Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
1. Food and carbon								
1.1 Field and crop data - IACS register	Common agricultural policy of European Union has been applied in Finland since 1995. Approximately 90 % of farmers have committed to the system and it covers more than 90 % of field area. The field register (part of IACS) of Finnish Food Authority has approximately 200 different plant or land use codes for different types of field use. Though the data is collected for administration and control purposes, it can be used also to calculate biomass potentials, monitor land use, estimate nutrient demand in different areas etc.	Finnish Food Authority collects register of cultivation plans made by Finnish farmers. The original data owner is therefore the farmer. The integrated administration and control system, IACS is a register for management for payments to farmers. The farmer reports every spring the cultivation plans for the coming growing season.	The time span for field parcel data is from 1995 to the current year. There might appear new plant codes when terms for common agricultural policy (CAP) change. Also, some old codes might go out of use. Usually, the continuity of the codes is good, and it is possible to form continuous time series.	Public and free. Fee for research purposes.	The data is collected from the farmers who have committed to implement common agricultural policy and get payments based on cultivation areas. In Finland, appr. 44 300 farmers are participating in the Vipu service.and only 2500 farmers send the information in paper format. Other EU member countries have the same system of subsidiaries and database for the integrated administration. In Finland, data is collected every spring by Vipu electronic services for farmer. The data is assigned from the database of the Food Authority in text format, eg. *-dat format and sent by e-mail or secure link for download.	The database is expected to be maintained in the future, as common agricultural policy as well as subsidies for food production will continue. Changes in attributes are expected along with policy changes.	The IACS database is originally designed to collect data for administration and control of subsidies for food production. The use for circular economy applications is therefore restricted. There needs to be more exact data on species and cultivar level. As the primary purpose of data collection is the administration of common agricultural policy (CAP), the data attributes might change between CAP seasons. New plant codes and especially land use codes appear and some old codes cease. Cropping plans made by farmers change depending on market prices and springtime weather conditions. Therefore, the actual situation in farming can be seen from the IACS register. For trends or long-term situation, it is recommendable to see the data over multiple years.	Finnish Food Authority (Ruokavirasto). Natural Resources Institute Finland (Luke). Centres for economic development, Transport and the Environment (ELY-Centres). European Union.
1.1 Field and crop data - crop production statistics	Crop production statistics contain harvest data on Finland's most important field crops, including cereals (wheat, rye, barley and oats), turnip rape, potato, sugar beet and herbage crops. Detailed description of the statistics can be found at https://stat.luke.fi/en/tilasto/175/kuvaus/1128.	The Natural Resources Institute Finland produces and processes Finland's statistics on food and natural resources. Producing statistics about agricultural production is one of its basic tasks as statistical author. Statistic data can be found at Natural Resources Institute Finland website https://stat.luke.fi/en. Agricultural statistics are produced to follow and understand agriculture and its development and trends. It is needed for decision making e.g., for food security, regional development, and environment protection.	Data is available for the whole Finland and by Centres for economic development, Transport and the Environment (ELY-Centres). Data is available from the 1920s onwards. The statistics contain harvest data on Finland's most important field crops. The cereals included are spring and winter wheat, rye, malting barley, feed barley, oats, mixed grain and other grains. Other plant groups are turnip rape, oilseed rape, caraway, peas, table potatoes, early potatoes, processed food potatoes, starch potatoes, other potatoes and sugar beet. The herbage crops included are timothy seeds, hay, fresh grass, silage (fresh and dried) and reed canary grass. The statistics also contain harvest data for green chop, wholegrain silage and fresh silage. Data on the field crop harvest is presented in both kilos per hectare (10,000 m2) and as total yield in millions of kilos. The dry matter content of harvested herbage is also given. The statistics are updated annually.	Crop statistics are public, open and free to use. Reference to mention is OSF: Natural Resources Institute Finland, Crop production statistics.	The main source for field area data is gathered from farmers during their dealings with Finland's agricultural industry administration. The per-hectare harvest data is based on information collected from farmers by statistical data inquiry. Statistic databases are available at https://stat.luke.fi/en/crop-production-statistics with different options to explore, edit and save the data as tables, figures, files, links, and html embeddings. Data can be downloaded as files or read it through PX-Web API (application programming interface) in formats of xlsx, csv, json, json stat, sdmx and px. There is also web portal for statistical information. The figures in statistics websites are an example of PX-Web API implementation. Data behind figures are loaded every time the web page is opened or updated, and when the database is updated, the figure will be updated automatically.	Due to the long history and well-established regime of the statistics, continuity of the data is expected to be good also in future. Reported crops can change depending extent of cultivation. For example, triticale yield was asked this year and oil hemp will be asked next year for the first time. Legislation changes for Eurostat reports (SAIO regulation) will cause some changes to statistics content. Silages will be calculated as dry matter and sugar beet yield probably reported also as sugar produced. Larger part of the field will be in non-marketable products. There will be more statistics on various environmental subsidies, carbon sequestration, etc. in addition to traditional statistics on primary production. The use of satellite data in arable crop statistics is changing data collection.	Objective and need for the crop data collection has been developed long before there was any idea of circular economy. Circularity has been built into old-fashioned agriculture though it was not named so or measured and need for monitoring has decreased as volumes have grown. Though measuring production more than circularity, statistical data is well structured and suites for many purposes. Crop data can be used for circular economy planning, for example plant and crop data is needed for planning more effective use of nutrients in agriculture. When making decisions, if one should use the data of a certain year or long time averages it is good to keep in mind that there is fluctuation between years. Weather conditions during growing season and harvest time effect on crop quality and decisions if a cereal crop will be harvested for feed, flour or malt, or silage sward harvested for silage, hay or green fodder. In circular economy lots of emphasis is put on better utilisation of side streams. There is no statistical data of sidestreams in agriculture. But it can be estimated with statistical data and literature values, which is done in Biomass Atlas.	Finnish Food Authority (Ruokavirasto). Natural Resources Institute Finland (Luke). Centres for economic development, Transport and the Environment (ELY-Centres). European Union.

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
1.1 Field and crop data - field, crop and side stream data in Biomass Atlas	Biomass Atlas (1.15) combines the field data from IACS register and Luke crop production statistics, showing data of field land use, crop potential and crop side streams. Crop data from IACS register have been sorted and reclassified for Biomass Atlas according to land use, crop yield and side stream type.	Biomass Atlas is a service that gathers spatial data on biomasses formed in forestry, agriculture, food industry and municipalities. Constituting of approximately 300 data layers and covering all Finland, Biomass Atlas is a significant data source of land use, production, side streams and wastes. It is widely used for strategic regional planning since 2017 with ca. 1500 users per year. Biomass Atlas web map application consist of database and a user interface. UI offers a tool to explore different types of biomasses visually by thematic maps, make spatial analysis and summarize mass amounts by selected regions on a map and export the results for later use. Data layers are also available via web map service (WMS) and web feature service (WFS) interfaces and can be downloaded as files. Data is spatially harmonised to 1 km grid which enables fast functionality in web service. All the data, features and functionalities of Biomass Atlas will be described in article of Lehtonen et al. (in preparation). Besides of map user interface, Biomass atlas web page describes main biomass types, where they are formed, how they are typically used and what kind of possibilities there are for other uses.	Data is available for the whole Finland. Crop data in Biomass Atlas describes the situation of a year. For field use there are 49 data and map layers: Utilized agricultural area, winter wheat, spring wheat, spring rye, rye, triticale, malting barley, other barley, oats, mixed cereals, whole crop cereals, peas, mixed crops, broad beans, potatoes, sugar beets, turnip rape, rape, special crops, fiber and energy plants, outdoor vegetables and roots, garden pea, heading cabbages, other cabbages, carrot, beetroots (red and yellow), other beetroots, gherkin, onion, lettuce, berry bushes, fruit trees and strawberry, fruits, currants and gooseberries, raspberry, flowers and ornamental plants, nursery production, caraway, green manure sward, cultivated pasture, silage sward, hey, fresh silage sward, natural pasture, herbage seed production, set aside and uncultivated field, green fallow and nature management fields, buffer zones and buffer strips. Unit is hectare [ha]. Data for field use in Biomass Atlas comes originally from IACS register and original plant codes are reclassified, and field areas are joined to 1 km x 1 km grid. For crop production potential the map and data layers are winter wheat, spring wheat, spring rye, rye, malting barley, other barley, oats, mixed cereals, whole crop cereals, peas, broad beans, potatoes, sugar beets, turnip rape, rape, oil linen, reed canary grass, caraway, pasture yield, silage sward, hay, fresh silage sward, herbage seed, garden pea, heading cabbages, other cabbages, carrot, beetroots (red and yellow, other beetroots, onion, gherkin, lettuce, fruits, currants and gooseberries, raspberry, strawberry. Unit is tons of dry mass per year [t(TS)/a]. Data for crop production potential originates from IACS register land use and Crop statistics of Luke. For each plant, the yield in each ELY-centre is joined to field area of the same plant and of the same ELY-centre to estimate crop production potential in each grid cell, based on crop area in that certain grid and crop yield in the ELY-centre where the field is located. For those plants which are found in Crop Statistics, the calculation is straight forward. For silages, hays and grass form nature management fields different types of estimates are used. For crop production sidestreams the map and data layers are cereal straw, stems from peas and broadbean, potato tops, sugarbeet tops, potential additional harvest of greenmanuring sward, straw of herbage seed crops, potential biomass of green fallow, biomass of bufferzone vegetation, stems of oil crops. Unit is tons per year [t/a]. Sidestream calculations are based on crop production potential and plant specific harvest indices. Amounts of biomass and sidestreams and areas of fields are calculated for 1km x 1km grid. It is possible to make map queries and get biomass summaries for selected areas Select options include freely selected areas, central point with chosen radius by a circle radius or along a road network, or preselected areas. Pre-selected areas include Centres for Economic development, Transport and the Environment (ELY-Centres), municipalities, provinces, postal code areas and drainage basins. Biomass Atlas was published 2017 with data from previous year and updates are done annually or when necessary. The data descriptions l. metadata of main biomass types is available at National geoportal Paikkatietohakemisto (National Land Survey Finland, 2021).	Data can be explored in Biomass Atlas webservice (Natural Resources Institute Finland (Luke), 2021), which is open and free to use. There are WMS and WFS interfaces to get the data. Registered users can also download it. The data is licenced by CC4 by name.	Register data for fields (IACS) comes to Biomass Atlas from Finnish Food Authority by text files, and crop statistics are requested from API of Luke Statistics by JSON query. The data from two different sources are then combined by plant code and imported to Biomass Atlas by batch processing. SQL syntaxes are used for different groups of field use and crops. Biomass Atlas database uses Postgre SQL database system with PostGis extension. WMS and WFS services are used to share the data in map format. Biomass atlas system utilizes Oskari, which is a framework for building web mapping applications utilizing distributed spatial data infrastructures like INSPIRE. It is based on open-source components such as Open Layers, Geo Tools and GeoServer. Oskari supports the EU directive INSPIRE and OGC standards.	In the future, one of the ways to improve the data basis might be the more holistic use of the information collected daily in markets. Also the estimates of food waste of consumers need to be improved.	Biomass Atlas has improved the availability of spatially explicit data of field use and biomass potential in Finland and it seems to be quite unique also compared to data availability in other countries. The lack of a regular maintenance and updating protocols and their resources makes the system vulnerable.	Natural Resources Institute Finland Luke. Finnish Environment Institute SYKE. Finnish Food Authority Ruokavirasto.
1.2 Crop based products	Statistics on cereals purchased, used and stockpiled by industry and trade published by Luke are quarterly statistics on the volumes of cereals, turnip rape and oilseed rape purchased directly from farmers and the volumes used by the cereal industry. Biannual statistics on the stocks of cereals, turnip rape and oilseed rape held by enterprises that buy and use cereals. The statistics contain data on the volumes of cereals purchased from farms. Finnish Food Production Chain association publishes Forkful of Facts (Finfood, 2021), a yearly compilation of food statistics covering the entire food production chain, including food manufacturers by sector as well as import and export of foodstuffs. The Finnish Cereal Committee (VYR) is a co-operation platform of the Finnish cereal and oilseed sector. They produce information on grain production and processing in Finland, e.g. a map of processing places. Data is in form of reports and pictures.	-	-	-	-	-	-	-

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
1.3 Fertilizers	Finnish Food Authority upholds register for activities involved with fertilizer manufacture for sale or release, use of animal by-products (excluding manure), supplying for markets, and imports from inside or outside EU.	*There is no information on the data collection systems of the entrepreneurs producing, marketing and/or importing fertilizer products.*	Finnish Food Authority upholds register for activities involved with fertilizer manufacture for sale or release, use of animal by-products (excluding manure), supplying for markets, and imports from inside or outside EU. Using industrial by-products or other similar waste streams in fertilizer products are also considered as manufacturing and are monitored. Operators who only store, transport or resell fertilizer products are not required to register. An exception to this is the storage of fertilizers of animal origin, which requires approval. The entrepreneur must supply Finnish Food Authority with the details of the purchases and origin of fertilizer products and their raw materials for traceability. The quantities of products manufactured, the deliveries of products and storage locations must be recorded. In addition, a record must be kept of the import and export volumes. The annual report is submitted to Finnish Food Authority by all registered entrepreneurs in January of the following year. Finnish Food Authority is also responsible for paying and implementing subsidies to farmers funded by the European Agricultural Guarantee Fund, the European Agricultural Fund for Rural Development and national funds. The applying process for farmers is organized in an online service called VIPU. Subsidies are mainly based on the number of farm animals and arable land area. As part of the subsidy system, the majority of Finnish farmers have committed to a voluntary agri-environmental support scheme regulated by the Ministry of Agriculture and Forestry Decree on Environment Payments (327/2015), which requires very strict and field specific bookkeeping of all cultivation measures (e.g. date of cultivation, sowing and fertilizing, cultivation method, crop species, amount and types of fertilizers used, liming, yield information). However, this large database remains hidden even from research as the VIPU online system is open only for farmers, local advisory services, and municipal rural business authorities. Documents outside the online system concerning actual cultivation measures are kept in each farm for occasional monitoring purposes.	Finnish Food Authority publishes the national register of operators in fertilizer sector annually. The public list comprises the name, address, and industry (manufacturing, import etc.) of the company, and, in the case of requiring approval, the approval number. Specific information on the fertilizer products and nutrient flows is not publicly available. Statistics of mineral fertilizers sold in Finland are annually published by Natural Resources Institute Finland (Luke) based on the information collected from Kemira Agro Ltd/Yara Finland Ltd, and fertilizer importing enterprises by Finnish Food Authority. The data is published as kilograms of nutrient (nitrogen, phosphorus, potassium) per hectare of cultivated agricultural land (excl. fallow). Luke upholds the statistics of cultivated agricultural area (ha). No similar dataset for other types of fertilizer products, such as organic fertilizer products, ashes, and soil conditioners are available for open access. Finnish Food Authority collects in the annual reports, but it is not publicly available. It is used e.g. in the calculation of nutrient balances (nitrogen, phosphorus) indicating agricultural nutrient use efficiency. National nutrient balances are calculated annually in accordance with the calculation methods of Eurostat resulting in nutrient balances for phosphorus and nitrogen (kg/ha; since 1995). Also, the use of mineral fertilizers is included in the nutrient balances. However, the datasets behind the resulting nutrient balances are not publicly available. Fertilizer use data collected directly from farmers as part of the voluntary agri-environmental support scheme is used only for advisory and monitoring purposes and it is not available for other use.	Excel-based annual reports of fertilizer products are annually sent to Finnish Food Authority who makes the necessary compilations and forwards the data to permitted uses. There is no information on the data collection systems of the entrepreneurs producing, marketing and/or importing fertilizer products. Significant variation in data collection systems and the precision of the data is to be expected.	The legislation on fertilization will be updated in Finland starting in 2021. The goal is to have the legislation ready by 2023 when the new CAP is implemented. The fertilizing limits are planned to be removed from the voluntary agri-environmental scheme and henceforth regulated by legislation.	The datasets on fertilizer products are scattered between the data collected and maintained by the entrepreneurs, the authorities monitoring their production, marketing and import, and the official statistics. From the viewpoint of circular economy, a large part of the data is hidden into either the archives of the enterprises or into those of Finnish Food Authority. A significant part of the data – fertilizer products actually used in farms – is not even available to research though farmers are obliged to record strict and field-specific measures as part of EU agricultural subsidies.	Finnish Food Authority.
1.4 Feed	Approximately half of produced grain yield (4 million tons of cereals and oil seeds) in Finland is used as animal feed. Most, appr 85 % feed used for cattle, pigs and poultry is originated from Finland. Moreover, soy and other protein rich plants are used for feed. Big part of the feed used is direct use at farms and data of the feed used remains at farms. Definitions related to feed can be found in the feed labeling guide of Finnish Food Authority.	Finnish Food Authority statistics and original declaration forms made by feed manufacturers. Manufactured feed and raw materials used for feed are reported by places of manufacture. Imported feed is reported by country of origin.	Finnish Food Authority keeps statistics of manufacture of feed materials. Feed materials of plant origin, animal origin and other feed materials are reported in total and to domestic market and export. Direct domestic use is distinguished for the feeding of farmed animals, domestic animals and wild animals. Amounts are reported in tons. The data is based on annual declarations made by feed sector actors. The newest statistics available is from two years before today. Statistics are available on pdf-files. Finnish Food Authority compiles the statistics from annual feed declarations. A complete list of materials used for feed can be found in the EU legislation (EU 2017/1017, part C) on the catalog of feed materials. Main feed categories are: 1) Cereal grains and products derived thereof, 2) Oil seeds, oil fruits, and products derived thereof, 3) Legume seeds and products derived thereof, 4) Tubers, roots, and products derived thereof, 5) Other seeds and fruits, and products derived thereof, 6) Forages and roughage, and products derived thereof, 7) Other plants, algae and products derived thereof, 8) Milk products and products derived thereof, 9) Land animal products and products derived thereof, 10) Fish, other aquatic animals and products derived thereof, 11) Minerals and products derived thereof, 12) Products and by-products obtained by fermentation using micro-organisms, inactivated resulting in absence of live micro-organisms, and 13) miscellaneous. Manufactured feed and raw materials used for feed are reported by places of manufacture. Imported feed is reported by country of origin.	The manufacture statistics are at website of Finnish Food Authority. Original declaration forms are held by the Finnish Food Authority in form of excel sheets.	Data is requested from feed business operators yearly by excel sheets by e-mail or mail. Therefore, data is manually (?) input by feed sector actors. Processed/manipulated data is distributed via Excel sheets and pdf files.	Feeding data can be used to model circulation of nutrient and carbon in food chain. If feeding is known the manure amount and properties can be better estimated.	Feeding data can be used to model circulation of nutrient and carbon in food chain. If feeding is known the manure amount and properties can be better estimated. Though manufacture of feed materials can be originated to operators, and destination of feed is asked, exact numbers of feed used in farms or at regional level does not exist. Maybe such numbers would be possible to model based on feed manufacturing, animal amounts and feeding recommendations. However, recommendations may not be realized at farms.	Finnish Food Authority.
1.5 Feed waste and feed surplus	Estimations of excess silage and grass produced in nature management fields can be found in Biomass Atlas, which is described in Appendix 1, chapter 1.15. There are harvest losses of silage at field, storage and when feeding the cattle. Silage storage loss is typically 5-15 %. Puustinen has measured silage losses to be 7,9 % of feed dry matter in her thesis (2020) and 1,3 % of it consisted of natural degradation to gas and 6,6 % of silage spoilage. Also, 3,7 % of catered feed was not used by animals. Feed eaten by ruminants varies a lot. There is more exact information on feed of pigs and poultry, but waste and surplus are hard to estimate.	-	-	-	-	-	Gaps: There is no data of grass use as feed. As there are no data on feed used at farms, the data of feed waste does not exist either.	-

