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Article

Finland's Dependence on Russian Energy—Mutually Beneficial Trade Relations or an Energy Security Threat?

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Abstract: Studies on energy security in the context of relations between European Union (EU) and Russia tend to focus on cases, with an open conflict related to supply, such as "hard" energy weapons, or on only one fuel, often natural gas. However, there is a need to understand the long-term impacts that energy relations have politically, economically and physically, and their linkages between resilience, sustainability and security. We analyse the Finnish-Russian energy relations as a case study, as they are characterised by a non-conflictual relationship. To assess this complex relationship, we apply the interdependence framework to analyse both the energy systems and energy strategies of Finland and Russia, and the energy security issues related to the notable import dependence on one supplier. Moreover, we analyse the plausible development of the energy trade between the countries in three different energy policy scenarios until 2040. The findings of the article shed light on how the trends in energy markets, climate change mitigation and broader societal and political trends could influence Russia's energy trade relations with countries, such as Finland. Our analysis shows that Finland's dependence on primary energy imports does not pose an acute energy security threat in terms of sheer supply, and the dependence is unlikely to worsen in the future. However, due to the difficulty in anticipating societal, political, and economic trends, there are possible developments that could affect Finland.

Keywords: energy security; energy trade; import dependence; energy policy; Russia; Finland

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1. Introduction

The crises associated with the supply of natural gas in 2006 and 2009 stimulated the European Union (EU) to develop a European energy security strategy in 2014 [1]. One of the key concerns of the strategy is that member states have not placed similar emphasis on security of supply compared to other energy policy areas. To enhance energy security, the EU has made reducing dependence on imported fuels and dominant suppliers its key targets, thus advancing the EU-level energy market and infrastructure integration and coordination among member states. Increasing the share of renewable energy sources and implementation of energy efficiency measures are also key targets that link energy security with climate policy [2,3]. Regardless of the EU targets, national policies and responses tend to vary not only because of differing energy infrastructures, but also due to differing perceptions of threats and risks.

Finland is an interesting example of the EU-Russia energy trade in several ways. Firstly, Finland ranks among the most energy-intensive countries in the world [4] due to its cold climate and energy-intensive industry. Secondly, Finland has practically non-existent domestic fossil fuel and uranium resources. Consequently, Finland imports almost two thirds of its primary energy [5], the vast majority of which comes from Finland's neighbour in the east, Russia. This has sparked debate in Finland concerning whether the low self-sufficiency in energy and the high dependence on one supplier are in fact threats to energy security or merely a sign of mutually beneficial trade relations. Compared with, for example, the East European states, and issues related to outdated energy infrastructure or a lack of connections to global energy markets, securitisation of energy has remained limited in Finland, as has consideration of energy as a foreign policy tool. For instance, the Nord Stream I and II natural gas pipelines (that are not linked to Finland's gas supply) have only been a subject of environmental regulation. At the same time, the pipeline has become a political issue in many other EU countries [3].

In contrast to Finland, Russia is often portrayed as an energy superpower with abundant fossil fuel and uranium resources. Energy exports comprise a notable share of Russia's gross domestic product (GDP), and hence, the Russian economy is strongly affected by the global demand and market prices of energy. Academic interest has broadened due to the Russia-Ukraine gas disputes and increasing politicisation of energy issues [6–9]. Furthermore, as Kustova [8] notes, there is still a tendency to assess energy in the context of Russia's relations with the EU or its member states either as an openly traded market commodity or as a tool for foreign policy influence. One of the ways to provide a more nuanced understanding could be to assess both energy security threat perceptions and physical energy relations in the operational milieu [8,10]. Energy security is a multi-dimensional issue and thus cannot be neatly simplified into an issue of supply or market optimisation. Therefore, assessments of societal, (geo)political and technical development are also equally vital.

Finnish energy policy or, more specifically, energy security has been studied widely. One part of the literature has assessed public debate and political processes related to energy. Valkila and Saari [11] and Ruostetsaari [12] have studied Finnish energy elites and decision-making. In terms of specific energy forms, inter alia Teräväinen et al. [13], Ylönen et al. [14], Vehkalahti [15], Laihonen [16] and Aalto et al. [17] assessed the public debate and political processes concerning nuclear power. Similarly, Huttunen [18] and Kivimaa and Mickwitz [19] have studied the debate on bioenergy. In terms of energy security, Lempinen [20] studied the ways energy security, including threat perception of Russia, have been used as a rhetorical tool in the marketing of peat, while Karhunen et al. [21] provide a survey-based assessment on the governance of security of supply for combined heat and power (CHP) plants. Another significant part of the literature has assessed the Finnish energy system with techno-economic analysis (e.g., Reference [22]). Zakeri et al. [23] and Aslani et al. [24] have assessed the integration of renewable energy into the current Finnish energy system. Saastamoinen and Kuosmanen [25] applied a quality frontier model to measuring the quality of domestic electricity supply security. Pilpola and Lund [26] used a national energy system model to assess policy risks related to nuclear power and biomass. Excluding the studies of Aalto et al. [17] and Ochoa and Gore [27], the analysis of Finnish-Russian energy relations is typically based on historical analysis focusing on oil (e.g., References [25,28]) and nuclear power (e.g., References [29,30]). Compared to previous research, this article concentrates on the current system and on future trends relating to Finnish-Russian energy relations and Finland's resilience against external shocks.

This article uses an interdisciplinary approach to analyse Finland's resilience regarding primary energy import dependence and the plausible energy security risks related to the notable dependence on Russian energy trade beyond import-related aspects. First, Section 2 reviews the current literature on energy security, including key approaches, disciplines and Russia's energy policy. Section 3 introduces the applied methods that combine energy policy, energy system and energy technology analyses. Section 4 analyses the dynamics of Finnish-Russian energy trade currently, and Section 5 analyses the future of Finnish-Russian energy trade through three different scenarios. Section 6 discusses the findings and finally, Section 7 draws conclusions.

2. Literature Review

In the literature, energy security remains a slippery or polysemic concept that varies contextually, culturally, politically, temporally, spatially and in terms of energy source [31,32]. The concept has traditionally been linked to securing supply and demand of oil and gas, but climate policy goals and increased use of renewables have resulted in electricity playing a growing role in the framing of energy security concerns [33,34]. Energy security can be loosely considered as secure supply for countries lacking primary energy resources, while for countries with an abundance of energy, it is commonly framed through the (external) demand side dynamics [35,36]. However, a general disciplinary consensus on what energy security is or how it should be assessed is still missing.

One of the reasons for the lack of agreement could also be the disciplinary divide. Cherp and Jewell [37] categorise energy security research into three perspectives: 'Sovereignty', which has commonly been studied by social science approaches, such as security studies and international relations; 'robustness', with the key research coming from natural sciences and engineering; and 'resilience' analyses of economics and the complex systems approach. The sovereignty perspective focuses more on external issues and geopolitics, such as the policies and actions of exporting countries or their respective companies, and the stress is placed more on threat perceptions rather than on physical supply. The robustness perspective assesses energy security through quantifiable factors, such as demand, scarcity or infrastructural capacity. The resilience perspective assesses more generic characteristics of energy systems by combining political, technical, and economic elements and qualitative and quantitative assessments that enable more nuanced anticipation of known and unknown risks [38]. With its focus on risks, this perspective brings the concept closer to the broader debate on sustainability [39].

Considering also that energy mixes and societal and political dynamics vary significantly across countries and regions, the meaning of energy security could be deepened with an assessment of country interactions [40]. The literature also notes that market-based assessment alone is not sufficient, and energy security is often considered as an element of (national) security in general [38,41]. It is hence tied to societal and (geo)political development, making it difficult to assess through one discipline. As Mayer and Schouten [42] note, energy security is more like a specific assemblage that consists not only of perceptions of (in)security, including political and market trends, but also material flows and physical infrastructures. This comes close to the concept of "vital systems security", linking the level of domestic control over an energy system with the systemic capacity to respond to disruptions [33]. This paper follows the proposal of Cherp and Jewell [38] that defines energy security as "low vulnerability of vital energy systems". That is, energy security is a temporally specific construct based on the power of associated institutional interests tied to specific infrastructures [43].

The gap between physical infrastructure reliability and the perception of energy security [42] can vary significantly not only between energy experts and the general public, but also within the expert audience across countries [44–46]. In other words, experts tend to frame the concept in more narrow terms than the public. Among experts, the argumentation often falls between a liberal, market-orientated world-view and a more nationalist or geopolitical world-view stressing sovereignty that can establish completely opposing outlooks, which are hard to reconcile [47].

One common theme in the literature is that strategies of resilience between consumers and producers are likely to differ—and the latter, especially, may tend to use strategies of resistance [48]. For instance, price-setting [49] by producer countries or individual companies are strategies enabling governance or the spread of influence 'at a distance' [50] or 'co-optation' [51], i.e., seductive or covert use of power. Strategies of energy transition (i.e., aims to achieve a low-carbon energy system by increasing renewable energy production and energy efficiency), as well as the introduction of shale oil, and shale gas, as well as liquefied natural gas (LNG) into the global energy market [52] can bring about a significant shift.

Although the shelves are full of research that has assessed whether Russia would use a so-called energy weapon, i.e., using energy trade for political leverage with direct or indirect issuance of threats, it still remains an issue of dispute in research [31,53,54]. This could be due to the division in international relations scholarship between realist and liberal schools of thought, which also reflects social scientific analyses of energy security and trade [8,55]. The former perceives the world as an anarchic place where states are key actors pursuing security, often with military means. There is also consideration of little cooperation among the actors operating at the international level, while the economy is only one of the spheres of foreign policy influence. The latter stresses that economic interdependence and free trade are sources of political integration and increased security. States and other actors perceive cooperation as a key goal to strengthen wealth instead of political power. Therefore, law and institutions are also of high value. In Europe, energy dependence is often perceived as a symmetric alignment, in which both the EU and Russia are dependent on the continuation of trade relations. This does not necessary apply to the situation with individual countries or companies, which can be subject to occasional or systemic use of the "energy weapon", i.e., differing pricing or contractual terms [56,57].

This has also partially led to an analytical bias, as Russian state-owned or controlled companies make energy contracts not with the EU, but with individual member states and their respective energy companies under national ownership or control [54,57]. In contrast, the argument this paper aims to develop is that energy trade relations in the context of Russia's influence on Western countries are best understood through the analysis of threat perceptions and the ability to substitute current incomes from other energy forms [17,24,26]. Although Russia may not behave as a liberal actor as the EU [58], it may still operate through spheres of trade. That is, instead of issuing direct threats, Russia aims to influence via geoeconomic measures [59]. In contemporary Russia, it is therefore not security of supply, but security of export or demand that is constructed around the principle of sustaining and increasing energy export revenues [60].

In the sphere of broader security and international relations, there is a trend towards weakening relations between Western countries (the EU and US) and Russia via the increased use of sanctions. This may hinder the development of the Russian energy sector, but it is still highly likely that the EU and Russia will retain their status as key trading partners. For example, in the sphere of natural gas contracts last until the 2030s and penalties on both sides sustain a relationship based on interdependence [3]. That is, energy infrastructure and supply chains built over many decades are sustaining the dependence of key Russian trading partners on Russian energy not only through trade but also through infrastructure as an element of geopolitical influence [61]. However, both EU countries and Russia have a growing interest in establishing alternative energy export and import routes. This may force Russia and its energy companies to react strategically to sustain security and resilience, but also to consider applying soft energy weapons, such as price-setting, that could sustain dependence [57]. Finally, Casier [53] argues that increasing threat perceptions of the EU energy security are not so much a result of increased import dependence from Russia, but are due to increased competition and geopoliticisation of EU-Russia relations in general. That is, perceptions are reproduced in the energy sector that may lead to a reductionist and simplified geopolitical frame and physical import dependence should not be directly conflated as political dependence [62].

3. Materials and Methods

This section introduces the applied methods and data used to analyse Finnish-Russian energy trade and its plausible future trends. Section 3.1 introduces the key materials and Section 3.2 provides the methodology applied to analyse the current state of relations. Section 3.2 introduces the approach to the scenario analysis.

