SECTOR-WIDE CIRCULARITY ASSESSMENT

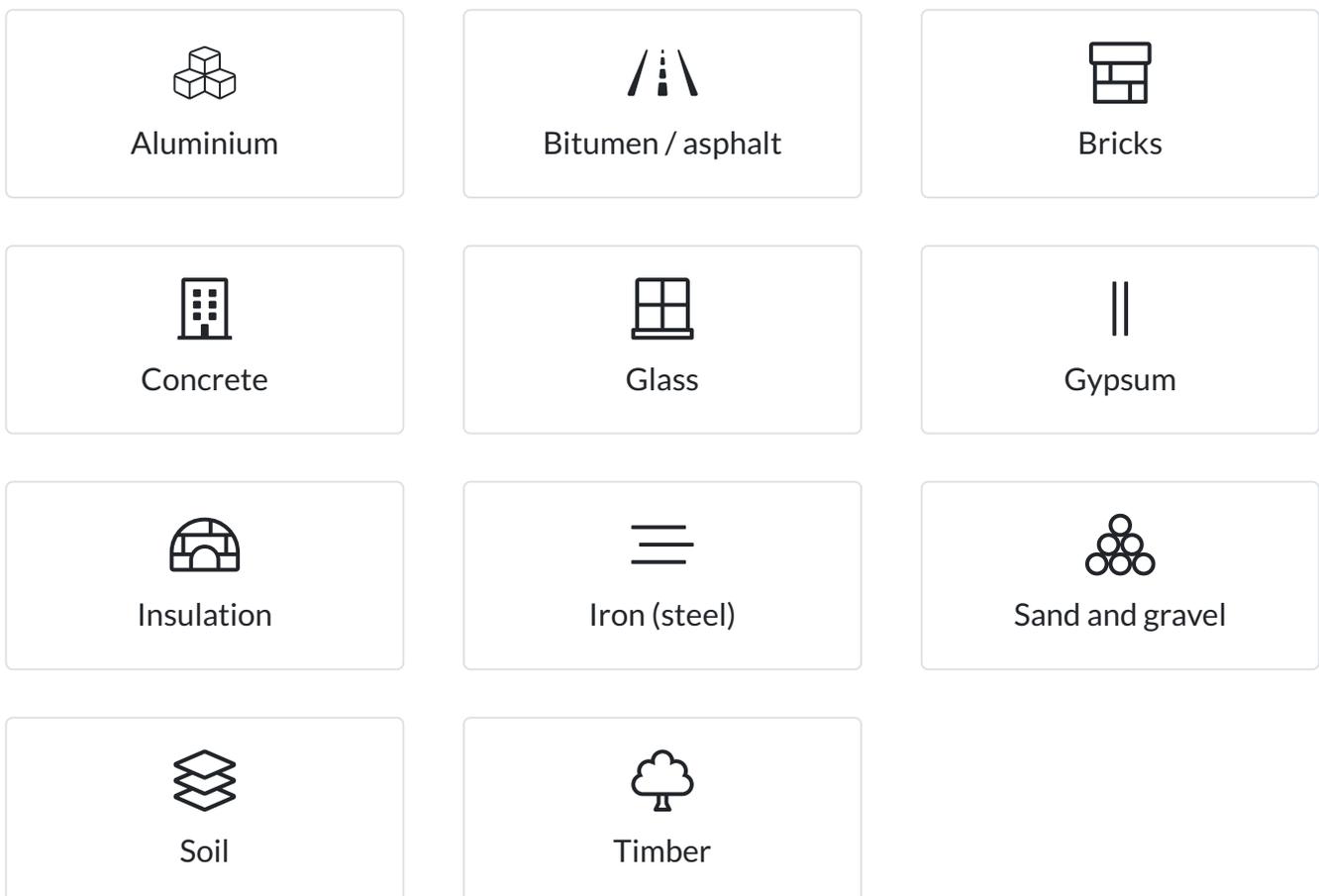# FOR THE CONSTRUCTION SECTOR

MIKKELI

CITYLOOPS

METABOLISM OF CITIES

Introduction

The EU Horizon 2020 funded CityLoops project focuses on closing the material loops of two central sectors of any city in terms of material flows, societal needs and employment, namely the construction and biomass sectors. Due to their sizes, they represent a considerable opportunity for cities to transform their metabolism and economy towards a more circular state.

Within this project, seven European cities, amongst those also the City of Mikkeli are planning to implement demonstration actions to kickstart their circularity journey. To better understand what the current circularity status quo is, as well as the impact of these actions, and the efforts needed to transform their sector, a [Sector-Wide Circularity Assessment](#) method was developed. This method combines a circular city and circular sector definition, a material flow and stock accounting method, as well as circularity indicators. The sector itself was defined in terms of a number of representative materials that make up a large share of the sector and associated economic activities. The construction sector is made up of 11 materials, depicted as icons here, which were studied along the entirety of their supply chains. Altogether, these elements help to set a solid knowledge and analytical foundation to develop future circularity roadmaps and action plans.

Aluminium	Bitumen / asphalt	Bricks
Concrete	Glass	Gypsum
Insulation	Iron (steel)	Sand and gravel
Soil	Timber	

The assessment was carried out by the cities themselves after receiving extensive training in the form of courses on data collection ([construction](#) and [biomass](#)) and [data processing](#). Numerous additional insights can be found in the individual [Data Hubs](#) of each city.

This current Sector-Wide Circularity Assessment report provides contextual information on the city and the economic sector under study. It then illustrates how circular these sectors are through circularity indicators and a Sankey diagram. Finally, it analyses and interprets the results, presents the limitations from the data used and offers recommendations about how to make this sector more circular.

(* The italic texts in this report were written by [Metabolism of Cities](#)' Aristide Athanassiadis and Carolin Bellstedt. They provide relevant general information and serve as connecting elements of the single report parts.)

Urban context

To contextualise the results of the sector-wide circularity assessment, this section provides population and land use information data of the city. In addition, population and area of the city under study, as well as its corresponding NUTS3, NUTS2 and country were included. Data for these scales were added to better understand how relevant and important the approximations are when downscaling data from these scales to a city level.

