INSTITUTE FOR ENERGY AND ENVIRONMENTAL RESEARCH HEIDELBERG

LCSA from theory and experimental applications to practice: The ILCSA approach

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88th LCA Discussion Forum

DISCUSSION FORUM ON LIFE CYCLE ASSESSMENT

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GREENPEACE

DBU
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Coca-Cola

DAIMLER

And various other companies, associations (national and international), authorities, foundations etc.

Perspective of this presentation: 20+ case studies

>10 years comprehensive prospective sustainability assessments

- **Pathways to defossilisation: bio-based, CO_2 as feedstock, green power/H_2**

Downloads at https://www.ifeu.de/publikationen?tx_solr%5Bq%5D=integrated+sustainability

Perspective of this presentation: 20+ case studies
Typical boundary conditions (at least for us)

- **Substantial effort**, only made if:
  - Substantial investments to be made: time horizon 15-25 years
  - Scalability/replicability is aimed at: range of conditions likely to be diverse
  - In practise: EU-funded (technology development) projects
- Only makes sense **before major decisions are made**
  - Not yet implemented, high uncertainty
  - Project participants with diverse backgrounds
  - Typically many options and variants under discussion: **Goal rather exclusion of options and management of trade-offs** than picking a “winner”

Prospectivity

Uncertainty

Co-creation

Transdisciplinarity

Result integration

Perspective of this presentation: 20+ case studies
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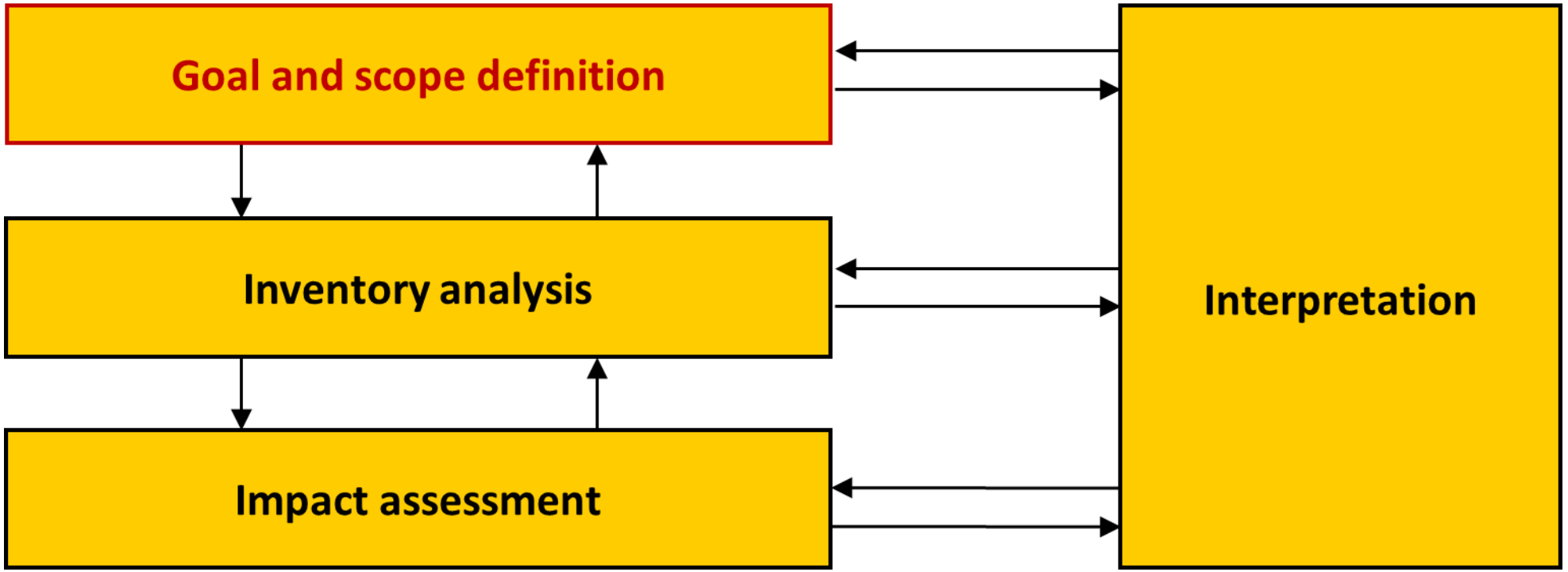
Prospectivity

Uncertainty

Our methodological approach in ILCSA to each specific problem:

- **Use available methodologies as far as they take us**
- **Address all other relevant aspects of a in a coarse and unconventional way**
- **Generalise and integrate helpful aspects as far as possible into our approach**

Integrated life cycle sustainability assessment (ILCSA)



Co-creation, transdisciplinarity in goal, scope and scenario design

Asking useful questions

- **Suitable goal&scope**

  Technology experts phrase guiding questions for us to answer

- **Scenario design together with technology and sustainability experts**
  - Thinking beyond pilot scale and beyond today
    Finding the boundary between visions of future technology development and dreams
  - Indirect effects out of usual scope (e.g. co-benefits in use phase) → enlarge it*
  - Address all good ideas and legitimate concerns

