



REVOLUTIONISING ENERGY GENERATION WITH CO₂-FREE POWER

Th
Thorium
232.038

The Problem-Risk-Need-Analysis

RISK
Deindustrialization



RISK
Popular uprising



RISK
Oil based transportation

RISK
Coal based heat production



RISK
Constant requirement of natural resources



RISK
Transuranic nuclear waste

RISK
Chain reaction



RISK
Instabilities due to weak power-grid expansions



RISK
Volatile renewables



RISK Loss of critical infrastructure

RISK
Climate change



...all these RISKS could be avoided with ONE solution!

Criteria for a Solution

No chain reaction

Zero CO₂ emission

No risk of explosion

Non-volatile energy

No meltdown risk

No large powerlines

No Plutonium or Uranium 235

High power density

No rare-resource dependency

High profitability with global impact

Secure energy supply

Low land-use requirements for systems

No uncontrolled nuclear waste > 100,000 years

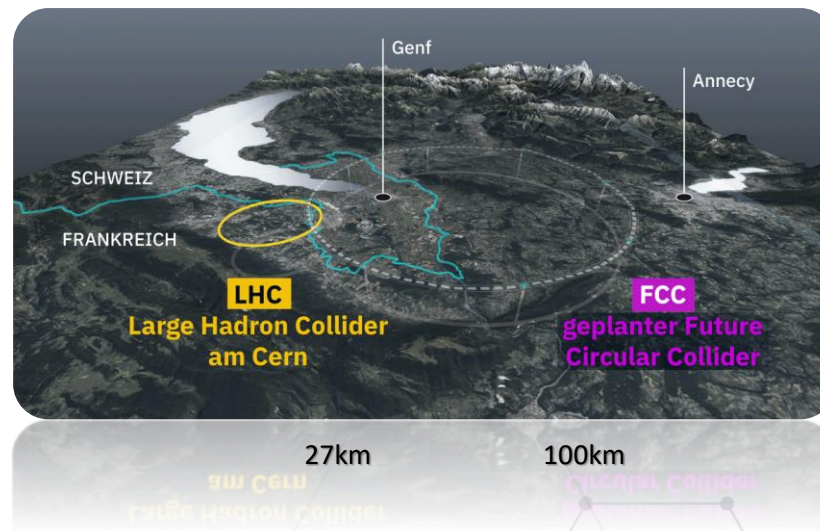
Affordable high temperature heat > hydrogen or electricity

+ USP - "WOW"-effect

+ "Proof of concept"



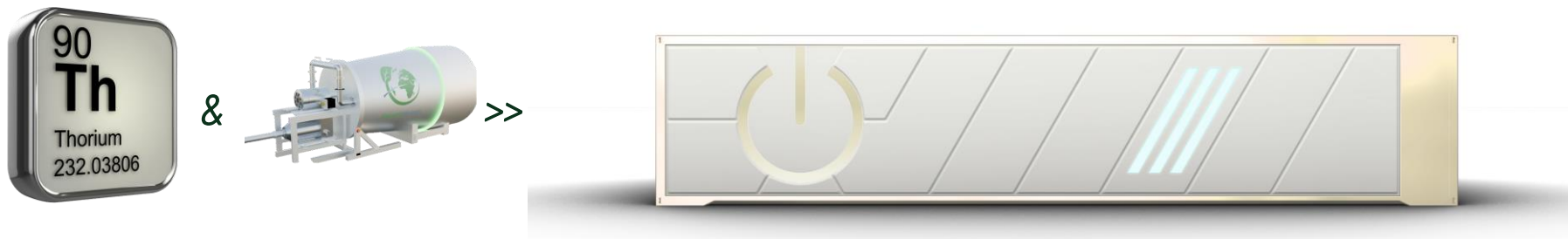
"We have an energy source that could last for thousands of years, be safer than current nuclear power and generate much less waste." Carlo Rubbia



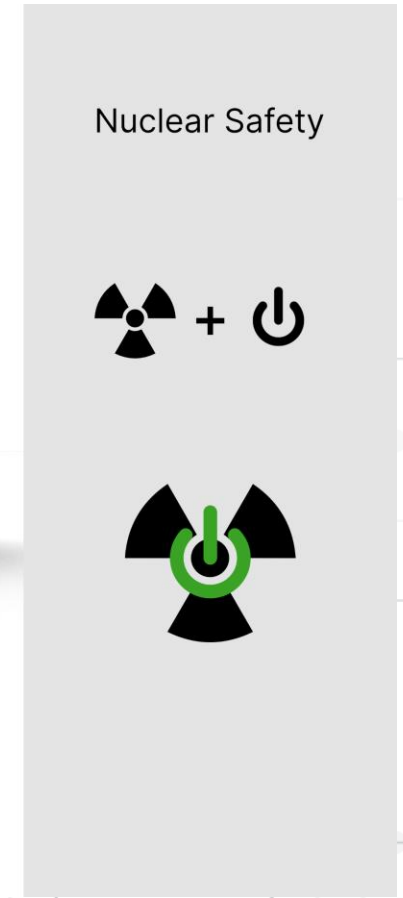
**Carlo Rubbia, Nobel Prize in Physics 1984,
CERN Director and creator of the *Energy Amplifier* concept**

>> 2019 ADES - Accelerator Driven Energy Source

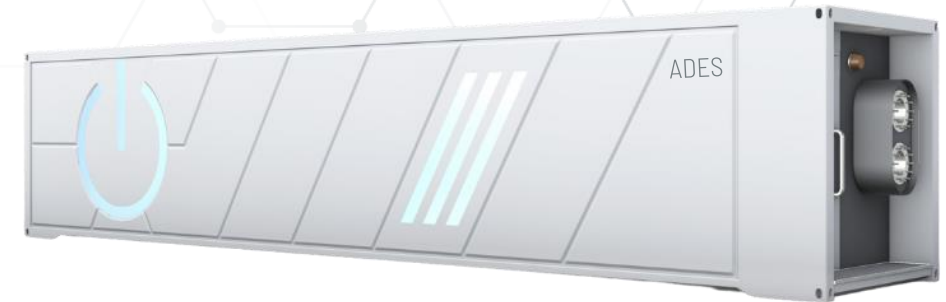
"Emerald Horizon AG is bringing this world-changing concept into series production by using Thorium & compact particle accelerators"



"We call it ADES – Accelerator Driven Energy Source" Florian Wagner

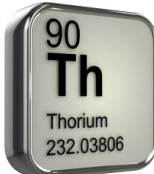


THE FUSION OF THE 4 RELEVANT FACTORS OF ADES



- ✓ No Plutonium and Uranium added
>> no transuranic waste
- ✓ No critical chain reaction needed
>> no risk of explosion

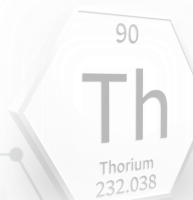
OIL vs. THORIUM (Th)

$$2.800.000 \times \text{OIL} = 0,34 \times \text{Th}$$


OIL: Barrel = 2.800.000 pcs.
 $m = 360.000.000 \text{ [kg]}$
 $E = 4,4 \text{ [TWh]}$

THORIUM energy-eq:
 $m = 440 \text{ [kg]}$ $V = 44 \text{ L} \sim 0,3 \text{ Barrel}$
 $E = 4,4 \text{ [TWh]}$

Thorium & ADES



The Scalable and Risk-Optimized Solution for CO₂-Free Energy



ON/OFF switch

- ADES has a **passive-safe ON/OFF** control unit.



AI-powered optimization

- ADES **leverages AI** to **adjust its power output** based on the installation location.
- ADES thereby ensures **optimal performance** in **diverse environments**.



No traditional nuclear waste

- **80%** of thorium is **converted** into energy. Even the remainder contains raw materials that **can be reused**. No final repository for nuclear waste is hence necessary.
- ADES **produces 0% transuranic waste** of Plutonium, Neptunium, Americium and Curium, ... known as "nuclear waste".
- It only produces radioactive fission products with short half-lives.



No chain reaction

- ADES runs **subcritically**.
- When the injector impulses the thorium, it causes a reaction - **but no critical chain reaction** - making ADES much safer than conventional nuclear power plants.
- Zero explosion risk since there is **NO overpressure** and **NO water / steam**.



