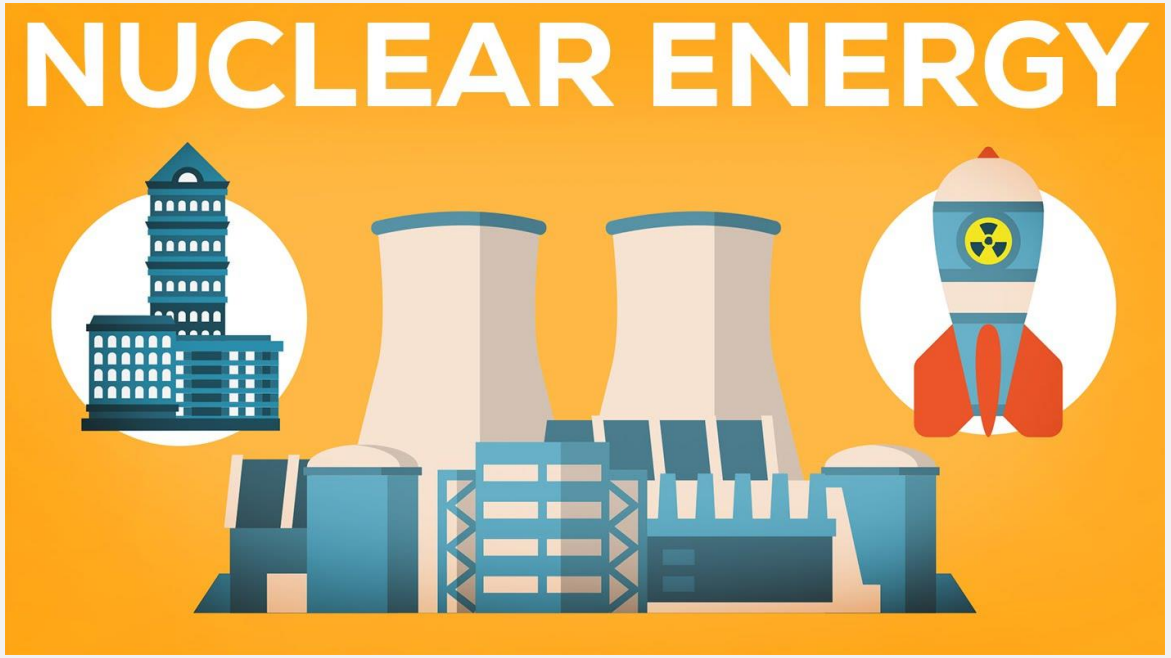
NUCLEAR (ENERGY) DIPLOMACY

THE CASE OF RUSSIAN FEDERATION

Dr Vassilios Sitaras

Unipi, 24-5-2025

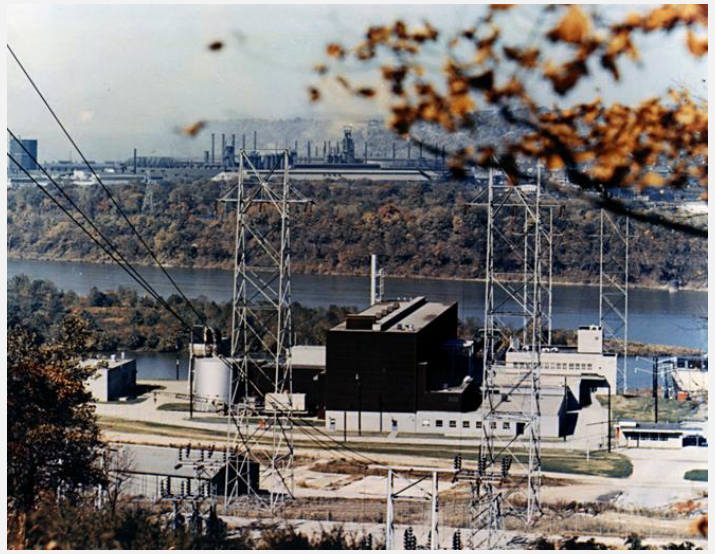
DEMONIZED LIKE NO OTHER ENERGY SOURCE, NUCLEAR IS PROBABLY OUR ONLY HOPE, TOGETHER WITH RES, TO FIGHT CLIMATE CHANGE…



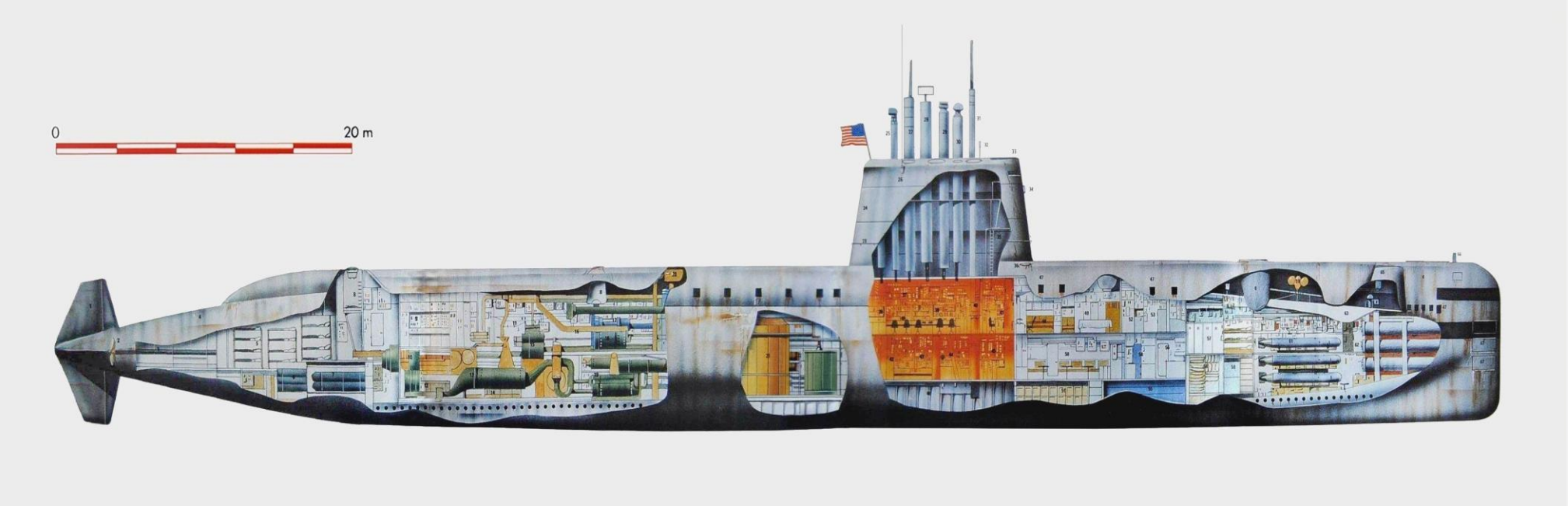
DECEMBER 1953 – "*ATOMS FOR PEACE*" SPEECH

