LIFE12 ENV/FI/000592

# CARBON FOOTPRINT FINAL REPORT

## CARBON FOOTPRIN REPORT PERIOD 5

## LIFE12 ENV/FI/000592 UPACMIC

# Carbon footprint report

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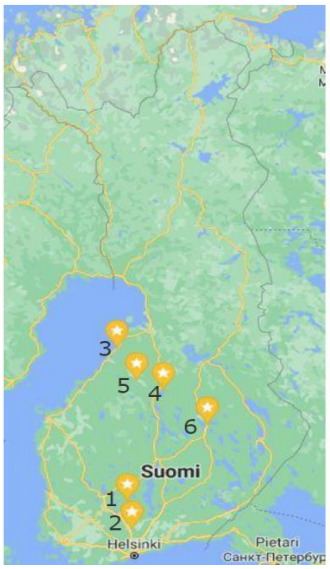
# 1. INTRODUCTION

This carbon footprint report sets out the results of the carbon footprint monitoring done so far in the UPACMIC project. The Carbon footprint monitoring is done in order to keep track of the greenhouse gas emissions developed by the project. A carbon footprint is the total greenhouse gas emissions caused by project presented as carbon dioxide.

The results of the UPACMIC carbon footprint are compared with the carbon footprint of ABSOILS LIFE09 ENV/FI/000575 in Finland. The ABSOILS project had similar actions as UPACMIC, including material testing and piloting. The major difference between the projects is that the piloting targets in UPACMIC are located in mining environments and waste centre around Finland, when the ABSOILS pilots were related to the road and field construction in the capital region of Finland. Transportation distances in ABSOILS are obviously shorter than distances in UPACMIC. Locations of the key points in the UPACMIC project are visualized in figure 1.




1 Ramboll, Luopioinen
2 Fortum, Riihimäki
3 Skarta, Pyhäjoki
4 Pyhäsalmi Mine, Pyhäsalmi
5 Hitura Mine, Nivala
6 Waste deposit site Sorsasalo, Kuopio

**Figure 1. UPACMIC project piloting sites and partner's locations.**

The ABSOILS project ended in June 2015. The UPACMIC project ends in August 2022. This final carbon footprint report includes carbon dioxide ($CO_2$) emissions of the project from July 2013 to end of the year 2021. Project's last eight months is mostly monitoring and reporting in office. Deskwork doesn't cause huge carbon dioxide emissions, so this period has left out from the report.

With the help of the carbon footprint report the project can point out actions or working methods that generates a lot of carbon dioxide emissions relating to the results by certain action. The overall point of this carbon footprint reporting is to observe the emissions created by this project. The final carbon footprint report will present the total carbon footprint of the project. With this report can also estimate emissions of the different project stages and working methods.

The methodology of the carbon footprint calculation and the assumptions made in the calculation are presented in chapters 2 and 3. The results of the carbon footprint calculation as well as the evaluation and comparison of the results are presented in chapter 4. Summary of the report is presented in chapter 5.

# 2. METHODOLOGY

The carbon footprint monitoring is based on the documented work hours, driven kilometres and used vehicle. Each partner documented the travelled kilometres (by car, by train or by airplane) during the project. In pilot projects used materials loading, transportation and construction work caused emissions which were documented, and emissions calculated. The piloting emissions are calculated for different structures. In Sorsasalo emission is whole structures emission and in Hitura it represented only sealing layers emissions. The sealing layer of enrichment sand basin and pre-crushing site is the only part of structures which is monitored by UPACMIC so only it is considered to causes emission due to project.

The deskwork in the project is normal deskwork and the $CO_2$ emissions from the deskwork can be calculated based on the deskwork hours which are documented on the timesheets. The emissions from the laboratory work are also calculated based on the work hours. The additional energy consumption related to the laboratory equipment needed for the material tests are calculated in the consumption of energy on hourly basis, which is thus included to the carbon footprint of the work.

# 3. ASSUMPTIONS

The following assumptions were made before the carbon footprint calculations.

