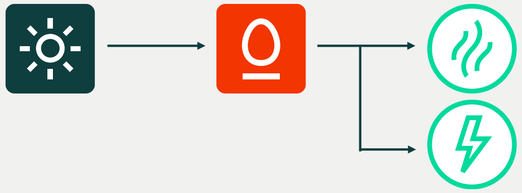


- Integrate directly into plant/cluster steam grid and charge with excess steam.
- Avoid dumping or back-cooling of valuable steam or optimize CHP-plants on site.

Pulp & Paper, Chemicals, Must-run power-plants, CCGTs

Concentrated solar

for 24/7 use on demand



- Concentrated Solar Power (CSP), solar heat for industry.
- Low CAPEX alternative to molten salts storage or oil tanks.

Parabolic trough, Linear Fresnel, etc.

The core of our technology: ThermalBattery™ module – a solid-state high temperature heat storage

Material
Solid-state thermal concrete Heatcrete®
+ Steel piping
+ Frame

Integration
Plug & play standard shipping containers

Process
Temperature up to
427 °C
Pressure up to
100+ bar

Maintenance
No moving parts
Maintenance free
Lifetime
30 years+

Capacity
Up to
2 MWh_{th} (20ft)
Up to
4 MWh_{th} (40ft)

Technology
Piloted in Masdar
Reviewed by DNV and Fichtner

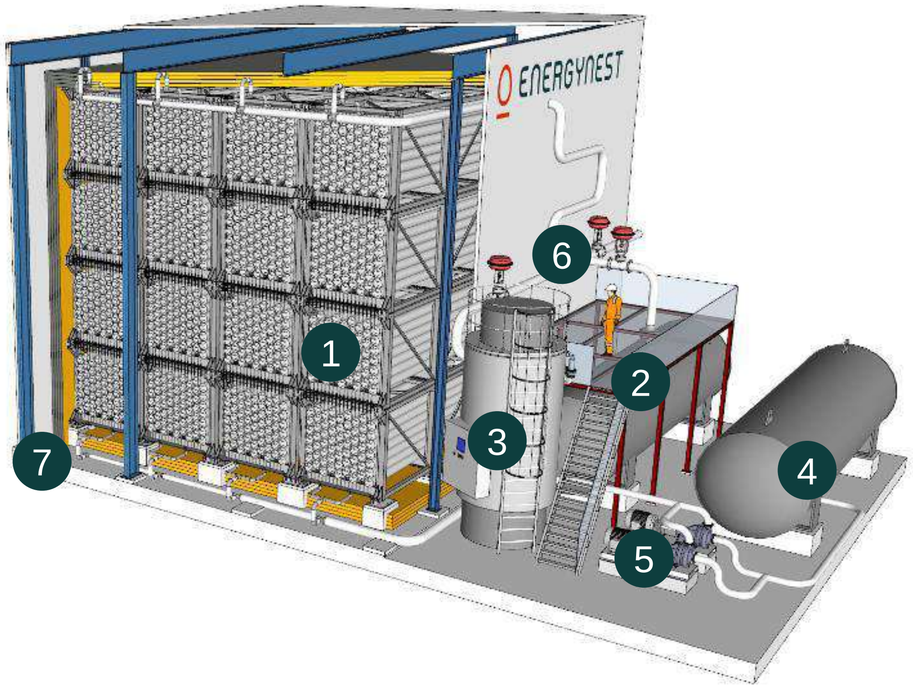
Flexibility
Thermal oil or **steam** as heat transfer fluid

Efficiency
Thermal efficiency
> 95 %
Carbon payback in 2 months

Scalability
Modular system from 3 MWh to
> 1000 MWh

What our steam service offering entails

Illustrative system for factory-scale green heat applications

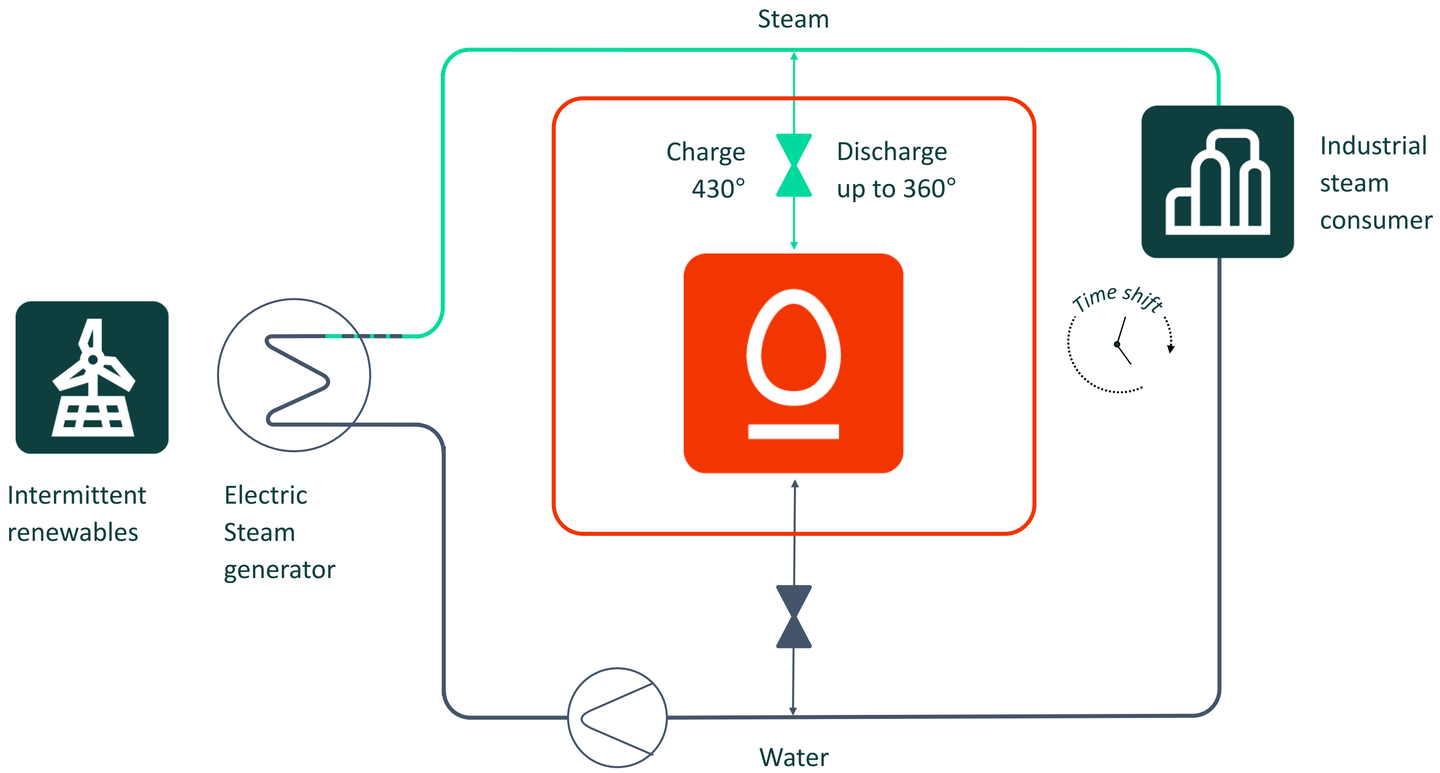


1. **ThermalBattery™ modules** – ENERGYNEST core technology (OEM) – stores thermal energy
2. **Steam/condensate vessel** – Integrated component in steam ThermalBattery™. Stores thermal energy and condensate
3. **Electric boiler** – Converts renewable electricity - from grid or local direct wire - to thermal energy in the form of steam
4. **Feedwater tank** – Buffers steam flow to/from ThermalBattery™ with client steam system
5. **Feedwater pumps** – pumps feedwater from client to ThermalBattery™
6. **Balance of Plant** – Instruments and valves to operate the system and integrate with clients control system
7. **Superstructure & foundation** – Protective and insulative shell, structural support platform for ThermalBattery™
8. **SCADA / EMS** – Interface for control and dispatch of equipment and components


CRAMO


ENERGYNEST
YARA

Example use case:
Cost competitive, secure, green heat from PV and wind



- Energy from PV, wind or power grid
- Continuous heat production through time shifting energy
- Short to long duration storage without degradation
- System response time less than five seconds
- Total system efficiency up to 95%
- 24/7 operations: on demand
- Low maintenance and reliable steam production
- Predictable cost supporting confidence in margins

Establishing a unique track of generating value: our technology is operational today

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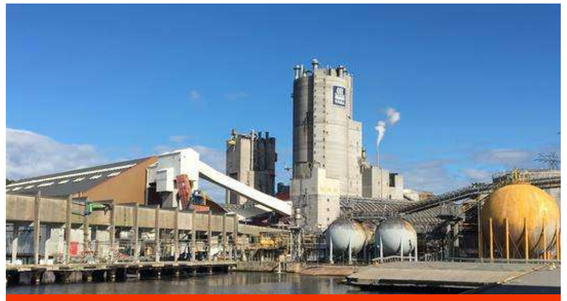

Yara Porsgrunn, Herøya
Mineral fertilizer plant

- Integrated chemical plant with continuous steam demand in multiple processes and auxiliary systems
- Steam generated by CHP-plant and gas-boilers, plus exothermic processes
- 4 MWh ThermalBattery™ balances fluctuations on steam grid and reduces need for dumping excess steam
- Increases electricity production potential for CHP-plant supplying site
- Client can put gas-boilers in cold standby, thereby achieving increased security of supply whilst improving sustainability targets.

Eni S.p.A., Gela
Oil refinery

- Integrates a 3 MWh ThermalBattery™ into a major European refinery, thereby extending production of solar energy beyond sunset
- Renewable steam is provisioned on-demand for onsite consumption and for electricity generation with a CST-heated HTF, day or night
- Reducing fossil fuel consumption across its oil treatment and refinery assets is a key objective for Eni to reach net zero emissions in its upstream business until 2030

Azteq/Avery Dennison, Turnhout
Adhesive manufacturing plant[1]

- The project replaces heat required in manufacturing process from natural gas with renewable solar thermal energy (CST)
- Excess thermal energy will be stored in the TB and can be dispatched upon demand, day or night
- TB allows for deeper reduction of CO_2 emissions and helps the plant meet the company's 2030 sustainability targets and reach net zero by 2050
- Project is developed by solar player Azteq and will be the biggest of its kind in Europe

Pilot, Masdar Institute Solar
Platform (MISP) Abu-Dhabi

- In 2015 ENERGYNEST installed and commissioned a ThermalBattery™ pilot with 1 MWhth capacity at the Masdar Institute Solar Platform (MISP) in Abu Dhabi, UAE
- Construction and interfacing successfully executed within 6 months, followed by a 15-month operating period
- 6,000 hours of cycling with more than 300 cycles operation showed stable and repetitive performance without any signs of degradation of elements

1 This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 859232
Source: ENERGYNEST

Steam grid balancing Yara Porsgrunn

Description: Connected to steam grid at Herøya industrial park in Porsgrunn, Norway, operated by Yara. ThermalBattery™ will balance short-term (minutes) fluctuations in steam supply, utilize excess steam, and increase energy efficiency

Key numbers:

- Charge: 34 barg, 272°C (de-superheated)
- Discharge: 5 barg, 189 °C (dry steam)
- Capacity: 1-5 tonnes per hour (0.7 – 3.5 MW), 5 tonnes (3.5 MWh)
- Design life: 200,000 hours. 462,000 cycles
- Config.: 4 modules + 8.7 m^3 pressure vessel

Status: In operation

CST field + thermal storage

Description: Integrated with concentrating solar thermal (CST) plant to supply green heat to Avery Dennison factory in Turnhout, Belgium. ThermalBattery™ will store solar energy during sunlight hours, dispatch heat after sunset, balance fluctuations from solar field.

Key numbers:

- Charge/discharge: 380/310 °C
- Capacity: 0 – 1.5 MW, 5 MWh
- Design life: 25 years; 18,250 cycles
- Configuration 6 modules, including constant temp. control*

* By-pass within stacks of modules to enable constant outlet temperature

Status: In commissioning

Avery Dennison:
5 MWh_{th} thermal storage integrated into thermal oil loop of CST field

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Get in touch: meet us at stand 6.C023 @ ESNL Pavilion

