Prospective LCA modelling
for chemically produced fragrances

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The necessity to reach Net Zero

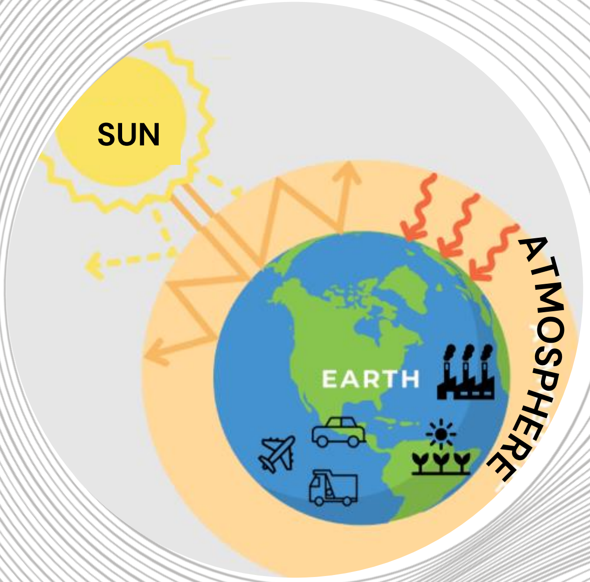
From global warming To global boiling

Leading to irreversible impacts

Climate crisis is a Human crisis

Towards unlivable conditions

Human activity driver Of climate change



+ 50% CO_2 in last 200 years

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Measure today To shape tomorrow

Precision through data

100% LCA Data on all ingredients in 2024

Global standards

Foster Carbon Emissions data access & exchange

Data-driven future

Track, inform & drive progress towards decarbonisation

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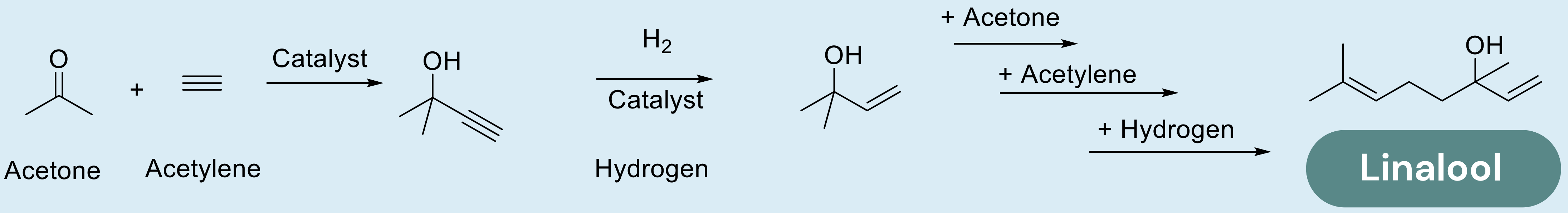
LCI data source of Linalool production



W. KIMEL, J. D. SURMATIS, J. WEBER, G. O. CHASE, N. W. SAX, A. OFNER, *J. Org. Chem.* **1957**, *22*, 1611–1618.

- Primary data: Steam production, steam consumption and electricity consumption (measured on site).
- Supplier specific data: Purchased acetone, acetylene and hydrogen.
- Secondary data: Energy and raw material consumption from our suppliers' supplier (e.g. benzene production for making acetone) and electricity grid etc are from databases (Ecoinvent).

