WP4 – PRESENTATION

22/04/2024, Thessaloniki, Greece

CERESiS

ContaminatEd land Remediation through Energy crops for Soil improvement to liquid biofuel Strategies

Our partners

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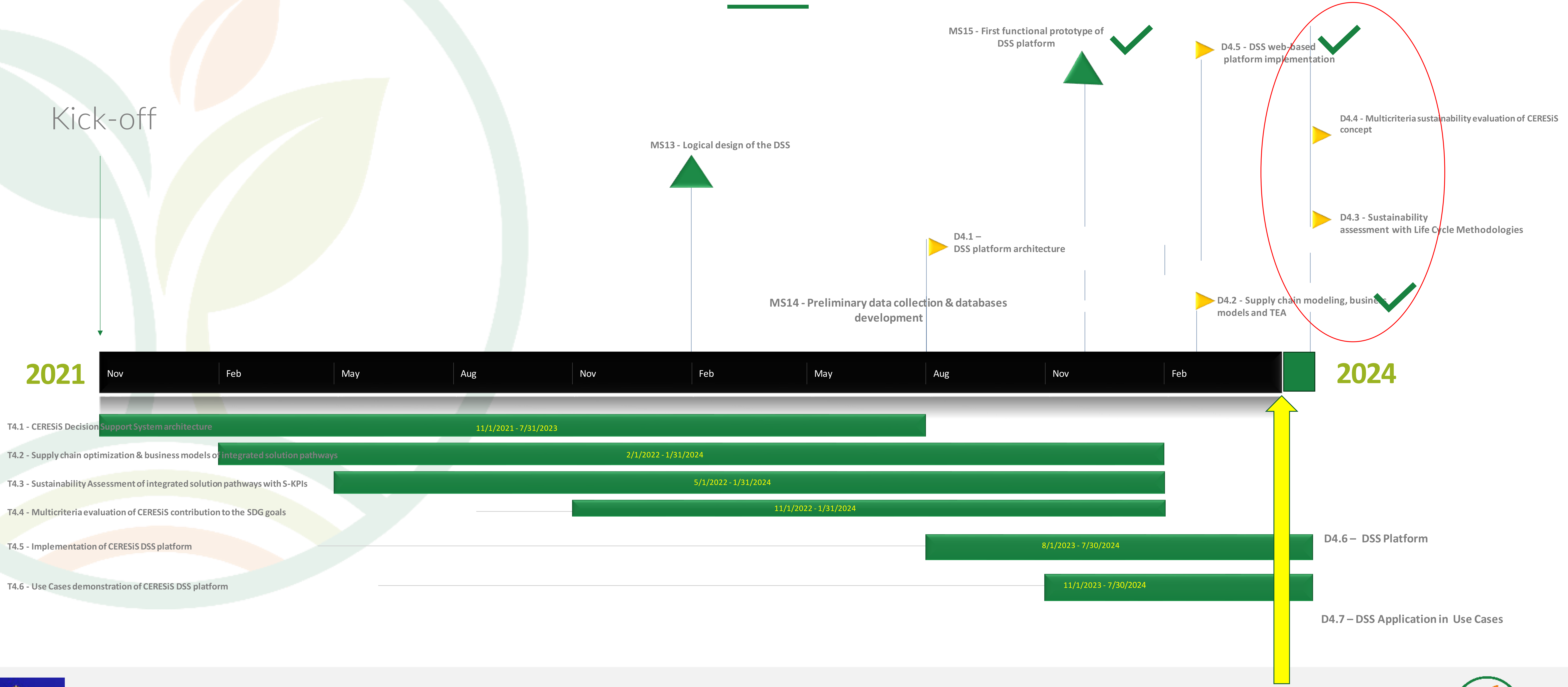
WP4: Objectives

- Sustainability evaluation of the integrated production pathways identified in WP1 by quantifying customized KPIs reflecting the CERESiS contribution towards meeting the SDGs.
- Development and implementation of evaluation tools based on Life Cycle Analysis and Supply Chain optimization methodologies.
- Understanding of potential applicable business models.
- Development and implementation of a dedicated DSS platform providing critical information to decision makers on the suitability of pathways consisting of combinations of energy crops and biofuel conversion technologies for specific applications
- Application of the DSS for a number of real-life Use Cases

