ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ

UNIVERSITY OF PIRAEUS

Energy and Environmental Policy Laboratory

Nuclear Energy Geopolitics: the case of ROSATOM

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Working Paper 8

January 2018

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ISBN

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Preface

The subject of nuclear power remains a short of "terra incognita" in Greece. Therefore, the first two (2) chapters of this paper are introductory to the peaceful use of the atom, with a brief historical account of nuclear energy generation globally plus an analysis of the challenges the industry faces, and the following four (4) deal with ROSATOM itself.

Russian energy diplomacy during the era of Vladimir Putin is usually associated with oil and natural gas. Indeed, both Putin's Ph.D. Thesis (1997), entitled "*The Strategic Planning of Regional Resources under the Formation of Market Relation",* and the White Paper *"Russian Energy Strategy until 2020"* (2003) emphasized on hydrocarbons, where Russia enjoys vast reserves. Nevertheless, the Soviets were the first in the world to generate electricity from fission, as early as June 1954 (two plus years before the UK and three years before the US). From the late 1950s, Soviet nuclear reactors were installed in the so-called "satellite" states, first experimental and then commercial ones. The collapse of the USSR in 1991 was an almost fatal blow to the sector, but it gradually recovered due to huge state support. Technologically, Russia is probably a world leader by now, having already commissioned the first "*Generation 3+"* reactor and working towards "*Generation 4".* In November 2007, Putin consolidated the entire Russian atomic complex -until then loosely supervised by a Ministry- under the corporate umbrella of ROSATOM (Государственная корпорация по атомной энергии - State Atomic Energy Corporation).

During its first decade of its existence (late 2007 - late 2017), ROSATOM has proved itself to be a titan of global energy politics. It's the world champion as far as the number of international projects is concerned. Even traditional allies of the "West" such as Turkey, and, potentially, South Africa and Saudi Arabia, were enchanted by ROSATOM's allure, creating great concern in the US. Russian atomic energy diplomacy is a power projection mechanism by the Kremlin that is not to be underestimated. Still, there is no atomic diplomacy "on the cheap" - it's facing challenges, relative to Russia's precarious economic situation. As the most capital-intensive of energy projects, nuclear stations are not easy to implement, even if all other (political and regulatory) issues have been addressed.

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NOTES: 1) For references and bibliography, please see the text's footnotes 2) A much smaller version of this paper -in Greek- was originally presented as a lecture in UNIPI (May 2017) and then published online by FOREIGN AFFAIRS (Hellenic Edition) on 25 May 2017. It's available http://www.foreignaffairs.gr/articles/71285/basilis-sitaras/i-rosiki-diplomatia-tis-atomikis-energeias

I. ORIGINS OF THE NUCLEAR REVOLUTION. It's been 64 years now since US President Dwight Eisenhower delivered his historic speech *"Atoms for Peace"* to the United Nations General Assembly (8/12/1953). In front of a global audience immensely terrified by the two 1945 A-bomb drops against Japan and, even more, by the late 1952 H-bomb test, Eisenhower praised the peaceful uses of atomic energy.[1] The two main applications of nuclear energy Eisenhower had in mind were a) propulsion and b) electricity generation. As early as July 1951, under the Harry Truman Administration, the US Congress had authorized the construction of a nuclear-powered submarine, named the "*Nautilus*" (SSN-571) and eventually completed in 1954[2]. On 30/8/1954, Eisenhower signed the Atomic Energy Act, which encouraged private corporations to build nuclear reactors producing electricity, with the first of them (in the small town of Shippingport, PA) being connected to the grid in December 1957. It was officially commissioned in May 1958 and remained operational until 1982. A few months earlier, however, in April 1957, a smaller SM-1 Reactor (in Fort Belvoir, VA) became the first atomic power plant to go online and produce electricity for the US power grid, albeit for experimental purposes.

OFFICIAL "ATOMS FOR PEACE" LOGO, USA, 1955.

[1] Probably the most striking quotation of the President's 1953 speech, which summarized the US initiative, was the following: "To the making of these fateful decisions, the US pledges before you, and therefore before the world, its determination to help solve the fearful atomic dilemma - to devote its entire heart and mind to find the way by which the miraculous inventiveness of man shall not be dedicated to his death, but consecrated to his life."

[2] On 17/1/1955, this vessel signalled the historic message *"Underway on nuclear power"* – it was the first time in History that an object of significant size moved on nuclear propulsion alone… The first Soviet nuclear-powered vessel was the submarine "Leninsky Komsomol" (K-3), commissioned in 1958.

But America was only *second* in the West to generate electricity from the atom - In the United Kingdom, post-war austerity did not prevent significant funds being allocated to atomic research, both for military and non-military use. Despite the existence of domestic coal reserves, power generation from the atom went forward at an amazing pace. Thus, the powerful Calder Hall nuclear station in Cumbria was successfully connected to the grid in August 1956. This station, which cost £ 35m at the time, was able to produce electricity *"too cheap to meter"*, according to a Press release of the time. The last of the four Calder Hall reactors was shut down only in 2003.

CALDER HALL, CUMBRIA, UK, 1956 (www.britannica.com)

Meanwhile, in the Soviet Union (USSR), important technological developments were also taking place, under the veil of top secrecy. After testing their first nuclear warhead in August 1949, the Soviets initiated a program of nuclear power plants in early 1951, mainly for experimental reasons. Scientific giant Igor Kurchatov (1903 – 1960), AKA *"the father of the Soviet A-bomb"*, was put in charge of this project, too. A technological triumph of the "Red" science came on 27/6/1954, when Obninsk Atomic Energy Station (Обнинская АЭС) was successfully connected to the electricity grid of the Kaluga Oblast, not far away from Moscow. The small AM-1 reactor, with a gross capacity of only 6 MWe and a thermal capacity of 30 MWe, went critical on 6/5/1954[3]. AM stands for "Атом Мирный" or *"Atoms for Peace"* in Russian! Obninsk was, beyond doubt, the first electricity generation facility in the entire World using atomic power, ahead of similar

[3] https://www.iaea.org/PRIS/CountryStatistics/ReactorDetails.aspx?current=447

establishments in the UK-US (albeit in a smaller scale - Calder Hall 1 was 10 times more powerful at 60 MWe and Shippingport reached 68 MWe). Obninsk was decommissioned only in 2002 -after 48 years of successful operation- and it's now a museum.

OBNINSK NUCLEAR STATION IN KALUGA, RUSSIA, NOW A MUSEUM (www.wikipedia.org)

Nevertheless, as far as sheer numbers are concerned, the US remained a leader the industry for decades after WW2: in the next 50 years after the commissioning of Shippingport, no less than 132 nuclear reactors were built in the US alone, more than in any other country, but another 121 (42% of the 253 originally ordered) were cancelled, especially after the Three Mile Island accident in March 1979. Apart from the US and the UK, other major "Western" powers to rely on nuclear energy have been France, which eventually became the world's largest *net exporter* of electricity, F.R.Germany, Spain and Sweden, as well as South Korea and Japan in the Far East. Italy, another advanced industrial state, had built just four reactors since the 1960s, but, following a referendum in 1987 (a year after the Chernobyl NPP accident – see below), phase-out was decided and all plants had been closed by 1990. Even eco-friendly Switzerland succumbed to the charm of A-power. Few remember that one of the three European Communities established by the original six Western nations back in the 1950s was EURATOM, under a 1957 Treaty that is still in effect. EURATOM deals specifically with the peaceful use of atomic energy, focusing on safety issues, such as standards. In 2016, total nuclear energy generation by the 447 commercial reactors globally[4] was about 592 million tonnes of oil equivalent (significantly down from 635 million tonnes a decade ago -

[4] http://www.world-nuclear.org/information-library/facts-and-figures/world-nuclear-power-reactors-archive/world-nuclear-power-reactors-and-uranium-requi-(4).aspx

2006), with the following five countries being the "market share" leaders: US (32,4% or 191,8 million), France (15,4% or 91,2 million), China (8,1% or 48,2 million), Russia (7,5% or 44,5 million) and South Korea (6,2% or 36,7 million)[5].

