



Under the Damocles Sword: Managing Swedish energy dependence in the twentieth century

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ABSTRACT

In 1900 a Swedish member of parliament argued that Sweden had a Damocles Sword hanging over it due to the country's rapidly growing imports of coal. This energy import dependence has continued to plague Sweden ever since. While coal dominated imports in the first half of the twentieth century, oil and uranium dominated in the second half. This article examines how Swedish public and private actors coped with the country's energy dependence. Several crises prompted such efforts. Coal strikes in the Interwar years and oil embargoes in the 1970s spurred diversification and collaboration with other importing countries. During World War II Sweden built trustful coal relations with Nazi Germany and stockpiled coal. In the post-war era fear of the international oil majors spurred attempts to increase public control over energy imports, and a state-owned company for foreign oil exploration was set up. Moreover, during and after wars and other acute crises Swedish actors intensified their efforts to exploit more of the country's domestic energy resources. However, when the crisis was over it often proved to be cheaper to import energy from abroad. Thus imports have remained high and the Damocles Sword is still hanging over Sweden.

1. Introduction

In January 1900 Nils Persson, an industrialist from Helsingborg and member of the Swedish parliament, submitted a parliamentary motion of the more unusual kind. The message was that Sweden's coal imports were growing at an unprecedented pace, and that these imports posed a serious threat to the country. Total coal imports had doubled in the past ten years and now amounted to more than 3 million tons on an annual basis; coal had become Sweden's single largest import commodity, he pointed out. "Our industry, our communications, our floating defence are thus ... dependent on imported coal. In case of war, with a blockade of our harbours, ... our defence and our industries would face the most utter difficulties due to lack of fuel. ... Our country's entire independence and economy thus has a Damocles sword constantly hanging over it" (Motions in the First Chamber 1900, No. 13.).

To reduce the dependency on imported coal Persson proposed the exploitation of domestic peat resources, arguing that these resources were almost inexhaustible, corresponding to 4 billion tons of coal. He further argued that a major obstacle to their wider use was the high transportation costs, and he therefore proposed that the freight rates for peat on the State Railways be reduced by 50%. Persson's motion was successful in the sense that it led to a lowering of the freight rates for peat, but in the end this did not stimulate a large-scale production of

domestic peat, nor did it prevent a further increase of coal imports. On the contrary, Swedish coal imports continued to grow until the mid-20th century, apart from interruptions during the wars. After that, they were rapidly replaced by huge imports of oil and later on also by uranium. In the 1970s, Swedish energy imports peaked; at that time they made up 75% of the country's total energy supply. Today, energy imports still exceed 60% of total supply. The Damocles sword has thus kept hanging over Sweden for more than a century and at times, in particular during the two world wars, the string holding the sword has been on the verge of bursting.

This article analyses various strategies that Swedish actors – politicians, industrialists, government officials – have used to handle dependencies on energy imports. They have adopted two main approaches. Firstly, they have sought to *reduce the vulnerability of energy imports* by diversifying imports in terms of countries and type of sources, by building trustful relations with exporters or by cooperating with other importers, by stock-piling fuel, by building flexible heat and power plants, etc. Secondly, they have sought to *reduce the need for imports* by developing and expanding domestic energy sources such as hydropower, bioenergy and peat, and by increasing energy efficiency. Sweden is an interesting country to study when it comes to energy dependence because it has imported most of its energy from abroad even though it is rich in domestic resources such as wood, peat and

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uranium. Moreover, Sweden has pursued a foreign policy centred on neutrality, and has succeeded in staying outside both world wars. How has this foreign policy impacted on energy import policies? How did Sweden cope with its energy dependence during the wars? And how have the perceptions of energy dependency and the ways to handle it changed over time? The article has a chronological structure and focuses on six phases, each one featuring different characteristics regarding energy imports.

2. The emergence of Sweden's coal dependence

The Swedish dependency on coal imports was a fairly recent phenomenon at the time when Nils Persson submitted his parliamentary motion. Until the mid-19th century, Sweden had been almost self-sufficient in energy supply. Sweden had ample resources of forest, waterfalls and farmland, and consequently wood, charcoal, hydropower and fodder and food for animals and humans were the major energy sources – in an economy that was still dominated by agriculture. During the second half of the 19th century, and in particular after 1870, the imports of coal grew very rapidly in response to a fast industrialization process. A growing number of steam engines were installed in industries and for transportation purposes (railways and steamboats), while the country's burgeoning iron industry embarked on a transition from domestic charcoal to imported coke. From the 1850s onwards gasworks were established in many cities and towns, and in the last two decades of the century electricity generation emerged as another promising market for the black fuel. Moreover, urban households started replacing firewood with coal and coke for heating on a large scale; as of 1870 no less than 40% of all coal was used in domestic heating (Kander, 2002). Some decades later, in 1913, industry used about 60% of all coal and coke, transport another 30%, and households about 10% (Enström, 1917).

Why did Sweden import so much coal from abroad, when the country had ample access to domestic energy sources? The main reason is that imported coal was cheaper. This was so especially from 1850 onwards, at least in part of the country (Kander, 2002, p. 146). However, the cost of coal depended strongly on transportation. As the railway network grew rapidly in Sweden in the last decades of the 19th century, cheap coal, imported mainly from England, became available in cities, towns and industries on the coast and along the railways, while firewood remained the major fuel in the countryside. Besides the price, the special qualities of coal and coke, not least in terms of their high energy density, were very important in numerous applications (Göth, 1939).

