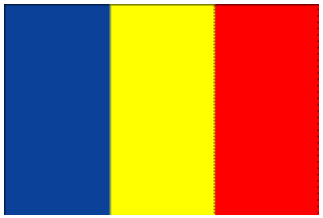

Sustainability of the Romanian nuclear program

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2025

Topics

Nuclear energy in the World and in Romania history and trends

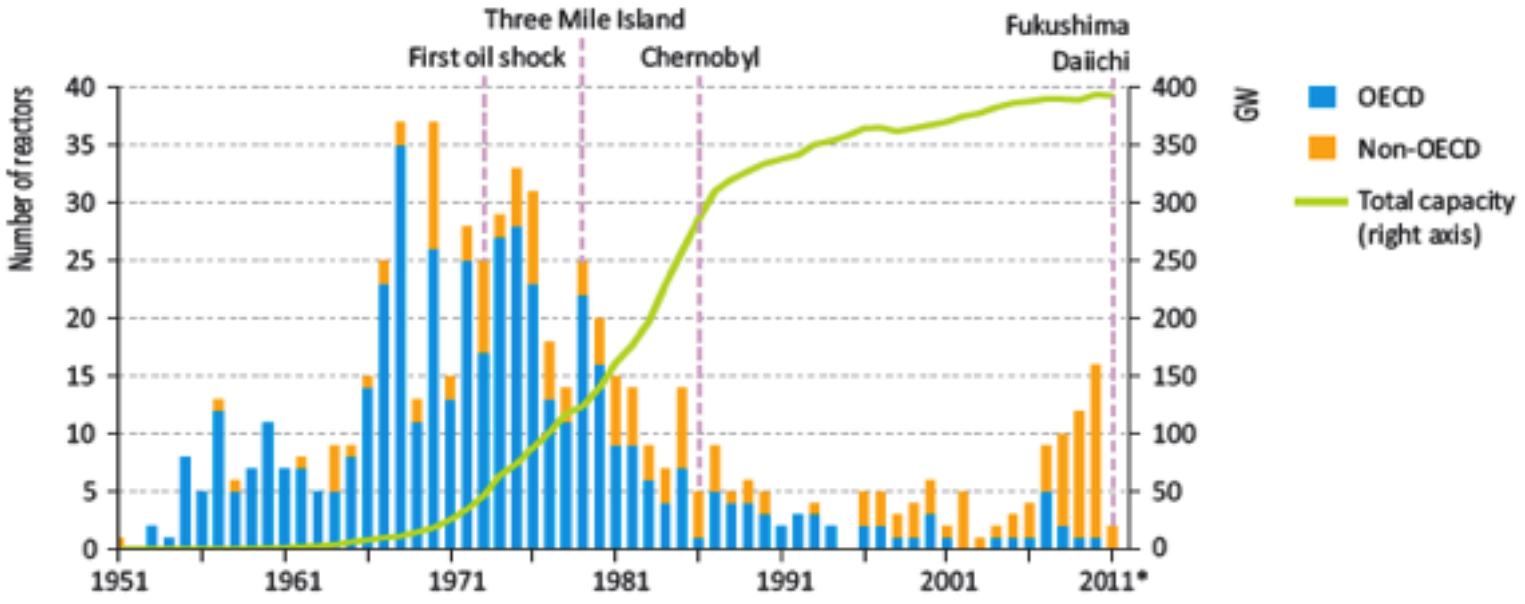
Nuclear energy in Romania – the fuel cycle

Sustainability of the nuclear field in Romania

From old to new technologies

Nuclear energy in the World and in Romania history and trends

Nuclear reactors evolution and significant events



*Data as of 31 Aug 2011.

The nuclear program based on CANDU reactors with natural Uranium fuel

1967-1968: First contacts with US and Canada for CANDU technology transfer followed by the decision to build 2 units of 300MW each. Construction delayed and restarted in 1977 with 4 units of 660MW.

Oak Ridge National Laboratory NEWS

A Publication for the ORNL Employees of Union Carbide Corporation

Vol. 21 — No. 23 OAK RIDGE, TENNESSEE Wednesday, November 27, 1968

SIDELINE to his regular job of operating the Laboratory's radioactive waste disposal systems, G. E. Davis, Operations Division, records data every four hours for this Metals and Ceramics Division experiment located in Building 3025. This is just one of 40 such jobs inspected by chemical operators who provide shift and weekend patrol service.

