RUSSIA'S ATOMIC PARTNERS: FRAMATOME, SIEMENS ENERGY AND ROSATOM

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Cover
Russian army checkpoint at the occupied Ukrainian nuclear power plant Zaporizhzhya

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12 weeks before Russia attacks Ukraine: Alexey Likhachev, Director General of Rosatom and Bernard Fontana, CEO of Framatome, Paris 2nd December 2021.[1]

"Together with Framatome, we are creating a solid foundation for developing high-quality nuclear energy solutions within the scope of current and future areas for collaboration"
– Alexey Likhachev, Director General of Rosatom, 2 December 2021.[2]

"By working closely with our industrial partner Rosatom, we strengthen our contributions for safe and reliable generation of clean energy generated by our customers nuclear operating plants. Together, we build on our expertise for maintaining operations for the existing nuclear

[1] Rosatom, Rosatom and Framatome sign long-term cooperative agreement, 2 December 2021, https://rusatom-energy.com/media/rosatom-news/rosatom-and-framatome-sign-long-term-cooperative-agreement/

[2] Framatome, Framatome and Rosatom sign long-term cooperation agreement, 2 December 2021, https://www.framatome.com/medias/framatome-and-rosatom-sign-long-term-cooperation-agreement/, accessed 18 April 2023.

fleet and preparing for the next generation of nuclear energy"
– Bernard Fontana, CEO of Framatome, 2 December 2021[3]

Continued business with Rosatom despite withdrawal from Russia

"Siemens Energy has not been represented in so-called 'hot' nuclear technology for more than a decade... However, Siemens Energy is still represented in the so-called operational control technology ('control systems')"[4] – Siemens Energy Board, 7 February 2023.

Foreword

On the very first day of Russia's invasion of Ukraine, 24th February 2022, Russian military forces seized and occupied the Chornobyl nuclear plant in Ukraine. Ten days later, Europe's largest commercial nuclear plant at Zaporizhzhia in southern Ukraine was attacked and seized by the Russian military. But Russia's aggression doesn't solely involve military actors: other Russian state institutions have been, and continue to be, involved. One such institution is the Russian State Atomic Energy Corporation, Rosatom.[5] During the days and weeks that followed Russia's seizure of Chornobyl and Zaporizhzhia, personnel from Rosatom-owned nuclear power plants were deployed at these two nuclear sites in Ukraine, making Rosatom an active player in the aggression against Ukraine. The Russian military and Rosatom left Chornobyl by 1st April 2022, leaving destruction of equipment and laboratories in their wake.[6] In Zaporizhzhia, meanwhile, the occupation by the Russian military and Rosatom continues to this day. The situation there has now been exacerbated by the demolition of the Kakhovka dam.

Rosatom is a State Corporation, a type of non-membership and non-commercial entity that was introduced in Russia in 1999. Each state corporation is created by a separate Russian federal law, and wholly and directly owned by the Russian Federation. Rosatom was created by Russian President Vladimir Putin in the mid-2000s, and it encompasses both Russia's civil *and* military nuclear industry.[7] As then-Prime Minister Dmitry Medvedev described in 2012, Rosatom is a 'sui generis' corporation – 'of its own kind/genus' – because it does not merely strive "to expand its business operations", it "accomplishes some ministerial tasks". The specifics of Russia's nuclear power industry, Medvedev explained, and its "dual-purpose nuclear technologies" – ie civil and military – mean that "Rosatom will remain a state corporation for a very long time."[8]

In essence, business dealings with Rosatom are business dealings with the Russian state. Trade in nuclear technology and expertise with Rosatom is trade that serves Russia's strategic interests, and helps Russia's invasion of Ukraine.

[3] Framatome, 2 December 2021, ibid.
[4] Siemens Energy AG, 7 February 2023, https://assets.siemens-energy.com/siemens/assets/api/uuid:6a9b6f73-b546-4597-9860-bc3f73e933d3/gegenantraege-hv2023-de-2023-01-25.pdf?_ste_sid=5bdcd7a13c9f616c3d9577659d7717f9, accessed 20 March 2023. Translated from German.
[5] Also known as the Rosatom State Nuclear Energy Corporation or Rosatom State Corporation, Rosatom has hundreds of subsidaries.
[6] Greenpeace Germany, Investigation inside the Chornobyl Exclusion Zone, August 2022, https://storymaps.arcgis.com/collections/89f769079c4a40c98a4b158e9e87d17c, accessed 10 may 2023
[7] Greenpeace France, L'industrie Nucléaire Française,UneAlliée Du Régime DeV.Poutine: Le nucléaire peut-il garantir l'indépendance énergétique française? March 2022, https://www.greenpeace.fr/espace-presse/decryptage-lindustrie-nucleaire-francaise-une-alliee-du-regime-de-v-poutine/
[8] Prime Minister Dmitry Medvedev gives an interview to Kommersant newspaper, 29 November 2012, http://archive.government.ru/eng/docs/21653/, accessed 25 April 2023.

Executive Summary

Rosatom's active role in the Russian invasion of Ukraine

Rosatom is an active participant in the invasion of Ukraine: the Russian state nuclear corporation has been involved in the armed seizure and theft of foreign assets worth tens of billions of euros. Rosatom illegally claims ownership of the six reactors at the Zaporizhzhia nuclear plant, which are the property of Ukraine, and by collaborating in the military occupation of the plant, puts the Ukrainian – and wider European – population at risk of a major nuclear disaster.

The destruction of the Nova Kakhovka hydroelectric dam by Russian military forces on the 6th of June 2023, resultant massive flooding and loss of the Kakhovka reservoir not only has increased safety risks at the Zaporizhzhia nuclear plant. It has also highlighted the possibility of a deliberate malevolent act by Russia at the nuclear plant. It is unprecedented in the history of nuclear energy that a commercial nuclear power plant is under direct threat of destruction by an occupying foreign nuclear corporation, Rosatom, and that country's military forces.

But rather than having a devastating impact on the Russian nuclear company's ability to conduct international trade, Rosatom has, to date, been spared from the EU's sanctions against Russian companies. What's more, 2022 saw Rosatom's export sales increase significantly, despite Russia's invasion of Ukraine.

This report examines how it is possible that Rosatom, despite being directly involved in the armed invasion of a sovereign nation, has avoided any kind of censure from the European Union. The answer, it finds, lies in the shared interests that certain EU member states have with Rosatom. France and Hungary, which have together managed to block all efforts at EU nuclear sanctions, are undermining international efforts to put pressure on the Russian economy, putting their short and medium-term economic interests over their support for the people of Ukraine.

Nuclear technology exports from France and Germany to Russia demonstrate the need for sanctions

Much has been made of Rosatom's exports of enriched uranium and nuclear fuel to the EU as being a large factor in Rosatom so far avoiding sanctions, but these are only one important part of the commerce between Russia and EU member states. As this report documents, the nuclear trade with Russia is not one way: major European corporations have contracts worth hundreds of millions of euros for the export of their advanced technology and expertise to Russia's nuclear power plants, and to Rosatom's nuclear projects abroad. Without these technology- and knowledge- transfers, many of Rosatom's most important new nuclear reactor projects, in Russia and overseas, would grind to a halt, potentially terminally. EU companies, by providing their technology and expertise, contribute directly to the maintenance and expansion of Rosatom's business – and thereby indirectly contribute to sustaining the aggression against

Ukraine.

This analysis focuses on the European nuclear consortium of French company Framatome and its German technology partner Siemens Energy. Together, these companies play a key role in Rosatom's nuclear reactor program, both in Russia and internationally. Through the export of advanced technology, software, knowledge and expertise – particularly the Instrumentation and Control (I&C) systems that act as the brain and central nervous system of a nuclear power plant – they have helped to enhance Rosatom's role in global nuclear trade, with Rosatom now the world's single largest supplier of nuclear power plants under construction. This report furthermore demonstrates that through their strategic partnerships with Rosatom, Framatome and Siemens Energy are directly furthering the economic and geopolitical interests of the Russian state (as well as the economic interests of France and Germany's nuclear industries).

These realities highlight precisely why the continuation of business-as-usual with Russia's nuclear industry is unacceptable, and demonstrate why comprehensive and immediate EU sanctions against Rosatom are so urgently needed.

More questions than answers

Almost all of the business between Russia, Framatome and Siemens Energy takes place out of sight, with little if any transparency. Consequently, what we *have* learnt of their nuclear dealings raises many more questions – questions that the two European companies should be required to answer. By confronting Framatome and Siemens Energy with these questions – key among them, whether their personnel have worked at Rosatom nuclear plants (both in Russia, and elsewhere) since the invasion of Ukraine began – we aim to move closer to securing comprehensive EU nuclear sanctions against Russia.

Such sanctions would target trade between Rosatom and the nuclear industry of the European Union, and in particular France and Germany, and include the termination of existing I&C contracts and other advanced technology contracts. This would be an important step in ending Europe's substantive support for the Russian state – and in challenging the continued operation of nuclear reactors globally. As the current crisis at Zaporizhzhia, and the history of Chornobyl and Fukushima Daiichi, so clearly demonstrates, the continued use of nuclear power plants has the potential to be catastrophic.

It is also crucial that more light is directed on the end use of the dual-use-technology that Framatome and Siemens Energy have delivered to Rosatom: technology that could benefit Russia's nuclear military program, including submarine reactor operations. Given that Rosatom is responsible for all areas of Russia's nuclear program, from reactors to weapons and submarines, there can be no confidence in any Rosatom assurances of end use compliance. Thus, while Russia attacks the democratic state of Ukraine, wielding the threat of a nuclear strike, there is a very real risk that European companies have been providing Russia with nuclear technology that could be weaponized.

1. Rosatom: History of a civil and military nuclear giant

Rosatom – established by President Putin in 2004 and turned into a State Atomic Energy Corporation in 2007 – is responsible for all of Russia's domestic and overseas nuclear programs, both military and civil. Rosatom inherited the vast nuclear infrastructure launched by the Soviet Union in the 1940s and carried forward by the Russian Federation when it was formed in 1991.[9] Rosatom's enormous size and scope make it a civil and military nuclear giant. It is responsible for all areas of Russia's nuclear weapons program,[10] from warhead and missile design, fissile nuclear materials production and management, to submarine reactor design, manufacture, maintenance and decommissioning operations. On the civil side, as well as operating Russia's large nuclear power plant sector, Rosatom is the biggest global exporter of commercial nuclear power reactors, and a major supplier of enriched uranium and nuclear fuel.[11]

Today, as in the Soviet period, Russia's secretive nuclear empire has little separation between the military nuclear program and nuclear power used for generating electricity. Rosatom's empire of nuclear facilities, infrastructure, closed cities, and hundreds of thousands of employees stretches across the nation, and has been built with decades of investment. President Putin had at least two objectives in founding Rosatom: firstly, to secure vital commercial contracts overseas and thereby increase revenue to a beleaguered domestic program, and secondly, on a more strategic level, to use nuclear exports to gain leverage and influence around the world, in particular in Europe, the Middle East, sub-Saharan Africa, and south and southeast Asia.[12] Add to all this Rosatom's more recent portfolio expansion: Rosatom's active participation in the armed seizure and control of two nuclear facilities in Ukraine, at Chornobyl and at Zaporizhzhia.[13]

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[9] Greenpeace International, Rosatom RISKS: Exposing the troubled history of Russia's state nuclear corporation, 2014, https://wayback.archive-it.org/9650/20200313133935/http://p3-raw.greenpeace.org/hungary/PageFiles/636986/rosatom_risks.pdf and, Rosatom Industry Structure, http://www.rosatom.ru/en/about/nuclear_industry/Industry_structure/

[10] Hans M. Kristensen, Matt Korda, Eliana Reynolds, Nuclear Notebook: Russian nuclear weapons, 2023, Bulletin of Atomic Scientists, 9 May 2023, https://thebulletin.org/premium/2023-05/nuclear-notebook-russian-nuclear-weapons-2023/, accessed 10 May 2023

[11] Mycle Schnieder (ed), The World Nuclear Industry Status Report 2022, 18 November 2022, https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2022-HTML.html, accessed 10 May 2023

[12] Rosatom, Long-Term Strategic Goals, Business Strategy until 2030, 2016 Annual Report, https://ar2016.rosatom.ru/?/en/45-long-term-strategic-goals; Boyan Dobrev , Rosatom & Russia's Nuclear Diplomacy, Situation Reports, 17 May 2016, https://www.geopoliticalmonitor.com/rosatom-russias-nuclear-diplomacy/; Tracey German, 'Russia's Energy Power' in Assessing Russia's Power: A Report, Eds. Natasha Kuhrt and Valentina Feklyunina 2017, https://kclpure.kcl.ac.uk/portal/files/71017736/Assessing_Russia_s_Power_EditorsKUHRTFEKLYUNINA_Published_February_2017.pdf; Vladimir Slivyak, South Africa is waiting for Rosatom's money, Belona, 3 September 2015, see https://bellona.org/news/nuclear-issues/2015-09-south-africa-is-waiting-for-rosatoms-money; and, Andrea Bonelli, Rosatom in Europe: Russia's Trojan Horse?, ICDS, March 2021, https://icds.ee/wp-content/uploads/2021/03/ICDS_Brief_Rosatom_in_Europe_Andrea_Bonelli_March_2021.pdf, accessed 2 March 2023.

