bw_timex

Capturing temporal evolution and distribution in LCA

Arthur Jakobs, Timo Diepers, *Amelie Müller*

Temporal representation of time in LCA trending...

→ bw_timex in press:

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LCI METHODOLOGY AND DATABASES

Check for updates

Time-explicit life cycle assessment: a flexible framework for coherent consideration of temporal dynamics

Amelie Müller[1,2] · Timo Diepers[3] · Arthur Jakobs[4] · Giuseppe Cardellini[2] · Niklas von der Assen[3] · Jeroen Guinée[1] · Bernhard Steubing[1]

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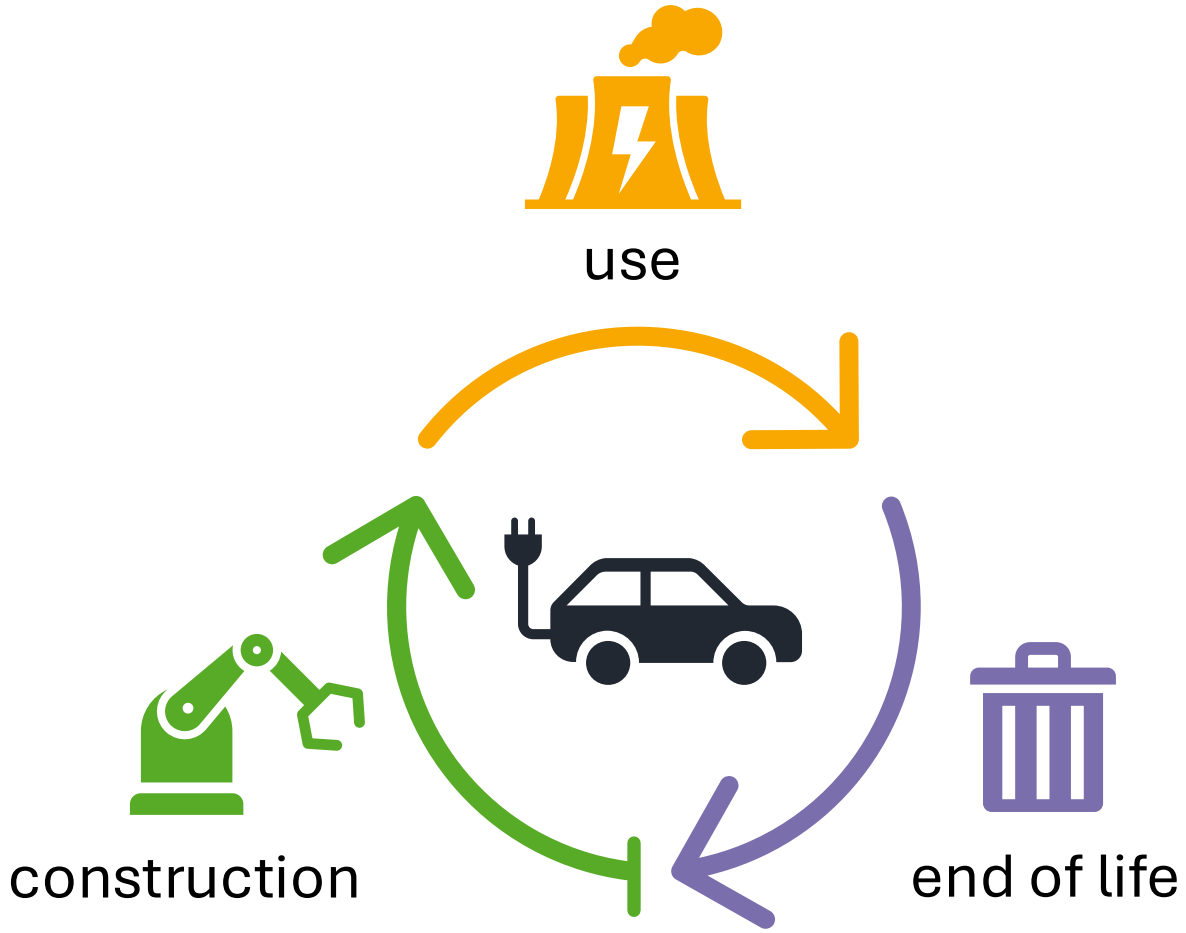
Abstract

