UNITED NATIONS
ENVIRONMENT PROGRAMME
Chemicals Branch, DTIE

EXCERPT: Lead in Ammunition from Final review of scientific information on lead 2010

UN Comtrade Statistics

Lead and Ammunition

1. Key scientific findings for lead

1.1. Sources of releases.

Releases to land and aquatic systems.

Some lead-containing products are disposed of in various waste deposits or released to soil or the aquatic environment. The major categories are: waste and loss of ammunition from hunting, disposal of products, mine tailings and smelter slag and waste. Other products and wastes, in no particular order, that may contribute to releases during their life-cycle, include paints with lead, lead balancing weights for vehicles, lead sheathing of cables left in the ground and lead batteries (loss by breakage and recycling), and mine tailings and other wastes. The handling of wastes may lead to elevated local and regional release levels in developing countries.

1.2. Production and uses of lead

Lead is used and traded globally as a metal in various products. The major use of lead in recent years is lead batteries, accounting for 78 per cent of reported global consumption in 2003. Other major application areas are lead compounds (8 per cent of the total), lead sheets (5 per cent), ammunition (2 per cent), alloys (2 per cent), cable sheathing (1.2 per cent), and petrol additives (less than 1 per cent).

The most significant change in the overall use pattern over the period 1970–2003 is that batteries account for an increasing part of the total, whereas the share of cable sheathing and petrol additives has decreased. Lead as pigment in paints has been discontinued in developed countries but is still used in some developing countries, specifically in industrial settings.

2. Anthropogenic sources in a global perspective

2.1 Releases to land (soil and waste deposits)

Accumulation of lead in farmland

The main sources of lead to farmland are atmospheric deposition and the use of lead shot.

Based on an assessment of the loss of lead shot in the environment and the corrosion rate of lead shot in soil, Tukker et al. (2001) estimated that lead shot/ammunition will be responsible for 80 percent of total anthropogenic lead releases to soil in 2030 (EU15 countries). The report estimated that on average, lead releases may result in an annual enrichment of the upper 25 cm of the soil by 0.2-0.5 percent per year (0.048 mg/kg/year), which on average implies a doubling of the lead concentration in European soils in 200 to 500 years. For the estimate, an average natural background concentration of 10-30 mg/kg was assumed. For grasslands, in which the accumulation mainly takes

place in the upper 5 cm, the report concluded that the lead content of the 5 cm top-layer may double in 40 years if a "clean" soil concentration of 10 mg/kg is assumed. However, according to ILZRO, the estimations of Tukker et al. study (2001) would be restricted to hotspots like firing ranges and not to all farmland of the EU states.

2.2. Particulars on lead in ammunition and sinkers

The use of lead shot and other ammunition where lead is used leads to significant releases of lead to terrestric and aquatic environments. Whereas releases to the terrestric environments result mainly in local impacts releases of lead shot in wetlands has a transboundary perspective.

Lead releases to soil

The major source of direct lead releases to soil is the use of ammunition. In 2003, the total global consumption of lead for ammunition was about 120,000 tonnes (in Table 6-5 the figure of 104,000 tonnes represents about 86 percent of the world total). Ammunition is partly used for hunting and lost to the environment, and partly used in shooting ranges, where the lead is either accumulated at the range or collected for recycling.

In a study conducted for the European Commission, Hansen et al. (2004a) estimated that in total, 39,000 tonnes of lead were used for ammunition in the EU15 in 2003. Through hunting activities, about 3,500 tonnes (best estimate) of lead were released to wetlands, and about 14,000 tonnes to other biotopes (grassland, forests, etc.) (best estimate). The remaining part was mainly used in shooting ranges. It should be noted that the breakdown of the total use of lead shot into the different application areas is quite uncertain, and consequently the actual releases to the different environmental compartments is also uncertain. In the EU15, consequently, about half of the used ammunition was released directly to the environment, although the percentage may vary among countries.

366. In Japan in 2004, 1,440 tonnes of lead were used in shooting ranges, whereas only 158 tonnes were used in field hunting (Japan's submission, 2005). Scheuhammer and Norris (1995) estimated that about 2,000 tonnes of lead were discharged with ammunition in Canada in the mid-1990s. Of this, about 780 tonnes were used for waterfowl hunting (wetlands) and about 1,110 tonnes for other hunting activities.

