Decision support system (DSS)

Andreas Ciroth
GreenDelta
GCSM conference
Berlin, 25 September 2013

Agenda

- ProSuite: Goals, introduction
- A new sustainability assessment framework
- Decision support tool
- Towards standardisation?

Project PROSUITE

Goals, introduction

GreenDelta

Project PROSUITE

Development and application of a standardized methodology for the PROspective SUstaInability assessment of TEchnologies

GreenDelta

In a nutshell…

- Tools that are applicable in a generic way to assess all aspects of sustainability of future technologies
- A new integrative framework addressing five major impact categories:
  - Human health
  - Social well-being
  - Prosperity
  - Natural Environment
  - Exhaustible resources
- Integration through normalisation and use of MCA-tools
- The PROSUITE open source decision support system

In a nutshell…

- Economic deliverables
  - Hybrid LCA model for modelling full scale adoption of a technology
  - Standardized Cost Estimation for New Technologies (SCENT)
- Environmental deliverables
  - PROSUITE methodology (midpoint and endpoint)
  - Improvement of selected characterisation models (metals, nanoparticle exposure) and assessment of uncertainties in existing models
- Social deliverables

  Participatory approaches for selecting impacts and categorize them into
  - Safety, security and tranquility;
  - Autonomy;
  - Participation and influence
  - Equal opportunities

PROSUITE case studies

Four case studies for testing and demonstrating the methodology on emergent technologies

- Biorefineries and organic waste
- Nano technologies
- Carbon capture and Storage
- Multifunctional mobile devices

Consortium

1	Utrecht University (UU), Department of Science, Technology and Society / Copernicus Institute
2	Norwegian University of Science and Technology (NTNU)
3	Technical University of Denmark (DTU)
4	Dialogik
5	Ecological Economics and Management Centre - Foundation of the Faculty of Sciences and Technology, New University of Lisbon (UNL)
6	Swiss Federal Institute of Technology Zurich (ETH)
7	Institut Symlog (SYMLOG)
8	Finnish Environment Institute (SYKE)
10	Gent University (UG)
10	International Institute for Applied Systems Analysis (IIASA)
11	Hungarian Academy of Sciences Institute of Sociology (Magyar Tudományos Akadémia, MTA)

12	Universitat Autònoma de Barcelona (UAB)
13	Pré Consultancy (PRE)
14	GreenDelta (GD)
15	FORTH
16	Solvay
17	Organic Waste Systems (OWS)
18	Nokia
19	HeiQ Materials AG (HeiQ)
20	Paul Scherrer Institute (PSI)
21	Sony Ericsson
22	DSM
23	Radboud University Nijmegen (RU)
24	Hybrid Plastics™

About us

GreenDelta is an independent capital company founded 2004 in Berlin by Andreas Ciroth; our work focusses on sustainability research, consulting, and software development for sustainability.

- Life Cycle Assessment
- Life Cycle Costing
- Social Life Cycle Assessment
  - Case studies
  - Method development (social LCA; uncertainties; aligning different LCA approaches)
  - Training
  - Reviews
  - …

GreenDelta

About us

GreenDelta is an independent capital company founded 2004 in Berlin by Andreas Ciroth; our work focusses on sustainability research, consulting, and software development for sustainability.

- **Web-based software & desktop software**
- **Enterprise solutions, SME, open source solutions**
  - openLCA
  - E-DEA
  - BEST
  - Nexus
  - …

GreenDelta

prosuite

Web page

www.prosuite.org

Updated regularly

GREENDELTA

PROSUITE Final conference

Brussels,
30 October 2013

- Sign up to receive an invitation

A new sustainability assessment framework

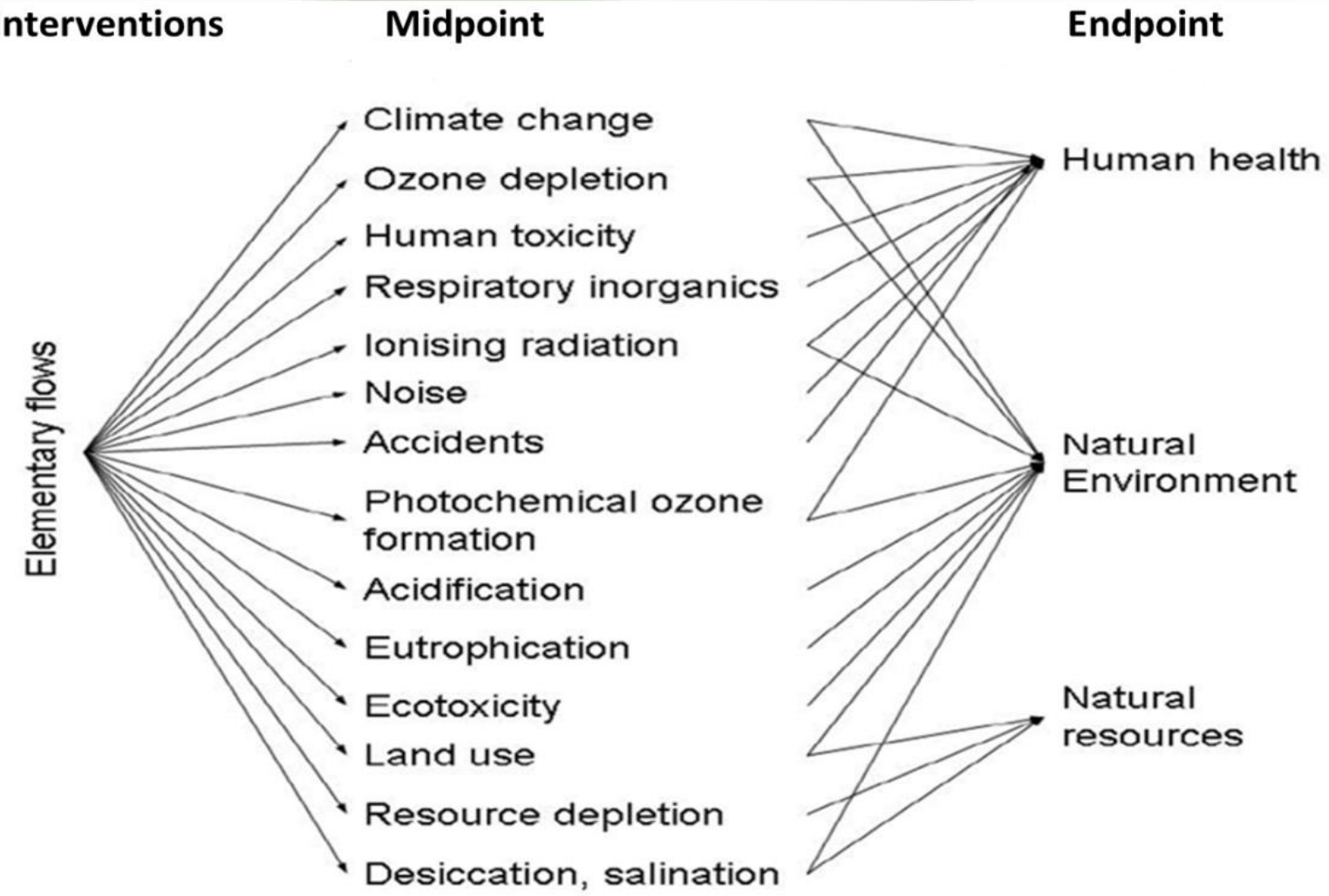
GreenDelta

Problem definition

- Conventional methodologies for sustainability assessment:
  - Often too specific for certain products
  - Not applicable to wide range of technologies
  - No clear aggregation of various impacts