[13] Roman Petrenko, Invaders seize Zaporizhzhia power plant and claims it is part of Rosatom, Pravda Ukraine, 12 March 2022, see https://www.pravda.com.ua/eng/news/2022/03/12/7330624/, accessed 2 May 2023. The first reporting of this was in a posting by the head of Ukrainian state nuclear company EnergoAtom, Peter Kotin, and cited in Ukrainian newsite Pravda: "Representatives of the so-called military-civil administration came to the station and gathered the management. They did not give their names, they only said that they were representatives of the military-civil administration. They told the management that it [Zaporizhzhia nuclear power plant] was now a Rosatom station, and it no longer belonged to Ukraine. They said that they are here for the long term and it is now their territory, so the nuclear power plant must operate in accordance with Rosatom decrees."

Since the February 2022 Russian invasion of Ukraine, Rosatom has been central to Russia's military occupation of the Zaporizhzhia nuclear plant.[14] **As of April 2023, the Russian government maintains that the six reactors at Europe's largest nuclear power plant are no longer Ukrainian, but owned by Rosatom and therefore Russian federal property.[15] A joint-stock company, Zaporizhzhia NPP Operational Organization, was formed by Presidential decree for Rosatom to take ownership of the nuclear plant.** Its ambition to connect the reactors to the Crimea grid has, however, so far been thwarted.[16] Also prevented were efforts by the Russian military to seize control of the three reactors at the South Ukraine nuclear plant.[17]

In the decades long history of nuclear power, Rosatom's role in Russia's invasion of Ukraine, including the intimidation, abduction and terrorising of Ukrainian nuclear plant workers, and threatening of a major nuclear disaster at the Zaporizhzhia nuclear plant, is a uniquely outrageous milestone.[18]

Yet **Rosatom, a nuclear company that has actively put a nuclear power plant at risk of major disaster by collaborating with armed forces who attacked and occupied the plant, continues its business-as-usual trade with the world**, including its European partners. 2022 was, in fact, a successful year for Rosatom's export business, with sales increasing by 20 percent. As British think tank RUSI recently reported, "Russia's nuclear export sector has continued to thrive since the invasion of Ukraine. This trade in nuclear technology will directly benefit state corporation Rosatom, which appears to be actively supporting Russia's invasion of Ukraine."[19] Russian customs data, compiled by RUSI and Bloomberg, show that despite its invasion of Ukraine, Russia's overall exports of nuclear energy related technology and materials reached US$1 billion between March and December 2022.[20]

With the EU failing to impose sanctions against Rosatom, one cannot help but ask how it is possible that Russia's nuclear industry, and its business dealings with Framatome and Siemens,

[14] State Nuclear Regulatory Inspectorate of Ukraine (SNRIU), Zaporizhzhia NPP status update as of 16 March 2022, https://snriu.gov.ua/en/news/zaporizhzhia-npp-status-update-16-march-2022

[15] As designated by the decree of 5 October 2022 by President Putin. Russia's RIA news agency quoted Deputy Foreign Minister Sergei Vershinin as saying, "The Zaporizhzhia nuclear plant is now on the territory of the Russian Federation and, accordingly, should be operated under the supervision of our relevant agencies", see DW, "Putin decrees takeover of Zaporizhzhia nuclear plant", 5 October 2022, see https://www.dw.com/en/putin-decrees-takeover-of-zaporizhzhia-plant/a-63347253. The decree handed the use of its "financial, material and other resources" to a new operating company owned by a Rosatom subsidiary, "to ensure the safety of nuclear facilities, radiation sources, storage facilities for nuclear materials and radioactive substances, and radioactive waste storage facilities", see Catherine Belton,"Russia's state nuclear company aids war effort, leading to calls for sanctions", Washington Post, 20 January 2023, https://www.washingtonpost.com/world/2023/01/20/rosatom-ukraine-war-effort-sanctions/

[16] Lilia Rzheutska, Zaporizhzhia plant no longer connected to Ukraine grid, DW, 7 November 2022, https://www.dw.com/en/zaporizhzhia-power-plant-no-longer-connected-to-ukraine-grid/a-62976178

[17] Greenpeace International, Interactive Map - Russian military threat to Ukraine's nuclear reactors and facilities, May 2022, https://www.greenpeace.org/international/campaign/russian-military-threat-ukraine-nuclear-reactors-facilities/, accessed 10 May 2023

[18] Hanna Arhirova, Ukraine nuclear workers recount abuse, threats from Russians, 6 October 2022, Associated Press, https://apnews.com/article/russia-ukraine-kyiv-business-153cc4ffe3a9eede8f852d22abd5ed01, accessed 10 May 2023

[19] Darya Dolzikova, Atoms for Sale: Developments in Russian Nuclear Energy Exports, RUSI, Special Report, 14 February 2023, https://rusi.org/explore-our-research/publications/special-resources/atoms-sale-developments-russian-nuclear-energy-exports, accessed 18 April 2023.

[20] Darya Dolzikova, 14 February 2023, ibid, and Jonathan Tirone, Russia's Grip on Nuclear-Power Trade Is Only Getting Stronger, 14 February 2023, https://www.bloomberg.com/news/features/2023-02-14/russia-s-grip-on-nuclear-power-trade-is-only-getting-stronger?srnd=premium-uk&leadSource=uverify%20wall, accessed 20 April 2023.

continue to be excluded from sanctions . Answering this question has many dimensions, but one simple truth is that due to large-scale and ongoing trade with Rosatom,[21] Russia's nuclear business partners in Europe, and their governments, continue to veto any sanctions.[22] As a result of these countries' conflicting interests, efforts to restrict Rosatom's operations have, until now, failed.[23]

One of Russia's largest nuclear partnerships in Europe is with the French nuclear industry. This report focuses on an area that has received too little attention – the close relationship between Rosatom and the largely state-owned French nuclear company Framatome, together with their long-standing partner Siemens Energy (Siemens AG's Power Generation Services division). And, in particular, the trade of these French and German companies with Rosatom in advanced technology Instrumentation and Control (I&C) systems for nuclear power plants.

2. The French-Russian Strategic Nuclear Partnership

The EU's nuclear industries have a long history of business with the nuclear industry of the Soviet Union, and then Russia.[24] With the largest nuclear industry in Europe, French companies have been at the forefront of this trade. In the 1990s, French state company AREVA and its German partner Siemens established nuclear technology agreements with utilities operating Soviet-designed reactors in Eastern and Central Europe. From the 2000s, this expanded to reactors operating inside Russia. The most recent extended partnership agreement between Framatome and Rosatom – evolving out of their decades-long relationship – was signed in December 2021, just months before Russia invaded Ukraine.[25]

BOX A: Spotlight on Framatome

A successor to French state nuclear company AREVA, Framatome describes itself as "an international leader in nuclear energy recognized for its innovative solutions and value added technologies for the global nuclear fleet… the company designs, services and installs components, fuel, and instrumentation and control systems for nuclear power plants." Framatome is owned by the French state electricity company, EDF Group (75.5%), Mitsubishi Heavy Industries (MHI – 19.5%) and Assystem (5%).[26]

[21] See for example, Patricia Lorenz's, Russian Grip on EU Nuclear Power, 4 May 2022, https://wua-wien.at/images/stories/publikationen/russian-grip-on-eu-nuclear-power.pdf

[22] Henry Samuel, France accused of funding Putin's war effort by buying his nuclear fuel, The Daily Telegraph, 2 December 2022, https://www.telegraph.co.uk/world-news/2022/12/02/france-accused-aiding-putins-war-importing-russian-nuclear-fuel/

[23] POLITICO, Zelenskyy calls on EU holdouts to sanction leaders of Russia's nuclear energy giant, Suzanne Lynch, 3 February 2023, https://www.politico.eu/article/ukraine-president-volodymyr-zelenskyy-eu-leaders-sanctions-russia-nuclear-energy-giant-zaporizhzhia/

[24] Greenpeace International, 2014, ibid.

[25] WNA, Framatome and Rosatom expand cooperation, 2 December 2021, https://www.world-nuclear-news.org/Articles/Framatome-and-Rosatom-expand-cooperation, accessed 18 February 2023.

[26] See Framatome press statement on 2 December 2021, https://www.framatome.com/medias/download/?id=6545&n=Framatome-Rosatom-sign-cooperation-agreement-pdf

The nuclear trade between France and Russia takes place in the context of shared strategic goals regarding the development of nuclear power. In 2018, Presidents Vladimir Putin and Emmanuel Macron were witness to the "Plan for the Strategic Document on Russian-French Partnership in the Field of Peaceful Use of Atomic Energy."[27] The signing ceremony between Rosatom's Director General, Alexey Likhachev, and the Administrator General of French Alternative Energies and Atomic Energy Commission (CEA), François Jacq, in St Petersburg in May 2018, emphasised that France and Russia "share common approaches to the development of nuclear energy".[28]

24th May 2018: Rosatom and French Alternative Energies and Atomic Energy Commission signing the strategic document on French-Russian partnership in the peaceful uses of atomic energy.[29]

"Long-term cooperation between Russia and France in a number of areas in the nuclear field has been going on for over 45 years. We are proud of the partnership with our French colleagues, and we believe that today's signing is another step towards even more productive cooperation."
– Alexey Likhachev, Director General of Rosatom, July 2019[30]

The global nuclear industry is made up of hundreds of large corporations, in many cases backed by their respective governments, with their own strategic interests. They are competitors, but

[27] Rosatom, Rosatom and French Alternative Energies and Atomic Energy Commission signed a partnership agreement, 25 May 2018, https://rosatom.ru/en/press-centre/news/rosatom-and-french-alternative-energies-and-atomic-energy-commission-signed-a-partnership-agreement/, and CEA, Chairperson of the CEA accompanied President Macron on his visit to Russia (May 24-25), 2018, https://www.cea.fr/english/Pages/News/The-Chairperson-of-the-CEA-accompanied-President-Macron-on-his-visit-to-Russia-(May-24-25)-.aspx, accessed 21 February 2023

[28] Rosatom, Rosatom and CEA strengthen cooperation in the field of atomic energy, 12 July 2019, https://www.rosatom.ru/en/press-centre/news/rosatom-and-cea-strengthen-cooperation-in-the-field-of-atomic-energy/, accessed 21 February 2023.