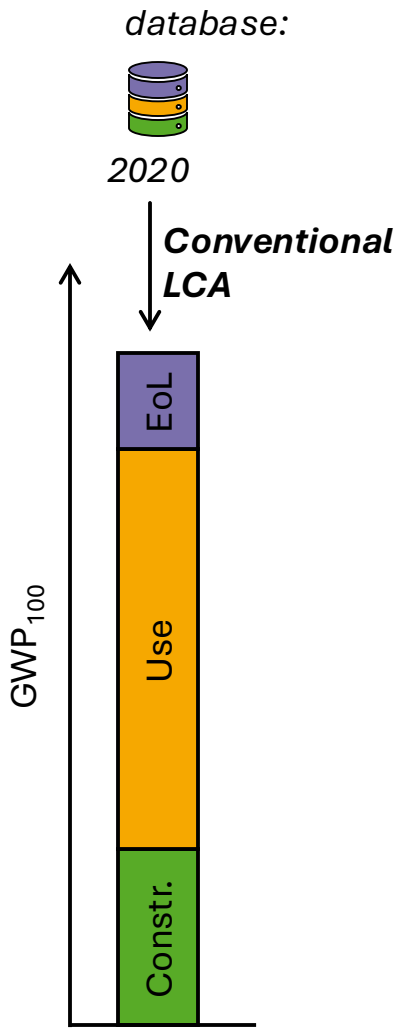
Purpose A well-known limitation of conventional Life Cycle Assessment (LCA) is the lack of temporal considerations, particularly the temporal distribution and evolution of processes, emissions, and environmental responses. While these aspects have been explored to some extent in dynamic and prospective LCA, a comprehensive approach for considering both temporal distribution and evolution is currently missing. We introduce a novel framework for time-explicit LCA that integrates the temporal distribution and evolution of product systems in the Life Cycle Inventory (LCI) phase and supports dynamic characterization of emissions in the Life Cycle Impact Assessment (LCIA) phase.

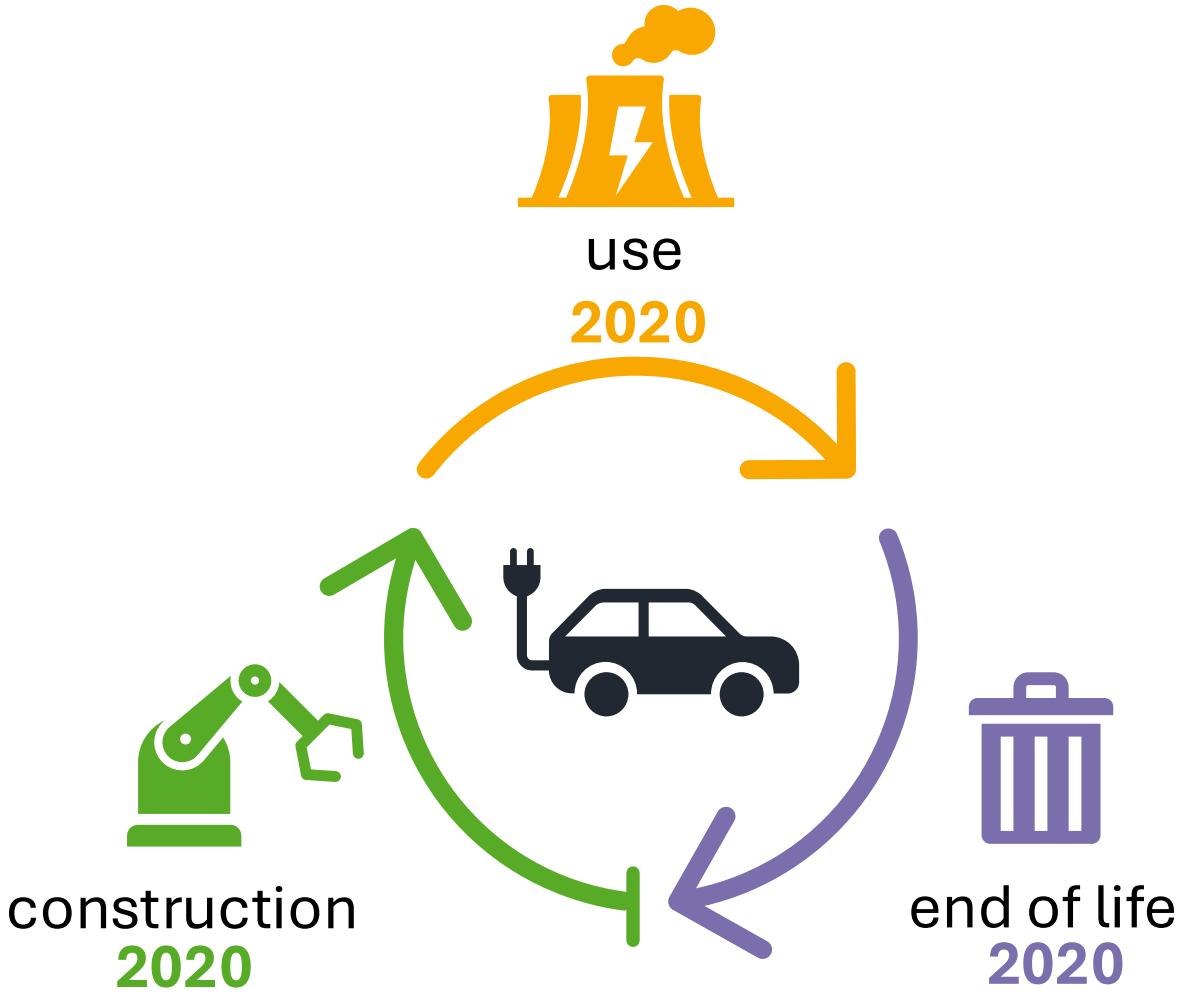
Methods The proposed approach expands the conventional LCA matrices to incorporate timing and time-based changes.