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
1.6 Livestock	Finnish Food Authority keeps many different registers of animal keepers and shelters, livestock amounts etc, which are mainly aimed to guarantee safety of food production and avoid spread of animal-borne diseases. Statistics of Natural Resources Institute Finland, Luke keeps statistics of Agriculture and Production, among them are Number of Livestock, which has 13 statistical tables about livestock number, categorized by animal species, municipality, ELY-centre, herd size range or by different timing.	-	-	-	-	-	-	-
1.6 Livestock - animal registers	The register of animal keepers and holdings (shelters) is kept because the food production chain of animal origin can be monitored from start to finish. This ensures that food is safe and traceable throughout the production chain. In the case of serious animal diseases, it is essential to know the locations, where the animal disease has been diagnosed. This also applies to recreational animals. The register can improve the control of animal welfare too. The bovine register refers to the system used to produce and implement services required for the labelling and registration of bovine animals. All bovine animals born in Finland and imported to Finland are registered. Each animal must be uniquely identifiable. This is done by ear marks. Registry data is used primarily for preventing animal diseases, traceability of animals and beef and in the management of agricultural subsidies. Also, pig keeper must register the place where pigs are kept, and pigs must be marked either with tattoo or ear mark. Poultry means all species of birds reared to produce meat, eggs or other products. For example, broilers, laying hens, turkeys, geese, ducks etc. They must be registered. For each registered holding, a record must be kept of the animal species, categories of animals and number of animals. In addition, records must be kept of animals entering and leaving the holding. Also, bees, horses, camels, rabbits, sheep, goats, dogs, cats, frets, foxes, minks, and other animals are registered. The complete list of animal registers can be found at https://www.ruokavirasto.fi/viljelijat/elaintenpito/elainten-merkinta-ja-rekisterointi/ [in Finnish].	Finnish Food authority keeps the registers of animals. They include the number of pigs, bovine, poultry, sheep and goats and horses kept on farms, farm ID and farm location. Pigs are given by size, sex and life stage, bovine animals by age, sex and production type, also breed data exist. Registers are not openly accessible. They contain personal data (farm location).	Animal group, species, purpose of animal keeping and maximum capacity for animals are asked for the register of animal keeper and holdings. Number of animals usually kept on holding is asked. Identification of animal keeper (personal id, farm code or company id), for agricultural subsidies the registration is made by farm code. Mode of operation, starting and ending date of operation are stored in database. Examples of the mode of operation are breeding, meat production, milk production, sucler cow production, keeping of companion and hobby animals, production of piglets, storage of gametes or embryos, other. All animal species and modes of operation are listed in a document of Finnish Food Authority. Numbers of pigs, bovine, sheep or goats are declared as exact numbers to their own registers. Declarations concerning events with bovine animal, like calving, purchases, transfers and imports from abroad must be done within 7 days of the event. When calve is born the birthday, sex, race, intended use are declared. The keeper must also keep an up-to-date list of animals by holding. The keeper can maintain the list digitally to the database of the Food Authority or the list can be maintained on paper at the farm. The paper list of animals must be kept for three years from the last date on which the animal was last time marked on the list. The list contains information on EU-id, ear number, name, day of birth, holder at birth, sex, breed, use, day of entry, previous holder, day and way of removal, next holder, information of mother and father, reasons if not registered, way of disposal. From the listed information other variables like age group can be conducted. Also, if the breed is used for milking or meat production can be named.	The key premise is that the rural business administration information system can only be used for the purpose for which the data were collected and stored. On the other hand, the documents of the authorities are public, which is based on Act on the Opennes of Government Activities. In addition to the Act on openness, the Personal Data Act applies to register data, because it is possible to join field data to farmer data, which is personal data. Therefore, it is possible to get the data for scientific research and the researcher in charge must ensure that the personal data is not disclosed to outsiders. For research purposes it is possible to ask Finnish Food Authority to detach certain data from their register. The permission is required first. Usually, it takes several weeks to ask and get the permission and then later get the data. A fee covers work expenses and is typically some hundred euros.	-	Legislation on the identification and registration changed on 21 April 2021 when EU Animal Health Code (EU 2016/429) and the acts adopted on the basis thereof became applicable. Food safety authority has a development project for new bovine register. In March 2022, the new bovine register will be operational. There will be an interface for animal keepers as well as for authorities. The new bovine register is based on architecture, where Data Exchange Layer enables stakeholders and authorities to build complex information processing and all actors have equal opportunities to build applications on bovine data in accordance with open data principle. The change to new system is described in report (Evira 2013). The new bovine register also introduces the Suomi.fi credits, which allows animal keepers to authorize the other actor, eg slaughter house, to act on their behalf. That will reduce the number of invalid registry entries.	Horse amounts only at farms are reported. For other horses only housing sites are registered with the capacity and typical amount. From April 21 2021 the new animal health regulations on animal housing and traceability oblige the operator responsible for the housing of the horses to keep a record of the animals entering, born or dead or leaving the housing. The records must show the number and identity of the equidae in the housing at any given time. The new regulation results more information on horse amounts and locations. However, the data is distributed to each housing, and only presented to the authority upon request. Fur animals are registered, but a significant number of fur farms are missing.	-
1.6 Livestock - animal statistics	Number of livestock include cattle, pigs, poultry, and sheep and goats. Depending on the species, livestock numbers are recorded on 1 April or 1 May and on 1 December. Data is presented by ELY Centre and municipality. Information is also available by other regional classifications and herd size. Information about the number of domestic animals is mostly obtained from registers.	See chapter (1.1), Sources of crop production data.	The statistics are presented by ELY Centre and municipality and contain the numbers of cattle, swine, sheep, goats, poultry and farm horses. The cattle statistics give a breakdown of the numbers of cows, suckler cows, bulls, heifers and calves. The swine statistics show the numbers of sows, boars, fattening pigs and piglets. The poultry statistics give a breakdown of the numbers of hens, chicks, roosters, broilers, turkeys and other species. The number of livestock at 1 April or 1 May and the number of cattle at 1 December are also available by other regional classifications and by herd size. The classification of farms into regions is based on the municipality in which a farm's administrative centre is located. Statistics of the number of domestic animals mainly includes production animals at farms entered in the register of agricultural and horticultural enterprises. Registered farms include agricultural and horticultural enterprises, the financial size of which is at least EUR 2,000. The number of poultry and horses on farms entered in the register of agricultural and horticultural enterprises (as of 1 April) is based on data collected from farmers in conjunction with the spring subsidy application. Numbers of pigs at 1. April are taken from the Pig Register. The number of pigs at 1 December are drawn up using a sample of the data collected from farmers for the Farm Survey. The numbers of cattle at 1 May and 1 December are taken from the Bovine Register as a complete enumeration, and the numbers of sheep and goats at 1 May are taken from the Sheep and Goat Register. The statistics on cattle and pigs are drawn up twice a year, while the statistics for poultry, sheep, goats and farm horses are drawn up once a year. Data is available from the 1950s onwards.	Number of livestock statistics are public, open and free to use. Reference to mention is OSF: Natural Resources Institute Finland, Number of Livestock.	Statistic databases are available at https://stat.luke.fi/en/crop-production-statistics with different options to explore, edit and save the data as tables, figures, files, links, and html embeddings. Data can be downloaded as files or read it through PX-Web API (application programming interface) in formats of xlsx, csv, json, json stat, sdmx and px. There is also web portal for statistical information. The figures in statistics websites are an example of PX-Web API implementation. Data behind figures are loaded every time the web page is opened or updated. And when the database is updated, the figure will be updated automatically.			Natural Resources Institute Finland Luke. Ely-Centres. Municipalities.
1. Food and carbon								

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
1.7 Animal products	Luke statistics have yearly numbers for milk and milk products, meat production and egg production in agriculture production statistics. Finnish Food Production Chain association publishes Forkful of Facts, a yearly compilation of food statistics covering the entire food production chain, including food manufacturers by sector as well as import and export of foodstuffs (Finfood, 2021).	-	-	-	-	-	-	Natural Resources Institute Finland Luke. Finnish Food Production Chain Association.
1.8 Manure	Information on the quantity and composition of manure for different animal categories and manure types. The calculation is a mass balance starting from excretion of animals and proceeding to the technologies and practices during animal housing and manure storage. Excretion calculations are made by Luke with separate models for each animal category.	Data is collected by an electronic survey on manure management on livestock farms.	The Finnish Normative Manure System is connected to the model calculating gaseous nitrogen emissions from agriculture. The model is used for annual inventoring and reporting of the emissions for the UN Convention on Long-range Transboundary Air Pollution (CLRTAP), EU National Emission Ceilings Directive (2001/81/EC) and the UN Framework on Climate Change (UNFCC). The model is updated irregularly as required and guided by the inventory protocol. The main responsible organization maintaining and using the model is SYKE. There are no similar guidelines available to the other sections of the Normative Manure System, but it has been developed using several different references and basic principles of mass balance calculations. The Normative Manure System may also be developed and updated by SYKE and Luke when required for its different uses or when new background data is available. However, there are no regular resources available for this and the work is done under different projects and/or other tasks of the organizations.	Summary report available. Primary data restricted. The manure analysis results of commercial laboratories are not openly available. The largest company Eurofins publishes some average data irregularly on its website. The original datasets may be purchased for given uses, such as the table values in legislation, but it must be ensured that no specific farms can be identified.	The Finnish Normative Manure System is an Excel-based model, as are also the excretion calculation models per animal category. The background data for it was previously collected by an electronic survey on manure management on livestock farms.	The maintenance and updating protocols are being discussed and developed by Luke and SYKE including the resources needed and their origin. The data produced is of vital importance for emission inventories from agriculture (greenhouse gases, gaseous nitrogen emissions, nutrient loading to waters), agricultural nutrient balance calculations (required by Eurostat), legislation regulating manure management and use on farms, and R&D work towards improved manure use efficiency.	Due to the data collection work made in Luke and SYKE since 2010, manure data in the Finnish context is better than in many other countries (e.g. in the Baltic Sea Region, Luostarinen and Kaasinen 2016). Still, the the lack of a regular maintenance and updating protocols and their resources makes the system vulnerable.	Natural Resources Institute Finland Luke. Finnish Environment Institution SYKE.
1.9 Slaughter waste and other sidestreams of animal origin	Sidestreams of animal origin formed in meat industry. This category includes those parts of animals and products of animal origin, which are not used to human nutrition: animals which die or are killed at farms, slaughter waste, waste from fisheries, fur animal bodies, food waste of animal origin.	The main data source for sidestreams of animal origin is the YLVA database of the environmental administration of Finland. Responsibility reports of companies processing animal waste.	Based on EC and national laws (517/2015) the sidestreams are classified to three safety classes, and the possibilities to use sidestreams depend on the safety rules. YLVA database (described at chapter 2.13.2) contains amounts of waste from industrial units where waste of animal origin is generated. European Waste Codes for animal tissue waste are animal-tissue waste from agriculture and forestry (02 01 02), animal-tissue waste from manufacture of fish and meat products (02 02 02) and materials unsuitable for consumption or processing (02 02 03). Honkajoki Oy is the biggest company treating and refining the sidestreams of animal origin in Finland. At least 50 % of the sidestream goes to Honkajoki. Figure A 3 describes the use of animal-tissue waste.	-	-	-	-	Honkajoki Oy. Ministry of the Environment.
1.10 Food waste	Inedible (like bones and peels of fruits) and edible food which is not utilized as human consumption, feed or other value components.	Different parts of the food chain: primary production, food industry, retail, catering, and households.	The data includes amount of food waste and edible food waste in Finland at various parts of food chain: primary production, food industry, retail, food services, and households. For food waste from primary production data is given for 17 indicator products which cover 97 % of agricultural production in Finland. The products are wheat, barley, oat, rye, potato, sugar beet, carrot, strawberry, tomato, cucumber, beef, pork, chicken, eggs, milk, caught fish and cultivated fish. For waste from food industry the data is divided to six branches: 1) drinks; 2) dairy products; 3) vegetarian products and conservatives; 4) flour mills and bakeries; 5) meet processing and slaughter; and 6) other like readymade foods, coffee, sugar and sweets. For retail waste the data is divided into product sectors: 1) fresh vegetables, roots, potato, fruits, and berries; 2) fresh bread and bakery products; 3) meat, meat products, fish and seafood; 4) milk and dairy products, cheese, fat and eggs; and 5) others. Data is given only in percentages of waste. Estimates are given also for destinations and treatments of food waste. In the food service sector FW have been categorized to kitchen waste, serving waste, plate waste and in-editable food waste and the data is given as percentage of food produced and g per customer in different kind of branches: student restaurants, personnel restaurants, schools, day care centers, elderly care homes, hospitals, a la carte restaurants, hotels, gas stations and cafes and for all branches together. Household food waste was studied with two methods: food waste diaries and sorting studies. The results are given as amount per capita and type of food. The food waste data is collected in the years 2018-2019, but in some numbers used for calculations are based on older data. The amounts are presented at accuracy of 105 kg/year (for primary production) and as a percentage (formed waste per produced or prepared amount of food; for primary production, food industry). Percentage depends on definition for food waste and is given for three different definitions: EC, national and FAO.	The report for Food waste monitoring and road map is published and available at https://www.luke.fi/ruokahavikkiseuranta/en/	Data about food waste from agriculture was collected from previous studies, farm register and literature values. Retail food waste data collection was made in cooperation with retail sector actors. Luke made a form for data collection and Päivittäistavarakauppa ry collected the data from companies and aggregated the results. Data of food service FW was collected in form of waste diary. A specific data collection on-line application, Lukeloki was designed, to steer catering personnel to input same attributes of the data in same format. Questionnaires complement the diary results and give extra information about reasons for food loss and methods to diminish the loss. Food waste at households were studied by sorting study, diary and questionnaire.	Sampling at the first complete food waste research was not randomized as participation was voluntary. In future studies, the sampling will be developed further. There are plans to make regular updates for the food waste data by the methods presented in the report. A delegated decision on the measurement of food waste (2019/1597) entered into force in May 2019. According to decision member states must report their food waste to the Commission every year since 2020. Luke is Finland's equivalent expert institution, which is responsible to report the food waste data of Finland to the European commission.	For some waste categories absolute amounts are not given but only percentage of waste generated. It is not always possible to differentiate between wastes originating edible and non-edible food. Most values are aggregated in national level. Regional estimations might be possible to made if data about population, companies and agriculture is available and can be joined to food waste estimates.	Natural Resources Institute Finland (Luke).
1.11 Biowaste	Biowaste generated in municipalities is estimated to Biomass Atlas based on census data of Statistics of Finland and waste generated per capita. Biomass Atlas is described in chapters 2.2.1 and 2.2.13.	Big companies from YLVA.	Biodegradable waste from companies and biodegradable waste from waste treatment plants is reported to YLVA database, which is described in chapter 2.13.2.	-	Municipalities modeled with census data and waste generated per capita to Biomass Atlas.	-	-	Ministry of the Environment.