Mikkeli

👥 53,134

📐 3,229 km^2

Etelä-Savo

👥 144,615

📐 19,130 km^2

Pohjois- ja Itä-Suomi

👥 1,278,237

📐 236,450 km^2

Finland

👥 5,525,292

📐 390,908 km^2

Population of Mikkeli

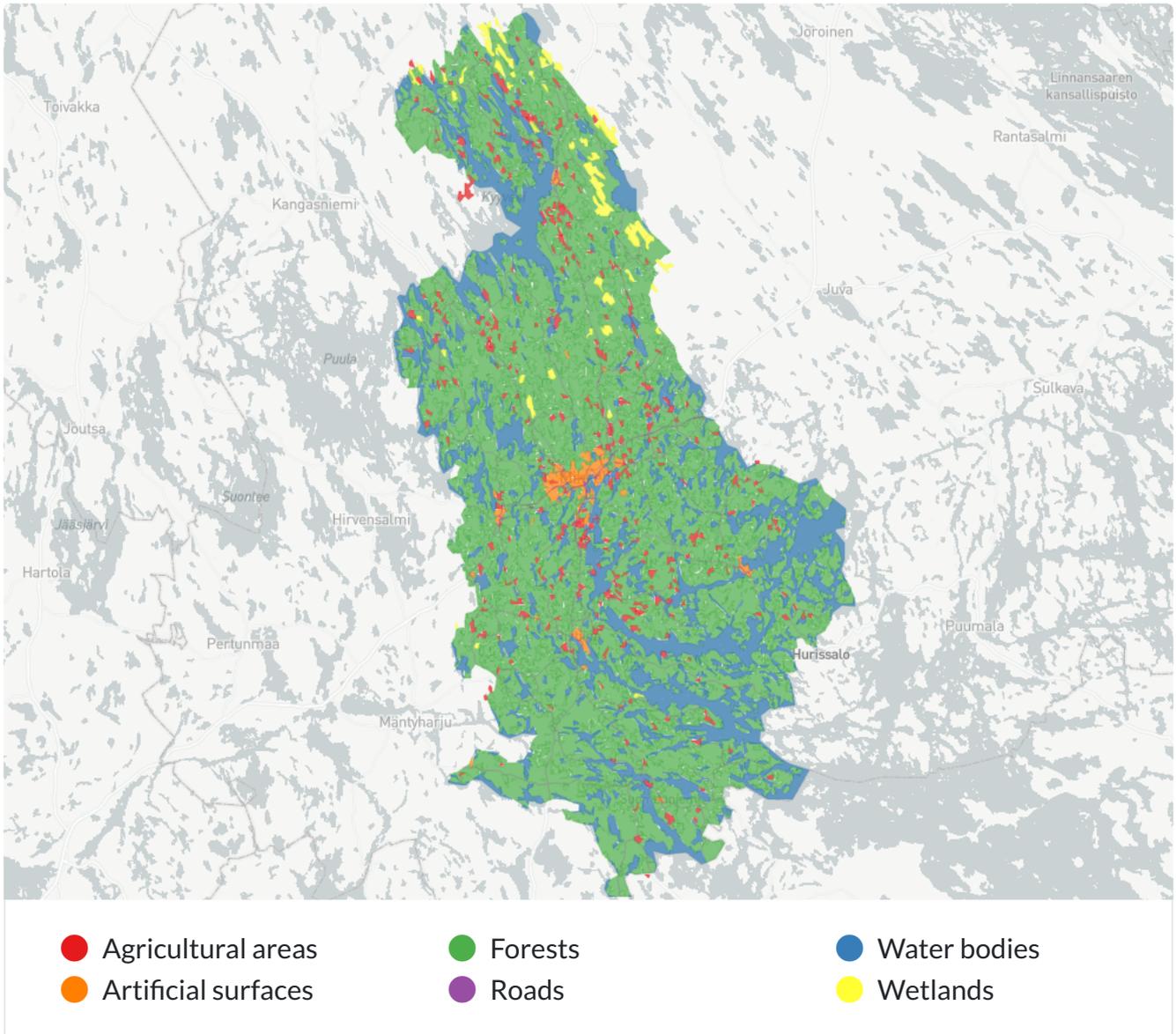Population of Mikkeli in years 1994–2019

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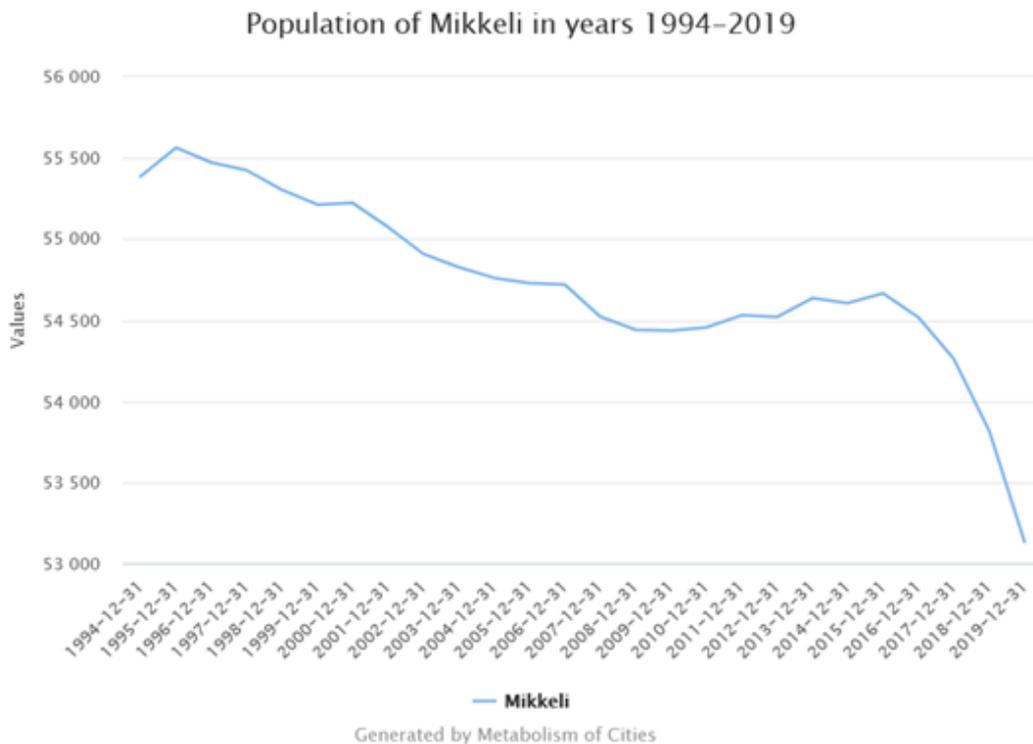
Data source

In year 2019, there was 53 130 inhabitants in the city of Mikkeli, of which 13.9% were aged 0-14, 60.2% were aged 15-64 and 25.7% were over 65 years old. The population of the city of Mikkeli has been slightly declining in the 21st century, but since 2016 the population change has clearly accelerated and the city lost almost 1 400 people between 2016 and 2019. The negative demographic development of the city of Mikkeli is largely the result of two components: natural demographic change has accelerated slightly, but especially outward migration (particularly emigration of young adults) has increased considerable in 2016-2019. In 2019, Statistics Finland published a new population forecast for the city of Mikkeli. The city's population is predicted to decline by 11 % by 2040. (Kumpusalo 2020, Mikkeli Development Miksei Ltd)

In 2018, Mikkeli was the 18th largest city in Finland by population. (City of Mikkeli website)

Land use

● Agricultural areas   **● Forests**   **● Water bodies**
● Artificial surfaces   **● Roads**   **● Wetlands**

There are various living environments in Mikkeli. These include a growing downtown area, developing agglomerations and the quiet of the rural area. Living in Mikkeli is divided in two main area types: city/agglomerations and dispersed habitat/rural area. There are numerous summer cottages at the lake- shores of the rural areas. There are around 700 lakes and ponds in Mikkeli and water covers 424.7 km2 (13 %) of the city. (Riihelä et al. 2015)

Forests and other natural areas account for 89.6% and agriculture for 5.8% of Mikkeli's land area. (Use of land in Mikkeli for extraction and harvesting, agriculture and forests 2018)

Economic context of construction sector

This section puts into perspective the economic context of the sector under study. It describes how many people are employed in this sector, as well as who the main actors involved (from all lifecycle stages for the sector's materials) are.

	GVA (monetary value, in €)	Employees
Mikkeli	141,000,000	1,307
Etelä-Savo	272,000,000	3,515
Pohjois- ja Itä-Suomi	3,227,000,000	9B
Finland	14,978,000,000	167,861

The construction sector in Mikkeli

The construction sector employs 11,2% of employees in Mikkeli. The corresponding percentage for the whole country is (7%). The most significant employment sectors in Mikkeli are industry (22,6%) and wholesale and retail trade (17,6%). Construction accounts for about 10% of Mikkeli's net sales. Based on turnover, the most significant industries in Mikkeli are wholesale and retail trade (28%) and industry (26%). (Data of Statistics Finland on industries and employees in Mikkeli) Data is from year 2018 (GVA and employees data from reference year 2019 was not available).

In Mikkeli, the largest construction projects are often managed by national companies and employees can also come from outside the area. According to the 2019 statistics, the number of new buildings in Mikkeli was 171 and the total floor area was 19,994 m2. About half of the floor area (48 %) was residential buildings. 76% of the house types were detached houses, 21% terraced houses and 2% apartment buildings.