[29] Rosatom, 25 May 2018, ibid.

[30] Rosatom, 12 July 2019, ibid.

they are also collaborators and joint business partners, working together with a common goal: securing the survival of nuclear power as a global energy source. To this end, **many of Rosatom's objectives are shared by European nuclear companies. They are even members of the same atomic club: despite the Russian invasion of Ukraine, Rosatom remains on the management board of the World Nuclear Association (WNA).**[31]

In December 2021, **less than three months before Rosatom joined the Russian military invasion of Ukraine in its seizure and occupation of the Chornobyl and Zaporozhzia nuclear plants, a new long-term partnership between Rosatom and Framatome was welcomed by the WNA.**[32] At the World Nuclear Exhibition in Paris, Rosatom boss Alexy Likhachev said that *"Together with Framatome, we are creating a solid foundation for developing high-quality nuclear energy solutions within the scope of current and future areas for collaboration".*[33] Framatome's CEO, Bernard Fontana, meanwhile, said that *"By working closely with our industrial partner Rosatom, we strengthen our contributions for safe and reliable generation of clean energy generated by our customers nuclear operating plants"*.[34] This run-of-the-mill PR propaganda speech – describing an industry with unacceptable risks and hazards as 'safe' and 'reliable' – looked even more at odds with reality when Framatome's business partner Rosatom took Europe to the brink of nuclear disaster just months later, by occupying Europe's largest nuclear power plant.

2.1 The brain inside Rosatom nuclear power plants: Framatome follows in the footsteps of AREVA and Siemens

> *"Our high-performing people have been commissioning automation systems at nuclear power plants in Russia for many years."* – Frédéric Lelièvre, Framatome's Senior Vice President Sales Regional Platforms and I&C, October 2019.[35]

A nuclear reactor contains thousands of components, such as motors, pumps, valves and sensors, connected by electric cables that can exceed 1500km in total length.[36] All of these must operate in a coordinated way, through automated process control systems, performed by an overarching Instrumentation and Control (I&C) system.[37] Globally, two of the major suppliers

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[31] The management Board of the WNA includes Kirill Komarov, First Deputy Director General, Rosatom.

[32] Framatome, 2 December 2021, ibid.

[33] Framatome, 2 December 2021, ibid; and, Rosatom, 2 December 2021, ibid.

[34] Framatome, 2 December 2021, ibid.

[35] Framatome, RASU JSC and Framatome-Siemens consortium sign contract to supply automated process control systems for Hungarian Paks-2 Nuclear Power Plant, 23 October 2019, https://www.framatome.com/medias/rasu-jsc-et-le-consortium-framatome-siemens-signent-un-contrat-de-fourniture-de-systemes-de-controle-de-processus-automatises-pour-la-centrale-nucleaire-hongroise-de-paks-2/, accessed 21 February 2023

[36] EC, European Tools and Methodologies for an efficient ageing management of nuclear power plant Cables, as of 7 February 2023, see https://cordis.europa.eu/project/id/755183, accessed 15 February 2023.

[37] As the International Atomic Energy Agency (IAEA) explains, "through its constituent elements, such as equipment, modules, sensors, transmitters, motors, valves and others, the I&C system senses plant parameters, monitors performance, integrates information, and makes automatic adjustments to the NPP's operations as necessary. It also responds to failures and off-normal events, thus ensuring efficient power production and safety. Particular attention is given to the design, testing, operation, maintenance, licensing, operation, and modernization of I&C systems." See https://www.iaea.org/topics/operation-and-maintenance/instrumentation-and-control-systems-for-nuclear-power-plants, accessed 15 February 2023.

of I&C – described as the brain and central nervous system of nuclear power plants[38] – are Framatome and Siemens Energy. An I&C system fulfils multiple functions – it measures, monitors, checks, communicates and controls the nuclear plant's operations, and is central to the operational parameters of the reactor, as well as performing key safety functions.[39]

The original I&C technology now marketed by Framatome and Siemens Energy was developed in the 1990s by French state nuclear company AREVA,[40] and its consortium partner Siemens. They installed it in multiple Russian reactors, as well as Russian supplied reactors in eastern and central Europe.[41] Thus, the current Framatome I&C nuclear supply business with Rosatom would not have been possible without this earlier, decades-long trade between AREVA-Siemens and Russian/Soviet-supplied reactors overseas.

Throughout the 1990s, AREVA and Siemens gained extensive and unique experience in safety I&C systems for Soviet-designed and supplied VVER-type reactors. The opening of the Russian nuclear market for AREVA and Siemens began in the early 1990s with reactors operating in central and eastern Europe. For example, the operator of Hungary's Paks nuclear plant, supplied by the Soviet Union and comprising of four VVER 440-213 reactor units, decided to replace the plant's Soviet-designed reactor protection system with state-of-the-art western I&C technology.[42]

2.2 Giving thanks to Putin, as ties with Russian nuclear industry grow

The growing ties between the French and German companies and Russia's nuclear empire did not falter in the 2000s. At a February 2009 meeting with Vladimir Putin – then-Prime Minister of Russia – Siemens CEO Peter Loescher said:

> *"I'd like to thank you personally and the Russian Government for the trust you have put in our company in planning further development of cooperation in the power industry, particularly in the nuclear power industry. Considering our long-standing relationship, I'd suggest setting up a working group between our company and the Rosatom Corporation to discuss all possible types of cooperation and make concrete decisions as soon as possible".*[43]

[38] Framatome, Instrumentation & Control: the brain and central nervous system of the plant, https://www.framatome.com/en/expertise/instrumentation-and-control/, accessed 21 February 2021.

[39] These functions can be summarised as: the reactor trip system; the neutron flux monitoring system; the reactor power control and limitation system; the priority control and control interface system for safety-related loads; the diesel generator control system; the accident monitoring system; the operating and control equipment in the main and back-up control rooms.

[40] AREVA was created on 3 April 2001 by the merger of Framatome (later: Areva NP, now: Framatome), Cogema (later: Areva NC, now: Orano Cycle) and Technicatome (later: Areva TA, now: Technicatome).

[41] I&C were developed separately by both AREVA and Siemens, in the first instance to supply their own domestic reactor programs.

[42] Siemens, International Topical Meeting on WER Technical Innovations for Next Century, Prague Experience in Modernization of Safety I&C in WER 440 Siemens Nuclear Power Plants Bohunice V1 and Paks, 17-20 April 2000, Michael Martin, https://www.osti.gov/etdeweb/servlets/purl/20146163, accessed 12 March 2023.

[43] Executive Branch Russian Government, Prime Minister Vladimir Putin met with Siemens AG CEO Peter Loescher, 9 February 2009, see http://archive.government.ru/eng/docs/3258/, accessed 12 April 2023.

By 2010, new Russian-designed nuclear plants at Mohovce in Slovakia were installing the TELEPERM XS safety I&C supplied by AREVA, and the SPPA-T2000 operational I&C from Siemens.[44] AREVA and Siemens had also conducted a comprehensive modernization of the I&C system for the Soviet-supplied VVER-type reactors Loviisa 1 and 2 in Finland, and installed their I&C in numerous other Russian-supplied reactors, including at Bohunice in Slovakia, Kozloduy in Bulgaria, and Dukovany in the Czech Republic.[45]

In January 2008, the AREVA-Siemens consortium secured a contract with Rosatom for the I&C systems at two nuclear sites within Russia.[46] AREVA-Siemens made an agreement with the Russian Research Institute for Nuclear Power Plant Operation (VNIIAES), a subsidiary of Rosatom, for the supply of a TELEPERM XS system to be used in the modernization of the existing reactors at the Kola nuclear power plant in northern Russia. Another contract with VNIIAES, the first for a new reactor construction project, was for Novovoronesh-2 in central Russia. First concrete construction began on the two VVER 1200 reactors at Novovoronesh-2 in 2008 and 2009, which began operation in 2016 and 2019 respectively.[47] This was then followed by contracts for Leningradskaya II-1 and 2 VVER 1200 reactors under construction at Sosnovy Bor, near Saint Petersburg.

According to Siemens, I&C contracts with Russian nuclear plant operators made Siemens "responsible for the engineering, supply, installation and commissioning of the I&C equipment in the meaning of the digital safety I&C system TELEPERM XS."[48] But their business interactions did not stop there: between 1982 and 2000, Siemens offered lifetime extension agreements for TELEPERM ME I&C systems, giving their customers unlimited lifetime support up until 2018.[49] Beyond this date, the status of Siemens service contracts for TELEPERM is unconfirmed, but for its TS2000 technology and software, Siemens offers lifetime support with long-term service and maintenance agreements, and product "support for maximum profitability throughout the entire life cycle".[50] I&C service agreements are long-lasting, and can provide major benefits to Russia, in terms of reduced running costs and greater efficiency of their nuclear generation (see Box B, p.22).

[44] The AREVA EPR™ reactor I&C is also based on the TELEPERM XS and SPPA-T2000 digital safety and operational systems.

[45] Areva and Siemens Consortium to Supply Digital Supervision, Protection And Control Systems for Nuclear Power Plant in Slovakia, 26 April, 2010, https://www.sa.areva.com/EN/news-8366/areva-and-siemens-consortium-to-supply-digital-supervision-protection-and-control-systems-for-nuclear-power-plant-in-slovakia.html

[46] AREVA, Systems Contract for New Slovak Reactors, 29 April 2008, https://www.contractorsunlimited.co.uk/news/100429-areva+siemens+slovakia.shtml

[47] IAEA PRIS, Russia, as of 13 February 2023, see https://pris.iaea.org/PRIS/CountryStatistics/ReactorDetails.aspx?current=898, accessed 12 April 2023. For more details about the evolution of these reactor designs, see César Queral, Mikel Kevin Fernandez-Cosials, Victor Hugo Sanchez Espinoza and Elena Redondo-Valero, Safety systems of Gen-III/Gen-III+ VVER reactors, NucleanEspaña, October 2021, https://www.researchgate.net/publication/355809041_Safety_systems_of_Gen-IIIGen-III_VVER_reactors, accessed 19 April 2023.

[48] Siemens, 17-20 April 2000, ibid.

[49] Siemens Energy, Preventive Maintenance for I&C, https://www.siemens-energy.com/global/en/offerings/services/maintenance/instrumentation-controls/ic-preventive-maintenance.html

[50] Siemens Energy, ibid.

What all this means, is that there are at least three different time frames when, under contract, AREVA/Framatome or Siemens' personnel – ie engineers and technicians, and their subcontractors – are required to be stationed at Rosatom nuclear plants:

- when existing reactors arebeing **modernised** with new I&C systems, before and during outage;
- when they are **servicing** the installed I&C systems, during operation and outage of existing reactors;
- during the **construction**, testing and start-up of new Rosatom reactors.

These periods, what's more, may last for years at a time. From AREVA's own documentation,[51] we know that between 2009 and 2016, the time frames for the delivery of AREVA-Siemens contracts with Rosatom partner VNIIAES (in terms of engineering and installation, and working with VVER I&C), at existing and new Russian reactors, were as follows:

- New Build Project Novovoronezh II-1, from December 2009 to December 2014;
- New Build Project Leningrad II-1, from July 2010 to December 2014;
- Modernization on Kola 3&4, from January 2011 to August 2014;[52]
- New Build Project Leningrad II-2, from March 2014 to June 2016.[53]

[51] AREVA, "AREVA Our experiences with Rosatom", Atomex, Marion Horstmann , Vice President Offers and Partnerships Large Projects AREVA Germany, Budapest 30 November – 1 December, 2015, see http://www.atomeks.ru/old/mediafiles/u/files/Atomex-Europ_2015/materials/1_Horstmann_AREVA.pdf, accessed 10 February 2023.

