



› **BEVSIM TOOL | FLAMINGO WEBINAR**

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› **BEVSIM | PART OF WP1 ALMA PROJECT**

BATTERY ELECTRIC VEHICLE SUSTAINABILITY IMPACT ASSESSMENT MODEL

INTRODUCTION

VALUE PROPOSITION

CAPABILITIES

SIMULATION WORKFLOW

RESULTS EXAMPLES

CLOSING REMARKS

› BEVSIM

INTRODUCTION & FEATURES

Battery Electric Vehicle Sustainability Impact Assessment Model (BEVSIM)

- › Web-based tool based on TNO's DIAMONDS platform with R Shiny programming suite and built-in database on lifecycle impacts.
- › **Best-in-class LCA models** for materials production, processing, Use Phase, EoL fate and EoL recycling processes.
- › **BEV versus ICE comparison possible** for segment C and D passenger cars.
- › **Customisable** → Model a full car, a sub-system, or a part for LCA, LCC, Circularity Analysis
- › Possibility to include customer, user specific datasets
- › **Download** Word report and extended Excel results
- › **Version control** possible and easy to update LCI datasets

Compare Design Alternatives

Designed For NON-LCA Experts

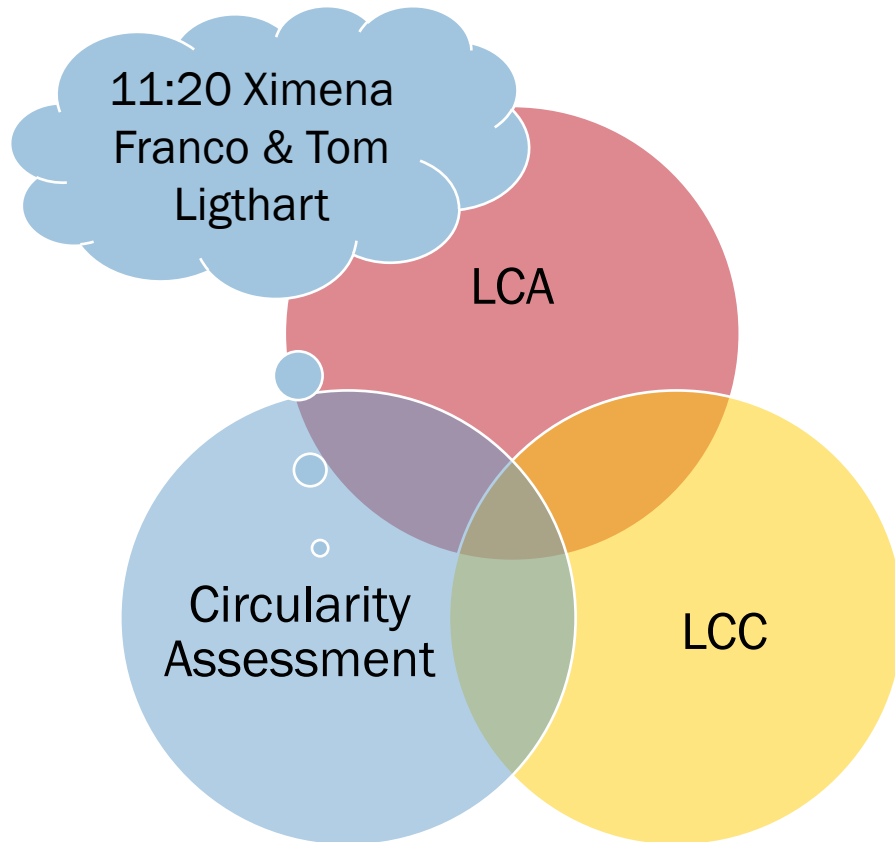
Early Sustainability Evaluation

Faster LCA Results

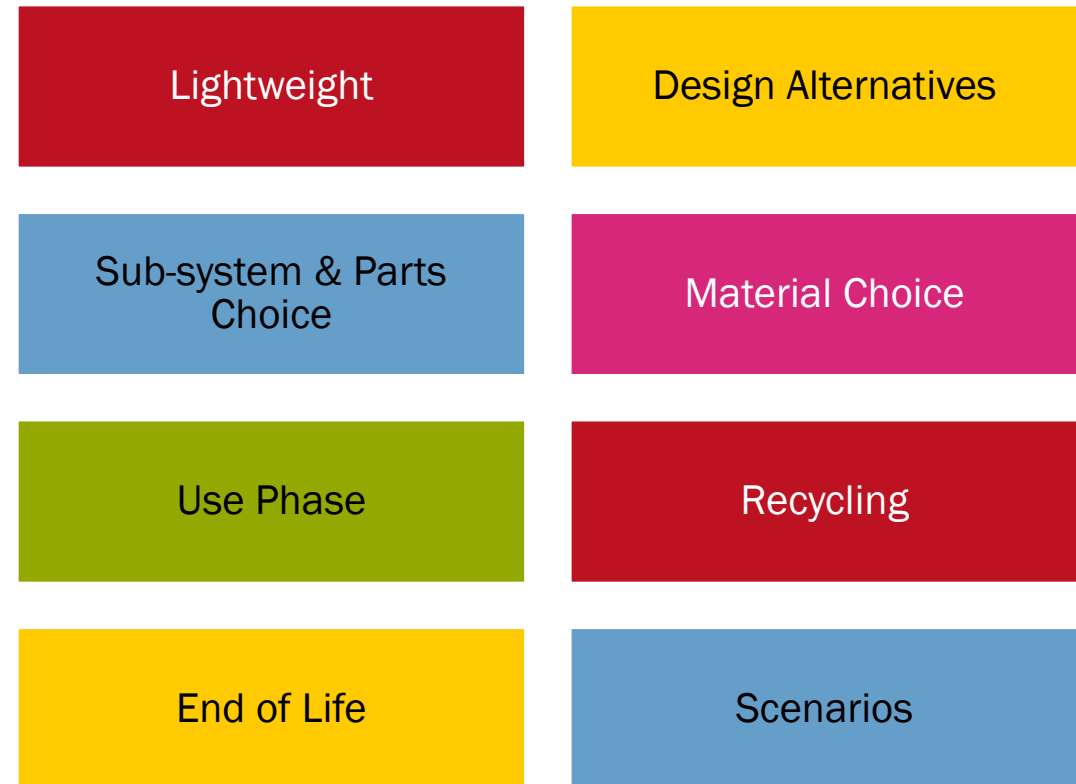
Scenarios

› BEVSIM CAPABILITIES

Single Tool



Measure Impacts



LIFE CYCLE PHASES

Raw Materials	<ul style="list-style-type: none"> • Plastic granules, plastic pellets, mineral fillers, glass fibre, carbon fibre, cold rolled steel sheets, rods, aluminium sheets, Al rods, metals in finished form before part production, acids, materials for batteries.