Life cycle of an electric vehicle

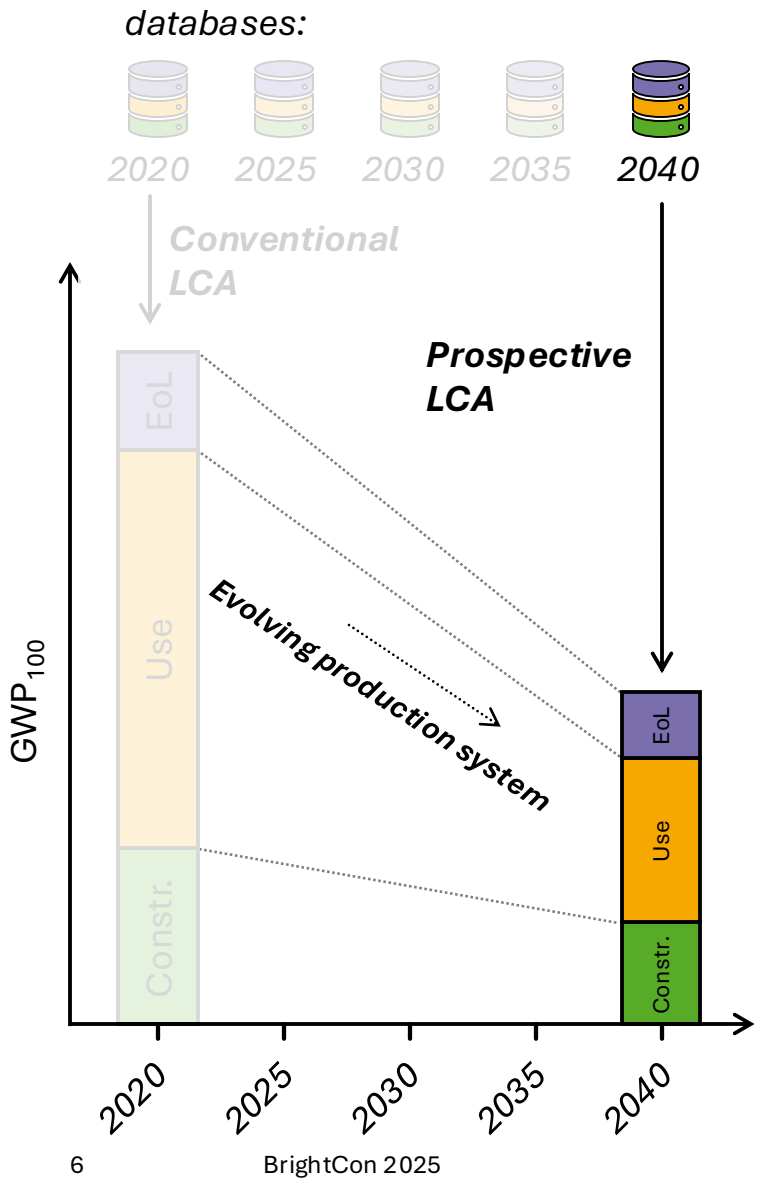


