ODS waste treatment in the Nordic Countries

A Nordic Ozone Group Project 2011

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Preface

The last 20 years of global efforts to reduce ozone depleting substances (ODS) and restore the ozone layer is one of the great successes of international environmental cooperation. However, in spite of the collective progress made, the potential for eventual release of a major quantity of ODS stored in “banks” poses a significant threat to the stratospheric ozone layer and could reverse much of the progress made towards ozone recovery. These banks are contained mostly in stationary and mobile refrigerators, heat pumps, air conditioners, thermal insulating foam in land and ships and stockpile of new or recovered ODS.

According to the Technology and Economic Assessment Panel, “end-of-life” measures are consistent and significant contributors to savings in terms of both ozone and climate, with cumulative savings of around 300,000 ODP tonnes and about 6 billion tonnes CO₂-eq. from 2011 to 2050. Other studies underline the same conclusions, e.g. were the CFC/HCFC bank in Denmark for the period 2002–2050 calculated to more than 10,000 ODP tonnes. The trend is presumed applicable for most of the Nordic countries.

Environmentally sound disposal of ODS is increasingly recognized as an important issue in terms of both the protection of the ozone layer and the effect on climate change. However, there is only a limited overview in the Nordic countries of ODS containing product groups, regulation, available treatment technologies, and waste infrastructure etc. This report provides an overview of the ODS waste treatment and regulation in the Nordic countries. The report identifies gaps, proposes solutions and provides recommendations for relevant Nordic efforts within the area.

The purpose of the study has been to analyze existing waste collection and destruction practices of ozone depleting substances in the Nordic countries. Focus is dedicated to ODS waste containing CFC's and HCFC's. Other ODS such as halons, tetrachloromethane, trichloroethane and methylbromide are well regulated/controlled and the quantity in the Nordic countries is small.

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Note: This report was written in 2011. There might be some changes in regulation since then and the reader is advised to check relevant legislation.

Summary

ODS waste treatment is in general well-functioning in the Nordic countries in terms of the regulatory framework, the technical facilities, and appropriate infrastructure.

A rough extrapolation of the actual Nordic ODS banks in 2011 shows an ODP potential of at least 10,000 ODP tonnes in total. The ODP bank related to refrigerants is relatively small as it is based only on HCFC-22 (with low ODP value). The largest potential for improvement of ODS recovery and ODS disposal/destruction is related to appropriate treatment of old district heat pipes. The potential is assumed to 2,000–4,000 ODP tonnes based on the precondition that 15–30% of the original ODS contents is still contained in the foam at end of life.

The table below summarizes the ODP potential from the main waste groups.

Table 1. Nordic ODP potential from waste categories

ODS waste	ODP (tonnes)
Refrigerants	80–110
Demolition waste	7–8.000
Other foam	500–1.500
District heat pipes	5,000–6,000

ODS refrigerants

The only ODS containing refrigerant in the Nordic is HCFC-22 (R-22), which is primarily used in old, larger commercial refrigeration systems in industries, ships and the retail sector. There is no longer a CFC bank in Nordic household refrigerators.

Construction of new R-22 refrigeration systems were more or less phased out in 2000–2002 because of national bans (e.g. in Denmark) and technological development. The R-22 systems were substituted with HFC, ammonia, propane/butane and CO₂ refrigeration systems. While refrigeration systems generally have a lifetime of 20 years, it is assumed that the R-22 based refrigeration systems in the Nordic countries will be phased out no later than 2020.

One major reason for this is that suppliers can only deliver *regenerated* R-22 to the Nordic market and only 15–20% of the demand can be covered – the price is therefore rapidly increasing. Owners of R-22 refrigeration systems have strong economic incentives to invest in more efficient non-ODS refrigeration systems.

The R-22 refrigerant has an ODP value of 0.055 ODP tons. A rough estimate of the total Nordic bank of R-22 is 1,500–2,000 tonnes, of which 750 tonnes are contained in ships from Norway, Iceland and the Faroe Islands. The total ODP potential in the R-22 banks are 82.5–110 ODP tonnes.

All Nordic countries have the infrastructure for recovery and destruction of R-22 refrigerants in place, including collection, recovery and destruction. All countries have suppliers/collectors with equipment and procedures to ensure appropriate recovery and access to special treatment facilities for destruction of ODS gases.

Related to eliminating the impact of R-22 it is relevant only to target reduction of R-22 leakages from the existing systems and a complete phase out of the R-22 refrigeration systems.

ODS blowing agents

There is no system in place for control, collection, recovery and treatment of ODS containing foams and waste materials for which ODS has been used as blowing agent, e.g. district heating pipes and insulation panels.

The ODP potential in *district heating pipes* is substantial and there is a clear need and opportunity for improving handling and disposal of old heat pipes. Most of the pipes containing the ODS bank are still in operation but new requirements to energy efficiency will cause increased replacement of old district heat pipes in the coming years. The estimated Nordic ODS bank in district heating pipes are estimated to 5,000–6,000 ODP tonnes, with 50% in Denmark and 30% in Sweden.

Costly disposal and a lack of regulative requirements means that old pipes are typically left in the ground without treatment of the ODS foam and PVC and no reuse of the metals. In some instances metals and plastics from the old pipes are recycled, but without recovery of the ODS in foam. ODS treatment facilities in Denmark and Sweden have no request from contractors or district heat companies for their special treatment services of ODS foam. A stakeholder has mentioned examples of pressing insulation foam from pipes before shredding and without recovery.

It will be most relevant to establish mechanisms and procedures that ensure reuse of old pipes, recovery of ODS from shredding and/or direct separation and incineration of the foam. Scientific tests and technical knowledge indicate that 15–30% of the original amount of the ODS blowing agent is still present in the end-of-life pipes, but there is a need for more test to validate previous estimates of the environmental impact. It is therefore recommended to analyze more samples of old district heating pipes.

ODS contaminated waste from the building sector is sparsely controlled and regulated. However, the general waste infrastructure in the Nordic countries ensures appropriate disposal. The expensive landfill costs in all the Nordic countries constitutes a strong incentive for effective waste treatment with separation of combustible waste such as foam products, insulation panels etc. Norway has specific regulation and control mechanism for building waste containing ODS, but the environmen-

tal impact of the treatment of this waste in the other Nordic countries is not considered more harmful than in Norway, assuming that ODS foam waste and similar combustible demolition waste are incinerated professional incineration plants and not landfilled. Municipal incineration plants are approved as ODS treatment facilities (EU 1005, appendix 7).

Demolition waste from the building sector may contain CFC-11/12 or HCFC 141b/142b, popular blowing agents until the CFC ban in 1994–1995 and HCFC bans (as blowing agent) in 1998–2000. The ODP value for CFCs is 1 and for HCFC-141b/142b 0.11 and 0.065. There are no complete data to calculate the total ODS contents in insulation and construction foam in the Nordic but based on extrapolation of Swedish, Finnish and Danish estimates, the total potential bank in demolition waste from construction and buildings is estimated to be 8,000–10,000 ODP tonnes.

The most important effort in relation to reduce the impact of ODS containing demolition waste is to secure that this waste does not end at landfills. This is done by optimal separation of combustible waste and disposal to incineration plants. Reducing the mechanical treatment of ODS waste (foam etc.) during demolition and separation phases can reduce emissions of ODS. Open air shredding of insulation panels, XPS foam etc. should be avoided.

ODS waste from insulation panels in freezers (household and commercial) is handled by municipal collection and treatment systems. The treatment is well regulated with recovery of refrigerants, reuse of metals and shredding and incineration of the foam. Recovery of ODS from the shredder process is common for most large treatment facilities in the Nordic countries. The ODS banks from this product category is limited as most CFC/HCFC based fridges and freezers are already disposed off. A rough estimate for the Nordic ODS bank from this product category is 200–400 ODP tonnes.

Waste treatment of larger units construction foam from boats, caravans, windmills etc. needs to be investigated and improved further. The technical difficulties with treatment of glassfibre provide a challenge for appropriate treatment of the hard foam. The lack of overview and control with optimal disposal of this fraction leads to inappropriate land filling. Large unit construction foam in boats, caravans etc. produced before 1995 contain CFC blowing agent.

It is recommended to take initiative to implement procedures which ensure separation or correct treatment of hard foam during the treatment and disposal phases to avoid landfill.

1. Findings

A survey of the Nordic regulation and technical arrangement for treatment of ODS waste are conducted. The information is disseminated from national reports or documents and by interviews with representative stakeholders in the Nordic. The main results from the survey are summarized and listed in the findings below.