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
1.12 Sewage sludge	About one million tonnes of sludge per year is produced in water treatment plants according to Statistics Finland.	Sewage sludge from wastewater treatment plants is reported to YLVA database, which is described in more detail in chapter 2.13.2. In YLVA there are generated amounts but poor information where the sludge ends up.	Finnish Water Utilities Association (FIWA) is the co-operation and member association of the Finnish water and wastewater utilities and it makes a survey to waste water treatment plants about the sludge quality, treatment, transport, utilisation and final disposal.	-	-	-	Gaps: Poor information on where the sludge ends up.	Finnish Water Utilities Association FIWA. Ministry of the Environment.
1.13 Processing of manure and plant waste	Processing of manure and plant waste takes place mainly in biogas plants.	Data on processing of manure and plant waste formed at farms is scarce and scattered. Environmental permits are one potential source of data, but the permit allows the treatment of different biomass types and processing can vary due to biomass changes. Therefore, environmental permits are more likely to give data on capacity of the biogas plant than amounts processed or process operations.	-	-	No data. Models of processing in Nutrient calculator.	-	-	-
1.14 Forest biomass, forest statistics	National forest inventory (NFI) produces data of Finnish forests based on measured data with a nationwide sampling site network with a good coverage over the land area of Finland (www.luke.fi. VMI). Finnish forest statistics (www.Luke.fi) compile the various aspects related to forests and forest products.	The Finnish forest statistics can be found in: • suomen_metsatilastot_2020_verkko.pdf (luke.fi) • Suomen metsätilastot 2020 (2020) and NFI results in: • https://www.luke.fi/tietoa-luonnonvaroista/metsa/metsavarat-ja-metsasuunnittelu/metsavarat/#:~:text=Valtakunnan%20metsien%20inventointi%20%28VMI%29%20on%20metsien%20ja%20mets%C3%A4varojen,metsien%20monimuotoisuudesta%20sek%C3%A4%20metsien%20hiilivaroista%20ja%20niiden%20muutoksista.	Finnish forest statistics 2020 is a compilation of key statistics of Finnish forests, forestry, and forest industries. It also includes statistics concerning the forest environment and forest protection. Finnish forest statistics provides also comprehensive statistics on the roundwood trade and roundwood removals. Additionally, wood consumption figures for the forest industries and energy industries are presented. Finnish forest statistics has a long history, dating back 50 years. The forest statistics is part of the Finnish forest statistical system, which is of first rate on a global scale.	Public and free at https://stat.luke.fi/metsa.	NFI is a continuously running monitoring system which is producing continuously accumulating areal and nationwide information of Finnish forests, land use, forest health, biodiversity, carbon stocks and carbon sinks.	The NFI measurements and publication of Finnish forest statistics will continue and new properties are added according to the future needs. The utilization rate of the data is high, the annual costs of NFI are 1,8 M€.	NFI has been continuously developed to respond to growing needs for up-to-date information. For example, it can be used to monitor the sustainable use of forests and changes in forest carbon stocks. The different means and amounts of circulated forest products can be improved.	Natural Resources Institute Finland Luke.
1.15 Food system data service - Biomass Atlas	Biomass Atlas is a web-based service that provides spatially explicit data on crop production and its sidestreams; manure; municipal biowaste; biodegradable waste of companies and public services, forest cutting sidestreams on 1km x 1km resolution. Description of the service is also given in chapter 1.1 on field and crop data, but other data available at Biomass Atlas is described below.	Various sources.	The service covers Finland in 1km x 1km grid. Data has been accumulated annually since 2016. The latest data is visible on map application, but older datasets can be downloaded by registered users. Manure – calculation method is from Finnish Normative Manure and is based on animal amount, excretion factors and fodders used. Field use – Integrated Administration and Control System (IACS) land parcel identification system (LPIS), farmers make annually report of their cultivation plan. The raw data is grouped to main field use types. Crop potential – field use combined with crop statistics to form an annual potential for crop production. Field sidestream potential – harvest index based estimate on remaining part of the plant after main crop is harvested. The potential is theoretical yield of plant sidestream and reductions need to be done by user to acquire technical or sustainable potential. Separately collected biowaste from municipalities – modeled by census population data and average waste yield per capita. Biodegradable waste from companies – from YLVA database, of environmental governance for environmental licence administration. Ashes from incineration plants – from YLVA database too. Selected summaries from multisource national forest inventory. Forest chip potentials: small wood and branches of deciduous trees, pine and spruce.	The service is available at https://www.luke.fi/biomassa-atlas/en/.	Various technologies.	-	-	Natural Resources Institute Finland Luke.
1.16 Calculation tool for regional nutrient and carbon recycling	Nutrient calculator is a tool for planning regional nutrient and carbon recycling. It contains data of nutrient-rich biomasses: quantity, composition and location on three levels: national, region and municipality. User can simulate biomass use by different processing techniques and choose different shares of the biomass for the processes and simulate various end-products. Biomass quantity and nutrients are provided after processing. Fertilization can be calculated in three different strategies: environmental scheme, crop phosphorus requirement or nitrates decree. Regional surplus or deficit in nutrients can be calculated as a comparison between nutrients in biomasses and nutrients given in fertilization. Also an estimate of nutrients bound in crop yield is available. Phosphorus balance is used for estimating the change in soil phosphorus status.	-	-	-	-	-	-	-
2. Batteries - data trough the battery value chain								
2.1 Regional State Administrative Agency, water and environment permits information service	Regional State Administrative Agency provides water and environmental permits information service. Information service provides a tool to search water and environmental permit cases and related public documents initiated, notified and decided to the Regional State Administrative Agency.	Regional State Administrative Agency provides water and environmental permits information service. In that service, documents related to water and environmental permit cases by battery value chain actors can be searched for.	Environmental permits include data of raw materials, products, by-products, and production capacities. Data of main chemicals used in processing, process side flows and waste, effluents (emissions to air).	In Regional State Administrative Agency water and environmental permits information service, data is open access and free of charge for public use. In the information service, water and environmental permit cases initiated, notified and decided by Regional State Administrative Agency, and related public documents can be searched for. However, personal data and / or confidential information has been removed from the documents.	-	-	-	Regional State Administrative Agency.

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
2.2 Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)	The European Union REACH legislation considers the registration, evaluation, permit procedures and regulations of substances. The legislation obligates the manufacturers, importers, producers, users and distributors. Hazardous chemicals intended for professional use or common consumption require a chemical notification submitted to TUKES. The notification is provided by the company producing a chemical to domestic market or a Finnish company importing a chemical to Finland.	Data is collected by different stakeholders. Collected data is submitted to European Chemicals Agency (ECHA) by registering the substance. Registration concerns any producer importing substances to the EU or a manufacturer producing > 1000 kg/year inside the EU.	Distributors are required to collect data on the features and uses of a substance they either manufacture or import. They are also required to evaluate risks and hazards of the products as well as to specify the requirements to the safe use of a substance. Notifications are submitted through Kemidigi-system.	ECHA supports cooperation in the field of chemicals regulation through involvement in several cooperation platforms and initiatives. Stakeholders are required to share data and work together.	Data is collected by different stakeholders and combined by ECHA.	By working together with stakeholders, including industry representatives and NGOs, authorities can help ensure the transparency and predictability of regulatory activities, and make sure that all parties are informed on the progress made in addressing particular groups of substances.'	ECHA is actively aiming to avoid gaps, overlap and duplication of data by working together with stakeholders.	European Chemicals Agency ECHA.
2.3 Hazardous chemicals data by Kemidigi	Kemidigi service provides open access data of hazardous chemicals available in Finnish market.	Data required from the companies includes quantities of import or production as precisely as possible (in tons).	Data is collected annually. Authorities are monitoring the quality of the submitted data.	Registered companies and authorities have access to chemical data, their own information, notifications and directories. Data is available to other parties upon request.	-	Regulations and permit requirements are updated due to needs.	Data cannot be used to identify a certain company or a certain product.	Finnish Safety and Chemicals Agency (Tukes).
2.4 Substances in Products in the Nordic Countries (SPIN)	SPIN provides substance quantities openly available in the Nordic countries. The intention behind the database SPIN is to make available to the public as much data as possible from the registers.	The national product registers of Finland, Sweden, Denmark and Norway.	Substance quantities in the market are updated annually. SPIN contains use information from several years.	SPIN is a free of charge open access database.	The SPIN database is available in an offline version and uses the Microsoft Access format. Four index tools are developed: • Use Index: A general emission/exposure estimation chemical of different human and environmental target groups. • Range of Use index: Indicates the broadness of the use of a substance in a Nordic country. • Article Index: Gives indications if a substance may end up as a part of an article. • Quantity Index: Is based on the amount of annually consumed substance. All the data are summarized and no references can be made to specific concentrations of any given substance in any kind of product. The summarized data in SPIN are in general based on the data in the Nordic product registers.	-	Non-chemical products are not included. For example, biocides and heavy metals contained in articles are not included in SPIN. When the composition of a product is changed, the companies do often not report this to the product registers. SPIN gives a rough estimation of quantities used in different areas in the Nordic countries. The figures are not as accurate as the number of digits suggests, when using them preferably round them off considerably. Secrecy rules have made it necessary to exclude data on many substances in SPIN. As a result of secrecy considerations some substances in the Nordic product registers are only mentioned in SPIN by their name.	Finnish Safety and Chemicals Agency (Tukes).
2.5 Substances of Concern in Articles as such or in Complex Objects (SCIP) Database	Substances of Concern In articles as such or in complex objects (Products) i.e. SCIP database, was established under the EU's Waste Framework Directive (WFD, EU 2018/851, amending Directive 2008/98/EC on waste). The objective is to prevent of waste generation containing substances of concern. The further aims for the database are to ensure that information on hazardous substances is available for all (consumers, authorities and other operators) throughout the whole life cycle of products and materials. It also aims to reduce the content of hazardous substances in products and materials as pushing for substitution of substances of concern. Aim is also to improve waste treatment operations and so contribute to managing hazardous substances in circular economy. European regulation on chemicals, Registration, Evaluation, Authorisation and Restriction of Chemicals, i.e. REACH-regulation, has guidance for producers and importers of articles, to identify whether they have obligation under REACH in registration and notification according to Article 7 and in relation to article supply chain communication according to Article 33.	European Chemicals Agency ECHA established and maintains the database of SCIP notifications following Article 9(2) of WFD. The companies are required to submit information to SCIP database when supplying articles containing substances of very high concern (SVHCs) on the Candidate List in a concentration above 0,1 % weight by weight. "The SCIP database has three main objectives: 1. Decrease the generation of waste containing hazardous substances by supporting the substitution of Candidate List substances in articles placed on the EU market. 2. Make information available to further improve waste treatment operations. 3. Allow authorities to monitor the use of substances of concern in articles and initiate appropriate actions over the whole lifecycle of articles, including at their waste stage." (ECHA, 2020)	Companies need to submit information to ECHA when supplying articles containing SVHCs (0.1 % w/w) on EU-market. It is possible to refer the data that is submitted by a supplier or by own company. The information needed is: • identification of the article / complex object (brand or model names and public identifiers included) • identification, concentration range and location of the Candidate List substance(s) present in the article • information on the safe use of the article and sufficient information to proper management of the article in waste phase.	SCIP notification costs for the companies. The data is available for authorities, waste operators and consumers.	ECHA has provided IT tools such as an online tool (ECHA Submission Portal) to submit information on articles that contain Candidate list substance in a concentration above 0,1 % w/w.	SCIP is regulated by the EU and so obligatory for any supplier.	The SCIP database is necessity for future safe circular economy and safe and sustainable recycling processes of products and materials without severe hazardous substances.	European Chemicals Agency ECHA.
2.6 Battery management system (BMS)	Battery use phase data in the application is collected by a battery management system (BMS). The BMS monitors the state of the of the battery with direct measurements (e.g., cell voltages, current, power, temperature, energy throughput (kWh)), and calculates state estimates (state of charge (SOC), state of health (SOH), remaining useful life) and key performance indicators (KPIs) from the measured data.	The data originates from the BMS, which monitors, processes, and transmits the data.	BMS monitors the battery with numerous direct measurements (e.g., cell voltages, cell or module level temperatures, current) on a time scale from tens of milliseconds to seconds. In most applications it is not reasonable to collect and store all the measured data, but instead the BMS sends some aggregated battery data (e.g., min/max cell voltages, pack voltage, min/max temperatures, current) and calculated state estimates (e.g. SOC, SOH) on a time scale from seconds to minutes to the VCU or SCADA system. This data can be stored at the vehicle/system level or at the fleet level in a cloud-based battery data platform.	The data is owned by the companies, and hence, the data is not public.	BMS stores some historical usage data, but it is not capable of storing large amounts of data. In vehicular and industrial applications, BMS typically sends processed data to the data bus, from which VCU or SCADA can read the data that it needs for control and data storage. BMS keeps track on battery system warnings and faults along with some KPIs. In most advanced systems, data is transmitted to a cloud-based battery data platform, which provides powerful data storage and analytics capabilities. There are already some companies that offer platforms for battery data monitoring, diagnostics, and analysis in the cloud.	Advanced cloud-based data analytics platforms and services are currently being developed that can improve the battery management and provide predictive maintenance. This results in longer battery lifetime and may reduce the downtime of the battery system caused by malfunctions or scheduled maintenance. The European Commission (EC) has prepared a proposal for a regulation of the European Parliament and of the Council concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020 (Battery Regulation). The proposal is very broad and addresses many aspects through the battery value chain, including • traceability; battery composition and origin of minerals must be available (Battery Passport) • BMS data processing; key performance indicators are defined and their measurement method is specified in detail • BMS data availability; selected battery usage data must be openly available from the BMS • second life and recycling; battery composition, SOH, and lifetime history must be openly available	There are significant business opportunities emerging in the advanced cloud-based battery analytics and management. There are already some commercial platforms and services available, but the market is not yet fully established. The closed data interface of the BMS limits severely the possibilities to explore the second-life possibilities of a battery after it has reached the end of life in the vehicle. In the battery refurbishment and second-life application segments, the vehicle OEMs have established partnerships with selected companies to provide refurbished batteries and second-life battery storage systems. The proposal for the Battery Regulation addresses this gap by obligating battery suppliers to partly open the BMS interface so that some of the battery usage history data will become accessible to all stakeholders.	Various companies.
2.7 Chemicals data by Finnish Safety and Chemicals Agency (TUKES)	The Finnish Safety and Chemicals Agency, or Tukes is an agency within the Ministry of Employment and the Economy of Finland. Its task is to monitor and enforce safety and regulations compliance in technology, chemicals and hazardous materials, workplace safety and consumer and product safety.	The data is collected from the Register for Market Surveillance maintained by TUKES.	Accessible information covers the past three years and is updated daily.	Some of the data provided by TUKES has been made open access and free of charge for public use. Open data includes information on hazardous products restricted by TUKES as well as security releases, product recalls and removals by the companies themselves. Accessible information covers the past three years and is updated daily.	-	The EU aims to guarantee the free movement of products by harmonising requirements for products.	Harmonised European requirements are not specified for all products.	Finnish Safety and Chemicals Agency (Tukes).