Minimum maintenance

- The final ADES module **will not need to be serviced** continuously.
- A **Safety Security Environment Software** will ensure safe control.
- No refueling required for 20 years



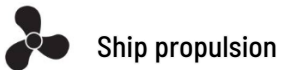
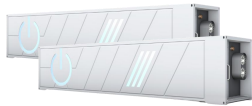
1 x ADES module: 25 MW(th) for 20 years



.. can be combined
to create the largest system in the world!

ADES – MULTIPLE USE CASES

ADES ideal for hydrogen production



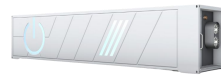
Ship propulsion

20-year term without refueling

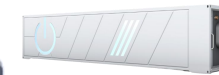
ADES for critical infrastructure -protects life



ADES modules can make a hospital self-sustaining
- i.e. used without energy from other sources
- Ideal for military base as well

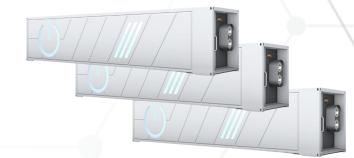


ADES enhances wind, water and solar energy by giving them stable production as well



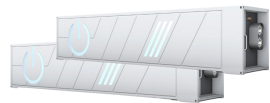
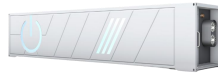
UPGRADE of conventional & nuclear power plants

ADES modules can replace conventional (Oil | Gas | Coal) and risky nuclear power plants. The infrastructure can still be used – the modules only enhance the existing plants



ADES for energy-intensive industries

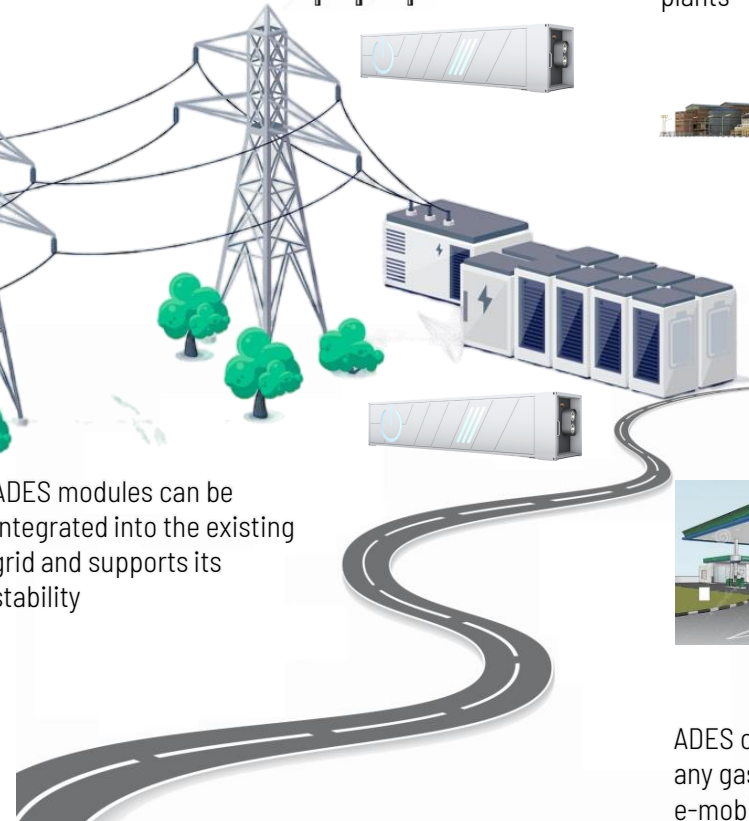
ADES can be installed directly at industrial companies that have a high demand of heat, hydrogen or electricity



ADES can be used for **data centres** to support AI or other critical infrastructure directly

ADES can be used as a redundant electricity support to make the conversion to carbon free real estates possible. 1ADES = 10.000 households

ADES modules can be integrated into the existing grid and supports its stability



ADES can be brought to any place in the world at any time - emerging markets e.g.

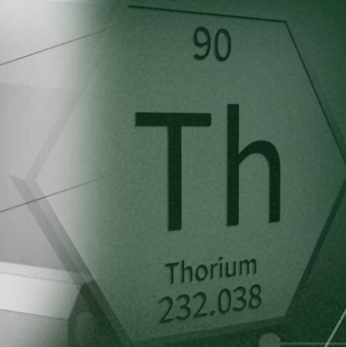
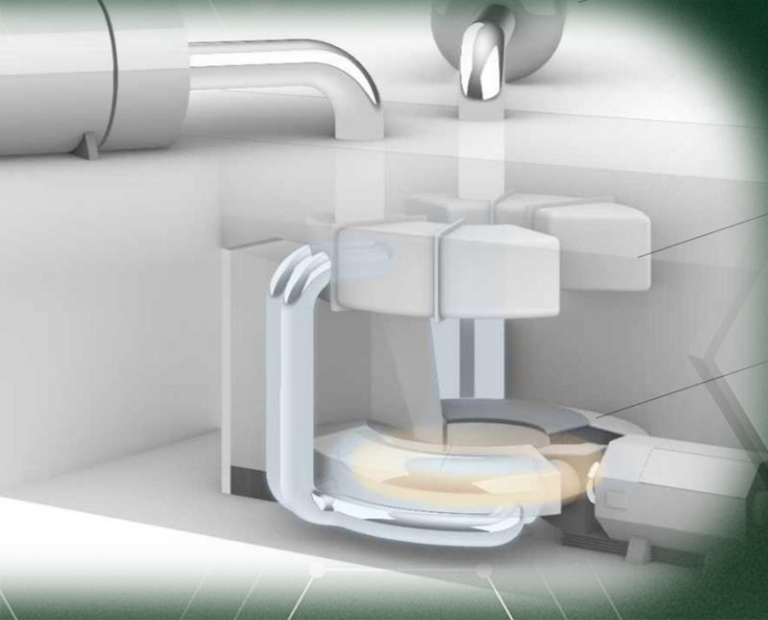
ADES for e-mobility



ADES can be installed at any gas stations to make e-mobility charging possible everywhere

