Final report

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Understanding and managing the impacts of climate change on Australian onion production

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Public summary

Consumers, retailers and other supply chain partners are paying increasing attention to the environmental impacts of onion production in Australia. To help growers better understand these impacts, thinkstep-anz was contracted to undertake a life cycle assessment (LCA) study for the Australian onion industry. An LCA is a recognised method for assessing a product's environmental impacts across different stages of its life cycle – including greenhouse gas emissions, rather than looking at one stage in isolation. Onion growers can use the results to understand how the environmental impacts of their own operations compare with a national average.

LCA specialists completed the study in line with international standards, including ISO 14040 and ISO 14044 for Life Cycle Assessment, ISO 14067 for product carbon footprints and the GHG Protocol standards for organisational and product carbon footprints. RM Consulting Group (RMCG) supported data collection by engaging with onion growers through site visits, emails and phone calls. thinkstep-anz then used a purpose-built LCA model to calculate several environmental impact categories, including greenhouse gas emissions (aka carbon footprint). These results represent a national benchmark for Australian onion growers.

Onion growers who contributed data to the LCA also received a short snapshot report showing how the environmental impact of their farm compared with the national average.

The findings and recommendations of the project were communicated in an industry workshop, presented as an online recording. AUSVEG, the national industry body representing Australian vegetable, potato and onion growers, may use the workshop recording at future onion industry meetings to raise growers' awareness of the findings.

The LCA has shown that the cradle-to-gate carbon footprint of Australian-grown onions is 0.34 kg CO_2-eq. per kg of packed onions. The main contributors to the carbon footprint of onions were also identified in the study – these form the basis of the recommendations provided to onion growers to reduce their operational emissions.

The deliverables from the project included:

- An LCA report
- Plain English summary and four case studies, presented as "In a Nutshell" report
- Individual grower snapshots
- A recording of the industry workshop

All deliverables, excluding the individual grower snapshots, will be published on the Knowledge Hub website hosted by AUSVEG in 2026. The grower snapshots are confidential and will be available to the corresponding growers only.

Keywords

Life Cycle Assessment; LCA; Carbon Footprint; Greenhouse Gases; Emissions; Onions; Australian Onion Industry

Introduction

Australian onion growers are increasingly being asked to provide clear information about the environmental impacts of their operations. Consumers, retailers, governments and investors expect greater transparency, including greenhouse gas reporting and evidence of environmental performance. While individual Australian onion growers may have some awareness of their own impact, there is no standardised approach for growers across the country to measure and compare the environmental footprint of their operations. This makes it difficult to respond to these growing stakeholder expectations.

To empower growers to answer these questions, Hort Innovation commissioned a Life Cycle Assessment (LCA) of onion production across Australia. The LCA assesses several environmental impact categories across multiple stages of production – including greenhouse gas emissions (aka carbon footprint).

Growers can use these results to understand their environmental performance compared with a national benchmark and to make changes to their operations based on the identified hotspots.

Methodology

The project kicked-off with a meeting between project partners thinkstep-anz and RM Consulting Group (RMCG) in July 2024. This meeting established roles of the project team, project timeline and methodology.

As part of the project initiation and setup phase, a stakeholder engagement plan was developed. This plan listed growers, consultants and representatives of industry bodies who were connected with the Australian onion industry. To expand this list of contacts, thinkstep-anz developed promotional materials, that summarised the project and encouraged growers to get involved. These materials were distributed to growers through several channels, including the Pub in the Paddock onions workshop (VN21000, November 2024), the AUSVEG Grower Magazine (January 2025), the AUSVEG Onion Communications and Extension Project, Project Reference Group meetings (Feb 2024, Aug 2025, and June 2026), and regional growers group meetings (VN21000, March 2025).

Figure 1: A snippet from one of the flyers developed by thinkstep-anz to promote the project to onion growers.

