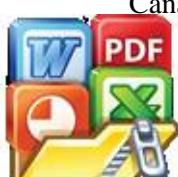


## DAFTAR PUSTAKA

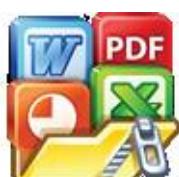
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# LAMPIRAN

## Lampiran 1 Tahapan *running* data di SimaPro

The screenshot shows the SimaPro software interface. The left sidebar contains a navigation tree with categories such as Wizards, Goal and scope, Description, Libraries, Inventory, Processes, Impact assessment, Methods, Calculation setup, Interpretation, Document Links, and General data. The 'Processes' category is currently selected. The main workspace displays a list of processes with columns for Name, Unit, and Project. One process, 'Penintangan Brick Baru (Step 1)', is highlighted. The right side of the interface has a toolbar with buttons for New, Edit, View, Copy, Delete, and Undo/Redo. A status bar at the bottom indicates '102371 items' and '1 item selected'.

The screenshot shows the SimaPro software interface with the 'Input/output' tab selected. The 'Products' section lists 'Penintangan Brick Baru (Step 1)' with an amount of 1 kg, allocated 100% to the 'Brick Refractory' category. The 'Inputs' section shows energy from hydro power at 0,0013122 kWh. The 'Outputs' section lists various emissions and waste flows, including Emissions to air, Emissions to water, Emissions to soil, Final waste flows, Non material emissions, Social issues, and Economic issues. The right side of the interface has a toolbar with buttons for Documentation, Input/output, Parameters, and System description. A status bar at the bottom indicates '102371 items' and '1 item selected'.



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CAUsers\Public\Documents\Simapro\Database\Professional\_LCA Brick Refractory - [Edit processing process 'Penambangan Brick Baru (Step 2)']

File Edit Calculate Tools Window Help

Documentation Input/output Parameters System description

**Products**

Outputs to technosphere: Products and co-products	Amount	Unit	Quantity	Allocation %	Category	Comment
Penambangan Brick Baru (Step 2)	1	kg	Mass	100 %	Brick Refractory	
Add						
Outputs to technosphere: Avoided products	Amount	Unit	Distribution	SD2 or 25D	Min	Max
Add						

**Inputs**

Inputs from nature	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Water, lake		0,14355	l	Undefined				
Energy, from hydro power		0,00388	kWh	Undefined				
Add								
Inputs from technosphere: materials/fuels		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Add								
Inputs from technosphere: electricity/heat		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Add								

**Outputs**

Emissions to air	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Emissions to water		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Emissions to soil		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Final waste flows		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Non material emissions		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Social issues		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Economic issues		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment

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CAUsers\Public\Documents\Simapro\Database\Professional\_LCA Brick Refractory - [Edit processing process 'Pengangkutan Brick Bekas Chipping (Converter-TPS)']

File Edit Calculate Tools Window Help

Documentation Input/output Parameters System description

**Products**

Outputs to technosphere: Products and co-products	Amount	Unit	Quantity	Allocation %	Category	Comment
Pengangkutan Brick Bekas Chipping (Converter-TPS)	0,07068957	kg	Mass	100 %	Brick Refractory	
Add						
Outputs to technosphere: Avoided products	Amount	Unit	Distribution	SD2 or 25D	Min	Max
Add						

**Inputs**

Inputs from nature	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Energy, from oil		0,004933865	MJ	Undefined				
Add								
Inputs from technosphere: materials/fuels		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Add								
Inputs from technosphere: electricity/heat		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Add								

**Outputs**

Emissions to air	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Carbon dioxide, fossil		0,000080599	kg	Undefined				
Methane		4,91388E-8	kg	Undefined				
Dinitrogen monoxide		2,96032E-8	kg	Undefined				
Add								
Emissions to water		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Add								
Emissions to soil		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Add								
Final waste flows		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Add								
Non material emissions		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Add								
Social issues		Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Add								

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Two screenshots of the SimaPro software interface showing LCA results for two processes:

**Top Screenshot: Pengangkutan Brick Bekas Chipping (TPS-PPU)**

Category	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Outputs to technosphere: Products and co-products	Pengangkutan Brick Bekas Chipping (TPS-PPU)	0,46367511	kg	Mass	100 %	Brick Refractory		
Outputs to technosphere: Avoided products	Add							
Inputs from nature	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Energy, from oil	Add	82,3442	MJ	Undefined				
Inputs from technosphere: materials/fuels	Add							
Inputs from technosphere: electricity/heat	Add							
Emissions to air	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Carbon dioxide	Add	6,101707919	kg	Undefined				
Methane	Add	0,000023442	kg	Undefined				
Dinitrogen monoxide	Add	4,94065E-5	kg	Undefined				
Emissions to water	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Emissions to soil	Add							
Final waste flows	Add							
Non material emissions	Add							
Social issues	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment

**Bottom Screenshot: Pengangkutan Brick Sisa Potongan (Converter-Slag Pot)**

Category	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Outputs to technosphere: Products and co-products	Pengangkutan Brick Sisa Potongan (Converter-Slag Pot)	0,047953243	kg	Mass	100 %	Brick Refractory		
Outputs to technosphere: Avoided products	Add							
Inputs from nature	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Energy, from oil	Add	0,017131474	MJ	Undefined				
Inputs from technosphere: materials/fuels	Add							
Inputs from technosphere: electricity/heat	Add							
Emissions to air	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Carbon dioxide	Add	0,001289442	kg	Undefined				
Methane	Add	1,71315E-7	kg	Undefined				
Dinitrogen monoxide	Add	1,027799E-8	kg	Undefined				
Emissions to water	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment
Emissions to soil	Add							
Final waste flows	Add							
Non material emissions	Add							
Social issues	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Min	Max	Comment



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CAUsers\Public\Documents\Simapro\Database\Professional\_LCA\_Brick Refractory - [Edit processing process 'Penambatan Brick Sisa Potongan']

File Edit Calculate Tools Window Help

Documentation Input/output Parameters System description

**Products**

Outputs to technosphere: Products and co-products	Amount	Unit	Quantity	Allocation %	Category	Comment	
Penambatan Brick Sisa Potongan	1,161986-5	kg	Mass	100 %	Brick Refractory		
Add							
Outputs to technosphere: Avoided products	Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add							

**Inputs**

Inputs from nature	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Water, lake		0,02478973	l	Undefined				
Energy, from hydro power		0,001062417	kWh	Undefined				
Add								
Inputs from technosphere: materials/fuels		Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add								
Inputs from technosphere: electricity/heat		Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add								

**Outputs**

Emissions to air	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add								
Emissions to water	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add								
Emissions to soil	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add								
Final waste flows	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add								
Non material emissions	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add								
Social issues	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add								
Economic issues	Sub-compartment	Amount	Unit	Distribution	SD2 or 25D	Mins	Max	Comment
Add								

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File Edit Calculate Tools Window Help

Home Search Project LCA

**Wizards**

- Product stages
- Assembly
- Other
- Life cycle
- Disposal scenario
- Decomposition
- Reuse

**Product stages**

Name	Project	Status
LCA Brick Refractory (Scenario-1)	LCA Brick Refractory	None
LCA Brick Refractory (Scenario-2)	LCA Brick Refractory	None

New Edit View Copy Delete Used by Show as list

Filter on: And Or Clear 2 items 1 item selected

FILTERS

2 items 1 item selected

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Three screenshots of a software application window titled "LCA Brick Refractory - [Edit assembly] LCA Brick Refractory Scenario-01". The window displays a table of materials and processes used in the scenario.

**Table Data (Scenario-01):**

Name	Status	Comment					
LCA Brick Refractory (Scenario-01)	None						
Materials/Assemblies	Amount	Unit	Distribution	ID2 or ZID	Mn	Mai	Comment
Processes	Amount	Unit	Distribution	ID2 or ZID	Mn	Mai	Comment

**Process Data (Scenario-01):**

Pembongkaran Brick Baru (Step 1)	1	kg	Undefined				
Pembongkaran Brick Baru (Step 2)	1	kg	Undefined				
Penganggulatan Brick Bata Chipping (Cinnereter-TPS)	0.1184342	kg	Undefined				
Penganggulatan Brick Bata Chipping (TPS-PPU)	0.1184342	kg	Undefined				

**Table Data (Scenario-02):**

Name	Status	Comment					
LCA Brick Refractory (Scenario-02)	None						
Materials/Assemblies	Amount	Unit	Distribution	ID2 or ZID	Mn	Mai	Comment
Processes	Amount	Unit	Distribution	ID2 or ZID	Mn	Mai	Comment