Japan is no longer in the list, despite being the third biggest user of nuclear power until the March 2011 Fukushima accident (with up to 69 million tonnes of oil equivalent from more than 50 reactors). Actually, after the 1973 oil shock, nuclear energy had been named a national strategic priority, with expectations to produce 40% of electricity by 2017. The Fukushima accident forced it to gradually shut down all its plants, although in late 2015 very small-scale usage restarted. In February 2017 Toshiba, the industry leader in Japan, announced it was exiting for good the nuclear business. Germany, too, decided to significantly reduce nuclear power generation after the above-mentioned disaster, so by 2016 it was generating "only" 19 million tonnes of oil equivalent, half of its 2006 levels. It is likely that, by 2022/23, there are no more operational reactors in Germany.

II. CHALLENGES AND PERSPECTIVES. It's beyond doubt that the high hopes associated worldwide with "Atoms for Peace" in the 1950s and 1960s remained, to a very high degree, unfulfilled. As a recent paper by Nephew and De Blasio summarized the issue, *"geopolitical competition, economic factors and safety concerns have limited the use of nuclear power."*[6] Let's examine them one by one from our own perspective.

Geopolitically, of particular anxiety to the US was the likelihood -which contributed to the loss of many lucrative contracts abroad- that NPPs in developing countries might serve as "Trojan Horses" for nuclear weapons proliferation. The signature of the Non-Proliferation Treaty of 1968 (in effect since 1970) only exacerbated these fears and the case of Iran in the 2010s is a typical example. Israel's Air Force pre-emptively ...bombed the (unfinished) Iraqi Oshirak NPP back in 1981 exactly because of this fear, creating a huge international incident.

[5] BP Statistical Review of World Energy, June 2017, www.bp.com In electricity terms, the energy produced by all nuclear reactors in 2016 was 2.490 TWh or 10,6% of global electricity generated.

[6] Nicola De Blasio & Richard Nephew, *The Geopolitics of Nuclear Power and Technology*, Columbia University, SIPA, March 2017, www.energypolicy.columbia.edu p.p. 8.

Economic factors are even more important, especially nowadays. Privately-owned utility companies, which dominate the Western World, have to think twice, especially after the financial crisis of 2008/2009, before committing billions to the construction of a nuclear reactor. These projects are extremely capital-intensive, more than any other form of electricity generation of a comparable output, and they also take a very long time to materialize, so the investment risk is great.[7] Of particular significance *against* nuclear power was the *"Shale Gas Revolution"* in the US during the last decade, which made natural gas cheap thus very competitive[8]. The US has also introduced strong incentives -such as tax credits- promoting renewable energy, so nuclear lacks a levelled playing field[9]. A key development occurred in March 2017, when one of the global pioneers of A-power, Westinghouse Electric Corp, filed for bankruptcy under Chapter 11, due to cost overruns at its US nuclear plant projects. The Toshiba decision one month earlier (see above) was perhaps a forerunner of this, as the Japanese company had been a major shareholder of Westinghouse since 2006. The French Areva also suffered a huge loss in 2016 and in December 2017 transferred its nuclear reactor operations to EDF.

Nevertheless, we strongly believe that the peaceful use of nuclear power, despite its 60-year-long contribution to global energy security, has yet to unleash its full potential. Atomic energy is practically infinite and is due to take-off in the upcoming decades, especially in the developing nations, which desperately need it. The global energy map is changing: for decades up to 2006, the (relatively few) OECD states were ahead of non-OECD states in total energy consumption. Now, they and are left well behind and the gap is widening. The entire developing World is the "natural" market for much more electricity, regardless of its source, due to industrialization and rapid population increase. There is also one other factor: Environment. Nuclear energy is the only serious option if we want to combat global warming, which is due to the use of fossil fuels, and to implement the Paris Agreement on Climate Change, adopted in December 2015 within the United Nations Framework Convention on Climate Change (UNFCCC). Its 170 contracting parties so far (out of the 195 original signatories) are obliged to shift to

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[7] Ferguson remarked during the peak of that crisis: *"Faced with higher capital costs and relatively long construction times, nuclear power appears non-competitive compared to coal and natural gas plants".* Charles Ferguson - *A Nuclear Renaissance?* in Gal Luft (ed.), *Energy Security Challenges for the 21st Century: A Reference Handbook*, Praeger Security International series, Praeger 2009. p.p. 299

[8] Nicola De Blasio & Richard Nephew, ibid, p.p. 15

[9] Ibid.

cleaner energy, so fossil fuels, and especially coal, is not a viable option in the long-term[10]. That's why 56 new reactors were under actual construction in September 2017, with 160 on order or planned (plus 350 proposed)[11]

The leader in this field is no other than China, which is already building 20 new reactors (as of December 2017) to complement its 38 existing ones, with mature plans for at least 40 more[12]. US global hegemony, exemplified today by 99 operational reactors, is due to be challenged soon, as only a couple of reactors are currently being built in the US and 14 planned. Overall, the *"Nuclear Renaissance"* under way today is mainly evolving in "state-capitalist" countries, such as Russia, China, India and even the oil-rich United Arab Emirates. In the latter, the first of four reactors in Barakah -300 km west of Abu Dhabi- is now 100% ready and it will be connected to the grid in 2018[13]. To sum up, the global nuclear club is due to number at least 50 members by the early 2030s, compared to 30 in 2017, with all new members being emerging markets.

Of course, even if the financial issues are solved, safety concerns are still present. Public opposition is still common against the reactors in many countries, especially Western ones. The "green" movement, in particular, considers them dangerous and Eco-unfriendly, mainly because the waste disposal issue. It's true that, even today, no country has opened a permanent and safe repository for nuclear waste, with the notorious Yucca Mountain in Nevada -a former nuclear test site- being designated as such in 1987, but still not completed, due to political opposition by the locals[14]. An official US Senate report published in March 2006 described it as *"The most studied real estate on the planet"*. Especially after the 2011 Japan disaster, public outrage erupted worldwide against nuclear energy in general, more or less unjustifiable, in my opinion (given the particular characteristics of this obsolete reactor and the extreme natural phenomenon which had occurred).

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[10] Renewable energy is obviously not enough to cover the entire World, soon to reach 8 billion inhabitants. Renewable energy is a luxury which only few countries can afford at a large scale.

[11] http://www.world-nuclear.org/information-library/facts-and-figures/world-nuclear-power-reactors-and-uranium-requireme.aspx

[12] The first Chinese reactor to generate electricity was Qinshan 1 (310 MWe) in December 1991.

[13] Contracted to a South Korean consortium, this mega-project is worth some USD 20 billion and all 4 reactors will be online by late 2020, generating some 5.600 MWe.

[14] See full story here https://www.nei.org/Issues-Policy/Used-Nuclear-Fuel-Management/Disposal-Yucca-Mountain-Repository

Technological breakthroughs are due to boost the attractiveness of nuclear energy and also reduce the cost. Apart from the two traditional elements which have been used for atomic fuel to date, which are *uranium* and its radioactive by-product, *plutonium* (first generated in 1940), there is also *thorium*, still little-known but extremely promising, which could offer many hundreds of years of nuclear energy generation. Another option -already used in some countries- is to reprocess the fuel already spent, although this increases -slightly- the cost of energy produced. And while all commercial nuclear reactors until today have been using the nuclear *"fission"* procedure, there is huge potential from the nuclear *"fusion"* procedure, which could produce energy for thousands of years to come. Actually, the biggest technological challenge of the 21st Century in the entire energy spectrum is to be able to successfully industrialize fusion: this milestone, which is not beyond reach as of 2018, would make future nuclear reactors much more cost/effective (and also much safer) than the present ones.