Lead accumulated in shooting ranges may represent a risk of contamination of groundwater and surface water and limit the future use of the area. A comprehensive survey of soil contamination of shooting ranges in Germany from 1998 (Working Group, 1998) demonstrated only a few cases of groundwater contamination in the vicinity of shooting ranges, but concluded that the lead accumulated in the soil in the long term, depending on the conditions at the site, represents a considerable risk for the surroundings. The extent of lead-contamination of shooting ranges was indicated by a calculation showing that 137 ranges in Lower Saxony, Germany, were contaminated with 2,722 tonnes of lead (as of 1990).

Release of lead shot and sinkers in wetlands and aquatic environments

The releases of lead shot and small fishing sinkers to wetlands are of particular concern due to the high risk of poisoning of birds ingesting the lead shot (further discussed in section 5.2.4). Besides the local impact, the lead pollution of wetlands has a transboundary perspective, as wetlands are important habitats for migrating birds. Reduction of the use of lead shot in wetlands is, for this reason, addressed in the Agreement on the Conservation of African-Eurasian Migratory Waterbirds as described in section 9.2.7. According to the Action Plan of the Agreement, Parties shall endeavour to phase out the use of lead shot for hunting in wetlands by the year 2000.

As quoted above, it is estimated with some uncertainty that about 3,500 tonnes of lead, corresponding to approximately 10 percent of the total lead consumption for ammunition, were released to wetlands in the EU in 2003 (Hansen et al., 2004a). Scheuhammer and Norris (1995) estimated that about 780 tonnes were used for waterfowl hunting in Canada in the mid-1990s.

Small sinkers for angling may also be ingested by birds, which is the rationale behind the prohibition in the United Kingdom of the use of lead split shot and sinkers above 0.06 grams and below 28.35 grams (1 ounce) in freshwater (see section 9.1) (Hansen et al., 2004a).

Besides the poisoning of birds, the loss of lead sinkers in inland waters is of concern in some countries. The fate of lead shot and sinkers in the aquatic environments is highly dependent on the chemistry of the water and mechanical disturbances. Highest corrosion rates are expected in rivers with acidic water and high velocity, whereas low rates are expected in sedimentation areas in the marine environment.

Relatively high corrosion rates of about 1 percent per year have, e.g., been demonstrated in

lead sinkers in Swedish rivers (pH 6.3-6.7) with a high velocity (Jacks and Bystöm; 1995). For this reason, the use of lead sinkers has been abandoned in many Swedish rivers (Hansen et al., 2004a)

3 Production, use and trade patterns

3.1. End Uses

Ammunition

Lead is used in different types of ammunition. The major application is lead shot for shotguns. Of the 52,700 tonnes of lead used in ammunition in the EU15 in 1993, 90 percent was used for lead shot, the remaining 10 percent used for bullets for rifles and pistols (Hansen et al., 2004a). Of particular concern are the significant releases of lead shot to wetlands and other biotopes through hunting, as discussed in section 5.2.4.

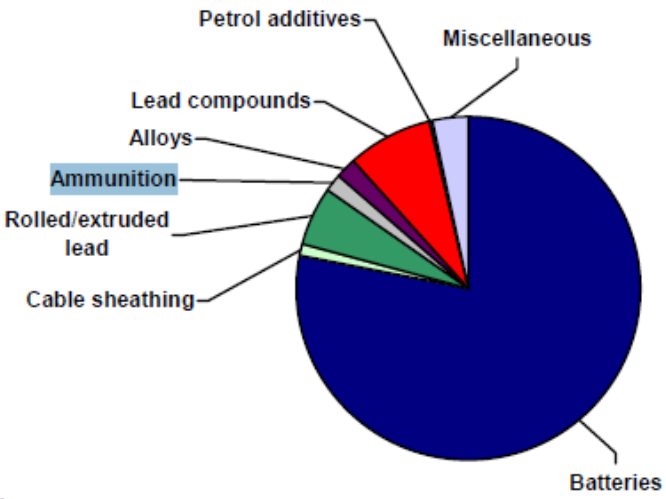
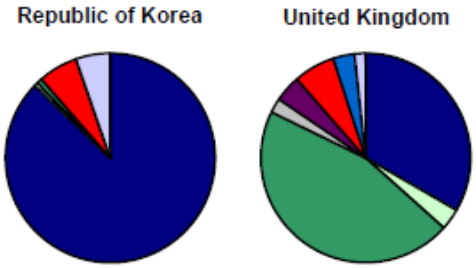