3.1. Materials

Our research uses both qualitative and quantitative data in order to demonstrate how 'vital energy system' is defined in Russian and Finnish contexts, and what trends and risks could emerge in different scenarios. In terms of qualitative data, we assess the Russian and Finnish energy strategies, namely Finland's Climate and Energy Strategy up to 2030 and, on the Russian side, Russia's Energy Strategy up to 2030, the Draft project up to 2035 and a Forecast of scientific and technological development by the Ministry of Energy. This is triangulated with a literature review and an assessment of Finnish and Russian newspaper articles discussing key issues related to energy trade between Finland and Russia.

3.2. Interdependence Framework

Here we apply the 'interdependence' framework loosely, but expand it beyond assessment of bilateral energy relations in the sphere of natural gas [10,54] to any given energy type. Interdependence is considered to apply between trading partners when intensive transactions across the border bring certain expenses that prevent one side from fulfilling its aims due to high dependence on what the other side makes. There are two assumptions in this framework. The first one is that cooperation establishes possibilities to benefit from the given relationship. The second is that the actors become dependent on each other, which decreases their ability to act autonomously. The relationship can be symmetric or asymmetric, with the latter being more common. The analytical goal is thus to define whether the relationship is about dependence or interdependence [54]. The model consists of three dimensions, which are physical energy relations, the dominance of the energy agenda in mutual relations, and the influence of the European Union. Physical energy relations are studied by analysing the flow of fuels and electricity between Finland and Russia and the infrastructure that connects the energy systems. In line with the critiques of the framework [62], we would like to stress that the influence of Russia cannot be reduced to simple import dependence, and therefore the second dimension is important. The dominance of energy in mutual relations is analysed with a content analysis of key strategic documents and official statements by looking at the perceptions actors give for energy (in)security. Finally, the influence of the EU is examined through an assessment of the extent to which a given member state has aligned with EU policy, but also how the sanctions have impacted. Compared to the aforementioned studies, our main focus is on the first two dimensions while we also take a closer look at the internal dynamics within Russia and Finland and at the global market trends that are equally important when assessing Russia's ability to exercise power [63].

In our analysis, we combine assessment of threat perceptions with the development of physical energy relations. As the framework suggests, power or the ability to influence through energy trade should not be reduced to physical import dependence. Rather, the focus is on the role of substitutability in fossil fuels and uranium in the context of the changing energy landscape, which includes the emergence of renewables and unconventional fossil fuels, namely LNG and shale gas, but also fourth generation nuclear power.

3.3. Scenario Analysis

Future development of the Finnish-Russian energy trade is analysed through three global energy market scenarios. The first of these is the market trends scenario, which is based on current market trends. That is, it comprises planned and decided climate actions, limiting global warming to 3–3.5 degrees Celsius. The second is the low carbon scenario, an optimistic scenario in terms of climate change mitigation, where global warming is limited to two degrees via substantial reduction of global CO_2 emissions. The third is the high carbon scenario, a scenario where global climate policy has failed, and CO_2 emissions continue at an unsustainable growth rate. In this scenario, the global consumption of energy together with Russian exports of fossil fuels, uranium and energy technology are on the rise. The scenarios are based on inter alia energy strategies of Finland and Russia, the International Energy Agency (IEA) and Intergovernmental Panel on Climate Change (IPCC) scenarios, and previous studies by the authors. The scenarios are developed until 2040 and presented in more detail in Section 5.

The way in which we use the scenarios comes close to the thought experiment approach [34], i.e., our main interest is not the likelihood of a given scenario, but to provoke the imagination of a reader [64]. Predicting global energy market trends in the future is challenging—not only because of the uncertainties related to technological development and demand for energy, but also due to political trends and global ambitions related to climate change mitigation.

4. Finnish-Russian Energy Trade

Finland has a long history of energy trade with Russia. The trade is practically one-directional, as Finland lacks domestic fossil fuel reserves in comparison with its substantial demand for energy, whereas Russia has significant export volumes. In order to map plausible vulnerabilities related to Finland's dependence on Russian energy, this section analyses the relations of Finland and Russia with regard to energy trade. Furthermore, this section aims to develop a synopsis of the most relevant energy security-related data and political and security aspects of Finnish-Russian energy trade. Sections 4.1 and 4.2 introduce the Finnish and Russian energy systems, respectively. Section 4.3 takes a deeper look into the dynamics of the Finnish-Russian energy trade. With regard to the interdependence framework, Sections 4.1, 4.2.1, 4.3.1 and 4.3.2 deal with the first dimension, i.e., the physical relations, while Sections 4.2.2 and 4.2.3 unpack the political debate and the influence of EU via sanctions.

4.1. Energy in Finland

Section 4.1.1 reviews the demand for energy in Finland and Section 4.1.2 deals with the supply side. Unless otherwise mentioned, Finnish energy policy targets and future development of the Finnish energy system are based on the Policy scenario of the new National Energy and Climate Strategy of Finland from late 2016 [65].

4.1.1. Demand

Finland has substantial energy consumption per capita due to its cold climate and energy-intensive industry. The most significant sectors of (primary) energy consumption in 2016 were industry (45%), space heating (26%) and transport (17%) [66]. Figure 1 presents the Finnish primary energy consumption and energy sources in 2007–2016 [66], 2020 and 2030 [65]. Primary energy consumption is expected to reach 418 TWh by 2030 [5].

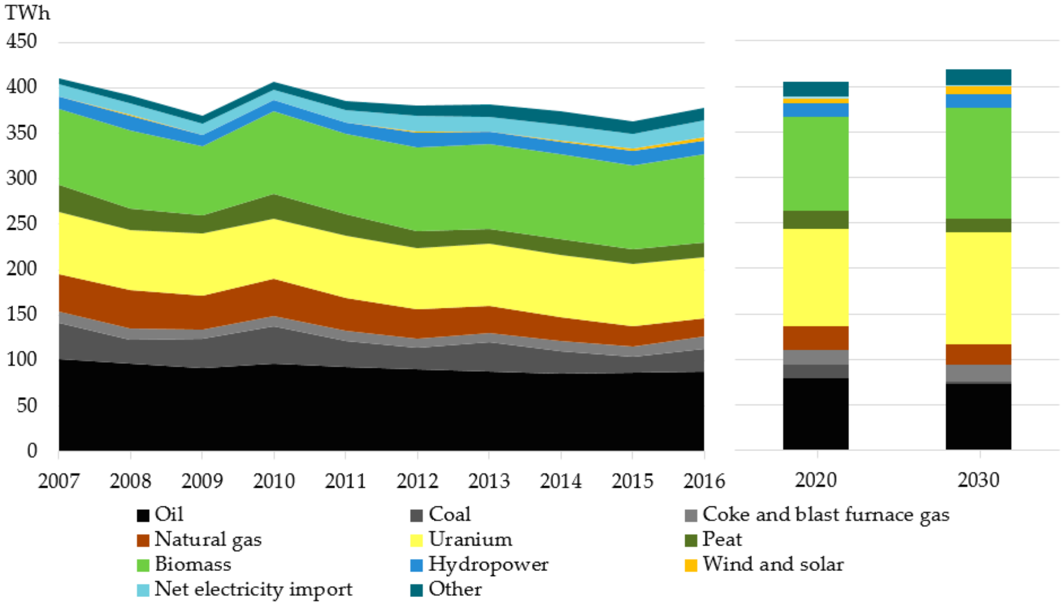

Figure 1. Primary energy consumption and energy sources in Finland in 2007–2016, 2020, and 2030.

Demand for electricity has remained at around 82–85 TWh/a in Finland in the 2010s. During the past decade, the demand has been lower than expected due to the financial crises and exceptionally warm weather. However, the annual electricity demand peaks in Finland have grown, reaching an all-time high in early 2016 (15,105 MWh/h) [67]. This has spurred debate on generation adequacy in Finland [68,69]. The main sectors of electricity consumption are industry and construction (47%, 2016 figures), residential and agriculture (27%), and the public sector (23%), with transmission and distribution losses covering 3% of electricity use in 2016 [66]. In 2030, the Energy and Climate Strategy estimates an annual electricity consumption of 93 TWh and an upper limit of 16,235 MWh/h for the annual demand peak in Finland [5].

In addition to the high demand for electricity and space heating, a noteworthy feature in the Finnish energy system is the role of district heating and cogeneration in particular. Demand for district heat was approximately 33.6 TWh in 2016, i.e., 46.1% of total space heating [70]. Approximately 70% of the district heat was based on combined heat and power (CHP) production. Demand for district heat is expected to remain approximately at its current level until 2030 [5].

4.1.2. Supply

As illustrated in Figure 1, the most important primary energy sources in Finland are biomass (25.9%, 2016 figures), oil (23.2%) and uranium (18.2%) [66]. Finland imports practically all of its fossil fuels, and a vast majority of the imports come from Russia. In total, imports comprised 64.0% of the total primary energy supply in 2016, of which the majority originated in Russia (Table 1). The imports are presented in more detail in Section 4.3. The most notable domestic primary energy sources in Finland are biomass (71%, 2016 figures), peat (15%) and hydropower (10%) [66]. Figure 1 presents the development of primary energy supply in Finland in 2007–2016 and the political targets for 2020 and 2030.

Finland has a highly diversified electricity production mix. During the past few years, electricity supply in Finland has been distributed between thermal power (29.6%, 2016 figures), nuclear power (26.2%), hydropower and wind power (21.9%), and net import (22.3%) [71]. Installed power capacity in Finland in early 2018 was approximately 17,400 MW [72]. However, as some of the capacity is allocated in system reserves and the availability of, for example, wind and hydropower vary according to external conditions, the highest electricity production peak in Finland in 2016, for example, was approximately 11,600 MW [67]. This corresponds to the estimate of Fingrid, the national transmission system operator, regarding the available domestic power capacity during the winter peak-demand period in 2016 [66]. Thus, Finland is highly dependent on electricity imports for supplying the annual demand peaks. The cross-border transmission capacities from Sweden, Russia, and Estonia are approximately 2700 MW, 1400 MW, and 1000 MW, respectively; resulting in a total import capacity of 5100 MW. This is more than one third of the record high demand peak.

Finland has set a target of self-sufficiency in annual electricity production by 2030 [65]. However, two new cross-border transmission lines are being planned and constructed between Finland and Sweden, and Finland's dependence on imported electricity to supply the annual demand peaks might thus even grow by 2030 [69]. In addition to the new transmission lines, the most significant foreseeable changes in the Finnish energy system by 2030 are the following:

- Two new nuclear power plants: Olkiluoto 3 (1600 MW, deployment in 2019) and Hanhikivi 1 (1200 MW, deployment after 2024).
- Phasing out coal in normal energy use and halving the use of imported oil.
- Increasing the share of renewable energy sources to 50% and self-sufficiency to 55% of final energy consumption.

The Finnish energy system comprises a variety of capacity and energy reserves. In addition to the peak load reserves (currently 729 MW of power plants and demand response [73]), Fingrid controls different frequency restoration reserves, which comprise inter alia approximately 1000 MW of fuel oil powered gas turbines. The Finnish legislation on imported fuels (28.11.1994/1070) obliges parties importing or utilising coal or natural gas to store fuel for three months' consumption and parties importing or utilising oil to store fuel for two months' consumption. However, in practice natural gas storages are substituted via storing fuel oil. Uranium is excluded from the legislation, but nuclear power producers store uranium for 1–2 years' consumption. In addition to the obligations for importers and producers, the Finnish National Emergency Supply Agency (NESA) has emergency fuel storages.

4.2. Energy in Russia

Due to the very different characteristics of the Finnish and Russian energy sectors, we also analyse energy in Russia with a different approach. Russia is the world's largest country in terms of land area and its energy market is much more scattered than that of Finland. In terms of energy security in Finland, energy generation capacity and energy infrastructure outside western Russia are of lesser importance. Therefore, in addition to the direct linkages in the Finnish-Russian border, this section will concentrate on Russia's role as an energy exporter and its energy strategy. Section 4.2.1 reviews the demand for and supply of energy in Russia, Section 4.2.2 analyses the strategic role that the energy sector has in Russia, and Section 4.2.3 analyses the impacts of the EU and US sanctions on the Russian energy sector.