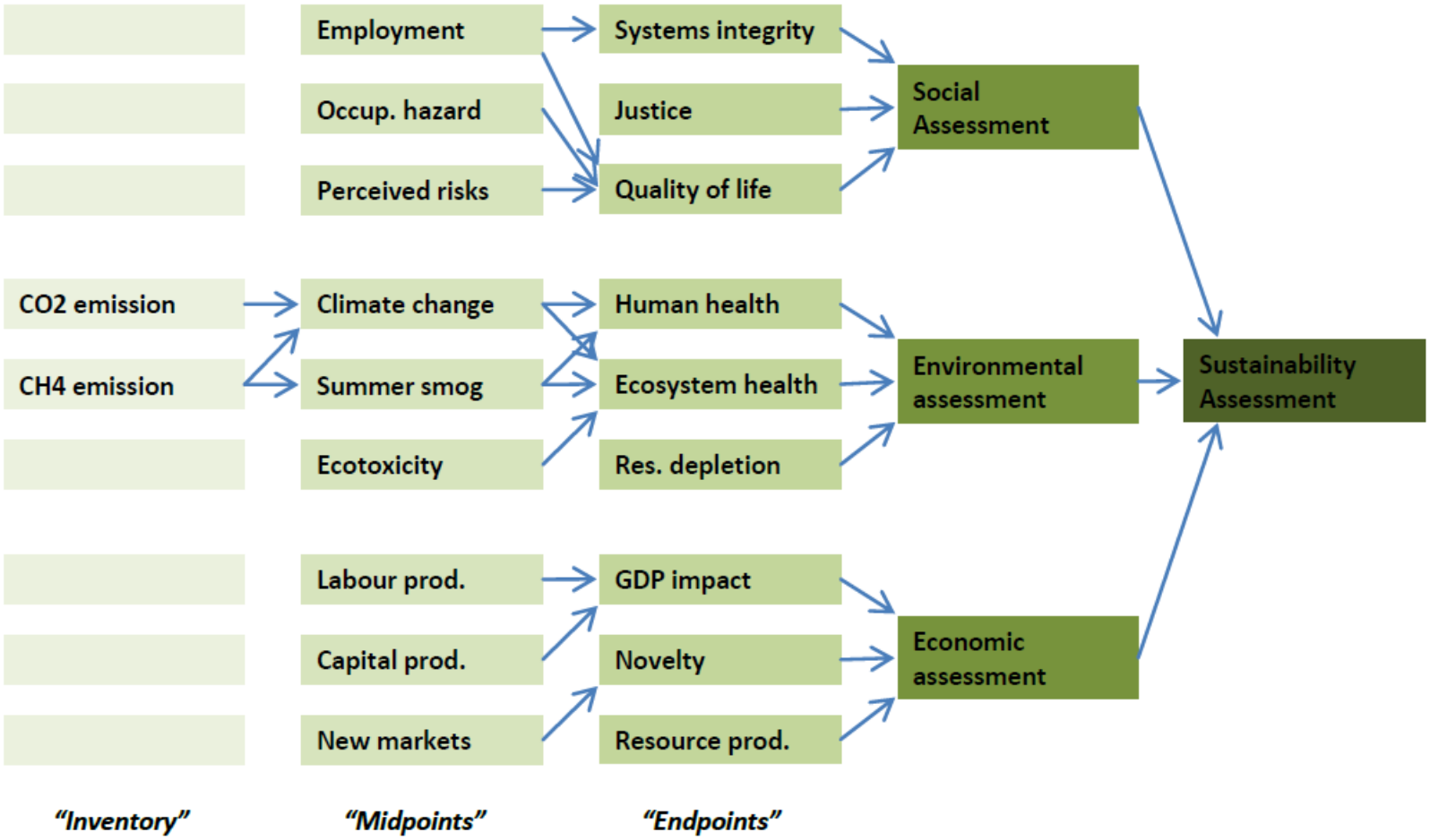
- There is a need for sustainability assessment method that:
  - Covers all dimensions of sustainability in a comprehensive way
  - Is applicable to a wide range of technologies
  - Pursues a rigorous assessment along the cause-effect chain to ultimate scores

Impact assessment in environmental LCA



European Commission, 2010

Initial approach in Prosuite



Problems with initial approach

- There are overlaps:
  - Social impacts (quality of life) could include health (env) and income (econ)
  - If an external cost approach were applied, all impacts are economic
- Health impacts from environmental interventions considered part of environmental pillar, but occupational health part of social pillar

New approach within Prosuite

- 5 Endpoints:
  - Impact on human health
  - Impact on social well-being
  - Impact on prosperity
  - Impact on natural environment
  - Impact on exhaustible resources

Mostly present generation

Mostly future generations

GREENDELTA

Impact on human health

prosuite

inventory data | *midpoints* | *endpoint*

Toxic exposures → Impact on consumption related human health → Impact on human health (DALYs)

- # Non-fatal accidents at work
- # Fatal accidents at work
- # Occupational diseases
- # Accidents ending with death/inability to work

→ Impact on occupational human health → Impact on human health (DALYs)

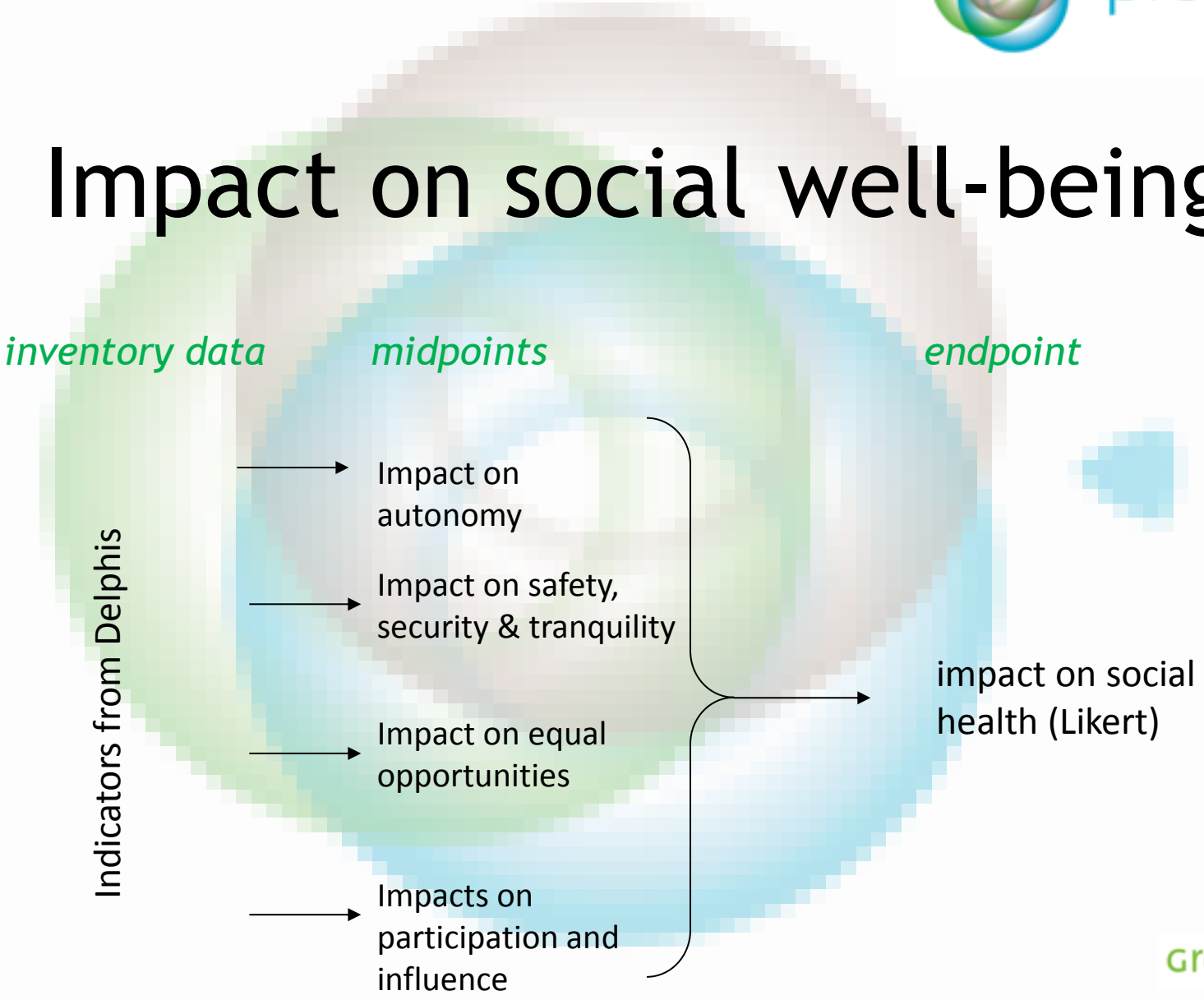
Elementary environmental flows →

- Climate change
- Ozone depletion
- Human toxicity
- Respiratory organics
- Ionising radiation
- Photochemical ozone formation

→ Impact on environmental human health → Impact on human health (DALYs)