Figure 6

Intentional lead consumption by end-uses in 2003 as reported by member countries of the International Lead and Zinc Study group (ILZSG) representing about 86 percent of the total global consumption of lead. (ILZSG, 2006)



Two country examples of distribution of lead for "first uses" i.e. use of lead for manufacturing processes, by application area. (ILZSG, 2005)

Table 6-5 Lead consumption by end-use in OECD countries in 1970 and 1990, and globally in 2003

Category	Lead consumption in OECD countries				Lead consumption, ILZSG reporting countries	
	1970 [1]		1990 [1]		2003 [2]	
	1,000 tonnes lead	Percentage	1,000 tonnes lead	Percentage	1,000 tonnes lead	Percentage
Batteries	1,190	39	2,120	63	4,590	78
Cable sheathing	370	12	170	5	71	1.2
Rolled/extruded lead (mainly sheets)	370	12	300	9	319	5
Ammunition	120	4	100	3	104	2
Alloys	210	7	130	4	115	2
Lead compounds	340	11	340	10	481	8
Petrol additives	310	10	70	2	14	0.2
Miscellaneous	150	5	130	4	192 [3]	4
Total	**3,050**	**100**	**3,365**	**100**	**5,889**	**100**
Total World	**4,502**		**5,627**		**6,852** [4]	

1) Source: (OECD, 1993). Volumes are recalculated from data on percentages and total consumption.

2) Source: (ILZSG, 2005). Countries included: Australia, Austria, Belgium, Brazil, Canada, China, Czech Republic, Finland, France, Germany, India, Italy, Japan, Republic of Korea, Mexico, Netherlands, New Zealand, Scandinavia, South Africa, South East Asia, Spain, Switzerland, United Kingdom, United States of America. This represents about 86 percent of total global consumption.

3) The category "Semi-manufacturers" reported for China and Czech Republic is included in "rolled/extruded lead".

4) Source: (ILZSG, 2006).

Lead consumption by first-use in 6 countries is presented in Table 6.6 "First use" means, in practice, the use of refined (as opposed to recycled) lead for manufacturing of lead products. Thus, the differences among countries to some extent reflect the industry structure of the country as it pertains to the manufacture of lead-containing products. In the Republic of Korea, batteries account for 87 percent of lead consumption, reflecting the significant car industry in the country. A majority of the lead will be exported with the finished products. Similarly, the large consumption of lead for ammunition in Italy (6.4 percent) reflects the fact that Italy is the major producer of ammunition in Europe with a significant export (Hansen et al., 2004a). In the United Kingdom, rolled/extruded lead accounts for 46 percent of consumption. This may partly reflect some regional differences in the use of lead for building purposes. Due to tradition and the style of buildings, the consumption of lead sheets for building purposes, notably lead roof flashing, is significantly higher in northern European countries than in southern European countries (Tukker et al., 2001).

Table 6-6 Lead consumption by first-use in 2003 [1)]

Application area	Percentages of total lead consumption (first use) in 2003					
	Rep. of Korea	China	Italy	United Kingdom	India	Mexico
Batteries	87.2	79.5	81.1	33.3	77.0	85.6
Cable sheeting	0.7	1.9	0.6	3.3	4.2	0.2
Rolled/extruded lead (mainly sheets)	0.8	1.9	0.0	45.6	0.0	0.0
Ammunition	0.0	0.0	6.4	2.3	0.0	0.0
Alloys	0.1	0.0	0.3	4.1	6.1	1.2
Lead compounds	6.1	10.0	7.5	6.4	10.7	6.0
Petrol additives	0.0	0.0	0.0	3.3	0.0	2.4
Miscellaneous	5.2	6.8	4.2	1.8	2.0	4.6
Total	**100**	**100**	**100**	**100**	**100**	**100**
Total (1000 tonnes Pb/year)	**349**	**1,183**	**236**	**247**	**142**	**259**

1) Source: (ILZSG, 2005). Shows the percentages of lead for "First-use", i.e. mainly consumption of lead for manufacturing of lead-containing products in the country.

