Carbon footprint of recycled solvents at the sectoral level compared to virgin solvents

Study for the European Solvent Recycler Group (ESRG)

October 2018

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Title of the study: Carbon footprint of recycled solvents at the sectoral level compared to virgin solvents

Client: European Solvent Recycler Group (ESRG)

Date: October 2018

Project carried out by: ETHOS Research

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Executive summary

This report presents the carbon footprint of solvents recycled annually in Europe by ESRG members. This is compared to the carbon footprint of virgin solvents to estimate annual savings in greenhouse gas emissions due to solvent recycling.

Life cycle assessment was used as a tool to estimate the carbon footprint of both the recycled and virgin solvents. The main goal of the study was to estimate the annual carbon footprint of recycled solvents from 'cradle to gate' or 'business to business'. The life cycle stages considered included transport of waste solvents to the recycling plant, solvent recycling processes and the subsequent transport of recycled solvents to the user.

The unit of analysis (functional unit) was defined as the 'annual manufacture of recycled solvents'.

Data on the amounts of a wide variety of solvents recycled annually were received from 23 ESRG member companies. It total, these companies recycled 308,750 tonnes of solvents in 2017.

However, the carbon footprints were available only for the following six types of solvent: acetone, methyl ethyl ketone, mixed solvents, perchloroethylene, triethylamine and tetrahydrofuran. The study relied on these data to estimate the carbon footprints of all the recycled solvents by grouping them into six categories to correspond as closely as possible to the six solvents for which the carbon footprint data were available. This categorisation was guided by the similarity of their recycling processes. It should be noted that this approach has limitations and the estimates presented here can only be considered as representative rather than actual.

For the purposes of the report, the solvents were also grouped into the following three categories: non-chlorinated, chlorinated and mixed solvents. These results are given in Figure 1 which shows the annual carbon footprint by solvent category in comparison to their virgin equivalents. It can be seen that the total carbon footprint of the solvents recycled annually is equal to 109 kt CO_2 eq. per year. By comparison, the carbon footprint of producing the same amount of virgin solvents is equivalent to 727 kt CO_2 eq./yr. Therefore, recycling 309 kt of solvents saves around 618 kt CO_2 eq. per year compared to producing the same amount of virgin solvents. This saving in greenhouse gas emissions is equivalent to taking 280,000 diesel cars off the road annually.

However, these findings should be interpreted bearing in mind the above-mentioned methodology limitations. Nevertheless, the differences in the carbon footprints of recycled and virgin solvents are relatively large, providing confidence in the results.

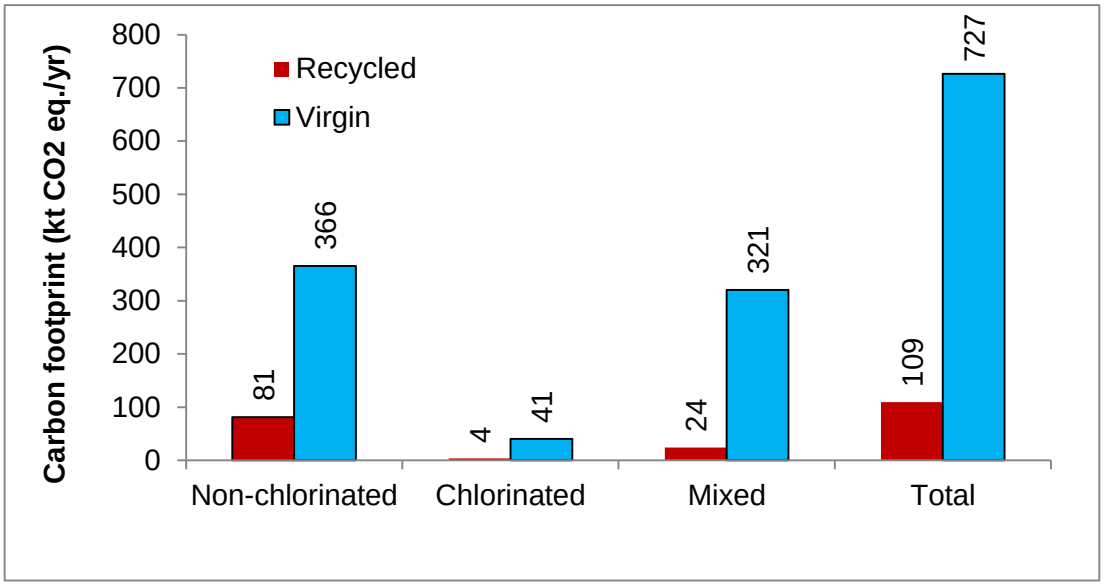

Figure 1 Annual carbon footprints of recycled and virgin solvents

1 Introduction

This carbon footprinting study was commissioned by the European Solvent Recycler Group (ESRG) to estimate the carbon footprint of solvents recycled annually by its members. The results were compared to the carbon footprint of virgin solvents to estimate annual savings in greenhouse gas emissions due to solvent recycling.

