Carbon footprint of the National Library of Finland

A report on carbon footprint assessment for 2019

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1 Introduction

1.1 Goals of carbon footprint assessment

This carbon footprint assessment is part of the National Library of Finland's sustainability work and the first step on our way towards carbon neutrality. A working group was established for this assessment in spring 2021. The goal of the assessment is to gather information and raise awareness, but also to help determine the measures the library will have to take to achieve carbon neutrality by 2030. The University of Helsinki has set itself the goal to be carbon neutral by 2030, and the National Library of Finland has decided to adopt the same target. The year 2019 was decided as the focus of the assessment, since the years 2020 and 2021 were exceptional for local operations because of the coronavirus pandemic.

The most important **goals** for the first stage are to determine

- What information is relatively easily available on our operations,
- What kinds of tools are available for our independent assessment, and
- Which areas we cannot investigate ourselves, or where do we need support either from our partners or from an external expert.

Further goals include to

- Produce the first carbon footprint assessment for operations that can be easily investigated
- Increase our own understanding and expertise regarding the assessment of the ecological sustainability of our operations

This work supports the two main goals of the National Library's sustainable development programme: to achieve carbon neutrality by 2030 and to embed sustainability as an integral component of our operations.

1.2 Key concepts

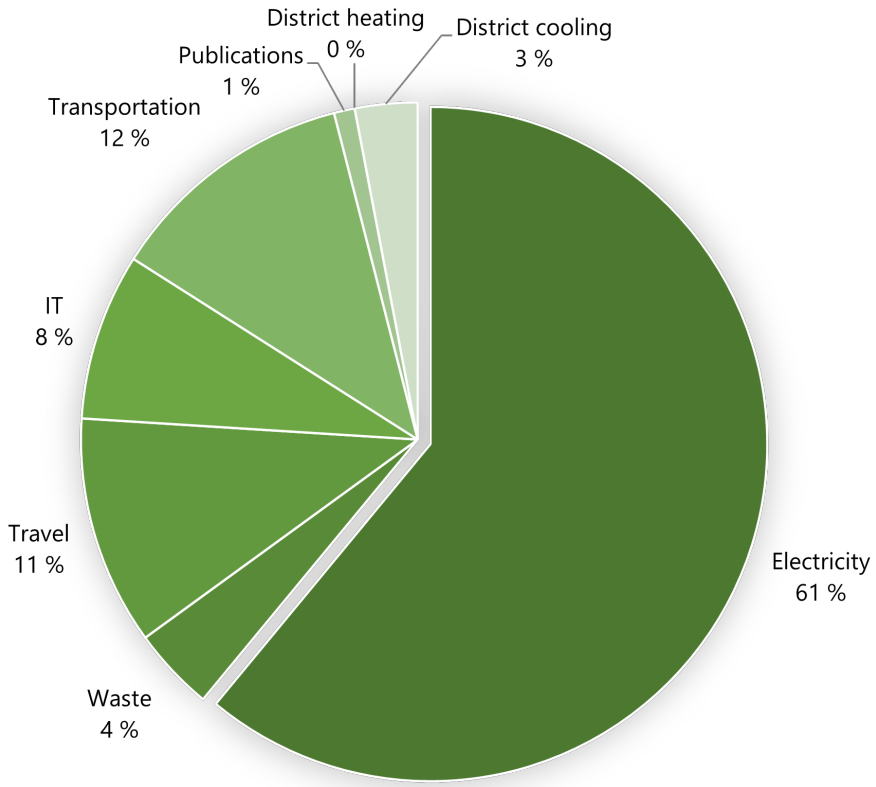
Carbon neutrality defines the state in which an organisation's operations do not change the amount of carbon in the atmosphere. The term may be ambiguous, and therefore it is necessary to clearly define what it means for the University's operations.
The **carbon footprint** is a metric intended to illustrate impact on the climate. For the purposes of calculating the carbon footprint, all climate emissions are rendered as commensurable carbon dioxide equivalents (CO2-eq). Calculations can then determine the main sources of emissions so that measures can be productively targeted (Seppälä 2014).

1.3 Summary of assessments conducted by peer organisations

Not all of the National Library's peer organisations have made their carbon footprint reports openly available online. Some of the summaries are based on information received via email or presentations given at various events. For this report, original reports were not requested directly from the organisations in question.

Finnish National Gallery

The Finnish National Gallery is similar to the National Library of Finland in terms of number of staff and type of operations, and therefore a good point of comparison. The National Gallery has been a pioneer in working to assess its own ecological footprint and mapping ways to decrease it, as well as in communicating these efforts to the museum and cultural heritage field – including, for instance, its Green Handprint workshop concept. It has also served as an encouraging example for our library at the early stages of our own efforts.



Graph 1. Carbon footprint of the National Gallery in 2019. (Ahlgren 2021).

The National Gallery is aiming for carbon neutrality by 2035. It has been endeavouring to calculate its own carbon footprint, but this has proven challenging. The carbon footprint calculations have included district heat and cooling, electricity, waste management, travel, IT, transportation and publications. The National Gallery's estimated carbon footprint in 2019 was a total of 963 tCO2-eq, of which electricity contributed 61 %, transportation 12%, travel 11% and IT 8%. District heat and cooling are produced with renewable energy, which reduced energy emissions by approximately one third. The carbon footprint of waste transportation was reduced by cutting the frequency of waste transportation for some locations (Ahlgren 2020, 2021).

The assessment found that it was particularly difficult to estimate the carbon footprint for digital services, and that the process involved a great number of uncertainties. The estimated emissions from services were a total of 81 tCO2-eq (office equipment 88.6%, use of digital services and in-house network hardware 5.3%, in-house server room services 4.6%, outsourced software and server room services 1.5%). The National Gallery has approximately 30 services and software suites on several servers, and a total of approximately 1,000 pieces of equipment (office equipment 86%, servers 5% and network hardware 9%) (Ahlgren 2020).

This means that most of the emissions associated with IT came from office equipment. The calculation was made based on the PCF (Product Carbon Footprint) figure retrieved from the manufacturers of the equipment, and the number of devices. *"The PCF figure takes into consideration emissions from both the manufacture of the device and its use. It also includes the emissions resulting from the device's energy consumption for 2–5 years. In our calculation, we determined the emissions for one year by dividing the total emissions in the PCF figure by the number of years it covers. We have chosen the average of the PCF figures announced by the manufacturer, and we have ignored any variation."* (Peiponen & Ikäläinen 2020:2) Not all manufacturers provided these figures. In such cases, we used the arithmetic mean of similar products from different manufacturers. In addition, the assessment noted that the emission values of each device varied based on manufacturing year, which should be considered in the procurement stage if the goal is to reduce emissions year-on-year (Ahlgren 2020; Peiponen & Ikäläinen 2020:2).

