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EU-Russian Nuclear Energy Cooperation:

*The 'marriage of Convenience' **has become** a 'marriage of Inconvenience'*

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Danger work in progress!

Abstract

Much academic analysis of EU-Russian energy cooperation focuses on the natural gas and oil energy sectors; however in this paper attention is directed to cooperation between the two parties in the field on nuclear energy. The unprecedented change to the geopolitical environment in Europe since 2014 challenges the agreed objectives of cooperation in the nuclear sector, established since the early 1990s, specifically those of nuclear safety, nuclear fuel security and nuclear technology collaboration. It appears that narrow Russian political ambition is undermining the economic and political benefits of EU-Russian nuclear energy cooperation for both parties. This paper analyses the evolving but seemingly short-sighted paradigm shift in Russian policy from a traditional realist approach to one based on a discourse of ethno-nationalism that is undermining energy cooperation. What are the implications for the EU? It is argued in this paper the current situation highlights the importance of the EU's member states adopting a concerted approach in their relations with Russia in all energy sectors, irrespective of their national policies with regard to the use of nuclear energy. Secondly it draws attention to the role of the EURATOM Treaty in the EU as a mechanism to support joint action.

Abbreviations

AA Association Agreement

BOO Build, Own, Operate

DCFTA Deep and Comprehensive Free Trade Agreement

EEAS European External Action Service

ENP European Neighbourhood Policy

ESA EURATOM Supply Agency

EU European Union

FSU Former Soviet Union

ITER International thermonuclear experimental reactor

IUEC International Uranium Enrichment Centre

RBMK Reaktor Bolshoy Moshchnosty Kanalny [Russian designed light water graphite reactor of the type at Chernobyl, does not have an exterior containment vessel, only remaining RMBK reactors in operation are in Russia]

SET-Plan European Strategic Technology Platform

UNEQP Ukrainian Nuclear Fuel Qualification Project

USSR Union of Soviet Socialist Republics

VVER Vodo-Vodynoi Energetichesky Reator [Russian designed light water pressurised reactor]

WNA World Nuclear Association

Introduction

The concern of both parties, the European Union [EU] and the Russian Federation [Russia] discussed in this paper is that of energy security. In the case of the European Union it is security of access to supply that is the concern. For Russia the issue is secure access to a stable market ensuring demand for energy. Much academic analysis of EU-Russian energy cooperation focuses on the natural gas and oil energy sectors but in this paper attention is directed to the status of cooperation between the two parties in the field of nuclear energy. The EU is highly dependent on Russia for about one-third of its nuclear fuel supply [comprising supplies of natural uranium, supply and enrichment of nuclear fuels for use in Russian designed reactors operating in the EU's member states and agreements for fuel supplies for planned new Russian designed reactors within the EU]. The same features of division and disagreement amongst the national governments of the EU about the most appropriate external energy supply policy to adopt towards Russia in the areas of natural gas and oil characterise the EU's external nuclear energy policy. The same approach by Russia using energy as a powerful weapon to press its national interests and exercise political influence is present in the nuclear energy sector as in the natural gas and oil sectors. The unprecedented change to the geopolitical environment in Europe since 2014 challenges shared objectives of cooperation in the nuclear sector, established since the early 1990s, specifically those of nuclear fuel security, nuclear safety, and nuclear technology collaboration.

The EUs energy policy is based on three underlying objectives – to improve energy security, to complete the single market for energy and to ensure sustainability – but autonomy of choice of energy resources is left to the individual member states. National interests have created divisions in the EU energy sector. It has been difficult to achieve a coherent and holistic energy policy within the EU. The EU's chosen strategy in its energy relations with Russia is founded on the liberal market model based on shared values and norms supported by rules and regulations as identified in the energy 'acquis'. The focus of the EU's strategy has been to attempt to foster good relations with Russia but the attempt by the EU to adopt the hegemonic role in the nuclear sector through the use of the energy 'acquis' as a condition of agreements is not appealing to Russia. The EU's lack of an efficient internal energy policy undermines the effectiveness of its external nuclear energy policy. The result has been to provide an opportunity for Russia to engage in energy agreements with member states individually and leave open the space for a 'divide and rule' approach by Russia. Russia is able to use energy as lever to maintain or gain influence over the group of states that were part of the Soviet Union and are now members of the EU, or exert pressure over those states which are considered by Russia as its 'near abroad' and by the EU its 'near neighbours.

The energy relationship between Russia and the EU is complex and no single model will be able to capture that complexity [Rutland 1999]. It is based on significant interdependency and cooperation is mutually beneficial to both parties. But the interdependency is asymmetrical in that the EU needs energy and Russia needs a market and the result is differing energy policies and approaches to fulfil their respective needs. The analogy being used in the paper is that of a marriage of convenience as interests of both parties are satisfied [borrowing from Johnson 2005]. However the marriage of convenience between two parties has become a marriage of inconvenience as both parties realise that core values underpinning the relationship are not after all shared. There is also a realisation that a divorce is not possible because of the children – or rather in this case one very specific 'child' - ENERGY. But the asymmetry characterising the relationship has become more pronounced as the Russian government makes use of energy as a weapon to maintain influence amongst the EU states and in the

wider European region. The marriage has also now also become a somewhat crowded space as a third partner - Ukraine, wooed by both parties - has become involved. For the EU support for Ukraine includes increased attention to upgrading the strategic partnership on energy with Ukraine because of the importance of its role as a transit state for energy resources. In particular the focus of the partnership is on setting up the appropriate regulatory framework for the electricity market and increasing energy efficiency as a means of reducing Ukraine's dependency on imports from Russia.

Rutland's Russian bear model is used to view energy as a weapon being used by Russia in order to restore its position as a power in the region that is considered to be Russia's 'near abroad'. [Rutland 1999]. The current situation suggests that a model of a 'resurgent Russian bear' is appropriate as Russia seeks to exploit its energy resources and ensure that former Soviet Union [FSU] states gains in independence and national sovereignty are undermined. It has become difficult for Russia in the post Cold War world to define a global role in the light of growth of power in China and the continued dominance of the US. For President Vladimir Russian sovereignty and power is built on economic independence, military strength and cultural identity. This is an ideational stance that Krastev considers Putin has been able to turn into an instrument to invigorate his personal power and legitimacy. He argues that Putin as leader and director of policy has overseen the evolution of a nationalist ideology, based on ethnic grounds and social conservatism and a number of beliefs including the brotherhood of the Slavic race, homophobia, the concept of Holy Russia, intending to recreate the Soviet empire. [Krastev in Alcaro et al. 2015]. This marks a departure from the notion of 'empire' in the Russian political discourse as seen in the early 1990s when it was generally applied to Russia of the past. The notion of a Russian 'empire' in the political discourse in Russia in the twenty-first century is being used in the sense of the capability of Russia to gain international influence and affect the politics of states that are formally independent sovereign states. [Malinova in Guelke 2010].