Life Cycle Assessment (LCA) was used to estimate the carbon footprint, following the ISO 14044 [1] methodology. CCaLC2 [2] was used to model the system and estimate the carbon footprints of recycled solvents.

The goal and scope of the study are outlined below. The results of the study are presented in Section 3 and the conclusions are drawn in Section 4.

2 Methodology

2.1 Goal and the scope of the study

The goal of the study was to estimate the annual carbon footprint of different solvents recycled by ESRG members. The scope of the study was from 'cradle to gate' or 'business to business'. The life cycle stages considered (Figure 2) included transport of waste solvents to the recycling plant, solvent recycling processes, waste management of in-process waste streams and transport of recycled solvents to the user. The use of solvents was excluded from the study, in congruence with the goal of the study. The unit of analysis (functional unit) was defined as 'annual manufacture of recycled solvents'.

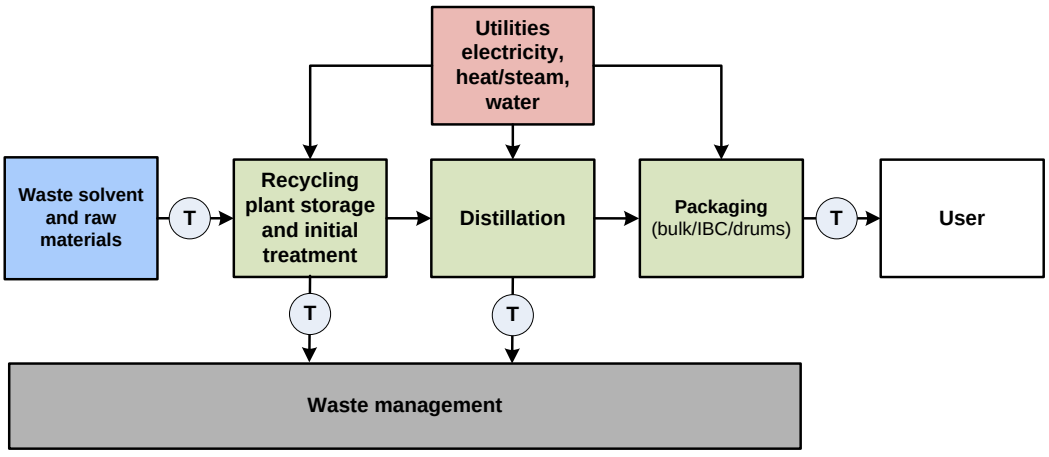

Figure 2 Scope of the study and system boundaries for recycling of different solvents

[Use of recycled solvent is excluded.]

2.2 Data and assumptions

The data on the amounts of different recycled solvents were provided by 23 ESRG member companies. These data are summarised in Table 1. As can be seen, 308,750 tonnes of solvents were recycled in 2017 by these companies.

In total, over 300 data points were provided which, after harmonising the solvents terminology, were reduced to around 160 solvents. These were then grouped in two ways by members of the ESRG Board. First, they were classified as non-chlorinated, chlorinate or mixed solvents. Secondly, they were approximated by one of the six types of recycled solvent for which the carbon footprint data were available: acetone, methyl ethyl ketone (MEK), mixed solvents (MS), perchloroethylene (PERC), triethylamine (TEA) and tetrahydrofuran (THF). This approximation was guided by the similarities in their processing.

The carbon footprints of these six solvents were then used to estimate the annual carbon footprints of all the solvents recycled in 2017 for which the data were provided. The carbon footprints of the six solvents were estimated in an earlier study carried out by Ethos Research for ESRG [3] using the CCaLC V3.0 [2] and Ecoinvent V2.2 [4] databases. Their individual carbon footprints are shown in Figure 3 in comparison to their virgin equivalents.

It should be noted that, due to the limitations of the above approach, the obtained estimates can only be considered as representative rather than actual. For the latter, the carbon footprints of each type of solvent would be needed; however, this was now available and was outside the scope of the study.