1.1 ODS waste treatment in the Nordic

1. There is appropriate facilities in the Nordic to ensure optimal recovery and destruction of ODS waste (foam and refrigerants):
 - All countries has municipal incineration plants which can receive ODS foam for incineration and destruction.
 - Denmark, Sweden, Finland and Norway have special facilities to recovery of ODS in hard foam, e.g. from district heat pipes and building waste.
 - With respect to refrigerants, Denmark, Finland and Sweden have facilities for regeneration, reuse and destruction of ODS containing refrigerant.
 - Faroe Islands, Iceland, Greenland and Åland distribute contaminated refrigerants to destruction at facilities in Norway or Denmark.
2. The infrastructure for recover and destruction of R-22 refrigerants is in place in all Nordic countries and there is no need for further efforts to improvements in accordance to collection, recover and destruction. All countries have representation of suppliers/collectors who has equipment and procedures to ensure appropriate recovery and access to special treatment facilities for destruction of ODS gases.
3. Handling of ODS in A/C appliance from vehicles at end of life is regulated and controlled in all Nordic Countries. Directive 2000/53/EC requires Member States to ensure that end of life vehicles are dismantled and hazardous materials removed, including CFC and HFC refrigerants used in AC systems. The amount of ODS in mobile A/C is considered minor while ODS has been substituted with F-gases from mid-nineties. There is no ODS containing mobile A/C left in the Nordic. Cars with ODS are from mid-nineties or before and mobile A/C cannot avoid leakages that many years. Vehicle

dismantlers have confirmed that only HFC-134a (F-gases) and no CFCs/HCFs are contained in mobile A/C today.

4. When it comes to collection and treatment of ODS containing foams and similar waste materials for which ODS has been used as blowing agent, e.g. district heat pipes and insulation panels, recovery and appropriate control with treatment is lacking. In particular are ODS contaminated waste from the building sector not directly controlled and regulated. But despite there is no direct control effort ensuring appropriate disposal of ODS containing foam product, the general waste infrastructure in the Nordic ensures appropriate disposal. For all Nordic countries, landfill is more expensive than incineration. It provides strong incentives for entrepreneurs to reduce cost for disposal through optimal separation where the combustible fractions preferable go to incineration. If ODS foam etc. are delivered to incineration instead of disposal on landfill, the ODS is destroyed appropriately. High temperature municipal incineration are approved by EU as appropriate facility for ODS destruction.
5. Appropriate disposal of ODS containing building waste is most common regular incineration of the waste. Other special treatment where ODS are recovered from foam are also an option. Inappropriate disposal of ODS containing building waste is dumping on landfills. In such cases ODS emit within a certain years timeframe due to mechanical exposure of the waste.
6. There is only poor Nordic experiences with special treatment of ODS containing foam in end of life district heat pipes. Norway, Denmark and Sweden have special treatment facilities for ODS containing foam from district heat pipes but no municipalities are using the facilities because there is no incentives or requirements. The barrier for treating end of life district heat pipes is the extra cost related to the disposal.

Two case are actual when replacement of district heat pipes; a) if old pipes are placed in other traces the pipes are left in the ground without any treatment and disposal, b) if new pipes are placed in same trace as the old pipes, end of life pipes are moved from the underground to provide space for new pipes and treated according to general rules for waste disposal. In this case end of life district heat pipes are typically shredding and metal fractions reused. Plastic and foam goes to incineration. ODS in foam are not in focus during the treatment and there seems to be options for improvement.

Treatment facilities claims that it is technical possible to develop treatment facilities to recover CFC from the insulation foam. Some enterprises has already developed concept in Norway and Sweden.
7. Norway (as the only Nordic country) operate with limit thresholds for ODS contents in demolition waste. If waste contain more than 0.1 % CFC the waste are defined as hazardous waste and should be treated hereafter.

1.2 ODS Regulation

1. Most of the legislative framework on treatment of unwanted ODS waste in the Nordic countries is decided on a transnational level in the European Union. Norway and Iceland (non-members of the European Union) follows to a large extent the same regulations as EU, due to their commitment in the European Economic Area (EEA) which extends the principles of the internal market of the European Community to Iceland, Liechtenstein and Norway. Faroe Islands and Greenland is parts in the Danish “Rigsfællesskab” and has to some extend same regulation as DK.
2. Since *2009 Regulation no 1005/2009 on substances that deplete the ozone layer* has formed the basis for handling of substances that deplete the ozone layer. 2037/2000 covers production, importation, exportation, placing on the market, use, recovery, recycling, reclamation, and destruction of ODS.
3. In 2009 the Council adopted a recast of the legislation with the purpose of simplifying the legislation, and at the same time incorporate a new amendments made in the Montreal Protocol in 2007. As part of this regulation a new set of control measures are taken to ensure that both products containing ODS, and products for which the design or the functioning requires the presence of ODS will comply with the regulation. It means that future product design presumable will not contain ODS.
Furthermore the regulation stipulates that all these products must be recovered if it is technically and economically feasible. It is authorization of the commission “to compile a list of those products and equipment containing or relying on ODS, for which recovery, or destruction without prior recovery, of controlled substances will be considered technically and economically feasible and therefore will be mandatory.” Heat pumps are expected to be required mandatory recovery in EU. Moreover the recast moves forward the production phase-out of HCFCs.
4. There are multiple regulations targeting the recovery and destruction of banked ODS at the EU level.
5. EU regulations explicitly require the recovery of all ODS/F-gas refrigerants from certain categories of products and equipment at end of life.
6. For construction foams, the obligation to recover (or immediately destroy) depends on whether it is technically and economically feasible.
7. For vehicles and household/small commercial appliances – schemes are mandated to assign responsibility for and ensure the safe disposal of products and equipment and the ODS/F-gases contained therein.

8. *Regulation (EU) 842/2006* on certain fluorinated greenhouse gases applies the above mentioned regulation (2037/20 and 3622/09) to all F-gases, except there is no demand for recovery of the foam blowing agent from refrigerated equipment.
9. *Regulation (EU) 1013/2006* on shipment of wastes secures the shipment of hazardous ODS waste between member states, this regulation is important since there is few treatment facilities in the Union, and many countries are dependent on treatment in other member states.
10. *Directive 2002/96/EC* concerning Handling of Appliances and Small Stationary AC at end of life requires that waste household appliances and small commercial refrigeration equipment containing ODS or gases with a GWP above 15 to be collected separately. This pertains to the refrigerant and foam contained in appliances. The Directive also sets minimum recovery and recycling rates. In practise it means all CFCs and HCFCs.
11. Refrigeration appliances (and liquid refrigerants) are well regulated in all the Nordic countries. The WEEE directive on producer responsibility sets the overall framework and the national regulation sets well defined obligations for the responsible actors in regard to sorting, collection and treatment of both appliances and liquid refrigerant. New products placed on the market are produced in the European Union, with corresponding legislation banning the use of ODS in the new products. Treatment of old refrigeration systems are well regulated and no new products containing ODS will be introduced to the Nordic market, hence no additional problems are expected from this product group, and the current legislative framework in the countries are assessed to be sufficient.
12. The ODS regulation of construction and demolition waste and heat pipes are inadequate in most Nordic countries except Norway and Sweden, where reasonably newly arranged voluntary agreement has been set up, setting demands for the sorting and treatment of the hazardous fractions in the construction and demolition waste.
13. There is no legislation in the Nordic countries concerning recovery of ODS from insulation foam in EOL district heat pipes.
14. New district heat pipes produced outside EU might still contain ODS and can therefore prolong the problem if these are imported to EU, but directive 2037 forbids this import. No illegal imports are identified in the survey.
15. In general, areas where regulation appoints specific stakeholders, e.g. municipalities or the producers of the products, to treat and dispose products containing ODS, seems to work efficiently.

1.3 ODS data and banks

1. ODS containing refrigerants in the Nordic is limited to HCFC-22 (R-22), which primary are used in old larger commercial refrigeration systems in industries, ships and retail sector. There is no longer CFC banks in Nordic refrigerators.
2. It is fair to assume all R-22 based refrigeration systems in the Nordic will be phased out no later than 2020.
3. The amount of ODS in demolition waste is not verifiable from the existing data but it is known that there are contents of ODS in various foam- and insulation product produced before 1995.
4. A rough estimate of the total Nordic bank of R-22 refrigerants is 1,500–2,000 tonnes, where 750 tonnes are banks in ships from Norway, Iceland and Faroe Islands. The total ODP potential in banks are then 82.5–110 ODP tonnes.
5. There is only sporadic data for the Nordic ODS contents in the various product categories and banks but Denmark, Finland and Sweden have conducted a ODS survey for most categories and estimated ODS banks. The other Nordic countries have no data or only a few general estimates.
6. There exist no economical assessments of cost benefit for sorting and separation of certain ODS waste categories, e.g. district heat pipes or ODS foam in demolition waste.
7. The data for amounts of ODS content in hard foam reaching end of life is not yet scientifically determined in a large scale. Various test results estimate different amounts of ODS contents during the lifetime evaporation of ODS. The rate of ODS evaporation depends of a number of factors like the specific PUR, the size of cells in hard foam, and the mechanical threat during the products life time. New data from Chalmers indicate that the contents of ODS in foam from Swedish heat pipes is between 25–50% after 5 years and 15–25% after 20 years. These test results indicate that considerable environmental effects will be achieved with appropriate treatment of ODS waste.
8. A rough extrapolation of the actual Nordic bank divided into refrigeration and foam show an ODP recovery potential of more than 10,000 ODP tonnes in total. The ODP bank related to refrigerants is relatively small compared to foam banks because this bank is only based on HCFC-22 (with low ODP value). The largest potential for improvement of ODS recovery and disposal/destructions of ODS in banks are related to appropriate treatment of old district heat pipes.
9. Approx. 60,000 km district heat pipes are installed in the Nordic countries. The largest amount is installed in Denmark, then Sweden, Finland, Iceland and Norway, which only have a smaller amount. The total potential amount of ODS for recovery in district heat pipes

in the Nordic are estimated to 4,000–5,000 ODS tons, whereas Denmark cover more than 50% and Sweden 30%. New pipes do not contain ODS. The potential is assumed is based on the precondition that 15–30% of ODS contents are in foam at end of life and a number of old CFC containing heat pipes already are replaced.