[52] In addition, there was a contract for the supply of I&C to the Baltic 1&2 project between July 2012 and December 2015, which was not completed due to the suspension of construction in 2013, though there were reports of a possible revival in July 2021. See: Nuclear Engineering International, Rosatom to consider new investors for Baltic NPP, 8 July 2021, https://www.neimagazine.com/news/newsrosatom-to-consider-new-investors-for-baltic-npp-8879263, accessed 10 May 2023

[53] NucNet, Areva Signs Safety Systems Agreement For New Russian Units, 28 May 2009, https://www.nucnet.org/news/areva-signs-safety-systems-agreement-for-new-russian-units

Novovoronezh nuclear plant, Voronezh Oblast, central Russia
Source: Google Earth.

It is important to understand these time frames in the context of current Framatome/Siemens contracts with Rosatom. Records show, for example, that the AREVA-Siemens I&C project at the new build construction at Novovoronezh II-1 lasted for 5 years (beginning one year after the start of construction in June 2008, and ending over a year before the reactor began operation in 2016).[54] For the second project at Novovoronezh II-2, the AREVA-Siemens project lasted two years (beginning five years after start of construction in 2009, and ending over two years before the reactor was connected to the grid in May 2019).[55] In other words, the recent agreement between Framatome/Siemens and Rosatom could see the French and German companies actively working on Rosatom nuclear power plants in Russia and overseas for many years to come.

2.3 Framatome and Rosatom enter a new era

"The project marks another highlight of the continuing collaboration with our Russian partners in the field of safety I&C solutions. It demonstrates our capability to support the Russian reactor designs with our TELEPERM XS technology, both for new build and modernization projects"
– Frédéric Lelièvre, Senior Vice President Sales Regional Platforms and I&C at AREVA NP, January 2017.[56]

[54] IAEA, Russia PRIS, ibid.

[55] IAEA, Russia PRIS, ibid.

Framatome, together with Siemens Energy, offers many I&C products to customers in France and internationally: they design, manufacture, install and maintain "cutting-edge" nuclear I&C solutions that they claim will ensure the "safety, availability and reliability of nuclear power plants throughout the world."[57] The December 2021 agreement between Rosatom and Framatome expanded on an earlier 2017 agreement, and created a framework for joint work in new areas, specifically focused on developing fuel fabrication and I&C technologies.[58] One of the I&C systems that Framatome supplies to Rosatom is the TELEPERM XS[59] – originally developed by Siemens in Germany – though few details of the contracts are disclosed.

AREVA NP reverted to its original name of Framatome in 2018, and in the same year it signed a memorandum of understanding with Rusatom Automated Control Systems (RASU) JSC, a Rosatom subsidiary and "integrator" of I&C and electrical engineering businesses.[60] The 2018 Framatome-RASU JSC memorandum includes "cooperation in delivering I&C subsystems designed by Framatome" to Russian nuclear power plant construction projects, "with the potential localization of components and systems manufacturing at Rosatom's enterprises".[61]

Framatome's supply of I&C to Russian nuclear plants allows Rosatom to extend the life of its reactors and continue to operate them in the years ahead. The lasting impact of the late 1990s ruble crisis on the Russian nuclear power industry was one of the factors that led to Rosatom's foundation, and for its focus to be on an export-oriented business model.[62] The AREVA-Siemens and Framatome I&C business deals with Rosatom effectively modernised the I&C systems of the Russian reactor fleet to digital systems, contributing to improved performance and output. This, in turn, improved Rosatom's prospects for nuclear plant exports.

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[56] RUSSIA: AREVA NP supplies safety instrumentation and control system for generation 3 reactor", 3 January 2017, https://www.sa.areva.com/EN/news-10896/russia-areva-np-supplies-safety-instrumentation-and-control-system-for-generation-3-reactor.html

[57] Framatome, Instrumentation & Control: the brain and central nervous system of the plant, https://www.framatome.com/en/expertise/instrumentation-and-control/, accessed 12 April 2023.

[58] European Nuclear Society (ENS), Framatome and Rosatom Signed A Long-Term Cooperation Agreement, 2 December 2021, and as described by ENS, "two ENS Corporate Members, Framatome and Rosatom, signed a long-term strategic agreement to further expand the companies' efforts to develop fuel fabrication and instrumentation and control (I&C) technologies." See https://www.euronuclear.org/news/framatome-rosatom-cooperation-agreement/ accessed 10 February 2023.

[59] TELEPERM XS is Framatome's "flexible and modular system platform" comprising "all hardware and software components, including the tools required for engineering, testing, commissioning, operating, and troubleshooting safety I&C systems." See https://www.framatome.com/solutions-portfolio/docs/default-source/default-document-library/product-sheets/a1650-b-fr-g-en-broschuere-txs-a4-en-preview.pdf?Status=Master&sfvrsn=ebd33edd_2

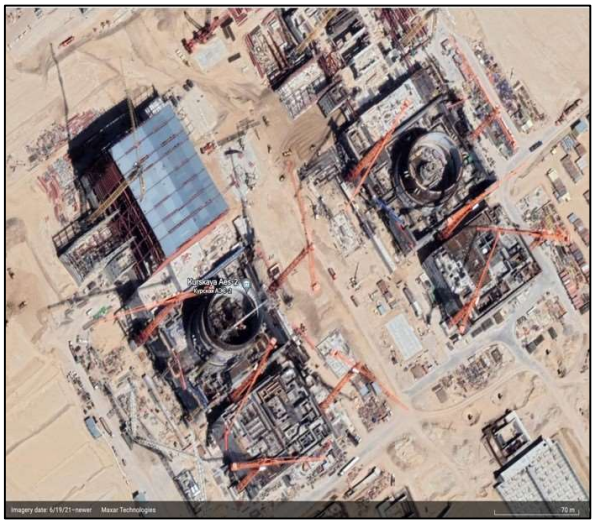
[60] RASU, Integrator Profile Rusatom Automated Control Systems, https://rasu.ru/documents/materials/IntegratorEn.pdf, accessed 10 February 2023.

[61] Framatome, Framatome to deliver reactor protection system to Kursk Nuclear Power Plant II in Russia, 8 April 2020, www.framatome.com/medias/framatome-to-deliver-reactor-protection-system-to-kursk-nuclear-power-plant-ii-in-russia/ accessed 10 February 2023.

[62] Miles Pomper, The Russian Nuclear Industry: Status and Prospects, Nuclear Energy Futures Paper No. 3 January 2009, Centre for International Governance Innovation, https://www.nonproliferation.org/wp-content/uploads/2020/03/russian_nuclear_industry.pdf, accessed 2 March 2023.

2.4 Urgent questions around Framatome's supply to Russia's KURSK-2 nuclear plant

In April 2020, it was announced that Framatome would supply its I&C TELEPERM system for reactor units 1&2 at the KURSK-2 nuclear power plant in western Russia.[63] Construction of these reactors began in 2018 and 2019 respectively, using a Russian design of reactor (the 1200 MW, Generation III+ design VVER-TOI, model VVER-V-510), that Rosatom plans to export.



Images of construction phases of KURSK II, two VVER-TOI 1200 MW reactors under construction in western Russia. Framatome is contracted to supply and install TELEPERM I&C systems. The satellite image from June 2021 (top) shows multiple heavy lift cranes at KURSK II unit 1. The March 2022 image (left) shows one of the main auxiliary buildings still under construction, whereas by April 2023 (right) both cooling towers and external auxiliary buildings are completed. Source: Maxar Technologies/Google Earth 9 June 2021, Sentinel 25 March 2022 and Sentinel 9 April 2023 respectively.

[63] Rosatom, Framatome to Deliver Reactor Protection System to Kursk Nuclear Power Plant II in Russia, 10 April 2020, https://rosatom-europe.com/press-centre/news/framatome-to-deliver-reactor-protection-system-to-kursk-nuclear-power-plant-ii-in-russia/, accessed 2 March 2023.

The reactor protection system contract for KURSK consists of 45 TELEPERM XS I&C cabinets. Framatome is to deliver the I&C cabinets to RASU's integration centre in Moscow, and provide supervisory services in the test bay and during installation and commissioning activities at the KURSK-2 plant.[64] The installation is due to be completed at the end of 2025 – nearly four years after Russia's invasion of Ukraine.

> *"This contract is proof of the excellent worldwide reputation of Framatome's people and I&C solutions. We are proud to provide these solutions as we continue to build on the strong partnership we enjoy with RASU."* – Dr. Andreas Teufel, Head of I&C Country Project Line Germany, Framatome, April 2020.[65]

The time frame for delivery of I&C systems depends on various factors (e.g. the number of reactors at a site; project modernization or new reactor construction), but for installation of a new system, I&C engineers are typically assigned to a nuclear plant project for at least 2-3 years.[66] This has serious implications for the KURSK II nuclear plant currently under construction in western Russia, and for the active presence of Framatome engineers and technicians during this process. As the examples noted above demonstrate, the time frame for I&C design, delivery and installation usually takes a number years – and I&C projects may only begin several years into a new plant's construction. Given that reactor construction of KURSK II unit 1 began in April 2018,[67] and that grid connection is planned for 2025, **there are urgent questions that Framatome must answer.**

In the more than one year since Russia began its invasion of Ukraine in February 2022:

- **have Framatome engineers or technicians, or their subcontractors, visited the RASU test centre in Moscow – or do they currently work there?**
- **have the I&C systems been delivered to RASU in Moscow – and if so, when?**
- **have Framatome personnel worked at the KURSK-2 nuclear power plant – and what is the current status of the installation of the Framatome I&C systems at the plant?**

In light of Russia's aggression against Ukraine, it is imperative that Framatome answers these questions concerning KURSK II, to help shed light on the extent of their ongoing support towards the nuclear arm of the Russian state.

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[64] Framatome, 8 April 2020, ibid.

[65] Rosatom, 10 April 2020, ibid. The Framatome I&C program is based at the company's German headquarters at Erlangen in Bavaria. See: Framatome, Erlangen is Framatome's Germany headquarters, serving local and global markets from Business Unit and corporate function employees that call Erlangen home, https://www.framatome.com/en/implantations/framatome-erlangen/

[66] See for example the position of Chief Specialist for (Siemens SPPA-T2000) (J950204), which was planned to be installed in the Russian VVER 1200 reactor in Finland, but which was cancelled in May 2022. See Chief Specialist recruitment, https://www.aplitrak.com/?adid=eWVsZW5hLjkzNTE2LjEwNDUzQG1waC5hcGxpdHJhay5jb20, accessed 12 April 2023.