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ENERGYNEST

novar WarmteStad

Zonthermiepark Dorkwerd

Zonthermiepark Dorkwerd

novar

24.000
Panelen

12
hectare

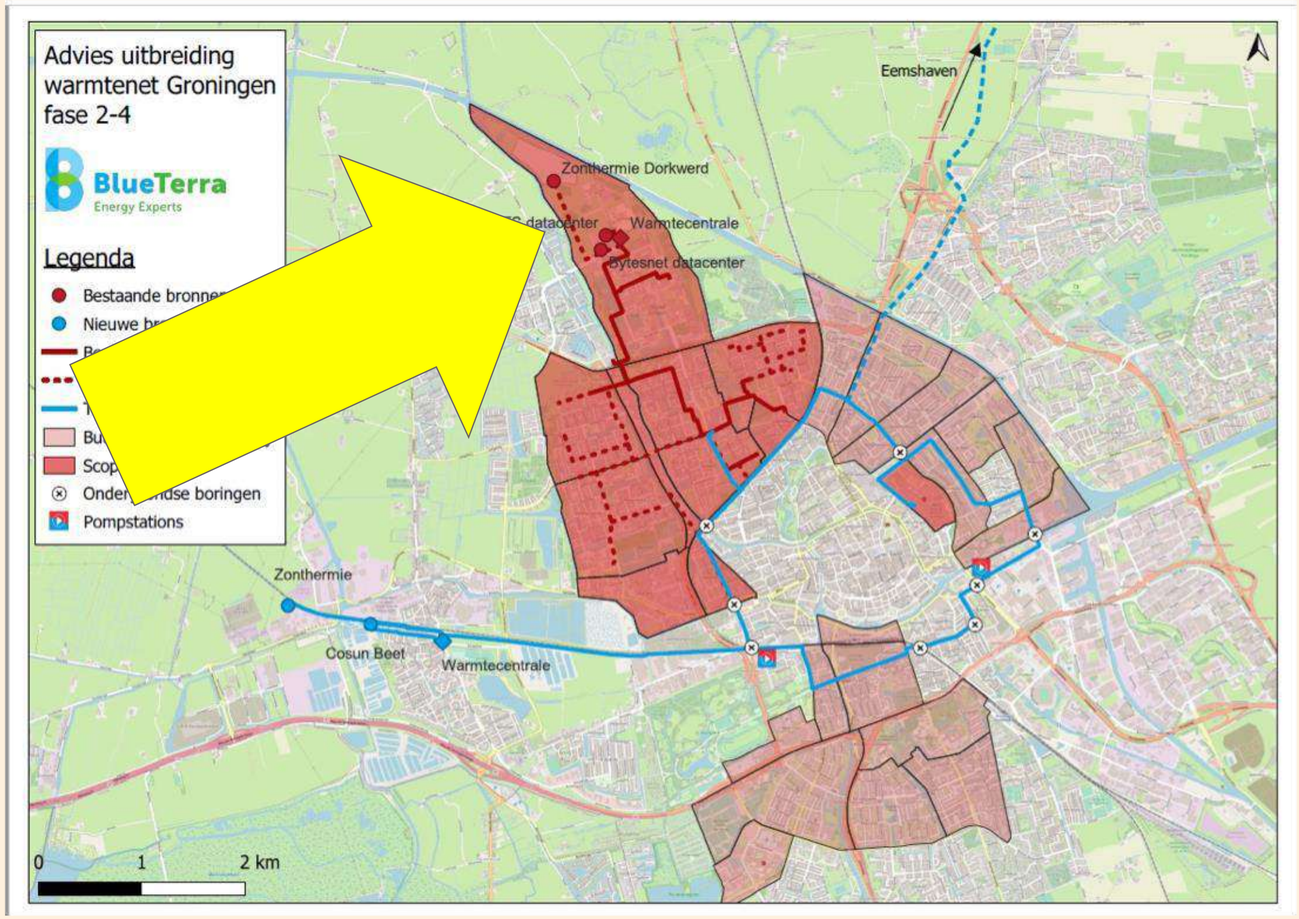
25
GWh/Y

2600
Huizen

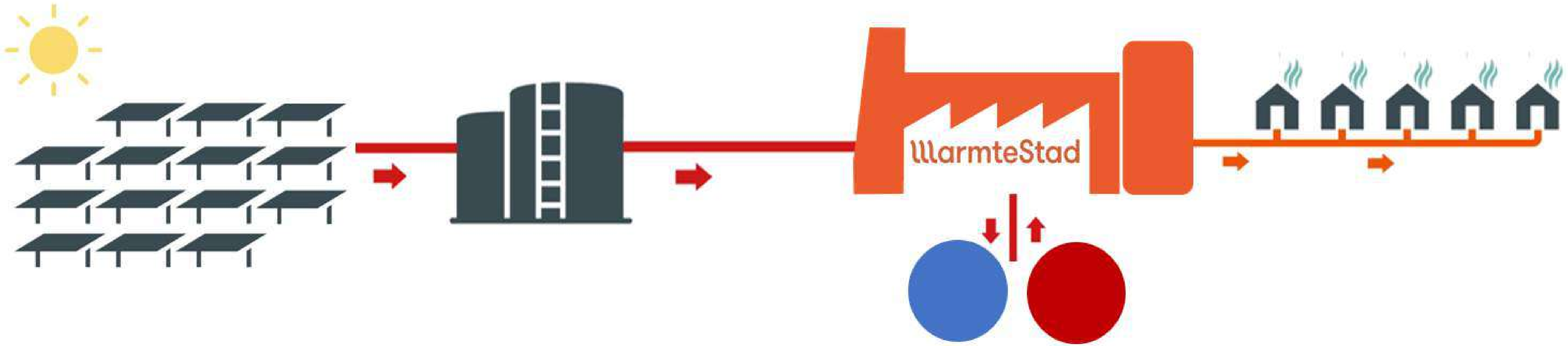
5700 ton
CO2/j

SOLARFIELDS

Onderdeel energiesysteem



Warmteketen



1 24.000 collectoren

2 Opslag

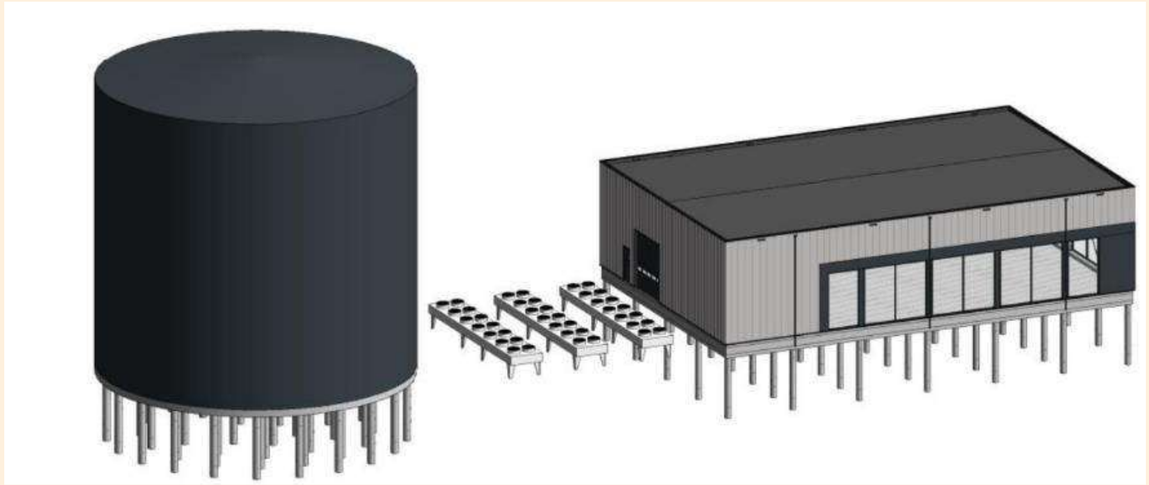
3 warmtecentrale met seizoensopslag

4 Het warmtenet

Twee type opslagsystemen

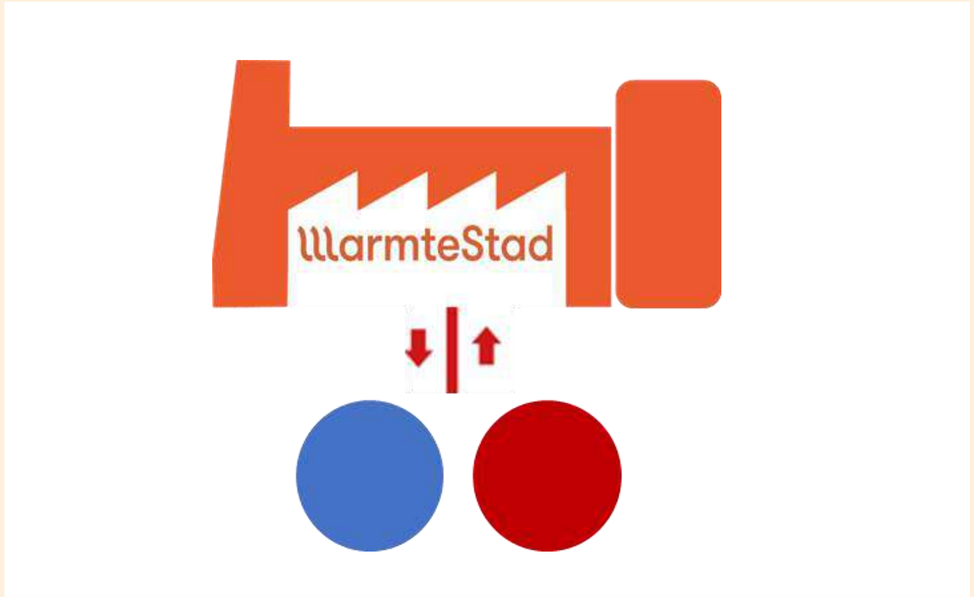
Dag opslag

TES - Novar



Seizoensopslag

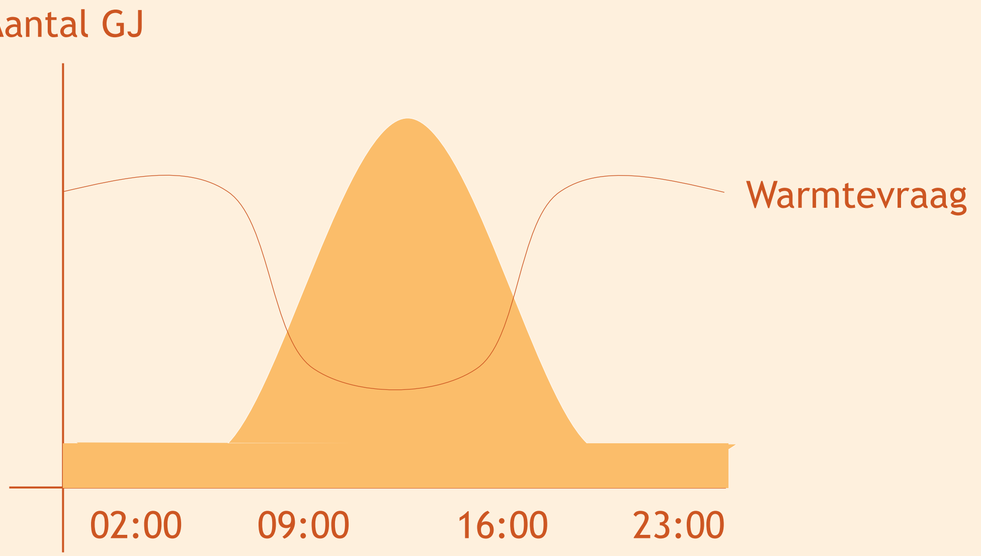
MT - ATES - Warmtestad

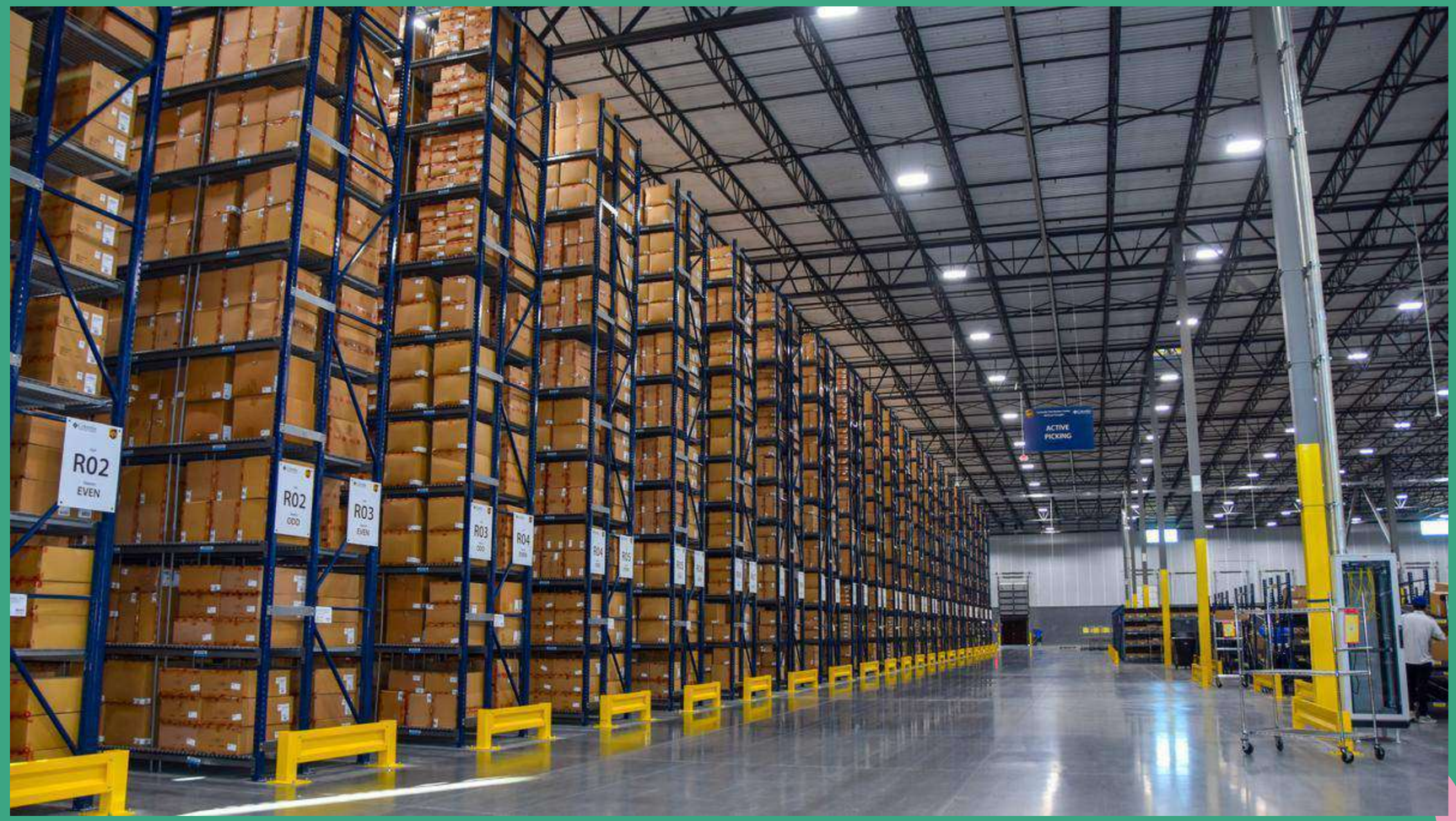


Eigenschappen TES

- 6000 m^3 (23m hoog, 21m diameter) & 3 Compartimenten
- Thermische capaciteit van 374 MWh (11 uur max productie)
- Temperaturen t/m 90 °C
- 240 uur in winter van 90°C naar 40 °C