Number (and square area) of new buildings by typology in Mikkeli

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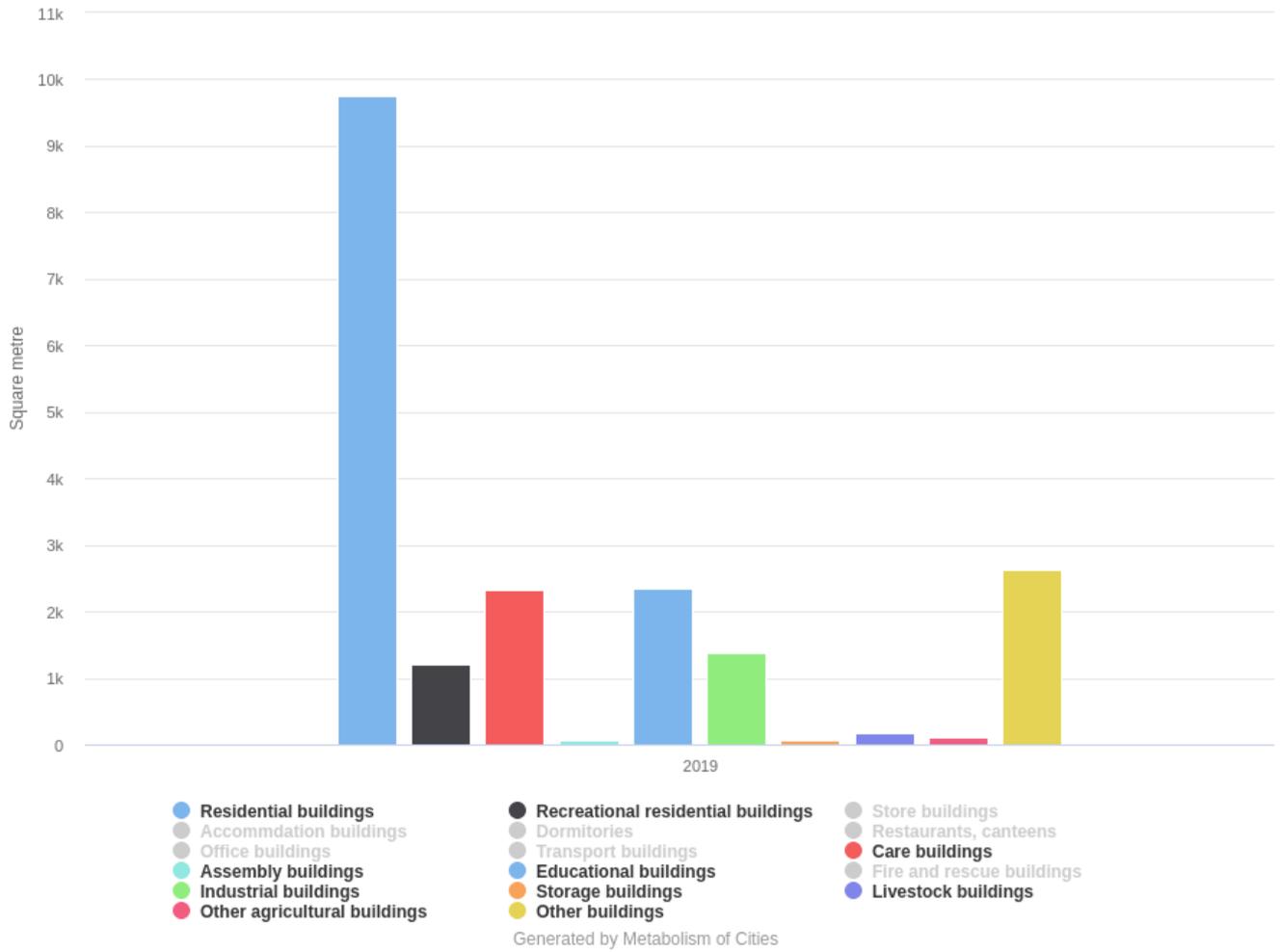
Data source

The actors of the construction sector
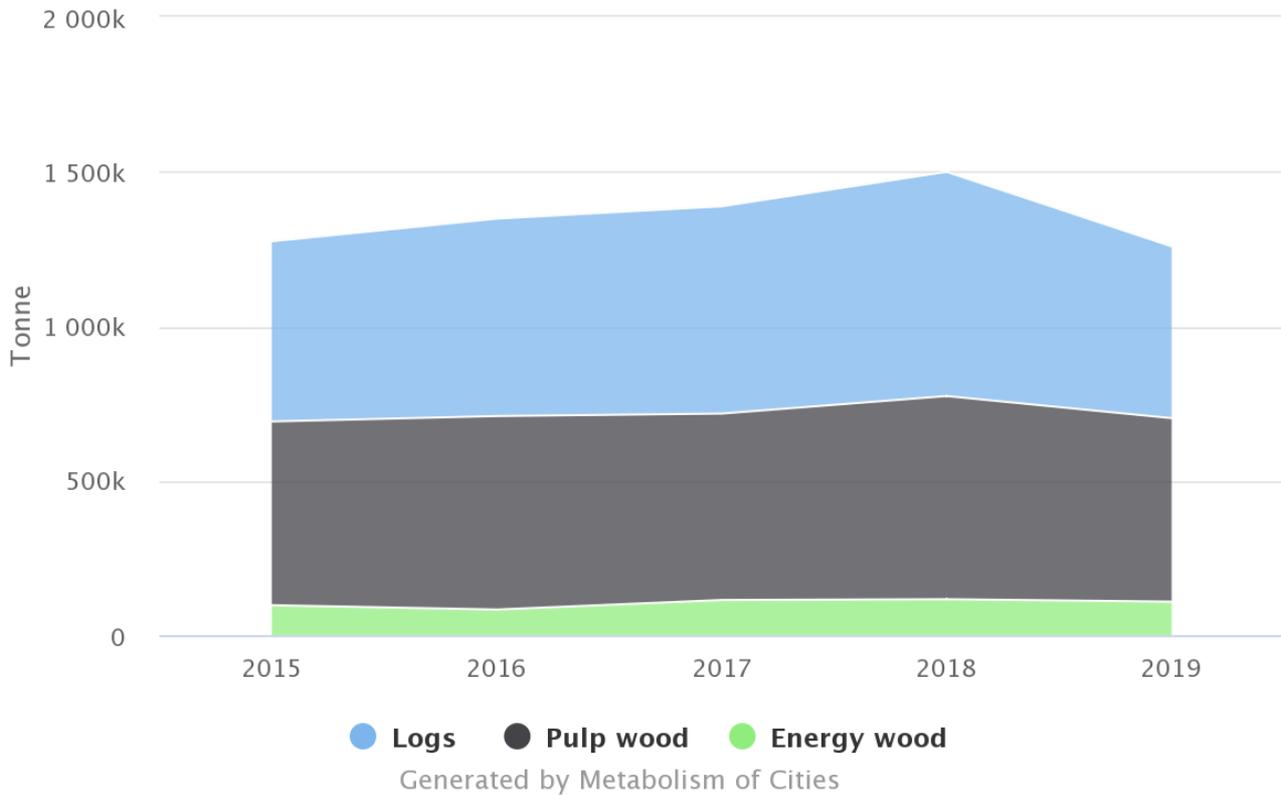

Data source

The actors of construction sector were listed by using data of Statistics Finland, where the total number of actors, employees as well as economical information are given by NACE-codes (EU classification of economic activities): (Industries and employees in Mikkeli 2013-2018).

Also A list of actors in Mikkeli by Nace codes was available. However, the list is not totally coverable and some important actors are missing from this listing. Information was collected from companies webpages as well.

Extraction and harvesting

Forests and forest-based industries are very important source of economic well-being in Southern Savonia. The incomes from the harvesting of province´s forests are the highest in the country. The forests are mostly owned by private forest owners. (Metsäkeskus 2020)

Amount of harvested wood in Mikkeli

Generated by Metabolism of Cities

Data source

Mikkeli has a total of 52 soil extraction permits for gravel and sand, 35 for stone materials and 8 for other materials. Materials are used for construction and for manufacturing of concrete. There are no statistics on actors available, but e.g. Metsähallitus, concrete manufacturers and earthwork companies own extraction sites. (Data on soil extraction pemits and amount of extracted rock and gravel in Mikkeli)

