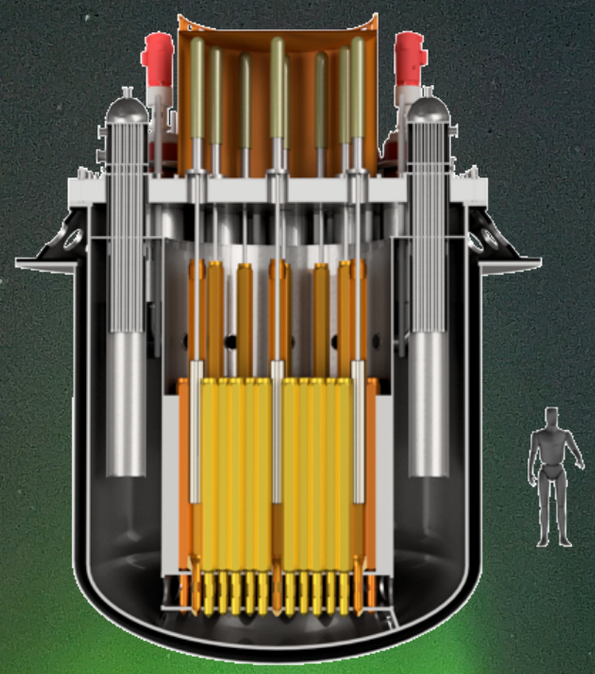
The programme for commercialization of SEALER SMRs in Sweden



