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Using databases from different data providers in parallel for a case study on light bulbs

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1 Motivation and background

Motivation and background

The number of LCA databases is increasing worldwide.

LCA Databases differ in terms of their content, intended usage, price, availability, structure and format, and several other aspects

(still) two main comprehensive LCA databases worldwide, ecoinvent and GaBi

→ Where and possibly why are they different when they are applied, on a simple case study.

Motivation and background

Databases are typically used in one LCA software tool

- GaBi databases – GaBi LCA software;
- Ecoinvent – SimaPro LCA software;

openLCA is the only LCA software which provides most recent GaBi and ecoinvent databases and will be used in this exercise, as follows:

openLCA 1.4; ecoinvent 2.2 (ecoinvent cut-off 3.1); GaBi Professional 2013; LCIA method pack 1.4.1 openLCA; ILCD midpoint 2011

2 Case study design

Case study design

2 core systems are modelled, based on industry and otherwise publicly available data outside of LCA

1) “CFL”: Candescent Fluorescent Lamp

2) “IL”: Incandescent Fluorescent Lamp

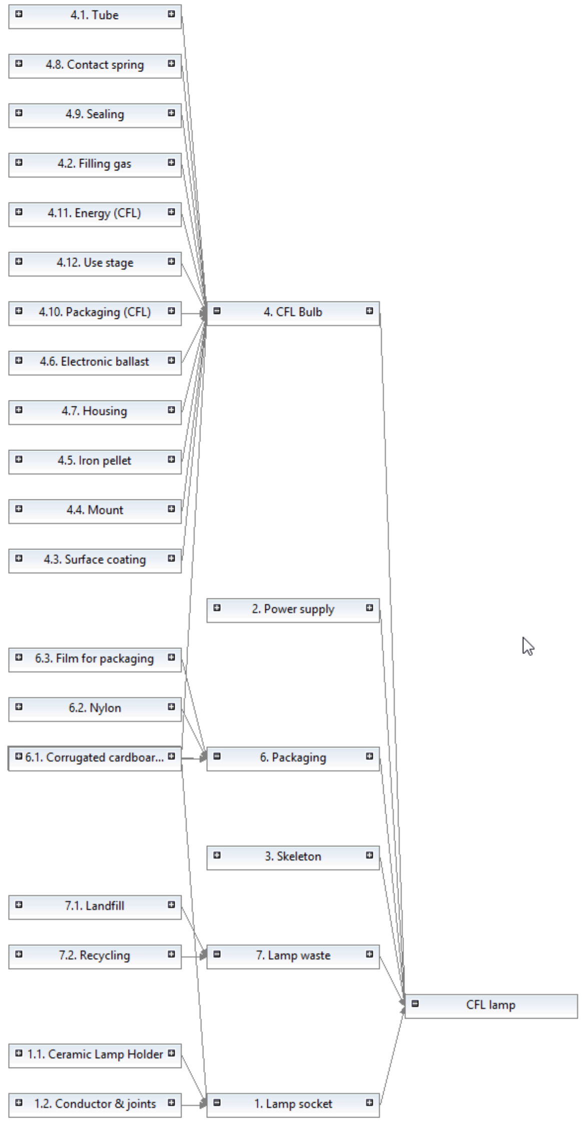
	INCANDESCENT LAMP (IL)	COMPACT FLUORESCENT LAMP (CFL)
Product name	CLASSIC A 40W 230V E27	DULUX SUPERSTAR STICK 8W/825 E27
Average lifetime:	1.000 h	10.000 h
Luminous flux:	415 lm	400 lm
Wattage:	40W	8W
Voltage:	230V	230V
Base designation:	E27	E27
Packaging weight:	11.5g	7.4035g
Consumed energy in its lifetime:	80kWh	40kWh

Table 2.1: technical information about the bulbs

Case study design

Both light bulbs are used in a lamp:

