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# Structured Integration of Social Sustainability in Strategic Network Design: The Case of Bioethanol Production in the EU

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# Introduction

## Social Aspects in OR Models for Social Network Design

**Conclusion of Messmann et al., 2020** (<https://doi.org/10.1016/j.jclepro.2020.120459>)

*How to quantify social impacts in strategic supply chain optimization: State of the art*

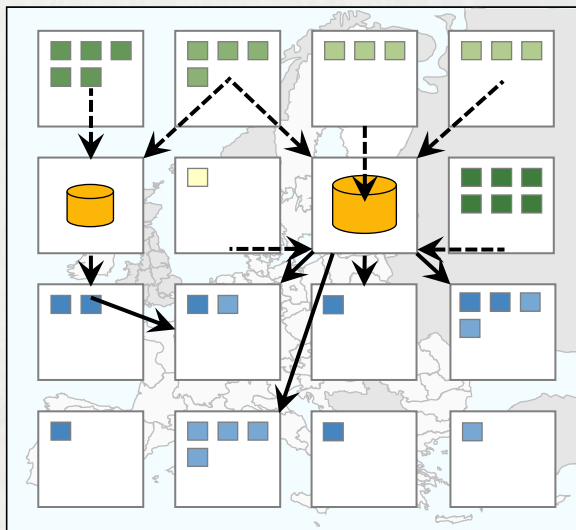
- Existing frameworks (e.g. UNEP’s SLCA guidelines, GRI Standards, ISO 26000) are rarely cited
- Articles that cite a framework use a higher number of social parameters per article than those that don’t, however...
- ... employment creation is by far the most dominating aspect/goal (and often the only or primary one)






Consequently, *jobs created* is the only consistently used indicator in optimization models for the quantification of decisions (followed by *days lost*, *local development*, and generic *social scores*)

- *Comprehensive set of applicable indicators needed*
- *Need for a structured indicator selection process based on existing social frameworks*
- *The Social Hotspots Database (SHDB) would provide an impact assessment method, similar to LCA endpoints*

1. Provide a **reproducible and tangible approach** for the **selection of social indicators** for a given application case (here: strategic bioethanol production planning in the EU)
2. What are the benefits of **optimal second-generation ethanol production network configurations** to substitute **petrol and first-generation ethanol**, considering different **environmental, economic, and social aspects**?

