PE Group - Life Cycle Engineering Services

Germany

USA

Canada

Japan

Life Cycle Engineering: Performing LCIA and Sensitivity Analysis Using GaBi 3

Sabrina Spatari
PE-Americas, LP
1-888-222-1451

Presentation Outline

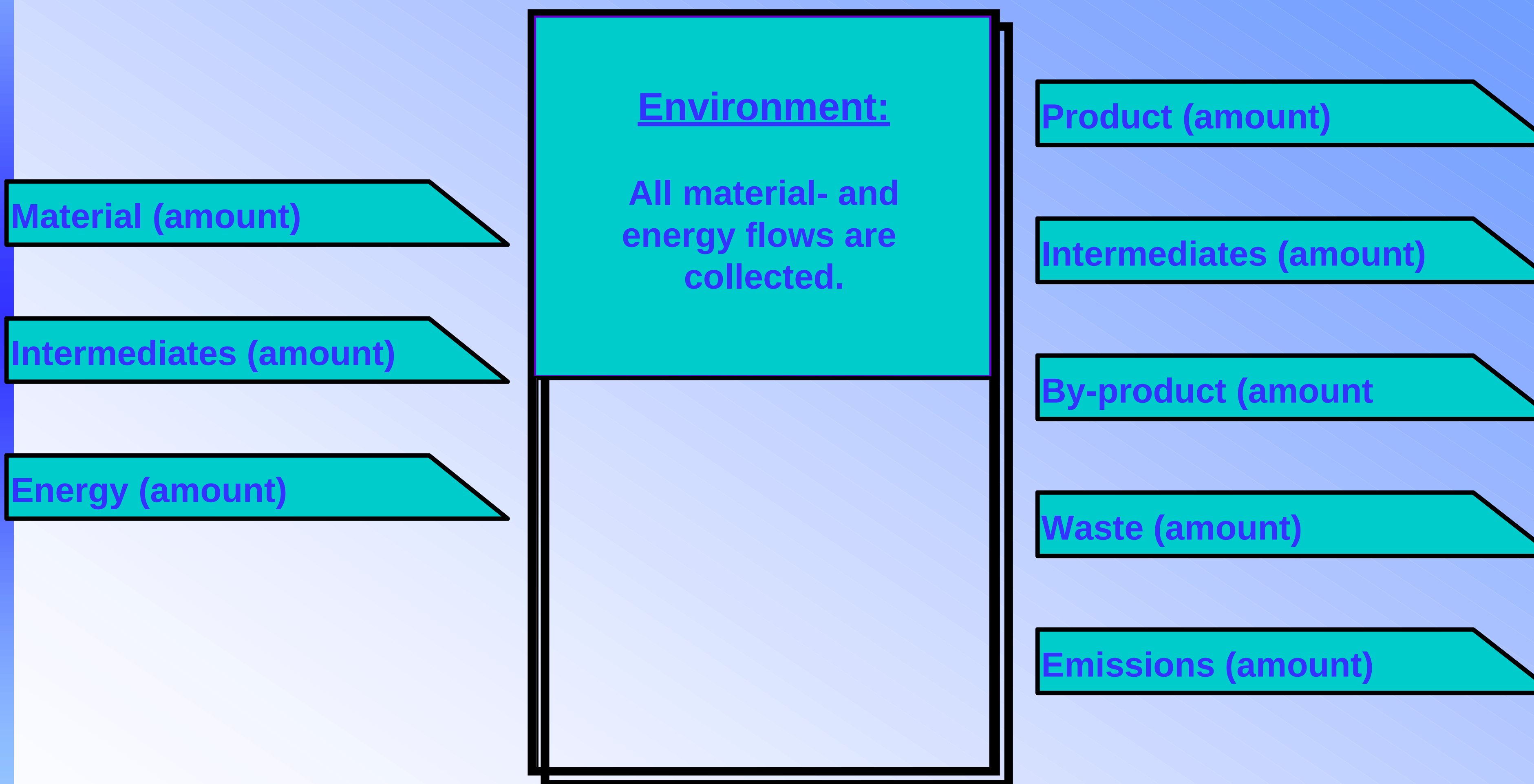
- LCA/LCE framework for Decision-making
- GaBi - LCA modeling Tool
- Modeling sensitivity and LCIA
- Examples: Automotive part
  kitchen appliance
- Discussion and Outlook

Why LCA ?

- Tool for highlighting environmental tradeoffs for:
  - product related decisions (i.e., Product A vs. Product B)
  - optimal material selection
  - most significant life cycle stages
  - product improvement

PE Group - Life Cycle Engineering Services

LCA - Environmental Data



Germany

USA

Canada

Japan

PE Group - Life Cycle Engineering Services

Germany

USA

Canada

Japan

LCE - Environmental and Economic Data

Inputs:

- Material (amount)
- Material (price)
- Intermediates (amount)
- Intermediates (price)
- Energy (amount)
- Energy (price)
- Working time (amount)
- Working time (price)
- Machines (amount)
- Machines (price)

Environment:

All material- and energy flows will be collected.