Case study design: CFL core system



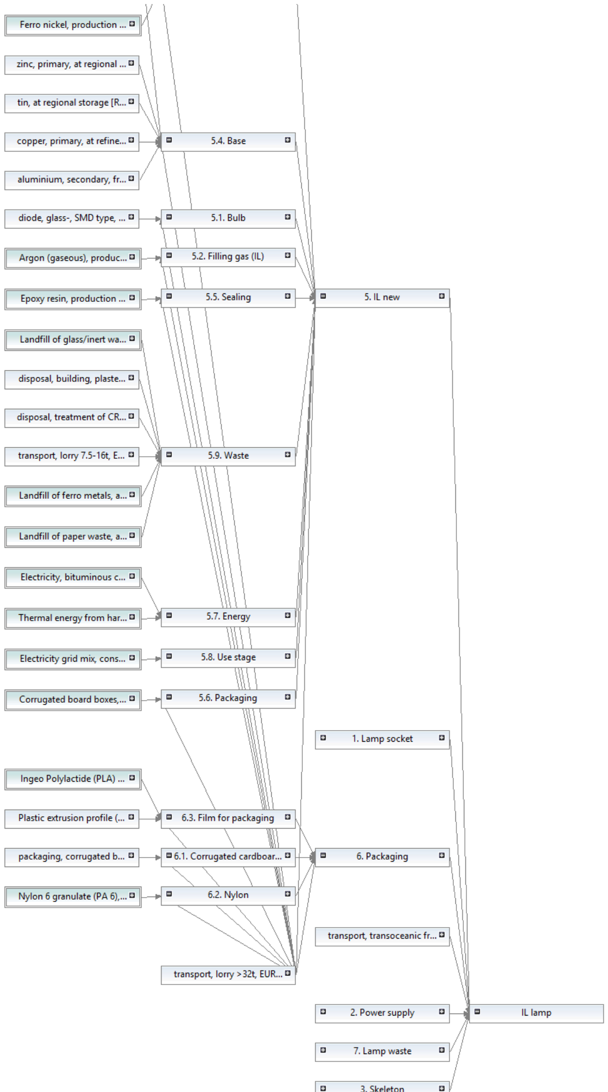
Case study design: completing the core system

Where needed, each core system is completed with background data from ecoinvent or GaBi; in a second iteration, processes that seemed better suited from "the other database" have been used in addition:

Core - ecoinvent – (GaBi)