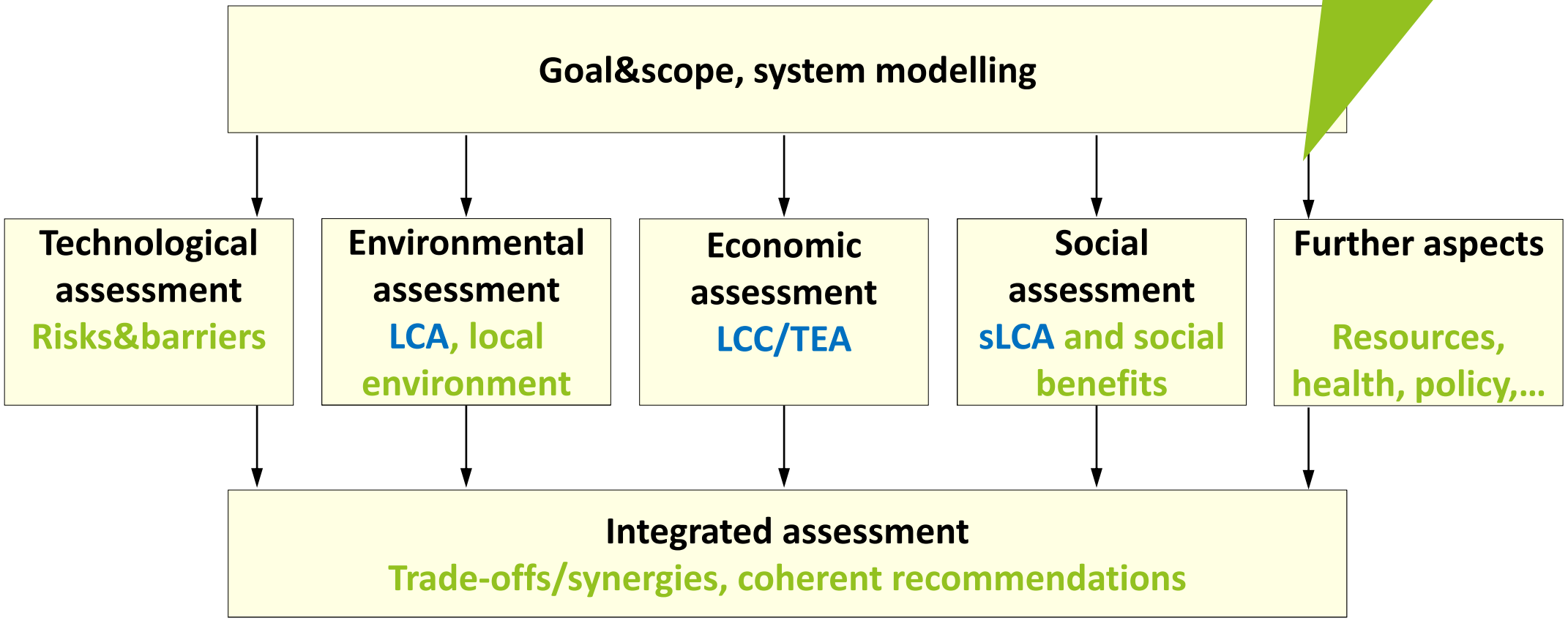
- **Interactive discussion essential**
- **Structured approach to co-creation: workshop on goals and scenarios at start**

*: Examples for non-drop-in bio-based products in H. Keller, N. Rettenmaier: Unconventional product applications: big but often neglected levers for sustainability and success, EUBCE 2024, Marseille

Comprehensive prospective sustainability assessment

Integrated Life Cycle Sustainability Assessment (ILCSA)

More than 3 pillars



- **Goal: strategic decision support for developers, implementers, policy makers**

ILCSA: Keller et al. (2015), http://dx.doi.org/10.1016/j.apenergy.2015.01.095

Comprehensiveness of scope: sustainability beyond the “3 pillars”

Examples from previous and ongoing projects

Further potential impacts

- Local environment (soil, flora, fauna,…)
- Health/safety
- Animal welfare

Further resource aspects

- Biomass availability/potentials
- Circularity
- Criticality

Potential barriers and risks

(“great, but …” → “scenario quality indicators”)

- Technical: complexity, hazard risks, maturity, …
- Regulatory/Policy

Other approaches extending LC(S)A:

- Health and sustainability of food
- Safe and Sustainable by Design (SSbD) for chemicals

Example from practise

- Well meant, bad ending
- Efficiency vs. robustness: make common trade-off transparent in results

- **Do not exclude good ideas and legitimate concerns but make them visible**
- **Flexible framework needed to align/integrate more than “3 pillars”**

Relevant aspects beyond the “3 pillars”

Two current examples: offshore electricity

SUREWAVE

Offshore floating PV

- Local impacts in marine environment: elements of EIA
- Potential conflicts about marine space