The 'bear' seems to have learnt new tricks and is using a discourse of ethno-nationalism [defined as protection provided for all Russians speakers no matter where they live and, in the case of Ukraine, irrespective of whether they have been subject to discrimination or not] to justify its increasingly aggressive stance in the wider European region. By so doing President Putin has provided a powerful narrative to gain domestic support, presenting himself as the defender of Russia's identity as a conservative minded, proud, sovereign nation, ready to with-stand pressure from the West. [Alcaro R in Alcaro et al. 2015]. Putin has established the EU as an aggressor and a threat to Russian interests and not as a partner in cooperation that will be of mutual benefit.

Bond highlighted the lack of appreciation in the EU of the focus that has emerged in Russian foreign policy. He concluded that the West had assumed that the Russian focus in the post Cold War world would be on making money not war, but instead the focus of Russian foreign policy has been on asserting the rule of force over the rule of law, national wealth has been spent on enriching a narrow and unaccountable elite and rebuilding Russian military might. [Bond et. al. 2015]. Short-sighted views have been adopted leading to a lack of understanding of motives for action by both parties and the progress of cooperation that has been established between the EU and Russia has been undermined. In the energy sector it will be difficult to re-invigorate it until "…conditions are right [when] the EU will consider re-framing the energy relationship with Russia, based on a level playing field in terms of market opening, fair competition, environmental protection and safety for the mutual benefit of both sides." [COM (2015) 80 final:7].

The concept of 'security' in the EU-Russian energy discourse

Throughout the history of the EU security of supply and access to supply of energy has been an important element of the political discourse and a key objective of European Union energy policy. The ideal situation for the EU would be for all energy resources to be indigenous and large-scale so that the EU's member states are able to respond to current demands and have confidence in their independence from other countries for future energy needs. However the member states are heavily dependent on imported sources of energy, a situation not likely to alter significantly in the future. Security of access to supply depends on the "…resilience of the energy system to unique and unforeseeable events that threaten the physical integrity of energy flows or that lead to discontinuous energy price rises, independent of economic fundamentals…" [NEA/OECD 2010:3]. Vulnerability to risk of interruption of fuel supply to meet energy demand has implications for energy policy developments within the EU and exposes the EU to geopolitical changes in the wider European region wrought by Russian increasingly aggressive policy and lack of EU unity.

Events have moved rapidly in recent years to re-set the relationship between the EU and Russia in the energy sector. Trenin in Baev et. al [2008] asked - Should one worry about Russia as an energy superpower? The short answer he gave was No – as Russia's energy policy is more about seeking profits than establishing political domination, in a similar strategy to the model Rutland [1999] described as 'Kuwaitisation' or the approach of an oil exporter developing hydrocarbon industries and using the revenues to diversify into new economic activities. More recently Barysch [2011] described the relationship between the EU and Russia "…as warmer than in years…". She concluded that determining the appropriate EU policy to adopt towards Russia was no longer a significant obstacle to developing EU policy as there were no big contentious issues on the EU-Russia agenda and no need for the EU national governments to take sides. [Barysch 2011:2]. However since late 2013 the relationship between the EU and Russia has moved from that of strategic partnership to that of strategic rivalry as Russia has become less a partner in cooperation and more the focus of EU foreign policy strategy. [Kuzemko 2014:67].

The problem of dependency

"In the past two decades, indigenous energy production in the EU has steadily declined…" [COM (2014a) 330 final: 12. More than 50% of EU 28 gross inland energy consumption comes from imported sources. Import dependency for crude oil is almost 90%, natural gas 66%, solid fuels 42% and nuclear fuel 40%. Estimates suggest that this could rise to as much as 80% in the case of oil and gas by 2035 [ibid]. There are significant differences in the levels of dependency amongst the EU's Member States. Some states are more vulnerable to disruptions in energy supply than others because of their lack of alternatives and national energy choice. Only Denmark is a net exporter of energy. Malta, Cyprus and Luxemburg are entirely dependent on primary energy imports. There is a significant dependency amongst the EU states on imported supplies of energy from the Russia. Russia provides 39% of EU natural gas imports meeting 27% of total EU gas consumption. Eight EU states are 100% dependent on supplies of Russian gas, totalling between 10 and 36% of total energy consumption in those states [see Table 1 EU countries most dependent on Russian gas supplies]. In addition one-third of EU imports of oil and oil products are from Russia [ibid: 20]. Three member states [Latvia, Lithuania and Estonia] are dependent on one external operator for the operation and balancing of their electricity networks.

Table 1 EU countries most dependent on Russian gas

EU countries 100 % dependent on import of Russian natural gas	Gas as % of total energy consumption
Bulgaria	14
Czech Republic	18
Estonia	10
Finland	10
Latvia	30
Lithuania	36
Hungary (98%)	35
Slovakia	28

Source Bond I et al 2015:15

"It is however possible to slow down this trend in the medium term by further increasing the use of renewable energy, **nuclear energy**, as well as sustainable production of competitive fossil fuels where these options are chosen." [ibid: 12], with author's emphasis]. But this raises the issue of vulnerability of the EU states in the field of nuclear fuels. Of the eight states that are 100% dependent on Russia for natural gas supply four are also 100% dependent on Russia for nuclear fuel supply' increasing their energy vulnerability to Russian influence significantly. Nuclear electricity provides up to 52% of electricity in these states. The vulnerability of the 4 states varies, with Hungary [51%] and Slovakia [49%] being at most risk from dependency on Russia for its energy supplies. Finland is 48% reliant on Russia for nuclear fuel and 28% for electricity. The five states have a collective population of 80 million people.

Table 2 EU states with a high level of gas and nuclear dependency on Russia

EU countries 100% dependent on Russian nuclear fuel	Nuclear as % of total consumption	Total % gas and nuclear dependency
Bulgaria	11	25
Czech Republic	16	34
Hungary	16	51
Slovakia	21	49
Finland [48% dependency]		

Nuclear energy is perceived to have a number of advantages that lower the risk of interruption in supply not possessed by fossil fuels. For the supporters of the use of nuclear energy fuels "… nuclear fuel security of supply…provides a unique service…essential for the EU at large, for geopolitical reasons of autonomy, but also to the utilities for their direct business success and for the adequate electricity supply to society". [ESA 2005:4]. As 90% of its inputs in terms of value may be sourced domestically nuclear energy is perceived as a largely indigenous source of energy. Only small amounts of the basic raw material – natural uranium - are needed in contrast to the large amounts of fossil fuels needed for electricity generation. The market for uranium is less sensitive to price variations than other fuels needed for electricity generation. Sufficient uranium resources exist to support the continued use of nuclear electricity in the long term [150 years] at current use.