The future of nuclear power

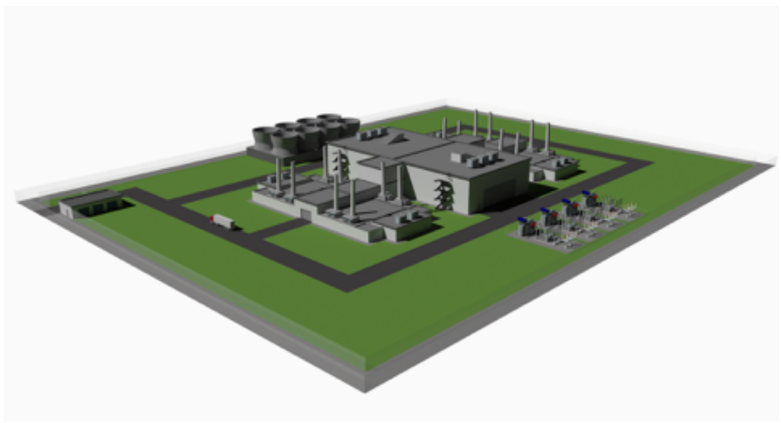
Janne Wallenius

LeadCold

CET 2022, Oskarshamn

Problem formulation

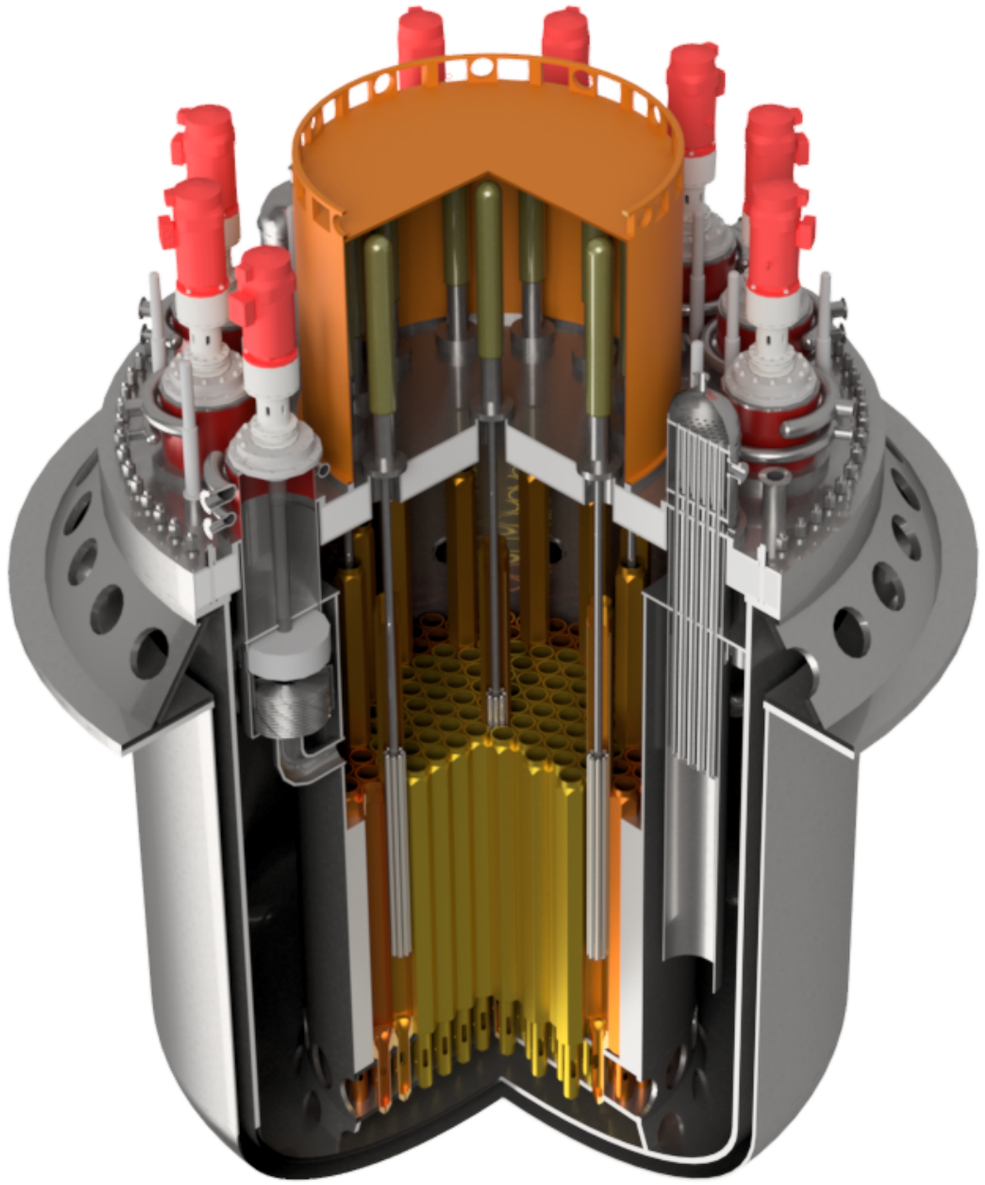
2022



2030

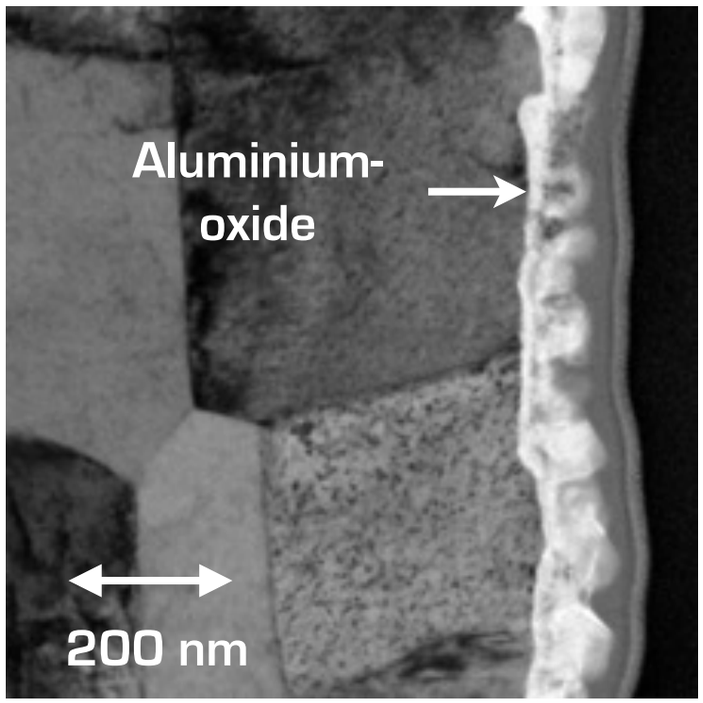
- 450 commercial reactors produce 25% of world's climate friendly electricity.
- Global use of electricity expected to double until 2050.
- Quality problems during nuclear new-build of large light water reactors cause increased costs: 10 G€/unit, out of which 50% is interest.
- Automated manufacture of small reactors can address this issue.