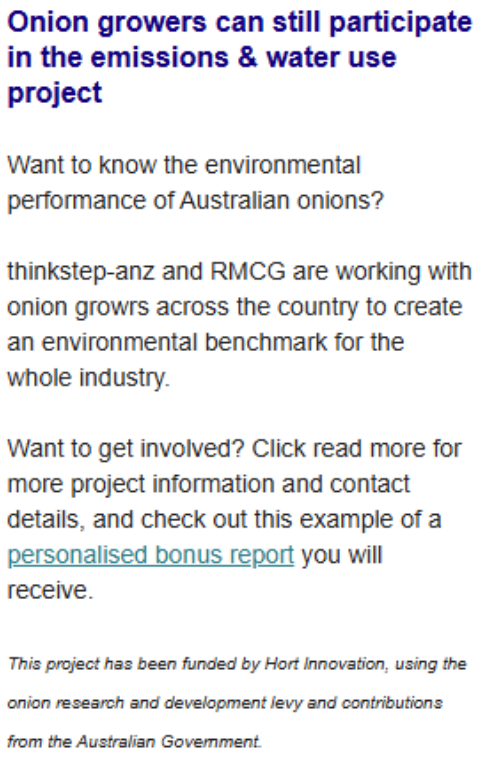
During this recruitment process, thinkstep-anz undertook a literature review of existing LCA studies for onions in Australia and in other countries. The findings helped identify the information needed from growers and informed the data collection template. This template was then used to collect data from our initial group of growers identified in the stakeholder engagement plan.

The initial recruitment had limited success. It became apparent that onion growers were hesitant to participate in the study for various reasons. The amount and detail of data required has been one of the challenges. Time-limited onion producers have to consider where their time is best spent; this time is usually spent on the most pressing issues and activities or those that have a value proposition. Grower participation was critical for the study, as a larger sample size would enable a more accurate national benchmark, hence ensuring higher quality project outcomes for growers. This risk was captured in a project risk register and was addressed by increasing efforts to gain trust from growers. This initially involved working closely with AUSVEG SA to help growers understand LCA and how it could prepare them for future requests for scope 3 greenhouse gas emissions data. Participating growers were also offered an individual snapshot report showing the environmental performance of their farm. Despite these efforts, no additional growers expressed interest in participating.

RMCG then took the lead in recruiting growers, drawing on its established relationships with onion growers across Australia. Rather than trying to collect data from a large group of growers, as was the original intent, we decided to

collect data from a smaller group of growers through site visits. This approach was better suited to how growers usually work and was expected to increase participation than requesting data through email or phone calls. RMCG worked with several growers on a per-region basis to collect data from Queensland, South Australia, Tasmania and Western Australia. They also continued to promote the project at events, such as Hort Connections in June 2025.

To supplement the data collected by RCMG, thinkstep-anz planned to distribute an industry-wide survey. This would give onion growers the opportunity to still participate, if they wanted to. In October 2025, AUSVEG promoted the project to growers in their weekly update article. This gave growers the opportunity to opt into the study, rather than just sending out a study to all onion growers as per recommendation from the industry. No growers responded, so the industry-wide survey did not proceed.



Onion growers can still participate in the emissions & water use project

Want to know the environmental performance of Australian onions?

thinkstep-anz and RMCG are working with onion growrs across the country to create an environmental benchmark for the whole industry.

Want to get involved? Click read more for more project information and contact details, and check out this example of a personalised bonus report you will receive.

This project has been funded by Hort Innovation, using the onion research and development levy and contributions from the Australian Government.

Figure 2: A snippet from the AUSVEG Weekly Update (October 2025) article aiming to recruit growers for the LCA study.

Overall, data was collected from five growers across three states: one in South Australia, three in Tasmania and one in Western Australia.

The project team reviewed the grower data and followed up where information was missing or required clarifications. Once the data was complete, it was used to build the LCA model. The model estimated the environmental footprint of Australian onion production and identified the main contributors, known as environmental hotspots. The LCA report documents the study's methodology, findings and recommendations.

To communicate the findings in a practical way, the project team developed a series of case studies. These case studies focus on a hypothetical onion grower, who makes changes to their operations and compares the resulting environmental footprint against the national benchmark. The case studies show how growers can use the LCA findings to explore potential improvements and reduce their environmental impacts.

To summarise the project findings and recommendations, the project team recorded a webinar for AUSVEG to share with growers at upcoming PRG and regional grower group events. Industry representatives recommended this approach because a live webinar was expected to attract few, if any, attendees. All major deliverables were written by thinkstep-anz and reviewed by RMCG.

Results and discussion

The results of the LCA are summarised below.