Data source

Amount of extracted rock and gravel in Mikkeli

Generated by Metabolism of Cities
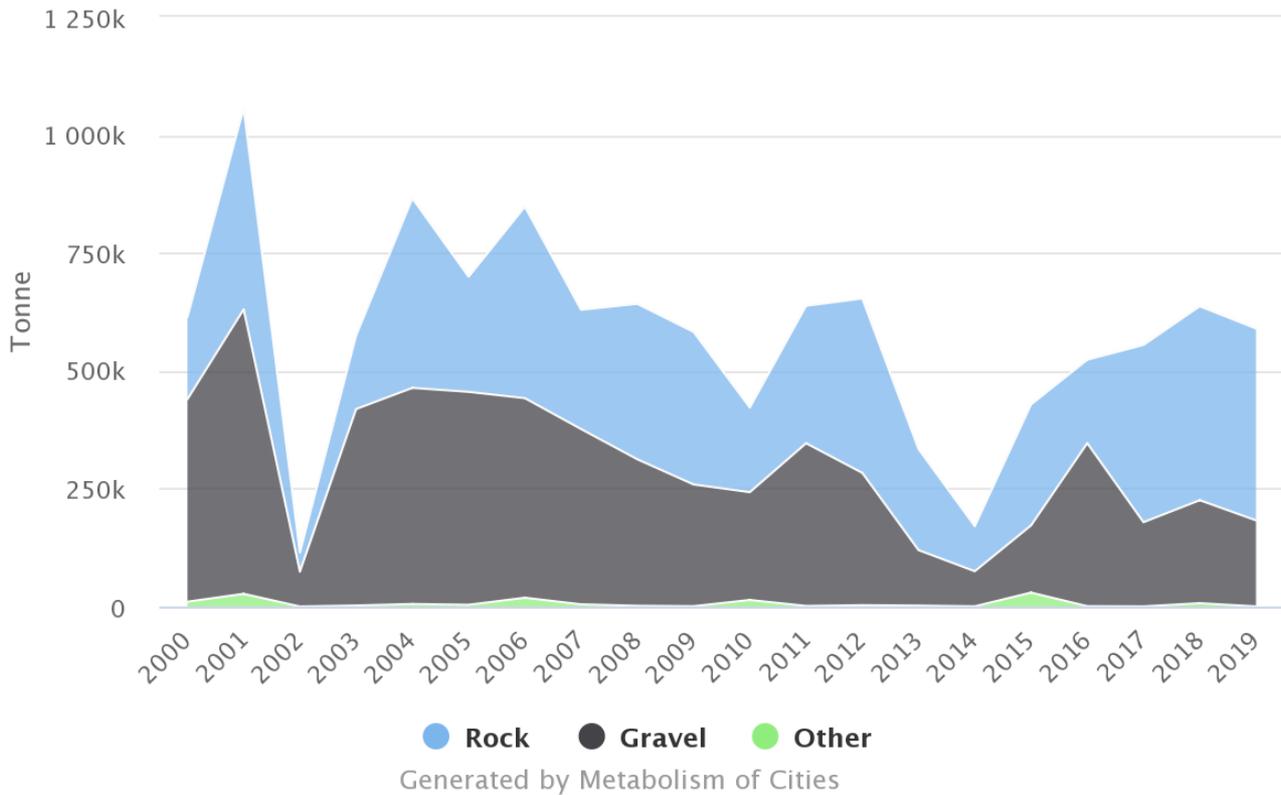
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Manufacturing

Mikkeli has several actors manufacturing timber and concrete products for construction sector throughout Finland and for export.

Actors in timber manufacturing:

According to Statistics Finland, there were a total of 12 actors in the sawmilling and planing of wood, 1 actor in manufacture of veneer sheets and wood-based panels, 1 actor in manufacture of assembled parquet floors and 6 actors in Manufacture of other builders' carpentry and joinery in 2018. (Industries and employees in Mikkeli 2013-2018).
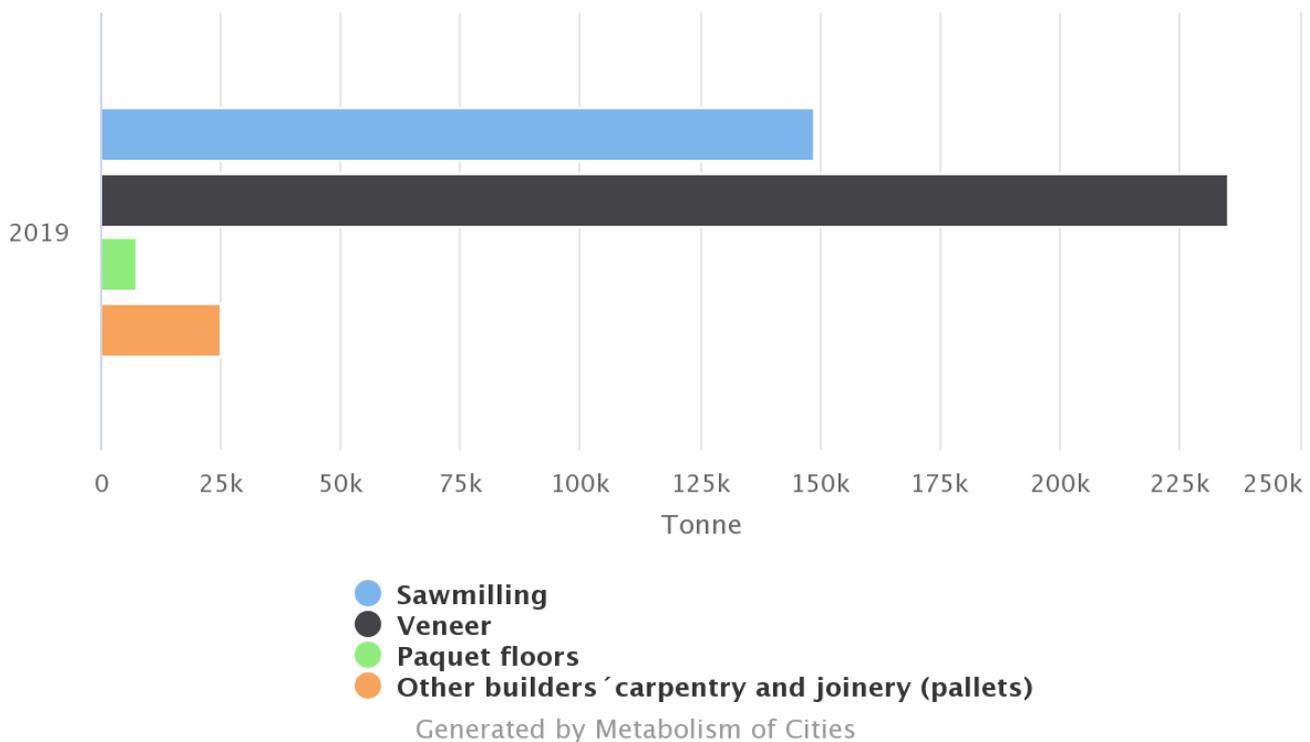
There were also 6 actors in Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials, 4 actors in Manufacture of kitchen furniture and 3 actors in Manufacture of other furniture. However, the role of these actors to the total material flows is assumed to be low. The most important actors in timber manufacturing are:

- UPM Pellos' plywood mill is Europe's largest plywood mill. It produces approximately 480,000 cubic meters of plywood per year from approximately 1.1 million cubic meters of Southern Savonia spruce logs for the Finnish and European markets. The factories employ about 600 people and are the largest industrial employer in Southern Savonia (Kumpusalo 2019, Mikkeli Development Miksei Ltd)

- [Versowood Otava Ltd](#): The production capacity of spruce sawing is about 275,000 m³ per year. 90% of production is exported.
- [Misawa Homes of Finland Ltd](#) is a sawmill which export spruce lumber to Japan.
- [SWM-Wood Ltd](#) manufactures heat-treated wood for the needs of the construction and carpentry industries and retailers. Company is the 2nd largest manufacturer of Thermowood® in Europe
- Oplax Ltd: manufacturing of pallets
- Parla Floor, Timberwise: manufacturing of parquet floors

The production volumes of these companies were used to calculate material flows in manufacturing of timber products in Mikkeli.

## Manufacture of timber (sawmilling, plywood, parquet, pallets) in Mikkeli

Generated by Metabolism of Cities

- Sawmilling
- Veneer
- Paquet floors
- Other builders´carpentry and joinery (pallets)

[Data source](#)

Actors in concrete manufacturing:

- [SBS Betoni Ltd´s plant in Tikkala](#), Mikkeli is the largest in Finland in terms of area and production capacity [(Savon Sanomat 2014)](#). The plant produces ready-mixed concrete and concrete elements.
- [BetSet Ltd plant in Pursiala](#), Mikkeli manufactures wall elements and ready-mixed concrete. Concrete elements are manufactured for use in the construction industry throughout Finland.
- [Sora ja Betoni V. Suutarinen Ltd´s plant in Suomenniemi](#), Mikkeli. The plant produces ready-mixed concrete and concrete elements.