- The laboratory and deskwork facilities in Luopioinen office building consume energy about 75 000 kWh per year and the total working hours of the office are 21 000 h per year. The approximate power consumption of a working hour is 3,6 kW and the $CO_2$ eq emissions are 800 g $CO_2$ eq per working hour. Assumption that the laboratory work and desk work consume the same amount of energy as the energy consumption is difficult to allocate to different kinds of work. However, a normal office with no laboratory consumes lower amount of energy and therefore the following assumption is made.
- In the other offices with only deskwork facilities the energy consumption is estimated to be 2,6 kWh and the $CO_2$ eq emissions are 580 g $CO_2$ eq per working hour.
- The emissions of vehicles are assumed to be the same as the manufacturer declares (g $CO_2$ eq/km) multiplied by the kilometres travelled. For those with no manufacturer information the data was taken from ilmastolaskuri webpages (WWF, 2022).
- The emissions for used working machines are calculated on the basis of the LIPASTO database developed by the Technical Research Centre of Finland. Values are defined for a typical machine in each working machine category in Finland. (Teknologian tutkimuskeskus VTT Oy, 2017.)
- The emissions from the use of office supplies such as paper, pens, pencils, plastic products (binders, folders) etc. are assumed to be zero as the emissions would be too difficult to evaluate correctly and on the other hand the emissions would be so small that it is negligible when compared to other activities of the project.
- The $CO_2$ emissions from the used waste and surplus materials production are not taken in account because those would be produced anyway regardless the UPACMIC project. Only materials loading caused emissions.
- The moraine used in pilot structures is virgin material and $CO_2$ eq emission moraine excavating is 1,57 kg/$m^3$ (Rapal, 2019).
- Pilot structures construction works emissions based on fuel consumption of the working vehicle (excavator, dumper, tractor etc.). The emissions for used vehicles are calculated on the basis of the LIPASTO database developed by the Technical Research Centre of Finland. Figures are defined for a typical machine in each working machine category in Finland (in terms of power use and age of fleet) (Teknologian tutkimuskeskus VTT Oy, 2017).

# 4. RESULTS OF UPACMIC CARBON FOOTPRINT CALCULATIONS

The results of the UPCAMIC project are calculated on the basis of the information given by the partners. The total carbon footprints are calculated periodically in five period. Each period carbon emission is divided to three sub-category which are travelling, piloting work and deskwork.

The total carbon footprint in the first reporting period of 1st July 2013 to 31st October 2014 is 9,4 tonnes of $CO_2$ equivalent. In the II reporting period of 1st November 2014 to 31st October 2015 the carbon footprint is 3,2 tonnes $CO_2$ equivalent. In the III reporting period of 1st October 2015 to 31st December 2016 the carbon footprint is 9,1 tonnes $CO_2$ equivalent. In the IV reporting period of 1st January 2017 to 31st December 2019 the carbon footprint is 699,5 tonnes $CO_2$ equivalent. In the V reporting period of 1st January 2020 to 31st December 2021 the carbon footprint is 172,0 tonnes $CO_2$ equivalent. The carbon footprint is divided to travelling, piloting and deskwork according to the following table 1 which presents the generated $CO_2$ emissions during the reporting periods from 1st July 2013 to 31st December 2021.

**Table 1. CO2 emissions generated during the project.**

| | **Tonnes of $CO_2$ equivalent** | | | | | |
|---|---|---|---|---|---|---|
| **Period** | **I 1.7.2013-31.10.2014** | **II 1.11.2014-31.10.2015** | **III 1.11.2015-31.12.2016** | **IV 1.1.2017-31.12.2019** | **V 1.1.2020-31.12.2021** | **Total** |
| **Days** | **487** | **364** | **426** | **426** | **730** | **2433** |
| **Travelling** | 5,7 | 1,8 | 2,4 | 32,6 | 2 | 44,5 |
| **Piloting work** | - | - | 3,8 | 656,5 | 163,1 | 823,4 |
| **Deskwork** | 3,7 | 1,4 | 2,9 | 10,4 | 6,9 | 25,3 |
| **TOTAL** | **9,4** | **3,2** | **9,1** | **699,5** | **172** | **893,2** |