SEALER-55 (Swedish Advanced Lead Reactor)

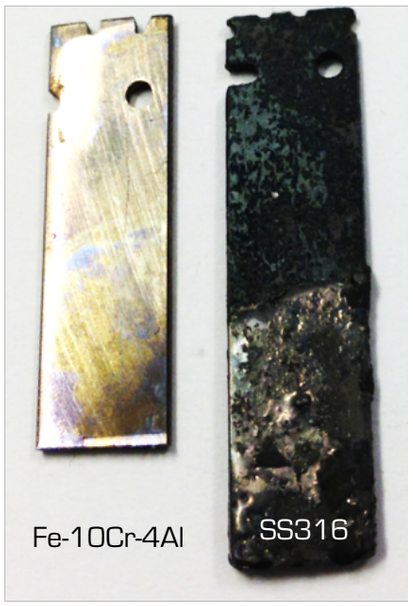


Item	Value
Power	140 MWth/55 MWe
Lead coolant mass flow	7400 kg/s
Lead inventory	800 tons
Core inlet/outlet temperature	420ºC/550ºC
Height	5.5 m
Diameter	4.8 m
Fuel	Uranium nitride (UN)
Fuel residence time	25 years

Break-through solution

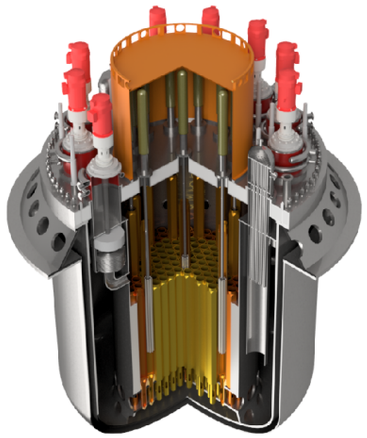


AFA on SS316



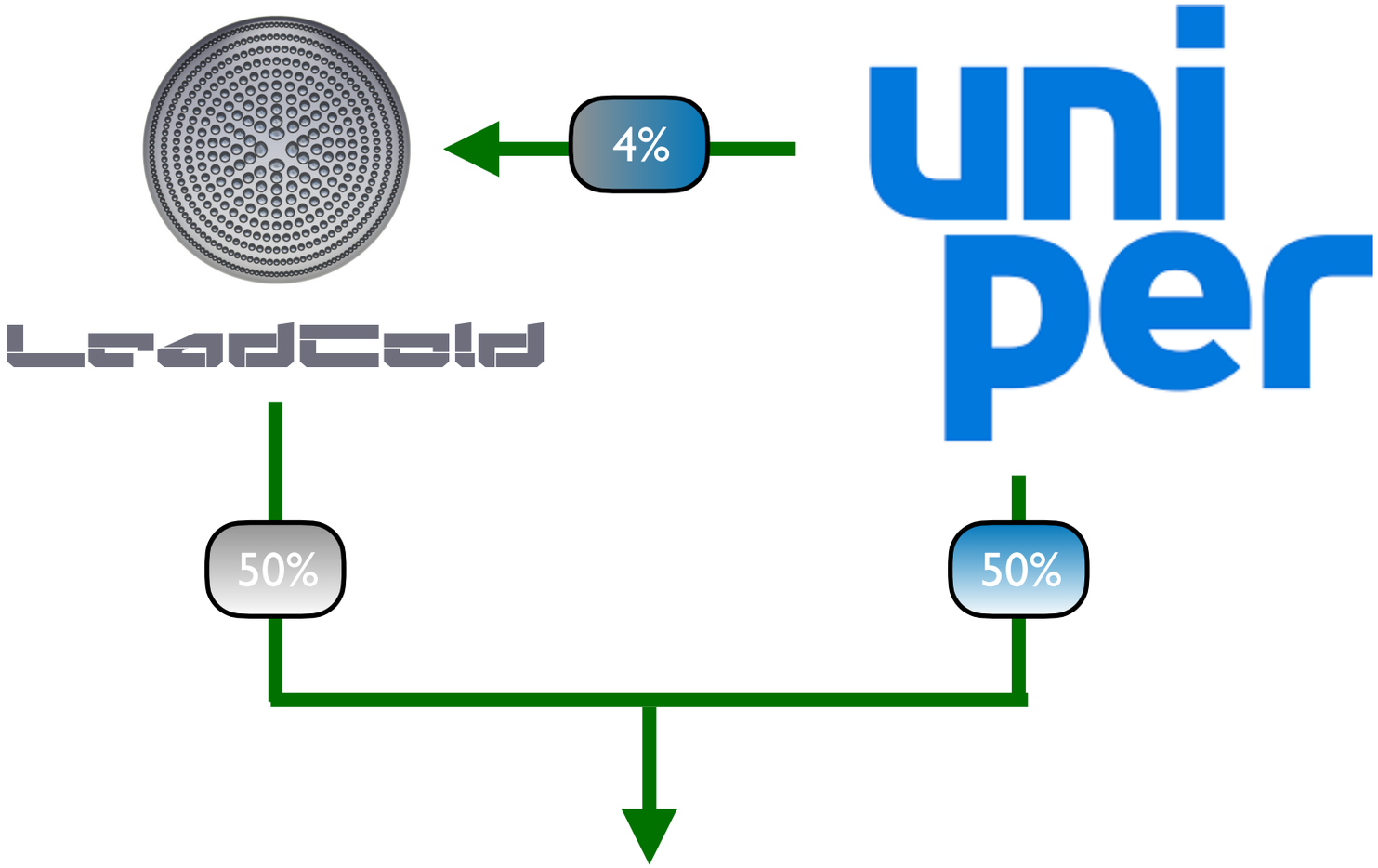
- Potential show-stopper for commercialisation of lead-cooled reactors: corrosion of stainless steels
- LeadCold's solution: aluminium alloyed steels:
  - Fe-10Cr-4Al-RE (RE = Zr, Ti, Nb, Y)
  - Alumina forming austenitic steels (AFA)
  - Alumina forming martensitic steels (AFM)
- Form 100 nm thin, ductile and protective alumina film on surfaces exposed to lead with low oxygen content.
- Fe-10Cr-4Al-RE successfully tested at 550ºC for 2 years & 850ºC for ten weeks.
- Unique combination of break-through R&D with manufacturing capability of Kanthal

Swedish market



