Cost of Late Action - the Case of PCB

An environmental impact study by Jenny von Bahr and Johanna Janson, environmental economists, Green Index, Stockholm,

within an impact study project directed by Urban Boije af Gennäs, Swedish Ministry of Environment with the assistance of Lars Gustafsson and Torbjörn Lindh, Swedish Chemicals Inspectorate

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The Nordic Council
was formed in 1952 to promote co-operation between the parliaments and governments of Denmark, Iceland, Norway and Sweden. Finland joined in 1955. At the sessions held by the Council, representatives from the Faroe Islands and Greenland form part of the Danish delegation, while Åland is represented on the Finnish delegation. The Council consists of 87 elected members - all of whom are members of parliament. The Nordic Council takes initiatives, acts in a consultative capacity and monitors co-operation measures. The Council operates via its institutions: the Plenary Assembly, the Presidium and standing committees.

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Preface

This is a report on environmental costs in Europe due to the misstep to use PCBs (polychlorinated biphenyls).

It is a contribution to the assessment studies of possible impacts if the proposed EC legislation on Registration, Evaluation and Authorisation of Chemicals (REACH) is introduced.

The study is one of two on the impacts of REACH within a project that has been initiated and founded by the Nordic Council of Ministers.

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The Nordic project was directed by Urban Boije af Gennäs, Swedish Ministry of Environment, with the assistance of Lars Gustafsson and Torbjörn Lindh, Swedish Chemical Inspectorate.

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English terms and expressions have been revised by Johanna Farelius, environmental economist at Ambientus.

Summary 1

Estimated Costs for PCB in the Enlarged European Union, EU25

The study concludes that the estimated environmental costs for the PCB misstep in EU25, during the years 1971 to 2018, will reach a total of at least EUR 15 billion[1]. Costs have been derived from a case study attesting that actual costs in Sweden are expected to amount to EUR 320 - 550 million (SEK 3,5 – 4,5 billion).

Significant Benefits with Early Action

The study confirms that early action gives considerable environmental benefits to society. Assuming that the REACH regulation (a proposed new EC chemicals legislation) is adopted and that one medium or five smaller chemical missteps, but similar to the PCB-misstep, could be avoided, society would save at least EUR 7 billion, apart from savings from avoiding health damages and irreversible effects on biodiversity and ecosystems. The European Commission is expecting the implementation of REACH to cost EUR 2.8 – 5.2 billion through a period of ten years.

Inadequate Knowledge

There is insufficient information today about environmental costs for hazardous chemicals. No comprehensive research seems to have been done in the field and there is a substantial need for further investigation.

Background

The aim of the study is to assess the economical impact of avoiding environmental damage from chemical agents. To avoid such damage is one of the main purposes of REACH, although among impact assessments published so far, data on benefits of avoiding environmental costs are sparse or lacking.

The economical consequence of PCB pollution is considered to be a suitable case to study. The access to data on the costs for remediation measures is relatively good, as several years have elapsed since remediation started.

In the scope of this study it has been possible to find Swedish data on costs for remediation of contaminated soil, buildings and electrical installations and there are also inventories of remaining needs for remediation. This data has to some extent been compared with similar costs in Norway.

PCB is an extreme pollutant that was used during a long time and could as such be considered untypical compared to the chemical use of today. There is however a number of chemical substances where we already know that they will cause substantial

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[1] *To avoid confusion:* When a *billion* is mentioned in this report it is equal to 10^9 or in other words equal to a so called British *milliard*

future remediation costs, others where there is a strong suspicion of such future problems. Still others that pose a threat to health and environment remains to be discovered among the over 30,000 chemical substances on the market within the European Community, where the knowledge about their properties is very insufficient. It is considered highly probable that some of these substances could cause large costs for society in the future.

A crucial component of REACH is to avoid future costs through early action by improving information about chemical risk. The study contains some calculations of cost scenarios for chemical missteps of minor magnitude compared to the case of PCB. REACH poses an opportunity to avoid such future costs.

Summary 2

Kostnader för PCB i EU med 25 medlemsländer, EU25

Studien visar att kostnader för miljöåtgärder under åren 1971-2018 till följd av misstaget att använda PCB inom EU25 kan uppskattas till åtminstone 15 miljarder[2]. Denna kostnadsuppskattning bygger på en fallstudie som anger att förväntade kostnader i Sverige under samma period kan komma att uppgå till mellan 3,5 – 4,5 miljarder svenska kronor (EUR 320 - 550 million).

Att sätta in åtgärder tidigt ger betydande fördelar

Studien bekräftar att tidigt insatta åtgärder ger samhället avsevärda miljöfördelar.

Om vi förutsätter att REACH-förslaget (förslaget till ny kemikalielagstiftning inom Europagemenskapen) genomförs och att unionen därmed undviker att ett PCB-liknande men hälften så allvarligt misstag inträffar, eller att fem mindre liknande misstag inträffar, kunde det undanröja kostnader på åtminstone sju miljarder Euro.

Detta oräknat kostnader till följd av hälsoskador och på grund av oåterkalleliga följder för den biologiska mångfalden och ekosystemen. EG-kommissionen räknar med att införandet av REACH kommer att kosta 2,8-5,2 miljarder Euro under en tioårsperiod.

Otillräckliga kunskaper

Idag saknas tillfredsställande information om vilka kostnader som farliga ämnen leder till för miljön. Det saknas grundläggande studier på området och forskningsbehovet ärdärför stort.

Bakgrund

Studiens syfte är att bedöma de ekonomiska effekterna av att undvika skador på miljön från kemiska ämnen. Att undvika miljöskador är ett av huvusyftena med REACH, men bland de konsekvensanalyser som har publicerats hittills saknas uppgifter om fördelarna för miljön helt och hållet eller förekommer bara sparsamt.

Vi menar att det är lämpligt i det här fallet att studera de ekonomiska följderna av föroreningar från PCB. Det har förflutit åtskilliga år sedan några insatser började att göras på området och det finns ett tämligen gott underlag med uppgifter om vad åtgärder har kostat.

Inom studiens ram har det blivit möjligt att finna uppgifter i Sverige om kostnader för sanering av förorenad mark, byggnader och elektriska installationer samt att ta del av inventeringar över behov av insatser som återstår att göra. En del uppgifter har kunnat jämföras med kostnader av liknande slag i Norge.

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[2] *För att undvika missförstånd:* En miljard är 10^9. En miljard heter på amerikansk engelska *One Billion*.

PCB är ett extremt miljöstörande ämne som har använts under en lång period. Ämnet skulle därför kunna betraktas som mindre representativt för dagens användning av kemikalier.

Vi känner emellertid redan till att det finns andra kemiska ämnen vars användning kommer att leda till betydande framtida kostnader för sanering och omhändertagande och det finns starka misstankar om framtida problem i i samband med ytterligare ämnen. Därutöver återstår att upptäcka hur många bland de drygt 30 000 ämnena på Europamarkanden som utgör ett hot mot hälsa och miljö och om vilka våra kunskaper är ytterst bristfälliga. Det bedöms mycket sannolikt att en del av dem kan förorsaka stora kostnader för samhället i framtiden.