GreenDeLTa

Impact on social well-being

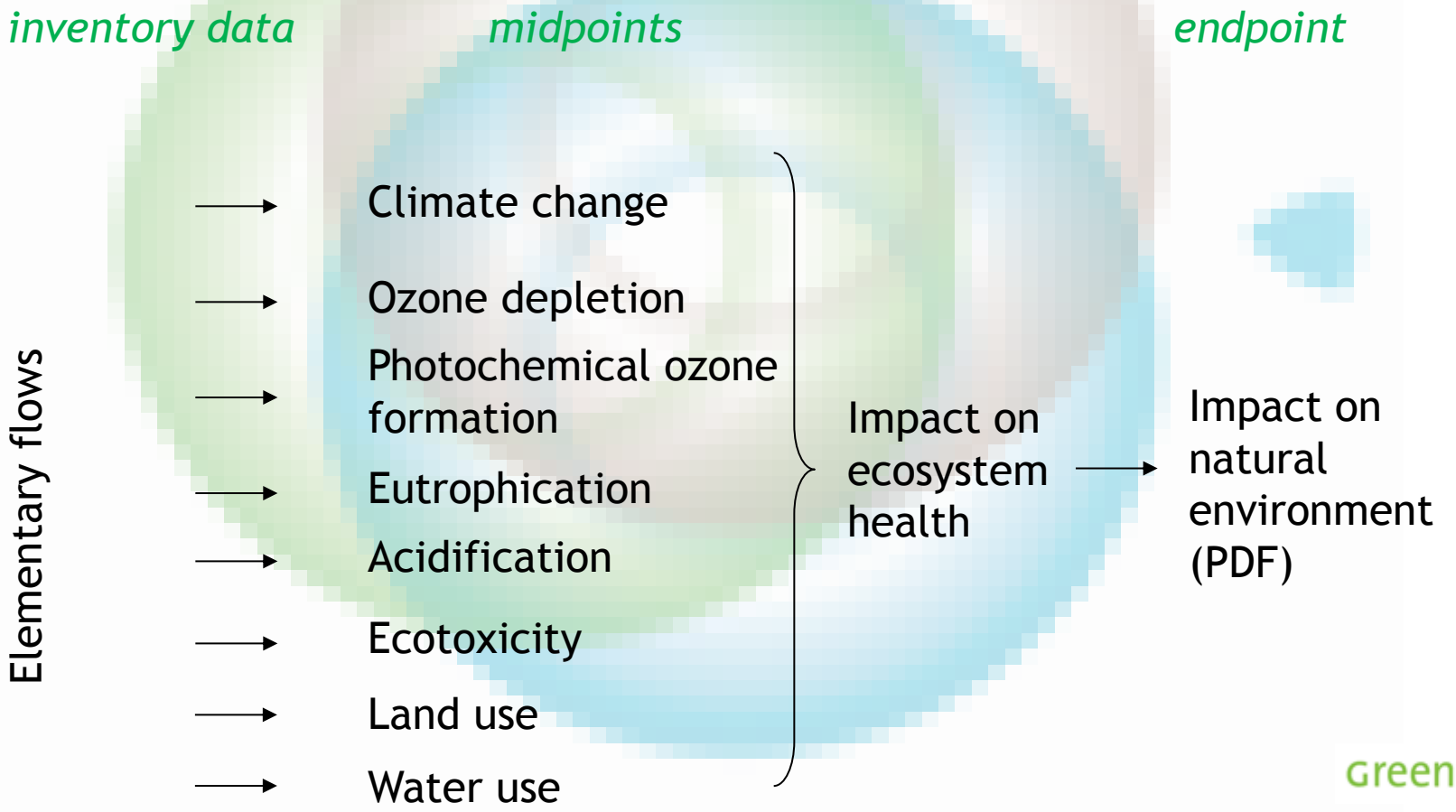


Social indicators

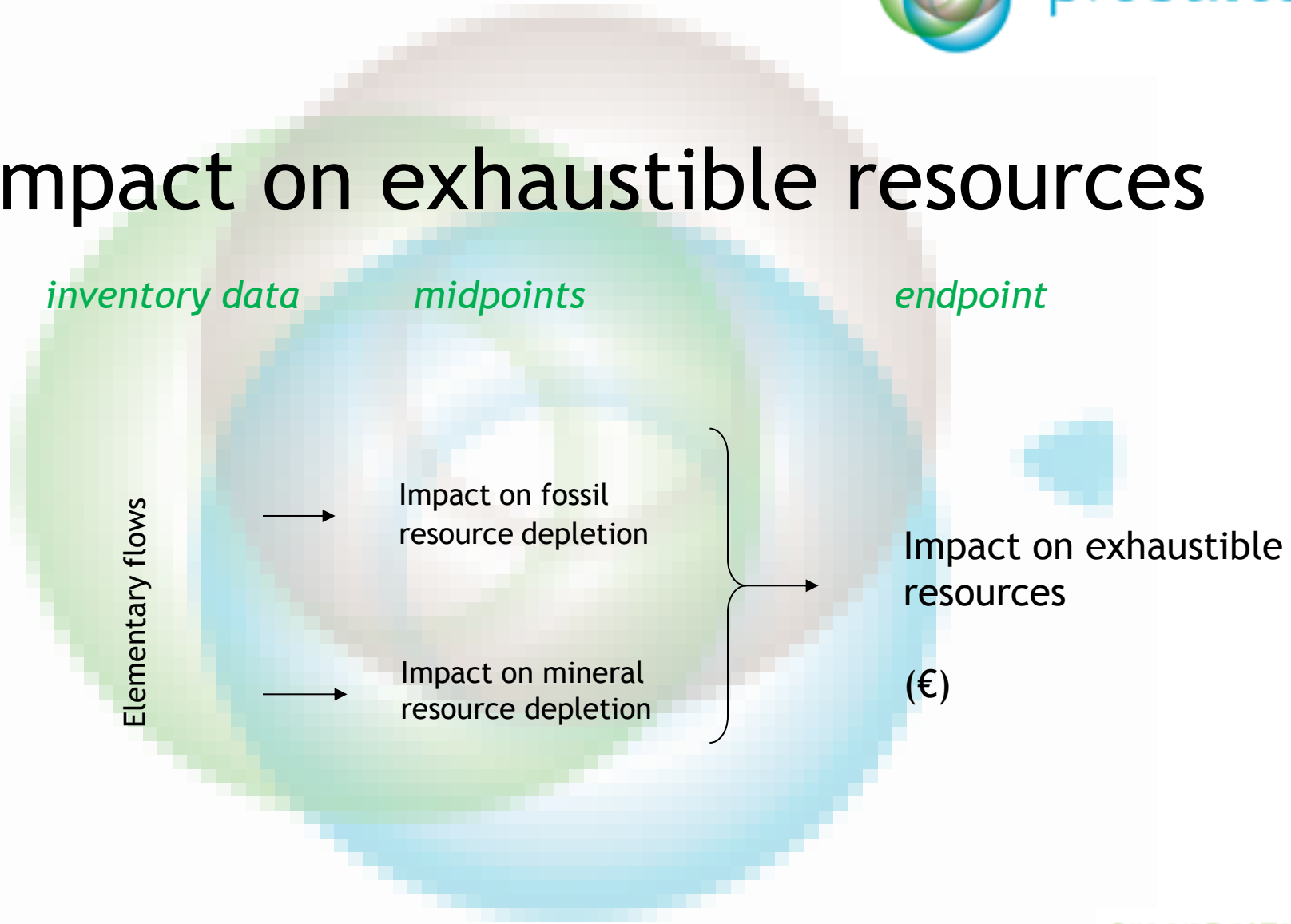
- **Safety, security and tranquility**
  - Knowledge-intensive jobs
  - Total employment
  - Risk perception
  - Possibility of misuse
- **Autonomy**
  - Child labour
  - Forced labour
- **Participation and influence**
  - Trust in risk information
  - Stakeholder involvement
  - Long-term control functions
- **Equal opportunities**
  - Regional income inequalities
  - Global income inequalities