surewave.eu

MADE4WIND

Offshore floating wind

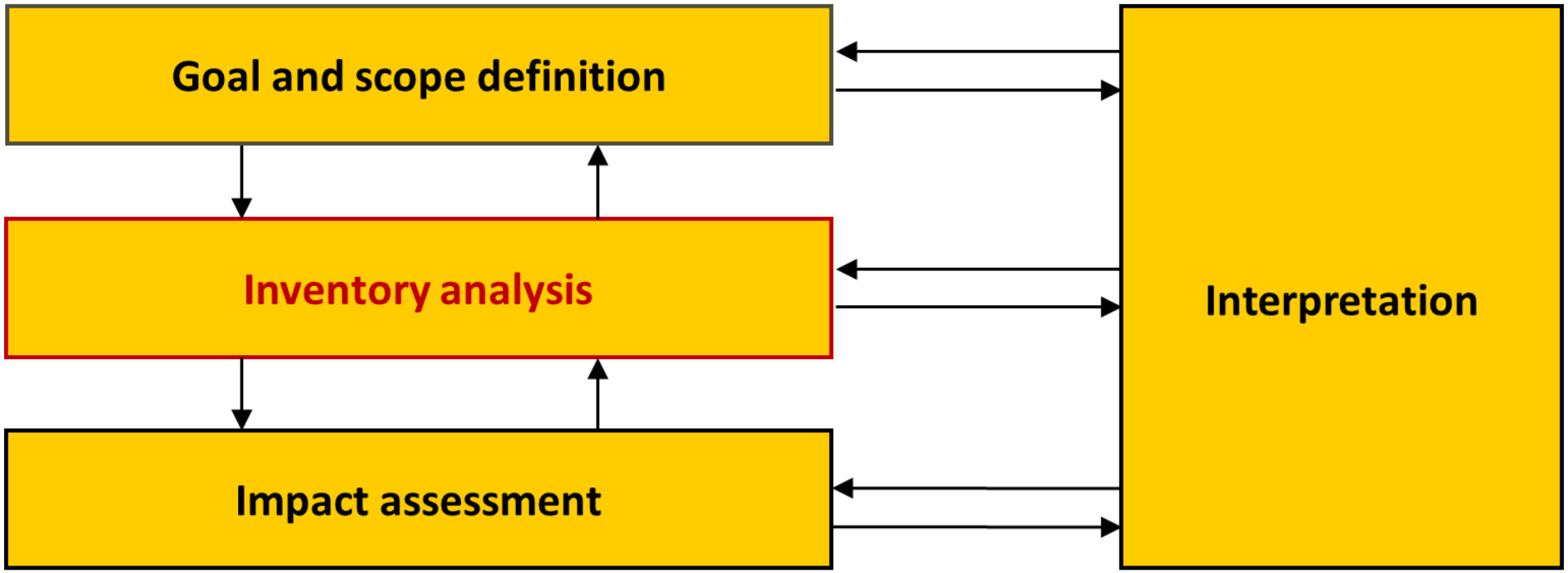
- Local impacts in marine environment: elements of EIA
- Potential conflicts about marine space
- Circularity
- Resource criticality

made4wind.eu

Funded by the European Union

The projects receive funding from the European Union’s Horizon Europe research and innovation programme

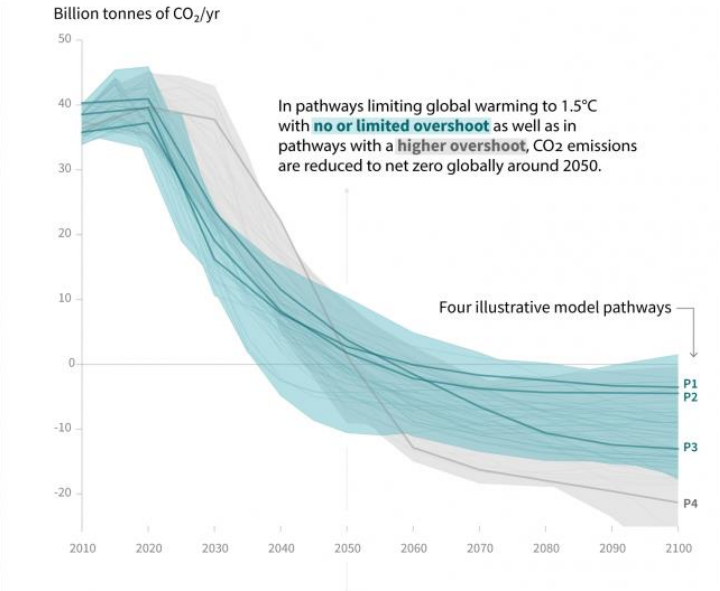
Integrated life cycle sustainability assessment (ILCSA)



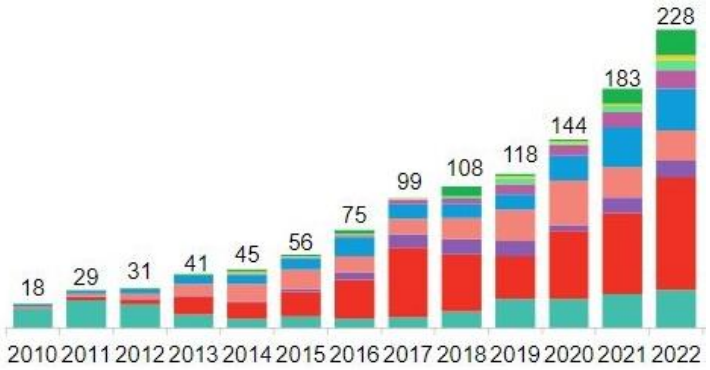
Prospective: How will external influence change in the next 25 years?

Dramatic need for change meets exponential developments

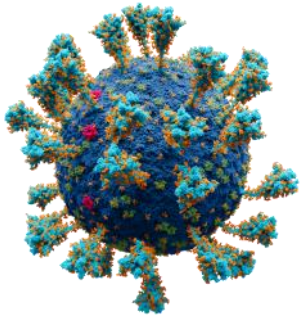
Global CO_2 emission reduction pathways



Global PV installation



Unexpected events



© wikipedia, Solodovnikov et al. 2021, CC BY-SA 4.0

© wikipedia, Government of Ukraine

- **Potentially misleading without prospective LCA, risks and barriers, co-creation**
- **Use ranges of parameters and results**

Sources: IPCC Special Report on Global Warming of 1.5°C
BloombergNEF 2022, https://about.bnef.com/blog/solar-10-predictions-for-2022/