Ett huvudsyfte med REACH är att förebygga framtida kostnader genom att motåtgärder sätts in tidigt. Detta skall uppnås genom att tillgången till information om riskerna med kemiska ämnen förbättras. I denna studie finns beräkningar av kostnader vid scenarier av liknande slag som i fallet med PCB, men av mindre omfattning. REACH skapar möjligheterna att undvika framtida kostnader av detta slag.

1 Introduction

1.2 Background – Why a Case Study of PCB?

The costs for REACH have been subject to an increasing number of studies, at least 20, by the Commission, Member States, and Industry. Some have been very extensive.

So far, the savings from REACH, however, have been subject only to a very limited number of studies. The Commission has financed two studies carried out by the consultants Risk and Policy Analysts, RPA. One of these presents indicative calculations that REACH may result in fewer occupational related cancer cases, one consequence being lower costs for society[3]. The other study indicates possible lower social costs for four substances causing environmental and human health damages, had early action been taken[4]. However, there are no calculations of total potential benefits to society.

When considering launching a Nordic study to try to fill parts of the gap regarding potential savings from REACH, there were a few preconditions that had to be met. It was presumed that cost calculations would be possible only for a well-known substance of very high concern, known to have caused major impacts including remediation needs. In addition, a number of years had to have elapsed from the initial signs of damage to allow for a range of remediation efforts to have taken place. This led to the choice of PCB, for which broad remediation actions have been conducted or is demanded by legislation. However, it soon became evident that even for PCB it was not easy to retrieve data. It became necessary to attribute most of the project time to the retrieval of very spread data of a wide range of remediation costs mainly in Sweden, and to some extent in Norway. Detailed information on PCB-related costs in other Nordic countries, and elsewhere, was too time-consuming to conduct within the short time frame of the study.

The choice of PCB – though - may nevertheless be questioned with the argument that for such an extreme pollutant, action would probably have taken place much quicker today, especially when comparing to legislation in the 1960s and 1970s.

However, a pattern of late action remains even with present chemical policies. Even in cases where there is rather disturbing information about side effects of chemicals, action has been delayed for decades. This is especially evident when substantial business impacts are anticipated. Restrictions for Nonyl Phenol Etoxylates, NPEs, and SCCP [5] were, for instance, not decided upon until very recently, in spite of a growing

[3] Assessment of the Impact of the New Chemicals Policy on Occupational Health, Final Report, March 2003, prepared for the European Commission Environment Directorate-General, RPA

[4] The Impact of the New Chemicals Policy on Health and the Environment, Final Report, June 2003, prepared for the European Commission Environment Directorate-General, RPA

[5] Directives 2002/45/EC and 2003/53/EC

knowledge already in the 1970s about environmental and health impacts.[2] The same counts for chemicals as for most aspects of life: It is often easier and less costly to prevent a hazardous situation than to live with the damage costs or to rehabilitate.

1.3 Objective

This report was written with the objective to discuss environmental costs and possible future benefits for society if preventing further exposure of substances of very high concern by the introduction of REACH, the new EU chemicals legislation.

1.4 Method

This study is based on a case study of the environmental costs for the misstep to introduce one pollutant, PCB, in one EU Member state, Sweden. Only actual costs that have been paid or will be paid are included, such as costs for removal, transport, decontamination and permanent storage. Among actual costs are also non-regulated costs for society, i.e. costs for science, administration and volunteer action. All these costs are referred to as “PCB-costs” below.

The PCB-costs in the Swedish society have been compiled from 1971 to 2018. PCB was identified as a problem in Sweden in 1971 and PCB-related costs such as costs for research, monitoring and sustenance feeding of the white-tailed sea eagle (*Haliaeetus albicilla*) started to accumulate. The case study also projects future costs from the year 2003 to 2018. This time frame was chosen because it is highly probable that there will be PCB-costs for yet another 15 years to come.

An estimation of the total PCB-costs in EU25 was made having the case study of Sweden as a platform and a survey of the situation in Germany, Spain, Norway and Denmark, as well as a review of the situation in EU25 as a whole, as an indication of the overall situation.

The case study is used for an estimation of PCB-costs for the years 1971-2018 at the EU25 level. This figure has in turn been used to estimate general costs for future chemical missteps at the EU25 level, in order to estimate the economical benefits for the society of the REACH legislation.

The overall approach has been to analyse existing research and to collect new information through interviews over telephone and e-mail with key actors. More information on the collection of data is available in chapter 3.

Estimates in chapter 4 of PCB-costs in EU25 are based on amounts of PCB used within the Community, the extrapolation of Swedish PCB-costs and a plausible span of levels of ambition.

1.5 Premises

These general presumptions were made for the calculations in the case study:

- The index year is 2003 and all values from other years are discounted with a discount rate of 4 per cent, according to the prevailing standard. An alternative scenario was also computed where a discount rent of 1.5 per cent has been used.
- All prices have been adjusted to the 2003 Consumer Price Index (CPI).
- The average exchange rate of the euro for 2003 (EUR 1.00 = SEK 9.125) has been used.
- In cases where there are recurrent PCB-costs, but data is only available for parts of the period, the costs for the whole time frame have been extrapolated according to the known patterns.
- Information from acknowledged sources were assumed to be correct. In cases where there is conflicting data, the more conservative standpoint (usually the lowest value) was chosen.
- Only the extra costs caused by PCB-contamination or to prevent PCB-contamination are included, i.e. ordinary maintenance costs are excluded, et cetera.

1.6 Constraints

Costs due to human health effects are not included, neither are costs due to damages to biodiversity nor ecosystems. PCB-costs in this report do not reflect any ambition to restore the environment to a state it had before PCB was introduced.

Future PCB-costs are only forecasted until the year 2018.

Due to shortage of basic data and lack of time some potentially large PCB-costs were never regarded. This is discussed more thoroughly in a separate section of chapter 3.

2 PCB – Use and Legislation in Europe

The following chapter gives a brief background to the PCB situation in EU25. The information in this chapter is gathered from Internet-based reports[6], and it is not used for the calculations of PCB-costs.

The class of materials known as polychlorinated biphenyls or PCBs is produced from the reaction of biphenyl with chlorine to produce a range of highly stable compounds. They have similar physical properties ranging from oily liquids to waxy solids. Most PCBs are fire-resistant, have low volatility, high boiling point, and electrical insulating properties and are relatively stable and persistent, making them well suited for industrial use - but also problematic in the environment. They have been used since the 1920s in hydraulic oils, dielectrics, coolants and lubricants in electrical transformers and in other electrical equipment. They have also been used in seam sealants, as plasticizers in paints and rubber products, in pigments, dyes, carbonless copy paper and weather roofers and to prolong residual activity of pesticides.[7]

2.1 PCB's effect on humans and the environment

Because of their high persistence, and their other physical and chemical properties, PCBs are present in the environment all over the world - in the air, water, soil, sediments, flora and fauna. Most PCBs is very fat-soluble and are stored inside fat tissue of animals and humans. Most PCBs will bio accumulate, making the percentage of PCB in living organisms higher than what is found in their living environment. PCB biomagnifies – that is, the higher up in the food chain an organism is found, the higher will the content of PCB be.[8] PCB has been proven to give reproduction disorders in seals, minks, otters, guillemot (*Uria aalge*) and white-tailed sea eagle (*Haliaeetus albicilla*).[9] One of the more important effects of PCB in humans is the unfavourable effect it has on the nervous system. American studies of children to women who have eaten large quantities of fish show that even a moderate exposure to PCB can give slight learning disorders and hyperactivity.[10]

2.2 PCB in EC legislation and the POPs convention

In 1976, the Directive 76/769/EEC on restrictions on the marketing and use of certain dangerous substances and preparations limited the open use of PCB in the EU. Further limitation of the use of PCB has since then been made by other directives

[6] OSPAR Commission 2001, Background Document on Polychlorinated Biphenyls (PCBs), ISBN 0 946956 78 2

[7] www.ne.se 040305

[8] www.ne.se

[9] Niklas Johansson from www.sanerapcb.nu

[10] www.ne.se

supplementing this directive, such as Directive 85/467/EEC which banned the use of PCB in new equipment from 1986.