Nuclear energy is a unique energy resource in that a significant proportion of energy demand is met in the modern industry by the use of secondary sources rather than direct mine input. These secondary sources include commercial stockpiles of natural and enriched uranium [although commercial considerations of the companies involved may limit the information

available], nuclear weapons stockpiles and blending down of plutonium and uranium from processing of used fuel and re-enrichment of depleted uranium tails. Once on stream a nuclear reactor is able to produce constant and reliable volume base load electricity and is thus capable of ensuring security of access to supply of electricity. Nuclear electricity is based on fuel supply inventories of materials in process within the procurement chain amounting to several months of requirements. These advantages provide greater autonomy for nuclear electricity than that generated by conventional combustion means such as natural gas or coal. The security of supply situation in OECD countries has **"…unequivocally improved** [author's emphasis] since the early 1970s…" [NEA/OECD 2010:10]

However whilst security of nuclear fuel supply is significantly better than that of fossil fuels used for electricity generation it has become weaker in the light of changed market conditions and increased levels of demand for the fuel globally. The market is more open for both producers of and suppliers of resources and electricity. The number of suppliers of nuclear materials has increased but the source of natural uranium remains limited to a small number of states. Liberalization in the market has led to a decrease in the levels of stocks held by nuclear utilities in response to requirements to cut operational costs at the utilities. This is coupled with the lack of requirement for utilities to hold stocks of resources in the same way as requirements are expected for holdings of oil or natural gas. Demand for nuclear materials is increasing globally. China for example is committed to a nuclear build programme including 39 new reactors. There are as a result a number of challenges with potential to undermine the EU's resilience to interruption of nuclear fuel availability: -

1. Interruption in the supply of natural uranium.
2. Uncertainty about secondary sources e.g. the suspension of production or shortages in conversion, enrichment or fabrication facilities.
3. Transportation problems of various types but especially lack of seaports open to nuclear transports.
4. Permanent closure of a uranium mine or nuclear fuel conversion facility.

These challenges highlight the issue of EU dependency on imported fuel supplies or external collaborations to support the nuclear sector and the need to ensure measures to meet potential vulnerabilities. Furthermore the changed geopolitical situation has given a renewed prominence to the necessity for concerted EU action in all areas of energy policy towards Russia and neighbouring states, particularly the important energy transit state of Ukraine. Within the EU as the process of integration in the energy system has intensified policy decisions taken at national level on the level of fuel supply, infrastructure development, energy transformation or consumption have been shown to have significant potential for spill-over and impact on other states strengthening the arguments for collaborative action. The consequence of the high level of integration in the energy sector has been to strengthen the arguments for EU common policy on energy with common aims and objectives that apply to all energy resources including nuclear electricity. Increased integration, accompanied by further diversification of the European energy system is an essential component of the EU's energy policy on security of access to supply. "Nuclear energy can play an important role across all of the dimensions of the Energy Union…any solution to our wider energy challenges has to factor in nuclear if we want to be realistic… [and] electricity from nuclear power plants…plays an important role in energy security…" [Canete (2015)].

The EU has an instrument to support the objective of security of energy supply – the Treaty from 1957 that established the European Atomic Energy Community [EURATOM] and the

competences that continue conferred for joint action. In the light of the actions of the Russian government to use all energy fuel resources as weapons to exert influence over states an important step forward would be for the European Union to take joint action using the full range of the Treaty competences, including the competences that have been established for the EURATOM Supply Agency [ESA]. Its role has been deemed in the past to be essential to ensure a regular supply of uranium and nuclear fuels through careful monitoring and approval of supply contracts. [European Nuclear Society 2006]. The ESA's role focuses on the ratification of contracts being made by companies or government-to-government contracts including those made with Russia. In 2015 during the negotiations between the Hungarian government and ROSATOM for the new reactor developments at the Paks nuclear power plant confirmation of the contracts was invoked. Concerns existed that these contracts were not fully open to competition and provided an opportunity for Russia to exert pressure and influence through the linkage of nuclear fuel access with other energy resources upon which the EU is heavily dependent. Furthermore as "…Russia is a key competitor in nuclear fuel production and offers integrated packages for investments in the whole nuclear chain…the possibility of fuel supply diversification needs to be a condition for any new investment to be ensured by the ESA." [COM (2014a) 330 final:16]. The ESA ratified the contracts for the Paks developments on the basis that the Russian fuel supply would be maintained for 10 years and not the original proposal of 15.

An important step forward that the EU could take to ensure security of nuclear fuel supply would be to enhance the role of the ESA, specifically in monitoring of markets, reiterating the recommendation that all EU states using and operating nuclear power stations maintain stocks of nuclear materials and diversify their sources to prevent excessive dependency on a single third country source. There is the opportunity for the EU to introduce a security of supply mandate to ensure that power companies of the most vulnerable countries to Russian pressure take action to diversify their fuel supplies in a similar way to France which was obliged to open its nuclear fuel market in 2000.

EU-Russia Energy Relations – the terms of the 'marriage.

Energy cooperation and collaboration between the EU states and Russia has existed for some time - energy was exported from the former Soviet Union [FSU] to Austria from 1968 and Germany from 1973. Following the ending of the Cold War and the emergence of the Russian Federation as the largest of the states of the FSU in the early 1990s new policy priorities were established for co-operation between the two parties. These were built on a significant element of mutual energy interdependency based on the interests of one party, the EU, with a high demand for energy and the other, Russia, with supplies. EU agreements with Russia may be concluded on the basis of the Treaty on the European Union that gave the legal basis for a Partnership and Cooperation Agreement. In the field of nuclear energy the EURATOM Treaty has provided the opportunity for the EU states to act as a single entity concluding agreements with Russia on nuclear safety, accountability of nuclear materials to ensure they are not diverted to military usage, the trafficking of nuclear materials and technology transfer. Whilst the EU's member states may also conclude bilateral agreements with Russia in the fields of nuclear safety, a collective and coherent approach from all the EU's member states is of vital importance to ensure that concerns about the trans border implications of new nuclear developments in Russia, expressed not only by states using nuclear energy but also those opposed to its use, are met.