[67] IAEA, Russia PRIS, https://pris.iaea.org/PRIS/CountryStatistics/ReactorDetails.aspx?current=903

2.5 Lucrative and long-term ties with Rosatom

"Cooperation of Rosatom and Siemens in the field of operational I&C has strong long-term basis." – Siemens, 2015.[68]

Siemens Energy remains deeply involved in the nuclear power industry, in particular with Russia and Rosatom. As a leading company in the development of I&C technology during the last 30 years, it remains committed to marketing its technology to Rosatom nuclear plants in Russia and overseas.[69] In recent years, Siemens Energy, in partnership with Framatome, has secured contracts to supply their SPPA-T2000 Platform I&C to Rosatom reactors in China. Namely, Tianwan units 3&4,[70] which were connected to the grid in December 2017[71] and October 2018, respectively.[72] Framatome had earlier supplied I&C for Tianwan 1&2 reactors, with the French nuclear giant noting that the project marked "another highlight of Framatome's continuing collaboration" with Rosatom in the field of safety I&C" and "demonstrates our unique capabilities to support Russian reactor designs in all areas with technology solutions and our proven VVER I&C engineering skills, both for new build and modernization projects".[73]

The historical relationship between Siemens Energy and Rosatom – as with AREVA/Framatome and Rosatom – is measured in decades not years. After more than thirty years of technology and knowledge transfer, **Siemens Energy has contracts with Rosatom nuclear plants that will stretch into the second half of this century. The reactors recently commissioned in Russia and China, and those under construction in Russia, or planned, are expected to operate for at least 60 years.** The lifetime service contracts offered by Siemens (and, presumably, Framatome) are both a long term income stream and source of profit for the German company, and essential for Rosatom to operate its reactors (see Box B)

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[68] Siemens AG, Siemens cooperation with Rosatom", Viktor Verle, Country Division,E

[69] In recent years Siemens has also secured contracts with Rosatom for the manufacture and supply of major plant components at the Novovoronezh NPP-2 in Russia, and the Ostrovetsk 1&2 two reactors in Belarus, one of which began operation in November 2020, with the other still under construction.

[70] Siemens AG, November 2015, ibid.

[71] IAEA PRIS, China, see https://pris.iaea.org/PRIS/CountryStatistics/ReactorDetails.aspx?current=973

[72] IAEA, PRIS, China, ibid.

[73] Framatome, China: Framatome delivered comprehensive instrumentation and control system for Tianwan Unit 3, 5 M18,

[74] Siemens Energy, Time-based Maintenance: Regular maintenance to a set schedule", https://www.siemens-energy.com/global/en/offerings/services/maintenance/instrumentation-controls/ic-preventive-maintenance.html, accessed 21 February 2023.

[75] Framatome, IC Academy training solutions 2021, https://www.framatome.com/solutions-portfolio/docs/default-source/default-document-library/miscellaneous/a3102-training-operational-instrumentation-control-(i-c)-concept.pdf?Status=Master&sfvrsn=944ca58c_2, accessed 24 March 2023.

Box B. How long-lasting I&C service contracts benefit Russia

Following successful installation and operation of I&C systems, regular inspection and maintenance is essential to how they perform. Framatome and Siemens Energy offer their clients – such as Rosatom – scheduled periodic maintenance of electrical and I&C systems. As Siemens explains, these are "vital to avoid power plant outages and the associated high costs."74 Under these service contracts with Rosatom, I&C maintenance, testing and commissioning personnel from these European companies are assigned to Rosatom's nuclear plants, during regular shutdowns or outages, to identify hardware faults, replace faulty modules, change parameters, save changes and load software.75

These services, carried out during refuelling outages, when reactors are shutdown, are done "to minimize costs" – Siemens Energy, for example, promises its clients that it will carry out "the inspection and maintenance of electrical and I&C system components while your turbines are being overhauled to make optimal use of downtime and keep maintenance costs to a minimum".[76] The benefits for Rosatom provided by Siemen Energy's service contracts include "Experienced, qualified staff from the manufacturer".[77] By aiming to reduce outage times, I&C service contracts help reduce costs and increase the time reactors are generating electricity – thereby providing direct benefits to the Russian economy.

There are, however, almost no details published regarding the net values for nuclear I&C contracts – be it for the design, manufacture, supply, installation and testing or servicing of I&C systems. One rare disclosure relates to Framatome I&C, based around TELEPERM XS, and supplied to nuclear utility Duke Energy in the United States in 2011. This contract was for an upgrade in I&C from analog to digital, for three reactors at Oconee in South Carolina, and was reported as costing US$250 million.[78] Considering the combination of original supply contracts, together with service contracts over several decades, this suggests that the value of I&C contracts overall could run into the hundreds of millions of euros *for each nuclear plant*.

And the financial gain goes both ways, by helping Rosatom maximise its profits, too. As Siemens Energy states, its "tailored long-term service and system maintenance contracts" provide lifetime support for their clients' I&C systems "so that you can permanently maximize your profitability"[79] (see Box B).

2.6 Are Framatome or Siemens Energy personnel currently operating in Russia?

Beyond the specific questions concerning Framatome's contract for the KURSK-2 nuclear power plant, noted above (see 2.4), there are broader questions that arise from Framatome and Siemens Energy's I&C business with Rosatom. **Have engineers and technicians from Framatome – or Siemens – been operating in Russia since the Russian invasion of Ukraine in February 2022? Are they continuing to operate there in 2023?**

[76] Siemens Energy, February 2023, ibid.

[77] Siemens Energy, February 2023, ibid.

[78] American Nuclear Society, Duke upgrades to digital I&C at Oconee, December 2011, https://www.ans.org/pubs/magazines/download/article-791, accessed 10 April 2023.

[79] Siemens Energy, Lifetime Support: Long-term service and maintenance agreements for I&C systems, https://www.siemens-energy.com/global/en/offerings/services/maintenance/instrumentation-controls/ic-preventive-maintenance.html, accessed 21 February 2023.

It is notable that in the period since Russia's seizure of the Crimea in 2014, Rosatom has completed construction and begun operation of the two reactors at the Novovoronesh-2 plant in central Russia – reactors whose I&C systems were supplied by AREVA-Siemens, as noted above. **Not surprisingly, there is little public disclosure about AREVA, Siemens or Framatome personnel operating in Russia** – whether during modernisation, construction or servicing.

However, **there are indications, based on the time frames for I&C maintenance, that Framatome and/or Siemens Energy personnel or subcontractors may have been operating at Rosatom nuclear plants in the period since Russia's invasion of Ukraine**. Global nuclear industry practice is for commercial nuclear reactors to operate on 12-18-month fuel cycle, after which refuelling and maintenance outages, or shutdowns, take place. The outage period of a Russian nuclear reactor is, therefore, an indicator of the time window during which Framatome and/or Siemens I&C personnel or subcontractors could be working in Russia. For example, on 1 December 2022, the Leningrad II-2 reactor was taken off line for maintenance.[80] It was returned to the grid in mid-January 2023. During this one and half month period, 500 additional personnel, including engineering support specialists, would be working at the site, according to nuclear plant's press division.[81] There is no public information on how many, if any, were from Framatome and/or Siemens. The question, then, is if during these six weeks of shutdown, personnel from Framatome and/or Siemens were at the Leningrad reactor site servicing Rosatom's I&C systems.[82]

Another example is the Kola nuclear power plant in northern Russia. Confirmation that the reactor units at Kola were shut down for maintenance and repair was given by the plant operators on 28 October 2022.[83] All four reactors underwent outages during 2022, for a combined total of 226 days. Units 3&4 at Kola operate with AREVA/Siemens supplied I&C systems. Repairs and maintenance work undertaken included "reactor, turbine, electrical, chemical shops, as well as the shop for supporting systems and thermal automation and measurements",[84] which are all of direct relevance to I&C systems. Planned outages for 2023 will also include units 3&4, and therefore raise the possibility of servicing by the French and German companies' I&C specialist engineers, under service contracts with Rosatom.

In December 2022, it was announced that all Russian VVER 1200 reactors are to operate on an 18-month fuel cycle, compared with the previous 12-month cycle. Public data suggests that two of Russia's VVER 1200 reactors are already operating on this longer cycle, with the remaining ones to achieve this objective by 2025, according Rosenergoatom, the electric power division of Rosatom.[85] The relevance of this, is that maintenance operations, including I&C servicing by Framatome and Siemens for reactors operating with their systems, will become less frequent but in some ways *more* important, given the longer period between inspections and repairs.

[80] Interfax, 1 December 2022, see https://www.interfax.ru/russia/875003, accessed 12 May 2023.
[81] Interfax, ibid.
[82] Nearly one year earlier, in February 2022, the same reactor completed maintenance and re-fueling which had lasted 46 days. See Interfax. ibid.
[83] Department of Information and Public Relations of the Kola NP, Kola NPP: preventive maintenance of power unit No. 2 was completed ahead of schedule, 28 October 2022, http://atominfo.ru/newsz05/a0647.htm, accessed 12 May 2023.
[84] Department of Information and Public Relations of the Kola NP, ibid.
[85] Tass, Russian nuclear power units of generation "3+" will be restarted one and a half times less often, 6 December 2022, https://tass.ru/ekonomika/16516237, accessed 12 May2023.

Based on a review of publicly available literature, there have been several reactor outages since the full-scale Russian invasion of Ukraine began in February 2022. Of the six Russian reactors identified in this report as operating with AREVA/Framatome and/or Siemens Energy I&C systems, as of May 2023, two appear to be operating on 18 month fuel cycles, which indicates I&C maintenance will be due some time in 2024. The other four reactors, without evidence to the contrary, remain on 12 month cycles. If that is so, there is a high probability that several – if not all – of these reactors have undergone outages between February 2022 and May 2023, the period since the full scale invasion of Ukraine by Russia.[86] This means it is a clear possibility that Framatome and/or Siemens I&C service contract personnel have been operating at all six of these Rosatom operational reactors in Russia in the 2022-23 period – or that they are due to in the remainder of this year.

In the context of Russia's invasion of Ukraine, the active role that Rosatom has taken in it, and the ongoing ties between European nuclear companies and Rosatom – including the clear possibility that Framatome and Siemens I&C service contract personnel have been operating in Russia since the Ukraine invasion – we believe that the following questions must be answered:

- **Do Framatome/Siemens currently have personnel (or any subcontractors) at Rosatom nuclear plants in Russia, or in third countries building Rosatom reactors?**

- **Since the Ukraine invasion began in February 2022,**
    - **how many Framatome/Siemens personnel or subcontractors have worked at Rosatom nuclear projects** in Russia and/or Rosatom plants under construction or operating overseas – and **at which plants, in which countries?**
    - **under service contracts with Rosatom, how many Siemens/Framatome engineers, technicians and/or subcontractors have worked in Russia** or at Rosatom supplied reactors in third countries **– and what future deployment of Siemens/Framatome personnel and/or subcontractors to Russia or Rosatom-supplied nuclear plants are planned during 2023?**

And last but not least:

- **What plans do Siemens/Framatome have to suspend and terminate their I&C business' with Rosatom,** including the deployment of their engineers, technicians and other personnel to Russia and Rosatom-supplied nuclear plants in third countries?

The mere fact that we are forced to ask these questions – and that it is so difficult to find answers to them – highlights precisely why comprehensive EU nuclear sanctions against Russia are urgently needed. As a step towards this, immediate public disclosure by the French and German companies of their on-going nuclear operations in Russia is required.

[86] This does not include other Russian reactors that may be operating with Framatome and/or Siemens Energy I&C not identified in this report. Nor does it include the possibility that Framatome personnel have been at the Kursk II plant since February 2022.