Manufacture of concrete in Mikkeli

Generated by Metabolism of Cities
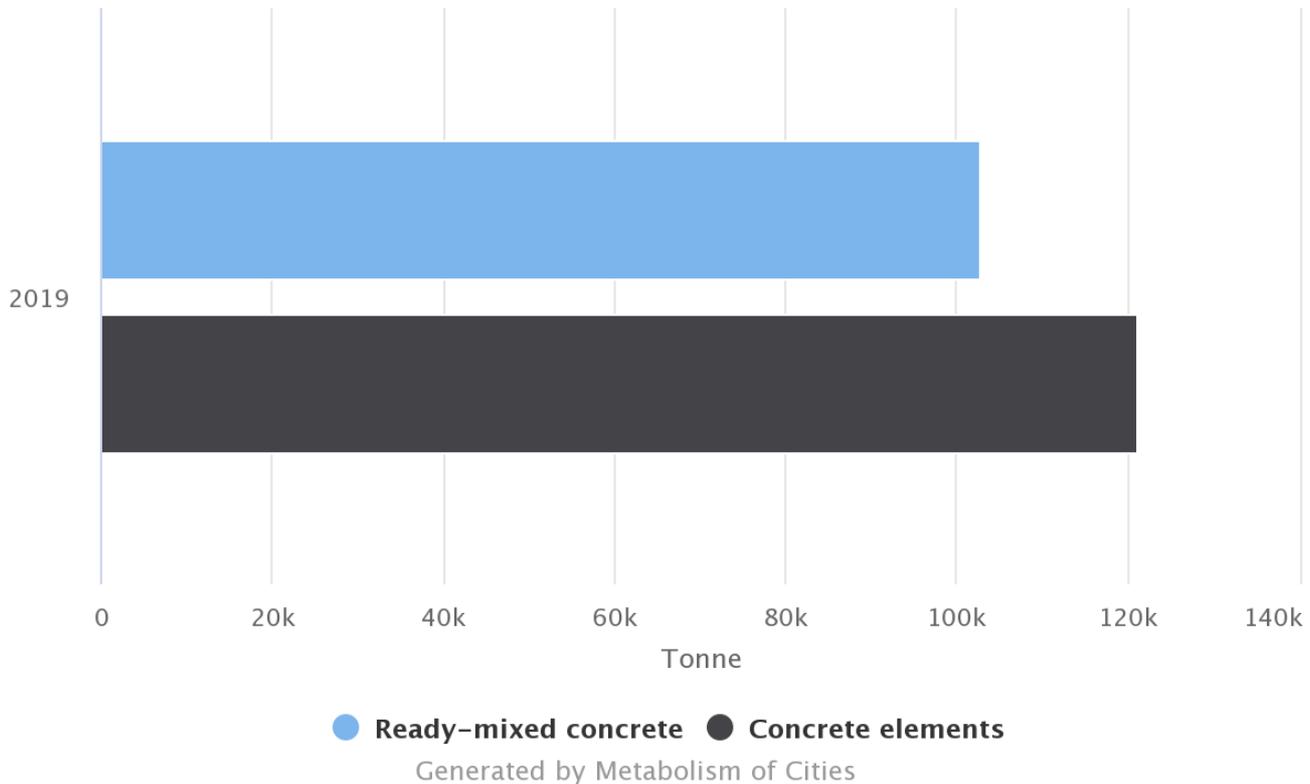
[Data source](#)

There are also companies of metal industry in Mikkeli (17 actors in 2018) who manufacture metal products (metal structures and their parts, metal doors and windows, and perform metal processing and coating). [(Industries and employees in Mikkeli 2013-2018)](#)

Retail and wholesale

In 2018, Mikkeli had 45 actors related to the retail and wholesale of construction materials (NACE codes 46.73 Wholesale of wood, construction materials and sanitary equipment and 47.52 Retail sale of hardware, paints and glass in specialised stores). Some biggest actors are e.g. K-Rauta, Carlson and Stark. [(Industries and employees in Mikkeli 2013-2018)](#)
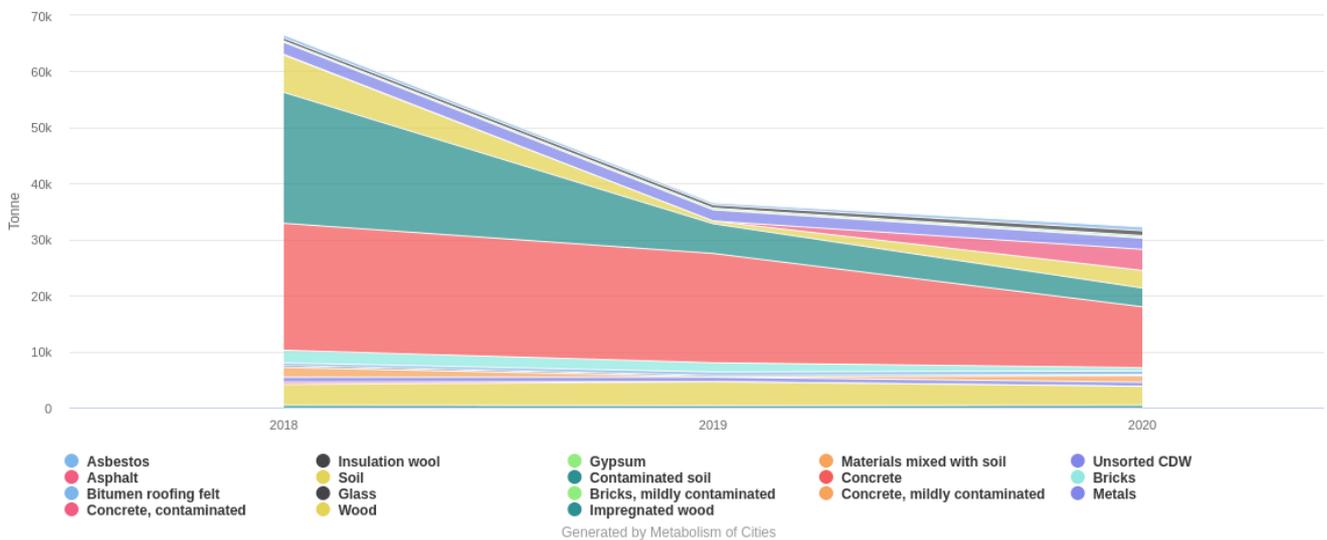
Use

There were 425 actors in the construction sector in Mikkeli in 2018 [(Industries and employees in Mikkeli 2013-2018)](#). Most of these are small companies. The largest construction projects are often managed by national companies such as YIT, Skanska and Destia.

Waste collection and treatment

The most significant operator responsible for waste collection and treatment in Mikkeli is the city-owned waste management company [Metsäsairila Ltd](#). All construction and demolition waste generated from the City of Mikkeli's own sites is delivered to Metsäsairila. Private operators can deliver waste elsewhere, also outside Mikkeli, depending on the contractor. [Otavan Metalli Ltd](#)

and [Mikkelin Romu Ltd](#) receive scrap metal in Mikkeli. Mikkelin Romu Ltd receive also construction, wood and demolition waste. According to environmental permits of companies, concrete and timber manufacturers treat (e.g. crush) waste fractions generated from their own production and deliver for recycling or incineration. Suutarinen Ltd can also crush concrete waste from the construction and demolition sites in their concrete plants in Tikkala and Suomenniemi. In addition, at least [Mikkelin Autokuljetus Ltd has an environmental permit](#) for crushing and receiving concrete waste. [Mikkelin Toimintakeskus assoc.](#) focuses on the re-use fixing and upcycling of goods and materials. They sells small quantities of materials from e.g. renovation and demolition sites to reuse.

CDW waste flows, Metsäsairila Ltd. 2018-2020

Legend: Asbestos, Insulation wool, Gypsum, Materials mixed with soil, Unsorted CDW, Asphalt, Soil, Contaminated soil, Concrete, Bricks, Bitumen roofing felt, Glass, Bricks, mildly contaminated, Concrete, mildly contaminated, Metals, Concrete, contaminated, Wood, Impregnated wood

Generated by Metabolism of Cities

[Data source](#)

Indicators

To monitor the progress of this economic sector towards circularity, a number of indicators were proposed and measured. Altogether, these indicators depict several facets of circularity of the sector. As such, they need to be considered in combination rather than in isolation when assessing circularity. In addition, these indicators can be compared to other cities or spatial scales (such as the country level). However, this has to be done with great care and use of the contextual elements in the previous sections of the report. Finally, the value measured from these indicators can be traced over time to track the sector's progress towards circularity.