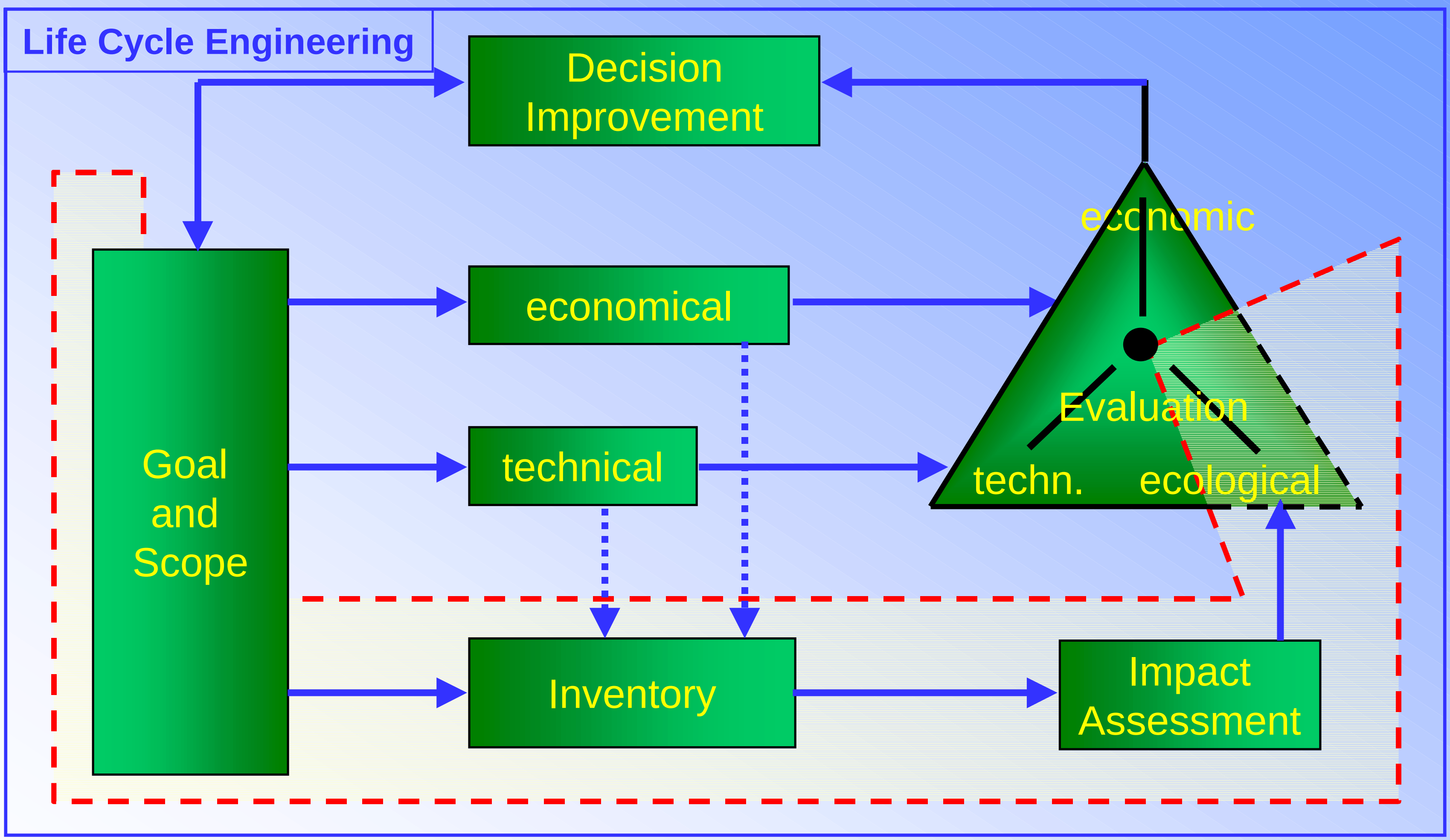
Economics:

All prices for energy and material flows. Mashines and working time are new input parameteres.

Outputs:

- Product (amount)
- Product (price)
- Intermediates (amount)
- Intermediates (price)
- By-product (amount)
- By-product (price)
- Waste (amount)
- Waste (price)
- Emissions (amount)
- Emissions (price)

LCE Framework



PE Group - Life Cycle Engineering Services

Germany

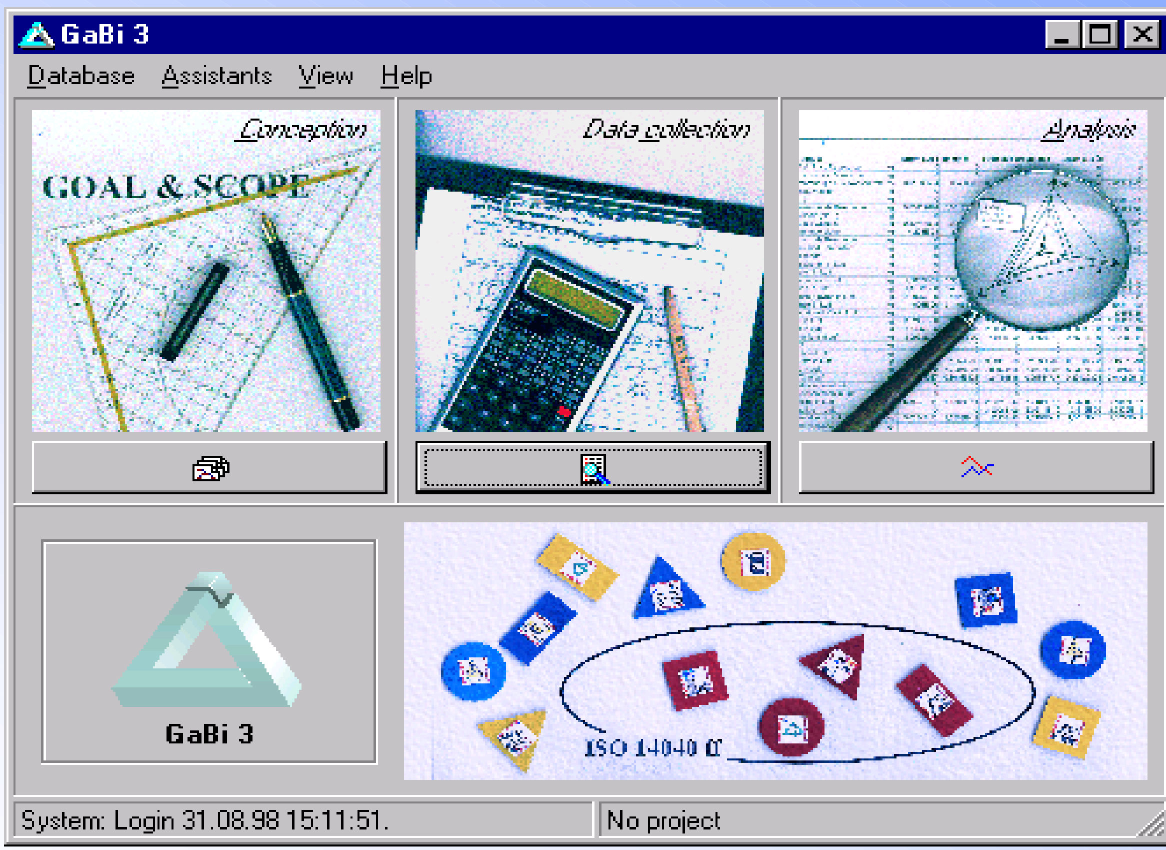
USA

Canada

Japan

GaBi 3 Software System for LCA / LCE

Starting screen, main working fields



- Optimum transparency
- Support for fully ISO compatible studies.
- Extensive, high quality LCI Database.
- Full Impact Assessment and Interpretation.
- Optimization Assessment for Products, Processes and Organizations.
- Inclusion of Cost Parameters.