The Swedish state had a positive attitude towards the import of coal and did not impose any duty on it. When a parliamentarian in 1892 proposed the introduction of such a duty to stimulate the use of domestic energy sources, the parliamentary committee handling the motion responded: "To impose duties on fuels like coke and coal, which are not only essential for our whole industry but also, due to the cold climate of our country, are used in considerable amounts in private homes, the committee cannot approve [the duty], but recommends that the duty exemption on these products remains." (*Bevillningsutskottets betänkande No. 9, 1892*)

The first coal imports to Sweden were handled by British trading firms, but gradually Swedish traders were able to enter the coal business. From the 1870s Swedish trading houses started to import coal first as a side business, when their ships returned home after bringing Swedish products to Britain, but gradually on a larger scale. In 1902, the Swedish Coal Importers Association, SSIF, was established by 22 leading coal traders in order to strengthen the position of Swedish traders on the Swedish market. By 1914 it had 71 members which together imported more than 80% of all coal and coke (Molin, 1952). To decrease the heavy dependence on British suppliers, Swedish traders began to buy coal and coke also from Germany, thus diversifying their supply. But as of 1914 Germany still only supplied 7% of the total (SOU

1922:14, p. 12).

In the beginning of the 20th century coal floated steadily from coal mines abroad to energy users in Sweden along arteries created by railways and sea routes. However, occasionally these flows were interrupted by strikes. The British coal-miners were very militant and major strikes took place in 1890, 1893, 1910 and 1912 – with repercussions in the form of coal shortages and increased prices in Sweden (Mitchell, 2011). The Swedish workers also posed threats to the country's coal supply. In April 1908 a dock worker strike spread to all Swedish harbours. The conflict escalated when some stevedoring companies brought strike-breakers from Britain. In Malmö a boat on which strike-breakers were housed was exposed by a bomb attack, killing one strike-breaker and severely injuring seven others. The Swedish Employers Federation reacted by giving notice of a general lockout. This made the government appoint a conciliation commission, which was able to achieve an agreement between the employers and the trade unions. After more than three months the coal import was resumed – but the dock workers had demonstrated their ability to disrupt the vital flow of a critical energy source (Molin, 1952).

In parallel with the rapidly growing imports of coal, a number of Swedish actors eagerly sought to develop domestic energy sources. Some focused on finding fossil fuels. Sweden had only one coal mine, in Höganäs in southern Sweden. It had been operating for several centuries and had a yearly production of about 350,000 t in the beginning of the 20th century. This coal was of rather low quality, and most of it was used in the immediate vicinity of the mine (Sundin, 1981). Around the turn of the century 1900 several motions were put forward in Parliament demanding that the Government finance the exploration for additional coal fields through deep drilling. The proposal was rejected because of the high costs involved but a more superficial investigation was approved (*Statsutskottets utlåtande No. 166, 1907*). Furthermore, Sweden had some known oil-shale resources and a parliamentary motion submitted in 1912 suggested that the possibilities to produce oil products from these resources be studied in further depth. The motion was approved and a commission with three experts was set up, which presented its findings in 1919 (Sundin, 1981).

However, the likelihood of finding major fossil-fuel resources in Sweden seemed small and many analysts argued that the main emphasis should be on developing the country's rich wood and peat resources. At an aggregate level, wood was still the major energy resource in Sweden at the turn of the century, both for heating and cooking in households in the countryside and in small towns and for making charcoal for the iron industry. But there was growing competition for the forest resources from the rapidly expanding sawmill and pulp and paper industries, which generated most of Sweden's export incomes. According to forest experts, Sweden was already cutting as many trees as was sustainable in the long run, and the main interest, therefore, was in new ways of exploiting waste products from sawmills, pulp and paper mills and from charcoal production. Following a 1902 parliamentary motion the Government decided to fund a long-term research project at the Royal Institute of Technology with this aim (Sundin, 1981). The project resulted in five exhaustive volumes on the properties of the chemical and technical properties of Swedish sorts of wood (*Kemisk-tekniska undersökningar, 1909–1930*).

Nils Persson and many others also saw peat as a huge potential source of fuel, and unlike wood there was no competition from other industries for this natural resource. As mentioned above, freight rates for peat on the state-owned railways were reduced by 50% in 1900 and a range of further measures were taken by the government in the following decade to stimulate domestic peat production. Among other things, a peat school was established, state peat engineers were employed and the State Railways and other state companies were encouraged to switch to peat as a fuel (Brinell, 1916). However, these measures had only a very limited effect, the main reason being that peat, the governmental support notwithstanding, remained much more expensive than imported coal (Sundin, 1981).

By contrast, the efforts to exploit Sweden's waterfalls – often referred to as Sweden's “white coal” – for electricity generation were much more fruitful. The invention of alternating current (AC) technology during the 1890s made it possible to transmit electric power over long distances, and thus waterfalls located far from urban areas and industrial plants could be taken into use for power generation. As it seemed, hydropower could become much cheaper than electricity generated in coal-fired plants. In the first decade of the 20th century a number of regional power companies were established in various Swedish regions, often with municipal utilities and energy-intensive industries as shareholders. Moreover, in 1909 the government set up a State Power Board, dubbed Vattenfall, which it charged with exploiting a number of very large, state-owned waterfalls. Vattenfall was the world's first state-owned power producer. Vattenfall and the private power companies built regional electricity grids in many parts of southern and middle Sweden in the early 20th century. By 1914, 70% of all electricity was generated in hydropower stations, as compared to 60% in 1900 and only 18% in 1885 (Hjulström, 1940). More than 90% of the electric power was used for industrial purposes and the low cost of hydroelectricity gave many Swedish energy-intensive export industries a major competitive advantage. One of Sweden's leading electrical engineers, Axel F. Enström, estimated that if the electricity generated in the country's hydropower stations would have been produced in coal-fired plants, the country's coal imports would have increased by 65% in the early 1910s (Enström, 1917).