Whilst broad principles of security of access, sustainable energy objectives and the development of a competitive energy market appear the same for both parties in their energy policies, for Russia the security of supply issue is not the same as that of the EU. For the EU the risk is that of the high level of dependency on imported energy resources, for Russia the issue is that of ensuring that the resources that play such an important role in the Russian economy are utilised to the best effect. As a result of the changing geopolitical environment in the wider Europe following the ending of the Cold War in 1989, the subsequent disintegration of the former Soviet Union and the emergence of the Russian Federation in 1991, the relationship between the EU and Russia in the energy field has remained complex, fragile and volatile. It is a relationship that has a significant impact on a number of states that border the EU and Russia and in particular Ukraine, an important energy transit state between the two in addition to being an energy producing state.

Nuclear energy and technology play an important role in the energy relationship both directly and indirectly. The EU, using the competences of the EURATOM Treaty to conclude international nuclear research agreements is cooperating with Russia in various aspects of nuclear research. Nuclear fission is one of the energy technologies included in the European Strategic Energy Technology Plan [SET-Plan] to accelerate the development and deployment of technology that can help to achieve a low carbon economy and mitigate climate change. An important aspect of the collaboration between Russia and the EU focuses on increased safety, particularly following the catastrophe at the Dai-ichi nuclear power plant, Fukushima, Japan in 2011. Russia and the EU have established technology development and research exchange in the development of small modular reactors and fusion technology. In nuclear fusion research Russia is a party with the EU of the International Experimental Reactor [ITER or 'the way'] development in Cadrache, France which is a major multi-national project. Other parties to the ITER initiative include China, India, Japan, South Korea and the USA.

The EU is 95% dependent on imported uranium supplies and 40% dependent on supplies of fissile materials. Much of the natural uranium comes from politically stable areas such as Canada and Australia but 18% comes from Russia. Russia produces about 3,000 tonnes per annum. In 2013 ROSATOM took over the Canadian mining company Uranium One, increasing its share of the global market for natural uranium, continuing what appears to be a long term strategy of the company supported by the Russian government "…to add another energy-related means of extending its long-term political influence [not just in Europe] throughout the world…" as nuclear developments do not impose the same geographical constraints and requirement for proximity as exports of other sources of energy. [Thorburn 2015]. Russia is a key supplier and source of fuel of all types for the EU [natural uranium, fabricated fuel rods, 'take-back' of spent fuel from reactors in Eastern European EU member states]. The FSU began exports of enrichment services in 1973 and Russia has continued with this export trade. Russia has 45% of the world's enrichment market and 15% of the world's capacity for spent fuel conversion.

Russia is engaged with international markets in nuclear technology, well beyond its traditional eastern European client states, representing 5% of the global nuclear energy market. [WNA 2015]. Russia has 15% of the world's reactors with plans to build more. [See Table 3] In 2015 ROSATOM, had 29 reactors in various stages of planning or construction, more than the French company AREVA that had not sold a reactor since 2007. An important measure to increase the impact of the export capability of the Russian nuclear industry had been taken in August 2011 when ROSATOM established RUSATOM Overseas Company,

with authorized capital of 1 billion roubles. In mid-2015 RUSATOM became JSC RUSATOM Overseas Inc. It is responsible for implementing non fuel-cycle projects in foreign markets, but also promotes products, services and technologies of the Russian nuclear industry generally to the world markets. In 2015 ROSATOM's foreign portfolio totalled $US101.4 billion, of which $66 billion was reactors and $13.6 billion was attributable to the sales of fabricated fuel assemblies and uranium. ROSATOM's goal is to gain half its revenue from exported goods and services. The company has also claimed an ability to undercut world prices for nuclear fuel and services by 30%. [ibid 2015].

Table 3. Who is building new reactors? Russia is building new reactors - 37% of global total.

India	4%
Rest of the world	6%
France	8%
Russia	37%
China* 39 additional reactors are planned in China, but to June 2015 no technology provider had been identified.	28%
USA	7%
Korea	10%

Thorburn [2015] attributed the success of the Russian company ROSATOM in gaining contracts to build new reactors to four issues: -

1. Favourable financing as a result of significant state subsidies to ROSATOM which is then able to offer preferential pricing to prospective buyers, despite the current economic and financial problems of Russia,
2. The 'build, own and operate' [BOO] approach adopted by the company – i.e. cheap finance is provided by ROSATOM to enable the build to proceed, nuclear fuel, processing of depleted fuel, education for workers and technicians, maintenance and installation of any needed upgrades. This is a model which is particularly attractive to a number of developing world states and is being used for the construction of a new nuclear power plant at Akkuyu, Turkey.
3. Freedom from governmental control for the company in terms of which countries to negotiate agreements with, unlike the French AREVA or the US company, Westinghouse.
4. Deal sweeteners – i.e. the proposed new reactor is part of a broader package of Russian measures in a region. The Russian agreement with Vietnam being one example as Vietnam is also purchasing submarines and other military equipment from Russia.

Within Europe the market for nuclear fuels is not fully opened and many deals in Eastern Europe are opaque. Government to government contracts are bundled together with several different energy costs even including prices for Russian gas. Westinghouse has asked the European Commission to investigate these contracts on the basis of uncompetitive practices but the EU's Competition authorities do not have the required access to Russian facilities. [Oliver 2014].

Parallels to the 'BOO' approach were evident in the contracts agreed between ROSATOM and the Finnish and Hungarian governments in 2013 and 2014 to build new reactors in both countries. These projects proved to be highly controversial at national and EU levels because of the existing dependency of both states on energy resources from Russia and the nature pf the preferential agreements being offered by ROSATOM. The intergovernmental agreement signed between the Hungarian government and ROSATOM to construct two VVEr-1200 units at the Paks nuclear power plant, included two low interest Russian state loans of 10.5 billion euros and 12.6 billion euros to finance the majority of the project. In February 2014 an agreement between the Finnish government and ROSATOM was signed by Kirienko, CEO of ROSATOM, and Vapaavuori, Finnish Minster of Economic Affairs, in Helsinki for the development and operation of a 1,200 megawatt nuclear power reactor on the Hanhikivi peninsula near Pyhajoki in northern Finland. This agreement was based on ROSATOM acquiring a 34% share in Fennovoima, the Finnish 40 company consortium, providing a loan at preferential rates for 2 billion of the estimated 6-7 billion euros cost [agreed by the DUMA the lower house of the Russian parliament in January 2015], and agreement to provide the fuel for start-up and operation of the plant. The financial elements in these agreements were not affected by the imposition of sanctions by the EU and retaliatory action by Russia in 2014 and 2015, nor by the deteriorating condition of the Russian economy. [WNN (2015c)].