Processing and Part Production	<ul style="list-style-type: none"> • For Plastics → Injection moulding, blow moulding, compounding, painting, , PU foam production, • For Metals → Casting, stamping, cutting, polishing, carburizing, machining, painting • For Batteries → battery production • Tires → tire production from SBR rubber, steel and thread
Assembly	<ul style="list-style-type: none"> • “Gate to Gate” boundary of automotive manufacturing plant e.g. Ford, VW assembly line. • Assembly of parts, components of complex parts, assembly of sub-systems.
Use Phase	<ul style="list-style-type: none"> • Use phase of the car / car part, consumables, maintenance emissions.
EoL	<ul style="list-style-type: none"> • EoL Scenario for EoL treatment: Incineration, Landfill, Recycling (mechanical, pyrolysis, solvolysis) • Dismantling, Shredding, EoL treatment
Avoided Production	<ul style="list-style-type: none"> • Avoided production of energy, materials and products (going to spare parts)

› SIMULATION WORKFLOW

STEP 1: SELECT “USER DESIGN”

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BEVSIM v3.33

Intro & Manual

Intro

Manual

Glossary

Select "User Design"

Edit "User Design"

Edit Material & Process costs

Select "Reference Design(s)"

Select Use Phase Method

Select End-of-Life Scenarios

Compare Bill of Materials

Evaluate LCA Impact

Evaluate LCC

Evaluate Circularity Assessment

Save

The Team

Settings

Debugging

Plot

Normal

Large

Select 'User Design' for a car, sub-system or a part to analyze.