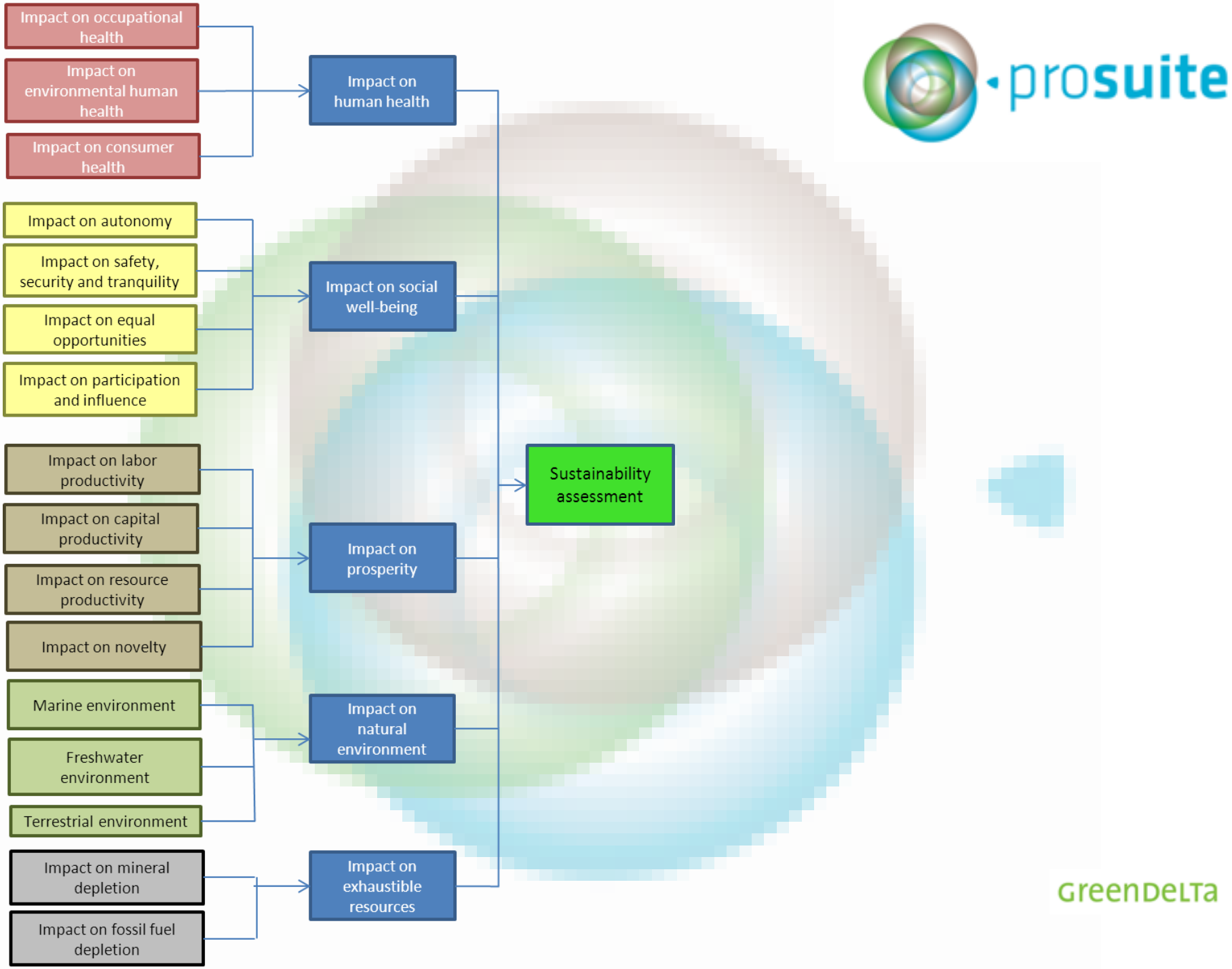
Impact on prosperity

Impact on natural environment



Impact on exhaustible resources




Impact on occupational health
Impact on environmental human health
Impact on consumer health
Impact on human health
Impact on autonomy
Impact on safety, security and tranquility
Impact on equal opportunities
Impact on participation and influence
Impact on social well-being
Impact on labor productivity
Impact on capital productivity
Impact on resource productivity
Impact on novelty
Impact on prosperity
Marine environment
Freshwater environment
Terrestrial environment
Impact on natural environment
Impact on mineral depletion
Impact on fossil fuel depletion
Impact on exhaustible resources
Sustainability assessment
prosuite
GREENDELTA

Overall sustainability assessment

- Assessment across all impact categories is needed.
- Various approaches available:
  - No aggregation, leave as it is
  - Multicriteria analysis, results shown as hierarchy
  - Aggregate into one single score

Conclusions

- A framework is proposed that covers all dimensions of sustainability
- For all impact categories, an assessment is possible on a life-cycle basis and across the full cause-effect chain
- The impact categories follow the McKinsey ‘MECE’ principle: Mutually Exclusive, Collectively Exhaustive (Friga, 2008)

Main challenges for LCSA (1)

- Development of indicators for the social assessment
- Define a quantitative metric for these indicators
- Determine how to aggregate them into one value for the end-point indicator ‘social well-being’

Main challenges for LCSA (2)

- How to integrate/interpret the endpoint indicators across the environmental, economic and social domain?
  - Aggregation into one value (yes/no)?
  - Multi-criteria analysis
  - Other…?

Decision Support Tool

prosuite

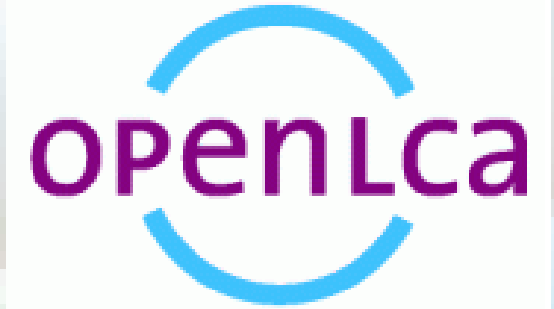
GreenDelta

Decision Support System

- Modular software consisting of a framework and set of tools for scenario analyses and technology assessment
- Implementation of PROSUITE methods in openLCA
  - Specific plugins
  - Improvement of the overall architecture of openLCA
- Freely available, as open source software

