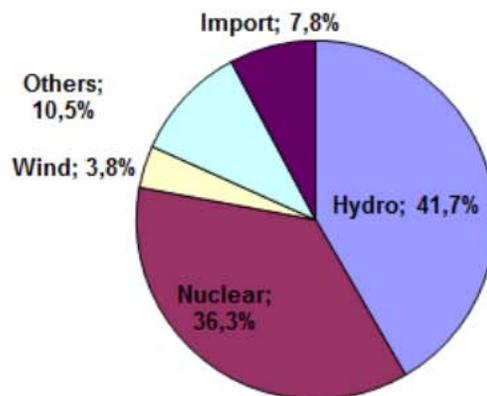


## RADIOACTIVE WASTE AND MANAGEMENT PROGRAMMES IN OECD/NEA MEMBER COUNTRIES

### SWEDEN [2013]

#### NATIONAL NUCLEAR ENERGY CONTEXT

Commercial utilisation of nuclear power in Sweden started in 1972 and as of 2012 ten nuclear power units supply electricity to the grid. In 2011, nuclear power generated 58 TWh of electricity, 36 % of the total electricity generated.



*Electricity supply by sources 2011 (160,0 TWh)  
(Source: Statistics Sweden)*

#### SOURCES, TYPES AND QUANTITIES OF WASTE

Nuclear waste arises from 12 commercial nuclear power plants at Barsebäck<sup>1</sup>, Forsmark, Oskarshamn and Ringhals and from research activities, mainly from Studsvik. Other radioactive wastes, so called small user waste, arise from a number of facilities using radioisotopes in medical, research and industrial applications.

The long-term planning for the waste management programme is based on a reference scenario where the reactors in Ringhals and Forsmark are assumed to have an operating time of 50 years and OKG's reactors 60 years. The quantity of spent fuel to be disposed of amounts to about 12,000 tonnes of uranium (counted as uranium).

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<sup>1</sup> The two units in Barsebäck were permanently shut down 1999 and 2005

The total volume of decommissioning waste for all nuclear power plants as well as from research and demonstration facilities is estimated to 160 000 m<sup>3</sup>.

The LILW programme is aimed at disposing of all the low- and intermediate-level operational and decommissioning waste from the Swedish nuclear power programme. The reference scenario gives rise to a total of about 200 000 m<sup>3</sup> of short-lived waste and about 10 000 m<sup>3</sup> of long-lived waste from the nuclear power plants.

By the end of 2011 about 34 400 m<sup>3</sup> of short-lived low- and intermediate level waste had been disposed of in the disposal facility for short-lived low- and intermediate level waste (SFR<sup>2</sup>) in Forsmark, and 19 600 m<sup>3</sup> had by the end of 2010 been disposed of at shallow land burials at the nuclear power plant and Studsvik sites.

## **RADIOACTIVE WASTE MANAGEMENT POLICIES AND PROGRAMMES**

### **Radioactive waste management policies and practices**

The producer-pay-principle is since the beginning of the 1980's implemented in the Swedish legislation for nuclear fuel cycle wastes.

Spent fuel is destined for direct disposal in a geological disposal facility. The concept involves encapsulation of spent fuel elements in a cast iron insert in a copper canister that to be disposed of in a vertical deposition holes in tunnels in a granitic type of host rock at a depth of about 400-500 meters. Spent fuel is currently stored in a central interim storage facility for spent nuclear fuel (Clab), near Oskarshamn. The implementing organisation, SKB<sup>3</sup>, submitted a applications for the construction of a spent fuel disposal facility in March 2011, currently under review by the regulatory authority.

Long-lived low- and intermediate level waste is destined for disposal in a geological disposal facility at a depth of about 300 meters. The implementer, SKB, plans to have a disposal facility in operation in the mid 2040's.

Short-lived low- and intermediate level waste is disposed of in the disposal facility for short-lived radioactive waste, SFR.

Very low-level waste is disposed of in shallow land burials or cleared for unrestricted use or for disposal as conventional non-radioactive waste.

### **Programmes and projects**

#### *Disposal of spent nuclear fuel*

SKB submitted in November 2006 a license application under the Act of Nuclear Activities for the construction of an encapsulation plant. Extensive supplements were submitted in September of 2009.