- **SEALER-55** design developed for Swedish market.
- Introduced to meet increase in power demand from de-carbonisation of steel and mining industry in 2030's.
- 100 TWh new base-load capacity required.
- Market for up to 200 SEALER units, to be built on existing nuclear sites (now) and on new green industry sites (later).
- UNIPER supports the development of SEALER-55, aiming at serial production in an Oskarshamn factory.

Joint Venture

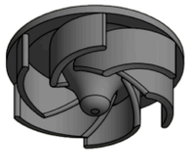


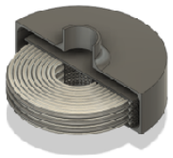
Swedish Modular Reactors

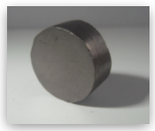
(SMR AB)

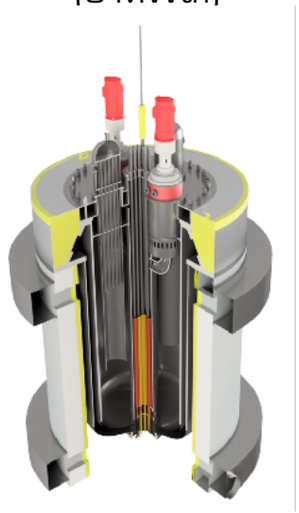
Programme to commercialise SEALER-55

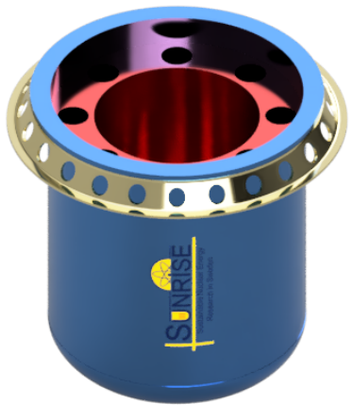
Research	Prototype	Demonstration	Commercial product
SUNRISE (2021-2026)	SEALER-E (3 MWth)	SEALER-D (80 MWth)	SEALER-55 (140 MWth)
BOREALIS (2021-2029)	2024	2028	2030
ASGARD (2021-2023)		Reactor factory in Oskarshamn	
FREDMANS (2022-2026)	UN fuel pilot plant	UN fuel industrial plant	