Benodigd om vraag en aanbod curve over 24 uur te verdelen



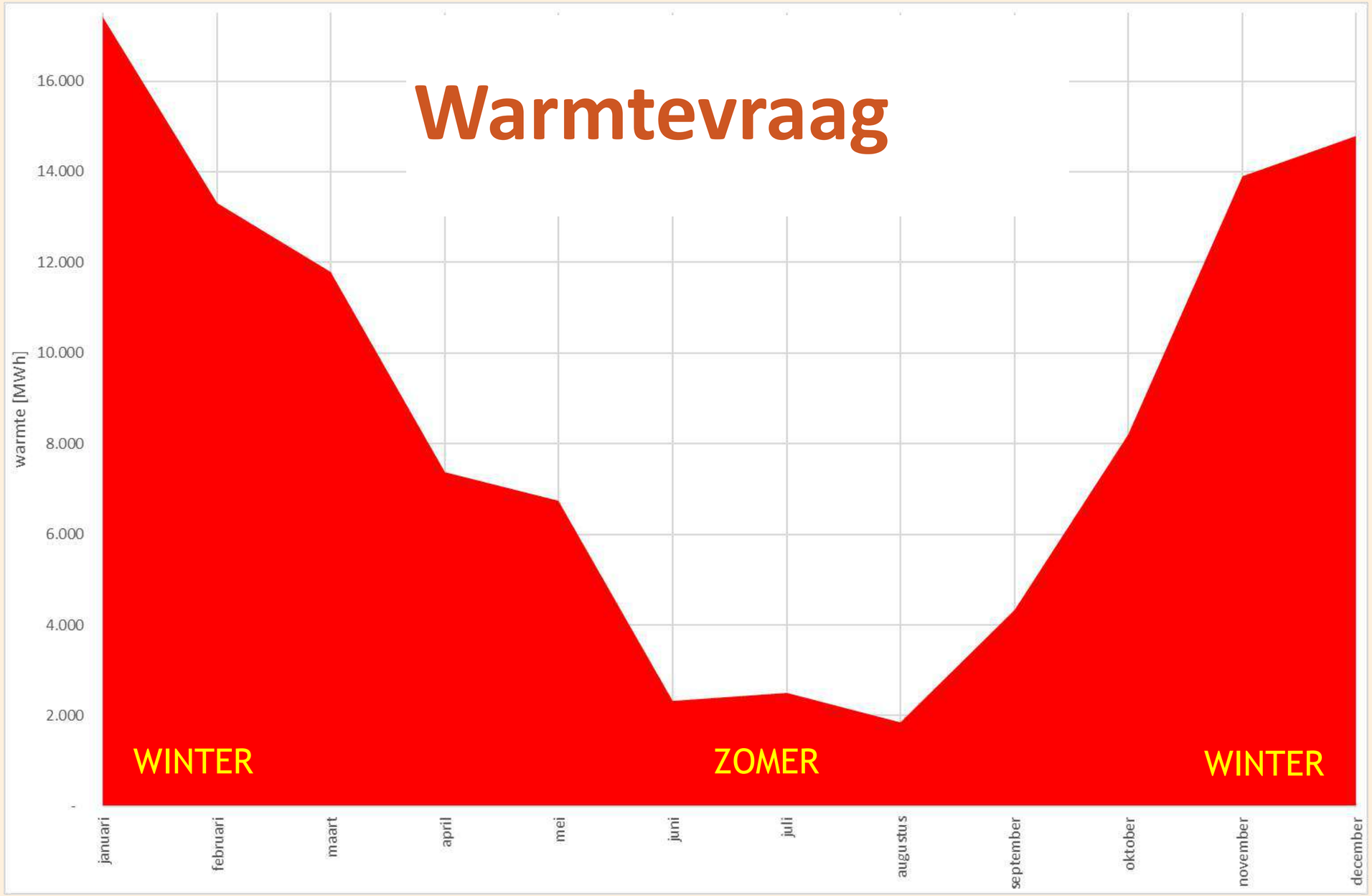


Seizoensopslag warmte : ATES

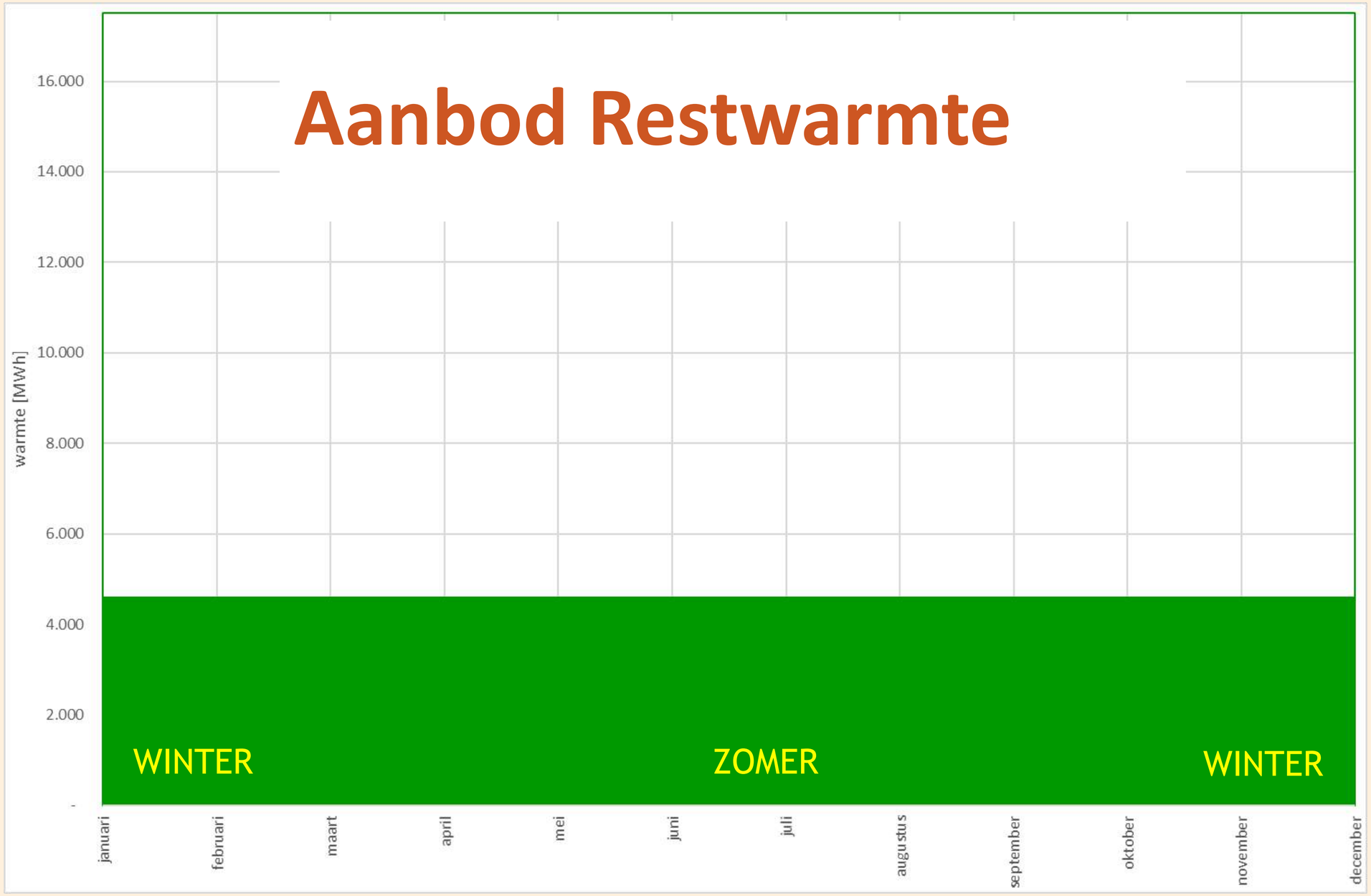
1 oktober 2023

WarmteStad

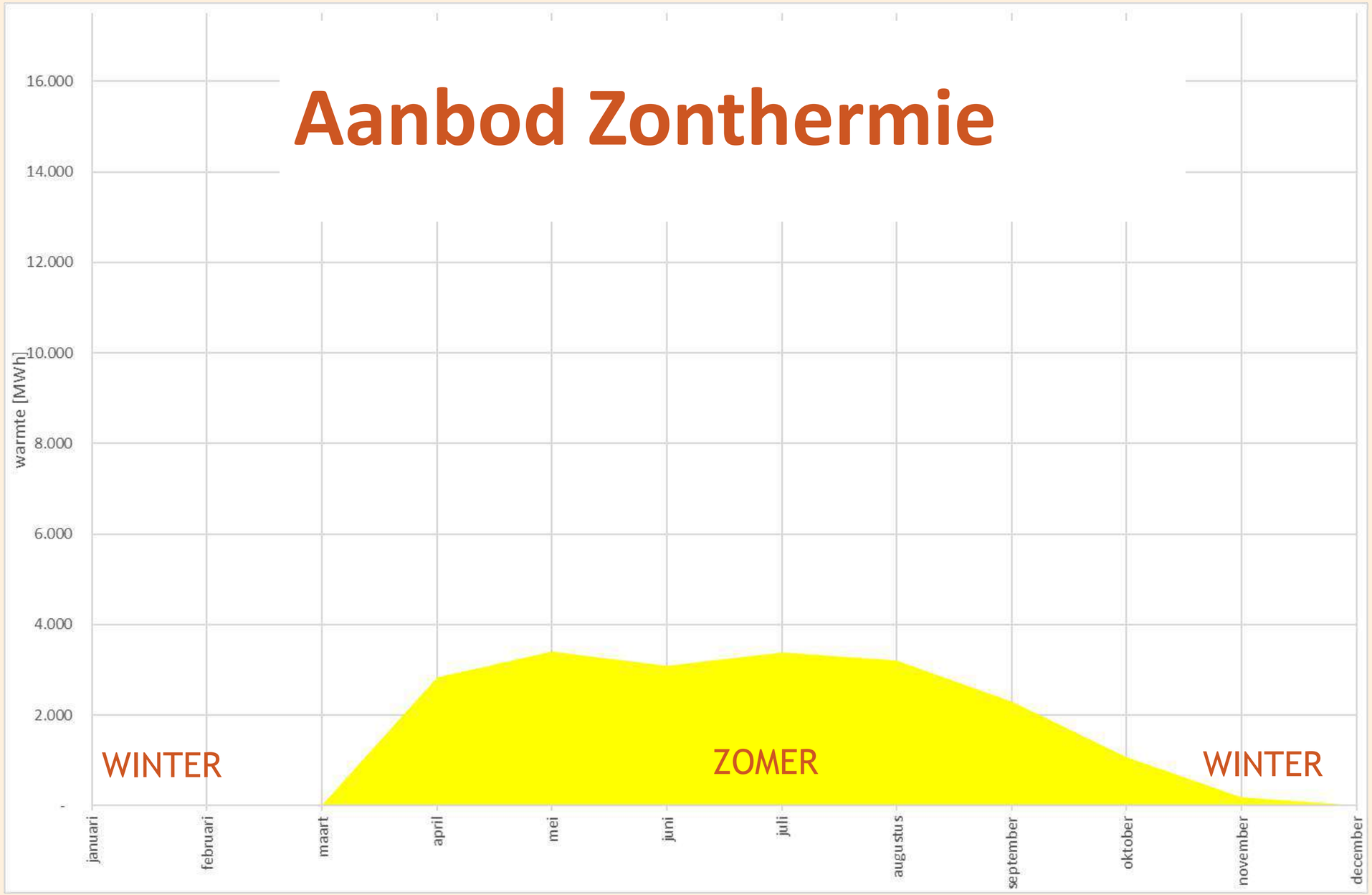
Warmtevraag



Aanbod Restwarmte

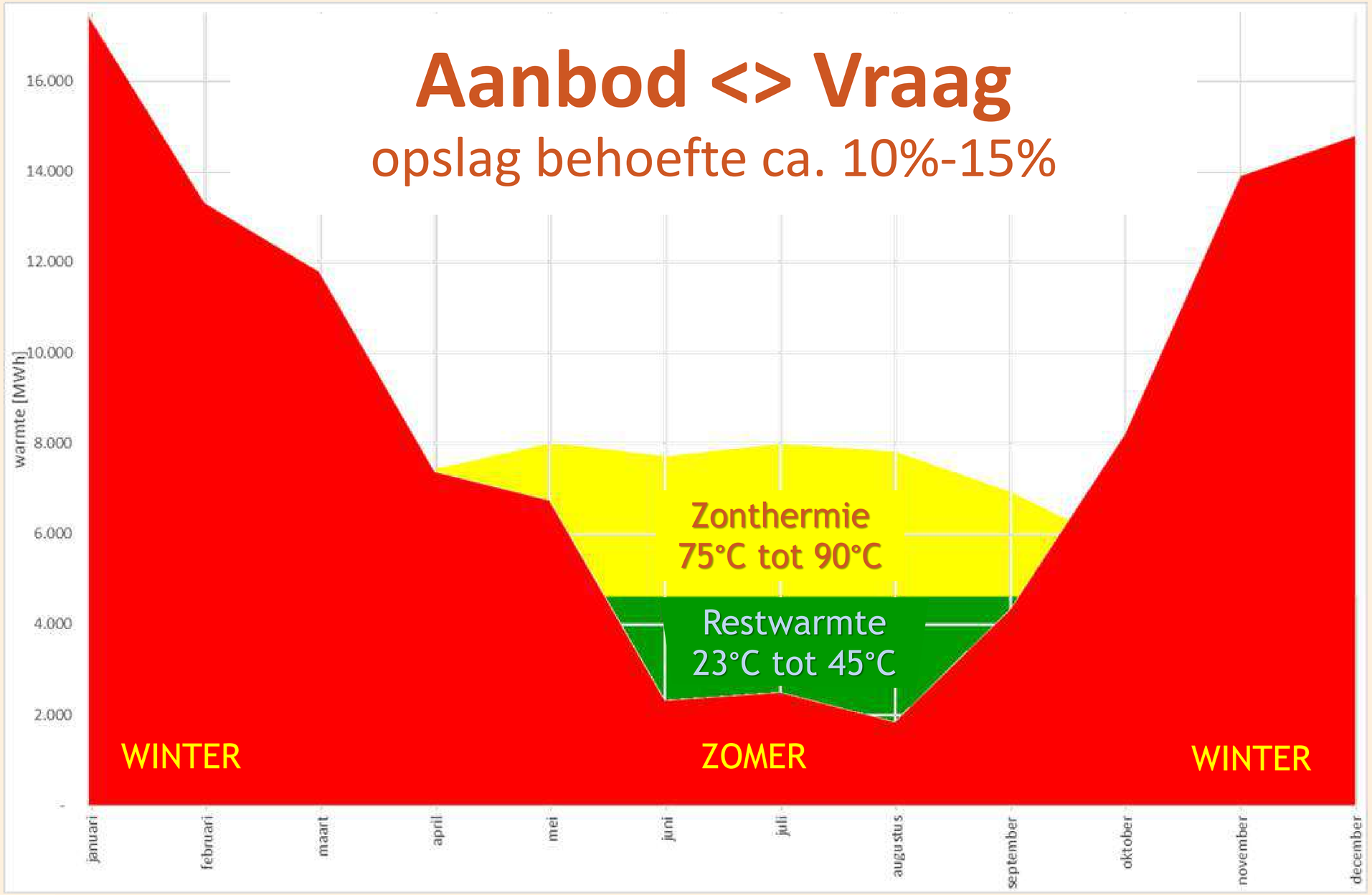


Aanbod Zonthermie

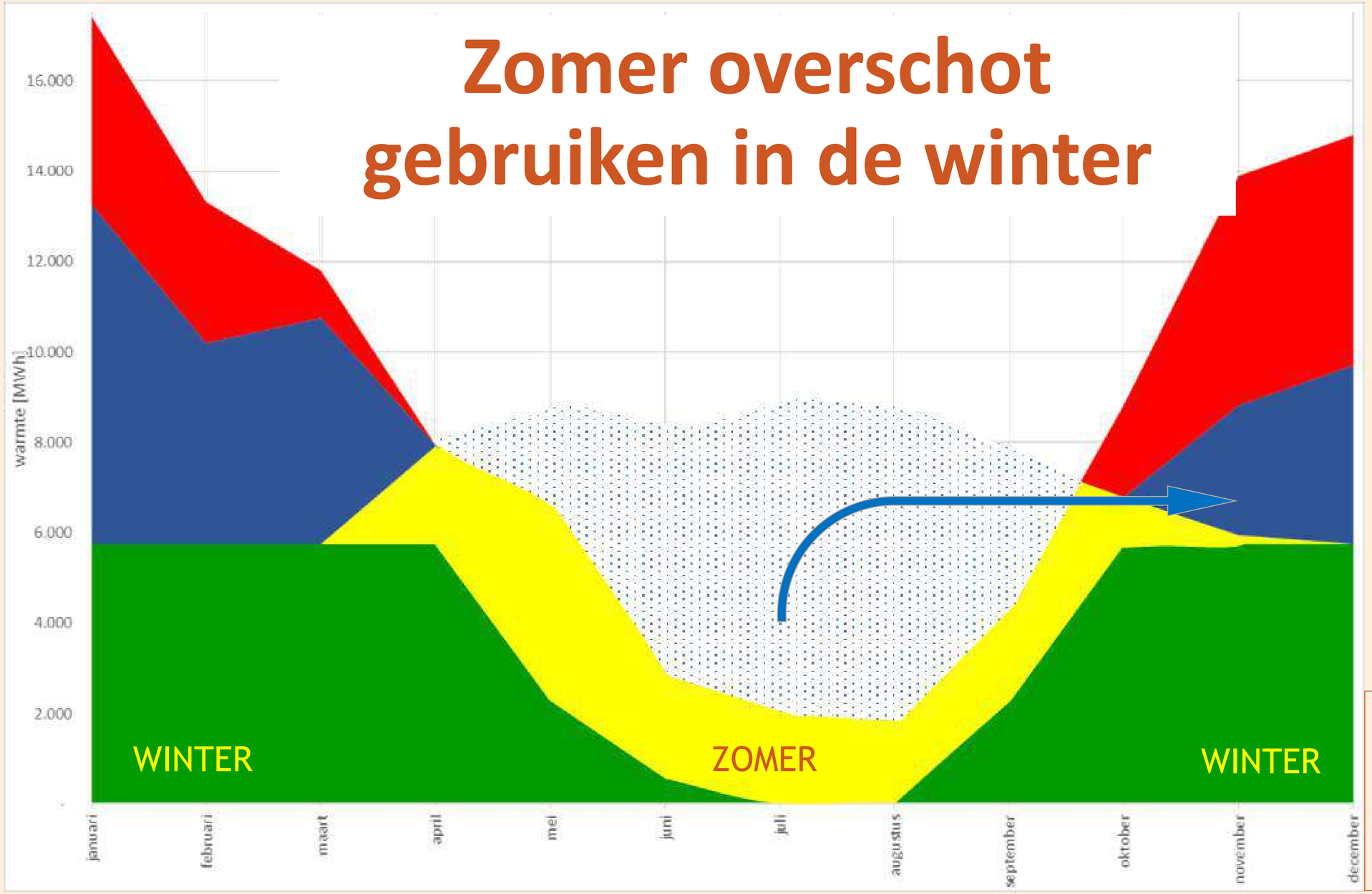


Aanbod <> Vraag

opslag behoefte ca. 10%-15%

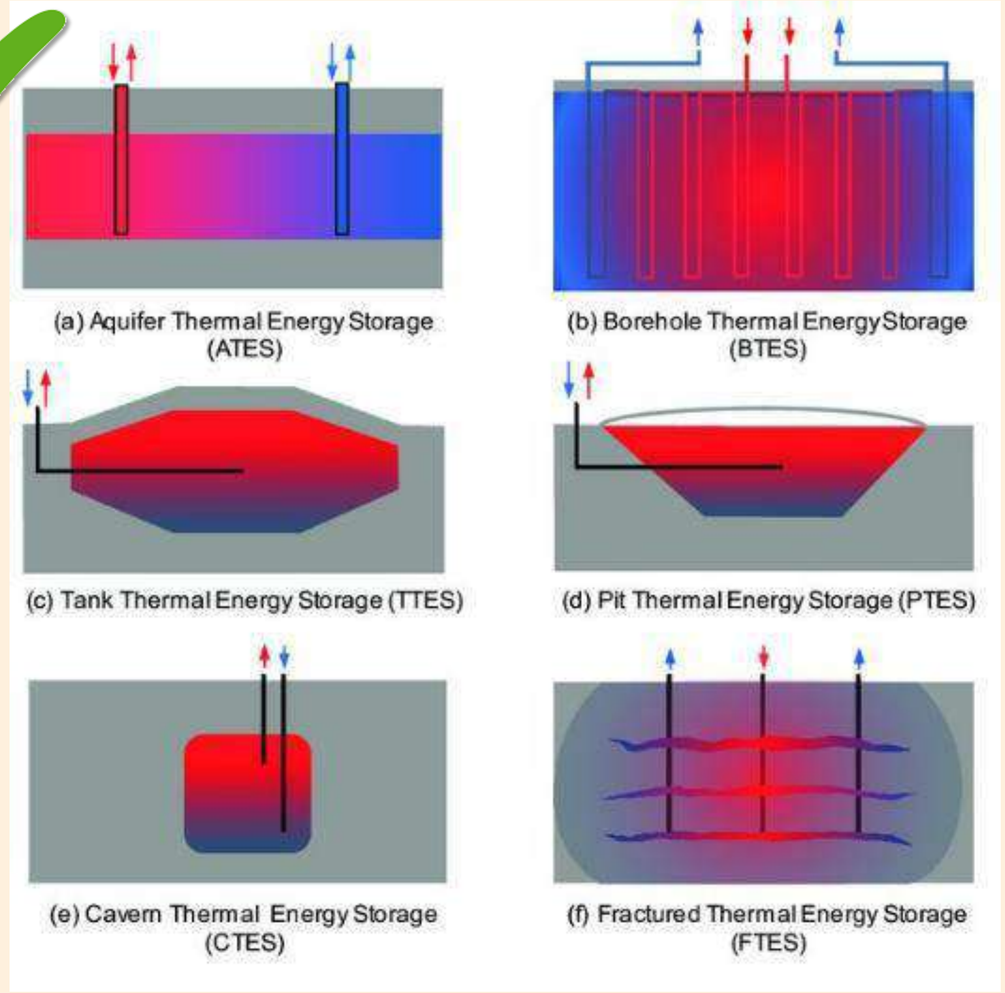


Zomer overschot gebruiken in de winter

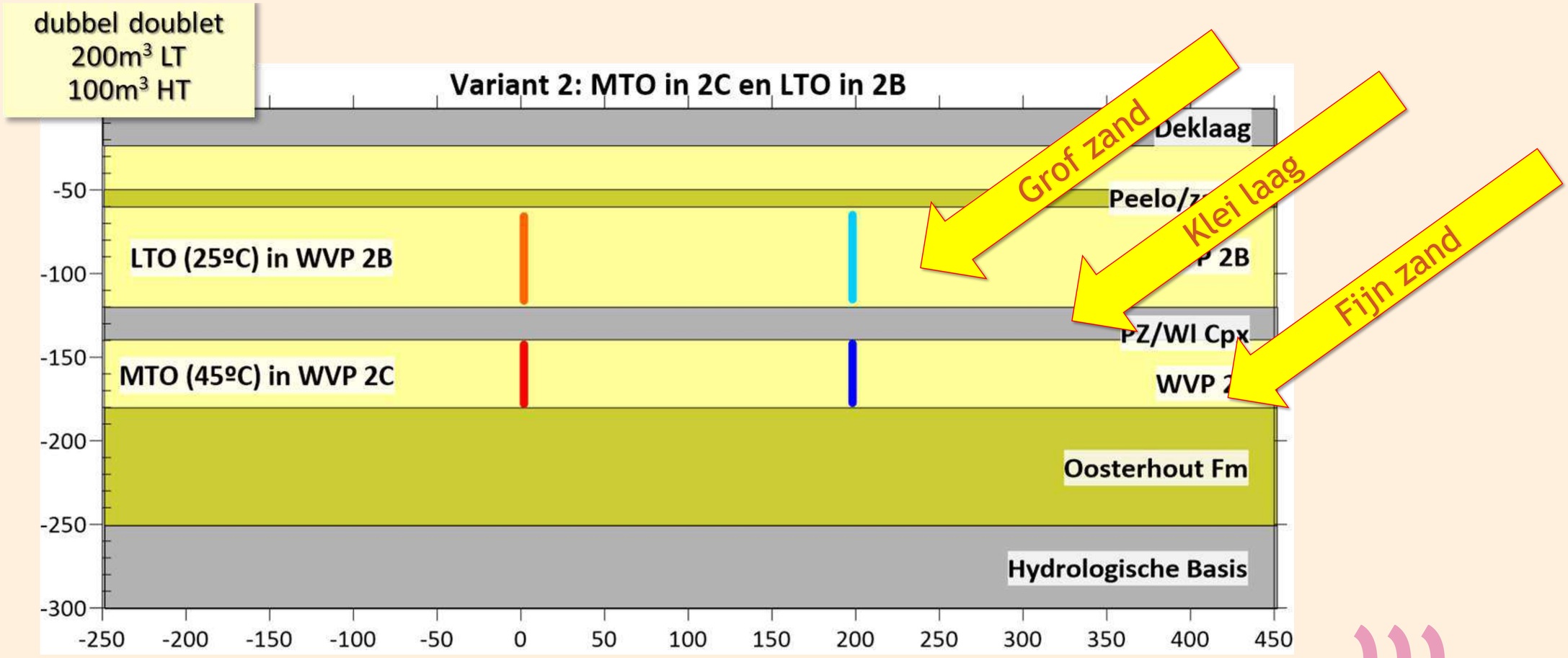


ATES (=WKO)

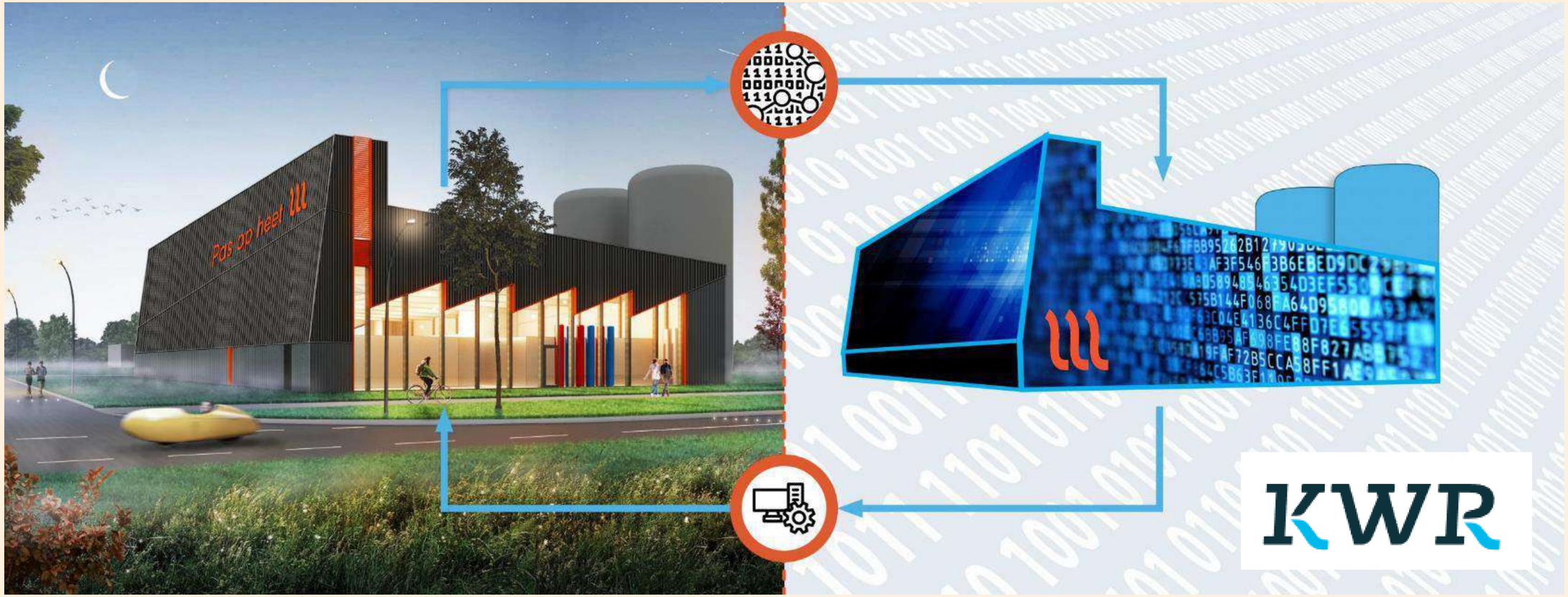
- Beperkte temperaturen
- Bekende techniek
- Standaard materialen
- Investering beperkt
- Geen bovengronds ruimte beslag
- MT en LT opslag beide mogelijk
- Grote opslag capaciteit
- Provincie als bevoegd gezag (tot -500m.)