In March 2011 SKB submitted a license application under the Act of Nuclear Activities for a disposal facility for spent nuclear fuel. SKB also submitted updated material to supplement the application for the encapsulation plant. At the same time SKB submitted also a license application under the Environmental Code for establishment of the KBS-3 system for disposal of spent nuclear fuel, i.e. the application covers both the encapsulation plant and the disposal facility for spent fuel.

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<sup>2</sup> Disposal facility for short-lived low- and intermediate level waste (Slutförvar för kortlivat radioaktivt avfall)

<sup>3</sup> Svensk Kärnbränslehantering AB (Swedish Nuclear Fuel and Waste Management Company)

The regulatory review of the applications under the Act on Nuclear Activities is co-ordinated with the review of the application under the Environmental Code by the Environmental Court.

#### *Disposal facility for decommissioning waste*

SKB has initiated the consultation process to site a disposal facility for short-lived low and intermediate level decommissioning waste as an extension to the existing disposal facility for short-lived operational waste (SFR). Investigation of the bedrock started in 2008 and were finalised by 2010. SKB plans to submit an application late 2013 and to have the disposal facility in operation in 2023.

## **RESEARCH AND DEVELOPMENT**

### **Responsibilities**

The Nuclear Activities Act (1984:3) requires that the holder of a licence for the operation of a nuclear power reactor shall - in co-operation with the other holders of a licence for the operation of nuclear power reactors - establish and carry out an research and demonstration programme for the safe handling and disposal of spent fuel and nuclear waste, including decommissioning. The programme shall be submitted to the Government for review and approval on a three year basis. The next programme, will be submitted by SKB in September 2013. SKB's budget for RD&D-activities for 2011 was SEK 378 million (equivalent to € 44 million). In addition, SEK 185 million (equivalent to € 22 millions) was spent on site investigations and design.

### **Research and demonstration facilities**

SKB has established three research- and demonstration facilities in the municipality of Oskarshamn to carry out necessary research and demonstration activities. The Äspö Hard Rock Laboratory to develop and test such things as site characterisation, deposition and retrieval of canisters, as well as methods for excavation of tunnels and shafts. The Canister Laboratory, mainly used for development of welding techniques and methods for non-destructive testing of canisters and welds. The Bentonite Laboratory for conducting large-scale tests of the properties of the bentonite and to further develop the industrial handling process for backfilling of tunnels.

### **Regulatory research activities**

The research budget dedicated for research on safe disposal of spent fuel and nuclear waste for 2012 was in the order of SEK 23 million (equivalent to € 2,7 million) mainly for contracting university institutions and consultant companies in Sweden and abroad. It is also used for contributing to some international projects organised by OECD/NEA, IAEA and EU.

## **DECOMMISSIONING AND DISMANTLING POLICIES AND PROJECTS**

### **Decommissioning strategy**

The main strategy is to start dismantling a plant as soon as it has been taken out of service. In this way a long period of shutdown operation is avoided. The power companies' common goal for decommissioning of the nuclear power plants is that the site should be used for future energy production after decommissioning, since there is extensive and valuable infrastructure there including power lines, roads, harbours, cooling water channels etc. Certain buildings will also be able to be used after being released for unrestricted use.

## **Decommissioning of the Barsebäck nuclear power plant**

The two BWR units in Barsebäck were permanently shut down 1999 and 2005, respectively. The facilities have been prepared for a period of care and maintenance awaiting dismantling (off-site shipment of fuel, downsizing of organization, adjustment of supervision and maintenance, energy saving measures etc). Primary system decontamination of both units was performed during the winter 2007/08. Processing of the wastes from operation and decontamination is proceeding. Dismantling of internal parts is planned to start 2015. Comprehensive dismantling activities are planned to commence 2022, pending the extension and relicensing of the existing SFR facility to accommodate also decommissioning waste.

## **Decommissioning of Studsvik material test reactors**

The two material test reactors in Studsvik (one tank type and one mobile pool type) were permanently shut down in 2005. Preparations for dismantling of the reactors are ongoing. Decontamination of two test loops was performed early 2008. Dismantling of the reactors is planned to start 2013 and to be completed by 2017. Radioactive waste will be treated and stored on site awaiting disposal.