From the Russian perspective the agreement with Finland was seen as a validation of the credibility of the Russian nuclear industry and affirmation of the political nature of cooperation in the nuclear sector. The view of ROSATOM, expressed by the CEO Kirienko was that "The fact that ROSATOM has been selected as the vendor of nuclear power technology to Finland we consider a confirmation of success of the Russian-Finnish relations. ROSATOM offers the AES-2006 design, which has references and meets all post-Fukushima safety requirements." [ROSATOM 2014]. Further controversy arose within the EU in summer 2015 following accusations that the Finnish government was placing Russian interests before those of EU foreign policy objectives. The Finnish Parliament had imposed a condition that 60% of the construction should be borne by companies residing or domiciled in the EU or the wider European Free Trade Association [EFTA] formed by the EU states with Norway, Iceland and Switzerland. However the actual control of the Croatian consortium Migrit Solarna Energija, owning 9% of the Fennovoima interest, could not be established with confidence. Its origins lay in Russian ownership and it appeared that Russian ownership was continuing, although it was unclear if this was an increased holding by ROSATOM itself. As a result the planned power station did not appear to meet the Finnish parliament's requirement for EU/EFTA financing. [Crouch 2015]. But what the controversy appears to demonstrate is further evidence of the manipulation by the Russian state of the energy vulnerability of EU states and the willingness to use energy as a weapon to exert political influence by the Russian government led by Putin.

Diversifying nuclear fuel supplies?

Whilst it is possible to obtain uranium and easily store it from a number of suppliers globally the final nuclear fuel assembly process in EU reactors remains managed by a limited number of companies. Uranium must undergo milling, conversion and enrichment procedures before it is fabricated into tailor-made, reactor specific fuel assemblies. For EU reactors which are of western design these processes can be split and diversification of suppliers is possible, however agreements were made with the eastern European states during their accession to the EU and permission granted for the nuclear operators to stay with Russian nuclear fuel and send the waste back to Russia during the lifetime of the reactors. The final fuel assembly

process for Russian designed reactors used in the central and eastern European EU states and Ukraine is managed by one Russian company, TVEL.

In 2010 TVEL won a tender to construct a fuel manufacturing plant in Ukraine, against competition from the US company, Westinghouse. TVEL has a long-term contract to supply fuel to the Ukrainian reactors until the end of their useful life, which could be up to 35 years. Further contracts were secured by TVEL with partners in Finland, Hungary and Slovakia as well as for research reactors in the Czech Republic and the Netherlands. With other contracts secured by TVEL in 2014 the company had a ten-year order book equal to more than 10 billion dollars and was able to claim that it had 17% of the global nuclear fuel supply market. [WNAa 2015]. Because of the contracts between TVEL EU fuel assemblies are 40% dependent on non-EU suppliers [SWD (2014): 330 final: 10]. "There is a clear security of supply issue… (if) you do not have a second supplier. The utilities that are currently entirely dependent on Russia are playing a game of gambling … a second supplier is needed in the case of technical failures in the fuel supply as well as any political sanctions". [Kirst, Westinghouse vice-president for strategy, cited in Oliver (2014): 5]

It is usual for vendors to supply a new reactor's first load of fuel and subsequent fuel reloads. However…"The goal of a resilient Energy Union…is to give EU consumers - households and businesses - secure, sustainable, competitive and affordable energy." [COM (2015) 80 final: preamble]. To help to achieve this goal the aim is therefore to ensure that all nuclear power plants have more than one longer-term fuel supplier – an objective overseen by the ESA. In 2015 Westinghouse and eight European consortium partners announced that funding of 2 million euros was to be provided by the EU from the EURATOM Research and Training Programme [part of Horizon 2020] to focus on licensing alternative nuclear fuel supplies for Russian-designed pressurised water reactors [VVERs] of which there are four VVER-1000 and 14 VVER-440 units operating in the EU states. The contracts for fuel supplies to the current developments and those planned in Hungary and Finland are however already in place.

Russian energy policy to 2050.

The objective of Russian energy policy is to achieve rational fuel and energy balance to optimize the production, domestic consumption and export of fuel and energy resources while considering the requirements for energy security, economic and energy efficiency and strengthening the country's foreign economic positions [Russian Ministry of Energy (2009): 24]. The rationale for this approach is to ensure that Russia is able to repay its foreign debt and also act as a catalyst for domestic expenditure. A major challenge to the effectiveness of this policy is the fact that easily obtainable natural gas and oil sources in Russia are running out. The country still has reserves but increased investment is urgently needed to exploit these resources in the future. The Russian draft energy strategy to 2035, launched in 2014, reiterated the importance of import substitution, diversification of energy export trade and the search for alternative energy resources. From a domestic energy policy perspective it is in the interests of Russia to concentrate the natural gas and oil reserves in foreign trade and to develop indigenous resources of energy including nuclear [currently meeting about 18% of electricity demand] alongside renewable energy for domestic electricity consumption.

The relationship between the Russian Federation and the EU since the ending of the Cold War and the establishment of the Russian Federation in 1991 has been subject to frequent periods of heightened levels of tension in the arena of energy relations [e.g. 2006, 2009,

2014] as a consequence of disputes between Ukraine and Russia over supplies of natural gas and the potential from that of resulting interruption of supplies to the EU. The most recent of these disputes was in June 2015 following the expiration of the Winter Package agreement in March 2015, that was partially extended until June 30th. A trilateral consultation between the EU, Ukraine and Russia was initiated with the EU in the role of mediator to find a compromise position between Russia and Ukraine to ensure security of energy supply for the 2015/2016 winter season.

The events in 2013 and 2014 leading to the annexation of the city of Sevastopol and the Crimean Peninsula to Russia threw the EU-Russia energy relationship into starker relief and heightened concern about the potential vulnerability of the EU's nuclear industry to disruption in supplies of Russian natural uranium and nuclear fuel supplies. Ukraine a former state of the USSR became an independent state in December 1991 but the eastern area of the new state continued to maintain a strong attachment to Russia and included many ethnic Russians amongst the populations of Crimea and eastern Ukraine. It was this situation that Putin was able to manipulate, gaining support for intervention in Ukraine on the basis of 'protecting' the Russian ethnic population. The result was also to increase the fragility of the existing triangular relationship that had evolved between the EU and Ukraine, Ukraine and Russia and the EU and Russia [See Figure 1 EU-Russia-Ukraine relations – a crowded marriage!!!] Overall the outcome has been that "…any idea, as there was in the early 2000s of turning Europe and Russia into a single energy space with common rules in now totally dead. EU-Russia energy relations will be purely transactional, conducted deal by deal by companies or issue by issue by government officials, without any political or policy framework to guide them." [Buchan (2014): 2/3].

Figure 1 EU-Russia-Ukraine relations – a 'crowded marriage'.