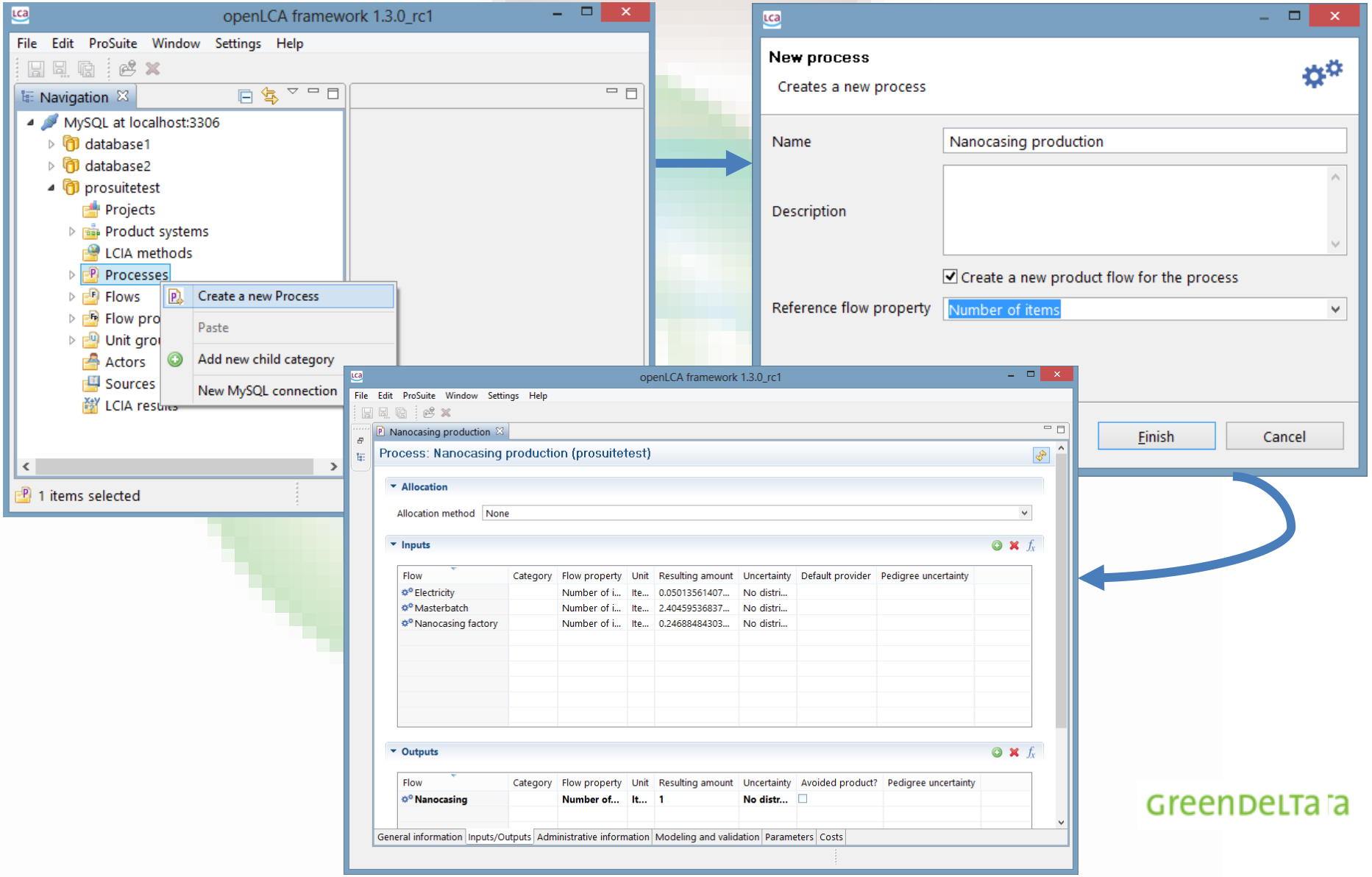
GreenDelta

openLCA as a basis: a professional, open source LCA software

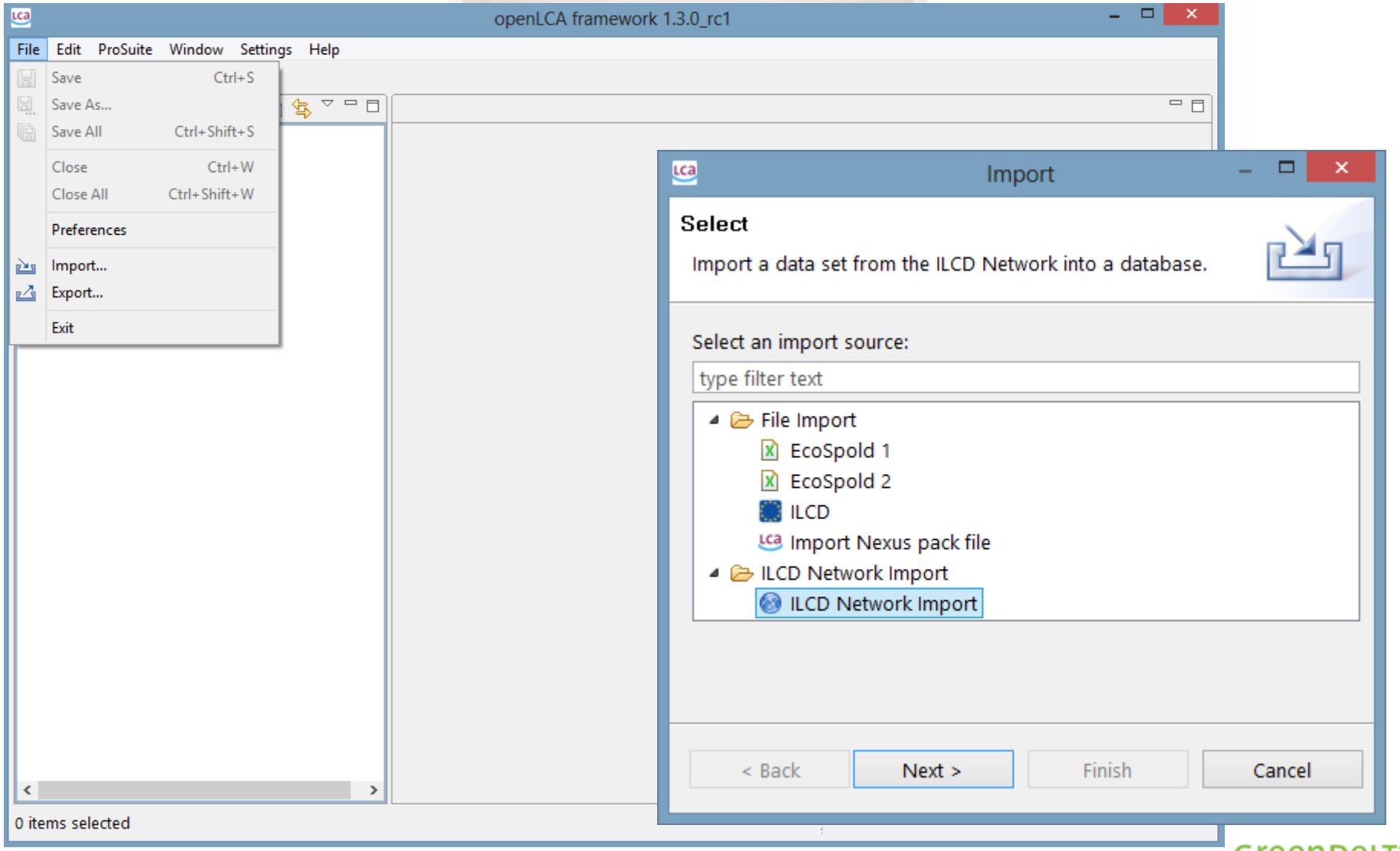


GreenDelta

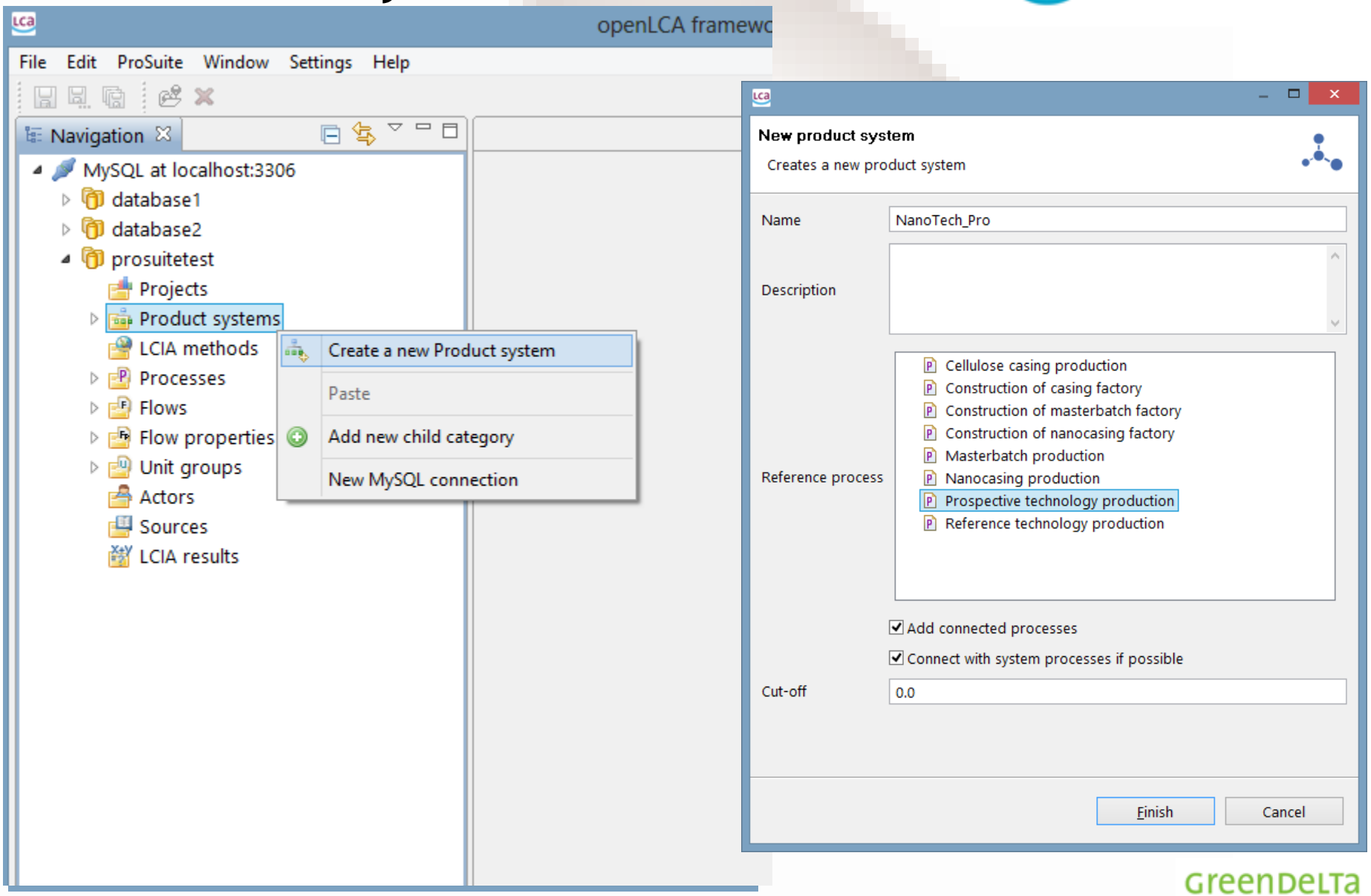
– Process creation



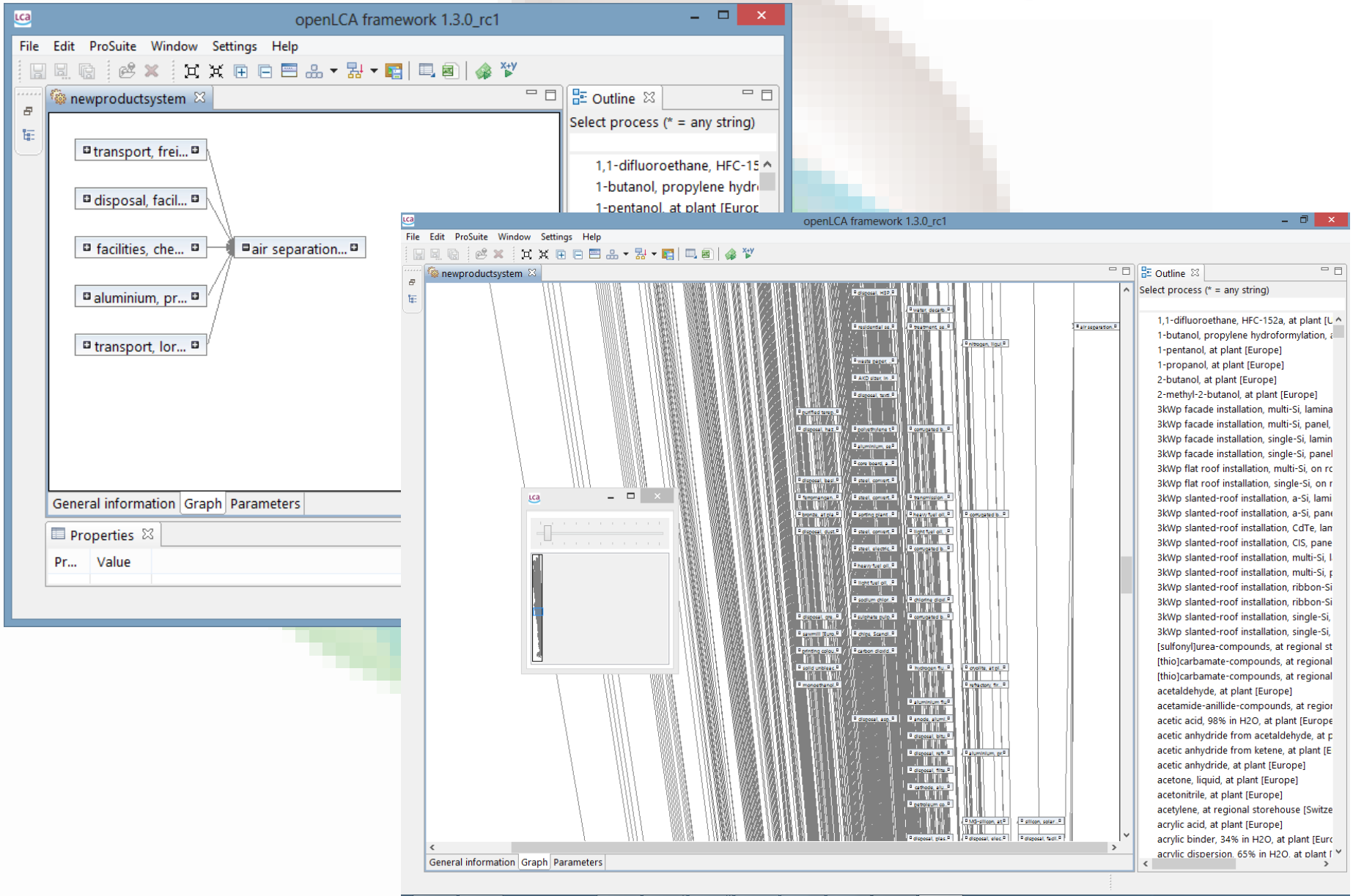
– Data import/export



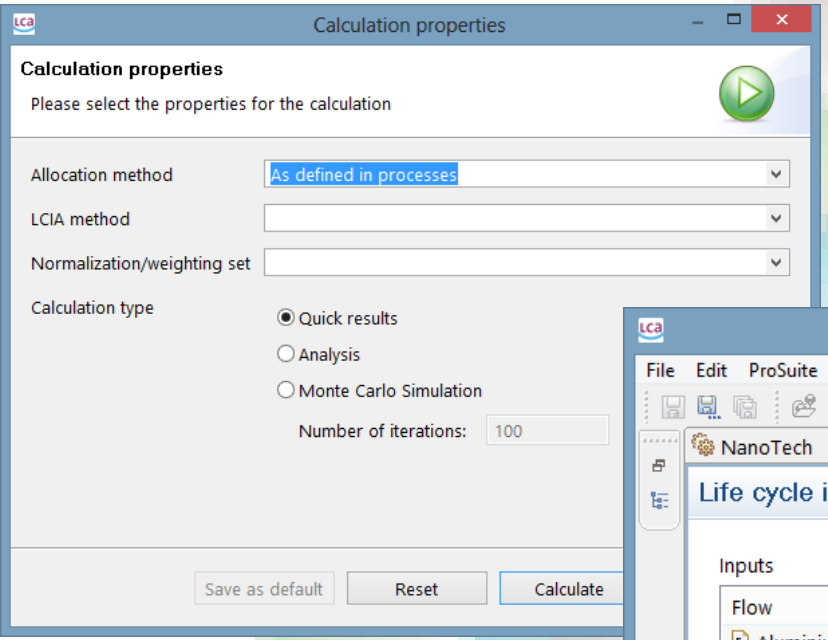
– Product systems

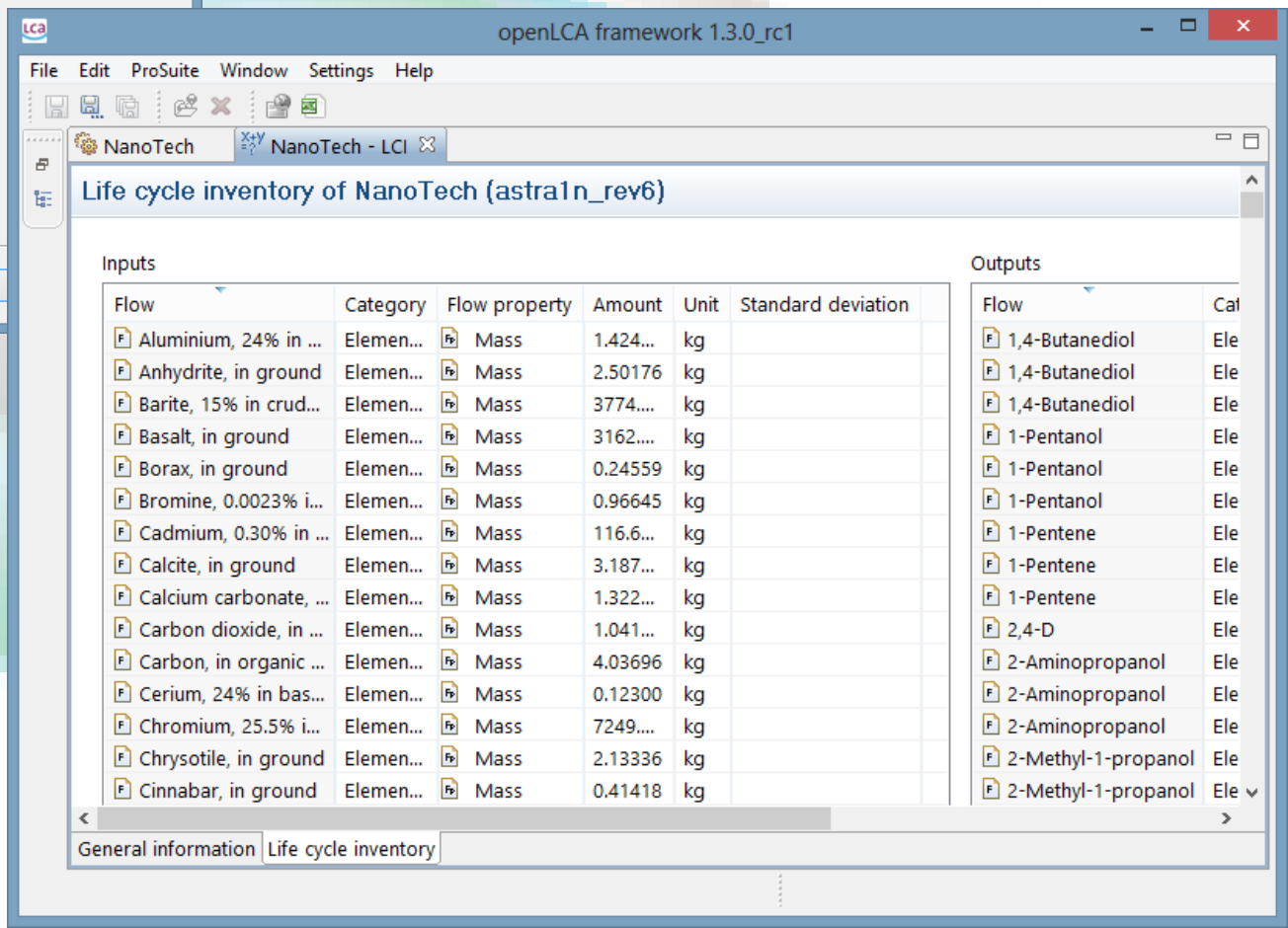


– System view

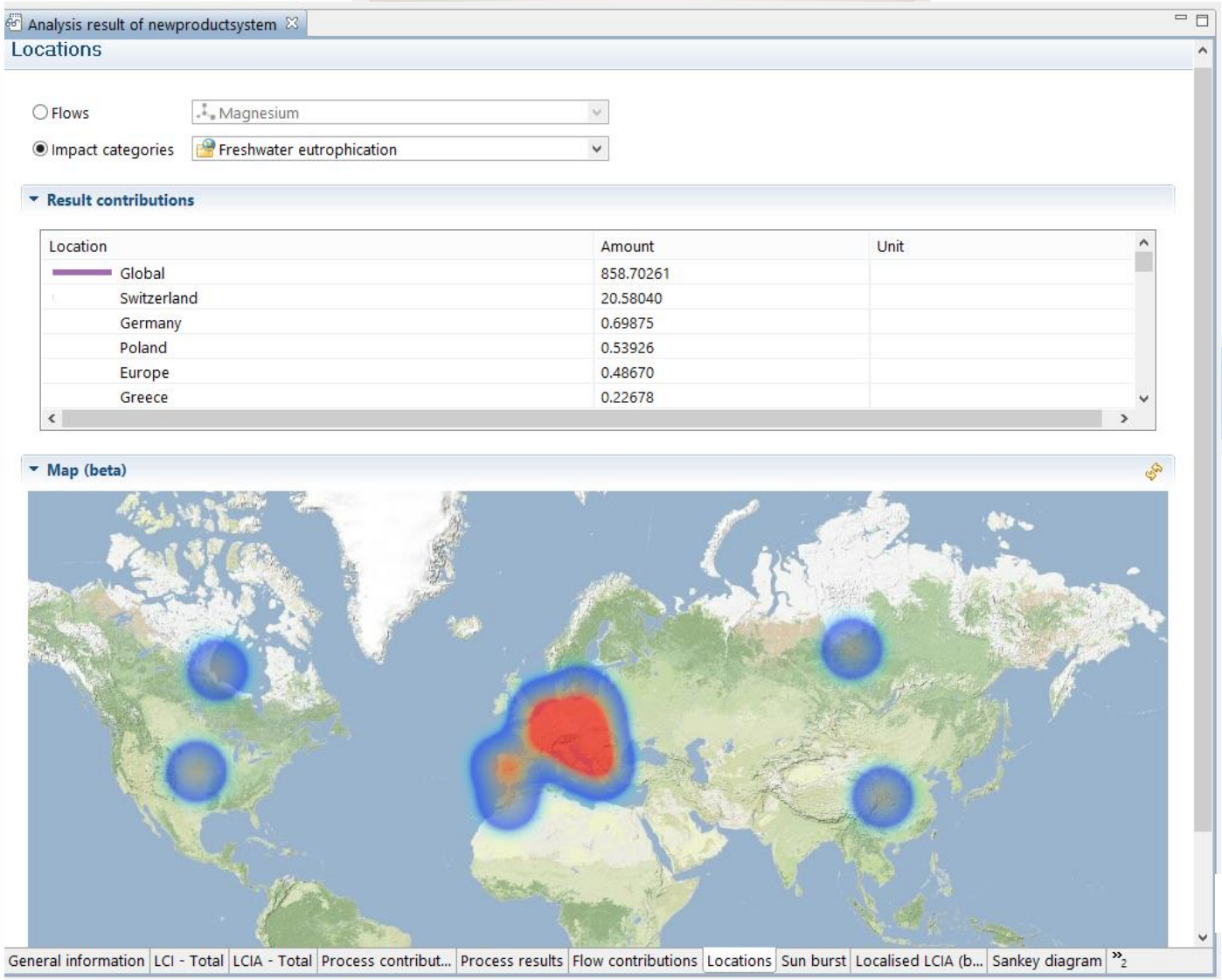

openLCA framework 1.3.0_rc1
File Edit ProSuite Window Settings Help
newproductsystem
transport, frei...
disposal, facil...
facilities, che...
aluminium, pr...
transport, lor...
air separation...
General information Graph Parameters
Properties
Pr... Value
Outline
Select process (* = any string)
1,1-difluoroethane, HFC-15
1-butanol, propylene hydr
1-pentanol, at plant [Euro