Core – GaBi - ecoinvent

Case study design: completing the core system: core – GaBi - ecoinvent



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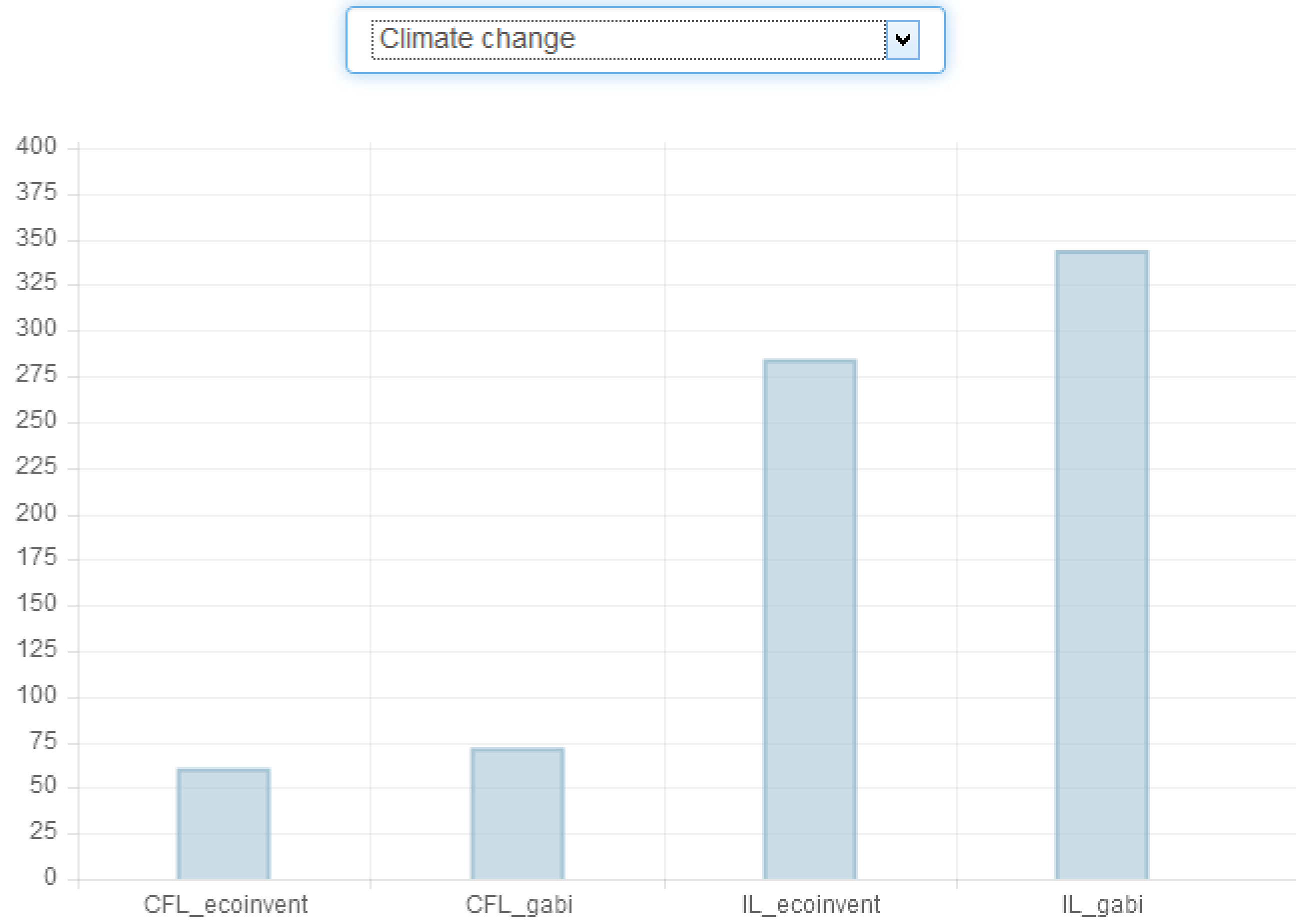
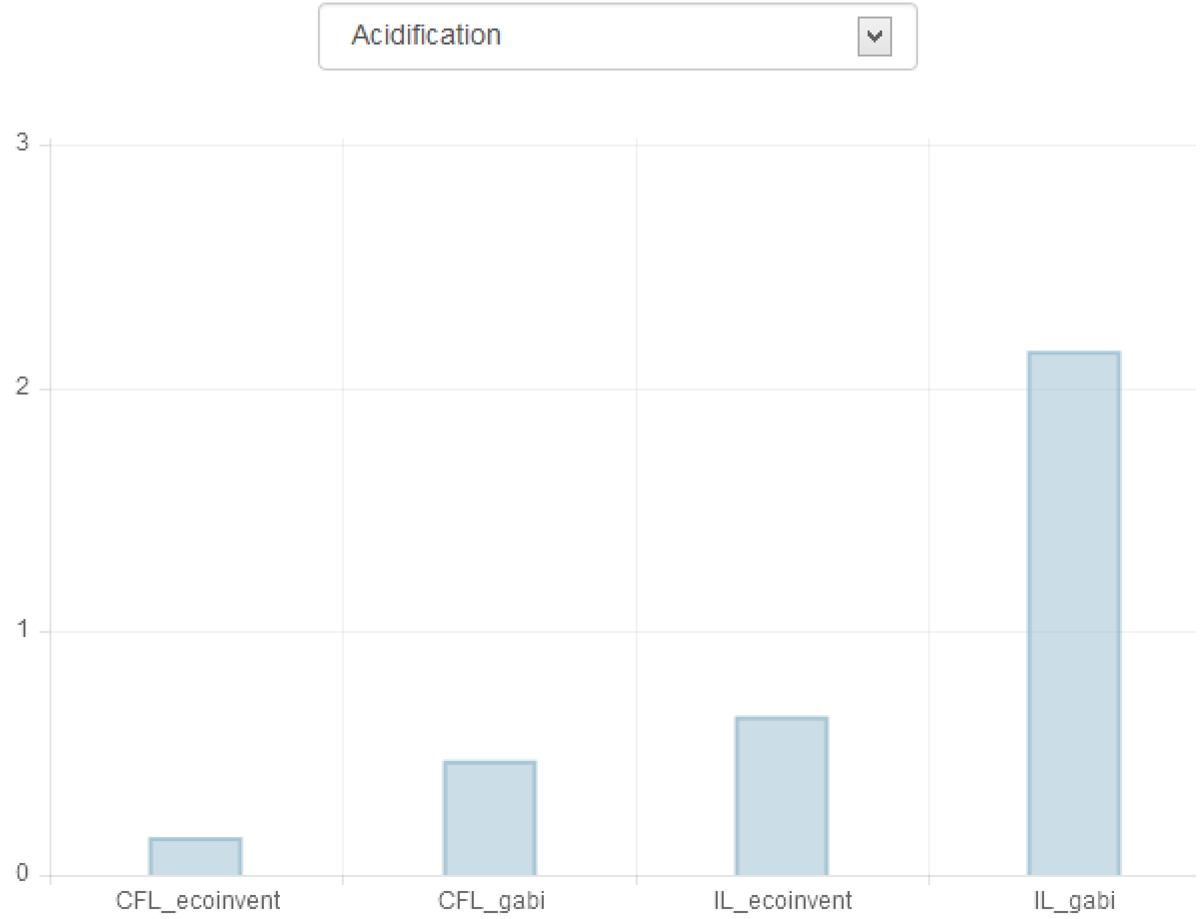
3 Results