The Directive 76/403/EEC was the first directive to require specific disposal of PCB and PCB-containing equipment. Directive 96/59/EC requires the Member States to dispose and decontaminate all PCB equipment before 2011. The equipment is defined as an item containing more than 5 litres of liquid with a PCB concentration exceeding 0.005 per cent. This implies that for instance all PCB transformers and power capacitors are to be collected and decontaminated or disposed of within less than 7 years from now. A number of Member States were late in implementing Directive 96/59/EC. A separate regulation, Directive 91/689/EEC on Hazardous waste, governs the handling of other PCB waste.

A number of remediation efforts, such as decontamination of soil and buildings, can also be enforced by other legislation. One of the more important is Directive 2000/60/EC

- Water Framework Directive - that intends to ensure clean ground and surface waters.

Further actions are proposed in the Community Strategy for Dioxins, Furans and Polychlorinated Biphenyls [11]. Indirectly this may necessitate further remediation efforts.

Finally, Parties to the Stockholm Convention on Persistent Organic Pollutants[12] (the POPs Convention) shall eliminate the use of PCB in equipment by 2025, and take action in accordance with a number of priorities:

- Make determined efforts to identify, label, and remove from use, equipment containing 0.05 per cent PCB and >5 litres of liquid
- Endeavour to identify and remove from use equipment containing >0.005 per cent PCB and >0.05 litres of liquid
- Make determined efforts to subject liquids containing more than 0.005 per cent of PCB to environmentally sound waste management no later than 2028

The Convention requests a total phasing out of PCB including the safe management of waste before 2028. This implies that there will be far reaching demands on waste handling of PCB when the EC Regulation implementing the POPs convention takes effect.[13]

2.3 Occurrence of PCB in Europe

The European Community law incorporates all members of the union. In addition, a number of Member states have their own legislations on how to deal with PCBs. To get a sense of how PCB has been used in Europe, we chose to study four countries in more detail: Spain, Germany, Denmark and Norway.

[11] COM (2001) 593 Final, Community Strategy for Dioxins, Furans and Polychlorinated Biphenyls

[12] Stockholm Convention on Persistent Organic Pollutants, including annex A Elimination/Part II Polychlorinated Biphenyls

[13] Regulation 850/2004/EC

Germany[14]

Germany has produced, as well as imported and exported, PCB. An estimation of the total amount of PCB used within the country is 87,000 tonnes[15].[16] There have been the following main uses:

- Capacitors with dielectric fluid (volumes of more than 1 litre had to be disposed of before December 31, 1993)
- Transformers, temperature sensors and temperature regulators with PCB-containing dielectric fluid (allowed to be operated until December 31, 1999)
- In dielectric impregnates for capacitors for small single-phase motors in kitchen appliances and for fluorescent lamps, such as discharge lamps (until December 31, 1999)
- Plasticizers in seam sealants and in cables
- Heat transfer fluids in heat exchangers
- Hydraulic fluids for lifting gear and the like
- In plastic floor, furniture and wallpaper

The use of PCB in open systems, such as in seam sealants and in flooring, was prohibited in 1978. PCB was used in closed systems, like in capacitors and transformers, until 1984.

Between the years 1996 and 2000 there was the remediation of approximately 200,000 tonnes of PCB-containing waste per year in order to comply with German legislation. Not all amounts of PCB produced and used were disposed of properly, nor is this the case today although sophisticated decontamination methods are used for the closed applications. PCB used in most of the open applications, such as seam sealants, is expected to already have reached the environment via various disposal routes. Part of the problem is that PCBs often are constituents of equipment and materials.

Spain

By 1984, about 28,000 tonnes of PCB had been produced in Spain.[17] PCB was among other things used as:

- Dielectric fluid in transformers and in capacitors
- Plasticizers in plastics and in rubber
- Lubricants in hydraulic fluids

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[14] Bavarian Institute for Waste Research - BIfA GmbH, http://www.chem.unep.ch/pops/stpeter/stpete2b.html

[15] Metric tons

[16] http://www.chem.unep.ch/pops/POPs_Inc/proceedings/slovenia/neumeier2.html

[17] Inchem, Environmental Health Criteria 140. http://www.inchem.org/documents/ehc/ehc/ehc140.htm#3.0

A separate legislation for PCB has existed in Spain since 1989, but there have unfortunately not been any major changes in the way PCB is handled. PCB is still used in various closed systems – for instance in the mining industry, in rail roads, hospitals, offices, houses, car repair shops, within the military and in different types of waste disposal plants.

Norway

PCBs have been used in a variety of applications, including for example: transformers, capacitors, heat transfer fluids and lubricants. They have also been used in paints, paper coatings and certain packaging materials as plasticizers.

The prevalent uses of PCB in Norway have been as components in[18]:

- Transformers and capacitors
- Insulated window panes (used in Norway until 1975)
- Seam sealants (between 1960 – 1978)
- Capacitors in refrigerators, fluorescent lamps and electric appliances
- Paints
- Plasticizers for floors
- Mortars

Approximately 1,200 tonnes of PCB were used in Norway until PCB was prohibited in 1980. About 450 tonnes are still in use and the other 750 tonnes have been disposed of. According to official information, 415 tonnes have been properly taken care of, but the rest is not accounted for. These roughly 335 tonnes are believed to have been dumped in landfills without any environmental consideration.

PCB is on the Norwegian environmental authorities' list of priorities and on their Observation List for hazardous chemicals. Large transformers, condensers and capacitors with oils containing PCB were phased out by 1995. A regulation taken into effect in April 2000 stated that the use of small capacitors in fluorescent lamps is to be prohibited by January 1, 2005. Seam sealants, insulated window glass and other products, appliances and compounds containing PCB are to be treated as hazardous waste when they are no longer in use.

The Norwegian Pollution Control Authority (SFT) has surveyed the occurrence of PCB-contaminated sediment and sites. *Sorfjorden* in Odda, *Haakonsvern* in the outskirts of Bergen and *Hortenskanalen* are some sites that have been decontaminated. A series of environmental research and development projects have been carried out at these sites.[19]

Denmark[20]

[18] www.pcb.no

[19] www.sft.no

[20] Report on substance analyses, HELCOM, 20 August 2001

Denmark has not produced PCB. Total use is estimated to be between 1,100 and 1,200 tonnes. Around half of the amount has been used in electrical appliances and the rest has predominantly been used in seam sealants, paints and in carbonless copy. There is probably about 235 tonnes of PCB left in buildings.