4.2.1. Demand and Supply

Russia has the world's fourth largest primary energy consumption after China, USA, and India, covering 5.2% of global energy consumption in 2016 [74]. The annual consumption in 2016 was 689.6 Mtoe (~8020 TWh). In addition to the Russian consumption, the global demand for primary energy has a vital role in the Russian energy market due to Russia's role as an energy exporter: Russia was the world's largest exporter of oil and natural gas in 2016, exporting 74% of its produced oil, 33% of produced natural gas, and 54% of produced coal [74]. Russia's primary energy consumption, fuel reserves, domestic production and exports in 2016 are presented in Table 1. Uranium is not traded as openly, and hence its production and export figures are absent from the table.

Table 1. Russian primary energy consumption, fuel reserves, domestic production and exports in 2016 [74].

Energy Source	Consumption (TWh/a)	Share	Reserves (TWh)	Global Share	Production (TWh/a)	Global Share	Net Export (TWh/a)
Natural gas	4201.9	52.4%	~348,000	18.0%	5900	16.6%	2070 [4]
Oil	1773.6	22.1%	~169,000	6.3%	6470	12.7%	4770 [5]
Coal	1037.4	12.9%	~892,000 [2]	15.5%	2260	5.3%	1220 [6]
Uranium	517.5	6.5%	~70,000 [3]	8.9%	-	-	-
Hydropower	486.1	6.1%	-	-	-	-	-
Other [1]	3.5	0.0%	-	-	-	-	-
Total	8020.0	100%	-	-	-	-	-

[1] Including wind and solar power; [2] At the end of 2017; [3] A rough estimate based on 507,800 tons of uranium reserves [75] and a heat value of 500 GJ/kg [76]; [4] Including pipeline and liquefied natural gas (LNG) trade; [5] Including crude oil and oil products; [6] Including anthracite, bituminous and lignite.

In 2010, the Russian government implemented a mechanism called the capacity delivery agreement (CDA) in order to incentivise investment in power capacity [77]. Due to lower-than-expected demand for electricity after the financial crises around 2010, the mechanism has resulted in a notable surplus of generation capacity in Russia. Power production capacity in Russia is approximately 240 GW, of which 68.0% is thermal power, 20.1% hydropower, 11.6% nuclear power and 0.23% renewables other than hydropower [78]. Russia's gross electricity production, electricity consumption and net electricity imports in 2016 were 1071 TWh, 900 TWh and 15 TWh, respectively [79].

4.2.2. Energy as a Strategic Asset in Russia

Energy plays an important role in the Russian economy. It is often more than a commodity and it is linked with other strategic sectors, such as the military [80]. Hydrocarbons in particular are also considered a tool for construction of the energy superpower identity [81,82]. As a result, broader security and strategic concerns are openly expressed and they are closely tied to geopolitical considerations [83]. The most recent finalised document remains the Energy Strategy up to 2030 [84], while the yet to be finalised Energy Strategy is in the project stage [85]. This is remarkable, as other key Russian security strategies have been updated during 2014–2016 [80]. Equally important is a forecast of scientific and technological development by the Ministry of Energy [86].

Recent energy strategies in Russia have not functioned as blueprints for action, but rather served as 'documents for documents', i.e., the Russian government uses interlinked documents to govern energy sector development [87]. Therefore, the energy strategy itself provides little detailed information about the exact measures, but rather describes risks and key strategic objectives. Furthermore, according to previous research, the estimates for fuel and energy balance, as well as domestic technological capability are rather optimistic and, depending on the fuel, can significantly differ from global estimates [88–90]. Furthermore, there is variation on how different documents illustrate the development of politics. The energy strategy project does not discuss issues, such as geopolitics very much, while the forecast of technological development perceives energy as a tool for political influence and considers that the USA and the EU are, in cooperation with their allies, conducting a new kind of war with Russia [91].

The draft version of the energy strategy assesses the development of the Russian energy sector through "optimistic" and "pessimistic" scenarios, of which the former is one of our sources for the high carbon scenario in Section 5. Both scenarios in the draft focus on the development of fossil fuels and have a rather optimistic annual GDP growth of 2–3% [85,91]. At the moment, the (external) energy security question for Russia is how to best manage fluctuations in energy prices, as half of the Russian budget comes from energy revenues (80% oil and 20% natural gas) [87]. Nuclear power is expected to become a more significant source of revenue, but also to replace domestic natural gas consumption for export [88]. Russia aims to double its nuclear energy production by 2030 [85] and to turn nuclear power into a major export industry [17,88].

The importance of developing a more balanced economy that is not based only on fossil fuels or energy revenues is also acknowledged [84,85]. A forecast of scientific and technological development by the Ministry of Energy [86] considers it risky for Russian energy companies to focus only on the development of large scale fossil fuel projects. However, previous research shows that progress has remained limited [92,93]. In contrast, energy efficiency measures have had a stronger foothold strategically, and they are assumed to save up to 40% of the domestic production and enable an increase in export revenue [94]. Furthermore, one of the issues the strategy highlights is technological dependence on Western technology and it sets the target of having energy equipment produced 85–90% (previously the target was 95–97% by 2030 [84,95]) domestically by 2035 [85]. Under the current Russian policy targets, the critical challenges in terms of (internal) energy security are finding sufficient investments, increasing the technology level, increasing energy and economic efficiency to keep up with global levels, and developing energy infrastructure [87]. With current and even higher oil prices, it is difficult to sustain the societal security without broad restructuring of society. That is to say that current financial security mechanisms, such as welfare funds are running out, and without new income new energy infrastructure investments are also hard to finance [91].

If carbon reduction targets increase significantly, uranium and also natural gas, due to its lower carbon intensity, could play an even more significant role than today [57]. In terms of natural gas, there are three important factors: (1) How the EU market integration continues and what is the level of ambition regarding climate policy; (2) how the demand for natural gas in India and in China will evolve [60]; and (3) how the LNG market will develop. The global production network for LNG has more than doubled between 2002 and 2015. Furthermore, establishing a new kind of pricing regime that could reduce the power of traditional long-term contracts is equally important [52].

4.2.3. Impact of Sanctions on Russia

The EU, the US and some other countries have introduced sanctions on Russia since spring 2014, after the annexation of Crimea. Economic sanctions have so far affected mostly new greenfield projects and especially the oil sector [96], which is the most vulnerable due to its dependence on foreign technologies [95]. Furthermore, the sanctions have also influenced diplomatic relations at the EU level. For instance, the EU-Russia Energy dialogue has not organised any high-level meetings, since the introduction of sanctions [96]. It is peculiar, however, that the nuclear power sector has been left outside sanctions, although there are many greenfield projects in Europe [91].

The sanctions have the most notable impact financially and technologically. In the financial sphere the sanctions have resulted in depleted access to long-term loans and a decrease in credit ratings for key Russian energy companies [97]. In the oil sector, the difficulty in brownfield projects is to retain current volumes. In greenfield projects, the development of new projects has slowed down or been postponed due to difficulties in cooperation [95,97], although the use of non-Western technology has helped slightly [98]. It is also worth noting that in addition to sanctions, the Third Energy Package of the EU with the key strategic goal of liberalising the natural gas market has forced Gazprom to unbundle distribution from production [3]. Gazprom is currently trying to solve this issue via World Trade Organisation (WTO) arbitration, but if the decision favours the EU, it could strengthen the impacts of sanctions.

The impact of sanctions has been less remarkable for natural gas, as the Russian reserves are at a high level and the long-term nature of trade contracts mitigates short-term risks. However, politically one possible result is that the experience of sanctions will push Gazprom's newer European customers towards LNG and other energy sources [96]. If the sanctions continue, the difficulty for Russian LNG could be to keep up with more modern and cost effective methods, while non-Russian companies could gain a larger market share in Europe [97].

The likely impact of the sanctions could be twofold: On the one hand, they reduce demand and highlight the dependence on Western technology, while on the other hand, they provide a push towards internal renewal and economic modernisation [90]. However, due to Russia's significant economic and political dependence on oil and gas, this type of internal development is challenging. That is, the Russian regime needs to take corporate interests into account. Domestic interest groups could, for instance, push for strengthening energy sector subsidies and a strategic focus on it [99]. The societal impact could be the increased control of citizens due to a simplification of economy and centralisation of power. If the broader Russian economy stalls, this could even lead to citizen protests [57].

4.3. Energy Trade Relations between Finland and Russia

Despite the concerns and public debate on Russia's reliability as a supplier of energy, there has in practice been no noteworthy disturbances in energy flows from Russia to Finland in the last few decades. The debate mirrors Finnish-Russian relations in general, and the perceptions of threat related to Russia [15]. On the one hand, the debate has thus been about security in general and whether Russia could reach its foreign and security policy goals via energy trade. On the other hand, there has also been liberal consideration that free trade enables positive interdependence and cooperation in Russia [17,57]. The latter is more dominant in the Finnish energy strategy and related documents [5,65], but also in diplomatic meetings with the Russian president [100,101]. Key politicians and industry representatives have also argued against energy trade having political or security implications [102]. Consequently, despite Russia's significant role in supplying energy to Finland, the new energy strategy of Finland does not mention Russia even once, and the background report only mentions Russia briefly when discussing the opening up of the Finnish natural gas market.

As noted in the previous section, the Russian energy sector is one of the strategic sectors, and therefore market-based rationale can be neglected if the state security or foreign policy needs are more important. In Finland, the major energy companies operate on the basis of market logic, although energy is, to some extent, always an object of strategic considerations. Therefore, most of the large Finnish energy companies are also partially state-owned [57].

4.3.1. Primary Energy

Finland imported 64.0% of its primary energy in 2016 and 63.0% of this amount originated in Russia, i.e., 40.4% of the total primary energy in 2016 was of Russian origin. Table 2 presents the primary energy imports from Russia in more detail. The value of Finnish primary energy imports in 2016 amounted to 7128 MEUR, of which 67.7% was related to trade with Russia [66].

As shown in Table 2, the most notable energy sources from Russia are oil, uranium, coal and natural gas, respectively. Natural gas is the most sensitive in terms of security of supply, as practically all the natural gas consumed in Finland still comes through a single pipe from Russia. Moreover, unlike other imported fuels, there are practically no natural gas storages in Finland. However, consumption of natural gas in Finland has decreased significantly in the 2010s due to its declining economic competitiveness [66], and the natural gas market in Finland is about to open up via LNG terminals and a new pipeline between Finland and Estonia, Balticconnector.

Table 2. Primary energy sources in Finland and the share of Russian imports in 2016 [66].

Energy Source	Consumption (TWh/a)	Share	From Russia (TWh/a)	Share of Total	Share of Imports
Biomass	99.5 [1]	26.3%	10.9 [2]	11.0%	91.5%
Oil	88.1	23.3%	67.4 [3]	76.5% [4]	76.5%
Uranium	67.5	17.9%	26.6 [5]	39.4%	39.4%
Coal and coke	35.3	9.3%	21.6	61.2%	61.2%
Natural gas	20.3	5.4%	20.3	100%	100%
Net electricity import	19.0	5.0%	5.9	30.9%	30.9%
Hydropower	15.6	4.1%	-	-	-
Peat	15.6	4.1%	0.1	0.5%	52.5%
Recycled and waste energy	8.1	2.1%	-	-	-
Heat pumps	5.9	1.6%	-	-	-
Wind and solar	3.1	0.8%	-	-	-
Other	0.3	0.1%	-	-	-
Total	378.2	100%	152.7	40.4%	63.0%

[1] Including all wood-based fuels, black liquor, biogas and other bioenergy; [2] Natural Resources Institute Finland [103]; [3] Including crude oil, middle distillates, heavy fuel oil, LPG, methanol and other petroleum products; [4] Estimated figure, as some of the oil is refined in Finland and exported; [5] Based on fuel sources and production volumes of Finnish nuclear power producers in 2016. Due to the relatively easy storability of uranium, consumption of uranium is a better indicator than the imports of a single year.

As mentioned in Section 4.1.2, Finland aims to halve its oil imports and phase out coal in normal energy use by 2030. Moreover, the global markets for crude oil and coal are liquid. Uranium, on the other hand, is not traded as openly, but there is still a variety of suppliers globally. All of the aforementioned three fuels (oil, coal and uranium) are relatively easy to transport and store. Furthermore, due to the obliged storages of imported fuels, disruptions in their supply would not cause acute shortages for end users of energy.