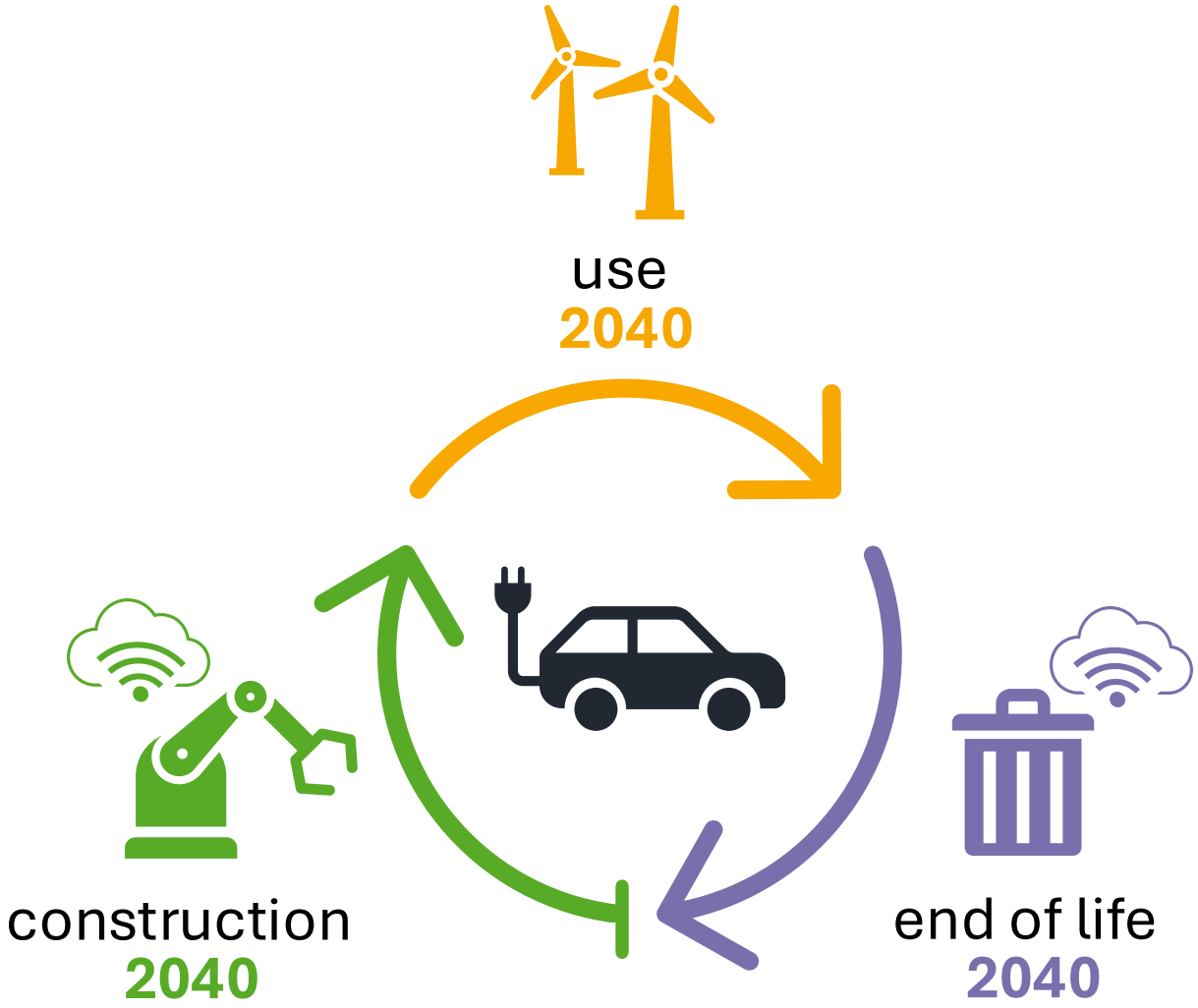
‘Conventional’ LCA: *“system today”*



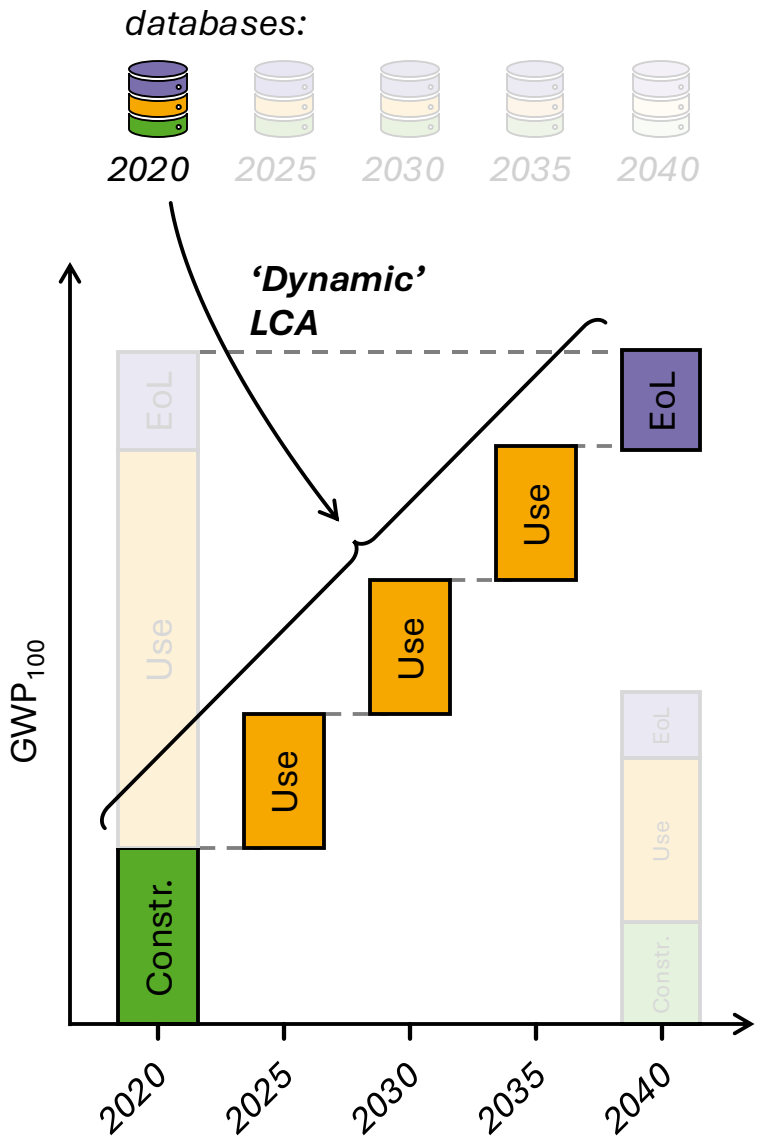