Table 1 Annual production of recycled solvents by 23 ESRG member companies in 2017

Type	Proxy[a]	Amount (t/yr)
Simple non-chlorinated	Acetone, MEK, MS, TEA, THF	142,166
Chlorinated	Perchloroethylene	10,399
Mixed solvents	Mixed solvents	156,185
Total		**308,750**

[a] MEK: methyl ethyl ketone; MS: mixed solvents; TEA: triethylamine; THF: tetrahydrofuran.

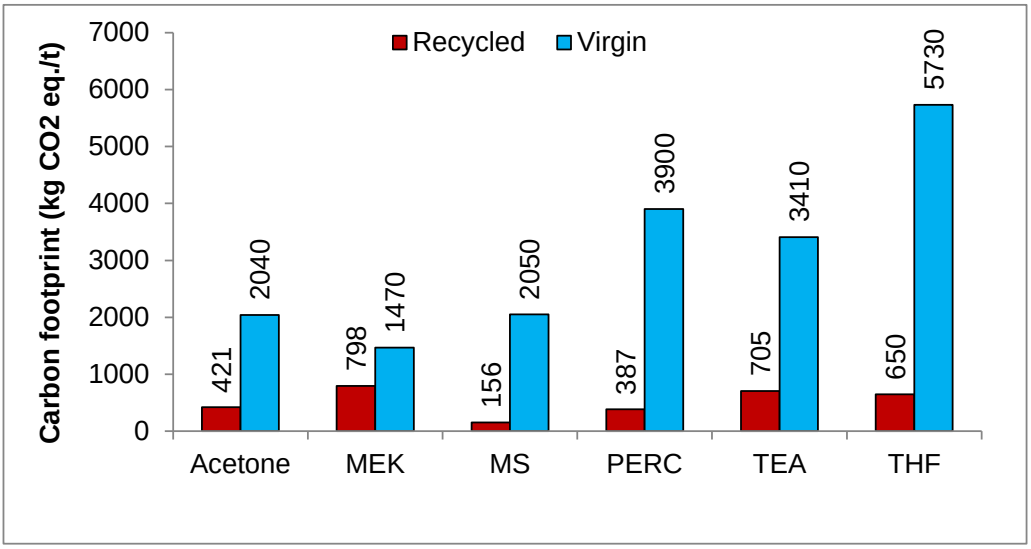

Figure 3 Carbon footprint of recycled and virgin solvents [3]

(MEK: methyl ethyl ketone; MS: mixed solvents; PERC: perchloroethylene; TEA: triethylamine; THF: tetrahydrofuran)

3 Results

The results are presented in Figures 4 and 5. The former shows the carbon footprints of the recycled solvents grouped into the above-mentioned six types of solvent while the latter presents the carbon footprints of the solvents grouped into non-chlorinated, chlorinated and mixed solvents.

It can be seen from the figures that the total carbon footprint of the solvents recycled annually is equal to 109 kt CO_2 eq. per year. The carbon footprint of producing the same amount of virgin solvents is equivalent to 727 kt CO_2 eq./yr. Therefore, recycling 309 kt of solvents saves around 618 kt CO_2 eq. per year compared to producing the same amount of virgin solvents. This saving is equivalent to taking 280,000 diesel cars off the road annually.