### Strategic supply chain network design



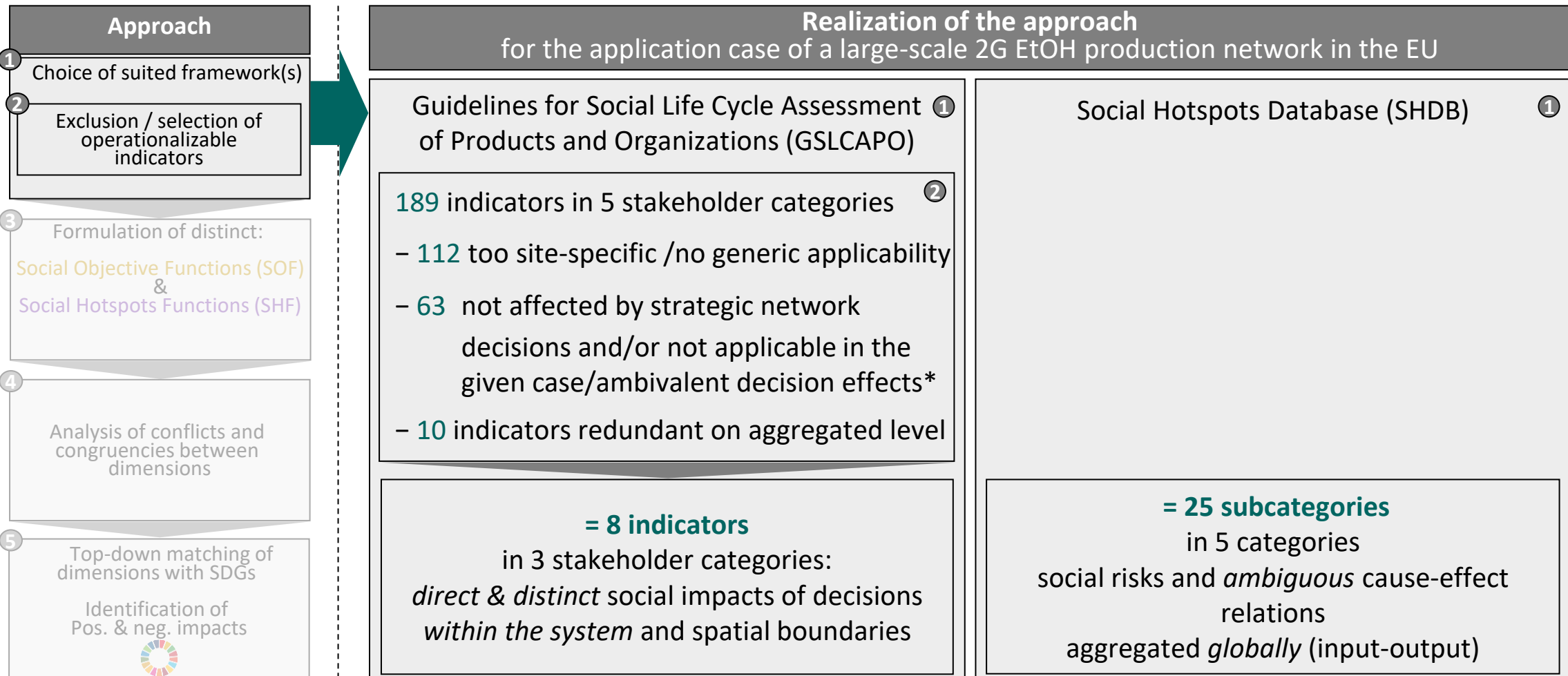
-  Feedstock type and amount per region
-  Feedstock transport mode and amount
-  Biorefinery location and production capacity
-  Bioethanol transport mode and amount
-  Bioethanol distribution and substitution

- > **5 taxation scenarios for economic profit**
- > **3 environmental damage categories**
- > **18 environmental impact categories**
- > **X social aspects**

Environmental benefits of large-scale second-generation bioethanol production in the EU: An integrated supply chain network optimization and Life Cycle Assessment approach  
*J. of Ind. Ecology* **2020**, <https://doi.org/10.1111/jiec.13083>