3. World War I: coping with energy shortages

When World War I broke out Sweden declared itself neutral and during the first two and half years of the war imports of coal and coke continued without much interruption. In fact, the imports in 1916 were higher than ever before, totalling 6.2 Mton, due to the boom in Swedish industry which was supplying the belligerent nations with goods that their industries could not produce because of shortage of labour. However, a major change occurred in the *origin* of the coal shipped to Sweden; in 1916 Britain supplied only 27% and Germany 71%. This was because Britain prioritized supplies to its navy and its allies France and Italy, while Germany lost its pre-war exports to these countries and was looking for new markets for its excess supply (SOU 1922:14, p. 12).

After Germany launched unrestricted submarine warfare in February 1917, the imports of coal fuels from Britain decreased drastically, due to rapidly increasing freight costs. At the same time the German government took control of all fuel exports in an effort to come to grips with growing domestic demand in a strained war economy. The Swedish government negotiated a trade agreement with the German government, whereby Swedish access to German coal was conditioned by guarantees from the Swedish side that the coal would not be used for the production of strategic goods intended for Germany's enemies (SOU 1922:14, p. 270). Germany's more restrictive policy meant that the total coal imports to Sweden in 1917 were only 2.3 Mton, or roughly one-third of the 1916 level. To cope with this difficult new situation, the Swedish government established a Fuel Commission, consisting of government officials and industrialists, who were charged with planning and managing the country's fuel supply. It introduced a rationing system for coal and coke so that the most urgent needs were met first. This meant that the Commission took total control of the Swedish coal market. The main task of the Fuel Commission was to rapidly increase the domestic production of fuelwood. It quickly established a large administration for managing large-scale felling in state-owned forests as well as railway transports to cities. It also took care of storage, and it sold wood through a rationing system at fairly low prices (SOU 1922:14). However, the Fuel Commission was in the end not able to meet the enormous demand for wood that resulted from the disruption of coal supplies. As a result, a parallel black market evolved, featuring much higher prices. This in turn made it very lucrative for unscrupulous dealers to sell the official wood at black market prices (Schön, 1993).

Sweden's import of oil products also decreased dramatically in 1917. In particular, the lack of kerosene for lighting posed difficulties, not least in rural areas. This spurred efforts aimed at electrification of the countryside. Vattenfall and private power companies helped farmers to establish electricity cooperatives and a state fund for rural electrification was established in 1918. As a result the number of electricity cooperatives increased tenfold during the war. In the early 1920s about half of the larger farms were electrified (Modig, 1984).

4. The interwar years: shifting dependency patterns

The first priority for the government after the war was to try to re-establish coal imports. However, both the German and the British mining industries faced enormous problems and it took several years for them to recover. As a result coal prices remained very high and Swedish coal imports were even lower in 1919 than in 1918. In the spring of 1920 the Swedish government feared a further shortage of coal and it put pressure on the Swedish coal traders to sign contracts with suppliers from faraway countries like the United States and Australia – even if this meant high transportation costs. However, coal prices fell dramatically in the autumn of 1920 in conjunction with a deep post-war recession in Europe, and a number of the coal traders that had signed long-term contracts went bankrupt (Molin, 1952).

Another Swedish strategy to cope with the crisis took the form of attempts to exploit coal in the Arctic archipelago of Svalbard (Spitsbergen). In 1917 Swedish mining industrialists had established the Spitsbergen Coal Company, which built a small coal mine there. Mining under Arctic conditions was challenging and the company asked the Swedish government for state support, arguing that Svalbard could become an important future coal supplier – and a Swedish colony. In 1921 the government decided to engage in the endeavour, but by then the world coal prices had already started to fall. During the following years the Swedish coal mine on Svalbard made huge losses and after a devastating fire in the mine in 1926 it was sold and the company was dissolved (Avango, 2005).

In the first half of the 1920s Britain regained its traditional position as the dominant coal exporter to Sweden and Scandinavia. In 1923 SSIF together with its counterparts in Denmark and Norway formed the Scandinavian Coal Importers' Association. The purpose of this Association was to obtain more favourable trade deals through co-operation among buyers (Olsson, 2010). In the mid-1920s the north European coal market experienced a dramatic change. Poland was a new nation after the war and coal was one of its few export products. Through low wages and government subsidies Polish coal exporters competed with low prices, and in 1925 a new railway from the Silesian coal fields to Gdynia on the Baltic coast was completed. When Britain experienced a long-lasting miners' strike in 1926, the doors for Polish coal were opened in Sweden and the other Nordic countries. Five years later the Polish share of Swedish coal imports had grown to no less than 58%, while the British share was only 25% (Olsson, 2011).

In the early 1930s the British government fought hard to regain its market shares on foreign coal markets. In this context it demanded bilateral trading agreements from some of its major trading partners, including Sweden. Britain was a very important market for Swedish industry, and the Swedish-British negotiations resulted in an agreement in March 1933, which guaranteed Sweden very low duties on the British market for its main export products – pulp, paper and steel – in return for a Swedish commitment to source 47% of the country's coal import from Britain. It was no easy task for the Swedish government to convince Sweden's coal traders to implement this agreement, as British coal was more expensive than Polish. However, the Swedish industrialists that were most dependent on exports to Britain agreed to buy British coal and so Sweden was able to fulfil its part of the bilateral deal (Olsson, 2011; Nilsson, 1983).

During the interwar years coal was by far the dominant Swedish energy source. However, the import of oil products grew quickly. Most

of the oil was used for transportation purposes – for cars and trucks. There was a huge difference in the market organization of oil as compared to coal. While the flow of coal was handled by thousands of traders and retailers, almost all of which were Swedish enterprises, the flow of oil to Sweden was controlled by five foreign, global companies: Standard Oil of New Jersey, Shell, Texaco, BP and Gulf. In the mid-1920s they had all established subsidiaries in Sweden. In the following decade they built no less than 12,000 petrol stations in Sweden, through which they supplied the Swedish car, truck and bus fleets with 1.2 million tonnes of petrol and diesel in 1939 (Olsson, 2011). Besides the foreign giants there were two small Swedish importers. One of these was a cooperative association, IC (later renamed OK), founded in 1926 by vehicle owners wishing to lower fuel prices through cooperation (Stolpe, 1967). The other company, Nynäs Petroleum, was founded in 1931 by a major coal trader, Axel Ax:son Johnson, who built a refinery at Nynäshamn on the Baltic coast just south of Stockholm (De Geer, 1998). By the end of the 1930s these two Swedish companies sold no more than 1% of all oil products in Sweden. The pervasive dominance of the foreign oil companies on the Swedish market was criticized by Leftist politicians. In the mid-1930s three consecutive government commissions were given the task to analyse the Swedish oil market. However, none of the commissions dared put forward any concrete proposals to alleviate the foreign dominance (Lundgren, 1978).