**Process Data (Scenario-02):**

Pembongkaran Brick Baru (Step 1)	1	kg	Undefined				
Pembongkaran Brick Baru (Step 2)	1	kg	Undefined				
Penganggulatan Brick Bata Chipping (Cinnereter-TPS)	0.470488937	kg	Undefined				
Penganggulatan Brick Bata Chipping (TPS-PPU)	0.470488937	kg	Undefined				
Penganggulatan Brisa Sisa Potongan (Cinnereter-Slag Put)	0.047935243	kg	Undefined				
Pemanfaatan Brisa Sisa Potongan	3.16786E-5	kg	Undefined				



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S:\Client\Public\Documents\Simapro\Database\Professional\_LCA\_Brick\_Refactory - [LCA Explorer]

The screenshot shows the LCA Explorer interface. On the left is a navigation tree with categories like Wizards, Product design, Impact assessment, and Interpretation. The main area displays a table of scenarios:

Name	Project	Status
LCA Brick Refactory (Scenario-1)	LCA Brick Refactory	New
LCA Brick Refactory (Scenario-2)	LCA Brick Refactory	New

A context menu is open over the second scenario, listing options: New, Edit, View, Copy, Delete, and Undo by. A "Show as list" button is also visible.

S:\Client\Public\Documents\Simapro\Database\Professional\_LCA\_Brick\_Refactory - [New calculation setup]

This screenshot shows the 'New calculation setup' dialog. It includes fields for Name and Comment, and a 'Calculation function' section with radio buttons for Network, Tree, Analyse, and Compare. The 'Compare' option is selected. Below this is a 'Method' section with a table:

Product	Amount	Unit	Project	Comment
LCA Brick Refactory (Scenario-1)	1	t	LCA Brick Refactory	
LCA Brick Refactory (Scenario-2)	1	t	LCA Brick Refactory	

Below the table are sections for 'Current library' (Softe) and 'Replacing library' (Softe). At the bottom are checkboxes for 'Exclude infrastructure processes' and 'Exclude long-term emissions'. Buttons for Help, Calculate, and Close are at the bottom right.



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S:\Users\Public\Documents\Simapro\Database\Professional\_LCA\_Brick\_Refactory - [New calculation setup]

File Edit Calculate Tools Window Help

General Analysis groups Chart options

Name: Select a method and a normalization/weighting set

Comment:

Calculation function: Network, Tree, Analyze, Compare

Method: CML-IA baseline V3.05 / EU25

Product: LCA Brick Refactory (Scenario-1), LCA Brick Refactory (Scenario-2)

Current library:

Replacing library:

Switches: Exclude infrastructure processes, Exclude long-term emissions

Methods (European):

Name	Version	Project
CML-IA baseline	3.05	Methods
CML-IA non-baseline	3.04	Methods
Ecological Scarcity 2013	1.06	Methods
EPD 2003	1.07	Methods
EF Method (adapted)	1.00	Methods
Environmental Prices	1.00	Methods
EPD (2018)	1.00	Methods
EPS 2015d	1.00	Methods
EPS 2015dx	1.00	Methods
ILCD 2011 Midpoint+	1.10	Methods
IMPACT 2002+	2.15	Methods

Normalization/Weighting: EU25

EU25: the Netherlands, 1997, West Europe, 1995

CML-IA is a LCA methodology developed by the Center of Environmental Science (CML) of Leiden University in The Netherlands.

This method is an update of the CML 2 baseline 2000 and corresponds to the files published by CML in August 2016 (version 4.7). The CML 2 baseline 2000 version can be found in the 'superseded' list. For most impact categories, substances have been added and removed and/or characterisation factors were updated, according to new scientific insights. Only the impact category Photochemical oxidation did undergo any changes.

79 items | 1 item selected

Help Calculate Close

FPL ITSM 001

S:\Users\Public\Documents\Simapro\Database\Professional\_LCA\_Brick\_Refactory - [New calculation setup]

File Edit Calculate Tools Window Help

General Analysis groups Chart options

Name: FPL ITSM 001

Comment:

Calculation function: Network, Tree, Analyze, Compare

Method: CML-IA baseline V3.05 / EU25

Product: LCA Brick Refactory (Scenario-1), LCA Brick Refactory (Scenario-2)

Current library:

Replacing library:

Switches: Exclude infrastructure processes, Exclude long-term emissions

Amount Unit Project Comment

1 kg LCA Brick Refactory

1 kg LCA Brick Refactory

Switches: Sulfur, Sulfur

Calculate Close

FPL ITSM 001

9.3.0.3 Faculty

Q Search



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The screenshot shows the SimaPro software interface. A 'Status' dialog box is open in the center, displaying 'Calculating' and a progress bar at 95%. Below the progress bar, it says 'Updating windows'. A 'Cancel' button is visible in the bottom right corner of the dialog.