Temporal Evolution: *"prospective state of the system"*

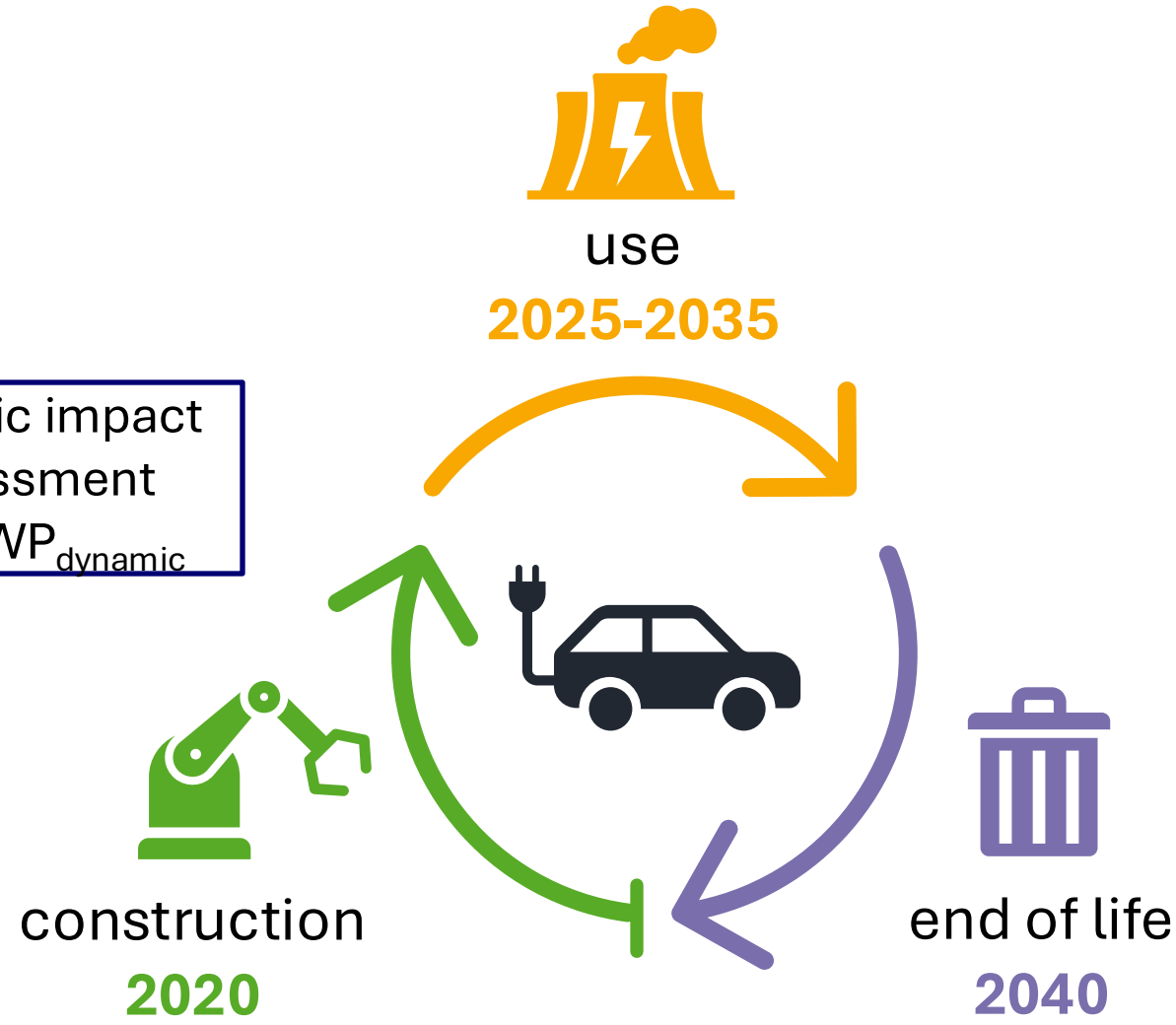