Imported coal and oil supplied a growing share of Sweden's total energy needs during the Interwar years. This worried many Swedish industrialists, politicians and militaries, who had the energy shortages during the war and its aftermath in fresh memory. The Swedish Academy of Engineering Sciences (IVA) was established by leading engineers in 1919, one of its main goals being to organize and conduct research and investigations in the energy field. IVA focussed on measures for increasing energy efficiency in industrial processes and in domestic heating as well as on possibilities for using domestic fuels. A particular interest was devoted to methods for using wood or peat for fuelling cars. One option was to produce liquid fuels like ethanol from sulphite or by hydrogenation of wood or peat. Another was to construct small wood gas generators to be mounted directly on vehicles that would gasify wood or charcoal and feed the motor with gas. All these options proved to be technically feasible, but much more expensive than importing petrol (Sjölander et al., 2014; Sundin, 1981).

The only domestic energy source which was clearly economically viable was hydropower, and a fast expansion of power plants and grids took place in the Interwar years. A close cooperation evolved between major power companies (not least Vattenfall), major electrical equipment suppliers (primarily ASEA, now ABB) and energy-intensive industries (especially metal industries and pulp and paper mills). The electricity use in the steel and paper industries grew rapidly. Furthermore, some of the major railway tracks were electrified. To meet the growing demand for power the main power producers wanted to transmit hydropower from rivers in the north to cities and factories in Sweden's industrial heartlands. A prerequisite for this, however, was the development of new high voltage technology. ASEA collaborated closely with Vattenfall in this endeavour. As a result a number of very long 200 kV transmission lines were built in the Interwar years (Fridlund, 1999).

5. World War II: Nazi coal and domestic gasifiers

Germany's invasion of Poland in September 1939 immediately cut Polish coal exports to Sweden. The Swedish government was afraid that deliveries from other countries would be affected as well and immediately took steps to secure energy imports. Shortly after the outbreak of the war it established a Coal Commission, charging it with controlling all coal imports to the country in cooperation with the largest Swedish coal trading companies. The government sent trade delegations to Berlin and London, comprising diplomats and leading industrialists – including the brothers Jacob and Marcus Wallenberg,

owners of Sweden's largest bank – to negotiate the terms of trade with Britain and Germany. Iron ore was Sweden's trump card in Berlin. In December 1939 the Swedes struck an agreement with the Hitler regime, which promised to supply Sweden with 4.5 million tons of coal fuels in return for 10 million tons of iron ore during 1940. Export of iron ore to Nazi Germany was a sensitive issue vis-à-vis Britain, and before signing the agreement, the Swedish negotiators informed the British government about what was about to happen. The British, unsurprisingly, were not happy about large-scale Swedish ore exports to their main enemy in the war, but since they were not able to offer coal exports themselves, they informally approved of the agreement (Häggblöf, 1958).

After the German occupation of Denmark and Norway in April 1940, the Swedish trade with Britain ceased almost completely and Sweden became increasingly dependent on its trade with Germany. The trade agreement with Germany was renewed each year until 1944 with the same amounts of coal fuels and iron ore, even though the Allies put increasing pressure on Sweden to reduce its ore exports. The trade relations between Sweden and Germany during the war were very business-like, building on mutual trust. In the autumn of 1939, for example, the German negotiators, citing huge strains on the German railway system, wished to borrow 500 Swedish railway wagons. The Swedes accepted the request and the wagons were shipped to Germany, where they were used in shuttle traffic from the mines to the export harbours. When the coal exports from Germany eventually ceased in August 1944, Sweden requested that the Germans send back the wagons, which they also did – in spite of their desperate economic and military situation (Olsson, 1975).

Oil imports were also heavily affected by the war. Almost all of Sweden's oil came from faraway countries, most of it from America. These imports were cut off in April 1940. Thanks to an agreement with Germany, Sweden managed to buy small quantities of oil products from Rumania, which were transported by rail through German-controlled territories. But total imports decreased to less than 10% of the pre-war level. Oil products had to be prioritized for defence purposes, and Sweden's civilian fleet of trucks, buses and cars threatened to come to a standstill due to lack of fuel. Now the big investments in research that Sweden had pursued in the Interwar years paid off. When the war broke out the government immediately set up a special Wood Gas Commission, chaired by the head of IVA, to promote the production of wood gasifiers. Within two years nearly 75,000 vehicles had been equipped with gasifiers. The gas powered vehicles rolled slower and caused pollution and health problems to the drivers, but the new technology achieved what it had been developed for: a major part of the commercial vehicle fleet – trucks, buses and taxis – could continue rolling using domestic wood and charcoal as fuels (IVA, 1950). Moreover, the government established a state owned company for producing oil from oil shale deposits at Kvarntorp, 200 km west of Stockholm. It also supported the production of ethanol based on fuelwood. But the domestic production of these liquid fuels was fairly modest, and it was without doubt the gasifiers that played the key role in keeping the Swedish car fleet afloat during the war (SOU 1952:50, p. 841ff).

