# Socioeconomic analysis of nuclear power in Sweden

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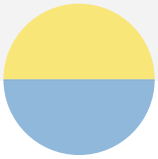

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## Summary

In this report we present a literature study on the socioeconomic development of municipalities with nuclear power plants in Sweden. The report illustrates the positive socioeconomic development for the Swedish municipalities where nuclear power plants have been deployed.

The impact peaked during construction, but the effects are long-lasting and have contributed to the municipalities' population, employment rates, and tourism. It is also noted that the support for nuclear power is greater in regions with nuclear facilities compared to the rest of the country. We begin with an overview of the sites and the nuclear power development in Sweden, along with relevant siting criteria. To assess the degree of socioeconomic development, we examine a number of parameters, such as population growth, employment rate per business sector, real estate prices etc. In order to have a fair comparison, we compare these municipalities to others with similar characteristics but without nuclear power plants in their region. We also present a number of facts regarding the construction period, such as the handling of the workers' housing, as it constituted a significant topic in the negotiations between the municipalities and the construction companies and had repercussions in the development of the areas. Lastly, we summarize the public opinion on nuclear power.

# Version History

| Version | Revised pages | Revision information |
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| 1.0 | - | New document |
| 2.0 | | Rewording (from “localization” to “siting”) |

# Definitions and abbreviations

| Definition/Abbreviation | Description |
|---|---|
| AB Atomenergi | Swedish public company built to develop nuclear power in Sweden. Nowadays Studsvik AB. |
| ASEA | Private Swedish electrical engineering company. Nowadays ABB Ltd. |
| ASEA-Atom | ASEA’s subsidiary company to develop nuclear power related products. Nowadays Westinghouse Electric Sweden. |
| AKK | Private company built to construct and operate the power plant in Oskarshamn. |
| BKAB | Private company fully owned by Sydkraft Nuclear Power AB. Owns and operates the power plant in Barsebäck. |
| FKA | Private company owned 66% by Vattenfall, 25,5% by Mellansvensk Kraftgrupp Aktiebolag and 8,5% by Sydkraft Nuclear Power AB. Owns and operates the power plant in Forsmark. |
| Fortum | Finnish public energy company. |
| OKG | Private company owned 54,5% by Uniper and 45,5% by Fortum Sweden AB. Owns and operates the power plant in Oskarshamn. |
| RAB | Private company owned 70,4% by Vattenfall and 29,6% by Sydkraft Nuclear Power AB. Owns and operates the power plant in Ringhals. |
| SKB | Company founded by the Swedish nuclear power industry. Its primary operations are the management and disposal of nuclear waste and expended nuclear fuel. |
| Sydkraft Nuclear Power AB | Uniper’s subsidiary company in Sweden. |
| Uniper | German energy company. |
| Vattenfall AB | Swedish public energy company. |

# 1. Introduction

In this section we present a few basic facts regarding the nuclear power plants and the municipalities they belong to.

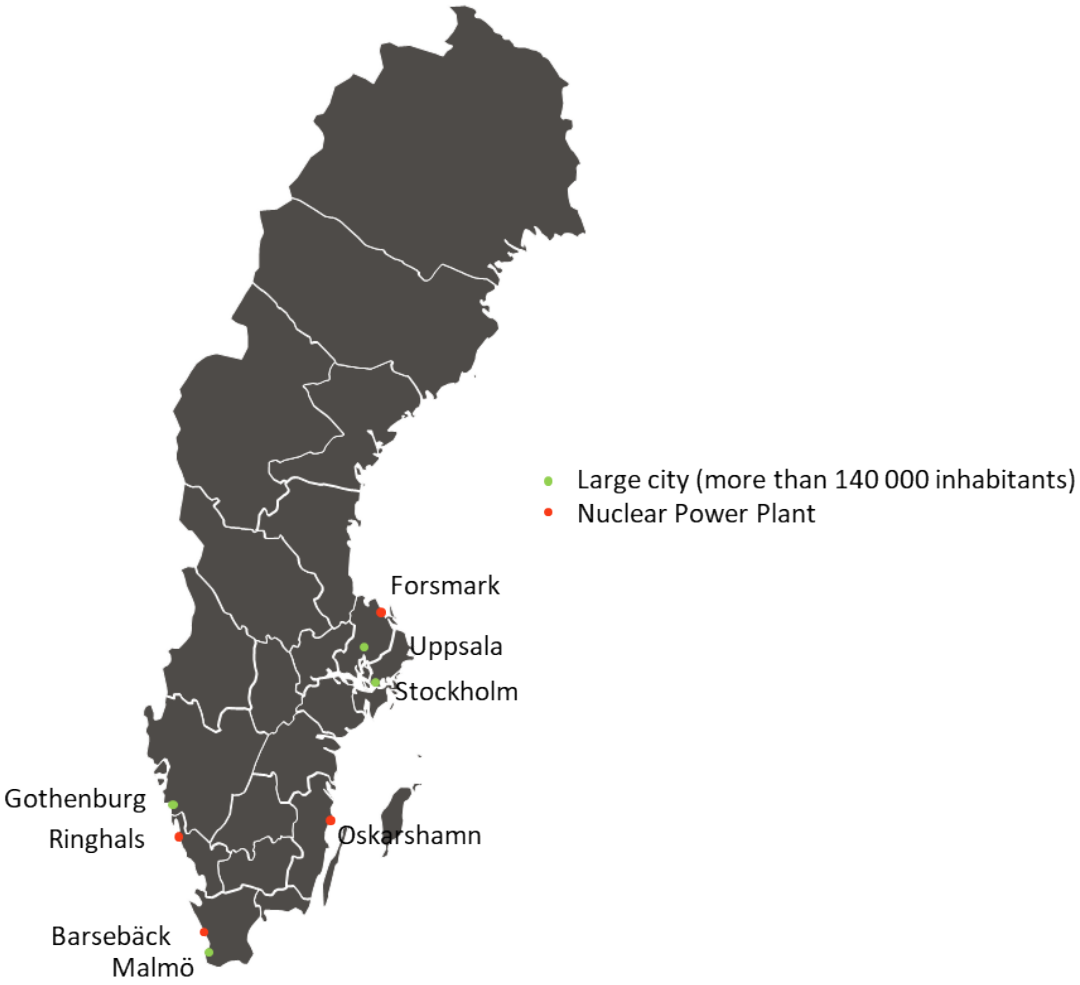


Figure 1 Map of Sweden with green marks on the four largest cities and red marks on the location of nuclear power plants.

## Barsebäck Nuclear Power Plant

| | |
|---|---|
| Owner | Barsebäck Kraft Aktiebolag (BKAB). Fully owned by Sydkraft. |
| Municipality | Kävlinge |
| County | Skåne |
| Inhabitants Kävlinge town (2020) | 10 026 |
| Inhabitants Kävlinge municipality (2021) | 32 194 |

The nuclear power facility is located on the west coast of Sweden, approximately 590 km southwest of Stockholm, and 28 km north of Malmö. The two units (B1

and B2) are under decommissioning. They came in operation in 1975 and 1977, and closed already in 1999 and 2006 due to political decisions.

## Oskarshamn Nuclear Power Plant

| | |
|---|---|
| Owner | Oskarshamnsverkets Kraftgrupp (OKG). Uniper owns 54.5% and Fortum 45.5%. |
| Municipality | Oskarshamn |
| County | Kalmar |
| Inhabitants Oskarshamn town (2020) | 18 907 |
| Inhabitants Oskarshamn municipality (2021) | 27 225 |

The nuclear power facility is located on the east coast of Sweden, approximately 340 km south of Stockholm and 26 km northeast of Oskarshamn. This is one of the oldest commercial nuclear sites in Sweden. The first reactor (O1) was taken into operation in 1972, the second (O2) in 1975 and the third (O3) in 1985. O3 is still in operation but O1 and O2 are permanently closed since 2017 and 2015 respectively for financial reasons.

The intermediate storage for spent nuclear fuel (Clab) operated by the Swedish Nuclear Fuel and Waste Management Co (SKB) is located at the same site. The encapsulation plant for the spent nuclear fuel is also planned to be built at the site (a government decision is still pending at the time of writing this document).

A neighboring municipality is Västervik (located north of Oskarshamn) and it is used as comparison in the assessment of Oskarshamn. The Västervik municipality has 36 791 inhabitants (2021).

## Ringhals Nuclear Power Plant

| | |
|---|---|
| Owner | Ringhals AB (RAB). Vattenfall AB owns 70,4% and Sydkraft, owns the rest 29,6%. |
| Municipality | Varberg |
| County | Halland |
| Inhabitants Varberg town (2020) | 36 019 |
| Inhabitants Varberg municipality (2021) | 66 051 |

The nuclear power facility is located on the west coast of Sweden, approximately 480 km southwest of Stockholm, 24 km north of Varberg, and 68 km south of Gothenburg. Two units (R3 and R4) are in operation and two units (R1 and R2) are permanently closed since 2020 and 2019 respectively. The years when the reactors came into operations are R1: 1976, R2: 1975, R3: 1981 and R4: 1983.

A neighboring municipality is Kungsbacka (located north of Varberg) and it is used as comparison in the assessment of Varberg. The Kungsbacka municipality has 85 186 inhabitants (2021).

## Forsmark Nuclear Power Plant

| | |
|---|---|
| Owner | Forsmarks Kraftgrupp Aktiebolag (FKA). Vattenfall AB owns 66% and Mellansvensk Kraftgrupp and Sydkraft owns 25,5% and 8,5% respectively. |
| Municipality | Östhammar |
| County | Uppsala |
| Inhabitants Östhammar town (2020) | 4 977 |
| Inhabitants Östhammar municipality (2021) | 22 351 |

The nuclear power facility is located on the east coast of Sweden, approximately 140 km north of Stockholm, 19 km northwest of Östhammar, and 75 km north of Uppsala. Three units are in operation (F1, F2, F3). The reactors were taken in operation in 1980, 1981 and 1985 respectively. The final repository for low and intermediate level nuclear waste operated by SKB is also located at the same site. The final repository for spent nuclear fuel is planned to be built at the site (a government decision is still pending at the time of writing this document).