PE Group - Life Cycle Engineering Services

Germany

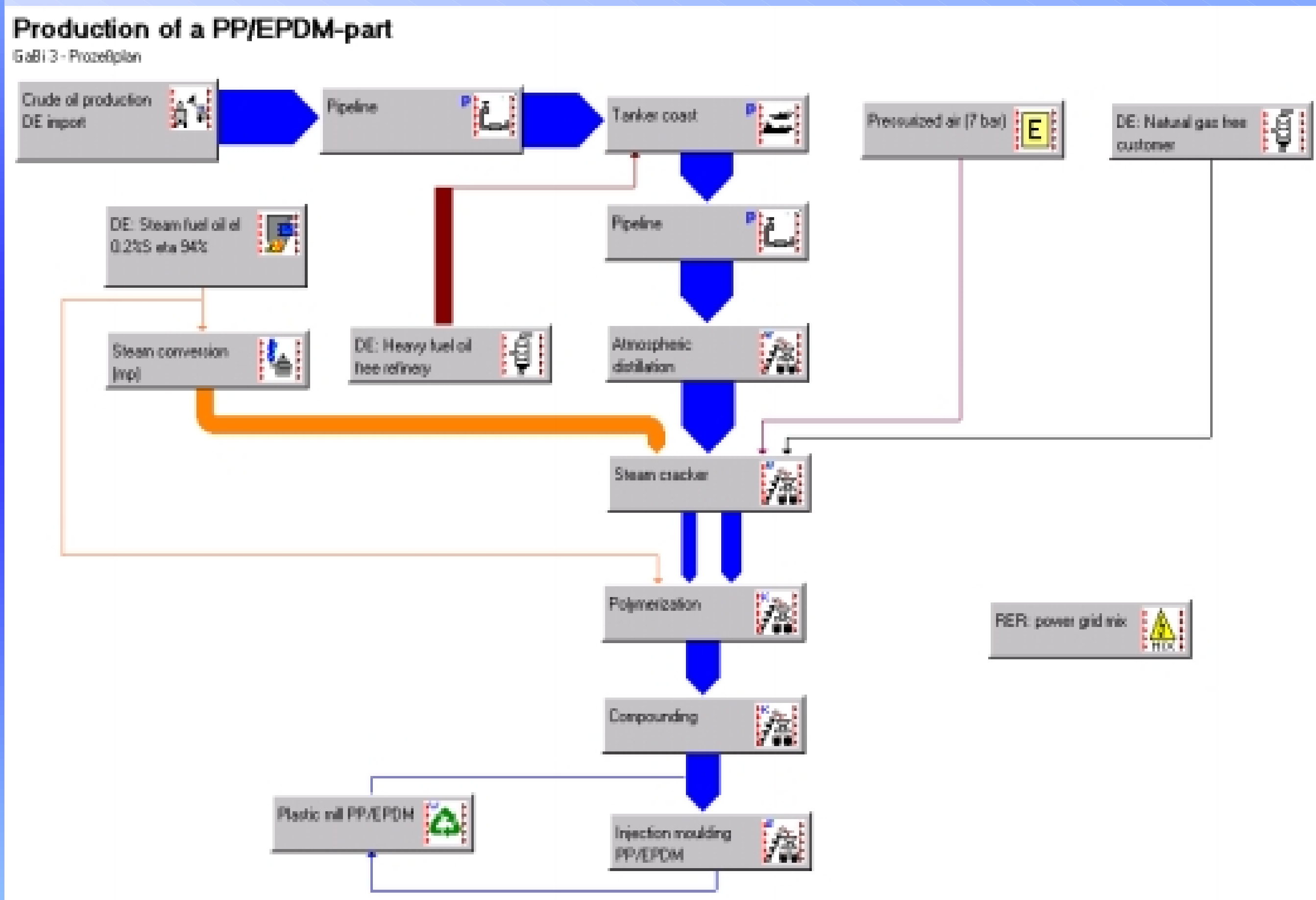
USA

Canada

Japan

GaBi 3 Software System - for LCA/LCE

Sankey-Diagram “Plan”-Editor



- Building up plans with “drag & drop” technique.
- Sankey Diagrams visualising relevant flows.
- Energy and Material Flow Network becomes visible.
- Transparent and reliable process tree modelling.
- Automated calculation of loops and actualization.
- Multi-layer plan hierarchy possible.

PE Group - Life Cycle Engineering Services

Germany

USA

Canada

Japan

Example: Automotive Part

- Battery housing design using secondary materials (polypropylene)
- Building the life cycle model
- Modeling sensitivity during product use