Building on the experience from the First World War, the Swedish government established a Fuel Commission in 1940, into which the Coal Commission and the Wood Gas Commission were incorporated. It consisted of government officials and industrialists and was given a broad mandate and substantial powers. One of its tasks was to quickly increase the output of wood and peat for replacing coal and for supplying the gasifiers. Unlike the Fuel Commission in the First World War, it did not organize large scale felling and marketing of the wood. Instead, it focused on regulating the prices. This policy was more successful than the First World War policy; the production of fuelwood and peat more than doubled. Tens of thousands of forest workers were relieved from war service to cut trees and dig out peat, and a considerable part of Sweden's railway wagons were put to use for transporting wood and peat to cities and industries. Luckily much of the railway network

had been electrified in the previous decades. Another task of the Fuel Commission was to regulate the coal and coke imports from Germany, and to make sure that part of this fuel was stored in reserve stocks (SOU 1952:50). By 1944 these stocks had grown to about 5 million tons and became an invaluable asset in the following two years, when coal imports almost ceased completely (Olsson, 1975).

World War II signified the most profound shift of Sweden's energy supply ever. The mobilization of domestic energy resources increased radically through concerted efforts of all sectors of society, orchestrated by powerful Government Commissions. However, unless Sweden had been able to import coal and coke from Germany, its energy situation would have become precarious, particularly in urban areas, and many industries would have come to a standstill. It was the fear that this nightmare would become reality that pushed Sweden, while formally a neutral state throughout the war, to strike a strategic partnership with Hitler. It was Nazi coal, more than anything else, which prevented the string holding the Damocles sword from bursting.

6. The cold war: oil vulnerability and nuclear ambitions

An urgent task for the Government when the war ended was to re-establish imports of coal and oil. A trade delegation was immediately sent to Warsaw, as it was obvious that Britain and Germany would not be able to export coal for a long time. In the summer of 1945 an agreement was reached and Poland became Sweden's main coal supplier in the following years. The deal helped Sweden to reach, by the late 1940s, its pre-war consumption level, even though the Polish mining industry had great difficulties fulfilling its commitments. In return for Polish coal Sweden exported not only industrial products like iron ore, pulp and paper, machinery and ball bearings, but also horses for Poland's agriculture (Olsson, 1988; Karlsson, 1992). This trade with Poland became controversial when the Cold War intensified (cf. Rüdiger, this issue). The United States and its allies were introducing a policy of export controls to the Eastern Bloc and put pressure on Sweden to refrain from exporting products such as ball bearings, since these were defined as strategic items. However, Britain was not willing to increase its coal exports to Sweden due to escalating domestic demand, and American coal was too expensive. Thus Sweden continued importing a substantial part of its coal from Poland until the mid-1950s, while keeping its ball-bearing exports very limited (Nilsson, 1991).

In contrast to the European coal mines, the oil fields in America had not been affected by the war, and oil imports were resumed very quickly after the war's end. In 1947 Sweden imported no less than 3 million tons of oil – twice the pre-war level. When petrol became available, car owners quickly dismantled their filthy gasifiers. By 1950 there were only 500 cars that still had gasifiers. The international oil companies were thus back in business at a very early stage. Once again, however, their dominance aroused controversy in Sweden. The possibility of nationalizing oil imports was seriously discussed among the economists and politicians in charge of planning the nation's post-war recovery. Gunnar Myrdal, a leading economist, was appointed Minister of Trade in the new Social Democratic government that took office in July 1945 and immediately set up a Government Commission to investigate the future organization of the Swedish oil market (Jonter, 1995). In its final report, presented in February 1947, the commission recommended a nationalization of the oil market, through the establishment of a company with 51% state ownership. However, the commissioners were not unanimous; a minority opposed nationalization, among them the commission's chairman, K.-G. Ljungdahl, one of the managers of the war-time Fuel Commission (SOU 1947:14, p.299ff).

The proposal to nationalize the oil companies was also heavily criticized by conservative and liberal politicians, and by parts of the ruling Social Democrats. While proponents of nationalization argued that a Swedish oil company could make direct deals with oil exporting countries, the opponents claimed that the big oil companies controlled the international oil market anyway, and that it would be safer to keep

good relations with them. Moreover, they were concerned about how the United States would react to a Swedish nationalization (Jonter, 1995). Washington was indeed alarmed about the Swedish nationalization plans. A strategic goal for the United States was to prevent West European dependence on coal imports from the East Bloc. The US aimed to make oil the new major fuel in Western Europe, drawing mainly on oil flows from the Middle East, where US-based oil companies were becoming increasingly important. A Swedish decision to nationalize oil imports, the US feared, might inspire other West Europeans as well and the US government exerted considerable pressure on the Swedish government to shelve the nationalization proposal. In the end, the Swedish government did not dare challenge the US and decided to refrain from nationalization. Minister of Trade Gunnar Myrdal then resigned (Jonter, 1995).

With the harsh experiences from the war in fresh memory Sweden's future energy supply was much discussed in the late 1940s and early 1950s. In particular, how could the country's energy import dependence be reduced? All analysts agreed that the expansion of hydropower should continue at a high pace. The world's first 400-kV transmission line was built in Sweden in 1952; as a result, a national grid covering the whole country was completed and ASEA became a world leader in high-voltage technology (Fridlund, 1999; Högselius and Kaijser, 2007). It was clear, however, that the available hydropower would be exploited within three decades if the growth in electricity consumption continued as before. Thus a number of additional pathways for the future energy supply were explored. A government commission was set up and in a preliminary report, authored by the above mentioned K-G Ljungdahl, a whole array of options were outlined. These comprised not only the developments of domestic energy sources like peat, wood, shale oil, wind power and uranium, but also the potential for more energy-efficient buildings, for building flexible district-heating systems with combined heat and power plants, and for introducing heat pumps (SOU 1951:32). However, a few years later almost all attention was focused on only one of these options: nuclear energy.