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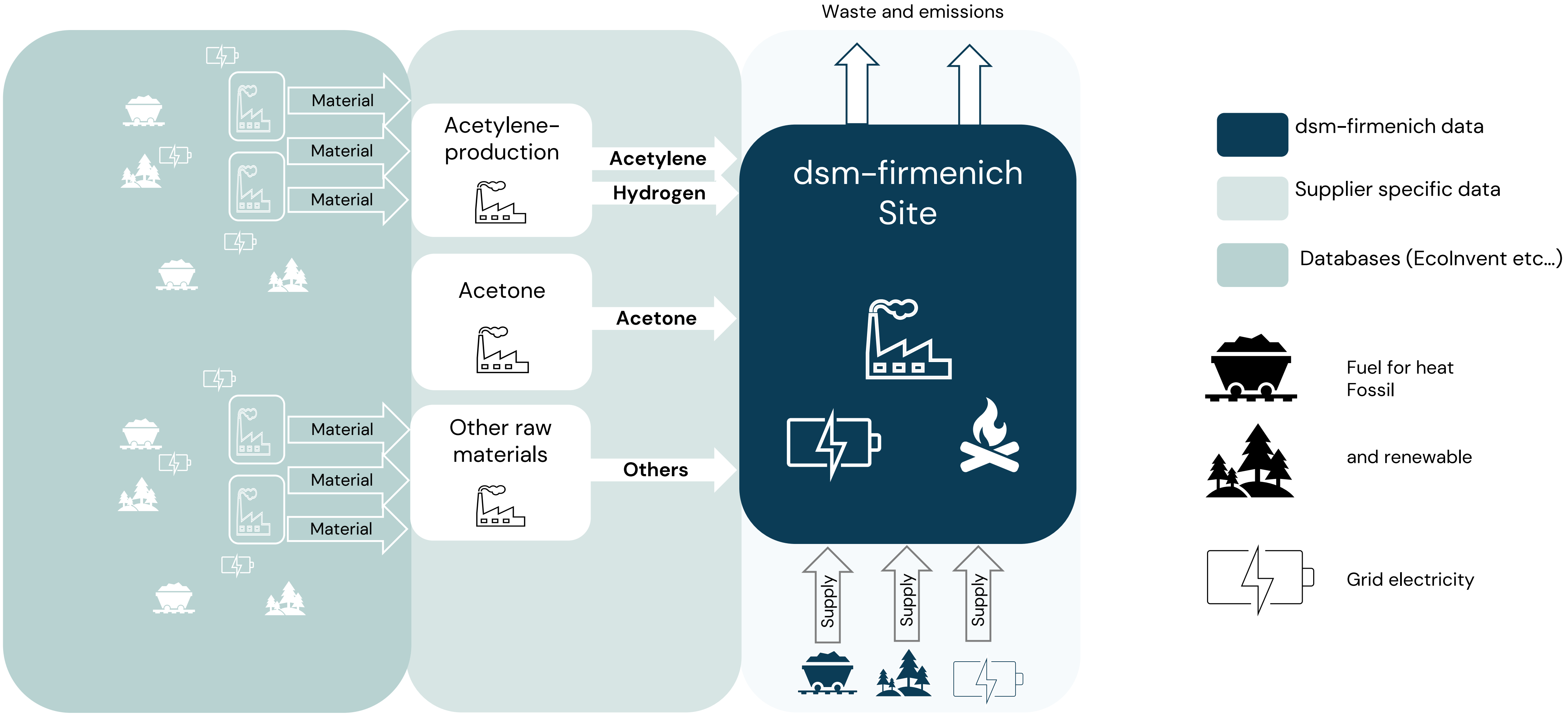
Creation of LCA models of our own processes:

Current footprint is calculated by summing up of consumption data, consisting of foreground and background data