The LCA found an average cradle-to-gate carbon footprint of 0.34 kg CO_2-e per kg of packed onions. Note that CO_2-e combines the warming effect of different greenhouse gases into one common measure, based on the equivalent amount of carbon dioxide. Growers can use this national benchmark to compare their results and identify opportunities to reduce their carbon footprint.

The emission sources that contribute to the carbon footprint of Australian onions are categorised as either "upstream" or "core" and are visualised in Figure 3:

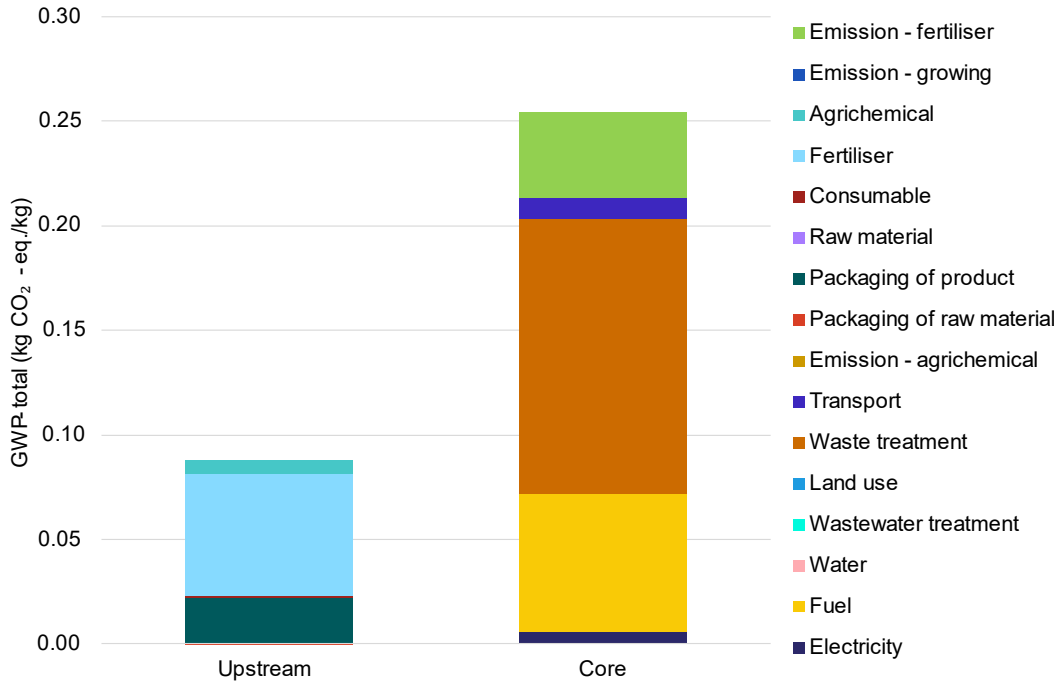


Figure 3: Cradle-to-date carbon footprint per 1 kg of Australian onions

The study identified the following main contributors, or hotspots, to the carbon footprint of Australian onions:

- Disposal of rejected onions on farm.
- Fuel used on farm including for tractors, irrigation pumps and other machinery.
- Production of raw materials, particularly fertilisers and soil amendments (e.g. lime).
- Emissions from using fertiliser and soil amendment.
- Packaging of finished onions, particularly plastic net use.

You can find more details in the full LCA report.

Outputs

Table 1. Output summary

Output	Description	Detail
An industry level Life Cycle Assessment (LCA) to inform onion industry of a baseline of environmental impacts	The output of the assessment was an LCA report. The intended audience is Australian onion growers and other LCA practitioners who want to build upon this body of work.	The LCA involved a data collection process, where data collection templates were developed and distributed to growers to fill out. All findings and aggregated data can be found in the LCA report, which is available on the Knowledge Hub repository on the AUSVEG website pending approval from Hort Innovation.
Industry-focused workshop to present identified strengths and gaps in environmental data, knowledge and performance.	An industry-focused workshop delivered as a recorded video, which describes the project outcomes, identified strengths and gaps in environmental data, knowledge and performance. The intended audience is members of regional grower groups (RGGs) who generally attend meetings with AUSVEG.	The industry-focused workshop recording was delivered to AUSVEG so that they may present it to growers at future RGG meetings. Project updates were sent to growers frequently. These updates included presentations from PRG meetings, an article in the AUSVEG Grower Magazine, and flyers handed out to growers in person.
A final report including recommendations for industry, to address gaps in knowledge and future R&D requirements to reduce future climate change risks	The final report is an LCA report which captures LCA findings, background calculations and recommendations for growers. The intended audience is Australian onion growers and other LCA practitioners who want to build upon this body of work.	The LCA report is available on the Knowledge Hub repository on the AUSVEG website pending approval from Hort Innovation.
Case studies to provide adaptation and risk mitigation options	Four case studies intended to be read by onion growers.	The case studies are intended to be publicly available on the Knowledge Hub repository on the AUSVEG website.