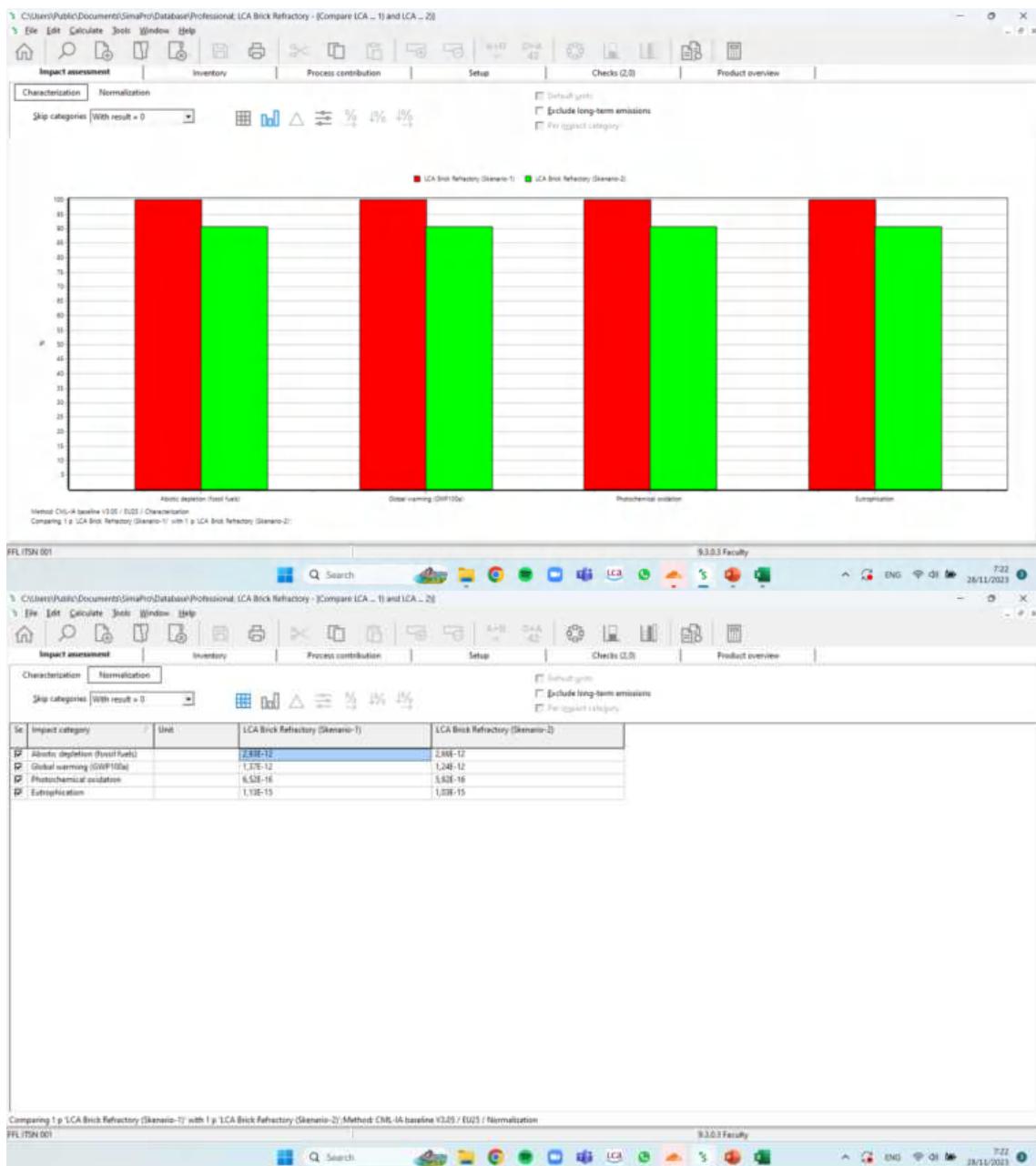
The main window displays a comparison between two LCA scenarios. The table has two columns: 'LCA Brick Refactory (Scenario-1)' and 'LCA Brick Refactory (Scenario-2)'. The rows represent different impact categories:

Impact category	Unit	LCA Brick Refactory (Scenario-1)	LCA Brick Refactory (Scenario-2)
Aerosol deposition (fossil fuels)	Mt	8E-1	8E-1
Global warming (GWP100a)	kg CO <sub>2</sub> eq	8,88	6,23
Photochemical oxidation	kg C <sub>2</sub> H <sub>6</sub> eq	5,52E-6	5,02E-6
Eutrophication	kg P(PO <sub>4</sub> ) <sub>2</sub> eq	1,49E-5	1,23E-5