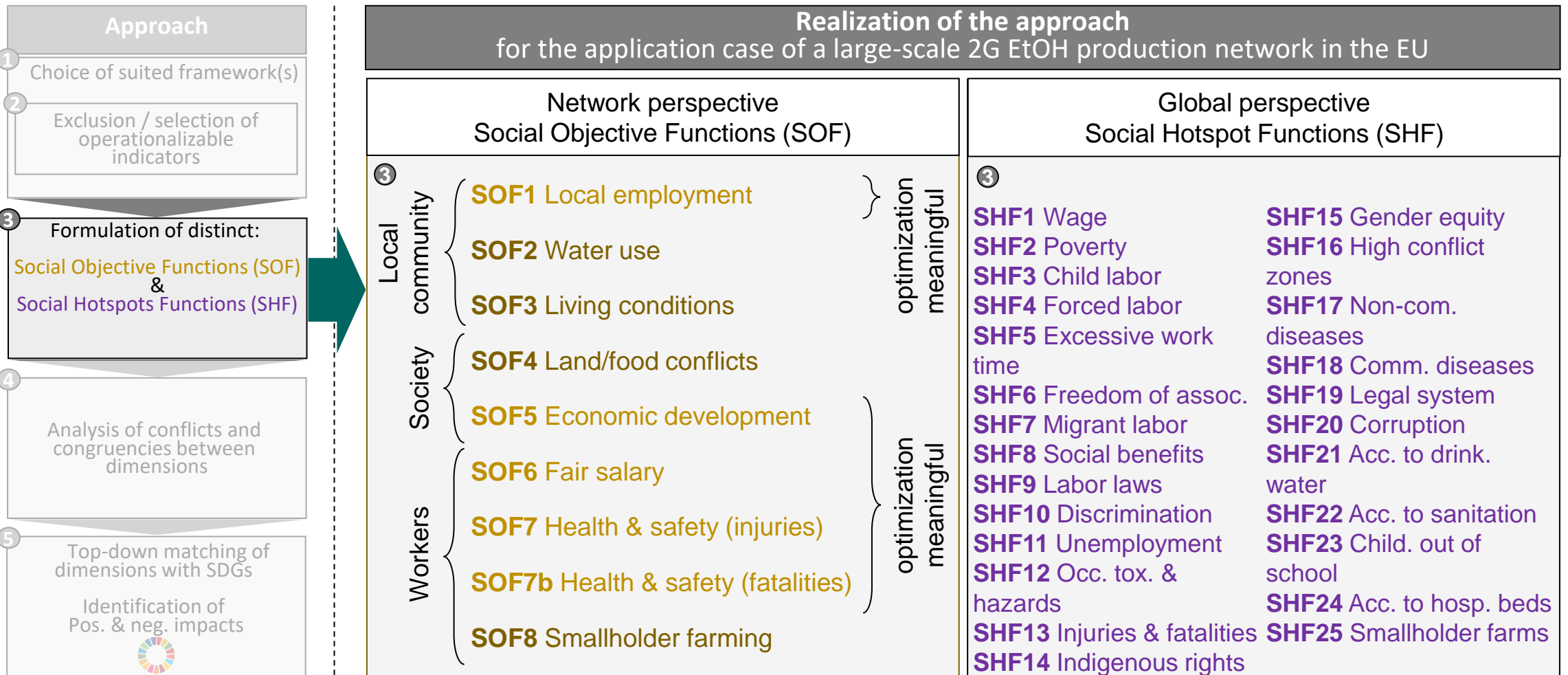
# Method

## Research approach and indicator selection



# Method

## Research approach and indicator selection



# Method

## Modelling the social dimension


Number of jobs created by decision

Any decision variable (DV) in region r

Social objective function	Generic formulation	Example
1) Local Employment	$\text{maximize: } DV_r * \text{job factor}_r * \frac{\text{unemployment rate}_r}{\text{unemployment rate}_{EU27}}$	DE2 (Bavaria): 0.30 → 2.0% ES6 (Andalusia): 3.02 → 6.6% → 19.9% → 6.6%

### Social Objective Functions alone lead to completely unrealistic results

- E.g. SOF1: Created jobs weighted by regional unemployment rate

 No product output is delivered → as no additional jobs are created (or even “substituted”)

 Build the largest possible Biorefineries wherever allowed → due to biorefinery jobs and construction jobs

 Source as much feedstock as possible from as far as possible → due to transportation jobs

 Use the transport mode that has the highest specific job factor → due to transportation jobs

→ To force the model into certain boundaries, a large number of constraints are necessary.