In the first period, travelling has caused most of the $CO_2$ emissions, 5,7 tonnes, and deskwork 3,7 tonnes of $CO_2$ equivalent. There have been several meetings during the first period, which explains the higher travelling $CO_2$ result. In the second period, travelling has caused 1,8 tonnes and deskwork 1,4 tonnes of $CO_2$ equivalent. In the third period, travelling $CO_2$ equivalent has risen again caused by the field tests performed in spring 2016 in Pyhäsalmi Mine. Pilot structure's materials, transportation and construction work also caused additional 3,8 tonnes of $CO_2$ emissions.

In the fourth reporting period there has been a lot of ongoing actions. Cover structure piloting has been completed in Hitura phase I and emissions caused from piloting was 656,5 tonnes of $CO_2$ equivalent. Most of those emissions are generated during fibre clay transportation, because fibre clay is side stream material from paper industry and all three (Metsä Tissue Mänttä, Stora Enso Oulu, Äänekoski) paper production plants are located over 150 km away from Hitura (figure 2).

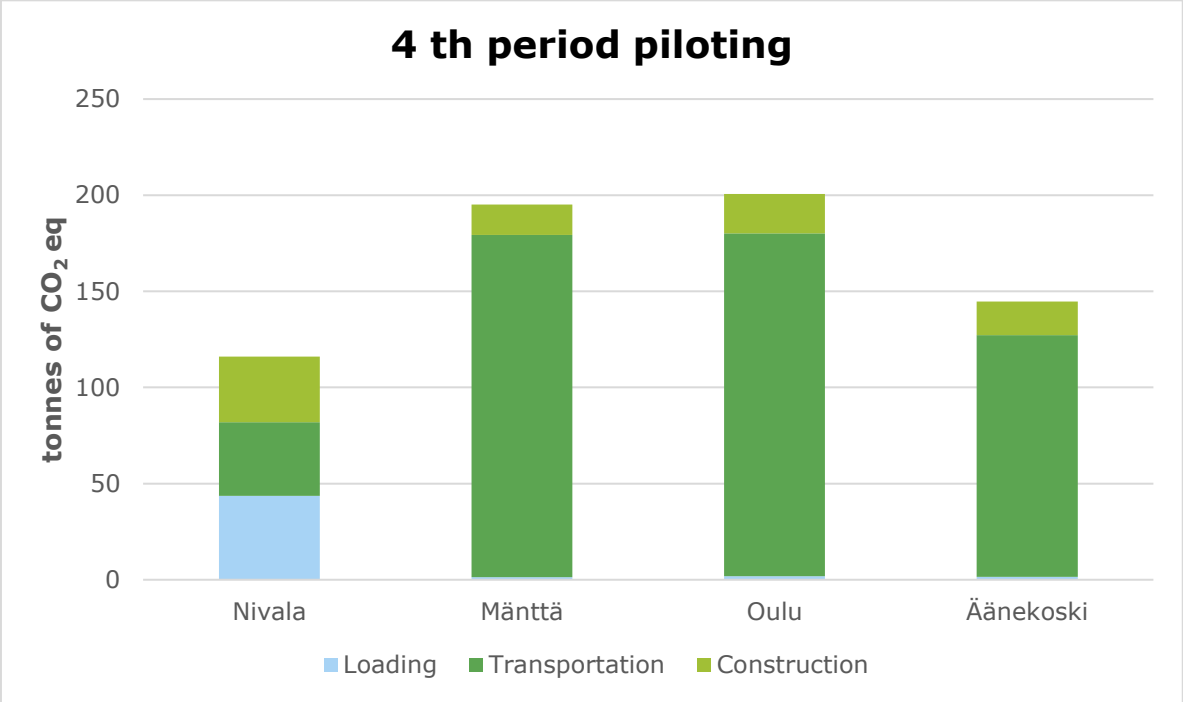



**Figure 2. Hitura fibre clay pilot structures' CO2 emissions. Explanation of the terms: Nivala is Moraine; Mänttä, Oulu and Äänekoski are fibre clays.**