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
2.8 Producer responsibility register by The Pirkanmaa Centre for Economic Development, Transport and the Environment (PIRELY)	PIRELY maintains a platform for producer responsibility. Producer responsibility applies to all battery and accumulator importers and manufacturers in Finland. It also applies to batteries and accumulators imported to Finland, that are included in vehicles (such as cars, etc.) as well as inside electric and electronic equipment. Companies importing or manufacturing batteries and/or accumulators to Finland may comply with the producer responsibility requirements by joining a producer responsibility organization (Akkukierrätys Pb Oy, Suomen Autokierrätys Oy, Recser Oy, ERP Finland ry). By joining a PRO, company ('producer') may transfer their producer responsibility obligations for the PRO. PROs report to The Pirkanmaa Centre for Economic Development.	PIRELY maintains a platform for producer responsibility that lists producer responsibility organisations (PRO) and information on their members. PROs collect data on quantities and compiled statistics of batteries, monthly scrapping statistics, and a collection point register.	PIRELY reports the quantities of batteries and cells imported and collected in Finland to the European Commission. Producer responsibility in Finland is based on the Waste Act (646/2011) as well as on the Government Decree on Batteries and Accumulators (520/2014).	Data availability differs between the PROs. Producer listings are openly available. Producer reports and details are processed confidentially and securely and therefore are not openly accessible.	-	-	Detailed information is not publicly available. There are no producer responsibility organizations for lithium-based starter batteries or electric motorcycle traction batteries.	Pirkanmaa Centre for Economic Development, Transport and the Environment (PIREFLY).
2.9 International waste transfer data by The Finnish Environment Institute (SYKE)	The Finnish Environment Institute is a research institute and government agency under the Ministry of the Environment. SYKE monitors international waste transfers in Finland.	SYKE requires waste transfer permits from the operatives handling the transfer and environmental permits from the operatives receiving the transfer. The data and information are produced and collected mainly by the organizations of environmental administration, especially Finnish Environment Institute (SYKE) and Centers for Economic Development, Transport and the Environment (ELY Centers).	Open access lists for valid TFS-notifications are available for the past year.	International waste shipments system (Finnish TFS) publishes open access lists for valid TFS-notifications. Data is accessible by utilizing web services, spatial datasets and satellite observations, as well as data stored in environmental information systems. Environmental data can also be viewed in various web map applications.	Descriptions of different datasets and data systems can be viewed in the metadata portal. Creative Commons By 4.0 International license for open datasets lets others distribute, remix, tweak, and build upon others work, even commercially, as long as they credit the original creation. The source references for credits can be found in the metadata of each data product.	-		Finnish Environment Institution SYKE.
3 Textiles	In 2021 SYKE led a survey about mapping the textile flows in Finland (3.2). Making such survey was not an easy task since even though some waste management related data is gathered (3.3 and 3.4), there is no systematic collection of all the data needed for such mapping. Furthermore, information was collected from various sources and one challenge is that some data sources were indicating value (euros) and some of them weight (kg/tons). These same challenges apply on circular textile data and information in general. There are very few data sources that are systematically collected and automatically updated. Information is generated periodically, for example, by textile organizations such as Finnish Textile & Fashion (3.5) or Euratex (3.6), or produced within surveys and projects when funding for those are available, for example, textile flow survey (3.2), Telaketju projects (3.7), and Nordic research collaborations (3.8).	-	-	-	-	Circular textile system is very complicated and currently changing. This change is occurring due to EC level decision that separate collection of textile waste is to be started by EU member states by 2025. In Finland this separate collection of textile waste will be starting in 2023, however, separate collecting pilots are already going on), for example, by Turku, Helsinki, Tampere and Rauma areas by local municipal waste management companies. Furthermore, processing plant for this collected textile as well as textile waste from commercial origins, is to be operational in Paimio during 2021.	-	Research projects, companies and other organizations within circular textile system
3.1 Textile flow survey 2021	Textile flows in Finland – update for the 2013 survey is a project funded by the Ministry of the Environment, Suomen Tekstiili ja Muoti ry, ETU ry, KIVO ry and the Finnish Environment Institute SYKE (Finix project). The project is coordinated by SYKE and carried out in co-operation with Turku AMK and Lounais-Suomen Jätehuolto Oy. The 2013 survey (Dahlbo et al. 2015, Dahlbo et al. 2017) was based on 2012 data, now updated using the 2019 data. The survey followed the methodology developed in several previous Nordic studies (Tojo et al. 2012, Watson et al. 2018).	The textile flows cover the supply of textiles in Finland ((domestic production+import)-export) and the flows of used textiles (reuse in Finland, reuse abroad, recycling, incineration).	The data covers the Finnish textile flows in 2019. For some of the flows, the most recent data originated from 2018. In these cases, the validity of this data for year 2019 was estimated and when relevant was applied for 2019.	Public report available at http://julkaisut.turkuamk.fi/isbn9789522167873.pdf.	Data was collected from various sources by different organisations and combined by SYKE. The supply was calculated based on statistics on the domestic textiles production, the Customs database (Uljas). The flows of used textiles were obtained from questionnaires to charity organisations and other operators collecting used textiles separately. Additionally, data from laundries on the used textile flows was collected with questionnaires.	Data is now collected as project work. In the future there should be continuous recording of textile flows from various sources. The data includes several sources of uncertainties, which are described in the report.	There is no continuous collection system for this data.	Ministry of the Environment. Suomen Tekstiili ja Muoti ry. ETU ry. KIVO ry. Finnish Environment Institute SYKE. Turku AMK. Lounais-Suomen Jätehuolto Oy.
3.2 Textile waste in municipal waste statistics	End-of-life phase data on textiles can be found from national compliance database for environmental permit monitoring (YLVA) (Ministry of the Environment, 2021a). Textile (200111) and clothing (200110) waste from municipalities have individual codes in waste categorisation. This data is available upon request and for a service fee from Finnish Environment Institute SYKE. In addition to source-separated waste streams, textile waste ends up in mixed municipal solid waste (MSW). In Finland, mixed MSW is incinerated. There is national data available on the consistency of mixed MSW from Finnish households, where the mass-based share of textiles can be seen. More information on the data sources regarding waste in Finland can be found from chapter 1.18.	YLVA database collects data on waste from actors who have environmental permits. Most of national waste data in YLVA database. The waste-related data in YLVA is mostly public. It is available for monitoring purposes directly and for other purposes somewhat modified upon request. An organisation for public waste management in Finland governs a database on the consistency of mixed MSW from Finnish households (Suomen kiertovoima ry KIVO, 2021). The database is intended for summarising and collecting the different picking analyses to provide open and high-quality data. It is based on a national suggestion for carrying out picking analyses for mixed MSW.	YLVA includes data on waste streams arriving to or leaving treatment as well as storage. The waste is categorised according to EWC waste codes, and also the type of treatment follows a standardised categorisation. The database is constantly updated with new data. The data on the consistency of mixed MSW is based on individual picking analyses carried out in public waste management companies in Finland, following a harmonised method. The analyses considered in the national estimate are going through a manual quality check. The national estimates currently available are based on four picking analyses carried out in 2015–2019. Carrying out picking analyses and providing the data to the database is voluntary and based on individual development projects.	Available upon request and for a service fee from Finnish Environment Institute SYKE. Waste-related data in YLVA is mostly public. It is available for monitoring purposes directly and for other purposes somewhat modified upon request.	YLVA database with textile classification.	There is a broad development project going on in the administration to improve the data systems for material and waste streams. YLVA database will also be further developed. In the future there are also needs to monitor the consistency of mixed MSW from other sources than only from households, such as stores and offices.	Textile waste is a broad category which does not differentiate between the plethora of materials used in textiles. Also, the waste statistics do not directly account for textile waste found in mixed waste fractions nor reused textiles.	Finnish Environment Institute SYKE.
3.3 Reused textile products in EU waste framework directive monitoring	The member states will begin monitoring reuse of certain products, including textiles, in 2021 according to the revised EU waste framework directive. Until now, there has not been continuous monitoring on reuse of textiles. Finnish Environment Institute SYKE is developing methods for monitoring on reuse of textiles. The monitoring will cover textiles sold or given away to secondary use from actors, such as recycling centres, auctions, and second-hand shops as well as online marketplaces. The monitoring will not cover all actors in such fields. It will be based on sampling. The monitoring data will be made publicly available. (Koskinen 2021)	As part of EU waste framework reporting, monitoring of reuse will be used to evaluate the development in Finland, as well as in EU. The data will be available on public websites or databases.	The national data will be updated every three years. The data sets will provide data on reused textiles in masses. SYKE is responsible for both collection of the data and reporting to EU. The data will be available in a database based on Harava system from which the data can be retrieved as csv or excel.	The data sets from EU waste framework reporting will be open for public free of charge. The background data potentially concerning individual actors will not be public.	The data will be available in a database based on Harava system from which the data can be retrieved as csv or excel.		The monitoring of textile reuse only accounts for some of the streams and cannot so far provide a full picture on all streams of reused textiles.	Finnish Environment Institute SYKE.

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
3.4 Statistics by Suomen Tekstiili & Muoti (STJM)	STJM is the central organization for textile, clothing and fashion companies in Finland. It keeps up statistics of textile sector in national level https://www.stjm.fi/julkaisut-ja-tilastot/tilastot/ Statistics include e.g. • Number of companies, turnover and personnel https://www.stjm.fi/julkaisut-ja-tilastot/tilastot/tekstiili-ja-muotialan-yritysten-lukumaara-liikevaihto-ja-henkilosto/ • Textile exports and imports https://www.stjm.fi/julkaisut-ja-tilastot/tilastot/vienti-ja-tuonti/ • How much money people use on textiles https://www.stjm.fi/julkaisut-ja-tilastot/tilastot/rahankaytto-tekstiiliin-ja-muotiin-suomessa-ja-euroopassa/ • Global fibre production https://www.stjm.fi/julkaisut-ja-tilastot/tilastot/kuitujen-tuotanto/ • In addition STJM has service where its member companies can be searched by name, location or product category https://www.stjm.fi/liitto/jasenyritykset-toimialoittain/ Owner: Suomen Tekstiili & Muoti	Sources identified in STJM webpage for each statistic.	Data properties identified in STJM webpage for each statistic. Most of these updated annually.	Public, open access, free.	Reports available in pdf form.	Updated annually.	Gaps include slow updating. Opportunities include good overview of textile sector and its volymes, customers and actors.	Suomen Tekstiili & Muoti (STJM).
3.5 Statistics and analyses by The European Apparel and Textile Confederation - Euratex	Euratex is s the central organization for national textile, clothing and fashion organizations in Europe. It keeps up statistics of textile sector in European level (including Finland) https://euratex.eu/statistics/ Statistics include e.g. • Key facts and figures https://euratex.eu/facts-and-key-figures/ • Economic analyses and updates Owner: Euratex	Sources identified in Euratex webpage for each statistic.	Data properties identified in Euratex webpage for each statistic. Some of these updated annually.	Public, open access, free.	Reports available in pdf form.	Statistics updated annually. New analyses published sporadically.	Gaps include slow updating. Opportunities include good overview of textile sector and its volymes, customers and actors.	Statistics and analyses by The European Apparel and Textile Confederation - Euratex.
3.6 Telaketju Research Activities Research Data via Telaketju webpage	Telaketju is an active network of actors aiming for better circularity of textiles in Finland. The webpage of Telaketju activities can be found in www.telaketju.fi / https://telaketju.turkuamk.fi/. It contains research results in forms of reports, webinars, presentations, etc. made within different Telaketju projects as well as links to research report etc. materials made by others. Projects contribution to public knowledge included: • Telaketju YM (funded by ministry of environment) 2017-2018 • Telaketju Tekes (funded by Tekes) 2017-2019 • Telaketju TEM (funded by Ministry of Economic Affairs and Employment) 2018-2020 • Telaketju 2 BF (Funded by Business Finland) 2019-2021 Materials and links include e.g. • Final reports of Telaketju first stage projects: Telaketju Tekes project 2019 https://cris.vtt.fi/en/publications/telaketju-towards-circularity-of-textiles, Telaketju YM project 2019 https://storage.googleapis.com/turku-amk/2019/07/telaketju-ym-kokeiluhankkeen-loppuraportti.pdf and Telaketju TEM, 2020 https://telaketju.turkuamk.fi/uploads/2020/09/a90428d0-telaketju-tem-hankkeen-loppuraportti.pdf • Report on suitability of different textile fractions to recycling processes (2019, Telaketju Tekes, in Finnish) https://cris.vtt.fi/en/publications/tekstiilimateriaalien-soveltuvuus-kierr%C3%A4tykseen (summary in English in Telaketju Tekes report - see above) • Report on risks and risk management on textile recycling (2019, Telaketju Tekes, in Finnish) https://www.vttresearch.com/sites/default/files/pdf/technology/2018/T343.pdf (summary in English in Telaketju Tekes report - see first bullet) • Report on economic modelling of textile collecting, sorting and recycling (2019, Telaketju Tekes, in Finnish) https://cris.vtt.fi/en/publications/tekstiilikierr%C3%A4tyksen-prosessien-kustannusmallinnus (summary in English in Telaketju Tekes report - see first bullet) NOTE model is to be updated in Telaketju 2 project • Description of concept for national textile waste collection system in Finland (2020, Telaketju 2 BF & Telaketju TEM,) https://telaketju.turkuamk.fi/uploads/2020/08/5d8cc5d4-poistotekstiilin-valtakunnallinen-kerays_lsjh.pdf and https://telaketju.turkuamk.fi/uploads/2020/08/0c08d295-national-collection-of-end-of-life-textiles-in-finland_lsjh.pdf Authors are indicated in each report. More information available via project manager Pirjo Heikkilä.	Research work carried out in different Telaketju projects. Sources of data vary report by report.	Reports from different topics. Data collection and origin depends on the report. Not updated systemically. Not standardized, normal project work and related quality control (project group's best understanding at a time).	Public, open access, free. Available at www.telaketju.fi and https://www.oneplanetnetwork.org/nordic-council-ministers	Reports available in pdf form.	More reports in different topics to be included as long as Telaketju activities go on.	Gaps include e.g. that data is not updated systemically, and it only covers selected topics from the project work. Opportunities include e.g. that new research results are included about topics that are not widely studied yet.	Telaketju: VTT, Turku University of Applied Sciences, LAB University of Applied Sciences, project partners. Nordic: various project partners.

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
3.7 Nordic cooperation in textiles	Under the Nordic Council of Ministers, Nordic cooperation has carried out a number of surveys and projects related to textiles in the Nordic countries. The topics of the projects range from textile waste prevention, indicators, recycling, commitments and ecolabels. The results of the most significant projects from a global perspective have been collected in United Nations' One Planet best practices database under the umbrella of Nordic Council of Ministers.	The projects are carried out by the Nordic Council of Ministers to promote the sustainability in the Nordic region and beyond. The results are open to general public free of charge.	There are no official, updated data sets from the projects. However, there is a lot of even quantitative data collected in the projects. For an example overview on European and global markets for used textiles and estimates on the amounts of used textiles exported from the Nordic region can be found from the reports.	All the project reports are publicly available.	-	Circularity in the textile industry is still a high-priority theme in the Nordic cooperation. More research and development projects in the topic are expected.	No actual databases where data would be easily accessible. All updates on data rely on project activity.	-
4. Primary mineral raw materials and mining waste								
4.1 Mineral deposits and mines	This state-of-art database on mineral deposits in Finland shows where known mineral deposits are located and provides a full range of further information on them as well as original source documents. Both metallic and industrial minerals are covered, including precious stones and industrial rocks. Soapstone, other dimension stones, sand, gravel, clay or comparable earth materials, or peat are not covered. Data on mineral production represents material entering the circular loop, data on resources and reserves represent the material that could potentially enter the loop in the future.	The data is publicly available free of charge at https://gtkdata.gtk.fi/mdae/ (English language only) and at https://hakku.gtk.fi/en/locations/search. Original sources includ all relevant and reliable material, e.g., publications, reseach papers, reports, media releases or websites of companies, research organisations, mining authority etc. Original source documents are available via the database.	GTK's Mineral deposit database currently contains information on over 1200 mineral deposits in Finland.	A so-called Licence 1 (Basic licence version 1.1; 28.9.2016), see http://tupa.gtk.fi/paikkatieto/lisenssi/gtk_basic_licence_1.pdf) regulates the terms of use for the data. The data is publicly available to be downloaded free of charge. However, without the advance permission of GTK, the data can only be used for certain personal purposes or for internal use within an organization (documents created for authorities, scientific publications and teaching materials being exceptions).	GTK personnel store the data in GTK's Mineral Deposit Database by using the METSO interface specifically designed for this purpose. The data can be publicly viewed in web browser as well as viewed and downloaded as ESRI Geodatabase format and pdf files.	A layer visualising resources and reserves in UNFC reporting code is planned to be added in Mineral Deposit and Exploration webservice at https://gtkdata.gtk.fi/mdae. New categories for mining waste will be added to the METSO inferface to accommodate a wider range of different data, however this does not eliminate the issue of lack of mining waste data in public primary data sources. GTK's Mineral deposit database is being continuously updated.	Data on mineral deposits and mines mostly describe what has entered the circular loop via mineral and metal production and what could potentially enter the circular loop in the future (reserves, resources). It takes a considerably long period until these materials reach end-of-life status and are available for recycling in the context of circular economy. Data on secondary mineral raw materials is very scarce in the database and currently limited to annual extraction of left-over rocks in mines (Section 4.2).