# Results

## Single objective optimization reveals conflicts between social and economic dimension

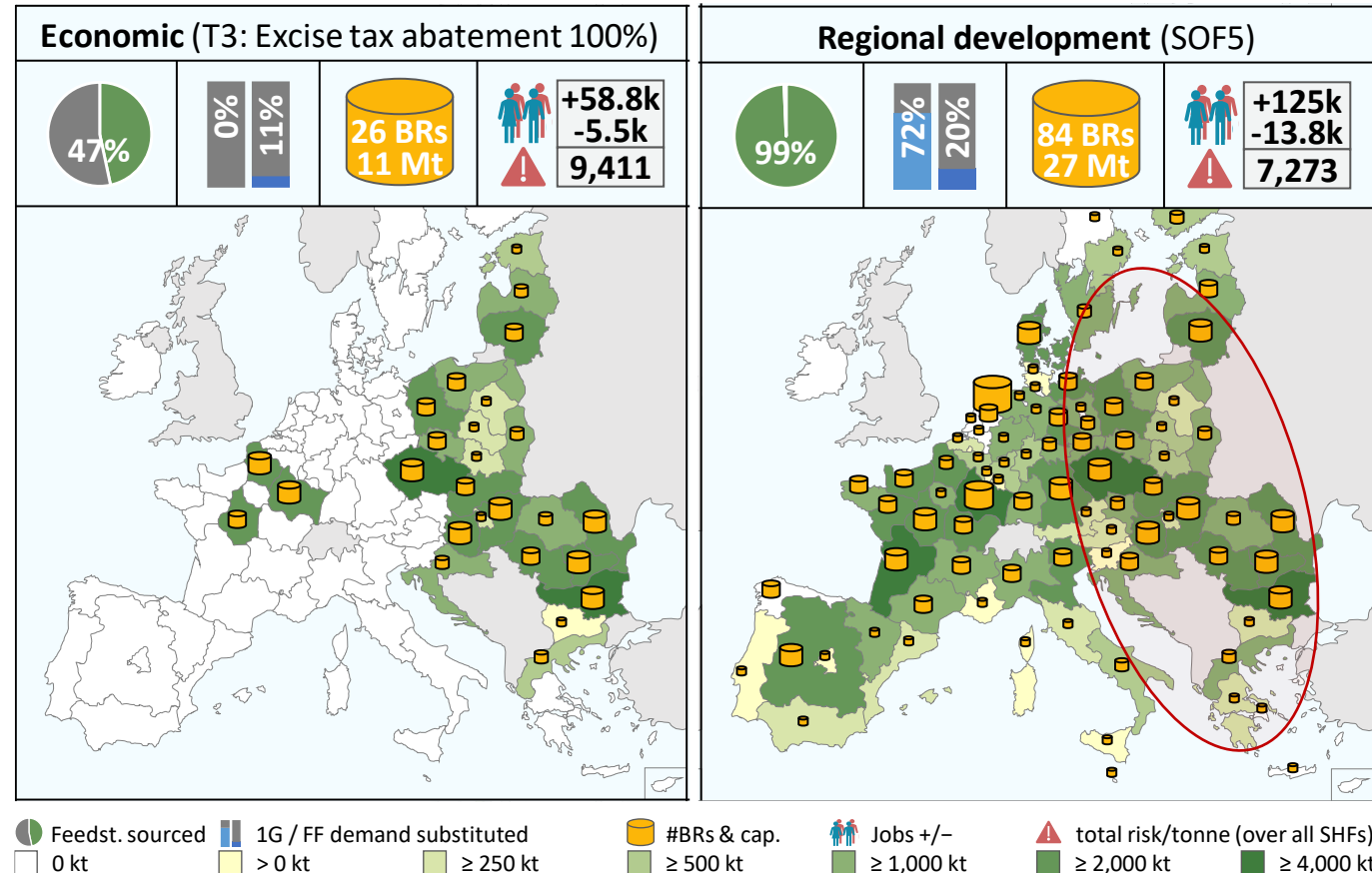


### Economic

- Network concentrated on Central and Eastern European regions
- Smaller and more centralized network
- About 60.000 jobs created in the EU

### Social

- Concentration of activities on regions with benefits for selected objective
- Economically strong metropolitan areas are significantly less focused than rural regions
- About 125.00 jobs created in the EU