A neighboring municipality is Tierp (located west of Östhammar) and it is used as comparison in the assessment of Östhammar. The Tierp municipality has 21 445 inhabitants (2021).

# 2. Historical overview of the Swedish nuclear power deployment program

Starting in the mid-1950s with the first oil crisis, Sweden started to embark on the road to nuclear power. Another reason behind the decision was the fact that most of the large scale electricity production (hydropower) was located in the northern part of Sweden, while most consumers were located in the south and middle of Sweden, leading to uneven load on the national grid. Moreover, environmental groups were opposed to further use of hydropower [1].

At the time, Swedish research institutes already had substantial expertise on nuclear physics and engineering. The first Swedish nuclear energy committee was established already in 1945. Its purpose was to plan research activities and identify peaceful uses of nuclear energy. AB Atomenergi, a company co-owned by the state and private industrial companies, was established in 1947 with a purpose to perform research, build research reactors and, at a later stage, aim at commercial operation. The first research reactor was located at the Royal Technological Institute in Stockholm and was established in 1954 and the second was started in 1961 at the same place. The legislative framework that regulates the operation of nuclear power in the country was established in 1956.

In 1958 it was decided to build the first commercial reactor in Ågesta, south of Stockholm. The reactor was a heavy water reactor and the plan was to use uranium from Sweden, i.e. to have the whole value chain in the country. The reactor was taken into operation in 1963 and the capacity was mainly used for district heating. The unit was closed in 1974 for profitability and safety reasons. The plan was to build another similar but larger reactor in Marviken, between Oskarshamn and Stockholm, but it was cancelled in 1965 due to profitability issues. The same year, OKG AB was established aiming at building nuclear reactors at the Oskarshamn site. In 1968, ASEA-Atom was established as part of the ASEA group, and the design phase of the first reactor for the Oskarshamn site was initiated. Between 1965 and 1971, nine reactors were ordered for the Swedish nuclear power program from ASEA-Atom.

At the time when the first Swedish nuclear power plants were built, nuclear power was not a controversial topic, neither from a safety nor from an environmental perspective. It was seen as the power generation method of the future, that would also bring new job opportunities and had support from all political parties. It was mostly hydropower that was criticized for its environmental impact and nuclear power was seen as a good, environmentally friendly alternative.

The first critiques of nuclear power appeared a few years later, and in 1973 the government decided that no further investment decision should be taken before a new, multifaceted examination of the research results and the progress potential was presented to the government. Later that year, the oil crisis began and the fuel prices quadrupled, which led to the realization that an energy system which is fully relied on oil is not sustainable.

According to Swedish law, the nuclear power producers are responsible for the management of the radioactive waste. In 1973 a new company called SKB (Swedish Nuclear Fuel and Waste Management company) was established by the nuclear power companies, in order to take care of all waste produced and find

a solution on a final repository for the fuel. The operation of the intermediate nuclear fuel handling facility, Clab, was started in 1985 in Oskarshamn and the repository for low and medium level radioactive waste, SFR, began its activities in 1988 in Forsmark.

The 1979 Three Mile Island accident in the USA, presents a turning point for the nuclear power industry and its public perception. The matter received significant media and political attention both in Denmark and Sweden, which led to a wide reactor safety investigation. The investigation showed that the Swedish plants were prone to safety issues similar to those that lead to the accident. A few days after the Three Mile Island event, opposition parties organized demonstrations outside the Barsebäck power plant in Sweden, and in Denmark 312 000 signatures were collected in a petition to shut down the plant. On the Swedish side, it was decided to have a referendum in 1980 to decide about the future of nuclear power in the country.

Following the referendum result, the government decided to approve the operation of 12 reactors, which meant that all units that were already in operation, as well as those that were under construction at the time, would continue as planned, but no new reactors would be built. It was also decided that all reactors would be decommissioned by 2010. However, how and when exactly that would happen was unclear. This decision was later changed, omitting a reference to a fixed decommission date.

At the time of writing this document, there are 6 operating reactors in Sweden. The units in Barsebäck were taken out of operation in 1999 and 2005, for political reasons. In 2015 there were two separate decommissioning decisions, one regarding Oskarshamn 1 and 2 and one regarding Ringhals 1 and 2. The decisions to close the units were made on commercial grounds.

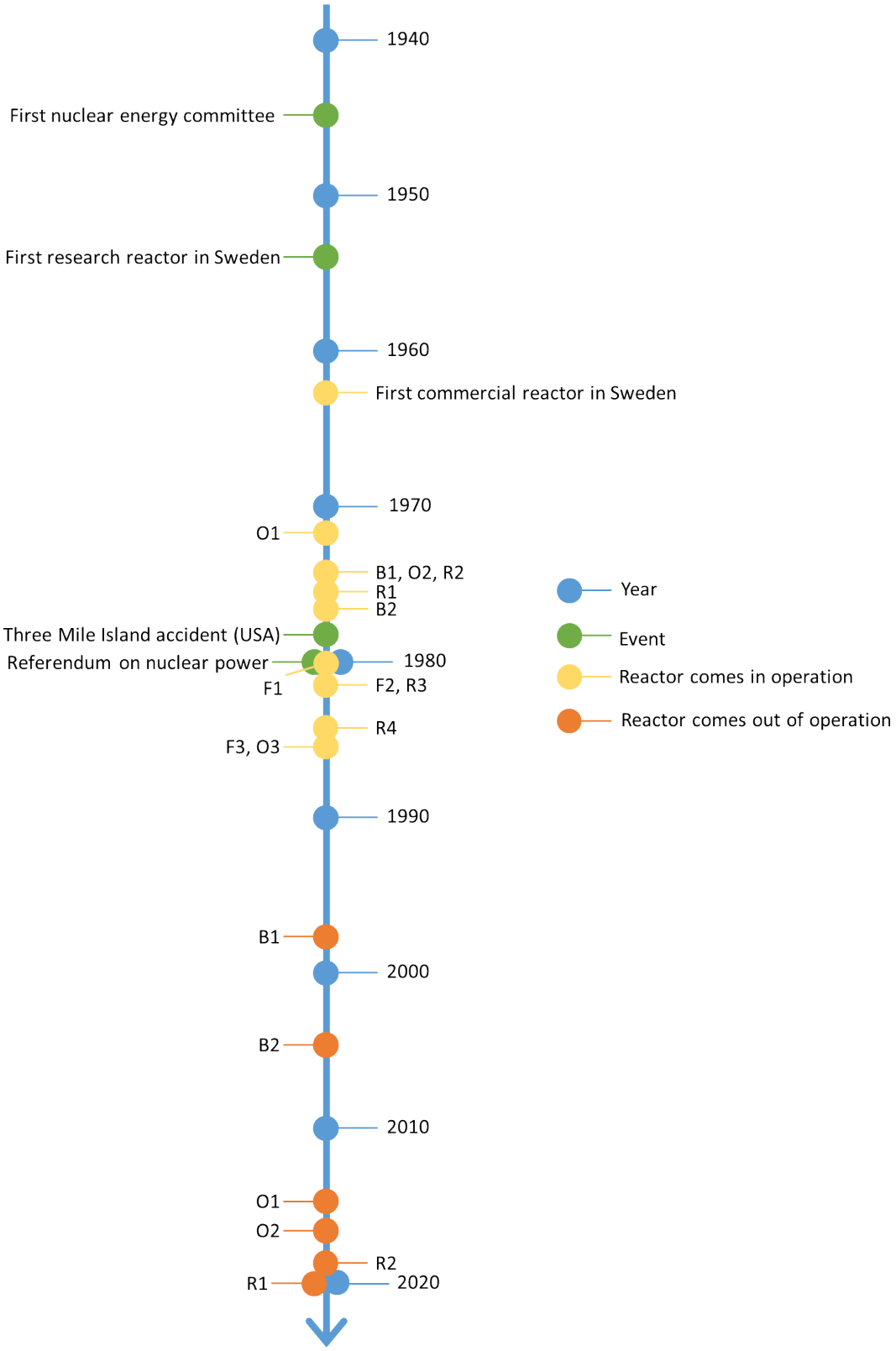


Figure 2 Timeline of the Swedish nuclear power deployment program.

# 3. Siting

The decision process regarding the siting of nuclear facilities in Sweden has changed significantly since the beginning of the industry. In the past, a small number of people, mostly politicians, researchers, and administrators took decisions in a more or less closed negotiation process. This is in sharp contrast to the more open decision processes that are followed nowadays for the siting of the final repository for spent nuclear fuel.

Some of the factors that influence the siting process are the following [5]:

- Social factors: distance to urban areas, current regional plans, employment effects, national security aspects.
- Technical factors: access to cooling water, available space for plant and power lines, ground properties, transportation possibilities, availability of fresh water.
- Environmental factors: impact of cooling water emissions (fog formation, ice conditions, oxygen solubility, marine plants and animals), radioactivity emissions, archeological and natural site conservation, aesthetical aspects.

## Barsebäck

The only requirements that the reactor placement committee had at the time of siting, were connected to population density [4]. More specifically, population density “should not be too big 10 km around the plant” and that it “should be supervised and regulated in such a way that evacuation would easily take place if required” [5]. An additional consideration was the constraint that once the power plant was constructed, it was not allowed to build any new building in a 2 km radius.

Sydkraft started an investigation for suitable sites in 1964. After an initial selection of 20 locations, 6 seemed technically and economically suitable. The technical requirements were cooling water supply, and grid stability, while the economical ones were proximity to future customers, and land acquisition possibilities. Barsebäck was chosen for the aforementioned reasons and the additional benefit that the land was owned by only one entity. The low population density on a 10 km radius and the future possibilities to supply district heating to nearby cities were also taken into account.