The negotiations for a renewed EU-Russia Partnership Agreement, begun in 2008, were suspended in the light of Russia's actions in 2014. The increased strains in the relationship between the two parties are evidenced in the contrast of the political rhetoric in statements from the European External Action Service. A press release following the 31st EU-Russia Summit in June 2013 described the EU and Russia as "…not only neighbours but also strategic partners"… stressing the importance of their relationship, recognised by both parties [EEAS 2013]. By the end of 2014 however the suspension of negotiations on the new PCA was attributed by the EU to Russia's '"…illegal actions to annex Crimea and the continued destabilization of Ukraine – including aggression by Russian armed forces on Ukrainian soil…" [EEAS 2014].

The EU developed the policy of extending influence and support for neighbouring countries in Eastern and Central Europe from the mid-1990s. In the early 2000s the prospect of accession to the EU of a number of these states led the EU to adopt the European Neighbourhood Policy [ENP]. The ENP was launched by the European Commission in March 2003 and followed by the formal adoption of a Strategy Paper in May 2004 [COM (2004) 373 final]. The objective of the Neighbourhood Policy was to achieve a framework for partnership and co-operation amongst states in what was considered to be an 'arc of instability' on its eastern, south-eastern and southern peripheries of the EU. An inevitable consequence of the deepening of the dialogue with the ENP states lying to the east was that the EU had to engage in more structured dialogue with Russia as the states identified by the EU as neighbours in its 'circle of friends' were states of Russia's 'near abroad'.

For Ukraine the launch of the ENP coincided in 2004 with events leading to the pro-democracy movement in Ukraine known as the 'Orange Revolution'. But the agreements framed in the ENP were based on the experience the EU had in the use of 'conditionality' in the 2004/7 accession process. The Country Strategies agreed with the EU for each of the ENP states outlined conditions for access to the benefits of the internal market. The EU was able to exert positive leverage through the 'conditionality approach' including support in various funding programmes and the other benefits but most importantly through access to the internal market. In 2006 the Commission identified a group of nuclear issues of common interest where increased multilateral action would enable the ENP states and the EU to respond to more effectively in the wider regional context. A commitment was also made to enhance the dialogue with ENP partners planning to use nuclear energy in the future. [COM (2006) 726 final: 17] The outcome for Ukraine appeared to offer little support during this period for the pro-democracy movement [Wilson 2014:13] because of the vulnerability of the country's economic and energy sector towards Russian influence.

Steps taken by the Russian government during summer 2014 led to the annexation of Crimea and the city of Sevastopol to Russia and support by the Russia government continued for armed conflict between separatists in eastern Ukraine, who favoured annexation of the region to Russia, and the Ukrainian government supporters. Both the EU and Russia proceeded to introduce retaliatory sanctions against each other during the course of 2014 with a specific target on the energy sector. In June 2014 Petro Poroschenko the President of Ukraine signed the core economic element of the AA to establish the DCFTA. This was followed in September by approval in the Verkhovna Rada [the Supreme Council of Ukraine] of a draft law on the ratification of the AA, which was signed by President Poroschenko on September 16th. However in the light of continued opposition from Russia and in the hope of encouraging a lasting cease-fire to the on-going conflict in the eastern provinces of Ukraine the implementation of the agreement was delayed to the end of 2015. In the interim Ukraine

was able to export goods to the EU without incurring customs duties. As a consequence of the delay of implementation Russia also agreed not to cancel its free trade agreement with Ukraine. Included in the energy chapter of the DCFTA is the prohibition of interruption of transit or the removal from transit of energy goods destined for another party that had been an issue between the EU and Ukraine following measures taken when supplies of energy from Russia to Ukraine were cut.

Throughout the period since the disintegration of the Soviet Union and the emergence of Ukraine as an independent state the Russian authorities have used energy security as a mechanism to maintain influence in Ukraine. Unlike the 1970s when Ukraine was the energy provider for the Soviet Union, by the 1990s inefficiency and falling production had left the new state heavily dependent on Russia. Naftogaz the Ukrainian gas company, created in 1998, was a source of corruption, maintaining artificially low energy prices and opaque finances which eventually had to receive € 6.4 billion to keep the company afloat but much of this went to Russia's Gazprom to pay for Ukraine's energy imports. Gazprom the state controlled Russian gas utility cut gas supplies to Ukraine in 2006 causing reduction in gas supplies to some EU states, similar action followed in 2009. In 2014 gas flows to Ukraine were cut in June as part of a payment dispute between the Ukrainian government and Gazprom, further disputes followed in summer 2015. The EU was able to broker a settlement as the dispute continued into the winter of 2014 and in the light of concerns raised about the impact the dispute might have on gas flows to eastern European states of the EU.

These events and the changed geopolitical environment in Ukraine highlighted the potential risk of dependency on Russia and the necessity for diversification of all energy resources, including those needed for the nuclear sector. Most Ukrainian nuclear fuel comes from Russia. Ukraine also relies on Russia to take back and store nuclear waste with no potential alternative. Russia provides enrichment facilities for Ukraine. Ukrainian uranium concentrate and zirconium alloy are sent to Russia for fuel fabrication by the Russian company TVEL and then returned to the nuclear power plants. Under the terms of an agreement reached in 2010 Ukraine's State Concern Nuclear Fuel sells natural uranium to the International Uranium Enrichment Centre [IUEC] at Angarsk in Siberia. Ukraine's Nuclear Fuel holding company holds a 10% stake in the IUEC. IUEC sells enriched uranium to the Russian TVEL, which fabricates the fuel assembly rods and then sells them back to Energoatom.

Attempts have been made by Ukraine to diversify its nuclear fuel supplies but Russian pressure to continue the high level of dependency on Russian supply was evident. Early in 2010 various proposals were made by Russia for a number of civil nuclear joint ventures. Dmitry Medvedev, then President of Russia suggested there should be full-scale cooperation of the nuclear industries of Russia and Ukraine including the creation of a large holding company that would include power generation, heavy engineering and fuel cycle facilities. In addition he proposed that Russia and Ukraine could collaborate on foreign markets on the basis of financing provided by the Russian government and leading financial institutions. Some of the proposed measures were met with approval by then President Yanukovych [February 2010-February 2014].

Ukraine is TVEL's largest foreign client totalling 55% of its exports [WNA 2015]. In June 2010 Energoatom signed a long-term 25-year contract with TVEL for fuel supply to all 15 of Ukraine's reactors including the continued dependency for TVEL fuel for the remaining VVER-440 units 1 and 2 at the Rovno nuclear power plant. In 2010 TVEL sold Ukraine nuclear fuel for €449 million. ROSATOM offered a substantial discount of more than US $1

billion to Ukraine if it signed the contract with TVEL. At the same time ROSATOM offered to transfer up to 50% of shares in Novobirsk Chemical Concentrates Plant in Siberia to Ukrainian partners and establish domestic fuel production either as a shareholding company or a new plant on Ukrainian territory.