Table 8-1 Options for substitution of lead with initial indication of level of expenses relative to lead-technology

Application	Alternatives	Price relative to lead technology [1)]	Extension of alternatives
Ammunition	Steel, soft iron, wolfram, bismuth and tin may be used as alternatives to lead shot. Wolfram is used as powder in a polymer matrix. No research seems to have been carried out regarding alternatives for other applications like bullets for rifles and pistols. In principle, all non-toxic metals with a density close to or above lead could be appropriate.	"+/++" – Costs differs with substitute: Steel Shot: + 20% Tin shot: + 50-150% Bismuth shot: + 200-400% (Hansen *et al.*, 2004a).	Lead shot for use in wetlands are prohibited in a number of European countries. The market is dominated by steel shot. In forests supplying wood for veneer production only wolfram and bismuth shot are typically allowed, as steel shots in wood damage wood saws (Hansen *et al.*, 2004a).

4 Initiatives for preventing or controlling releases and limiting exposures

4.1 National initiatives

Environmental source controls/regulations that control lead releases into the environment

Ammunition

Lead shot for hunting in wetlands has been banned in several countries due to the consequences to birds, and in particular water fowl, that may ingest the lead shot. Some countries have established a more general restriction on the use of lead shot in forests and other terrestrial environments, while Denmark and Sweden have also restricted lead shot for clay target shooting. In Sweden, furthermore, a use restriction on the use of lead for rifle ammunition will come into force on 1 January 2008. This regulation concerns rifle cartridges for both hunting and shooting, but lead containing bullets may be used on shooting ranges if the used bullets are managed properly from an environmental and health perspective (Hansen et al., 2004a).