PE Group - Life Cycle Engineering Services

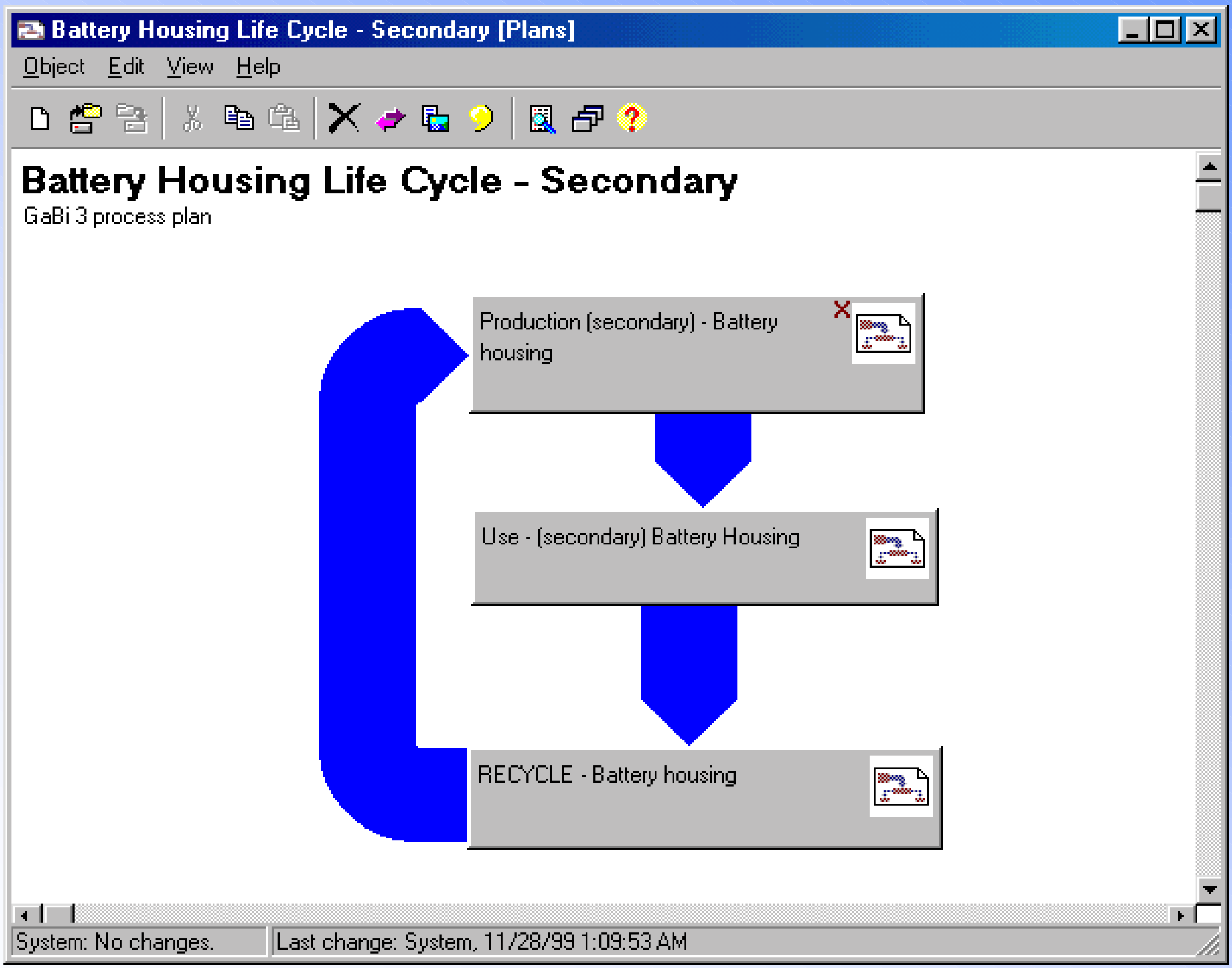
Germany

USA

Canada

Japan

Life Cycle Flow Diagram



PE Group - Life Cycle Engineering Services

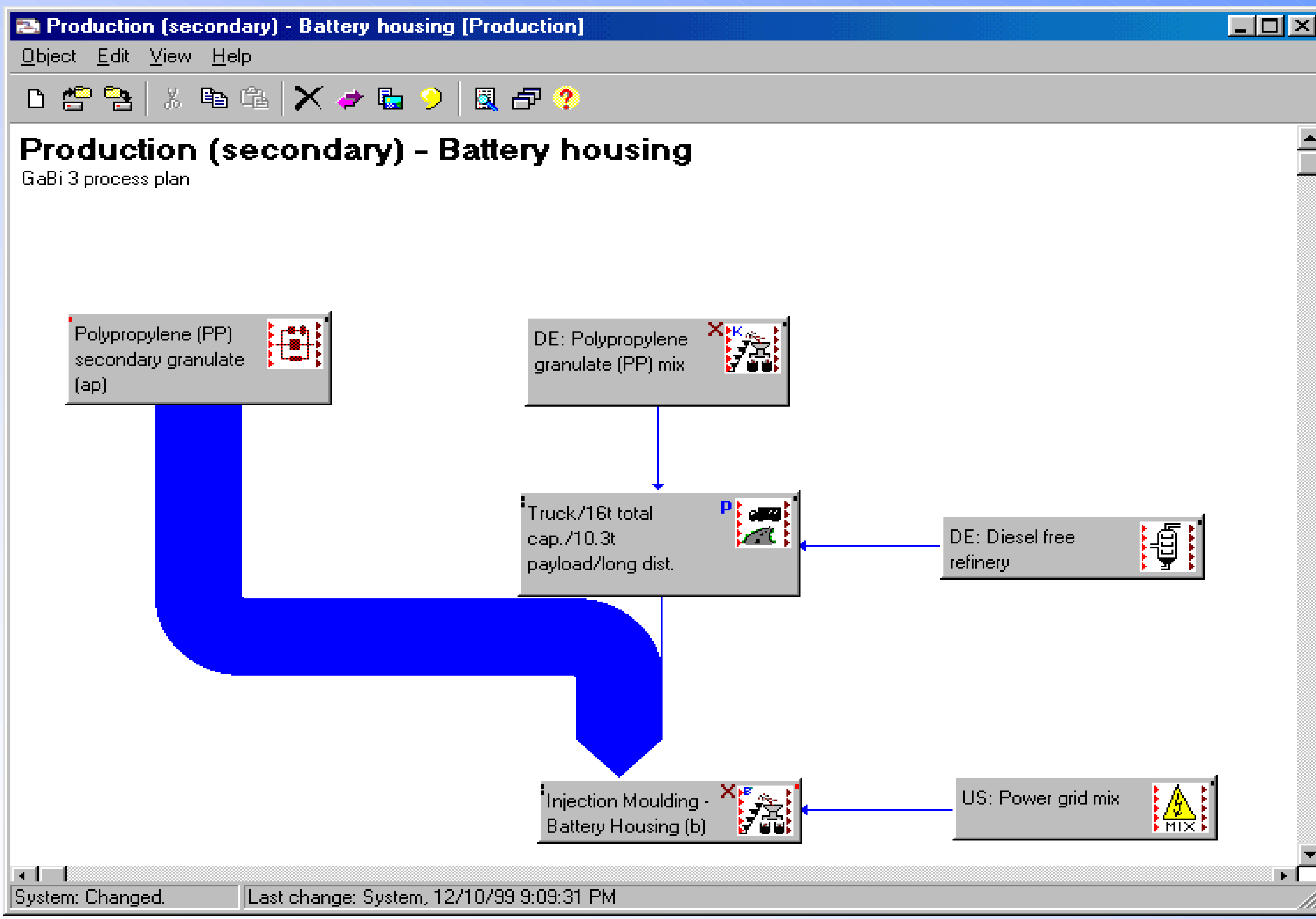
Germany

USA

Canada

Japan

Battery Housing - Production



PE Group - Life Cycle Engineering Services

Germany

USA

Canada

Japan

Example: Automotive Component

- Parameter Variation and Sensitivity Analysis during Vehicle Use
- Energy = $0.3 * \rho_{fuel} * \frac{(distance/100) * part\ mass}{100}$
- Vary fuel consumption correlation with mass between 0.2 and 0.4