Dwarsdoorsnede ondergrond doublet

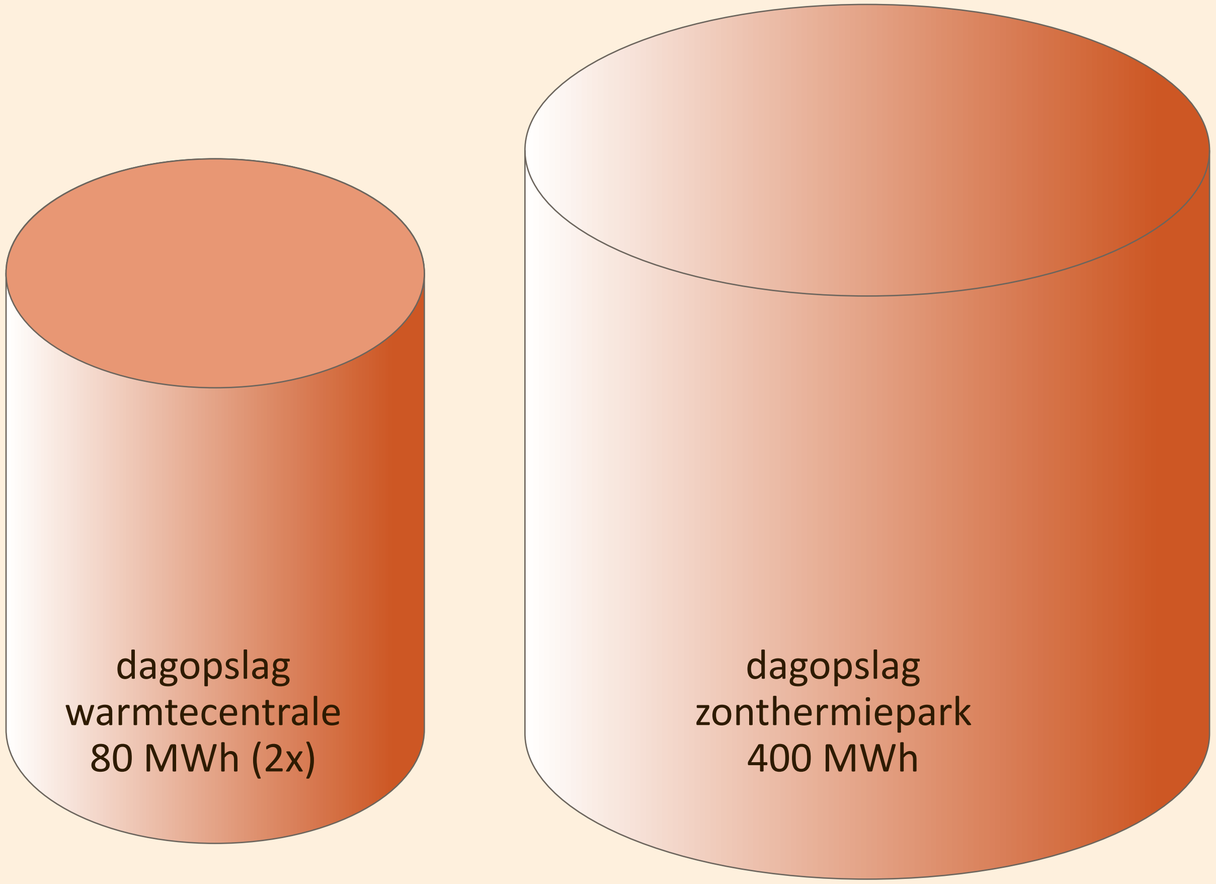


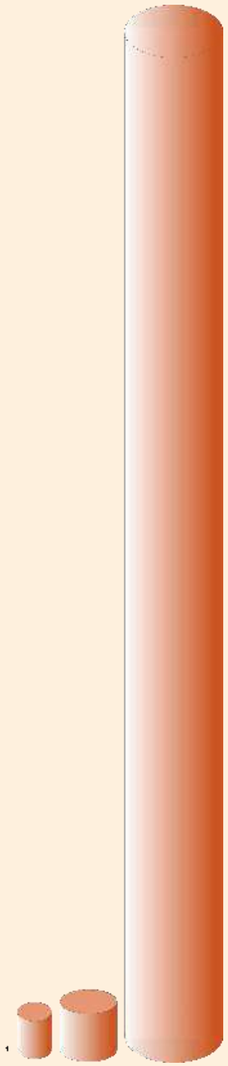
Laadscenario’s met digital twin

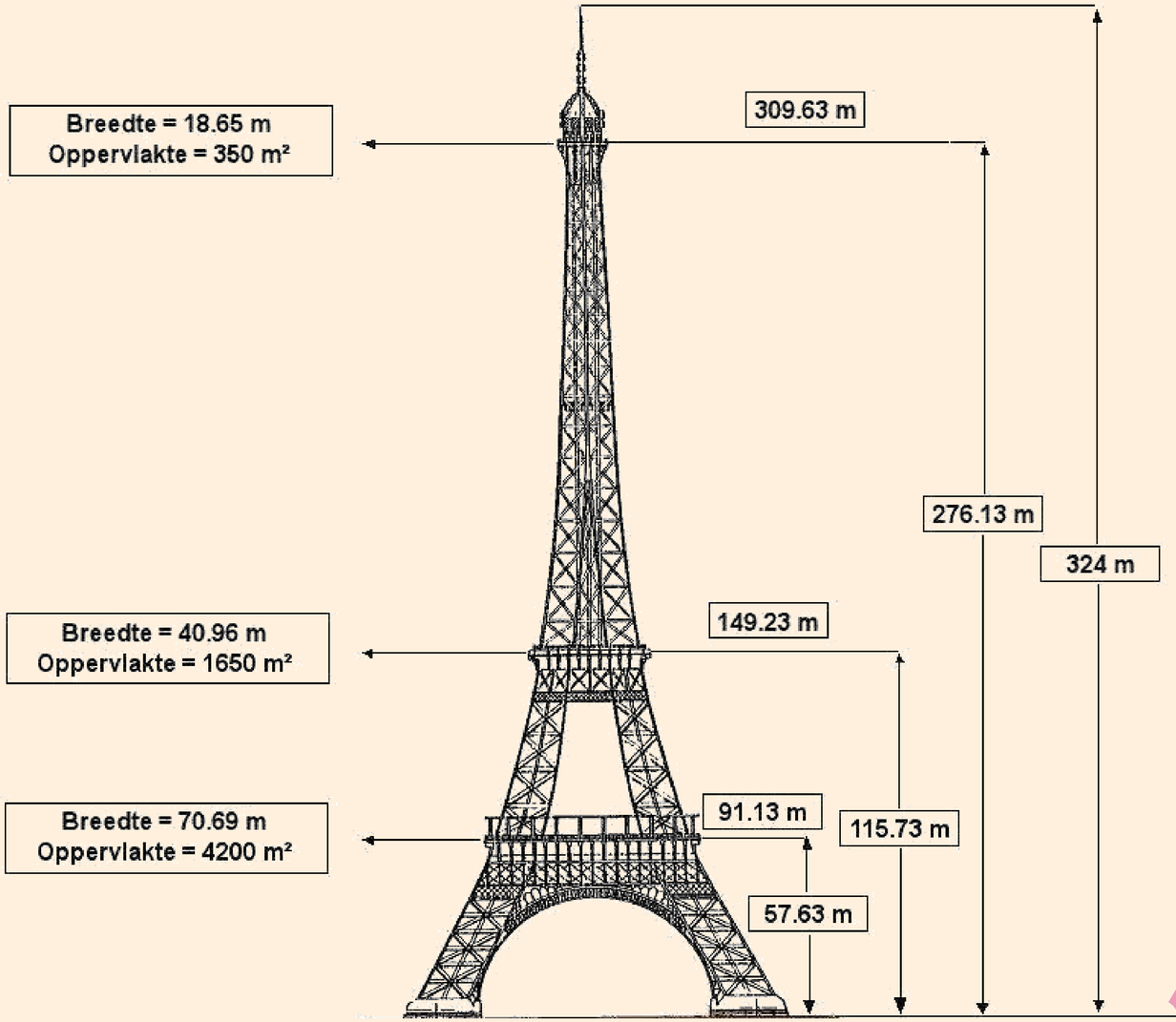


WarmteStad

Afmetingen


dagopslag
warmtecentrale
80 MWh (2x)
11x18m.
dagopslag
zonthermiepark
400 MWh
18x23m.
seizoensopslag
warmtecentrale
10.000 MWh
60x300m.




Breedte = 18.65 m
Oppervlakte = 350 m²
309.63 m
276.13 m
324 m
Breedte = 40.96 m
Oppervlakte = 1650 m²
149.23 m
Breedte = 70.69 m
Oppervlakte = 4200 m²
91.13 m
115.73 m
57.63 m

Bevindingen

- Opslag warmte parallellen met opslag elektriciteit
- Dag opslag noodzaak bij grootschalige zonthermie
- Grote volumes nodig voor gelijkmatige afgifte
- Seizoensopslag warmte in Nederland nog (te) weinig toegepast
- Faciliteert economische haalbaarheid van broncombinaties en verdere verduurzaming warmtenetten
- Vergunningstraject opslag lang (zorgvuldig)
- Systeemkeuze : tijd, opslagvolume en temperatuur
- ATES = bekende WKO techniek tot ca. 45°C

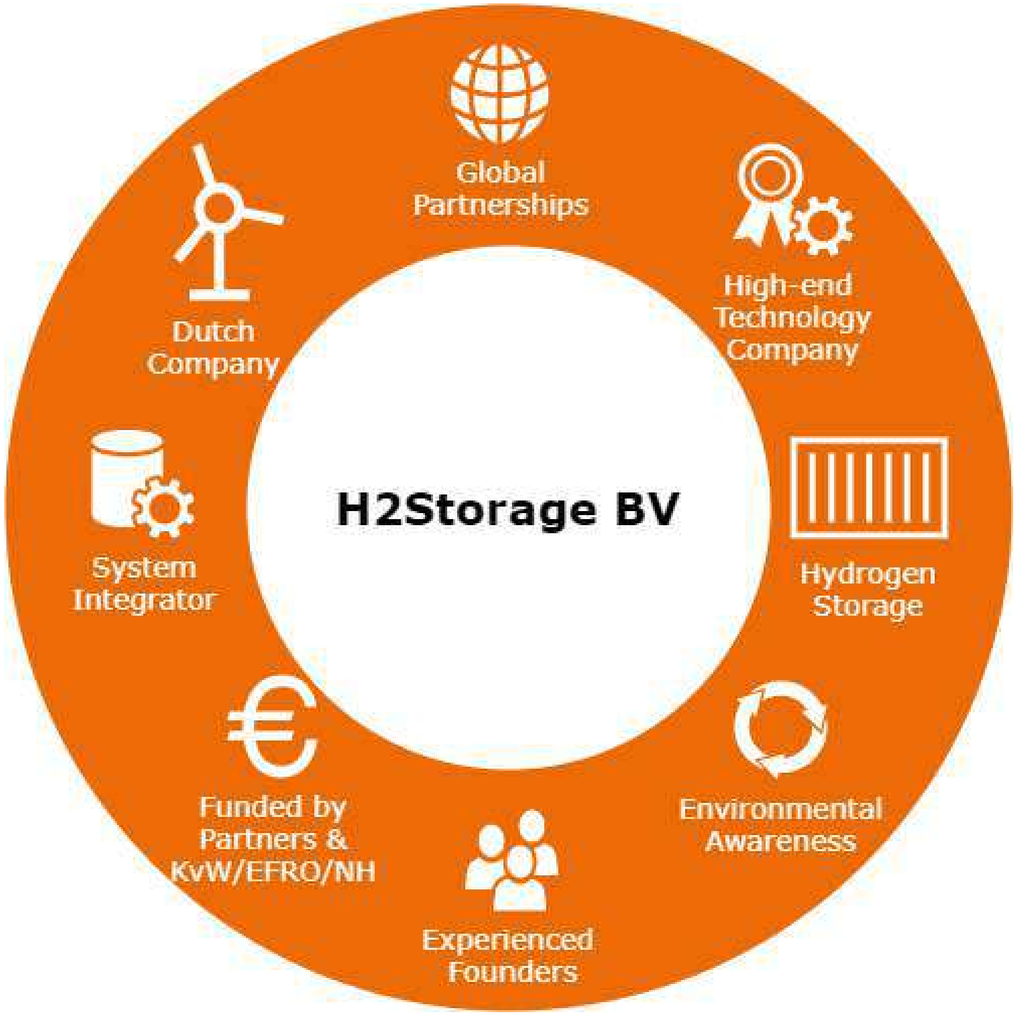
Wij

werken

139848

aan een duurzame toekomst

warmtestad.nl



h2storage

Lightweight energy storage solutions

Energy Storage Day
11 oktober 2023
Storage in the shape of Molecules

Europese Unie
Europees Fonds voor Regionale Ontwikkeling

G4P4 Kansen voor West II

Provincie Noord-Holland

1) Introducing H2storage

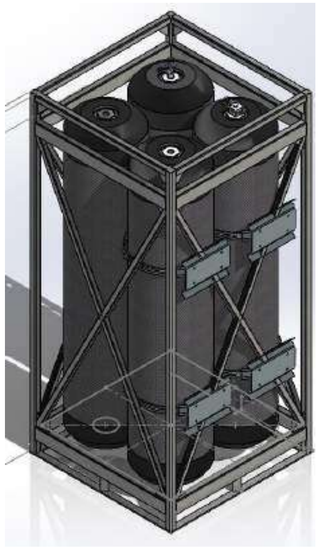
- Start-up company which utilizes the experience of the founders and European network to change the market of high pressure storage of hydrogen.
- A system integrator for storage of hydrogen (H_2) for high pressure systems 700bar.
- System supplier of modular storage systems for construction equipment , inland shipping and stationary applications.
- Supplier of rolling pipeline solutions

2a) H2Storage Solutions

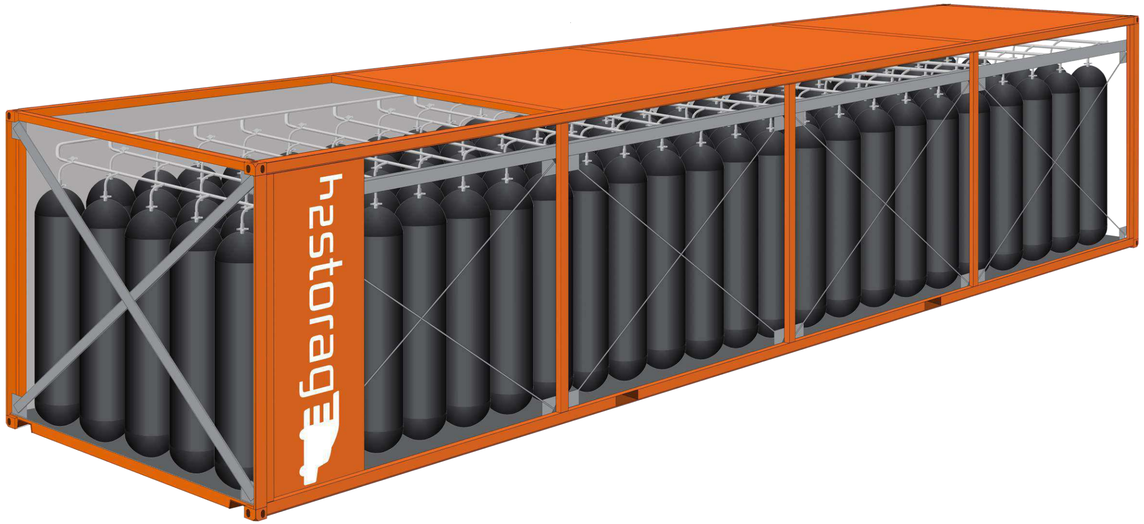
CHP tank 700 Bar

Tank

Bundle



ISO Containers (Road, Water, Transport)



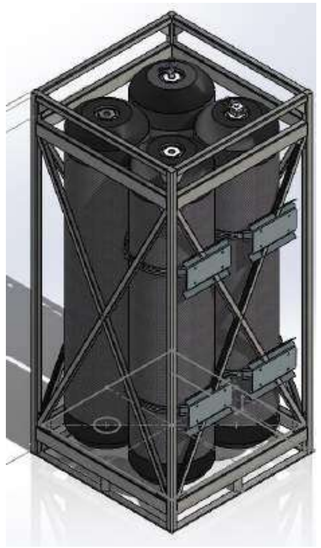
2b) H2Storage Solutions

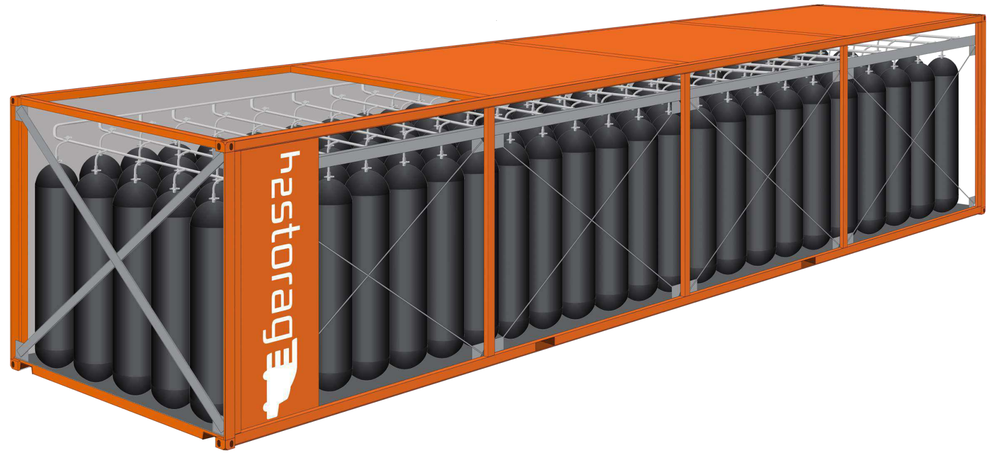
Tank
- 14 kg @ 700 bar
- 0.5* MWh
- 600x600x2.450