There have been restrictions with the use of PCB in Denmark since the middle of the 1970s. In 1977, it was prohibited to use PCB. A total ban on sale and use of PCB was enforced in 1986, with a few exceptions – such as in small electrical installations (with a total weight less than 1 kg) that were to be use during the technical life of the appliance. PCB was not allowed to be used in capacitors after Dec 31, 1999 (after a five year grace period of phasing out old capacitors).

Sweden

No PCB has been manufactured in Sweden. Between 8,000 and 10,000 tonnes of PCB was imported during the period between 1957 and 1980. Approximately half of the amount has been exported as components in different products.[21] This brings the total use of PCB within Sweden to 4,000 – 5,000 tonnes.

PCB has been used in:

- Transformers and power capacitors
- Seam sealants
- Insulated window panes
- Plasticizers for floors
- Small capacitors
- Glue, paints and carbonless copy paper

The use of PCB in open systems was banned in Sweden in 1973. Until 1978, special permissions to operate power capacitors were given in circumstances where there were no available technical alternatives. According to the Swedish PCB-regulation (SFS 1985:837) from 1986, it is not permitted to manufacture, process, sell, transfer or reuse products containing PCB, thus prohibiting new PCB-containing products in closed system. In 1995, the use of PCB in old transformers and power capacitors was banned.

One of the larger sources of PCB in closed systems was in the electrical power industry where PCB was used in power capacitors and in transformers. PCB has also been identified as a contaminant in dielectric fluids in high voltage cables made from mineral oils and in cable connecting equipment to mention a few applications. Almost all PCB that was used in closed systems have been dismantled and destroyed. In open systems, the largest volumes of PCB was used in seam sealants, but the impact of its use as a plasticizer in glues and paints, and as a solvent in carbonless copy paper, have also been

[21] Swedish Chemical Inspectorate report 4/96, p. 131

considerable. PCB remains in building material dating back to the period between 1956 and 1973.[22]

The content of PCB in the Swedish environment has decreased since the eighties, but the decrease rate has plateaued lately. To further reduce the amount of PCB present in the environment, existing emissions of PCB must stop completely.[23]

22 Swedish Environmental Protection Agency report M2002/2286/Kn, Kunskapsläget Förstudie inom ramen för Naturvårdsverkets uppdrag att kartlägga källor till oavsiktligt bildade ämnen mm. http://www.naturvardsverket.se/dokument/press/2002/december/forstud.pdf

23 www.sanerapcb.nu

3 Case Study - PCB-costs in Sweden

The analysed results of the case study are presented in this chapter. The chapter is concluded with a non-response analysis and a summary of the total PCB-cost for the period in the case study.

3.1 Remediation Costs for PCB in Soil and Sediments

Background

There are PCB-contaminated soils and sediments in vast areas of the country. There may for instance have been a paper mill at a site or a landfill with contaminated construction waste. As a result, there is a risk that PCB is discharged and absorbed in ecosystems. To mitigate this problem contaminated soils and sediments are usually excavated and treated. Old landfills can be covered using methods to minimize future leakage.

Availability of Data

Today the Swedish Environmental Protection Agency, *Naturvårdsverket*, does not have an aggregated view of how much rehabilitation of PCB-contaminated soils and sediments has cost in total. Costs for an average soil decontamination project are between SEK 20 million and 40 million (EUR 2.2 – 4.4 million). To clean up a single average contaminated sediment site costs between SEK 50 and 100 million (EUR 5.5 – 11 million). No one knows for sure how many sites remain to be restored.[24] The number of chemically contaminated sites in Sweden is 40,000-45,000.

Approach to Data Collection

County Administrations in Sweden was asked to contribute to establish the magnitude of past, present and future costs to clean up PCB-contaminated soil and sediments.

Six of the counties delivered quantifiable data relating to site-specific clean up costs for PCB. Five administrations had not run any decontamination project. In seven additional cases responses indicated that PCB-contaminated sites had been rehabilitated but that the administration had no data on actual costs. Three counties did not reply.

In some cases data do not cover the entire county. Administrators referred to clean up projects commissioned by local municipalities and private companies. This information was not possible to verify within the time frame of this case study.

It is probable that early decontamination efforts are underestimated. At the other hand future costs may be somewhat overestimated because it was assumed that all sites

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[24] Per Gullbring, Swedish Environmental Protection Agency, 2004

classified in the top category are high-risk sites that must be dealt with within a few years.

Presumptions

County administrations that gave satisfactory data are geographically well distributed in Sweden and represent 72 per cent of the total population[25]. There are no indications that you should encounter deviating situations in other Member states. Data is therefore amplified to represent all of them.

In cases where the total clean up costs also cover other chemical compounds, the PCB decontamination part of costs has been calculated by percentage.

Apart from historic costs, this report presents an estimation of future decontamination costs. As a basis for these calculations, the Swedish Environmental Protection Agency's observations of mean values for average sediments and soil rehabilitation projects are used. Future decontamination costs for sediments are set to SEK 75 million (EUR 8.2 million) and future clean up costs for contaminated soil is assumed to be SEK 30 million (EUR 3.3 million). In case it is known today that the site is contaminated with other pollutants apart from PCB, the cost attributed to PCB is 50 to 75 per cent of the total cost depending on the number of pollutants.

Only sites that are considered high-risk sites have been included. From an environmental perspective, even the risk sites - the next lower category - should be decontaminated, according to experts at the Swedish Environmental Protection Agency. Interviews with the County Administrations imply that this will not be the case within a near future.

Results

In the table below estimates of total clean up costs for PCB-contaminated soil and sediments. As is shown in table 3.1, future costs are estimated to be larger than the historic costs. The County Administrations report of a large number of high-risk sites that are to be decontaminated.

Table 3.1. Costs to clean up PCB-contaminated soil in Sweden

Costs	Reported for 11 County Administrations	Estimated for 10 County Administrations
Clean up costs until 2003	SEK 272 million (EUR 30 million)	SEK 103 million (EUR 11 million)
Expected costs 2004 - 2018	SEK 393 million (EUR 43 million)	SEK 149 million (EUR 16 million)

3.2 Handling of Hazardous Waste

Background

[25] Statistics Sweden, www.scb.se, population statistics, 2003.

Inappropriate waste handling can lead to considerable amounts of discharge of PCB, making it important to dispose of PCB products in an environmentally acceptable way. Waste containing PCB is classified as hazardous waste and is to be decontaminated in special treatment facilities. In Sweden, the toxic waste disposal facility *SAKAB* in Kumla has permission to treat PCB-contaminated waste.

Availability of Data

In total, *SAKAB* received about 26,000 tonnes of PCB-contaminated waste in different waste categories between 1987 and 2002 (see table 3.2).[26] There is no data on how much PCB-contaminated waste that has been put in municipal landfills as regular household waste, like PCB-contaminated insulated glass panes and small capacitors in fluorescent lamps. Besides costs for the treatment of waste there may be costs due transports and due to special equipment needed on original sites.

Approach to Data Collection

SAKAB in Kumla was asked about amounts of treated PCB-contaminated waste. The total volume was specified in sub-categories making it possible to match with *SAKAB*'s prices for various treatment methods.

Presumptions

The information has been equally distributed between 1987 and 2002. There were no detailed records of how the pattern of received PCB-contaminated waste has changed over the years, but the general impression is that the amount has decreased radically over the last few years. No future costs for treatment of Swedish PCB-contaminated waste were therefore assumed in this study, except for future costs of handling PCB in seam sealants and in insulated glass panes.