Finland is much less significant a purchaser of energy from Russia than what Russia is to Finland as a supplier. Of all Russian hydrocarbon exports in 2016, 1.4% of oil (Neste's refinery actions excluded), 1.0% of natural gas and 1.7% of coal were exported to Finland [66,74].

4.3.2. Electricity

Russia is not a part of the Nordic wholesale electricity market, Nord Pool, but is connected to it via two DC links and an AC line on the Finnish-Russian border. There are two modes of power trade between the countries, which are bilateral trade (1160 MW RU-FI and 180 MW FI-RU) and direct trade capacity (140 MW) [104]. In addition, Fingrid has reserved 100 MW of transmission capacity between the countries for system reserve. The lack of electricity market coupling between Finland and Russia has a few consequences. First, experiences of uncoordinated capacity remunerative mechanisms indicate that integrating different market mechanisms pose challenges and result in under-usage of capacity and welfare losses [77]. Secondly, the bilateral trade volumes need to be confirmed before the closure of the Nordic spot market, which complicates trade between the countries. Moreover, in contrast to the Nordic energy-only market model with zonal prices, Russia's market design is an energy-plus-capacity market with nodal prices, i.e., electricity prices are defined separately for each location of the grid. Nodal pricing is typically applied in systems that have congestion within the system and high transmission losses.

Along with the investment subsidies, Russia implemented capacity payments for electricity sales in late 2011, which significantly decreased the flow of electricity between Russia and Finland. As shown Figure 2, a majority of Finland's net electricity imports came from Russia until 2011 [66]. Since 2012, electricity has been imported from Russia mostly during peak demand periods, and the majority of imports come from Sweden. In 2016, approximately 40% of Russian net electricity exports were imported by Finland [66,79], which indicates that Russian electricity exports are far lesser in volume than those of energy fuels.

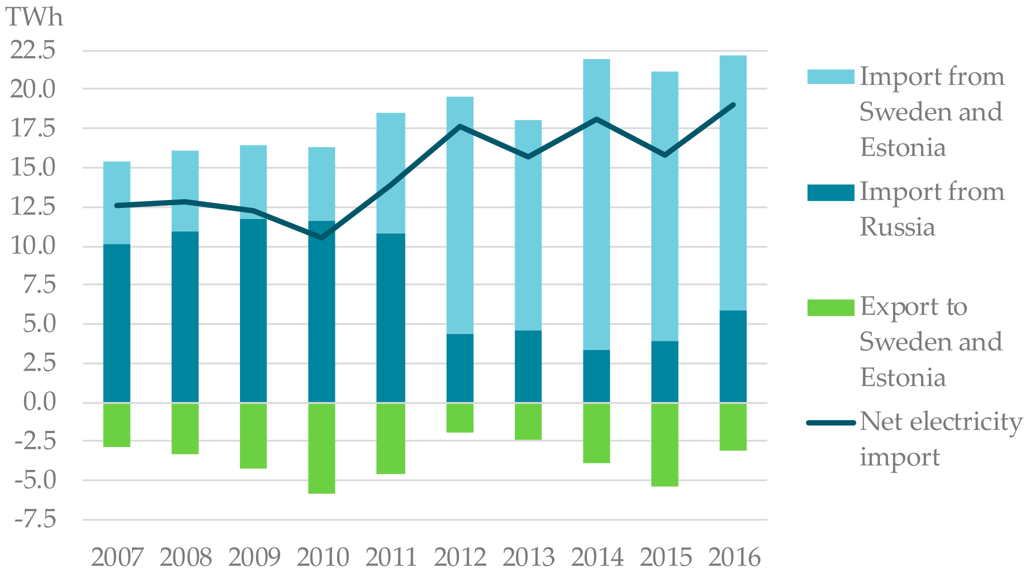

Figure 2. Electricity import and export in Finland in 2007–2016 and the decline of Russian electricity imports in 2012 [66].

Due to the notable subsidisation of power capacity in Russia, it is highly unlikely that electricity trade between Russia and Finland could be hindered by a lack of available capacity in western Russia. The power capacity in western Russia exceeds the annual demand peaks by almost 70% [105].

4.3.3. Political and Security Aspects of Finnish-Russian Energy Trade

In addition to supplying fuels and electricity to Finland, there are a few other connections rooted between Russia and the Finnish energy sector through corporate ownerships and technology transfer that have been the object of political debate. The key companies on the Finnish side are the half state-owned oil company Neste and the energy company Fortum, as well as a more recent actor, the Fennovoima nuclear power company. On the Russian side, they collaborate with the mostly state-owned companies Rosneft, Gazprom, and Rosatom. The Russian state has been cautious with regard to allowing foreign companies to operate in sectors it considers strategic, namely the energy sector [98], but Finnish companies are somewhat of an exception to this. However, there could be a possibility of trade with small enterprises, e.g., in biomass with less political risk, as they are mostly private businesses [99]. The two countries differ significantly as energy producers, and Finland's relations with Russia could be characterised more through asymmetric dependence. Yet, there are also elements of interdependence that are particularly evident in technology transfer enabled by Fortum.

Neste has operated in the oil business since the 1940s, and has been developing its portfolio towards biofuels. Nowadays, it could be considered a rather depoliticised case, but historically the company has been an object of political leverage from great powers, including Russia [28,106,107]. In the case of Neste, Russian influence comes from the fact that its processes are optimised for Russian Urals oil quality. This is also a topic acknowledged in the EU energy security strategy [1]. Therefore, fully changing to, for example, Norwegian Brent quality would bring significant economic loss [91]. The company is roughly 50% state-owned and it was an object of taxation worth 3.8 billion euros in 2017 [108]. Therefore, changes in the supply or profitability could have a fiscal impact on the Finnish government. Finland's Climate and Energy Strategy up to 2030 focuses only on domestic consumption of oil, but it is worth mentioning that the company exports oil products worth around 3 billion euros. Thus, regardless of domestic targets Neste could continue trading oil products to other countries.

Fortum used to be part of Neste as well, but it has grown through acquisitions from a domestic and Northern European company into a medium-sized global operator. The acquisition of Russian heat and power company TGC-1 in 2008 was the largest Finnish investment in Russia [109], and it allowed Fortum to gain a role as a regional player in Russia. Fortum also recently established the Wind Development Investment Fund with Rusnano, which is a subsidiary of the Russian nuclear company and agency Rosatom [110]. The joint project won a tender in 2017 to build 1000 MW of wind power capacity [111]. The expected income based on a guarantee price would be close to half a billion euros annually. Compared to the Nord Pool spot average price of 30–35 EUR/MWh in the recent years, while the guarantee price of 115–135 EUR/MWh in Russia is substantial. In a strategic sense, this project enables technology and knowledge transfer for Rosatom and allows Fortum to strengthen its market position in Russia. However, the recent Uniper acquisition by Fortum [112] is probably the most remarkable case. The acquisition links Fortum with the politically contested Nord Stream II gas pipeline [113], but it also makes Fortum a notable player in the Russian energy market, as Uniper is the third largest private utility in Russia. This has also opened some Russian concerns. For example, a politician and an economist, Mikhail Delyagin, even considered Fortum as a threat to national security in a Russian governmental newspaper [114]. Fortum disagreed with these comments, proceeded with legal actions and argued that energy is only about trade, not politics [115]. The Russian minister of energy also disagreed with this statement in the same newspaper and considered the company to be one of the greatest investors in the Russian energy sector [116].

Nuclear power has played an important role in Finland and is, generally speaking, widely accepted among the public [117]. However, Fennovoima continues to be an object of political dispute [29,118], with one of the reasons being Russian ownership and the contract for purchasing uranium from Russia for ten years after completion of the power plant. Although Russia has been a reliable supplier, this is a political victory at a time when the relations between Russia and the EU have deteriorated. Fennovoima is an important case from the perspective of Russian security of demand or energy diplomacy in general, as it would be the first Western project—something that Rosatom is currently lacking [17,89]. The EU energy strategy [1] has also raised concerns that member states should not be dependent on the Russian uranium supply and therefore diversification should be a key criterion in the new nuclear power plants. Rosatom is a fully state-owned corporation established in 2007 by the Russian Atomic Energy Ministry and continues to fulfil strategic objectives of the state [57]. Unlike, for example, Rosatom's Western counterparts, the company is part of the Russian armed forces and a central guarantor of Russia's Great Power position via nuclear threat, but it also provides expertise and regulation for the full nuclear power production cycle, from mining to nuclear waste. As the joint project with Fortum demonstrates, Rosatom is also aiming to broaden its portfolio to renewables and energy storage [119].

However, the way in which events have proceeded with Fennovoima has left questions in the public debate. One of the themes is that the Russian actors have been accused of pressuring the

Finnish government to make decisions in favour of Rosatom. For instance, the Finnish president Sauli Niinistö has been accused of pressuring Fortum to become a partner of Fennovoima [120], while the former minister of economic affairs, Olli Rehn, changed his position unexpectedly from opposing the project to full support. As he noted, the project could even have been cancelled in the summer of 2015. This would have significantly harmed Finnish-Russian relations, as Finland had at that time refused to obtain visas for Russian diplomats for participation in a meeting of the Organisation for Security and Cooperation in Europe due to EU sanctions, which led to a minor diplomatic issue [121]. That is, in line with the argument of Casier [10], the threat perception from security or foreign policy could have spilled over into the sphere of energy policy. In the early stages of the Fennovoima project, Russia was perceived in a negative fashion and Russian nuclear technology was perceived as outdated. Moreover, the Russian option was not included in the Decision-in-Principle. As Vehkalahti [15] notes, the debate on Finland's (external) energy security is always mirrored against Russia. The debate is coherent as long as Russia stays on the negative side. It has been discursively and politically challenging to frame Russian ownership as positive. For instance, the chairman of the board of Fennovoima, Esa Härmälä, argued that Fennovoima reduces Finland's dependence on Russia [122]. A more balanced argument could be that the power plant improves generation adequacy in Finland, while over the next decades Finnish dependence on Russia will remain more or less the same, which can be difficult to justify at the EU level with consideration to the EU energy security strategy [1].

If we place these cases and events in the interdependence framework, they show that energy is a dominant topic in mutual relations, although in terms of physical energy relations the risks are manageable. Finnish actors are balancing their interests with Russian ones, but also with the EU policy. It is relevant to note that regardless of the EU sanctions, Finnish companies have actually increased their cooperation with Russian actors, especially in the cases of Fortum and Fennovoima. With regard to oil, the Finnish energy and climate strategy focuses mostly on reducing domestic consumption, which means that the refinery activities of Neste are mostly unaffected.

5. Finnish-Russian Energy Trade in the Future

This section analyses the future of Finnish-Russian energy trade in three different scenarios: Market trends scenario, low carbon scenario and high carbon scenario.

5.1. Scenario 1: Market Trends

The market trends scenario is based on currently decided and implemented energy policy and climate actions. This scenario is in line with Pöyry's Basic scenario [91], which is in turn based on the scenarios of the World Energy Council (WEC), IEA, Energy Information Administration (EIA), McKinsey and BP. Despite the brief optimism and consensus regarding climate change mitigation after the Paris agreement, concrete actions to tackle the increasing amount of CO_2 in the atmosphere have been vastly inadequate. The uptake of renewables (and nuclear power) continues, but the global warming by the end of the century will be 3–3.5 degrees Celsius.

The energy transition proceeds as in the 2010s. That is, wind and solar power will retain their significant growth rates of around 7.5%/a, but a majority of the increasing demand for energy is covered with fossil fuels. Global consumption of fossil fuels thus increases, particularly in developing countries. Coal consumption peaks in 2025, but the consumption of natural gas and oil keeps increasing by approximately 1%/a until 2040. Development of the Finnish energy sector proceeds according to the Finnish energy and climate strategy from late 2016 until 2030. After 2030, the Finnish energy system develops according to its climate roadmap until 2050, i.e., towards 80–95% CO_2 emission reduction compared to the level in 1990 [123]. Despite the production costs of wind and solar power becoming much lower than those of fossil fuels by 2030, technological development of electricity storages is not fast enough to enable more rapid penetration of renewables.