CALDER HALL NPP,
UK, 8/1956, 60 MW

SHIPPINGPORT NPP,
USA, 12/1957, 68 MW



17/1/1955: "*UNDERWAY ON NUCLEAR POWER*" (SSN-571, NAUTILUS)

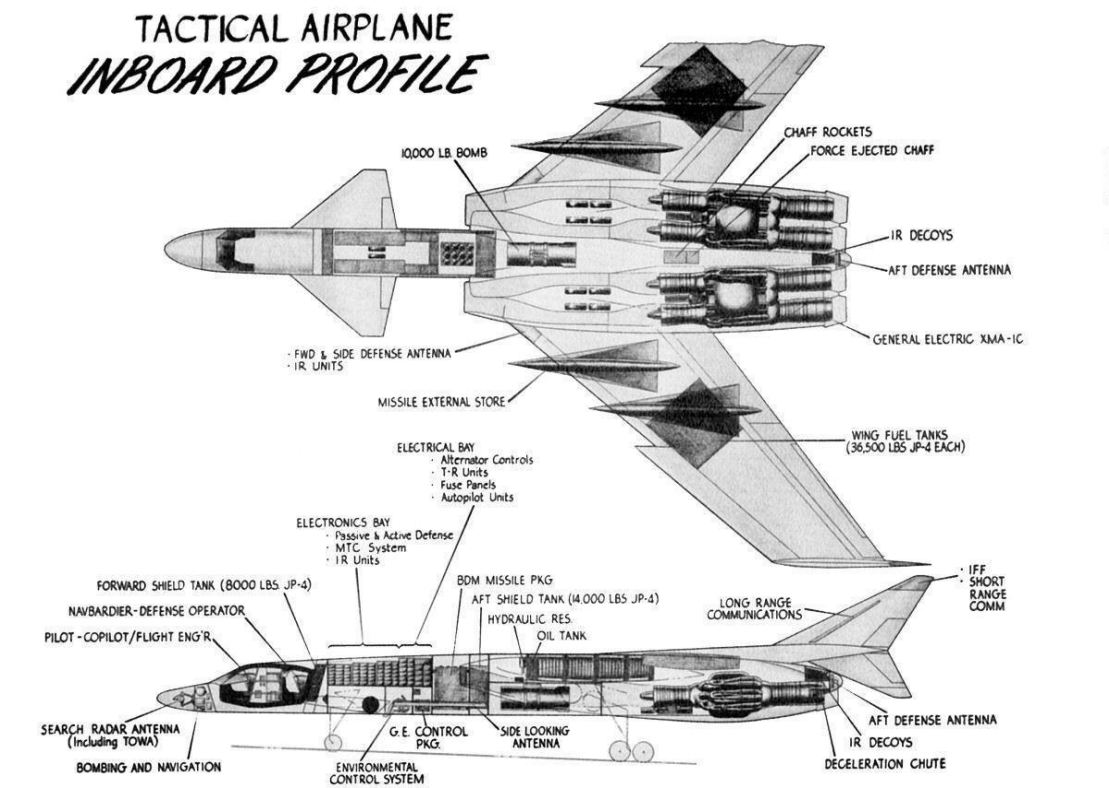


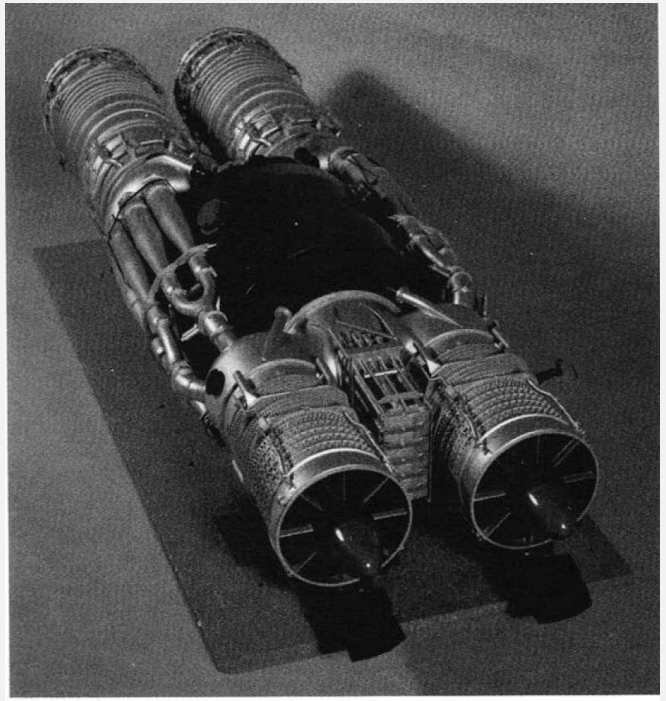
ONLY SUBMARINES AND AIRCRAFT CARRIERS? NO!