In parallel with these discussions Sweden experienced a period of fast economic growth under a long lasting Social Democratic government, led by Tage Erlander, Prime Minister from 1946 to 1969. The country also experienced an exceptionally fast increase of oil imports; the share of oil in Swedish energy supply rose from 20% in the late 1940s to more than 70% in the early 1970s. The car traffic boom was one important reason; no other European country experienced a similar growth in the number of cars. It was encouraged by two growing car manufacturers, Volvo and Saab. Besides petrol and diesel for vehicles, heavy oil was increasingly used, replacing coal for the heating of dwellings, for industrial applications and for electricity generation. This transition was spurred by lower prices and the much easier handling of oil compared to coal. The share of coal in Swedish energy supply fell from almost 40% in 1950 to a miniscule 4% in 1970. The rapid increase of oil imports was mainly managed under the auspices of the international oil companies. However, the two domestically-owned oil companies, OK and Nynäs Petroleum, gradually increased their market shares to 10% in the mid-1960s (Stolpe, 1967).

While oil was flowing into the country in ever larger quantities, Sweden developed a very ambitious program for nuclear power from the mid-1950s. Already in the autumn of 1945, the National Defence Research Institute (FOA) started investigations into nuclear weapons, and in 1948 the Atomic Energy Company (AE), with the state as majority shareholder, was set up to conduct civilian nuclear research. AE built a small research reactor that was taken into operation in 1954. But power companies were not very interested yet as the costs for nuclear power seemed very high. The Geneva Conference on Atomic Energy in 1955 contributed to an international optimism regarding a coming commercialization of the new technology, and one year later the Swedish Parliament adopted a very ambitious long-term policy to develop an entirely domestic nuclear fuel cycle based on Swedish uranium

resources. In 1945 it was found that Sweden had Europe's largest uranium deposit, located at Ranstad (100 km east of Gothenburg). This uranium was to be used in heavy-water reactors without prior enrichment, which was a technology too expensive for Sweden. Moreover, reprocessing plants would be built as a means to extract plutonium for use in fast breeder reactors or for nuclear weapons production. This autarky policy had an obvious military dimension and the dual national goals of energy self-sufficiency and nuclear weapons explain why the government invested so much in this research. Through the 1950s and 1960s, nuclear technology was the largest recipient of R&D in Sweden (Lindström, 1991).

The first commercial heavy-water reactor in Sweden – designed by AE, built by ASEA and operated by Vattenfall – was built south of Stockholm in 1964 and was used for both district heating and power generation. Yet it turned out to be much more expensive than expected, and in what followed Swedish electricity companies as well as equipment suppliers such as ASEA became sceptical about this type of reactors. Light-water reactors, based on enriched uranium, had been ordered by American utilities in the early 1960s and seemed more profitable. The Swedes followed this new trend closely, and in 1965 a private Swedish power company, OKG, ordered a large light water reactor from ASEA. Two other power producers, Sydkraft and Vattenfall, followed suit in the following years, ordering several large reactors from ASEA. This change from heavy-water reactors to light-water reactors had far-reaching implications. It meant that the ambitious policy to create a domestic nuclear fuel cycle was undermined, and that Sweden became dependent on uranium that was enriched abroad and thus susceptible to foreign inspection. From this perspective nuclear energy was no longer a pathway to energy independence. Moreover, in 1968 all plans to build nuclear weapons came to an end when the Swedish Parliament decided to sign the Non-Proliferation Treaty (Fjaestad and Jonter, 2010; Agrell, 2002).

Already in the 1940s it was clear that Swedish uranium resources were low grade and much more expensive to exploit than uranium resources in other parts of the world. The main incentive for developing uranium production in Sweden at this time was to achieve independence and not least to be able to produce nuclear weapons. A uranium production facility was completed at Ranstad in 1965. Four years later, however, it was put on hold. Now that enrichment abroad was needed anyway, the advantage, from an energy dependence point of view, of using Swedish uranium was much smaller. The power companies that had ordered light water reactors showed no interest in paying more for the uranium just because the ore was extracted domestically; they simply wanted the cheapest possible fuel. Moreover, extraction of uranium in Ranstad would have severe environmental consequences and local opposition was likely to emerge (Dsl, 1971; Jonter, 2002).

As a result of this strategic shift in the nuclear field, ensuring reliable access to foreign uranium ore and foreign enriched services became a new challenge not only for the power companies but also for the government, as contracts for enrichment, given the security dimensions involved, had to be signed by governments. There were a number of potential uranium suppliers to choose from. The United States, Canada, South Africa and France already operated uranium mines, while Australia, Niger and Southwest Africa were starting up new ones. But there were only two countries that could provide enrichment – the United States and the Soviet Union – and both had overcapacity in their enrichment plants. In 1966, the Swedish Government signed a 30-year framework agreement with the US government concerning the purchase of enrichment services for the five reactors that had been contracted at the time. The deal included regular inspections of the plants. Four years later an amendment to the contract was made for six additional reactors. The same year the Swedish government made an additional agreement with the Soviet Union regarding enrichment services. Under the umbrella of these government agreements the Swedish nuclear reactor owners – Vattenfall, OKG, FKG and Sydkraft –

concluded specific enrichment contracts. Furthermore they signed contracts with foreign uranium producers (Dsl, 1971).

By 1970, the supplies of enriched uranium were thus secured for the medium term perspective, but there were still worries for the long term supply, both among government officials and the nuclear operators. Many countries had very ambitious plans for their nuclear industries, and there was a fear that this might lead to fuel shortages in the 1980s and 1990s. Officials in the Ministry of Industry feared that “Instead of letting the price mechanism achieve an equilibrium, producer countries may prefer to introduce measures to cater for the needs of their own power industries in the first place. Other countries may get in to a position of absolute shortage.” (Dsl, 1971, 35) One way for Sweden to handle this risk would be to join an international consortium aiming to build enrichment plants. (For example, the Netherlands, Britain and West Germany had formed such a consortium.) But this was believed to be very expensive. Instead the Swedish government proposed to establish a special company, the Swedish Nuclear Fuel Supply Company (SKBF), to coordinate the uranium imports at the national level. Established in 1972, the company was to monitor the main trends on the global nuclear fuel market and also closely follow technical developments in enrichment technology. The national coordination would also strengthen the bargaining power of the Swedish nuclear power companies’ vis-à-vis the foreign suppliers. SKBF was owned jointly by the nuclear power companies, including the state owned power producer Vattenfall. A high ranking civil servant at the Ministry of Industry was appointed chairman of the board to ensure political influence over the company (Fjaestad and Åberg, forthcoming; Dsl, 1971).