Russia retains its role as an energy exporter. The increasing demand for fossil fuels in Asia compensates for the decreasing demand in Europe. The Russian economy continues to grow, but only slowly, by around 1–1.5% annually. Russia includes climate change mitigation in its policy, but this is not actively implemented. In terms of influence, Russia's ability to act will remain the same or decreases slightly. As energy incomes do not increase significantly, hard methods of influence, such as issuing threats, are unlikely.

Development of Finnish-Russian Energy Trade in the Market Trends Scenario

Table 3 presents the development of Finnish energy imports from Russia in market trends scenario. Biomass and peat are excluded from the table, as Finland has abundant domestic resources of both.

Table 3. Development of Finnish energy imports from Russia in the market trends scenario.

Energy Source (TWh/a)	2016	2020	2025	2030	2035	2040
Oil	67.4	65.0	50.0	33.7	28.0	24.0
Uranium	26.6	26.6	26.6	25.6 [1]	25.6	25.6
Coal and coke	21.6	20.0	16.0	8.0 [2]	6.0	3.0
Natural gas	20.3	17.0 [3]	14.0	10.0	10.0	10.0
Electricity [1]	5.9	3.0 [4]	1.0	1.0	1.0	1.0
Total	141.8	131.6	107.6	78.3	70.6	63.6

[1] Loviisa 1 and 2 are decommissioned and Hanhikivi 1 is deployed; [2] Coal is phased out in normal energy use. However, some of the industrial consumption remains; [3] The consumption of natural gas remains quite steady, but the Balticconnector and developing LNG markets reduce imports from Russia; [4] Finland becomes self-sufficient regarding electrical energy via the new nuclear power plants. However, Finland will continue to import electricity from Russia during annual demand peaks.

As shown in Table 3, energy imports from Russia decrease notably by 2040. This is mainly due to Finland's reduction of fossil fuels in its energy mix, and the largest decreases are in consumption of oil and coal. Finnish primary energy consumption reaches around 410–420 TWh/a by 2020 and remain roughly at that level until 2040. Therefore, assuming there are no biomass or peat imports in 2040, approximately 16% of Finnish primary energy consumption in 2040 is of Russian origin (comparing to 40.4% in 2016).

5.2. Scenario 2: Low Carbon

In the low carbon scenario, a strong global consensus and political will are achieved regarding climate change mitigation. In terms of world politics, this is achieved via a rather peaceful world without much confrontation among the great powers, as they are the ones with the most significant emissions. This scenario is in line with the 450 scenario of the IEA and Pöyry's Fast development scenario [91]. The scenario develops according to the aims of the Paris agreement, but inadequately in terms of limiting global warming to 1.5 degrees. Despite the prominent global growth in wind and solar power capacity and the reduction in consumption of oil and coal, global warming is 2 degrees Celsius by the end of the century.

The production costs of wind and solar power fall below those of fossil fuels in the 2020s. Furthermore, technologies for electricity storage develop quickly, allowing for faster penetration of variable renewable energy technologies. Global wind and solar power capacity growth rates are around 10%/a. Electric cars develop rapidly, which leads to a decrease of 1%/a in the use of oil. Demand for coal decreases by 2–3% annually. In addition to cheap wind and solar power, the increasing demand for energy in developing countries is met mostly with natural gas-based production. Therefore, demand for natural gas increases significantly by 2030, after which it retains a steady growth of around 0.5%/a.

Russia is still a prominent energy exporter in this scenario. However, the decreasing demand for coal and oil along with the consequent reduction in their market prices and growing emission allowances prices reduce Russia's incomes from energy exports notably. The increasing demand for natural gas, particularly in Asia, is not rapid enough to compensate for the reduction in demand for oil. In terms of influence, Russia's ability to act decreases notably. Russia increases its domestic consumption of coal and nuclear energy as the role of natural gas exports increases.

Development of Finnish-Russian Energy Trade in the Low Carbon Scenario

Table 4 presents the development of Finnish energy imports from Russia in the low carbon scenario.

Table 4. Development of Finnish energy imports from Russia in the low carbon scenario.

Energy Source [TWh/a]	2016	2020	2025	2030	2035	2040
Oil	67.4	62.0	47.0	30.0	24.0	20.0
Uranium	26.6	26.6	26.6	25.6 [1]	25.6	25.6
Coal and coke	21.6	20.0	13.0	6.0 [2]	4.0	3.0
Natural gas	20.3	17.0 [3]	12.0	8.0	7.0	6.0
Electricity [1]	5.9	3.0 [4]	1.0	1.0	1.0	1.0
Total	141.8	128.6	99.6	70.6	61.6	55.6

[1] Loviisa 1 and 2 are decommissioned and Hanhikivi 1 is deployed; [2] Coal is phased out in normal energy use. However, some of the industrial consumption remains; [3] The consumption of natural gas decreases, and the Balticconnector and developing LNG markets reduce imports from Russia; [4] Finland becomes self-sufficient regarding electrical energy via the new nuclear power plants. However, Finland keeps importing electricity from Russia during annual demand peaks.

As shown in Table 4, energy imports from Russia decrease slightly faster than in scenario 1 by 2040. The difference in the scenarios comes from the more rapid reduction in the use of oil and natural gas in Finland. Assuming no biomass or peat imports in 2040, approximately 13% of Finnish primary energy consumption in 2040 is of Russian origin (compared to 40.4% in 2016).

5.3. Scenario 3: High Carbon

The high carbon scenario is based on the IEA's RCP8.5 scenario [124], the Slow development scenario of Pöyry [91] and the Optimistic scenario in Russia's draft energy strategy up to 2035 [85]. The energy transition that started in the 2010s stagnates and global climate goals are abandoned. Instead of working on a systematic reduction in emissions, decision-makers keep prioritising national short-term economic growth and arguing over whether nuclear power or renewables are better for addressing the challenges related to climate change. The share of renewable energy in global power production mix keeps growing, but slowly. Growing scarcity of rare earth metals combined with slow development of electricity storage technologies hinder the cost reduction and penetration of wind and solar power. Electric vehicles remain much more expensive than those with internal combustion engines, and thus no electric vehicle revolution takes place before 2040. Demand for energy and the use of fossil fuels keep growing particularly in Asia. Energy trade with both the EU and China increases and, consequently, the Russian economy grows at an annual rate of 3% (compared to the current growth of around 1% per year). Russia's political leverage via energy trade strengthens significantly.

This scenario is in stark conflict with global climate change mitigation targets. However, the scenario also comprises increased demand for Russian uranium and nuclear power technology, and nuclear power is seen as a plausible tool for decreasing global CO_2 emissions [125,126].

Development of Finnish-Russian Energy Trade in the High Carbon Scenario

Table 5 presents the development of Finnish energy imports from Russia in the high carbon scenario.

As shown in Table 5, Finnish energy imports from Russia decrease slightly by 2040. Finland abandons its ban on coal for security of supply reasons, but the use of coal decreases as some of the power plants reach the end of their technical lifetime. Natural gas utilisation decreases slightly due to deployment of the Balticconnector and LNG terminals. However, as Estonian natural gas also originates in Russia, most of the natural gas eventually comes via the pipeline from Russia. Biomass and peat imports in 2016 remain at the same level until 2040. Therefore, approximately 32% of Finnish primary energy consumption in 2040 is of Russian origin (compared to 40.4% in 2016).

Table 5. Development of Finnish energy imports from Russia in high carbon scenario.

Energy Source [TWh/a]	2016	2020	2025	2030	2035	2040
Oil	67.4	66.0	65.0	64.0	63.0	62.0
Uranium	26.6	26.6	26.6	28.6 [1]	31.6	34.6
Coal and coke	21.6	20.0	18.0	16.0 [2]	14.0	13.0
Natural gas	20.3	17.0 [3]	15.0	15.5	16.0	16.5
Electricity [1]	5.9	4.0 [4]	4.0	4.0	4.0	4.0
Total	141.8	133.6	128.6	128.1	128.6	130.1

[1] Loviisa 1 and 2 are decommissioned and Hanhikivi 1 is deployed. TVO starts to purchase a growing share of its uranium from Russia; [2] Due to security of supply concerns, coal retains its role in the Finnish energy market; [3] The consumption of natural gas increases slightly, but the Balticconnector and developing LNG markets reduce imports from Russia; [4] The new nuclear power plants reduce electricity imports slightly.

6. Discussion

At the time of writing, it is still unknown how long the sanctions on Russia are going to continue and whether they will be broadened. Finnish companies are mostly cooperating with the state-owned Russian companies that have been the key targets of sanctions. In response to the broadening sanctions, Russia could, for instance, establish a stricter policy for foreign companies in the energy sector. This could increase the political risk for Fortum due to its ownership of Russian energy infrastructure. Furthermore, if sanctions were extended to the nuclear sector, they could weaken Rosatom's organisational and technological capacity to finish the Fennovoima power plant. As we have noted, both of these companies have been mentioned in high-level diplomatic meetings, meaning that the Russian side also acknowledges their importance and benefits. Russia's energy sector development is also closely tied to the interests of the regime of President Putin. If the regime shift occurs peacefully, the impacts on the Russian energy market will probably be minor, but if it does not, the political and economic risks could increase significantly.

The most relevant dimensions of energy security in our analysis were resilience regarding self-sufficiency, security of supply, affordability and the environmental impacts of energy supply. System balance is also an increasingly vital component with the growing share of variable renewable energy sources, and hence the role of, for example, demand side management [127], electrical energy storages [128], and power-to-fuel technologies [129,130] will become more important in the future. However, system balance has not been a major issue in Finland due to, e.g., the significant hydropower capacity in the Nordics. Despite the recent concerns about generation adequacy during electricity demand peaks in Finland [68], no threats have materialised so far. Therefore, particularly with regard to Finnish-Russian energy trade, the dependence on primary energy is a more compelling issue. Energy in general also continues to be a dominant topic on the diplomatic agendas of both countries.

One difficulty in terms of generalising results in energy security-related research is the unique nature of national energy systems and their corresponding trade relations. The analysed phenomena are so interdisciplinary and varied in nature that no single indicator can capture the complexity and define the specific level of (in)security. For example, the severity of the longer-term impacts of climate change are very difficult to compare with risks related to one country's political leverage on another via energy trade. However, on a global sustainability perspective, each passing year seems to raise the risks related to climate change higher on the list of acute energy security threats to be addressed.

As noted earlier, climate change mitigation is not high on the Russian agenda. However, inclusion of Russia in the global climate policy is important, as it produces roughly 5% of global CO_2 emissions. Another key question is what kind of procedures the climate change mitigation regime would enact for those countries that do not commit to the rules. For instance, France has proposed a carbon border tariff for those that do not commit to the Paris agreement [131]. If the EU proposed similar measures, would Finland follow the rules or try to retain good relations with Russia?

The scenarios in Section 5 should not be considered attempts to predict the future, and none of the scenarios is likely to materialise as such. Due to the growing urgency around climate change mitigation, it is anyhow advisable that the future is closer to the low carbon scenario than the high carbon scenario. It should be noted, however, that in the global perspective the low carbon scenario grows more unlikely by the day, as no consensus concerning the mitigation methods has been reached. Preferences on the mitigation methods vary between inter alia wind and solar power, nuclear power, and carbon capture and storage (CCS) [132]. It is not clear that any of these methods alone would suffice anymore [132,133], but rather a deep transition beyond current energy system optimisation is required [134]. Moreover, the currently planned and pledged climate actions result in emissions that are far higher than those required to limit the warming to two degrees [135,136] and the investment needs to fulfil the gap are substantial [137].

One subject of future research is the more thorough inclusion of embodied energy in intermediate trade, as Russia is among the largest net exporters of it [138]. Finland both imports and exports energy-intensive goods and, for example, Neste's refineries are optimised for Russian oil. Another subject of future research could be to calculate the marginal costs of increasing the self-sufficiency in energy supply in Finland. That is, at what cost could a self-sufficiency of 40–100% in primary energy supply be obtained. A third possible subject is a more systemic comparison of threat perceptions within a timeframe of multiple years and multiple energy forms, or case studies, e.g., to expand the research on public debate over Fennovoima to cover other energy companies, such as Neste or Fortum.