Outcomes

Table 2. Outcome summary

Outcome	Alignment to fund outcome, strategy and KPI	Description	Evidence
The Australian onion industry understands the potential environmental impacts and can develop future strategies for sustainability.	This outcome helps to achieve Outcome 2 of the Onion Strategic Investment Plan 2022-2026 by suggesting improvements to production efficiencies that will drive long-term sustainability outcomes.	Flyers, conference presentations and direct engagement during data collection helped raise awareness within the Australian onion industry of the environmental impacts of onion production – particularly carbon footprint. Growers can use the LCA report and case studies to understand the main environmental hotspots, consider practical improvements and support the long-term sustainability of their operations.	The project did not directly measure changes in the industry's understanding. However, responses to the data collection templates and participation in group meetings suggested that participating growers were becoming more aware of the environmental impacts of onion production. This evidence is qualitative and cannot be applied to the wider industry. Once published, the LCA report and case studies will help growers identify environmental hotspots and plan practical improvements.
Inform onion growers nationally of the environmental performance of the sector.	As above.	The environmental performance of the sector was a key outcome of the study. This outcome is yet to be communicated to the broader onion industry. It is intended that the industry workshop, delivered as a recording, will be presented to growers at future Regional Grower Group (RGG) meetings. This workshop – along with the LCA report and case studies – will discuss the benchmark carbon footprint of the overall industry.	The project did not directly measure changes in the industry's understanding. The environmental performance of the sector was determined at the end of the project and so has not yet been broadly communicated. We recommend that website traffic or other metrics are measured to see how many onion growers access the project outcome documents once they are published. Attendance at RGG meetings where the industry workshop is presented should also be recorded.
To develop onion growers' understanding of the potential environmental impacts of the industry on a total and per kilogram basis and produce important external communications based on the findings.	As above.	As above. The LCA report, case studies and industry workshop capture the national benchmark in terms of kg per packaged onions.	As above.

Monitoring and evaluation

Table 3. Key Evaluation Questions

Key Evaluation Question	Project performance	Continuous improvement opportunities
To what extent has the project increased the adoption of sustainability strategies among onion growers?	The adoption of sustainability strategies based on conversations with growers during the data collection phases has not been measured. It is more likely that growers will adopt these strategies once the information is available to them in the LCA report (yet to be published).	Shortly after the LCA report is public, growers should be contacted by onion industry representatives to evaluate how they have incorporated the recommendations from the LCA to implement sustainability strategies.
To what extent has the project met the need of levy payers to produce sustainable products?	Participating growers have received information about the main environmental hotspots in onion production and opportunities to reduce their impacts. Once the project resources are published, other onion levy payers will be able to use this information to make more informed production decisions.	A future study could re-evaluate the national benchmark to measure if the carbon footprint of onion production has decreased due to adoption of sustainability strategies.
To what extent were the target engagement levels of onion industry levy payers achieved?	Growers were engaged directly through data collection activities and regional grower group meetings held during the project. The number of growers engaged during these group activities ranges from 15-50. Growers from at least four different states were engaged. Events included VegNET national RDO meeting (Nov 2024), Forthside Vegetable R&D Day (Nov 2024), Onion 'Pub in the Paddock' (Nov 2024), Onion event Lockyer Valley (Dec 2024), SA Onion Regional Grower Group (Mar 2025), and Tas Farm Innovation Hub collaborative forum (Oct 2025). At least 34 people from 25 onion growing businesses were engaged directly via phone calls and farm visits. In addition, stakeholders and key influencers were also engaged including: VegNET Regional Development Officers (RDOs), peak bodies and agronomists in Tasmania, South Australia, Western Australia, Victoria and Queensland. This included discussion to identify potential grower recruitment opportunities.	The number of growers engaged directly through future studies should be recorded so that the level of engagement is clearer and can be compared with a target.