Non-public data is not stored in GTK's Mineral deposit database, because all data stored in the database is publicly available as mineral deposit reports in pdf format.

Major data gaps exist with following items (e.g., Eilu, et al., 2021):
- What are the contents of battery metals in known mineral deposits and occurrences? Concerning battery metals, data coverage for nickel is the best.
- What are to contents of possible by-product metals (battery and other critical metals) in known deposits? | Geological Survey of Finland (GTK). |
| 4.2 Mining waste | Mining waste is mineral waste formed in mining or subsequent processing of ore. Only waste formed by extraction or exploitation of the so-called mining minerals defined in the Mining Act are considered here. Data describes what has currently exited the national circular loop, but could potentially re-enter it. | The mining waste data is stored in GTK's Mineral deposit database and is owned by GTK. Within GTK intranet, the database can be accessed by using the 'METSO' interface. An external user can access the data by using the data product 'Mineral deposits' that can be viewed and downloaded for free. Appendix A, Section 4.1. already described in detail how to access the data (either at https://gtkdata.gtk.fi/mdae/ or https://hakku.gtk.fi/en/locations/search). After opening an information box of an individual mineral deposit, a mineral deposit report can be downloaded from a link as a pdf file. In that report, cumulative total of mining waste is in section MINING, below heading 'Other materials' (Figure A 7). Annual mining waste figures are under heading 'Mining activity'.

GTK's Mineral deposit database is the state-of-art database on mineral deposits in Finland. It has been designed to facilitate a full range of information on mineral deposits, including mining waste. Mining waste data are needed, when planning how to use it as secondary raw material. | A sophisticated mining waste hierarchy has been designed to facilitate information on different types of mining waste (Figure A 8). However, due to poor data availability only two of the categories are regularly used: 01.2 to record extraction of left-over rocks in metallic ore mines and talc mines and class 01.1 to record extraction of left-over rocks in industrial mineral mines (excluding talc mines). The data on extraction of left-over rocks is directly sourced from the annual mining statistics published by the Finnish Safety and Chemicals Agency (Tukes) at www.tukes.fi each spring. This data is annually updated in GTK's Mineral deposit database (in March-April). | A so-called Licence 1 (Basic licence version 1.1; 28.9.2016), see http://tupa.gtk.fi/paikkatieto/lisenssi/gtk_basic_licence_1.pdf, regulates the terms of use for mining waste data (already described in Appendix 1, Section 4.1.). | GTK personnel store the data in GTK's Mineral Deposit Database by using the METSO interface. The data can be publicly viewed in web browser as well as viewed and downloaded as ESRI Geodatabase format and pdf files. | Currently there is no significant practical application for the dataset of left-over rocks extracted from mines, but development in national mineral policy to increase the use of mining wastes could change the situation. This issue will be addressed sooner or later, and at that point the data stored over the years becomes crucial.

Database structure is being developed to facilitate even more diverse types of mining waste data, however, the issue on lack of primary public data sources remains. | The data covers annual and cumulative tonnages of left-over rocks extracted in each mine, but the data does not cover any event of the left-over rocks beyond extraction. Therefore, the current location and current total tonnage of left-over rocks available for use are not accurately known. In most cases the majority of the left-over rocks are probably still in the vicinity of the mine, if not fed back into the mine itself. Some of them may have been used for various construction purposes and are not available for other use. The database contains no direct information on the composition of the left-over rocks, even though some clues are provided by description of the wall rock of the deposit.

GTK's Mineral deposit database could accommodate a wide range of data on different mining waste types, but this data needs to be first made publicly available. Companies operating in Finland produce and record some mining waste data, but it is not a standard practice for them to publish this data. We suspect that much of the existing information and data are currently confidential and only held by the companies. There are major data gaps in metal contents of side streams in mines, refineries, and smelters (e.g., Eilu, et al., 2021).

Ideally, annual production figures of many kinds of mining waste would be stored in the database; the application automatically calculates cumulative totals for each waste type. If some production figure is a sum from several years (instead of an annual figure), also this sum can be stored in the database: just assign it for a certain year with a note that in reality it is sum from several years. Also storage type (surface / covered / underground / underwater) as well as environmental impact can be recorded in the database. | Geological Survey of Finland (GTK). |

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
4.3 Mineral statistics in European Minerals Yearbook	This electronic database was originally created in the Minerals4EU Project (2014−2015) funded by the EU. For primary minerals, the Yearbook contains data on production, import and export, resources and reserves, and exploration. For secondary raw materials, some waste flow data is included. After the end of the Minerals4EU Project, the Yearbook has been updated to contain production and trade data for all years between 2004 and 2018. In January 2022, the Yearbook was in the process of being updated to contain the statistical year 2019 for production, import and export, resources and reserves and exploration of primary mineral raw materials.The purpose of the Yearbook is to contain official and best possible mineral statistics of the European countries. The Yearbook will be regularly updated. Mineral statistics data is highly valuable for a great number of different purposes and is essential for example in supporting political decision making related to utilization of natural resources and in supporting investment decisions.	European Minerals Yearbook can be found at http://minerals4eu.brgm-rec.fr/m4eu-yearbook/index.html. The main data providers are European geological surveys, which in turn collect the data from a number of various sources.	The European Minerals Yearbook contains production data for 40 countries during 2004−2018, for over 65 primary mineral and metal commodities. For Finland, data on 27 commodities is included. The data are collected by the British Geological Survey (BGS) using long-established BGS procedures with an international network of contacts from data providers. The data is collected by three main ways: writing directly to the data source, often using a questionnaire; receiving printed or digital publications; and consulting websites or web-based databases.

Import and export data for primary minerals covers 35 countries during 2004−2018 and over 65 commodities (and many more sub-commodities). For Finland, import and export data on 57 commodities or sub-commodities is included. The trade data is purchased in bulk from an agency that specialises in monitoring trade information. The data is then compared to the United Nations (UN) commodity trade web-database, to the Eurostat's online database, or, in some cases, databases compiled by national statistical offices.

Resource and reserve data and exploration data for primary minerals cover about 30 countries and over 65 commodities. These data are only available from countries that returned the questionnaires during the Minerals4EU project AND where data in those countries was available. Resources and reserves data depicts the situation as at 31.12.2013, exploration data depicts year 2013.

For Finland, resource data includes 27 commodities and reserve data includes 14 commodities. The data for 2013 is presented in deposit level, i.e., the data has not been aggregated into national level. There are two reasons for that: 1) companies had used many different reporting codes while carrying out the original reporting of resources and reserves and 2) ideas about a uniform reporting code and related conversion methods had not been widely adopted by the geological community in 2015, but only during later years. Considerable progress in this issue is taking place and described under Future developments. Exploration data for year 2013 in Finland only contains written notes, but the update for 2019 will also contain numerical data, described under Future developments.

Waste flow data covers 33 countries for 2010 and 2012. This data is only available by category, not by commodity. The categories included in the Yearbook are: batteries and accumulators, combustion wastes, discarded equipment, discarded vehicles, dredging spoils, glass waste, ferrous metal wastes, non-ferrous metal wastes, mixed metal wastes, mineral waste from construction and demolition, mineral wastes from waste treatment, other mineral wastes. Of these, the following data are presented: waste generated (tonnes), waste imported (tonnes), waste exported (tonnes) and waste treated (tonnes). Waste treated data has been divided into six treatment options displayed in green characters. In addition, there is data on waste facilities in 2010 and 2012. Waste data was collated from public sources including the Eurostat waste statistics database, the Eurostat Comext database and other national databases and publications (from National Environment Agencies, Ministries of Environment, etc). | Open access to all data at: http://minerals4eu.brgm-rec.fr/. | A sophisticated online platform was created in the Mintell4EU Project for national data providers to submit data on production, resources and reserves and exploration of primary mineral raw materials. This platform was used for the first time when collecting data for the year 2019 in the Minetell4EU minerals survey. The data goes through the quality control of the British Geological Survey before being published in European Minerals Yearbook. | The aim is that European geological surveys would submit national resources and reserves data as extensively as possible. This could eventually allow formation of extensive resources and reserves data in harmonised UNFC reporting code and formation of figures of resources and reserves aggregated in national and even pan-European level. | Common data gaps, addressed in several EU-funded projects, are listed below:

In many European countries, varying accessibility of resource and reserve data and the use of non-standardised reporting codes prevent formation of meaningful resource and reserve figures aggregated from deposit level into national level.

Lack of up-to-date resources data: resource estimates may have been done several years or even decades ago.

Lack of access to resource data on industrial mineral deposits held or mined by non-listed companies.

Inadequate quality data. Documentation of resource estimates does not always ensure transparent view of the resources. In such cases, the reader cannot clearly understand the basis of the resource estimates and their classification.

CRM data is dominantly of low quality.

Very little quantitative information exists on potential secondary mineral and metal resources. | All European geological surveys. |