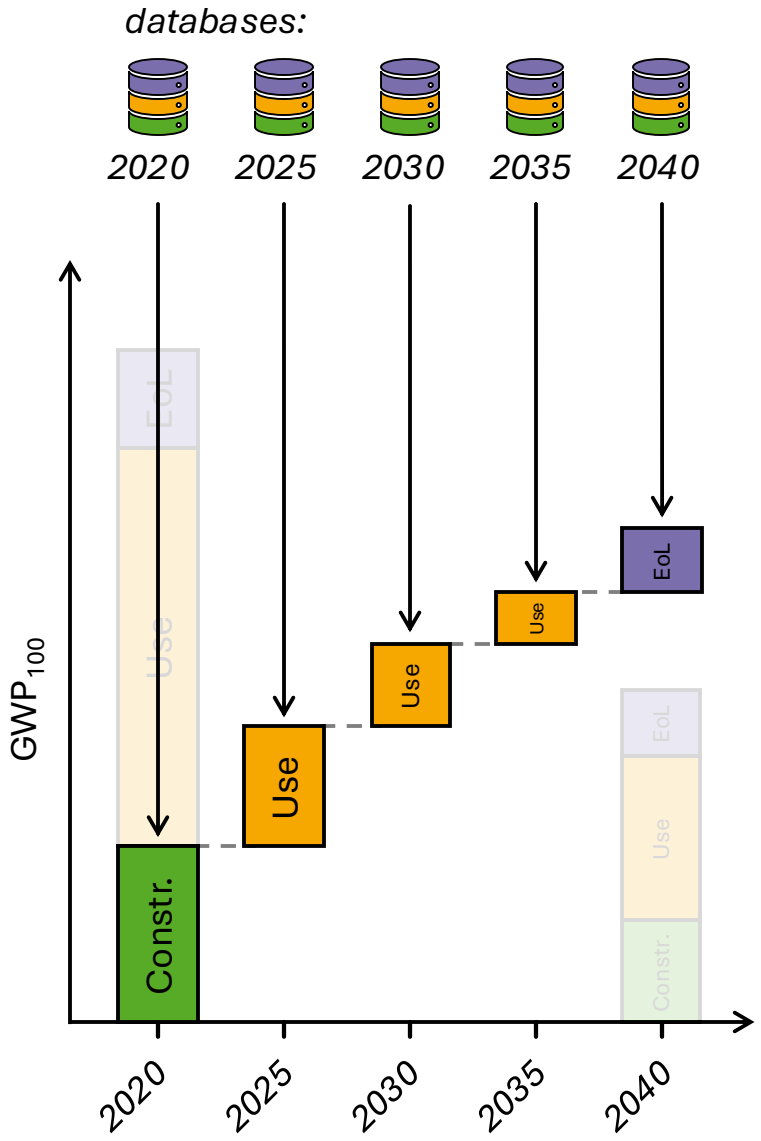
Temporal distribution: *"the system over time"*