WP4: Gantt


Kick-off
MS13 - Logical design of the DSS
MS15 - First functional prototype of DSS platform
D4.5 - DSS web-based platform implementation
D4.4 - Multicriteria sustainability evaluation of CERESiS concept
D4.3 - Sustainability assessment with Life Cycle Methodologies
D4.1 – DSS platform architecture
MS14 - Preliminary data collection & databases development
D4.2 - Supply chain modeling, business models and TEA
2021
Nov
Feb
May
Aug
Nov
Feb
May
Aug
Nov
Feb
2024
T4.1 - CERESiS Decision Support System architecture
11/1/2021 - 7/31/2023
T4.2 - Supply chain optimization & business models of integrated solution pathways
2/1/2022 - 1/31/2024
T4.3 - Sustainability Assessment of integrated solution pathways with S-KPIs
5/1/2022 - 1/31/2024
T4.4 - Multicriteria evaluation of CERESiS contribution to the SDG goals
11/1/2022 - 1/31/2024
T4.5 - Implementation of CERESiS DSS platform
8/1/2023 - 7/30/2024
D4.6 – DSS Platform
T4.6 - Use Cases demonstration of CERESiS DSS platform
11/1/2023 - 7/30/2024
D4.7 – DSS Application in Use Cases

Task 4.2: Progress

- Finalized D4.2
- Final data collected from both partners and literature sources
- Completed techno-economic analysis of the Supercritical Water Gasification (SCWG) pathway
- Identified business models for the supply chain
- Designed final version of supply chain optimization model for both Fast Pyrolysis (FP) and SCWG pathways
- Applied to use case to project its future applicability across various scenarios

Task 4.2: Techno-Economic Analysis Introduction and Main Challenges

- Techno-Economic Analysis (TEA) → evaluate feasibility and profitability of SCWG by combining technical and economic factors
- Challenges
  - Data Limitations: accurate and up-to-date data for input parameters is challenging, impacts the accuracy of assessments
  - Technology Readiness: technology not commercially available, leading to uncertainties in cost estimation
  - Processes Upscaling: lab or pilot scale plant, requiring adjustments from literature and assumptions