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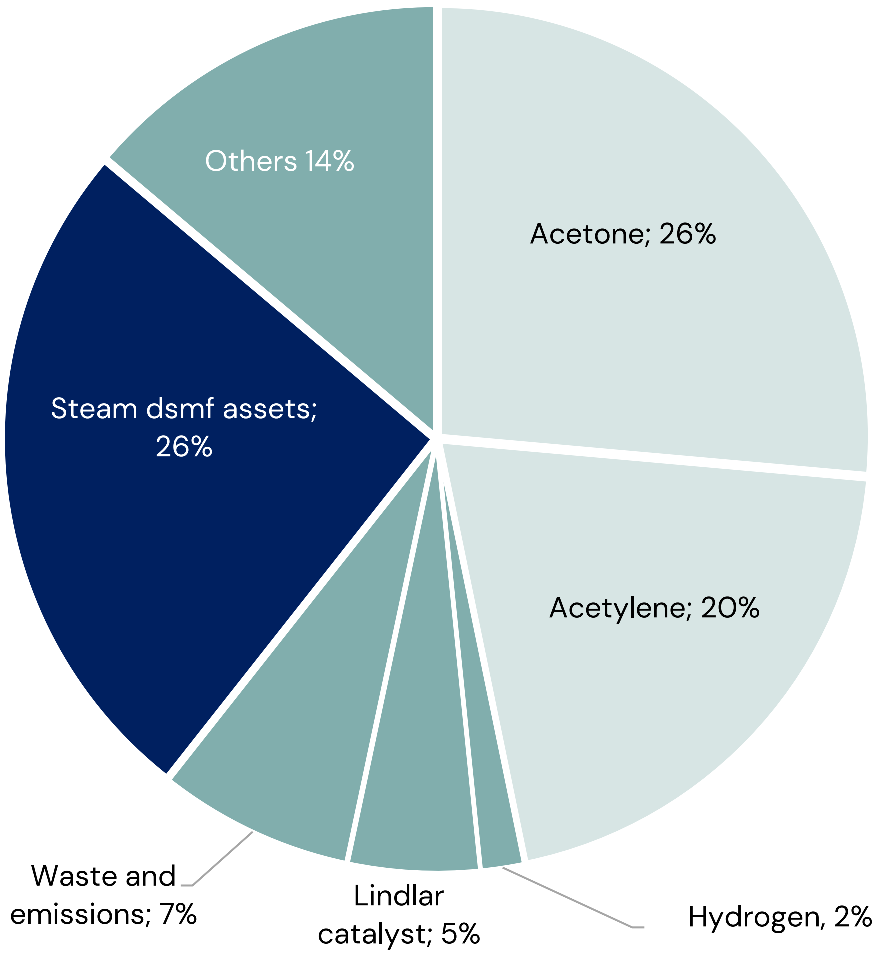
Carbon footprint analysis

Today's footprint of linalool is well below 10 kg CO_2-equiv.



Net-zero: SBTi requires reduction by 90%. Only 10% can be compensated

Implementing changes in manufacturing processes take several years.
How will the footprint of that process change be in several years?

2024

- Replacement of natural gas as heat source for steam generation
- Purchase acetone produced on a different technology, e.g. from CO_2
- Acetylene?
  From different technology?
  Replace acetylene by a different building block?

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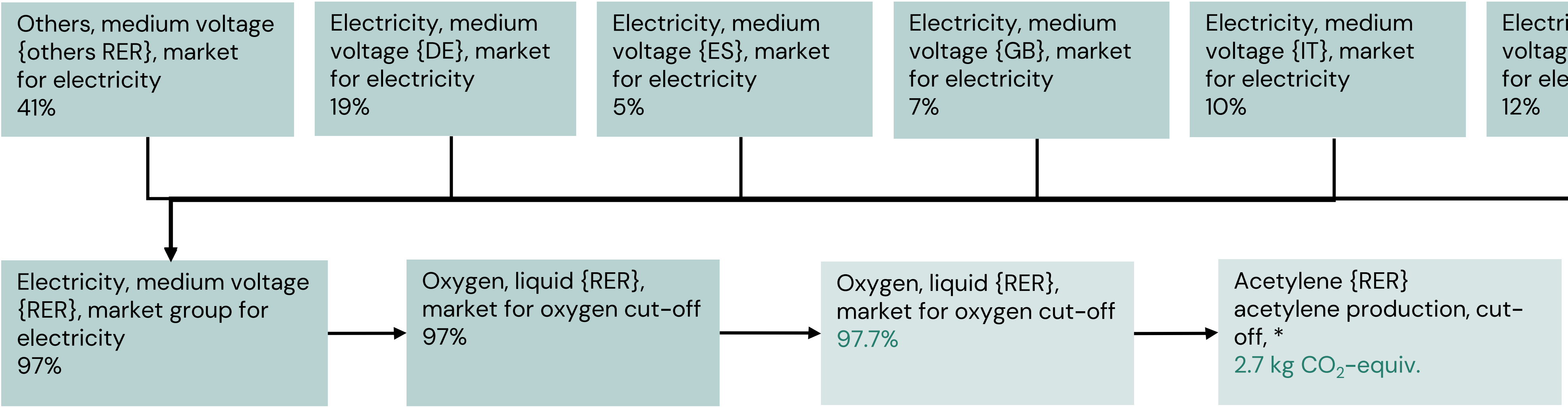
The main impact from acetylene production is **electricity***…



- Environmental impacts from electricity from the grid are background data
- Appropriate conclusion: Switch to acetylene made by another route?
- Actually, also alternative acetylene production processes require a high amount of electricity
- Then rather change to a process without acetylene?