During 4th period has been a lot travelling due to piloting. Also there has been a lot of meetings concerning planning and negotiating of Hitura phase II. In addition, the fact that Finland is a sparsely populated country (average 18 persons/km$^2$, EU average 116 persons/km$^2$), so the use of public transportation is not always possible outside urban areas as the timetables are non-suitable for work travelling or there is no public transportation at all. The Hitura mine is located in Northern Ostrobothnia so the travelling distances are very long.

In the fifth period has constructed more pilot sites. Cover structure piloting has been continued in Hitura phase II and reactive barriers testing started, there has also made an isolative pilot structure in Kuopio. Emissions caused from piloting were 159,4 tonnes of $CO_2$ equivalent, emissions have shown in figure 3. There isn't shown reactive barriers emissions, because emissions were negligible when compared to other structures (4,3 tonnes $CO_2$).

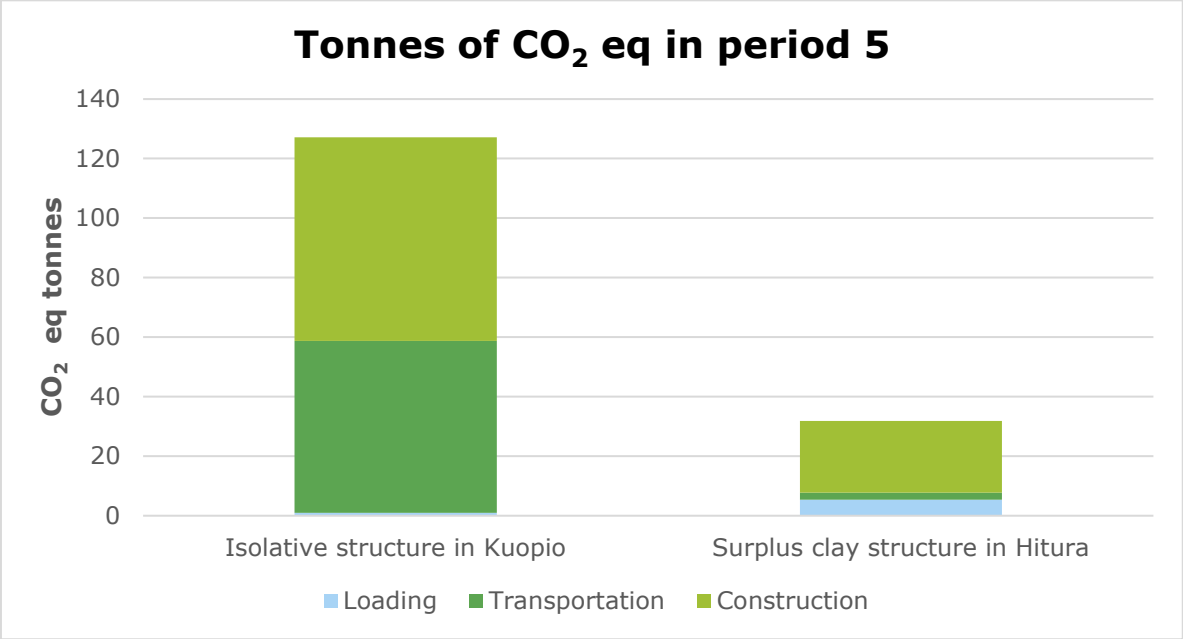



**Figure 3. Period fifth pilot structures emissions without reactive barriers.**

During fifth period travelling restrictions has been introduced for prevent the spread of the COVID-19 pandemic and new virus variants, therefore emissions caused by travelling is smaller than IV period. Meetings and seminars are organized and hosted in online and only compulsory travelling could be done from spring 2020 to the end of the year 2021. Travelling emissions were 10 % compared emissions in years 2017-2019.