ADES for desalination





Megatrend AI – Many companies are investing in SMR now

SMR vs. ADES

Without transuranic waste & no chain reaction risk

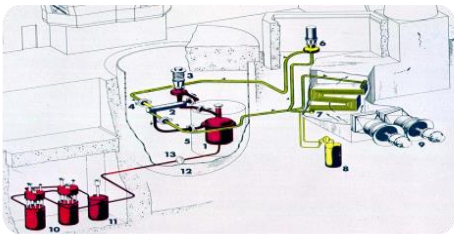


→ ENERGY/FUEL



THORIUM
USAF 50s

→ LIQUID CARRIER



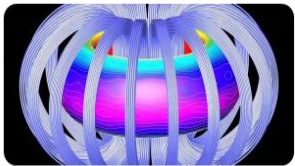
MOLTEN SALT REACTOR
OAKRIDGE 60s

→ HIGH TEMP



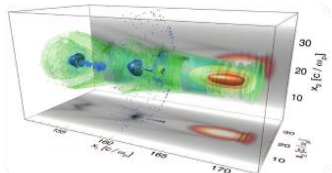
THTR-300
Germany 1983-89

→ GEOMETRY



FUSION
ITER 50s+

→ SHRINK ACC



WAKEFIELD
CHIRP 2010+

→ SIZE OF REACTOR



NUCLEAR SUBMARINE

→ ACCELERATOR



ACCELERATOR
CERN 50s+

→ HEUREKA

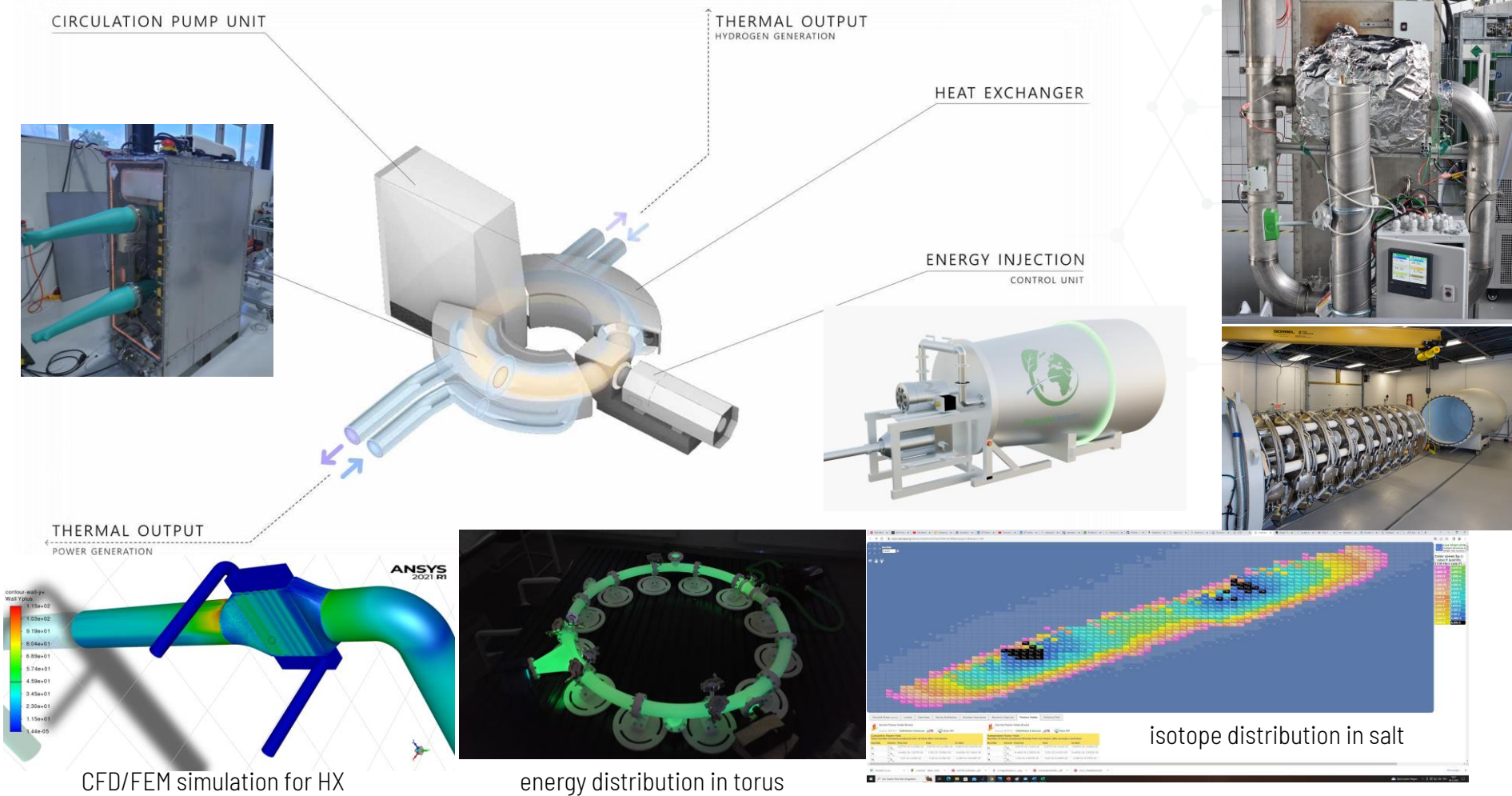


AMPLIFIER
Carlo RUBBIA 80+90s

ADES

accelerator driven energy source

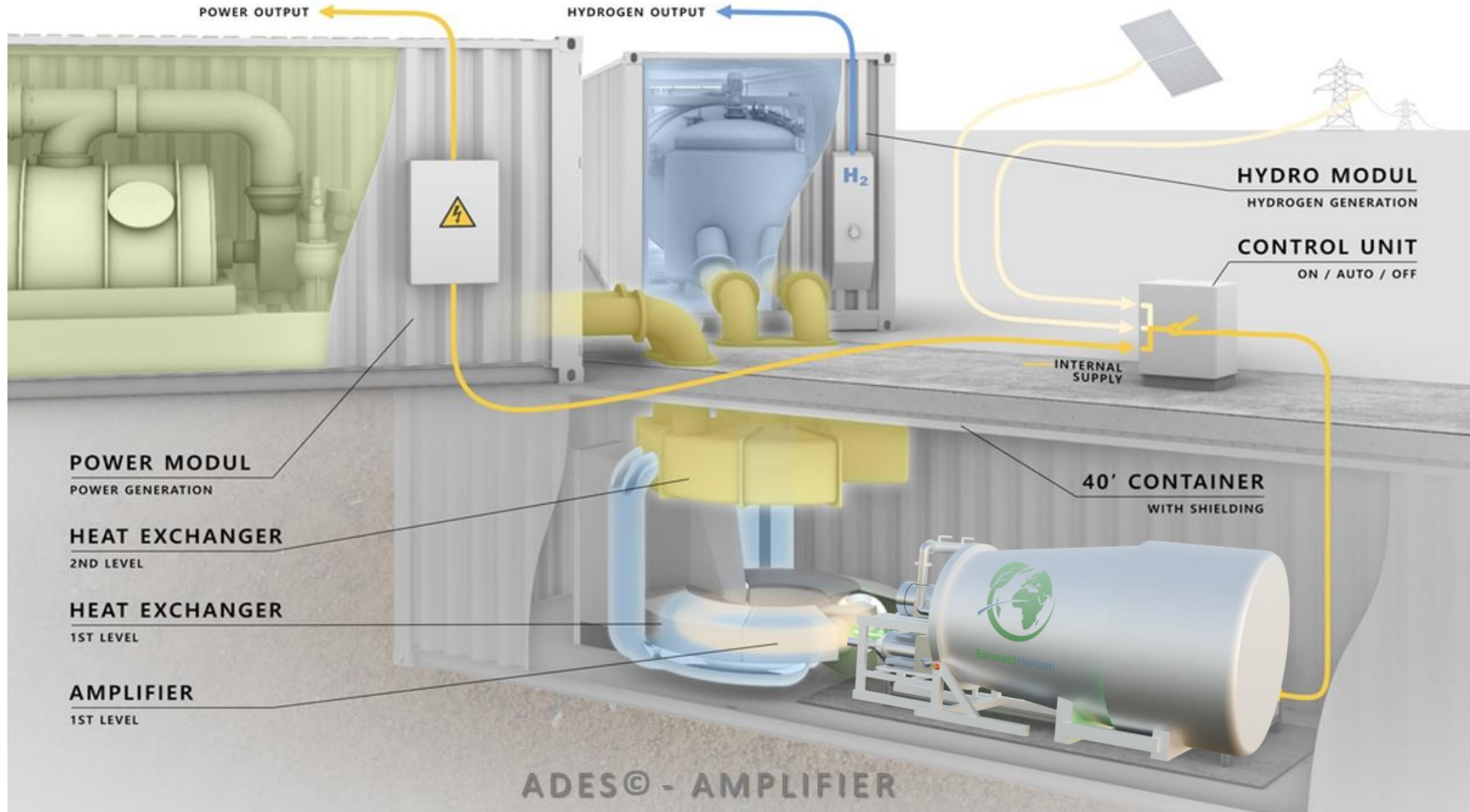
PROTOTYPE – ALREADY UNDER CONSTRUCTION



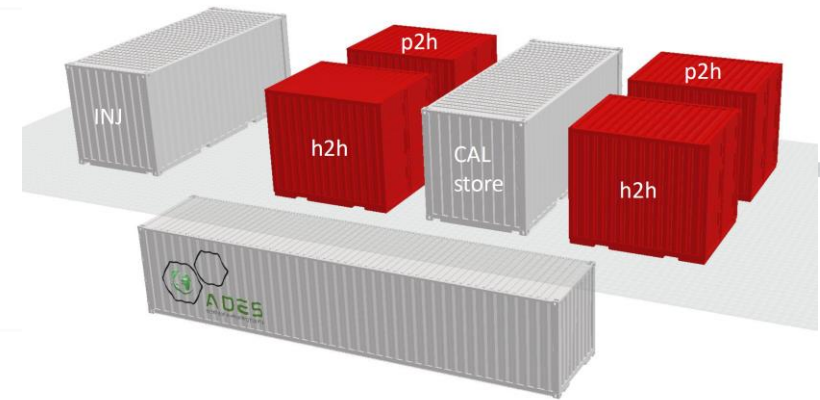
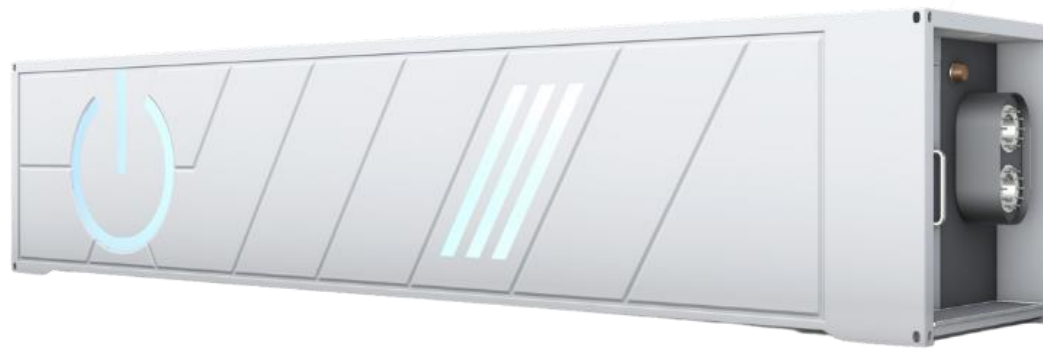
SAFETY CONFIRMATION

First ADES analogue-prototype illustrates basic principles: with injection (from left) energy level increases (represented by green light) – no injection: immediate shut down, which is the significant difference to the self-sustaining chain reaction in recent NNPs – even next generation NPPs (version 3+4) are based on chain reaction. ADES nuclear energy generation is fundamentally new – no criticality because of external neutronic control WITH ENERGY INJECTION (Particle Accelerator).