Chemical Operators Perform Many Jobs

By CAROL GROVE

ORNL Prepares Largest Strontium Source For Advanced Generator

Adaptable For Ocean Depths

Many ORNL Papers On APS Agenda

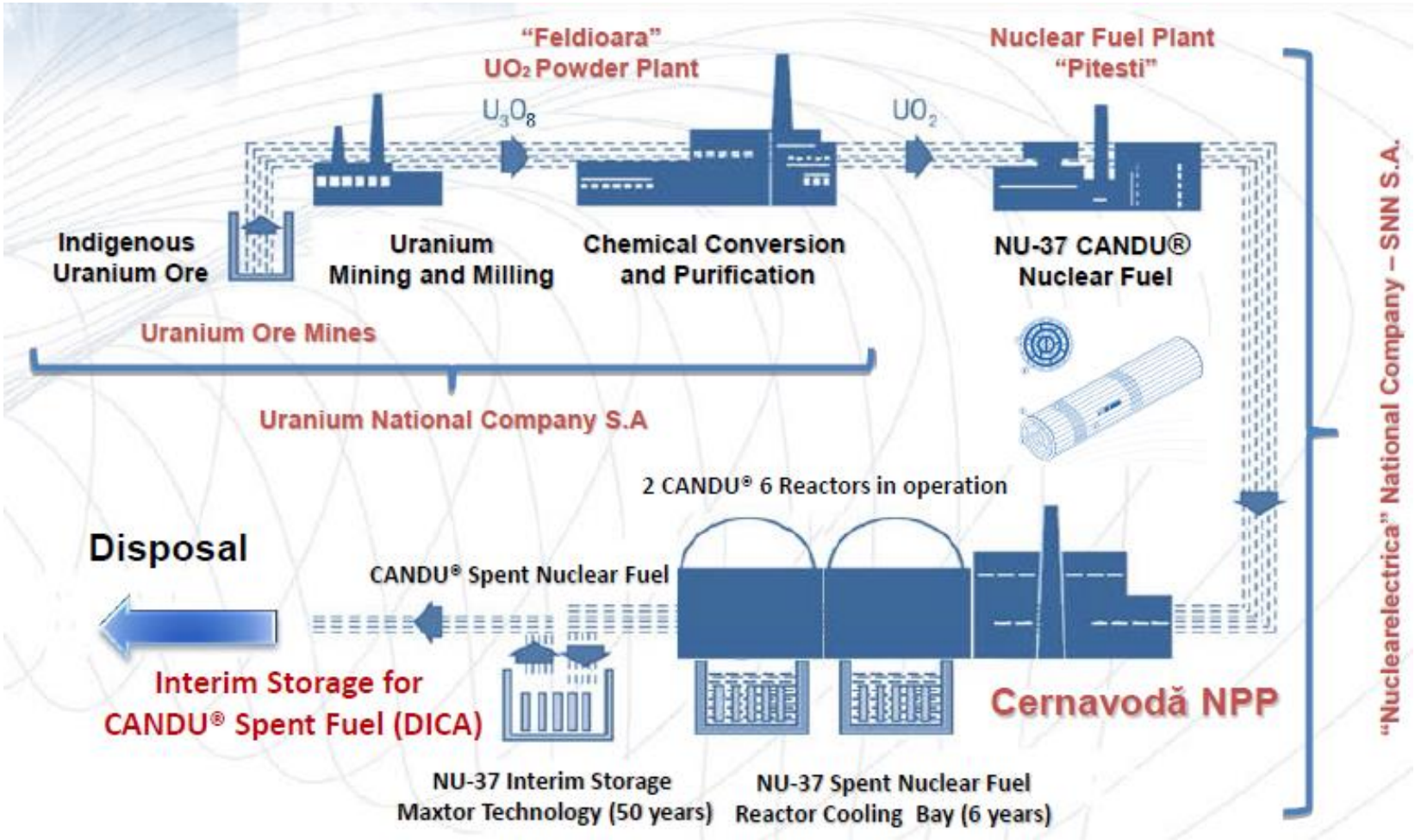
HORIA S. HULUBEI (left), chairman of the Romanian Committee for Nuclear Energy, waits to sign the guest book at the Graphite Reactor during his visit there last Thursday (November 21). He and other Romanian officials are touring U. S. nuclear facilities at the invitation of the U. S. Atomic Energy Commission. Other members of the party are (L-R) Ionel Purica, head of the Reactor Department, and Marius Petrascu (signing), head of the Laboratory of Nuclear Reactions. Both are from the Institute of Atomic Physics in Bucharest.

1968

1968- the Romanian delegation to the ANS Conference, New York

Nuclear energy in Romania – the fuel cycle

Romania nuclear fuel cycle



Cernavoda NPP construction and operation at high load factors

Having a fully fledged nuclear program, that manufactured the fuel for CANDU type nuclear reactors, as well as the nuclear grade Heavy Water, operating two NPPs and having other two under construction, the Romanian nuclear program is one of the few that never stopped.

Sustainability of the nuclear field in Romania

Climate change

- Each nuclear unit producing 5 TWh (5 million MWh) per year reduces GHG emissions with 3 millions tCO2/year (at a power system emission coefficient of 0.6tCO2/MWh)
- Units 3 and 4 at Cernavoda may substantially contribute to achiving the EU targets for 2030 and 2050 for emission reduction i.e. 40% (ref 1990) in 2030 and 80% in 2050.

Energy security

Considering the elements of volatility in the power system (e.g. hydraulicity, eolian) it results a need for approx. 1000MW capacity of which 600 could be nuclear and 400 coal.

Thus one of the two units in Cernavoda is needed to secure system security.

