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How LCA can assist German transport planning and policy-making:

Evaluating environmental and economic impacts of Longer-Heavier-Vehicles

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GreenDelta GmbH

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  - ***Infrastructure plan in Germany***
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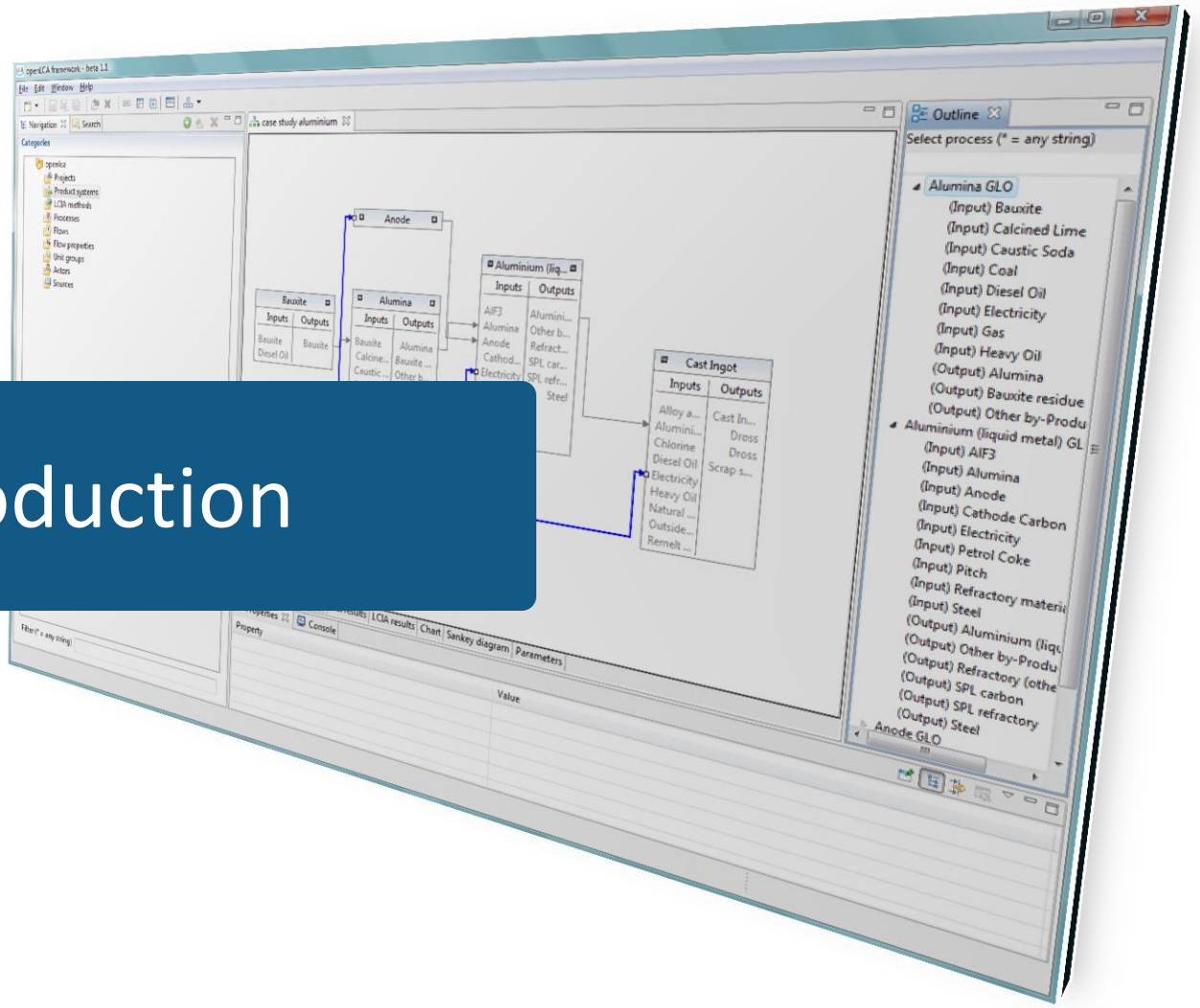
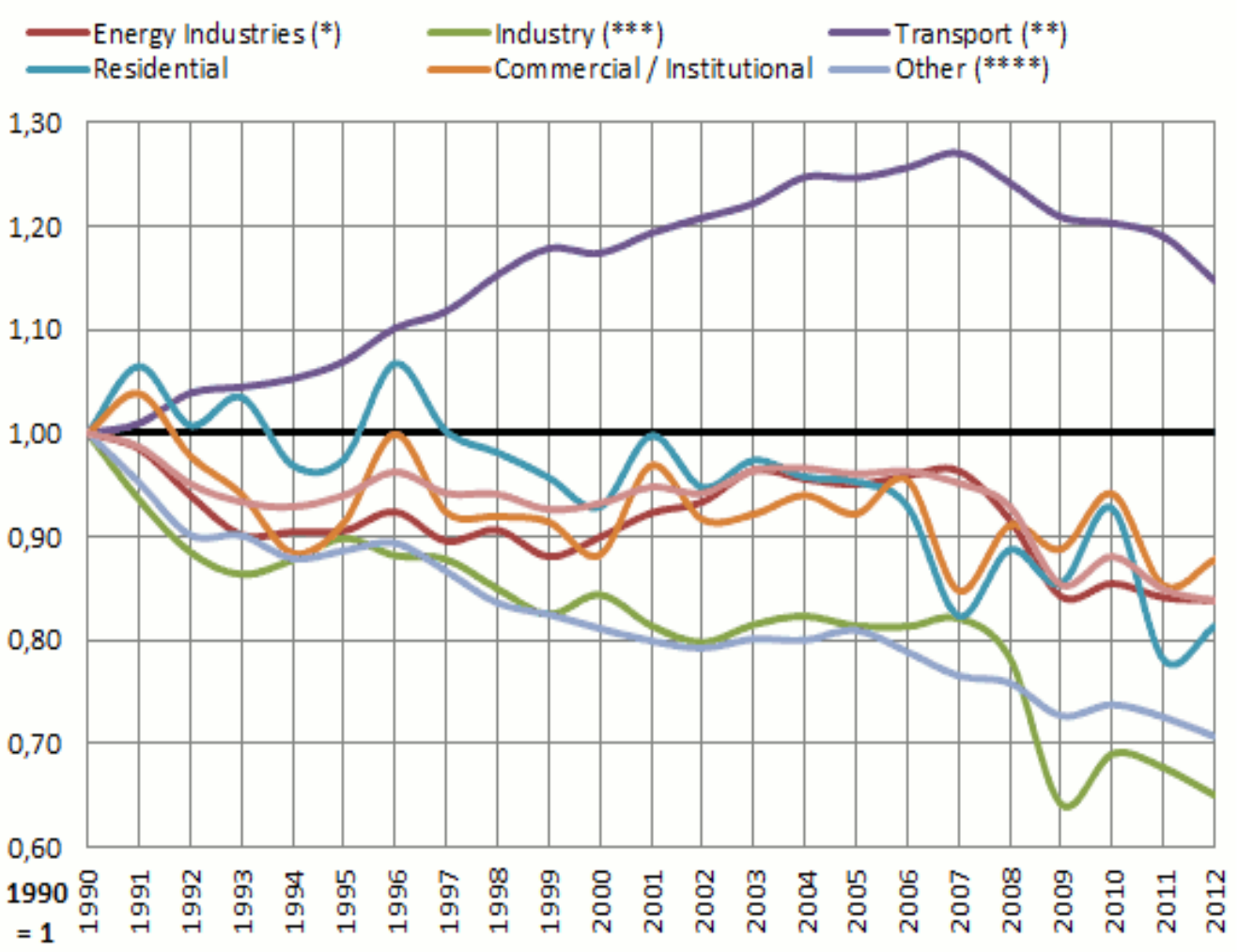
Introduction



EU has an official target to reduce 20 % of green-house gas (GHG) emissions compared to 1990 by 2020.



EU greenhouse gas emissions from transport and other sectors, 1990-2012

Source : EP, 2012

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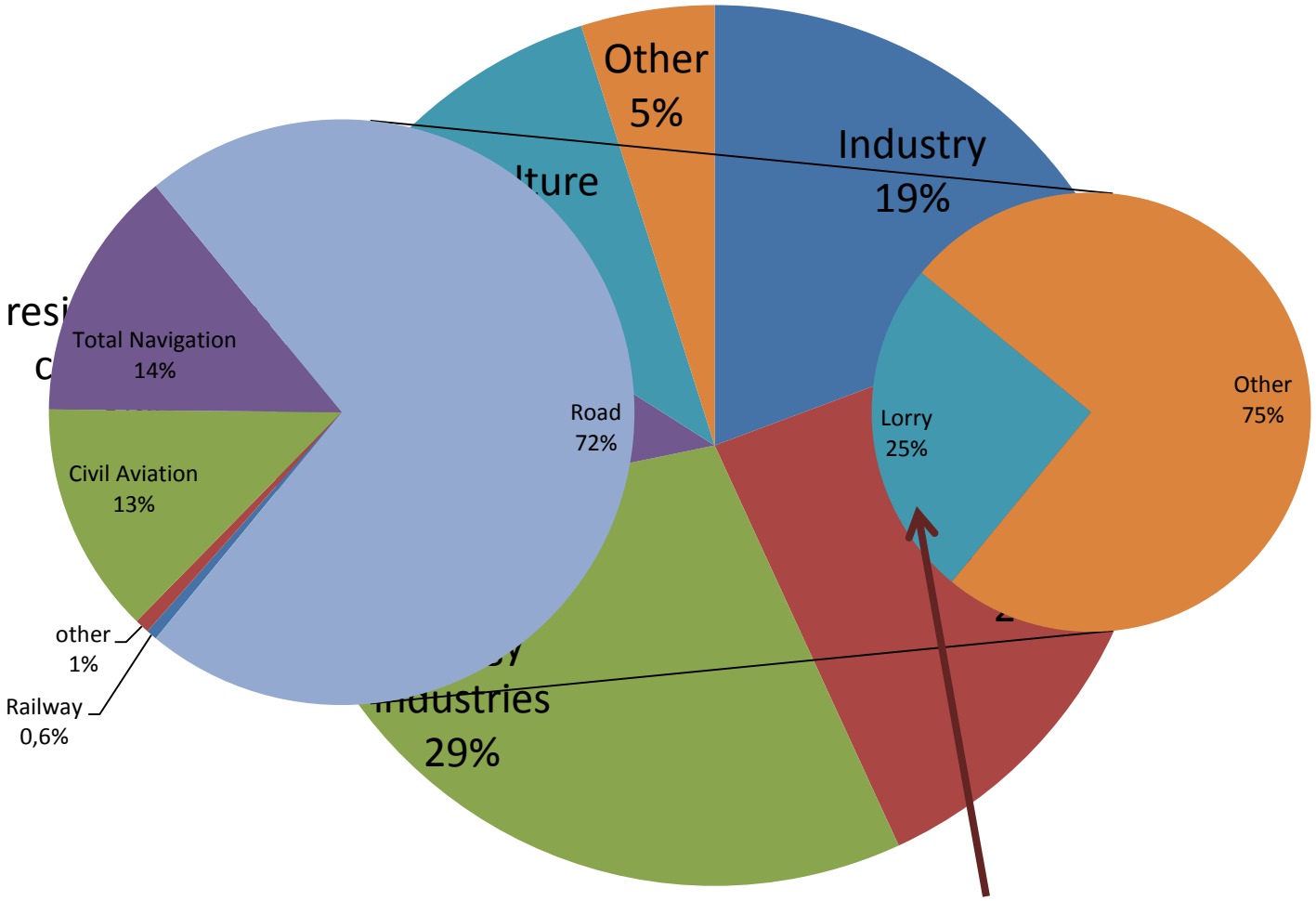
EU GHG Emissions by sector