10. The ODS contents in demolition waste from building sector is CFC-11/12 or HCFC 141b/142b in XPS blocks and other insulation foam. These substances were popular blowing agent until the CFC ban in 1994–1995 and HCFC bans for using HCFC as blowing agent in 1998–2000. The ODP value for CFCs are 1 and HCFC-141b/142b is 0.11 and 0.065. There are no complete data to calculate the total ODS contents in insulation and construction foam in the Nordic but based on extrapolation of Swedish, Finnish and Danish estimates, the total potential bank in demolition waste from construction and buildings are assumed to be 8,000–10,000 ODP tonnes contained in XPS blocks, insulation panels etc.
11. ODP waste from insulation panels in fridge/freezers (household and commercial) is handled through the municipal collection and treatment systems. The treatment is regulated and standard procedure is recovery of refrigerants, reuse of metals and shredding/incineration of foam. Recover of ODS during the shredding process is common for most large treatment facilities in the Nordic. The ODS banks from this product category was considerable but the ODP potential today is more limited, while most CFC/HCFC based fridge and freezers are already disposed. A rough estimate for the actual Nordic ODS bank from this product category is 200–400 ODP tonnes.
12. HCFC-22 refrigerant has an ODP value of 0.055 ODP tons. A rough estimate of the total Nordic bank of R-22 refrigerants is 1,500–2,000 tonnes, where 750 tonnes are banks in ships from Norway, Iceland and Faroe Islands. The total ODP potential in banks are then 82.5–110 ODP tonnes.
13. HCFC-142b is widely used in XPS insulation block and data estimate more than 100 ODP tonnes contained in XPS blocks in railways, roads and house constructions, only for Finland. Same scale may be assumed in Norway and Sweden.

2. Conclusions

The conclusions below summarize reflections from the survey and the findings. The conclusions are structured according to regulation, waste treatment and data gaps.

2.1 Regulation

- Nordic countries have the necessary regulatory framework to ensure appropriate disposal of ODS waste.
- EU will provide a list of mandatory products to recovery. This list is not expected to affect the Nordic regulation while recovery for the product groups happens already.
- If EU requirement for recover is extended to foams, there will be a need for regulatory arrangement in all Nordic EU member states.
- It is announced from EU that F-gases within a short timeframe will meet requirement for recovery of gases in foam. Nordic member states will then need to improve regulatory and technical arrangement for foam recover.
- Nordic countries have full compliance with EU regulation and control of collection and treatment of small household appliance and mobile A/C.
- ODS waste can be shipped and treated in other EU countries which make it possible to utilize transnational treatment facilities.

2.2 ODS Data gaps

- The existing overview of ODS waste in the Nordic is poor. The specific product categories where ODS can occur are well known. But the gradual transition from ODS blowing agent or refrigerants to alternative substitutes and no measures from realized disposal of ODS foam leave only few parameters to assess ODS banks. Due to improvement of ODS waste treatment it has only minor relevance to have detailed ODS bank data but the lack of data makes it difficult to monitor achieved environmental effects.
- Strategies and effort should be planned anyhow because ODS banks are in same products as F-gas banks. It means that precaution and treatment of ODS banks also is precaution of f-gas banks (refrigeration, insulation foam, construction foam).

- A precondition for initiating systematically recovery of ODS from first generation district heat pipes is better documentation for the resting contents of ODS in end of life foam. Test determining ODS contents should therefore be initiated so a precise strategy for district heat pipe recover can be formulated.

2.3 Waste treatment

- The largest potential for ODS recover must be in Denmark, where the district heat infrastructure is extensive and also contains early generation pipes. Sweden and Finland also have a considerable potential for ODS recovery from district heat pipes. The other Nordic countries only have a minor potential.
- Larger units like glassfibre boats, caravans, windmills etc. represent a waste fraction with high volume and special difficulties according to appropriate treatment. This waste fraction consists typically of sandwich constructions of glassfibre and hard foam. Glassfibre is a challenge in waste treatment because the material is armed and shredding is not possible. While incineration only is an option for units below 1 m³, it is likely that this waste is sent to landfill after crushing. There is lack of data for this waste fraction and there is no control or procedures for appropriate treatment of the ODS foam.
- CFC 11 and CFC 12 are contained in pipes produced before 1995. HCFC 141b/142b can be used in pipes produced before 2005. No European manufactures produce pipes with ODS today. The used blowing agent in heat pipe insulation foam is now HFC-134a.
- The Nordic facilities for appropriate ODS waste treatment are in place.
- The waste infrastructure in the Nordic countries basically ensures ODS containing demolition waste appropriate disposed. Well functioning high temperature incineration plants and cost incentives to reduce landfill waste are effective instruments. The relevant stakeholders in the building sector (demolition companies, entrepreneurs, craftsmen etc.) are normally sorting out foam products and other combustible waste fractions and send it to incineration.
- In Nordic areas with poor access/long distance to incineration plant, there might be situations, where ODS containing demolition waste are reaching landfill instead but it is considered only to be a little potential.
- There are no general procedures for appropriate treatment of ODS foam in the Nordic countries.
- The Nordic waste infrastructure with well represented incineration plants and high cost for disposal to landfill provide incentives to stakeholders for delivery of combustible foam to incineration.

- Interview with controlled landfills indicate, that hard foam is only occurring occasional in very small amounts. I periodical visual inspection of waste fractions to selected controlled landfills can determine amounts of ODS waste from construction and demolition. If no amounts are detected, it can be concluded that all ODS waste from demolition are disposed appropriate through combustion.
- A strong incentive to improve recovery of ODS in foam is if ODS and f-gases will be included in the Kyoto Protocol mechanism. The GWP potential from foam recovery is extensive because of ODS and f-gases potent GWP value.

3. Recommendations

Based on the findings and conclusions described above, a number of recommendations are formulated.

In overall there is no need for further effort in relation to regulation, control and treatment of ODS refrigerants in the Nordic. The suggested effort are related to treatment of ODS foam waste, where some issues can be improved further.

District heat pipes - supplier management

End of life heat pipes represent valuable materials (metals and plastic component) but can potentially also contain ODS and other unwanted substances like e.g. PVC. Reuse and recovery of heat pipes is therefore a relevant and likely option from an environmental perspective.

To ensure more control with reuse and recovery of heat pipes it is most obvious that such conditions are negotiated and integrated in (new) contracts with suppliers involved in district heat pipe replacement projects. The agreement should contain specification for treatment and disposal method for the various materials – reuse of steel pipe and reuse/recover of PE/non ODS PUR coating, and appropriate destruction of PVC and ODS containing PUR foam. Further, requirements for documentation should be defined.

The actual and increasing focus on energy-efficiency has high priority at the agenda in the district heat companies. It means that effort improving the transmission of energy leads to replacement of old pipes with new more energy efficient and better insulated pipes. The discussion of treatment, reuse and recovery of end of life pipes are therefore very relevant in these years, while many district heat companies upgrade their infrastructure. For example in Denmark are the incentive for replacement of district heat pipes intensified in 2010, while the Danish Energy Agency has increased the requirements and standards for energy efficient district heat supply.

It is therefore recommended to establish mechanism or procedures which ensure improved reuse of end of life pipes, recover of ODS at shredding or direct separation and incineration of foam.

Further it is recommended to clarify and develop the scientific results indicating that 15–30% of ODS contents in foam still are in pipes at end of life. In general there is a need for a broader documentation of the environmental potential for ODS recovery in foam. Improved documentation will clarify when it is reasonable to straightening efforts for recovery from EOL foam.

Recovery versus destruction of ODS

There are two basic methods when treating ODS waste; a) recovery/reuse and b) incineration. In general most ODS in refrigerants are recovered and ODS in foam are destructed through municipal incineration.

It is recommended to dispose ODS waste foam directly to incineration where possible; even that facilities in the market can pre-treat and recover ODS from foam. Incineration is a cost effective and well known method.

In cases where the mechanical threats of foam will be extended, e.g. because of shredding into small pieces, a recovery before incineration should be performed to avoid/reduce ODS emissions from pre-treatment of foam waste.

Reducing leakages of ODS refrigerants during operation

While infrastructure for recover and destruction of R-22 refrigerants is in place there is no need for further efforts to improvements in accordance to collection, recover and destruction. Efforts of relevance are actions which target reduction of R-22 leakages during operation and actions which target a phase out of the R-22 refrigeration systems.

Demolition waste

Efforts to improve treatment of demolition waste containing ODS is first of all to secure that waste do not end at landfills. This is done by optimal separation of combustible waste and disposal to incineration plants. If possible, a reduction of mechanical threat of ODS waste (foam etc.) during the demolition and separation phases, can ensure unwanted emissions of ODS are reduced further. Open air shredding of insulation panels, XPS foam etc. without recovery should be avoided if appropriate and possible.