PE Group - Life Cycle Engineering Services

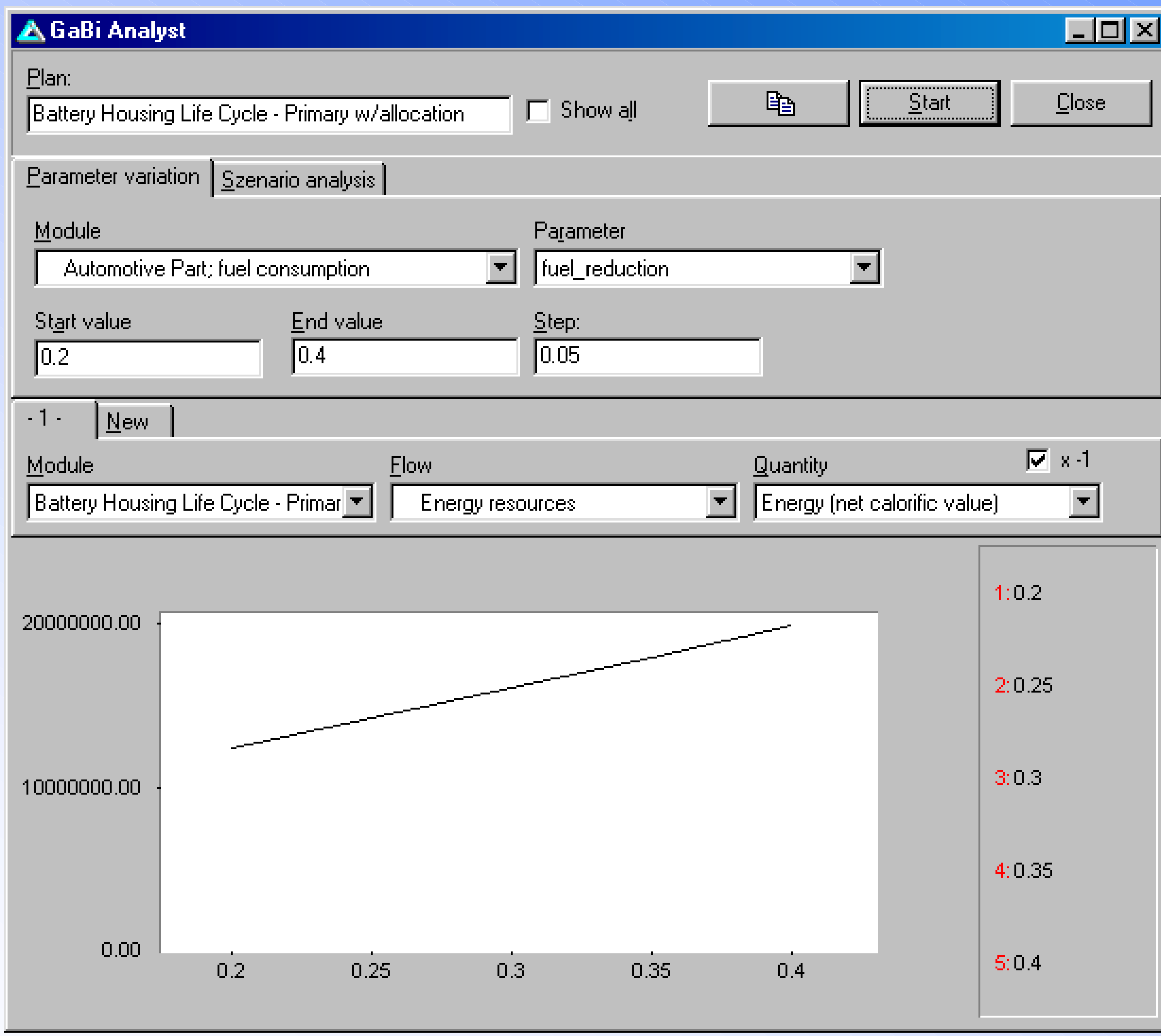
Germany

USA

Canada

Japan

Sensitivity Analysis - Energy



Example: Kitchen Appliance

- Modeling the use of a kitchen appliance
- Non-linear relationship between energy consumed and # of starts per use
- Build-up of lime on elemental surface
- E = *f* (operating hours, # starts)

PE Group - Life Cycle Engineering Services

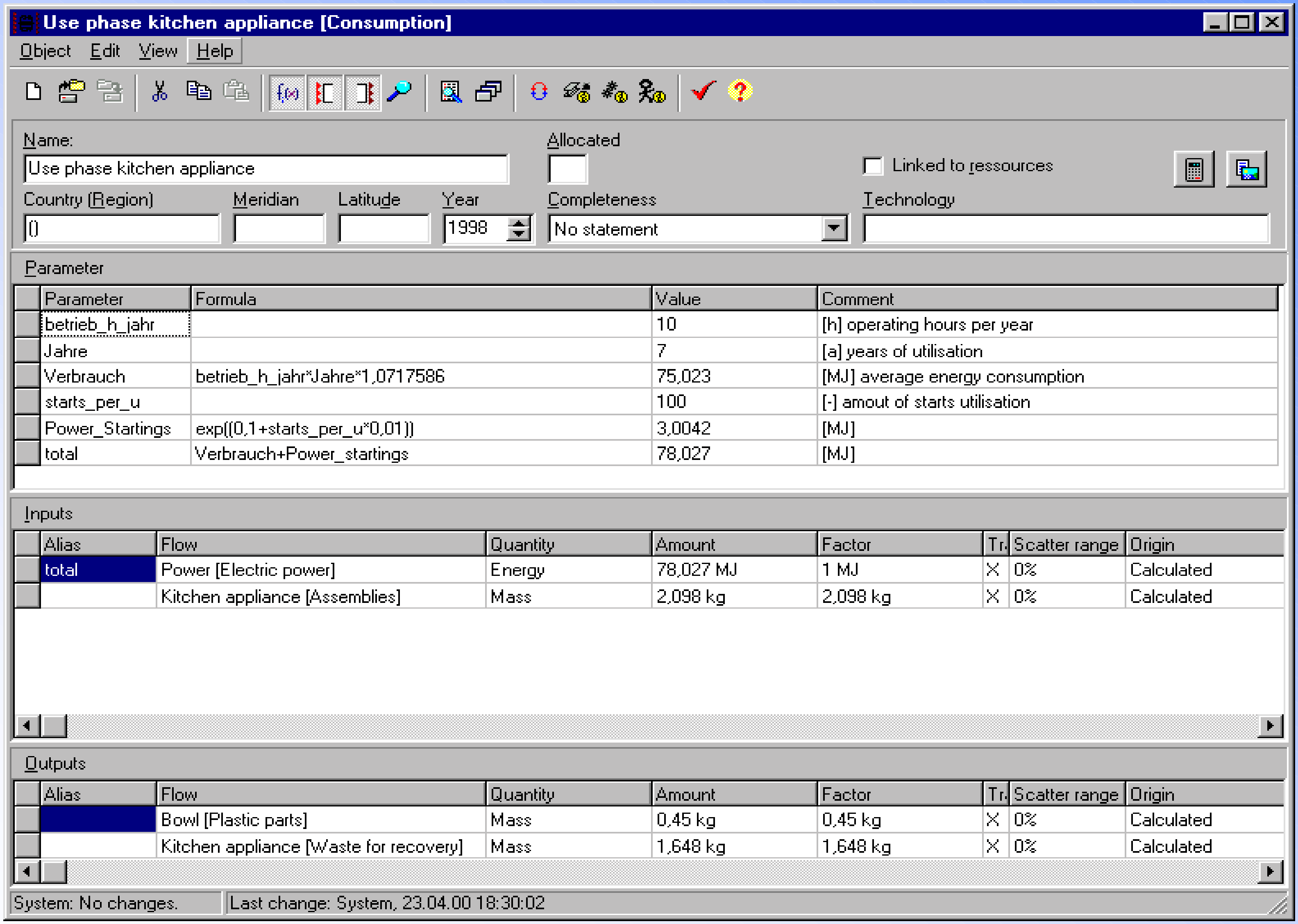
Germany

USA

Canada

Japan

Kitchen Appliance



Use phase kitchen appliance [Consumption]

Object Edit View Help

Name: Use phase kitchen appliance

Allocated

Linked to ressources

Country (Region): ()