EU GHG Emission from transport by mode



Lorry accounts for 6% of the whole EU emission

Source : EP, 2012

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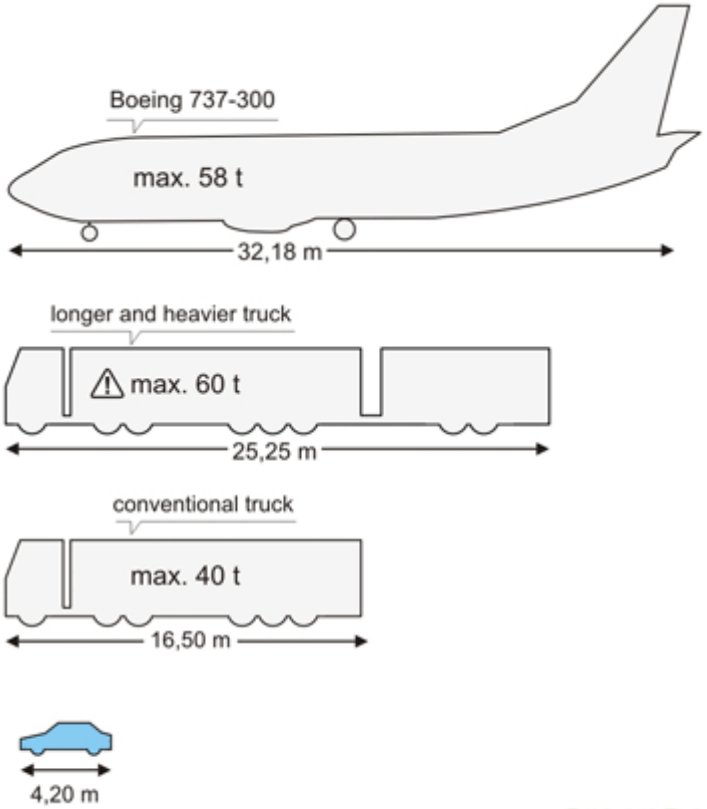
EU Transport White Paper 2011

- A vision for a competitive and sustainable transport system
- The target of emission reduction of 60% by 2050 compared to 1990
- 30% of the road freight should shift to rail or waterway by 2030, and more than 50% shift by 2050

Longer-Heavier Vehicles (LHVs)

- Suffering from congestions and growing costs
- Improving the road transport efficiency
- Solution to decoupling the economy and the environment.
- Revise Directive 96/53/EC
- Weight: up to 60 tons
- Length: 25,25 m



Longer-Heavier Vehicles(LHVs)

- Allowed in Finland ,Sweden, NL, and few German states
  - \+ 15-20% reduction of road transport cost
  - \+ 20% less fuel consumption per tkm
  - \+ 20% CO_2 & 40% NO emission reduction per tkm

    →Rebound effect, more GHG Emission

  - \- 20% more road space needed

    →More infrastructure needs

- More detail investigation needed

TRL(2008), TML(2008), FMTC(2002)

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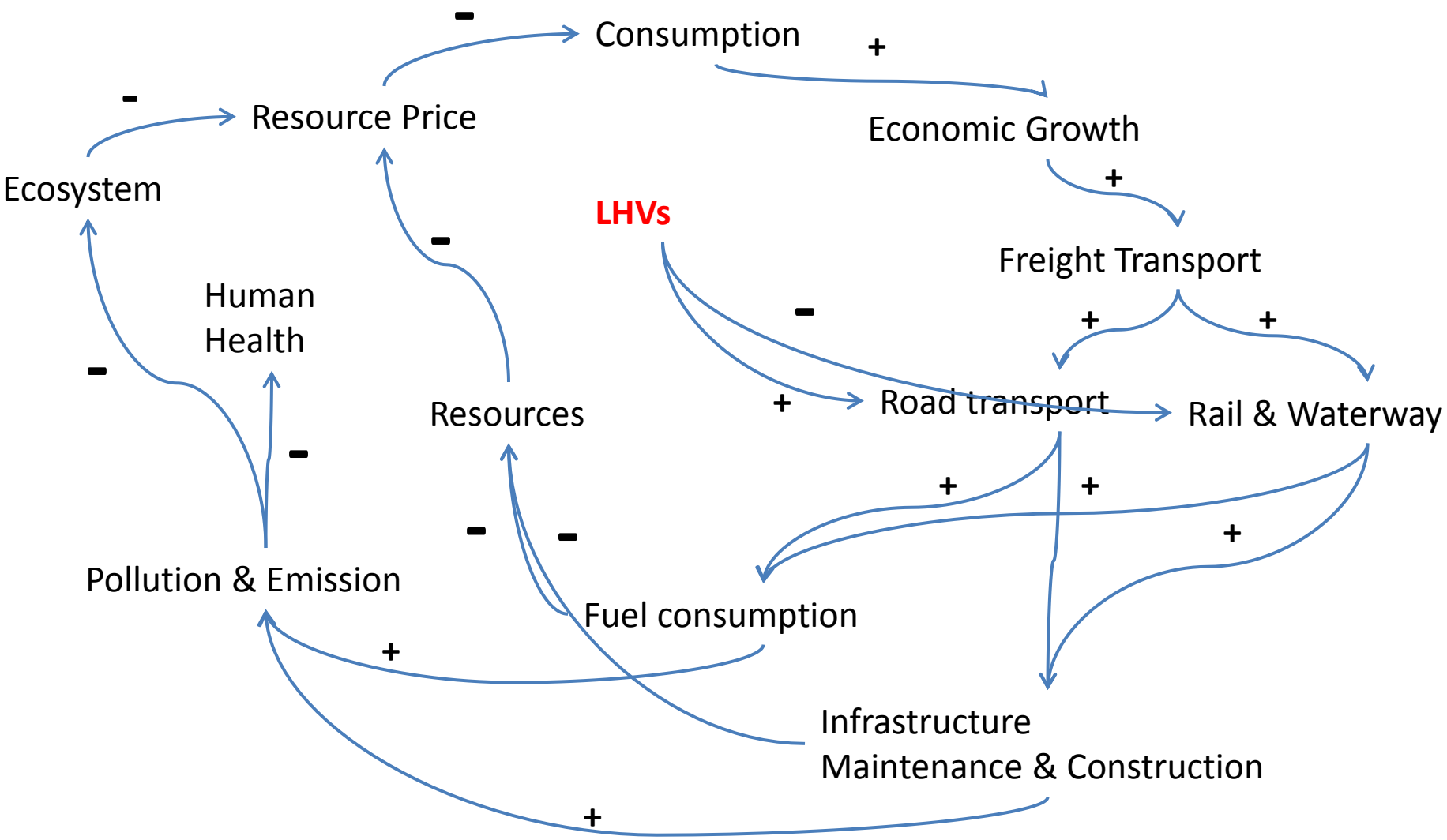
Potential Modal shift Prediction

	Road	Rail	Waterway
JRC(2009)	8.2% of LHVs	-1.5%	same
TML(2008)	25% of LHVs	-3.8%	-2.9%
UBA(2007)	14% of LHVs	-38%	-16%
ISI(2008)	30% of LHVs	-10%	same