	Levy payers were also engaged indirectly through industry communications distributed online through the AUSVEG Weekly Updates and Grower Magazine article (Autumn 2025). In addition, information was included in regional e-newsletters and the Soil Wealth and Integrated Crop Protection (SWICP) bulletin.	
Did the project engage with onion industry levy payers through their preferred learning style, in language which made sense to them?	While the LCA report contains technical language in order to be compliant with international standards, the "summary nutshell report" and case studies were written in plain English and included practical information for onion growers. All other grower-facing communications were also written in plain English. The project flyer was continually updated based on industry feedback to ensure the wording and messaging would resonate with onion growers better.	More webinars or documents could be offered that explain the findings in plain English and linking the suggestions to practical advice that onion growers can realise on their farms.
What efforts did the project make to improve efficiency?	The project utilised the existing Project Reference Group (PRG) for the Onion Communications and Extension project, rather than establish a separate PRG which would most likely include some of the same members.	The existing PRG could be utilised for future studies.

Recommendations

Based on the environmental hotspots identified in the LCA study, the following practical steps were recommended to growers:

- Improve saleable yield (wherever feasible) supported by good soil management, pest and disease management, crop nutrition and irrigation management.
- Avoid leaving rejected onions on farm where suitable alternatives are available, such as using them for animal feed.
- Use less fossil fuel use by improving energy efficiency and moving away from diesel, LPG and petrol where practical.
- Optimise fertiliser use through practices, such as improving soil organic matter, reducing fallow periods and tillage, using cover crops, splitting fertiliser applications, applying fertilisers at the appropriate timing, and considering enhanced efficiency fertiliser products (e.g. coated and slow / controlled release fertilisers).
- Take a whole-of-life view before making changes so improvements in one area do not create bigger impacts somewhere else.

We recommend that onion growers start with the In a Nutshell report, which presents the project findings and recommendations in plain English with supporting graphics. Growers who want more technical detail can refer to the full LCA report, which explains the methodology, calculations, data sources and assumptions used in the study.

We also recommend repeating the LCA within five to ten years. A future study should allocate more time and resources to grower engagement to recruit a larger and more representative sample. This would strengthen the national benchmark and provide a more reliable estimate of the average carbon footprint of Australian onion production.

References

AEMO. (2022). Distribution loss factors for the 2021/22 financial year v8.0. Australian Energy Market Operator. Retrieved from https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/loss_factors_and_regional_boundaries/2021-22/distribution-loss-factors-for-the-2021-22-financial-year.pdf?la=en

ALCAS. (2025). The Australian National Life Cycle Inventory Database (AusLCI) version 2.45. Melbourne: ALCAS.

Australian Government. (2024). Australian Energy Update 2023. Canberra: Australian Government Department of Climate Change, Energy, the Environment and Water. Retrieved from https://www.energy.gov.au/publications/australian-energy-update-2023

Bontinck, P.-A., Tim, G., Roihatai, K., & Charongpun, M. (2021). Recalculating Australian water scarcity characterisation factors using the AWARE method. The International Journal of Life Cycle Assessment, 26, 1687-1701.

Bos, U., Horn, R., Beck, T., Lindner, J., & Fischer, M. (2016). LANCA® - Characterisation Factors for Life Cycle Impact Assessment, Version 2.0, 978-3-8396-0953-8. Fraunhofer Verlag, Stuttgart.

Boulay, A., Bare, J., Benini, L., & et al. (2018). The WULCA consensus characterisation model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). The International Journal of Life Cycle Assessment.

Brown, J. L., & Grant, T. F. (2025). Life Cycle Inventory of Australian Electricity. Melbourne: Lifecycles.

CEN. (2019/2021). EN 15804:2012+A2:2019/AC:2021, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. Brussels: European Committee for Standardization.

DCCEEW. (2023). Australian National Greenhouse Accounts Factors. Canberra: Department of Climate Change, Energy, the Environment and Water.