SERIAL PRODUCT - 25MW(th) - 20-year term without refueling

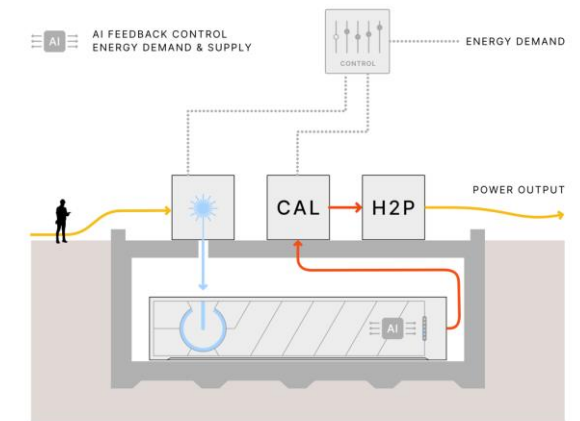
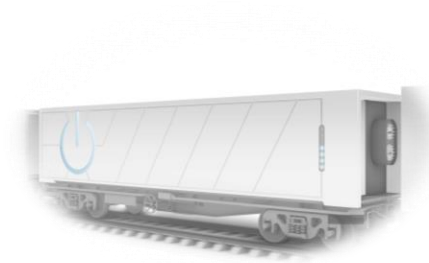


Energy Generation with NO CARBON EMISSION



Solution: A (Accelerator) D (Driven) E (Energy) S (Source) – ADES

- **No Carbon emission / CO₂-free** – EaaS: Energy as a Service
- **Up to 25 MW(th) of non-volatile power** – grid integration via CALstore & AI
- **Self-sufficient fuel supply** – factory fill last up to 20 years (no refill required vs. OIL | GAS | COAL | WOOD | URANIUM)
- **Intrinsic safety**, energy harvesting with ADES based on Thorium (100%) runs sub-critical (Safety-Key #1) with ON/OFF button (Safety-Key #2)
- **No classical nuclear waste, just small amount of fission products** – no transuranic like Plutonium, Americium, Curium or Neptunium (“nuclear waste”)



Integrated Unit

OFFICE TOWER and R&D EMERALD HEADQUARTER and CO-development & serial production by VDL



4,500m2
Laboratory

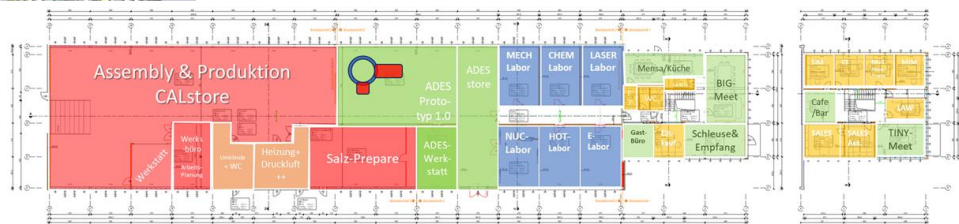
9-figure
valuation

8-figure
raised capital
and loan

7-figure
grants

8 patents
(directly or
indirectly access)

3 neutron
accelerators
(cancer use case)

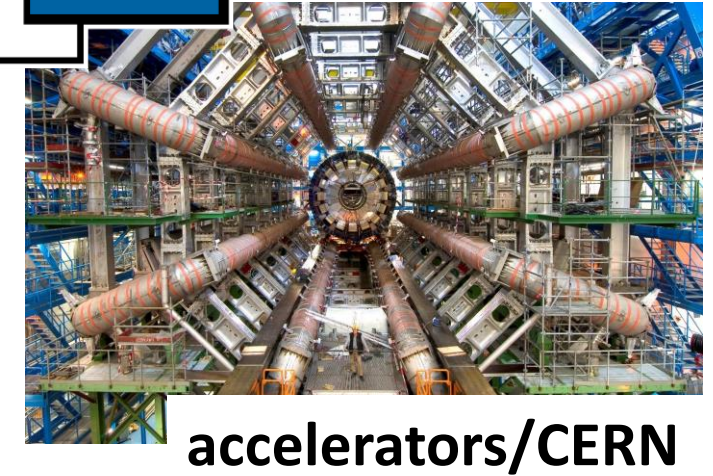
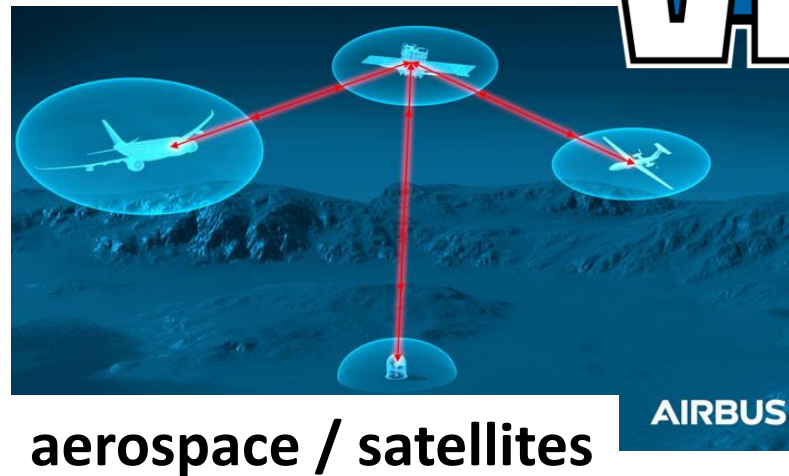
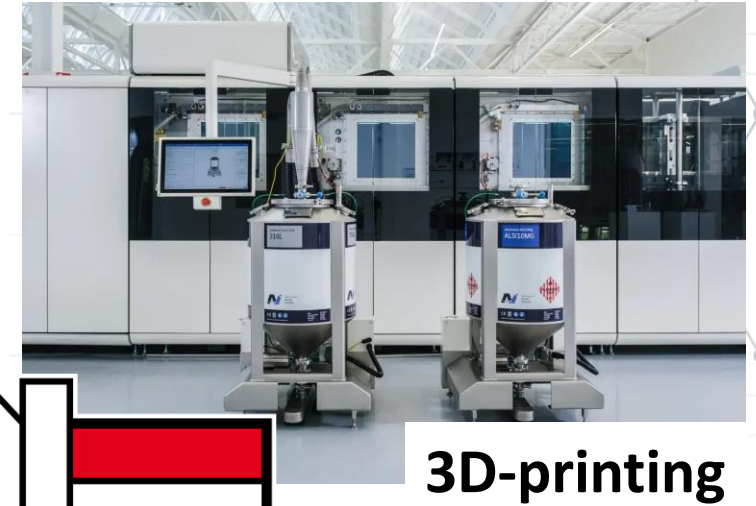
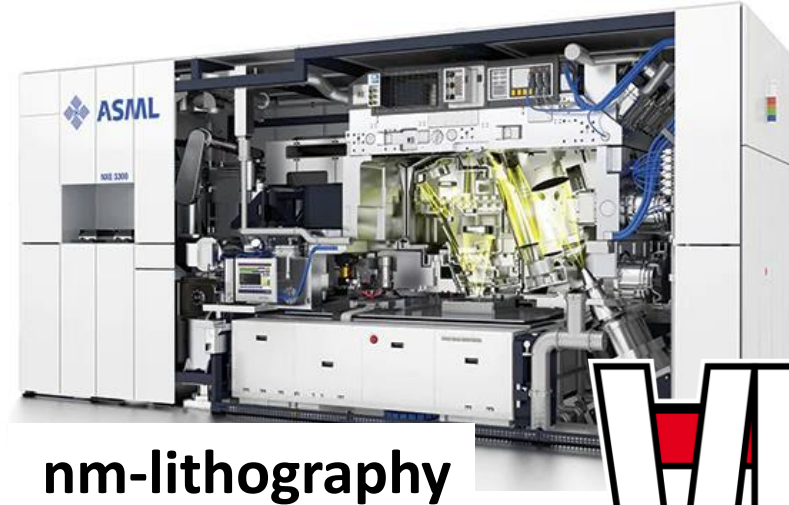