Large unit construction foam

Waste treatment of larger units construction foam from boats, caravans, windmills etc. need to be investigated and improved further. The technical difficulties with treatment of glassfibre provide a challenge for appropriate treatment of the hard foam. The lack of overview and control with optimal disposal of this fraction leads to inappropriate land filling. Large unit construction foam in boats, caravans etc. produced before 1995 is assumed to contain CFC blowing agent.

It is recommended to take initiative to implement procedures which ensure separation or correct treatment of hard foam during the treatment and disposal phases to avoid landfill.

4. Norsk sammendrag

Den globale innsatsen med å redusere ozonødeleggende stoffer de siste 20 årene med påfølgende restituering av ozonlaget, er en av de store suksesser i internasjonalt samarbeid. Men til tross for de gode resultatene fra dette arbeidet, er det en viss fare for at stoffer som fremdeles finnes lagret i produkter og brukt utstyr ("banks"), kan lekket ut og utgjøre en fare for restitueringen av ozonlaget i stratosfæren. Stoffene finnes for det meste i stasjonære og mobile kjøle-/fryseanlegg, varmepumper, luftkondisjoneringsanlegg, isolerende skum samt lagre av ny eller gjenvunnet ozonødeleggende gass.

Det tekniske og økonomiske panelet (TEAP) under Montrealprotokollen har estimert at det å gjennomføre tiltak for å hindre utslipp etter at gassene har vært brukt i produkter og utstyr, vil spare atmosfæren for utslipp av ca. 300.000 ODP-tonn og ca. 6 milliarder tonn CO₂-ekvivalenter til sammen i perioden 2001–2050.

Det er i de nordiske land begrenset oversikt over produktgrupper som inneholder ozonødeleggende stoffer, regulering, mulige teknologier for behandling, infrastruktur for avfallshåndtering og lignende. Denne rapporten gir en oversikt over avfallsbehandlingen av ozonødeleggende stoffer og dens regulering i de nordiske landene. Videre identifiserer den mangler og foreslår tiltak og gir anbefalinger som er relevante for dette området i Norden. Det har vært fokus på avfall som inneholder stoffene KFK og HKFK. De andre ozonødeleggende stoffene, så som haloner, tetraklorometan, trikloreten og metylbromid er godt regulert og mengdene av disse stoffene i Norden er små.

Rapporten konkluderer med at avfallsbehandlingene av ozonødeleggende stoffer er velfungerende i de nordiske landene. Avfallshåndteringen er regulert og det finnes tilstrekkelig infrastruktur og destruksjonsfasiliteter.

Et grovt estimat angir at det i 2011 totalt finnes minst 10.000 ODP tonn med ozonødeleggende stoffer lagret i produkter og utstyr. ODP i kjøle- og fryseanlegg er relativt lavt, da det er stort sett bare HKFK i disse produktene. HKFK har relativt lav ODP. Det største potensialet for forbedring er knyttet til innsamling og behandling av gamle rør som brukes bl.a. til fjernvarmeforsyning. Det er benyttet skum i disse rørene som inneholder ozonødeleggende stoff.

Rapporten er utarbeidet av PlanMiljø ApS (Danmark) for Nordisk Ozongruppe. Utarbeidelsen av rapporten har blitt finansiert av Nordisk Ministerråd, gjennom Nordisk kjemikaliegruppe og Nordisk avfallsgruppe.

5. Appendix 1.

ODS waste

The current chapter will bring an overview of the specific identified ODS waste fractions in the Nordic consisting ozone depleting substances (in form of primary CFC 11, CFC 12 and HCFC-141b/142b, HCFC-22).

5.1 ODS waste products

The potential ODS banks from different product groups reaching the waste sector at end of life in the Nordic are listed in the following.

Retail and industrial refrigeration systems (HCFC-22)

A various number of refrigeration system in retail, ships and industry still contain HCFC-22 refrigerants. But it is prohibited to install new installations with HCFC-22. Over a time period of 5 years (2015) this ODS refrigerants is assumed more/less phased out. From 2015, sale of regenerated HCFC-22 is phased out.

Refrigerant in bulks

In the Nordic countries refrigerant importers/distributors offer free take-back services on used refrigerant to ensure proper disposal, with costs being recovered through a tax on the sale of new refrigerant.

Large commercial refrigeration/AC equipment

Large commercial refrigeration/AC equipment is handled by installation companies that recover refrigerant for reuse, reclamation, or destruction, and then decommission the systems for metal recycling. Actual refrigerant recovery level from this type of equipment is high.

Household appliances

Refrigerant recovery from household refrigerators/freezers is well organized in the Nordic countries. Regulation and procedures ensures that staffs are trained in use of recovery equipment and recovery level is assumed optimal.

The recovery of foam from domestic appliances is practiced in compliance with regulations. Depending on the facility, it can be recovered/pressed at site or sent to incineration without pre-treatment.

The substitution worldwide from ODS to f-gases was implemented in the period 1990–1995. ODS refrigerants (CFC-12 and HCFC-22) in fridg-

es/freezers occurs therefore from units produced before 1995. The number of ODS containing units in Nordic is expected small. Contents of ODS pr. unit is approx. 0.15 kg. Insulation in units produced before 1995 also contain CFC (blowing agent). The used amount is approx. 0.3 kg.

Most fridges and freezers are collected at local recycling centres and sent to treatment facilities, dismantling the units containing ODS.

The process described in table A.1 is an example of the procedure for treatment of refrigerant and foam in Sweden.

Table A.1. Description of Swedish handling of refrigerators at Svensk Freonåtervinning

Steg 1. Freonet återvinns ur kylsystemet. Återvinningsgrad: 95%

1. Kylmöblerna samlas in.
2. Kylsystemet töms med hjälp av en vacuumpump. Sedan sker en termisk avdrivning av freoner.
3. Freonet tappas på gasflaskor och oljan på fat.
4. Kompressorn klipps av och återvinns.
5. Skåpet går vidare till steg 2.

Steg 2. Freonet återvinns ur isoleringen. Återvinningsgrad: 90%

1. Skåpet tuggas sönder i centimeterstora bitar med en kvarn.
2. Den lätta isoleringen skiljs från tungt material med hjälp av en stark uppåtgående luftström. Tungt material, dvs plast och metall transporteras vidare till återvinning.
3. Isoleringen finmals, då frigörs freonet.
4. Eventuellt kvarvarande freon avdrives på termisk väg.
5. Nu har freon, isoleringspulver, metaller och plast omhändertagits på ett miljöriktigt sätt.

MAC (Mobile air-conditioning)

Recovery of ODS refrigerant from old motor vehicles is no longer relevant in the Nordic Countries, because the substances have been phased out.

Construction foams

ODS containing construction foam is not typically separated from other materials and recovered. Thus, the waste treatment infrastructure in the Nordic ensures foam is incinerated.

ODS containing construction foam from building materials is typically XPS foam blocks, insulation foam used around windows, in panels and doors. Further, ODS foam has been used as filler/sealant in building.

Normally it is the contractor on a demolitions project there are responsible for appropriate handling of the different waste fractions. Contractors use waste company to transport and handle the further process of treatment. ODS foam is not separated from other building materials

and recovered in the waste stream. The waste is combustible while the typical disposals are municipal incineration.

Separating ODS material at building demolition and ensuring proper disposal presents a significant challenge, especially in cases where the type of blowing agent in the insulating foam is not discernible. An exception to this is the Norwegian way to handle larger demolition project whereas bigger amounts of ODS has to be separated and treated as hazardous waste.

Hard foam – other products

Hard foam (*CFC's HCFC-141/HCFC-142*) has been used for products as windmills, insulation in caravan, boats, foam in cars and surf boards etc. Waste treatment companies states that waste fractions containing construction foam are not handled in any special way to day. It normally ends up as part of a mixed fraction being incinerated or land filled.

Larger units like glassfibre boats, caravans, windmills etc. represent a waste fraction with high volume and special difficulties according to appropriate treatment. These waste fractions consist typically of sandwich constructions of glassfibre and hard foam. Glassfibre is a challenge in waste treatment because the material is armed and shredding is not possible. While incineration only is an option for units below 1 m³, it is likely that waste are send to landfill after crushing. There is lack of data for this waste fraction and there is no control or procedures for appropriate treatment of the ODS foam.

District heat pipes

Heat pipes consist of a metal pipe covered with insulation foam and a plastic tube. The insulation foam is hard foam with closed cells. Depending on age, the insulation foam can be blown with ODS (CFC's and HCFC-141/HCFC 142). From approximately 1995 (CFCs) or 2002 (HCFCs), the ODS blowing agent were phased out and substituted with f-gases (HFCs). ODS contents in heat pipe occurs therefore in pipes older than 15 years. The typical lifetime for heat pipes is 30–50 years.

Renovation and replacement of district heat pipes are an on-going exercise and old ODS containing pipes reach therefore end of life. The situation for replacement depends on the specific renovation project, but in general the procedure is to replace existing pipes, when same traces are used. If new traces are planned, the old pipes will not be replaces but leaved in the ground. Replaced pipes are sent to authorize waste handlers for reuse and disposal.

The District Heat Associations in Denmark, Sweden and Finland do not have documentation for the number of replaced pipes but claims that it is a common procedure to leave pipes in the ground, when you are not working in same traces.

The table below provides a Nordic overview of the present lengths of District heat pipes in the Nordic (km) and estimated amount of ODS in the insulation foam.