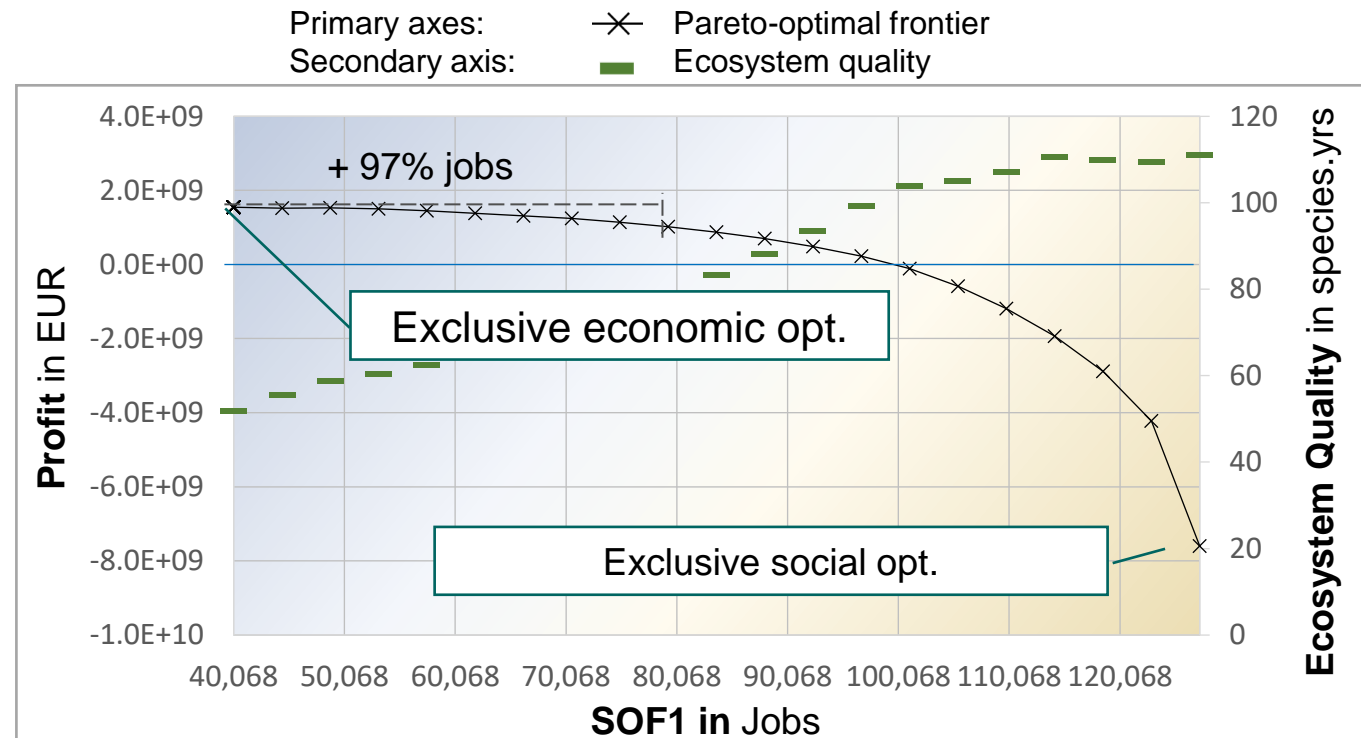


# Results

## Multi criteria optimization reveals similar behavior of social and environmental dimension

### Economic vs. Social

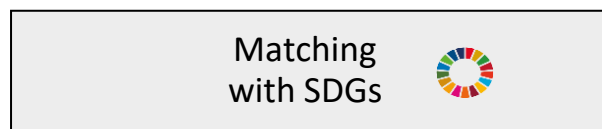
- Profit and number of jobs created are not contradictory to a certain extend
- It is possible to double the number of jobs created without strong decrease of the economic outcome
- Benefits in the ecosystem quality more then doubles from economic optimal to social optimal result





# Results

SDG matching shows that in many cases it is difficult to pursue one SDG without violating others



All objective functions are matched with SDGs to identify positive and negative impacts.