“LENIN” ICEBREAKER 1959

MERCHANT SHIP SAVANNAH 1962

AND MORE…. (WEAPON SYSTEM 125)





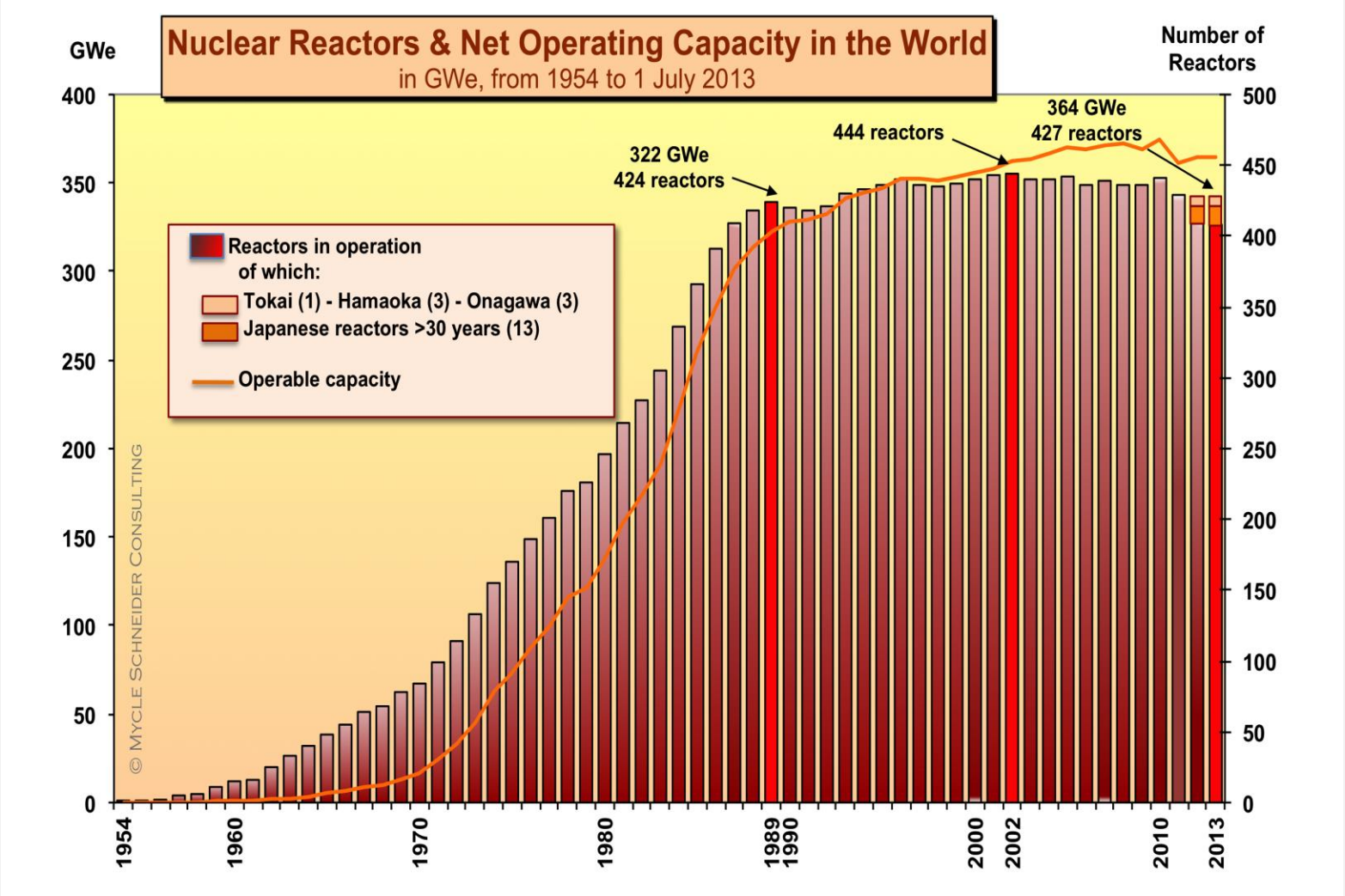
X211 1/10th scale mockup.
Note: Control rods between the two compressors.

AND MUCH MORE!!!