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Supplier specific data

Databases (EcoInvent etc…)

* The data shown are from the EcoInvent model. For dsm-firmenich internal modelling we have own supplier specific data and LCA models, which are not shown here due to confidentiality issues. Various acetylene production processes are consuming high amounts of electricity, so the rationale behind the study and the final conclusion shown here are comparable.

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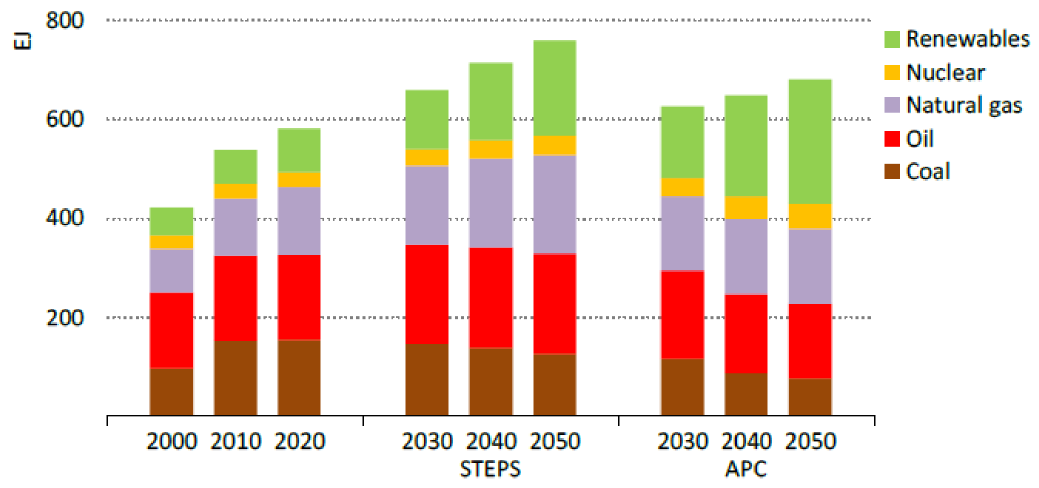
But the world does not stand still

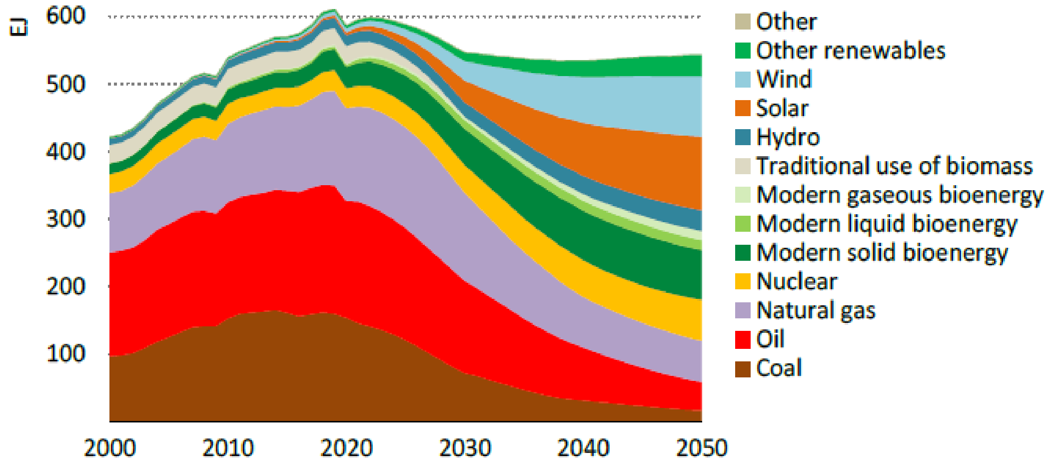
The energy transition will lead to shifts in energy sources -> towards more renewable energy sources.