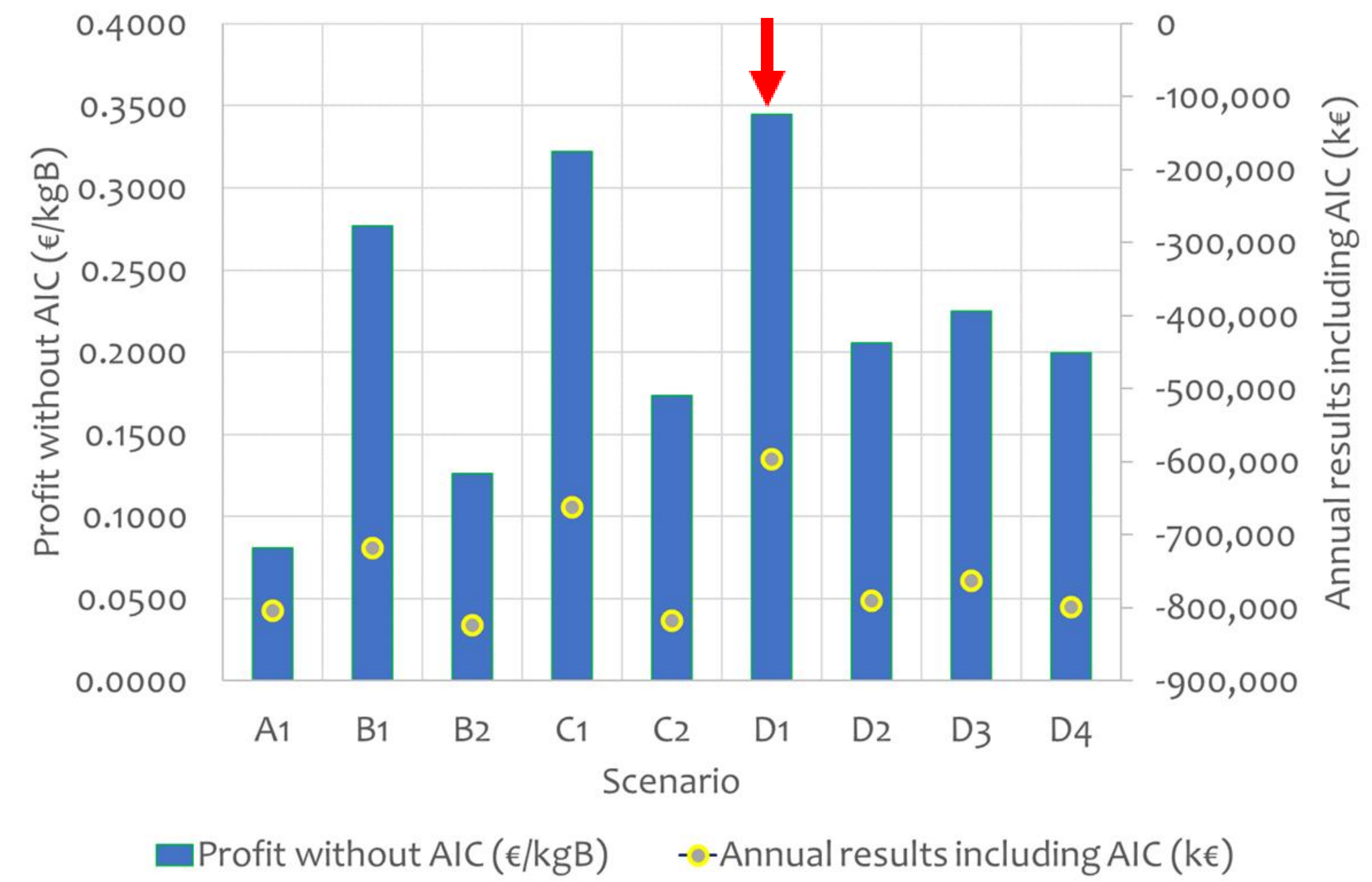
Task 4.2: Techno-Economic Analysis Methodology