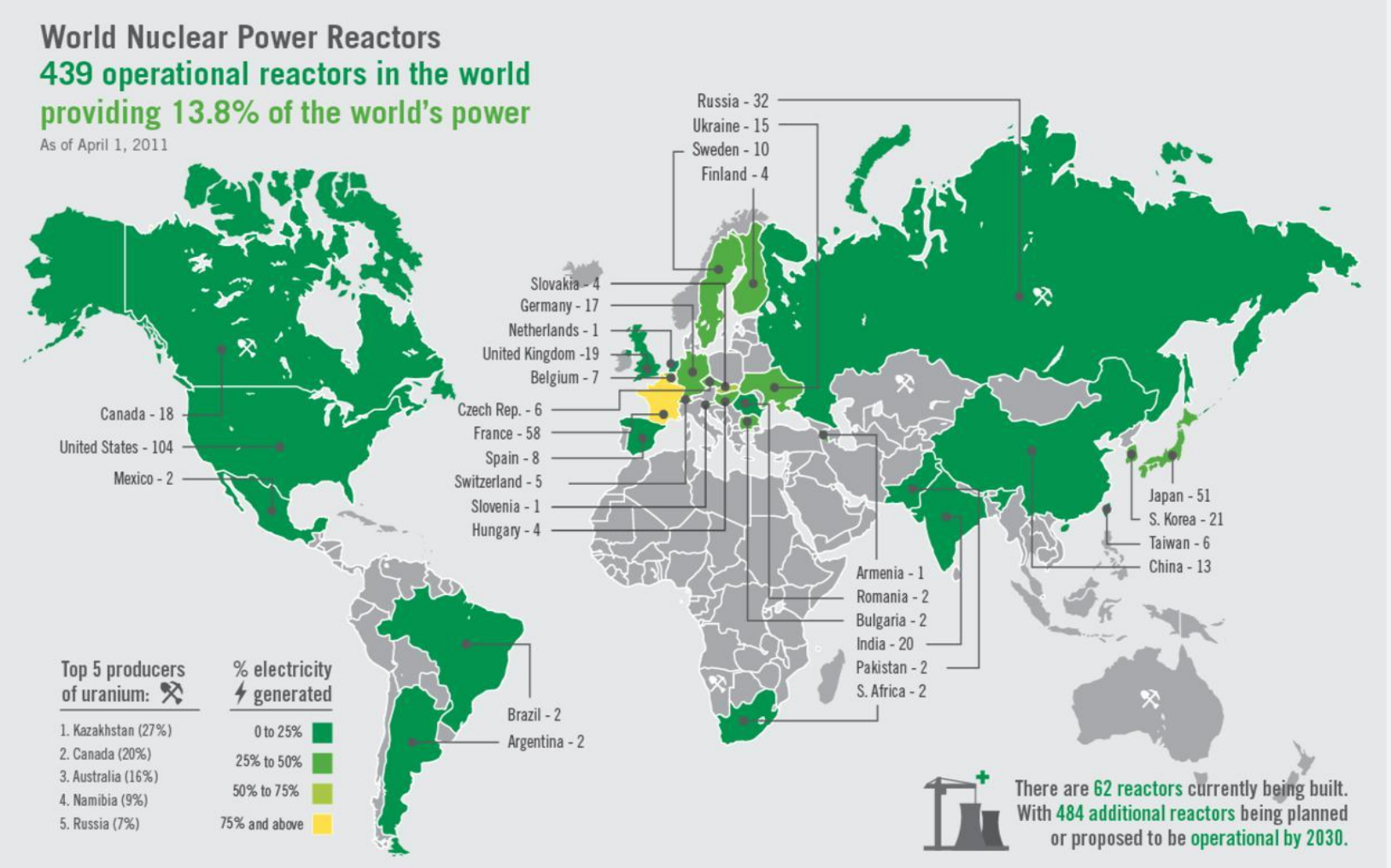
- April 2021 DARPA awards contracts to Lockheed Martin, Bezos' Blue Origin and General Atomics for a nuclear-powered **spacecraft** to orbit Earth
- "Kanyon" or "Poseidon" Unmanned Underwater Vehicle (UUV), basically a giant torpedo with nuclear propulsion and practically unlimited range. Said to be deployed on Russian submarines by **2027**

NUCLEAR ENERGY - **A DREAM TOO MUCH?**

93 LEFT IN THE US OUT OF 133, PLUS121 CANCELLED…



THE SITUATION AT THE FUKUSHIMA INCIDENT



TODAY: 9% OF GLOBAL ELECTRICITY / 18% IN THE 37 OECD COUNTRIES / 20% IN THE US (93)

STILL, THERE IS HUGE POTENTIAL…

439 OPERATIONAL / 67 BEING BUILT / 100 PLANNED

2024 GLOBAL ELECTRICITY GENERATION BY SOURCE

- Coal (34.4%)
- Natural gas (22.1%)
- **Hydro (14.4%)**
- **Nuclear (9%)**
- **Wind (8.12%)**
- **Solar (6.92%)**
- Other (5.10%)

WORLD LEADERS IN NET CAPACITY 2025

- USA 97,000 MWe (1/4 of the World total)
- France 63,000
- China 57,000 plus 33,000 building
- Japan 32,000
- Russia 27,000
- South Korea 26,000
- Total net capacity close to 400,000 MWe

CHALLENGES AND OPPORTUNITIES

CHALLENGES

- **Financial** (capital-intensive) 70% of the cost of a kWh in 60 years life span is accounted for by the cost during the construction phase alone…
- **Inherent** Each NPP is unique
- **Geopolitical**: NPT "*Trojan Horses*", e.g. export limitations for US companies, as Section 123 of the Atomic Energy Act generally requires the conclusion of a nuclear cooperation agreement
- **Regulatory**, for safety reasons/see EURATOM
- **RAW** Management (e.g. Yuka mountain)

OPPORTUNITIES

- Alternative source of electricity (demand for which will double by 2050)
- "*Too cheap to meter*", once operational
- Utilization at 94-95% of installed capacity vs just 35% for wind and 25% for solar
- 600 million tons of oil equivalent annually
- 2015 Paris Agreement is good news
- Promising technological breakthroughs, like fusion and thorium

NOBODY CAN DOUBT THAT:

- Unlike RES, which offer an intermittent energy supply, nuclear energy has already demonstrated that it can provide reliable and flexible power **24/7**, while using **less land** than most RES
- A proven and relatively safe technology, it has evolved dramatically since the first reactors of the 1950s.
- It is the only zero-carbon option that works for **high-temperature industrial processes**, such as steel or cement production.
- Jobs in the industry (130,000 Direct and 470,000 Indirect in NA alone) are very well paid…

SMALL MODULAR REACTORS

TYPICAL REACTOR

- 1,000 - 1,700 MWe
- Electricity Generation for the Grid
- CAPEX 4 to 10 billion USD
- Construction phase 7 to 10 years
- OPEX 10-20 USD per MWh
- Life of 60 years extended up to 80