Meridian

Latitude

Year: 1998

Completeness: No statement

Technology

Parameter

Parameter	Formula	Value	Comment
betrieb_h_jahr		10	[h] operating hours per year
Jahre		7	[a] years of utilisation
Verbrauch	betrieb_h_jahr*Jahre*1,0717586	75,023	[MJ] average energy consumption
starts_per_u		100	[-] amout of starts utilisation
Power_Startings	exp((0,1+starts_per_u*0,01))	3,0042	[MJ]
total	Verbrauch+Power_startings	78,027	[MJ]

Inputs

Alias	Flow	Quantity	Amount	Factor	Tr.	Scatter range	Origin
total	Power [Electric power]	Energy	78,027 MJ	1 MJ	X	0%	Calculated
	Kitchen appliance [Assemblies]	Mass	2,098 kg	2,098 kg	X	0%	Calculated

Outputs

Alias	Flow	Quantity	Amount	Factor	Tr.	Scatter range	Origin
	Bowl [Plastic parts]	Mass	0,45 kg	0,45 kg	X	0%	Calculated
	Kitchen appliance [Waste for recovery]	Mass	1,648 kg	1,648 kg	X	0%	Calculated

System: No changes.

Last change: System, 23.04.00 18:30:02

PE Group - Life Cycle Engineering Services

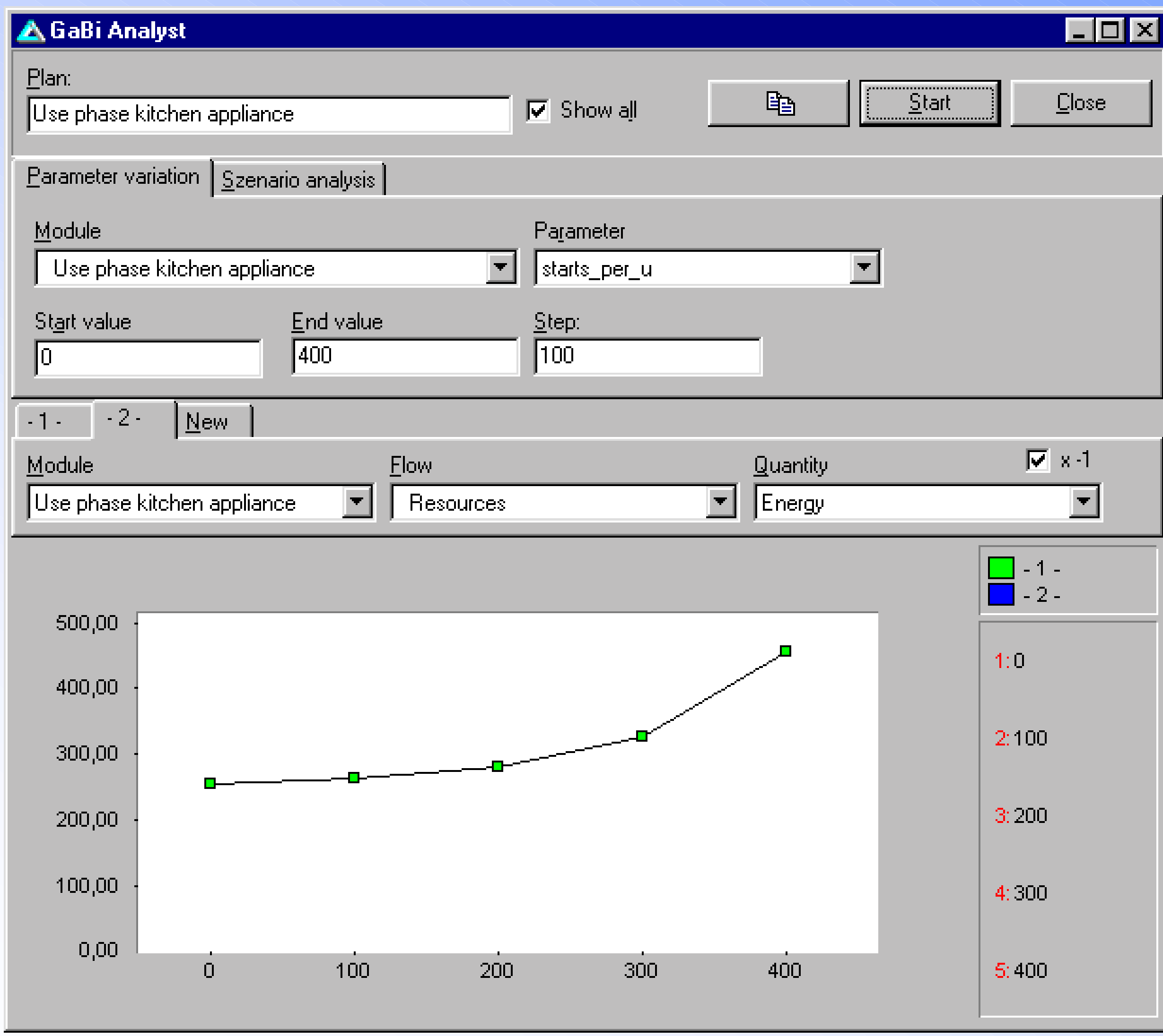
Germany

USA

Canada

Japan

Kitchen Appliance



- Variation in starts per use
- Non-linear energy response to number of times machine is started

Scenario Analysis: Kitchen Appliance

- Modeling the use of a kitchen appliance
- Two Scenarios: Intensive Use
  Moderate/Normal Use
- Examine the change in energy in each scenario