7. Conclusions

Finland's complex relationship with Russia regarding energy trade has raised concerns over whether the dependence on one supplier is in fact an energy security threat for Finland. In order to address this concern, we have analysed the energy systems and energy strategies of Finland and Russia and the Finnish-Russian energy trade including key aspects of recent public debate by loosely applying the interdependence framework. Furthermore, we have analysed the societal and (geo)political aspects of the energy trade, as the trade relations cannot be understood only through techno-economic analysis. We have also outlined three global energy market scenarios in order to analyse the future of Finnish-Russian energy trade.

Through purely techno-economic analysis, we found no acute energy security threats related to the energy trade, despite the fact that Finnish-Russian energy relations are constantly being discussed in Finnish and Russian media and in diplomatic meetings. Finland does import all of its natural gas and significant shares of its oil, coal, uranium and electricity from Russia. Of these, disturbances in the supply of natural gas and electricity are the most tangible, as they are connected to the existing pipelines and transmission lines, respectively. However, consumption of natural gas in Finland and Russian electricity imports have decreased significantly during the 2010s. For coal, oil and uranium, there is a variety of suppliers globally. Moreover, Finland stores an amount equivalent to at least several months' consumption for all of these fuels. There are no natural gas storages in Finland, but the critical demand for natural gas can be substituted with oil. Therefore, disturbances in the fuel supply would not cause an immediate energy crisis.

However, as noted in the literature, the energy relations and the concept of energy security go beyond the flow of fuels and electricity. Finnish policy has traditionally focused on retaining good relations, but not everything can be controlled by Finland. The energy sector plays a vital role in the Russian economy and it is entrenched deep within Russia's political strategy. If a strategic shift occurs, spill-over effects to Finland or Finnish companies are possible. The Finnish and Russian energy strategies are also very different in nature. Finland aims for carbon neutrality and self-sufficiency while retaining its security of supply, whereas Russia aims to strengthen its role as a global energy supplier. In other words, Russia is more concerned with the security of demand. Apart from the Fennovoima project, Finland's energy policy is thus directed towards decreasing dependence on Russian energy, while Russia's energy strategy would prefer the opposite.

We studied the development of Finnish-Russian energy trade until 2040 in three global energy market scenarios: Market trends, low carbon and high carbon. The share of Russian imports in the

Finnish primary energy mix decreases in each scenario, comprising 16%, 13% and 32% of the Finnish energy supply by 2040, respectively. This is mainly due to decreases in the use of oil, coal and natural gas in Finland. The scenarios inevitably vary in terms of how the Finnish-Russian energy trade develops, but the more significant differences are in their impact on the global climate and the Russian economy. The Russian economy generally benefits from the increasing global demand for fossil fuels and uranium. Apart from uranium and nuclear power technology, what is beneficial for the Russian economy in terms of energy can be detrimental to climate change mitigation. As the market trends scenario is already dubious with regard to climate change mitigation and the plausible multiplicative effects caused by climate change, realisation of the high carbon scenario could result in challenges far greater than the slower development of Finnish self-sufficiency in energy supply.

In conclusion, Finland's notable dependence on Russian energy has so far not resulted in the materialisation of any security of supply threats, and the dependence is unlikely to worsen in the future. All the analysed scenarios result in a reduction in the use of fossil fuels in Finland, and, consequently, also in energy imports from Russia. However, as we are currently experiencing turbulent times, in terms of societal, political, and economic trends, there are possible risks and feedback loops that could affect Finland.

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References

1. European Commission. European Energy Security Strategy. Available online: Eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX%3A52014DC0330&from=EN (accessed on 9 September 2018).
2. Cucchiella, F.; D'Adamo, I.; Gastaldi, M. Future Trajectories of Renewable Energy Consumption in the European Union. *Resources* **2018**, *7*, 10. [CrossRef]
3. Siddi, M. The EU's gas relationship with Russia: Solving current disputes and strengthening energy security. *Asia Eur. J.* **2017**, *15*, 107–117. [CrossRef]
4. The World Bank. Electric Power Consumption (kWh Per Capita). Available online: Data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?year_high_desc=true (accessed on 20 September 2017).
5. Ministry of Economic Affairs and Employment. Energia-ja Ilmastostrategian Taustaraportti ('Background Report of the Energy and Climate Strategy'). Available online: Tem.fi/documents/1410877/3570111/Energia-+ja+ilmastostrategian+TAUSTARAPORTTI_1.2.+2017.pdf/d745fe78-02ad-49ab-8fb7-7251107981f7 (accessed on 20 September 2017).
6. Richter, P.M.; Holz, F. All quiet on the eastern front? Disruption scenarios of Russian natural gas supply to Europe. *Energy Policy* **2015**, *80*, 177–189. [CrossRef]
7. Bouwmeester, M.C.; Oosterhaven, J. Economic impacts of natural gas flow disruptions between Russia and the EU. *Energy Policy* **2017**, *106*, 288–297. [CrossRef]
8. Kustova, I. EU–Russia Energy Relations, EU Energy Integration, and Energy Security: The State of the Art and a Roadmap for Future Research. *J. Contemp. Eur. Res.* **2015**, *11*, 287–295.
9. Romanova, T. Is Russian Energy Policy towards the EU Only about Geopolitics? The Case of the Third Liberalisation Package. *Geopolitics* **2016**, *21*, 857–879. [CrossRef]
10. Casier, T. The Rise of Energy to the Top of the EU-Russia Agenda: From Interdependence to Dependence? *Geopolitics* **2011**, *16*, 536–552. [CrossRef]
11. Valkila, N.; Saari, A. Experts' view on Finland's energy policy. *Renew. Sustain. Energy Rev.* **2013**, *17*, 283–290. [CrossRef]
12. Ruostetsaari, I. Stealth democracy, elitism, and citizenship in Finnish energy policy. *Energy Res. Soc. Sci.* **2017**, *34*, 93–103. [CrossRef]

13. Teräväinen, T.; Lehtonen, M.; Martiskainen, M. Climate change, energy security, and risk—Debating nuclear new build in Finland, France and the UK. *Energy Policy* **2011**, *39*, 3434–3442. [CrossRef]
14. Ylönen, M.; Litmanen, T.; Kojo, M.; Lindell, P. The (de)politicisation of nuclear power: The Finnish discussion after Fukushima. *Public Underst. Sci.* **2015**, *26*, 260–274. [CrossRef] [PubMed]
15. Vehkalahti, P. *Pohjoisen Ydinmylly: Julkinen Keskustelu Fennovoiman Ydinvoimalasta 2007–2013 ('The Northern Nuclear Mill: Public Debate on the Fennovoima Power Plant 2007–2013')*; Acta Electronica Universitatis Tamperensis 1819; Suomen Yliopistopaino Oy—Juvenes Print: Tampere, Finland, 2017; ISBN 978-952-03-0541-3.
16. Laihonen, M. *Political Foreplay for Nuclear New Build: Defining good at the Intersection of Politics, Economy and Technology*; Aalto University Publication Series, Doctoral Dissertations 247/2016; Unigrafia Oy: Helsinki, Finland, 2016; ISBN 978-952-60-7156-5.
17. Aalto, P.; Nyyssönen, H.; Kojo, M.; Pal, P. Russian nuclear energy diplomacy in Finland and Hungary. *Eurasian Geogr. Econ.* **2017**, *7216*, 1–32. [CrossRef]
18. Huttunen, S. Stakeholder frames in the making of forest bioenergy legislation in Finland. *Geoforum* **2014**, *53*, 63–73. [CrossRef]
19. Kivimaa, P.; Mickwitz, P. Public policy as a part of transforming energy systems: Framing bioenergy in Finnish energy policy. *Promot. Transform. Sustain. Consum. Prod. Resour. Energy Intensive Econ. Case Finl.* **2011**, *19*, 1812–1821. [CrossRef]
20. Lempinen, H. Jos se ei riitä, siitä riidellään Energiaturvallisuuden kieli ja kuvakieli turve-energian markkina-argumentteina ('"If there's a scarcity, it will be fought over"—Language of energy security and imagery of peat energy as market arguments'). *Alue Ja Ymp.* **2017**, *42*, 53–63.
21. Karhunen, A.; Laihanen, M.; Ranta, T. Supply security for domestic fuels at Finnish combined heat and power plants. *Biomass Bioenergy* **2015**, *77*, 45–52. [CrossRef]
22. Helin, K.; Jääskeläinen, J.; Syri, S. Energy Security Impacts of Decreasing CHP Capacity in Finland. In Proceedings of the IEEE Xplore 15th International Conference on the European Energy Market (EEM), Lodz, Poland, 27–29 June 2018.
23. Zakeri, B.; Syri, S.; Rinne, S. Higher renewable energy integration into the existing energy system of Finland—Is there any maximum limit? *Sustain. Dev. Energy Water Environ. Syst.* **2015**, *92 Pt 3*, 244–259. [CrossRef]
24. Aslani, A.; Helo, P.; Naaranoja, M. Role of renewable energy policies in energy dependency in Finland: System dynamics approach. *Appl. Energy* **2014**, *113*, 758–765. [CrossRef]
25. Saastamoinen, A.; Kuosmanen, T. Quality frontier of electricity distribution: Supply security, best practices, and underground cabling in Finland. *Energy Mark.* **2016**, *53*, 281–292. [CrossRef]
26. Pilpola, S.; Lund, P.D. Effect of major policy disruptions in energy system transition: Case Finland. *Energy Policy* **2018**, *116*, 323–336. [CrossRef]
27. Ochoa, C.; Gore, O. The Finnish power market: Are imports from Russia low-cost? *Energy Policy* **2015**, *80*, 122–132. [CrossRef]
28. Kuisma, M. *Kylmä Sota, Kuuma Öljy: Neste, Suomi ja Kaksi Eurooppaa 1948-1979 ('Cold War, Hot Oil: Neste, Finland and Two Europes 1948-1979')*; WSOY: Porvoo, Finland, 1997; ISBN 978-951-0-20811-3.
29. Michelsen, K.-E.; Särkikoski, T. *Suomalainen Ydinvoimalaitos ('Finnish Nuclear Power Plant')*; Edita: Helsinki, Finland, 2005; ISBN 978-951-37-4530-1.
30. Särkikoski, T. *Rauhan Atomi, Sodan Koodi: Suomalaisen Atomivoimaratkaisun Teknopolitiikka 1955-1970 ('Atom of Peace, Code of War: Technopolitics of the Finnish Nuclear Power Solution 1955-1970')*; Historical Studies from the University of Helsinki XXV; Unigrafia: Helsinki, Finland, 2011; ISBN 978-952-10-7287-1.
31. Aalto, P.; Korkmaz Temel, D. European Energy Security: Natural Gas and the Integration Process: European energy security. *JCMS J. Common Mark. Stud.* **2014**, *52*, 758–774. [CrossRef]
32. Bridge, G. Geographies of peak oil: The other carbon problem. *Geoforum* **2010**, *41*, 523–530. [CrossRef]
33. Jewell, J.; Cherp, A.; Riahi, K. Energy security under de-carbonization scenarios: An assessment framework and evaluation under different technology and policy choices. *Energy Policy* **2014**, *65*, 743–760. [CrossRef]
34. Scholten, D.; Bosman, R. The geopolitics of renewables; exploring the political implications of renewable energy systems. *Technol. Forecast. Soc. Change* **2016**, *103*, 273–283. [CrossRef]