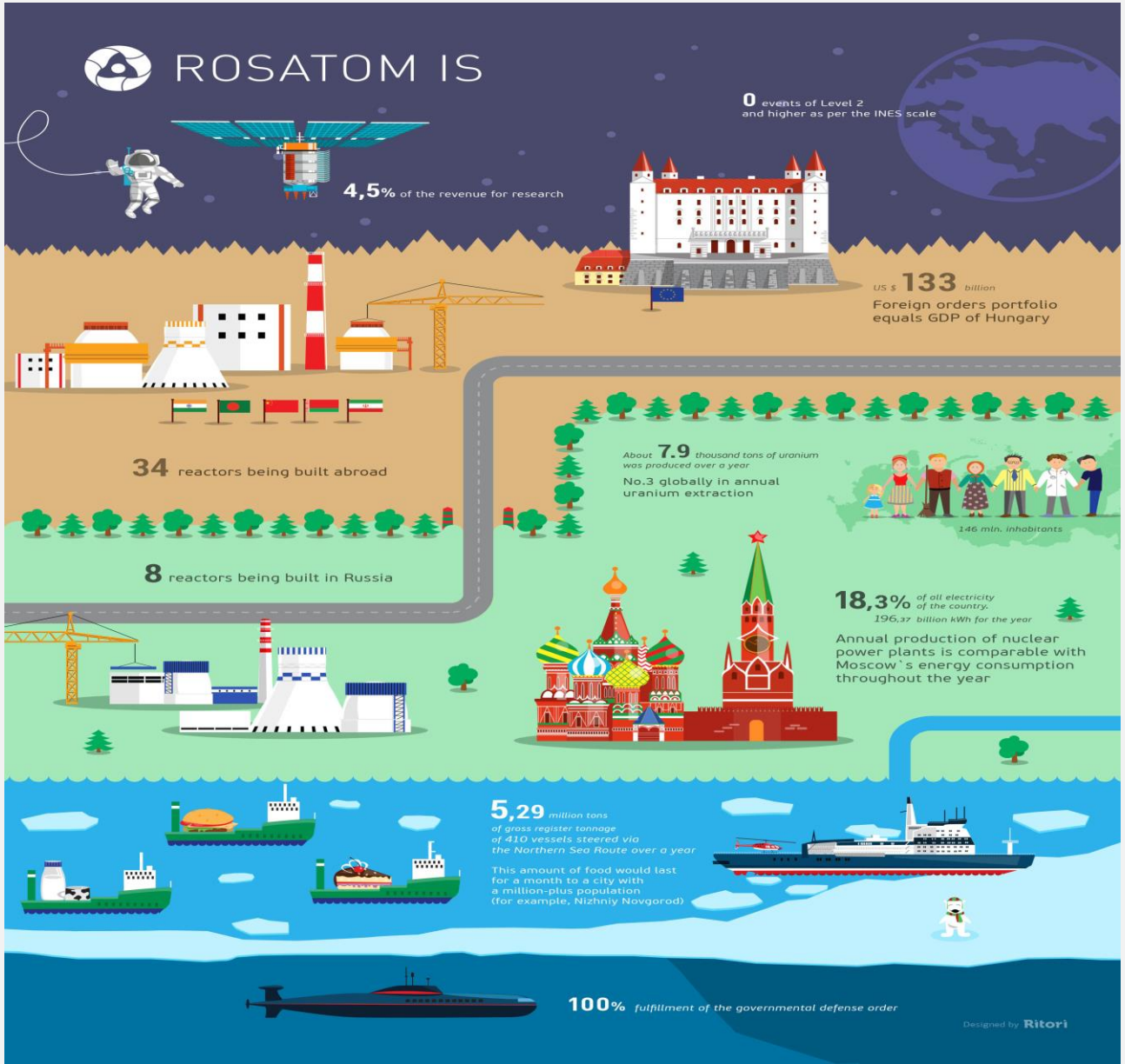
SMR

- 10 - 300 MWe
- Data centres, Desalination, Hydrogen Production and many other uses
- CAPEX 0.5 to 2 billion USD
- Construction phase 3 to 5 years
- OPEX 15-35 USD per MWh
- Life of 40 years extended up to 80

ROSATOM STATE CORPORATION

ESTABLISHED DECEMBER 2007

UNDISPUTED WORLD LEADER IN NUCLEAR ACTIVITIES



SOME MAJOR DIVISIONS

- **Gidropress** Reactor Design Bureau (OKB)
- **Atomflot**, operator of the World's only nuclear icebreaker fleet
- **UraniumOne**, one the World's biggest extractors of natural uranium
- **Rosenergoatom**, operator of all 36 commercial reactors in the R. Federation plus another 6 (iddle) in occupied Ukraine
- **Atomstroyexport**, successor of the Soviet Atomenergoexport (1973), builder of NPPs abroad

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Kazakhstan	19,451	21,317	22,451	23,127	23,607	24,586	23,321	21,705	22,808
Canada	9145	8999	9331	9134	13,325	14,039	13,116	7001	6,938
Australia	5983	6991	6350	5001	5654	6315	5882	6517	6,613
Namibia	3258	4495	4323	3255	2993	3654	4224	5525	5,476
Uzbekistan	2500	2400	2400	2400	2385	2404	2404	2404	3,500
Niger	4351	4667	4518	4057	4116	3479	3449	2911	2,983
Russia	2993	2872	3135	2990	3055	3004	2917	2904	2,911
China	885	1500	1500	1500	1616	1616	1885	1885	1,885