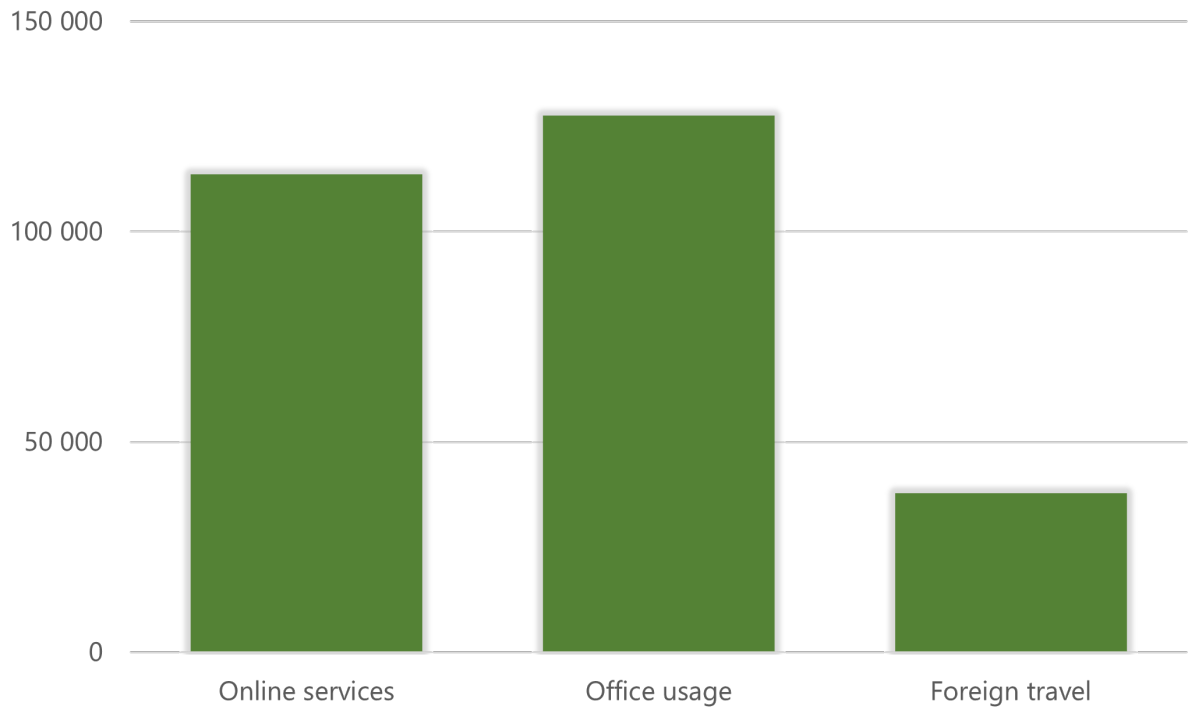


Figure 2. One-year carbon footprint for Europeana's online services, office usage and travel (Ehlert 2018).

The Green Library project of Finnish public libraries

The National Library of Finland is a national service provider for public libraries, which assessed the environmental impacts of libraries in the project run by the Helsinki City Library: *Bringing environmental awareness of public libraries to the 2020s*. The project included 13 pilot libraries along with Positive Impact, an expert company. The calculations were limited to facilities, logistics and operations. Information was gleaned from invoices in accounting, statistics, reports and questionnaires. No reliable information could be acquired on telecommunications or on IT systems.

The average carbon footprint of a library was calculated to be 45 tCO2-eq, and the joint carbon footprint of all Finnish libraries: 32,000 tCO2-eq. The results are approximate, and the carbon footprints of the pilot libraries have been cross-referenced with statistical information on Finnish libraries. The project also compared the emissions of lending physical and electronic books, but did not consider the emissions from storing electronic books, just the lending process. It should also be noted that the calculations exclude information on information systems and IT. (Positive Impact 2021).

Looking through the assessment results of the pilot libraries, it is interesting to note that while the proportionate emissions of procurement, book acquisitions and travel increase as the size of the library (staff) increases, the contribution from facilities does not seem to correlate positively with the size of the library. The report proposes climate indicators for national statistics: a loan- and visit-specific indicator as well as facility and procurement emissions.

Europeana

Europeana is a search service that promotes European digital cultural heritage, much like the National Library of Finland's Finna.fi service. The National Library aggregates resources from Finnish archives, libraries and museums to Europeana through its own Europeana Formula service.

Europeana conducted its first carbon footprint assessment during 2018–2019. The work began as part of the annual Europeana hack week, where employees can take a week to work on a Europeana-related project of their choice. The first stage calculated the carbon footprint of online services and international travel. Energy consumption in offices was later added to the assessment.

The carbon footprint for online services was calculated by estimating the average power consumption of different types of servers, multiplying that by the number of servers and then multiplying by the country-specific carbon footprint of the location of the server per kWh. During the calculation, a new data harvesting system was used alongside the old one, and the assumption was that emissions would go down by 43 % once the old system was fully discontinued. The carbon footprint of the offices was calculated based on the energy and water consumption data of the Royal Library building in the Hague which was divided by the overall estimate of the percentage of office space used by Europeana. The footprint for travel was calculated by entering all completed trips into a digital carbon footprint calculator (178 flights, 46 train trips and one car trip). Flights represented close to 98% of emissions associated with international travel.

The biggest challenge in the calculation was retrieving information from service providers.

Due to the limited time allowed for the project, it was not considered necessary to comply with the GHG Protocol or the ISO 14040, ISO 14044 or ISO 14064-1 standards, but the report did take the most central criterion of these standards into account, namely, identifying and documenting assumptions made during the calculation and the limits of the data available.

University of Helsinki

The National Library of Finland is an independent institute of the University of Helsinki, so the strategic guidelines and practical measures made by the University in terms of promoting ecological sustainability greatly influence the operations of the National Library.

The University has set an objective to be carbon neutral by 2030. A University-wide project was launched in autumn 2021 to draft a roadmap for achieving carbon neutrality by 2030. The roadmap determines which operations will be included in the carbon neutrality goal while defining and calculating the carbon footprint of the University for its different operations. The University participated in the carbon working group operating under the Finn-ARMA cooperation network of institutions of higher education. The carbon working group shares information and good practices on the carbon footprint efforts of Finnish institutions of higher education while developing the commensurability of carbon assessments.

In spring 2022, the A Carbon Neutral University By 2030 -project determined the calculation method for the university's carbon footprint and calculated the carbon footprint for the year 2019. The calculation will need to be refined, especially with regard to indirect emissions, i.e. the procurement of goods and services. A list of measures needed to achieve carbon neutrality for all areas (real estate, acquisitions, travel, ICT services and food) will be compiled into a road map with the participation of the university community.