Small Modular Reactors may contribute to the saety of supply of strategic objectives. ALFRED research is developing such a projects of SMR.

Jobs at U3 and U4

From the experience of Units 1 and 2 during the construction period about 20000 direct jobs are created to which about 60000 indirect jobs are added.

At an average fiscality of 500 Euro per job per month the budget receives 40M Euro every month.

Research and teaching

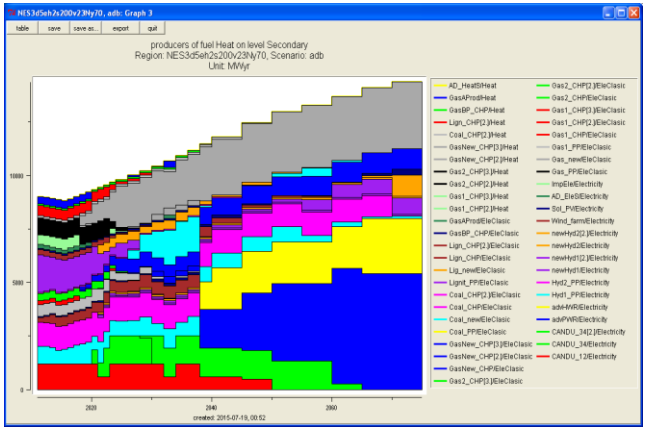
The teaching programs from Politechnical University of Bucharest and from the Pitesti University are of international level and have a significant continuity.

The Centers fo excellence in Mioveni and Magurele are in contact with simillar centers from countries having advanced nuclear programs.

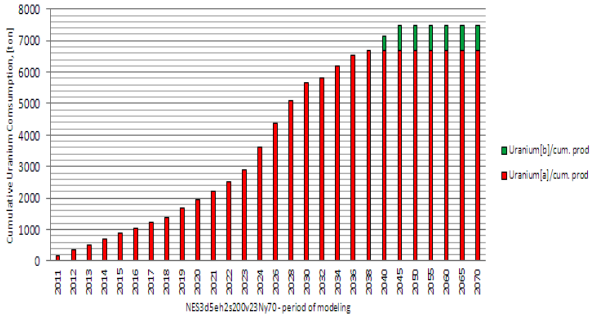
The project of fast breeder lead cooled modular reactor is under development with support from EU and EURATOM.

Scenario modeling capabilities

Model nuclear strategic parameters' evolution with the MESSAGE model of IAEA.



A) Cumulative Uranium Comsumption, [ton]



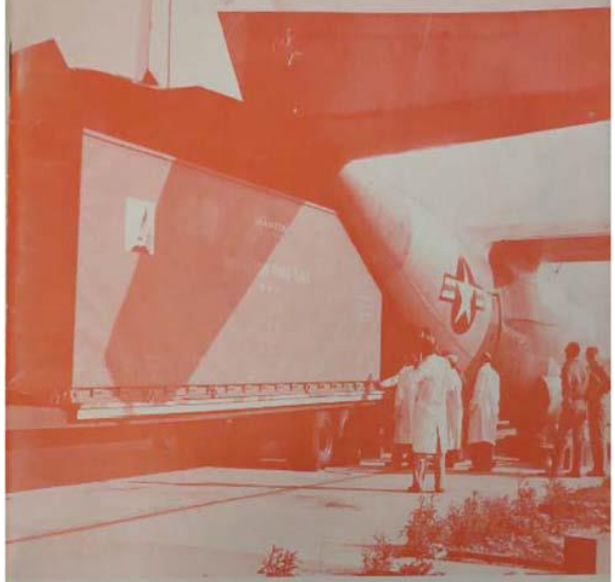
From old to new technologies

Research reactor VVR control room - Magurele

Cernavoda NPP – control room

Decommissioning of the research reactor VVR

POWER REACTORS IN SMALL PACKAGES



U. S. ATOMIC ENERGY COMMISSION / Division of Technical Information

PORTABLE AND MOBILE NUCLEAR POWER PLANT PROGRAM

Designation	Location[1]	Application	Operator	Designer[2]	Date critical[3]	Date operational	Electrical output (megawatts)	Core life (megawatt-years)[4]	Reactor type[5]	Primary coolant	Primary pressure (psig)[6]	Core outlet temp. (°F)	Power cycle	Total weight (tons)	Number of packages
PROTOTYPES															
[illegible]	NRTS, Idaho	Training, training	Army	ANL	9-58	10-58	0.2	0.7	BWR	Water	300	462	Rankine	—	—
[illegible]	Ft. McNair, Va.	Training, training	Army	A.L.Co.	6-57	6-57	1.65	33.0	PWR	Water	1200	459	Rankine	—	—
[illegible]	NRTS	Portable power in arctic	Army	Aerojet-General	3-61	6-62	0.50	3.78	GCR	Nitrogen	315	1250	Brayton	UF_6	4
OPERATIONAL PLANTS															
[illegible]	Ft. Greely, Alaska	Base power and heat	Army	A.L.Co.	3-62	6-62	1.84	32.0	PWR	Water	1200	463	Rankine	—	—
[illegible]	Sundown, Wis.	Base power and heat	Air Force	Martin Co.	3-62	6-62	1.0	24.0	PWR	Water	1200	470	Rankine	600	29
[illegible]	Camp Century, Greenland	Base power and heat	Army	A.L.Co.	10-60	2-61	1.5	10	PWR	Water	1750	560	Rankine	210	37
[illegible]	Mt. Harris Range, Antarctica	Base power and heat	Navy	Martin Co.	3-62	6-62	1.0	24.0	PWR	Water	1300	470	Rankine	600	33
[illegible]	Barge mounted (Barge)	Portable mobile power	Army	Martin Co.	1-67	1-68	10.0	67.5	PWR	Water	1400	520	Rankine	—	—