Indicator number	Indicator	Value	Unit
34	[Domestic material consumption (DMC)](#)	561,715.39	Tonnes/year

Indicator number	Indicator	Value	Unit
39	Circular Material Use Rate	2.58	%
48	EU self-sufficiency for raw materials	4.91	%
55	EOL-RR (End of Life Recycling Rate)	25.26	%
57	Amount of sector specific waste that is produced	35,598.00	Tonnes/year
58	End of Life Processing Rate	97.27	%
59	Incineration rate	0.00	%
61	Landfilling rate	7.59	%

Due to deficiencies in data quality, not all indicators could be calculated with complete reliability.

Domestic material consumption

DMC is the total amount of materials directly used by an economy and is defined as the annual quantity of raw materials extracted from the domestic territory, plus all physical imports minus all physical exports. Formula for domestic material consumption is: DMC = Domestic extraction used (DEI) + Imports (IMP) – Exports (EXP).

In the case of Mikkeli, DEI was calculated using reliable local or regional data on extraction of sand & gravel and soil (peat) as well as harvesting of wood. This value was allocated for manufacturing (50 %), retail (20 %), use (10 %) and waste collection (10 %). Assumed allocation values defined by Metabolism of Cities (MOC) were used.

Imports (IMP) were calculated using Finnish Customs data from Finland and downscaling it to Mikkeli by using employees of construction sector. This value was allocated for manufacturing (40 %), retail (40 %), use (0 %) and waste collection (0 %). Assumed allocation values defined by Metabolism of Cities (MOC) were used.

Amount of exports (EXP) are based on rough estimations and downscaling of national Finnish Customs data (see Chapter Data Quality).

The resulted DMC in Mikkeli is 561,715.39 tonnes per year and 10.6 tonnes per capita which is slightly better than the reference value 13.4 tonnes per capita for EU-28 in 2019 (Eurostat). Generally a decrease in the indicator value is beneficial to the environment and to the Green

Economy Source.

Circular material use rate

Formula for Circular material use rate is: (domestic recovery – imported waste for recycling – exported waste for recycling) / ((domestic material consumption + (domestic recovery – imported waste for recycling – exported waste for recycling)).

Domestic recovery is amount of collected waste that is recycled. In case of Mikkeli, the reliable data was obtained from the most important actor Metsäsairila Ltd but data does not cover all waste flows from private sector (see chapter Data Quality).

Imported waste for recycling is based on assumed allocation values defined by the Metabolism of Cities. Assumption is that 20 % of all imports are allocated to recycling. In case of Mikkeli, imports (IMP) were calculated using Finnish Customs data from Finland and downscaling it to Mikkeli by using employees of construction sector. From this value, 20 % was allocated to recycling

Exported waste for recycling is based on actual amount of metal waste that is collected by Metsäsairila and exported outside of Mikkeli for recycling. Data does not cover local private actors, who receive metal waste or other CDW and export it for recycling.

Calculation of Domestic Material Consumption has been described above. In case on Mikkeli there are many uncertainties due to downscaling, rough estimations and assumed allocation values.

The resulted Circular Material Use Rate CMU for Mikkeli is 2,58 % which is low compared to 12.4% for EU-28 or 6,3 % for Finland in 2019 (Eurostat). Low value means that less secondary materials have substituted for primary raw materials in Mikkeli than in EU or Finland. However, the data collection and quality should be developed to get more reliable value.

EU self-sufficiency for raw materials

Formula for EU self-sufficiency for raw materials is: Import Reliance (IR) = Net import / Apparent consumption = (1- (Import - Export)) / (Domestic production + Import - Export).

Import value is based on Finnish Customs data from Finland. Data has been downscaled to Mikkeli by using employees of construction sector.

Export value is based on rough estimations and downscaling the Finnish Customs data (see Chapter Data Quality).

Domestic production is the manufacturing of construction products in Mikkeli. Value is based on reliable local data on manufacturing of concrete and timber products and downscaled PRODCOM data of Statistics Finland for manufacturing of aluminum and iron (see Chapter Data Quality).

The resulted value for EU self-sufficiency for raw materials in Mikkeli is 4,91 %. The reliability of the value is weakened by the uncertainties of the import and export data. EU statistics [(Eurostat)](#) are given for individual materials (mostly metals) and e.g. timber and concrete are not listed in the statistics. EU self-sufficiency for e.g. aluminum for EU-28 was 9,8 % and for iron 28,2 % in 2018.

EOL Recycling Rate

For each material fraction, the End-of-Life recycling rate is defined as the End-of-Life mass recycled divided by the available mass of End-of-Life materials. It is the product of the Processing Rate and the Collection Rate (EoL RR = EoL PR x EoL CR). Formula is: EOL RR = EOL Mass recycled / EOL Mass collected x 100.

In case on Mikkeli EOL mass recycled include CDW collected by Metsäsairila Ltd which is recycled at Metsäsairila (e.g. concrete waste used in road, field and landfill structures) or exported to recycling (metals). Data does not cover CDW collection of private actors.

EOL mass collected is calculated by summing the following amounts:

- share of materials from "use" lifecycle stage that goes to waste collection (allocation value of Metabolism of Cities, 20 %). Data on use of construction materials is based on statistics of e.g. new buildings and roads in Mikkeli and there are many uncertainties in unit conversions of the data (see Chapter Data Quality).
- share of stock materials that goes to waste collection. In case of Mikkeli this is calculated by using amount of CDW collected by Metsäsairila and assumed allocation value defined by Metabolism of Cities, 99 %.
- share of imports that goes to waste collection. However, allocation value has not been given and the value is 0.

The resulted EOL Recycling Rate for Mikkeli is 25,97 %. There are many uncertainties and assumptions associated with calculating the value. If only the realised amount of CDW collected by Metsäsairila and CDW fractions recycled by Metsäsairila or exported to recycling are taken into account, the recycling rate is 80%. Through the EU Waste Directive, Finland was committed to utilizing at least 70% of the construction and demolition waste generated in the country as a material by year 2020. The aim of the CityLoops project is that the recycling rate of construction waste is close to 95 % in Mikkeli.

Amount of sector-specific waste that is produced

The amount of sector-specific waste that is produced was 35598 t. The amount is based on only data of Metsäsairila Ltd. Asbestos (376 t) and insulation wools (596 t) were removed from total CDW amount received by Metsäsairila Ltd. because they are not in scope of materials selected to SCA. (Materials included to SCA have been listed in the introduction part of this report. Insulation material included in SCA is only plastic based insulation.) Private sector can deliver CDW also to other local waste collectors or export it outside from Mikkeli. Mikkeli Development Miksei Ltd

have studied waste management of CDW in Mikkeli (see report here). According to the study, it is estimated that about 70 % of all concrete and brick waste from big demolition projects (area of buildings >250 m2) are delivered to Metsäsairila. Consequently, the amount of sector-specific waste that is produced is bigger than amount calculated here.

End-of-Life Processing Rate

The End-of-Life Processing Rate measures the efficiency of the end-of-life processing process. The formula is: End-of-Life Processing Rate = End-of-Life mass recycled / End-of-Life mass collected for recycling x 100. The indicator shows only the local situation of the municipality and exported waste flows are not included in the calculation. This aspect helps with local circularity planning. Recycling waste elsewhere means that these materials aren't necessary available locally anymore.

In case on Mikkeli, EOL mass recycled include CDW collected by Metsäsairila Ltd which is recycled at Metsäsairila (e.g. concrete waste used in road, field and landfill structures).

EOL mass collected for recycling include CDW collected and recycled by Metsäsairila Ltd (e.g. concrete waste used in road and field structures) as well as metal waste which is collected by Metsäsairila but exported outside of Mikkeli for recycling.

The resulted EOL Processing rate is 97,27 %, which means that almost all of the waste collected by Metsäsairila Ltd for recycling, are also recycled at Metsäsairila area and only small part (metals) are exported elsewhere for recycling. In case of Mikkeli, most of CDW is utilised in Metsäsairila area in field, road and landfill structures. Data does not cover CDW collection of private actors.