COUNTRY	SUB-MISSION	STANDARDS FOR ENVIRONMENTAL MEDIA MAXIMUM ACCEPTABLE LEAD CONCENTRATION FOR DIFFERENT MEDIA	ACTIONS AND REGULATIONS THAT CONTROL RELEASES FROM ENVIRONMENTAL SOURCES THAT CONTAIN LEAD	ACTIONS AND REGULATIONS ON PRODUCTS THAT CONTAIN LEAD	OTHER STANDARDS, ACTIONS AND PROGRAMMES RELEVANT TO LEAD
Norway	Yes	**Environmental quality standards, specifying a maximum acceptable lead concentration for different media, such as:** a) Drinking water; 10 µg/l b) Surface water: Existing guidelines for classification of water quality are under revision and will be harmonised with EQSs to be decided under the EU Water framework directive (2000/60(EEC). c) Ground water;. - d) Irrigation water: - e) Air (urban air, background, etc); Target limit value 0,5 µg/m^3 as yearly average f) Soil: Most sensitive land use: 60 mg/kg g) Food standards, specifying a maximum acceptable lead concentration for different food categories, such as fish and seafood, milk, meat; cereals, etc Established maximum level of lead in foodstuffs: Fish: 0.2 – 0.4 mg/kg wet weight depending on species Seafood: 0.5 – 1.0 mg/ kg wet weight depending on species Cows milk: 0,02 mg/ kg wet weight Meat: 0,1 mg/ kg wet weight Cereals: 0,2 mg/ kg wet weight Vegetables: 0,1 mg/ kg wet weight Leafy vegetables and cultivated fungi: 0,3 mg/ kg wet weigt Fruit: 0,1 mg/ kg wet weight Berries: 0,2 mg/ kg wet weight Fats and oils: 0,1 mg/ kg wet weight Fruit juices 0,05 mg/ kg wet weight Wines: 0,2 mg/ kg wet weight	**Environmental source actions and regulations that control lead releases into the environment:** a) Air and water point sources, such as: • *Smelters*; Each smelter has/ will have got an emission permit in accordance with BAT, which i.a. includes particle emission limit values, thus indirectly regulating the emissions of Cd and Pb. • *Energy production*; No coal combustion power plants are operating in Norway. The gas/oil/biomass power plants (> 50 MW) are regulated in accordance with the EU Directive 2001/80/EC and BAT. Medium sized biomass combustion plants has got emission permits which i.a. include particle emission limit values, thus indirectly regulating the emissions of Cd and Pb. Coal is not used for residential combustion, and only certificated wood stoves (stoves with good combustion efficiency) are allowed on the Norwegian market. • *Metal ore mining*; In general all mines have got emission permits. In Norway no metal ore mining is in operation to day. • *Iron and steel manufacturing processes*; The plants are given emission permits, including limit values for particle emission to air, thus indirectly regulating the emissions of Cd and Pb. The permits are/ will be updated in accordance with the EU IPPC Directive (EU Directive 96/61/EC) and BAT. • *Cement, lime, plaster and concrete manufacturing processes*. Each plant has got an emission permit in accordance with BAT (i.a. EU BREF), which i.a. includes particle emission limit values, thus indirectly regulating the emissions of Cd and Pb. The cement and LECA (clay based Light Weight Aggregate) plants in Norway use waste as additional fuel, therefore their emission limit values are the same as for waste incinerators, i.e. the emission limit values given in accordance with EU Directive 2000/76/EC on incineration of waste. b) Waste disposal restrictions, such as: • *Waste from outdated products*; Outdated products containing lead/lead compounds has to be treated as hazardous waste if the concentration exceeds limits given in the regulation on hazardous waste. An extensive system for taking care of waste from EE-products containing hazardous substances is established, putting obligations on dealers, producers and the local government. An extensive system for collection, recovery and disposal of used batteries (batteries hazardous to the environment) is established, putting obligations on dealers, enterprises using batteries, importers and producers. Components in vehicles containing heavy metals shall be labelled and removed from the vehicle when it is scrapped. • *Specific waste from different industrial activities.*; Industrial waste disposal is regulated in the emission permits. Hazardous industrial waste must be delivered to certificated hazardous waste receivers, non hazardous can be deposited in industry deposits which fulfil the requirements in the EU Directiv 1999/31/EC and 2003/33/EC. Some industries are permitted to reuse waste fractions in the process. • Treated wastewater : - • *Sewage sludge*: Maximum limit for lead concentration in fertiliser products based on sewage sludge is 40 - 200 mg/kg dry weight depending on use.	**Product control actions and regulations for lead-containing products, including marketing and use:** a) *General use of lead*: Lead is on the Norwegian list of prioritised chemicals, for which emissions shall be substantially reduced by 2010. The ultimate aim is to reduce the level of lead in the environment as close to background level as possible by 2020. b) *Specific products containing lead, such as*: • Cable sheathing; • Sheets for corrosion protection in chemical industry; • Plating of gasoline tanks; • Yacht keels; • Lead tubes and joints for drain and water pipes; • Radiation shielding; • PVC stabiliser; Lead and lead compounds are not used as stabiliser or pigment in PVC. • Pigments; It is not allowed to produce, import, export, sell or use paint containing lead carbonates or lead sulphates. • Glass of cathode ray tubes; • Other products: *Lead shots*: It is not allowed to produce, import, export, sell or use lead shots. *Petrol*: The content of lead in petrol must not exceed 0.005 g/l. *Batteries*: Batteries containing > 0. 4 % lead must be labelled. *Packaging*: Legislation prescribing maximum allowable content of heavy metals in packaging is established. The accumulated concentration of lead, cadmium, mercury and chromium (VI) must not exceed 100 mg/kg. *Components in vehicles*: From 1. July 2003 it has been prohibited to import vehicles with components containing Hg, Pb, Cd or Cr VI. Components exempted from the ban are listed in an Annex to the regulation. Components allowed to contain heavy metals shall be labelled and they shall be removed from the vehicle when it is scrapped. *EE-products*: From 1. July 2006 it will be prohibited to produce, import, export and sell EE-products containing more than 0,01 % Cd, 0,1 % Pb or 0,1 % Hg (or o,1 % Cr VI, 0,1 % PBB or 0,1 % PBDE). Certain areas of use given in an annex to the regulation are exempted from the ban. The producer is responsible for providing information on which component in the product that contains hazardous substance(s). c) *Import/export*: When bans on use of chemicals are introduced normally also bans on import and export are included in Norwegian regulations.	**Other actions, standards and programs relevant to lead:** a) *Regulations on occupational exposures to lead in the workplace*. Legislation on occupational safety and health to avoid unacceptable occupational exposures to hazardous substances in the workplace is established. The employer has the obligation to survey the occurrence of chemicals in the work place, to evaluate the risk they pose to the employees and to take the actions necessary to reduce the risk to an acceptable level. OELs (occupational exposure limit values) are established for several lead compounds. Lead and inorganic lead compounds, lead phosphate, lead sub phosphate and lead acetate have OEL = 0, 05 mg/m^3 in indoor air, calculated as lead. Lead chromate has an OEL of 0, 02 mg/m^3 calculated as chromate. b) *Classification, other marketing and use regulation, packaging and labelling regulations*; The classification, packaging and labelling regulations in Norway are the same as in the EU. Marketing and use regulations are described under point C above. c) *Information and reporting requirements*; Industry is obliged in their permits to annually report their emissions and discharges to the Norwegian Pollution Control authority (registered in the Norwegian PRTR). Every year a national report on consumption and releases of substances prioritised for action according to the national strategy for work with hazardous substances is worked out. Hazardous chemicals marketed in a quantity of 100 kg or more per year must be declared to the Norwegian Product Register. National lead emissions to air and monitoring data are reported to EMEP (The Cooperative Programme for Monitoring and Evaluation of the Long –range Transmission of Air Pollutants in Europe) every year. National emission data on lead and data from the different monitoring programmes under the OSPAR convention are reported to the convention. d) *Monitoring programmes*; Lead is monitored weekly in air and precipitation at a couple of stations at the mainland and Svalbard (air only). Through monitoring programmes in OSPAR lead is measured yearly in different marine species along the coast, every 10 year in sediments (OSPAR/JAMP), and monthly in the water column in 10 Norwegian rivers (OSPAR/RID). Every 5 year heavy metals in mosses are monitored. On a less regular basis the concentration of heavy metals in lakes and lake sediments is monitored. e) *Voluntary reduction programmes*; A requirement to apply the substitution principle is included in the chemicals legislation implying that enterprises must evaluate their use of chemicals and replace them with less hazardous substances, if available, provided that this does not cause unreasonable cost or inconvenience. Recommended criteria for undesired properties of chemicals are established by the authorities and a list of chemicals meeting the criteria is drawn up. Use of these chemicals should be reduced or substituted by less hazardous chemicals. Lead and its compounds are included in the list. On a voluntary basis work to reduce military use of lead containing ammunition in military shooting fields is going on in Norway. According to the plans purchase of lead containing ammunition shall stop after 2006. f) *Implementation of international conventions and programs*; Norway has ratified the Aarhus Protocol on Heavy Metals under the UN ECE LRTAP convention, the OSPAR convention, the Basel convention, the Rotterdam convention and the Stockholm convention and implemented their obligations.