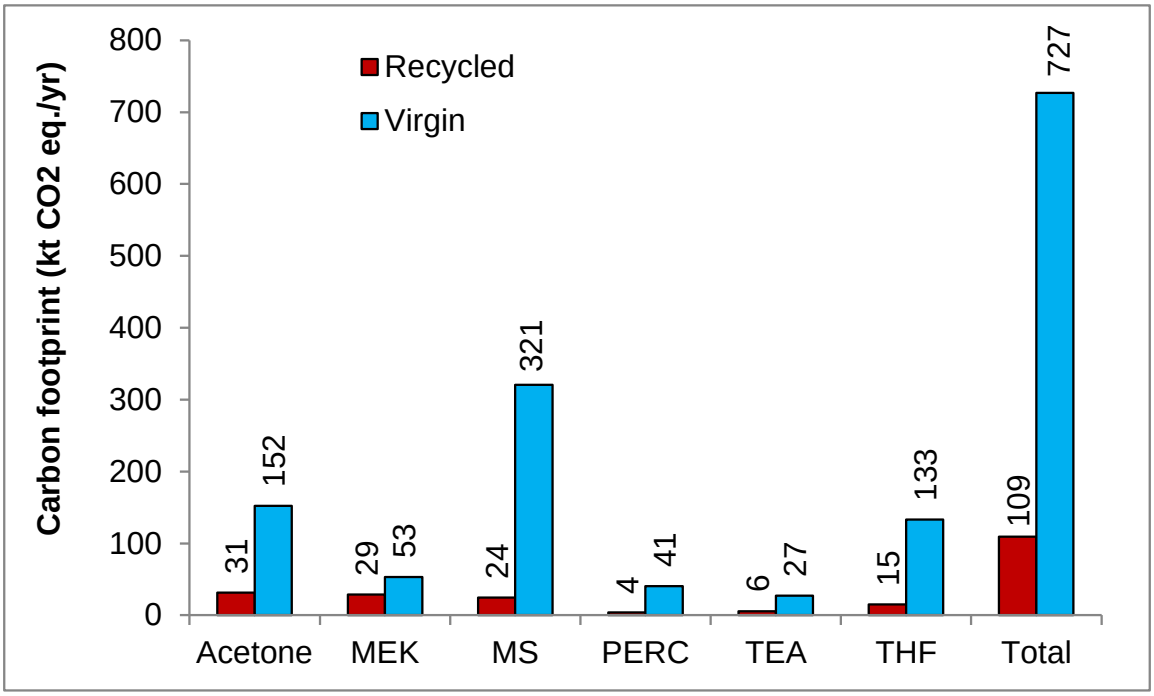

Figure 4 Carbon footprint of recycled solvents according to the proxy solvent types considered in the study

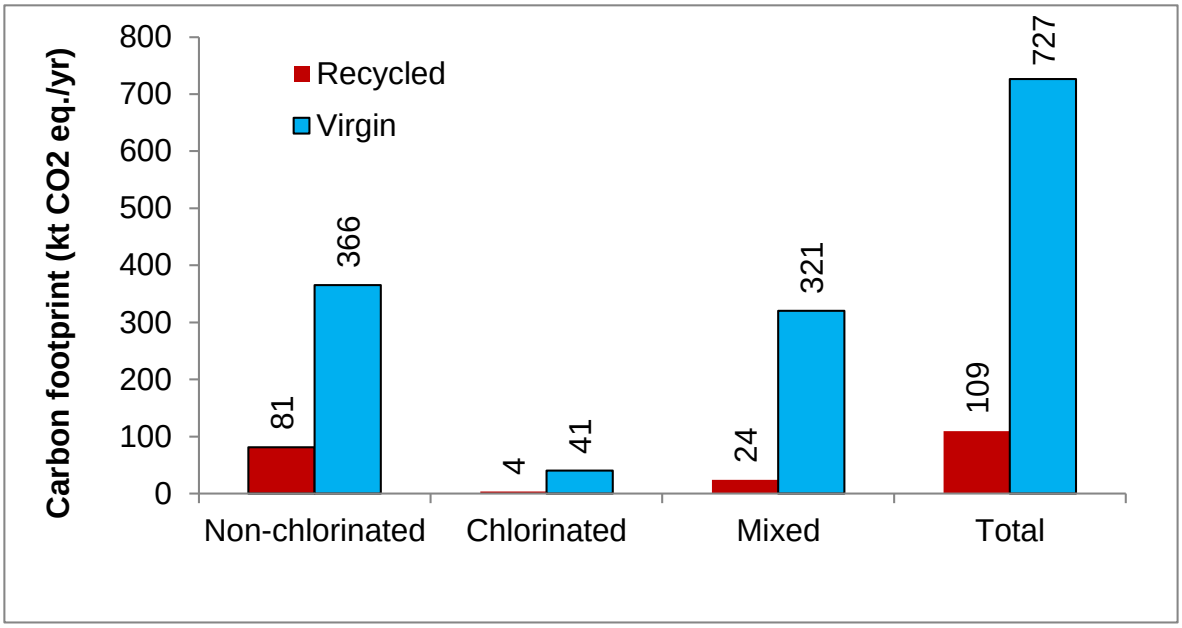

Figure 5 Carbon footprint of recycled solvents grouped into non-chlorinated, chlorinated and mixed solvents

4 Conclusions

This study estimated the savings in greenhouse gas (GHG) emissions associated with solvent recycling, compared to producing the same amount of virgin solvents.