During fifth period there were not as much deskwork as fourth period nevertheless it includes pilot result reading and reporting. The $CO_2$ emissions from deskwork and laboratory are presented in Table 2.

**Table 2. $CO_2$ results from the deskwork by different partners.**

| Beneficiary | Working period | Working hours | Lab/desk | Emission coeficcient [kgCO2/hour] | kg $CO_2$ ekv total | kg $CO_2$ ekv total, cumulative | t $CO_2$ ekv total, cumulative |
|---|---|---|---|---|---|---|---|
| RAMFI SUM | 1.7.2013-31.10.2014 | 4431 | | 0,8 | | | |
| Luopioinen | | 2880 | Desk+Lab | 0,8 | 2304,12 | 2304 | 2,3 |
| Espoo and Oulu | | 1551 | Desk | 0,58 | 899,493 | 3204 | 3,2 |
| BELVEDERE | | 438 | Desk | 0,58 | 254,04 | 3458 | 3,5 |
| Maastorakentajat | | 70 | Desk | 0,58 | 40,6 | 3498 | 3,5 |
| EKOKEM | | 267 | Desk | 0,58 | 154,860 | 3653 | **3,7** |
| RAMFI SUM | 1.11.2014-31.10.2015 | 1530,5 | Desk+Lab | 0,8 | 1224,4 | 4878 | 4,7 |
| BELVEDERE | | 332 | Desk | 0,58 | 192,56 | 5070 | 4,9 |
| Maastorakentajat | | 79,5 | Desk | 0,58 | 46,11 | 5116 | 5,0 |
| EKOKEM | | 239,29 | Desk | 0,58 | 138,7882 | 5255 | **5,1** |
| RAMFI SUM | 1.11.2015-31.12.2016 | 3128,25 | Desk+Lab | | | | 5,1 |
| Luopioinen | | 2950 | Desk | 0,8 | 2360 | 2360 | 7,5 |
| Espoo, Oulu and Tampere | | 178,5 | Desk | 0,58 | 103,53 | 2464 | 7,6 |
| Maastorakentajat | | 292,5 | Desk | 0,58 | 169,65 | 2633 | 7,7 |
| EKOKEM | | 468,41 | Desk | 0,58 | 271,6778 | 2905 | 8,0 |
| RAMFI SUM | 1.1.2017-31.12.2019 | 6372,5 | Desk+Lab | | | 2905 | 8,0 |
| Luopioinen | | 5706 | Desk+Lab | 0,8 | 4564,8 | 7470 | 12,6 |
| Espoo, Oulu and Tampere | | 666,5 | Desk | 0,58 | 386,57 | 7856 | 13,0 |
| Maastorakentajat | | 132,5 | Desk | 0,58 | 76,85 | 7933 | 13,0 |
| Fortum | | 479 | Desk | 0,58 | 277,82 | 8211 | 13,3 |
| RAMFI SUM | 1.1.-2020-31.12.2020 | 1170,5 | Desk+Lab | | | 8211 | 13,3 |
| Luopioinen | | 1037 | Desk+Lab | 0,8 | 829,6 | 9040 | 14,1 |
| Espoo, Oulu and Tampere | | 133,5 | Desk | 0,58 | 77,43 | 9118 | 14,2 |
| Maastorakentajat | | 156,5 | Desk | 0,58 | 90,77 | 9209 | 14,3 |
| Fortum | | 993 | Desk | 0,58 | 576,056 | 9785 | 14,9 |
| RAMFI SUM | 1.1.2021-31.12.2021 | 1817,5 | Desk+Lab | | | 9785 | 14,9 |
| Luopioinen | | 1636 | Desk+Lab | 0,8 | 1308,8 | 11094 | 16,2 |
| Espoo, Oulu and Tampere | | 181,5 | Desk | 0,58 | 105,27 | 11199 | 16,3 |
| Skarta | | 302 | Desk | 0,58 | 175,16 | 11374 | 16,5 |
| Fortum | | 1475 | Desk | 0,58 | 855,732 | 12230 | 17,3 |