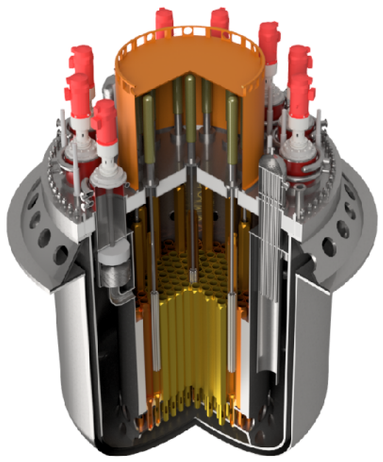




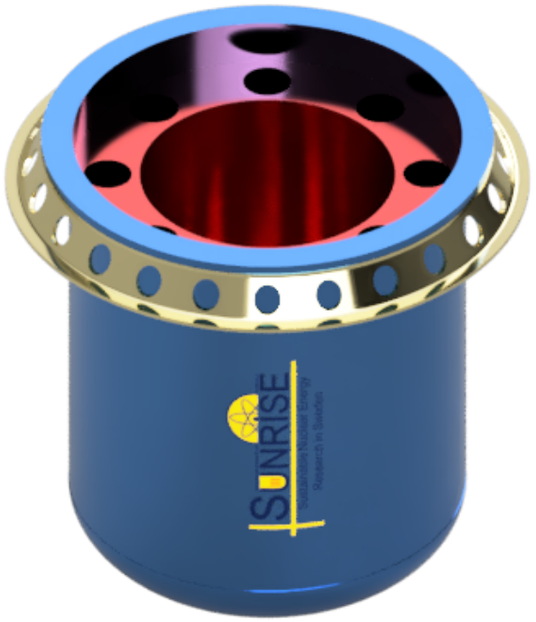






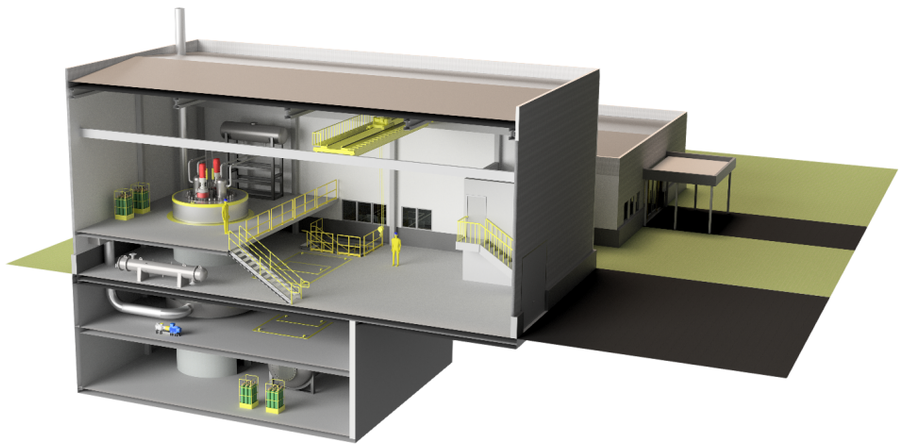


The SUNRISE project



- SUNRISE project funded with 50 MSEK by Swedish strategic research foundation.
- Partners: KTH, Uppsala University, Luleå University of Technology.
- Design, safety analysis and supporting R&D for an 80 MW_{th} lead-cooled research/demo reactor to operate in Oskarshamn by 2030.
- Potential revenues from production of H_2, HVO, pyrolysis oil & bio-char.
- Stakeholder group includes Swedish nuclear and steel industry, regulator, Canadian industry and universities from US, UK and Australia.