3. Paks II: Russia's nuclear plant in the European Union

Framatome and Siemens Energy are the contractors selected by Rosatom for the I&C system at the Paks II nuclear plant in Hungary. The highly controversial Paks project is a partnership between Rosatom and the Hungarian government for the construction of two VVER 1200 reactors at the existing nuclear plant site, where four Soviet-supplied reactors continue to operate.[87] In October 2019, the Framatome-Siemens consortium signed an agreement with Rosatom-subsidiary RASU JSC "to manufacture, deliver and commission automated process control systems" for the Paks reactor units 5&6.[88]

Andrei Butko, the CEO of RASU JSC, said at the time that "We highly value the level of trust between our organizations" and "are confident that our cooperation will expand".[89] Frédéric Lelièvre, a Senior Executive Vice President at Framatome, meanwhile, described how Framatome – "in conjunction with our partner, Siemens" – was "proud" and "delighted" to use their expertise in I&C for Russian-VVER reactors, in Europe. "Our high-performing people have been commissioning automation systems at nuclear power plants in Russia for many years" and Paks II would "add to a long list of successful projects with Rosatom."[90]

The debate around the application of EU nuclear sanctions against Russia has to a significant degree been centred around the Paks II project. **There is no doubt that the Russian invasion of Ukraine has put the Paks II nuclear project in a vulnerable position**, more so than ever before. **The German government has so far not issued an export permit for the I&C to be supplied by Siemens Energy[91]** – and has yet to do so as of 18 July 2023. France, however, has shown no such concerns. Hungary's Minister of Foreign Affairs Péter Szijjártó stated in February 2023 that "We are grateful to the French government for allowing Framatome to supply the control system for the new Paks nuclear power plant. **We also agreed that there is no point in imposing sanctions against cooperation with Russia in the nuclear sector."[92]**

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[87] In 2014, Russia and Hungary signed an intergovernmental agreement on the construction of the 5th and 6th units of Paks nuclear power plant, two generation 3+ VVER-1200 reactors. Rosatom's engineering division JSC ASE Engineering company was tasked with construction, and RASU JSC to implement "a comprehensive project for the development, supply and commissioning of automated process control systems" for the new units.

[88] The automated control systems for Paks are based on the I&C technology supplied by AREVA-Siemens to the Russian nuclear plant, Leningrad II between 2010-2016. See Framatome, RASU JSC and Framatome-Siemens consortium sign contract to supply automated process control systems for Hungarian Paks-2 Nuclear Power Plant, 23 October 2019, https://www.framatome.com/medias/rasu-jsc-et-le-consortium-framatome-siemens-signent-un-contrat-de-fourniture-de-systemes-de-controle-de-processus-automatises-pour-la-centrale-nucleaire-hongroise-de-paks-2/, accessed 21 February 2023.

[89] Framatome, "RASU JSC and Framatome-Siemens consortium sign contract to supply automated process control systems for Hungarian Paks-2 Nuclear Power Plant", 23 October 2019, https://www.framatome.com/medias/rasu-jsc-et-le-consortium-framatome-siemens-signent-un-contrat-de-fourniture-de-systemes-de-controle-de-processus-automatises-pour-la-centrale-nucleaire-hongroise-de-paks-2/, accessed 21 February 2023.

[90] Framatome, 23 October 2019, ibid. The contract was signed by Vice President Sales Nuclear I&C of Siemens AG Jens König, Commercial Sales Director Nuclear I&C of Siemens AG Jens Bostelmann, together with CEO of RASU JSC Andrei Butko, and Managing Director of Framatome GmbH Carsten Haferkamp.

[91] Siemens has applied for an export license from the Federal Office for Economic Affairs and Export Control. The Hungarian government has accused German Vice-Chancellor, Minister for Economic Affairs and Climate Action Robert Habeck, as well as German Foreign Minister Annalena Baerbock, of blocking the export to Paks. See: Rainer Ackerman, Do Habeck and Baerbock cross?, Budapest Newspaper, 28 January 2023, https://www.budapester.hu/ausland/stellen-sich-habeck-und-baerbock-quer/, accessed 2 March 2023.

[92] TASS, France backs Hungary on removing Russian nuclear sector from sanctions — Hungarian FM, 14 February 2023, https://tass.com/world/1576353, accessed 12 April 2023.

As recently as 12 April 2023 – more than a year after Russia began its invasion of Ukraine – Rosatom CEO Alexey Likhachev met with Hungarian Foreign Minister Szijjártó to agree modifications to the construction and financing contract for the Paks II project. Details of the new deal, however, were not published.[93] The Hungarian Energy Minister was reported to have said that, according to Szijjártó, "the European Commission would have to approve the changes."[94] Hungary has proposed increasing the role of Framatome, as a result of the German government's block on Siemens Energy to supply I&C.

The mounting pressure on Hungary over its nuclear business with Russia makes the Paks II nuclear project look increasing vulnerable.[95] Nonetheless, Hungary – together with France – has been blocking EU sanctions against Rosatom, partly as a way to avoid destabilising the Paks II project, in a bid to protect its own nuclear interests.

4. Framatome, Siemens and the Russian nuclear submarine program

Another important factor that raises serious concerns over Framatome/Siemens Energy's I&C trade with Rosatom is the dual use capability of their advanced hardware and software technology. Rosatom is an enormous nuclear enterprise spanning all areas of nuclear technology and materials, including Russia's nuclear weapons program. Of particular relevance is Rosatom's design, installation and maintenance of nuclear reactors within Russia's ballistic missile submarine (SSBN) program. The nuclear reactor-powered SSBNs are the platform for targeting and launching Russian strategic nuclear weapons. While the submarine reactors are much smaller in capacity than commercial nuclear plants, they still require I&C for successful operation.

Over the decades, multiple research institutions in the Soviet Union and Russian Federation have been responsible for the design and development of nuclear powered submarines. Today, all of these bodies are under the overall authority of Rosatom.

Historically, the Central Design Bureau No. 1 (CDB 1), established in 1952, was responsible for the design of instrumentation systems and devices for the Soviet Union's nuclear program, both civil and military. CDB 1 systems and instruments were installed at the world's first nuclear power plant in Obninsk, the nuclear-powered ice-breaker ship *Lenin*, and the Soviet Union's

[93] Budapest Business Journal, Hungary, Russia Agree to Modify Paks II Contract, 12 April 2023, https://bbj.hu/business/industry/deals/hungary-russia-agree-to-modify-paks-ii-contract, accessed 14 April 2023.

[94] WNA, Hungary and Russia amend Paks II nuclear project agreement, 12 April 2023, https://www.world-nuclear-news.org/Articles/Hungary-and-Russia-amend-Paks-2-nuclear-project-ag, accessed 14 April 2023.

[95] Marton Dunai, Henry Foy in Brussels, Leila Abboud, Hungary in talks with France over role in Russian-led nuclear plant, Financial Times, 23 March 2023, https://www.ft.com/content/52707196-4882-45af-9342-59413472c443, accessed 18 April 2023.

[96] Rosatom, Nervous System for Nuclear Plants, May 2022, https://rosatomnewsletter.com/2022/05/29/nervous-system-for-nuclear-plants/, accessed 21 February 2023.

first nuclear submarine, the Leninsky Komsomol, launched in 1957.[96] CDB-1 eventually became the Research Institute for Instrumentation Engineering (SNIIP), which today is a subsidiary of RASU JSC – the Rosatom company that has I&C contracts with Framatome/Siemens Energy.

The lack of separation between Russia's civil and military nuclear programmes – and the fact that I&C systems are needed in both of them – raises questions about the end use certification of advanced digital software and hardware supplied to Russia by Siemens Energy and Framatome (and earlier, AREVA) under their contracts with RASU JSC. Questions that need to be answered in order assess the possibility that advanced technology and knowledge transfers of I&C systems from Siemens and Framatome are benefiting the Russian nuclear weapons program, include:

- **What are the specified end use certificates of I&C systems supplied to Rosatom by AREVA, Framatome and Siemens?**
- **What oversight and control, beyond certification, exists for I&C technology and software transfers to Russia?**
- **Has AREVA, Framatome and/or Siemens undertaken investigations into the potential transfer from civilian to military application of its I&C software and hardware supplied to Russia, including security implications?**

These are questions that need urgent answers, in light of the ongoing invasion of Ukraine, and the continued lack of EU nuclear sanctions against Russia. Whatever the answers, however, it should be noted that **ultimately, given the nature of Rosatom and the Russian nuclear industry – which contains no practical separation between civil and military – there can be no confidence in any assurance given by Rosatom to AREVA/Framatome or Siemens (or their respective national export bodies**) **that their technology and knowledge would not be transferred to, or in any way assist, Russia's military nuclear program.**

5. Supporting Russia's expanding domestic and global nuclear program

The contracts between Framatome, Siemens Energy and Rosatom are of direct commercial benefit to Rosatom, and, therefore, to the Russian state. While I&C contracts, on the face of it, represent a financial flow from Russia to France and Germany, Rosatom's business interests are well served by being able to offer their services to potential customers overseas. One direct benefit of Framatome/Siemens Energy's technology supply for Rosatom is in the branding of its nuclear plants for export.

Russia's VVER-TOI nuclear reactors (developed from the VVER-1200) – which are the basis for the Akkuyu nuclear plant project in Turkey, Paks II in Hungary and El Dabaa project in Egypt – were, in 2019, the first Rosatom reactor design to secure certification from the European Utility

Requirements (EUR) organization. EUR is an association of European utility operators, set up in 1991 to create a set of technical specifications for the new generation of light water nuclear reactors. **As Rosatom stated in 2019, having the EUR certification for the VVER-TOI design would "contribute to the promotion of Russian nuclear technologies in foreign markets"[97] – and having the most advanced digitalised I&C systems from Framatome and Siemens is one reason that the VVER-TOI was able to get the EUR certification in the first place.**

It must also be recognised that Rosatom's exports to foreign markets play a critical role in furthering Russia's broader geo-strategic objectives. In particular, in terms of expanding its sphere of influence in the global South, including to north and sub-Saharan Africa, south and southeast Asia. The majority state-owned French company Framatome, together with German company Siemens Energy, are therefore directly and indirectly assisting the commercial and geopolitical goals of their 'competitor' in nuclear power exports, Rosatom.

Box C: Russia's export model has made it the world's biggest supplier of nuclear reactors

The financial status of Rosatom's business operations are far from transparent, but there is no doubt that Russia's nuclear export model – in particular, the major financing it provides to third countries, and the Build-Own-Operate model that sees reactors supplied, financed and operated by Russia – has helped establish Rosatom as the largest single supplier of nuclear power plants globally, with five reactors under construction in Russia and 19 overseas.[98] In 2020, Rosatom's First Deputy Director General for Corporate Development and International Business, Kirill Komarov, stated that Rosatom aimed to maintain its high levels of orders from abroad, noting that "We have already accumulated a very decent portfolio of foreign orders, which ranged between $135 billion and $140 billion in recent years. Our main task today is not to increase this portfolio, but to maintain it".[99]

How much revenue these projects will generate for the Russian state is, however, unclear. In the short term, these projects are only viable due to loans from Russian banks,[100] as, for example, with the Akkuyu nuclear project in Turkey (see 5.1). Rosatom and its client states have generally failed to raise overseas private capital to fund these nuclear projects – a reality not limited to Rosatom, but a global nuclear industry problem.[101]

On the domestic front, there are also direct benefits from Rosatom's trade with Framatome/Siemens to Russia's energy production and economy. In 2022, Rosatom's 11

[97] World Nuclear Association, Russia's VVER-TOI reactor certified by European utilities,

[98] World Nuclear Status Report, WNISR, 2022 and World Nuclear Power Status as of April 2023, see https://www.worldnuclearreport.org/

[99] Nuclear Engineering International, Rosatom reveals plans for foreign nuclear plant construction,

[100] Vladimir Slivyak, Shunning Rosatom Prospects of Russia's nuclear expansion in the context of widening global sanctions, ECODEFENSE' REPORT, May 2022, https://www.laka.org/docu/boeken/pdf/2-34-6-50-05.pdf#page=2, accessed 2 March 2023.

[101] Nadira Barkatullah and Ali Ahmad, Current status and emerging trends in financing nuclear power projects, 2 October 2017, https://www.sciencedirect.com/science/article/abs/pii/S2211467X17300561, accessed 2 March 2023.