[1]Abbreviations designational

First Letter — Second Letter

S = stationary — L = low power (up to 1 megawatt)
P = portable — M = medium power (1 to 10 megawatts)
M = mobile — H = high power (over 10 megawatts)

Location:
NRTS = National Reactor Testing Station, Idaho

Designer:
ANL = Argonne National Laboratory
A.L.Co. = American Locomotive Co.

Reactor type:
BWR = Boiling water
PWR = Pressurized water
GCR = Gas cooled

[3]Point of attainment of self-sustaining nuclear reaction

[4]Thermal megawatt-years, net electrical

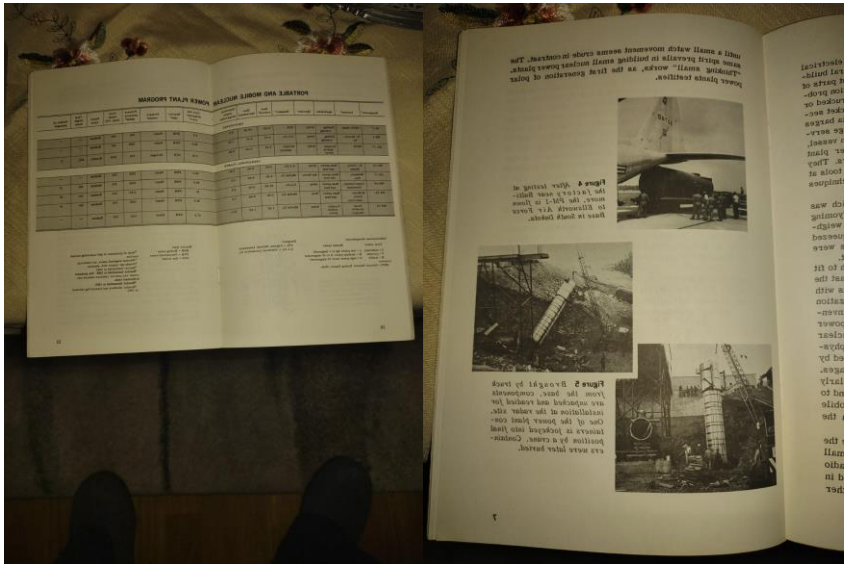
[5]Pounds per square inch, absolute

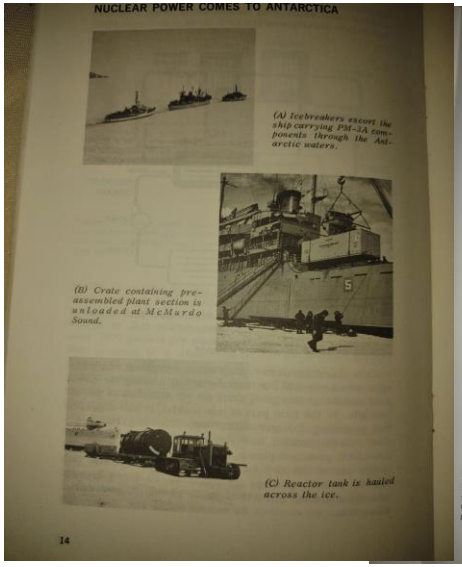
[6]Reactor dismantled in 1962

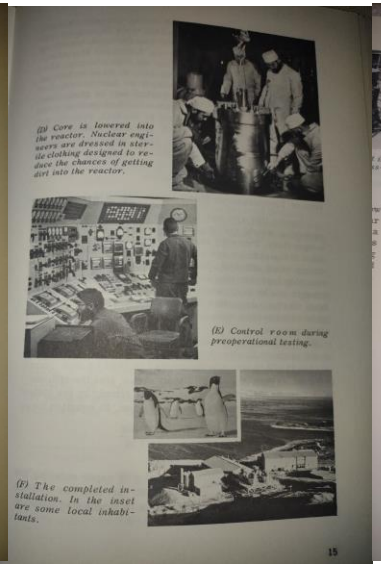
[7]Reactor dismantled in 1965. The pressure vessel was used for radiation-induced embrittlement tests.

[8]Reactor dismantled in 1965.

[9]Reactor shutdown and dismantling initiated in 1966.