As already stated, nuclear energy is mainly used as a means of producing electricity and, secondary, of providing heating, while atomic-driven transportation machines (essentially surface ships and submarines, but also space rockets) have remained a very rare case, at least outside the military forces of the Great Powers, mainly because of the fears concerning a possible accident[15]. Nevertheless, as electric cars and trucks are due to multiply in the following decades, countries relying on nuclear-produced electricity can apply, even indirectly, this form of energy to their transportation sector. Therefore, gradual reduction of dependence on oil will help both the environment (CO2 emission decrease) and the energy security status of these countries, as oil is mainly imported. Another nuclear "option" with potential transportation application is the generation of hydrogen in very high temperatures, for the so-called “fuel cell” powered vehicles.

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[15] Apart from the 1954 USS “*Nautilus*” and the hundreds of submarines which followed it up to this date, nuclear power has mainly been used for the few super-aircraft carriers, starting from the USS “Enterprise” (in service from 1961 until 2012). The civilian “Lenin” icebreaker ship of the USSR, also nuclear-powered, was launched in 1957 and commissioned in 1959, being the first commercial -and also the first surface ship of any kind- with this kind of propulsion. The American SS “Savannah” (the first in a class of four merchant ships) was launched in 1959 and commissioned in 1962. US aircraft manufacturer Convair was the first in the world to install a nuclear reactor into the fuselage of a B-36 bomber in 1955 and this vehicle (known as the NB-36H Crusader) flew 47 times in 1955-1957. In the USSR, a similar Tupolev Tu-95 bomber, modified with a small nuclear reactor on board, first flew in 1961, but the project of a nuclear-powered aircraft was also abandoned soon afterwards. In addition, “Project Rover” was an American project (1955-1972) to develop a nuclear thermal rocket for space.

III. ROSATOM - HISTORIC BACKGROUND & PRESENT STRUCTURE In June 1953, soon after Stalin's death, MINSREDMASH or Ministry of Medium Machine Building was established in the USSR, to deal with all applications of nuclear energy. Despite the success of the Obninsk power plant in 1954 (see above), post-war industrialization in the USSR actually made little use of nuclear energy, at least for the first 25 years up to 1970. Heavy reliance on the triplet of coal, oil and natural gas left the industry idle for a full decade after the Obninsk "world first". Therefore, the first two commercial-scale nuclear power plants in the USSR started up only in 1964 (the 110 MWe Beloyarsk 1 in April and the 210 MWe Novovoronezh 1 in September of that year).

Technologically, the Soviets relied for many years on the RBMK concept, which stands for Реактор Большой Мощности Канальный or "High Power Channel-type Reactor". Developed by OKB (Experimental Design Bureau) Gidropress, main designer of Soviet -and then Russian- nuclear reactors after WW II, this minimalist design used regular -not heavy- water for cooling and solid graphite for neutron moderator. Fuel of the RBMK series was natural uranium, instead of the more expensive enriched uranium. The inherent design flaws of RBMK became apparent only in April 1986, when the brand-new (commissioned in 1983) "Chernobyl 4" in the Soviet Socialist Republic of Ukraine exploded during a safety test. 31 people were killed on the site and thousands more died or got sick afterwards from radiation. All four reactors have been shut down, the last of them in 2000, while "Chernobyl 5" and "Chernobyl 6" were never completed.

CHERNOBYL MONUMENT AND THE CLOSED N. 4 REACTOR, UKRAINE (www.wikipedia.org)

The Chernobyl event remains the worst nuclear tragedy ever. This, combined with the abrupt collapse of the USSR five and a half years later was a severe -almost lethal- blow to the national nuclear industry. The entire 1990s were a period of disinvestment and disarray, with the first all-new nuclear reactor in Russia (Rostov 1) being commissioned only in 2001, followed by Rostov 2 in 2010 and Rostov 3 in 2014. Another four new reactors have been installed since the 2000s in the existing power plants of Kalinin (2004 and 2011), Beloyarsk (2016) and Novovoronezh (February 2017 - see below about the state-of-the-art features of this particular reactor, Novovoronezh 6). As of today, the Russian Federation has 35 reactors connected to its grid, generating 26.895 MWe or almost 18,5% of its "energy mix" for electricity generation (roughly the same percentage with the US). Another seven are currently under construction in the Russian Federation, all to be operational by 2022.[16] Nevertheless, many old plants will be retired by 2030, so the absolute number of reactors is due to remain roughly the same.

Technologically, the obsolete RBMK design concept has now been abandoned for good. In fact, well before the Chernobyl tragedy occurred, the great reactor designer V.V.Stekolnikov of Gidropress had focused on the now classic WWER (Water-cooled & water-moderated power reactor) concept, of which it has constructed 73 commercial units so far. As of today (late 2017), no less than 19 NPPs worldwide use this system, with an excellent safety record. This is the most prevailing type of "light water" reactors and here water is used as coolant as well as moderator, in place of solid graphite.[17]

V.V. STEKOLNIKOV, HEAD OF OKB GIDROPRESS FROM 1962 TO 1992 (Gidropress)

The culmination of this design trend is the brand-new Novovoronezh 6 (1.200 MWe), *"the first Generation 3+ reactor in the world to be commissioned"*,[18] and also with a design life of 60 years, up to 2077. Due to the huge funds allocated by the Putin

[16] http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx

[17] http://www.gidropress.podolsk.ru/en/projects/wwer.php

[18] Ibid

Administration for R&D, Russia has become, once again, a world leader in the field of nuclear reactors, determined to deploy operationally the first *"Fourth Generation"* reactor, namely the BN-1200 sodium-cooled fast neutron reactor, by 2025 the latest. The BN-1200 has been preceded by the BN-350, BN-600 and BN-800 models, developed originally by the rival OKB named after Igor Afrikantov (1916-1969). These advanced reactors can burn any radioactive fuel and leave no waste at all. The deployment of fast reactors was given priority in Russia as early as February 2010, when the government approved the federal target program designed to bring this new technology platform ahead as soon as possible. Originating from the propulsion system of submarines, this generation is destined to *provide "reliable and safe operation during the assigned service life at the given parameters of the working medium (steam-water) and coolant (sodium)"*.[19] Another striking Russian innovation is the floating NPPs, featuring small modular reactors. No less than eight such ships are currently planned, starting with the vessel named *Academician Lomonosov*, which has been completed by late 2017. Designed for utilisation in the Arctic and the Far East, this program has been facing various challenges and none is still operational at the time of writing, but most likely *Academician Lomonosov* will be by October 2019.

All the developments above concerned internal (Soviet-Russian) market. But there has also been an external dimension or "atomic diplomacy", which is already 60 years old now. During the Khrushchev era (1955-1964), small or research reactors were exported from the USSR to friendly countries, such as People's Republic of China, German Democratic Republic, Bulgaria, Hungary, Romania and even the non-aligned Yugoslavia, starting from 1958. Commercial nuclear power plants, however, were constructed in five of the so-called Moscow's "satellite states" during the Brezhnev era (1964 - late 1982): in the German Democratic Republic from October 1966 (date of commissioning of the pioneer Rheinsberg NPP with a 70 MWe output, although the groundbreaking ceremony for this actually took place as early as January 1960, under Khrushchev's consent[20]), in Czechoslovakia from 1972, in Bulgaria from 1974, in neutral Finland from 1977[21] and in Hungary from 1982.