PE Group - Life Cycle Engineering Services

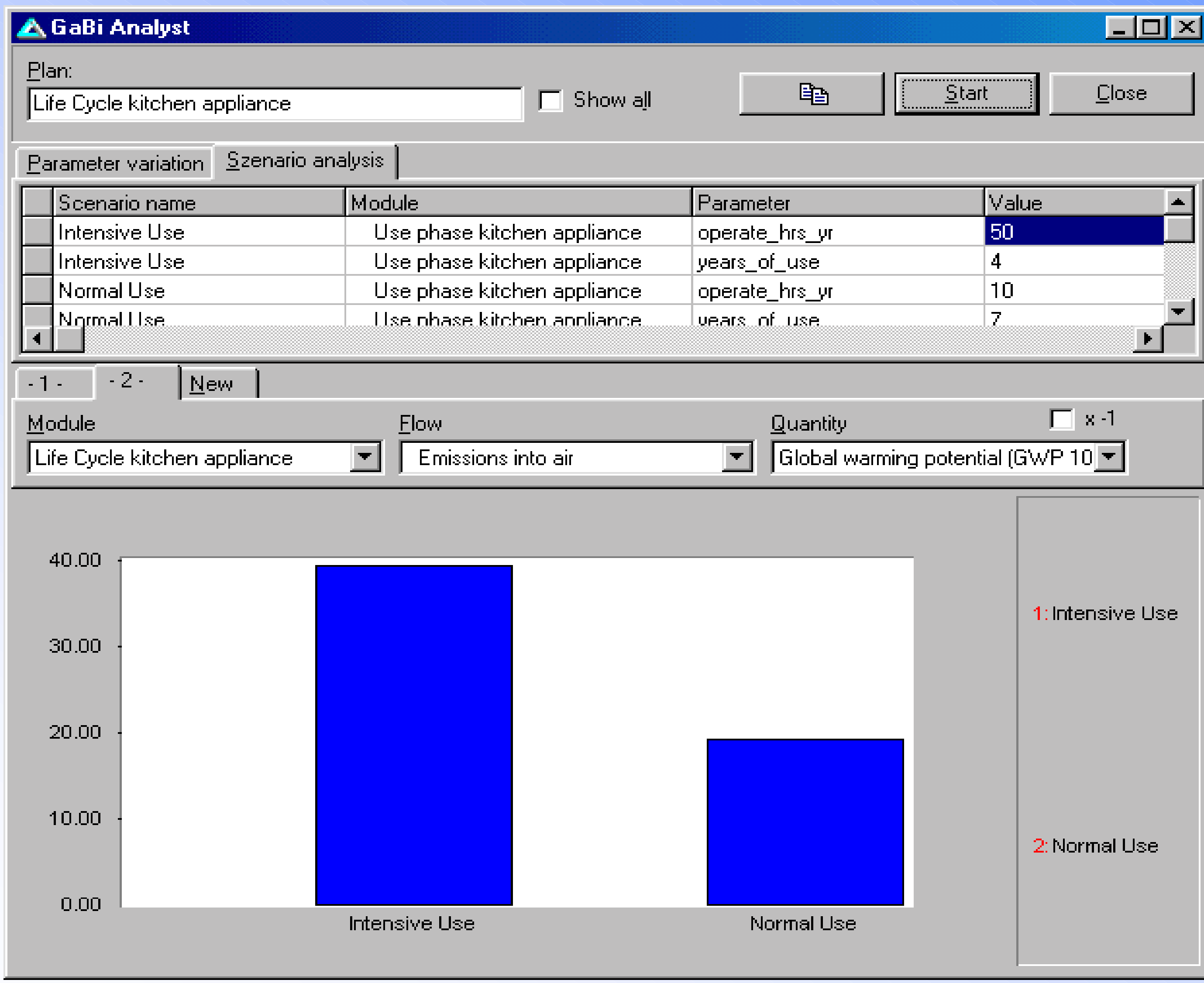
Germany

USA

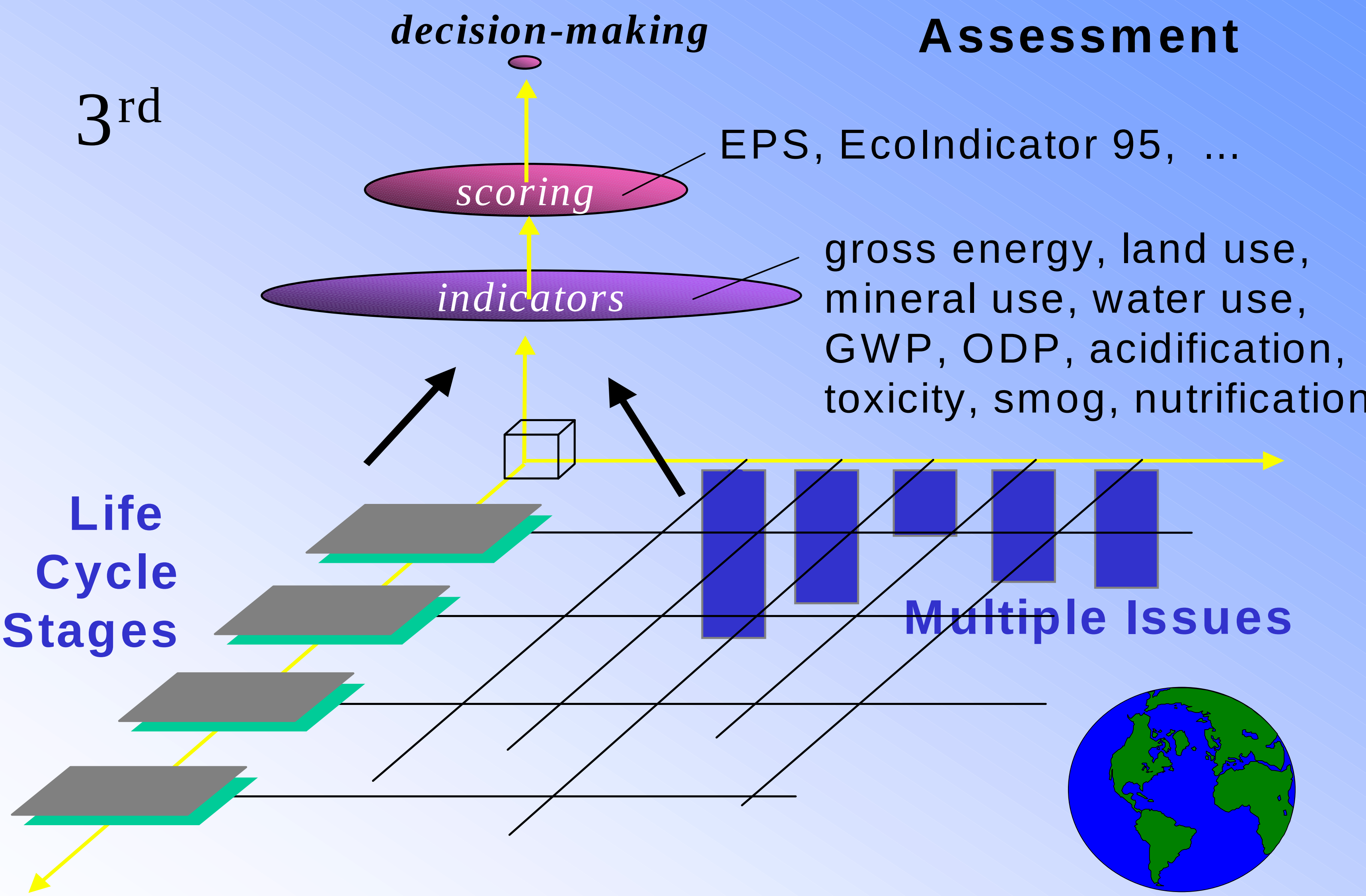
Canada

Japan

Scenario Analysis



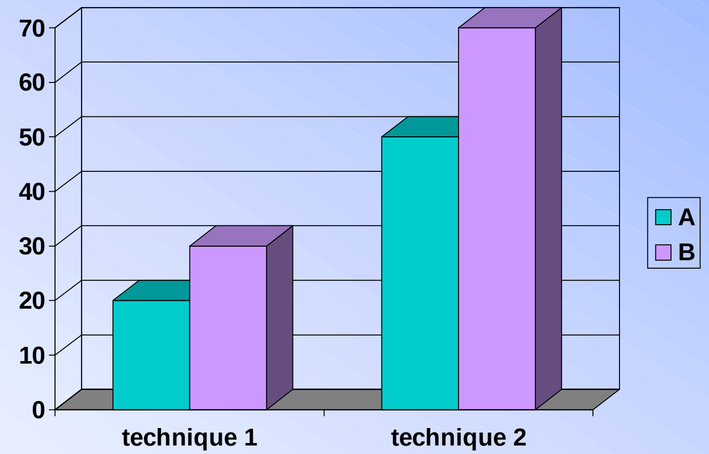
Assessment


3rd
decision-making
scoring
EPS, EcoIndicator 95, ...
indicators
gross energy, land use, mineral use, water use, GWP, ODP, acidification, toxicity, smog, nutrification
Life Cycle Stages
Multiple Issues