Results

Table 3.2 shows total amounts of PCB-contaminated waste that was treated at *SAKAB* between 1987 and 2002.

[26] Mia Jameson, Sydkraft SAKAB AB

Table 3.2. Removal of PCB in waste, 1987 – 2002

Category of waste	***Tonnes***
PCB liquid, 25-500 ppm PCB	*4 900*
PCB liquid, >500 ppm PCB	*155*
PCB oil 2-50 ppm PCB	*9 293*
PCB oil 51-500 ppm PCB	*815*
Capacitors containing PCB, small	*4 018*
Capacitors containing PCB, small <500 ppm PCB	*233*
Capacitors containing PCB, large	*319*
PCB in solid waste <500 ppm PCB	*5 667*
PCB in solid waste >500 ppm PCB	*301*
Transformers containing PCB	*213*
Transformers, 2-50 ppm PCB	*52*
Transformers, 50-500 ppm PCB	*176*
Transformers, >500 ppm PCB	*1*
PCB in seam sealants	*292*
PCB in floors	*41*
Total:	***26 476***

Source: Sydkraft SAKAB AB. Note: Different reporting systems make data groups partly overlapping.

About 26,000 tonnes of PCB-contaminated waste have been treated and disposed of in Sweden between 1987 and 2002.

Total costs 1978-2002 for PCB decontamination of waste are estimated to SEK 525 million (EUR 58 million). There was no information about PCB-costs prior to 1978.

3.3 PCB in Seam Sealants

Background

One area of use that has received a lot of attention lately is the use of PCB as a plasticizer in seam sealants. Seam sealants were used in the building sector during *Miljonprogrammet*, a large-scale housing project during the 1960s and 1970s when a million homes were to be constructed during a ten-year period. Most of the buildings were prefabricated houses with precast concrete elements that were insulated against precipitation with an elastic mixture that often contained PCB. If the seam sealants are openly exposed, there is a significant risk of emission of PCB. PCB has also been shown to migrate to the surrounding material, contaminating the adjoining concrete element. PCB has also been found in soil and air in the proximity of PCB sealed walls.

Availability of Data

There are approximately 100 tonnes of PCB left in seam sealants. The Ecocycle Council for the Building Sector, *Byggsektorns Kretsloppsråd*, has launched a voluntary program for house owners to remove PCB-sealants and other PCB-products from their buildings. One of the ambitions of the program was to identify and decontaminate all PCB containing materials that posed a risk to health and the environment by January 1, 2003. This goal was not fully accomplished. A mere 10 per cent of PCB-sealants were removed and decontaminated at that time.

Approach to Data Collection

The Swedish Property Federation, *Fastighetsägarförbundet*, has commissioned a report of plausible replacement costs for PCB-sealants.[27] Most of the calculations in this section are based on that report.

Presumptions [26]

Aging seam sealants need in any case to be replaced in a near future. Therefore only additional costs because of PCB content were included in the report.

About 10 per cent of new homes in Sweden 1956-1973 were built in Stockholm. Therefore, it is assumed that also 10 per cent of the PCB-sealants would be there. The total amount of PCB in seam sealants in buildings in Stockholm is estimated to be about 10 tonnes, making the total amount in the country about 100 tonnes.

The cost calculations were made with the following background data:

- About 100 tonnes of PCB in seam sealants need to be decontaminated.
- About half of the original PCB content is left in the sealants.
- The average content of PCB in sealants is 100 mg PCB per kg.
- A PCB-sealant usually weighs 0.25-0.30 kg/m. The higher weight is assumed in this study to get a more conservative result.
- In this case, 100 tonnes of PCB would equal about 3,300,000 meter PCB-sealant.
- Each meter sealant weighs 0,7 kg, which converts to 2,300 tonnes PCB-contaminated waste (sealant).
- Replacing PCB-sealants compared to modern non-PCB-sealants is assumed to cost an additional 150 SEK/m (16.50 EUR/m) due to the safety measures.
- It is assumed that the transports to *SAKAB* and the decontamination will cost about 20 SEK/kg PCB-contaminated waste (2.20 EUR/kg).

[27] Uppskattning av PCB-mängder och kostnader, REX HUS & MILJÖKONSULT, July 2003

Results

The future extra costs to replace PCB-sealants will be about SEK 500 million (EUR 55 million). Transport and decontamination will at least cost about SEK 46 million (EUR 5 million).

Approximately 10 per cent of the PCB-sealants have already been removed, which would imply a PCB-specific cost of SEK 50 million (EUR 5.5 million). The further treatment of removed PCB has cost SEK 5 million (EUR 0.55 million).

3.4 PCB in Insulated Glass Panes

Background

PCB has been used as a plasticizer in the seal between the layers of glass in insulated window glass panes. This application of PCB was used mainly between 1956 and 1972.

Availability of Data

There are reasons to believe that there are still 35 tonnes of PCB left in insulated glass panes from the given period. The total replacement and decontamination costs are expected to be high relative to the amount of PCB since they involve the handling of whole windows. Estimations show that about 70 per cent of all PCB-panes have already been dumped on regular landfills.[28] It is highly probable that most of the PCB already has been discharged from the landfills and been absorbed into the surrounding ecosystems.

Approach to Data Collection

The calculations have been based on information from The Swedish Environmental Protection Agency[27] and *SAKAB*.

Presumptions

SPF, *Svensk Planglasförening* (the Swedish association for the leading glass manufacturers, glass processors and glass distributors) estimated in December 2000 that there were in total 165.000 PCB-containing insulated glass panes in use. To replace one of these windows costs approximately SEK 1,700 (EUR 190). The windows weigh on average 30 kilograms. After dismounting, transport of contaminated parts costs around SEK 3,000 (EUR 330) per tonne. The decontamination cost at *SAKAB* is SEK 8,819 (EUR 970) per tonne.

Results

The total discounted cost is SEK 334 million (EUR 37 million) to replace PCB-contaminated windowpanes and to remove and place PCB in a permanent storage.

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[28] Omhändertagande av PCB i byggnader, Swedish Environmental Protection Agency, June 2002

3.5 Costs for Research and Monitoring of PCB

Background

Society has paid for a lot of research about PCB. These resources could have been directed to other fields if the problems of PCB had not existed.

Availability of Data

There is no complete anthology about the costs for PCB-specific research in Sweden. The total costs for research in environmental toxicology are SEK 60 million (EUR 6.6 million) per year[29]. The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, *Formas*, provide information about the current funding for PCB-related research. The Swedish National Food Authority, *Livsmedelsverket,* and the Swedish Environmental Protection Agency do research and monitoring of PCBs.

The publication of a vast number of scientific articles since the early 1970s suggests that there has been the continuous research.[30] Costs for monitoring and surveys on a county and municipal level are not included in the study due to lack of data. These latter costs may be substantial.

Approach to Data Collection and Presumptions

All research projects that received funding from *Formas* during 2003 were scrutinized to sort out PCB-related research. Funding for longer periods than one year has been recalculated to yearly grants. Through this approach, eight PCB-related research projects with a total funding of SEK 3 million (EUR 0.3 million) were identified. It was assumed that this level of funding has been and will be held constant for the period 1972 – 2018. A research program about POPs (but with focus on PCBs) with a yearly budget of SEK 6.5 million (EUR 0.7 million) was conducted at the Swedish Environmental Protection Agency between 1992 and 1997[31].