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[19] http://www.gidropress.podolsk.ru/en/projects/SG-bn1200.php

[20] It was decommissioned in 1990, just a few months before German reunification.

[21] The first Finish NPP at Loviisa was an unorthodox "mix" of Western and Soviet technology, with the two reactors themselves -inaugurated in 1977 and 1980, respectively- made in the USSR, but with

EAST GERMAN BANKNOTE OF 1971 DEPICTING RHEINSBERG CONTROL ROOM, THE FIRST-EVER SOVIET NPP CONSTRUCTED ABROAD (www.wikipedia.org)

Roughly during the same period, commercial reactors were also built in four Soviet Socialist Republics other than Russia and today sovereign states, namely in Kazakhstan (operational in 1973 but now decommissioned[22]), in Armenia (1976), in Ukraine (1977) and in Lithuania (1983, decommissioned after the accession to the EU as part of the accession agreement). Therefore, ten countries -including Russian Federation itself- were already operating Gidropress-designed nuclear reactors by the time of the USSR's collapse in late 1991.

Surprisingly, Russian cooperation with **China** began only in 1999, when the Tianwan NPP (in the south-eastern province of Jiangsu) started being built. Nevertheless, the respective IGA had been signed as early as 18/12/1992, just a year after the demise of the USSR. After a long period of construction even by the standards of nuclear industry, Tianwan 1, which was described at the time by International Atomic Energy Agency (IAEA) as *"the safest NPP in the world",* was eventually commissioned in May 2007. Despite the fact that China has developed indigenous reactor technology, mainly by reverse-engineering Western designs, cooperation with Russia has continued ever since.

The Soviet government body responsible for negotiating, designing and executing NPP projects abroad was "Atomenergoexport", founded in 1973. It has now been renamed "Atomstroyexport" (Атомстройэкспорт) and constitutes a key part of the ROSATOM empire (see below)[23]. Actually, it was established in March 1998, almost a decade before the consolidation of Russian nuclear industry under the ROSATOM umbrella, and its first export success was the Chinese contract for Tianwan NPP the following year.

Westinghouse (USA) and Siemens (West Germany) supplying equipment and engineering expertise. This strange combination gave the project the nickname "Eastinghouse"!

[22] It was the pioneer BN-350 fast breeder reactor (see above) in Aktau, East shore of the Caspian.

[23] http://www.atomstroyexport.ru/wps/wcm/connect/ase/eng/

A major structural re-organization occurred in 2007 under the order of President Putin. The former Russian Ministry for Atomic Energy was transformed into ROSATOM (Государственная корпорация по атомной энергии - State Atomic Energy Corporation) effective from in November 2007 and it also absorbed all relevant entities.[24] Under the ROSATOM institutional "umbrella" operates today a giant conglomerate of more than 350 companies, enterprises and scientific organizations and more than 255.000 people. These are dealing not only with electricity generation from atomic energy, but also with the traditional military applications of the atom (i.e. nuclear warhead development).

According to the official ROSATOM website, *"its leading edge stems from a number of competitive strengths, one of which is assets and competences at hand in all nuclear segments. ROSATOM incorporates companies from all stages of the technological chain, such as uranium mining and enrichment, nuclear fuel fabrication, equipment manufacture and engineering, operation of nuclear power plants, and management of spent nuclear fuel and nuclear waste…"*[25] This high degree of vertical integration is perhaps the single most important advantage of ROSATOM when competing with Western firms for foreign markets, as will be shown later on.

ROSATOM LOGO IN ENGLISH (Rosatom)

[24] http://www.world-nuclear-news.org/C/Russian_power_giants_join_forces_210208.html

[25] http://www.rosatom.ru/en/about-us/

The company is headquartered in Moscow at Bolshaya Ordynka Street. Among the numerous ROSATOM branches, the most important ones are perhaps Rosenergoatom[26] (public utility, which operates all the NPPs in Russian Federation), Atomenergoproekt[27] (engineering company, general designer of NPPs) and, of course, the above-mentioned OKB Gidropress[28] (nuclear reactor designer) and Atomstroyexport[29] (export contracts). Very interestingly, a major shareholder of Atomstroyexport with 49,8% of its shares is no other than Gazprom Bank[30], indicating the strong interconnection between the two Russian titans, the nuclear and the gas one.

Since the fall of 2016, the Director General of ROSATOM is Mr Alexey Likhachev, former Deputy Minister of Economic Development of the Russian Federation, while the Deputy Director General in charge of international cooperation is former Ambassador Mr Nikolai Spasskiy (Atomstroyexport division, in particular, is headed by Mr Alexander Lokshin). A key person in the first decade of ROSATOM's existence was Mr Likhachev's predecessor, Mr Sergey Kiriyenko, a very well-known political figure in Russia, who currently serves as First Deputy Chief of Staff of the Presidential Administration.

ROSATOM DIRECTOR GENERAL A.LIKHACHEV (Rosatom)

[26] http://www.rosenergoatom.ru/en/

[27] http://www.aep.ru/en/

[28] http://www.gidropress.podolsk.ru/en/

[29] http://www.atomstroyexport.ru/wps/wcm/connect/ase/eng/

[30] http://www.gazprombank.ru/eng/

ROSATOM is, by far, the global leader in uranium enrichment process today with approximately 36% of the market. It's also among the leading producers (extractors) of raw uranium with 8.000 tonnes annually, of which 5.000 tonnes abroad, mainly in Kazakhstan. Raw materials in Russia and Kazakhstan alone are considered big enough to supply both the domestic and the international projects of the company for the next hundred years[31]. In terms of nuclear power generation, however, ROSATOM is "only" the third in the world, through the 35 operational reactors of its Rosenergoatom affiliate (*see exact figures in Chapter 1*). It has a global market share of almost 18% in the nuclear fuel production and it operates the world's one and only nuclear icebreaker fleet, continuing the heritage of the legendary *"Lenin"*[32].

IV. CONQUERING EMERGING MARKETS – MAJOR PROJECTS UNDERWAY. It's not easy to summarize the international activity of ROSATOM during the 10 years of its existence. Suffice to say it has become the indisputable world leader in building NPP abroad: at the end of 2016, ROSATOM's confirmed order book outside the Russian Federation was 34 reactors in 13 countries valued at 133 billion USD. This compares with "only" seven reactors under construction for the domestic market (see above) and proves the export-oriented character of the conglomerate. Prospects also look bright: ROSATOM estimates that the global market for reactors in the 2020s will be at least new 16 units per year. Out of that, it targets a "market share" of 30% or 5 units per year. Taking into consideration that each unit costs, on average, from billion to 7 billion seven USD, it's a lot inflow of money for the Russian economy.