Search:

ID	Name	Project	Owner	Type	Country	EoL Scenario	Num Records	Created	Select
1	demo	example1	jackssrrr	Internal Combustion	0	Future Scenario	94	2021-11-18 00:49:02	<input checked="" type="radio"/>
2	milad_ice	test	milad	Internal Combustion	0	Current Scenario	123	2021-11-09 05:48:33	<input type="radio"/>
98	ALMA-Chassis-Deliverable	ALMA	Milad	Electric	Electricity, grey (Germany)	Current Scenario	20	2021-11-16 09:51:02	<input type="radio"/>
101	Test_steel	Testing BEVSIM	Tom	Electric	0	Current Scenario	1	2021-11-09 06:18:19	<input type="radio"/>
102	Test ABS	Testing BEVSIM	Tom	Electric	0	Current Scenario	1	2021-11-09 06:18:22	<input type="radio"/>
104	Car104	ALMA	Milad	Electric	0	Current Scenario	5	2021-11-09 06:18:25	<input type="radio"/>
105	Car105	ALMA	Milad	Electric	0	Current Scenario	20	2021-11-09 06:18:26	<input type="radio"/>
106	Car106	ALMA	Milad	Electric	0	Current Scenario	20	2021-11-09 06:18:29	<input type="radio"/>
108	Car108			Electric	0	Current Scenario	none	2021-11-09 06:18:30	<input type="radio"/>
109	Car109			Electric	0	Current Scenario	none	2021-11-09 06:18:32	<input type="radio"/>
110	Car110			Internal Combustion	0	Current Scenario	2	2021-11-09 06:17:29	<input type="radio"/>
113	Car113	ALMA	Milad	Electric	0	Current Scenario	2	2021-11-09 06:18:41	<input type="radio"/>
114	Car114	ALMA	Milad	Electric	0	Current Scenario	1	2021-11-09 06:18:43	<input type="radio"/>
116	Car116	ALMA	Milad	Electric	0	Current Scenario	20	2021-11-09 06:18:45	<input type="radio"/>
117	Car117	ALMA	Milad	Electric	0	Current Scenario	1	2021-11-09 06:18:48	<input type="radio"/>

Showing 1 to 15 of 46 entries

Add New User Design (Car)

Next

1 Click on a row in the table to select your User Design (Car) to edit and/or analyse. You can quickly search by typing in the box at the top-right above the table or browse through the different pages (bottom right). Use the "Add New User Design (Car)" button below the table on the left to create a completely new User Design (Car). Use the "Delete Selected Design (Car)" -button below the table on the right to delete the currently selected User Design (Car).

“Select ‘User Design’” Tab will show available designs. Click on a row to select your design.

Alternatively, one can add a new user design.

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› LIFE CYCLE COSTING DATA

STEP 2: EDIT “USER DESIGN”

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BEVSIM v3.33

Intro & Manual
Intro
Manual
Glossary
Select "User Design"
Edit "User Design"
Edit Material & Process costs
Select "Reference Design(s)"
Select Use Phase Method
Select End-of-Life Scenarios
Compare Bill of Materials
Evaluate LCA Impact
Evaluate LCC
Evaluate Circularity Assessment
Save
The Team
Settings
Debugging
Plot
Normal
Large

Edit Material Costs Edit Process Costs

Edit Material Costs

Show 15 entries

	id	material	unit	default_costs	user_costs
1	100	Aluminium, wrought alloy	kg	2.413	2.413
2	95	ABS	kg	1.888	1.888
3	102	Boron	kg		6
4	172	Steel HDG (World Steel) [BH, MS, HF, DP, HDG]	kg	0.675	0.675
5	101	Battery_Material	kg		5
6	96	Adhesive	kg	1.494	1.78
7	97	Air Conditioner refrigerant	kg	6.71	
8	98	Aluminium, cast alloy	kg	2.413	
9	99	Aluminium, primary, ingot (up to date)	kg	2.413	
10	103	Brake fluid	l	2.686	
11	104	Brake Pads_material	car	3.777	
12	105	brake rotor_material	kg		
13	106	Cable, unspecified	kg		
14	107	Carbon fibre reinforced plastic, injection moulded	kg	25.2	
15	108	Cast iron	kg	0.425	

Showing 1 to 15 of 94 entries

Search:

Double click in the table to

Cell(6,5) changed to (1.78)

record(id=96,material=Adhesive)=,1.78 Saved to database!

For the LCC, we provide a default list of prices per **Material** and per **Process**. However, you can edit these prices by double-clicking in rightmost column.

Note that these prices will be attached to your personal user-account in the future, so they will be overruling the defaults for all your cars.