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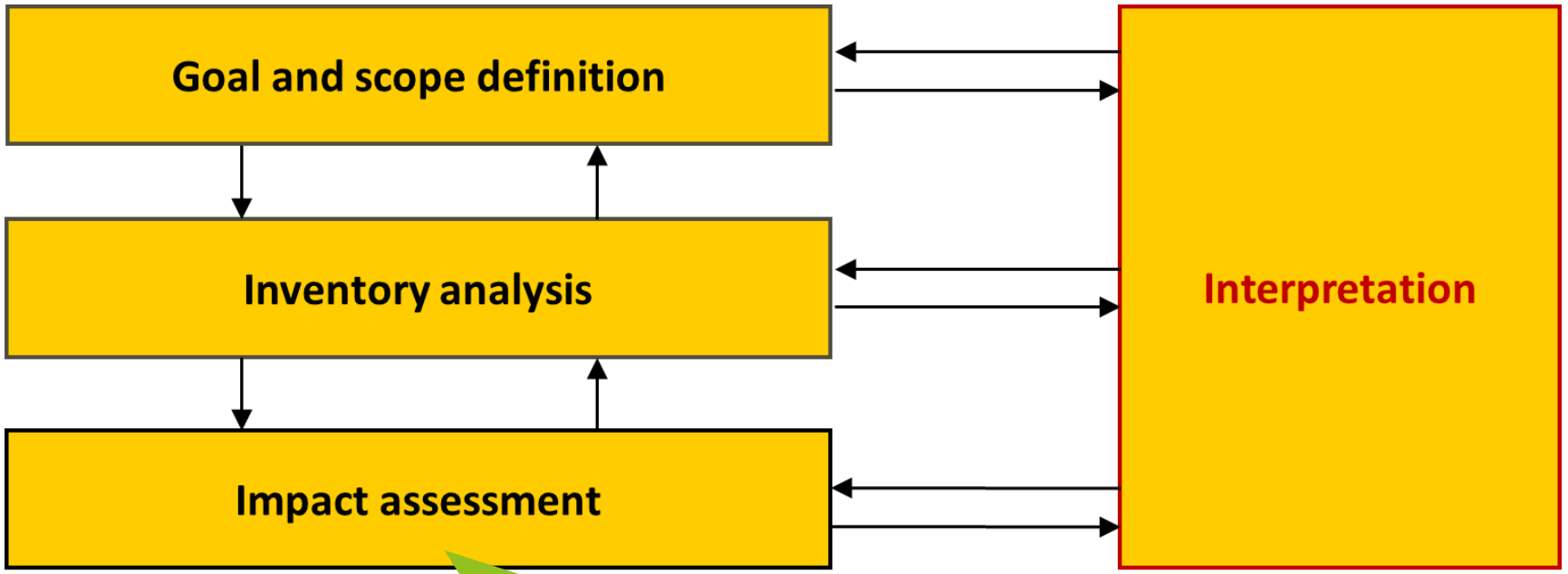

Integrated life cycle sustainability assessment (ILCSA)
Approach for integrating results

“Structured transparent discussion”

1. **Selection of individual indicators**
2. **Collection of qualitative and quantitative results**
3. **Categorisation of all indicators**
4. **Optional: Selection of additional conflict mitigation indicators**
5. **Benchmarking**
6. **Discussion**

Source: Keller, H., Rettenmaier, N., Reinhardt, G. A. (2015): Integrated life cycle sustainability assessment – A practical approach applied to biorefineries. *Applied Energy*, Vol. 154, pp. 1072–1081.

Integrated life cycle sustainability assessment (ILCSA)

Approach for integrating results

		Typical performance													
		UNRAVEL scenarios													
Scenario name in report		Basic scenario (beech)	Lignin to fillers	Residues to heat only	Lignin combustion	Wheat straw, pre-extraction	Wheat straw	Roadside grass, pre-extraction	Birch & bark, pre-extraction	Birch & bark	Mixed feedstock, alternating	Physically mixed feedstocks	Reference (ethanol organosolv)	Wheat straw, France	Wheat straw, Eastern Europe
Environment															
Non-renewable energy use	GJ / t biomass DM input	-4,1	27,6	-4,7	1,4	7,2	3,4	6,5	4,3	-0,2	5,7	5,7	7,2	3,4	3,4
Climate change	t CO2 eq / t biomass DM input	-0,32	1,60	-0,36	0,05	0,43	0,21	0,35	0,21	-0,06	0,32	0,32	0,40	0,21	0,21
Climate change incl. competition	t CO2 eq / t biomass DM input	0,52	2,44	0,48	0,89	1,15	0,92	0,35	0,97	0,70	1,06	1,06	1,24	0,92	0,92
Acidification	kg SO2 eq / t biomass DM input	0,2	5,0	0,4	1,8	2,7	2,5	1,7	1,4	1,1	2,1	2,1	1,5	2,5	2,5
Eutrophication, terrestrial	g PO4 eq / t biomass DM input	-2	368	10	137	370	335	141	130	83	250	250	142	335	335
Eutrophication, aquatic	g PO4 eq / t biomass DM input	17	17	17	17	930	918	21	24	14	477	477	17	918	918
Ozone depletion	g CFC-11 eq / t biomass DM input	-0,7	-0,3	-0,6	-0,4	3,3	3,3	0,1	-0,2	-0,4	1,5	1,5	0,5	3,3	3,3
Summer smog	kg NMVOC eq / t biomass DM input	0,3	3,4	0,3	1,5	1,6	1,3	1,1	1,2	0,9	1,4	1,4	0,9	1,3	1,3
Particulate matter formation	kg PM2,5 eq / t biomass DM input	-0,2	4,4	-0,1	1,6	1,8	1,6	1,1	0,9	0,7	1,4	1,4	0,7	1,6	1,6
Land use	m² aL-eq · a / t biomass DM input	271	290	271	263	-39	-31	-17	-37	-37	-38	-38	320	-31	-31
Phosphate rock use	kg phosphate rock eq / t biomass DM input	23	977	23	24	50	51	25	23	24	37	37	25	51	51
Soil	-	–	–	–	–	o	o	+	–	–	o	o	–	o	o
Water	-	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Biodiversity	-	o	o	o	o	o	o	+	–	–	o	o	o	o	o
Economy															
Investments	Million EUR	289	297	287	289	363	346	352	324	295	363	351	314	344	328
OPEX	€ / t biomass DM input	613	612	619	402	756	684	645	623	563	697	702	745	653	585
Green premium required	% of total product revenue	16%	99%	17%	95%	42%	44%	42%	33%	32%	39%	35%	35%	42%	37%
Society & biomass availability															
Social risks: labor rights and decent work	Thousand medium risk work-hours eq. / t biomass DM input	0,4	-1,3	0,4	0,4	0,3	0,2	0,4	0,8	0,6	0,5	0,5	1,3	0,4	2,8
Social risks: health and Safety	Thousand medium risk work-hours eq. / t biomass DM input	0,3	-2,1	0,4	0,3	1,0	0,9	1,0	0,8	0,5	0,9	0,9	1,3	1,5	6,0
Social risks: human Rights	Thousand medium risk work-hours eq. / t biomass DM input	0,5	-0,8	0,5	0,4	0,4	0,3	0,4	0,7	0,6	0,5	0,5	1,1	0,2	0,8
Social risks: governance	Thousand medium risk work-hours eq. / t biomass DM input	0,6	-1,4	0,6	0,6	0,3	0,2	0,4	1,0	0,9	0,6	0,6	1,7	0,3	7,3
Social risks: community	Thousand medium risk work-hours eq. / t biomass DM input	0,6	-0,6	0,6	0,5	0,3	0,3	0,3	0,8	0,7	0,5	0,5	1,2	0,2	1,4
Creating quality employment	-	o	o	o	o	+	+	o	+	+	+	+	o	+	+
Strengthening rural economies	-	+	+	+	+	+	+	++	+	+	++	++	+	+	+
Sustainable biomass availability	-	–	–	–	–	+	+	o	o	o	++	++	–	+	+