Table A.2. Nordic overview of the district heating

	Denmark	Sweden	Norway	Finland	Iceland
Pipes length (km)	27,575	17,782	900	11,000	4,300
Estimated tons of ODS (t)	4,500	2,000	?	1,264	265
District heating penetration (%)	60	50	2	49	95

This table shows that the size of the problem varies from country to country. The ODS amount is proportional with the pipe length.

5.2 Nordic ODS bank

Table A.3. Estimated CFC-11 banks from Denmark, Finland, Sweden

Product	Denmark CFC (t)	Finland CFC (t)	Sweden CFC (t)	Estimated amount back in 2010 (%)	End of period for waste generation
Insulation foam in heat pipes	4,770	1,260	2,200	> 90	- 2,048
Insulation in buildings	3,070	4,200	3,420	> 80	- 2,024
Insulation foam in mobile refrigeration	790	-	600	25–90	
Insulation foam in fridges/ freezers and retail systems	1,090	-	3,300	10–20	-2,014
Construction foam	270	14	250	< 20	-2,019

Three national surveys form basis for a general overview of the ODS banks in the Nordic countries. The surveys are covering the ODS banks in Denmark, Sweden (2002) and Finland (1994/2010) and estimate the expected banks in relation to product groups.

In building insulation the special type of insulation XPS (extruded polystyrene) has been used a lot in both the Swedish and Finnish building sector. XPS insulation blocks have also been widely used for insulation of ground layer in connection with cold area road construction in Finland, Norway and Sweden.

5.3 ODS waste treatment at country level

5.3.1 *Denmark*

Fridges/freezers

According to waste statutory order (Elektronikaffaldsbekendtgørelsen) the municipalities are responsible for the public waste handling system for wasted fridges and freezers. The fridges and freezers are collected at recycling facilities. Citizens are responsible for bringing them to the recycling facilities. According to the WEEE directive it is the producers of the electronic products which hold the overall responsibility for the correct treatment of the waste, and the cost associated with the treatment. EOL appliances must be dismantled in a way that can secure that a minimum of ODS are emitted. Foam from the units are shredded at treatment facilities and the emitted CFC from the insulation foam is bottled and burned or converted to a salt water solution which can be treated at a normal waste water treatment plant. The foam, with small remaining amounts of CFC, is sent to incineration.

Fridges and freezers are regulated with respect to ODS/f-gas recovery of refrigerants and insulation foam. This fraction comprises approximately 300,000 units per year.

Domestic and industrial refrigeration systems

Technical arrangement due to ODS refrigerant is reuse or destruction. The responsible is the maintenance company/person for the specific installation. Contents of ODS can be from 5–500 kg. The responsible body shall ensure appropriate destruction of polluted refrigerant, e.g. the KMO organisation in DK receive reports from maintenance companies concerning refill and destruction at Kommune Kemi.

Treatment of larger installation systems are sent to authorised treatment facilities at companies like HJ Hansen, Uniscrap and Stena Technoworld.

Heat pipes

Heat pipes containing insulation foam with ODS has been used in the years 1960–1992 and the total amount is approximately 4,500 tons CFC-11. With an expectation of life around 50 years most of the pipes, placed in this period, are still in function.

As an indication a company report states that 30% of the pipes are replaced and removed in Odense Kommune Fjernvarmeforsyning (2002). There exist no data on the amounts of pipes being handled. Road authorities can require the space in the ground, then district heating companies are demanded to remove old pipes.

It is not present in the companies or district heat association to have a policy for handling the ODS foam in pipes.

It is the owner of the pipes that has the responsibility for the right treatment of the pipe. The owner, normally district heating companies, hires a waste collector to transport the pipes to a specific treatment facility or to handle both collection and treatment.

Insulation foam in panels, filler, building insulation

ODS in building materials are not handled in any special way. It normally ends up as part of a mixed fraction being incinerated.

5.3.2 Norway

Fridges/freezers

One of the technologies being used in Norway is a modern facility which handles fridges, freezers and other kinds of WEEE. The machine is used for gentle dismantling of electrical and electronic scrap and refrigerators. The device operates with rotating chains which catapult the charged material against the walls resulting in disintegration of the composite materials.¹ CFC and HCFC emits when the cores of PUR foam are crushed in the machine.

The emission is assembled and condensates by a cryo-technology (frozen nitrogen) and ends up as dust. The dust is sent to an incineration plant with permission to incinerate hazardous waste.² The refrigerant is sent to Stiftelsen ReturGass.

Domestic and industrial refrigeration systems

Used refrigerant is handled in a return system. Stiftelsen ReturGass (SRG) is the recipient of used CFC containing gases. The company is a nationwide recipient for a variety of environmentally threatening wastes with focus on ozone-depleting substances and greenhouse gases. SRG's return system is partly based on an economic model that credits the waste producer for the type of waste delivered. This is done through redeeming of a deposit and/or governmental reimbursement. For wastes not covered by the arrangement previously mentioned, the customer will be charged for handling and treatment of the waste.

SRG's finances are partly based on a prepaid waste treatment system for CFCs and HCFCs. Under bilateral agreements between SRG and various importers of refrigerant gases, an environmental fee is charged per kilogram of gas imported to Norway. This environmental fee is credited to SRG to cover administrative and operational cost. In addition, SRG credits waste owners per kilogram of used CFCs and HCFCs through a

¹ <http://www.mewa-recycling.de/en/footer/lexikon/lexikon/querstromzerspaner-1/75.html>

² Eirik Syrstad Brattli, KS/HMS-leder, WEEE Recycling AS, mail Dec. 2010.

refundable fee as an incentive to ensure a high percentage of collection. This concept is unique in the international refrigeration and heat pump market. The tax refund scheme was introduced by the Norwegian authorities in July 2004.

Table A.4. Description of the Norwegian financial model for recyclingsystem

Financial model for the Norwegian Recyclingsystem

For å finansiere returordningen ble det innført en miljøgebyr - og panteordning. Ordningen fungerte slik at kuldemedium - importørene belastet sin kunder med et miljøgebyr pr. kg. omsatt CFC. Gebyrinntektene ble overført fra den enkelte importør til SRG med basis i bilaterale avtaler. SRG benyttet inntektene til å dekke kostnader for drift og administrasjon av retursystemet, samt å utbetale såkalt pant for innleverte brukte CFC - holdige gasser og senere HCFC 22. Panten innebar i prinsipp at kunden fikk tilbakebetalt miljøgebyret ved innlevering av brukt/ kassabel CFC og/eller HCFC 22 til SRGs mottak i Hokksund.

Gebyr- og panteordningen fungerer fortsatt etter samme modell idag, men SRG får ikke lenger gebyrinntektene fra de ozonreduserende klimagassene CFC og HCFC. Gebyrinntektene på CFC opphørte i forbindelse med at CFC ble forbudt å importere til Norge fra 01.01.1995. Tilsvarende opphørte gebyrinntektene på HCFC fra 01.01.2010. Likevel er økonomien i retursystemet til SRG god nok til å opprettholde utbetaling av pant på innlevert CFC og HCFC 22 i lang tid fremover. Idag utbetales det kr. 40,- pr. kg for *ren* HCFC22 (>90% renhet) og kr. 55 pr. kg for CFC holdig kuldemedium til aktører som er med i ordningen

Heat pipes

In Norway district heating only distributes a little part of the energy. One of the main reasons district heating has a low penetration in Norway is access to cheap hydro based electricity. However, there is district heating in the major cities.

Building materials

In the production of insulation foam environmentally harmful blowing agents such as CFCs, HCFCs and HFCs have been in use until approx. 2003. These gases are emitted from the insulation over time, but there may be significant amounts of blowing gas left in the discarded insulation. CFCs, HCFCs and HFCs can be found in the following products:

- Blowing agent mainly in garage doors and insulations panels in cooled storage (PUR)
- Insulations plates/panels (XPS)

Demolition materials containing ODS at a certain concentration is considered hazardous waste. Concentration Limits for hazardous / non-hazardous waste for ODS is 0.1% of each drug [avfallsforskriften, Annex

3A, R59]. This means that waste containing more than 0.1% ODS is hazardous waste. Measurements of the ODS concentration level has to be made on separate waste fractions and not in the mixed waste. If the fraction has a ODS concentration limits over 0.1%, it is to be delivered to approved facilities for hazardous waste. The ODS containing insulations foam is identified during the mandatory elaboration of a waste plan during the planning of a renovation or demolition of bigger buildings (bigger than 100 m² or 10 ton waste).³

5.3.3 Sweden

Fridges/freezers

As in Denmark and Norway this areas is well-regulated and therefore the ODSs in old fridges and freezers are being destroyed. In Sweden the treatment of fridges and freezers is primarily carried out by Svensk Freonåtervinning and Stena Recycling. The Freon released is converted into not harmful salt water concentration.

Heat pipes

Sweden has a long tradition for using district heating in urban areas. The handling of older heat pipes in district heating companies is as in Denmark where the normal praxis is to leave the pipes in the ground if replacement is not in same trace. There exists no statistics or specific requirements concerning the handling of older heat pipes. (Eriksson, Svensk Fjärrvärme AB).