35. Aalto, P.; Dusseault, D.; Kennedy, M.D.; Kivinen, M. Russia' s energy relations in Europe and the Far East: Towards a social structurationist approach to energy policy formation. *J. Int. Relat. Dev.* **2014**, *17*, 1–29. [CrossRef]
36. Chester, L. Conceptualising energy security and making explicit its polysemic nature. *Energy Policy* **2010**, *38*, 887–895. [CrossRef]
37. Cherp, A.; Jewell, J. The three perspectives on energy security: Intellectual history, disciplinary roots and the potential for integration. *Curr. Opin. Environ. Sustain.* **2011**, *3*, 202–212. [CrossRef]
38. Cherp, A.; Jewell, J. The concept of energy security: Beyond the four as. *Energy Policy* **2014**, *75*, 415–421. [CrossRef]
39. Fernández Carril, L.; García Arrazola, R.; Rubio, E.J. Discursive Overlap and Conflictive Fragmentation of Risk and Security in the Geopolitics of Energy. *Sustainability* **2013**, *5*, 1095–1113. [CrossRef]
40. Brown, M.A.; Sovacool, B.K. *Climate Change and Global Energy Security: Technology and Policy Options*; MIT Press: Cambridge, MA, USA, 2011; ISBN 978-0-262-51631-0.
41. Yergin, D. Ensuring Energy Security. *Foreign Aff.* **2006**, *85*, 69–82. [CrossRef]
42. Mayer, M.; Schouten, P. Energy Security and Climate Security under Conditions of the Anthropocene. In *Energy Security in the Era of Climate Change*; Anceschi, L., Symons, J., Eds.; Palgrave Macmillan: London, UK, 2012; ISBN 978-0-230-27987-2.
43. Leung, G.C.K.; Cherp, A.; Jewell, J.; Wei, Y.M. Securitization of energy supply chains in China. *Appl. Energy* **2014**, *123*, 316–326. [CrossRef]
44. Blumer, Y.B.; Moser, C.; Patt, A.; Seidl, R. The precarious consensus on the importance of energy security: Contrasting views between Swiss energy users and experts. *Renew. Sustain. Energy Rev.* **2015**, *52*, 927–936. [CrossRef]
45. Leung, G.C.K. China's energy security: Perception and reality. *Energy Policy* **2011**, *39*, 1330–1337. [CrossRef]
46. Sovacool, B.K. Differing cultures of energy security: An international comparison of public perceptions. *Renew. Sustain. Energy Rev.* **2016**, *55*, 811–822. [CrossRef]
47. Valkenburg, G.; Gracceva, F. Towards Governance of Energy Security. *Low-Carbon Energy Secur. Eur. Perspect.* **2016**, 207–229. [CrossRef]
48. Geels, F.W. Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective. *Theory Cult. Soc.* **2014**, *31*, 21–40. [CrossRef]
49. Øverland, I.; Orttung, R.W. A limited toolbox: Explaining the constraints on Russia's foreign energy policy. *J. Eurasian Stud.* **2011**, *2*, 74–85. [CrossRef]
50. Müller, M. Opening the black box of the organization: Socio-material practices of geopolitical ordering. *Polit. Geogr.* **2012**, *31*, 379–388. [CrossRef]
51. Levy, D.L. Political Contestation in Global Production Networks. *Acad. Manag. Rev.* **2008**, *33*, 943–963. [CrossRef]
52. Bridge, G.; Bradshaw, M. Making a Global Gas Market: Territoriality and Production Networks in Liquefied Natural Gas. *Econ. Geogr.* **2017**, *93*, 215–240. [CrossRef]
53. Casier, T. Great Game or Great Confusion: The Geopolitical Understanding of EU-Russia Energy Relations. *Geopolitics* **2016**, *21*, 763–778. [CrossRef]
54. Mišík, M.; Prachárová, V. Before 'Independence' Arrived: Interdependence in Energy Relations between Lithuania and Russia. *Geopolitics* **2016**, *21*, 579–604. [CrossRef]
55. Goldthau, A.; Sitter, N. *A Liberal Actor in a Realist World: The European Union Regulatory State and the Global Political Economy of Energy*; Oxford University Press: Oxford, UK, 2015; ISBN 978-0-19-871959-5.
56. Smith Stegen, K. Deconstructing the "energy weapon": Russia's threat to Europe as case study. *Energy Policy* **2011**, *39*, 6505–6513. [CrossRef]
57. Tynkkynen, V.-P.; Pynnöniemi, K.; Höysniemi, S. *Global Energy Transitions and Russia's Energy Influence in Finland*; Article Series of Government's Analysis, Assessment and Research Activities; Finnish Government's Analysis, Assessment and Research Activities: Helsinki, Finland, 2017; pp. 1–13.
58. Högselius, P. *Red Gas*; Palgrave Macmillan US: New York, NY, USA, 2013; ISBN 978-1-137-29371-8.
59. Wigell, M.; Vihma, A. Geopolitics versus geoeconomics: The case of Russia's geostrategy and its effects on the EU. *Int. Aff.* **2016**, *92*, 605–627. [CrossRef]
60. Sharples, J.D. Russian approaches to energy security and climate change: Russian gas exports to the EU. *Environ. Polit.* **2013**, *22*, 683–700. [CrossRef]

61. Bouzarovski, S.; Bradshaw, M.; Wochnik, A. Making territory through infrastructure: The governance of natural gas transit in Europe. *Geoforum* **2015**, *64*, 217–228. [CrossRef]
62. Judge, A.; Maltby, T.; Sharples, J.D. Challenging Reductionism in Analyses of EU-Russia Energy Relations. *Geopolitics* **2016**, *21*, 751–762. [CrossRef]
63. Kropatcheva, E. He who has the pipeline calls the tune Russia's energy power against the background of the shale "revolutions". *Energy Policy* **2014**, *66*, 1–10. [CrossRef]
64. Aligica, P.D. Scenarios and the growth of knowledge: Notes on the epistemic element in scenario building. *Technol. Forecast. Soc. Chang.* **2005**, *72*, 815–824. [CrossRef]
65. Ministry of Economic Affairs and Employment. National Energy and Climate Strategy for 2030. Available online: tem.fi/documents/1410877/2769658/Government+report+on+the+National+Energy+and+Climate+Strategy+for+2030/0bb2a7be-d3c2-4149-a4c2-78449ceb1976 (accessed on 20 September 2017).
66. Statistics Finland. Official Statistics of Finland (OSF): Energy supply and consumption. Available online: pxhopea2.stat.fi/sahkoiset_julkaisut/energia2017/html/engl0000.htm (accessed on 4 May 2018).
67. Fingrid. Open Data. Available online: data.fingrid.fi/en/ (accessed on 20 September 2017).
68. Jääskeläinen, J.; Huhta, K. Trouble Ahead? An Interdisciplinary Analysis of Generation Adequacy in the Finnish Electricity Market. *Int. Energy Law Rev.* **2017**, *8*, 302–312.
69. Jääskeläinen, J.; Veijalainen, N.; Syri, S.; Marttunen, M.; Zakeri, B. Energy security impacts of a severe drought on the future Finnish energy system. *J. Environ. Manag.* **2018**, *217*, 542–554. [CrossRef] [PubMed]
70. Finnish Energy. Kaukolämpö 2016 ('District heat 2016'). Available online: energia.fi/files/1560/DH_statistics_2016_pre_20170214.pptx (accessed on 20 September 2017).
71. Finnish Energy. Summary of Energy year 2016 in Finland. Available online: energia.fi/ajankohtaista_ja_materiaalipankki/materiaalipankki/energiavuosi_2016_sahko_sahkonkaytto_kaantyi_nousuun.html#material-view (accessed on 20 September 2017).
72. Finnish Energy Authority. Power Plant Register. Available online: www.energiavirasto.fi/web/energy-authority/power-plant-register (accessed on 20 September 2017).
73. Strategic Reserve—Energiavirasto. Available online: www.energiavirasto.fi/en/web/energy-authority/strategic-reserve (accessed on 10 August 2018).
74. BP. Statistical Review of World Energy. Available online: www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf (accessed on 15 August 2018).
75. World Nuclear Association. Supply of Uranium. Available online: www.world-nuclear.org/information-library/nuclear-fuel-cycle/uranium-resources/supply-of-uranium.aspx (accessed on 23 August 2018).
76. World Nuclear Association. Energy for the World—Why Uranium? Available online: www.world-nuclear.org/information-library/nuclear-fuel-cycle/introduction/energy-for-the-world-why-uranium.aspx (accessed on 23 August 2018).
77. Gore, O.; Vanadzina, E.; Viljainen, S. Linking the energy-only market and the energy-plus-capacity market. *Util. Policy* **2016**, *38*, 52–61. [CrossRef]
78. Ernst & Young. Power Market Russia. Available online: www.ey.com/Publication/vwLUAssets/EY-power-market-russia-2018/$File/EY-power-market-russia-2018.pdf (accessed on 17 August 2018).
79. U.S. Energy Information Administration (EIA). Russia—International Analysis. Available online: www.eia.gov/beta/international/analysis.php?iso=RUS (accessed on 10 August 2018).
80. Pynnöniemi, K. Russia's National Security Strategy: Analysis of Conceptual Evolution. *J. Slav. Mil. Stud.* **2018**, *31*, 240–256. [CrossRef]
81. Bouzarovski, S.; Bassin, M. Energy and Identity: Imagining Russia as a Hydrocarbon Superpower. *Ann. Assoc. Am. Geogr.* **2011**, *101*, 783–794. [CrossRef]
82. Rutland, P. Petronation? Oil, gas, and national identity in Russia. *Post-Sov. Aff.* **2014**, *31*, 66–89. [CrossRef]
83. Tynkkynen, V.-P.; Oxenstierna, S. (Eds.) *Russian Energy and Security up to 2030*; Routledge: Abingdon, UK, 2014; ISBN 978-0-415-63964-4.
84. Ministry of Energy of the Russian Federation. Energy Strategy of Russia for the Period up to 2030. Available online: www.energystrategy.ru/projects/docs/ES-2030_(Eng).pdf (accessed on 24 August 2018).
85. Ministry of Energy of the Russian Federation. Proyekt Energostrategii Rossiyskoy Federacii na Period do 2035 goda ('Energy Strategy of Russia up to 2035 project'). Available online: https://minenergo.gov.ru/node/1920 (accessed on 24 August 2017).