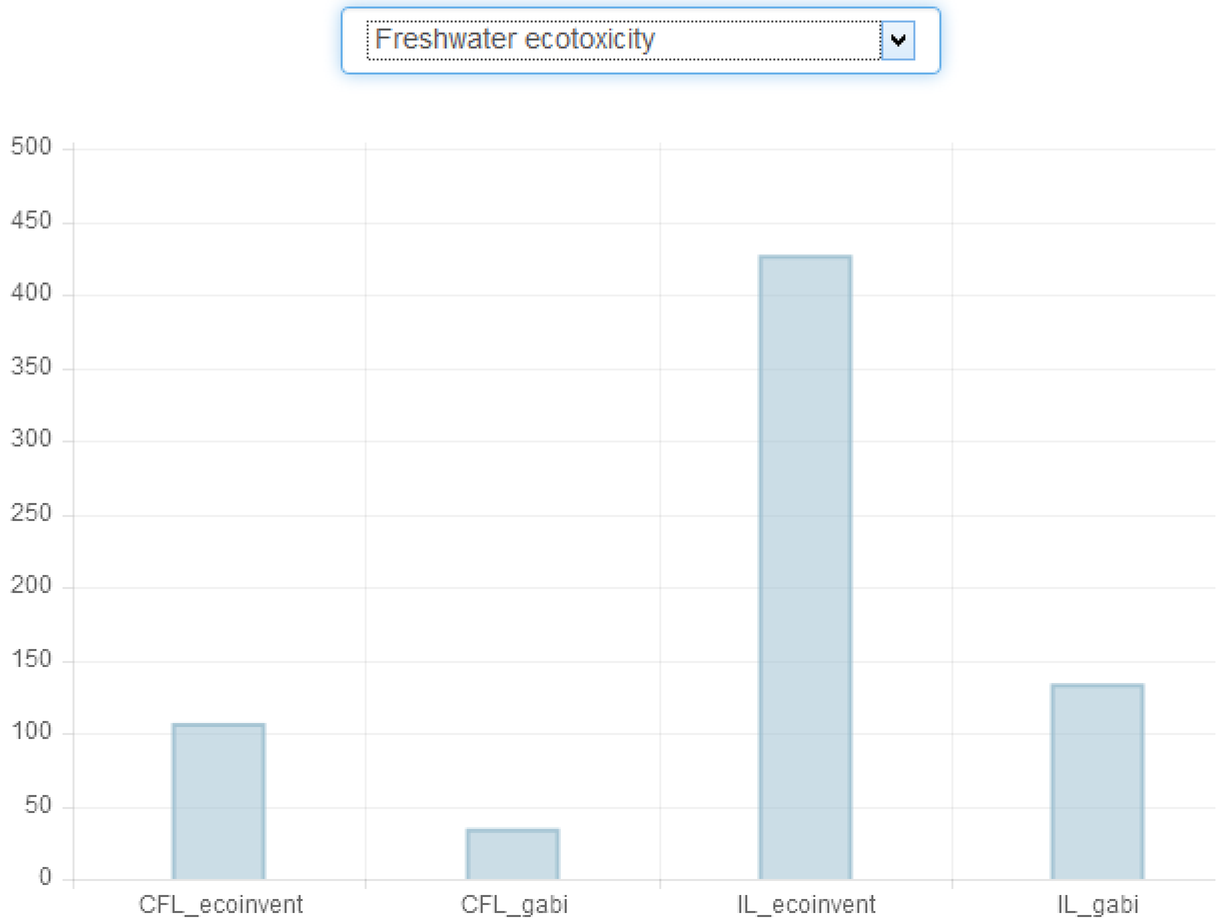
Case study results, preliminary



Case study results, preliminary



Case study results, preliminary



Case study results, preliminary

LCIA category	CFL_ecoinvent	CFL_gabi	IL_ecoinvent	IL_gabi	Unit
Acidification	7,23E-02	2,19E-01	3,03E-01	1,00E+00	mol H+ eq.
Climate change	1,77E-01	2,09E-01	8,27E-01	1,00E+00	kg CO2 eq.
Freshwater ecotoxicity	7,98E-01	2,59E-01	3,19E+00	1,00E+00	CTUe
Freshwater eutrophication	1,80E+00	1,99E-01	8,61E+00	1,00E+00	kg P eq.
Human toxicity - carcinogenics	1,18E+00	1,95E-01	4,91E+00	1,00E+00	CTUh
Human toxicity - non-carcinogenics	3,60E-01	3,11E-01	1,17E+00	1,00E+00	CTUh
Ionizing radiation - ecosystems	1,58E-02	2,08E-01	7,85E-02	1,00E+00	CTUe
Ionizing radiaton - human health	6,33E-02	2,05E-01	3,12E-01	1,00E+00	kg U235 eq.
Land use	4,06E-01	2,10E-01	1,69E+00	1,00E+00	kg SOC
Marine eutrophication	6,34E-02	2,16E-01	2,83E-01	1,00E+00	kg N eq.
Ozone depletion	1,31E+00	1,51E-01	5,53E+00	1,00E+00	kg CFC-11 eq.
Particulate matter/Respiratory inorganics	1,18E-01	2,19E-01	4,35E-01	1,00E+00	kg PM2.5 eq.
Photochemical ozone formation	7,18E-02	2,16E-01	3,05E-01	1,00E+00	kg C2H4 eq.
Resource depletion - mineral, fossils and ren	1,84E-06	2,31E-01	2,81E-06	1,00E+00	kg Sb eq.
Resource depletion - water	5,34E-04	2,09E-01	2,53E-03	1,00E+00	m3
Terrestrial eutrophication	4,46E-02	2,17E-01	1,90E-01	1,00E+00	mol N eq.

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Case study results: reasons for differences

Correct / suitable product selected? Diesel as product available from these processes in GaBi:

Produced by

- Diesel mix at refinery, production mix, at refinery, from crude oil and bio components, 10 ppm sulphur, 5.76 wt.% bio components - EU-27
- Diesel mix at filling station, consumption mix, at filling station, from crude oil and bio components, 8.49 wt.% bio components - DE
- Diesel mix at refinery, production mix, at refinery, from crude oil and bio components, 500 ppm sulphur, 3.68 wt.% bio components - BR