THE LEADER IN ENRICHMENT

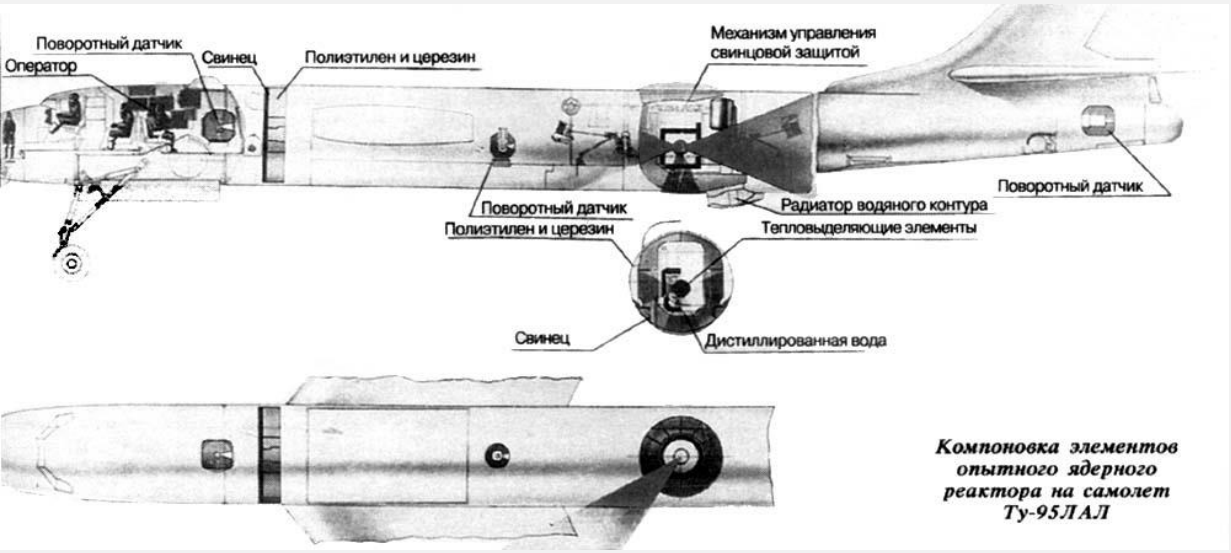
- Uranium found in nature consists largely of two isotopes, **U-235** and **U-238**. The production of energy in nuclear reactors comes from the 'fission' / splitting of the U-235 atoms
- Natural uranium in nature contains just 0.7% of the U-235 isotope. Isotope separation is a physical process to concentrate or **'enrich'** one isotope relative to others. Most reactors today are light water reactors and require uranium to be enriched from 0.7% to around 3 - 5% U-235 in their fuel. This is called low-enriched uranium (LEU). Nuclear weapons need much higher degree of enrichment.
- ROSATOM has the largest, by far, enrichment capacity in the World

AL. LIKHACHOV & NIK. SPASSKIY

GAZPROM BANK BEHIND ROSATOM'S INTERNATIONAL BRANCH!!!

JUNE 1954: OBNINSK NPP CONNECTED TO THE GRID IN KALUGA - 6 MW

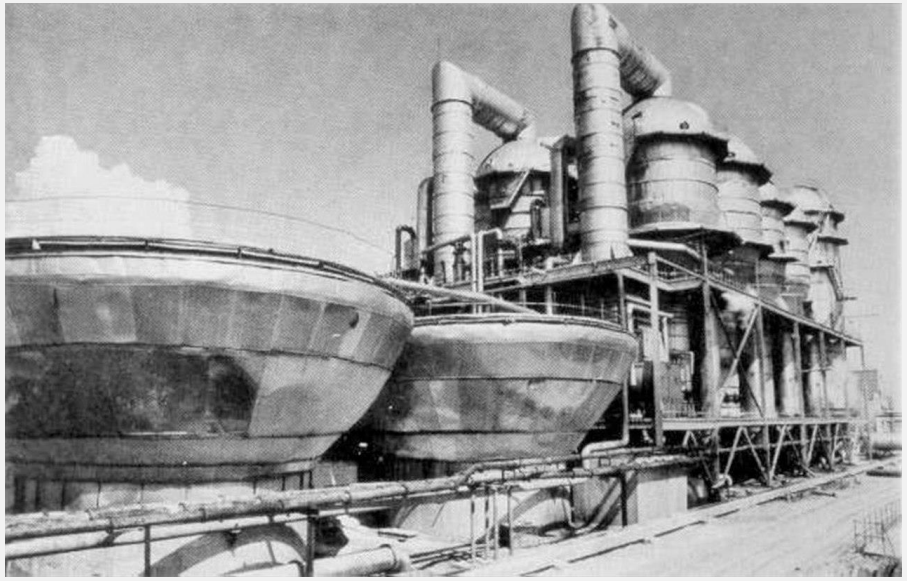
THEY EVEN TESTED A REACTOR INSIDE A MODIFIED TUPOLEV BOMBER IN 1961



MAJOR SOVIET MILESTONES

- **1953** "*Ministry of Medium Machine Building*" established, the forerunner of ROSATOM
- **1964** Beloyarsk 1 commissioned at 110 MW. Dominant concept was the minimalist **RBMK** by OKB Gidropress using *natural* uranium as fuel, *regular* water for cooling and *solid graphite* for neutron moderator
- **1966** Rheinsberg, the first NPP abroad (D.D.R.) used the **WWER** (water cooled, water moderated energetic reactor) also by OKB Gidropress, instead of the RBMK. Output 70 MW
- **1973** BN-350, the world's first "*breeder*" or "*fast neutron*" reactor commissioned in Aktau, SSR Kazakhstan. OKB Afrikantov. No neutron moderator needed like in classic thermal reactors plus they use almost all of their waste as fuel. In the meanwhile, in April 1977 Jimmy Carter decided to halt the construction of "breeders" in the US due to proliferation concerns…
- By the mid-1980s, the total capacity of Soviet nuclear power plants in operation reached a record of 37 GW or 10 GW above today's level (in Russia alone)