[102] TASS, Russian nuclear power plants set new generation record in 2022, 1 January 2023, https://tass.com/economy/1558495, accessed 14 April 2023.

[103] EMBER, Nuclear, April 2023, https://ember-climate.org/topics/nuclear/ accessed 18 April 2023.

[104] World Nuclear Industry Status Report 2022, Russia, https://www.worldnuclearreport.org/The-World-Nuclear-Industry-Status-Report-2022-HTML.html, accessed 18 April 2023.

Russian nuclear power plants (which together house a total of 37 nuclear reactors) generated record volumes of electricity[102] – 226 TWh in 2022[103] compared with 208.5 TWh in 2021.[104] Amongst the numerous factors that affect annual variations in nuclear operation, and how reactor operators seek to maximise generation, one significant factor is the availability and operation of modern I&C systems.

Framatome/Siemens Energy's service contracts with Rosatom for inspection, repair and maintenance of equipment are particularly aimed at reducing outage times (ie when the reactors are not generating electricity), thereby reducing operating and maintenance costs and increasing the time the reactors are connected to the grid and generating electricity (see Box B). These I&C service contracts – as part of the ongoing nuclear trade between Framatome/Siemens Energy and Rosatom – therefore provide direct benefits to the Russian economy.

And as long as Framatome and Siemens Energy continue to actively benefit Russia's economy, providing a technology boost for Russia's nuclear plants, they are indirectly aiding the Russian military operation across Ukraine, including its targeting of Ukraine's electricity and energy infrastructure and the illegal occupation of the Zaporizhzhia nuclear plant. It defies all logic that EU member states and the European Commission permit this to continue. Yet by failing to apply comprehensive sanctions against Rosatom – sanctions that immediately end all I&C business with Rosatom – they too are complicit in this continued support to Russia.

The urgent need to introduce EU nuclear sanctions against Russia is all the more imperative when viewed in light of how expansive Framatome's plans to partner with Rosatom are.

The May 2018 memorandum of understanding between Framatome and RASU JSC indicated that both parties would consider how Framatome I&C systems "could be integrated into Rosatom new build projects abroad, with the possible localization of component and system production on Rosatom sites."[105] The December 2021 agreement provided a framework for "the participation of RASU and Framatome in VVER and Framatome's nuclear power plant projects in the global market, cooperation in the fields of maintenance and modernization, training, development of nuclear infrastructure, and support for the certification of Russian equipment to ensure compliance with European and international norms and standards."[106]

In other words, Framatome-Rosatom's recent agreements represent a French-Russian strategic partnership for decades ahead, which, if permitted to continue, will further Russia's domestic and international nuclear business and geopolitical interests. In turn increasing the risks globally of a severe nuclear accident.

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[105] World Nuclear Association, Framatome and Rosatom expand cooperation, 2 December 2021, https://www.world-nuclear-news.org/Articles/Framatome-and-Rosatom-expand-cooperation

[106] World Nuclear Association, 2 December 2021, ibid.

[107] Assystem, 30 November 2020, ibid.

5.1 The role of European companies in Russian nuclear projects in Turkey, and beyond

Assystem is "committed to supporting Rosatom's international programme of nuclear investment"- French engineering company Assystem [107]

The construction of four Russian nuclear reactors at Akkuyu is Turkey's first commercial nuclear power plant. The initial construction of the Rosatom VVER 1200 Akkuyu nuclear project is funded by Russia's Sberbank, with a US$400 million credit line in 2019 being expanded by US$800 million in November 2021, to cover a period of seven years.[108] Much delayed due to local opposition, there remain major unresolved safety issues, including seismic risks. The site is located on the Mediterranean coast, 25km from the Ecemiş fault line, in a country that is one of the most seismically active in the world.[109] For Rosatom, however, the Akkuye project is a model nuclear project – supplied by Russia, financed by Russia and operated by Russia. This is no accident: Russia is effectively creating a Turkish dependency on Rosatom for the next six decades. And, as elsewhere, the French and German nuclear industry are contractually involved.

While the principal focus of this analysis is Framatome and Siemens Energy' I&C business with Rosatom, other major French nuclear business dealings with Russia are on-going, including at Akkuyu.[110] This includes a deep commercial relationship between French company Assystem and Rosatom. A major engineering company, Assystem – which owns a 5 percent share in Framatome – is central to the French nuclear industry, and has multiple contracts with Rosatom, including on the Akkuyu project.[111]

The Akkuyu plant in Turkey is the world's first nuclear project implemented under Rosatom's BOO model (Build-Own-Operate). Under the long-term contract, Rosatom has undertaken to provide the power plant's design, construction, maintenance, operation, and decommissioning. Four VVER 1200 reactors have been under construction in the Mersin province on the southern coast of Turkey since 2018. The project is 99.2 percent owned by Rosatom,[112] and despite the aggression against Ukraine, Russia's money to Akkuyu has kept flowing. In September 2022 – seven months into the invasion – it was reported that the Moscow-based, privately owned

[108] Nuclear Engineering International, Sberbank provides more loans for Akkuyu nuclear plant, 18 November 2021, https://www.neimagazine.com/news/newssberbank-provides-more-eloans-for-akkuyu-nuclear-plant-9260611, accessed 2 May 2023.

[109] Pinar Temocin, Framing Opposition to Nuclear Power: The Case of Akkuyu in Southeast Turkey, Asian Journal of Peacebuilding Vol. 6 No. 2 (2018): 353-377, 2018, http://ipus.snu.ac.kr/eng/wp-content/uploads/sites/2/2020/07/AJP-6-2_09_Pinar-Temocin.pdf, accessed 12 April 2023.

[110] In 2021, RASU supplied I&C for the Rosatom Akkuyu plant in Turkey, but there doesn't appear to have been any direct Framatome I&C technology supply to the Akkuyu reactors. See Rosatom, May 2022, https://rosatomnewsletter.com/2022/05/29/nervous-system-for-nuclear-plants/ "In 2021... RASU made the first shipments of I&C components for the Rooppur NPP in Bangladesh and Akkuyu in Turkey."

[111] Assystem, "Since 1966, Assystem has actively contributed to the development of nuclear energy, by supporting the construction and commissioning of the French nuclear fleet. From design to construction through to maintenance and decommissioning, we have developed leading-edge expertise based on technological independence." See https://www.assystem.com/en/sector/nuclear/ accessed 21 February 2023.

[112] It was disclosed in August 2022 that ownership of the plant had remained Russian, despite claims that a 49 percent share had been sold to Turkish companies. More details can be found in the report of Murat Yetkin, Main opposition leader slams Erdoğan over Rosatom's Akkuyu move, 22 August 22022, https://yetkinreport.com/en/2022/08/02/main-opposition-leader-slams-erdogan-over-rosatoms-akkuyu-move/, accessed 14 April 2023.

[113] Russian state firm signs $9.1bn loan deal to fund nuclear plant in Turkey, 16 September 2022, https://www.middleeasteye.net/news/russia-turkey-gazprombank-akkuyu-plant-loan-fund, accessed 15 April 2023.

Gazprombank still had access to the Swift international payment system that Russia was excluded from after its invasion of Ukraine began. Thus, Gazprombank was able to send money to Akkuyu's dollar and euro account with the Turkish state-owned Ziraat Bank.[113] Bloomberg reported in August 2022 that Rosatom had decided to wire US$15bn to Turkey for the construction of the $20bn Akkuyu nuclear power plant, citing officials who said that an initial US$5bn had already been received.[114]

Through its Turkish subsidiary Assystem Envy, French company Assystem has, since 2011, conducted initial and design stage site surveys, hydrogeological surveys, site inspection and safety assessment for Rosatom's Akkuyu project.[115] In 2020, Assystem was selected by Rosatom to oversee the construction of the Akkuyu nuclear power plant, with the contract running until 2026.[116] As Assystem said at the time, it is "committed to supporting Rosatom's international programme of nuclear investment."[117]

And French industry's involvement with Akkuyu doesn't stop there: GE Steam Power are responsible for manufacturing and supplying the steam turbines for the Rosatom reactors. Under an agreement with AAEM Turbine technology LLC, a joint venture between Rosatom subsidiary Atomenergomash JSC and General Electric (GE), manufacture began on the Arabelle steam turbines at the Belfort plant in eastern France, in June 2019.[118] The first steam turbine was delivered to the Akkuyu site in January 2021.[119] Andrey Nikipelov, CEO of Atomnergomash, highlighted that for the first time ever "the enterprises of Rosatom's Mechanical Engineering Division involved in the Akkuyu project" had started to produce turbine island equipment in line with European standards, "the outcome of successful strategic partnership between two heavy manufacturing giants – Atomenergomash of Rosatom and GE."[120]

Nor is France the only country whose industry has ties to Rosatom's flagship Turkish nuclear project. In addition to its I&C business with Russia, German company Siemens is contracted to supply key electrical equipment to the Akkuyu nuclear plant.[121] In September 2022, AKKUYU

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[114] Taylan Bilgic, Rosatom Inks Deal With Russian Builder at Turkish Nuclear Plant, Bloomberg, 30 July 2022, https://www.bloomberg.com/news/articles/2022-07-30/rosatom-inks-deal-with-russian-builder-at-turkish-nuclear-plant?leadSource=uverify%20wall, accessed 15 April 2023.

[115] Assystem, Assystem Wins New Independent Construction Inspection Contract For Akkuyu Nuclear Power Plant, 30 November 2020, https://www.assystem.com/en/news/assystem-wins-new-independent-construction-inspection-contract-for-akkuyu-nuclear-power-plant/, accessed 21 February 2023.

[116] Assystem, 30 November 2020, ibid.

[117] Assystem, 30 November 2020, ibid.

[118] General Electric, GE Steam Power and AAEM Joint Venture begin manufacturing for Turkey's first Nuclear Power Plant, 27 June 2019, https://www.ge.com/news/press-releases/ge-steam-power-and-aaem-joint-venture-begin-manufacturing-turkey%E2%80%99s-first-nuclear, accessed 15 April 2023. AEM and GE established its joint venture, AAEM Turbine technology LLC (AAEM), in 2007 to offer comprehensive solutions for conventional island of VVER nuclear plants. "Execution of the Akkuyu project is a major milestone in the development and growth of the Joint venture AAEM and for both GE and AEM as shareholders and participants to this landmark project," according to GE.

[119] General Electric, GE Steam Power delivers first Arabelle steam turbine module ahead of schedule for Akkuyu nuclear power plant, 12 January 2021, https://www.ge.com/news/press-releases/ge-steam-power-delivers-first-arabelle-steam-turbine-module-ahead-of-schedule-for, accessed 16 April 2023.

[120] General Electric, 12 January 2021, ibid.

[121] In December 2010, Rosatom established the AKKUYU Nuclear Joint-Stock Company (AKKUYU NÜKLEER ANONİM ŞİRKETİ), AKKUYU NPP Construction Project, see http://www.akkunpp.com/akkuyu-npp-construction-project, accessed 15 April 2023.