Bundle Quattro
- 64 kg @ 700 bar
- 2* MWh
- 1.207x1.220x 2.450

10ft / 20ft ISO container
- 336 / 672 kg @ 700 bar
- 11* / 22* MWh

40ft storage container
- 1344 kg @ 700 bar
- 44* MWh

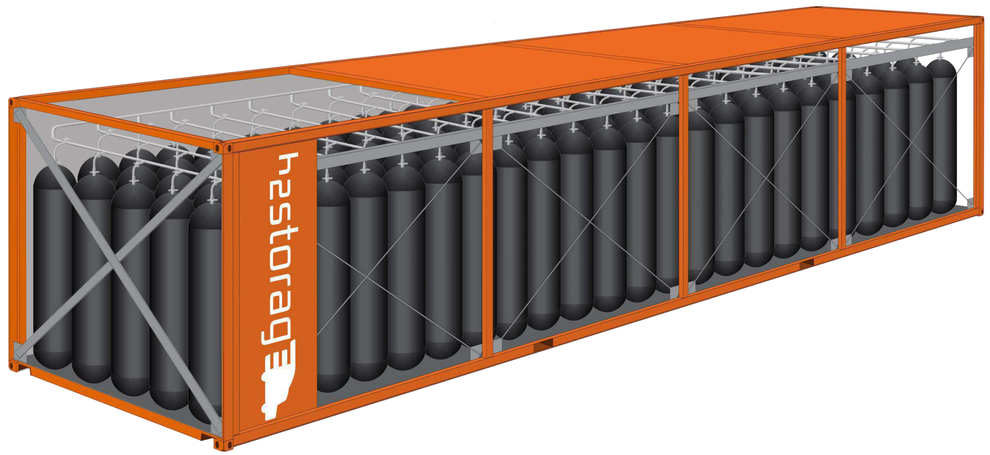




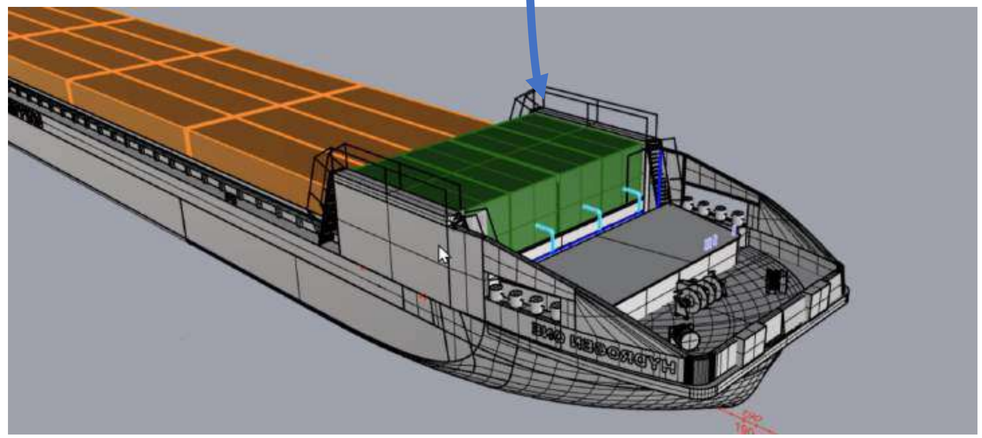
* Equivalent energy before Fuel Cell

3a) Launching Customers

SH2IPDRIVE (Sustainable Hydrogen Integrated Propulsion Drives), a consortium focussed on the application of hydrogen in the maritime sector. https://sh2ipdrive.com/



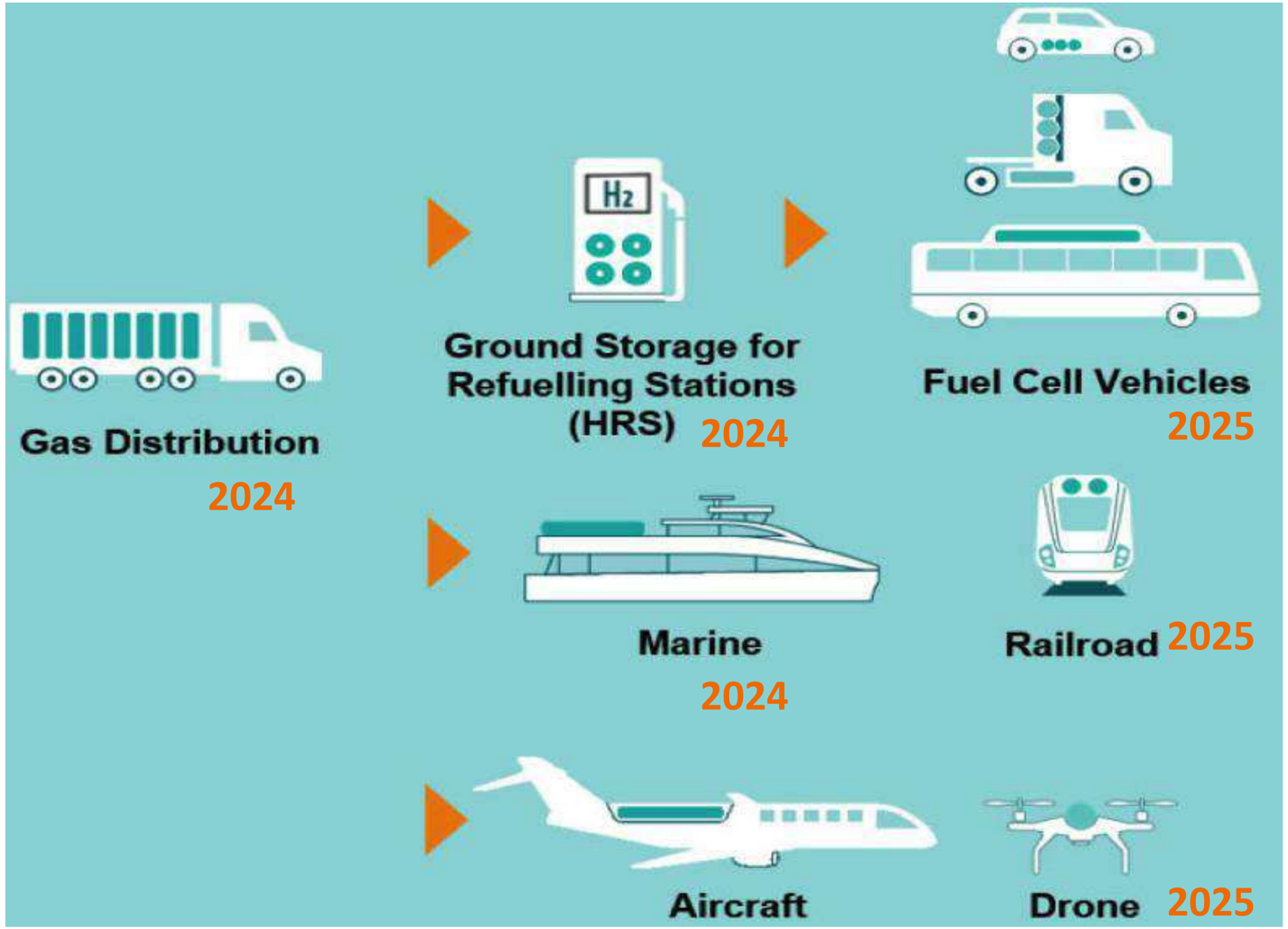
SH2IPDRIVE
HYDROGEN FOR MARITIME



3b) Launching Customers

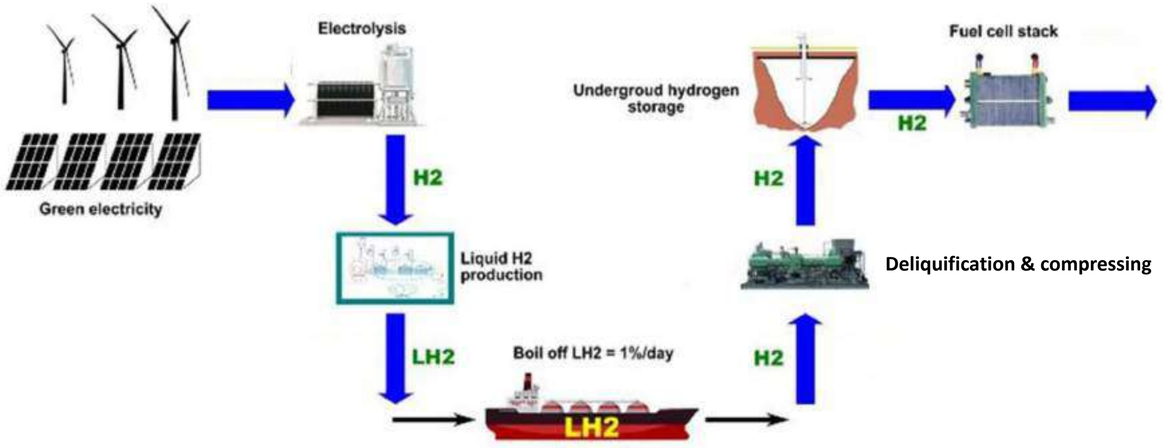
Eco Excavator:
DKTI project from: HFX research, Van Beers Hoogeloon & H2storage to retrofit a Diesel Komatsu excavator into a Hydrogen fuel cell operated excavator able to operate 10 day off-grid with local cascade refilling station
https://eco-excavator.nl/

4) H2storage CH2 solutions roadmap

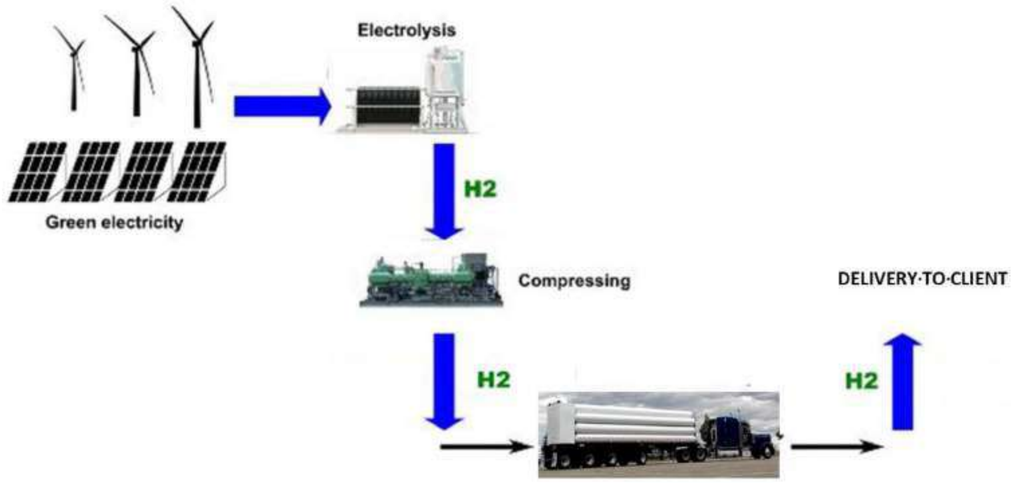


5) MOLECULES CH2/LH2

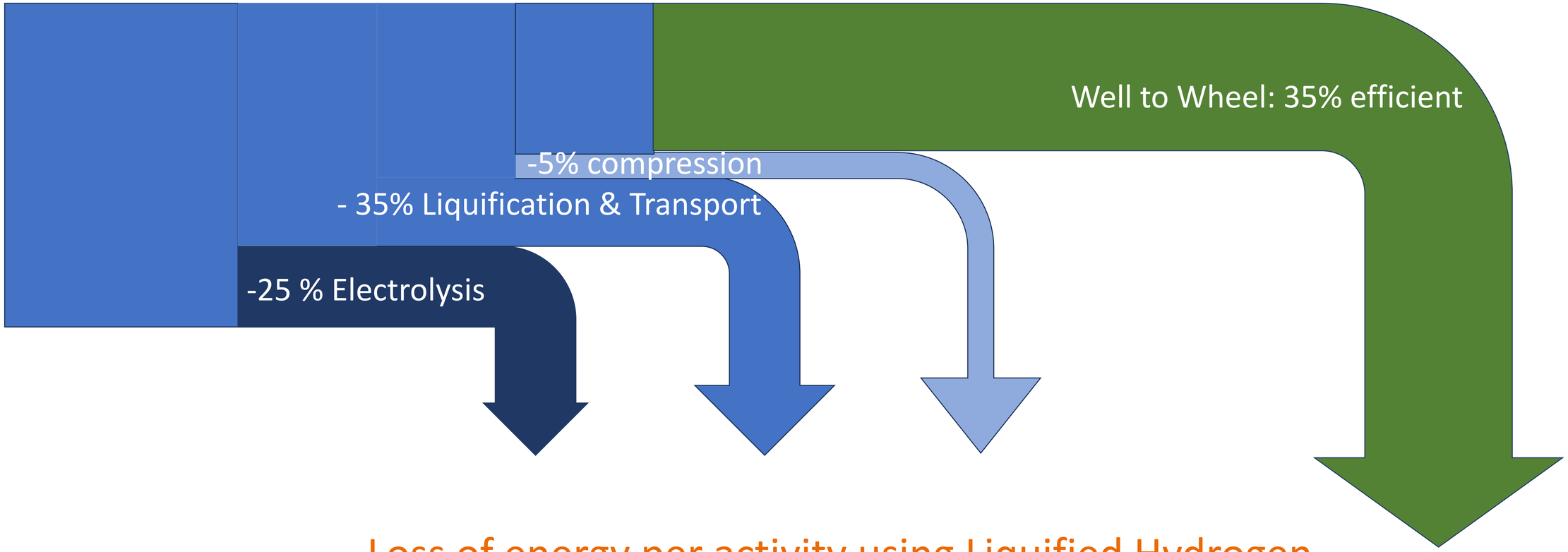
1. LIQUIFIED HYDROGEN SCHEMATICS



2. HIGH PRESSURE COMPRESSED HYDROGEN SCHEMATICS

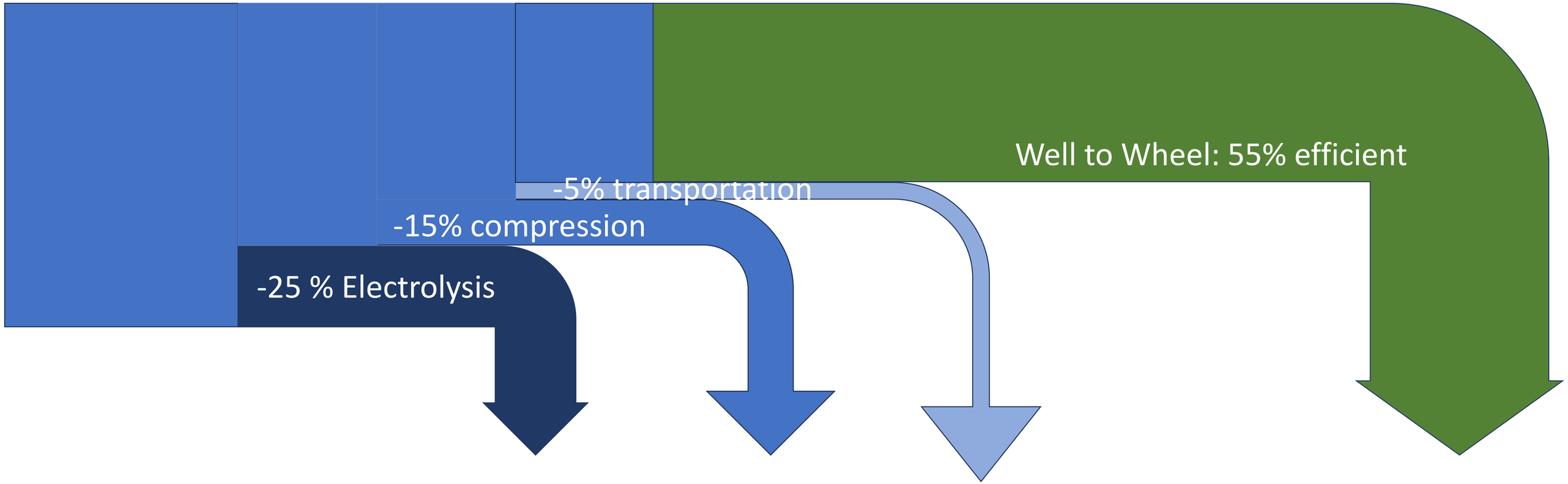


5) CH2 versus LH2



Loss of energy per activity using Liquified Hydrogen

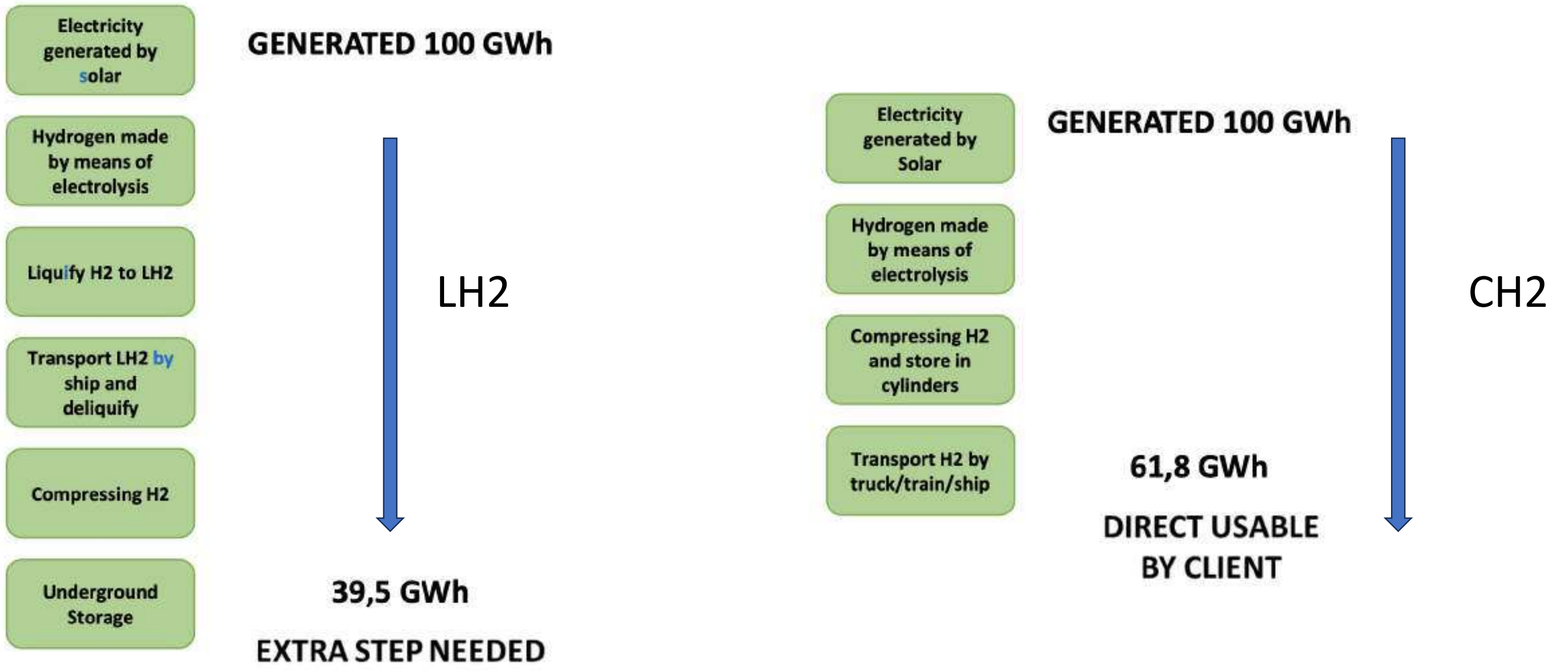
5) CH2 versus LH2



Loss of energy per activity using Compressed Hydrogen

6) Business case 100 GWh solar park in Marokko

OPTIONS COMPARED
HIGH PRESSURE SOLUTION: 55% LESS LOSS – DIRECT USABLE



7) Storage in shapes of Molecules

Lightweight energy storage solutions

Energy Storage NL POWERED BY DUTCH TECHNOLOGY

Werkgroep Moleculenopslag:

De rol van moleculenopslag in het energiesysteem is echter nog **in ontwikkeling**, terwijl de noodzaak van moleculenopslag voor 2030 en 2050 – in combinatie met elektriciteitsopslag en warmteopslag – steeds duidelijker wordt.