Incineration rate

Incineration rate is mass percentage of waste which is incinerated. The formula used in SCA is: Incineration Rate = Incinerated waste / (Total waste + imported waste - exported waste) x 100. The indicator shows the local incineration only.

In the case of Mikkeli, the amount of local incineration is 0 because there is not waste incinerator in Mikkeli. Consequently, the incineration rate is also 0 %. The value is based on data from Metsäsairila Ltd. However, timber waste collected by Metsäsairila Ltd, is exported outside of Mikkeli for incineration and energy recovery. The proportion of timber waste exported for incineration from all collected CDW in Metsäsairila Ltd. is 12.9 %. Also energy waste fraction consisting e.g. paper/cardboard- and plastic based wastes (also plastic based insulation) are exported from Metsäsairila to incineration. However, the proportion of energy waste fraction coming from construction sector is not possible to distinguish from other energy waste from statistics.

Landfilling rate

Landfilling rate is mass percentage of waste which is landfilled. The formula used in SCA is: Landfilling rate = Landfilled waste / (Total waste + imported waste - exported waste).

In case of Mikkeli, landfilled waste consists of reject which cannot be sorted, materials mixed with soil and gypsum. Also asbestos waste and insulation wool are landfilled in Metsäsairila, but these fractions were not under the scope of sector-wide circularity assessment (Materials included to SCA have been listed in the introduction part of this report).

Total waste include the CDW collected by Metsäsairila Ltd. Data does not cover CDW collected by local private actors or CDW transported outside of Mikkeli.

Imported waste is 0. Metsäsairila or other actors can receive waste also from nearby areas, but the data is not available.

Exported waste include metal and timber waste collected by Metsäsairila Ltd. Metal waste is exported for recycling and timber waste for incineration.

Landfilling rate of CDW received by Metsäsairila Ltd is 7.59 %.

Visualisations

Measuring circularity is a data heavy exercise. Numerous datasets were collected and visualised throughout the sector-wide circularity assessment process. To synthesise these findings, a Sankey diagram illustrates how material flows from the studied economic sector are circulating from one lifecycle stage to another. The height of each line is proportional to the weight of the flow. This diagram therefore helps to quickly have an overview of all the materials flows that compose the sector and their respective shares. The flows that are coloured in light blue in the Sankey diagram, are return flows. This means that they flow in the opposite direction of the lifecycle stages and are subjected to reuse, redistribution, or remanufacturing. Their size relative to the others is a good indication for the materials' circularity.
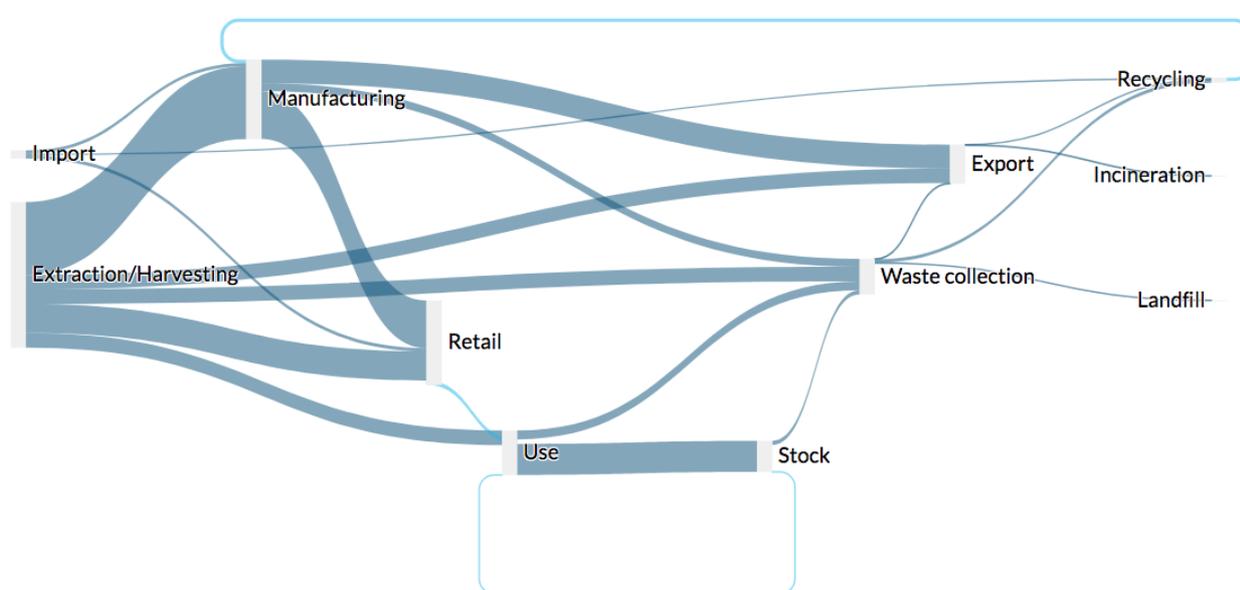
[Data source](#)

The Sankey diagram describes well that the main flows of construction materials in Mikkeli are in extraction and harvesting and in manufacturing. The amounts of extraction and harvesting as well as manufacturing are also the most reliable and complete datasets, which were collected. These lifecycle stages include extraction of sand and gravel and wood. Also extraction of peat was included to "soil" material according to SCA method, although it is not utilized by construction sector in Mikkeli. However, the proportion of peat production in extraction and harvesting lifestage is only 7 %. There are lot of manufacture of timber and concrete products in Mikkeli and considerable part of manufacturing is also exported outside the area. Most probably the proportion of export from manufacturing is even larger than illustrated in the Sankey diagram. From timber products even 90 % of biggest sawmill and plywood plants are exported abroad according to companies webpages. In addition to timber and concrete manufacturers, there are also smaller companies manufacturing metal products in Mikkeli.

There were no local or national statistics of retails available in tonnes. The material flows of retail lifecycle stage illustrated in the Sankey diagram is based only on assumed allocation values. Due to this data gap, material flows from retail to other lifecycle stages have not been estimated.

The Sankey diagram shows that the proportion of recycling of construction materials is very small but diagrman also shows that big part of the treatment of collected waste is unknown. The amount of materials at waste collection phase has been calculated by using assumed allocation values (assumption that 10 % from extraction, 10 % from manufacturing, 20 % from use lifecycle stages goes to waste collection). According to calculation, approximately 300 000 tonnes of construction and demolition waste are collected which could be potentially circulated in the city.

Currently, the amount of material flow that goes to recycling, landfilling and incineration is based on actual statistics of municipal waste management company Metsäsairila Ltd. The proportion of waste collected by Metsäsairila Ltd is only 12 % from the calculated total amount of waste collection. According to statistics, Metsäsairila Ltd. recycles 78 % of CDW, that it receives, in field, road and landfill structures in the area. Proportion of landfilling is 6 % (mainly materials containing hazardous substances and also gypsum). Timber waste (13 %) is exported to incineration and metal waste (2 %) is exported to recycling. In addition to Metsäsairila Ltd. there are also some small local actors who receive CDW and deliver it for recycling, incineration or landfilling. Part of the CDW is transported directly outside of Mikkeli for treatment but the amounts are not known. Recycling and incineration of wastes from manufacturing is currently not included in the Sankey diagram but some information is available in environmental permits of factories. The main waste flows of concrete plants operating in Mikkeli are wood and concrete waste, which are treated at the plants. Crushed concrete is utilized in civil engineering and wood chips in energy production. Sawmills and e.g. plywood factory generate typically peel, chew and chips as a by-product. These are usually utilized for energy in local or plant´s own power plant. Some of the by-products of e.g. plywood plant also go for further processing.

Data quality assessment

Numerous datasets were collected and considered in the sector-wide circularity assessment. In some cases, datasets were not available for some materials or for some lifecycle stages for the studied sector. Therefore, estimations need to be done by looking at data at higher spatial scales (region or country). This section qualitatively assesses how reliable the data used is.

Data quality

Before describing data gaps and assumptions, the overall data quality is considered. It is expressed through four data quality dimensions that are depicted in the data quality matrix: reliability, completeness, temporal correlation, and spatial correlation. Each dimension has its own criteria for the

ranking of high (green), medium (yellow) and low (red), which is based on this [Pedigree report](#) and shown in the table below. There can be additional explanations in some cells, as supporting information.