In order to put the siting decision in a bigger context, we should also note here that during the late 1950s and throughout 1960s, there was a plan to connect Sweden and Denmark with a bridge from Malmö to Copenhagen [4]. The goal was to create an economically flourishing urban region. Illustrations from that time show a power plant on one of the islands in the area and a big airport on another one. However, these ideas faced fierce opposition and were never realized due to environmental concerns (except for the construction of what is now called the Öresund bridge).

## Oskarshamn

The Simpevarp peninsula, where the Oskarshamn power plant is located, had been considered as a possible site for a nuclear power plant since the 1950s. At that time the area was inhabited, privately owned and mostly used for agriculture and fishing. The private company AKK was formed in 1955 and a few years later started investigating for a suitable site. The investigation led to the Simpevarp peninsula. In 1962 the area was bought for a reasonable compensation by AKK and the inhabitants started moving. OKG was established in 1965 and a 400MW reactor was ordered. The government approved the plans the next year and the construction started. [3]

## Ringhals

Vattenfall started looking for appropriate sites to build a new thermal power plant at the beginning of 1960s. In 1965, Vattenfall started buying land on the Ringhals headland without being clear yet if the fuel of the plant would be oil or uranium [2]. The place fulfilled the requirements that Vattenfall had for a thermal power plant: a) water for cooling the condenser, b) a deep harbor, which was important to provide fuel in case of an oil plant, c) fresh water supply, and d) good transportation options to nearby cities.

Vattenfall bought numerous real estate properties to prepare the area. Those who had residential buildings within what would eventually be the power plant area had to relocate. In some cases, the residents were allowed to build a new house close to the old one, so they did not necessarily need to leave the area altogether. However, Vattenfall had to buy the additional nearby lodges owned by people who did not want to live close to the plant, since there were no other willing buyers. The company also built a port for small boats in a nearby location, to accommodate the residents who used to dock their boats in the shore that Vattenfall now owned. The local inhabitants had regular meetings with the company to ask questions and get information about the project.

## Forsmark

The siting choice for Forsmark was to a certain degree influenced by the location of the high voltage network [5]. The initial plan was that the power plant would be in Trosa, a municipality south of Stockholm, where Vattenfall had started buying land at the end of 1960s, had applied for a permit and informed the nearby population. However, there were environmental protests in the area and, around the same time, the regulations became stricter. Vattenfall proposed Forsmark as an alternative, which would also provide more future expansion possibilities. The investment for the extension of the high voltage network was higher, but the political ground was more fertile compared to Trosa. Local politicians were working to attract new job opportunities in the municipality so the project was welcomed with enthusiasm. The area that was chosen was uninhabited and owned by corporations.

# 4. Socioeconomic analysis

## 4.1. Oskarshamn and Östhammar

Our account of the Oskarshamn and Östhammar municipalities relies heavily on an investigation of the impact of nuclear site investments conducted by the Swedish Nuclear Fuel and Waste Management Co (Svensk Kärnbränslehantering AB, SKB). The mission of this company is to manage the Swedish nuclear and radioactive waste in a safe manner. A series of reports were produced as part of SKB's investigations of a number of places in Sweden as suitable locations for a spent fuel repository. As Oskarshamn and Östhammar were two of the possible locations for the spent fuel repository, a thorough analysis of the impact of the previous nuclear investments on those sites has been performed [6][7][8][9].The rest of this subsection (4.1) includes the most relevant parts of [6][7][8][9].

The purpose of study [6], which is used very widely in this report, was to investigate how the installation of nuclear power production sites affected the population and the structure of the local municipalities. The study covers 20 years prior to the deployment of nuclear power units and 20 years after, in order to determine if the positive or negative trends were a result of this deployment or if they were part of a trend that preceded the investment decision. Note that in all the figures below, "Year 0" denotes the year when the first reactor in the region started its operation.

In what follows, it is important to keep in mind the particular characteristics of the two municipalities before the establishment of nuclear power. Both Oskarshamn and Östhammar were municipalities with more industrial activities than the Swedish average. At the same time both municipalities were agrarian societies. There were of course certain differences between the two, as Östhammar has expanded to a much larger degree after World War II compared to Oskarshamn, which has remained more isolated.

### 4.1.1. Comparison with close by municipalities

The study [6] uses two additional municipalities as references. These are Västervik (Kalmar county) for Oskarshamn and Tierp (Uppsala county) for Östhammar. They are chosen based on their economic structure and the geographical location (with proximity to Oskarshamn and Östhammar respectively), as well as the fact that they have not received any nuclear or other equally large investment.

In both nuclear municipalities the population increased during the time of the investment decision, the construction and the first years of operation. This positive effect declined in both municipalities, but the population was stabilized to a higher level than before. The increase was more evident in Oskarshamn than in Östhammar, but it also declined faster. The evolution of population can be seen in Figure 3.

The positive effect of the establishment becomes more obvious when we compare the evolution of their population with that of the reference municipalities (Figure 4 and Figure 5). Before the investment, the reference municipalities and

the nuclear ones had a similar, relatively weak, population increase. During the establishment of nuclear power, the population in the respective municipalities increased and the gap that was developed never closed. In absolute numbers, the population of the reference municipalities decreased, while in both nuclear municipalities it increased by circa 20%.

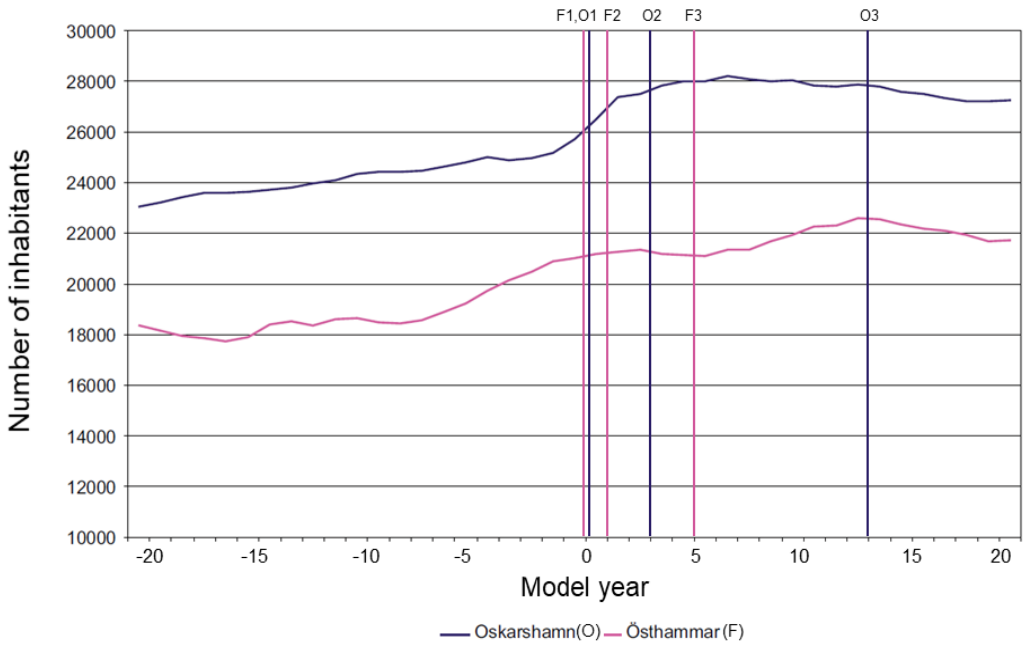


Figure 3 Evolution of population in Oskarshamn and Östhammar in model years (20 years before and after the first unit went into operation). The vertical lines indicate when each unit was connected to the grid. As the two plants began their operation in different years, the two timelines were shifted so that the operation start will coincide for comparison purposes. Thus, model year 0 corresponds to 1970 for Oskarshamn and 1980 for Östhammar (adapted from figure 3-2 in [6]).

Another effect that can be observed is that the population was much younger in the nuclear municipalities compared to the reference ones. The number of children and young people under 17 was higher in the nuclear municipalities and the average age was lower than in the reference municipalities and the county mean value. Compared to Sweden as a whole, the average age in Oskarshamn and Östhammar decreased in connection to the construction of the nuclear power plants. This effect persisted for a longer period in Östhammar than in Oskarshamn. At the end of the analysis period, both municipalities had returned approximately to the average population age of the country. In fact, Oskarshamn even had a slightly higher average population age than the rest of Sweden.

The lower average population age in the nuclear municipalities led to a lower death rate and higher birth rate. Thus, the population increased due to natural causes and not only because of population inflow. The effect was significant during the construction period and the first years of operation in Oskarshamn and Östhammar, although weaker in Östhammar. Östhammar had a birth surplus during the last 15 years of the study. Compared to the reference municipalities the natural population increase was stronger in the nuclear municipalities.

The immigration patterns to the municipalities should also be mentioned here. An excess of immigration to the nuclear communities can be seen during the construction years. This contributed to the decreased average age and the population increase through natural causes. The significant immigration flux stopped relatively quickly in Oskarshamn though, and it started fluctuating, with a small marginal increase observed at the end of the study period. The formerly male-dominated gender composition equalized during the construction years as families and children moved in.