37 people + VDL MULTI TEAM

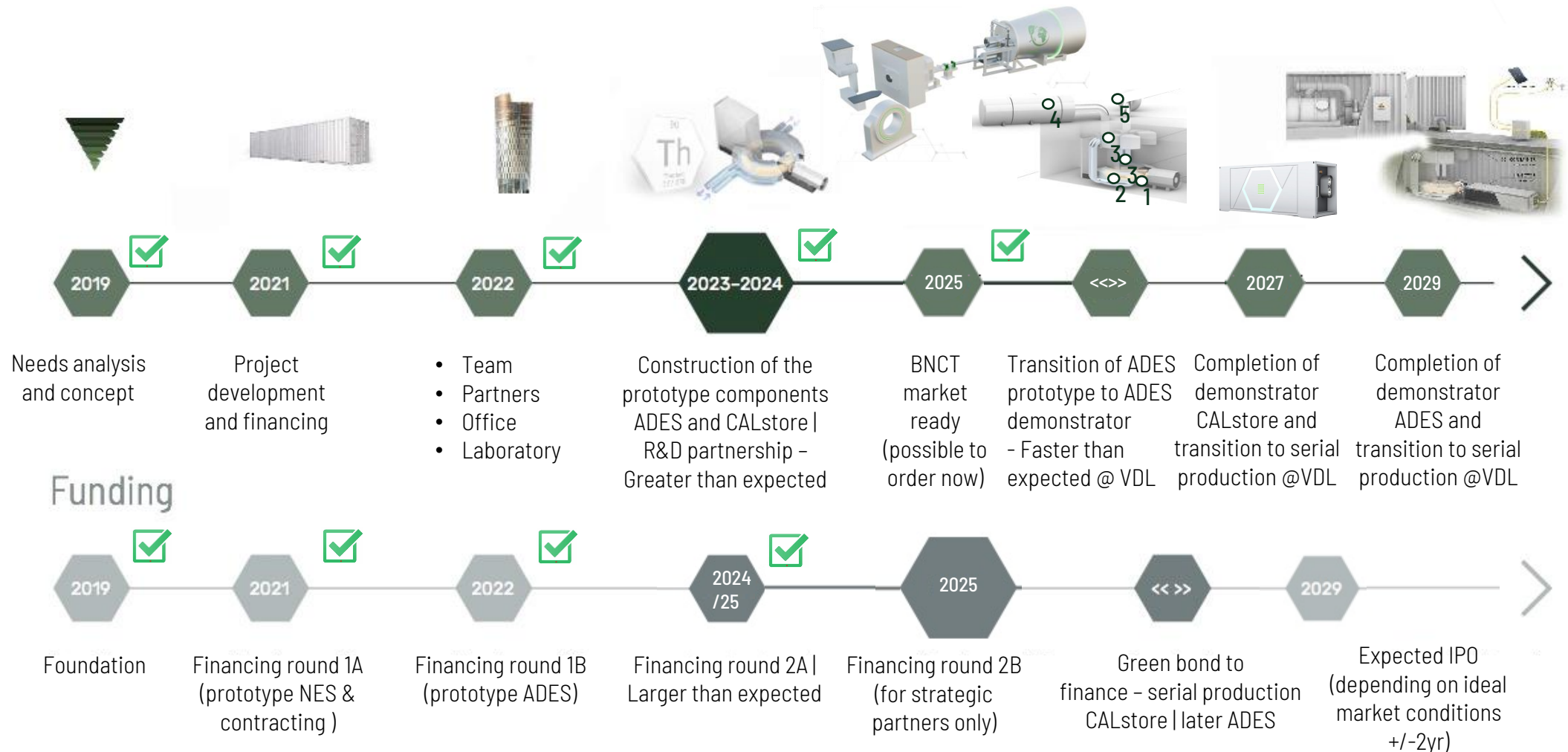
(internal & external) Expert-fields are: electrical-, mechanical- & chemical engineering, nuclear physics, LASER & plasma-physics thermodynamics, multi-physics simulations

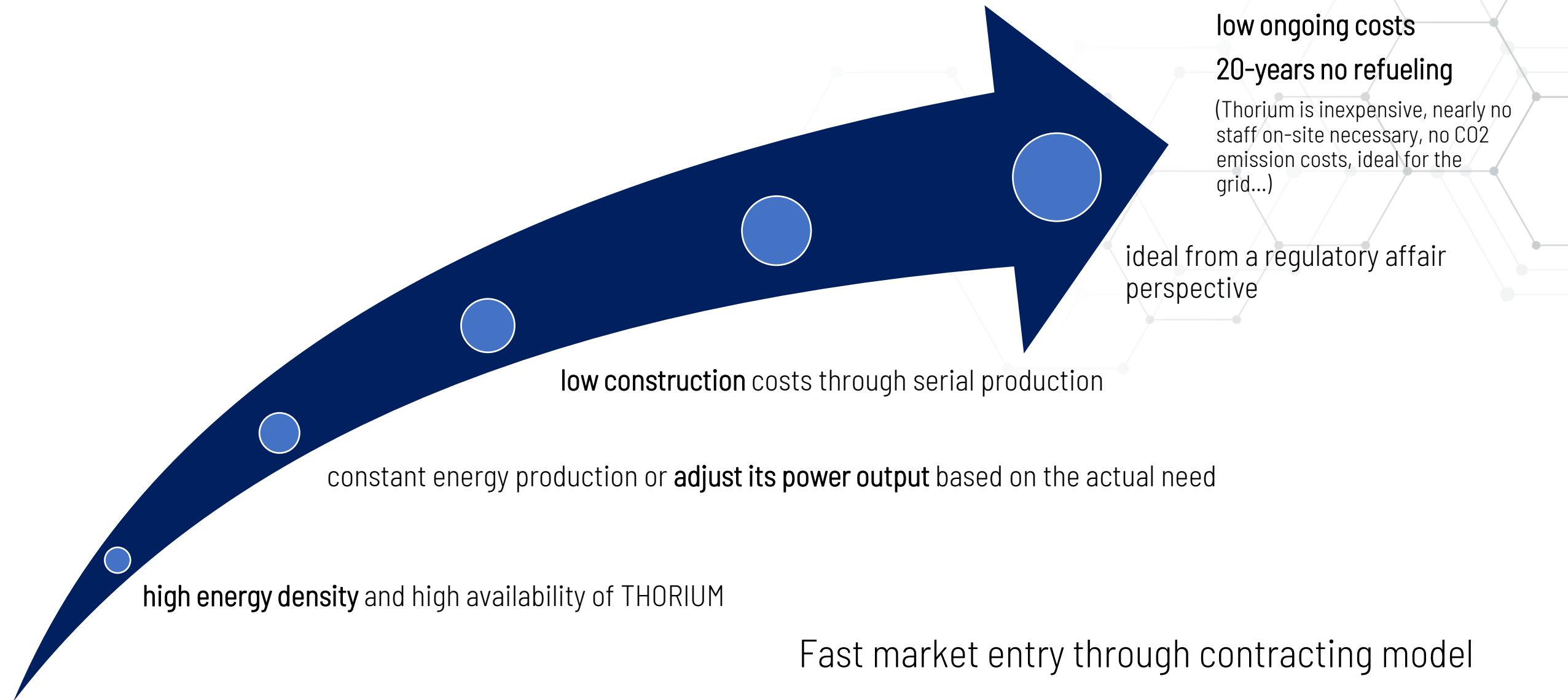


- o VDL Groep as ADES cooperation partner is a Dutch high-tech industrial leader specializing in advanced manufacturing for semiconductors, aerospace, and energy sectors.
- o VDL plays a key role in nm-lithography for ASML, accelerator components, and satellite technologies, delivering ultra-precise, high-end engineering solutions.
- o With cutting-edge expertise in mechatronics, precision machining, and system integration, VDL is the perfect partner for Emerald Horizon.