Source: Keller H, Senn J, Reinhardt G, Gärtner S, Rettenmaier N. (2022): Integrated sustainability assessment of an innovative lignocellulose biorefinery concept based on the acetone organosolv process. Final report on integrated assessment. IFEU - Institute for Energy and Environmental Research Heidelberg

Integrated life cycle sustainability

Approach for integrating results

2) Results for scenarios

1) Quantitative and qualitative indicators

3) Categorisation on 5-part scale (colours): absolute if possible

			Typical performance													
			UNRAVEL scenarios													
		Scenario name in report	Basic scenario (beech)	Lignin to fillers	Residues to heat only	Lignin combustion	Wheat straw, pre-extraction	Wheat straw	Roadside grass, pre-extraction	Birch & bark, pre-extraction	Birch & bark	Mixed feedstock, alternating	Physically mixed feedstocks	Reference (ethanol organosolv)	Wheat straw, France	Wheat straw, Eastern Europe
Environment																
	Non-renewable energy use	GJ / t biomass DM input	-4,1	27,6	-4,7	1,4	7,2	3,4	6,5	4,3	-0,2	5,7	5,7	7,2	3,4	3,4
	Climate change	t CO2 eq / t biomass DM input	-0,32	1,60	-0,36	0,05	0,43	0,21	0,35	0,21	-0,06	0,32	0,32	0,40	0,21	0,21
	Climate change incl. competition	t CO2 eq / t biomass DM input	0,52	2,44	0,48	0,89	1,15	0,92	0,35	0,97	0,70	1,06	1,06	1,24	0,92	0,92
	Acidification	kg SO2 eq / t biomass DM input	0,2	5,0	0,4	1,8	2,7	2,5	1,7	1,4	1,1	2,1	2,1	1,5	2,5	2,5
	Eutrophication, terrestrial	g PO4 eq / t biomass DM input	-2	368	10						83	250	250	142	335	335
	Eutrophication, aquatic	g PO4 eq / t biomass DM input	17	17							14	477	477	17	918	918
	Ozone depletion	g CFC-11 eq / t biomass DM input	-0,7	-0,3							-0,4	1,5	1,5	0,5	3,3	3,3
	Summer smog	kg NMVOC eq / t biomass DM input	0,3	3,4							0,9	1,4	1,4	0,9	1,3	1,3
	Particulate matter formation	kg PM2,5 eq / t biomass DM input	-0,2	4,4							0,7	1,4	1,4	0,7	1,6	1,6
	Land use	m² aL-eq · a / t biomass DM input	271	290							-37	-38	-38	320	-31	-31
	Phosphate rock use	kg phosphate rock eq / t biomass DM input	23								24	37	37	25	51	51
	Soil	-	–	–							–	o	o	–	o	o
	Water	-	o	o							o	o	o	o	o	o
	Biodiversity	-	o	o	o	o	o	o	+	–	–	o	o	o	o	o
Economy																
	Investments	Million EUR	289	297	287	289	363	346	352	324	295	363	351	314	344	328
	OPEX	€ / t biomass DM input	613	612	619	402	756	684						745	653	585
	Green premium required	% of total product revenue	16%	99%	17%	95%	42%							35%	42%	37%
Society & biomass availability																
	Social risks: labor rights and decent work	Thousand medium risk work-hours eq. / t biomass DM input	0,4	-1,3	0,4	0,4	0,3	0,2						1,3	0,4	2,8
	Social risks: health and Safety	Thousand medium risk work-hours eq. / t biomass DM input	0,3	-2,1	0,4	0,3	1,0	0,9						1,3	1,5	6,0
	Social risks: human Rights	Thousand medium risk work-hours eq. / t biomass DM input	0,5	-0,8	0,5	0,4	0,4	0,3						1,1	0,2	0,8
	Social risks: governance	Thousand medium risk work-hours eq. / t biomass DM input	0,6	-1,4	0,6	0,6	0,3	0,2	0,4	1,0	0,9	0,6	0,6	1,7	0,3	7,3
	Social risks: community	Thousand medium risk work-hours eq. / t biomass DM input	0,6	-0,6	0,6	0,5	0,3	0,3	0,3	0,8	0,7	0,5	0,5	1,2	0,2	1,4
	Creating quality employment	-	o	o	o	o	+	+	o	+	+	+	+	o	+	+
	Strengthening rural economies	-	+	+	+	+	+	+	++	+	+	++	++	+	+	+
	Sustainable biomass availability	-	–	–	–	–	+	+	o	o	o	++	++	–	+	+