In 2019, energy consumption at facilities, services and construction generated approximately half of the University's carbon footprint. For construction and maintenance, the carbon footprint was calculated based on the 'average coefficients' in the Exiobase database, and the definition of these coefficients will be further clarified and specified over the course of the autumn. In May 2022, the Institute for Atmospheric and Earth System Research (INAR) hired a summer employee who surveyed the extent of the carbon sinks in the forest areas owned by the University of Helsinki Group. The promotion of carbon neutrality links to several projects underway in the Facilities and Properties sector and HY247 (e.g., charging stations for electric cars, energy efficiency measures, tendering guarantees of origin for electricity) as well as some construction projects (e.g., the promotion of wood construction, district cooling and renewable energy).

The University's carbon footprint, including climate emissions from facility energy consumption as well as plane and train travel, decreased approximately 2.6 % from 2019 to 2020. Emissions from energy consumption went down by 4,732 tCO2-eq. This was the result of acquiring a guarantee of solar, wind or water-power origin for approximately 40% of electricity used, and slightly due to electricity consumption decreasing by 0.6%. On the other hand, the cold winter resulted in heating-related CO2 emissions increasing by 3,879 tonnes. District cooling, which has been carbon neutral since 2020, is in use in 13 buildings on the City Centre Campus and in the HUSLAB building in Meilahti. Emissions from flight and rail travel went down significantly from 2019, presumably because there was less travel during the COVID-19

Carbon footprint GHG Scope	Categories	Emissions in 2019, tCO2-eq	Emissions in 2020, tCO2-eq	Emissions in 2021, tCO2-eq
Scope 1: Facility fuel consumption	Heating oil	713	602	644
	Natural gas	320	261	237
	total Scope 1	1,033	863	881
Scope 2: Purchased energy	Electrical energy	16,921	15,753	11,020
	Heating energy	19,654	15,821	19,658
	District cooling	69	0	0
	Total Scope 2	36,644	31,573	30,678
Scope 3: Travel	Flights	4,603	321	373
	Train	27	5	5
	Total Scope 3	4,630	326	378
	Total Scope 1–3	42,307	32,763	31,937

Table 1. University of Helsinki's emissions 2019–2021.

pandemic. Travel emissions remained at a similar level through 2020 and 2021.

Other interesting benchmarks

The National Library of Finland also provides digital services for Finnish museums, particularly through Finna and interoperability services.

Several museums engaged in carbon footprint and sustainability work in late 2021. The City of Lappeenranta's museums used an external expert, LCA Consulting Oy, to calculate their carbon footprint according to the calculation standards of the GHG Protocol. In 2020, the museums of Lappeenranta had a total carbon footprint of 275 tCO2-eq, including both the operation of the museums and delivered energy. In addition to this, the calculations included the carbon footprint from procured goods and services, operations related to fuel and energy, transport and distribution of goods, waste generated and work-related travel. The largest emissions were overwhelmingly generated by the oil heating of the museum facilities and the use of a van. The museums are part of the organisation of the City of Lappeenranta, which has set itself the objective to achieve carbon neutrality by 2030. (Museums of the City of Lappeenranta 2021, City of Lappeenranta 2022).

In the Gallen-Kallela Museum and the Serlachius Museums, carbon footprints have been calculated as part of the adoption of environmental management systems. The results of these assessments were not publicly available online at the time of writing this report (Gallen-Kallela Museum 2021, Serlachius Museums 2021).

2 Methods

2.1 Working group and organisation

A specific working group for carbon footprint assessment was set to separate the work from the Sustainability working group which is in charge of the National Library's sustainability efforts. The reason was that, since the National Library's work takes so many forms, at this early stage the different operations should be represented as broadly as possible to ensure all relevant viewpoints are considered. At the same time, understanding of the topic will steadily increase throughout the organisation. Additionally, the sustainability work is conducted alongside employees' regular duties, and since this project was assumed to be challenging, the added responsibility would have been too much for the members of the Sustainability working group. However, two people participated in the work of both groups to ensure the flow of information between them. The carbon footprint assessment working group had a total of 12 members. The group met nine times between spring 2021 and spring 2022.

The group began by reviewing the carbon footprint assessments of peer organisations (see chapter 1.3). This way the group gained an understanding on how to move forward with the assessment work. The group agreed that the assessment should be relatively straightforward. The next steps could be discussed after the initial survey. It was also noted that even though external assistance would be available for the assessment, the initial data would have to be gathered by the organisation itself in any case.

The decision was to focus the assessment on 1) facilities, logistics and travel, 2) IT and digital operations (IT infrastructure of services) and 3) procurement. A subgroup was assigned to work on each target. The decision was made to have the subgroups work independently, with less frequent meetings for the full carbon footprint working group to compile the work of the subgroups.

With the exception of the University Services representative Virpi Kuitto, no member of the working group had participated in carbon footprint assessment before. As the work progressed, the group encountered problems relating to carbon footprint assessment(s) and various calculation methods. The information sources required and available for the assessment were also explored. At the same time, an understanding was gained regarding what type of information is not available, or what kind of baseline information is particularly difficult to acquire.

2.2 Information sources and tools

The most commonly used standards for carbon footprint assessments are the GHG Protocol and the SFS-EN ISO 14067 standard. In addition, the SFS-EN ISO 14064 standard may be used to calculate the carbon footprint of an organisation. At this early stage however, we decided to use the tools that were easiest for us to access, the Procurement Pulse (Hankintapulssi) -service and Y-Hiilari, tools produced by the Finnish Environment Institute.

Procurement Pulse (Hankintapulssi)

The most important information sources are purchasing invoices, which is what the Procurement Pulse service developed by the non-profit Hansel Ltd provides. Procurement Pulse is a procurement analysis service for organisations included in the Finnish government's budget. The service provides procurement metrics, one of which is the carbon footprint of procurements. The carbon footprint calculator for Procurement Pulse was created in cooperation with the Finnish Environment Institute and KEINO competence centre.

In Procurement Pulse, all public procurement is analysed with the same categorisation model. The calculations are based on purchase invoices and emissions coefficients from the Finnish Environment Institute.

During the work, we found the challenges of Procurement Pulse to be, on one hand, the poor usability and, on another, the lack of transparency in the information provided. However, the Finnish Environment Institute will publish an academic article on the calculation methods used in the tool.

Information on Procurement Pulse is accessible by all members of the organisation who request user rights from the service. The tool can, for example, provide information at the National Library level, itemised according to the expense structure. The service covers all purchasing invoices from the National Library, not just procurements made through Hansel.

Y-Hiilari

The Finnish Environment Institute's Y-Hiilari carbon footprint tool was also used, particularly in the evaluation of emissions from waste, travel and material transport. Y-Hiilari is based on the Greenhouse Gas (GHG) Protocol, which is a commonly used standard developed for climate impact calculations. It is a tool intended for calculating the carbon footprint of organisations and enables an organisation to track its climate impact. The calculator considers emissions from heat production, electricity production, waste management as well as transport and work-related travel.