ADES – R&D PROGRESS





COMPETITOR COMPARISON – NUCLEAR

ADES covers all 7 key areas

Technologies with a development horizon of 10+ years that have been made visible (press releases, databases, platforms) and are serious competitors to Emerald must show affinity in the following categories:

1. High energy density
2. Liquid salt transfer technology
3. High temperature technology (> 500°C);
4. Scalability for energy source and storage
5. Modular mechanical engineering solution with potential for industrial series production
6. Energy source and/or storage for nuclear energy without chain reaction
7. Primary energy source thorium (no uranium or plutonium)

There are technological competitors, in the segment of SMRs (Small Modular Reactors) to which Emerald's ADES can be partially assigned, in individual areas, but none that cover all 7 areas described above.

Name	Design organisation	Headquarter (city/region)	Country	Thermal power (MWth)	Outlet temperature (°C)	Spectrum (thermal/fast)	Fuel type
ARC-100	ARC Clean Technology	Saint John, New Brunswick	Canada	286	510	Fast	Metallic U-Zr alloy
CAREM	CNEA ¹	Buenos Aires	Argentina	100	326	Thermal	UO ₂ pellets
ACPR50S	CGN ²	Shenzhen	China	200	321.8	Thermal	UO ₂ pellets
ACP100	CNNC ³ and NPIC ⁴	Hainan Province	China	385	319.5	Thermal	UO ₂ pellets
Nuward	EDF ⁵	Paris	France	540	307	Thermal	UO ₂ pellets
BWRX-300	GE-Hitachi/Hitachi-GE	Wilmington, North Carolina	United States	870	287	Thermal	UO ₂ pellets
Hermes	Kairos Power	Alameda, California	United States	35	585	Thermal	TRISO pebble
SEALER-55	Leadcold Reactors	Stockholm	Sweden	140	432	Fast	Uranium nitride
Stable Salt Reactor - Wasteburner	Moltex Energy	Saint John, New Brunswick	Canada	750	590	Fast	Molten salt fuel
VOYGR	NuScale Power	Portland, Oregon	United States	250	321	Thermal	UO ₂ pellets
Aurora	OKLO	Sunnyvale, California	United States	4	500	Fast	Metallic U-Zr alloy
Rolls-Royce SMR	Rolls-Royce SMR Ltd	Manchester	United Kingdom	1 358	325	Thermal	UO ₂ pellets
KLT-40S	Rosatom	Moscow	Russia	150	316	Thermal	UO ₂ pellets
RITM-200N	Rosatom	Moscow	Russia	190	321	Thermal	UO ₂ pellets
RITM-200S	Rosatom	Moscow	Russia	198	318	Thermal	UO ₂ pellets
Natrium	TerraPower	Bellevue, Washington	United States	840	500	Fast	Metallic U-Zr alloy
HTR-PM	INET ⁶	Beijing	China	500	750	Thermal	TRISO pebble
MMR	Ultra Safe Nuclear	Seattle, Washington	United States	15	630	Thermal	TRISO prismatic
U-Battery	Urenco	Stoke Poges	United Kingdom	10	710	Thermal	TRISO prismatic
eVinci	Westinghouse Electric Company	Cranberry Township, Pennsylvania	United States	13	750	Thermal	TRISO
XE-100	X-energy	Rockville, Maryland	United States	200	750	Thermal	TRISO-X pebble

Source: NEA Small Modular Reactor Dashboard, 2023)

KLEINE ZEITUNG

Steirischer Investor will Atom Müll zu Strom machen

von Roman Vilgut | 08. November 2019

Business

Green Future | Innovative Wege zur grünen Zukunft

Redaktion | April/Mai 2021



© Klemm/Schöndt



UN Climate Initiatives Insights

Die Presse

Thorium-Reaktoren: Gefährlich oder Zukunftstechnologie?

Redaktion | Mai 2022

DER STANDARD

Suche nach Alternativen - Kann Thorium bei der Energiewende helfen?

Redaktion | August 2022

future zone

Grazer Unternehmen will einen besseren Atomreaktor bauen

Redaktion | September 2022

THE EARTHSHOT PRIZE**BBC**

Emerald Horizon NOMINATED 2025

**Kann dieser Mann Atomkraft sicher machen?**

© Florian Voggeneder

THE RED BULLETIN INNOVATOR

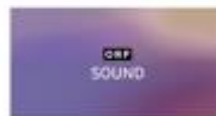
THE RED BULLETIN INNOVATOR

Redaktion | März 2023



Grazer Firma bastelt an Atomkleinkraftwerk

Redaktion | November 2022

ORF Radio
Radio Steiermark,
Journal vom 16.11.2022

Redaktion | November 2022

IMPRINTEmerald Horizon AG
Karl-Huber-Gasse 15
Emerald Lab Building
A-8041 Graz
AUSTRIA/Europa

Tel: +43 316 574648

E-Mail: office@emerald-horizon.com

Company register number: FN517877i

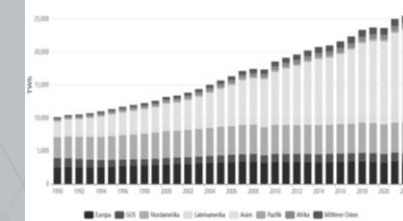
Commercial Register Court: Landesgericht für ZRS Graz

SPIRIT START-UP AWARD

TEAM



1. **The idea** – the concept – one universal energy module for several use cases with clear benefits compared to competitors ensures exponential growth and clear benefit for the environment
2. **The brains** – 37 experts – soon more than 100 with over 1,000 years of total experience & partner network



SOLUTION



FAST MARKET ENTRY



HIGH SAFETY

3. **High availability** in the near future – modular design prepared for serial production – less than 10 kg of Thorium meets the annual energy demand for 10,000 households.
4. **High safety** – accelerator driven – no chain reaction, no plutonium, no risk of explosion, no risk of meltdown, significant reduction of isotopic half-life.



MARKET POTENTIAL



LOW COSTS & HIGH INCOME

5. **High Income** & cost efficiency – high energy density, highly available, constant energy production, fast market entry through contracting model, low ongoing costs (Thorium is inexpensive, no staff on-site necessary, no CO2 emission costs,...), low construction costs through serial production- prepared for increasing demand
6. **Low investor risk** because of solid basic research – (based on 2 Nobel price laureates and a national laboratory) + „It's just one container @ risk“
7. **Low raw material risk** –Emerald Thorium reserve + Thorium deposit all over the world (6mio tons) – in Austria, too





CALstore

CALSTORE – A 5 MWH MOLTEN SALT ENERGY STORAGE SYSTEM

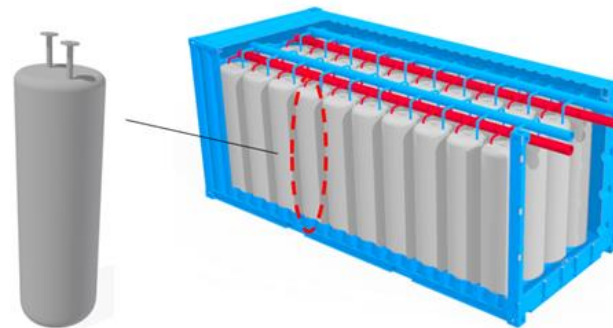
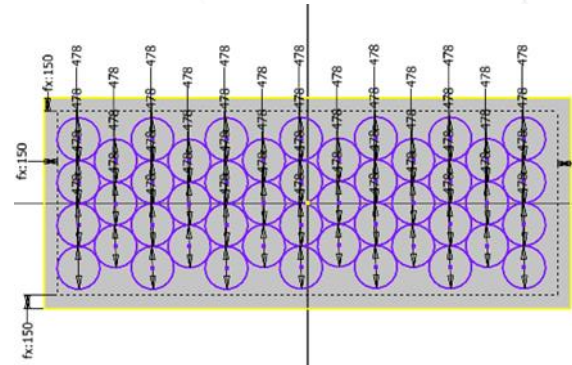
CALstore is a 5 MWh Molten Salt Energy Storage System to balance energy oversupply with required demand.