## SDG 8 Decent work and economic development:

- Job creation (SOF1)
- Profit (EC-t3)
- Regional Development (SOF5)
- Fair salary (SOF6)
- Health & safety workers (SOF7)

Almost identical	+++
Very similar	++
Partly similar	+
Neutral	0
Conflicting	-
Very conflicting	--

SDG	Optimization towards	SDG																		
		SDG3	SDG3	SDG3	SDG6	SDG7	SDG8	SDG8	SDG8	SDG8	SDG8	SDG8	SDG10	SDG11	SDG11	SDG12	SDG13	SDG14	SDG15	
Zero hunger	SDG2	+++	+	++	0	++	+	++	+	++	+	+	--	+++	+	++	+++	+++	+++	++
Zero hunger	SDG2	0	+	0	+	+	0	+	0	0	0	+++	--	0	-	0	0	0	0	0
Good health and well-being	SDG3	+++	++	+	+	+	++	+	++	++	++	0	0	++	+	+++	++	+++	+++	+++
Good health and well-being	SDG3	++	++	++	+++	+++	+++	+++	+++	0	-	+++	+++	0	++	++	++	+	++	++
Clean water and sanitation	SDG6	+	++	+++	+++	-	+	-	--	--	0	0	--	+++	+	--	--	+	+	+
Clean water and sanitation	SDG6	0	0	-	0	+	0	+	0	0	+++	+++	0	-	0	0	0	0	0	0
Affordable and clean energy	SDG7	--	--	--	--	+++	--	+++	--	--	0	0	--	--	--	--	--	--	--	--
Decent work and economic growth	SDG8	++	+	+	+	+	+++	+	++	++	0	0	++	+	++	++	++	++	++	++
Decent work and economic growth	SDG8	--	--	--	--	+++	--	+++	--	--	0	0	--	--	--	--	--	--	--	--
Decent work and economic growth	SDG8	++	+	+	+	+	++	+	+++	++	0	0	+++	+	++	++	++	++	++	++
Decent work and economic growth	SDG8	++	+	+	+	+	++	+	++	+++	0	0	++	+	++	++	++	++	++	++
Decent work and economic growth	SDG8	--	--	--	--	--	--	--	--	--	+++	0	--	--	--	--	--	--	--	--
Decent work and economic growth	SDG8	-	+	++	++	0	--	0	--	--	+++	+++	--	++	-	-	-	-	-	-
Industry, innovation and infrastructure	SDG9	0	+	0	+	+	0	+	0	0	+++	--	0	-	0	0	0	0	0	0
Reduced inequalities	SDG10	++	+	+	+	+	++	+	+++	++	0	0	+++	+	++	++	++	++	++	++
Sustainable cities and communities	SDG11	++	++	+++	+++	-	++	-	-	-	0	0	-	+++	++	-	-	++	++	++
Sustainable cities and communities	SDG11	+++	++	+	+	+	++	+	++	++	0	0	++	+	+++	++	++	+++	+++	+++
Sustainable cities and communities	SDG11	++	++	++	+++	+++	+++	+++	0	-	+++	+++	0	++	++	++	+	++	++	++
Responsible consumption and production	SDG12	++	+	+	+	+	++	+	++	++	0	0	++	+	++	+++	+++	++	++	++
Climate action	SDG13	++	+	+	+	+	++	+	++	++	0	0	++	+	++	+++	+++	++	++	++
Life below water	SDG14	+++	++	++	++	+	++	+	+	+	0	0	+	++	+++	++	++	+++	+++	+++
Life on land	SDG15	+++	++	++	++	+	++	+	+	+	0	0	+	++	+++	++	++	+++	+++	+++
Life on land	SDG15	+++	++	++	++	+	++	+	+	+	0	0	+	++	+++	+	+	+++	+++	+++



Thank you for your attention!

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## Backup