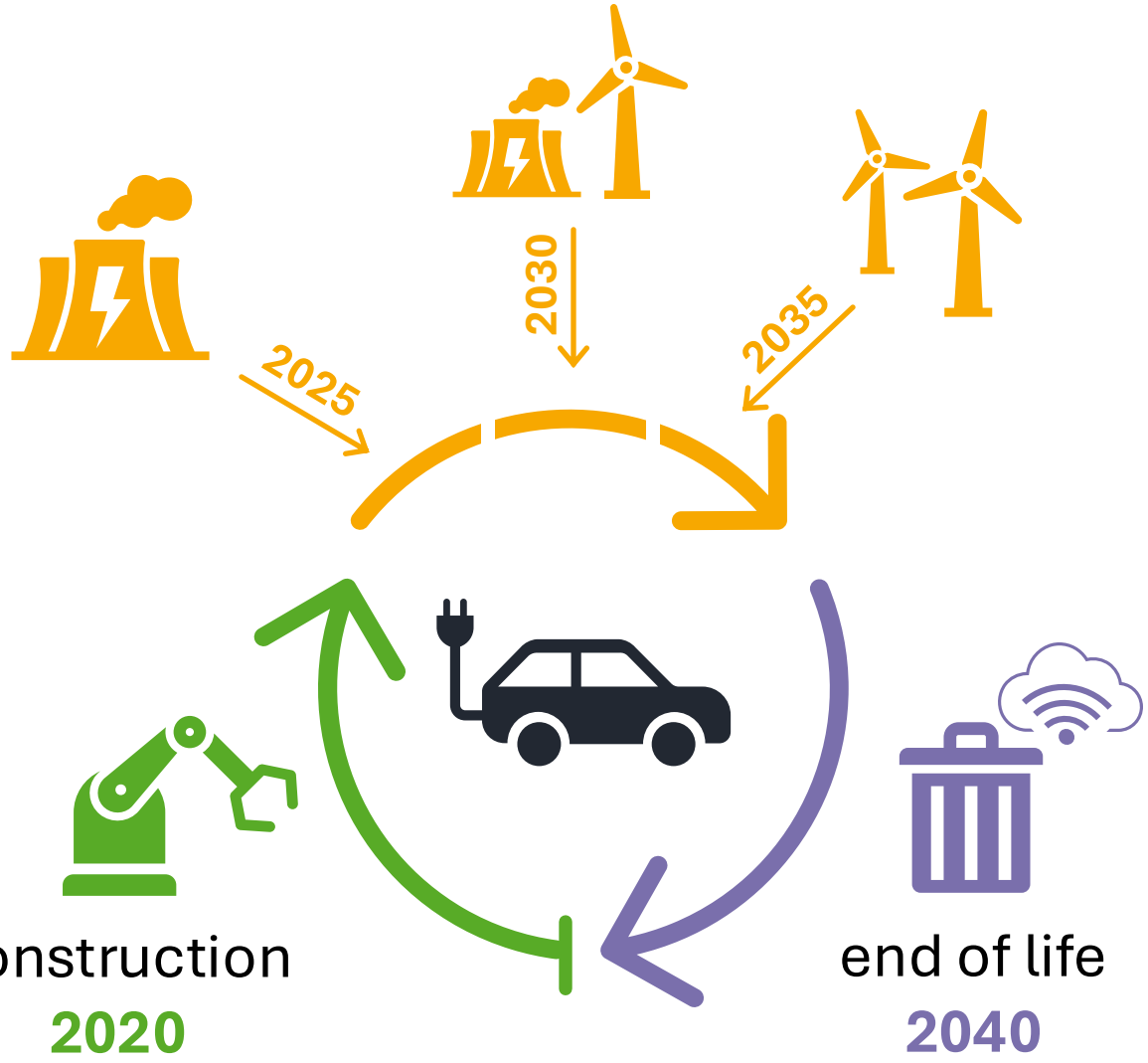


+ Dynamic impact assessment e.g. $GWP_{dynamic}$



Time-explicit LCA: *"Temporal distribution + evolution"*





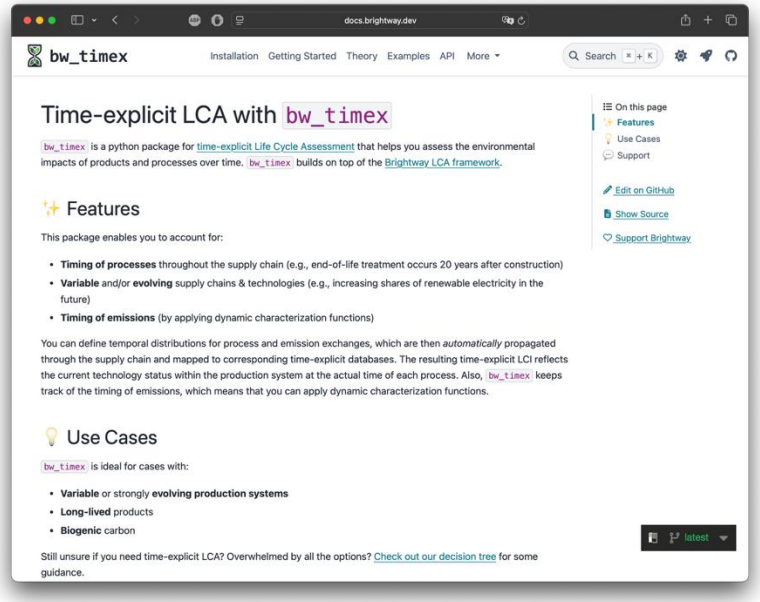
bw_timex - *managing time for you*

bw_timex enables you to account for

- Timing of processes
- Timing of emissions
- Evolving supply chains

While:

- Working with your favourite LCA software…
- Doing the hard work for you
- Providing extensive documentation