› SIMULATION WORKFLOW

STEP 2: EDIT “USER DESIGN”

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BEVSIM v3.33

- Intro & Manual
- Intro
- Manual
- Glossary
- Select "User Design"
- Edit "User Design"**
- Edit Material & Process costs
- Select "Reference Design(s)"
- Select Use Phase Method
- Select End-of-Life Scenarios
- Compare Bill of Materials
- Evaluate LCA Impact
- Evaluate LCC
- Evaluate Circularity Assessment
- Save
- The Team
- Settings
- Debugging
- Plot
 - Normal
 - Large

Edit User Design Edit Parts

Once “User Design” selected, one can edit the design

Edit User Design: Project Details, Vehicle Type & Geography

Nr: 147 Name User Design: Webinar

Create Project Name: ALMA Project Manager: Milad

Select Vehicle Type: ☒ Electric ☐ Internal Combustion Electricity: Electricity, grey (EU)

Edit User Design: Life-Cycle Costs (LCC) from Consumer perspective

Consumer price (ex. Tax, incl VAT): 70000 Mass Value to use in LCC Calculations: Standardized Mass Value Mass used in LCC Calculations: 1483

Edit User Design: Life-Cycle Costs (LCC) from Producer perspective

Fill in the values below with estimations per car

Design costs: 350	Assembly costs: 150	Lighting & HVAC costs: 5	Distribution costs: 60
Warranty & service costs: 260	Recycling, waste disposal costs: 35	Revenues: 35900	

Save Design in Database

Don't forget to save any changes!

Properties that affect the LCA.

Properties that affect the LCC.

› SIMULATION WORKFLOW

STEP 2: EDIT “USER DESIGN”

In the “Edit Parts” Tab, one can see and edit the individual parts, materials and processing.

Or add or delete parts.

When editing a new part, complete the form and press Update. (a maximum of three processes per part can be chosen).

The screenshot displays the BEVSIM v3.33 software interface. The left sidebar contains navigation options: Intro & Manual, Intro, Manual, Glossary, Select "User Design", Edit "User Design" (highlighted), Edit Material & Process costs, Select "Reference Design(s)", Select Use Phase Method, Select End-of-Life Scenarios, Compare Bill of Materials, Evaluate LCA Impact, Evaluate LCC, Evaluate Circularity Assessment, Save, The Team, Settings, Debugging, and Plot. The main area shows the 'Edit Parts' tab with a table of parts. The table has columns for SubSystem, Part, and Material. The 'Add Part' button is visible below the table. The right panel shows the detailed form for editing a part, including fields for SubSystem, Part, Material, Process 1, Process 2, Process 3, Mass (Kg), and Amount (Kg). The 'Update' button is at the bottom of the form.

SubSystem	Part	Material
Chassis	Lower front control arms	Aluminium, primary, ing
Chassis	Rear control arms	Aluminium, primary, ing
Chassis	Other (Corner Suspension)	Steel HDG (World Steel)
Chassis	Other (Corner Suspension)	Steel PHRC (World Steel)
Chassis	Steering Knuckle	Steel HDG (World Steel)
Chassis	Steering Knuckle	Steel PHRC (World Steel)
Chassis	Rotor	Cast iron
Chassis	Assembly Calliper	Steel HDG (World Steel)
Chassis	Assembly Calliper	Steel PHRC (World Steel)
Chassis	Other (Braking Systems)	Steel HDG (World Steel)

Showing 1 to 10 of 36 entries

Add Part

Edit User Design Edit Parts Edit Record

SubSystem
Body

Part
BIW

Material
Steel HDG (World Steel) [BH, MS, HF, DR, ▼]

Process 1
Cold Stamping, Steel

Process 2

Process 3

Mass (Kg)
213

Amount (Kg)

Recycled
1

Eff
58

Eff
100

Eff
100

Subsystem
Body

Part
BIW

Material
Steel HDG (World Steel) [BH, MS, HF, DR, HDG]

Process 1
Cold Stamping, Steel

Process 2

Process 3

Mass (Kg)
185.92

Amount (Kg)

Update

› SIMULATION WORKFLOW

STEP 3: SELECT “REFERENCE DESIGN(S)”

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Intro & Manual

Intro

Manual

Glossary

Select "User Design"

Edit "User Design"

Edit Material & Process costs

Select "Reference Design(s)"