86. Ministry of Energy of the Russian Federation. Prognoz Nauchno-Tehnologicheskogo Razvitiya Toplivo-Energeticheskogo Kompleksa Rossii do 2035 Goda ('Forecast of Scientific and Technological Development of Russian Heat and Power Sector for the Period up to 2035'). Available online: https://minenergo.gov.ru/node/6365 (accessed on 24 August 2018).
87. Gromov, A.; Kurichev, N. The Energy Strategy of Russia for the Period up to 2030: Risks and Opportunities. In *Russian Energy and Security up to 2030*; Oxenstierna, S., Tynkkynen, V.-P., Eds.; Routledge: Abingdon, UK, 2014; ISBN 978-0-415-63964-4.
88. Oxenstierna, S. Nuclear power in Russia's energy policies. In *Russian Energy and Security up to 2030*; Oxenstierna, S., Tynkkynen, V.-P., Eds.; Routledge: Abingdon, UK, 2014; ISBN 978-0-415-63964-4.
89. Thomas, S. Russia's Nuclear Export Programme. *Energy Policy* **2018**, *121*, 236–247. [CrossRef]
90. Kapustin, N.O.; Grushevenko, D.A. Exploring the implications of Russian Energy Strategy project for oil refining sector. *Energy Policy* **2018**, *117*, 198–207. [CrossRef]
91. Pöyry Management Consulting. Energia, Huoltovarmuus ja Geopoliittiset Siirtymät ('Energy, Security of Supply and Geopolitical Shifts'). Available online: tietokayttoon.fi/documents/10616/3866814/79_P%C3%B6yry_AI_energia_huoltovarmuus+ja+geopoliittiset+siirtym%C3%A4t_loppuraportti_151217_final.pdf/789a785e-18d9-4491-92e1-cd8524865bfd?version=1.0 (accessed on 21 August 2018).
92. Salonen, H. Public justification analysis of Russian renewable energy strategies. *Polar Geogr.* **2018**, *41*, 75–86. [CrossRef]
93. Smeets, N. The Green Menace: Unraveling Russia's elite discourse on enabling and constraining factors of renewable energy policies. *Energy Res. Soc. Sci.* **2018**, *40*, 244–256. [CrossRef]
94. Khrushcheva, O.; Maltby, T. The Future of EU-Russia Energy Relations in the Context of Decarbonisation. *Geopolitics* **2016**, *21*, 799–830. [CrossRef]
95. Abramova, A.; Garanina, O. Russian MNEs Under Sanctions: Challenges for Upgrading in GVCs (Cases of Energy and IT Industries). *J. East-West Bus.* **2018**, *0*, 1–21. [CrossRef]
96. Aalto, P.; Forsberg, T. The structuration of Russia's geo-economy under economic sanctions. *Asia Eur. J.* **2016**, *14*, 221–237. [CrossRef]
97. Belyi, A.V. Western Sanctions on Russian Hydrocarbons: Twofold Effects. *Oil Gas Energy Law Intell.* **2018**, *16*, 1–7.
98. Stephenson, S.R.; Agnew, J.A. The work of networks: Embedding firms, transport, and the state in the Russian Arctic oil and gas sector. *Environ. Plan. A* **2016**, *48*, 558–576. [CrossRef]
99. Tynkkynen, V.-P. Russian bioenergy and the EU's renewable energy goals: Perspectives of security. In *Russian Energy and Security up to 2030*; Oxenstierna, S., Tynkkynen, V.-P., Eds.; Routledge: Abingdon, UK, 2014.
100. President of Russia. Press Statements and Answers to Journalists' Questions Following Russian-Finnish Talks. Available online: www.en.kremlin.ru/events/president/news/51551 (accessed on 24 August 2018).
101. President of Russia. Joint News Conference with President of Finland Sauli Niinisto. Available online: www.en.kremlin.ru/events/president/news/51551 (accessed on 24 August 2018).
102. Tynkkynen, V.-P. Russia's Nuclear Power and Finland's Foreign Policy. *Russ. Anal. Dig.* **2016**, *11*, 2–5.
103. Natural Resources Institute Finland. Statistics Database. Available online: statdb.luke.fi/PXWeb/pxweb/fi/LUKE/?rxid=2df1507e-c55e-4aad-85a4-8f32ea957654 (accessed on 15 August 2018).
104. Fingrid. Cross-border Connections between Russia and Finland. Available online: www.fingrid.fi/en/services/power-transmission/400-kv-cross-border-connections-between-russia-and-finland/ (accessed on 10 August 2018).
105. ÅF-Consult Ltd. Selvitys Keinoista Sähkötehon Riittävyyden Varmistamiseksi Kulutushuipuissa ('A Report on Measures to Ensure Generation Adequacy during Demand Peaks'). Available online: www.energiavirasto.fi/documents/10191/0/Selvitys+keinoista+s%C3%A4hk%C3%B6tehon+riitt%C3%A4vyys+varmistamiseksi+kulutushuipuissa+-Raportti+%2800000004%29.pdf/d3ff1994-7f96-48ab-9123-b2a327635dbe (accessed on 20 September 2017).
106. Kuisma, M. *Valtion Yhtiöt: Nousu ja tuho ('State Companies: Rise and fall')*; Kustannusosakeyhtiö Siltala: Helsinki, Finland, 2016; ISBN 978-952-234-386-4.
107. Saastamoinen, J. *Brezhnevin Katoksessa Ja Muita Juttuja Nesteestä ('Under the Roof of Brezhnev and Other Stories of Neste')*; WSOY: Helsinki, Finland, 2007; ISBN 978-951-0-32997-9.

108. Neste. Nesteen Verojalanjälki ('Tax Footprint of Neste'). Available online: www.neste.com/fi/konserni/vastuullisuus/yhteiskunta/taloudellinen-vastuu/nesteen-verojalanj%C3%A4lki (accessed on 30 August 2018).
109. Popova, O.; Shuster, S. UPDATE 2-Fortum to Pay Record Price, $3 bln for TGK-10. Available online: www.reuters.com/article/fortum-tgk10/update-2-fortum-to-pay-record-price-3-bln-for-tgk-10-idUSL2815507620080228 (accessed on 24 August 2018).
110. Rusnano. New Investment Funds. Available online: www.en.rusnano.com/portfolio/investment-funds/wdif (accessed on 24 August 2018).
111. Simon, F. Rosatom Talks up Wind, Solar Power in Quest for 'Diversified Portfolio'. Available online: www.euractiv.com/section/energy/news/rosatom-talks-up-wind-solar-power-in-quest-for-diversified-portfolio/ (accessed on 24 August 2018).
112. Fortum. Fortum Closes Public Takeover Offer on Uniper. Available online: www.fortum.com/media/2018/06/fortum-closes-public-takeover-offer-uniper (accessed on 24 August 2018).
113. Vihma, A.; Wigell, M. Unclear and present danger: Russia's geoeconomics and the Nord Stream II pipeline. *Glob. Aff.* **2016**, *2*, 377–388. [CrossRef]
114. Delyagin, M. Kogda Gosti Stanovyatsya Xozyaevami: Zashita Zhiznenno Vazhnyh Dlya Rossii Otrasley Ekonomiki Dolzhna Byt Absolyutnoy ('When Guests Become Hosts: Protection of Vital Economic Sectors for Russia Must Be Absolute'). Available online: www.rg.ru/2018/04/11/zashchita-zhiznenno-vazhnyh-dlia-rossii-otraslej-ekonomiki-dolzhna-byt-absoliutnoj.html (accessed on 24 August 2018).
115. Sutinen, T.; Hakala, P. Fortumista Tuli Valtapelin Väline—Kokosimme Kahdeksan Keskeistä Kysymystä Venäjän Virallisen Lehden Virheellisistä Kirjoituksista, Jotka Saivat Energiayhtiön Ryhtymään Oikeustoimiin ('Fortum Became an Object of Power Games—We Gathered Eight Key Issues of Incorrect Writing of Russian Offical Newspaper That Lead Fortum to Legal Actions'). Available online: www.hs.fi/talous/art-2000005643454.html (accessed on 31 August 2018).
116. Manskiy, S. Finskaya Kompaniya Investirovala v Rossii 4,5 Milliarda Evro ('Finnish Company Invested on Russia Worth of 4,5 Billion Euros'). Available online: www.rg.ru/2018/04/22/finskaia-kompaniia-investirovala-v-rossii-45-milliarda-evro.html (accessed on 28 August 2018).
117. Litmanen, T.; Kari, M.; Kojo, M.; Solomon, B.D. Is there a Nordic model of final disposal of spent nuclear fuel? Governance insights from Finland and Sweden. *Energy Res. Soc. Sci.* **2017**, *25*, 19–30. [CrossRef]
118. Kojo, M.; Litmanen, T. (Eds.) *The Renewal of Nuclear Power in Finland*; Palgrave Macmillan: London, UK, 2009; ISBN 978-1-349-36588-3.
119. Foy, H. Rosatom Powers through Nuclear Industry Woes. Available online: www.ft.com/content/774358b4-5a4a-11e7-9bc8-8055f264aa8b (accessed on 24 August 2018).
120. Mörttinen, M.; Nurmi, L. *Sauli Niinistö—Mäntyniemen herra ('Sauli Niinistö—Master of Mäntyniemi')*; Into Kustannus Oy: Helsinki, Finland, 2018; ISBN 978-952-264-942-3.
121. Loikkanen, J. Rehn: Fennovoiman Ydinvoimalahankkeen Kaatuminen Oli Hyvin Lähellä ('Rehn: Cancelling Fennovoima Nuclear Power Plant Project Was Very Close'). Available online: https://www.mtv.fi/uutiset/kotimaa/artikkeli/rehn-fennovoiman-ydinvoimalahankkeen-kaatuminen-oli-hyvin-lahella/5856860#gs.x9ffQjo (accessed on 13 September 2018).
122. Kyytsönen, J. Fennovoiman Hinta Noussut jo 6,5–7 Miljardiin Euroon ('The Costs of Fennovoima Increased Already up to 6,5-7 Billion Euros'). Available online: www.maaseuduntulevaisuus.fi/talous/artikkeli-1.225844 (accessed on 26 February 2018).
123. Ministry of Economic Affairs and Employment. Energia- ja Ilmastotiekartta 2050 ('Energy and Climate Roadmap 2050'). Available online: tem.fi/documents/1410877/2628105/Energia-+ja+ilmastotiekartta+2050.pdf/1584025f-c5c7-456c-a912-aba0ee3e5052 (accessed on 21 August 2018).
124. Riahi, K.; Rao, S.; Krey, V.; Cho, C.; Chirkov, V.; Fischer, G.; Kindermann, G.; Nakicenovic, N.; Rafaj, P. RCP 8.5—A scenario of comparatively high greenhouse gas emissions. *Clim. Chang.* **2011**, *109*, 33. [CrossRef]
125. Knapp, V.; Pevec, D. Promises and limitations of nuclear fission energy in combating climate change. *Energy Policy* **2018**, *120*, 94–99. [CrossRef]
126. Lehtveer, M.; Hedenus, F. How much can nuclear power reduce climate mitigation cost? – Critical parameters and sensitivity. *Energy Strategy Rev.* **2015**, *6*, 12–19. [CrossRef]
127. Olkkonen, V.; Rinne, S.; Hast, A.; Syri, S. Benefits of DSM measures in the future Finnish energy system. *Energy* **2017**, *137*, 729–738. [CrossRef]

128. Kyriakopoulos, G.L.; Arabatzis, G. Electrical energy storage systems in electricity generation: Energy policies, innovative technologies, and regulatory regimes. *Renew. Sustain. Energy Rev.* **2016**, *56*, 1044–1067. [CrossRef]
129. Astiaso Garcia, D.; Barbanera, F.; Cumo, F.; Di Matteo, U.; Nastasi, B. Expert Opinion Analysis on Renewable Hydrogen Storage Systems Potential in Europe. *Energies* **2016**, *9*, 963. [CrossRef]
130. Ikäheimo, J. Power-to-gas plants in a future Nordic district heating system. In Proceedings of the 11th International Renewable Energy Storage Conference (IRES 2017), Düsseldorf, Germany, 14–16 March 2017; Volume 135, pp. 172–182. [CrossRef]
131. Simon, F. France to Push for EU Carbon Price Floor and Border Tariff. Available online: www.euractiv.com/section/energy/news/france-to-push-for-eu-carbon-price-floor-and-border-tariff/ (accessed on 24 August 2018).
132. Van Sluisveld, M.A.E.; Harmsen, M.J.H.M.; van Vuuren, D.P.; Bosetti, V.; Wilson, C.; van der Zwaan, B. Comparing future patterns of energy system change in 2 °C scenarios to expert projections. *Glob. Environ. Chang.* **2018**, *50*, 201–211. [CrossRef]
133. Luderer, G.; Vrontisi, Z.; Bertram, C.; Edelenbosch, O.Y.; Pietzcker, R.C.; Rogelj, J.; De Boer, H.S.; Drouet, L.; Emmerling, J.; Fricko, O.; et al. Residual fossil CO_2 emissions in 1.5–2 °C pathways. *Nat. Clim. Chang.* **2018**, *8*, 626–633. [CrossRef]
134. Schot, J.; Kanger, L. Deep transitions: Emergence, acceleration, stabilization and directionality. *Res. Policy* **2018**, *47*, 1045–1059. [CrossRef]
135. Riahi, K.; Kriegler, E.; Johnson, N.; Bertram, C.; den Elzen, M.; Eom, J.; Schaeffer, M.; Edmonds, J.; Isaac, M.; Krey, V.; et al. Locked into Copenhagen pledges—Implications of short-term emission targets for the cost and feasibility of long-term climate goals. *Technol. Forecast. Soc. Chang.* **2015**, *90*, 8–23. [CrossRef]
136. Raftery, A.E.; Zimmer, A.; Frierson, D.M.W.; Startz, R.; Liu, P. Less than 2 °C warming by 2100 unlikely. *Nat. Clim. Chang.* **2017**, *7*, 637. [CrossRef] [PubMed]
137. McCollum, D.L.; Zhou, W.; Bertram, C.; de Boer, H.-S.; Bosetti, V.; Busch, S.; Després, J.; Drouet, L.; Emmerling, J.; Fay, M.; et al. Energy investment needs for fulfilling the Paris Agreement and achieving the Sustainable Development Goals. *Nat. Energy* **2018**, *3*, 589–599. [CrossRef]
138. Wu, X.F.; Chen, G.Q. Global primary energy use associated with production, consumption and international trade. *Energy Policy* **2017**, *111*, 85–94. [CrossRef]