H2storage is ready for storage in moleculair shape of compressed Hydrogen Gas.

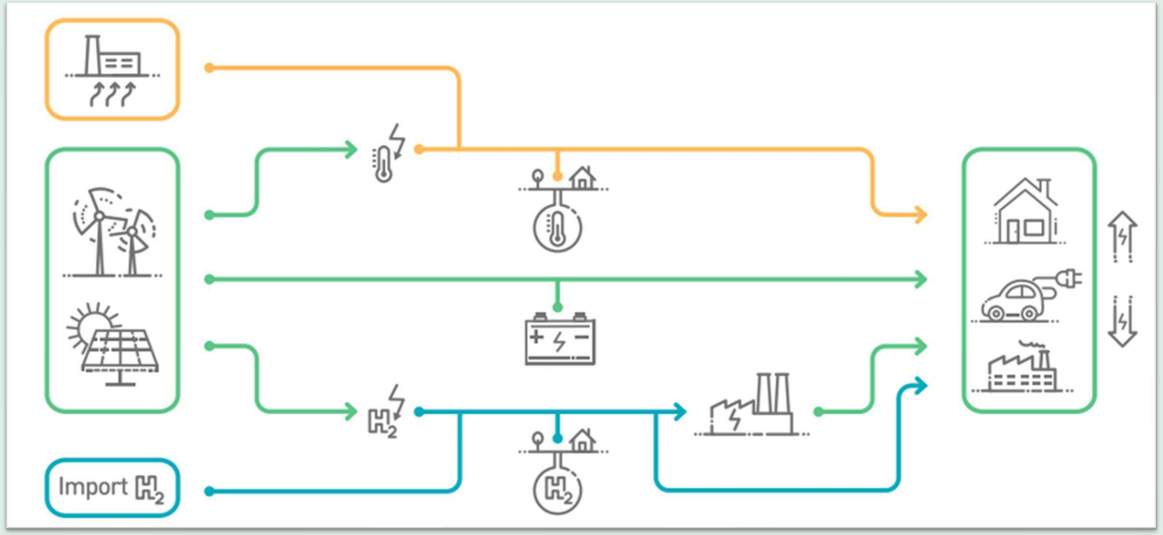
Energieopslag in zoutcavernes

Louwrens op de Beek

11 oktober 2023

NOBIAN

Het belang van (grote) energieopslag



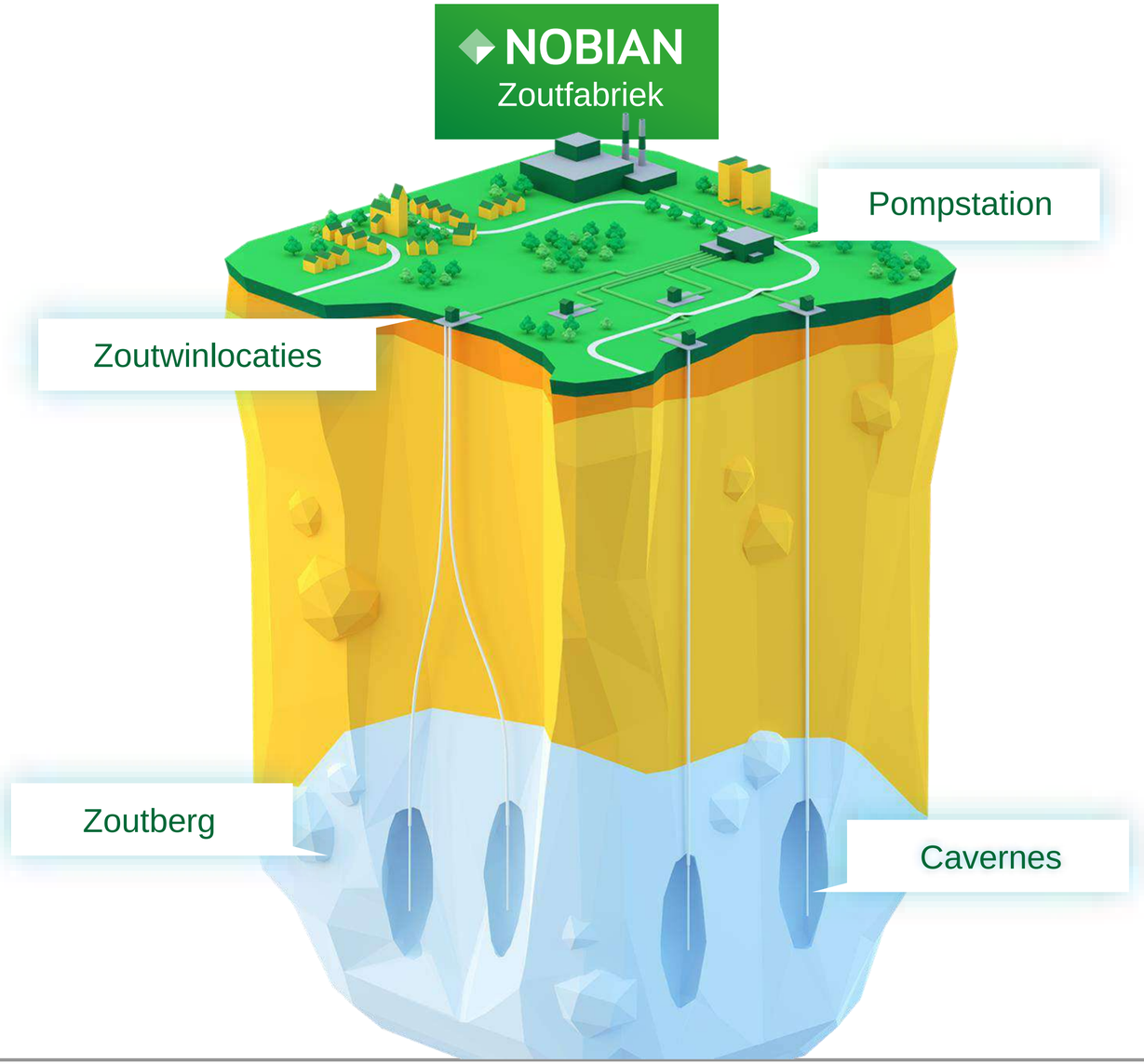
- Opslag vormt een buffer tussen vraag en aanbod van groene energie
- Zonder energieopslag geen business case voor groene energieprojecten
- Minimaliseren afhankelijkheid buitenland

Bron: ministerie van EZK, Routekaart Energieopslag, voorjaar 2023

Veel ervaring in Nederland met ontwikkeling cavernes

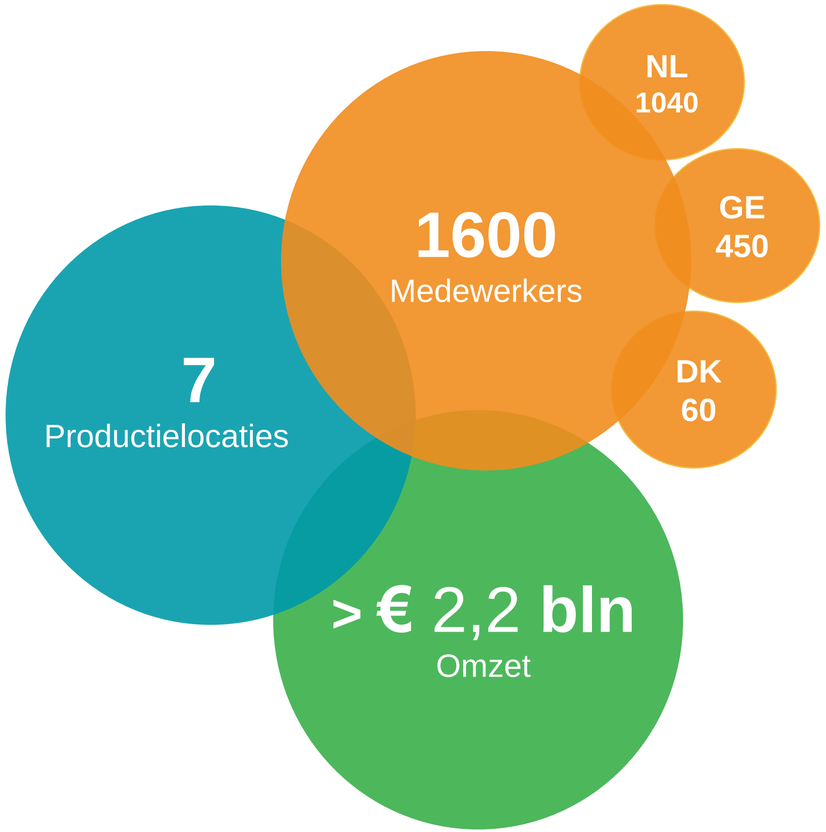
NOBIAN

- Lange ervaring in zoutwinning
- Grote deskundigheid in:
  - zoutgeologie
  - vergunningen en regelgeving
  - engineering
  - projectmanagement
- Concessies voor zoutwinning in Nederland en Denemarken
- Ontwikkeling cavernes voor energieopslag



Nobian in een notendop

Nobian heeft 3 zoutproductielocaties,
5 chloor-alkali-fabrieken en 1 chloormethaanfabriek
verspreid over 7 locaties.




ZOUT

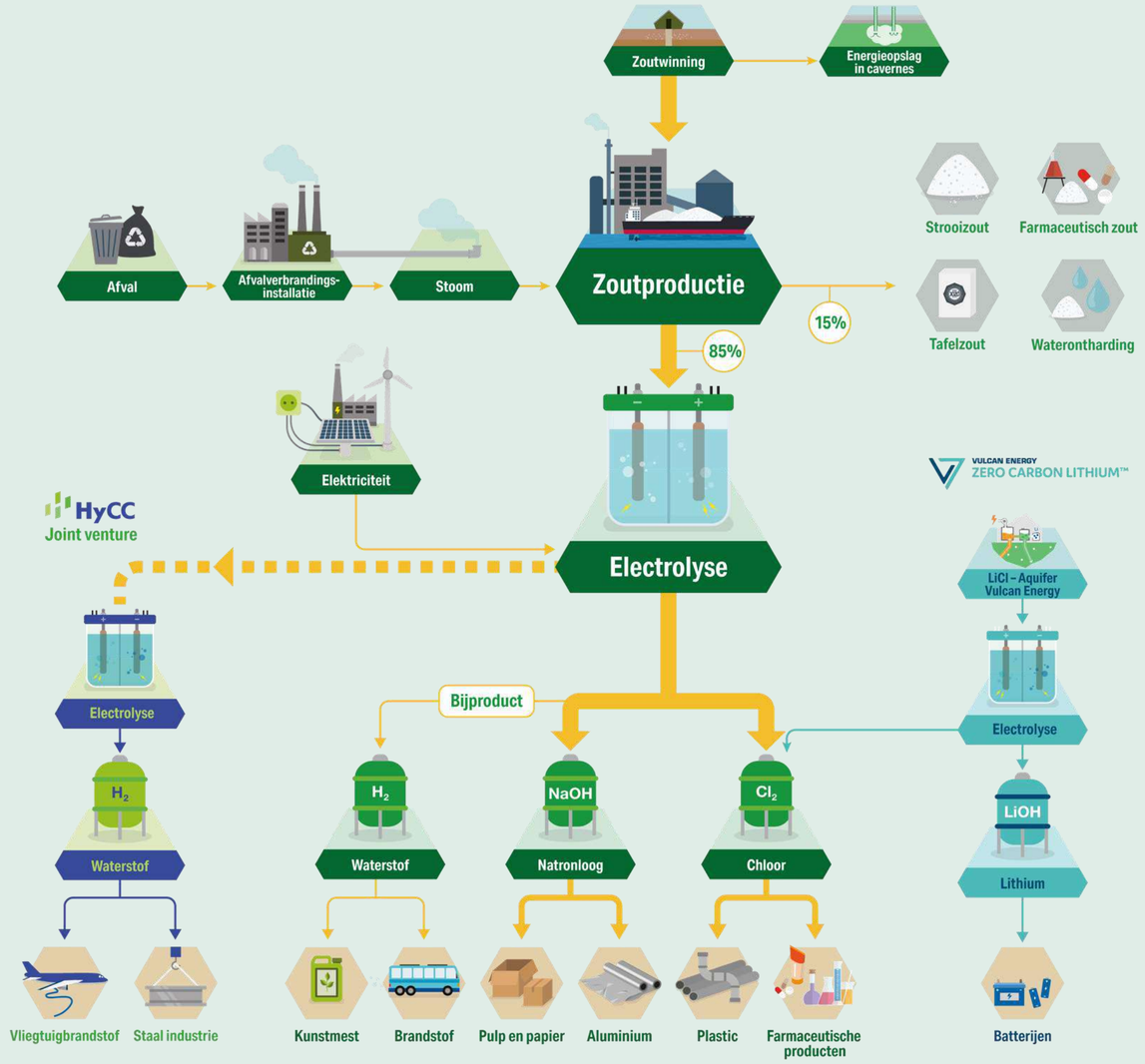

CHLOOR


NATRONLOOG


CHLOORMETHANEN


WATERSTOF

De waardeketen van zout



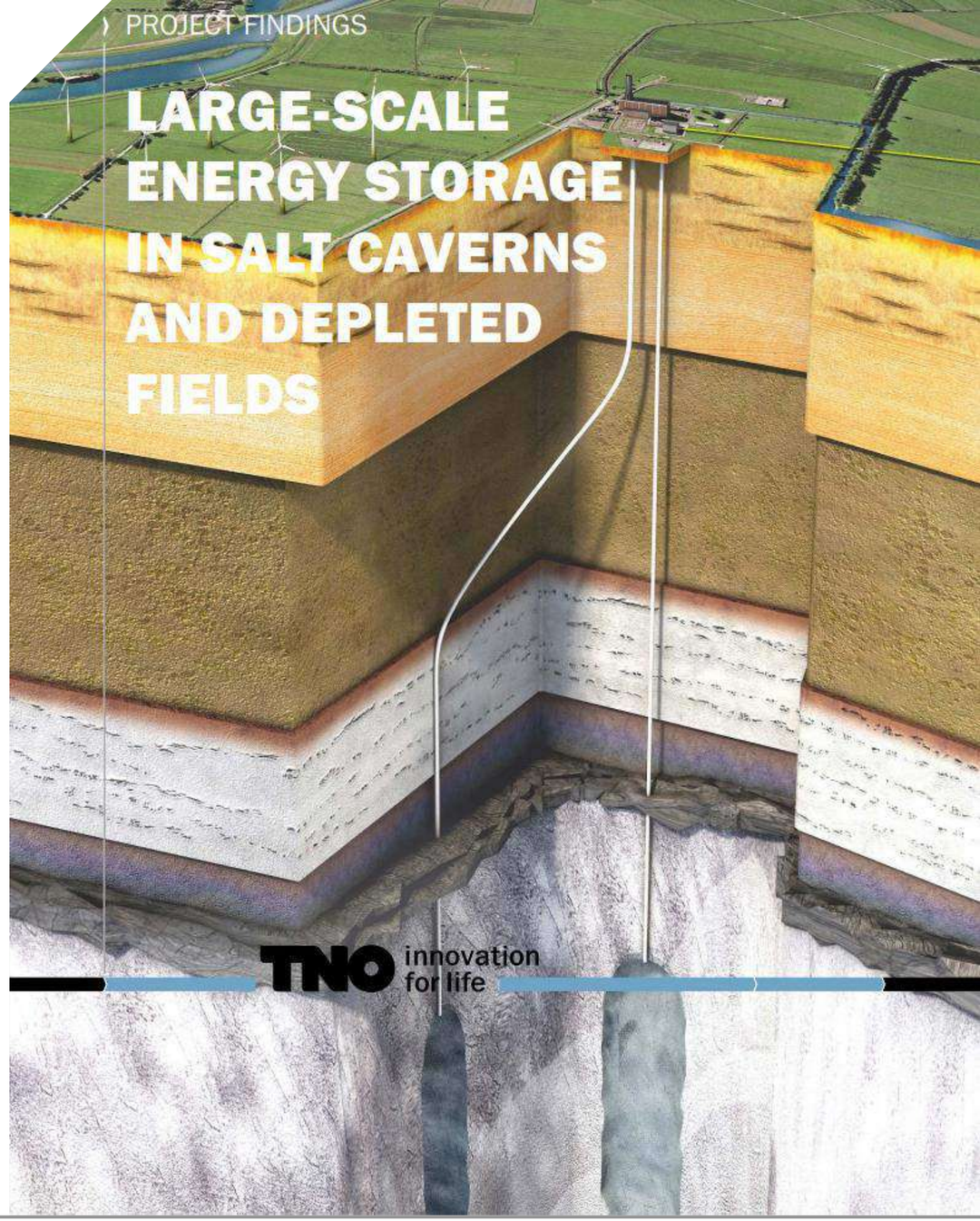
85% van het zout van Nobian wordt verkocht aan de chemische industrie.

40% van alle producten in de chemische industrie is afgeleid van zout.

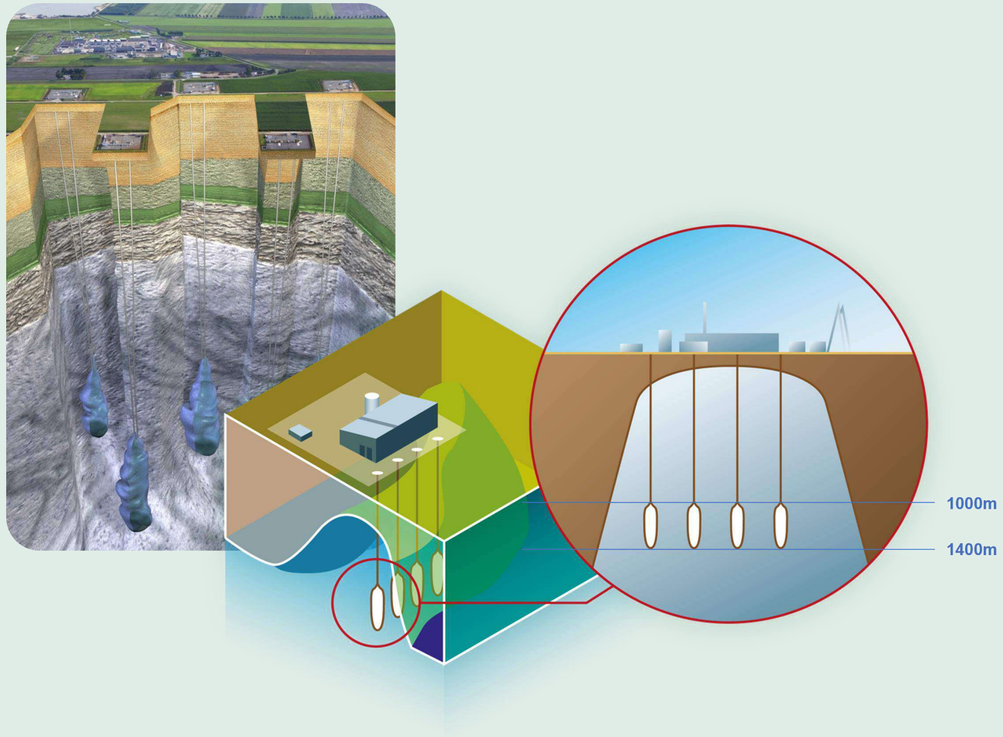
100% van het zout dat gebruikt wordt in de chloorclusters Delfzijl, Rotterdam, Leverkusen, Rafnes, Tessenderlo en Frankfurt is afkomstig van Nobian.