During the 40 years of the study the local populations were employed in agriculture, industry and facilities, trade and communication, and services (health and social care, schools, banks etc.). The employment structure as it was 20 years prior to the investment, at the investment year and 20 years after, can be seen in Figure 6 and Figure 7. The population percentages of those employed in the energy industry as a whole (gas, electricity, hydro, nuclear) in 1950, 1980 and 2000 can be seen in Table 1 for the cases of Sweden, Oskarshamn, Östhammar and the reference municipalities.

| Area | 1950 | 1980 | 2000 |
|---|---|---|---|
| Sweden | 1% | 1% | 1% |
| Oskarshamn | 0.6-0.7% | 3% | 6.5% |
| Västervik | 0.6-0.7% | 1% | 6.5% |
| Östhammar | 0.6-0.7% | 4% | 8.4% |
| Tierp | 0.6-0.7% | 1% | 0.5% |

Table 1 Percentage of population employed in the energy industry (gas, electricity, hydropower, nuclear power) in 1950, 1980 and 2000 for Sweden, Oskarshamn and Östhammar. (Adapted from [6]). The authors claim that an integrated labor market has been developed between Oskarshamn and Västervik which explains the identical percentages between the two municipalities in 2000. A similar relation was not developed between Östhammar and Tierp.

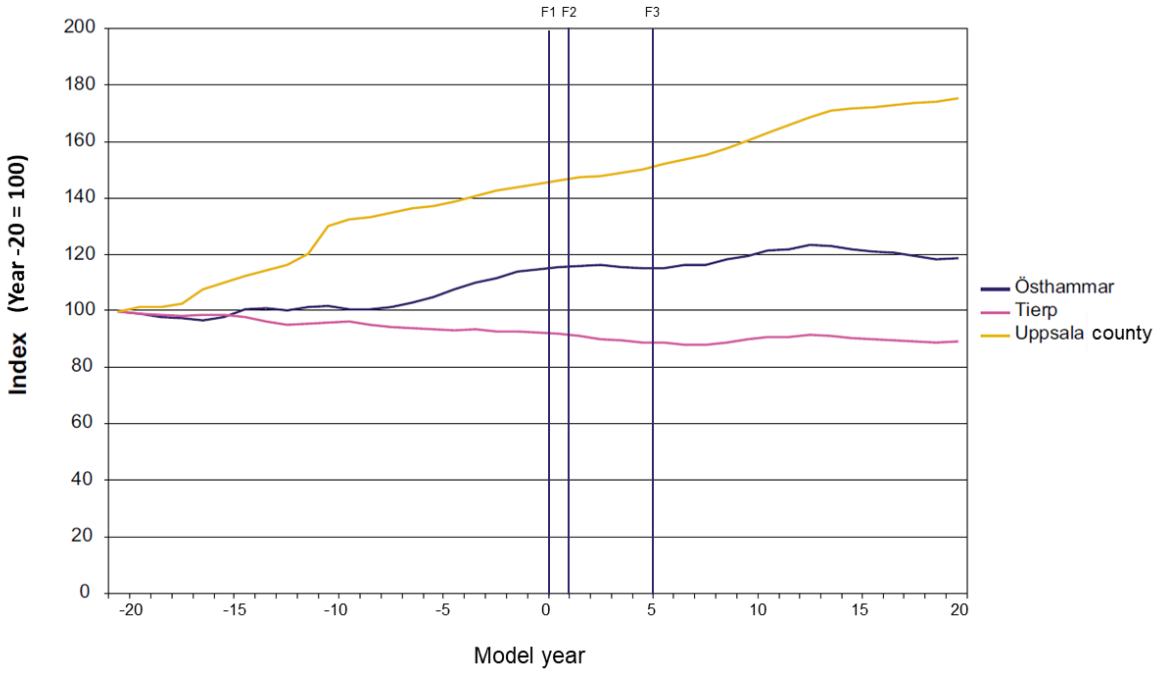


Figure 4 Rate of population change in Östhammar, Tierp and Uppsala county in model years (20 years before and after the first unit went into operation). The vertical lines indicate when each unit came to operation. Population on year -20 = 100. Model year -20 = 1960. (Adapted from figure 3-4 in [6]).

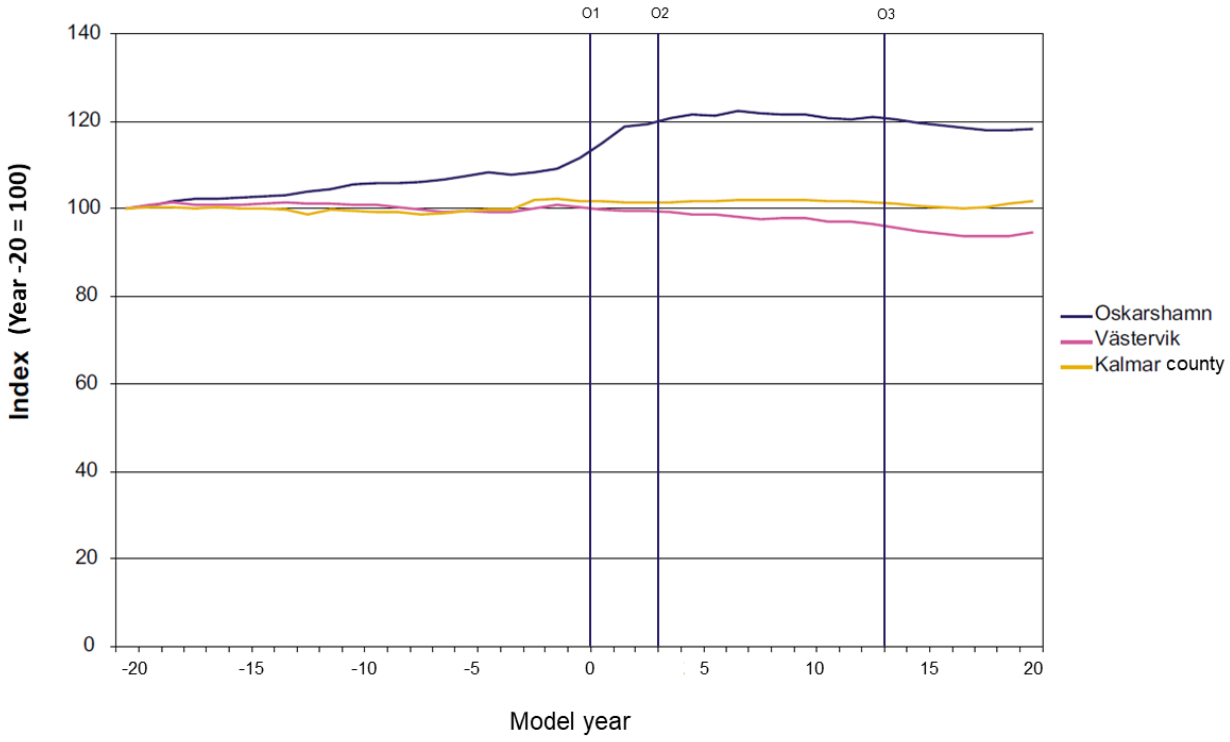


Figure 5 Rate of population change in Oskarshamn, Västervik and Kalmar county in model years (20 years before and after the first unit went into operation). The vertical lines indicate when each unit came to operation. Population on year -20 = 100. Model year -20 = 1950. (Adapted from figure 3-3 in [6]).

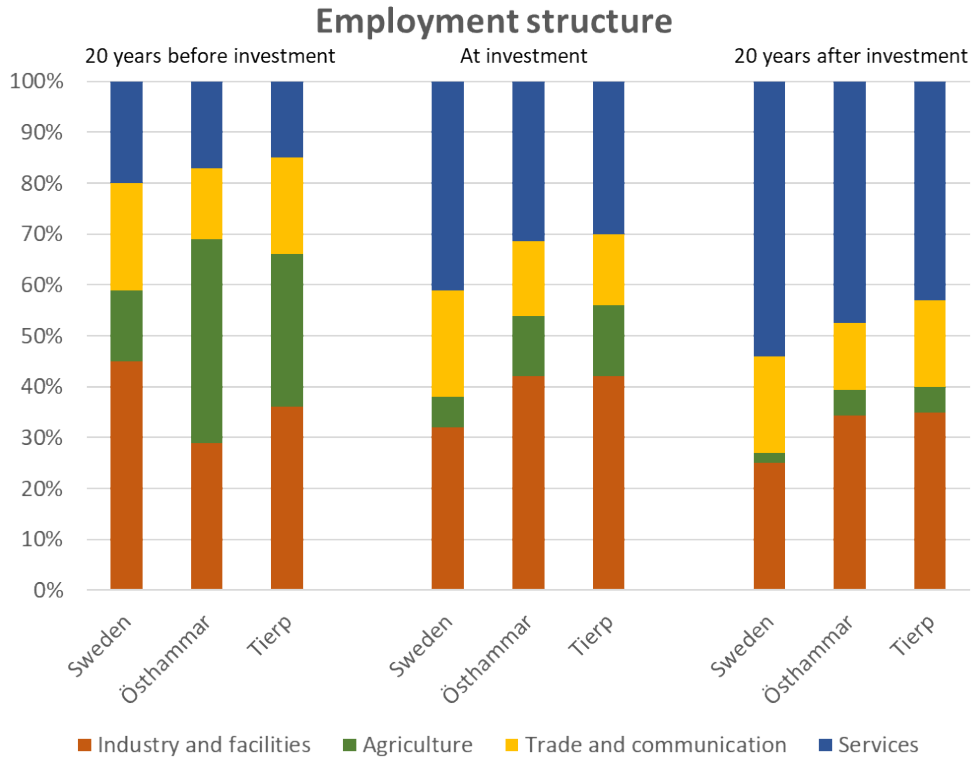


Figure 6 Employment structure in Sweden, Östhammar and Tierp 20 years before the investment, at the time of the investment and 20 years after. (Adapted from table 3-2 in [6]).