Out of the many projects executed -or planned- abroad by Atomstroyexport, we already mentioned Tianwan 1 & 2 in **China**, operational since 2007 with two WWER-1000 reactors of 990 MWe each. Two even bigger (1.126 MWe each) reactors are currently under the final stage of construction in the same NPP and will be connected to the electricity grid in 2018[33]. The controversial -to say the least- Bushehr 1 in the Islamic Republic of **Iran**, very close to the Persian Gulf, was finally commissioned in September

[31] http://www.rosatom.ru/en/about-us/
[32] Ibid
[33] http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-power.aspx

2011, despite the fierce Israeli and US reactions[34]. Its reactor is also of the WWER-1000 type, like the Chinese ones. This plant is designed to withstand up to 8 magnitude (Richter scale) earthquakes and indeed, it has successfully survived one in April 2013 of 7,7 magnitude. The anticipated energy generation from Bushehr 1 alone is the equivalent of 11 million barrels of oil or 1,8 billion cubic metres of gas per year, which can be exported for "hard" currency. In 2013, Iran's Energy Minister said that the country saved some 2 billion USD per year in oil and gas thanks to Bushehr. No surprise, therefore, that Units 2 and 3 of the Bushehr NPP have now been ordered, with the goal to be ready by 2024 and 2025, respectively (while Bushehr 4 & 5 are still planned). According to Marco Giuli, *"Iran represents the most successful model for Russia's use of nuclear energy cooperation to advance its strategic priorities vis-à-vis Washington"*.[35]

BUSHEHR 1 IN IRAN, OPERATIONAL SINCE 2011 (ISNA)

Kudankulam 1 and 2 in **India** were commissioned in December 2014 and April 2017, respectively, with another two under construction[36]. Once again, the WWER-1000 reactor type was used. Due to many reasons and especially to the Indian *"local content"* requirements[37], Kudankulam took more time to materialize than any other Russian atomic project abroad: the original India-USSR agreement was signed back in 1988 and

[34] http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/iran.aspx

[35] Marco Giuli, *Russia's nuclear energy diplomacy in the Middle East: why the EU should take notice*, European Policy Centre Policy Brief, February 2017, also available online here http://www.epc.eu/pub_details.php?cat_id=3&pub_id=7455

[36] http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/india.aspx

[37] *"Unlike other Atomstroyexport projects, such as in Iran, there was only a maximum of 80 Russian supervisory staff on the project"* (ibid).

amended (with Russia) in 1998[38]. A long-term credit facility covered about half the cost of the plant, said to be 3,3 billion USD. Even in India, however, there have been sceptical approaches to the bilateral nuclear deal, like an article which appeared in late 2017[39].

Belarus, Bangladesh, Finland, Hungary, Egypt, Armenia, Slovakia and Jordan have all ordered Russian NPPs. It seems that these projects will be implemented sooner or later, due to heavy Russian financial assistance. The Ostrovets plant, in construction since late 2013, will be the first of its kind in **Belarus** -including Soviet times- with Ostrovets 1 scheduled to be put into commercial operation by mid-2019 and Ostrovets 2 a year later[40]. Both reactors are WWER-1200 and about 9 billion USD of Russian financing has been lined up (or 90% of the total project cost). In 2018, both the Finish brand-new NPP in Hanhikivi and the Bangladeshi one in Rooppur (2 reactors) are due to start being constructed, followed shortly by the Armenian Metsamor 3, which will be ready by 2025/26[41].

In **Hungary**, the good relations between Victor Orban and Putin secured (January 2014) a mega-loan of 10,7 billion USD for the Paks 5 and Paks 6 reactors, also of the WWER-1200 type. They will be ready by 2025 and 2027, respectively, increasing Hungarian dependence on nuclear energy to 80%, one of the highest in the World. A big victory for Mr Orban came in March 2017, when DG-Competition in Brussels cleared the way for the project on the state aid issue, ruling that *“Hungary has demonstrated that the measure avoids undue distortions of the Hungarian energy market”.*[42]

Russia was the first country visited by the new leader of **Egypt**, general al-Sisi, immediately after he assumed power, and in 2014 the two countries signed an intergovernmental) agreement for a NPP, to be financed by the Russian side[43]. Still, by late 2017, construction works had not started, while proposals from China & South Korea have also been submitted. Egypt has considered establishing nuclear power since

[38] When construction of the first unit finally started, in 2002, it was due to be commissioned in March 2008. Actually, it missed the deadline by almost seven years.

[39] https://www.gatestoneinstitute.org/11351/russia-nuclear-diplomacy

[40] http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/belarus.aspx

[41] In that Caucasian country, Metsamor 2 (1980) somehow survived the tremendous earthquake of December 1988, despite being only 75 km from the epicentre. After a temporary shut-down, it was put back in operation in 1995, but it will be replaced by the new reactor of almost three times more capacity (1.060 MWe versus 376 MWe) and a service life of 60 years.

[42] http://europa.eu/rapid/press-release_IP-17-464_en.htm

[43] Marco Giuli, Ibid

the 1960s and many abortive efforts have taken place ever since, like the ambitious ten-reactor plan of 1978, all of which were due to be ready by 1999. Current plans focus on the El Dabaa site, with four ROSATOM reactors (once again WWER-1200) of 1.190 MWe each.

Potential customers of ROSATOM -with no firm orders yet- are Kazakhstan, South Africa, Algeria (where a rather vague intergovernmental agreement was signed in 2014), Saudi Arabia, Indonesia, Myanmar, Nigeria and even Bolivia and Argentina in the American continent! We shall focus on just two of them, S.Arabia and S.Africa.

Oil-rich **Saudi Arabia** seems committed to build 16 (!) reactors over the next 20-25 years, as its leaders *"want to catch up with the technological state of play their archenemy"* (Iran)[44]. The strategic visit of King Salman to Moscow, in October 2017, included nuclear cooperation high in the bilateral agenda. As early as 2010, a royal decree by his predecessor said that *"The development of atomic energy is essential to meet the Kingdom's growing requirements for energy to generate electricity, produce desalinated water and reduce reliance on depleting hydrocarbon resources."* Rumors say that, by the end of 2018, the Saudis will pick an international partner to kick-off their grandiose projects and ROSATOM, though not the sole candidate, looks a strong case. From 2011 until 2015, the Saudis signed numerous cooperation agreements on nuclear energy with many countries (France, China, South Korea and, of course, Russia, where a joint coordinating committee on nuclear affairs has been established).

South Africa is also another very big "prize" for Russian atomic energy diplomacy, given its previous links with the West, including in nuclear affairs. Elderly President Jacob Zuma (a very close friend of Mr Putin within the BRICS system of emerging powers) is determined to ensure energy independence for the nation, by building eight 1.200 MWe reactors at a total long-term cost -during their useful lifetime- of 75 billion USD.[45] If built, this will be, by far, the most expensive infrastructure project in South African history, creating storms of controversy. In November 2013, South African atomic utility NECSA -which operates since the mid-1980s two French-built commercial reactors- signed a broad agreement with Atomstroyexport to develop *"a strategic partnership"* including NPP construction and waste management, with financial assistance from Russia. A more

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[44] Marco Giuli, Ibid

[45] http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/south-africa.aspx

formal (intergovernmental) agreement followed in September 2014, which was kept secret from the South African pubic. Its disclosure by the Russian MFA, sometime later, caused a political storm in Pretoria. Nevertheless, progress ever since has been extremely slow and the scheduled replacement of Zuma by a new President in June 2019 casts doubts on the project. In March 2017, Zuma reshuffled his cabinet, due to objections of some ministers to the project, and the opposition Press described the move as *"ROSATOM's nuclear coup"*!

"BRICS" SUMMIT IN BRAZIL (2014), WITH JACOB ZUMA OF SOUTH AFRICA ON THE RIGHT. NUCLEAR COOPERATION BRINGS THEM EVEN CLOSER.

Unfortunately for Russia, the controversial Belene NPP in **Bulgaria** with two WWER-1000 reactors (initiated in 2008) was eventually cancelled in March 2012, but a resurrection is not entirely improbable. In June 2016, a Swiss arbitration court allocated to ROSATOM's Atomstroyexport division 620 million USD for equipment already built before the Belene cancellations, which was never delivered. Bulgaria currently operates the Soviet-era Kozloduy 5 and Kozloduy 6 in the Danube river, generating together about one-third of its electricity.[46] Kozloduy 1, 2, 3 and 4 have all been shut down. Kozloduy 5\6 remains the country's lowest-cost electricity producer and there are thoughts now to add, instead of Belene, another reactor in the same site, to be named Kozloduy 7. It is still unknown if this extra reactor, if installed, will be of Russian origin or of other.