2.3 Assessment and calculation principles, limitations

The working group wanted to keep the evaluation work simple and clear, to use existing calculation methods and formulas and make sure that the same data would not be counted in several different calculations. At the same time, it is essential that no significant emission sources are omitted, or at least that such omissions are clearly documented.

Data on emissions from facilities (heating, cooling and lighting) were obtained from the accounting documentation and energy contracts of the University of Helsinki's Facilities and Properties sector. Meanwhile, it was unfortunately impossible to calculate the climate impact of waste management for the Helsinki Library Quarter, as the University of Helsinki's waste management contracts incorporate several facilities and waste amounts generated by individual units cannot be reliably calculated.

Information from Hansel's Procurement Pulse service was used for material acquisitions and other purchases. For library collection acquisitions only printed material (books, periodicals) were considered, since there was insufficient information regarding the carbon footprint, calculation models and related research regarding electronic material.

The acquisitions of the IT equipment were included under 'other acquisitions'. In the future it should be noted that the lifespan of IT equipment is several years, but the Procurement Pulse service only targets the year of purchase. The process through which the tool calculates emissions for the year of purchase was unclear at the time of drafting this report.

For IT, the calculation was limited to the estimated emissions for digital service production service production, not the carbon footprints of the clients or service users. However, no progress was made in the assessment of emissions from service production, as it was impossible to calculate the carbon footprint of outsourced servers at this time. The providers of the outsourced servers – CSC – IT Center for Science and the University of Helsinki's IT Centre (TIKE) – are just getting started with their own carbon footprint calculation, and the National Library has requested to be included. It is still unclear how reliably it will be possible to extract information on such outsourced services to understand the exact amount of the National Library's energy consumption for each service.

Of the digital services that the National Library of Finland provides, most are based on open-source code, and the library is involved in extensive IT development of its own. This means that the emissions from service provision cannot be assessed solely based on purchased software licenses or purchased IT services. Further investigation is needed into how the emissions from software and digital services provided in-house can be calculated. It may also be necessary at a later point to move from assessing the IT-related emissions of the organisation, as a whole, to examining individual services, or the digitisation process and related services.

In terms of logistics and travel, the calculation was limited to work-related travel of employees, i.e., participation in conferences, training and meetings. Commuting was excluded at this point. In addition to work-related travel, the calculations included the Library's own material transport between Helsinki and Mikkeli Digitization Unit.

The decision was made to disregard transportation of legal deposit copies. Institutions under obligation to provide legal deposit copies organise the transportation of the copies to the Library facilities. We do not have precise information on such transportation, e.g., how many times material is transported, how long the journeys are, and what type of vehicles are used for the transportation. On the other hand, we would have to decide to whose carbon footprint these emissions should be allocated: the printing houses, the National Library or the legal deposit copy libraries.

2.4 Scope of the calculation: what the National Library of Finland took into account in its assessment

Facilities, logistics and travel

The National Library's facilities comprise a total of 25,700 square meters (Helsinki: Library Quarter, book cave; Mikkeli Digitization Unit: Saimaankatu 6 and Saimaankatu 8). Heat and electricity consumption was calculated for these facilities. However, it was difficult to estimate the amounts of waste, since waste is collected by building, and it is impossible to calculate the amount of waste for each organisation occupying the building. Waste from the National Library is essentially transported to the same location as waste collected from the University of Helsinki's Metsätalo and Topelia buildings as well as the buildings in the Elk Block.

For logistics, the focus was on the use of the Library's van between Helsinki and Mikkeli. For travel, only work-related travel was considered. This means that staff commutes were excluded from the assessment at this stage. Travel was assessed both in terms of money spent and on trips commissioned through a travel agency.

IT and digital operations / IT infrastructure of services

The carbon footprint of IT services and digital operations is paradoxical: on one hand, digital solutions can reduce emissions and on the other, cause them. This means that emissions should not be evaluated in a vacuum, and the focus should be on the overall net impact of digital solutions and the positive change that can be achieved. In the future, we may have to make principled decisions based on this total net impact in terms of the level and extent of using digital methods – it may be difficult to reach zero emissions.

Digital services are a core part of the National Library's service offering, and examining their emissions is essential for defining the Library's carbon footprint.

In the early stages, we decided to examine the emissions generated by the National Library's services, including at minimum its applications, infrastructure, digitisation and information networks. The goal was to focus strictly on the carbon footprint of service provision, and at this stage exclude the emissions generated by user behaviour. The University's internal IT services, such as HR systems, were excluded. Purchases of IT equipment and services were covered together with other procurements in Procurement Pulse. The decision was made to exclude digitisation and a comparison of digital and analogous material, primarily because the goal was to keep the assessment simple at the first stage. As the work progresses, these areas should be addressed.

Procurement: collection acquisition, preservation material, IT- and mobile devices, furniture

In the National Library's work, procurements consist of several small groups, and may not have a common denominator which would allow for reliable calculation of the carbon footprint. The overall level of the National Library's procurements is indicated in the annual report, but closer examination is required for making calculations for individual material groups. However, such procurements are a regular and visible part of the National Library's daily work and operations, and as such should be included.

The most important individual group in this category are collection acquisitions: printed monographs, newspapers and periodicals. The number of titles and amounts of money are known for these material types. The biggest challenge is to find calculations that are comparable. The calculated metrics for printed material vary greatly depending on whether the calculation method is from a Finnish or international source. For example, the lifespan of collections at the National Library is different from that of public libraries. The National Library's collections comprise several resource types, and emissions from their storage and use is already considered in the calculations for the facilities.

At the moment, electronic resources are a small but significant part of our material acquisitions. The FinELib consortium, which is in charge of a significant part of national electronic resource acquisitions, has no information of international metrics that could be used in this context, so the assessment of the climate impact of licensed electronical resources will have to wait. For licensed resources, the emissions calculations should be continued in cooperation with Helsinki University Library (HULib) and possibly with international university libraries.

Devices such as phones, desktop and laptop computers as well as monitors are needed in all of our work, and they do wear and break. Manufacturers may use different criteria to report on the carbon footprints of individual devices, and many different methods of calculation exist. At this stage we decided to examine emissions from IT equipment and phones based on the purchase invoices.

3 Results of the assessment

3.1 Facilities and waste management

Energy consumption of facilities

The National Library of Finland has four locations: the aboveground facilities at Unioninkatu 36 and the underground storage facility known as the 'book cave' in Helsinki, as well as two facilities at Saimaankatu 6 and Saimaankatu 8 in Mikkeli. At the moment, the rental agreements for all of the locations are administrated through the University of Helsinki's Facilities and Properties sector. Invoicing relating to facility maintenance and heating is also handled through Facilities and Properties.