The Swedish National Food Authority monitors contents of PCB in food, breast milk and blood and give dietary recommendations. Consideration of PCBs needs to be taken in the following food groups: Fish, shellfish, meat and dairy products.[32] Monitoring costs are parts of larger costs for the management of POPs and include salaries, costs for overhead and material.[33]

Results

Costs for PCB-related research and monitoring in Sweden 1972 - 2018 will at least be SEK 540 million (EUR 59 million).

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[29] Miljötoxikologiskt forskningsprogram, 2002-11-29, Formas.

[30] The database ELIN, Swedish Environmental Protection Agency

[31] Gunilla Lagerstedt, 2004, Swedish Environmental Protection Agency

[32] UNEP, http://pops.gpa.unep.org/19pcbs.htm#marin

[33] Per Ola Darneryd, the data has been revised by Anders Glynn and Marie Aune, Swedish National Food Administration, 2004

Table 3.3. Costs for research and monitoring.

Period	PCB-cost
1971-2003	SEK 460 million (EUR 50 million)
2004-2018	SEK 80 million (EUR 9 million)
The whole period	**SEK 540 million (EUR 59 million)**

3.6 Biological diversity – Project Sea Eagle

Background

The white-tailed sea eagle was the first species in Europe, from a water habitat, to show clear signs of a disturbing influence from toxins. A high content of environmental toxins like DDE (formed from the pesticide DDT), PCBs and other chlorinated hydrocarbons have had a disastrous effect on sea eagle eggs. Often not a single egg in a nest hatched, starting already from the 1950s. This pushed the white-tailed sea eagle to the brink of extinction in Sweden in the 1970s. In spite of this, the total number of eagles remained stable during this period with the help of volunteers from Project Sea Eagle – a project started in 1971 by the Swedish Society for Nature Conservation, *Naturskyddsföreningen*. Wintertime feeding, at special feeding points all over the country, helped a majority of young eagles to survive. Since 1989, monitoring of the fertility of the white-tailed sea eagle is part of the National Environmental Monitoring at the Swedish Environmental Protection Agency.

Availability of Data

There are no complete historic data of the costs of Project Sea Eagle. The calculations are based on the budgets assigned for the project since the start in 1971. Many volunteers have assisted at the feeding stations.

Approach to Data Collection

Information about the budget of the project has been given by the coordinator of the project. An interview has also been made with volunteers at one of the 20 feeding stations.

The project has a budget of SEK 650,000 (EUR 71,000) per year and it appears to have had the same sum allocated for running the project since the middle of the 1980s. The funding was significantly lower in the start of the project, but the budget increased as the project grew larger.

In addition to the budget, there are costs paid by volunteers such as work at the feeding stations and transportation. Some of the activities at the feeding stations were also paid by sponsors.[34]

Presumptions

The budget of Project Sea Eagle was SEK 650,000 (EUR 71,000) per year during the period 1985 to 2003. It is assumed that the budget on average was half the size of today's budget, i.e. SEK 350,000 (EUR 36,000) per year between 1971 and 1984. Voluntary work and sponsorship at feeding stations have been estimated to equal SEK 1,325,000 (EUR 145,000) per year.

Results

The total discounted cost for Project Sea Eagle during the period 1971 – 2018 is around SEK 140 million (EUR 15 million).

3.7 PCB and the Fish Industry

Background

Due to its hydrophobic qualities, PCB is not discharged as efficiently in water as it is in the atmosphere. However, the situation in the Baltic Sea is a bit different than in other seas because the poor circulation with other bodies of water makes the concentrations of environmental toxins unusually high.

PCB is accumulated in fat tissue and is bio accumulated in food chains. PCB is toxic to aquatic organisms and disturbs reproduction in fish and seal. Surveys have shown indications of lower birth weights in children to fishers on the Swedish Baltic Sea coast, but it is not completely confirmed that PCB causes it.

Although adsorption can immobilise PCBs for relatively long periods in the aquatic environment, desorption into the water column has been shown to occur both through the water and though organisms. Sediments may therefore act both as an environmental sink and a reservoir of PCBs to set free. In fact, most of the environmental load of PCBs has been estimated to be in aquatic sediment. Even though many countries have controlled both use and release of PCBs and new input into the environment is on a reduced scale, the available evidence suggests that the cycling of PCBs causes a gradual redistribution towards increasing PCB concentrations in the marine environment. Median levels in fish, reported in various countries, are of the order of 100 micrograms/kg (on a fatty basis). PCBs seem to affect populations more heavily in colder areas.[35]

Research has shown that PCB is accumulated most of all in fatty fish. Approximately half of the dioxin like substances, including PCB, that humans ingest comes from fish.

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[34] Björn Helander, Swedish Museum of Natural History

[35] UNEP, http://pops.gpa.unep.org/19pcbs.htm#marin

The Swedish and Finish markets are exempted from the ban of Baltic fatty fish.[36] The National Food Authority has issues dietary recommendations. Due to the high contents of environmental toxins, fatty fish from the Baltic Sea should not be eaten too often. Restrictions are directed to consumers of larger amounts and to women of childbearing age.

Availability of Data

There is no written material about the consequences of PCB-contents in fish for the fish industry. The data for the calculations of the PCB-costs were given at an interview over the telephone with a desk officer at the Swedish National Board of Fisheries.[37]

There is no data available that could show effects on the total sale because of dietary recommendations.

Results

This should not be understood as if there were no costs related to PCB and the fish industry. On the contrary, there is evidence of adverse human health effects that were not possible to calculate within the scope of this study.

The situation has certainly an impact on the Baltic fishing industry and its perspectives.

3.8 Analysis of Non-response

A consequence of the short time frame of this study is that many potentially large PCB-costs have been excluded from the study. The study does not pretend to give a comprehensive picture of all costs associated with the use of PCB in Sweden. However, the examples of costs in different parts of the Swedish society give an indication of the size of the costs.

Since there were very few calculations made of the PCB-specific costs, the project group had to do their own investigations. Most of the information was given at interviews over the telephone and through e-mail with experts in the field. The short time for the assignment did not allow for a complete follow-up on all leads. Unfortunately, a number of potentially large PCB-costs had to be left out. There may well be other areas of concern, but the following costs were identified by the project group as missing in the study:

1. Costs to decontaminate **high voltage cables** filled with oil containing PCB. Just in the area around Stockholm, the decontamination cost has been SEK 30 – 40 million (EUR 3.3 – 4.4 million). It was too time demanding to identify the cost for decontaminating all PCB-containing cables in Sweden or even to get an estimate of how many cables there were in Stockholm compared to the total number of PCB-contaminated cables in the whole country. These costs may show to be substantial.