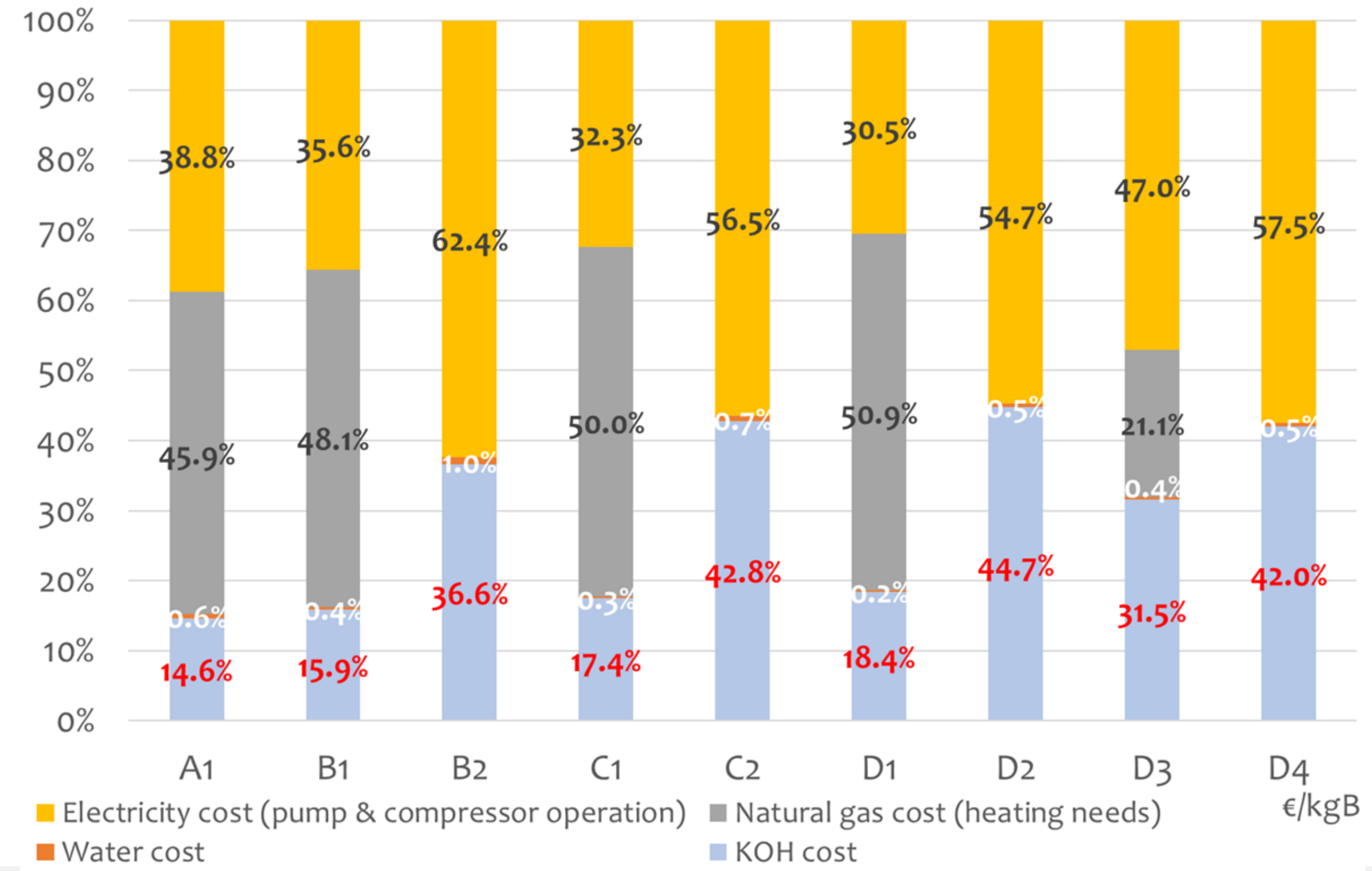
- Estimate capital costs, operational costs (reagent prices, energy requirements)
- 9 scenarios were created to identify the optimum parameters for SCWG
  - Biomass concentration
  - Thermal energy source
  - Syngas split fraction to combustion

Scenario	Biomass Concentration	Thermal Energy Source	Syngas split fraction to combustion
A1	6.5%	Natural gas	0%
B1	10%	Natural gas	0%
B2	10%	Syngas	55%
C1	15%	Natural gas	0%
C2	15%	Syngas	50%
D1	20%	Natural gas	0%
D2	20%	Syngas	45%
D3	20%	Syngas/methane	0%
D4	20%	Syngas/methane	15%

Task 4.2: Techno-Economic Analysis Results & Conclusions

- **Optimal Conditions (D1):** Highest profit per unit of biomass
  - 20% dry biomass concentration
  - External energy supply (natural gas) for fully coverage of heat requirements
- Conclusions:
  - Natural gas preferable compared to heat self-sufficiency
  - Energy cost is the most critical cost factor
  - Biodiesel, gasoline & jet fuel revenue share is 42%/40%/18%





Task 4.2: Business Models Overview

- **Target:** Exploring the most appropriate business models in the value creation chain (biofuel production & land decontamination).
- **Methodology:** "The Business Model Canvas" suitable for CERESiS
- **Stakeholders:** Agricultural cooperative & Biofuel producer.

Energy crops cultivation/ Phyto-remediation	Biomass pre-processing	Biomass Conversion/ Production of biofuel precursors	Conversion/ Upgrade of biofuel precursors	End product (biofuel)	End users
•Farmers •Agricultural cooperatives •Local government/ authorities •Contaminated landowners	•Biofuel producers •Intermediaries	•Biofuel producers •Technology providers	•Biofuel producers •Chemical industry	•Biofuel producers •Oil & gas industry	•Passenger transport •Freight transport •Decentralised power generation

Task 4.2: Business Models
Business Model Scenarios

Pure agricultural	Agro-industrial

• Biomass production and processing on contaminated land
• Customers:
  • plant operators
  • farmers/landowners
	• Expansion bio-oil/biochar and FTS products
	• Customers:
	  • Owners of upgrading units
	  • farmers/landowners
	  • biochar purchasers