Waarom energie opslaan in cavernes?

- Grootschalig
- Lange termijn – ‘Long Duration Energy Storage (LDES)’
- Bewezen technologie
- Veilig



Bestaande zoutcavernes voor energieopslag



Ervaring

- Opslag aardgas
- Opslag stikstof
- Strategische opslag diesel

Ontwikkeling zoutcavernes voor energieopslag

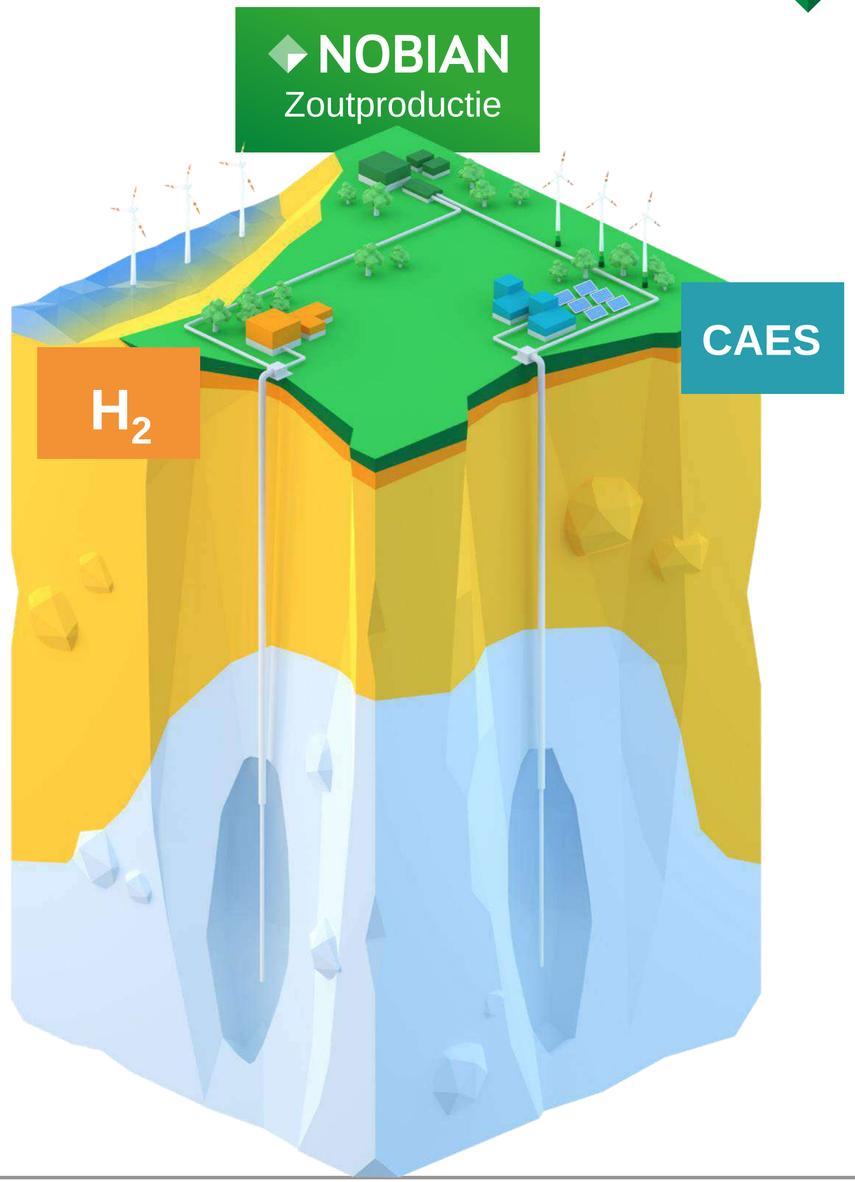
NOBIAN

Opslag van waterstof (H_2)

- Hernieuwbare energie (wind) om waterstof te produceren (H_2 electrolyse) als energiedrager
- Waterstof opgeslagen in cavernes als buffercapaciteit voor het H_2 netwerk

CAES – Perslucht energieopslag

- Overschot aan hernieuwbare energie (wind/zonne-energie) als perslucht opslaan in zoutcavernes
- Terug omzetten naar elektriciteit voor het net wanneer het aanbod laag is ('wind waait niet')



We hebben alles in Nederland om ambitieus te zijn!

- Nederland perfect gepositioneerd voor leidende rol in klimaattransitie

- Samenwerking en afstemmen in de keten
- De omgeving betrekken en informeren belangrijker dan ooit
- Nu is het moment!

GROW GREENER TOGETHER

NOBIAN

ENERGY STORAGE DAY 11 OKTOBER 2023

TECHTALK

Dirk van Asseldonk

Battery Competence Cluster

Angela Hulst

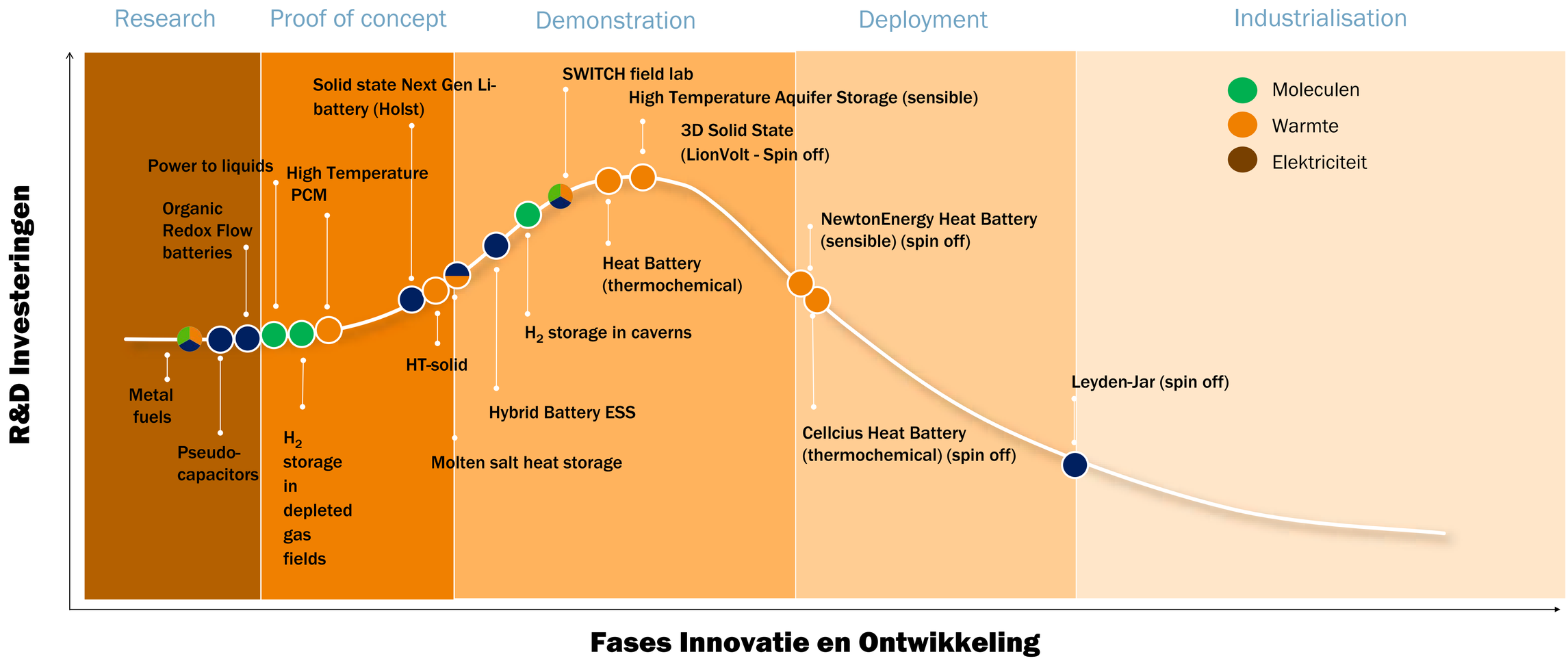
Stedin

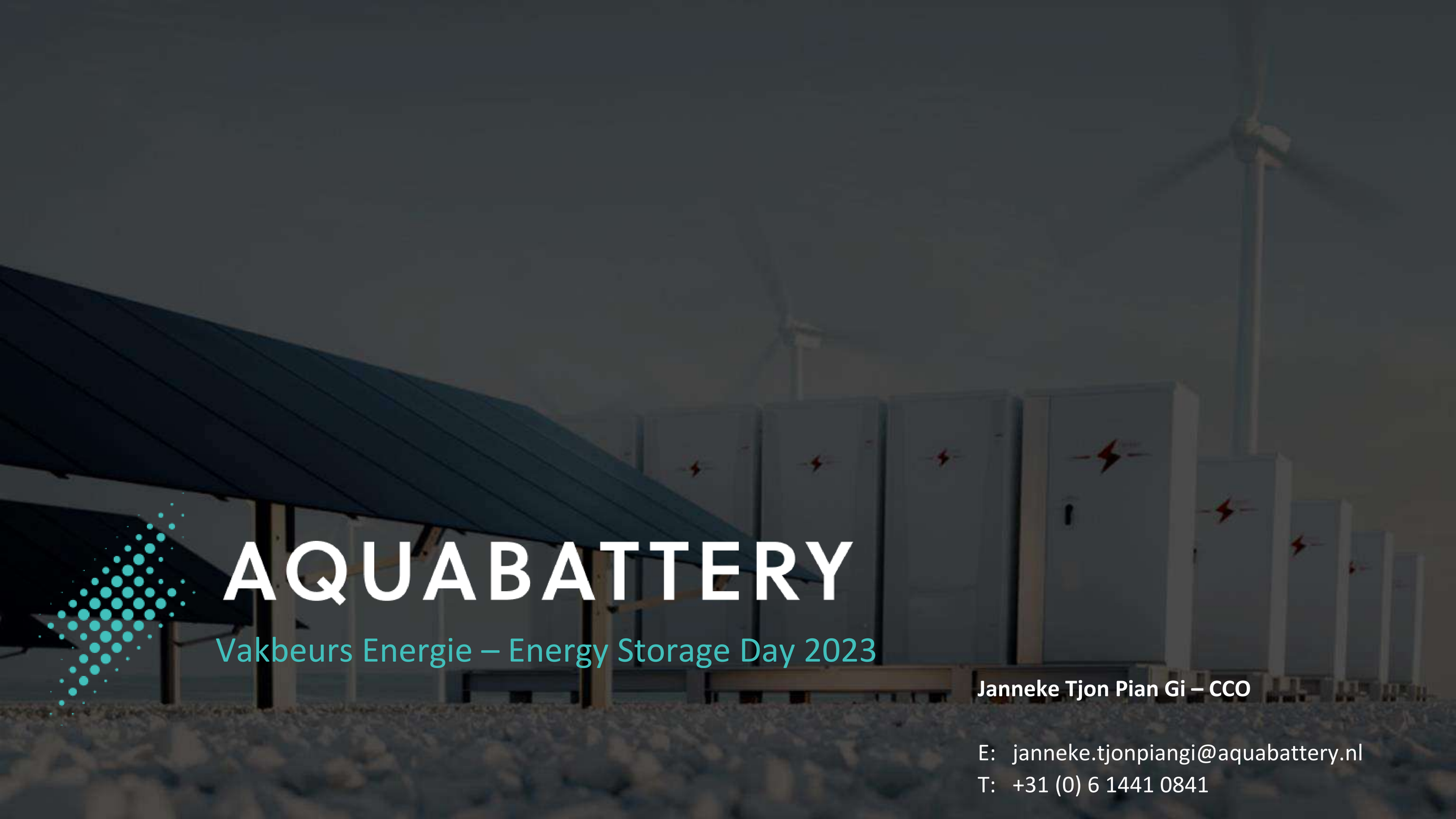
Joris Koornneef

TNO

Energy Storage NL POWERED BY DUTCH TECHNOLOGY

TNO PORTFOLIO AANPAK VOOR ENERGIEOPSLAG IN NEDERLAND





AQUABATTERY

Vakbeurs Energie – Energy Storage Day 2023

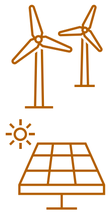
Janneke Tjon Pian Gi – CCO

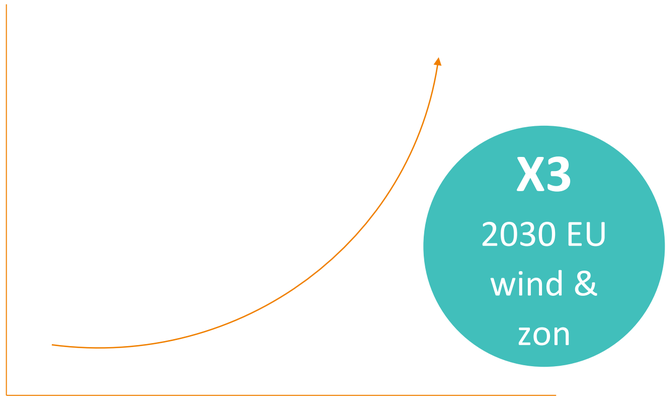
E: janneke.tjonpiangi@aquabattery.nl
T: +31 (0) 6 1441 0841

AQUABATTERY

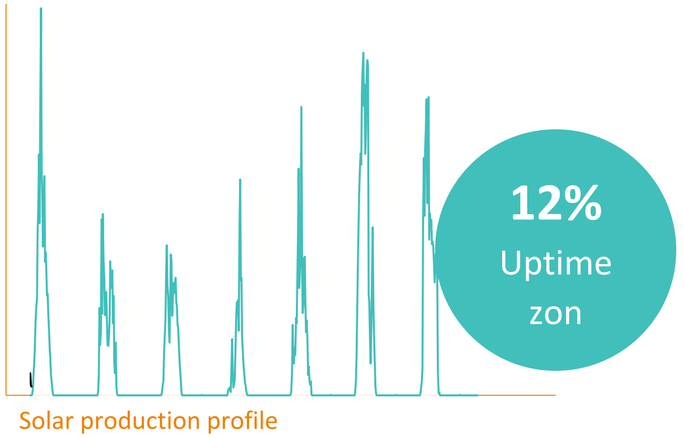
WAAROM HEEFT DE WERELD ENERGIEOPSLAG NODIG?

Elektrificatie en netto-nul ambities versnellen groei hernieuwbare bronnen





Resulterend in meer vraag met onzeker aanbod



ENERGIEOPSLAG

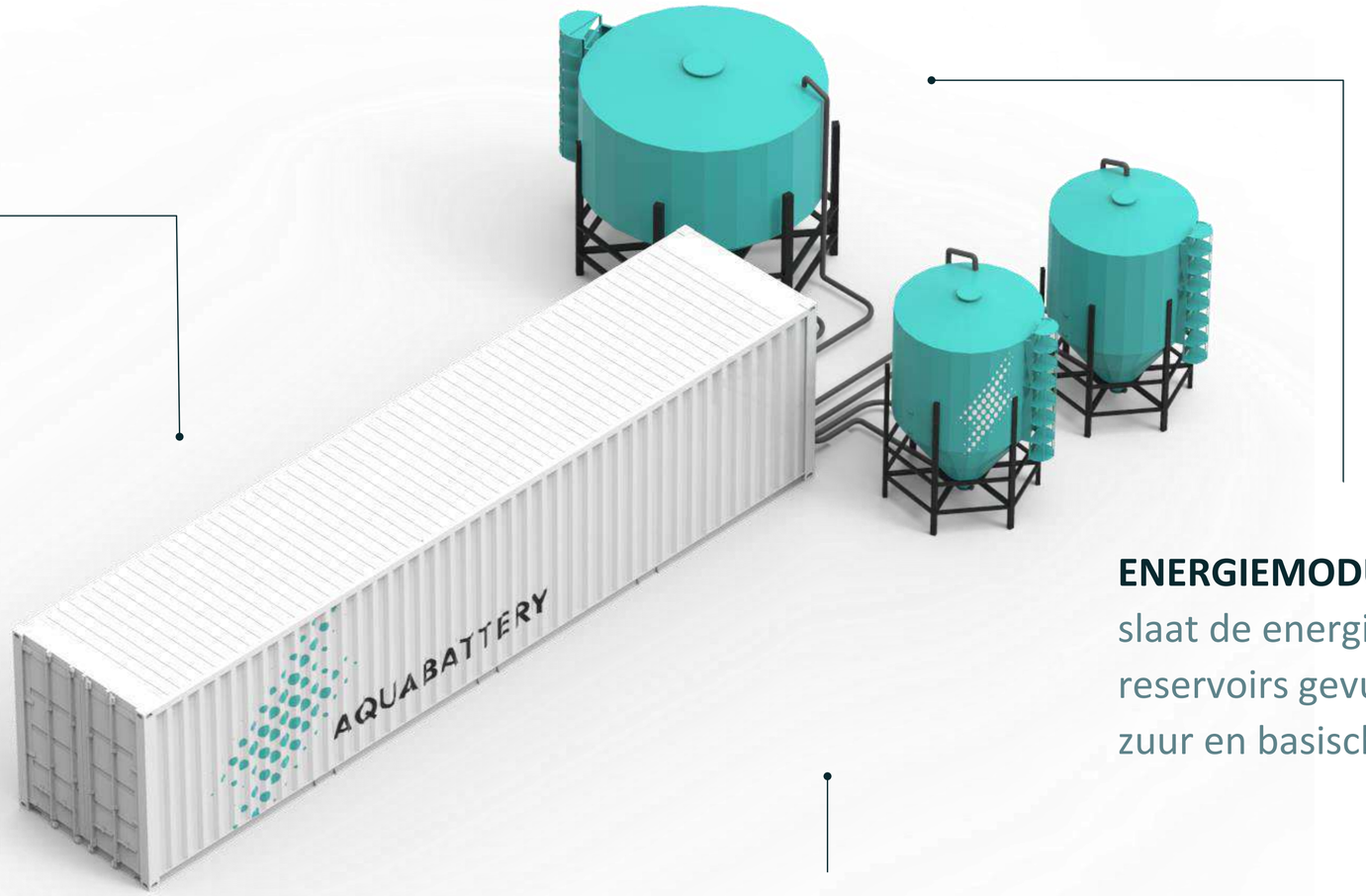
AQUABATTERY’s missie

‘Netto nul’ mogelijk maken door het aanbieden van ‘s werelds meest schaalbare, veilige en duurzame oplossing voor langdurige energieopslag