Figure 1.12 ▷ Total energy supply by source in STEPS and APC



Announced net zero pledges lift renewables in the APC from 12% of total energy supply in 2020 to 35% in 2050, mainly at the expense of coal and oil

Figure 2.5 ▷ Total energy supply in the NZE



Renewables and nuclear power displace most fossil fuel use in the NZE, and the share of fossil fuels falls from 80% in 2020 to just over 20% in 2050

Will that make a difference to Carbon Footprints?
How to implement that transition into LCA-models?

IEA report “Net Zero by 2050, A Roadmap for the Global Energy Sector” 2021.

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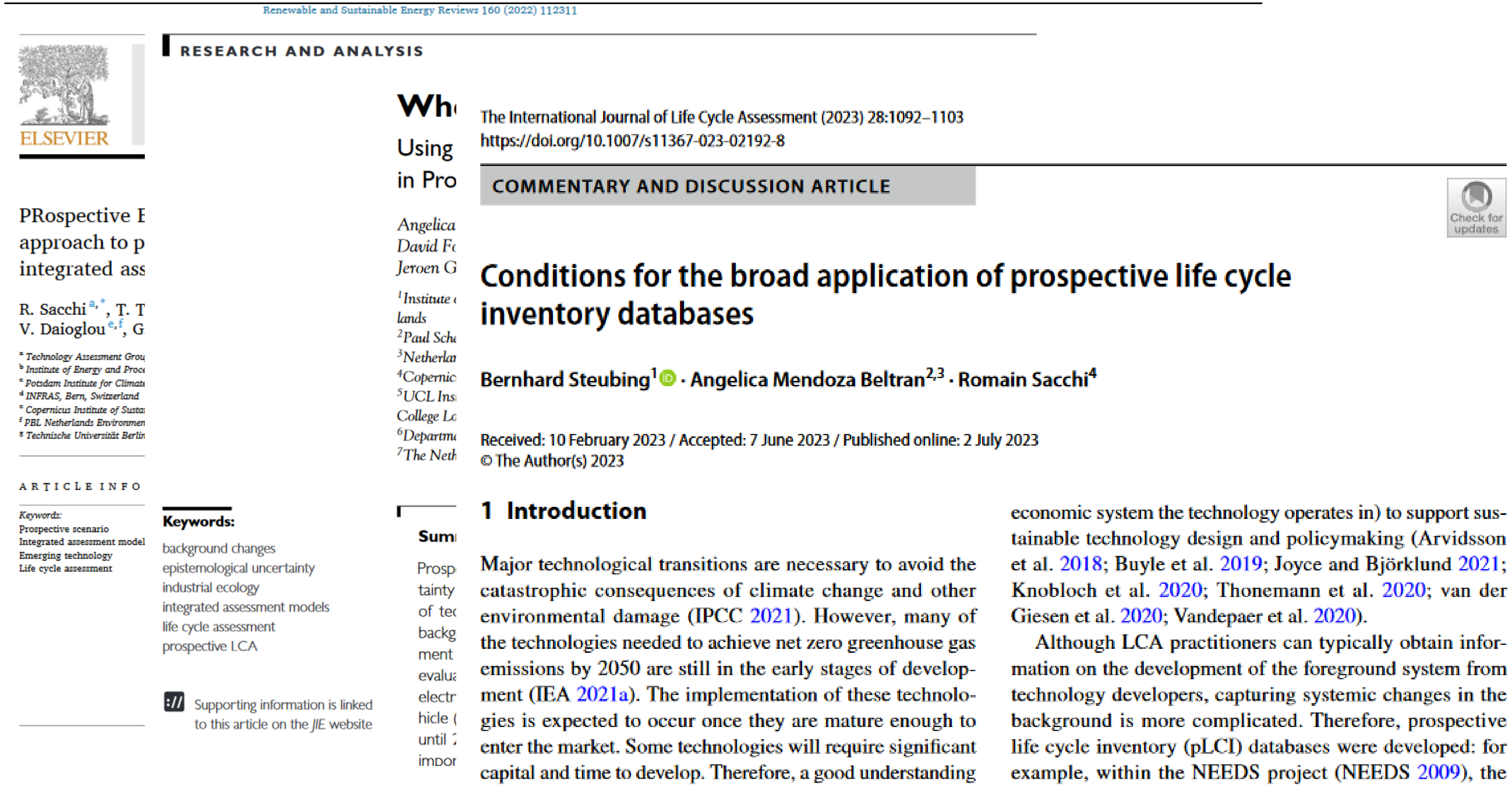
Using prospective LCA models: IAM-LCA coupling flow