openLCA framework 1.3.0_rc1
File Edit ProSuite Window Settings Help
newproductsystem
Outline
Select process (* = any string)
1,1-difluoroethane, HFC-152a, at plant [U
1-butanol, propylene hydroformylation,
1-pentanol, at plant [Europe]
1-propanol, at plant [Europe]
2-butanol, at plant [Europe]
2-methyl-2-butanol, at plant [Europe]
3kWp facade installation, multi-Si, lamina
3kWp facade installation, multi-Si, panel,
3kWp facade installation, single-Si, lamin
3kWp facade installation, single-Si, panel
3kWp flat roof installation, multi-Si, on rc
3kWp flat roof installation, single-Si, on r
3kWp slanted-roof installation, a-Si, lami
3kWp slanted-roof installation, a-Si, pane
3kWp slanted-roof installation, CdTe, lam
3kWp slanted-roof installation, CIS, pane
3kWp slanted-roof installation, multi-Si, l
3kWp slanted-roof installation, multi-Si, p
3kWp slanted-roof installation, ribbon-Si
3kWp slanted-roof installation, ribbon-Si
3kWp slanted-roof installation, single-Si,
3kWp slanted-roof installation, single-Si,
[sulfonyl]urea-compounds, at regional st
[thio]carbamate-compounds, at regional
[thio]carbamate-compounds, at regional
acetaldehyde, at plant [Europe]
acetamide-anillide-compounds, at regio
acetic acid, 98% in H2O, at plant [Europe
acetic anhydride from acetaldehyde, at p
acetic anhydride from ketene, at plant [E
acetic anhydride, at plant [Europe]
acetone, liquid, at plant [Europe]
acetonitrile, at plant [Europe]
acetylene, at regional storehouse [Switze
acrylic acid, at plant [Europe]
acrylic binder, 34% in H2O, at plant [Eurc
acrylic dispersion, 65% in H2O, at plant
General information Graph Parameters