## **Decommissioning of Ågesta PHWR**

The pressurized heavy water reactor in Ågesta was permanently shut down 1974. A license according to the Environmental Code for continued care and maintenance until 2020 was issued by the local environmental court in November 2008.

## **TRANSPORT**

All transportation of spent nuclear fuel and nuclear waste is by sea, since all the nuclear facilities are situated on the coast. SKB owns and operates the transport ship, M/S Sigyn, a custom-made ship to transport spent fuel and radioactive waste from nuclear power plants to Clab and SFR. The transportation system has been in operation since 1982 and consists of the ship M/S Sigyn, transport casks and containers, and terminal vehicles for loading and unloading. SKB has recently commissioned a new ship, MS Sigrid, to eventually replace MS Sigyn.

## **COMPETENT AUTHORITIES AND IMPLEMENTING ORGANISATIONS**

### **Regulation and Licensing**

The Government grants licenses for nuclear facilities and decides on fees to be paid to the nuclear waste fund as well as on financial guarantees to be provided for by the licensees.

The Ministry of Enterprise, Energy and Communications is responsible for matters relating to e.g. the business sector, energy and regional development and thus responsible for - if any - any promotion of nuclear energy.

The Ministry of the Environment is responsible for matters related to management – including financing arrangements - of spent fuel and radioactive waste from the nuclear fuel cycle as well as from use of radioactive substances from medical, research and industrial applications.

The Swedish Radiation Safety Authority (SSM) is the responsible regulatory authority as regards nuclear safety and radiation protection including management of spent nuclear fuel and radioactive waste,

as well as review of cost calculations for the entire spent fuel and radioactive waste management program.

The National Council for Nuclear Waste was established in 1985 and is an advisory body to the government on matters related to nuclear waste management. The Council is since 1992 an independent committee attached to the Ministry of the Environment.

### **Implementing organisations**

Under Swedish law, the holder of a licence to operate a nuclear facility is primarily responsible for the safe handling and disposal of spent nuclear fuel and radioactive waste, as well as decommissioning and dismantling of the facility. The four utilities operating nuclear power reactors in Sweden have formed a special company, the Swedish Nuclear Fuel and Waste Management Company (SKB), to assist them in executing their responsibilities. Thus, SKB is responsible for all handling, transportation and storage of spent fuel and radioactive waste outside the nuclear power plants.

SKB is also responsible for the planning and construction of all facilities required for the management of spent nuclear fuel and radioactive wastes, and for such research and development work as is necessitated by the provision of such facilities (R&D programmes), as well as for co-ordination and investigations regarding the costs associated with nuclear waste and future decommissioning.

## **FINANCING**

A special legislation is in place since 1981, requiring the nuclear power plant operators to pay fees to a special fund, the Nuclear waste Fund, to cover all costs incurred for the safe management and disposal of all spent fuel and radioactive waste from the Swedish nuclear program.

- The basic requirement stipulates that the holder of a licence for a nuclear facility which generate or has generated residual products must pay a fee to the Nuclear Waste Fund, to cover the licensee's share of the total costs for the management and disposal of spent nuclear fuel and/or nuclear waste. The licensees are required to submit updated cost estimates every three years. The regulatory authority appointed by the Government reviews the cost calculations and submits a proposal for the size of the fees and guarantees to the Government. The size of the fee is decided by the Government and is individual for each utility. The purpose of the fund is to cover all expenses incurred for the safe handling and disposal of spent nuclear fuel, as well as dismantling nuclear facilities and disposing of the decommissioning waste. The fund must also finance SKB's R&D as well as expenses for regulatory control and supervision of spent fuel and nuclear waste management activities.

The management of the nuclear waste fund is the responsibility of a separate government agency, the Nuclear Waste Fund.

## **PUBLIC INFORMATION**

### **The Government**

#### **The Ministry of the Environment**

Website: <http://www.sweden.gov.se/>

### **The Swedish Radiation Safety Authority (SSM)**

Website: <http://www.stralsakerhetsmyndigheten.se>

**The Swedish Nuclear Fuel and Waste Management Company (SKB)**

Website: <http://www.skb.se>

**The Swedish Training and Safety Center (KSU)**

Website: <http://www.analys.se>