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[36] Commission Directive 466/2001/EC; Council Directive 2375/2001/EC

[37] Rolf Persson, Swedish National Board of Fisheries

2. Neither has it been possible to estimate the PCB-cost for **small capacitors**, which are **still in use in some fluorescent lamps**. In Norway, they expect the costs to remove and decontaminate PCB in fluorescent lamps to be more than NOK 1 billion (EUR 125 million), probably significantly more.
3. Other potentially large costs concern **large capacitor and transformer stations**. Stations that contained PCB have been replaced and decontaminated (before 1995 by law). The **soil** surrounding the stations was analyzed thoroughly starting in the middle of the 1980s. There were also **decommissioning costs** for the industry, due to the need to reinvest before it was economically feasible. In addition, the soil surrounding the stations was decontaminated. All in all this would probably amount to very large PCB-costs.
   It was not possible to get access to records to verify if any **PCB-contaminated waste** was treated at SAKAB **before 1987**.
4. **Before 1993**, there were no reports of clean up costs for **PCB-contaminated soil**. It is possible that the knowledge of old clean up projects has not been passed on from the County Administrations.
5. PCB was also used as a **plasticizer in floors**. There was not enough data available to calculate the cost to decontaminate PCB-contaminated floors that are **still in use**.
6. There was no time to collect information from all **municipalities, county administrations and companies** about their costs for **PCB-related inventories and monitoring**.

If costs were paid long ago and are discounted to a yearly rate of 4 per cent, the impact of these missing costs is considerable, i.e. costs relating to electronic components and equipment (numbers 1 – 4 in the above list). A conservative assumption is that the missing PCB-costs amount to at least SEK 500 – 1,500 million (EUR 55 – 160 million).

3.9 Summary of PCB-costs for Sweden

In Table 3.4 is a summary of PCB-costs in Sweden. The costs are divided in historic (1971-2003) and future costs (2004 –2018).

Table 3.4 Summary of identified costs due to the use of PCB in Sweden (Million SEK)

Costs	**1971 - 2003**	**2004 – 2018**	**The whole period**
Research			
General PCB-related research	188	33	221
National Food Authority	214	44	258
Swedish Environmental Protection Agency, POPs 1992-1997	61	-	61
PCB in buildings			
Seam sealants	56	491	548
Insulated window glass panes	138	196	334
Handling of hazardous waste	525	0	525
Clean up of soil and sediments			
Respondents, (72 % of population)	272	393	665
Non-respondents, (28 % of population)	103	149	252
Project Sea Eagle	108	32	140
Total	**1,666** (EUR 180 million)	**1,335** (EUR 150 million)	**3,000** (EUR 330 million)
Estimation of missed costs			**500 – 1,500** (EUR 55-160 million)

Alternative Discount Rate

A lower discount rate was used to see how it would affect the results. A high rate makes future benefits and costs worth less than present costs and benefits. Not to promote short term thinking most environmental economists prefer the practice of a lower rate. In this case, a discount rate of 1.5 per cent results in a slightly lower total than a rate of 4 per cent (see Table 3.5).

Table 3.5. Comparison of PCB-costs calculated with a discount rate of 1.5% and 4%.

Costs	1971 – 2003	2004 – 2018	The whole period
Total PCB-cost, 1.5% discount rate	SEK 1,341 million (EUR 150 million)	SEK 1,512 million (EUR 160 million)	SEK 2,850 million (EUR 310 million)
Total PCB-cost, 4% discount rate	SEK 1,666 million (EUR 180 million)	SEK 1,335 million (EUR 150 million)	SEK 3,000 million (EUR 330 million)

In the scenario of a lower discount rate future costs are slightly higher than historic costs. Small differences between scenarios show that results remain relatively stable.

Below, a standard social discount rate of 4 per cent is used.

Total PCB-costs

The calculated PCB-costs in this case study amount to a total of around SEK 3 billion (EUR 329 million). This figure consists of numerous assumptions and estimates making the margin of error approximately +/- SEK 500 million (EUR 55 million). A more appropriate way to present the total would be SEK 2.5 – 3.5 billion (EUR 270 – 380 million).

If the estimation of missing costs were included, it would add SEK 0.5 – 1.5 billion (EUR 55 – 160 million) to the total. This sums up to a grand total of SEK 3 – 5 billion (EUR 320 – 550 million) or on average SEK 4 billion (EUR 440 million).

4 PCB-costs for EU25

The study shows that lack of awareness about the environmental and health consequences of one chemical, PCB, has caused substantial costs to one EU Member state. The total costs identified in this study related to the use of PCB in Sweden during the period from 1971 to 2018 have been estimated to be SEK 3 – 5 billion (EUR 320 – 550 million).

To translate the costs for one country to the total EU25 group is not easy. The best would be to have data for each country, but to find data for just one country has been challenging enough. Instead, it is assumed that there is a relation between used amounts of PCB and the PCB-cost.

In Sweden, approximately 4,000 – 5,000 tonnes of PCB were used. Consequently, the average PCB-cost per tonne in Sweden would be somewhere between SEK 0.6 – 1.25 million (EUR 0.07 – 0.14 million) per used tonne of PCB. Please note that this is not equal to the cost to decontaminate one tonne. It is the cost society, as a whole, has had for PCB, distributed per tonne PCB.

In the five Member states that have the largest population, see table below, about 400,000 tonnes of PCB were produced.[38] The world production of PCB has been estimated to be approximately 1,000,000 to 1,500,000 tonnes.[39]. In the following calculations, it is assumed that the usage equals the production and that the other 20 EU countries' usage lies between 50,000-150,000 tonnes. Those assumptions result in that around 450,000 – 550,000 tonnes of PCB have been used within EU25 (i.e. about a third of all PCB that was produced globally).

Table 4.1. PCB production in five EU Member states (Thousand Tonnes)

Member state	Production
Germany	155
France	118
United Kingdom	67
Spain	28
Italy	27

Using a case study of Sweden to represent the situation of EU25 may not be entirely adequate. On one hand, PCB was used for a shorter time in Sweden than in most Member states and it might make costs for remediation lower. On the other hand, there

[38] Inchem, Environmental Health Criteria 140.
http://www.inchem.org/documents/ehc/ehc/ehc140.htm#3.0

may be countries where the willingness (and the possibility) to pay for decontamination show to be higher or lower. These factors may, or may not, counteract each other.

The common EU-legislation will establish standard regulatory demands on PCB decontamination within the union. Legislations like directives 96/59/EC (on PCB), 91/689/EEC (on hazardous waste), and 2000/60/EC (on water policy) and regulation 850/2004 (on persistent organic pollutants, POPs) do all regulate aspects on PCB handling and decontamination.

The legislation is rather complex and the extent of the implementation varies among the member states, especially since 10 more states recently joined the EU. Both the water framework directive and the POPs regulation will probably have a large impact on the PCB standards, but as they are quite new their exact impact is still not known. Especially when it comes to minor occurrences of PCB, the political ambition and possibility to pay for decontamination will probably vary between different countries. The result of these factors is that it is not an option to establish a common cost level based on EU legislation. Besides, the scope of this study is all types of environmental costs for society, even non-regulated.

Instead, in this study, it is assumed that the cost per tonne in the other EU countries, on average, during the period 1971-2018 is approximately 50 – 100 % of the average cost per tonne in Sweden. This factor was added because there are different levels of ambition in dealing with PCB. Considering the assumptions above, the estimated PCB-cost for EU25 will be between EUR 15 and 75 billion. See table 4.2.