Construction foam – building materials

ODS can be found in the following products in Swedish buildings:

- PUR foam (Polyurethane foam)
- XPS

Some types of PUR foam and XPS are easy to dismantle from the other waste fractions and some are not.

³ Veileder for Kommuner – Avfallsforskriften Kapittel 15 om Bygavfall – 2356/2007, Statens Forureningstilsyn.

Table A.5. Description of Swedish handling of insulations foam from demolition at Svensk Freonåtervinning

Steg 1. Sortering och paketering

- Isoleringsplattor tas emot på vår anläggning i Hässelby.
- Eventuellt främmande material sorteras ut.
- Plattor från materialet skärs till i storlek 190x60 cm och paketeras för att uppnå bästa återvinningsgrad i fragmenteringen.
- Materialet går vidare till steg 2.

Steg 2. Freonet återvinns ur isoleringen. Återvinningsgrad: ca 90 %

- Buntar av materialet tuggas sönder i centimeterstora bitar med en kvarn.
- Den lätta isoleringen skiljs från tungt material med hjälp av en stark uppåtgående luftström. Tungt material, dvs plast och metall transporteras vidare till återvinning.
- Isoleringen finmals och freonet frigörs.
- Eventuellt kvarvarande freon avdrives genom värme.
- Nu har freon, isoleringspulver, metaller och plast omhändertagits på ett miljöriktigt sätt.

It has not been possible to find out how much insulation foam being treated and destroyed into salt water concentration and how much are disposed to landfill or incineration.

5.3.4 Finland

Fridges/freezers

Like the other Nordic countries this areas seems well-regulated and the ODS in old fridges and freezers are being destroyed. Some amounts are sent to Swedish treatment facilities.

Heat pipes

District heating accounts for almost 50 per cent of the total heating market.⁴ According to a smaller finnish study the CFC content of 20–30 years old pipes in the ground is about 10–20% of the original content as a new pipe. There exist no data either in Finland on the amounts of pipes being handled. Old pipes are only replaced if there is a lack of space for installation of new pipes. Old PUR is normally either burned in waste incineration plants or placed at a dump. CFC is not collected.⁵

⁴ <http://www.energia.fi/en/districtheating/districtheating>

⁵ Veli-Pekka Sirola – Finnish Energy Industries, mail Nov. 2010.

5.3.5 Iceland

Fridges/freezers

SORPA⁶ accept fridges and freezers from individuals at recycling centres and transport them to Efna for handling. Efna has licence to handle hazardous waste and freezers and fridges are transported to Denmark for destruction.⁷

Regarding the insulation material from refrigerators, there is introduced a new possibility in Iceland. A company is cutting insulation foam from the metal, and incinerate the insulation in Kolka Reykjanesbæ incineration plant.

Heat pipes

Iceland has the largest percentage of district heated buildings in the world, with more than 90% of houses connected.⁸ Orkuveita Reykjavíkur (Reykjavik Energy) owns around 70% of the transmission pipe system in Iceland.⁹ Total length of pipeline system is 4,300 km and 1,240 km¹⁰ of those are from Orkuveita Reykjavíkur is before 1995 and contains CFC insulation foam. There exist no register of the amount of pipes with CFC nationally. Old heat pipes are typically replaced and disposed to landfill.

⁶ Largest municipal owned waste management enterprise – sorpa.is.

⁷ Björn H. Halldórsson, Sorpa, mail Dec. 2010.

⁸ www.samorka.is

⁹ Mail from Pétur Kristjánsson, Samorka.

¹⁰ Maria Thórs – Reykjavik Energy, mail Jan 2010.

6. Appendix 2.

ODS Regulations

This chapter will bring an overview of the EU and country specific regulations and legal arrangements concerning the identified waste fractions consisting ozone depleting substances in form of primary CFC 11, CFC 12 and HCFC-22. The purpose of the regulation study is to identify gaps and differences between the Nordic countries in their regulation of products containing ODS. The focus will be on the most important waste/product categories; Refrigeration appliances (foam and liquid refrigerant), Heat pipes (foam), Construction and Demolition waste (foam).

6.1 EU regulations¹¹

Most of the legislative framework on treatment of unwanted ODS waste in the Nordic countries is decided on a transnational level in the European Union. Below is a summary of the relevant EU legislation. Norway and Iceland, who are not members of the European Union, will to a large extent have to follow the same regulations as EU, due to their commitment in the European Economic Area (EEA) which extends the principles of the internal market of the European Community to Iceland, Liechtenstein and Norway.

There are multiple regulations targeting the recovery and destruction of banked ODS at the EU level. ODS banks are found in various products when they reach their end of life (EOL) stage, ex. foam from demolition waste, heat pipes and refrigeration appliances.

EU regulations explicitly require the recovery of all ODS/F-gases from certain categories of products and equipment at end of life. The new ODS Regulations offer also the option of destruction without prior recovery. For the other categories, including construction foams, the obligation to recover (or immediately destroy) depends on whether it is technically and economically feasible.

¹¹ Based on a report from ICF International (2010).

For some end-uses – namely vehicles and household/small commercial appliances – schemes are also mandated to assign responsibility for and ensure the safe disposal of products and equipment and the ODS/F-gases contained therein. The regulations are listed in the table below.

6.1.1 Handling of ODS and F-Gases

Regulation order (EC) 2037/2000, replaced by regulation No 1005/2009 on substances that deplete the ozone layer

Since 2000 this regulation has formed the basis for handling of substances that deplete the ozone layer. 2037/2000 covers production, importation, exportation, placing on the market, use, recovery, recycling, reclamation, and destruction of ODS. In 2009 the Council adopted a recast of the legislation with the purpose of simplifying the legislation, and at the same time incorporate the new amendments made in the Montreal Protocol in 2007. As part of this regulation a new set of control measures are taken to ensure that both products containing ODS, and products for which the design or the functioning requires the presence of ODS will comply with the regulation. Furthermore the regulation stipulates that all these products must be recovered if it is technically and economically feasible. It is authorization of the commission “to compile a list of those products and equipment containing or relying on ODS, for which recovery, or destruction without prior recovery, of controlled substances will be considered technically and economically feasible and therefore will be mandatory”. Moreover the recast moves forward the production phase-out of HCFCs and sustains the decommissioning of all products containing halons except those found necessary for critical use as fire extinguishers for aircrafts, navy and military purposes.

Regulation (EC) 842/2006 on certain fluorinated greenhouse gases

842/2006 applies the above mentioned regulation (2037/2000 and 1005/2009) to all F-gases, except there is no demand for recovery of the foam blowing agent from refrigerated equipment.

6.1.2 Waste Classification and Shipment

Directive 2008/98/EC

This directive categorizes ODS and F-gases intended to be discarded as hazardous waste. Hazardous ODS waste has to be collected separately “if technically, environmentally, and economically practicable,” and thereafter recovered according to best practices. The hazardous waste cannot be mixed it with other wastes or materials with different properties. However there is three exceptions, the ODS waste may be mixed if (a) the activity is carried out by a specifically permitted establishment, (b) there is no increase in the adverse impact of the waste management on human health

and the environment, and (c) the mixing operation conforms to the best available techniques.

Regulation (EC) 1013/2006

Secures the shipment of hazardous ODS waste between member states, this regulation is important since there is few treatment facilities in the Union, and many countries are dependent on treatment in other member states. The regulation requires prior written notification and consent before shipments of ODS waste.

Regulation (EC) 1272/2008

This regulation sets standards for the classification, labeling and packaging of hazardous ODS waste, and thereby regulate the shipping of ODS between member states. Labeling is mandatory for manufactures, importers and users.

Directive 2002/96/EC

Handling of Appliances and Small Stationary AC at EOL Directive 2002/96/EC-requires that waste household appliances and small commercial refrigeration equipment containing ODS or gases with a GWP above 15 be collected separately, and that ODS be treated in accordance with Regulation 2037/2000. This pertains to the refrigerant and foam contained in appliances. The Directive also sets minimum recovery and recycling rates.

Directive 2000/53/EC

Handling of Vehicles at EOL Directive 2000/53/EC-requires Member States to ensure that EOL vehicles are dismantled and hazardous materials removed, including CFC and HFC refrigerants used in AC systems.

Directive 2008/98/EC

Directive 2008/98/EC-requires that by 2020, 70% of construction and demolition waste (by weight) be recovered. This will have implications for the treatment of construction foam.

6.2 Country specific regulation – overview

Table A.6 shows an overview of the country specific regulation targeting the ODS containing product groups.