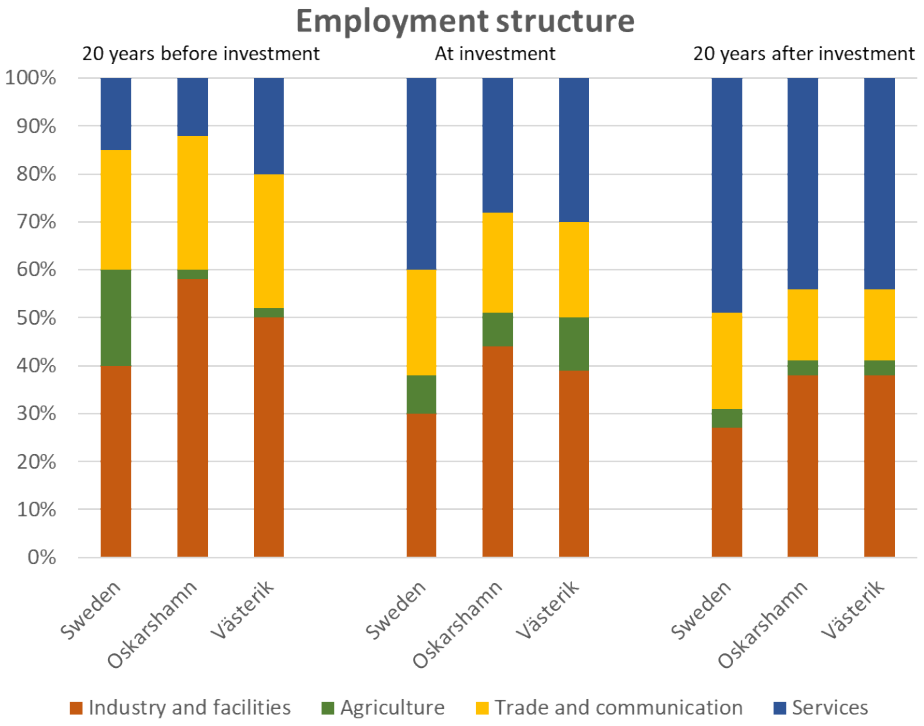


Figure 7 Employment structure in Sweden, Oskarshamn and Västervik 20 years before the investment, at the time of the investment and 20 years after. (Adapted from table 3-1 in [6]).

### 4.1.2. Comparison with medium sized and industrial municipalities

Both municipalities, Oskarshamn and Östhammar, have traditionally been industrial societies (as well as agrarian) with a significant part of the population employed in this sector. In terms of size, they are both considered medium sized municipalities, so a comparison with other communities of similar size and employment structure could be useful.

When comparing in terms of size, we observe an acceleration in the population growth at the time of the establishment. The nuclear municipalities grew faster than the average of this group (Figure 9).

The categorization of the municipalities as industrial was done based on the employment percentage of residents in the industry sector. An area was classified as industrial if more than the average of the employed population was working in industry. The trend has not been particularly positive for such municipalities. During the years that were studied, many industries were affected by increasing degrees of automation, which reduced the workforce needs, halting the growth of these areas. Moreover, in the 1970s, Sweden was hit by the oil crisis and the stock market crash. However, in contrast to other areas, nuclear municipalities were not affected by these events and, as seen in Figure 8, their population increase was strong.

In the 1990s, Sweden was affected by yet another crisis, namely globalization. Many traditionally industrial areas lost considerable amounts of job opportunities as factories moved out of the country. The population reduction was close to catastrophic for some of the areas such as Västervik. The nuclear municipalities were also affected by this general decline, as nuclear was not the only industry in the region, but compared to other areas, the crisis was much milder. This demonstrates that the nuclear industry, as site-bound, creates a more stable ground for a municipality.

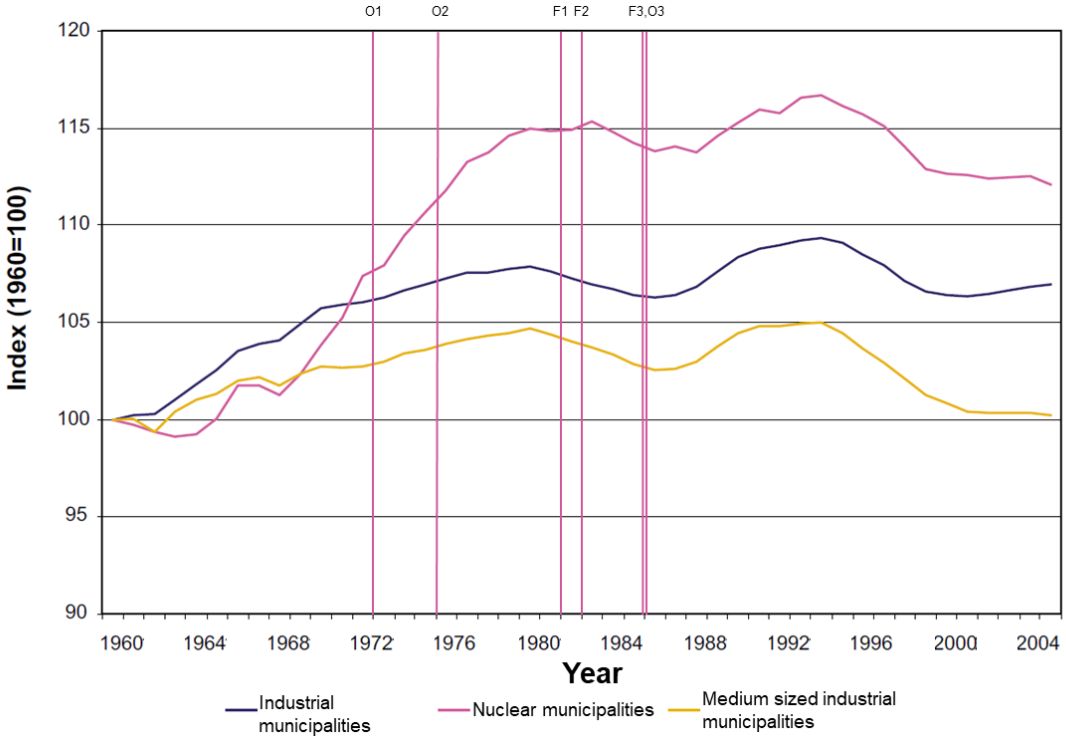


Figure 8 Rate of population change in nuclear municipalities, other industrial municipalities and other medium sized industrial municipalities in the period 1960-2005. The vertical lines indicate when each unit came to operation. (Adapted from figure 3-8 in [6]).

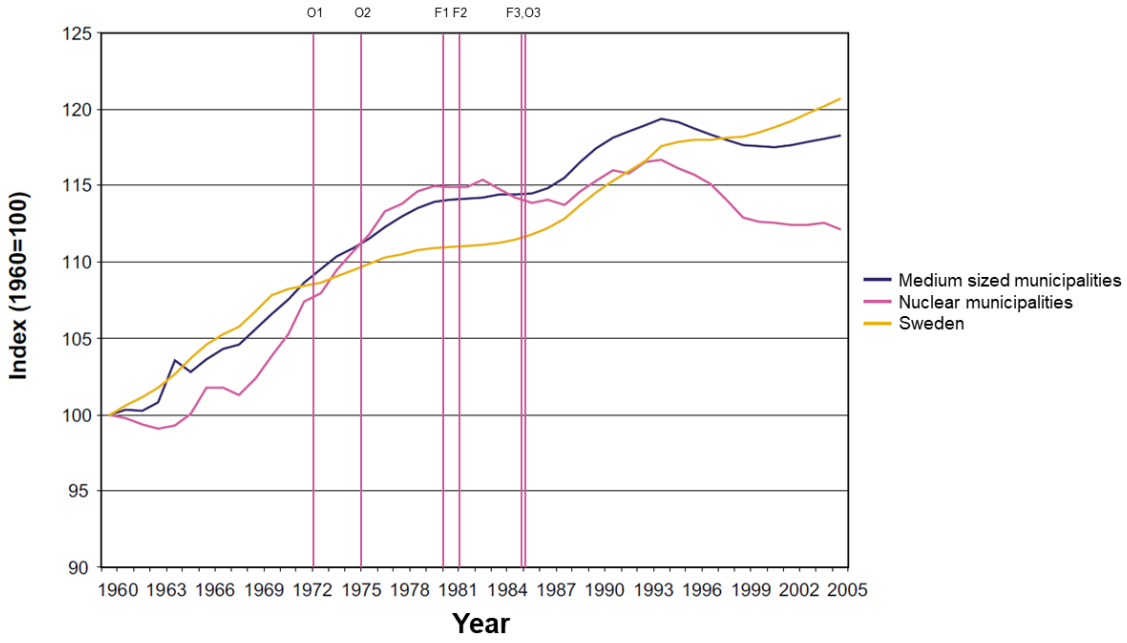


Figure 9 Rate of population change in nuclear municipalities, other medium sized municipalities and Sweden in the period 1960-2005. The vertical lines indicate when each unit came to operation. (Adapted from figure 3-6 in [6]).

### 4.1.3. Other effects on the population

The nuclear investments had an overall positive impact on the population development of the areas. However, this positive effect is most visible in a short-term horizon. It can be argued that the population growth was higher than what it would have been without the power plants. The investments gave a significant short-term boost, but this was more of an one-time event than a lasting transformation of the population structure. This is especially obvious for Oskarshamn, where the generation shift was evident and clear. During the construction period, the average age of the population was lowered only to deteriorate a few years later. At the end of the analyzed period, Oskarshamn was performing worse than the average for the whole country when it comes to both age and gender balance.

The post-construction population decrease was not so dramatic for Östhammar. The regional context might have played an important role in this case. Östhammar is close to Uppsala, the fourth biggest city in Sweden, which is very expansive and has a big university. Furthermore, the establishment of other industries, could be the cause for the difference with Oskarshamn. This shows the problem with isolating the effects of nuclear investments from other factors that influence the socioeconomic structure of a municipality.

Around 50% of the 900 FKA employees (2005) live in Östhammar municipality. One third of OKG employees live in Oskarshamn municipality and the majority of the remaining part in other municipalities in the county.