Future scenarios such as the socioeconomic pathways are used as inputs together with e.g. ecoinvent



Renewable and Sustainable Energy Reviews 160 (2022) 112311

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RESEARCH AND ANALYSIS

The International Journal of Life Cycle Assessment (2023) 28:1092–1103
https://doi.org/10.1007/s11367-023-02192-8

COMMENTARY AND DISCUSSION ARTICLE

Check for updates

Conditions for the broad application of prospective life cycle inventory databases

Bernhard Steubing[1] · Angelica Mendoza Beltran[2,3] · Romain Sacchi[4]

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1 Introduction

Major technological transitions are necessary to avoid the catastrophic consequences of climate change and other environmental damage (IPCC 2021). However, many of the technologies needed to achieve net zero greenhouse gas emissions by 2050 are still in the early stages of development (IEA 2021a). The implementation of these technologies is expected to occur once they are mature enough to enter the market. Some technologies will require significant capital and time to develop. Therefore, a good understanding economic system the technology operates in) to support sustainable technology design and policymaking (Arvidsson et al. 2018; Buyle et al. 2019; Joyce and Björklund 2021; Knobloch et al. 2020; Thonemann et al. 2020; van der Giesen et al. 2020; Vandepaer et al. 2020).

Although LCA practitioners can typically obtain information on the development of the foreground system from technology developers, capturing systemic changes in the background is more complicated. Therefore, prospective life cycle inventory (pLCI) databases were developed: for example, within the NEEDS project (NEEDS 2009), the

Keywords:
background changes
epistemological uncertainty
industrial ecology
integrated assessment models
life cycle assessment
prospective LCA

Supporting information is linked to this article on the JIE website

ARTICLE INFO

Keywords:
Prospective scenario
Integrated assessment model
Emerging technology
Life cycle assessment

Step 1: Ecoinvent data are connected to Integrated Assessment models (IAMs) by creation of a superstructure database.

Step 2: connection between ecoinvent and additional inventories, that represent emerging and future technologies.

Step 3: Export of the database into a common LCA software (Simapro, Brightway2)

Step 4 and 5: Producing LCA resource and environmental indicators (and feeding back into IAM).

R. Sacchi, T. Terlouw, K. Siala, A. Dirnaichner, C. Bauer, B. Cox, C. Mutel, V. Daioglou, G. Luderer, *Renewable and Sustainable Energy Reviews* **2022**, *160*, 112311; A. Mendoza Beltran, B. Cox, C. Mutel, D. P. van Vuuren, D. Font Vivanco, S. Deetman, O. Y. Edelenbosch, J. Guinée, A. Tukker, *Journal of Industrial Ecology* **2020**, *24*, 64–79; B. Steubing, A. Mendoza Beltran, R. Sacchi, *Int J Life Cycle Assess* **2023**, *28*, 1092–1103 and references cited therein