In the post-war decades, Sweden thus became increasingly dependent on energy imports of oil and later also on uranium from far away. From the 1960s there was also a growing exchange of electric power with the neighbouring Nordic countries. In 1961, Vattenfall – the State owned Swedish utility – invited representatives from all the larger power companies in the Nordic countries to a conference about Nordic power collaboration. The conference paved the way for a new organization, a power pool called Nordel. It was established in 1963 with the purpose of promoting power exchange among the Nordic countries. Nordel set up a number of committees studying a range of issues. These committees issued many recommendations, which were almost always followed by the participating companies even if Nordel did not have the authority to make binding decisions. The amount of power exchanged over the Nordic borders increased from about 2% in 1963 to about 10% thirty years later, and this exchange has been much appreciated by the participant companies, as it has led to lower electricity prices and improved supply security (Lalander, 1988). The Nordic power cooperation is interesting in that it was organized without government involvement and it was largely dependent on personal trust among the managers of the largest power companies in the Nordic countries, who were almost all electrical engineers and knew each other well (Kaijser, 1997).

7. The 1973/74 energy crisis and beyond

Following the 1973 October War between Israel and Egypt/Syria, the Arab oil exporting countries decided to stop oil exports to the US and the Netherlands and to raise their export prices. This led to the first oil crisis. The Swedish government felt compelled to introduce rationing of oil products in the winter of 1974, and suddenly the general public became painfully aware of the extent of Sweden's dependence on oil – more than 70% of the total energy supply. The oil crisis was aggravated by a simultaneous questioning in Sweden of both hydropower and nuclear power, which since long had been promoted as the main domestic alternatives to imported oil. A growing environmental movement had for a number of years highlighted the negative environmental impact of dams and power plants, and in 1972 the Swedish Parliament decided to stop further expansion of hydropower by explicitly forbidding any dam construction along four big rivers that had not yet been exploited. Nuclear energy, too, was being increasingly

questioned by environmentalists and others in the early 1970, and by the mid-1970s two of the five political parties in Parliament had taken an anti-nuclear stance. In short, energy became a central issue in the political debate.

A new energy policy to cope with the new situation was first formulated in a Government Bill in the spring of 1975 (Government Bill, 1975:30). It presented two overarching aims. The first was to decrease oil imports by slowing down the increase in energy consumption, by securing power supply through the building of two additional nuclear reactors (in addition to the eleven that were completed or under construction) and by launching an ambitious research program for developing new domestic energy sources. The second was to reduce the vulnerability of oil imports through an “active oil policy”.

To achieve the first aim a number of new government agencies were established. Energy taxes were increased to help finance these measures and spur energy efficiency. The broad R&D program, which was launched in the late 1970s, focused on improving energy efficiencies in buildings and industrial processes, and on the development and exploitation of domestic energy sources such as biomass, peat, wind and solar energy. For example, Sweden built two prototype wind turbines that were the biggest in the world in the early 1980s. The further development of nuclear power was the most contested part of the energy bill. The anti-nuclear movement demanded that no new reactors be commissioned and that the operating ones be phased out by 1990. After the 1979 Three-Mile-Island accident it was decided to hold a referendum on the future of nuclear power. The referendum, held in 1980, led to a compromise: the expansion of nuclear power would continue and all in all twelve nuclear reactors would be built, but all reactors would be phased out by 2010 (Kaijser, 1992).

The new energy policy also encouraged diversification to fossil fuels other than oil. Here, district heating systems played a key role as it was fairly easy to switch fuels there. In 1977 the government introduced generous loans to encourage cities and towns to invest in district heating. Swedish imports of coal almost doubled from 1975 to 1985, much of it replacing oil in district-heating plants. Moreover, the Swedish government made ambitious attempts to import natural gas from the Soviet Union, Norway and Denmark. Most of these negotiations failed, but in 1980 a contract was eventually signed with Denmark. Following the construction of a gas pipeline along the Swedish West Coast from Malmö to Gothenburg, the gas started flowing in 1986, contributing about 1.5% percent of national energy demand (Åberg, 2013).

As for the second aim – to reduce the vulnerability of oil imports – the new notion of an “active oil policy” signalled an ambition to involve the state to a much greater extent than before in all oil-related activities. One component of this was to create a state-owned company for oil exploration and trade. This company, Svenska Petroleum AB, was established the following year and was given a government guarantee of 2 billion SEK to enable investments in exploration and extraction. With the help of this guarantee, Svenska Petroleum made attempts to make long-term agreements for oil deliveries directly with the oil-producing countries and it managed to sign contracts for limited quantities with some Arab countries. A major ambition was also to reach agreements with Norway, but this turned out to be difficult as Norway did not want to give any special privileges to its Nordic neighbour. The company was only able to buy a minor part in one of Norway's North Sea fields. Moreover, Svenska Petroleum was unsuccessful in its oil exploration both on the Swedish mainland and in offshore Baltic projects. Nonetheless, by 1979 Svenska Petroleum controlled about 10% of the Swedish oil market and the two other Swedish-owned companies – OK and Nynäs Petroleum – controlled another 27%, thus diminishing the international oil companies' dominance (Government Bill 1980/81:90). Moreover, the Swedish owned oil companies had increased their refinery capacity and by 1980 70% of the oil products on the Swedish market were produced in domestic refineries as compared to only 40% in 1975 (Government Bill 1980/81:90; Johnsson, 2004).