THE BN-350 AKTAU PLANT OF 135 MW

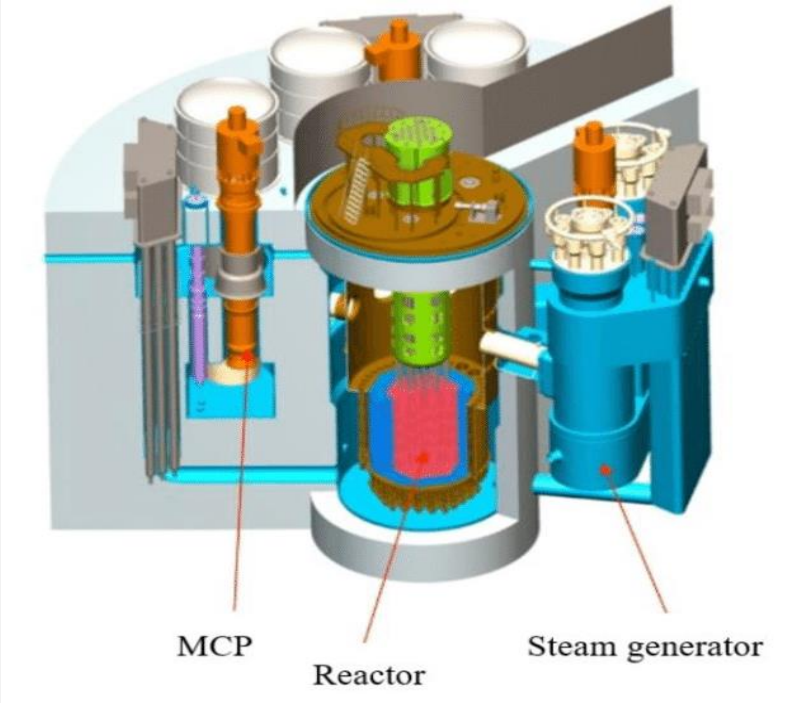


APRIL 1986: CHERNOBYL 4 TRAGEDY RBMK CONCEPT IS ABANDONED

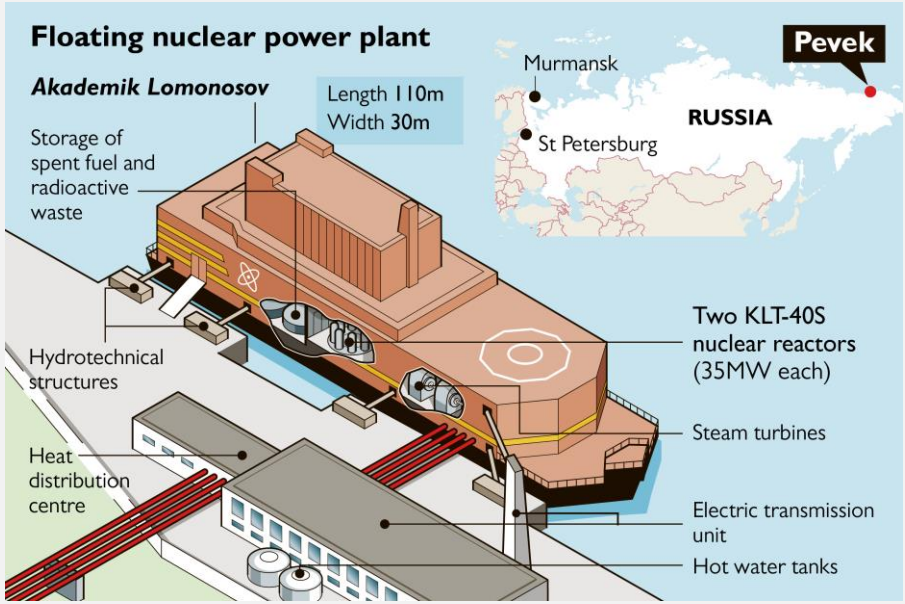
RECENT ACHIEVEMENTS

- Since its establishment in 2007, Rosatom has completed 25 new reactors in Russia and abroad, the *Akademik Lomonosov* floating nuclear power plant in December 2019 and the most modern icebreaker, *Arktika*
- **2016** Commissioning of the **first 3+ generation** reactor, WWER-1200 Novovoronezh 6, with a useful life of 60 years at 90% capacity factor. "*absolute safety and compliance with post-Fukushima requirements*"
- **2027** Commissioning the **first 4th generation** or lead-cooled fast neutron (i.e. breeder) reactor, the pilot BREST-300 at Seversk/Tomsk. AKA *Proryv / Breakthrough*, project. *The industry's resource base will practically become inexhaustible, thanks to the infinite reprocessing of nuclear fuel,* Likhachev said.

BREST-300



TWIN SMR IN *AKADEMIK LOMONOSOV*



22/39 R. UNDER CONSTRUCTION ABROAD,
EXPORT REVENUES $ 7.3 BN
FUEL SUPPLY FOR 75 NPP GLOBALLY
MARKET SHARE TARGET **30%** 5/16 ANNUALLY

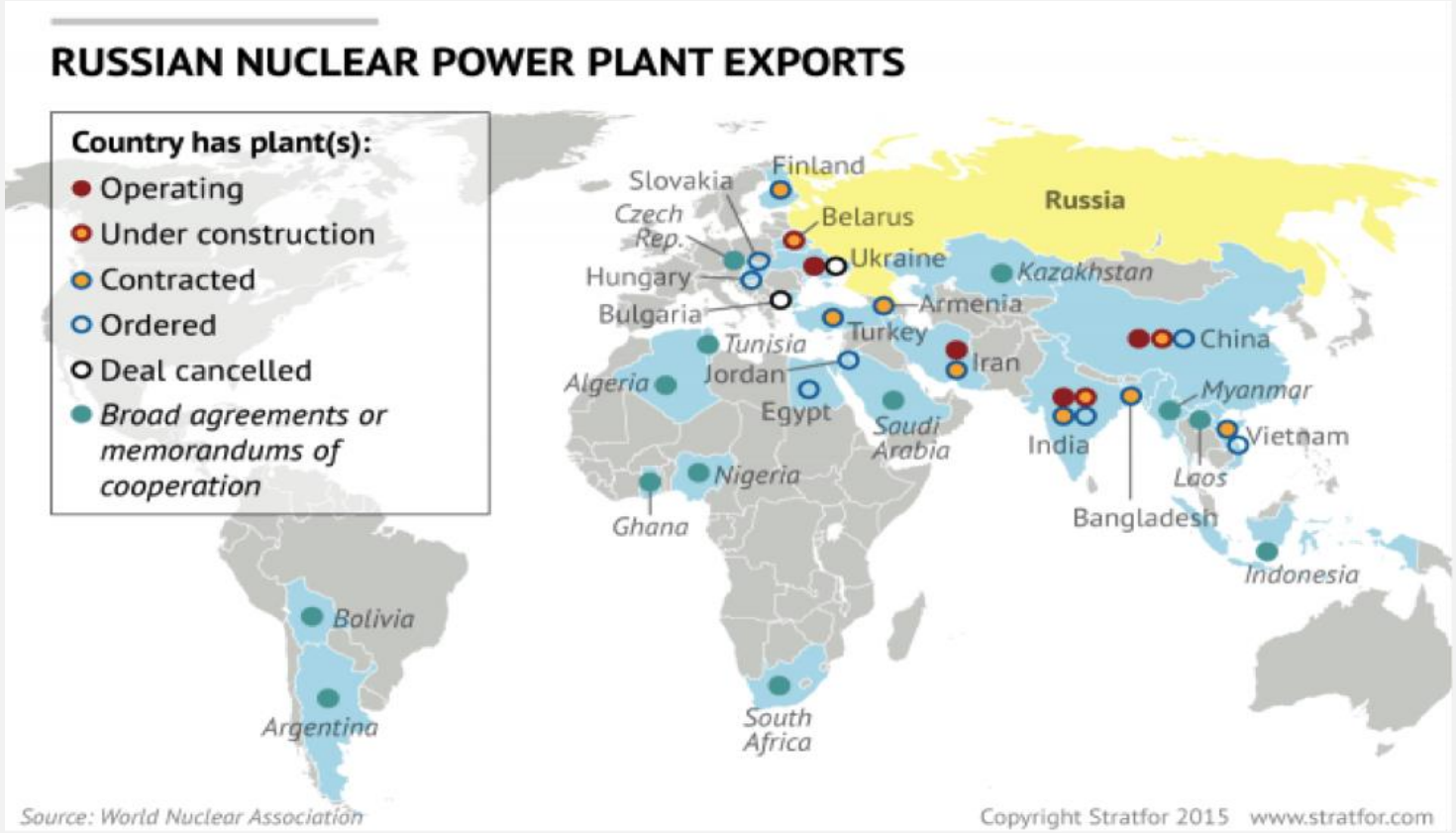
REACTORS UNDER CONSTRUCTION (2025)