The findings suggest that recycling 309 kt of used solvents can save 618 kt CO_2 eq. per year. This is equivalent to avoiding GHG emissions of 280,000 diesel cars annually.

However, these findings should be interpreted in light of the methodology limitations related to the estimates of carbon footprints of recycled solvents. Nevertheless, the estimated differences in the carbon footprints of recycled and virgin solvents are sufficiently large to provide some confidence in the results within the confines of the methodology and the assumptions.

Disclaimer

Any external communication of the results of the study should declare clearly the limitations related to the methodology and assumptions used in the study.

References

[1] ISO (2006) ISO 14044: Environmental Management - Life cycle assessment - Requirements and guidelines. Geneva, 2006.

[2] CCaLC2 (2018) CCaLC2 Software and Databases. www.ccalc.org.uk.

[3] Ethos Research (2013). Carbon Footprints of Recycled Solvents. Study for the European Solvent Recycler Group (ESRG). August 2013. https://esrg.de/media/PDF/Study_print_090514.pdf.

[4] Ecoinvent (2010) Ecoinvent v2.0 database. Swiss Centre for Life Cycle Inventories, Dübendorf, Switzerland.

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Goal and scope of the study

- Goal
  - To estimate the annual carbon footprint of recycled solvents
- Scope
  - From ‘cradle to gate’ or ‘business to business’
- Unit of analysis (functional unit)
  - Annual manufacture of recycled solvents by ESRG members

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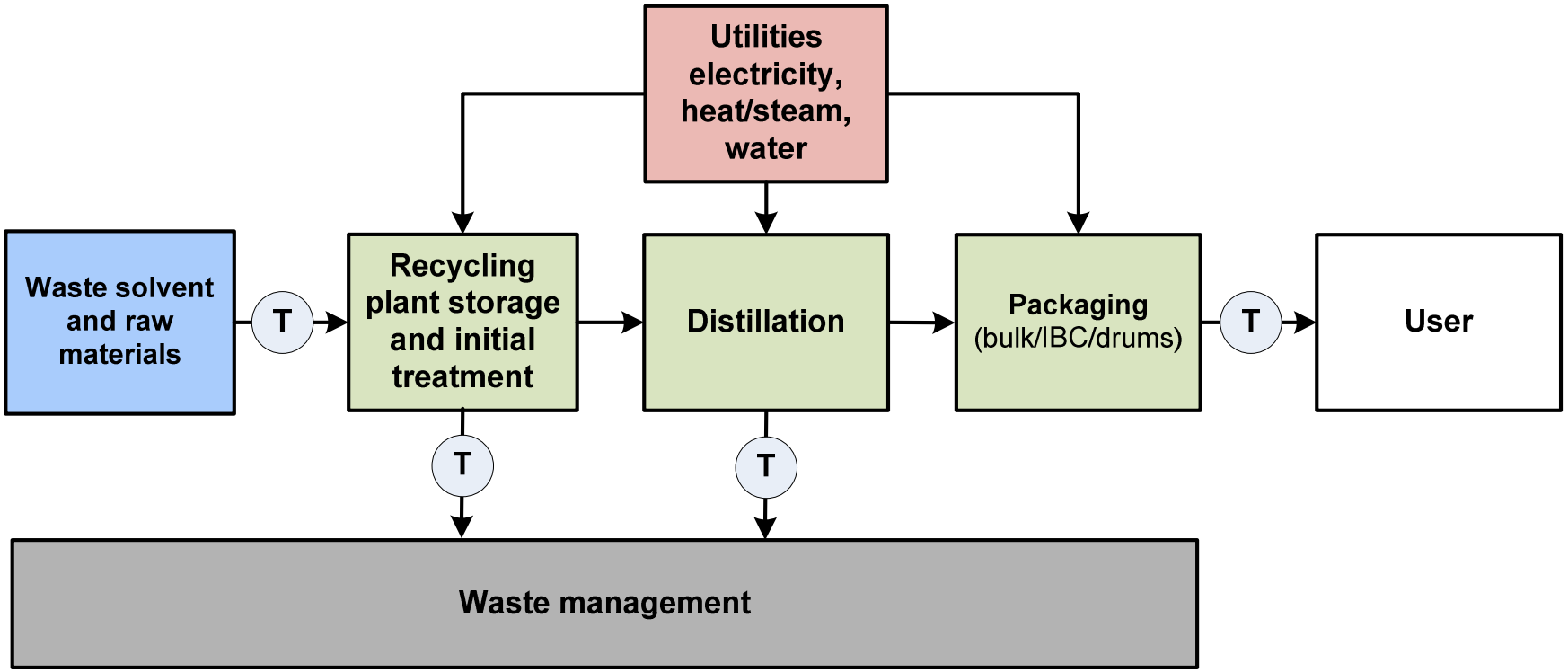
Scope and system boundaries