Source: Keller H, Senn J, Reinhardt G, Gärtner S, Rettenmaier N. (2022): Integrated sustainability assessment of an innovative lignocellulose biorefinery concept based on the acetone organosolv process. Final report on integrated assessment. IFEU - Institute for Energy and Environmental Research Heidelberg

Integrated life cycle sustainability assessment (ILCSA)

Approach for integrating results

Step 4: Selection of additional conflict mitigation indicators

		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9	Scenario 10	Scenario 11
Society	Indicator 1	+	+	0	0	0	0	0	+	+	+	+
	Indicator 2	+	+	0	0	0	0	0	0	0	0	0
	Indicator 3	+	+	0	0	0	0	0	0	0	0	0
	Indicator 4	+	+	+	+	-	-	-	+	+	+	+
	Indicator …	+	+	0	0	0	0	0	-	-	-	-
Environment	Indicator 1	-2,3	-1,1	0,2	0,3							-0,5
	Indicator 2	-40,5	-20,7	2,7	5,							-9,6
	Indicator 3	-3,9	-2,3	0,4	1,							0,0
	Indicator 4	-0,2	0,0	0,1	0,							0,0
	Indicator 5	+	0	-	-							+
	Indicator …	+	0	0	0							+
Economy	Indicator 1	190	-30	378	-42							147
	Indicator 2	-40,5	-20,7	2,7	5,5	-18,0	-22,9	-4,5	-10,2	-13,0	-7,6	-9,6
	Indicator 3	-3,9	-2,3	0,4	1,4	-1,7	-1,8	-1,1	-2,1	-0,6	0,4	0,0
	Indicator 4	+	+	-	-	-	-	-	+	+	0	0
	Indicator …	0	+	-	+	+	0	0	+	+	+	+

4) E.g.: CO_2 avoidance costs (if something can be avoided at a certain monetary expense)

Source: Keller, H., Rettenmaier, N., Reinhardt, G. A. (2015): Integrated life cycle sustainability assessment – A practical approach applied to biorefineries. *Applied Energy*, Vol. 154, pp. 1072–1081.

Integrated life cycle sust… t (ILCSA)

Approach for integrating…

5) Front-runner selected for benchmarking

Benchmarking algorithm can include result ranges

		Typical performance													
		UNRAVEL scenarios													
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Climate change	t CO2 eq / t biomass DM input	-0,32	1,60	-0,36	0,05	0,43	0,21	0,35	0,21	-0,06	0,32				
Climate change incl. competition	t CO2 eq / t biomass DM input	0,52	2,44	0,48	0,89	1,15	0,92	0,35	0,97	0,70	1,06				
Acidification	kg SO2 eq / t biomass DM input	0,2	5,0	0,4	1,8	2,7	2,5	1,7	1,4	1,1	2,1				
Eutrophication, terrestrial	g PO4 eq / t biomass DM input	-2	368	10	137	370	335	141	130	83	250				
Eutrophication, aquatic	g PO4 eq / t biomass DM input	17	17	17	17	930	918	21	24	14	477				
Ozone depletion	g CFC-11 eq / t biomass DM input	-0,7	-0,3	-0,6	-0,4	3,3	3,3	0,1	-0,2	-0,4	1,5				
Summer smog	kg NMVOC eq / t biomass DM input	0,3	3,4	0,3	1,5	1,6	1,3	1,1	1,2	0,9	1,4				
Particulate matter formation	kg PM2,5 eq / t biomass DM input	-0,2	4,4	-0,1	1,6	1,8	1,6	1,1	0,9	0,7	1,4				
Land use	m² aL-eq · a / t biomass DM input	271	290	271	263	-39	-31	-17	-37	-37	-38				
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Soil	-	–	–	–	–	o	o	+	–	–	o				
Water	-	o	o	o	o	o	o	o	o	o	o				
Biodiversity	-	o	o	o	o	o	o	+	–	–	o	o	o	o	o
Economy															
Investments	Million EUR	289	297	287	289	363	346	352	324	295	363	351	314	344	328
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Society & biomass availability															
Social risks: labor rights and decent work	Thousand medium risk work-hours eq. / t biomass DM input	0,4	-1,3	0,4	0,4	0,3	0,2	0,4	0,8	0,6	0,5	0,5	1,3	0,4	2,8
Social risks: health and Safety	Thousand medium risk work-hours eq. / t biomass DM input	0,3	-2,1	0,4	0,3	1,0	0,9	1,0	0,8	0,5	0,9	0,9	1,3	1,5	6,0
Social risks: human Rights	Thousand medium risk work-hours eq. / t biomass DM input	0,5	-0,8	0,5	0,4	0,4	0,3	0,4	0,7	0,6	0,5	0,5	1,1	0,2	0,8
Social risks: governance	Thousand medium risk work-hours eq. / t biomass DM input	0,6	-1,4	0,6	0,6	0,3	0,2	0,4	1,0	0,9	0,6	0,6	1,7	0,3	7,3
Social risks: community	Thousand medium risk work-hours eq. / t biomass DM input	0,6	-0,6	0,6	0,5	0,3	0,3	0,3	0,8	0,7	0,5	0,5	1,2	0,2	1,4
Creating quality employment	-	o	o	o	o	+	+	o	+	+	+	+	o	+	+
Strengthening rural economies	-	+	+	+	+	+	+	++	+	+	++	++	+	+	+
Sustainable biomass availability	-	–	–	–	–	+	+	o	o	o	++	++	–	+	+