### 4.1.4. Construction period

#### 4.1.4.1. Housing

In order to investigate how the housing issue during the construction period would be solved, a common working group was formed in Oskarshamn by the municipality and OKG.

It was known beforehand that a number of temporary houses would be needed, but the municipality had a strong preference that they should be utilized even after the construction phase was over. The solution was the following: first, ordinary houses would be used, second, holiday accommodation, and lastly camper trailers. One of the biggest housing projects was the construction of a holiday village, Hägnad. It was financed by OKG and, when it was no longer needed, it was bought by the municipality and resold to private parties. Smaller nearby sites and villages, where population had previously decreased, were also brought up by the municipality during the discussion, as it was a chance for them to develop again. Both permanent and prefabricated houses were built, while the road to the construction site was repaired by OKG. This was not a negotiation issue, as once the municipality made the suggestion, OKG considered it a good idea and proceeded to implement it.

Whether the solution that was eventually followed was optimal could be considered debatable. The reasons behind the use of permanent and holiday houses were mainly social, as a normal house would provide good living

conditions and quality of life to the workers. However, these were people who worked long hours during the day and often went away for the weekends. It was acceptable to them to live in a smaller house with many housemates in order to save money. According to interviews conducted as part of the studies [9], this often led to both merriments and conflicts. The municipality personnel were surprised that many of them chose to live in camper trailers, most likely for cost reasons.

It is now obvious that too many houses were built in some of the areas. This was though part of the original plans and was not influenced by the later needs of the construction. Some of the houses have been teared down since then and some of the moveable ones have been taken away from the area.

In contrast to Oskarshamn, the third reactor in Forsmark was built immediately after the first two, making the transition between them much smoother. Many of the laborers were part of the construction of all 3 reactors and some of them established themselves permanently in the area. A few of the workers who retired during the time also decided to stay.

Many workers in the construction of the Forsmark power plant commuted every day to the building site, but temporary houses also needed to be built. In this case, there were two housing options, either temporary houses close to the power plant, or camper trailers. The demands on the municipality were not particularly high. The road to the site and the temporary housing for the construction workers were handled by the company. No demands on resources and competences were made either. The only exception was related to the housing of permanent operational personnel, who were already put in place in the later stages of the construction phase. The municipality undertook the task to provide rental housing for the permanent personnel already from the very first contract between the municipality and the company.

### 4.1.4.2. Cooperation with the municipalities

It is generally reported that the cooperation between the companies and the municipalities was almost frictionless, especially for Oskarshamn. The project was seen as common with all relevant stakeholders participating in the decision making process. At that time, the energy industry was mostly viewed as socially governed with municipalities owning parts of energy companies. Electricity production and distribution was considered a social affair and it felt natural for the municipalities to be involved.

The situation was slightly different in Forsmark as Vattenfall is a state owned company (there was no municipality ownership in this case). That doesn’t mean that Vattenfall decided everything without taking into account the municipality. The collaboration group that was built in Forsmark dealt mostly with housing and population growth issues.

Local companies were used for both materials and services. Especially in Oskarshamn, there was an explicit strategy to use local and regional companies as much as possible. OKG could choose the contractors more freely compared to Vattenfall, and factors such as proximity to the site were taken into consideration.

Naturally, this did not apply to the main contractors and other big assignments, as the companies issued invitations to tenders to procure them.

### 4.1.5. Real estate prices

According to [8], a study has been conducted to analyze the development of the real estate prices and try to identify the effects of the establishment of nuclear power. The study did not show any long-term effects, neither for permanent, nor for vacation houses. The short time effects, if any, were positive. The real estate price curves follow the overall development of the country and no significant trend could be identified in the price development in connection to the establishment of nuclear power plants.

Interviews with real estate agents in the nuclear municipalities have confirmed this conclusion. No real estate agent perceived the establishment to have any negative effect in the prices neither for permanent nor vacation houses. Half of the real estate agents stated that, if any effect was to be identified, it was a positive one. Comments about the nuclear facilities from the customers were very rare. Furthermore, no difference could be identified between customers coming from other municipalities and local ones. It should be noted here that the majority of the real estate agents were positive to nuclear power but, even the ones who were not, answered in a similar way.

## 4.2. Varberg

The Varberg municipality has an environment favorable to growth due to its proximity to Gothenburg, the second biggest city in Sweden. The municipality has outmatched the average population growth in the county the last decades and, during the 2000s, it has grown by 500 inhabitants every year. There are well developed commuting options for work, both to the south and to the north.

The municipality has a strong business sector with Ringhals playing an important role, both direct and indirect. RAB is the biggest private employer in Varberg municipality and one of the biggest in the county. There are even companies in the area dedicated to the support the nuclear operations such as security services, cleaning operations, mechanical maintenance, transport etc.

Due to the operation of the Ringhals power plant, Varberg municipality has developed higher specialization in electricity, gas, heating, and cooling compared to the rest of Sweden. The labor market consists of manpower with higher education levels (12 years of education or more), but has a difficulty to attract and develop top competences, which are more concentrated in Gothenburg.

During the nuclear expansion in the 1970s, even nearby areas grew, but in different magnitudes. The population in Kungsbacka, a municipality very close to Ringhals, more than doubled during 1968-1978, an important period of Ringhals' history (Figure 10). At the same time, the population in Varberg increased by 20%. However, the population growth for both Kungsbacka and Varberg started many years before the beginning of construction and continued long after the operation started. The nuclear investment has therefore not been the only driving force of prosperity in the area.

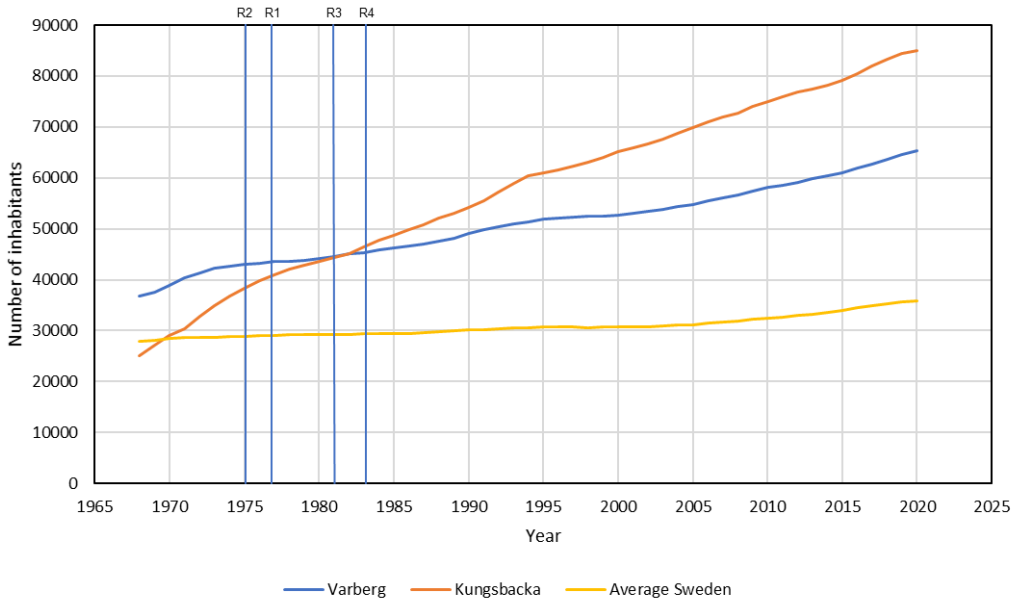


Figure 10 Evolution of population in Varberg, Kungsbacka and Sweden. The vertical lines indicate when each unit came to operation. Data from [10].

# 5. Companies and the general public

## Nuclear safety organizations

According to Swedish law, the public should have the possibility to get informed regarding the nuclear safety and radiation protection work in nuclear power plants. Therefore, in every municipality with a nuclear facility, there is a local nuclear safety committee. Their mission is to:

- Gather and publish information about the nuclear safety and security procedures that have been or are planned to be performed in the relevant nuclear facility.
- Gather and publish information about the preparedness in case of nuclear accidents.
- Answer to the public, authorities and institutions on local level about safety and security issues.

Through their work, the nuclear safety committees constitute a link among the various interested parties, such as the general public, the nuclear facility owner, the authorities, the county administrative board etc. The committees gather information from all the aforementioned parties, and they strive for simplicity in the information they release, to ensure accessibility for the general public.

The safety committee is neutral and consists of approximately 10 local politicians who represent either the municipality where the nuclear site belongs or nearby municipalities. The committee members are not experts themselves, but they are in a very close contact with specialists working in relevant authorities (such as the Swedish Radiation Safety Authority).

Besides the local nuclear safety committee, there is also an association of municipalities with nuclear facilities (KSO). The goal of the association is to facilitate cooperation and exchange of local experiences between these municipalities. Among other activities, they organize meetings, seminars, study tours and trainings, where they address and discuss questions of common interest. Other major issues of interest for the association is nuclear safety, competence building for nuclear staff and emergency planning/preparedness [11]. KSO also contributes in educating local politicians on nuclear issues.

## Tourism

The nuclear facilities around Forsmark and Oskarshamn are visitable sites. Most visitors lie in the following categories:

- Business visitors (engineers, managers, authorities' personnel, security personnel etc.)
- Personnel working during the planned yearly outages
- Students and teachers
- General public

Around 15 000–16 000 tourists visit Forsmark every year and around 4 000–5 000 business visitors [6]. The info center at Ringhals has 10 000–16 000 visitors each year [12]. Around 15 000 people visit the nuclear facilities in Oskarshamn

every year for study visits and maintenance work during yearly planned outages [6]. The high placement of Oskarshamn in touristic area ranks is directly connected to the nuclear operations. Even if the visitors are not permanent residents of the municipality, they contribute to the local economy through meals, means of transportation, hotels, free time activities and so on.