The energy consumption data for heating and electricity is taken from the invoicing, and the emissions calculated based on the amount of power used. Specific emissions factors were used in the calculation. The carbon dioxide emissions from the consumption of delivered electricity and heat are calculated using emission factors from Oomi Energia for electricity and emission factors from Helen Ltd for district heating. For the Saimaankatu facilities, the calculations were based on district heating in the City of Mikkeli. As heating is included in the rent for the Mikkeli locations, the heating emissions for those facilities has not been itemised.

The carbon dioxide emissions of heating and electricity consumption for 2019 were 670 tCO2-eq. There is no data on Saimaankatu 8, since the National Library had its own rental agreement for that facility until 2020, and no information on energy consumption is available. Heating energy for Mikkeli is also omitted.

Waste management

Baseline data for waste management is only available for Saimaankatu 6, Mikkeli. The Saimaankatu 8 location should not generate any waste, as it is a storage facility. Information on waste amounts is gathered from the facility's invoices. The baseline data were imported into the Y-Hiilari calculator of the Finnish Environment Institute, and the following assumptions were made: waste is transported over a distance of 10 km, compostable waste is composted and mixed waste incinerated.

Heating energy MWh	2018	2019	2020	2019 - > 2020 Change %
UNIONINKATU 36	530.7	540.6	486.1	-11.2
YLIOPISTONKATU 1, underground storage facilities (book cave)	407.7	343.8	299.9	-14.6
Saimaankatu 6, Mikkeli				
Total MWh	938	884	786	
Carbon footprint (tCO2-eq)	148	175	143	
Electricity MWh	2018	2019	2020	2019 - > 2020 Change %
UNIONINKATU 36	428	429	368	-16.4
YLIOPISTONKATU 1, underground storage facilities (book cave)	1,422	1,492	1,329	-12.3
Saimaankatu 6, Mikkeli	585	582	589	1.3
Total MWh	2,435	2,502	2,286	
Carbon footprint (tCO2-eq)	672	495	441	

Table 2. Energy consumption of facilities in 2018–2020.

3.2 Travel

Work-related travel

Work-related travel was assessed using both the Y-Hiilari and the Procurement Pulse tools, mainly to ensure the correct general quantities. In addition, the travel agency CWT provided information on travel and related emissions in 2019. The estimates in both Y-Hiilari and Procurement Pulse are based on purchase invoices.

The following assumptions were made in the Y-Hiilari calculations:

Travel expenses in 2019 were €152,998 excluding kilometre allowances and per diems.

- If the cost of a single work-related trip was €1,000 (flights + accommodation), this means there were a total of 153 trips.
- If the trips were to central Europe (2,000 km) and a single night was spent at a hotel per trip making a total of 153 hotel nights, the carbon footprint was as described in the below table.
- In addition, it was assumed that 100 work-related trips were taken by train between Helsinki and Mikkeli.

With these figures, the total emissions are 33 tCO2-eq.

According to the Hansel Procurement Pulse, a total of €120,000 was spent on travel services, but this is a little less than actual expenses from work-related travel. According to that figure, the carbon dioxide emissions were 0.05 million CO2-eq.

Table 5 features the figures for work-related travel based on trips booked through the CWT travel agency in 2019. According to that, the emissions in 2019 were 52 tCO2-eq, so practically the same as the calculations based on Procurement Pulse.

Material transportation between Helsinki and Mikkeli 2019

The National Library owns a van which is primarily used to transport library material between Helsinki and Mikkeli. In addition, the National Library delivers legal deposit copies to legal deposit libraries around Finland, but the deliveries are performed by a third party. In the carbon footprint assessment, the decision was made to exclude deliveries of legal deposit copies from the calculations.

The following assumptions were made for material transportation:

- One return trip from Helsinki to Mikkeli is 460 km.
- Library material is transported every other week, except in the summer.
- This means that the annual average of material transportation trips is 23, and the total distance 10,580 km.
- The calculations have assumed that the weight of the van is 2.7 tonnes, and that it is fully loaded.

For comparison, the estimated emissions for the same target were checked on Procurement Pulse. Fuel is only bought for the National Library's van. According to Procurement Pulse, the emissions from fuel and oil were 10 tCO2-eq. This is approximately four times the result from Y-Hiilari.

3.3 IT and digital services / IT infrastructure for services

External servers

The process began with an inquiry to CSC – IT Centre for Science and the University's IT Centre regarding their server infrastructures and the carbon footprint levels for the National Library as a whole. A brief survey was sent to service providers, explaining the goals of the assessment and requesting the necessary information on energy consumption and emissions with as much detail as possible (for the CSC this included long-term storage). It was also asked whether the service providers consider the full timespan of the server equipment in their calculations, or just runtime energy consumption. More information on the modes of energy production was also requested, but it proved challenging to obtain answers to these questions from organisations providing services to the National Library. Both the CSC and the IT Centre are at the very beginning of their carbon footprint assessments, and customer-specific ener-

Emission type	tCO2-eq
Emissions from waste management	2.6
Emissions from waste transportation	0.010
Total greenhouse gases generated by waste management	2.6

Table 3. Carbon footprint for waste in Mikkeli in 2019, based on the Y-Hiilari calculator of the Finnish Environment Institute.

	Km total	tCO2-eq
Flights within Europe	306,000	25.8
Train travel within Finland	46,000	0.7
	Number of trips	tCO2-eq
Hotel nights	153	6.1
total		**32.6**

Table 4. Emissions from work-related travel in 2019 based on the Y-Hiilari calculator of the Finnish Environment Institute.

Mo. 2019	Emissions tCO2-eq	km
Air	50,3	550 558
Rail	2,2	50 127
total	**52,5**	**600 685**

Table 5. Emissions from work-related travel booked through CWT in 2019.

	CO2-eq
Road transports	1,972
Fuel production	463
total	**2,435 = 2.4 tC02**

Table 6. Transportation emissions in 2019 based on the Y-Hiilari calculator from the Finnish Environment Institute.

gy consumption data was not available at the time of writing.

At the CSC, the carbon footprint assessment has so far focused on the LUMI supercomputer, which is being constructed in the Kajaani server room. Other measures to calculate the carbon footprint of services are underway, but the main work is just beginning. This means that there were no direct answers regarding the carbon footprint of services provided to the National Library. It was decided that in the future, it would be most efficient to find answers cooperatively, covering the entire service selection. This is because many decisions must be considered in the modelling, including impacts of equipment manufacture (or procurement in general) as well as how the share of things such as data traffic or storage capacity can be allocated for individual services, etc. This means that cooperation between the CSC and the National Library is required.

The next steps have already been tentatively discussed. For the CSC, the work has to do with the sustainability metrics in its strategy. The goal is to use recognised international methods. According to a preliminary estimate, determining emissions for virtual server solutions will be particularly challenging. The intention is to begin with a pilot project, even though a single pilot will not provide a comprehensive overview of the situation. However, cooperation on the assessment will be mutually beneficial for both the CSC and the National Library.