Select Use Phase Method

Select End-of-Life Scenarios

Compare Bill of Materials

Evaluate LCA Impact

Evaluate LCC

Evaluate Circularity Assessment

Save

The Team

Settings

Debugging

Plot

Normal

Large

Include reference design(s) by checking the Select boxes

Search:

ID	Name	Project	Owner	Type	Country	EoL Scenario	Num Records	Created	Select
144	Car144	ALMA	Milad	Electric	Electricity, grey (EU)	Current Scenario	1	2021-11-16 16:59:23	<input type="checkbox"/>
145	Car145	ALMA	Milad	Internal Combustion	Electricity, green (EU)	Current Scenario	1	2021-11-16 16:59:48	<input type="checkbox"/>
146	Car146	BEVSIM_TEST_LCC	Eugene	Internal Combustion	Electricity, green (EU)	Current Scenario	16	2021-11-20 12:36:18	<input checked="" type="checkbox"/>
147	Webinar	ALMA	Milad	Electric	Electricity, grey (EU)	Future Scenario	36	2021-11-18 11:01:03	<input checked="" type="checkbox"/>
148	Car148	ALMA	Milad	Internal Combustion	Electricity, green (EU)	Future Scenario	18	2021-11-18 13:21:50	<input type="checkbox"/>

Showing 41 to 45 of 45 entries

Currently Selected Reference Cars:

146 Car146 BEVSIM_TEST_LCC Eugene Internal Combustion Electricity, green (EU) Current Scenario

147 Webinar ALMA Milad Electric Electricity, grey (EU) Future Scenario

1

Select one or more existing designs from this table that you want to compare your own design with, byusing the checkbox at the far right of the table. You can quickly search by typing in the box at the top-right above the table or browse through the different pages (bottom right).

In the “Select ‘Reference Design(s)’” Menu one can select one or more reference designs to compare

Use the checkmarks to select reference designs.

› SIMULATION WORKFLOW

STEP 4: SELECT USE PHASE METHOD

The screenshot displays the BEVSIM v3.33 web application interface. On the left is a dark sidebar with navigation links: Intro & Manual, Intro, Manual, Glossary, Select "User Design", Edit "User Design", Edit Material & Process costs, Select "Reference Design(s)", Select Use Phase Method (highlighted), Select End-of-Life Scenarios, Compare Bill of Materials, Evaluate LCA Impact, Evaluate LCC, Evaluate Circularity Assessment, Save, The Team, Settings, and Debugging. At the bottom of the sidebar is a 'Plot' section with 'Normal' and 'Large' radio buttons. The main content area is titled 'Define Use Phase Method situation' and contains four input fields: 'Car Lifetime Distance (km)' with value 248500, 'Car Lifetime (years)' with value 14.91, '(BEV) kwh/100km' with value 16, and '(ICE) liter/100km' with value 5. Below these is an 'Electric Source' dropdown menu that is open, showing a list of options: Electricity, green (EU), Electricity, grey (EU), Electricity, green (France), Electricity, grey (France), Electricity, green (Germany), Electricity, grey (Germany), Electricity, green (UK), Electricity, grey (UK), Electricity, grey (NL), and Electricity, green (NL). A blue information icon is next to the dropdown. A faint instruction 'Select Use Phase using the dropboxes above' is visible in the background.

BEVSIM v3.33

Intro & Manual

Intro

Manual

Glossary

Select "User Design"

Edit "User Design"

Edit Material & Process costs

Select "Reference Design(s)"

Select Use Phase Method

Select End-of-Life Scenarios

Compare Bill of Materials

Evaluate LCA Impact

Evaluate LCC

Evaluate Circularity Assessment

Save

The Team

Settings

Debugging

Plot

Normal Large

Define Use Phase Method situation

Car Lifetime Distance (km)

248500

Car Lifetime (years)

14.91

(BEV) kwh/100km

16

(ICE) liter/100km

5

Electric Source

- Electricity, green (EU)
- Electricity, grey (EU)
- Electricity, green (France)
- Electricity, grey (France)
- Electricity, green (Germany)
- Electricity, grey (Germany)
- Electricity, green (UK)
- Electricity, grey (UK)
- Electricity, grey (NL)
- Electricity, green (NL)

Select Use Phase using the dropboxes above

In the “Select Use Phase Method”, one can change important options that effect the use phase of the vehicle.