Nuclear Joint-Stock Company stated that there had – at that stage – been no official notifications concerning supply from Siemens Energy, and that Siemens Energy had almost completed the manufacture of power equipment for Akkuyu's switchgear: "Now our partner Siemens Energy is complying with its contractual obligations for the supply of equipment."[122] However, more recently, amidst mounting pressure on Siemens Energy (see Box D), the German government has made some efforts to block exports to Rosatom-linked projects. Reportedly, the German Federal Office for Economics and Export Control has yet to issue all the necessary permits to Siemens Energy for the supply of the switchgear technology that is to be integrated into the four VVER 1200 reactors at Akkuyu.[123]

One reported reason for this is the concern that the Siemens technology could be diverted from Turkey to Russia. A proposed solution being considered is for the switchgear to be delivered directly to the nuclear power plant under the supervision of Siemens specialists. This, however, fundamentally misses the point. **The Akkuyu project is a Russian nuclear power plant, central to the geo-strategic aims of Rosatom and Russia. Siemens Energy, by its continuing efforts to deliver its technology to Akkuyu, together with France's Assystem, is materially promoting those interests (and its own). This clearly runs counter to the interests of European and global efforts to effectively sanction Russia and to reduce its influence in key markets such as energy.**

BOX D: Pressure is mounting on Siemens Energy

The strategy of Siemens Energy to keep a low profile, while still committing to its I&C business with Russia,[124] is looking increasing unsustainable. At its February 2023 annual general meeting, Siemens was confronted by shareholders and civil society demanding that the company terminates its nuclear trade with Russia.[125] The response from Siemens executives was as follows:

"Continued business with Rosatom despite withdrawal from Russia

Siemens Energy has not been represented in so-called "hot" nuclear technology for more than a decade. Siemens AG announced its exit from nuclear power as early as 2011. However, Siemens Energy is still represented in the so-called operational control technology ("control systems") - there are other international suppliers from Russia or China, for example, but Siemens Energy is the only supplier in the world that has references that allow qualification according to European standards. With its control technology, Siemens Energy thus makes an important contribution to the safety of civil nuclear plants. With regard to the nuclear power plant in the EU member state of Hungary, it was an explicit wish of the authorities there to use this control technology."[126]

This self-serving defence by Siemens Energy of its ongoing trade with Rosatom comes at a time when Germany has shut down its own nuclear power plants, in part due to the serious risk of accident. There

[122] Russian state firm signs $9.1bn loan deal to fund nuclear plant in Turkey, 16 September 2022, https://www.middleeasteye.net/news/russia-turkey-gazprombank-akkuyu-plant-loan-fund, accessed 15 April 2023.

[123] Turkish nuclear power plant hit a block Rosatom project may miss Siemens Energy equipment, 16 February 2023, https://www.kommersant.ru/doc/5826876, accessed 15 April 2023.

[124] Christian Schaudwet, RUSSIA-UKRAINE WAR: Siemens Energy in distress because of Rosatom, 7 February 2023, https://background.tagesspiegel.de/energie-klima/siemens-energy-in-bedraengnis-wegen-rosatom, accessed 12 April 2023.

[125] Urgewald, The nuclear pact with the devil - Siemens Energy must end its business relationship with Rosatom immediately, 6 February 2023, https://www.urgewald.org/medien/nukleare-pakt-teufel-siemens-energy-geschaeftsbeziehungen-rosatom-sofort-beenden, accessed 18 April 2023.

[126] Siemens Energy AG, 7 February 2023, https://assets.siemens-energy.com/siemens/assets/api/uuid:6a9b6f73-b546-4597-9860-bc3f73e933d3/gegenantraege-hv2023-de-2023-01-25.pdf?ste_sid=5bdcd7a13c9f616c3d9577659d7717f9

should, categorically, be no business-as-usual with Rosatom while the Russian company is involved in the illegal armed occupation of Europe's largest nuclear plant at Zaporizhzhia, an occupation that puts Ukraine - and the whole of Europe – at risk of nuclear disaster. Yet as the scandal of European companies' continued I&C trade with Russia shows, Siemens Energy has *not* exited nuclear power in the way that was commonly understood and claimed by the company, and continues its I&C business dealings with Rosatom. The current efforts by the German government to block exports to Rosatom-linked projects are fully justified, and should be shored up by EU-wide sanctions that include all I&C business.

Beyond Turkey, it is worth noting that French-Russian nuclear collaboration is extending into the Middle East. In 2018, Rosatom signed a contract with Assystem to support the development of four reactors at the El Dabaa nuclear power plant in Egypt.[127] A decades long commitment by Egypt, the El Dabaa project creates another energy dependency on Russia, with a lifespan of 70 to 80 years. Its construction is financed by a US$25 billion loan from Russia.[128] Assystem will work with the contractor of the project, Atomstroyexport – a Rosatom engineering company – to obtain the necessary licenses and permits from the Egyptian government, needed to build the plant.[129] Similarly, GE Power is contracted to supply the turbine island equipment for the El Dabaa nuclear plant through its joint venture with Atomenergomash.[130] Under the terms of the contract, GE Power will deliver the design of four basic conventional islands and supply four nuclear turbine generator sets, including the Arabelle half-speed steam turbines.

Despite the integral role that the French nuclear industry plays in the success of Russia's nuclear export strategy, there is no indication that France has made any assessment of the implications of its partnership with Rosatom. This provides further demonstration of why EU-wide nuclear sanctions against Russia are urgently needed.

5.2 Supporting Russia's global nuclear ambitions far into the future

Instead of reining in its nuclear support for Russia, France looks set to increase it. Plans to further expand the existing I&C business between Framatome and Rosatom were made clear in 2018 when RASU JSC signed a memorandum of understanding with Framatome, to enhance cooperation in I&C "for their mutual benefit." As Fréderic Lelièvre, a Senior Executive Vice President at Framatome, stated at the time:

> *"There are obvious synergies between Framatome and JSC RASU… We have a number of years of experience in jointly commissioning automation systems at nuclear power plants in Russia*

[127] Assystem, "The Signing Of A Contract With Rosatom To Develop A Nuclear Power Plant In Egypt", 10 October 2018, https://www.assystem.com/en/news/assystem-signs-a-contract-with-rosatom-to-help-develop-a-nuclear-power-plant-in-egypt/, accessed21 February 2023.

[128] Asma Alsharif, Russia to lend Egypt $25 billion to build nuclear power plant, Reuters, 1 May 2016, http://www.reuters.com/article/us-egypt-russia-nuclearidUSKCN0YA1G5, accessed 23 May 2016. And, as cited in, Haas, R., Mez, L., Ajanovic, A. (eds) The Technological and Economic Future of Nuclear Power. Energiepolitik und Klimaschutz. Energy Policy and Climate Protection. Springer VS, Wiesbaden. https://doi.org/10.1007/978-3-658-25987-7_17

[129] Assystem, October 2018, ibid.

[130] Power Technology, GE Power to supply turbine island equipment for El Dabaa plant, 11 October 2018, https://www.power-technology.com/news/ge-power-supply-turbine-island-equipment-el-dabaa-plant/, accessed 10 April 2023.

and are convinced that the conditions created under this agreement for specific cooperation projects will be in demand in global markets. The initial key markets for us are ***Turkey, Hungary and Egypt****. Cooperation between our two companies creates a win-win situation all round; for JSC RASU, for Framatome and, most importantly, for our customers to enable them meet the challenges they face today."*[131]

The four reactor Akkuyu nuclear project in Turkey is now under construction (see 5.1), as are the two Rosatom reactors at El Daaba in Egypt. And, as noted earlier, Framatome is the contractor for I&C systems at Paks II in Hungary (though its unclear who is providing the I&C for El Daaba).[132] What's more, as noted above, the 2018 memorandum focused not only on integrating Framatome I&C systems into Rosatom new build projects abroad, but on the "possible localization of component and system production on Rosatom sites".[133] It has not, however, been possible to confirm progress towards this latter goal.

Despite the lack of transparency, and the difficulty in uncovering the true extent of progress on the ground, one thing is abundantly clear: EU nuclear sanctions against Russia must ensure that contracts for further supply of Framatome/ Siemens Energy I&C are not permitted. Equally, localization of Framatome/ Siemens Energy technology must be prohibited.

6. Conclusion

This analysis has established that the Instrumentation and Control (I&C) business between Framatome, Siemens Energy and Rosatom is a decades long strategic partnership that is continuing today as if nothing has changed – when in reality everything has. Rosatom is an active participant in Russia's invasion of Ukraine, the largest conflict in Europe since 1945 and bringing the continent to the brink of nuclear disaster. What's more, their existing commercial agreements mean that the French and German companies' close relationship with Rosatom is set to stretch decades into the future, as well.

An important dimension of the I&C trade with Russia is that through I&C service contracts, Framatome and Siemens Energy directly assist Rosatom in reducing Russia's nuclear plants' outage times, thereby reducing costs and increasing the time reactors are generating electricity. **This is a direct benefit to Russia's economy from Rosatom's ongoing nuclear trade with Framatome and Siemens Energy.** One which sits in stark **contrast with Rosatom's seizure and illegal occupation of the Zaporizhzhia nuclear plant in Ukraine and the Russian military's**

[131] Framatome, Instrumentation & control: Framatome and Rusatom Automated Control Systems Sign Memorandum of Understanding, 25 May 2018, https://www.framatome.com/medias/framatome-rusatom-automated-control-systems-sign-memorandum-of-understanding/, accessed 12 April 2023.

[132] It has not been possible to confirm from available literature the I&C supplier for the El Dabaa project.

[133] Framatome, 25 May 2018, ibid.

targeting of Ukraine's electricity and energy infrastructure. Apart from the public and moral outrage this should generate, it defies all logic that EU member states and the European Commission permit this to continue by failing to apply sanctions that cover I&C business with Rosatom.

Immediate and comprehensive sanctions to end the nuclear trade between the EU and Russia are urgently needed. The transfer of advanced technology and knowledge in **I&C systems must be included in these sanctions**. Furthermore, the termination of any existing service contracts that involve Framatome and Siemens personnel or their subcontractors working for Rosatom should be included as a matter of urgency in an EU nuclear sanctions packages. **There should also be a commitment by Framatome and Siemens to enter no new contracts with Rosatom or Rosatom-related projects.**

Despite the clear evidence of how the continued nuclear trade with Europe is benefiting Russia, and therefore helping to fuel its aggression against Ukraine, the EU has so far failed to introduce sanctions against Rosatom. **There is no doubt that the blocking of EU nuclear sanctions against Russia – led by France and Hungary – is directly related to the I&C business between Framatome, its partner Siemens Energy, and Rosatom**. Current efforts by the German government to block Siemens Energy's exports to Rosatom-linked projects are welcome and a step in the right direction, but they must be shored up by EU-wide sanctions if Europe is to fully sever its support for the Russian state-run civil and military nuclear company, and its criminal actions in Ukraine.

Comprehensive EU nuclear sanctions against Rosatom are essential, but the need for consensus means that as long as France and Hungary put their own nuclear interests ahead of the people of Ukraine, they are likely to remain blocked. This is one reason that the many unanswered questions about Framatome and Siemens Energy's ongoing I&C trade with Rosatom should be brought into the limelight. The **European companies continuing their business with Rosatom must be required to disclose information about their dealings with the Russian state company.** To give answers to key questions about their nuclear trade – including whether their personnel have been operating in Russia (or at Rosatom-owned nuclear plants elsewhere) since its invasion of Ukraine. Shedding light on the details of their continued collaboration would be an invaluable step to overcoming the obstacles to EU nuclear sanctions against Russia – sanctions that are a moral and practical imperative for the EU to introduce.

It is also **crucial that more light is shined on the end use of the dual-use-technology** that Framatome and Siemens Energy have delivered to Rosatom: technology **that could be of use to Russia's military nuclear program**. With Rosatom's remit covering both civil and military nuclear operations, there can be no confidence in any Rosatom assurances of end use compliance. Thus, while Russia continues its invasion of Ukraine, and threatens Europe with nuclear disaster, European companies may have been providing Russia with nuclear technology that could be weaponized. This is one further reason amongst many why EU nuclear sanctions against Russia are long over due.