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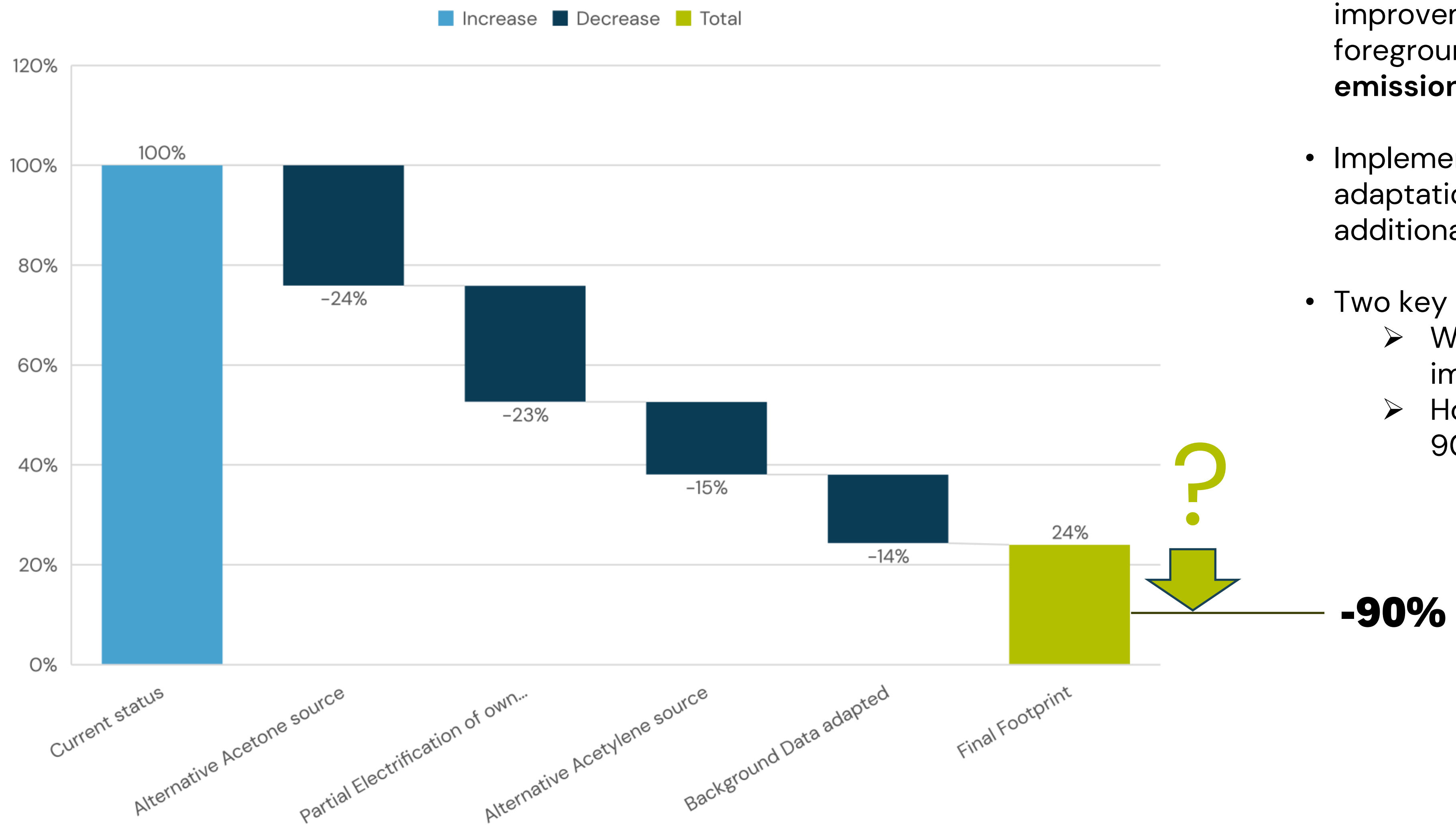
Implementation of various measures (foreground data) could help to lower the footprint by 62 %
Including the background total 76% reduction



- Potential implementation of improvement measures calculated by foreground data changes result in **62% emissions reduction**.
- Implementation of background data adaptation using premise results in additional **14% emissions reduction**.
- Two key questions :
  - ➢ What are the remaining impacts?
  - ➢ How to reduce these to achieve 90% emissions reduction?