Table A.6. Overview of Nordic ODS regulations

Regulation	General ODS legislation	Refrigeration appliances	Heat Pipes	Construction and Demolition waste	Liquid refrigerant
Denmark	Order 48/2010 (Affaldsbekendtgørelsen) Order 2002 /243 (Bekendtgørelse om forbud og anvendelse af vise ozonlagsnedbrydende stoffer)	Order 362/2010 (Elektronikaffaldsbekendtgørelse)	-	-	Order 362/2010 (Elektronikaffaldsbekendtgørelse)
Sweden	Order 2001:1063 (Avfallsförordningen) Order 2002:187 (Förordningen om ämnen som bryter ned ozonskiktet) New regulation in place, 2007:846	Ordinance (2005:209) producer responsibility for electrical and electronic product	-	Handbook 2010:1 (Återvinning av avfall i anläggningsarbeten.)	-
Norway	Statute 930/2004 (Avfallsforskriften)	Statute 930/2004 (Avfallsforskriften kap. 1) Statute 922/2004 (Produktforskriften kap 3)	-	National action plan and voluntary agreement with construction industry	Statute 922/2004 (Produktforskriften kap 3)
Finland	Act 1072/1993 (General waste act) Decree 262/1998(Ozone Depleting Substances)	Order 852/2004 (Waste Electrical and Electronic Equipment)	-	-	-
Iceland	Order 52/1988(Hazardous Substances) Order 586/2002(Ozone Depleting Substances)	-	-	-	-

The purposes of the national regulations are to secure a proper treatment and disposal of the products containing ODS on the Nordic markets. The regulation order 2027/2000 is the overall EU regulation securing a ban on production, import and placing on market of new products containing ODS. This general ban is implemented directly as a national law and it is the environmental protection agency in the respective countries that are the responsible authority for the national compliance.

As it is visible from the table refrigeration appliances (and liquid refrigerants) are well regulated in all the Nordic countries. The WEEE directive on producer responsibility sets the overall framework and the national regulation sets well defined obligations for the responsible actors in regard to sorting, collection and treatment of both appliances and liquid refrigerant. New products placed on the market are produced in the European Union, with corresponding legislation banning the use of ODS in the new products. Treatment of old refrigeration systems are well regulated and no new products containing ODS will be introduced to the Nordic market, hence no additional problems are expected from this product group, and the current legislative framework in the countries are assessed to be sufficient.

The regulation of both C&D (construction and demolition waste) and heat pipes is inadequate in all the countries examined except Norway and Sweden, where reasonably newly arranged voluntary agreement has been set up, setting demands for the sorting and treatment of the hazardous fractions in the C&D. Heat pipes are not included in this voluntary agreement in Norway and Sweden and there are no legislation in the other Nordic countries concerning either heat pipes nor insulation

foam from C&D waste. The lack of regulation towards treatment of the ODS containing PUR foam from heat pipes and C&D are hindering proper disposal of these fractions. In addition new heat pipes produced outside EU might still contain ODS and therefore prolong the problem if these are imported to the EU, but the directive 2037 forbids this import.

In general, it is the assessment that the areas where the regulation appoints specific actors, e.g. municipalities or the producers of the products, to treat and dispose the products containing ODS, are working efficiently. The areas regulated with the national EPA as the competent body, are without proper mechanisms and tools for control and compliances with the purpose of the legislation, hence it is plausible that ODS containing waste streams are improbably disposed of.

7. Appendix 3: Nordic Regulations

7.1 Denmark

In Denmark products containing ODS are in general regulated by the order 2002/243 – law on use and ban of some ozone depleting substances (Bekendtgørelse om visse ozonlagsnedbrydende stoffer), but the waste problems associated with ODS containing products are not specifically mentioned in this order. However in §8 of 2002/43, it is stated that dismantling of refrigeration systems, products containing solvents, and fire safety systems and fire extinguishers are to be carried out in a safe and controlled manner. Thereby making recycling or safe destruction of the ODS possible (Mst 2002).

Waste problems relating to ODS are mentioned in the overall Danish waste legislation order 48/2010 (Affaldsbekendtgørelsen 2010) where it is stated that waste containing ODS are to be classified and treated as Hazardous Waste.

The municipalities has the right to determine specific handling of waste fractions but a quick screening showed no results in specific handling of waste fractions containing ODS.

More specific legislation is targeting the product groups containing ODS waste. These specific regulations are presented below.

Commercial and household refrigeration systems

According to the Elektronikaffaldsbekendtgørelse (Waste Act for Electronic Products) approved April 2010, management of products containing ODS, whether it is collection, storage, treatment or transport, has to be conducted in a way that leads to the smallest possible leakage of ODS. It is stated that dismantling of products containing ODS must take place at an indoor facility with equipment for collection of ODS.

Refrigeration systems containing ODS in either foam or coolant has to be delivered to companies that are approved under the Miljøbeskyttelseslov § 33 (Environmental Protection Act) or if exported for reprocessing abroad, the facilities receiving the substance must be approved by similar legislation in the importing country (Elektronikaffaldsbekendtgørelse 2010).

From 1996 until 2006 refrigerators etc. were regulated by the statutory act 132. This act stipulates that it is the responsibility of the municipalities to dispose refrigerators from households, whereas businesses are responsible to find proper disposal for the worn-out refrigeration

systems. Since 1992 Kølebranchens Miljøordning (KMO) has been established as a voluntary environmental scheme from the industry of refrigeration system operators. KMO offers authorities consultancy in proper collection and disposal of refrigerants, which cannot be treated satisfactorily within the general waste system. With the implementation of the WEEE directive in 2006, the responsibility for collection and treatment of old refrigerators and freezers were passed to the manufacturers and importers. Households can still deliver old refrigerators through the municipal collection system.

The Waste Act for Electronic Products stipulates that ODS must be extracted and collected using the best available technologies. On average a minimum of 115g ODS from the actual cooling system and 300g ODS from insulation foam, has to be collected and destroyed when disposing household appliances such as refrigerators and freezers. The residual amount of ODS in the insulation foam and compressor oil must be under a maximum of 0.2% by weight. The ODS are to be destroyed in facilities that are approved to do so under the Environmental Protection Act § 33 or similar legislation abroad.

Construction and demolition

For several years it has been on the agenda in the Danish EPA to make legislation/guidance for separate treatment of construction and demolition waste containing ozone depleting substances. This new guidance is to specify when C&D waste can be classified as unpolluted (this will require additional tests and analysis in to the levels of hazardous substances in C&D). It is to be investigated by the EPA how to map the environmental standards of buildings before renovation or demolition.

The C&D guide will provide answers on questions regarding:

- Materials/substances in focus
- Acceptable criteria's for hazardous substances in C&D waste
- Sorting and handling of hazardous substances in C&D waste
- Documentation

Work on this guide has been commenced with start-up meetings between the EPA and Affald Danmark, the tar industry, Dansk Byggeri, KL, Municipality of Copenhagen, RENOSAM and RGS90. The work is expected to be continued in 2011. At the moment, the lack of legislation on the treatment of insulation foam containing ODS (the foam are found in buildings, heat pipes, cars, campervans, etc.), leads to land filling of the foam with the rest of the mixed C&D.

Heat Pipes

Old heat pipes can contain ODS in the insulation foam, but there is no specific Danish regulation, on the treatment of heat pipes.

7.2 Norway

ODS waste in Norway is regulated by two acts, one law on products regulation (Produktforskriften), and two law on waste regulation (avfallsforskriften).

Commercial and household refrigeration systems

The law on product regulations (produktforskriften) regulate products containing ODS in general. It stipulates that it is the responsible operator (maintenance, dismantling, repair, etc.) who is responsible for a appropriate collection, recycling, and disposal of the ozone depleting substances in the refrigerators, air conditioners and heat pumps. The second act, is the Norwegian waste regulation (avfallsforskriften) § 11-4. According to this regulation, ozone depleting substances that are subtracted from products are considered to be hazardous waste. To determine whether the discarded equipment containing ozone depleting substance should be regarded as hazardous waste, the European Waste codes (annex 1) are used. As an example it appears from waste code 16 02 11 that the discarded electrical and electronic equipment containing chlorofluorocarbons, HCFC and HFC are hazardous waste. According to the waste regulation, all companies that are to handle the EE waste have to be approved by the Norwegian Climate and pollution ministry (Klima- og forurensningsdirektoratet (Klif)).

Construction and demolition waste

The Norwegian government has adopted a National action plan for treatment of construction and demolition waste (C&D). As a part of this plan a guide for handling of six hazardous substances in demolition waste has been developed. One of the six substances is ODS = CFC. Demolition materials containing ODS at a certain concentration is considered hazardous waste. Concentration Limits for hazardous / non hazardous waste for ODS is 0.1% of each drug (avfallsforskriften, Annex 3A, R59). This means that waste containing more than 0.1% ODS is hazardous waste. Measurements of the ODS concentration level has to be made on separate waste fractions and not in the mixed waste. If the fraction has a ODS concentration limits over 0.1%, it is to be delivered to approved facilities for hazardous waste. The waste must be declared with both a Waste Material Number ex. 71 57 for “insulation materials with environmentally harmful blowing agents like CFCs and HCFCs” and a EWC code like 17 06 03 “Other insulation materials consisting of or containing dangerous substances.”

Heat Pipes

District heating is not that widely spread in Norway as it is in the other Nordic countries, hence the problem with the old pipes is smaller. There is no specific regulation stipulating a certain treatment of heat pipes in Norway.

7.3 Sweden

In Sweden ozone depleting substances in products are covered by the following national regulations: Avfallsförordningen (2001:1063), Förordningen om miljöfarlig verksamhet och hälsoskydd (1998:899), Förordningen (2007:847) om ämnen som bryter ned ozonskiktet and Halonföreskriften (SNFS 1993:7).

According to Avfallsförordningen all products containing ODS are classified as hazardous waste when they are discarded. The companies responsible for generating hazardous waste are subject to special requirements such as separate sorting and reporting obligations on amounts, type of waste and treatment facility. There are also specific requirements for the transportation of hazardous waste.