Qualitative Model



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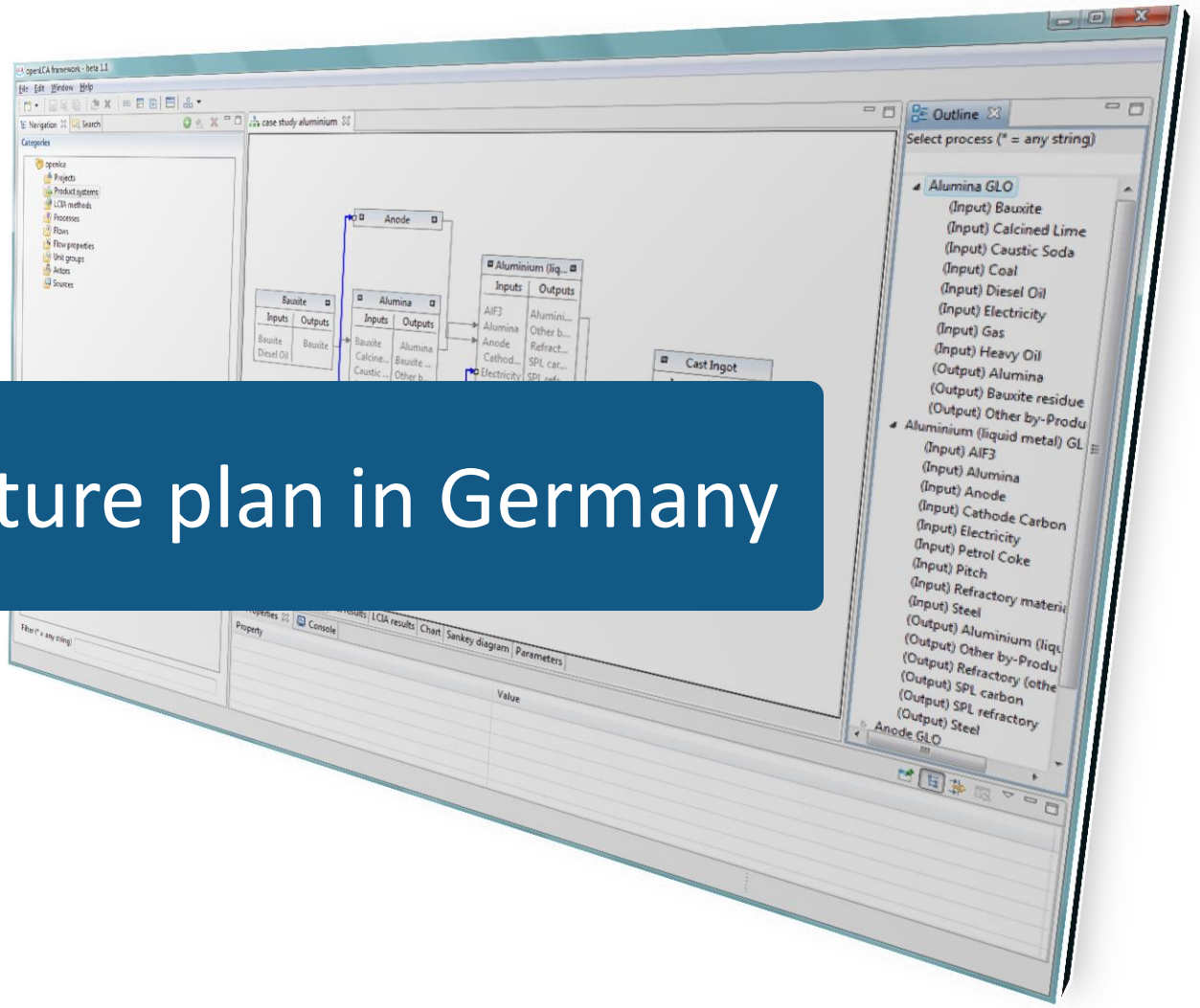
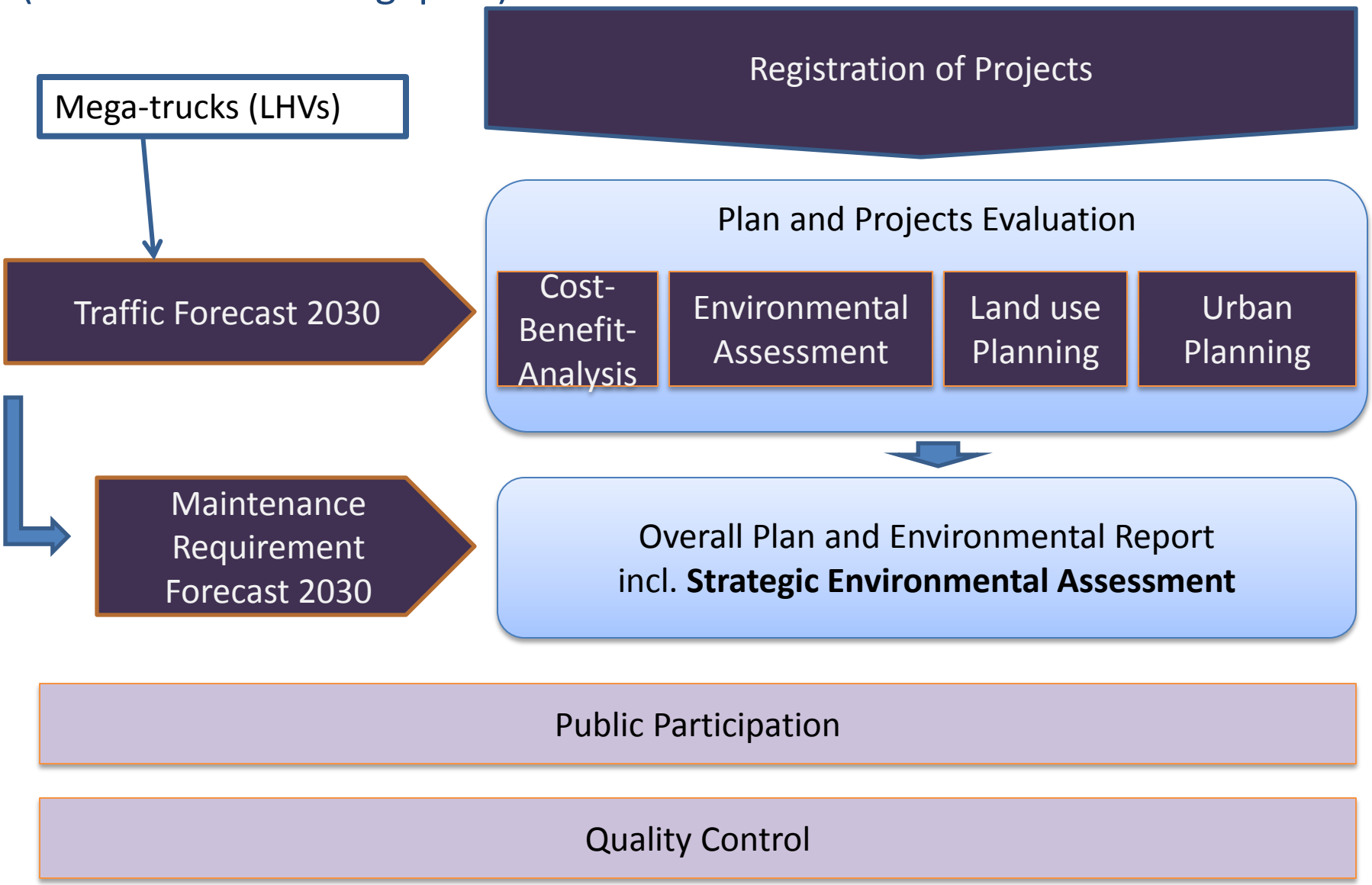
Infrastructure plan in Germany



2030 German Federal Transport Infrastructure Planning Procedure (Bundesverkehrswegeplan)



BMVI, 2015

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Traffic forecast 2030 Germany

creativefieldrecording.com

+42,9%

http://business.edf.org/files/2014/06/Red-Truck.jpg

+38,9%

articles.maritimepropulsion.com

+22,8%

BVU, 2014

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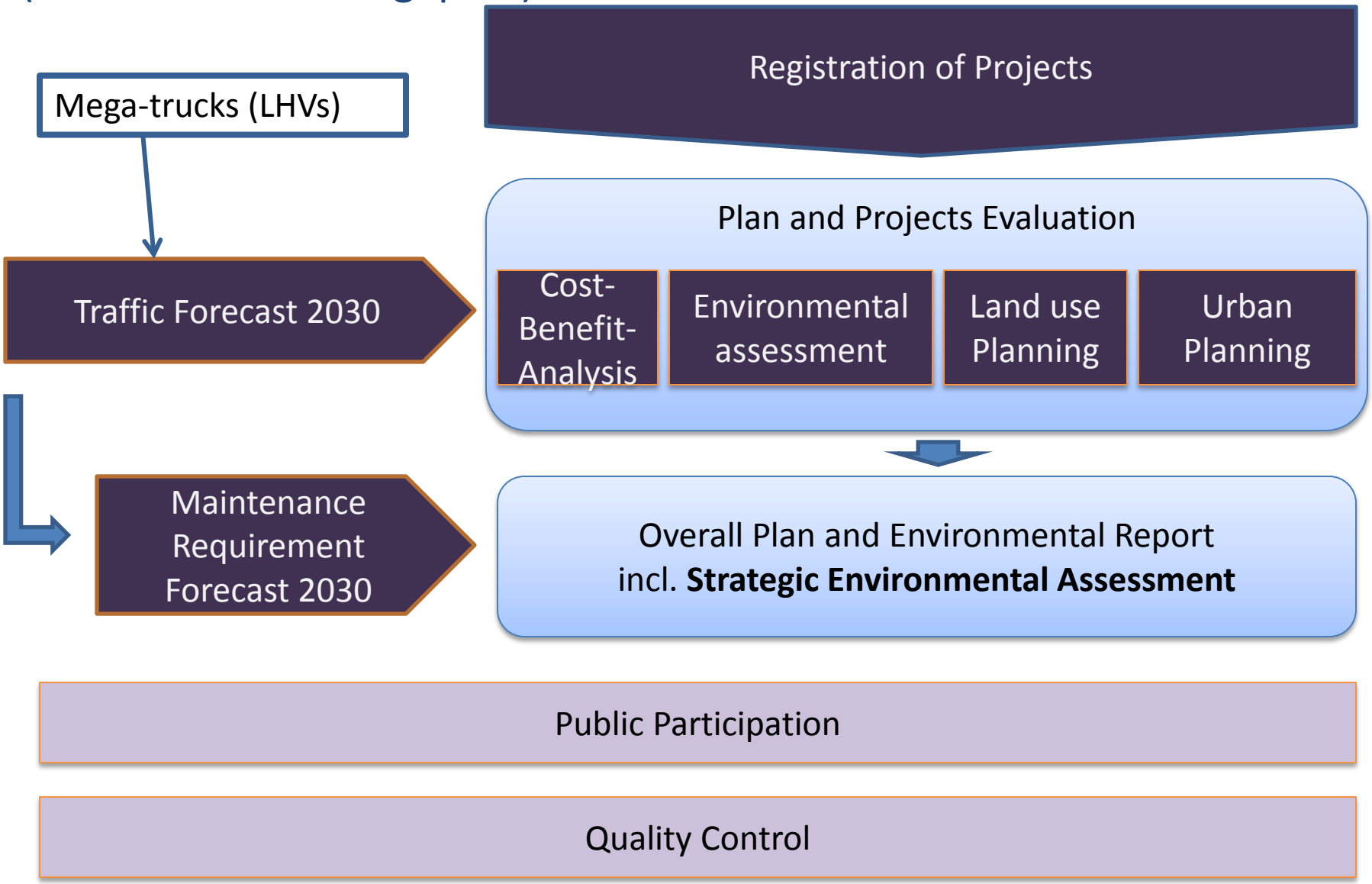
2030 German Federal Transport Infrastructure Planning Procedure (Bundesverkehrswegeplan)



BMVI, 2015

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Strategic Environmental Assessment

- A tool for non-environmental policies taking into considerations the environmental impacts of the policy
- Evaluates environmental impacts of policy, plan and program in early stages during decision-making process

- The essence of SEA is strategy
- Back-casting & Forecasting

- Directive 2001/42/EC (the SEA Directive)

§19b UVPG (2005)

Miliutenko *et al.*(2014) and Browning *et al.* (2011), Noble, (2000)