- Mochovce 4 of only 470 Mwe, started back in 2009
- Paks 5/6
- Akkuyu 1/2/3/4
- El Dabaa 1/2/3/4
- Bushehr 2
- Tianwan 7/8 and Xudabao 3/4 (ROSATOM only supplies the reactors)
- Kudankulam 3/4/5/6
- Rooppur ½

THE EU IS ALSO DEPENDENT…

- **20%** of EU natural uranium imports come from Russia at a worth of €200 million/year (third place after Niger and Kazakhstan, where ROSATOM presence is also strong)
- Namely, this uranium, processed as nuclear fuel, powers all 6 Czech reactors, 4 Slovak, 4 Hungarian, 2 Bulgarian and 2 Finnish (total 18)
- ROSATOM is exempt from sanctions, but….

TOTAL ORDERS EXCEED $ 130 BN



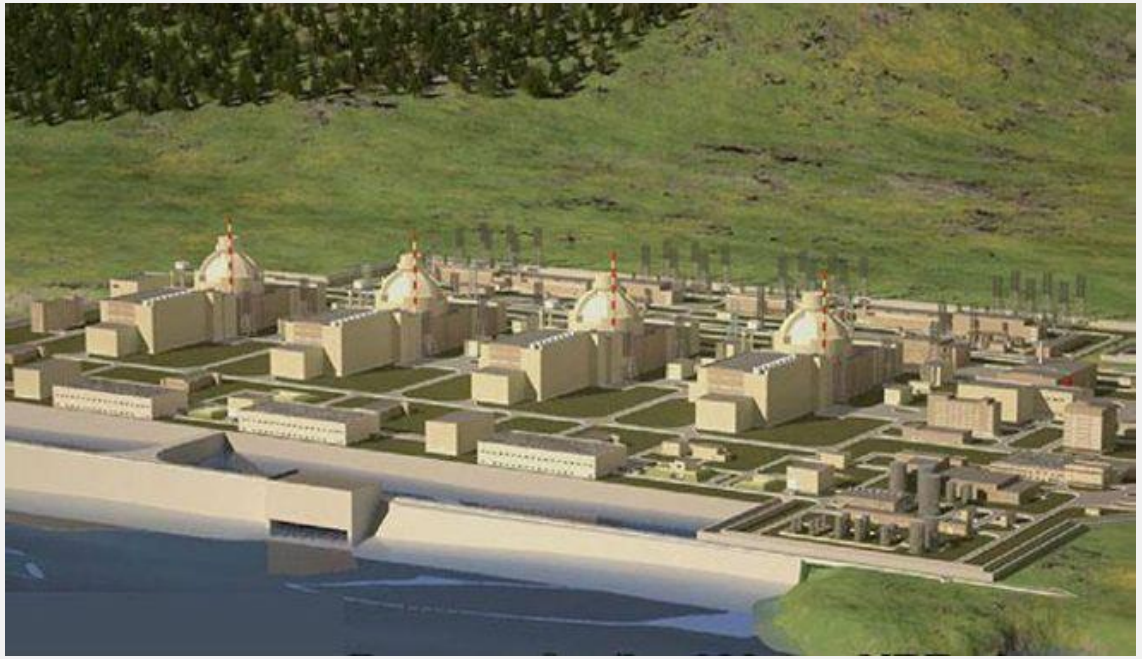
ROSATOM COMPARATIVE ADVANTAGES

- Full vertical integration and "full package", including return of RAW
- Enormous political and diplomatic support (diplomatic attaches in at least 15 Russian embassies)
- Projects financed up to 90% by export credits. Hungary $ 11 Bn
- BOO (Build-Own-Operate) model for the first time in Turkey, following the 2010 IGA. A kind of "Bastion" in a NATO country!
- Global reach, in contrast with the pipeline gas of OAO Gazprom
- Each deal forges a "strategic" cooperation of long-term nature

SEPTEMBER 2011: «BUSHEHR 1», IRAN «BUSHEHR 2» OPERATIONAL LATE 2028

INDIA AND CHINA ALSO BUY RUSSIAN…

EASTERN MEDITERRANEAN: STRONG PRESENCE, “AKKUYU 1” READY BY **2025** AT 27 BILLION, N.1 RUSSIAN FDI EVER



BRICS: UNITED BY NUCLEAR COOPERATION

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