NUCLEAR POWER COMES TO ANTARCTICA
(A) Icebreakers escort the ship carrying PM-3A components through the Antarctic waters.
(B) Crate containing preassembled plant section is unloaded at McMurdo Sound.
(C) Reactor tank is hauled across the ice.
14

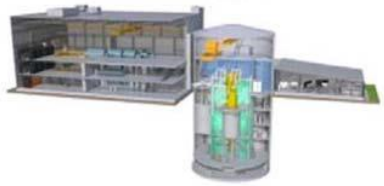

(D) Core is lowered into the reactor. Nuclear engineers are dressed in sterile clothing designed to reduce the chances of getting dirt into the reactor.
(E) Control room during preoperational testing.
(F) The completed installation. In the inset are some local inhabitants.
15


REACTOR
CONTROL ROOM
TURBOGENERATOR
COLLISION AND GROUNDING PROTECTION MARKING
PRIMARY COOLANT PUMP
Figure 12 The Sturgis (MH-1A), a floating nuclear power plant, achieved criticality on January 25, 1967. In the diagram the power lines run off the bow into the region needing power. The center photograph shows the Sturgis moored at Fort Belvoir, Virginia. On the right one of the 32 fuel elements that compose the core of the Sturgis is lowered into place during fueling operations.

1	**BANR SMR**	BWX Technologies
2	**Project Pele**	BWX Technologies
3	**Energy Well**	CVR
4	**DF300**	Dual Fluid Energy
5	**SMR-160**	Holtec International
6	**GTHTR300**	JAEA
7	**HTTR**	JAEA
8	**Jimmy**	Jimmy Energy
9	**SMART**	KAERI
10	**PWR-20**	Last Energy
11	**LFR AS 200**	newcleo
12	**BREST-OD-300**	NIKIET
13	**Kaleidos**	Radiant
14	**RITM-200M**	Rosatom
15	**CMSR**	Seaborg Technologies
16	**HAPPY200**	SPIC
17	**IMSR**	Terrestrial Energy
18	**TMSR-500**	ThorCon International
19	**4S**	Toshiba Energy Systems & Solutions Corporation
20	**Westinghouse LFR**	Westinghouse Electric Company
21	**TEPLATOR**	ZČU and CIIRC CTU