– LCI calculation



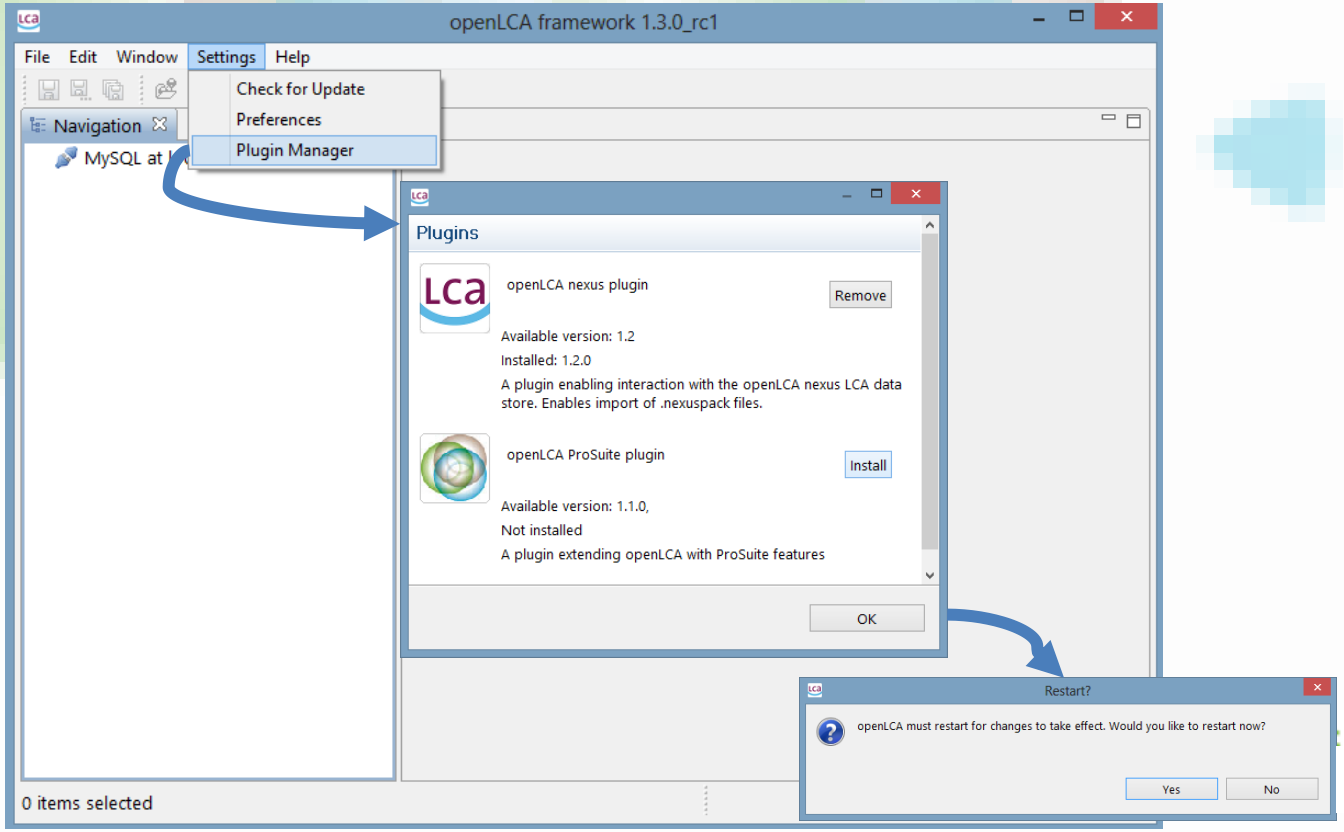


– Results analysis

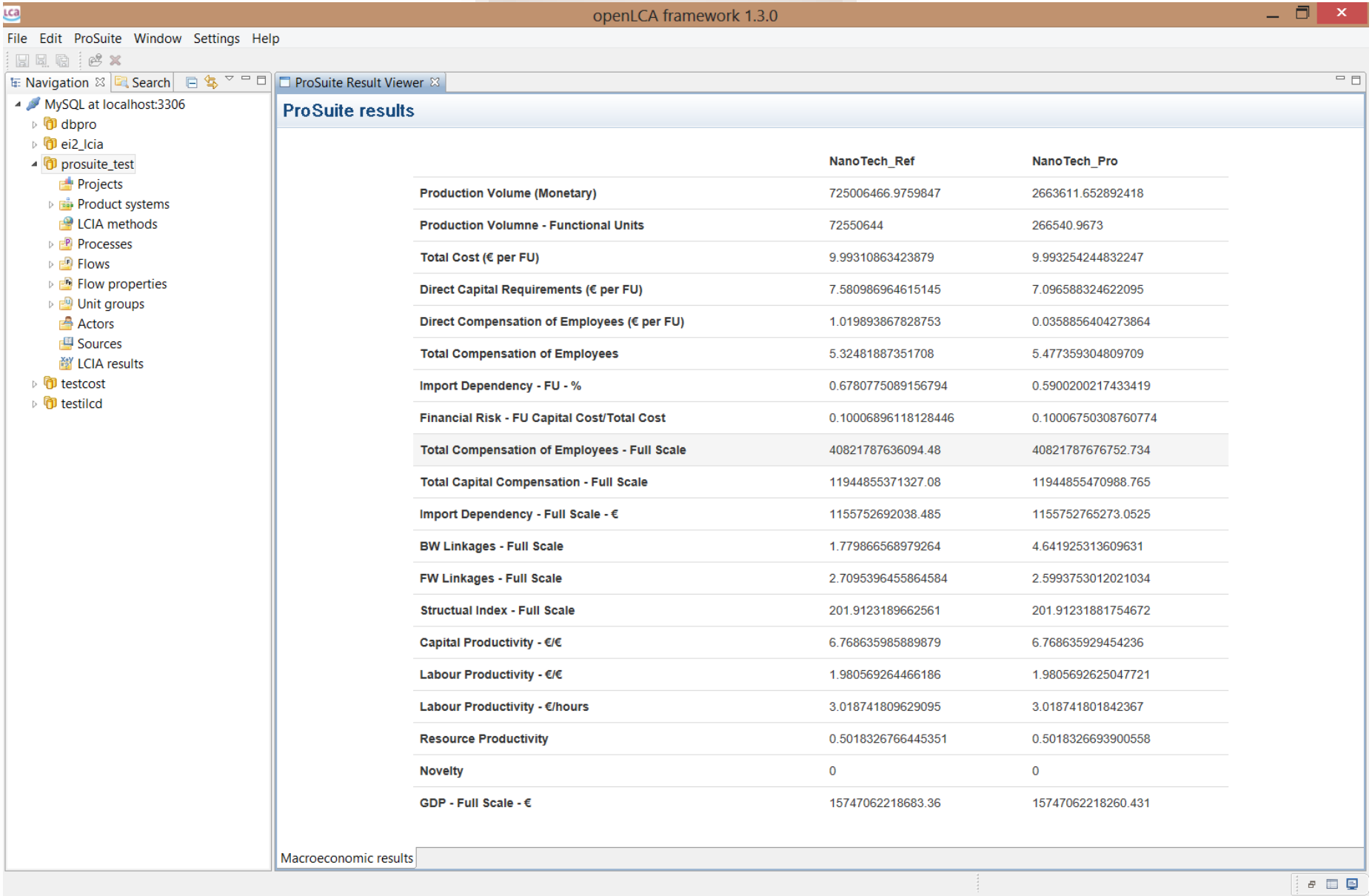


PROSUITE plugin

- A plugin-architecture and “framework” has been implemented in the DSS



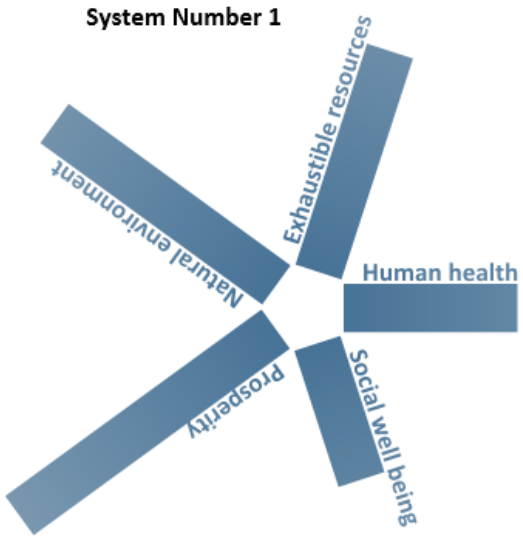
– Results of the macroeconomic module

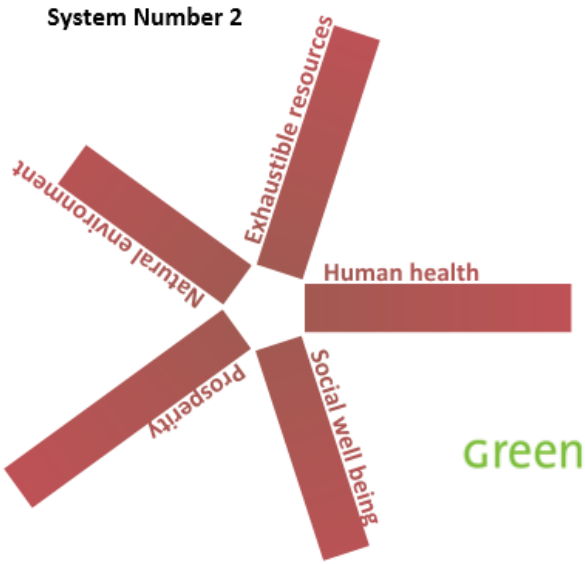


	NanoTech_Ref	NanoTech_Pro
Production Volume (Monetary)	725006466.9759847	2663611.652892418
Production Volumne - Functional Units	72550644	266540.9673
Total Cost (€ per FU)	9.99310863423879	9.993254244832247
Direct Capital Requirements (€ per FU)	7.580986964615145	7.096588324622095
Direct Compensation of Employees (€ per FU)	1.019893867828753	0.0358856404273864
Total Compensation of Employees	5.32481887351708	5.477359304809709
Import Dependency - FU - %	0.6780775089156794	0.5900200217433419
Financial Risk - FU Capital Cost/Total Cost	0.10006896118128446	0.10006750308760774
Total Compensation of Employees - Full Scale	40821787636094.48	40821787676752.734
Total Capital Compensation - Full Scale	11944855371327.08	11944855470988.765
Import Dependency - Full Scale - €	1155752692038.485	1155752765273.0525
BW Linkages - Full Scale	1.779866568979264	4.641925313609631
FW Linkages - Full Scale	2.7095396455864584	2.5993753012021034
Structual Index - Full Scale	201.9123189662561	201.91231881754672
Capital Productivity - €/€	6.768635985889879	6.768635929454236
Labour Productivity - €/€	1.980569264466186	1.9805692625047721
Labour Productivity - €/hours	3.018741809629095	3.018741801842367
Resource Productivity	0.5018326766445351	0.5018326693900558
Novelty	0	0
GDP - Full Scale - €	15747062218683.36	15747062218260.431

Sustainability assessment

- Input: results from the other modules
- Output→ Multi-Criteria tool:
  - Graphical display of alternatives performance for endpoint indicators





Multi-criteria tool

- Ranking of alternatives applying Condorcet decision rule
  - following a strong sustainability idea, the integration module will not compute a single score but keep the sustainability dimensions separate
- Sensitivity analysis results

Project PROSUITE

Towards standardisation?

Towards standardisation

- Candidates:
  - Sustainability framework..
  - ..or parts of it
  - Indicator sets
  - Approaches for data collection

  (in the context of life cycle sustainability assessment)
  - Approaches for data quality assurance

  (in the context of life cycle sustainability assessment)

Comments and feedback welcome!

Thank you for your attention

Contact: *Dr Andreas Ciroth*
GreenDelta GmbH
Müllerstrasse 135, D-13349 Berlin
ciroth@greendelta.com
www.greendelta.com

GreenDelta