Pure industrial	**Expanded industrial**

• Logistics managed by cooperative/third party.
• Biofuel producers own facilities
• Customers:
  • Oil refineries
  • biochar purchasers
	• Biofuel producer manages entire logistics
	• Fixed and mobile facilities for biofuel production
	• Customers:
	  • Oil refineries
	  • biochar purchasers

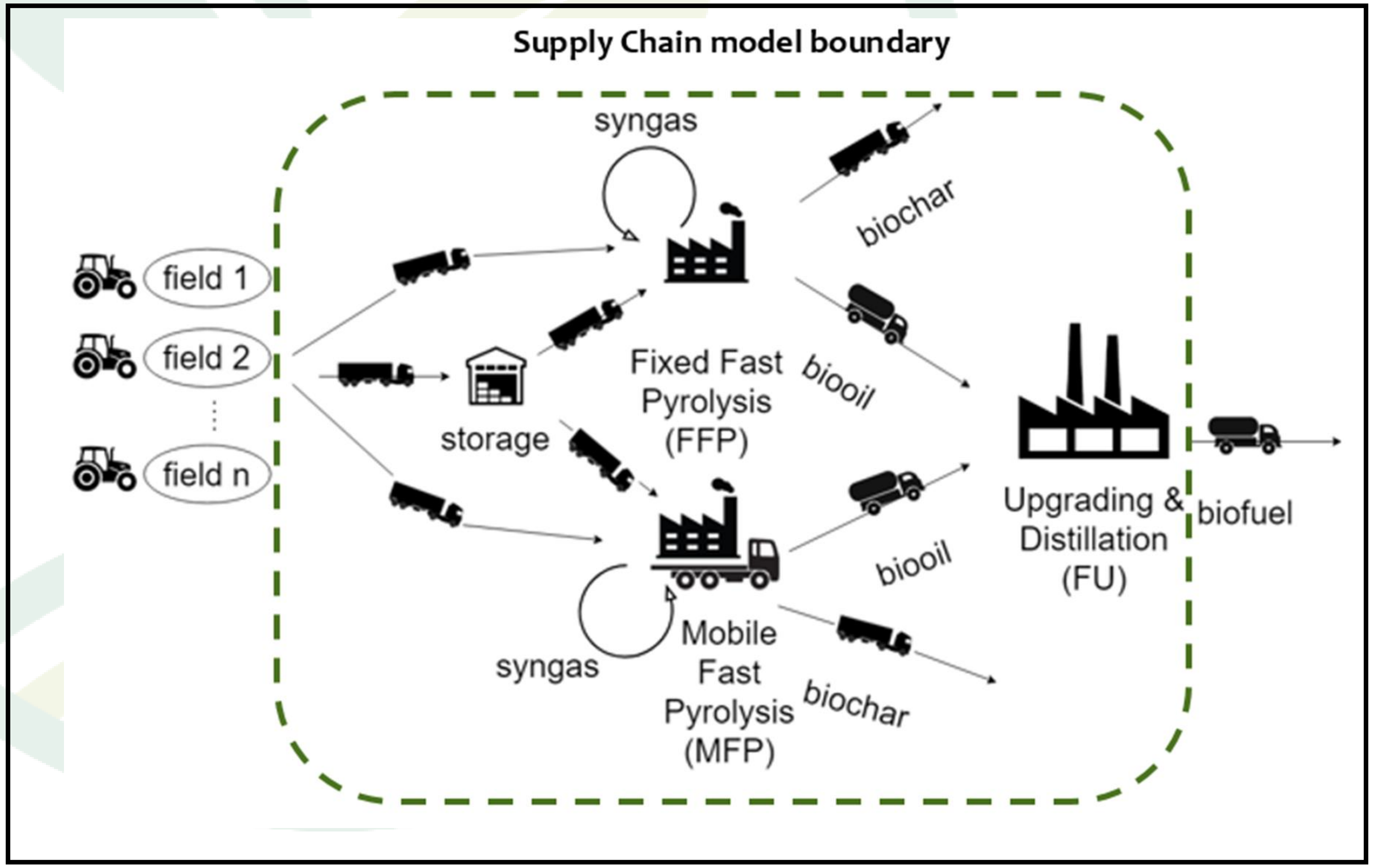
Task 4.2: Supply Chain Optimization Target & Objectives