SMR BWRX-300 de GE Hitachi de 300 MWe

USA et Japon



SMR Rolls-Royce de 470MWe

UK

SMR AP300 de Westinghouse de 300 MWe

USA

SMR Holtec de 160 MWe

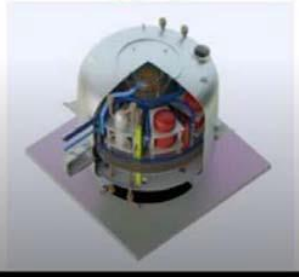
USA

SMR VOYGR de NuScale de 300 MWe

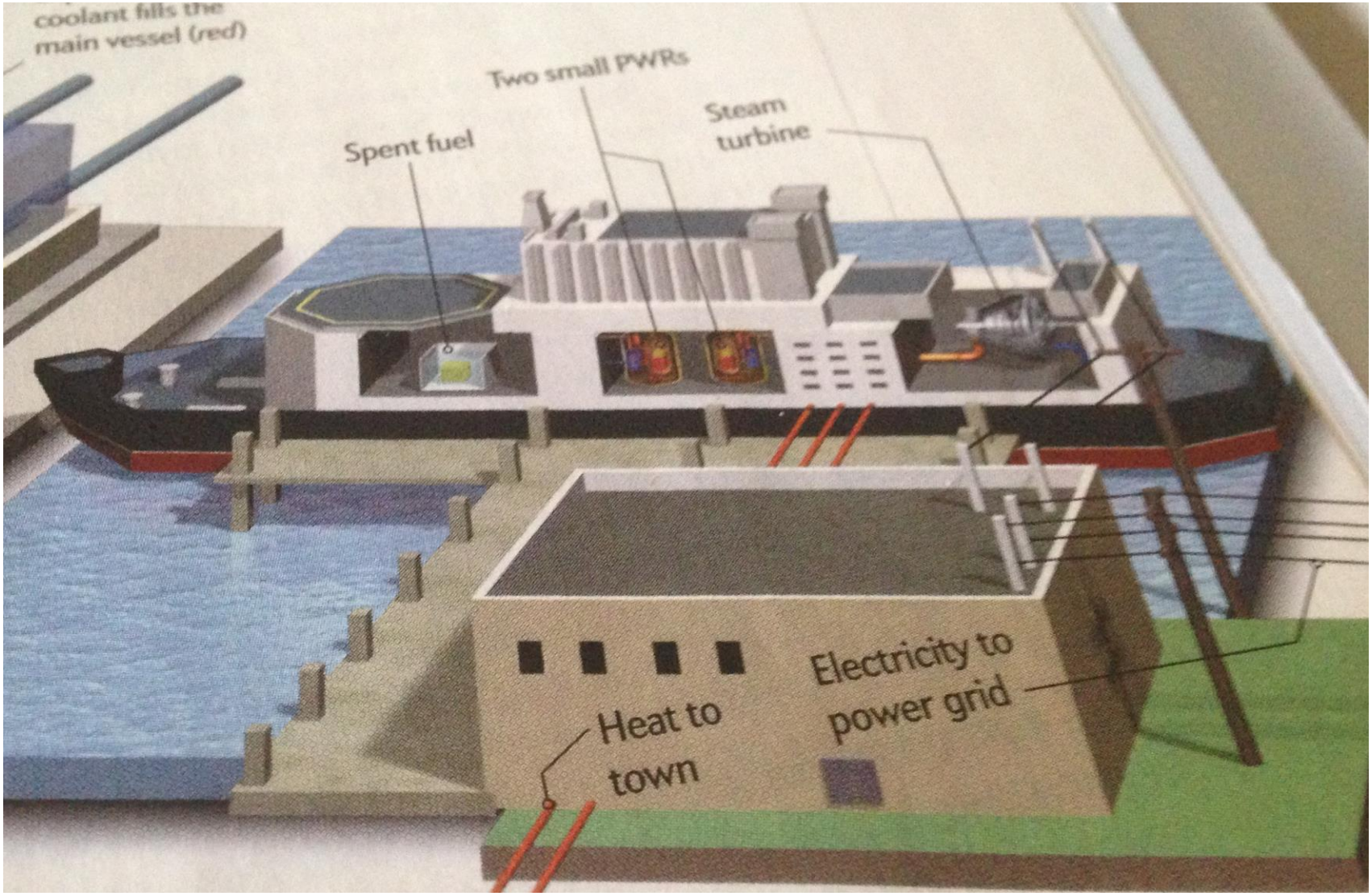
USA

SMR NUWARD d'EDF de 2x170Mwe

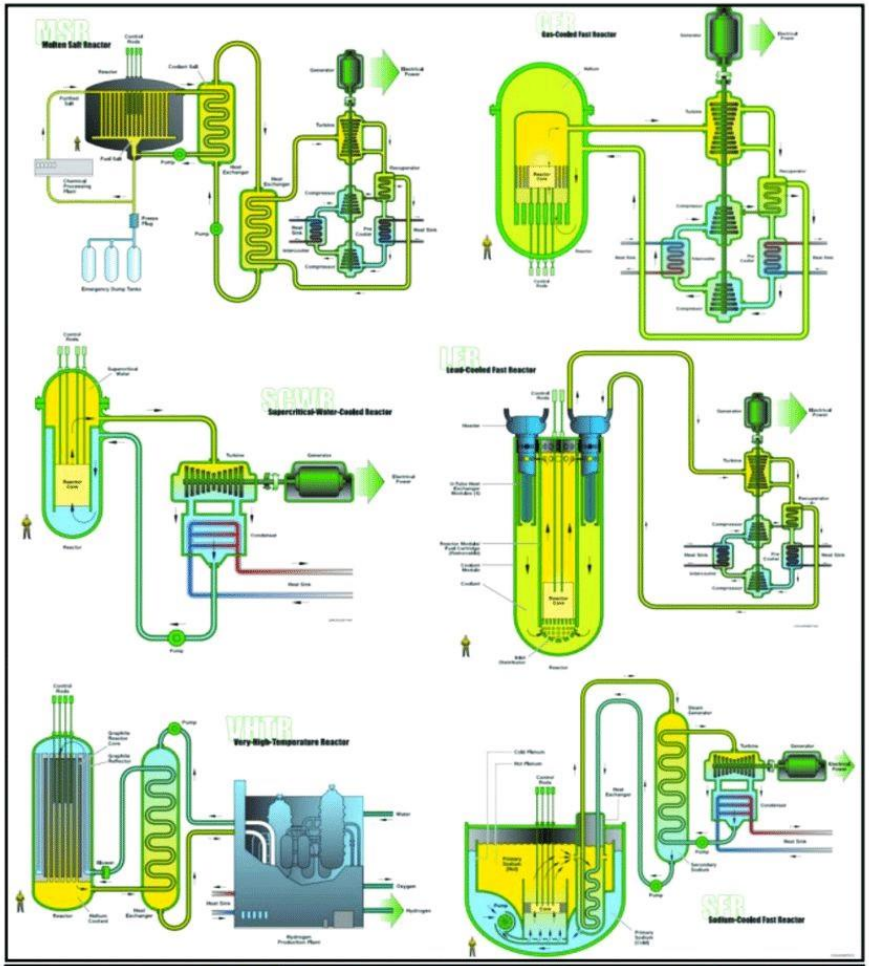
France



Russian nuclear reactor on a barge



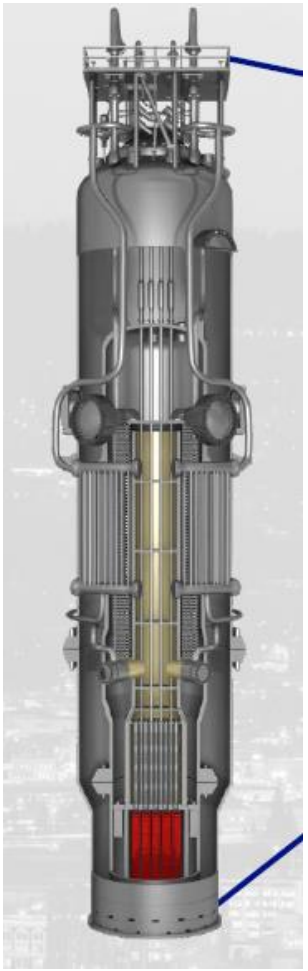
Thermal *Fast*



	Neutron spectrum	Coolant	Temperature (°C)	Fuel	Fuel cycle	Size(s) (MWe)
Sodium-cooled fast reactors (SFR)	Fast	Sodium	550	U-238 and MOX	Closed	50, 1700
Very high temperature gas reactors (VHTR)	Thermal	Helium	1000	UO_2 prism or pebbles	Open	275
Gas-cooled fast reactors (GFR)	Fast	Helium	850	U-238	Closed	300, 1500
Supercritical water-cooled reactors (SCWR)	Thermal or fast	Water	625	UO_2 or MOX	Open (thermal) or closed (fast)	1700