- Diesel mix at filling station Western Australia, consumption mix, at filling station, from crude oil and bio components, 0.80 wt.% bio components - AU
- Diesel mix at filling station, consumption mix, at filling station, from crude oil and bio components, 4.60 wt.% bio components - GB
- Diesel mix at refinery, production mix, at refinery, from crude oil and bio components, 350 ppm sulphur, 0.00 wt.% biocomponents - IN
- Diesel mix at refinery, production mix, at refinery, from crude oil and bio components, 10 ppm sulphur, 0.00 wt.% bio components - JP
- Diesel mix at refinery, production mix, at refinery, from crude oil and bio components, 15 ppm sulphur, 0.60 wt.% bio components - US
- Diesel mix at filling station, consumption mix, at filling station, from crude oil and bio components, 0.00 wt.% bio components - CN
- Diesel mix at refinery, production mix, at refinery, from crude oil and bio components, 10 ppm sulphur, 0.80 wt.% bio components - AU
- Diesel mix at filling station, consumption mix, at filling station, from crude oil and bio components, 3.68 wt.% bio components - BR
- Diesel mix at filling station, consumption mix, at filling station, from crude oil and bio components, 5.76 wt.% bio components - EU-27
- Diesel mix at filling station, consumption mix, at filling station, from crude oil and bio components, 4.39 wt.% bio components - NL
- Diesel mix at filling station, consumption mix, at filling station, from crude oil and bio components, 7.82 wt.% bio components - FR
- Diesel mix at filling station, consumption mix, at filling station, from crude oil and bio components, 0.60 wt.% bio components - US
- Diesel mix at filling station, consumption mix, at filling station, from crude oil and bio components, 0.80 wt.% bio components - AU
- Diesel mix at refinery, production mix, at refinery, from crude oil and bio components, 10 ppm sulphur, 4.60 wt.% bio components - GB
- Diesel mix at refinery, production mix, at refinery, from crude oil and bio components, 10 ppm sulphur, 8.49 wt.% bio components - DE