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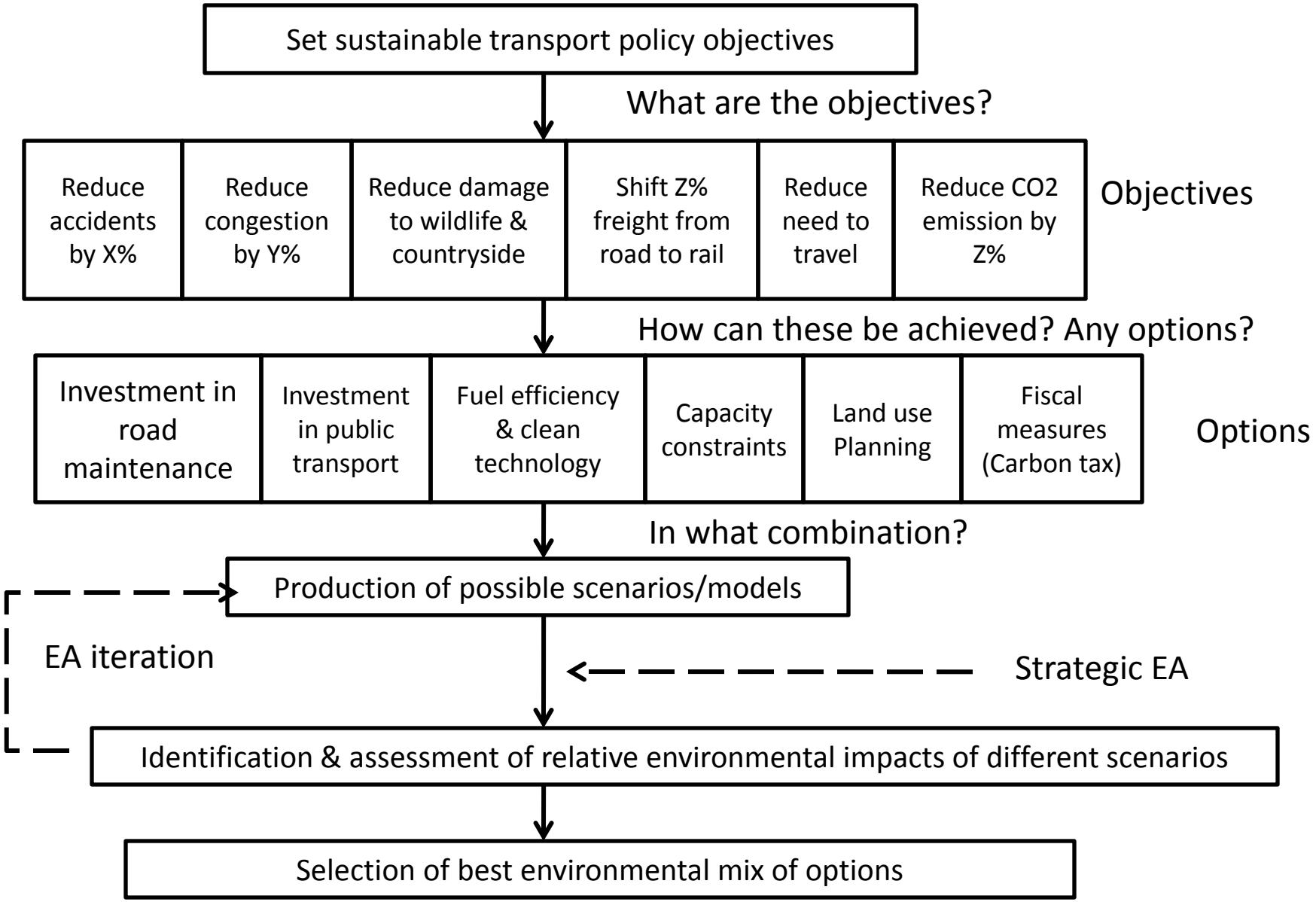

Formulation of SEA in objectives-led transport policy, Source: Sheate (1992)

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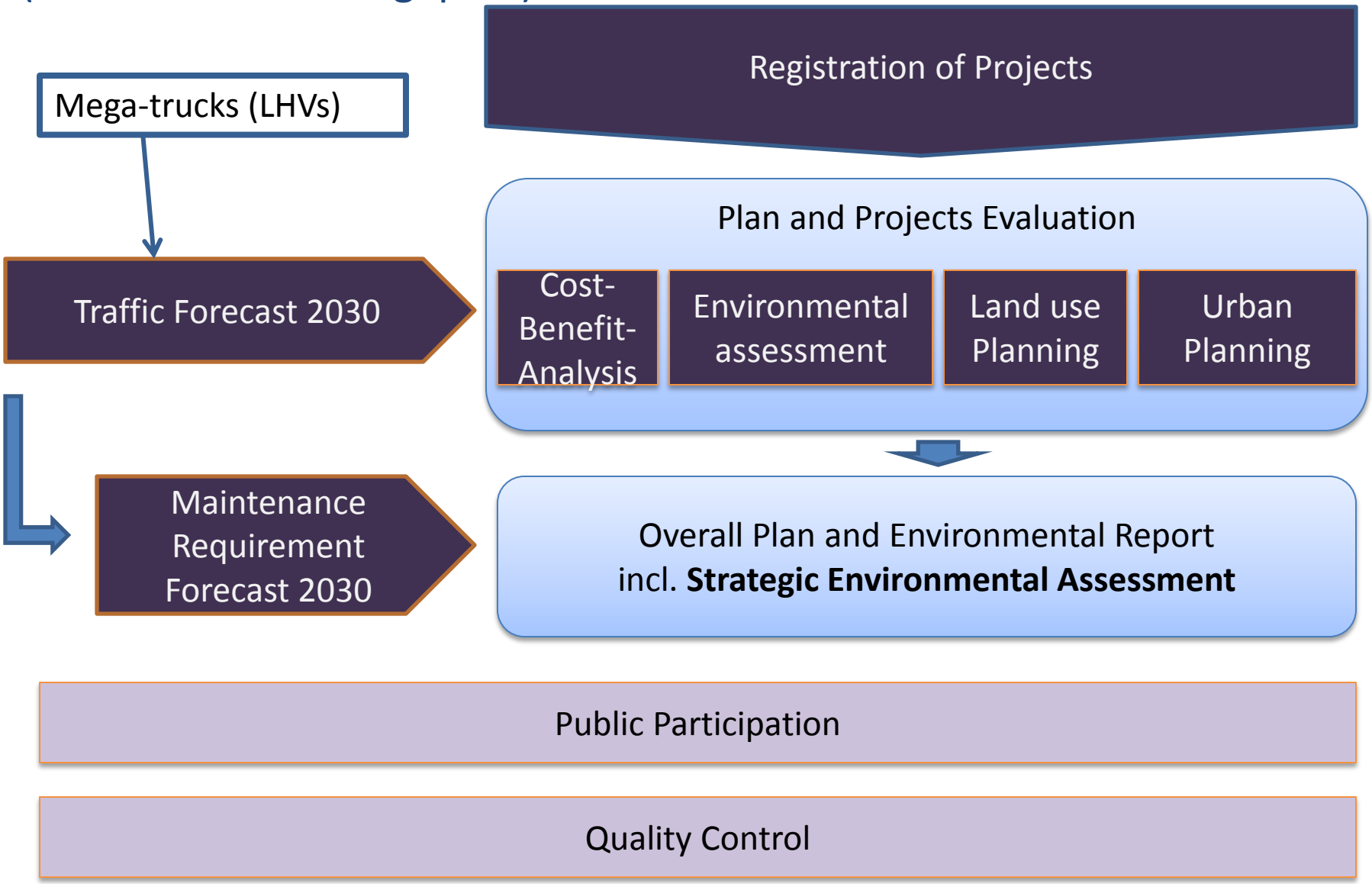
2030 German Federal Transport Infrastructure Planning Procedure (Bundesverkehrswegeplan)



BMVI, 2015

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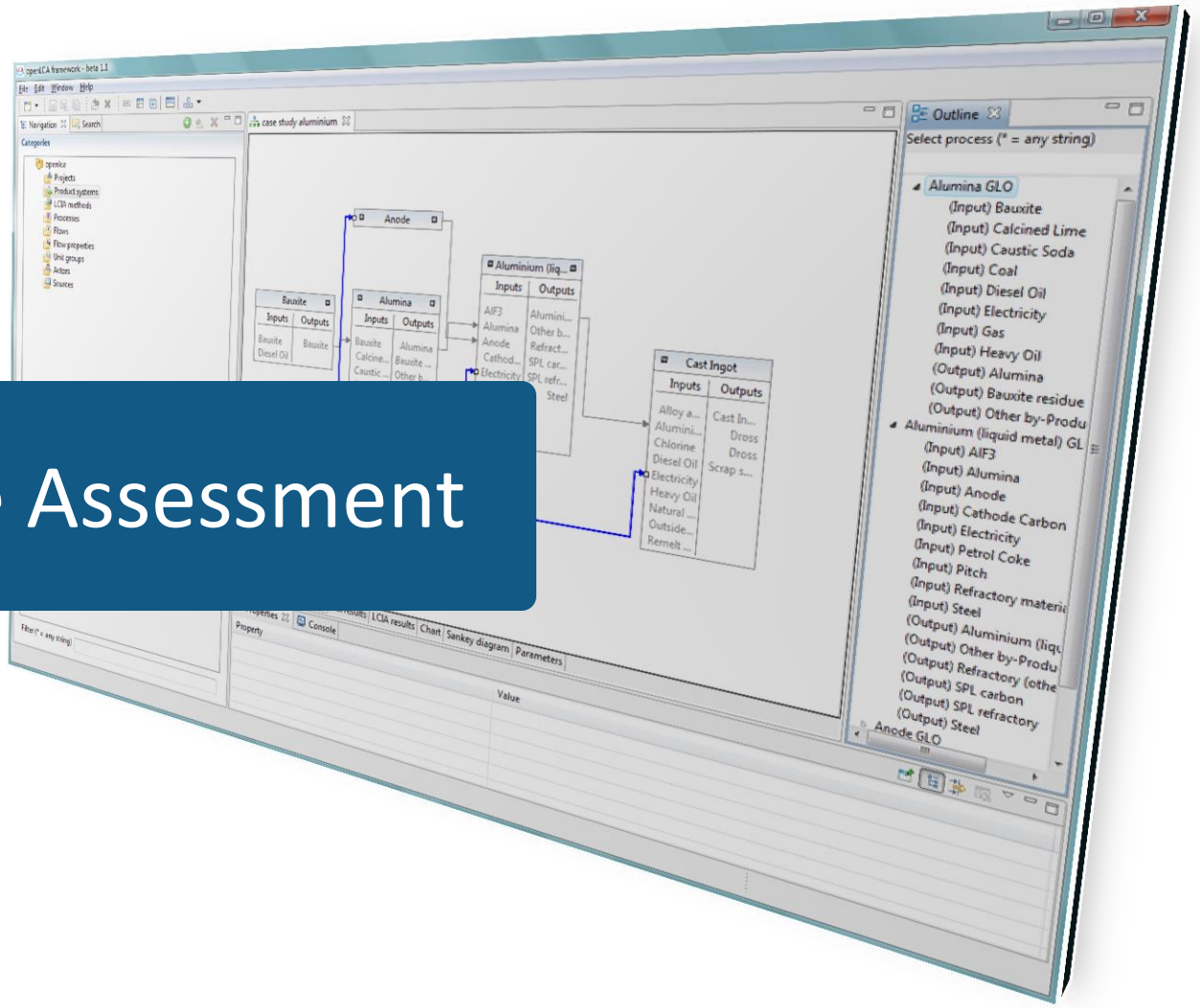
2030 German Federal Transport Infrastructure Planning Procedure (Bundesverkehrswegeplan)

- Strategy oriented
  - Choice of transport modality at the national level

- How to quantify the impact caused by materials used, energy used and GHG emission of the future traffic volume?