SEALER-E

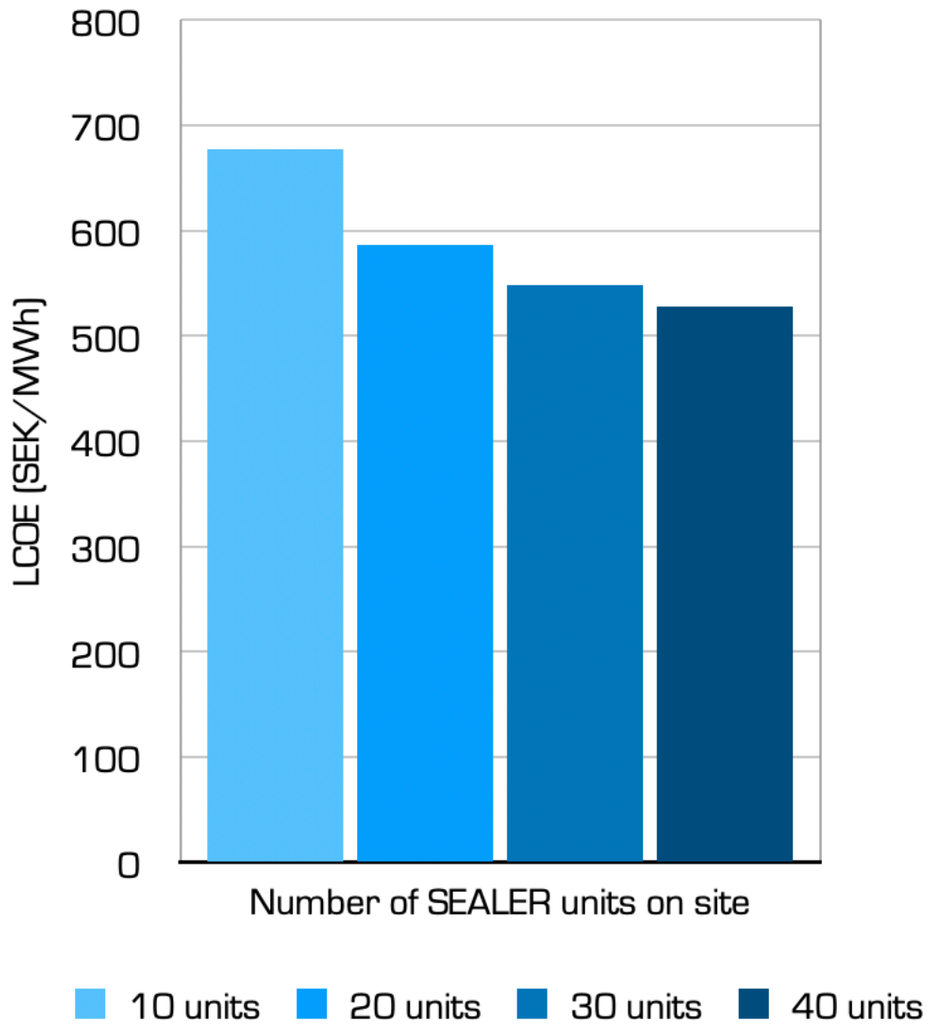


- 3 MWth electrically heated prototype
- Used to verify safety concept, corrosion control and materials, operation and maintenance procedures.
- Location: Simpevarp, Oskarshamn
- Duration of project: 2022 - 2028
- Cost: ≈ 25 M€
- 10 M€ grant from Swedish Energy Agency awarded in February 2022
- Operation scheduled for 2024.

Strategic investor: < norrsken >

- March 2022: Grant of 99 MSEK from Swedish Energy Agency
- August 2022: private investment of 2.5 M€ led by < norrsken >.
- Total cost of SEALER program: 700 M€
  - SEALER-E: 25 M€
  - Reactor factory: 300 M€
  - SEALER-D: 150 M€
  - Fuel factory: 150 M€

Cost of electricity production



- A nuclear power plant needs ≈ 100 security staff and ≈ 25 fire fighting staff.
- Each control room needs ≈ 25 staff.
- Commercial operation with single SMR unit is normally not feasible on national power grids.
- LCOE expected to be competitive on Nordic electricity market if > 10 units deployed on same site (550 MWe capacity)
- Single units may compete in applications where cost of power > 200 €/MWh (remote regions, off-shore).