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Data and assumptions

- Data on annual amounts recycled provided by ESRG members

- All solvents classified into groups:
  1. Non-chlorinated, chlorinated, mixed
  2. Acetone, methyl ethyl ketone, mixed solvents (MS), perchloroethylene, triethylamine and tetrahydrofuran

- Carbon footprints of the above six solvent types used to estimate the total carbon footprint of all solvents

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Data and assumptions

Type	Proxy[a]	Amount (t/yr)
Simple non-chlorinated	Acetone, MEK, MS, TEA, THF	142,166
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Mixed solvents	Mixed solvents	156,185
Total		308,750

[a] MEK: methyl ethyl ketone; MS: mixed solvents; TEA: triethylamine; THF: tetrahydrofuran.

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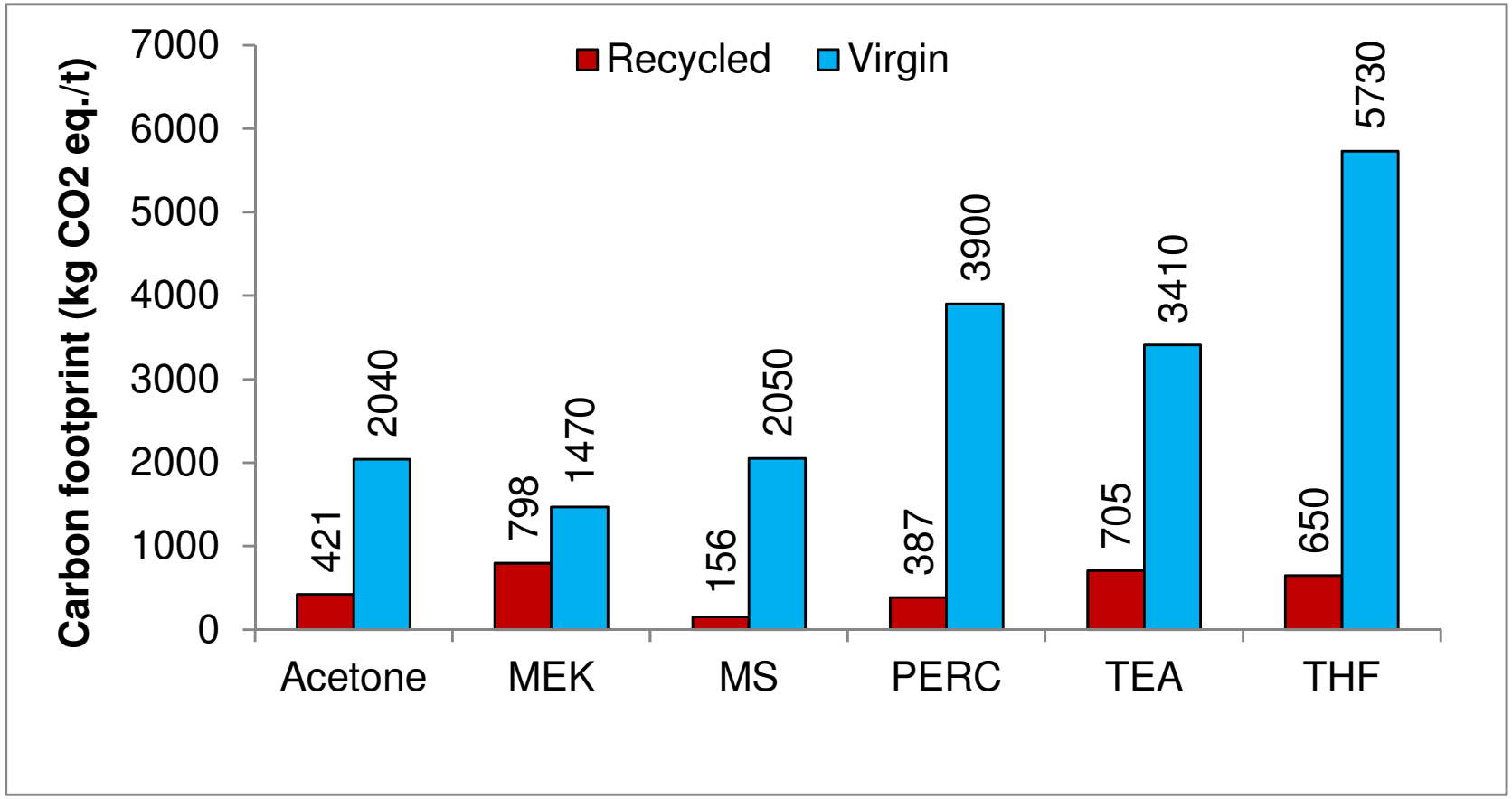
Carbon footprint per tonne recycled and virgin solvents