EPD International. (2024). PCR 2019:14 Construction Products version 1.3.4 of 2024-04-30 (valid until 2025-06-20). Stockholm: EPD International AB.

EPD International. (2025). PCR 2020:07 Arable and vegetable crops version 1.0.3 (published on 2025-05-05, valid until 2026-06-07). Stockholm: EPD International AB.

European Union. (2024). Candidate List of substances of very high concern for Authorisation. Retrieved from European Chemical Agency: https://echa.europa.eu/candidate-list-table

Fantke, P., Evans, J. R., Hodas, N., Apte, J. S., Jantunen, M. J., Jolliet, O., & McKone, T. E. (2016). Health impacts of fine particulate matter. In Global guidance for life cycle impact assessment indicators (76-99). SETAC.

Frischknecht, R., Braunschweig, A., Hofstetter, P., & Suter, P. (2000). Modelling human health effects of radioactive releases in Life Cycle Impact Assessment. Environmental Impact Assessment Review, 20(2), 159-189.

Guinée, J. B., Gorrée, M., Heijungs, R., Huppes, G., Kleijn, R., de Koning, A., . . . Huijbregts, M. (2002). Handbook on life cycle assessment. Operational guide to the ISO standards. Dordrecht: Kluwer.

Hort Innovation. (2026). Australian Horticulture Statistics Handbook 2024/25. Retrieved from https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/australian-horticulture-statistics-handbook/

IPCC. (2021). Climate Change 2021: The Physical Science Basis. Geneva: IPCC.

ISO. (2006a). ISO 14040:2006: Environmental management — Life cycle assessment — Principles and framework. Geneva: International Organization for Standardization.

ISO. (2006b). ISO 14044:2006: Environmental management – Life cycle assessment – Requirements and guidelines. Geneva: International Organization for Standardization.

ISO. (2018). ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification. Geneva: International Organization for Standardization.

JRC. (2010). ILCD Handbook: General guide for Life Cycle Assessment – Detailed guidance. EUR 24708 EN (1st ed.). Luxembourg: Joint Research Centre.

Posch, M. S. (2008). The role of atmospheric dispersion models and ecosystem sensitivity in the determination of characterisation factors for acidifying and eutrophying emissions in LCIA. International Journal of Life Cycle Assessment, (13), 477–486.

Rosenbaum, R. K., Bachmann, T. M., Swirsky Gold, L., Huijbregts, M., Jolliet, O., Juraske, R., . . . Hauschild, M. Z. (2008). USEtox—the UNEP-SETAC toxicity model: recommended characterisation factors for human toxicity and freshwater ecotoxicity in life cycle impact assessment. Int J Life Cycle Assess, 13(7), 532–546.

Seppälä, J. P. (2006). Country-dependent Characterisation Factors for Acidification and Terrestrial Eutrophication Based on Accumulated Exceedance as an Impact Category Indicator. International Journal of Life Cycle Assessment, 11(6), 403-416.

Struijs, J. B. (2009). Aquatic Eutrophication. Chapter 6. In M. H. Goedkoop, ReCiPe 2008 A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level. Report I: Characterisation factors, first edition.

thinkstep-anz. (2024). Australian Electricity Residual Supply Mixes FY2023 Factors. thinkstep-anz. Perth: thinkstep-anz. Retrieved from https://www.thinkstep-anz.com/software/residual/

UNEP. (2016). UNEP-SETAC Life Cycle Initiative, Global Guidance for Life Cycle Impact Assessment Indicators. Vol. 1. Retrieved from https://www.lifecycleinitiative.org/training-resources/global-guidance-lcia-indicators-v-1/

van Oers, L., de Koning, A., Guinée, J. B., & Huppes, G. (2002). Abiotic resource depletion in LCA. The Hague: Ministry of Transport, Public Works and Water Management.

van Zelm, R. M. (2008). European characterization factors for human health damage of PM10 and ozone in life cycle impact assessment. Atmospheric Environment 42 (3), 441-453.

Wernet, G. B.-R. (2016). The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, 21(9), 1218–1230.

WMO. (2014). Scientific Assessment of Ozone Depletion: 2014, Global Ozone Research and Monitoring Project. Geneva, Switzerland: WMO.

Intellectual property

Restrictions to the IP raised during the project apply. More details contained in the IP register.

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