UN Comtrade Statistics

HS1996 - 93 → ***Arms and ammunition, parts and accessories thereof***

930621 → ***Cartridges, shotgun***

930690 → ***Munitions of war, ammunition/projectiles and parts***

Years: 2013, 2014, 2015, 2016

- *CODE: 93 - Arms and ammunition, parts and accessories thereof*

Top Importers

Reporter Title	Trade Value
USA	$13,527,422,888
Canada	$1,839,104,202
Australia	$1,236,035,438
Norway	$961,376,578
Rep. of Korea	$891,883,335
Other reporters	$11,752,390,489
Total Import: $30,208,212,930	

Top Exporters

Reporter Title	Trade Value
USA	$19,657,159,696
Italy	$2,082,406,855
Russian Federation	$1,921,213,252
Germany	$1,727,691,999
Czechia	$1,437,205,167
Other reporters	$13,882,741,938
Total Export: $40,708,418,907	

- *CODE: 930621 - Cartridges, shotgun*

Top Importers

Reporter Title	Trade Value
USA	$245,661,273
Canada	$74,571,520
Rep. of Korea	$51,363,935
Turkey	$47,832,947
United Kingdom	$44,859,023
Other reporters	$574,251,291
Total Import: $1,038,539,989	

Top Exporters

Reporter Title	Trade Value
Brazil	$598,713,471
Italy	$282,277,539
Spain	$198,885,250
USA	$122,540,011
United Kingdom	$75,596,678
Other reporters	$300,409,634
Total Export: $1,578,422,583	

Recent Import Years in the selection

Period	Trade Value
2016	$117,480,155
2015	$273,036,379
2014	$358,772,911
2013	$289,250,544

- *CODE: 930690 - Munitions of war, ammunition/projectiles and parts*

Top Importers

Reporter Title	Trade Value
USA	$1,911,042,679
Australia	$627,393,081
Norway	$357,284,652
Rep. of Korea	$352,572,177
Japan	$248,873,181
Other reporters	$1,952,100,325
Total Import: $5,449,266,095	

Top Exporters

Reporter Title	Trade Value
USA	$13,335,824,125
Russian Federation	$1,520,240,217
Norway	$548,222,947
Canada	$399,584,447
Japan	$313,380,132
Other reporters	$1,529,274,596
Total Export: $17,646,526,464	

Recent Exports Years in the selection

Period	Trade Value
2016	$4,384,182,832
2015	$5,492,937,238
2014	$3,758,298,654
2013	$4,011,107,740