Table 4.2. Estimation of PCB costs for EU25, 1971-2018

Limits of intervals	Ambitions of Member states / the case of Sweden		PCB costs (Million Euro/tonne used)		Quantities used (Thousand Tonnes)		Total costs (Billion Euro)
Minimum level	0.5	x	0.066	x	450	=	14.8
Maximum level	1.0	x	0.137	x	550	=	75.3

Benefits from REACH

The REACH legislation regulates a large number of chemicals used in both smaller and larger volumes. Generally, REACH increases the demands of control, data and information for chemical compounds produced in volumes larger than 100 or1000 tonnes. This will probably lead to the discovery of at least some substances that need prompt action, because of the danger they pose to the environment and humans. Early detection of hazardous substances and new routines in decision-making should result in faster decisions on restrictions, the ban of use, preventive action and clean–up. Thus damage may be less severe and less costly.

When it comes to new substances in volumes minor to 100 tonnes a year, the REACH proposal demands less data than under present legislation. This might lead to a situation where some new substances are used during a longer time than today, and that a higher accumulative volume will have been used before a problem is discovered.

It is not correct to use the PCB-cost for EU25 as an estimation of the benefits of REACH. Instead a new estimation must be done. The PCB misstep was extraordinary large and PCB was used and spread in large volumes.

Of course, it is not possible to predict how many existing substances of this kind there are; How much earlier they will be discovered; how much faster there will be action; and what magnitude of efforts they may call for.

As an indication, it is here anticipated that REACH may prevent one misstep half the size of the one of PCB or, more likely, five chemical missteps in the size of 10 percent of the PCB misstep. Both scenarios result in half the cost of the PCB misstep.

When discussing future costs they have to be discounted. When costs are discounted, future costs and benefits are valued less than present and historic costs. This is a result of political economical theory that says that money invested today will increase in value tomorrow and therefore is more valuable today.

In this study, the discount rate is 4 per cent. This is the standard procedure, but it has been questioned as a reasonable method for calculating future irreversible environmental costs. Therefore, the alternative scenario with a 1.5 per cent discount rate was introduced.

Discounting

Discounting is a method that makes comparisons between costs from different periods possible. The costs are recalculated with a so-called discount rate. This shows how fast the value of future incomes declines over time. In Sweden, it is common to use a discount rate of 4 per cent in environmental or political economic analyses. It is considered low in an international perspective.

The estimated clean-up period has an impact on the result. Instead of a clean-up period of 47 years, as in the PCB case, the estimation for new chemical missteps is 23.5 years. Using a 4% discount rate, the costs during 1971 to 2018 are reduced with 50% for the period 2005 to 2028. Using a discount rate of 1.5 %, the reduction of the costs are just 27%.

The environmental costs also depend on how ambitious the different governments are to handle the environmental remediation. The costs for future chemical missteps will also vary depending on geological factors, climate, earlier actions etc. When calculating the PCB-cost for EU25 it was assumed that average ambitions in other Member states would be 50 – 100 percent of the Swedish level. However, since 1971, large progress has been made towards a common legislation within the EU. The Community has strived to harmonize environmental and chemical legislation, i.e. in regulations such as 96/59/EC (on PCB), 91/689/EEC (on hazardous waste), and 2000/60/EC (on water policy).

There is no reason to assume that Member states will have a future regulation that is less demanding than Sweden had in the past. Equal ambition levels are assumed for

EU25 during 2005 – 2028 as for Sweden during the period 1971- 2018. Consequently, some savings of preventing new chemical missteps are listed in Table 4.3.

Table 4.3. Possible costs for future chemical missteps similar to PCB, in billion EUR

Costs	**Minimum alternative**	**Maximum alternative**
Total PCB-cost in 1971 – 2018, with a low (50 %) to high (100%) ambition level.	14.8	75.3
Total cost in 2005-2028, for one other major chemical misstep, with a low (50 %) to high (100%) ambition level.	7.4	37.7
Total cost for one medium or five smaller chemical missteps during 2005 – 2028, with a low (50%) to high (100%) ambition level.	3.7	18.8
Total cost for one medium or five smaller chemical missteps during the years 2005 - 2028, with a high (100%) average ambition level.	7.4	18.8
Total cost for one medium or five smaller chemical missteps during the years 2005-2028, with a high ambition level, calculated with 1.5 per cent discount rate in the maximum alternative.	7.4	27.5

Thus, during the period 2005-2028 the benefits of REACH in avoiding these scenarios would be EUR 7 to 27 billion for EU25. Please note that the costs do not include costs for human health.

Table 4.4. Conclusion. Benefits of REACH for avoiding chemical missteps in the future

Benefits	**Minimum**	**Maximum**
Environmental cost avoided due to the REACH legislation, billion EUR.	7.4	27.5

5 Discussion

5.1 The level of costs

Will REACH save EUR 7 – 27 billion for environmental remediation during years 2005-2028? Compared to some results in other studies it is possible.

On its website, the European Environmental Agency has published information, updated in 2002, on expenditures for remediation of contaminated sites, indicating that 0.8 parts per million of the GDP of EU is spent each year. This represents 2.5 percent of the total needs for clean up. For EU25, this would mean total clean-up costs of approximately EUR 320 billion.

The findings in a study made by Risk and Policy Analysts, RPA[40], on four recently regulated substances point in the same direction. However, there are no complete calculations of the environmental costs. The following figures and conclusions are presented:

- Perchloroethylene, tetrachloroethylene, used e.g. for cleaning: RPA expects that the WFD will lead to remediation demands for a number of groundwater sources, that in individual cases may cost EUR 4-30 million. The figures RPA present seem to indicate that there could be costs in the order of EUR 1 billion, maybe more.
- Tributyltin, TBT, used for antifouling on ships: RPA calculates that the losses for just oyster fisheries in just one bay (Arcachon) over ten years equate to EUR 140 million. The figure presented indicates that total costs for TBT may sum up to billions.
- Short Chain Chlorinated Paraffins, SCCP, used e.g. as cutting fluids in metal: The report state that “The environmental impacts arising from the use of SCCP could have been minimized considerably”, and “Overall, it may take years for the full damage costs arising from the use of SCCPs in the applications of concern to be realized.”
- Nonylphenols, NPE, used e.g. for cleaning: The RPA report states that the costs of clean-up will not be realized until the measures under the Water Framework Directive, WFD, may be drawn up in 2009. Costs are expected e.g. for landfills or the incineration of sludge.

Figures and conclusions from the RPA indicate that the environmental costs for the studied substances alone may be counted in billions of EUR. These costs could have been minimized by earlier action.

[40] The Impact of the New Chemicals Policy on Health and the Environment, Final Report, June 2003, prepared for the European Commission Environment Directorate General, RPA and BRE Environment

5.2 Is there any dangerous compounds left?

The Perfluoroctyl Sulfonates group of substances, PFOS may have a similar fate as PCB. At this stage, though, it is not possible to foresee the environmental costs for PFOS, including potential costs for remediation. It indicates however that there may be other groups of substances that might give rise to extensive damages and large remediation costs.

5.3 Conclusion: REACH will save more than it costs

The European Commission has predicted costs for the present REACH proposal to be EUR 2.8 – 5.2 billion through a period of ten years. If the environmental and health cost exceeds these figures, large savings are made thanks to REACH. The effort to calculate the costs for one environmental pollutant has to be seen in this perspective. In fact, the avoidance of five smaller chemical missteps or one medium misstep would equal or exceed the costs for REACH. Savings from avoiding health impacts and non-remediable environmental impacts should be added to these figures.

Even if costs for companies will rise, REACH will lead to large savings for the society as a whole.