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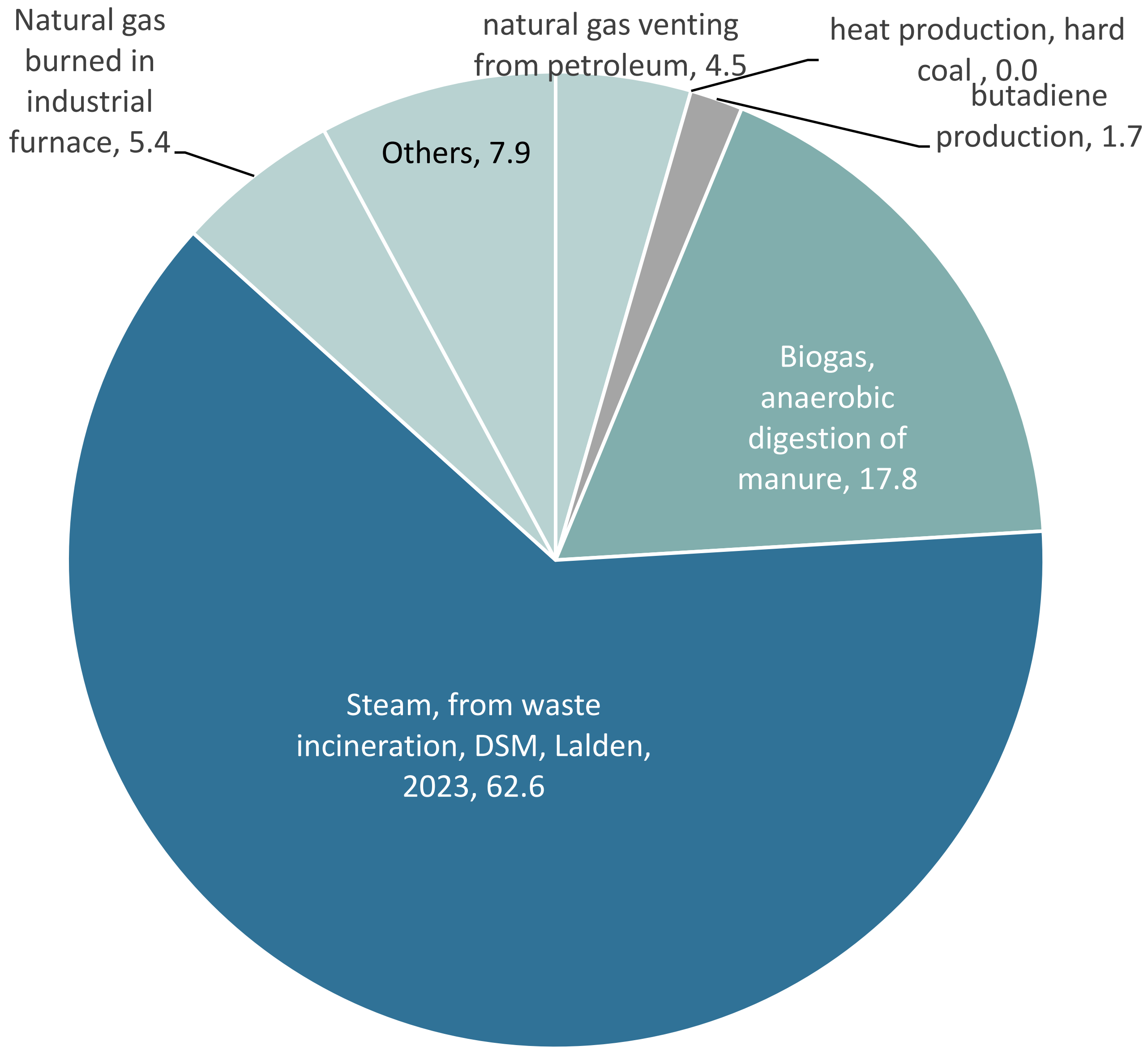
Where is the remaining footprint from ?



Potential carbon footprint:

And after energy transition gives access to a large share of renewable electricity

Linalool's footprint would be reduced by 75%

Main remaining contributor:
Heat generated from fossil-derived distillation/ recycling sludges

These can only be avoided when all materials used come from renewable sources.

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pLCA helps to identify future challenges

Analyzing Linalool's Carbon footprint by standard LCA and scenario LCA

Analyzing effect of potential internal process changes

Identification of reduction potential through worldwide energy transition.

Main challenge towards net-zero remains heat generated from fossil-derived distillation/ recycling sludges can only be avoided when all materials used come from renewable sources.

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