Lead-cooled fast reactors (LFR)	Fast	Pb or Pb–Bi	480–800	U-238	Closed	10–100, 600
Molten salt reactors (MSR)	Epithermal	Fluoride salts	700–800	UF in salt	Closed	1000

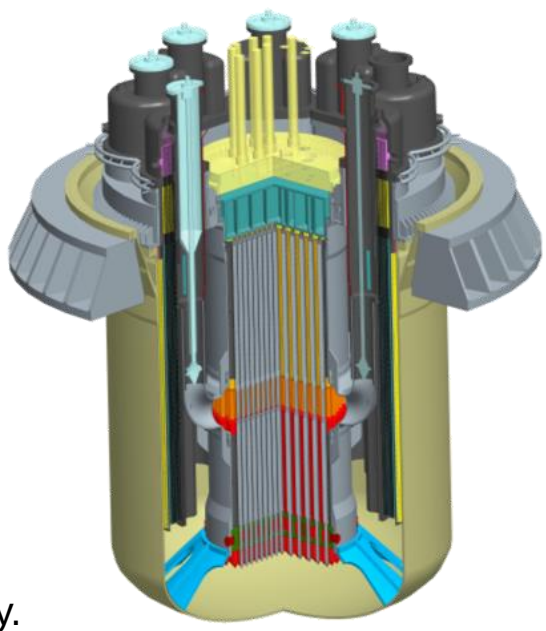
Electrical capacity	77 MWe (gross)
Capacity factor	>95 percent
Dimensions	76' x 15' cylindrical containment vessel module containing reactor and steam generator
Weight	~700 tons in total are shipped from the factory in three segments
Transportation	Truck, rail or barge

Cost	Numerous advantages due to simplicity, modular design, volume manufacturing and shorter construction times
Fuel	Standard LWR fuel in 17 x 17 configuration, each assembly 2 meters (~ 6 ft.) in length; up to 24-month refueling cycle with fuel enriched at less than 5 percent



What is ALFRED?