## 4.1 Comparison with ABSOILS-project

The UPACMIC carbon footprint results are compared with the ABSOILS (LIFE09 ENV/FI/000575) project results in table 3. The projects differs on piloting activities as the piloting in the ABSOILS project was about utilisation of surplus soils in different civil engineering actions and UPACMIC project takes place in mining environment. When compared the UPACMIC and ABSOILS results, there is a clear difference in the $CO_2$ results from the travelling. In the fourth reporting period, emissions from the pilot can be compared with the ABSOILS-project. Emissions from the piloting activities of UPACMIC-project are significantly lower than in the ABSOILS-project.

Travelling and deskwork has increased significantly as the piloting has been in the active stage and there has been a lot of meetings and preparations for the Hitura II phase. As it is clarified in the previous chapter, the Hitura mine is located in northern part of Finland, and in the ABSOILS project all the pilots were located in the capital region of Helsinki. In the ABSOILS project the $CO_2$ emissions from the train travelling were calculated on the basis of the Ilmastolaskuri webpage (WWF, 2022), which gives in small values, although the impact is very minimal to the final results. The $CO_2$ emission for the deskwork are similar between the projects. Table 3. Comparison of UPACMIC and ABSOILS LIFE project carbon footprints.

**Table 4. Periodically comparison of UPACMIC and ABSOILS LIFE-projects carbon footprints where UP = UPACMIC and AB = ABSOILS.**

| | Tonnes of CO2 equivalent | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Period** | **I** | | **II** | | **III** | | **IV** | | **V** | |
| **Duration/days** | **487** | **364** | **364** | **365** | **426** | **364** | **1094** | **364** | **730** | **364** |
| **Project** | **UP** | **AB** | **UP** | **AB** | **UP** | **AB** | **UP** | **AB** | **UP** | **AB** |
| **Travelling** | 5,7 | 3,1 | 1,8 | 4,1 | 2,4 | 3,9 | 32,6 | 8,5 | 2 | - |
| **Piloting work** | - | 2170 | - | 6176 | 3,8 | 4806 | 656,5 | 5453 | 163,1 | - |
| **Deskwork** | 3,7 | 3,6 | 1,4 | 2,3 | 2,9 | 3,2 | 10,4 | 2,3 | 6,9 | 4,6 |
| **TOTAL** | 9,4 | 2176 | 3,2 | 6182 | 9,1 | 4813 | 699,5 | 5464 | 172 | 4,6 |

# 5. SUMMARY

The massive cover structures in mining environs have many environmental effects therefore only review of $CO_2$ emissions doesn't give real picture from the new kind of application that were developed in the UPACMIC-project. Waste is global challenge, and "End-of-waste" is a process to facilitate the recovery or recycling of waste for use as a resource, to directly replace the use of raw materials.

Cover structures in Hitura is a great example utilization of waste, when the fibre clay is utilised in cover structure instead of burning it. At the same time there are saved about 37 200 $m^3$ virgin materials like moraine. The isolative structure in Kuopio has been made utilising only waste materials which are available in waste centre. Industrial wastes and by-products causing costs in many forms such as storing, transporting and storage area's maintenance, so the utilisation is better way from many aspects.

There weren't working online connections in project starting time and participants had to meet face to face. Online connections development was very fast, so management and communication modes changed during the project. Online meetings were main communication channel in the final stages, because covid-19 pandemic limits travelling. Travelling compared to deskwork caused much more emissions during the project, so in the future reducing unnecessary travelling would be easiest method to lower $CO_2$ emissions, but also Internet and servers increased usage generate $CO_2$ emissions which may need to take in account in the future projects.

Deskwork has been at the same level during the project except for period four when there has been a lot of fields actions ongoing. Deskwork includes reporting and monitoring which must be done in stages during the project.

# 6. REFERENCES

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