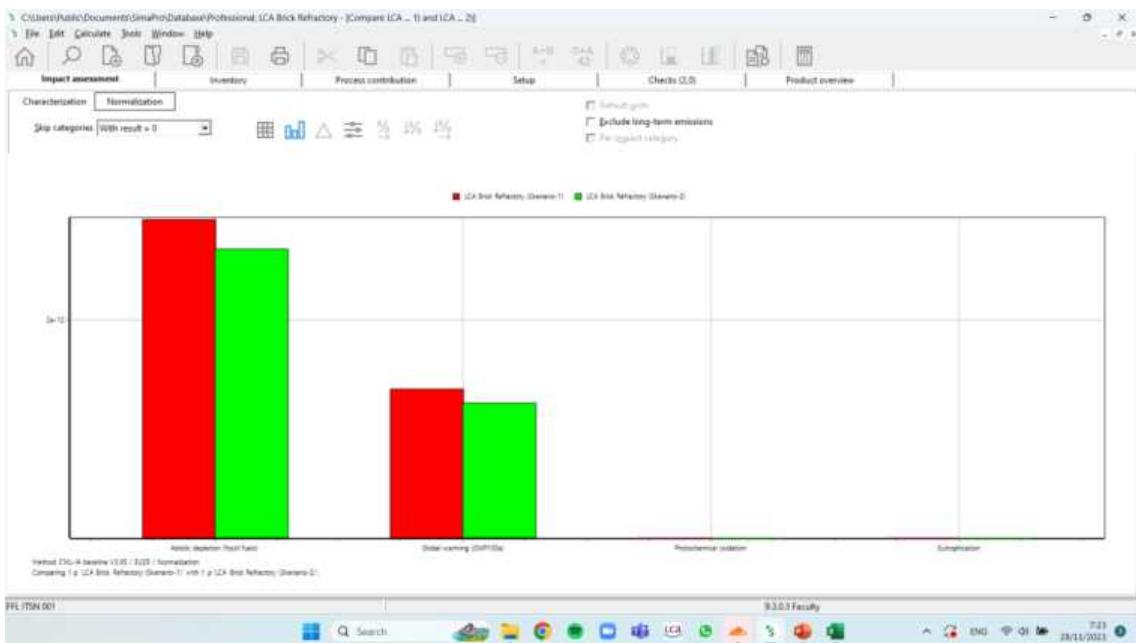
At the bottom of the main window, a message reads: 'Comparing 1 p LCA Brick Refactory (Scenario-1) with 1 p LCA Brick Refactory (Scenario-2). Method: CML-IA baseline V3.09 / EU23 / Characterization'.



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**Lampiran 2** Tahapan penggunaan kembali brick bekas sisa potongan pada ladle penampung converter matte



### Lampiran 3 Izin Penelitian



**KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET DAN TEKNOLOGI**  
**UNIVERSITAS HASANUDDIN**  
**FAKULTAS TEKNIK**  
**PROGRAM STUDI S2 TEKNIK LINGKUNGAN**  
 Jl. Poros Malino Km. 6, Bontomarannu (92172) Gowa, Sulawesi Selatan,  
 Telp. (0411) 586015, 586262 Fax (0411) 586015,  
<http://eng.unhas.ac.id> Email : teknik@unhas.ac.id

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Nomor: 530/UN4.7.7/PT.01.04/2023

6 Januari 2023

Hal : Permohonan Izin Penelitian / Pengambilan Data

Kepada Yth.  
PT Vale Indonesia Tbk

Dengan hormat, kami sampaikan bahwa dalam rangka penyelesaian proposal pada Program Studi S2 Teknik Lingkungan Fakultas Teknik Universitas Hasanuddin, maka kami mohon kebijaksanaan Bapak/Ibu kiranya berkenan memberikan kesempatan melakukan pengambilan data penelitian bagi mahasiswa :

Nama (NIM) : Fauziah Nur Aisyah (D092211006)

Atas perhatian dan kerjasama yang baik kami sampaikan terima kasih.

Ketua Program Studi S2 Teknik Lingkungan,



Dr. Roslinda Ibrahim, S.P., M.T.  
NIP. 197506232015042001

Tembusan :

1. Ketua Program Studi S2 Teknik Lingkungan FT-UH
2. Arsip