[46] http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/bulgaria.aspx

Also the **Vietnam** project (consisting, at first stage, of two WWER-1200 reactors) is rumored to have been stalled, at least for the time being. The Vietnamese have been in the nuclear track ever since 1995, with little results so far. Originally scheduled for completion by 2020, the Phuoc Dinh NPP in the Ninh Thuan province doesn't seem to be ready by 2028/29, the earliest. Russian credits of 9 USD/85% of the cost will be needed[47]

Last but not least, **Ukraine** is a country with 15 Soviet & Russian-made reactors generating half its electricity. It would have been a "logical" ROSATOM market for their replacement (as most of them are now very old and dangerous), but the bilateral political relations between Moscow and Kiev after the 2014 Crimea annexation seem to rule out this possibility. Therefore, the Ukrainians are already cooperating very closely with the French Areva (for reactor upgrade) and the US Westinghouse (for the supply of nuclear fuel up to at least 2020)[48]. The Westinghouse deal was the result of intense political and diplomatic lobbying by both the US and the EU.[49] Nevertheless, its 2017 bankruptcy will push Ukraine closer to the Russian "Bear", unless it's ready to face a situation of energy poverty. Please note that, despite the 2014 events, the country still depends partially on Russia for many nuclear fuel cycle services, notably enrichment.

ROSATOM's comparative advantages, apart from the high technological level of its products, are mainly the following:

a) First and foremost, due to its vertically integrated structure already mentioned above, it offers potential customers a *"complete solution"* or *"package offer"*, covering everything from the initial design phase to final decommissioning of the NPP (including

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[47]. In 2017, 28 Vietnamese became the first international graduates of a 6-year course on nuclear technology offered by Russia's National Research Nuclear University, while more than 500 in total have been trained in various projects. http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/vietnam.aspx

[48] In November 2015, Ukrainian utility Energoatom signed an agreement with Areva *"for safety upgrades of existing and future nuclear power plants in Ukraine, lifetime extension and performance optimization."* The 2012 agreement with ROSATOM to complete two half-built Soviet reactors Khmelnitski 3 & Khmelnitski 4 was revoked. By 1990, K 3 was ready by 75% and K 4 by 30%. In August 2016, Energoatom signed an agreement with South Korea on the completion of K 3 & 4. http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/ukraine.aspx

[49] Leonid Berdshinsky summarizes the story as following: *"Westinghouse enlisted U.S. diplomats to gain traction with European Union authorities worried about the security of Russian supplies after the Crimea annexation in 2014. In 2015, the EU awarded 2 billion USD funding to a Westinghouse-led consortium to develop a competitive fuel offering for the Russian reactors"*. https://www.bloomberg.com/view/articles/2017-03-30/u-s-nuclear-setback-is-a-boon-to-russia-china

training, construction, provision of nuclear fuel etc). This also affects the final price tag of a Russian-built NPP which is usually at least 20% below Western-built ones.[50]

b) In certain cases, it accepts even the return of RAW (radioactive waste) for disposal back to Russia, thus easing environmental concerns.

c) It enjoys, like Gazprom, full diplomatic support from the Kremlin. In approximately 15 Russian embassies today, there are permanently stationed ROSATOM executives, functioning as *"nuclear attaches"*, under the guidance of the respective Ambassadors. It is essential to note that ROSATOM is free from the Kremlin to sell NPP to any nation interested, no matter its international status or diplomatic relations with Russia (on the contrary, traditional pro-West and even NATO states are the prime targets, with the hope of offsetting Western influence). This comes in sharp contrast with the geopolitical "psychosis" of the US mentioned in Chapter 2, as American companies *"are prevented from building reactors in all but the 46 countries with which the US has already concluded the so-called "123 Agreements" on the sharing of nuclear expertise*" [51]

d) Projects abroad can be financed up to 90% by Russian export credits, e.g. from *Vnesheconombank*, the Russian Bank for Development and Foreign Economic Affairs, with which in June 2016 ROSATOM signed a Memorandum of Understanding.[52]

e) In Turkey and Jordan[53], the extremely attractive model of "build-own-operate" (BOO) has been offered, indicating zero cost and involvement for the recipient countries. Sometimes, these have neither the desire nor the expertise to operate the NPPs.

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[50]An amazing p.p. presentation of this integrated approach by ROSATOM itself (January 2013) is now available online and accessing it is highly recommended. It also shows that there can be many variations of the basic model, according to the customer's needs.
https://www.iaea.org/NuclearPower/Downloadable/Meetings/2013/2013-02-11-02-14-TM-INIG/11.sokolov.pdf

[51] https://www.reuters.com/article/thoburn-rosatom/column-russia-building-nuclear-reactors-and-influence-around-the-globe

[52]*"Vnesheconombank is ready to make every effort to assist ROSATOM as a strategic partner"*, its chairman said, while the Head of ROSATOM added: *"I am confident that implementation of projects in the framework of the signed agreement will help to address the global challenges of the nuclear industry and increase the energy security of the Russian Federation."* The agreement will *"contribute to the growth of the Russian economy and the expansion of Russia's presence in the global nuclear energy market,"* the ROSATOM statement concluded. http://www.world-nuclear-news.org/C-Russias-Rosatom-signs-10-billion-worth-of-deals-at-AtomExpo-01061601.html

[53] Jordan imports over 95% of its energy needs, at a cost of about one-fifth of its GDP. After talks with many foreign firms, in October 2013 it was announced that AtomStroyExport would supply two AES-92 (1.060 Mwe each) units, of which the first will be ready by 2023. These will contribute 48% of

On the other hand, the biggest single challenge ROSATOM faces is financial, relative to Russia's precarious economic situation: as said, most of its projects abroad (with the exception of cash-rich China) are financed, to a great extend of the total CAPEX needed, through low-interest export credit facilities. A brief estimate of the funds required to implement all these projects is 100+ billion USD, not including the Turkish NPP (*which is not a mere loan, but a Foreign Direct Investment-see next Chapter below*). The later will add another 22 billion USD to the "price" of Russian atomic diplomacy, which seems to be even more expensive than gas diplomacy, e.g. the pipelines to Europe and China. We leave aside the *"opportunity cost"* of the whole endeavor (whether all this money could have been used in a more rational way just to modernize the Russian productive base). The financing capabilities of the Federation, especially after the drop in oil and gas prices are not unlimited. Oil/gas sales (the income) and infrastructure projects (the expenses) are closely linked, as Gareth Evans has well noted: *"By channelling the income stream gained from oil and gas sales into long-term assets, the goal is to cement the country's future role as a major energy nation."*[54] Therefore, shrinking income from hydrocarbons *"will inevitably restrict Russia's ability to provide finance to other countries, which could have an impact on competitiveness"*.[55]