AQUABATTERY

ENERGIEOPSLAG IN WATER EN KEUKENZOUT

VERMOGENSMODULE
zet de energie om middels membraan stacks



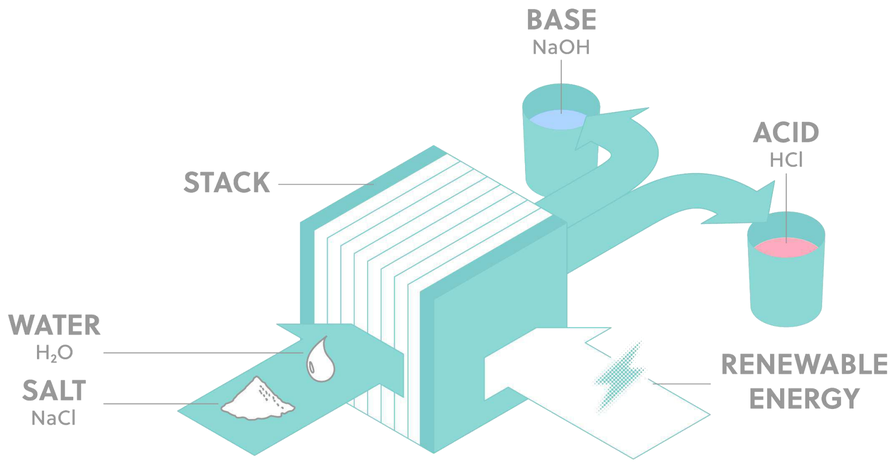
ENERGIEMODULE
slaat de energie op. Bestaat uit reservoirs gevuld met zout water, zuur en basische oplossingen

BATTERIJ MANAGEMENT SYSTEM (BMS)
Control software om het systeem aan te sturen en te monitoren

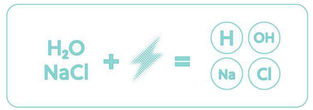
AQUABATTERY

DE TECHNOLOGIE UITGELEGD: LADEN & ONTLADEN

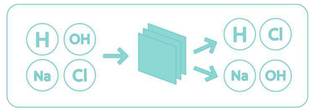
Laden



CHARGING

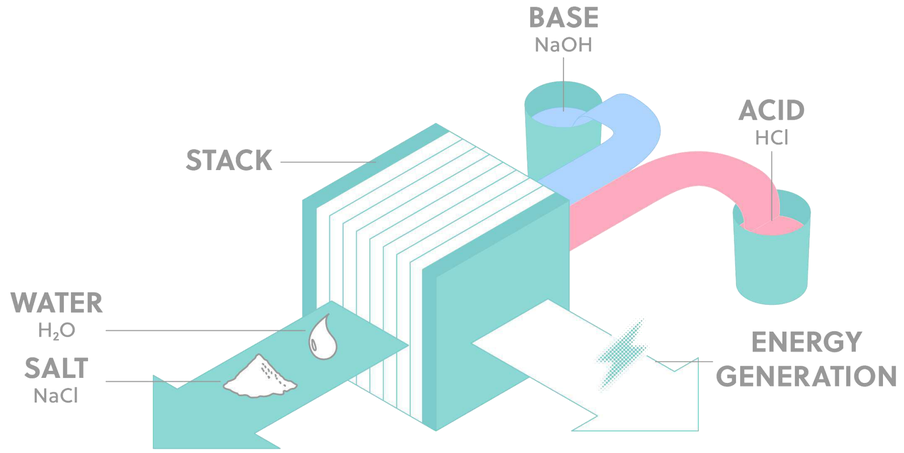


Breaking the bonding by electricity

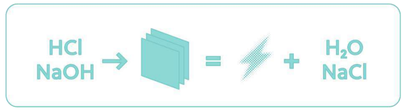


Ions sorted in the stack to form Acid and Base

Ontladen



DISCHARGING



Combining Acid and Base together in the stack creates electricity

AQUABATTERY

WAAROM ENERGIE OPSLAAN IN ZOUTWATER?

BETAALBAAR

VEILIG

SCHAALBAAR

DUURZAAM

AQUABATTERY

WAAR GAAN WE NAAR TOE?

>2025 — Commercial product

2024 — Pilot in NL – announcing soon

2022-2023 — **Pilot @ waterschap, NL**

2020-2021 — Pilot @ energy producer, IT

2017-2018 — Pilot @ microgrid NL

LET’S EMPOWER NET RO TOGETHER

AQUABATTERY

storing
renewable energy
at scale

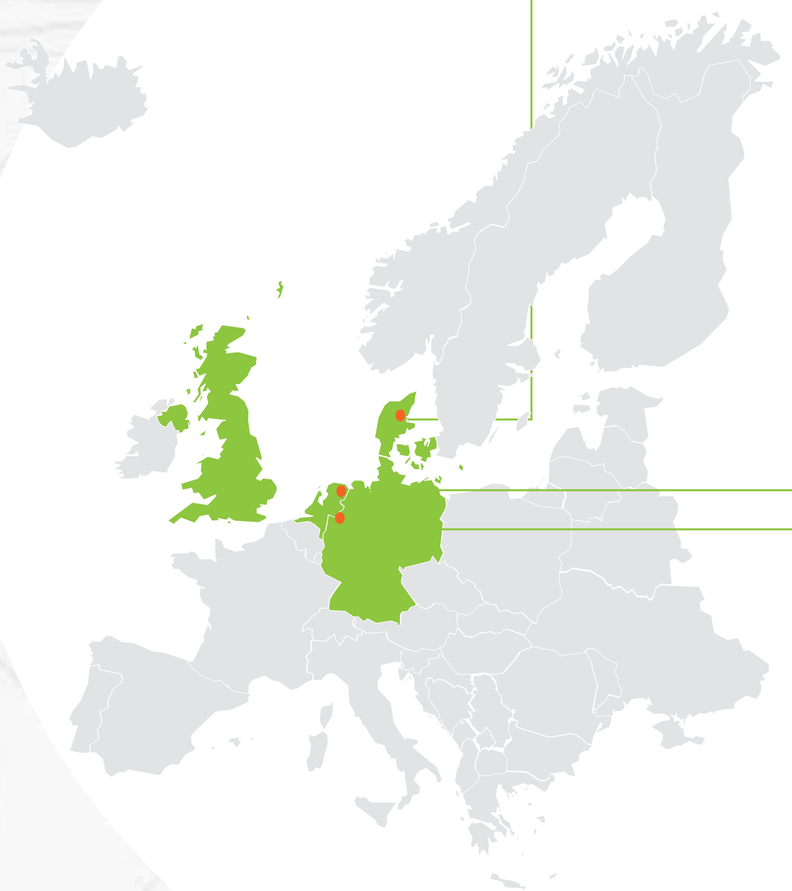



Compressed Air Energy Storage "CAES"

Corinne Faassen – Project Director
corinne.faassen@corre.energy

Corre Energy & CAES

Missie	De energietransitie mogelijk maken en de betrouwbaarheid en flexibiliteit van hernieuwbare energiesystemen te verbeteren door langdurige en grootschalige energieopslag te realiseren
Concept	Het basis concept “CAES” van Corre Energy kan tot 84 uur (3 ½ dag) elektriciteit leveren met een maximale output-capaciteit van 320 MW en elektriciteit afnemen met een capaciteit van 220MW voor ~2 ½ dag.
Projecten	• CAES Zuidwending Nederland • Green Hydrogen Hub Denemarken • Epe Duitsland



Denemarken

- Green Hydrogen Hub
- Project in Engineering fase (FID 2025)
- 160-320MW capacity
- Hydrogen storage

Nederland

- Project in Engineering fase (FID 2026)
- 320MW capaciteit met mogelijkheid tot uitbreiding (640MW grid connectie)
- 2 Cavernes

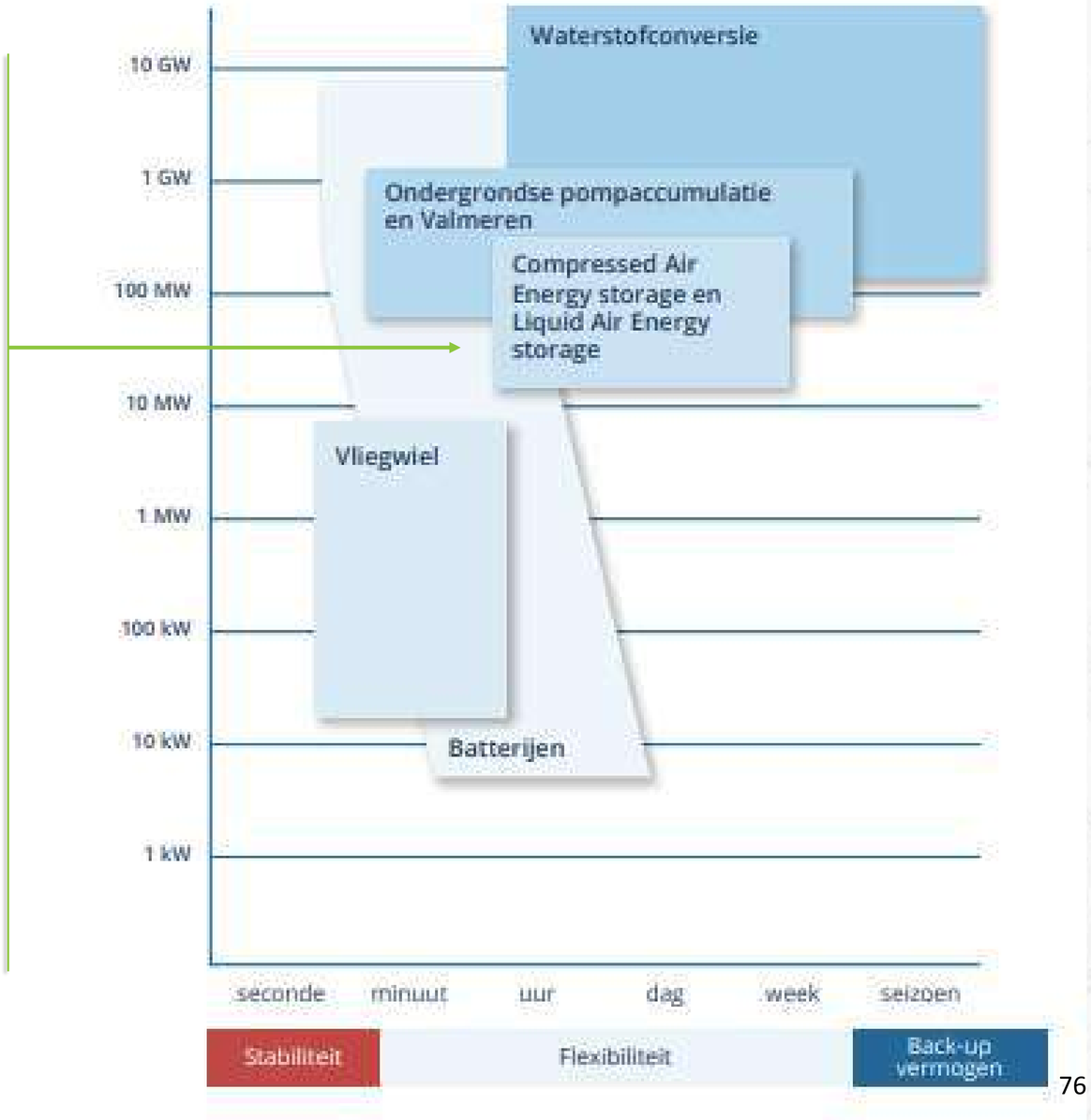
Duitsland

- Project in initiatie fase
- Caverne overeenkomst getekend

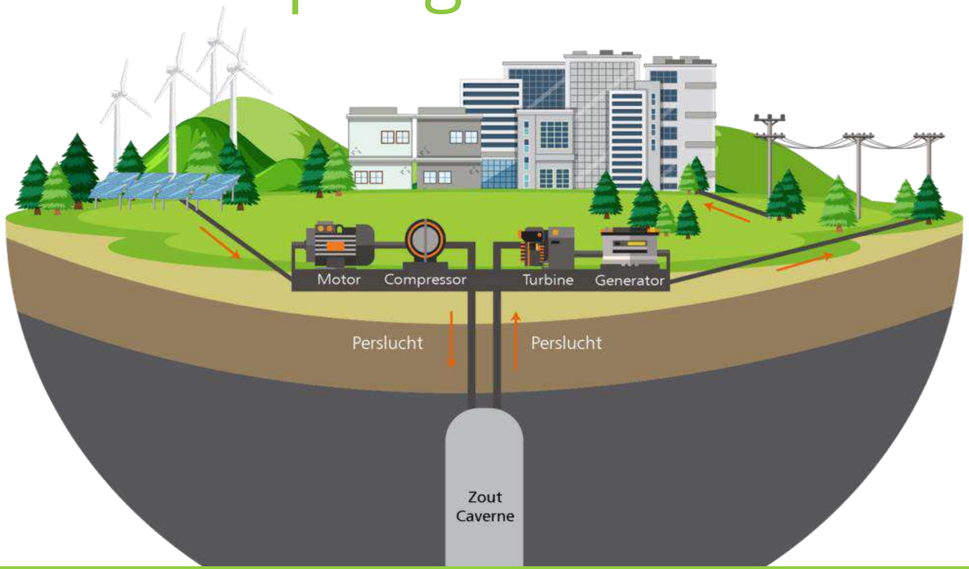
Nut en noodzaak van energie opslag – Flexibiliteit van CAES

- **Duurzaamheid**: CO_2-reductie en versnellen energietransitie
- **Leveringszekerheid**:
  CO_2- vrij regelbaar vermogen: balanceren
  Groene energie leveren
  Verlichten netwerkcongestie
- **Betaalbaarheid** : Minder uitbreiding aan het bestaande elektriciteitsnetwerk nodig omdat opslag de capaciteit van het netwerk maximaliseert. Maximaliseren van duurzame bronnen, door het minimaliseren van rendementsverlies van opgewekte energie

Het weerspatroon heeft gewoonlijk een cyclus van 3-5 dagen. Het energiesysteem is daarom gebaat bij een opslagoplossing voor dagen tot weken



Mechanische opslag van electriciteit als perslucht in zoutcavernes



Business model illustratie

Business model pijlers

Compressie van lucht naar opslag in caverne bij lage elektriciteits-prijzen

Produktie van elektriciteit uit opslag als de prijzen hoog zijn

Verkoop van balancerings-diensten op de elektriciteitsmarkt

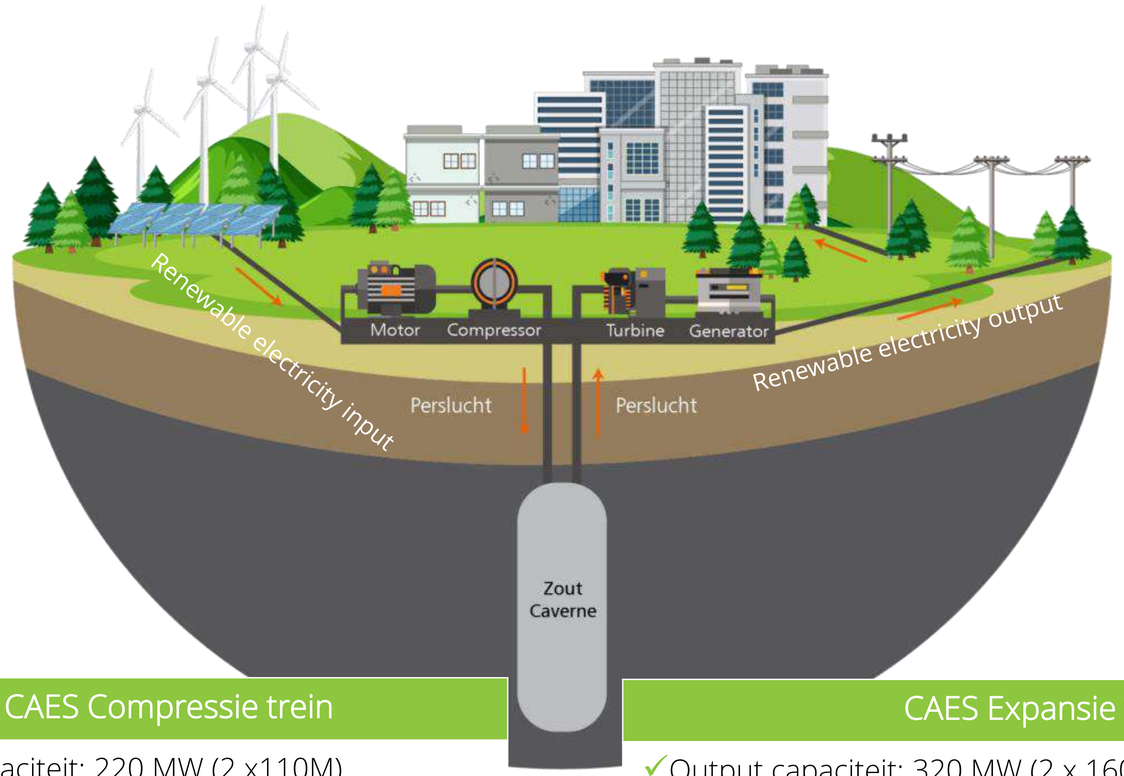
Verkoop overtollige groene waterstof-productie aan de industrie

*

Bewezen technologie

	Huntorf (Dld)	McIntosh (USA)
Caverne volume	310 000 m^3	538 000 m^3
Caverne diepte	600 m	450 m
Caverne druk	50-70 bar	45-75 bar
Compressie capaciteit	60 MW	50 MW
Expansie capaciteit	320 MW	110 MW
Ontladingstijd	~2 uur	~26 uur
Energie capaciteit	~640 MWh	~2860 MWh

Corre Energy’s CAES basis concept



CAES Compressie trein

- ✓Input capaciteit: 220 MW (2 x110M)
- ✓Start tot volledige capaciteit in 4 min
- ✓Koelen van de lucht voordat het de caverne in gaat

CAES Expansie trein

- ✓Output capaciteit: 320 MW (2 x 160 MW)
- ✓Start tot volledige capaciteit in 10 minuten
- ✓Van Min_{gen} tot volle capaciteit in 4 minuten
- ✓Verwarmen van de lucht: Aardgas, Biogas, of Groene waterstof

Opgeschaald en geïnnoveerd

CAES Zuidwending

Caverne volume	1 000 000 m^3
Caverne diepte	1100 m
Caverne druk	90-190 bar
Compressie capaciteit	220 MW
Expansie capaciteit	320 MW
Ontladingstijd	~84 uur
Energie capaciteit	~27 GWh

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SIEMENS energy

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CAES – de innovatie van bewezen technologie

Bewezen technologie

Flexibel

Langdurig

Grootschalig

Veilig

Betaalbaar

Kleine footprint/MWh

Energy Storage Day 2023

‘Innovaties in Energieopslag’

tot ziens op de netwerkborrel
paviljoen ESNL – hal 6 C035
16:00 – 17:30

11-10-2023