Advanced Lead Fast Reactor European Demonstrator



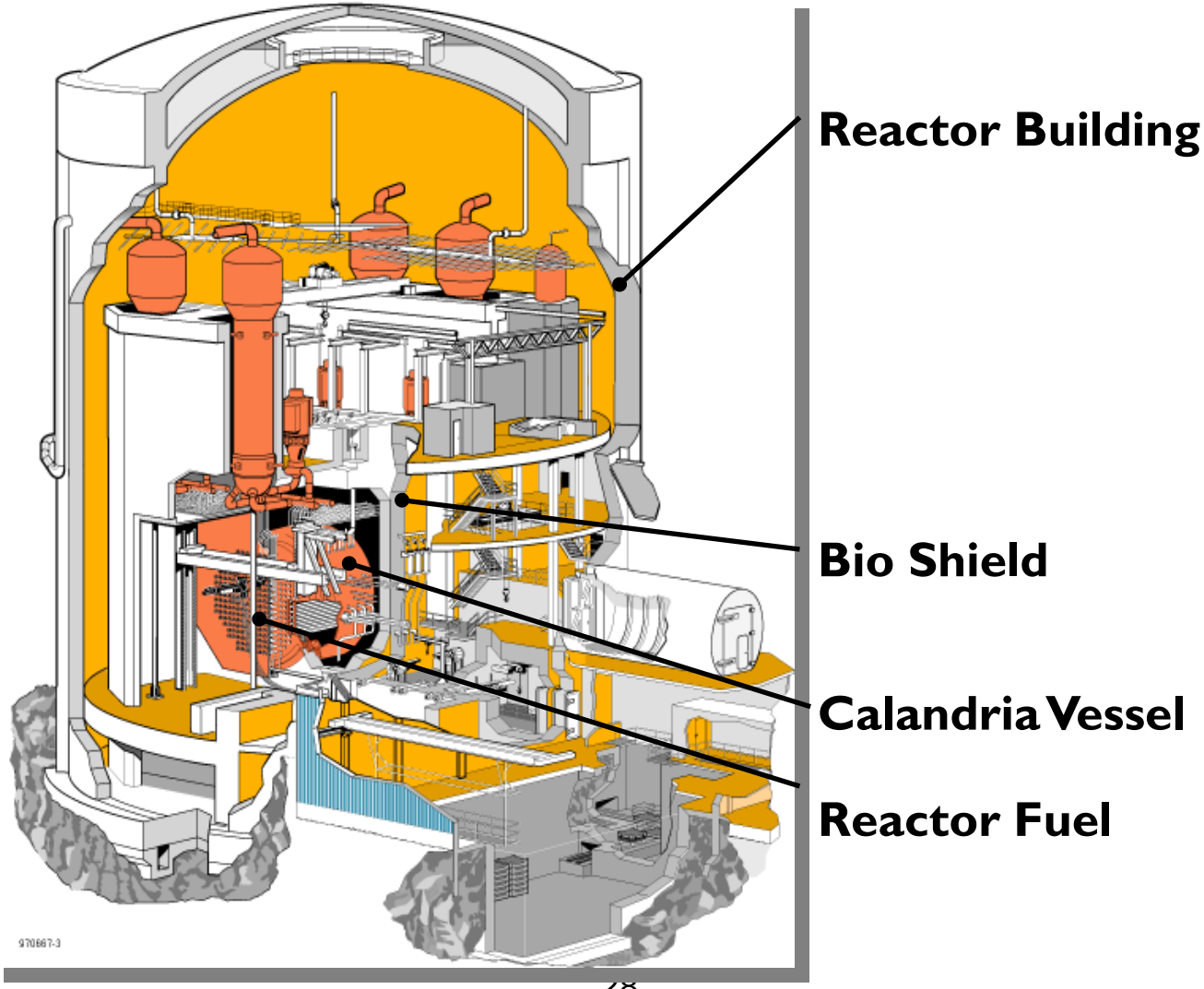
ALFRED is a Research Reactor, as part of a **pan-European Distributed Research Infrastructure**.

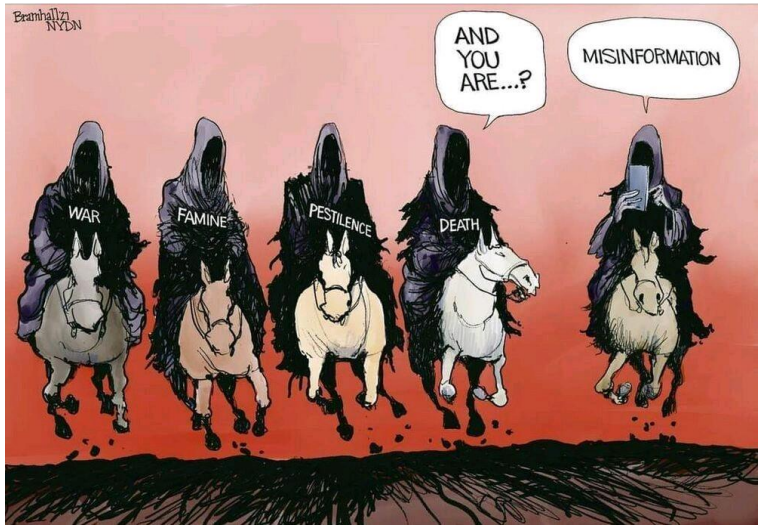
ALFRED is a **demonstrator**, and not a prototype, dedicated to the **development** of the LFR technology.

ALFRED is a 300 MWth **reactor** addressing the concerns on **safety**, **economics** and **sustainability** of nuclear energy.

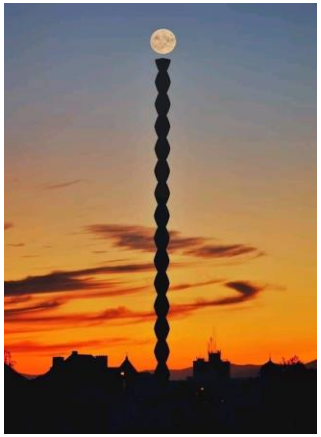
Demonstration of a safer and more sustainable secure energy

CANDU-6 Multiple Layers Protection





Missinformation may lead from :



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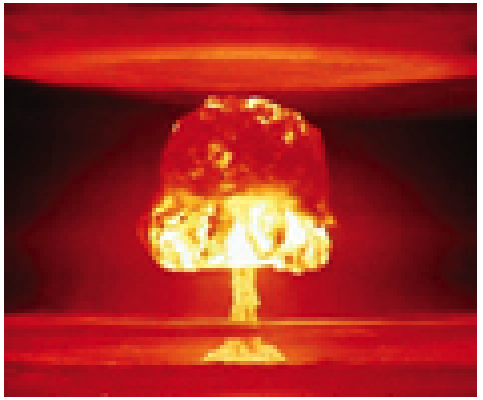

EVOLUTION

THE END

Welcome to the Romanian nuclear future

Thank you !