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
4.4 Mineral exploration activity and results	The Mining Register, maintained by Tukes, facilitates its legal obligation to administer licencing of exploration and mining activities and provides public information on the present status of licencing of different areas. All areas displayed in the Mining Register are currently reserved for on-going or future exploration or mining and are not available for other companies. The data on past exploration activity shows where exploration has already been carried out and what the main mineral discoveries were (if any). Other exploration companies can utilize the data, when planning exploration campaigns: they can build on knowledge gained from previous work and avoid duplicating expensive work that has already been carried out. The data can also be utilized in geological research.	Data in the Mining Register is maintained and owned by Tukes. Tukes provides the most recent version of the GIS files for download in its website at https://tukes.fi/en/mining-ore-prospecting-and-gold-panning/map-files. Tukes also provides this data in an interface from which it is harvested for several online map services, including: • 'Kaivosrekisterin karttapalvelu' maintained by GTK at https://gtkdata.gtk.fi/kaivosrekisteri/ (Finnish language only) • 'Mineral Deposits and Exploration' maintained by GTK at https://gtkdata.gtk.fi/mdae/ (path Exploration layers / Mining Registry) (Figure A 11) (English language only) • 'Paikkatietoikkuna' at https://kartta.paikkatietoikkuna.fi/ maintained by the National Land Survey of Finland (MML) (Figure A 12). The data product 'Expired claim and exploration permits' is publicly available in two locations and can be: • viewed in the online map service 'Mineral Deposits and Exploration' maintained by GTK at https://gtkdata.gtk.fi/mdae/ (path Exploration layers / Mining Registry / Expired claims) (Figure A 11) (English language only) • downloaded at Hakku webservice maintained by GTK at https://hakku.gtk.fi/en/locations/search and viewed in GIS software.	The Mining Register covers the whole Finland. A user can check for any area if it is in some way 'active' in relation to permitting for exploration or mining. Timewise, the Mining Register is kept updated to show the present situation. It shows separately areas under the current Mining Act (621/2011) and previous Mining Act. The current Mining Act is represented by ten different layers: eight related to industrial-scale mineral exploration or artisanal gold panning, two related to mining. Exploration is allowed in areas with valid exploration permit. The previous Mining Act is represented by six different layers: three related to exploration and three related to mining. In July 2021, the Mining Register contains 282 areas with valid exploration permit (current Mining Act) and 169 areas with valid claim (previous Mining Act). The attributes shown for each exploration permit and claim area are the permit code, permit name, name of permit holder, arrival date of the application, registration date (= date of decision), expiration date and the commodities explored. This information is sourced from applications submitted by exploration companies and from the decision documents of Tukes. The data is updated continuously, and updated data is published every two or three weeks. The mentioned online map services maintained by GTK or MLL present the Mining Register data as provided by Tukes. Once an exploration permit expires, the permit holder must within six months submit a final report on exploration activities to Tukes, as well as the exploration data. Once the quarantine period expires, the area is deleted from Mining Register and added into the data product 'Expired claim and exploration permits'. Exploration work report and exploration data are delivered by Tukes to GTK and linked in the data product (Figure A 11); other attributes presented are essentially the same than in the Mining Registry. The reported and non-reported areas are displayed with different symbology. Data is updated monthly. Data has also been sourced from previous mining authorities (the Ministry of Trade and Industry, KTM, followed by the Ministry of Employment and the Economy, TEM). Additional metadata on 'Expired claim and exploration permits' are available at https://tupa.gtk.fi/paikkatieto/meta/expired_exploration_permits.html.	The GIS data of the Mining Register are publicly available to be downloaded free of charge. Tukes presents the conditions for using the data at https://tukes.fi/karttatiedostot-rss-atomfeedina. There Tukes disclaims all responsibility for any consequences caused as a result of use of the material. As no other condition is mentioned, it is implied that this is open data and can be used in any way, also in commercial applications and services. A so-called Licence 1 (Basic licence version 1.1; 28.9.2016, see http://tupa.gtk.fi/paikkatieto/lisenssi/gtk_basic_licence_1.pdf) regulates the terms of use for the data of 'Expired claim and exploration permits'. The data are publicly available to be downloaded free of charge. However, without the advance permission of GTK, the data can only be used for certain personal purposes or for internal use within an organization (documents created for authorities, scientific publications and teaching materials being exceptions).	Tukes reports using MapInfo software to digitize the borders of areas subject to new application for exploration permit. By using georeferenced GIS database, Tukes can easily check, if an area in an application overlaps areas that are already included in the Mining Register with a status that prevents granting a new permit. Tukes provides Mining Register files for distribution as downloadable ZIP files and ATOM feed at https://tukes.fi/karttatiedostot-rss-atomfeedina. The ZIP files contain the GIS files in TAB, MIF and SHP formats, which allows viewing with GIS software, such as QGIS, open-source OpenJUMP or commercial MapInfo or ArcView. ATOM feed is an interface allowing other organisations to use the data. For example, at GTK an FME Desktop workspace reads the ATOM feed of Tukes and converts it into ESRI's Geodatabase format used in GTK's distribution channels. The database of expired claim and exploration permits was compiled by digitizing the borders of areas from claim reports between 2003–2010. Claim areas granted after 1995 or thereabouts, as well as exploration permit areas under the current Mining Act, have been picked from the map files of the Mining Register. The exploration work reports were scanned, mainly in 2003, and nowadays they are delivered by Tukes in electronic format.	The Mining Register facilitates the legal obligation of Tukes to administer licencing of exploration and mining activities. Without this public register it would be complicated for Tukes to fulfil this obligation, as well as complicated for exploration companies to know which areas have already been reserved by other companies. All this indicates that the Mining Register is an extremely important webservice and heavily used.	Data and information gaps include, at least: 1) Not all exploration work has been properly reported; 2) Location inaccuracies in the digitised material should be considered when using the data; 3) There commonly is not much information on possible by-products of a deposit. Regarding opportunities, data can be accessed through traditional (pdf reader, Microsoft Excel) and special software (ArcGis, FME). Dataset can be downloaded either as a Geodatabase file or a ESRI shapefile. As the data can be viewed and accessed with standard tools, there is no need for specific software documentation or specific software to be downloaded with the data.	Geological Survey of Finland (GTK) and Finnish Safety and Chemicals Agency (TUKES).
4.5 Undiscovered mineral resurces	Undiscovered mineral deposits contain economic mineral resources that are believed to exist in 0–1000 m depth in the bedrock, but have not been discovered yet, or are only partly known to exist. The assessments carried out by GTK since 2008 cover undiscovered mineral resources (in metal tonnes) of silver, gold, cobalt, chromium, copper, iron, lithium, molybdenum, nickel, lead, palladium, platinum, titanium, vanadium, and zinc, in 14 different mineral deposit types in Finland. The results do not show the exact location of the individual undiscovered mineral deposits but are presented per permissive area. These are contiguous areas where geological factors allow the presence of a particular type of mineral deposit. The data can be used by those who carry out for example exploration, research, or land-use planning.	The data can be viewed in the public webservice Mineral Deposits and Mines at https://gtkdata.gtk.fi/mdae/ (path Exploration layers / Permissive areas for mineral deposits) and can be downloaded in geodatabase format at https://hakku.gtk.fi/en/locations/search.	At https://gtkdata.gtk.fi/mdae, data on each of the 14 mineral deposit types are on different layer; in data downloadable at https://hakku.gtk.fi, each of the 14 mineral deposit types are within the same layer as different feature classes. Attributes associated with each permissive area can be opened by clicking the polygon and these include: • Mineral deposit type • Name of individual permissive area • Estimated number of undiscovered deposits at five probability levels (1%, 5%, 10%, 50%, 90%) • Expected (mean) number of undiscovered deposits • Estimated undiscovered resources (in metal tonnes) of silver, gold, cobalt, chromium, copper, iron, lithium, molybdenum, nickel, lead, palladium, platinum, titanium, vanadium, and zinc, each metal with 10%, 50%, and 90% probability levels • Median and mean estimates (in metal tonnes) of undiscovered resources of silver, gold, cobalt, chromium, copper, iron, lithium, molybdenum, nickel, lead, palladium, platinum, titanium, vanadium, and zinc. Undiscovered mineral resources have been assessed within the national borders of Finland – the assessment also extends to areas covered by water, i.e., bedrock under lakes, Gulf of Finland and Bothnian Bay. Among the 14 mineral deposit types, a total of 253 permissive areas have been delineated as polygons. The sum of the area of all polygons is 320 466 km2. However, permissive areas for different mineral deposit types commonly overlap resulting in multiple counting of some areas. The data product is updated each time the assessment of a new mineral deposit type has been completed. So far, no revision of assessments carried out earlier has been made to better reflect the increased knowledge and general situation. As the assessment focuses on undiscovered deposits that could be economically mined, which to a certain extent is dependent on metal prices and available technologies, revision in long-term cycles (e.g., 10–20 year) are worth to consider.	A so-called Licence 1 (Basic licence version 1.1; 28.9.2016, see http://tupa.gtk.fi/paikkatieto/lisenssi/gtk_basic_licence_1.pdf) regulates the terms of use for the data. The data is publicly available to be downloaded free of charge. However, without the advance permission of GTK, the data can only be used for certain personal purposes or for internal use within an organization (documents created for authorities, scientific publications and teaching materials being exceptions).	The data are synthesis of all available knowledge on the geology in Finland, global grade-tonnage data on the mineral deposit type in question, as well as subjective opinion of experts carrying out the assessment. The Delphi technique (Rowe & Wright, 1999) is used in assessing the number of undiscovered mineral deposits per permissive area. For each deposit type, the Finnish data and recent international data have been used to test the applicability of the global grade-and-tonnage models. This has resulted in both updating the global models and, in some cases, creation of new models better suitable for the geology of Finnish mineral deposits. In Finland, the assessments have been carried out by using simple office software and ArcGIS. However, in the MAP project (2018–2020) funded by EIT RawMaterials, a free software called MapWizard was developed to streamline the assessment procedure. This software, downloadable at https://github.com/gtkfi/MapWizard/releases, can be used in regional or local assessments in new projects or consulting work. The data is maintained as geodatabase files. ArcGIS and other commercial or free spatial data software can be used to further edit the dataset. The data are distributed as zip file that can be downloaded free from GTK´s Hakku webservice. The data can also be viewed in GTK's webservice Mineral Deposits and Exploration by using a web browser.	Assessment of undiscovered phosphorus and Rare Earth Element (REE) deposits in peralkaline rocks, carbonatites and Th-REE-rich dykes will be completed in 2022 and the data will be updated. After that all significant deposit types in Finland have been assessed for undiscovered mineral resources. At the moment, there is a major push, across Europe, to report all mineral resources by using the UNFC resource classification. In this classification, undiscovered mineral resources can be categorised into the class 3,4,4. This offers new possibilities for dissemination on undiscovered mineral resources and helps increasing its visibility. Another probable future development is to assess undiscovered resources of critical raw materials (CRMs) not yet assessed in as many as possible deposit types across Finland. No decision towards that objective has been done, however. GTK maintains dozens of datasets in the Hakku webservice. Therefore, maintenance costs for the dataset on undiscovered mineral deposits are not significant.	The subject of this dataset is hypothetical in nature. There is no guarantee that any of the estimated undiscovered resources will ever be found or utilized. The recent discovery of a major gold deposit in Sodankylä (Rupert Resources, 2021) is, however, an indication that 'undiscovered' resources may indeed turn into 'discovered'. The data does not indicate the exact locations of the undiscovered mineral deposits, but 1) areas where geology permits these deposits to occur, 2) the number of undiscovered mineral deposits within these areas, and 3) related tonnages of different metals. Using the data is quite strictly controlled by the user licence: without prior written permission from GTK, other organisations are not allowed to republish the data externally (apart from the use for authorities, in scientific publications and teaching materials). All results of the national assessments of undiscovered mineral resources carried out by GTK are public. Additional information on each assessment is published in GTK's publication series 'Report of Investigation', also available via the Hakku webservice at https://hakku.gtk.fi/. Main data gaps in the assessment of undiscovered mineral resources are as follows: Only those deposit types can be assessed for which there is enough grade and tonnage data to make a statistically reliable numerical model. A prime example of this hinder is that no assessment of Talvivaara-type nickel-zinc-copper-cobalt and Kevitsa-type nickel-copper-cobalt-platinum-palladium deposits has been possible to make. Lack of data also has prohibited to assess the metal endowment on most of the CRMs, as they are dominantly just possible by-products of mining and, hence, rarely included into published mineral resources. Examples of such metals include, e.g., antimony, beryllium, bismuth, gallium, germanium, indium, niobium, tantalum, and tungsten. Getting more deposit-scale information on all types of mineral deposits and on the potential by-products is the way to improve the quality and extent of the assessment of undiscovered mineral resources. All that information would also affect positively on how a mineral resource is mined and what is extracted from the ore.	Geological Survey of Finland (GTK).

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
4.6 Mineral exports and imports	Finnish Customs provides data on foreign trade of Finland in its statistical online database called Uljas. Huge amount of data is available in this complex database utilizing several classification systems, for example the Combined Nomenclature (CN) of the European Community and the Standard International Trade Classification (SITC) of the United Nations. Foreign trade of mineral raw materials in CN classification is divided in 21 Sections (I−XXI) that contain in total 99 Chapters (see https://tulli.fi/en/statistics/combined-nomenclature-cn). Mineral products form the Section V, which contains Chapters 25−27. These statistics give a reliable picture of the latest development of the international trade. They constitute an important instrument for the decision makers as well as planners and researchers in the public and private sectors, both at the national level and within the operations of the EU and several international organisations. Data on mineral exports and imports of Finland (as well as other European countries) is also described in Appendix A, Section 4.3.	Data on foreign trade of Finland is freely available in the electronic 'Uljas' database at https://uljas.tulli.fi/. This is the official information source of imports, exports, and balance of trade of Finland. The database is owned and maintained by the Finnish Customs. The information on the trade carried on by Finland with the other EU Member States is collected from the compulsory statistical declarations provided monthly by importers and exporters through the Intrastat system of internal trade. The information on the trade between Finland and Third Countries is obtained from customs declarations, which have to be submitted on every import and export consignment. The data on both internal and external trade is put together to form the statistics on the international trade of Finland.	Information according to CN exists since 1995. There are slight changes in the nomenclature each year, which means that it is not possible to make a coherent time series on all commodities. In practical terms, data collected from 2002 onwards is more unified with the current data. A user needs to first select between 'CN/HS 1989–2002' and 'CN from 2002->'. In Uljas database, a user needs to make a range of selections defining the variables for the data of interest. This includes the subcategory of CN classification and the items within this subcategory as well as selections concerning the time period, countries, direction of foreign trade (export/import), and the indicator of interest. Once completed the application instantly retrieves the queried data from the database. In this way, a user can find out, for example, what the value (in euros) of copper ores and concentrates imported to Finland from all countries together was in 2018. The most important trade items related to metallic ores and non-energy industrial minerals are listed in the Appendix 1 of the Sector report of the mining industry 2021 (Ministry of Economic Affairs and Employment of Finland, 2021, pp. 75-78). A user can select one or more countries for source of imports or destination of exports. Very useful is also the selection 'All countries together'. In addition, there is a wide range of country hierarchies that can be used. Concerning direction of flow, a user should select between imports or exports (or select both). The country of origin is the country in which the goods were produced or in which the latest economically important production stage took place. The packaging of the commodities is not regarded as production. As for export, the country of destination is the last country known at the time of the export of the commodities from Finland, either direct or via another country. In practical terms, there seems to be no difference between 'Imports by countries of origin' and 'Imports by countries of consignment'. Finally, a user should select one or more indicators. Two very useful indicators for basic use are 1) cumulative value in euros from the beginning of the year and 2) cumulative quantity (= cumulative quantity in kilograms from the beginning of the year). The monthly statistics are published within 9 weeks after the end of the respective month. The timetable for publishing is available at https://tulli.fi/en/statistics/publishing-timetable. At first the published figures are preliminary and contain estimates. They are supplemented by estimations on missing statistics declarations and those on companies with figures remaining below the threshold values. The statistics on each calendar year are confirmed by the end of August in the following year.	Data in the Uljas database at https://uljas.tulli.fi/ can be used freely in every feasible way (also commercially) provided that the source is mentioned. The Creative Commons Attribution 4.0 International licence is applied to Finnish Customs statistical data published in the Uljas database. This is a licence according to the JHS 189 recommendation for open data files in public administration.	Uljas is a web-based database that is used with a web browser. A user needs to make a range of selections defining the variables for the data of interest. Once completed the application instantly retrieves the queried data from the database. The data can be exported into an Excel file. A user can produce different graphs from the data in web browser or in the exported Excel file. Calculation tools in the web application are very modest so Excel is definitely recommended for making any calculations with the data.	-	Enterprises have the possibility to suppress data relating to trade in cases where enterprise-specific data is recognisable in publications and this would harm its business. Normally this refers to a case where one statistical class contains fewer than three enterprises or the enterprise which presented the request represents at least 75% of the total value of the statistical class. Finnish Customs suppresses statistical data only at the request of an enterprise engaged in trade. In practice the result of the suppression may be that country specific quantity data (in kilograms) revealing the country of origin or destination is not published or quantity data is not published at all. However, the data on the total value (in euros) of the so-called suppressed commodity subheadings is always published. Suppressed data are marked with three dots (…).	Customs Finland.
5 Surveys on industrial production and material utilization								
5.1 Industrial production materials and supplies	In a working circular economy, the demand for natural resources as raw materials decreases as they are replaced with recycled materials. Good planning can also improve the efficiency of production processes and extend the service life of products, and these measures are also reflected in a decreasing use of virgin raw materials. Currently, few statistical classifications distinguish the use of raw materials by source, but natural resources taken into use in the economy can be measured with domestic material use. The industrial production materials and supplies survey material contains purchasing information on the materials and supplies used in the manufacture of goods in industrial production. Purchasing information is requested from informants on an item-by-item basis. Purchased materials and supplies refer to raw materials, semi-finished products, additional materials and supplies purchased from outside the enterprise for production during the calendar year, for the manufacture of goods in industrial production, regardless of the year of use.	The industrial production materials and supplies survey covers the main industries of the Industrial Classification (TOL) 2008 "B Mining and quarrying" and "C Industry". As a general rule, all companies with at least 20 employees (legal units) with sites (establishments) in the industrial sector (B or C) are included in the inquiry. The reporting units are enterprises or their establishments. An establishment refers to an economic unit owned or controlled by an enterprise that produces goods and services of mainly one particular type usually at one location. The inquiry also covers subcontractors who carry out contract manufacturing on behalf of another company. The filling in instructions of material and supply data requests to report at least 80% of purchases and 100% of total use for the titles in which total use is inquired. So at least the most important materials and supplies used in production during the calendar year are collected from the units supplying the data.	Since the statistical year 2013, data have been collected only for uneven statistical reference years, ie every other year. Prior to that, data were collected annually. The change in Statistics Finland's business statistics system slightly weakened the comparability of data before and after the statistical year 2013. In the statistical year 2019, a nomenclature change was made. The nomenclature was changed from Statistics Finland's own classification to the CN classification (Combined Nomenclature). As an example, EUBIONET III project proposed a comprehensive and detailed list of present and potential new raw materials for bioenergy. The classification was based on the identified materials but also created a proposal for a Combined Nomenclature that divides the raw materials into connected groups (Alakangas, Nikolaisen, Sikkema, & Junginger, 2011). The joint work with Eurostat in developing a wood pellet CN (combined nomenclature) code (4401 30 20) has been finalised and first European trade statistics have been published since 2009. From 2012 onwards, have also been a corresponding HS (harmonised system) code for global use. This means that trade flows of a solid biofuels can be monitored with reasonable accuracy using official statistics (Alakangas, et al., 2012). Prior to the statistical year 2019, the nomenclature of materials and supplies is based on the classification developed by Statistics Finland on the basis of the European Community's CPA 2008 industry classification of products, applied to meet national needs. The length of the code is 6-7 digits. The first four digits of code correspond to the code of the Statistical Classification of Economic Activities in the European Community (NACE Rev. 2) and thus to the first four digits of Statistics Finland's classification of economic activities TOL 2008. The variables of the industrial production materials and supplies data set are listed in Table A 3.	Statistical legislation and the data protection and confidentiality practices specified in legislation are applied in compiling and releasing the data. The releasing of microdata is subject to a user licence. The price of the assignment is determined on the basis of its extent, requirements and the mode of use of the data. More information is available on Statistics Finland's research services: tutkijapalvelut@tilastokeskus.fi.	The target group of the industrial production materials and supplies survey is selected from the reporting units of the Industrial Commodity Inquiry. Since the statistical year 2017, the materials and supplies survey has had its own separate inquiry. Before that, it was done in connection with a commodity inquiry. However, for the statistical years 2017 and 2019, purchases of materials and supplies have still been asked of a small group of companies in connection with the commodity survey in the spring of the year following the statistical year, when the actual survey of materials and supplies was conducted only in autumn. Data are collected from sites or from combinations of sites. The information on the combinations of sites is presented in the material in the form of single establishments, i.e. distributed programmatically to the different sites of the enterprise.	There are minor changes in the nomenclature of materials and supplies from year to year, but not every year. For this reason, it is often not possible to compile comparable statistics between years using an accurate nomenclature. At a more aggregated heading level, e.g., at the 4-digit level of the heading (TOL 2008 level) or the 6-digit level (CPA level), statistics can be compiled between years. Statistics Finland calculates the value of domestic material consumption as part of the annually statistics on economy-wide material flow accounts. The consumption of domestic materials includes materials taken into use from Finnish nature, to which the weight of imported goods is added and from which the weight of exports is subtracted. The material intensity is obtained as a ratio of domestic material consumption to GDP. Both domestic material consumption and material intensity are among the UN's indicators for sustainable development.	Data on materials and supplies are inquired from all manufacturing establishments of enterprises with at least 20 persons (i.e., employees and entrepreneurs) and in certain cases smaller enterprises than this. The data supplier unit is an enterprise or an establishment of an enterprise, whose main activity is in manufacturing (in the industries mining and quarrying = industry B or manufacturing = industry C). Thus, even establishments of non-industrial enterprises engaged in industrial activity are included in the inquiry. The size of the target group has been 2,000–2,400 enterprises / sites each statistical year. The response rate has varied between 60 and 70%. The data describe production in Finland during a calendar year. The quality and coverage of materials and supplies data are inferior to that of import data and are not imputed accordingly. In the data collections prior to the statistical year 2019, quantity data were also asked for purchases of materials and supplies made for manufacturing production. In addition, total use for certain material and supply headings during the calendar year were asked, regardless of the year of purchase or acquisition. Total use included materials and supplies purchased from outside the enterprise (legal unit) and products prepared for further processing in the enterprise. In order to reduce the response burden, questions on quantity data and total use were discontinued since the statistical year 2019.	-