Miliutenko(2014)

Life Cycle Assessment



Life Cycle Assessment

- A tool to quantify, analyze and assess the environmental impacts of a product, process or activity during its **whole life cycle** in a scientific and objective measure. **Inventory resources used and wastes released** into the environment are assessed as well as the impacts of those inputs and outputs.
- ISO International Standard

Miettinen *et al.* (1997), ISO 14044 (2006)

Life Cycle Assessment

- Generating information to support decision making, widely used in the public-sector
- Understandable results for non-experts
- The EC mentioned LCA can be used for assessing life cycle energy use and GHG emissions
- Inclusion of energy used and emissions of construction, operation, maintenance and disposal phase.

- Directive 2014/52/EU, the need to assess the climate impact of projects

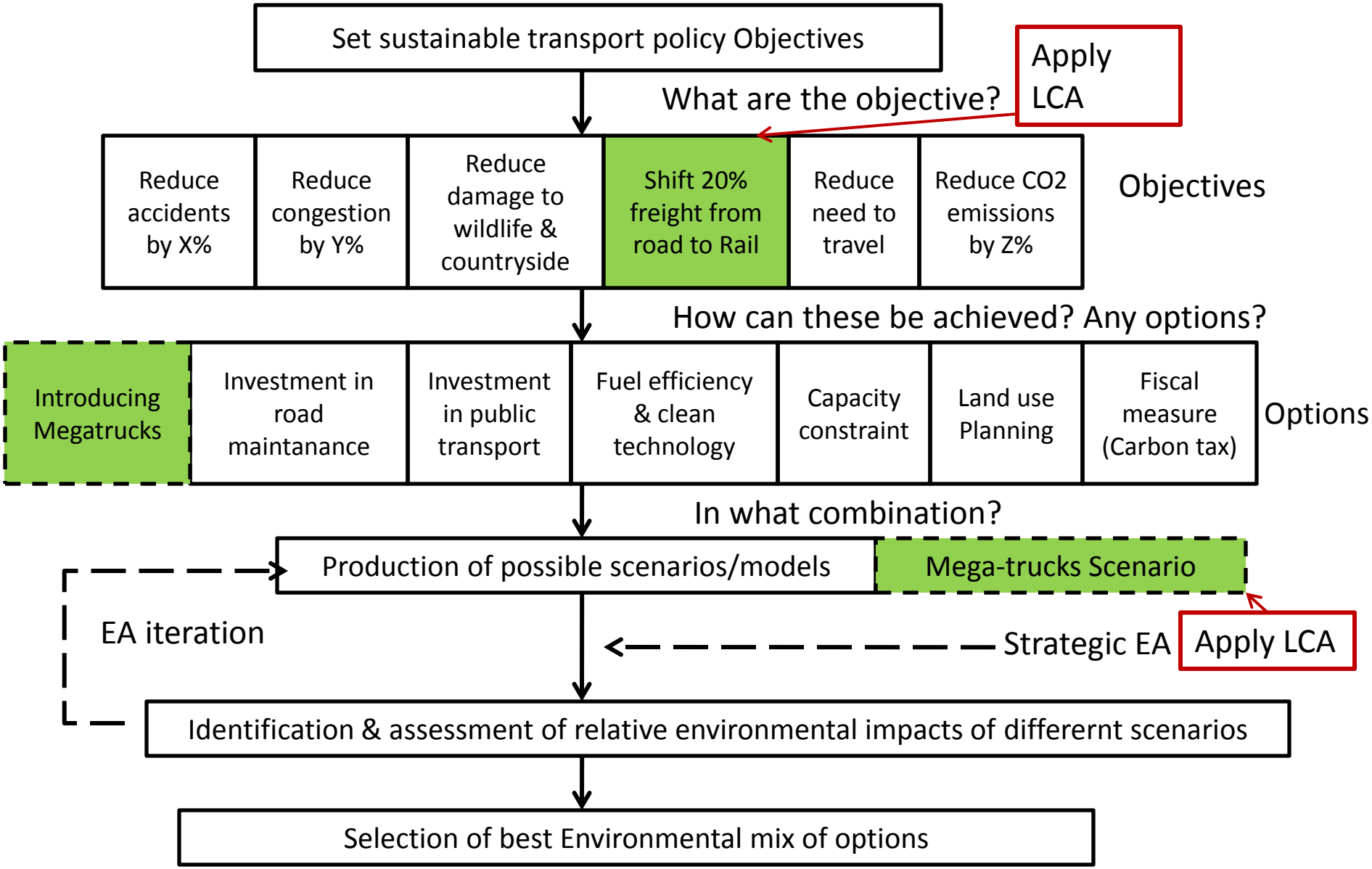
Cowell *et al*. (2002); EC(2013), Miliutenko(2014)

Life Cycle Assessment

- The Swedish Transport administration has indicated: There is a big potential to reduce the life cycle GHG emissions and energy use of infrastructure when these are taken into account in the whole planning process

- Various EU Member States try to apply LCA in road infrastructure plans

Miliutenko(2014), Trafikverket (2012)



Formulation of SEA in objectives-led transport policy, self-made, Source: Sheate (1992)

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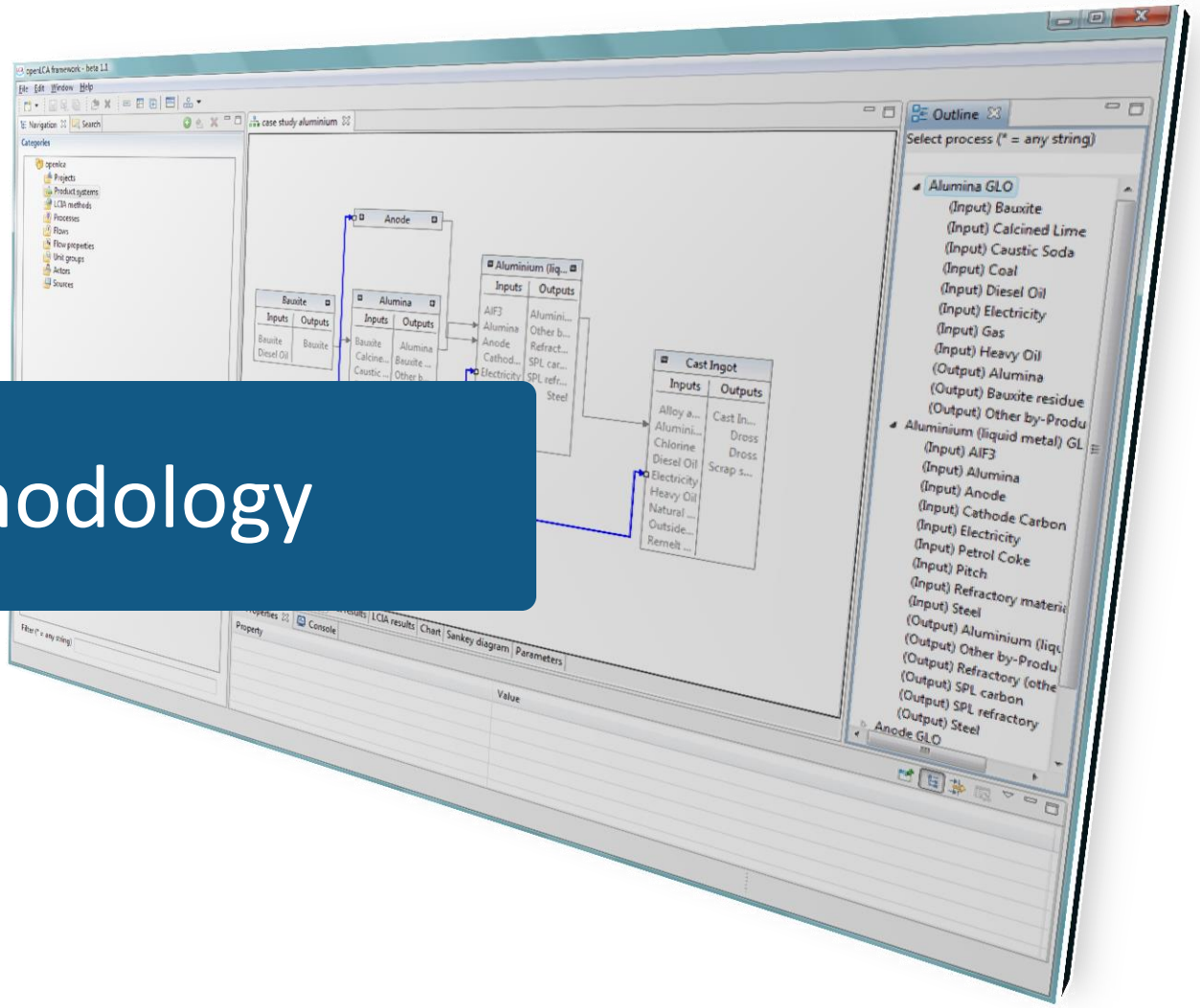
Research Question

- Comparing the environmental impacts of the scenarios with/without LHVs in Germany in 2030 (quantified by the LCA method)

- How can LCA support Strategic Environmental Assessment of transport planning with a scientific and objective approach?