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Integrated life cycle sustainability assessment (ILCSA)

Approach for integrating results

Example from practise
Conflict resolution: optimise reactor design

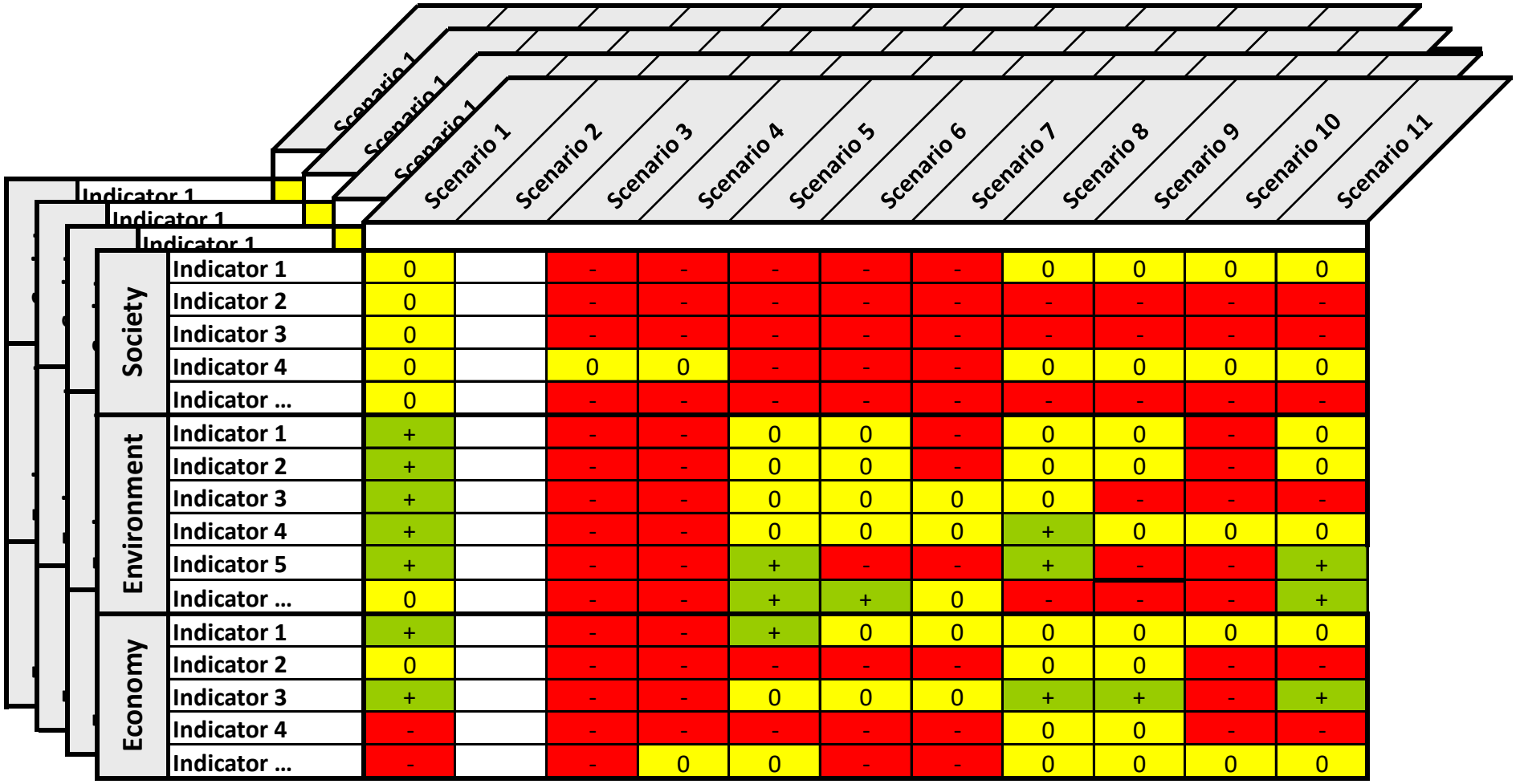
Scenario name in report	Benchmarking: Basic scenario (beech)	UNRAVEL scenarios: Lignin to fillers	Residues to heat only	Lignin combustion	Wheat straw, pre-extraction	Wheat straw	Roadside grass, pre-extraction	Birch & bark, pre-extraction	Birch & bark	Mixed feedstock, alternating	Mixed feedstocks	(ethanol organosolv)	France	Eastern Europe
Indicator														
Climate change		–	+	+	o	+	o	+	+	o	o	o	+	+
Climate change incl. competition		–	o	–	–	–	o	–	o	–	–	–	–	–
Acidification		– –	o	–	–	–	–	–	–	–	–	–	–	–
Eutrophication, terrestrial		– –	o	–	– –	– –	–	–	–	–	–	–	– –	– –
Eutrophication, aquatic		o	o	o	– –	– –	o	o	o	–	–	o	– –	– –
Ozone depletion		–	o	o	– –	– –	–	–	–	–	–	–	– –	– –
Summer smog		– –	o	–	–	–	–	–	–	–	–	–	–	–
Particulate matter formation		– –	o	–	–	–	–	–	–	–	–	–	–	–
Land use		o	o	o	++	++	++	++	++	++	++	–	++	++
Phosphate rock use		– –	o	o								o	o	o
Soil		o	o	o	+	+	++	o	o		+	o	+	+
Water		o	o	o	o	o	o	o	o					
Biodiversity		o	o	o	o	o	+	–	–					
Economy														
Investments		–	o	o	– –	–	–	–	o					
OPEX		o	–	++	– –	– –	–	–	+					
Green premium required		– –	o	– –	–	–	–	–	–					
Society & biomass availability														
Labor rights and decent work		+	o	o	o	o	o	–	o					
Health and Safety		+	o	o	–	–	–	o	o	o	o	–	–	– –
Human Rights		+	o	o	o	o	o	–	o	o	o	–	+	–
Governance		+	o	o								–	o	– –
Community		+	o	o	+	+	+	–	o	o	o	–	+	–
Creating quality employment		o	o	o	+	+	o	+	+	+	+	o	+	+
Strengthening rural economies		o	o	o	o	o	+	o	o	+	+	o	o	o
Sustainable biomass availability		o	o	o	++	++	+	+	+	++	++	o	++	++