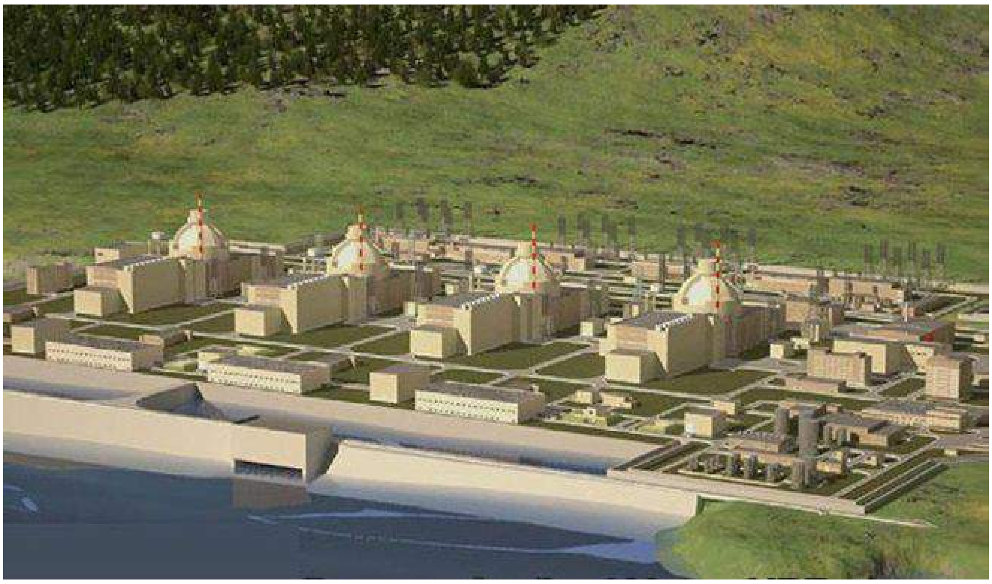
IV. RUSSIAN ATOMS FOR NATO: THE AKKUYU NPP IN TURKEY Of particular importance for Greece, as well, is the Akkuyu NPP in Southeastern Turkey, close to the port of Mersin. Akkuyu, being under consideration for more than forty years now, will be, when completed, the first project of its kind the wider Eastern Mediterranean area. And the prognosis today is that it *will* be built: for quite a long time just an idea surrounded by controversy and rumors about possible cancellation, this mega-plant is now under actual construction. The ground-breaking ceremony, which took place on December 10, 2017, after the issuance of a limited construction permit, confirmed the willingness of both parties to proceed, with the aim of commissioning the first reactor by October 2023, exactly 100 years after the declaration of the modern Turkish Republic[56].

Jordan's electricity and also enable exports. Eventually, it seems that the BOO model will *not* be applied in this project, with the shares being Jordan 35%, Russia 35% and China 30%.

[54] http://www.power-technology.com/features/featurerussia-new-nuclear-tech-titan-4647211/

[55] Ibid.

[56] http://www.world-nuclear-news.org/NN-Akkuyu-construction-formally-starts-12121701.html



ARTIST'S IMPRESSION OF AKKUYU NPP WITH ALL FOUR REACTORS IN PLACE (Rosatom)

For a loyal NATO ally since 1952, this unprecedented pro-Russian policy has created something of a stir, especially in the US. Suffice to say that back in 1955 Turkey had signed an agreement with the US on the peaceful use of atomic energy and its first experimental nuclear reactor, operational in 1960, was US-built. By the late 1960s, the idea of building a commercial reactor was gaining momentum in Turkey and the Akkuyu site was selected in 1976. Many international tenders followed for the next thirty years or so (1977-2008), but only the last one, in March 2008 for four reactors, was to prove fruitful.[57] Just a single bid was received from the 14 interested parties, this being from ROSATOM's Atomstroyexport division, which was officially declared the winner.[58] In May 2010, the Russian and Turkish heads of state signed an intergovernmental agreement for ROSATOM to build, own and operate (BOO) the Akkuyu NPP. Therefore, it will be staffed entirely by Russian technicians, at least initially. The IGA was ratified by the two parliaments shortly afterwards (in July 2010 by Turkey-Law 26748 and in November 2010 by Russia-Law 322 FZ) and *"JSC Akkuyu Nuklear"*, the Russian-owned Turkish company responsible for the project was established in 2011. 100% of equity belongs to the ROSATOM group, which will spend at least 22 billion USD for CAPEX alone, within the eight years of construction.

[57] Marco Giuli, Ibid

[58] http://www.world-nuclear.org/information-library/country-profiles/countries-t-z/turkey.aspx

In total, four reactors of the WWER-1200 type will be commissioned, one per year from late 2023 to late 2026. These reactors are extremely advanced or "*Generation 3+*", similar to the Novovoronezh 6 mentioned above. At full capacity, this 4.800 MWe project will cover the entire electricity needs of Southeast Turkey for many decades. More precisely, Turkish electricity utility TETAS is committed to buy a fixed proportion of the power (70% of the output of the first two units and 30% of that from the other two) at a fixed price of 12,35 USD cents/kWh for 15 years and the rest will be sold to the open market[59]. Despite the shoot-down of the Russian Su-24 jet in 2015, which temporarily suspended the project, now everything proceeds smoothly: The Turkish energy regulator EPDK issued a power generation licence for the NPP in June 2017 for 49 years (though useful life is due to be up to 60 years). The Turkish nuclear regulator followed in November 2017 with a "limited" construction permit (i.e. construction on non-nuclear parts) and a "full" construction permit, covering the reactors themselves, is expected in March 2018, after which the first safety-related concrete for the plant will be laid.

Akkuyu NPP is essentially the biggest FDI of any kind and by any country in the history Turkey. Despite being of BOO type, a lot of sub-contracting work will take place, benefiting Turkish suppliers: about 35-40% of all construction work, with an estimated value between 6 and 8 billion USD, is to be conducted by them. More than 350 Turkish companies have applied for inclusion in the list of potential suppliers, and the first of them have already received orders for the preparation of the plant's infrastructure, ROSATOM has said. To date (late 2017), the total number of personnel on the site is more than 300 people, of which 90% are Turks.[60]

Last but not least, implementing the strategic Akkuyu project seems to me just a part of a much wider Turkish-Russian "rapprochement" with significant geopolitical repercussions and despite a clash of interests elsewhere (e.g. in Syria). The whole "package" provided by Russia recently includes, apart from this NPP, the construction of the almost equally impressive "Turkish Stream" underwater pipeline destined to carry Gazprom's natural gas (two parallel strings, to be completed in 2019 and 2020, respectively) and the sale of the extremely advanced S-400 surface to air missile system. All this, of course, does not indicate a complete convergence of interests between Russia and Turkey, but it is -just another- sign of Ankara departing from the West.

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[59] Ibid

[60] http://www.world-nuclear-news.org/NN-Akkuyu-construction-formally-starts-12121701.html

VI. GEOPOLITICAL IMPLICATIONS Coming to the geopolitical implications of the developments listed above, they should not be underestimated. Nuclear cooperation and the transfer of the relative "know-how", even for peaceful purposes alone, is a very "sensitive" field of international cooperation, destined to forge very strong bilateral relations and to translate itself into significant political influence (upon the recipient state). No doubt it's a "strategic" level of cooperation, comparable to the sale of the most advanced weapon systems.

In addition, like most gas export contracts via pipelines, nuclear cooperation is by definition of long-term nature, as the design life of a NPP is at least 30 years, with the possibility of extending it by another 20-30 years. As already mentioned, the latest generation of Russian reactors has an initial design life of 60 years. Therefore, after "sales service", like the provision of nuclear fuel, keeps countries linked together for a considerable period of time. The bilateral relationship is even closer under the BOO model, like in Turkey (*see previous Chapter*), when the NPP literally becomes a "bastion" of Russia abroad.

To sum up, ROSATOM seems to complement Gazrpom as Kremlin's second *"energy arm abroad"*. If we look at the World map, then the combination of Gazrpom and ROSATOM projects all over the World, including the latter's potential customers, covers a very huge proportion of the Globe. One cannot help comparing the two Russian state titans and, out of this comparison, ROSATOM seems to be of no less strategic importance, mainly for the following two reasons:

First, it does have a much longer -truly global- reach than Gazrpom. The latter operates just a single LNG export plant (in Sakhalin since 2009, together with foreign investors who own 50% minus one share), so it exports mainly pipeline natural gas to countries situated not far away from Russia itself (*by definition, pipeline economics don't work after 4.000 to 4.500 km maximum, so the export potential of Gazprom is geographically limited*).