- Target:
  - Maximization of the overall profit
  - Monitoring of the environmental impact
  - Best resource utilization
  - Validate WP2 results of different sampling scheme

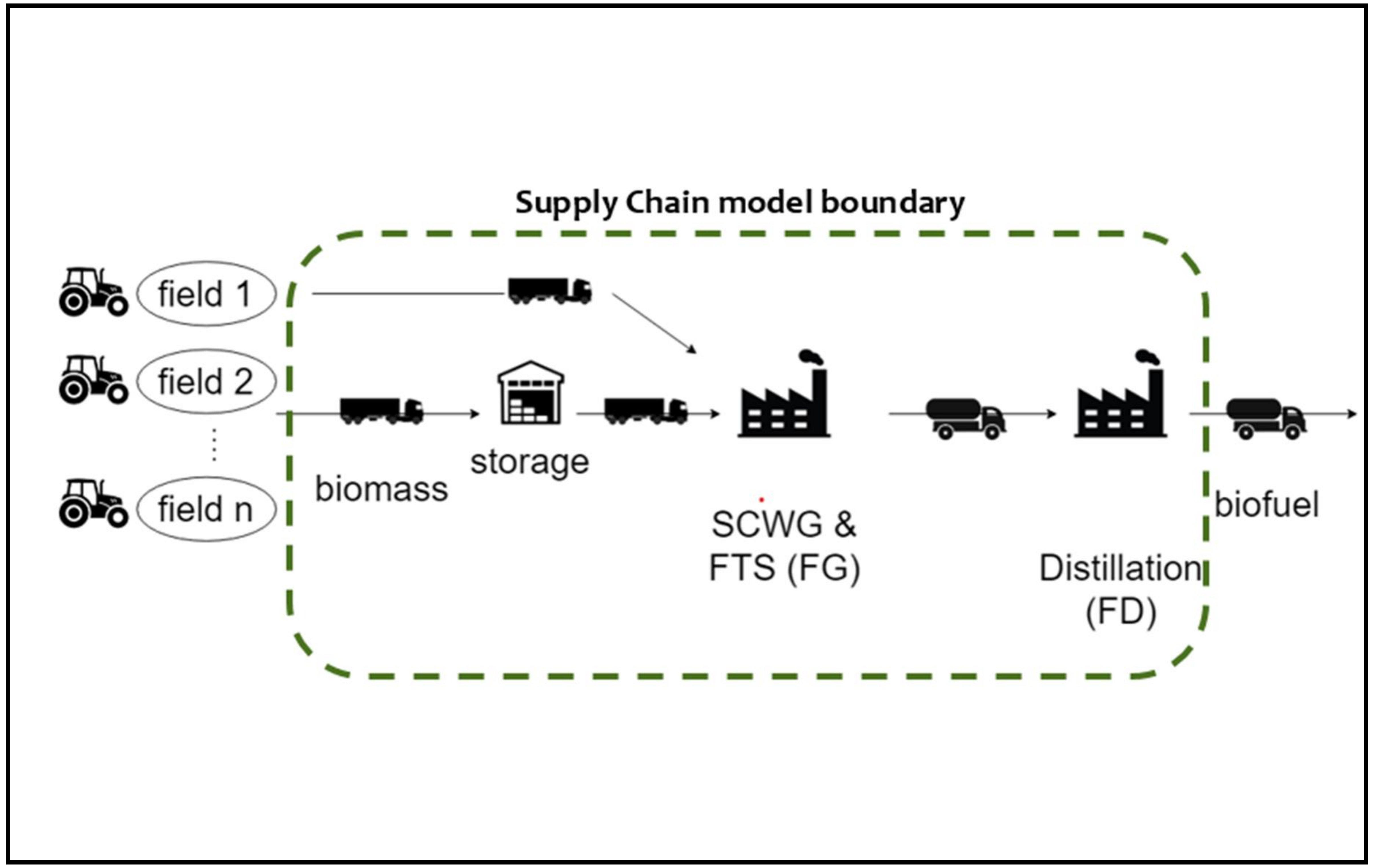
- Objectives:
  - Optimize biomass procurement schedule
  - Select conversion technology & warehouse specifications
  - Determine number of mobile units and optimize their routes
  - Optimize the quantity of materials/products handled in the supply chain
  - Determine the inventory levels throughout the year