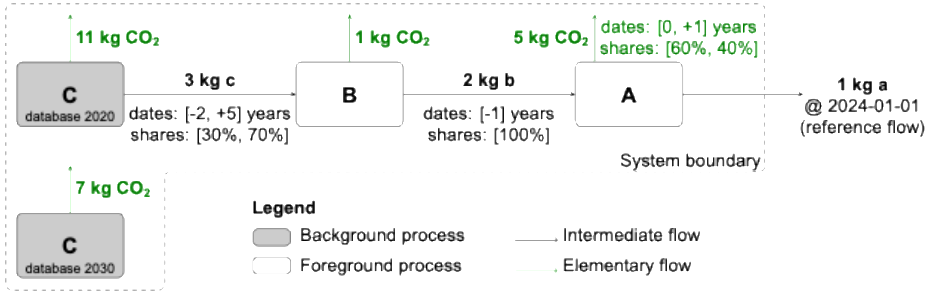
Time to get started…

Open the jupyter notebook on SPRING.brightcon.link👩‍💻:

→ teaching_example_ev_premise.ipynb

How does it work: A-B-C example

1) Flowchart of A-B-C example



2) Original matrices

A

	process A	process B	process C
product a	1	0	0
product b	-2	1	0
product c	0	-3	1

B

CO_2	5	1	11

3) Timeline of intermediate flows

Time of producing process	Producing process	Time of consuming process	Consum-ing process	Intermediate product	Amount	Temporal market shares
2021-01-01	C	2023-01-01	B	c	0.9	2020: 0.9, 2030: 0.1
2023-01-01	B	2024-01-01	A	b	2.0	–
2024-01-01	**A**	**2024-01-01**	**-1 (FU)**	**a**	**1.0**	**–**
2028-01-01	C	2023-01-01	B	c	2.1	2020: 0.2, 2030: 0.8

4) Time-explicit matrices

A^*

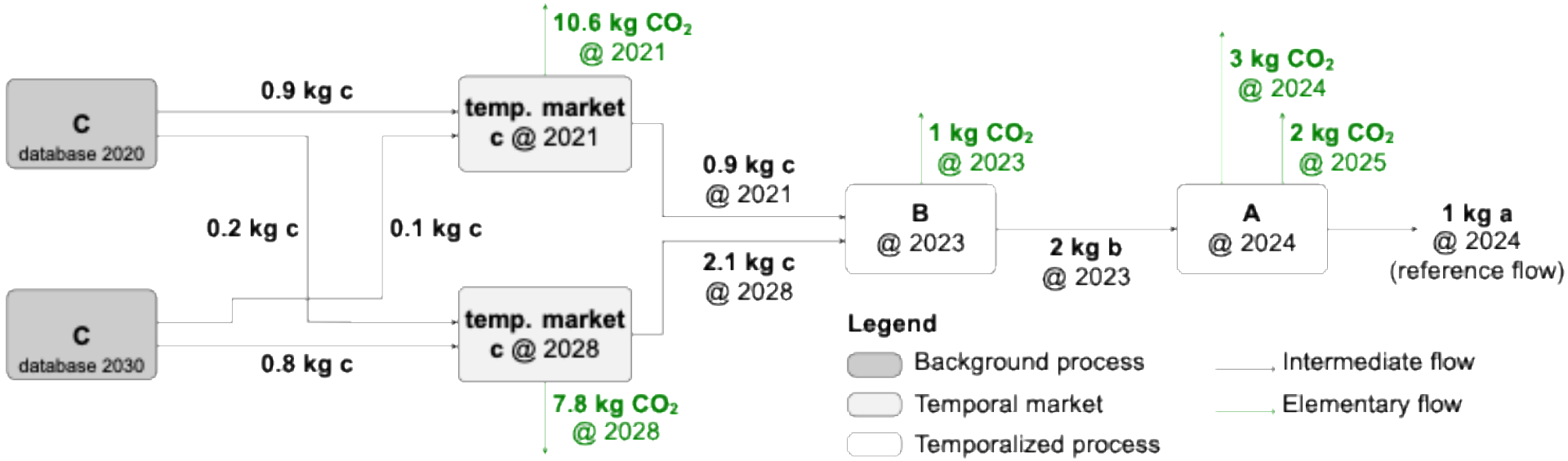
	process A @ 2024	process B @ 2023	process C @ 2020	process C @ 2030	TM c @ 2021	TM c @ 2028
product a @ 2024	1	0	0	0	0	0
product b @ 2023	-2	1	0	0	0	0
product c @ 2020	0	0	1	0	-0.9	-0.2
product c @ 2030	0	0	0	1	-0.1	-0.8
product c @ 2021	0	-0.9	0	0	1	0
product c @ 2028	0	-2.1	0	0	0	1

B^*

CO_2 @ 2021	0	0	0	0	10.6	0
CO_2 @ 2023	0	1	0	0	0	0
CO_2 @ 2024	3	0	0	0	0	0
CO_2 @ 2025	2	0	0	0	0	0
CO_2 @ 2028	0	0	0	0	0	7.8

How does it work: A-B-C example

5) Time-explicit supply chain



Time to do it yourself

Open the jupyter notebook 👩‍💻:

→ teaching_project_electric_vs_petrol_vehicle_premise.ipynb