It is not degrading, affordable and scalable:

- The system maintains stability in both **low and high temperature** conditions.
- As salt has a high energy density, CALstore **stores large amounts of energy (5 MWh)** which can be released when needed
- The system is **entirely water-free**, eliminating the risk of vapor pressure or detonation gas reactions.
- **Abundant, cheap, and well available salts** like potassium nitrate and sodium nitrate are used. These salts have the capacity to store substantial amounts of energy in a minimal space.
- **The configuration is adaptable** (salt mixture, storage capacity and temperature range) depending on the specific energy input and output requirements. The **scalability of the system** ensures mass-production.
- As the system is not degrading, **the storage capacity remains constant** over the life-cycle and requires only minimal maintenance.



- o The CALstore_battery is the smallest unit of the cellular system reaching out for scalability and modularity .
- o Container integration will be finalized in 2025 – up to 40 CALstore_batteries per 20-ft CALstore.
- o Energy input and output via heat transfer through the HX (h2h). Additionally, a power-to-heat (p2h) function is integrated.
- o Each CALstore_battery can store approx. 100 kWh of energy, with exchange power capacities of up to 20 kW.
- o A heat transfer system is currently in development as a closed-loop process – supporting h2h, p2h, and h2p subsystems.



Salt Mass	Salt Latent Heat	Specific Heat Capacity Liquid J/kg K	Temperature Lower Limit	Temperature Upper Limit
526.95 kg	116 kJ/kg	$\int_{T_1}^{T_2} 1443(T) + 0.86(T^2)$	225 °C	500 °C

Emerald Horizon, together with its partners, offers the most innovative cancer treatment:

Accelerator Driven Boron Neutron Capture Therapy



MEDtech
AD-BNCT

World's **only IAEA-compliant BNCT beam**

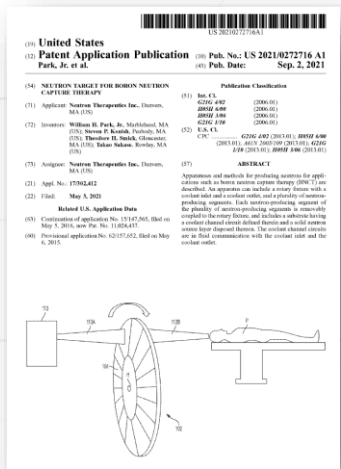
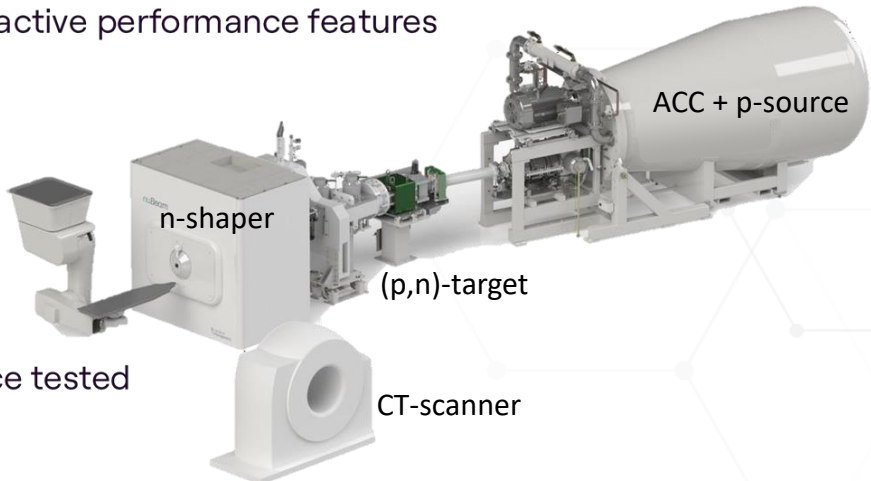
Low energy & high current (30mA) provide attractive performance features

- Short treatment times ~20 minutes
- Higher patient throughput
- Better patient experience and comfort

Designed with **uptime & serviceability** in mind

- Uses proven industrial technology
- DC accelerator is robust, reliable & endurance tested

Proven technology



**AVAILABLE
FOR ORDER**

BNCT has a higher RBE and can be delivered in fewer treatments compared to other forms of external beam radiation oncology

	BNCT	Photon Radiotherapy (X-Ray & Gamma Ray)	Proton Beam Therapy (PBT)	Carbon Ion Radiation Therapy (CIRT)
Approx. Number of Treatments (Fractions)	1-2	40	30 15-20 for H&N	20
Relative Biological Effectiveness ³	3.8	1.0	1.1	3.0

RBE = Ratio of biological effectiveness of one type of ionizing radiation relative to standard radiation

BNCT is a compelling modality for cancer treatment



Low Treatment Frequency
Tumor eradication may be possible in as little as one to two treatments



High Throughput
With the use of image-guided patient positioning



Safe Operation
Safe for staff, negligible radiation risk



Cost
Installation and treatment costs are a fraction of proton therapy or carbon ion



Strong Reimbursement Potential
In comparison to per session rates of other comparable treatment types



Minimal Downtime
Approximate 30 minutes per session treatment time allows for treatment of more patients



Footprint
Comparable to current radiotherapy installations



Clinical Proof of Concept
Approved in Japan for head & neck cancer

AD-BNCT – Cancer Therapy with ADES Technology

Basic Boron Neutron Capture Therapy (BNCT) is a targeted cancer treatment that relies on the accumulation of **boron-10 isotopes** in tumor cells. These cells are then irradiated with **low-energy neutrons**, triggering the production of **high-energy alpha particles**, which selectively destroy the cancer cells.

Originally proposed in the **1930s**, early BNCT trials faced challenges due to the reliance on **nuclear reactors as neutron sources**, limiting both **accessibility and precision**. However, advancements in **boron compounds and targeting methods** have significantly improved **tumor cell selectivity**, leading to **better therapeutic outcomes**.

More recently, the integration of **compact particle accelerators as neutron sources** has transformed BNCT into **AD-BNCT**, eliminating the need for large nuclear reactors. **AD-BNCT has made treatment facilities safer, smaller, and more practical**, enabling **decentralization of the therapy** and broader accessibility.

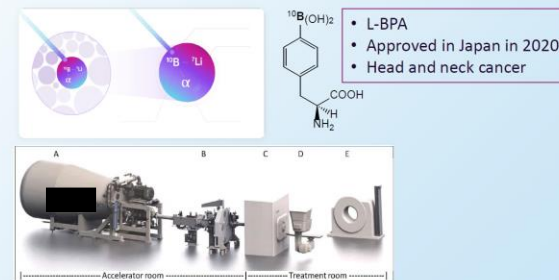
Emerald Horizon, with its expertise in **accelerator-driven systems** (see: ADES, a **disruptive nuclear energy source**), provides **neutron physics know-how** and supports the **establishment of BNCT centers in hospitals** instead of specialized research reactors.

As a result, **AD-BNCT is becoming a more viable and promising treatment for hard-to-treat cancers**, offering **high precision with minimal impact on surrounding healthy tissue**.

BNCT requires use of a boron delivery agent and tumor irradiation with safe neutrons



Boron delivery agents enable targeted cell death with minimal impact on adjacent normal tissues



General requirements for boron delivery agents

- (1) Low intrinsic toxicity
- (2) High tumor uptake ($\sim 20\text{--}50 \mu\text{g } ^{10}\text{B/g}$ tumor), low normal tissue uptake, ideally with a tumor:normal tissue and tumor:blood boron concentration ratios of $>3:1$
- (3) Relatively rapid clearance from blood and normal tissues, and persistence in tumor for at least several hours during neutron irradiations.