## Social responsibility

### Forsmark

The Forsmark village close to the power plant has around 100 inhabitants nowadays. It is classified as a historical heritage site, and the appearance of the historical buildings and environment is preserved and maintained by Forsmarks Kraftgrupp (FKA). The houses are owned by FKA and are renovated and furnished. There is also a mansion in the village, which is used for conferences. In the visitor center located in the village, people have the opportunity to drop by during summertime in order to get informed about nuclear power and join guided tours and other activities [13].

FKA sponsors sports and cultural activities for children and young people. The sponsored organizations should have respect for democracy and human rights, and share the companies views on security and the labor environment. FKA donates only to local organizations with close connection to the municipality.

It is worth noting that in Östhammar there was no high school up until 1980. FKA saw this as a problem both for the construction and for future recruitment possibilities. This led to the founding of “Forsmarksskola” (nowadays called “Vattenfall gymnasiet”). The school started in 1987 with an emphasis on scientific studies and especially data engineering and energy. Students have the opportunity for study visits in the Vattenfall facilities and have priority when looking for internships and summer jobs in the company [9].

### Ringhals

The Ringhals power plant has an infocenter, where the general public has the opportunity to learn more about the history of electricity, the concept of energy and work environment at Ringhals. For further information in addition to that provided by the exhibition, there is a possibility to book a study visit. The study visits usually last between two and three hours.

Ringhals is supporting various non-profit organizations in the municipality in order to contribute to the positive development of the community. The support is usually financial and is directed to sport, cultural or other activities of useful nature. The ambition is that the benefited organizations are compatible with the company’s core values: security, performance, cooperation and learning.

### Oskarshamn

Oskarshamnsverkets Kraftgrupp (OKG) has around 75 sponsoring projects every year. These differ in terms of size and interest area. OKG is cooperating with organizations that have a natural connection to the company and whose goals do not conflict with OKG’s principles. The sponsoring activities are targeting

organizations in the Oskarshamn municipality. In exceptional cases there are also sponsoring activities on a regional or even national level.

# 6. Public opinion on nuclear power

The Swedish public opinion on the future of nuclear power is shown in Figure 11. It should be noted here that there is no study that has not changed either the question asked to the public or the answer alternatives over time. Here, we have chosen to present the study that has changed the formulation fewer times. The way the question and the answer alternatives are formulated can influence the result and that is something that should be taken into account. In Figure 11, there is a clear decline for the answer alternative “Phase out when closed” (green line) from the 2002 to 2003. We believe that part of these votes moved to the answer alternatives “Develop and build more” (cyan line) and “Continue using as today” (blue line), which were introduced to the survey that year. More information about the distribution of the answers among various population groups can be found in [14].

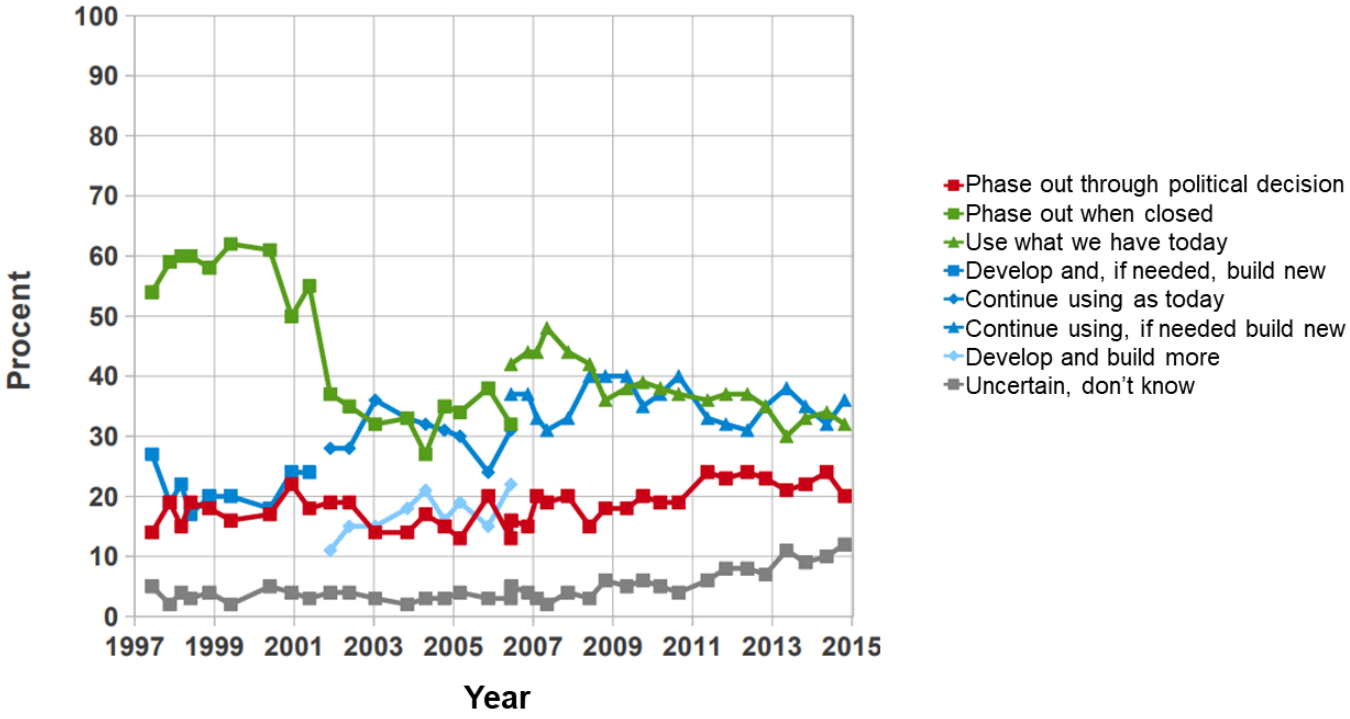


Figure 11 Evolution of public opinion in Sweden on the future of nuclear power. The exact question that was asked was: "What is your personal view about the future use of nuclear power as energy source in Sweden? Should we…” [15]

Interviews have also been performed in Oskarshamn municipality in 2018, 2019 and 2020 to report how much local populations trust the power plant. The results are shown in Figure 12. The results of a similar study for FKA are shown in Figure 13. We should point out that neither an incident that happened in Forsmark in 2006 nor the Fukushima accident in 2011 influenced the trust that people have on the power plant.

The reader might expect that proximity to a nuclear power plant would cause fear for problems and accidents. In reality it seems to be the opposite. The support for nuclear power is bigger in Oskarshamn and Östhammar compared to the rest of the country. The difference can be explained by access to more information, and employment in the plants [16]. In Forsmark and Oskarshamn, the companies

arrange guided tours in the plant, extensive school activities for all levels of education, and information that can be of general interest is printed in the local press.

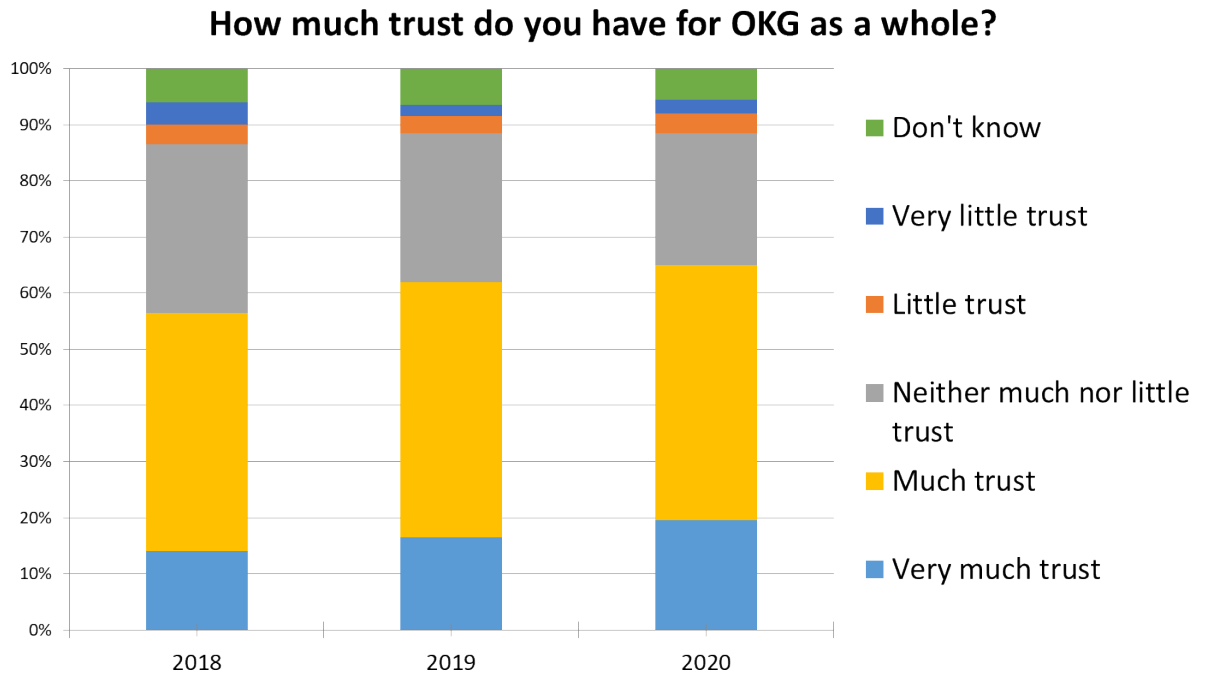


Figure 12 Evolution of public trust in Oskarshamn towards OKG (adapted from [17])