Correspondingly, the University of Helsinki is about to launch its project to reach carbon neutrality by 2030 in which a roadmap for this purpose will be drafted. This roadmap will include goals, a schedule and measures to reduce and compensate climate emissions from various operations. The University's carbon footprint will also be calculated and plans drafted to increase its carbon handprint. The National Library participates in this work.

The National Library's server

In addition to the external servers, the National Library has its own server in its Mikkeli location. The Mikkeli server was included in the energy consumption data of the facility, but was not separately itemised at this stage. Its share of the electricity consumption of the facility is approximately 10%. Emissions from cooling the space could not be calculated.

Calculator in development for climate emission assessment of digital services

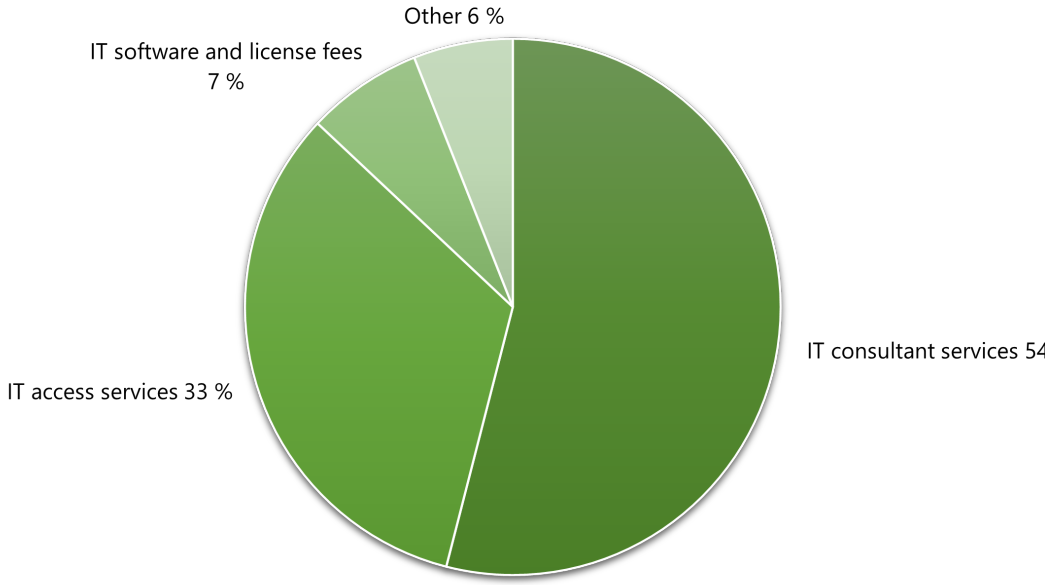
In addition to collecting the above information, we had a discussion with the *Julkisten digitaalisten palveluiden ilmastovaikutukset* –project (a project on the climate impacts of public digital services) of the Finnish Environment Institute, KPMG and LUT University. The project will create a calculator to determine the climate impacts of public digital services.

The calculator will first be piloted with digital services in the social and healthcare sector, which are reasonably small in scale when compared with the National Library's Finna service, for example. However, the goal is to include discussion on the applicability of the new calculator to estimating the climate impact of an infrastructure service such as Finna in the final report of the project. On this basis it will be easier to see how well the calculator would suit our other services. The intention is to continue dialogue and cooperation with experts from the Finnish Environment Institute after the project has ended.

3.4 Procurement: material acquisitions, library equipment, devices, furniture

Library collection procurement

The majority of the library's collections consists of consists of printed monographs, but it also includes e-journals and other licensed resources. According to the Hansel Procurement Pulse tool, the National Library's books, periodicals and other print procurements totalled €5.58 million in 2019. As procurements for the FinELib consortium are invoiced via the National Library, most of this is procurements of material for use by organisations other than the National Library. The National Library's own literature procurements in 2019 amounted to €580,000, or 10% of the total indicated by Procurement Pulse. According to Procurement Pulse, the carbon footprint of the books, periodicals and other printed resources was 870 tCO2-eq. If we calculate 10% of this as being the actual carbon footprint of the National



Graph 3. DIstribution of purchase invoices for ICT services in 2019.

Library's procurement, its total emissions would be 87 tCO2-eq.

Procurement Pulse can also provide information by product supplier or service provider. The National Library purchased €30,000 of protective equipment from Hakakansio in 2019. The estimated carbon dioxide emissions from the protective folders was 20 tCO2-eq.

ICT procurement

According to Procurement Pulse, the total cost of ICT service procurement was €1.03 million, and based on this, the carbon dioxide emissions were 100 tCO2-eq. ICT services included programming purchased from a third party (for digi.kansalliskirjasto.fi, Finto and Melinda services) as well as maintenance and development of the website kansalliskirjasto.fi. IT expert services constituted the largest service group, and the biggest service providers were Gofore Oy and CSC – IT Centre for Science. Most of the costs for CSC were for server maintenance. In 2019, the National Library purchased a total of €193,000 worth of services from CSC, of which only 0.65% were training costs and the rest server-related costs.

Purchasing invoices include CSC invoices which are mainly server costs, but there is no charge for the University of Helsinki's IT Centre servers, and the invoices exclude costs for long-term storage of digital resources (on CSC servers).

The cost of purchasing ICT equipment in 2019 was €150,000, and based on this, its emissions were 40 tCO2-eq. The purchased equipment were laptop computers (51%), IT terminals (20%), computer accessories (17%) and mobile phones (9%).

Equipment that is removed from use is recycled (the University's instructions are on the Flamma intranet). The equipment is auctioned in the Kiertonet online auction service.

The National Library uses its equipment for as long as possible. The average lifespan depends on the type of device: for computers, it is 5–6 years, for phones 2–4, for tablets, 4–6 and for tabletop printers, scanners and monitors, 8–10 years.

Furniture procurement

According to Procurement Pulse, a total of €90,000 was used on furniture purchases, with emissions estimated at 30 tCO2-eq.

Other procurement

Other materials and equipment €120,000 = 70 tCO2eq (IT accessories, cleaning supplies, tools, etc.)

Expert and research services €180,000 = 30 tCO2-eq. Most expert and research services purchased represented various types of consultancy and staff training.