However, the aim of the active oil policy was not to get rid of the majors. On the contrary, a 1980 government Bill argued that “the Swedish subsidiaries of the international oil companies have through their mother companies access to a diversified supply system. Supply through these companies may therefore imply smaller risks for disturbances due to political decisions than direct supply from oil producing countries” (Government Bill 1980/81:90, 147). Moreover, Sweden diversified its oil imports in geographical terms, away from OPEC. In 1975 more than half of all oil products came from OPEC member states; ten years later 80% came from the North Sea (Government Bill 1984/85:120).

Another component of the active oil policy took the form of international cooperation with other oil-importing countries under the auspices of the International Energy Agency (IEA), established in 1974 on the initiative of the United States. The members of IEA agreed to create stocks of crude oil equivalent to 90 days of consumption and to support each other in case of crisis. In accordance with this obligation, the Swedish Parliament in 1977 decided that the state must build up stocks of no less than 9 million tons of crude. This became a severe financial burden when, following the outbreak of the war between Iran and Iraq, the second oil crisis erupted, causing further price hikes. Therefore, Parliament passed a new law in 1984, which transferred the obligation of stockpiling to the oil companies and major oil users (Government Bill 1984/85:53).

From the mid-1980s onwards the active Swedish oil policy was gradually dismantled. Oil's share in Swedish energy supply had now decreased to about 50%, and world oil prices fell considerably from 1985 onwards. Moreover, the achievements in the previous ten years – with most of the oil coming from “reliable” neighbour countries, a larger share of Swedish oil companies in the Swedish market, an increased refinery capacity, sizeable stockpiles and agreements with other importing countries – had decreased the perceived vulnerability of oil imports. In 1986 Svenska Petroleum AB merged with OK to form OK Petroleum in which the state became a minority shareholder, and in 1991 the state sold its shares in the company, which meant the end of direct state participation in the Swedish oil market.

Energy has remained an important topic in Swedish politics. The nuclear issue in particular has caused much conflict. The Chernobyl accident re-intensified the debate over the pace of the nuclear phase-out, but the nuclear industry and its supporters – not least the trade unions – has managed to keep nuclear plants operating after the 2010 deadline for closure that the 1980 referendum had stipulated. Only two reactors – at Barsebäck in southern Swedish, located just 30 km from central Copenhagen – were closed by government decisions in 1999 and 2005, mainly to please the Danes, who for long had demanded a closure of this particular plant.

The goals of Swedish energy policy as they were formulated in the 1975 Government Bill have largely been achieved. Total energy consumption, which had grown at a high pace for more than a century, stabilized already in the late 1970s and has been fairly constant since, and the share of oil has decreased from 70% in the mid-1970s to less than 25% today. However, other energy imports – primarily uranium – have grown, increasing the country's overall energy dependence. The situation is changing now as several nuclear reactors are being phased out for economic reasons, but at the time of writing imported energy continues to supply about 60% of Sweden's total energy needs (Energimyndigheten, 2017).

From the late 1980s, climate change has become an increasingly important factor in Swedish energy policy. In the 1990s an increased use of biomass, especially in district heating, was supported by state subsidies. Later on state subsidies were also introduced to support the introduction of wind power and solar energy. Biomass, the lion share of which stems from domestic sources, has made a remarkable renaissance and currently has about the same share as oil in the Swedish energy system. Reduced emissions of greenhouse gases have thus gone hand in hand with increasing self-sufficiency.

8. Under the Damocles sword

Throughout the 20th century – with the exception of a few war years – Sweden has imported most of its energy. However, the perception of this energy dependence has changed considerably between periods of crisis and “normality”. During the two world wars Sweden's energy dependence became acute, and the government took a very active and direct role in coping with energy supply. In both wars it negotiated directly with Germany, seeking access to as much coal imports as possible. At the same time it set up Fuel Commissions with strong powers to quickly increase the production of domestic energy. When the wars ended the first priority was to re-establish pre-war imports as soon as possible. The war experiences also spurred discussions and government investigations about how to increase the share of domestic energy so as to avoid a similar crisis in the future. But as the import flows of cheap energy came back to normal and the memories of the war faded, the worries about the country's energy dependence faded too, and the government became more passive. The 1973 energy crisis had a similar but weaker impact. Here, there was first an acute phase of coping with supply interruptions and then a renewed focus on ways to increase the share of domestic energy, and the introduction of an active oil policy to decrease the vulnerability of oil imports. But again the dependency awareness gradually faded away when import flows were restored.

In the choice between the two main approaches to handle Sweden's energy dependence – reducing the *vulnerability* of energy imports versus reducing the *need* for imports – Swedish actors have mostly preferred the first one. The main drawback with the latter has often been that domestic energy sources, whether peat, wood or uranium, have been expensive to exploit. Being a small, open economy with an export oriented industry, leading politicians and industrialists have seen it as essential for the competitiveness of Swedish industry to provide it with as cheap energy as possible. Therefore much effort has been devoted to reduce the vulnerability of energy imports. Being a small neutral country Sweden has tried to keep cordial relations with all its energy suppliers. After World War II an attempt was made to nationalize the Swedish oil market, and set up a state owned oil company, but in the end the government did not dare challenge the international oil giants and the governments backing them. After 1975 diversification – both in terms of energy sources and of countries from which to import – became an overall strategy to decrease the country's oil-import dependence. This strategy has been fairly successful. Sweden has a much more diversified mix of energy sources today than in the 1970s, and the countries that are supplying Sweden are seen as more trustworthy too. But still more than 60% of Swedish energy supply is imported, and in case of a major international crisis the metaphor of a Damocles Sword may become relevant again.

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