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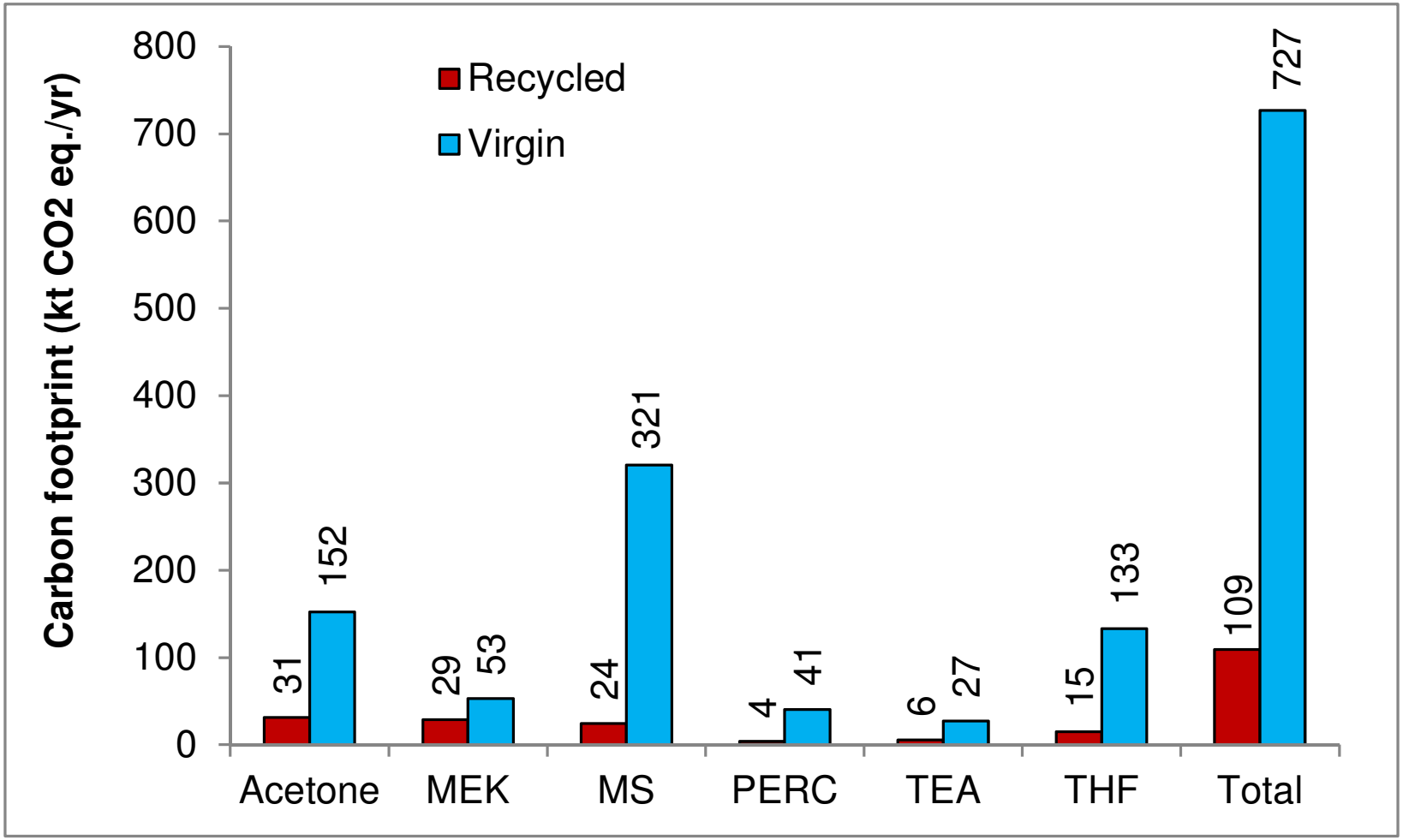
Results