› SIMULATION WORKFLOW

STEP 5: SELECT EOL SCENARIOS

BEVSIM v3.38

- Intro & Manual
 - Intro
 - Manual
 - Glossary
 - Classification
- Select "User Design"
- Edit "User Design"
- Edit Material & Process costs
- Select "Reference Design(s)"
- Select Use Phase Method
- Select End-of-Life Scenarios
- Compare Bill of Materials
- Evaluate LCA Impact
- Evaluate LCC

End of Life Scenario DefinitionEnd of Life Scenario Results OverviewEnd of Life Scenario Results Focussed

End of Life Scenario Definition Choices

Choose the End of Life Scenario for your "User Design"

Future Scenario

Save the chosen EoL Scenario in Database

	Current (Plastics & SMC)	Future Plastics	Future SMC
Mechanical Recycling:	0.314	0.314	0.314
Incineration:	0.686	0.686	0.686
Pyrolysis:	0	0	0
Solvolyis:	0	0	0

i Choose in the End of Life Scenario of your "User Design" in the dropdown box at the top and don't forget to press "Save EoL scenario in database". You have currently chosen "Future Design" for which some values for Plastics and SMC can be adapted (white) and others are fixed (gray). The values of all other materials are the same as the current scenario. Tip: make a duplicate "User Design" with alternative EoL scenario and select it as "Reference Design" to compare with each other in the next tab.

In the “Select End-of-Life Scenarios” menu and “Definition” Tab one can choose “Current Scenario” or “Future EoL scenario”.

› SIMULATION WORKFLOW

STEP 6: COMPARE “USER DESIGN” WITH “REFERENCE DESIGN(S)”



› LIFE CYCLE COSTING PERSPECTIVES

- › Two scopes for the Life Cycle Costing have been used:
 - › **Consumer's perspective** including all the costs and revenues for the consumer. It includes among others acquisition and use costs.
 - › **Producer's perspective** including all the costs and revenues for the producer of the car. Material and process costs are included as well as the sales revenues.

› SIMULATION WORKFLOW

STEP 7: EVALUATE LIFE CYCLE COSTS (CONSUMER)