Methodology



Methodology: Compare Scenarios

1. Baseline scenario: business-as-usual, no Mega-truck (BVU)
2. Mega-trucks scenario:
   - Proponent scenario: JRC
   - Opponent scenario: ISI,UBA and TML
3. The White Paper scenario: 30% road freight shift to other modal, no Mega-truck

Database: Ecoinvent 3.1

Software: openLCA

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Life Cycle Assessment

Functional Unit: the total transport volume of the year 2030 in Germany

System boundary

Road Transport

Production Phase
- Manufacture of lorry
- Construction of road
- Production of fuel

Operation Phase
- Maintenance of lorry, road
- Consumption of fuel

Disposal Phase
- Lorry, Road

Rail Transport

Production Phase
- Manufacture of train
- Construction of track
- Production of fuel

Operation Phase
- Maintenance of train, track
- Consumption of fuel

Disposal Phase
- Track and Train

Waterway Transport

Production Phase
- Manufacture of ship
- Construction of waterway, canal
- Production of fuel

Operation Phase
- Maintenance of ship, canal
- Consumption of fuel

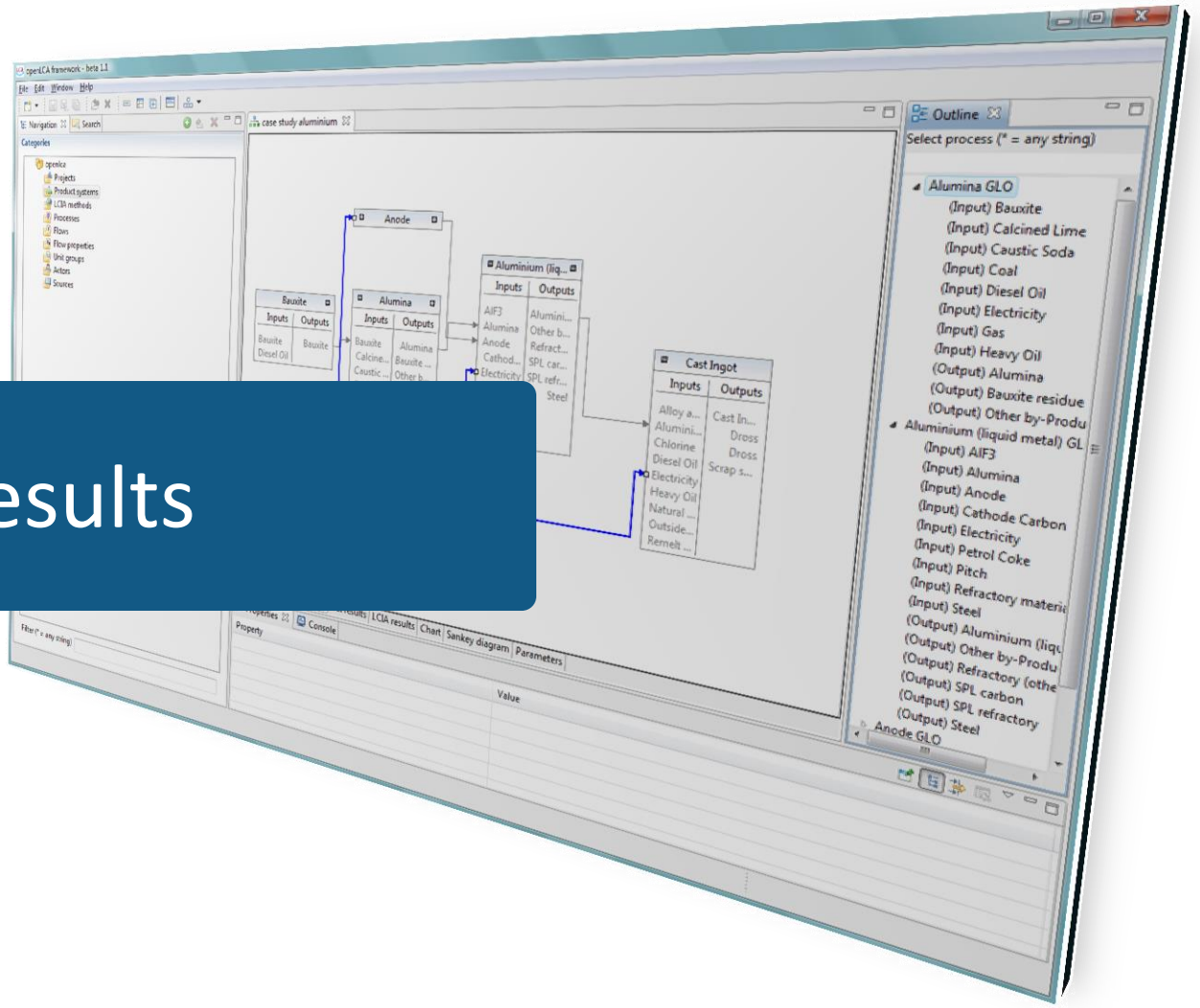
Disposal Phase
- Ship

Impact Assessment Method: ReCiPe (H)

- Most commonly used method
- 3 main categories:
  - Ecosystems (Species. yr)
    - Climate change
  - Human Health (Disability-Adjusted Life Year (DALY))
    - Climate change
  - Resources availability ($)

Goedkoop, 2008

Results


openLCA framework - beta 1.1
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case study aluminium
Anode
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(Input) Electricity
(Input) Gas
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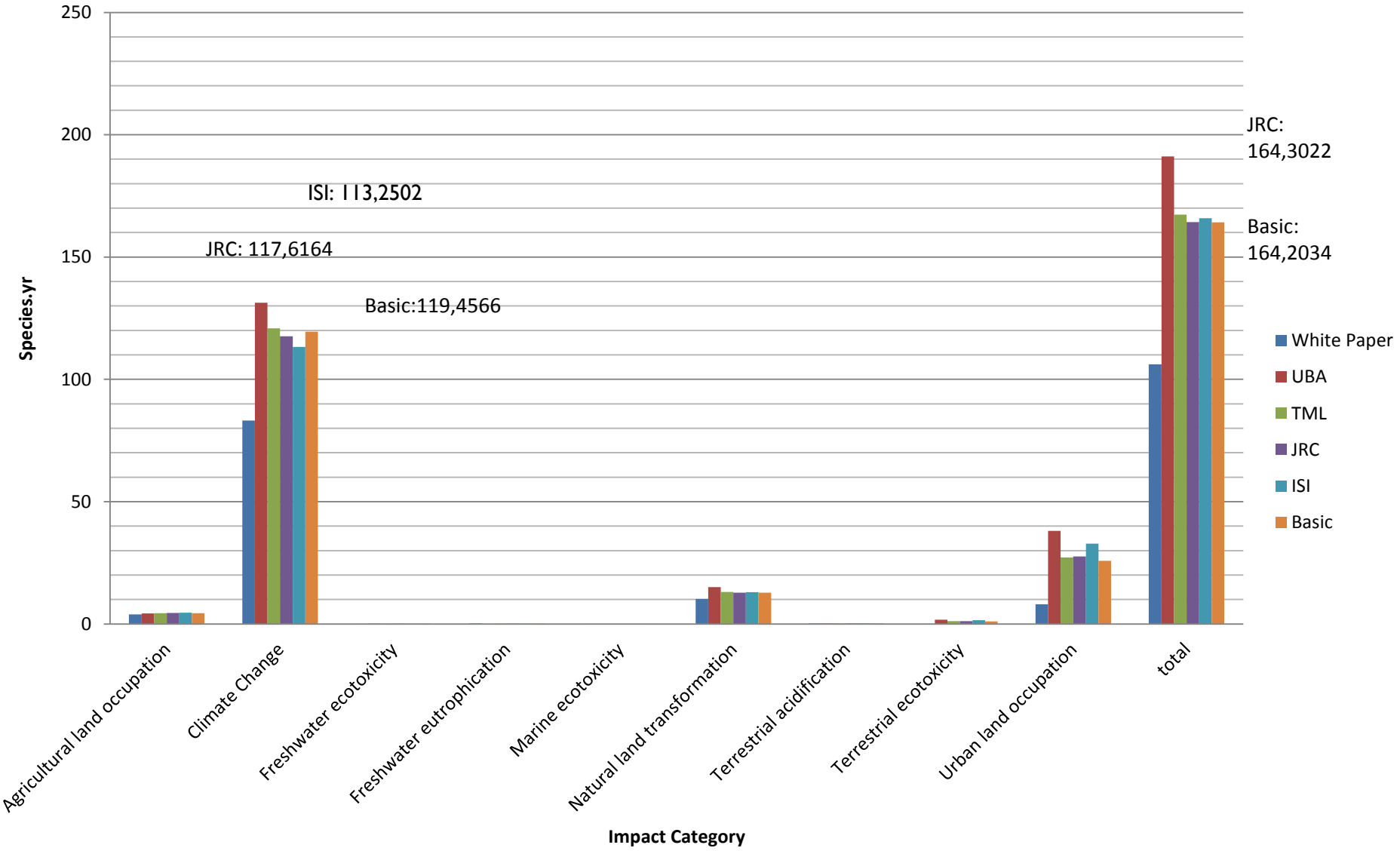
(Output) Alumina
(Output) Bauxite residue
(Output) Other by-Produ
Aluminium (liquid metal) GL
(Input) AlF3
(Input) Alumina
(Input) Anode
(Input) Cathode Carbon
(Input) Electricity
(Input) Petrol Coke
(Input) Pitch
(Input) Steel
(Output) Other by-Produ
(Output) SPL carbon
(Output) SPL refractory
(Output) Steel
Anode GLO
Property
Value
Console
Chart
Sankey diagram
Parameters

ReCiPe Endpoint (H) : Ecosystems



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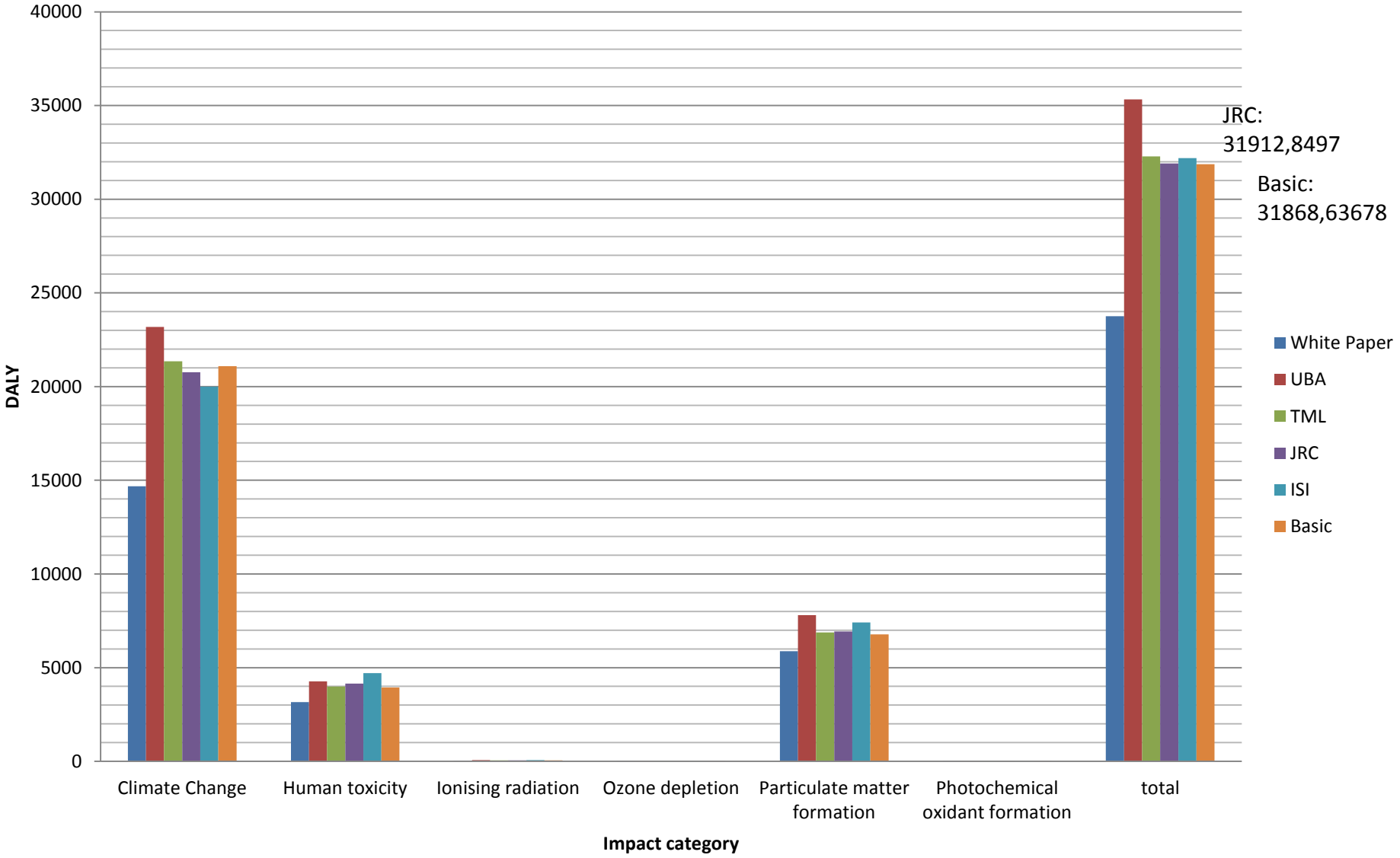
The most contributing process : Ecosystems