Confidential - Do not distribute

Aviko Radiopharmaceuticals Inc. © | 47



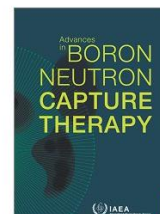
#Japan2023_NewTherapy4cancer.pdf



cancers-16-00869.pdf



CANCERSpub2023_LatestBNCTacts.pdf



CRCP-BOR-002_web.pdf



Hirose_et al_BNCT_HN_2021.pdf



IAEApub2020_ImprovedCancerTreatmentBNCT.pdf



Igaki_et al_2022.pdf



kawabata- GBM BNCT 2021.pdf



Maoluf BNCT Clinical Review 2021.pdf



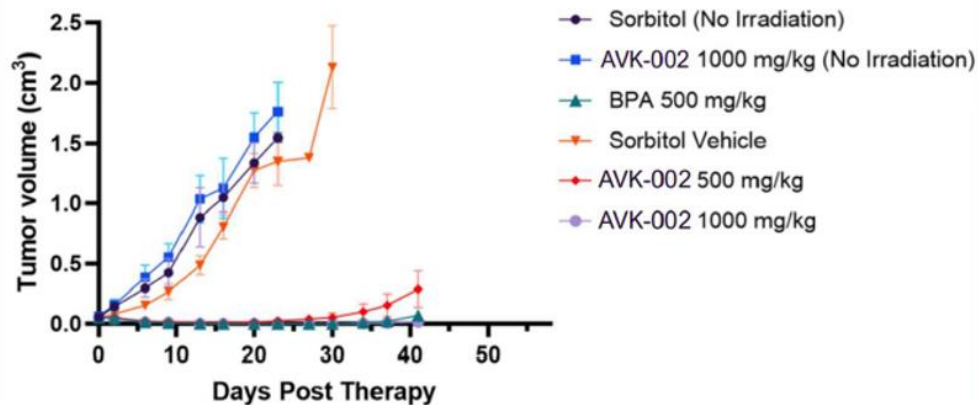
Suzuki_2020.pdf

Preclinical studies of Boron and neutron irradiation causes tumor regression in a model of HNSCC

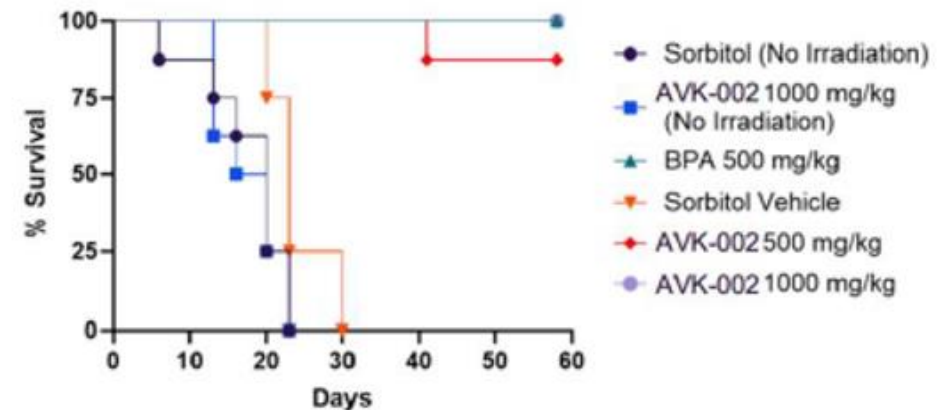
- o Neutron irradiation alone has minimal impact on tumor growth (27 minutes, skin doses of 6 Gy eq.)
- o Both BPA and Boron drug cause tumor regression in combination with neutron irradiation
- o 1.000 mg/kg Boron drug causes durable tumor regression and prolongs survival

Group	Description	Dose (mg/kg)	Irradiation	N
1	Sorbitol	---	N	8
2	AVK-002	1000	N	8
3	BPA	500	Y	8
4	Sorbitol	---	Y	8
5	AVK-002	500	Y	8
6	AVK-002	1000	Y	8

SAS Tumor Xenograft: Group Average Tumor Volume



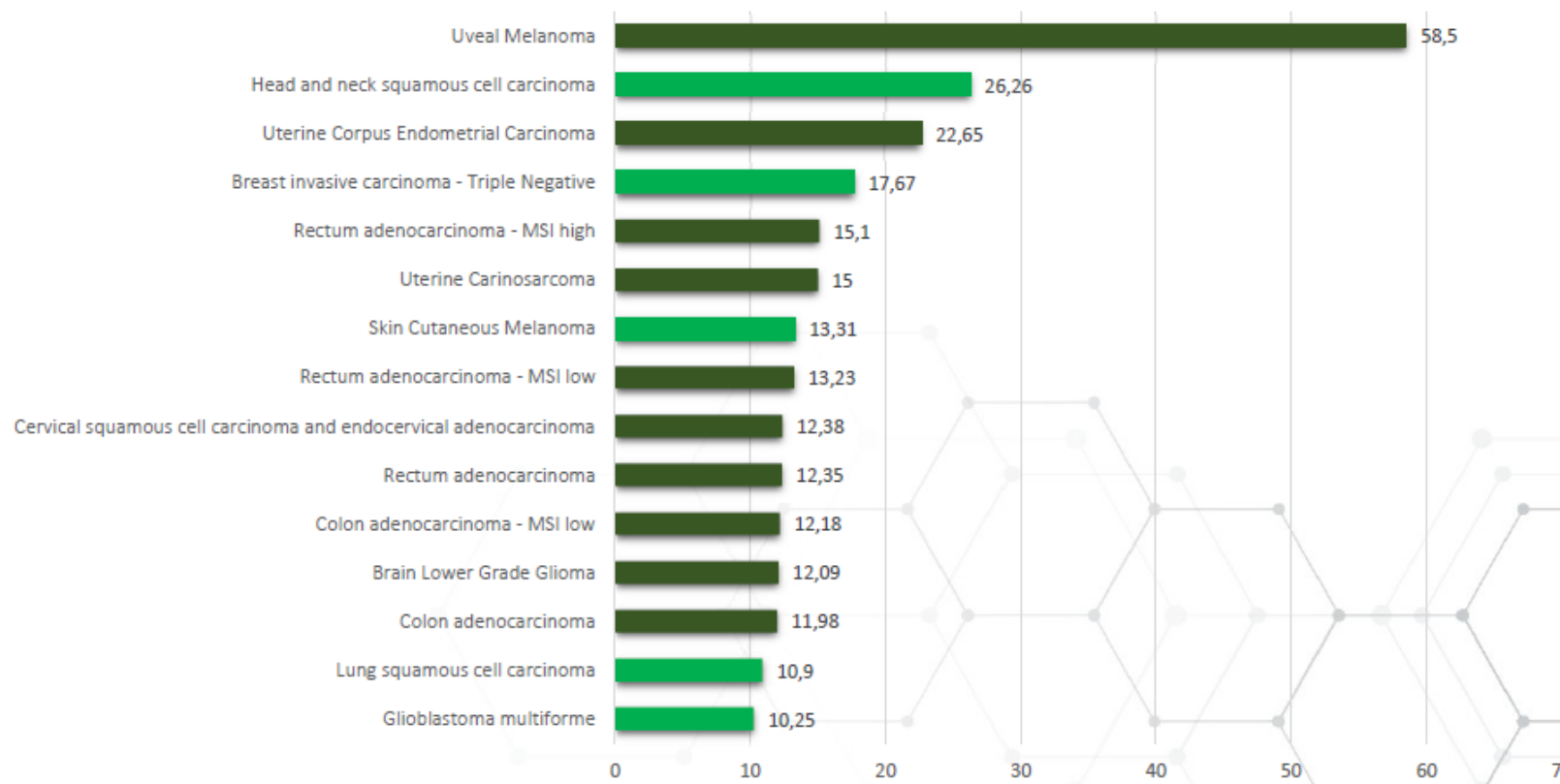
Survival - Weightloss Excluded



As the boron compound specifically targets and accumulates in cancer cells through uptake by LAT-1, there is a significant treatment potential for the following cancer indications through AD-BNCT.

All values above 3.5 are sufficient to proceed with the treatment.

LAT-1 expression compared to healthy tissue



- Consistent, high-duty operation demonstrated over a 3-year period
- Verification & Validation testing successfully completed
- Regulatory approval and CE marking achieved
- First Patient treatment in early 2025



ORDER of AD- BNCT | PREORDER of ADES

5m deposit per module + Delivery order based on time of order ++ 15% Discount compared to offer price

Contracting: all inclusive price per kwh ADES / treatment –AD BNCT – the deposit will be offset

If we are unable to deliver, the deposit will be returned

OFFER FOR INVESTORS

Investor Round 2b – strategic investors only

1. Q2 2025 –valuation at 790m (75m – target: diversified group of investors ~ 5-10m each)|
2. thereafter- new valuation at a range of 1,5-2,1b (150 m available – target one or two investors only)
3. Outlook: 3 joint ventures for 3 TERRA-factories (estimated price 1,8 and 2,8 bn each – produced by VDL)