Energoatom had initiated the Ukraine Nuclear Fuel Qualification Project [UNFQP] for VVER-1000 fuel on the basis of US manufactured fuel being used in reactor units in 2005, supplied by US-based company Westinghouse, majority owned by Japan's Toshiba. A test of 6 fuel assemblies was undertaken in 2005 at unit 3, South Ukraine nuclear power plant. This was followed by an agreement in 2008 to provide a batch of 42 fuel assemblies in mid-2009. Further tests at South Ukraine units 2 and 3 and Zaporozhe 5 in the period to 2011 were considered to be unsuccessful by Energoatom because of manufacturing defects leading to outages at two of the reactor units supplied. However at the time Westinghouse said that the outages were the result of errors in the loading of the assemblies. Differences emerged during 2014 following the annexation of Crimea. The new Ukrainian government extended the existing 2008 contract with Westinghouse for fuel supply to 2020. This fuel was to be fabricated at the Westinghouse Electric Sweden AB Plant located at Vasteras, Sweden. It was a demonstrable commitment to the requirement, announced by the Commission in May 2014, that investment for any non-EU reactor design to be built in EU member states must have more than one source of fuel supply. Although Ukraine is not an applicant state for EU membership the focus on diversification of nuclear fuel supply is in accord with the objective of moving away from Russian dominance and the ambition of the state for increased integration with the EU.

Decisions by Energoatom in autumn 2014 to diversify from its heavy reliance on the Russian nuclear sector were met with condemnation by Russia. In October, Ukrainian Prime Minister Areseniy Yatsenyuk told Energoatom management to speed up construction of new nuclear reactors and to enlist the help of "European partners" rather than Russia. This was followed by an agreement between Energoatom and Czech engineering company Škoda JS to sign a memorandum of cooperation that included cooperation in the construction, operation and maintenance of nuclear power plants. Energoatom also opened an office in Brussels in order to work closely with the European Commission and other European institutions. The main purpose of establishing an office in Brussels was to collaborate on the adaptation of Ukrainian regulations to European standards and closer cooperation with European institutions, including the EBRD and EURATOM to expand Energoatom's range of partners for joint projects in Ukraine and Europe. [WNN 2014a].

In December 2014 Energoatom indicated its intention to diversify the export and processing of used fuel, of both TVEL and Westinghouse types by Areva, the French company at its facilities in France instead of sending the material to Russia. At the same time Prime Minister Yatsenyuk announced plans to complete construction of units 3 and 4 at the Khmelnitski plant by 2018 with increased use of nuclear fuel assemblies from Westinghouse. [WNN 2014b]. Following the agreement between Westinghouse and Energoatom to 'significantly' increase nuclear fuel deliveries to Ukraine' nuclear power plants to 2020 the Russian foreign ministry responded in a statement that it was 'alarmed' by the agreement because Westinghouse was taking advantage of the unstable situation in Ukraine to gain a foothold in the market for Russian design VVER-1000 reactors.

The Russian statement included criticism that Ukraine was ignoring issues of safety and did not have the ability to respond to major incidents such as Chernobyl. Russian reservations

were also expressed about an incident on December 28th 2014 when unit 6 at the Zaporizhzhia plant was disconnected from the grid for 24 hours because of a problem with a turbine reducing the function of the plant to 40% of normal capacity. Subsequently the State Emergency Services of Ukraine and the IAEA indicated that there had in fact been no violation of safety conditions at Zaporizhzhia and indeed no Westinghouse fuel was being used in the reactor unit at the time. The fuel assemblies provided by Westinghouse for South Ukraine's reactor units had been operating without any defect in performance. [WNN 2014c]. Further diversification of Ukrainian fuel supplies was agreed between Areva and Energoatom in 2015. But paradoxically at the same time the EU has given the most vulnerable central and eastern European EU member states permission to stay with Russian nuclear fuel and continue to send the waste back to Russia during the lifetime of their Russian design reactors. This was contingent on the understanding that no western company could manufacture the fuel, but as seen above this was a point disputed by Westinghouse. [Oliver 2014].

Conclusions

The use of electricity in a low carbon economy in Europe will rise in order to meet the needs of the consumer, both industrial and domestic for low carbon energy. Much can be achieved to provide a secure supply of electricity through increased use of a range of materials for power generation, increased efficiency of the generating technologies and appliances, and more effective integration of the transmission grids and transfer between Member States of the EU. Europe's growing interconnectedness and the growing trade in electricity between the member states has already proved the security benefits that come from growing diversity. At different times short term surpluses of one form of electricity in one member state [e.g. nuclear power in France or wind and solar in Denmark or Germany] have been used to counter deficits in other member states. However a number of potential risks and vulnerabilities remain which highlight the importance of the European Union continuing to adopt a concerted response to their challenges irrespective of the national policy towards the use of nuclear technology.

In defining security of access to energy supply the NEA pointed to the importance of resilience in the energy system to unique and unforeseeable events that threaten the physical integrity of energy flows or that lead to discontinuous energy prices, independent of economic fundamentals. [NEA/OECD (2010): 9]. This brings both an external and an internal dimension to security of energy supply and in both nuclear energy has the potential to play a constructive role. [Canete (2015)]. The external dimension is mainly defined by concerns about the EU's import dependence for supplies from potentially unstable countries. The internal dimension focuses on creating appropriate mechanisms and frameworks to ensure continuous access to energy services at stable prices. In this paper the importance of the role of diversifying energy resources so that all energy resources are included in the national energy mix is supported as an important element of all national and EU energy policy.

The focus of the argument has been placed on the potential vulnerabilities of security of supply in the nuclear sector per se from the changing geopolitical environment in Europe. What is evident is the vulnerability of some member states of the EU as a result of their import dependency on Russia, increasingly seen as an unstable partner in energy relations with the EU. In the fields of natural gas and oil the EU is heavily dependent on Russian supplies, in the field of nuclear energy the EU is 40% dependent on imported sources of natural uranium and major secondary fuel resources. As in the case of oil and natural gas, the position of Ukraine and the relations of the EU with Russia as a consequence of the

annexation of Crimea from Ukraine to Russia in 2014 have a significant role and provide potential challenges to security of nuclear energy supply. The fragile triangular relationship which has evolved between the three parties remains complex and subject to strain as the EU and Ukraine search for ways to diversify their energy reliance away from Russia, but at the same time preserve the supplies needed to meet the demands of the populations of all states. The problem in short to medium term has been exacerbated as the result of the situation that developed in 2014 between Russia and the EU with regard to events in Ukraine and imposition of EU sanctions particularly targeting energy companies [although the companies involved in the nuclear sector are seeing this as an indirect rather than direct impact].