Rating	Reliability	Completeness	Temporal correlation	Spatial correlation
high	Reviewed or measured data	Data exists for all of the single materials and their respective economic activites	Data less than 3 years difference to the time period of the data set	City-level data
medium	Estimated data	Data exists for most single materials and most economic activities	Data less than 6 years difference to the time period of the data set	Regional-level data (NUTS 3)
low	Provisional data	Data exists for the sector only for the Life Cycle Stages	Data less than 10 years difference to the time period of the data set	NUTS 2 and country-level data

Data quality matrix

Lifecycle stage	Reliability	Completeness	Temporal correlation	Spatial correlation
Extraction/Harvesting				mostly local data
Manufacturing				mostly local data
Retail	Data gap			
Use	High uncertainties in unit conversions			local and NUTS2 data
Stock	High uncertainties in unit conversions			

Lifecycle stage	Reliability	Completeness	Temporal correlation	Spatial correlation
Waste collection		Only Metsäsairila Ltd data		
Landfill				
Incineration		Only Metsäsairila Ltd data		
Recycling		Only Metsäsairila Ltd data		
Anaerobic digestion	Not relevant for CDW			
Composting	Not relevant for CDW			
Imports	Uncertainties on downscaling data	Some materials missing		Country data
Exports	Rough estimations and downscaling			local and country data

Extraction and harvesting

Reliable local data was collected on sand & gravel extraction. Wood harvesting and peat extraction are based on regional South Savo data and downscaled to Mikkeli based on forest or wetland area. Sand & gravel used in concrete manufacturing was obtained from environmental permits of actors. There is no other extraction/harvesting in Mikkeli.

Manufacturing

Reliable data on manufacturing of concrete and timber products were obtained from environmental permits or webpages of companies. Data covers all concrete actors and the most important timber actors. Data on manufacturing of aluminium and iron (steel) products were obtained from country-level PRODCOM statistics of industry (Statistics Finland) and downscaled to Mikkeli based on employees on relevant NACE-code (25 Manufacture of fabricated metal products, except machinery and equipment). Employee's data was from year 2018 and PRODCOM data from year 2019.

Retail

Data in tonnes was not found. Statistic Finland has data on the trade turnover index which describes the development of the turnover of trade companies (source). However, it was not possible to convert this data to tonnes.

Use

Reliable data on floor area of new buildings was obtained from Mikkeli. Unit conversion to tonnes was based on data on realised masses of CDW fractions in buildings demolished recently in Mikkeli. The obtained values as t/m2 were based on four demolished public buildings and does not necessarily reflect material masses e.g. in detached houses. More reliable data for unit conversions from Finland was not found.

Reliable data on road pavements in kilometers were obtained from Eastern Finland. Many assumptions based on literature and statistics were made to convert kilometers to tonnes of bitumen/asphalt, which decrease data reliability. Data was downscaled to Mikkeli based on lengths of different road types.

Use of sand & gravel has been roughly estimated based on extraction. It was assumed that 80 % of extracted amount is used in Mikkeli and 20 % is exported to nearby areas.

Data does not cover e.g. use of concrete and metals in construction of bridges or railways. Also data on use of plastic based insulation is missing.

Stock

Reliable data on floor area of existing buildings and length of roads were obtained from Mikkeli. There are same uncertainties in unit conversions as explained for use data. Data does not cover e.g. stocks in bridges and tunnels, railways, summer cottages or smaller streets.

Waste collection

Reliable data on waste collection of the most important actor Metsäsairila Ltd was obtained (see data). Data covers all waste flows from construction and demolition projects of City of Mikkeli but not all waste flows of private sector. There are some local actors other than Metsäsairila who

collect metal, concrete and other construction waste. Their waste flows are currently missing from the data. In addition, CDW may be exported outside area. Manufacturer of concrete and timber products treat considerable amounts of waste from their own production.

Imports and exports

Reliable country-level data on imports and exports of construction materials were obtained and downscaled to Mikkeli based employees on construction sector. This not necessarily give reliable approximation on imports to Mikkeli. There was also uncertainties on choosing relevant products for Mikkeli from the country-level data. Data was not obtained for all materials.

National import-export data does not reflect the export of materials from Mikkeli to other parts of Finland. Rough estimations were made e.g. on export of sand & gravel to nearby areas (20 %). Export of concrete and timber products were roughly estimated based on information obtained from companies web pages. It was assumed that about 50 % of concrete production (ready mixed concrete and elements) are exported outside of Mikkeli. Export of timber products covers only export to abroad and was estimated based on information on companies webpages.

Data gaps and assumptions

The only full data gap is on retail data. Searching data sources will be continued. Data quality and completeness related to use and stocks could be improved by collecting more data on materials in bridges, railways etc. Quality of unit conversions concerning amount of materials in buildings could be improved if more accurate data on typical masses of materials in Finnish buildings could be found. Waste collection flows of different actors in Mikkeli can be complemented if data is available or data can be estimated. Also import and export data will be complemented if more accurate data is available.

Data analysis

This section analyses the Sankey diagram developed in the previous section. It discusses and interprets the results for the sector-wide circularity assessment. It also reflects on how the current demonstration actions fit within the bigger picture of the sector, as well as how they could be upscaled to accelerate the transition towards a more circular sector.

Insights on status quo of the construction sector
The detailed analysis of Sankey diagram and data and assumptions behind those have been described in the Chapter "Visualisations".

As a conclusion, there are lot of manufacture of timber and concrete products in Mikkeli and considerable parts of these are exported outside of the area. There are also lot of forests in Mikkeli and nearby areas, so raw wood is obtained from very close proximities. Virgin sand &

gravel and stone material is also easily available for concrete manufacturing and for construction of roads and buildings. However, other construction materials like metals, gypsum, bricks and insulation materials are imported to Mikkeli.

According to the calculation illustrated in Sankey diagram, approximately 300,000 tonnes of construction and demolition waste are collected from extraction, manufacturing and use lifecycle stages, which could be potentially circulated in the city. There are many circular flows in the city but when looking at the whole picture, the flows are quite small in mass. On the other hand, all the data related to CDW collection and treatment is not currently available. Even 80 % of CDW collected by the most important actor, municipal waste management company Metsäsairila Ltd is recycled, mostly on the road and landfill structures. Metal waste is exported to recycling and timber waste is exported to incineration and energy recovery. The greatest potential for developing circular economy of construction sector in the city is to utilise materials collected as waste in upcycled higher-value products, which could replace virgin materials in the construction sector.

There are still many assumptions behind the distribution of material flows visualised in the Sankey diagram. In the future, the information may be updated based on possible new and more detailed data.

Connection to and upscaling of demonstration actions
Mikkeli's demonstration in the CityLoops project involves the demolition of two public buildings Pankalampi Health Care Centre and Tuukkala hospital using circular material management methods, including digital tools. To carry out the demolitions with circular material management, the sites are scanned and a pre-demolition audit will identify potentially recoverable materials and their characteristics. After a selective demolition procedure, salvaged materials are incorporated into the digital databank and construction material marketplace. Miksei Mikkeli promote use of the marketplace by other construction sector actors, private and public, both to offer and to obtain secondary construction materials. After evaluation of the pilot demolitions, the learnings and experience will be incorporated into a circular demolition operations model and generic demolition contract that can be applied in further public projects.

Demonstration actions respond to the needs to develop documentation of material flows as well as upcycling of CDW which were also emerged in the SCA analysis.

Recommendations for making the construction sector more circular
Mikkeli has already many good practices on construction and demolition sector. However, in future CDW materials could be upcycled and reused more efficiently than at present. For example, furniture and building components could be sold more efficiently for reuse or utilised at the city's own sites. Wood waste could be reused as a building material instead of energy recovery. Bricks could be recovered and used in construction instead of crushing. Crushed concrete could be used on city´s construction sites instead of virgin soil material although virgin soil material is still readily available. New operating models for the recycling and reuse of

materials should be developed and tested, and new business could be created so that the circular economy can become part of the normal way of operating in construction and demolition in Mikkeli in the future. In addition, developing of documentation and data collection can improve assessment of circularity. The CityLoops project plays an important role in the development of these models and tools in the city of Mikkeli.

References

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