LCC Consumer Visualization

LCC Consumer Table

LCC Producer Visualization

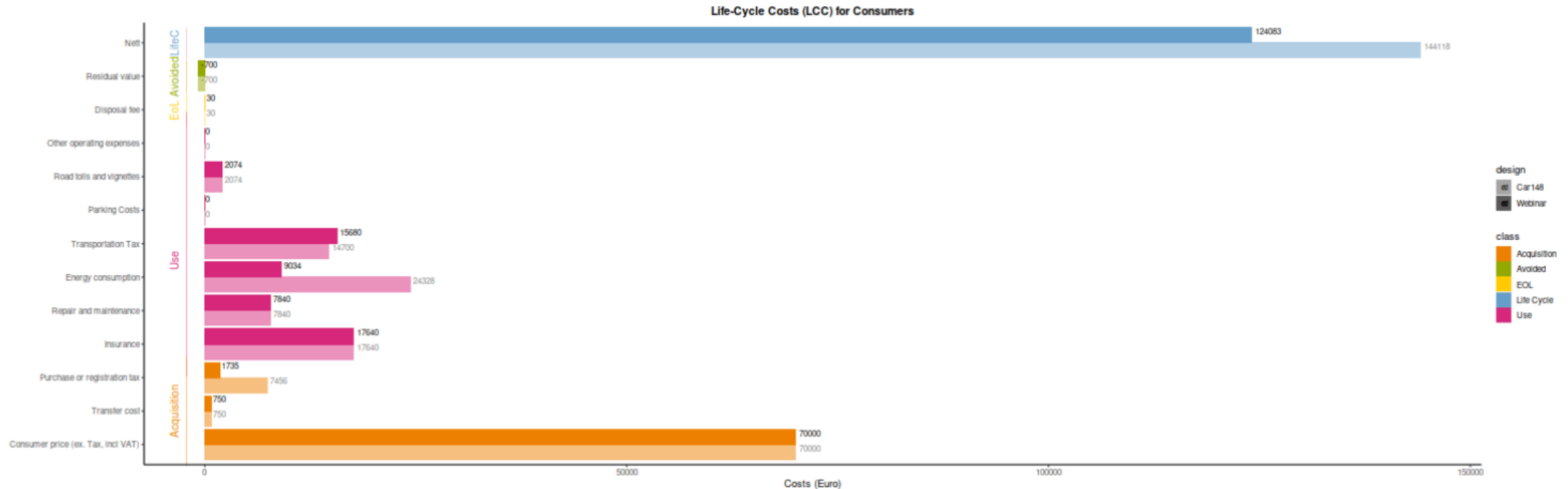
LCC Producer Table

LCC Consumer Visualization

☒ Show total

☒ Display values

☒ Transpose Axis



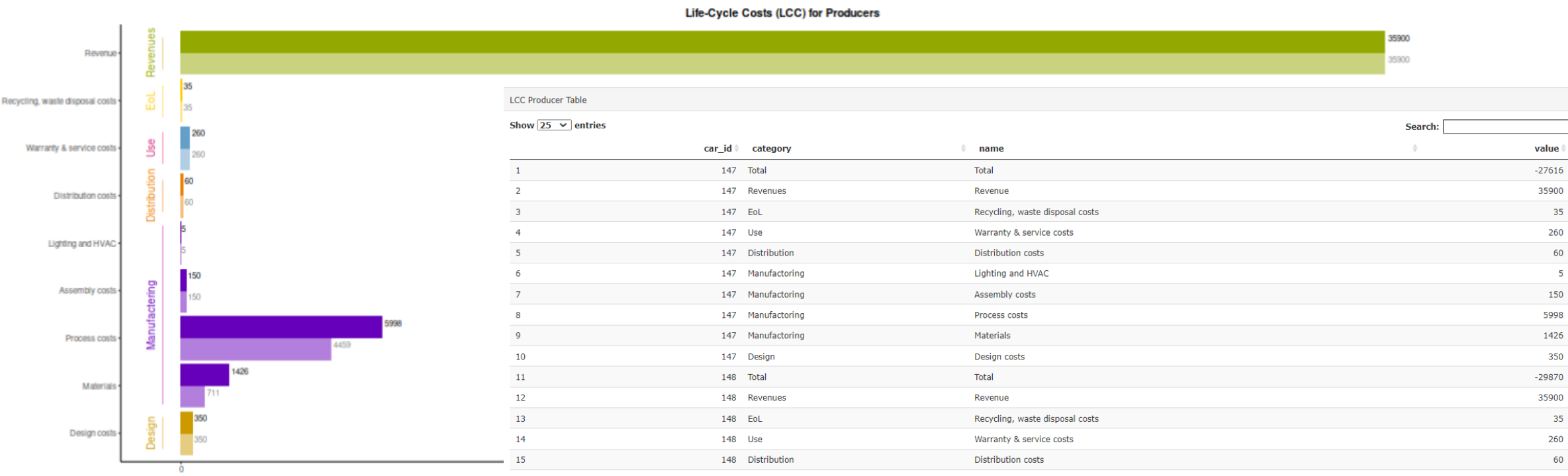
› SIMULATION WORKFLOW

STEP 7: EVALUATE LIFE CYCLE COSTS (PRODUCER)

LCC Consumer Visualization LCC Consumer Table LCC Producer Visualization LCC Producer Table

LCC Producer Visualization

☐ Show total ☒ Display values ☒ Transpose Axis



Bar graph showing the diverse Life-Cycle Costs (LCC) for producers, grouped and colored by li

› CLOSING REMARKS

- › BEVSIM is designed to assess the environmental, circularity, and economic impacts of passenger vehicles across the entire life cycle
- › Automotive application specific tool with simpler design that offers significant savings in time and effort for performing LCA studies
- › Designed for non-LCA experts for early screening of design alternatives in R&D phase
- › Consistency across LCA studies
- › Lower total cost of ownership compared to full suite LCA software
- › Can I have access to BEVSIM?
 - › Yes, on a case to case basis! Please reach out to us by email (tom.ligthart@tno.nl) to discuss your specific requirements.

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BEVSIM V2.5

Intro & Manual

Intro

Manual

Glossary

Classification

Select "User Design"

Edit "User Design"

Edit Material & Process costs

Select "Reference Design(s)"

Select Use Phase Method

Select End-of-Life Scenarios

Compare Bill of Materials

Evaluate LCA Impact

Evaluate LCC

Evaluate Circularity Assessment

Save

The Team

Settings

Debugging

Plot

Normal


Large

TNOinnovation
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BEVSIM

(Battery Electric Vehicle Sustainability Impact assessment Model)


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Alma



Online launch:

[https://almaproject.eu/
media/](https://almaproject.eu/media/)



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THANK YOU FOR
YOUR TIME

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