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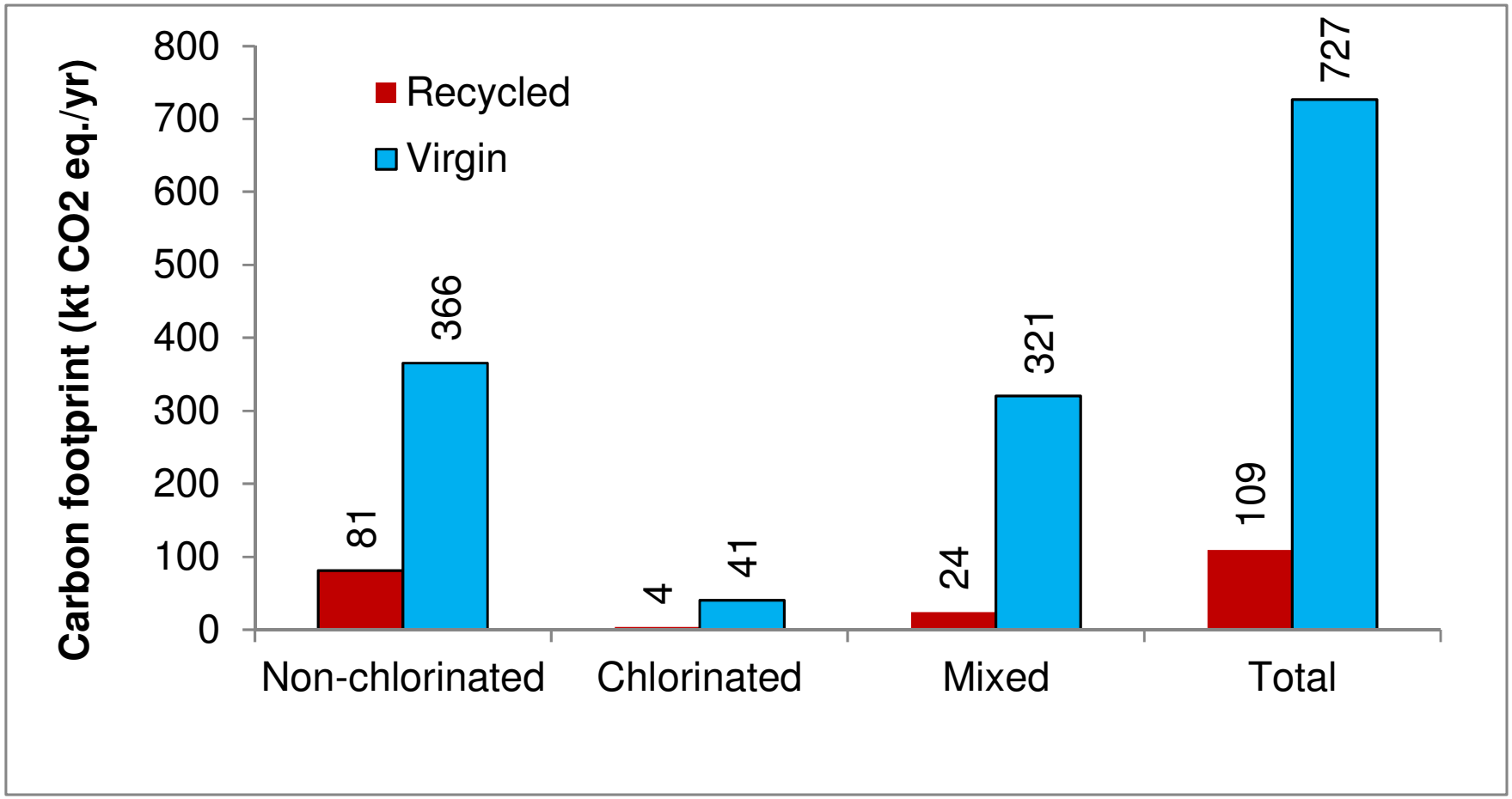
Results



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Conclusions

- Solvent recycling reduces carbon footprint significantly compared to virgin solvents
- Recycling 309 kt solvents saves 618 kt CO_2 eq. per year
- Equivalent to avoiding GHG emissions of 280,000 diesel cars annually

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Disclaimer

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