A number of challenges remain to a policy of diversification of nuclear fuel supplies away from reliance on a single supplier that illustrate the difficulties for the EU to achieve a coherent external nuclear energy policy. Uranium must undergo several processing steps – milling, conversion and enrichment before being fabricated into tailor-made, reactor type fuel assemblies. It may be purchased from multiple suppliers and easily stored but the final fuel assembly process is managed by a limited number of companies. For western designed reactors this process can be split and diversification of providers achieved. For Russian designed reactor the process is bundled and managed by one Russian company – TVEL currently with insufficient competition, diversification of supplier or back up. Russian reactors are found in Finland, Bulgaria, the Czech Republic, Hungary, Slovakia and as a result these EU states are potentially subject to the same pressures from Russian use of energy as a weapon to maintain influence in these states as seen in the natural gas and oil sectors. Concerns by the national governments about their national interests may undermine the development of a concerted EU approach to the issue of nuclear fuel supply.

For Ukraine the pressure being exerted because of dependency on nuclear fuel supply continues, although the Ukrainian government has adopted a diversification strategy and has under utilised domestic uranium reserves. Ukraine is vulnerable to Russian action for a number of reasons – reserves of natural uranium could provide all domestic demand for one hundred years, but natural uranium mined in Ukraine currently only meets 30% of domestic demand, the rest comes from Russia. Ukraine continues to be Russia's biggest external market for nuclear technology. Russia continues to exert influence over Ukraine as a transit state and user of Russian supplied natural gas. Ukraine is vulnerable to the potential of from Russian 'bundled' agreements that would include all fuel supplies [gas, oil and nuclear]. The direct influence of Russia in Ukraine is seen in the Russian backed separatist movement and conflict in the Eastern part of the country.

It is in the interests of all parties – the EU, Russia and Ukraine not only to cooperate and collaborate on nuclear issues to ensure supply of fuel, but also to strengthen the cooperation on research and technology developments in nuclear fusion and small modular reactor developments and to maintain cooperation and collaboration on nuclear safety. The role of nuclear energy in the EU's energy mix is unlikely to significantly increase overall in the foreseeable future as its use is highly controversial in some member states but it will continue to provide an important element of the supply of electricity for some time. Some EU states plan to build new reactors based on Russian technology; others such as the UK are using French and Chinese technology. Globally the market for nuclear energy is likely to significantly increase particularly in China and India, of that global market Russia is building 37% of the new reactors globally. Cooperation between the EU and Russia in the field of nuclear energy has become highly politicized and as a result the potential economic benefits from collaborative new nuclear technology developments have been undermined. In general,

there are significant opportunities for further improvements in terms of the integration of the research work, communication between research teams, reciprocity and the balance of efforts in order to maximize the overall impact of EU-Russia energy research cooperation. The scope of proposed cooperation platforms should include the development of common approaches to research and support of innovation activities. On the issue of nuclear safety both EU and Russia engaged in review of safety in the nuclear power plants following the catastrophic events in Japan in 2011. Ensuring safety of nuclear power plants is of concern to the public in the EU where Russian technology reactors are being constructed. Ukraine has adopted the standards and approch to safety used in the EU. The Russian public are concerned about the safety of reactors in operation in Ukraine [the legacy of the Ukrainian Chernobyl reactor].

The assymetrical nature of the relationship between the EU and Russia in the energy field has been exacerbated by the increasingly aggressive stance of Russian use of energy as a weapon to maintain influence in the wider European area. Tension is evident between the EU and Russia but the rationale remains for EU-Russia energy cooperation in nuclear energy policy. Cooperation will improve security of access to energy supply [the EU] and access to secure and stable markets [Russia], increase the opportunity for interconnnectivity in the electricity market, allay concerns about safety of nuclear technology in the light of new build reactors of Russian design in regions bordering the EU states and facilitate the transfer of nuclear technology in agreeents between the EU and Russia. Both parties have been short sighted in their evaluation of the motivation of the other in the relationship. Both parties still need one another, but the actions by Russia in Ukraine and the imposition of sanctions by the EU have undermined the opportunities to benefit from cooperation in the field of nuclear energy.

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Annex

Number of reactors in Europe [to June 2015]

	In operation (1)		**Under construction (2)**		**Planned (3)**		**Proposed**
		Net capacity MWe		**Net capacity MWe**		**Net capacity MWe**	**Net capacity MWe**
Belgium	7 (47.5%)	5,943	0	0	0	0	0
Bulgaria	2 (31.8)	1,906	0	0	1	950	0
Czech Rep	6(35.8%)	3,904	0	0	2	2,400	1 (1,200)
Finland	4 (34.6%)	2,741	1	1,700	1	1,200	1 (1,500)
France	58 76.9%)	63,130	1	1,750	0	0	1 (1,750)
Germany	8 (15.8%)	10,728	0	0	0	0	0
Hungary	4 (53.6%)	1,889	0	0	2	2,400	0
Lithuania (4)	0	0	0	0	1	1,350	0
Netherlands	1 (4.0%)	485	0	0	0	0	1 (1,000)
Poland	0	0	0	0	6	6,000	0
Romania	2 (18.5%)	1,310	0	0	2	1,440	1 (655)
Slovakia	4 (56.8%)	1,816	2	942	0	0	1 (1,200)
Slovenia (5)	1 (37.2%)	696	0	0	0	0	1 (1,000)
Spain	7 (20.3%)	7,002	0	0	0	0	0
Sweden	10 41.5%)	9,487	0	0	0	0	0
Croatia (5)							
EU European Neighbours							
Belarus	0	0	2	2,388	0	0	2 (2,400)

Russia	34 18.6%)	25,264	9	7,968	31	312,264	18(16,000)
Switzerland	5 (37.9%)	3,333	0	0	0	0	3 (4,000)
Turkey	0	0	0	0	4	4,800	4 (4,500)
Ukraine	15(49.4%)	13,107	0	0	2	1,900	11(12,000)

Notes to Table ?: 1

(1)% national share of electricity generated from operating reactors to end of 2014.
131 reactors in operation in EU member states, 185 in wider Europe, including Asiatic Russia,
438 operating globally, producing +10% of global electricity in 2012.
(2) 67 reactors under construction globally in 15 countries
(3) 150 planned globally
(4) Lithuania, - planned new nuclear power plant with Latvia, Estonia and Poland
(5) Croatia, - no nuclear power plant of its own but Croatian national electricity company has co-ownership of plant at Krsko in Slovenia

Source: various European Commission, IAEA, European Nuclear Society .