Case study results: reasons for differences

Different results for core processes, e.g. electricity; ecoinvent

Contribution tree

○ Flows — Hydrogen-3, Tritium - water/ocean

◉ Impact categories — Freshwater eutrophication

Contribution	Process	A...
100.00%	CFL Scenario A	0.0
84.31%	4. CFL	0.0
65.25%	4.12. Use stage	0.0
65.25%	electricity, medium voltage, at grid - DE	0.0
64.95%	electricity, high voltage, at grid - DE	0.0
00.30%	transmission network, electricity, medium voltage - CH	8.2
00.00%	sulphur hexafluoride, liquid, at plant - RER	1.4
17.20%	4.1. Tube	0.0
01.27%	4.6. Electronic ballast	0.0
00.52%	4.11. Energy	0.0

Case study results: reasons for differences

Different results for core processes, e.g. electricity; GaBi

Contribution tree

○ Flows — Carbon-14 - air/unspecified

◉ Impact categories — Freshwater eutrophication

Contribution	Process	A...
100.00%	CFL lamp	0.0...
87.20%	4. CFL Bulb	0.0...
58.87%	4.1. Tube	0.0...
58.87%	diode, glass-, SMD type, surface mounting, ...	0.0...
40.07%	production efforts, diodes - GLO	0.0...
17.16%	molybdenum, at regional storage - RER	0.0...
01.53%	copper, primary, at refinery - RER	0.0...
00.04%	tin, at regional storage - RER	3.0...
00.03%	aluminium oxide, at plant - RER	2.6...
00.03%	funnel glass, CRT screen, at plant - GLO	2.0...
00.00%	silicon, electronic grade, at plant - DE	2.9...
00.00%	lead, at regional storage - RER	1.7...
00.00%	epoxy resin, liquid, at plant - RER	7.8...
00.00%	transport, lorry >32t, EURO4 - RER	3.6...

Case study results: reasons for differences

There are three main reasons for differences in the case study

- Different inventory of the process data set
- Imperfect fit of an available data set to the needed product
- Differences in Impact Assessment
- Different units / reference flows / data set modelling approaches → here not, since these data sets can all be used in one software

Case study results: reasons for differences

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4 Discussion and Outlook

Discussion and Outlook

Performing a small case study for a lamp with light bulbs using ecoinvent and GaBi databases leads to different results, depending on the database.

For some impact categories and for some comparisons, the recommendation from the comparison remain stable, i.e. they are independent from the database,

For some not.

Discussion and Outlook

There are several reasons for differences,

Differences in the datasets as such is one that calls for interaction between database providers.

→ What is the “deeper” reason for these differences?
This is difficult to see from the outside if only aggregated processes are available.

→ Could database providers think of a different release of system processes, each fit to a specific “perspective” (i.e.: following the ecoinvent modelling guidelines; ...) ??

Discussion and Outlook

I would be happy to discuss this with different data providers, possibly using the small case study.

(unfortunately, a USeTox approach to identify a credible data set irrespective of modelling backgrounds does not work here)

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Thanks again.

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