3.5 Summary of the assessment work

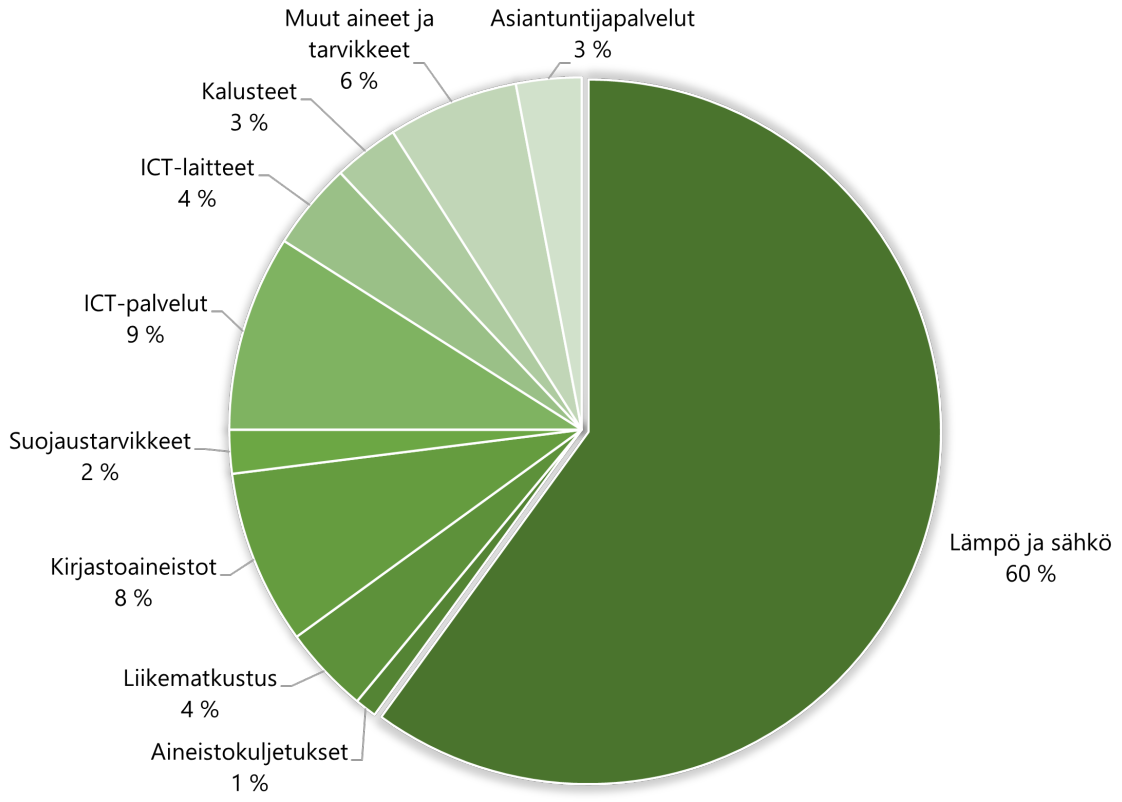
This chapter presents the results of the assessment. The sources and calculation principles for the figures are described at the beginning of the report.

According to Procurement Pulse, the National Library's carbon footprint based on its purchase invoices is 1,890 tCO2-eq, while the carbon footprint for all of the University of Helsinki is 91,980 tCO2-eq. This means that the National Library represents 2% of the University's carbon footprint. The estimated emissions from Procurement Pulse and those from the National Library's own calculations differ significantly. However, the National Library will use the total of 1,018 tCO2-eq from its own calculations for now, even though a large portion of the values are from Procurement Pulse. It has been possible to take things such as facility emissions better into account in the National Library's own calculations.

At the end of 2019, the National Library had 234 employees (on staff), and a total of 219 full-time equivalents were completed at the National Library in 2019. This means that at the National Library, carbon emissions/full-time equivalent were 4.65 tCO2-eq, which represents half of the average carbon emissions of the average Finn, or the production of 2,100 beef steaks of 150 grams (OpenCO2.net 2022). This factor should be viewed with some reservation, and direct comparison with other organisations is not without its problems. Whenever a figure such as this is used, background factors should be considered along with how the organisations being compared differ.

Assessment target	Carbon footprint (tCO2-eq)	Data source
Facilities		
Heating energy (2019)	175	Emissions factor by energy producer
Electricity (2019)	495	Emissions factor by energy producer
Waste (Mikkeli 2019)	2.6	Y-Hiilari
Logistics and travel		
Material transport Helsinki–Mikkeli–Helsinki	2,4	Y-Hiilari -10 tCO2-eq According to Procurement Pulse
Work-related travel (2019)	53	CWT (travel agency) -50 tCO2-eq According to Procurement Pulse -33 tCO2-eq Value based on Y-Hiilari
Procurement		
Library collections	87	Procurement Pulse
Protective folders	20	Procurement Pulse
Furniture	30	Procurement Pulse
Other materials and supplies	70	Procurement Pulse
Expert and research services	30	Procurement Pulse
IT		
ICT services	100	Procurement Pulse
ICT equipment	40	Procurement Pulse
Servers	Na.	Na.
Total	**1 018**	

Table 7. The National Library's climate emissions in 2019.



Graph 4. Distribution of the National Library's emissions in 2019.

4 Conclusion

This report describes the work of the carbon footprint team up until now as well as the results of the assessment. The assessment has revealed areas in which comprehensive information is unavailable, and provided ideas for how to continue the work. The work of the working group has been a very tentative survey, which has included a great deal of self-reflection and development of self-awareness on the part of the organisation. The following subchapters strive to answer the objectives set for the assessment in the introduction.

The report has also sought to draw comparisons with the University of Helsinki and other organisations.

4.1 Carbon footprint assessment

The work now completed on the carbon footprint assessment could be said to provide a superficial overview of the situation while increasing the National Library's understanding on the matter. The evaluation provides tentative perspectives on the kinds of issues the National Library can or should address.

At this stage of the evaluation, the National Library decided to use 1,018 tCO2-eq as the total sum of emissions. This number itemises emissions from facilities and travel in more detail than the Procurement Pulse assessment.

Energy consumption at the library facilities constitutes the largest share of emissions for the National Library, representing approximately two-thirds (60%) of all currently examined emissions. The emissions comprise electricity consumption as well as district heating and cooling. The development of the facilities is under the responsibility of the University of Helsinki's Facilities and Properties sector, with the exception of the Mikkeli locations. The University's goal in its facility development is to invest in energy efficiency, renewable energy and waste heat recovery. The University of Helsinki's carbon neutrality roadmap will be

completed in early 2023 and it includes facility development guidelines.

At 21%, procurement was responsible for a large portion of overall emissions. These are mainly procurements of ICT services and library material. Work-related travel and material transport played a smaller role at a total of 4%. The assessment work thus far is a good start. In the future and when drawing conclusions, it should be remembered that the assessment excluded emissions from server operation and coding work for digital services as well as the digitisation efforts in Mikkeli.

Emissions are only one way of evaluating sustainability, and to interpret the overall view, we must look beyond the figures and engage in a conversation about values regarding the reasons behind specific choices and their goals. We may have to accept some major emission sources to attain broader, longer-term social impact. When assessing the emissions of an organisation such as the National Library of Finland, the focus should be on both ecological sustainability and the context in which emissions are created, including the value generated through the cultural and social sustainability provided by our services as well as the overall value chain of our service production.