Second, the traditional clients of Gazrpom are European countries, where GDP and energy demand are expected to rise moderately during the next decades (with the single exception of Turkey). Only the *"Power of Siberia"* pipeline to China, to be completed around 2020, aims to carry 38 bcma at a non-European market[61]. In sharp contrast, ROSATOM mainly aims at developing countries, such as the so-called "BRICS" group, all of them with huge development potential during the next decades. In other words, most of the clients of Gazprom are rather *"saturated"* markets, while ROSATOM's are not.

It is surprising that ROSATOM's activities went for quite a long time rather unnoticed or at least under-estimated by Western analysts, who focused instead on Gazprom. Only recently did some of them deal -albeit briefly- with the emerging ROSATOM power and its global implications. The overture was probably in May 2015, when REUTER's staff Hannah Thoburn published an article under the alarming title *"Russia building nuclear reactors - and influence - around the globe"*.[62] Thoburn remarks: *"Moscow recognized roughly 10 to 15 years ago that ROSATOM's work enables Russia to add another energy-related means of extending its long-term political influence throughout the world"*. We would rather agree with this statement. Two interesting analyses appeared in the fall of the same year, written by Gareth Evans -and already quoted above-[63] and by William Tucker[64]. Dr Evans focuses mainly on the ROSATOM business model, recognizing that it is *"the only company in the world which can provide the industry's complete range of products and services"*. He concurs with analyst Rod Adams, who wrote -in 2014- that *"Russia's decision to invest in nuclear energy capabilities is a brilliant strategic move befitting a nation of chess players"*.[65]

Along the same line but with more international & geopolitical flavor, Tucker remarks that Russia today, together with China, is becoming a nuclear titan at a global scale, at the expense of the US (where nuclear industry is in decline, due, in part, to the Clinton Administration, which killed the fast breeder reactors back in the 1990s). *"Russia has already virtually cornered the market on bringing nuclear energy to the developing world"*, he observes rather rightly. Many of the ROSATOM existing or potential clients, Tucker observes, are *"key players"* where *"Russia has long sought to gain military and*

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[61] See UNIPI Working Paper N.1 *Pipeline Geopolitics in Eurasia* (May 2016) by this author available http://energypolicy.unipi.gr/index.php/work/pipeline-geopolitics-in-eurasia-the-new-gas-projects-linking-russia-and-china/

[62] https://www.reuters.com/article/thoburn-rosatom/column-russia-building-nuclear-reactors-and-influence-around-the-globe

[63] Gareth Evans, Ibid

[64] https://www.realclearenergy.org/articles/2015/11/05/russia_and_china_are_becoming_nuclear_titans_108868.html

[65] Gareth Evans, Ibid

diplomatic influence". The implementation of all these projects, he concludes, *"will cement their relationships"*. Tucker also accepts the analogy by Ian Armstrong, another analyst in Global Risk Insights, who has compared a nuclear plant abroad to an embassy or a military base, as *"it gives you a long-term or permanent presence in a country"* (adding, though, that this is essentially the case only with the BOO model)[66].

In February 2017, Marco Giuli wrote a brief policy paper -which has already been quoted- for the renowned *European Policy Centre*, examining ROSATOM's activities in the Middle East, North Africa and Turkey (MENA). This was an issue that had, until that time, aroused interest only in Israel itself, for obvious security reasons[67]. The author recommended that the EU and its members should not stay inert in view of these rather alarming developments. In particular, he insisted that *"they should prevent opportunistic incursions of more politically agile -but ultimately destabilising- actors such as Russia in a region vital for the Union's long-term strategic interests".*[68] His key proposal is for the EU to promote in the MENA region energy efficiency and renewable energy sources (RES), instead of the nuclear option.

Almost immediately after the Westinghouse bankruptcy in the US, which was described by Bloomberg (30/3/2017) as being "*a Boon to Russia & China",*[69] another policy paper appeared in the website of *Foreign Affairs*, focusing not on ROSATOM itself, but on the necessary US reaction (thus the subtitle - *"How the US should respond"*).[70] Written by Sagatom Saha, its key point is perhaps the following one: *"The Kremlin appears to be pressing its formidable nuclear market power to influence and bind countries around the world to its irredentist and revanchist aims. Unless the US restores its leadership in the global nuclear economy, this scene could play out repeatedly for decades".*[71]

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[66] William Tucker, Ibid

[67] http://www.inss.org.il/publication/russian-nuclear-diplomacy-in-the-middle-east/

[68] Marco Giuli, Ibid

[69] https://www.bloomberg.com/view/articles/2017-03-30/u-s-nuclear-setback-is-a-boon-to-russia-china The author, Leonid Berdshinsky, notes that this US development *"leaves state-controlled Russian and Chinese companies the dominant suppliers in the huge global market for nuclear technology".* Nevertheless, this particular analyst is not so afraid of ROSATOM cooperation being translated into Russian geopolitical influence, given the current situation: *"There is, of course, the danger that the Kremlin might try to exert political influence through its projects, but that looks less likely now that Russia's oil revenues have dropped and it needs to bolster its trade balance"*.

[70] www.foreignaffairs.com/articles/russian-federation/2017-04-02/russia-s-nuclear-diplomacy

[71] Ibid

Finally, the Hellenic Edition of the same magazine hosted an analysis of mine a month later (which I wrote unaware of the US one)[72]. What I didn't mention at the time and my concluding remark in this paper is the following one: The *"nuclear renaissance"* in Russia under V.Putin was 100% state-driven. It could have happened only under a paternalistic (centrally planned and bottom to down) economic environment and, overall, in a type of society where not too many *"sensitivities"* are allowed to exist. In the capitalistic nations of the West, like Britain, France and even the US, once at the forefront of nuclear power, the industry -mainly of private ownership- gradually declined. This has proved to be a classic *"market failure"* case to provide the necessary investments (or at least to attract financing from private banks). There is also the issue of -very strict- Competition Law in the West (imposing severe limitations to state aid in order not to distort the market), at the same time that the Russian government heavily subsidizes ROSATOM.

To sum up, many things have changed since the *"Atoms for Peace"* initiative of the 1950s. Great opportunities for NPPs exist globally, especially after the Paris Agreement on Climate Change, but in the West the industry is facing adverse headwinds: strong opposition by agents such as GREENPEACE has created an over-regulatory environment, short-sighted preference for coal guides certain American policy-makers including the incumbent Administration (as coal miners supported the Republicans in each of the past 13 election cycles in the US), US companies are prevented from building NPPs in 3 out of 4 of the world's countries, incentives for renewable energy have deprived the nuclear industry of a "levelled playing field" and the post-2008 financial crisis was just the nail in its coffin. *"Competing against ROSATOM has become increasingly difficult for Western corporations, which are steadily falling behind"*, Thoburn melancholically concludes.[73] This trend can hardly be reversed. Russian -and very soon Chinese- nuclear supremacy was something that Mr Putin didn't achieve alone: the West allowed it to happen. And still, the energy-oriented model of economic development in 21st Century Russia, either oil & gas or nuclear, leaves much to be desired. Comparative advantages as it may enjoy in both these sectors, Russia's productive base overall needs urgent modernization. Financing extremely expensive projects abroad instead of creating a local *"power-house"* may not be the optimum allocation of resources for the Russian Federation.

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[72] http://www.foreignaffairs.gr/articles/71285/basilis-sitaras/i-rosiki-diplomatia-tis-atomikis-energeias

[73] Hannah Thoburn (REUTERS), Ibid