5) Benchmarking to identify foregone benefits

Source: Keller H, Senn J, Reinhardt G, Gärtner S, Rettenmaier N. (2022): Integrated sustainability assessment of an innovative lignocellulose biorefinery concept based on the acetone organosolv process. Final report on integrated assessment. IFEU - Institute for Energy and Environmental Research Heidelberg

Integrated life cycle sustainability assessment (ILCSA)

Step 6: Discussion



		Scenario 1		Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9	Scenario 10	Scenario 11
Society	Indicator 1	0		-	-	-	-	-	0	0	0	0	
	Indicator 2	0		-	-	-	-	-	-	-	-	-	
	Indicator 3	0		-	-	-	-	-	-	-	-	-	
	Indicator 4	0		0	0	-	-	-	0	0	0	0	
	Indicator …	0		-	-	-	-	-	-	-	-	-	
Environment	Indicator 1	+		-	-	0	0	-	0	0	-	0	
	Indicator 2	+		-	-	0	0	-	0	0	-	0	
	Indicator 3	+		-	-	0	0	0	0	-	-	-	
	Indicator 4	+		-	-	0	0	0	+	0	0	0	
	Indicator 5	+		-	-	+	-	-	+	-	-	+	
	Indicator …	0		-	-	+	+	0	-	-	-	+	
Economy	Indicator 1	+		-	-	+	0	0	0	0	0	0	
	Indicator 2	0		-	-	-	-	-	0	0	-	-	
	Indicator 3	+		-	-	0	0	0	+	+	-	+	
	Indicator 4	-		-	-	-	-	-	0	0	-	-	
	Indicator …	-		-	0	0	-	-	0	0	0	0	

Source: Keller, H., Rettenmaier, N., Reinhardt, G. A. (2015): Integrated life cycle sustainability assessment – A practical approach applied to biorefineries. *Applied Energy*, Vol. 154, pp. 1072–1081.

Integrated life cycle sustainability assessment (ILCSA)
Benefits of structured transparent discussion

- Open for qualitative/semi-quantitative results
- Open for results from all methodologies
- Decision support for next development step:
  - Resolving trade-offs as far as possible
  - Exclude many options without specific advantages
  - Highlight remaining trade-offs for qualified decision process including relevant stakeholders

Your experience:
Benefits from weighting or outranking algorithms not available in ILCSA?
Acceptance of resulting decisions?

- **Allows for transparent management of complexity**
- **No decisions hidden in a “black box” model/algorithm**
- **Complete solution for complex (=real life) problems are hardly ever objective**

Source: Keller, H., Rettenmaier, N., Reinhardt, G. A. (2015): Integrated life cycle sustainability assessment – A practical approach applied to biorefineries. *Applied Energy*, Vol. 154, pp. 1072–1081.

Take home messages: ILCSA - our approach to implement LCSA in practise

Aim at practicable decision support

- **Structured approach to co-creation**: workshop on goals, scope and scenarios at start
  - Do not leave valuable ideas and concerns to chance
- **Include relevant ideas, concerns and knowledge** also if they don't fit the scheme
  - Effects not reflected in LC(S)A indicators → add new, mostly qualitative indicators
  - Indirect effects out of the usual scope → enlarge scope
- **Meet needs of decision making process**
  - Narrow down options
  - Resolve or highlight trade-offs
  - Don't try to make an algorithm decide for the stakeholders
- ILCSA framework can **integrate uncertainty, unconventional and qualitative aspects**
  - Pre-defined weighting/ranking algorithms are prone to exclude important available facts
  - Structured transparent discussion supported by semi-standardised benchmarking

Take home messages: ILCSA - our approach to implement LCSA in practise

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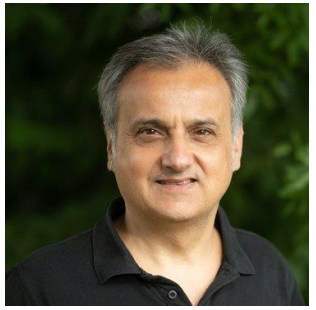
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