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
5.2 Industrial output	The statistics on industrial output contain data on sold and total outputs by commodity heading. The data are collected annually from enterprises or their establishments in the industry classes of Mining and Quarrying B, and Manufacturing C. Data are inquired on the value and volume of all goods produced by an enterprise / establishment and sold outside the enterprise. The units used for measuring physical volumes vary according to commodity heading, and there are nearly 40 units in use. In addition, data are inquired on the volume of total output of certain separately defined commodities (in the case of vessels, the value of total output).	The data are collected from enterprises or establishments of enterprises. The data describe production in Finland during a calendar year. An establishment refers to an economic unit owned or controlled by one enterprise that produces goods and services of mainly one particular type usually at one location. Because the data describe unit-level business activity, the use and release of the data are subject to general rules on data control. Value and quantity data for certain categories of commodities are encrypted at the request of the reporting enterprises. The number of companies is confidential information in all production items. From a company's or establishment's total production, it has been asked the values and usually also the quantities of production sold outside the company during the calendar year. In addition, the quantities of total production have been asked for separately defined products. The enterprises and establishments of the industrial output inquiry have been selected so that the representativeness requirement imposed by the EU's PRODCOM Regulation, or at least 90% of the production value of each manufacturing industry must be included in the statistics. Thus, information on manufacturing production is, as a rule, collected from all establishments of enterprises with at least ten persons. In addition, in some manufacturing industries the inquiry also includes some smaller establishments of enterprises in order to fulfil the EU's representativeness criteria. The size of the population has been around 3,000 to 3,500 sites in recent years.	The data supplier unit in the statistics on manufacturing commodities are all manufacturing enterprises with at least 10 persons (ie employees and entrepreneurs), all manufacturing establishments of non-manufacturing enterprises with at least 20 persons, and even smaller enterprises so that at least 90 per cent of the production value of each manufacturing industry will be included in the statistics. The data supplier unit is an enterprise or an establishment of an enterprise, whose main activity is in manufacturing (in the industries mining and quarrying = industry B or manufacturing = industry C). Thus, even establishments of non-industrial enterprises engaged in industrial activity are included in the inquiry. Since 1997, the classification of commodity headings referred to in the industrial production statistics has been based on the PRODCOM classification of industrial production of the European Union updated annually. The PRODCOM classification contains 8-digit product headings. The PRODCOM classification did not include all product groups, for which reason it was supplemented with additional national headings. Some of the PRODCOM headings were also divided into national subheadings. The national product heading codes comprise 10 digits. The first four digits of the codes correspond to the code of the standard industrial classification of the European Communities (NACE Rev. 2) and thus to the first four digits of Statistics Finland's industrial classification TOL 2008. The first six digits of the code correspond to the Classification of Products by Activity (CPA) of the European Communities. Starting from the statistical reference year 2019, the European Union's CN nomenclature (Combined Nomenclature) is used as the nomenclature of the inquiry. The CN nomenclature is the eight-digit classification of goods used in statistics on foreign trade. The variables of the industrial output data set are listed in Table A 4.	Statistical legislation and the data protection and confidentiality practices specified in legislation are applied in compiling and releasing the data. The releasing of microdata is subject to a user licence. The price of the assignment is determined on the basis of its extent, requirements and the mode of use of the data. More information is available on Statistics Finland's research services: tutkijapalvelut@tilastokeskus.fi.	The target group of the inquiry is formed mainly from Statistics Finland's Register of Enterprises and Establishments. The latter provides new enterprises and establishments for the statistical year, as well as closure and other change data for all observation units compared to the previous year, as well as data describing the size by reference period. The statistics also cover subcontracting companies that carry out contract manufacturing on behalf of another company. The statistics only apply to the production of the enterprise (legal unit) in Finland. Data are collected from sites or from combinations of sites. As of 2013, the information on the combinations of sites is presented in the material in the form of single establishments, ie distributed programmatically to the different sites of the enterprise. RIVIVÕÄl From the statistical year 2005, the response burden of the smallest industrial enterprises in inquiries was reduced to almost half. In order to reduce the response burden, a group of 10-19 industrial enterprises, of which there are about 1,550 in Finland, a set of survey frames was formed, from which a representative rotational sample is taken annually. Each small enterprise is included in the survey as a rotational sample in either even or odd statistical years. However, companies that have not responded in their own round to the survey (survey unit loss) are included in the survey for as long as they respond. The response data of the companies on hold from the survey are imputed (estimated by statistical methods) into the total statistical data programmatically. In the evaluation method, one general multiplier is first calculated. It is based on the average annual change in the survey response data (statistical year vs. previous year). The calculation of the multiplier takes into account the companies appearing in the response data in both years and the identical production items appearing in both years. From this synchronized set of observations, those observations in which the change in value / quantity has not been within moderate limits, in one direction or another, are removed. The multiplier is calculated separately for value and for quantity data. This general multiplication factor therefore does not depend at all on the industry or the PRODCOM heading. For the small companies on hold from the survey, any item changes between the consecutive years will first be taken into account. This is done in proportion to the response data of enterprises of all sizes appear in the most recent statistical year. This item-specific information is multiplied by the general multiplication factor, the value information by its own factor and the quantity information by its own factor. This gives the product name-specific value and quantity data for the company / establishment on hold from the survey, imputed for the statistical year. The patched response data of small industrial enterprises of 10-19 people are included in the unit-level aggregate, in addition to the genuine inquiry responses of enterprises and sites. The statistical year 2008, when the new Industrial Classification TOL 2008 and the revised PRODCOM nomenclature were introduced, was exceptional in the survey of small enterprises: all 10-19 person industrial companies were included in the survey. In addition, individual physical target data missing from the inquiry responses are estimated in different ways, but they can be missing from the final data also. The missing response data from the companies not answering the survey are estimated. This assessment is mainly done programmatically, partly also manually.	There are minor changes in the nomenclature of materials and supplies from year to year, but not every year. For this reason, it is often not possible to compile comparable statistics between years using an accurate nomenclature. At a more aggregated heading level, e.g., at the 4-digit level of the heading (TOL 2008 level) or the 6-digit level (CPA level), statistics can be compiled between years. The products0419_prodcom2019 file is available separately, where the main corresponding product code of 2019, if any, has been retrieved for the product codes of different years using the classification keys.	The response rate of the industrial output inquiry has been about 70–90% annually. The smallest 10–19 person industrial companies or their sites have the lowest response rate. If response data are not obtained directly from the reporting enterprise, the aim is to assess the data in as many cases as possible on the basis of the previous year's commodity response data and the financial statements for that statistical year. Often, the information on the company's product range found on the company's website can also be used to help select suitable product items.	-

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
5.3 Environmental protection activities	The statistics on industrial environmental protection expenditure describe the expenditure arising from environmental protection to industry. The statistics show the magnitudes of investments in environmental protection and operating expenditure by industry and use (by sector of environment). The statistics is intended for the needs of social decision-making, companies and their interest groups, and research. The statistics make it possible to compare expenditure on environmental protection between different industries. The statistics follow the statistical principles formulated by the EU's statistical office, Eurostat, which ensures the comparability of the data with the corresponding statistical data of other European countries and international organizations.	The data required for industrial environmental protection expenditure statistics are collected through an annual survey sent to around 2000 industrial sites. The survey concerns environmental protection expenditure incurred in the previous year and can be answered either on paper or on the Internet in electronic form. In the database based on Statistics Finland's register of enterprises and establishments, the basic framework of statistics consists of enterprises of at least one person whose industry is mining and quarrying, industrial manufacturing, energy supply or water purification and distribution. The survey covers the following sections of the industry classification TOL 2008: • B Mining and quarrying (05–09) • C Industry (10–33) • D Electricity, gas, steam and air conditioning supply (35) and • from Section E - Water collection, treatment and supply (36).	The statistics cover industrial industries, ie mining and quarrying, industrial manufacturing and energy supply, water treatment and distribution, sewage and waste management, households and the state and municipalities. The industry breakdown is in accordance with Statistics Finland's classification TOL 2008 based on the EU standard (Industry Classification 2008, Statistics Finland, Manuals 4, Helsinki 2008). Statistics on environmental protection expenditure include: • environmental protection investments • operating and maintenance costs of environmental protection equipment • other operational expenditure on environmental protection, such as research and development expenditure, administrative expenditure and miscellaneous charges and compensation Investments in environmental protection include investments to reduce and treat emissions. Measures to reduce emissions change the production process in such a way that the formation of emissions from production in relation to production volumes is reduced. Investments in environmental protection intended to treat emissions are purifiers and other accessories or solutions, the introduction of which does not substantially change the production process itself. Environmental protection is defined in these statistics as an activity intended to reduce harm to the physical environment or which is essentially related to the reduction of such harm. Such measures include, for example, the treatment of emissions and waste, the prevention of their generation, environmental monitoring and control, environmental management, training and information, remediation of environmental damage and research and development to reduce the environmental impact of production. In these statistics, material efficiency such as switching to renewable energy or recycling, energy saving and occupational safety measures are not included in environmental protection. The variables of the environmental protection expenditure accounts data set are listed in Table A 5.	Statistical legislation and the data protection and confidentiality practices specified in legislation are applied in compiling and releasing the data. The releasing of microdata is subject to a user licence. The price of the assignment is determined on the basis of its extent, requirements and the mode of use of the data. More information is available on Statistics Finland's research services: tutkijapalvelut@tilastokeskus.fi.	Environmental protection expenditure is recorded on the basis of its allocation, in accordance with the CEPA 2000 international classification of environmental protection measures and costs. (Classification of Environmental Protection Activities and Expenditure). CEPA categories include wastewater management, waste management, air protection, nature protection, and administration and other environmental protection. All enterprises with at least 250 employees are included in the inquiry. Stratified sampling is used for enterprises with fewer than 250 employees. The statistics include the industries of mining and quarrying, manufacturing, energy supply and water supply. The data supply obligation of enterprises is based on the Finnish Statistics Act (280/2004, Section 14).	The answers for the industrial environmental protection expenditure inquiry are checked at Statistics Finland to minimize measurement errors. Non-response is taken into account when increasing the data to cover all industrial activities in Finland.	Due to the sampling nature, there are always statistical uncertainties associated with the results. However, the sampling design used aims at obtaining comprehensive and more reliable statistics on the environmental costs of large industrial enterprises, which are the most significant. The response rate to the questionnaire sent to around 2000 sites has been 70–80% in recent years.	-
6 Built environment								
6.1 Built environment information system RYTJ	Built environment information system is a new national data system that will bring together the most relevant building and land use information. A new system is needed to produce up-to-date, high-quality, reliable information about the built environment. The development of the system is based on the objectives set on the government program about digitalization of built environment. The data system is to be utilized in the decision-making and processes related to land use planning and building. The system creates new opportunities to use information in both public administration and business and facilitates the access to information about planned changes in the area for anyone who is interested. The development and construction of the minimum viable product of the built environment information system is scheduled to be done in a four-year period 2020-2023.	Information on zoning plans and building permits will be compiled and processed into a coherent and accessible form. The system is designed to work with other platforms, and they can retrieve information from each other. Municipalities submit land use and building data in a defined standardized format. In the future, so-called core data on land use planning and buildings (e.g. use, planning permission) would be available in this new platform, from which other state information systems or other organizations in need of information would retrieve them. In turn, the new system uses e.g. real estate, apartment, owner and infrastructure data from other systems.	The platform consists of two data resources, one for building data and one for land use planning. In the first phase, the information will be used by the public administration in its statutory activities. The renewed Land Use and Building Act defines the information that must be obtained in digital form in the future. According to the current plan, the data to be exported to the built environment information system are: Land use planning: • Information on the stage of the plan • Plan proposal as a data model • Approved plan as a data model • Legally valid plan as a data model • Description of the plan • Information about building ban • Information about building restriction • Information about action restriction • Plot allocation plan • Plans for common areas • Building order • Urban development plan • Municipal land policy program and municipal land policy summary Building permits: • Building permit decision • Landscape-work permit decision • Demolition permit decision • Exemption permit decision • Construction site plan data model • Construction site realization data model • Operation and maintenance instructions for the subject of the building permit The data are stored only once, in an agreed format, in the national system, where they are up-to-date and reliably available to all systems.	In the first phase, the information will be used by the public administration in its statutory activities, but eventually through the system different actors can receive necessary land use and building information, for example: • Decision-makers receive more detailed information for assessment and foresight, which guides the use of areas and properties. • The municipality receives information that can be used, for example, to assess the need for repairs in the municipality's properties in the near future. • The owner of the building receives the core information of the site (e.g. building right and planning of the surrounding area) and can maintain, for example, repair information related to the renovation of the building. • The rescue department receives information about the specific features of the site, such as conservation decisions. • The tax authorities receive up-to-date information, for example, on property taxation. • Companies receive information for service development.	-	The development of the system has only just begun. SYKE is responsible for the development work. The definition of implementation will be clear by the end of 2021. The technical implementation takes shape during 2021. The progress of the project can be followed on the Ministry of the Environment website: https://ym.fi/ryhti (in Finnish). The development and construction of the minimum viable product of the built environment information system is scheduled to be done in a four-year period 2020-2023.	Opportunities relevant for circular economy: • Decision-makers receive more detailed information for assessment and foresight, which guides the use of areas and properties. • The municipality receives information that can be used, for example, to assess the need for repairs in the municipality's properties in the near future. • The owner of the building receives the core information of the site (e.g. building right and planning of the surrounding area) and can maintain, for example, repair information related to the renovation of the building. • Companies receive information for service development.	-