- Agriculture land Occupation : Road construction
- Climate change: Road construction
- Nature land transformation : Diesel production
- Urban land occupation: Road construction
- Total: Road construction

Impact categories | Ecosystems - Natural land transformation

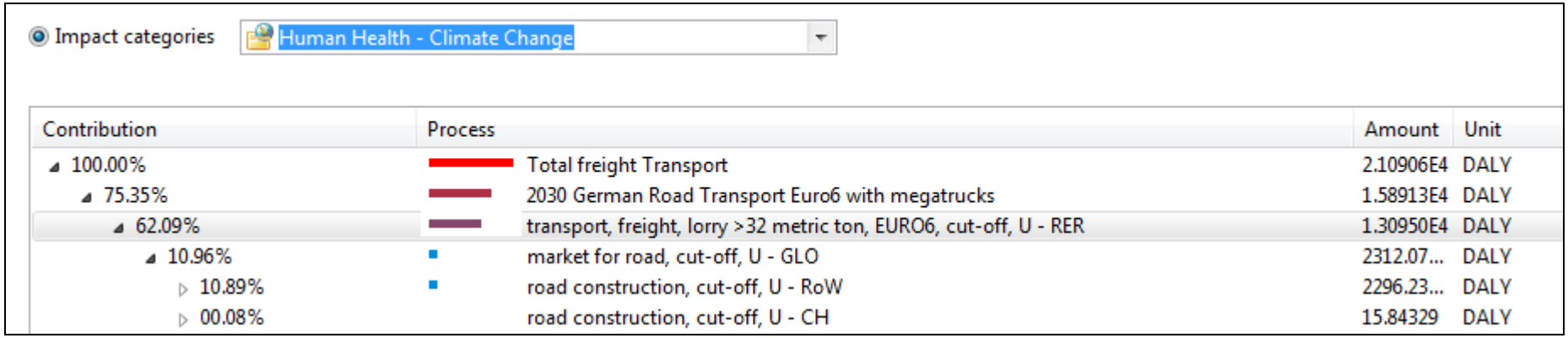
Contribution	Process	Amount	Unit
100.00%	Total freight Transport	12.83778	species.yr
77.48%	2030 German Road Transport Euro6 with megatrucks	9.94673	species.yr
65.39%	transport, freight, lorry >32 metric ton, EURO6, cut-off, U - RER	8.39401	species.yr
35.96%	market for diesel, low-sulfur, cut-off, U - Europe without Switzerland	4.61598	species.yr
34.95%	diesel production, low-sulfur, cut-off, U - Europe without Switzerland	4.48664	species.yr
34.88%	market for diesel, cut-off, U - Europe without Switzerland	4.47756	species.yr
00.04%	market for heavy fuel oil, burned in refinery furnace, cut-off, U - GLO	0.00455	species.yr
00.03%	market for heat, district or industrial, other than natural gas, cut-off, U - Europe without Sw...	0.00396	species.yr

ReCiPe Endpoint (H) : Human Health

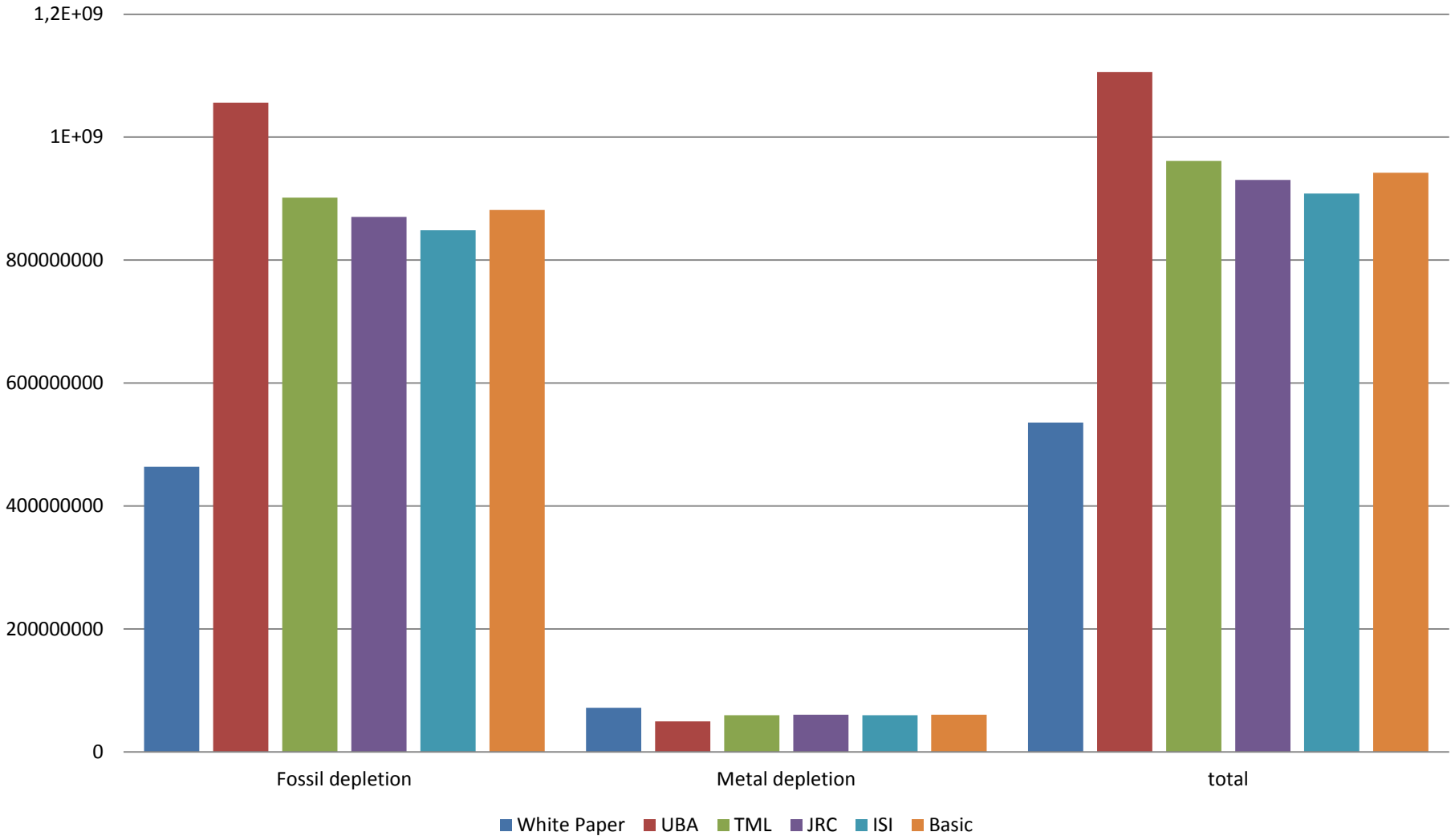


The most contributing process : Human Health

- Human toxicity: Brake wear emission
- Climate change: Road construction
- Particulate matter formation: Road construction
- Total: Road construction

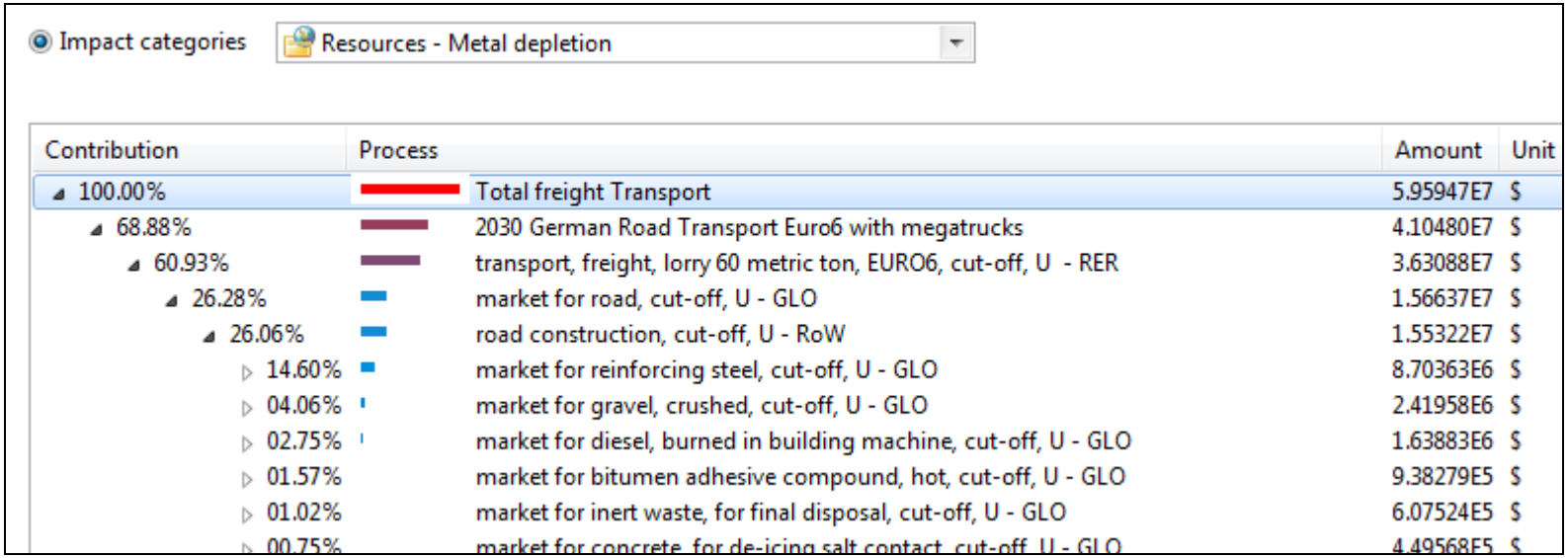


ReCiPe Endpoint (H) : Resources ($)