Commercial and household refrigeration systems

Ordinance (2005:209) on Producers Responsibility for Electrical and Electronic Equipment, which implements the WEEE Directive, stipulates that ODS waste from electrical and electronic products, such as commercial refrigerators and water heaters etc., can only be land-filled, incinerated or shredded if the waste has been pretreated at a designated recovery facility where ODS and HFCs can be recovered from the Insulation foam and the refrigeration circuits (Ordinance 2005:209).

For maintenance, repair and other measures affecting the refrigerant system, the refrigerants are to be recovered and should be returned to the same refrigeration unit. It is the responsibility of the company who imports or distributes refrigerants to collect, recycle or dispose the coolant (Ordinance 2005:209).

Refrigerants that are not recycled must be disposed of at SAKAB (the Swedish company providing treatment of hazardous waste). For household appliances containing ODS it is the municipality who is responsible for a proper disposal. The public can turn in their waste refrigerators and freezers at the municipal recycling centre and they will send it to the accredited companies for dismantling, recycling and disposal (Statutes 2005:20; Naturvårdsverket 2002).

Construction and demolition waste

Much of the waste containing ozone-depleting substances will occur from the construction and demolition sector as C&D waste. In 2001 the construction sector made a voluntary commitment under the sector environmental program called "Byggsektorns miljöprogram". The program consists of four focus areas, one of which is a proper disposal of waste. The C&D waste is to be sorted in a number of fractions, including hazardous waste. Each fraction will then be analysed to determine composition, classification, amounts and proper handling.

In November 2010 the EPA published a new handbook for recycling of Construction and Demolition Waste. In accordance with the voluntary

agreement with the building sector, the handbook is not specifically targeting ODS in C&D. Although there is no specific demands for the treatment of C&D waste containing ODS, the handbook mentions ODS as one of the things that should be phased out of building materials when future renovation and construction work are being carried out in Sweden.

Heat Pipes

Old heat pipes can contain ODS in the insulation foam, but there is no specific Swedish regulation, on the treatment of heat pipes.

7.4 Finland

There are two general acts for the regulation of ODS in Finland, The waste act 1072/1993 which is the general waste act in Finland, stating that hazardous waste including ODS waste has to be treated to cause as little harm on the environment as possible and the Council of State Decree on Ozone Depleting Substances 262/1998, which contains the national restrictions.

Commercial and household refrigeration systems

In Finland Treatment of wasted refrigeration systems, freezers etc. falls under the Government Decree on Waste Electrical and Electronic Equipment (852/2004). In this Decree it is stated that equipment containing gases that are ozone depleting or have a global warming potential (GWP) above 15 and are used in, for example, insulation foam and refrigeration circuits: these gases must be properly extracted and treated. Ozone-depleting gases must be treated in accordance with Regulation (EC) No 2037/2000 of the European Parliament and of the Council of 29 June 2000 on substances that deplete the ozone layer (Government Decree 852/2004).

Construction and demolition waste

The Government decision on construction waste 295/1997 does not hold any special requirement for the treatment of C&D waste containing ODS such as PUR foam etc. (295/1997).

Heat Pipes

District heating is widely spread in Finland, but there are no regulations which determine demands on the treatment of old pipes.

7.5 Iceland

Legislation regulating products containing ODS in Iceland is the regulation 586/2002 on ozone depleting substances and the act 52/1988 on hazardous substances.

Commercial and household refrigeration systems and C&D waste

The Icelandic regulation is based on the EU regulation 2037/2000 which bans import and placing of products containing ODS on the market in Iceland. Furthermore the regulation stipulates that all these products must be recovered if it is technically and economically feasible.

Heat Pipes

District heating is covering almost all households in Iceland, but there is no legislation targeting the old heat pipes.

References

Identifying and Assessing Policy Options for Promoting the Recovery and Destruction of ODS and F-Gases Banked in Products and Equipment, ICF International (2010).

Sources - Denmark:

Sander Poulsen, Nilsen et Lauridsen (2006), Kortlægning af CFC og HCFC-affald i Danmark, Miljøprojekt nr. 1076, 2006. Miljøstyrelsen.

<http://www.miljoevejledninger.dk/vejledninger/byggeoganlaegsmaterialer/fjernvarmeroer>

Affaldsbekendtgørelsen 2010: <https://www.retsinformation.dk/forms/r0710.aspx?id=129843>

Elektronikaffaldsbekendtgørelse 2010: <https://www.retsinformation.dk/Forms/R0710.aspx?id=130702>

Mst 2002: http://www.mst.dk/NR/ronlyres/E42C2CB3-B781-41F1-9616-A309915E7E8C/0/overblik_over_ozonregler.pdf and <https://www.retsinformation.dk/Forms/R0710.aspx?id=12553>

Kølebranchens Miljøordning - www.kmo.dk

Sources - Norway:

Holmgaard. Norske erfaringer med bygge- og anlægsaffald, præsentation DAKOFA seminar 9/11-2010.

<http://www.mewa-recycling.de/en/footer/lexicon/lexikon/querstromzerspaner-1/75.html>

www.returgass.no

Statens Forurensningstilsyn (2007), Veileder for Kommuner – Avfallsforskriften Kapittel 15 om Byggavfall – 2356/2007.

Produktforskriften: http://lovdata.no/cgiwift/wiftldles?doc=/app/gratis/www/docroot/ltavd1/filer/sf-20040601-022.html&emne=hkfk*#map015

Avfallsforskriften: <http://lovdata.no/for/sf/md/td-20040601-0930-056.html>

Isolations facht sheet: <http://www.klif.no/no/Publikasjoner/Publikasjoner/2010/Mai/Isolasjon-som-farlig-avfall/>

Sources - Sweden:

Norberg. Kartläggning af kvarvarande områden med ozonnedbrytande ämnen och uppföljning. 2002.

<http://www.freonatervinning.se/>

Statutes 2005: 20, Naturvårdsverket 2002: <http://www.naturvardsverket.se/Documents/publikationer/620-5253-5.pdf>

<http://www.regeringen.se/content/1/c6/04/70/12/c88be157.pdf>

[Naturvårdsverket 2010]: <http://www.naturvardsverket.se/sv/Nedre-meny/Webbokhandeln/ISBN/0100/978-91-620-0164-3/>

Sources – Finland:

Rakennustoiminnan CFC-jätteen talteenotto ja käsittely, Ministry of Environment, 1994.
<http://www.energia.fi/en/districtheating/districtheating>
Government Decree on Waste Electrical and Electronic Equipment (852/2004).
<http://www.ymparisto.fi/download.asp?contentid=35670&lan=en>
Waste act 1072/1993: <http://www.ymparisto.fi/download.asp?contentid=35671&lan=en>
Act 295/1997: <http://www.ymparisto.fi/default.asp?node=17870&lan=en#a2>

Sources – Iceland:

www.sorpa.is
www.samorka.is
Regulation No 586/2002 on substances that deplete the ozone layer.
Act no. 52/1988 concerning toxic and hazardous substance.

Interviews and mail communication:

Veli-Pekka Sirola, Adviser, District Heat Distribution – Finnish Energy Industries/
Energiateollisuus ry, nov. 2010
Anne Lise Dyvel, miljømedarbejder, Uniscrap, nov. 2010
Søren Kriegbaum, driftsleder, Uniscrap, nov 2010
Mogens Nielsen, Dansk Fjernvarme, mails nov 2010
Anne Birnbaum, forsyningsdirektør, Kbh Energi, nov. 2010
Troels Duhn, miljømedarbejder, VEKS, okt. 2010
Jan Eriksson, Svensk Fjärrvärme AB, dec. 2010
Lise Bonde, KMA-chef, Tscherning, okt. 2010
Thorvald Isager, H J Hansen, nov. 2010
Rikke Helstrup, HSE-chef, Stena Miljø, nov. 2010
Inger Werther, DAKOFA, nov. 2010
Finn R. Jensen, AV Miljø, nov. 2010
Frank Holmgaard, Rambøll (Norge), nov. 2010
Pétur Kristjánsson, Samorka, dec. 2010
Solveig Crompton, Klima- og forurensningsdirektoratet, dec. 2010
Henri Nieminen, CEO, Finnfoam. apr. 2011
Erik Syrstad Brattli, WEEE Recycling AS, Dec. 2010
Björn Halldórsson, Sorpa, dec. 2010
Jón Steingrímsson, Efnamóttakan, dec. 2010
Olle Jerker Ramnäs, Byggandsteknologi, Chalmers, jan.. 2011
Maria Thors, Reykjavik Energy, jan. 2011
Juudit Ottelin, Researcher, DI, Finnish Environment Institut (SYKE)
Tammilehto Olli, Ymparisto, apr. 2011

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ODS waste treatment in the Nordic Countries

A Nordic Ozone Group Project 2011

Environmentally sound disposal of Ozone Depleting Substances is increasingly recognized as an important issue in terms of both the protection of the ozone layer and the effect on climate change. However, there is only a limited overview in the Nordic countries of product groups containing Ozone Depleting Substances, regulation of the substances, available treatment technologies, and waste infrastructure etc. This report provides an overview of the waste treatment and regulation of Ozone Depleting Substances in the Nordic countries. The report identifies gaps, proposes solutions and provides recommendations for relevant Nordic efforts within the area.

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