These results are a useful starting point for recognising goals and targets for reducing emissions as we strive towards carbon neutrality by 2030. We can try to find ways of reducing electricity consumption, for example, but due to the nature of our work we can never fully attain carbon neutrality if the energy we use is generated with fossil fuels. Since the National Library is part of the University of Helsinki, cutting facility emissions is strongly tied to overall decisions made by the University in terms of how its electricity and heat are produced.

The National Library itself can impact the emissions from its material procurement and travel by taking the ecological perspective more strongly into account. In addition, we must pay closer attention to making sure our digital services are produced according to Green ICT and Sustainable Web Design principles. This requires comprehensive skills development. On the other hand, we must remember that in terms of outsourced services and other procurement, the National Library is tied by the University's framework procurement contracts.

4.2 Available baseline data and tools

Most of the available baseline data is financial information from accounting which is exported from the Hansel Procurement Pulse tool. The Procurement Pulse service features a carbon footprint assessment tool based on purchase invoices, and receives the National Library's purchase invoice information from accounting. The Procurement Pulse's method for calculating carbon dioxide emissions from purchase invoices is not transparent, but it is currently the best tool available for evaluating emissions. However, using the tool or, more importantly, interpreting the figures it provides, requires a good understanding of accounting and the finances of the organisation.

As the figures from Procurement Pulse have been generated based on coherent logic, at least within the University of Helsinki, they are a sensible basis for carbon footprint assessment. The benefit of Procurement Pulse is that information on money spent, and the carbon footprint based on it is available itemised according to the biggest suppliers. This makes it easier to see the source of the expense and estimated carbon footprint. For example, based on information from Procurement Pulse, we can sort the biggest contributors to the carbon footprint among purchased ICT services, or we can itemise the carbon footprint generated by protective equipment for the collections. However, in all these processes we must note that the calculation produces 'sufficiently accurate' information, not necessarily exact data. In all assessment, the main thing is to understand the scales and their correlations.

For facilities, information is available on electricity and heat energy consumption, which can be used as a basis for assessing the carbon footprint of facilities. Emissions from waste management can be assessed for the Mikkeli facilities, but no reliable information is available on waste amounts for the Helsinki library facilities.

The Y-Hiilari calculator from the Finnish Environment Institute can be used to estimate the carbon footprint contribution of facilities as well as emissions from transport and work-related travel. Then, the calculation is based on an estimate of annual transport journeys, or plane or train trips.

4.3 What have we learned? Support from partners and help from external experts

The biggest surprise of the process was that currently available information makes it impossible to fully delve into the carbon footprint of digital services. The digital dimension is key to the work of the National Library of Finland. Determining the emissions caused by digital infrastructure requires further work both with the University of Helsinki and the CSC. Both of these institutions are currently investigating their own carbon footprint, after which it may be possible to study the contribution of the National Library's services to total emissions. The carbon footprint of the long-term storage of the National Library's born-digital and digitised resources is a separate question. In addition, long-term storage is carried out on a CSC server.

During the work, we gained a clearer understanding of the connections of the National Library's work, services and processes to a number of external institutions. For carbon footprint assessment, it would be necessary to determine emissions for the entire operational chain. Emissions are created at different points along the chain of operators, and calculating them is not simple, or even possible for the National Library as a single institution.

Determining the emissions for operational chains requires cooperation among all institutions on the chain, significant transparency in operations and negotiating how emissions from various stages along the chain are allocated to individual institutions. It was almost surprising to see how little transparency there was among the parties. For example, no easily available data exists on the climate impact of servers or data transfer, or how emissions from electronic materials are calculated.

If we want to expand the work on carbon footprint assessment, we will need expert guidance and cooperation particularly among the various parties involved in operational and service processes. For the National Library, cooperation with the University of Helsinki, for example, will continue to be highly important. The special characteristics and needs of the National Library's work should be considered in the University's assessment work, and also in that of the CSC.

4.4 Further points of study

Even based on a cursory study, we can state that the National Library's operations, processes and service production form an extensive network of co-dependencies, where it may be possible to determine the general extent of the National Library's carbon footprint along with the main emissions sources and possibly compare them with those of other organisations, if certain delimitations are made and calculation methods clarified. However, exact figures are impossible to uncover.

In the future it could be interesting to analyse the overall emissions from the Finnish network of libraries and cultural heritage institutions; that is, at least to analyse how various emissions are generated across the field and their respective correlations. The conversation should include the entire cultural heritage field along with the organisations that produce the infrastructure that serves it, such as third-party providers of metadata. We should also specify the role of Finna as a platform service – how should emissions from Finna be considered in the emissions calculation of client museums, archives and libraries.

For digital services, we should also consider the dual ecological impact of digitalisation. In addition to climate emissions, we should study the green handprint, i.e., how much are emissions reduced because these services exist. In general, it would be both interesting and important to determine the social net impact of the work of cultural heritage organisations. Even though the field does generate some emissions, it also

provides a great deal of added value to society in other areas of sustainability and responsibility.

However, before embarking on such extensive analyses, we should first focus more on the emissions from the National Library's own work, including its ICT infrastructure and digitisation. Evaluating emissions from our equipment more closely would be work-intensive. The National Gallery's report on its IT equipment, described in chapter 1.3.1, provides a general understanding of this. There is no exact information available on the overall emissions from digital infrastructure. Determining the original manufacturing, etc., conditions of devices is also challenging, as not all of the related information is fully transparent. However, some device manufacturers do offer information of the lifetime emissions of their devices on their websites.

We also need to minimise the climate emissions from the software we produce. Finland is rapidly gaining expertise in Green ICT and Sustainable Web Design processes, and the National Library should also increase its in-house skills in this area. Following related international developments, information sources and indicators is also useful.

Emissions from licensed electronic resources which are central to the work of the National Library are especially related to major international publishers and their processes. Publishers have released responsibility reports, but they do not provide information relevant to carbon footprint calculation. In this area, the evaluation work should be international, and the allocation of emissions based on internationally agreed practices. Analysing emissions from electronic resources together with our stakeholders and partners, such as the Helsinki University Library, could also prove fruitful.

4.5 Suggestions for the management of the National Library of Finland

The working group makes the following suggestions to the management of the National Library for further carbon footprint assessment and for a roadmap towards carbon neutrality:

2023–2024:
- Determining emissions from digital operations in cooperation with the University of Helsinki's IT Centre and the CSC, server emissions with the IT Centre, CSC and Mikkeli location
- Digitisation; device emissions (lifetime)
- IT equipment, primarily employee computers (lifetime)
- How are we implementing principles of Green ICT and Sustainable Web Design? – In-house skill development
- Collecting background material
- Planning and implementing responsibility reporting for 2022 – leadership should draft the framework for the report

2024:
- Roadmap to carbon neutrality by 2030 together with the University of Helsinki

2025 and onwards:
- Emissions from supply and value chains; further evaluation of emissions from the Finnish library field, emissions from legal deposit copies – ***external expertise must be employed, funding sought for the evaluation work***

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