PE Group - Life Cycle Engineering Services

LCIA Tools

- Classification of inventory results
- Characterization into impact categories (e.g. GWP, ODP, . . .)
- Many LCIA evaluation techniques including,
  - CML
  - Expert judgement
  - Eco-Indicator 95, 99



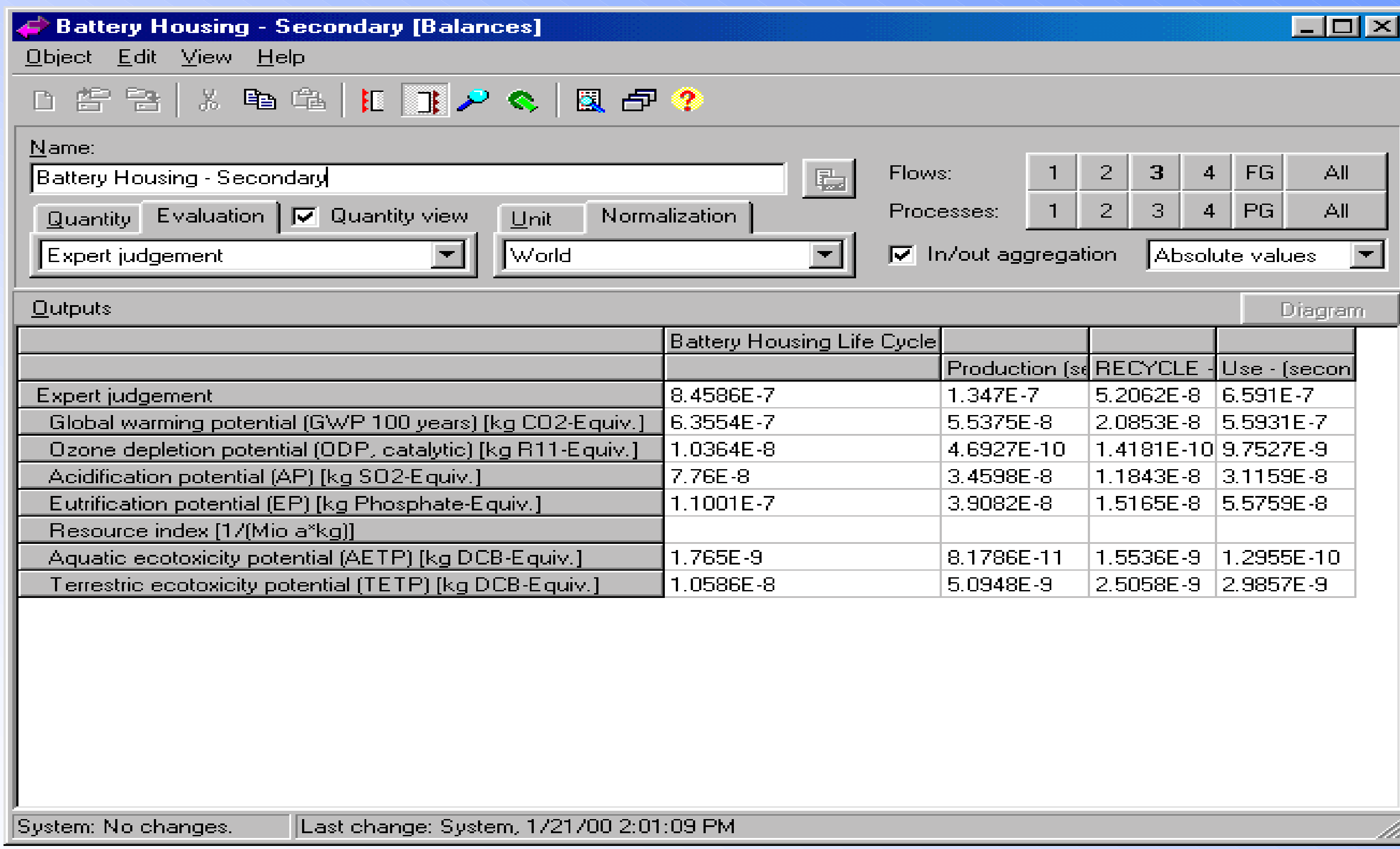
Germany

USA

Canada

Japan

Battery Housing LCIA



	Battery Housing Life Cycle			
		Production (se	RECYCLE -	Use - (secon
Expert judgement	8.4586E-7	1.347E-7	5.2062E-8	6.591E-7
Global warming potential (GWP 100 years) [kg CO2-Equiv.]	6.3554E-7	5.5375E-8	2.0853E-8	5.5931E-7
Ozone depletion potential (ODP, catalytic) [kg R11-Equiv.]	1.0364E-8	4.6927E-10	1.4181E-10	9.7527E-9
Acidification potential (AP) [kg SO2-Equiv.]	7.76E-8	3.4598E-8	1.1843E-8	3.1159E-8
Eutrification potential (EP) [kg Phosphate-Equiv.]	1.1001E-7	3.9082E-8	1.5165E-8	5.5759E-8
Resource index [1/(Mio a*kg)]				
Aquatic ecotoxicity potential (AETP) [kg DCB-Equiv.]	1.765E-9	8.1786E-11	1.5536E-9	1.2955E-10
Terrestric ecotoxicity potential (TETP) [kg DCB-Equiv.]	1.0586E-8	5.0948E-9	2.5058E-9	2.9857E-9

PE Group - Life Cycle Engineering Services

Germany

USA

Canada

Japan

PE Group - Life Cycle Engineering Services

Key Discussion Points

- Transparency in modeling, data quality, LCIA
- Extensive database
- Documentation parallel to modeling
- Flexibility in modeling sensitivity and scenario analysis
- Multiple evaluation techniques

Germany

USA

Canada

Japan

PE Group - Life Cycle Engineering Services

Germany

USA

Canada

Japan

Conclusions

- Quick turnover of study results
- Well-informed decisions

s.spatari@pe-americas.com

www.gabi-software.com

1-888-222-1451