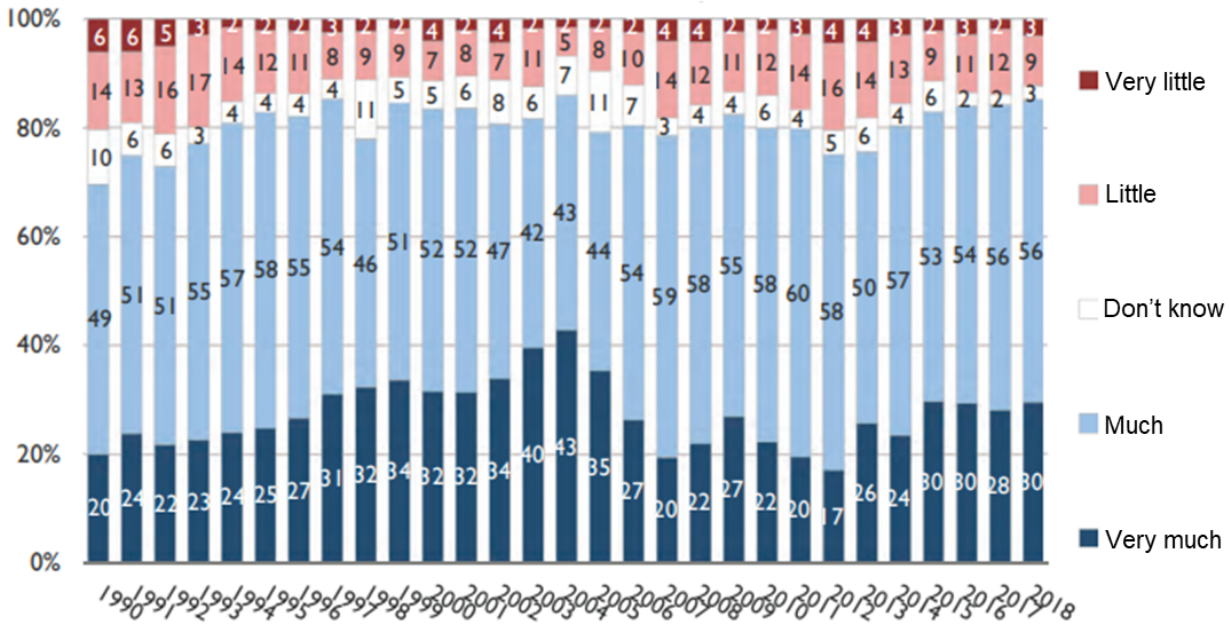


Figure 13 Evolution of public trust in Östhammar towards the power plant in Forsmark. The exact question that was asked was: "If you could give an overall assessment, how much do you trust the nuclear power plant in Forsmark?" (adapted from [18])

Lastly, differences of opinion on nuclear power did not cause problems during the investment phase according to interviews with residents of nuclear municipalities, which were performed as part of [9]. In social contexts, such as local churches and other associations, people could cooperate even if they had different opinions on the matter. No one could remember the topic affecting negatively socialization and everyday life in the municipalities. There were of course discussions and people from both sides engaged in debates. Going through press clippings and interviews, it seems that attention to the subject increased when some opinionated external visitor came to the area. However, the discussions did not last very long as people could get access to relevant information through the local safety committees.

# 7. Conclusions

What can be deduced with certainty is that nuclear power has had a significant impact on the local municipalities. The strongest effects can be observed during the construction time and the first years of operation while at later stages they decrease and become difficult to distinguish. This is in agreement with what has been observed for investments in other big infrastructure projects, such as railways. The rapid population growth associated with the investment stopped a few years after the construction period and subsequently returned to prior development patterns. However, the analyses indicate that in the case of nuclear power, the municipalities have stabilized at a higher socioeconomic level after the construction.

The nuclear industry provides a sizable and almost immovable workplace which gives a base for a local socioeconomic development that movable industries cannot provide. A nuclear power plant cannot be moved to an area with low salaries, it is difficult to be drawn out of business by competition, and it is almost impossible to be replaced by new technology before its lifetime is over. It is these properties that make an investment in nuclear technology a more stable ground for an area's economic development. It seems that site-bound industries in general generate employment and activities around them. However, it should be noted that in contrast to many other industries, the nuclear industry is dependent on political decisions.

If we examine the impact of industrial investments to the local communities in general across history, we observe that its strength weakens as we get closer to the present. With the increased ease and speed of transportation inside a country, the more globalized economy, and the increased levels of specialization, the local effects become more and more feeble as the years go by. This is particularly true in a specialized and technically advanced industry such as nuclear power. The nuclear industry is international. The market for both construction and operation is and has been international even if it has a strong national component. The local influence is small. It is enough to look at the ownership of the power plants to ascertain that. This trend will only become stronger with the increased globalization of the economy and the deregulation of the energy market.

The overall conclusion is that, even if the most obvious effects happened under a limited timeframe, the impact of the nuclear investment had a long-term positive effect on the socioeconomic development of local societies. As many of the interviewees have stated, it is difficult today to imagine Oskarshamn without OKG and Östhammar without FKA. The nuclear municipalities have dealt with economic crises better than the reference municipalities, despite the initially similar socioeconomic structure. The nuclear industry has provided robustness to the municipalities. Even the population composition has developed in a different way compared to the reference municipalities. This indicates that the introduction of nuclear power triggered a series of events in the local economy that lead to a structural change, which in the long run modified the socioeconomic structure of the municipalities.

# 8. Further reading

The following list can be useful for the reader who would like to learn more about the socioeconomic impact of nuclear deployment outside Sweden.

**[1]** GEN energija
The impact of Nuclear Energy sector to Socio-Economic Development in Slovenia and European Union
https://www.researchgate.net/publication/268925594_The_impact_of_Nuclear_Energy_sector_to_Socio-Economic_Development_in_Slovenia_and_European_Union

**[2]** Oak Ridge National Laboratory
Social effects of nuclear power plants
https://www.osti.gov/servlets/purl/4275538

**[3]** PricewaterhouseCoopers LLP (PwC)
Transforming Canada's energy future: The socio-economic impact of GE Hitachi SMRs
https://nuclear.gepower.com/content/dam/gepower-nuclear/global/en_US/documents/economic-impact/Transforming%20Canada%27s%20energy%20future%20%E2%80%93%20The%20socio-economic%20impact%20of%20GE%20Hitachi%20SMRs.pdf

**[4]** EDF and CGN
Hinkley Point C 2021 Socio-economic Impacts Report
https://www.edfenergy.com/sites/default/files/2021_hpc_socio_economic_brochure_-_web.pdf

# References


**[1]** Sveriges Kärntekniska Sällskap
Kärnkrafthistoria - den svenska linjen
https://www.karnteknik.se/karnteknik/sveriges-karntekniska-historia/karnkrafthistoria-den-svenska-linjen

**[2]** Vattenfall AB
Storsatsning på kärnkraft
https://historia.vattenfall.se/stories/fran-vattenkraft-till-solceller/storsatsning-pa-karnkraft

**[3]** Uniper
Kärnkraften i Sverige
https://www.uniper.energy/sverige/karnkraft/karnkraft-i-sverige

**[4]** Kulturgeografiska institutionen
Barsebäcksverkets lokalisering och nedläggning - Hur förutsättningar och omständigheter för ett kärnkraftverk kan komma att förändras
https://docplayer.se/7961785-Arbetsrapporter-kulturgeografiska-institutionen-nr-710.html

**[5]** Elforsk
Tillståndsprövning för kärnkraft Etapp 2 – analys av den svenska situationen
https://www.researchgate.net/publication/284031798_Tillstandsprovning_for_karnkraft_Etapp_2_-_analys_av_den_svenska_situationen

**[6]** Svensk Kärnbränslehantering AB
R-07-02 Växtkraft av kärnkraft? Kärnkraftetableringens socioekonomiska effekter i Oskarshamn och Östhammar 1960–2000
https://www.skb.se/publikation/1335870/R-07-02.pdf

**[7]** Svensk Kärnbränslehantering AB
R-08-68 Regionala konsekvenser av en slutförvarsetablering ur ett samhällsperspektiv: Oskarshamn/Kalmar
https://www.skb.se/publikation/1616321/R-08-68.pdf

**[8]** Svensk Kärnbränslehantering AB
R-08-70 Regionala konsekvenser av en slutförvarsetablering ur ett samhällsperspektiv: Östhammars kommun i Uppsala län
https://www.skb.com/publication/1622532/R-08-70.pdf

**[9]** Svensk Kärnbränslehantering AB
R-06-51 Byggandet av F3 och O3 - hur det påverkade Oskarshamns och Östhammars kommuner under byggprocessen och efteråt
https://www.skb.com/publication/1126214/R-06-51.pdf

**[10]** Statistiska centralbyrån
SCB Kommuner i siffror
https://kommunsiffror.scb.se/

**[11]** Kärnkraftskommunernas samarbetsorgan
https://www.karnkraftskommunerna.se/

**[12]** Vattenfall AB
https://www.visitringhals.se/

**[13]** Vattenfall AB
https://www.visitforsmark.se/

**[14]** Samhälle, Opinion och Medier
Åsikter om energi och kärnkraft, Den svenska miljö-, energi- och klimatopinionen (MEK)
https://www.gu.se/sites/default/files/2021-04/6.%20%C3%85sikter%20om%20energi%20och%20k%C3%A4rnkraft%20-%20MEK%202020.pdf

**[15]** Analysgruppen
Kärnkraftsopinionen över tid
https://analys.se/wp-content/uploads/2015/12/karnkraftsopinion-som-vs-analysgruppen-maj-2015.pdf

**[16]** Svensk Kärnbränslehantering AB
Samhällsforskningen 2004–2010 Teman, resultat och reflektioner
http://www.skb.com/pub/2198541/Samhallsforskningen2004-2010.pdf

**[17]** Uniper
OKG Communication department, surveys for internal use

**[18]** Östhammar kommun
Sammanträdesprotokoll
https://www.osthammar.se/globalassets/dokument/moteshandlingar/lokal-sakerhetsnamnd/2019/2019-02-07/protokoll-lokala-sakerhetsnamnden-7-februari-2019.pdf