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
6.2 Emission database for building products, services and systems, CO2data.fi	The CO2data.fi online service provides objective data on the climate impact of construction products used in Finland, such as carbon footprint and handprint, material efficiency and recyclability. The data harmonises the calculation of greenhouse gas emissions throughout the life cycle of buildings and facilitates the design of a low-carbon building. The database was published in March 2021 and is still being developed.	The data are based on public sources, mainly environmental declarations for construction products, on the basis of which comparisons, selection and calculation of averages have been made together with experts in the construction products industry. The Finnish Environment Institute SYKE is responsible for maintenance and development of the database on behalf of the Ministry of the Environment. Emission data has been compiled into easy-to-use results pages (see Figure A X), in addition to which more detailed background studies can also be found. All data is also available in machine readable format (json-file).	The database shows, among other things: • the carbon footprint of construction products • the carbon handprint of construction products • the scenarios for the recycling and recovery of construction products at the end of their life cycle • the waste percentages on construction sites • the technical lifetimes of frequently replaced products • the transport emissions data • the construction emissions data • emission data for different forms of energy and scenarios for the development of their carbon footprint for the coming decades • emission data on waste treatment The database contains only general and typical information describing Finnish construction. It does not contain information about individual products or companies. The data in the database have been compiled by the Finnish Environment Institute SYKE in collaboration with environmental experts and construction professionals. More than 100 experts and professionals have participated in the creation of the database. The database is based on existing public information and has been compiled from various sources, mainly environmental statements (including RTS EPD, EPD Norge, Environdec, IBU, other generic data if necessary, e.g., ÖkobauDat, ICE, VTT, IVL). Based on this, comparisons, selection and calculation of averages have been made. Industry expert groups from different product categories have been involved. Data on construction, transport, demolition and waste management are mainly based on Finnish statistics and surveys. The database has been created together with the Swedish authorities and experts. Database information is updated regularly/yearly based on feedback received.	The service is open to everyone free of charge.	Currently data is available both in simple user interface CO2data.fi and in machine readable format (json-file) from https://co2data.fi/api/co2data_construction.json.	Database coverage will be enlarged to include infrastructure construction and a more advanced API will be developed. More data will also be added based on user feedback i.e., when new generic products gain market share and environmental importance.	Identified in future developments.	The Finnish Environment Institute SYKE is responsible for maintenance and development on behalf of the Ministry of the Environment.
6.3 Construction and demolition waste	Construction and demolition waste is monitored nationally and for EU, however, the monitoring is less precise than monitoring of MSW.	The amount of waste produced in the construction sector in Finland is available in the national waste statistics by Statistics Finland (Statistics Finland, 2021b). In the waste statistics, the recycling rate or the treatment types for waste from construction sector is not available. SYKE and Statistics Finland compile data to monitor the development in recycling of MSW as well as construction and demolition waste towards the European targets. The data is available in CKAN database supported by environmental administration (link) (Merilehto & Salmenperä, 2021). The recycling rate calculated with WStat calculation method excludes soils.	National waste statistics and EU reporting on MSW as well as construction and demolition waste are available with a delay of 1.5 years. By the time of the writing, the data for 2019 is the most recent. The data are updated annually. The data is used for EU reporting, so the monitoring is expected to be continued in the future as well.	The data is publicly available free of charge.	-	Construction and demolition waste is one of the largest waste types in Finland. It is also one of the focus topic areas in the National Waste Plan. The EU has set targets on the recycling of construction and demolition waste. Thus, it is expected that the monitoring of both the production and utilisation of construction and demolition waste will be improved in the near future.	Currently there are considerable uncertainties in the monitoring of construction and demolition waste. Local data on waste streams could enhance the utilisation of construction and demolition waste.	-
7 Plastics								
7.1 Study on secondary plastic flows in Finland	Finnish Environment Institute SYKE has developed a model for estimating the secondary streams of plastic waste in Finland in a project *ALL-IN for Plastics Recycling (PLASTin)* and a mass balance for plastic flows in a project *Novel method for the accounting of forest ecosystems and circular materials (ENVECO)*. The estimate consists of data from national statistics, research projects and business sector.	The estimate on plastic waste streams is produced by SYKE, however it combines data from various national sources. Data on production of waste is rather well available, however, the use of secondary plastics in products, rejects in treatment processes, diffusion to nature (e.g., littering) and exports are poorly known. The overall data is openly available, yet some of the background data cannot be opened due to business secret. The estimate will be published as the project proceeds. The data is intended for open use for all stakeholders interested to positively contribute to the circular economy of plastics.	The data is shown as a flow chart which separates the different processing steps and plastic waste streams in the most detailed way possible. Updating the estimate is uncertain and depends on the future research activities. The accuracy of the data is monitored by offering the data for individual experts and stakeholders to assess.	The compiled, national data can be found in the report that is available online free of charge.	Manual compilation from multiple sources: - open data bases (e.g. waste statistics) - databases with limited access (e.g. YLVA database) - interviews with individual companies	There is a lot of attention towards the use of plastics as well as plastics waste globally due to its effect on climate as well as littering. In Finland, recycling of plastics from households has high potential in increasing the recycling rate of municipal solid waste to reach the EU-wide targets.	Since plastics are a diverse group of materials with different qualities and different paths in the recycling system, a more detailed knowledge on the streams of different types of plastics would be needed. In addition, more data on the use of secondary materials could be beneficial for circular economy.	Finnish Environment Instute SYKE.
8. Other data sources for the circular design approaches								
8.1 Geographic data on circular economy in Liiteri database	Finnish Environment Institute SYKE has built a geographic data tool that allows geographic visualisations and analyses on a variety of statistics. So far, the data related to circular economy is limited to accessibility of collection points, methane gas vehicle fuel stations and e-car charging stations. However, many of the data sets available in Liiteri have indirect connection to circular economy.	The service is one of Finnish Environmental Institute SYKE's data services. As the service can to large extent used without any fees, the service is available for everyone. The statistics used in Liiteri are open data sets produced by a number of Finnish organisations.	Liiteri has data related to climate, traffic, extraction of soils, land use, built environment etc. that is closely linked to circular economy. Liiteri consists of hundreds of map levels and over a thousand statistical data sets.	The service can be used without registration for basic browsing, as a registered used for more functionalities and as a service client with a fee, when one has a full functionality of the service in use. See: https://liiteri.ymparisto.fi/.	One can browse all the data sets in Liiteri and analyse them based on official geographic regions, such as municipalities, or define an individual geographic area to be studied. In addition to this, Liiteri service offers service packages covering different themes relevant to many users to make using Liiteri easier and more approachable for different user groups. Service packages are available e.g. related to climate change, cultural environment and planning of water management.	Liiteri service is constantly updated and improved. Circular economy is seen as a key strategic field development in Finland. As more official data on circular economy is available, it is possible that it would also be added to Liiteri.	The data sets related to circular economy are at the moment scarce. Geographical data on material streams would be particularly useful for circular economy.	Finnish Environment Instute SYKE.

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
8.2 Accounting of water use	Water accounting has been developed for monitoring and modelling water use and efficiency in Finland. The accounting describes the intake of both surface and ground water for domestic consumption, industry, cooling and irrigation in the Finnish economy. The publicly utilized information is available at vesi.fi portal.	In Finland, the municipal water authorities supply fresh water and process the sewage water. The usage of these is monitored carefully by the municipal water authorities, and the amount of these is the principal for the billing of the customers. Private wells are not monitored officially and the water quality is on their owners responsibility, just as well the amount of water used and the adequacy of the water source. The legislation regarding warm water usage monitoring was renewed in 2020. The new law requires that the water usage is monitored more carefully with user-specific water meters. (Motiva Oy, 2020)	-	Data of water usage by manufacturing companies is seen as confidential information, and it is owned by the manufacturing organizations. For example, in the recent studies by Salminen et al., the researchers could access the data for research purposes, but it is not published openly and regularly for anyone to access. Anyhow, some of the companies publish these figures as a part of their annual reports. It would be interesting to discuss, if the openness of water usage data should be included in the demands of responsible, sustainable organizations.	-	-	Regarding water consumption, about half of the Finland's water usage is so called virtual usage, where the consumption of water is related to the manufacturing processes of goods that are imported to Finland. Therefore, it is important to also consider the global aspect of fresh water resources and their management in the originating countries. (Salminen, Tikkanen, & Koskiaho, 2017). From the data perspective, it would require global open data resources of water usage in different countries and their industries, drilling down to a specific level of manufacturing and firms, even unique plants of the manufacturing process. This would help both the authorities and consumers to monitor sustainable water usage.	-
8.3 Indicators for the development of circular business by Statistics Finland	Statistics Finland has collected statistics related to circular business into a collection of 15 indicators in 8 themes. The indicators are related to circular design, material intake, production, logistics, trade and service, consumption, waste as well as reuse and recycling. The data is limited by the lack of comprehensive data on circular economy as well as limitations of classification of circular business. (Statistics Finland, 2021b)	The data sets are openly available, free of charge, in Excel from Statistics Finland: http://www.stat.fi/tup/kiertotalous/kiertotalousliiketoiminnan-indikaattorit.html. The data sets are intended for monitoring of the development of the circular economy in Finland.	The data are based on official statistics. Most of the time series cover 2013−2018. Majority of the data is available on a national level, however, some of the data sets are available regionally. Updating of the data series is uncertain.	The data are openly accessible free of charge. Reference is required.	The data sets are based on numerous statistics that utilise both surveys and data from different databases.	The need for development of circularity indicators to monitor the national development is evident. The national circularity strategy has proposed similar indicators to be monitored. So far it is unclear whether the data sets will be updated in the future.	The indicators only include branches of business that can be categorised as circular. However, the transition to a circular economy takes place in all branches of business. These indicators note the development in waste management sector and services. Yet, it does not recognise the changes in traditional industries, such as chemical, mechanical or pulp and paper industry. Many of the most relevant changes that are in the core of a circular economy are taken in industries which cannot be recognised with this division of circular businesses.	Statistics Finland.
9 Waste	Data on waste can be found from many sources and databases. The national statistics (Appendix 1, Section 9.1.) describe the general picture and trends in waste generation and utilisation (Statistics Finland, 2021a). Statistics rely primarily on data provided by producers and handlers of waste in the national database of environmental compliance monitoring system (YLVA) (Appendix 1, Section 9.2.) (Ministry of the Environment, 2021) and the producer responsibility statistics collected by Pirkanmaa Centre for Economic Development, Traffic and the Environment with producer responsibility organisations (Appendix 1, Section 9.3.) (Pirkanmaa Centre for Economic Development, Transport and the Environment, 2019). The development of waste amounts and recycling according to the National Waste Plan is monitored by Finnish Environment Institute SYKE (Appendix 1, Section 9.4.) (Finnish Environment Institute SYKE, 2021). In addition to these, there is data on transboundary shipments of waste, collected by SYKE (see Appendix 1, Section 1.8.10.) and the Finnish Customs (see Appendix 1, Section 1.9.). Some waste-related data can also be found in other sources, such as National Resources Institute Luke's data on food waste and Food Safety Authority's database on fertilizers (see Appendix 1, Section 1.6.). The national advocacy organisation for public waste management sector, Suomen Kiertovoima ry KIVO, also collects data on picking analyses on mixed municipal solid waste from households (Suomen Kiertovoima ry KIVO, 2021). Finally, different research projects provide a closer look on certain materials, waste streams or locations, or model the system further. The following sections provide basic information on the key sources of waste-related data in Finland.	-	-	-	-	-	-	-
9.1 National statistics on waste	National statistics on waste by Statistics Finland provide a general picture on the production and utilisation of waste in Finland. (Statistics Finland, 2021a) The data can be found in Statistics Finland's free-of-charge statistical databases (https://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/) under the general topic of Environment and Natural Resources and Waste statistics. The following data sets are currently available: • 12cv -- Municipal waste by treatment method in Finland • 12qw -- Waste generation by industry, 2018-2019 • 12qy -- Waste treatment by type of treatment, 2018-2019 • 001 -- Municipal waste by treatment method in 1997 to 2017 • 002 -- Waste treatment in 2015 - 2019 disaggregated by EU statistical waste classification • 003 -- Waste generation in 2015 - 2019 disaggregated by EU statistical waste classification Waste statistics are used in national steering as well as EU monitoring. It also provides valuable information on circular economy from the products' end-of-life perspective.	The statistics are primarily based on waste management data from YLVA database as well as producer responsibility statistics.	National waste statistics and EU reporting on waste are available with a delay of 1.5 years. The latest data for 2019 became available in June 2021. The data are updated annually. All the statistics can be retrieved from the database to Excel or in other standardised formats.	The data are publicly available free of charge in the open online database by Statistics Finland.	-	It is expected that the collection of national waste statistics will continue as it is part of the compulsory national monitoring. The data are used for EU reporting, so the monitoring is expected to be continued, even expanded, in the future as well. Most likely the focus on waste statistics will only increase due to the data needs in a circular economy.	More precise data on waste, such as local data on waste streams, more detailed data on different materials and data on recycling of specific materials or types of waste based on their origin, could enhance the utilisation of waste in the circular economy.	-

Data	Description	Sources of data	Data set properties	Data access	Technologies	Future developments	Gaps and opportunities	Organizations collecting and sharing the data
9.2 Production and treatment of waste in the national environmental compliance monitoring system (YLVA)	Data on waste produced, treated or stored is collected from individual actors to a national compliance database for environmental permit monitoring (YLVA). For an individual batch of waste, data required include for instance the type of waste (waste code and description), origin of waste, location of the activity, and the type of treatment. This data is available upon request and for a service fee from Finnish Environment Institute SYKE. The data is primarily used in environmental compliance monitoring by local, regional, and national authorities. (Ministry of the Environment, 2021)	YLVA database collects data on waste from actors who have environmental permits. Most, but not all, of the national waste streams are found in YLVA database.	YLVA includes data on waste streams arriving to or leaving treatment as well as storage. The waste is categorised according to EWC waste codes, and also the type of treatment follows a standardised categorisation. The database is constantly updated with new data. Also, corrections to the data are made if necessary.	The waste-related data in YLVA are mostly available for public upon request and a service fee from SYKE. Access to some parts of the data may be limited. The data are available for monitoring purposes directly and for other purposes somewhat modified upon request.	The accuracy of the data is monitored by local, regional and national authorities. The data are also used in national statistics, other monitoring and research.	There is a broad development project going on in the administration to improve the data systems for material and waste streams. YLVA database will also be further developed. Digitalisation could be utilised further so manual dialling and checking of the data could be autonomised.	Since the database is primarily constructed for compliance monitoring purposes, it is not an optimal source for waste statistics. The main problems in using YLVA's data in estimating national waste amounts are related to double-counting of individual batches of waste and the loss of data on the origin of waste. Double-counting may occur, since the batches of waste are often taken through a series of treatment steps, such as pretreatment, storage and final treatment, and the origin of the waste may be lost between the steps. One batch may be accounted first while it enters a pretreatment plant and again as it is entering an incineration plant. In addition, the geographical origin as well as the activity where the waste was produced (industry, municipalities etc.) may be uncertain.

Some significant waste streams, such as construction and demolition waste utilised directly on-site, are missing from YLVA data base. The data in YLVA consists of manually dialled amounts of waste, so there are dialling errors and mistakes there. Also, changes in the database, classification codes etc. may hinder the comparability of the data.

YLVA provides important data for national monitoring of waste management. However, it is not well-suited for local estimations of waste amounts. As the needs for a more detailed data on waste amounts and recycling are increasing, also YLVA and its data's utilisation is being developed. | Finnish Environment Institute SYKE. Ministry of the Environment. |
| 9.3 Producer responsibility statistics on waste | Pirkanmaa Centre for Economic Development, Transport and the Environment (Pirkanmaa ELY Centre) collects data on products and waste that are under producer responsibility schemes in Finland. Producer responsibility covers the following products:

1. Vehicles
2. Batteries and accumulators
3. Paper produce
4. Packaging
5. Tires
6. Electrical and electronic equipment

The producer responsibility statistics include data on the amounts of products entering the market as well as the amount and utilisation of the waste entering the producers' waste management systems. (Pirkanmaa Centre for Economic Development, Transport and the Environment, 2019)

As a practical example, the producer responsibility statistics on waste electrical and electronic equipment (WEEE) are presented in detail below. The statistics include monitoring of the amount (mass in tonnes) of WEEE provided to the domestic markets, collected from households, collected from other sources than households, recycled, incinerated, deposited, treated in Finland, treated in EU, and treated outside of EU. The data are annually updated and currently available from 2008 to 2018 (Figure A 16). The data on WEEE are also separated to a number of product categories: large household appliances, small household appliances, IT and telecommunications appliances, consumer electronics, lighting, light bulbs (excluding incandescent bulbs), electric tools, toys / sports / leisure equipment, health service equipment, surveillance equipment, and automatic dispensers. | Pirkanmaa Centre for Economic Development, Transport and the Environment is responsible for the collection of the data from producers and producer organisations. | The data sets present national data excluding the province of Åland. The data are annually updated with a delay of ca. one year. The length of the time series depends on the product type. Monitoring of paper, packaging, and tires have been carried out since mid-1990s. However, the data available currently online are shown in Table A 6.

The data are presented in pdf format available on the website. The data are also used in national statistics. | The data sets are publicly available, free of charge on the website for environmental administration, in Finnish. The data sets are available for everyone in the public website of the Finnish environmental administration: https://www.ymparisto.fi/fi-FI/Kartat_ja_tilastot/Jatetilastot/Tuottajavastuun_tilastot (in Finnish). The more detailed data on the producer responsibility schemes is not publicly available. | The producer responsibility statistics are utilised in the official national statistics on waste. | The collection and publication of these data are noted in waste legislation. The collection is thus expected to be continued, and possibly even become more detailed similarly to other waste-related monitoring in the EU. | The data on the products and waste under producer responsibility are not entirely complete, since not all the materials enter the producers' systems. In addition, Åland is not included in the national producer responsibility statistics. | - |
| 9.4 Monitoring of the National Waste Plan | Finnish Environment Institute SYKE collects the quantitative indicators for the monitoring of the National Waste Plan annually. The monitoring covers all the key topic areas in the National Waste Plan: municipal solid waste, construction waste, WEEE, and biodegradable waste. In addition to these, the monitoring includes indicators on general development in the waste sector in Finland, such as total amount of waste by sectors, the amount of hazardous waste, imports and exports of waste, development of the prices in waste transports, and employment and value added in the environmental business sector. (Finnish Environment Institute SYKE, 2021) | The indicators are based on waste statistics and data from Statistics Finland as well as producer responsibility statistics from Pirkanmaa ELY Centre. | There is a graphic summary on the monitoring available as well as Excel spreadsheets on all the indicators. | The indicator data as well as summaries on the results are openly available online free of charge in: https://www.ymparisto.fi/fi-fi/kulutus_ja_tuotanto/jatteet_ja_jatehuolto/jatesuunnittelu/valtakunnallisen_jatesuunnitelman_seuranta. | - | The monitoring of the National Waste Plan is compulsory. However, as the plan is renewed within regular intervals, there may also be changes in the indicators. | As it has been said above while discussing other sources of waste-related data, there is an increasing need for more detailed data on waste, recycling, and reuse in the transition to a circular economy. Monitoring of the National Waste Plan aims to provide information to support better regulation. This would benefit from more detailed data on the individual measures taken into action. | - |