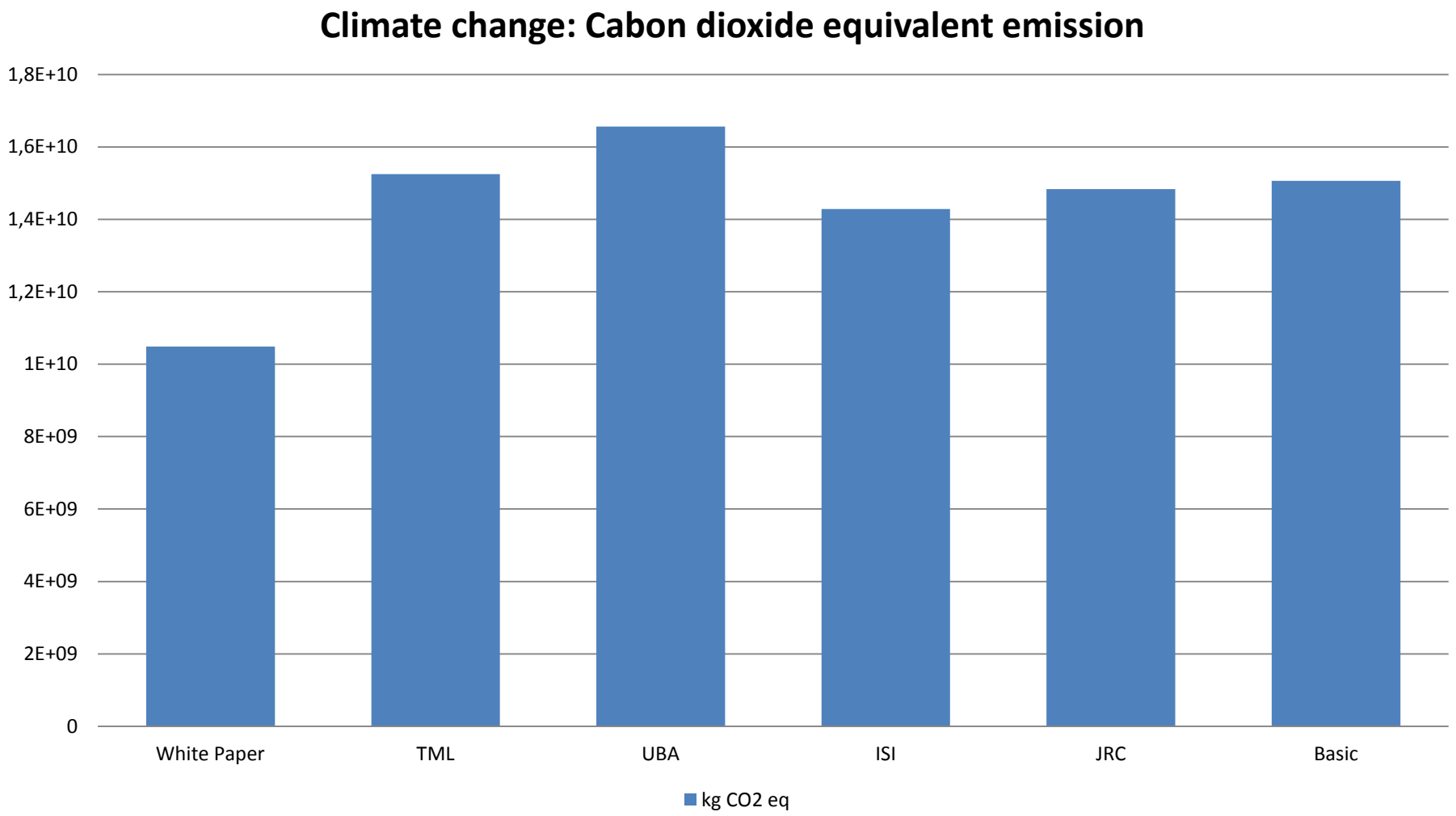
The most contributing process : Resources

- Fossil depletion: Diesel production
- Metal depletion: Road construction



Contribution	Process	Amount	Unit
100.00%	Total freight Transport	5.95947E7	$
68.88%	2030 German Road Transport Euro6 with megatrucks	4.10480E7	$
60.93%	transport, freight, lorry 60 metric ton, EURO6, cut-off, U - RER	3.63088E7	$
26.28%	market for road, cut-off, U - GLO	1.56637E7	$
26.06%	road construction, cut-off, U - RoW	1.55322E7	$
14.60%	market for reinforcing steel, cut-off, U - GLO	8.70363E6	$
04.06%	market for gravel, crushed, cut-off, U - GLO	2.41958E6	$
02.75%	market for diesel, burned in building machine, cut-off, U - GLO	1.63883E6	$
01.57%	market for bitumen adhesive compound, hot, cut-off, U - GLO	9.38279E5	$
01.02%	market for inert waste, for final disposal, cut-off, U - GLO	6.07524E5	$
00.75%	market for concrete, for de-icing salt contact, cut-off, U - GLO	4.49568E5	$

ReCiPe Midpoint (H) : Emission



Potential Modal shift Prediction

	Road	Rail	Waterway
JRC(2009)	8.2% of LHVs	-1.5%	same
TML(2008)	25% of LHVs	-3.8%	-2.9%
UBA(2007)	14% of LHVs	-38%	-16%
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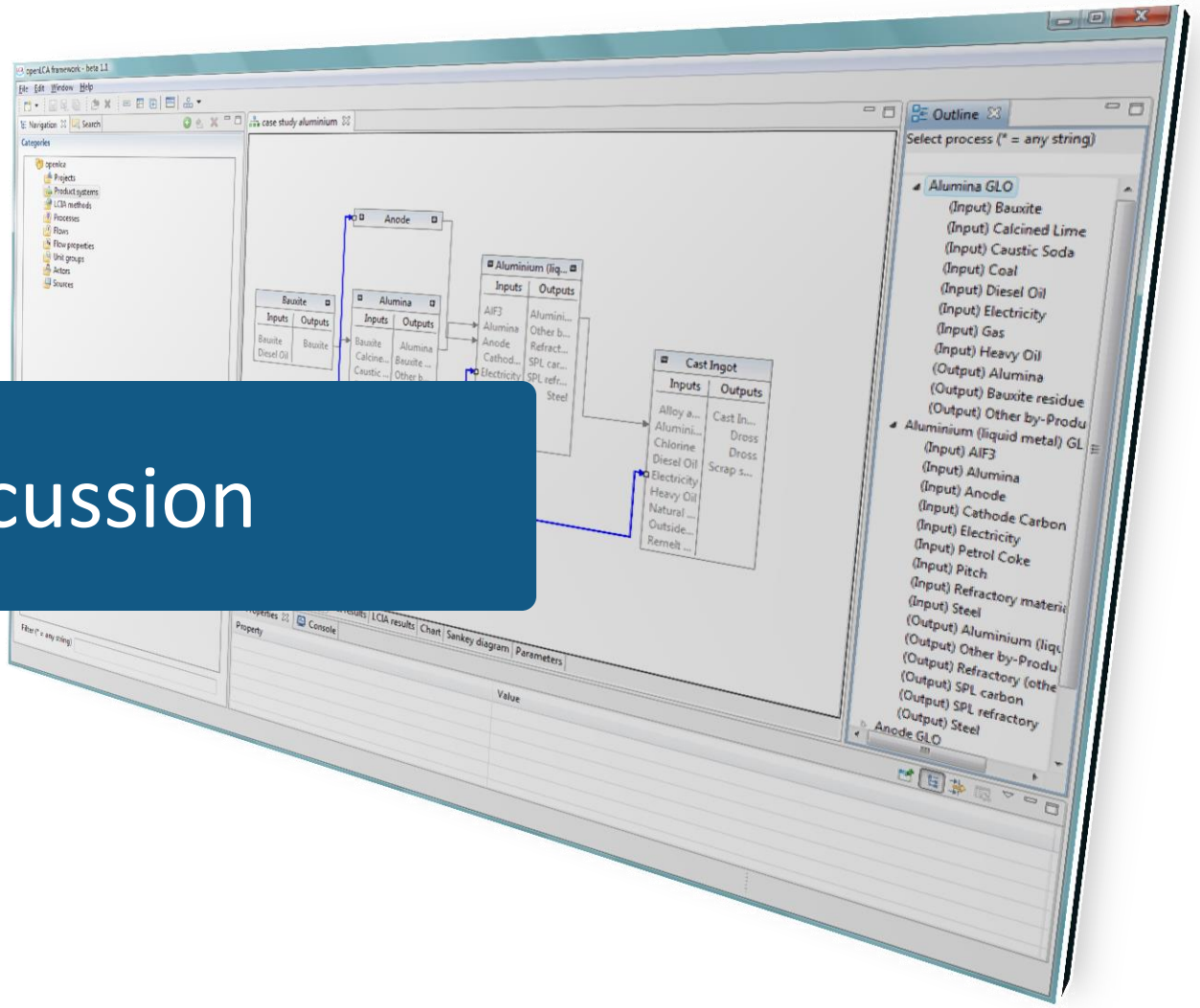
Discussion


Outline
Select process (* = any string)
Alumina GLO
(Input) Bauxite
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(Input) Coal
(Input) Diesel Oil
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(Input) Gas
(Input) Heavy Oil
(Output) Alumina
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Inputs
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Property
Value
Console
Chart
Sankey diagram
Parameters

Discussion

- The JRC & ISI scenario has slightly lower GHG emissions than the basic scenario
- The UBA scenario shows the highest impacts
- The White paper scenario has the lowest impacts
- If the significant modal shift does not occur (JRC & ISI), LHVs could help reduce small amount of emissions
- Still, the best scenario is White Paper, which is 30% less road transport

Conclusion

- If LHVs are permitted, LCA shows the LHVs only reduce a small amount of emissions, but in total impact, it has more environmental impacts
- If the EU wants to reduce emissions, it should try to cut down the road volume
- The 2030 BWVP should try to avoid building new roads
- LCA can support the transport planning and decision-making process

Outlook

- What kind of policy can make a major shift from road to rail and waterway?
- If LHVs are permitted, what kind of policy can avoid the rebound effect? Pricing or usage restriction?

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Thank you!

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