Task 4.2: Supply Chain Optimization Boundaries

FP

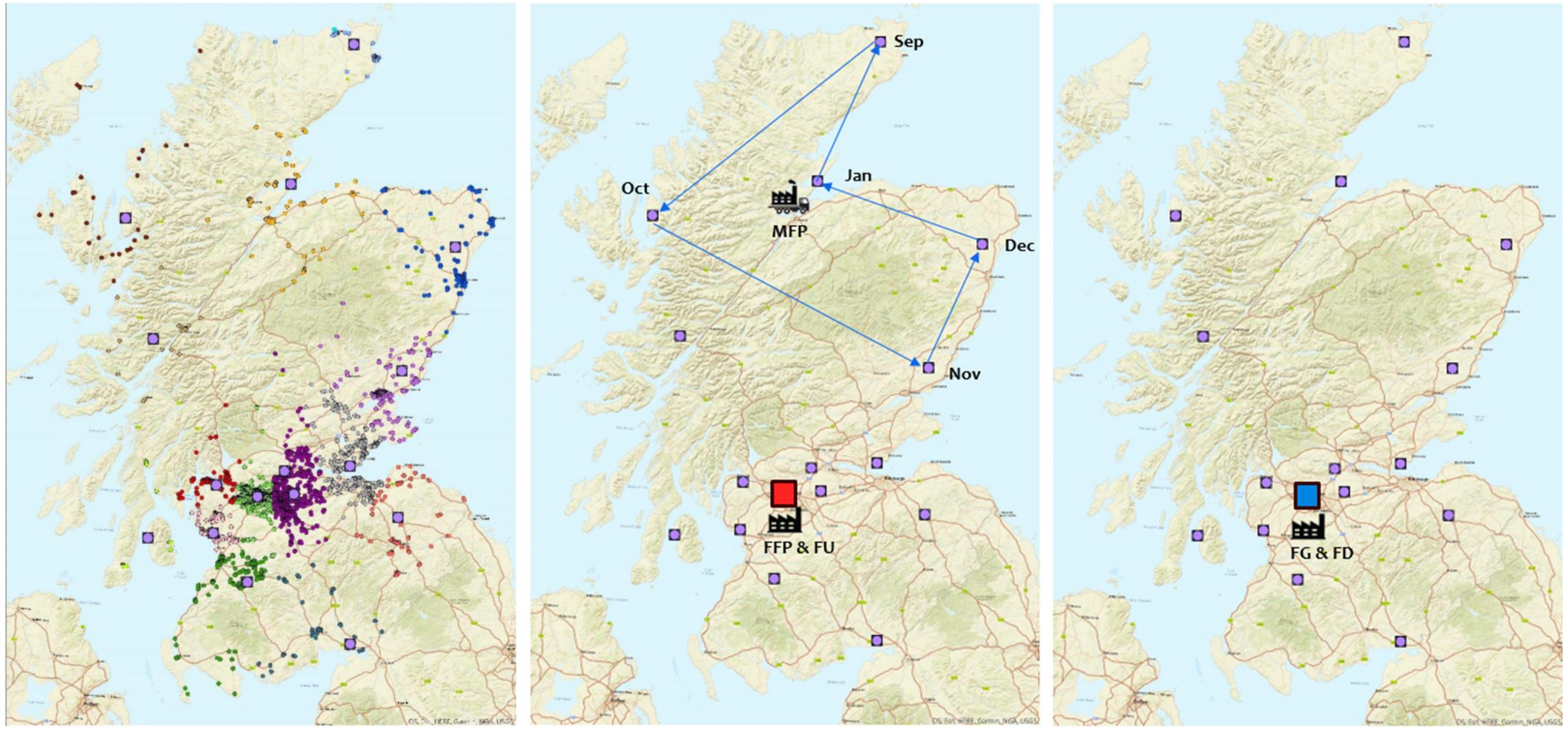


SCWG



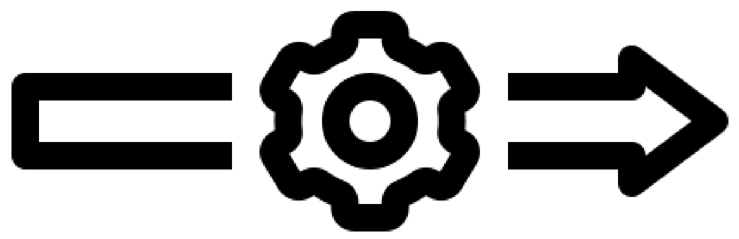
Task 4.2: Supply Chain Optimization Indicative Use Case

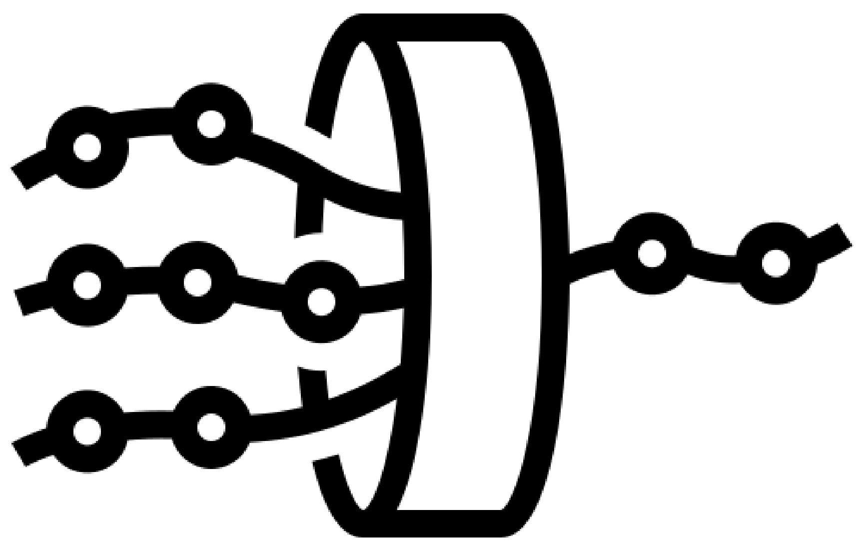
- Applied to a biofuel production use case in Scotland
- Characteristics of the supply chain: Economies of scale, mobile unit routing, differentiated harvesting schemes, biomass growth incorporation, supply-driven operation
- Assumptions:
  - Constant moisture content
  - Known locations of fields and processing facilities
  - Cyclical storage modelling, no limitations on biomass storage
  - Market capable of absorbing all products
  - Deterministic data



Task 4.2: Supply Chain Optimization Implementation

- Inputs:
  - Geospatial data from GIS
  - Technical specifications
  - Cost of facilities
  - Selling price of products
  - Biomass yields
  - Fields area
  - Candidate location of facilities
- Output:
  - Siting of all facilities
  - Routing of mobile facilities
  - Field harvesting schedule
  - Material flows throughout the supply chain
  - Inventory level
- Constraints
  - Material Flows
  - Capacity of facilities
  - Biomass yield (plant yield)
  - Mobile facilities relocation





Task 4.2: Supply Chain Optimization Implementation

Input


```
{"values_df": {
        "dieselPrice":1.444,
        "gasolinePrice":1.32,
        "LPGPrice":0.7,
        "jetfuelPrice":0.7,
        "StorageMaxCapacity": 400000,
        "min_cap_S": 0,
        "max_cap_S": 300000,
        "min_cap_U": 100,
        "max_cap_U": 2000,
        "min_cap_FP": 100,
        "max_cap_FP": 2000,
        "min_cap_WG": 100,
        "max_cap_WG": 2000,
        "price_BF": 1000,
        "price_BC": 250,
        "DiscountRate": 0.1,
        "HarvestingUnitCost": 83,
        "biomass":{"Miscanthus":6.353,"Reed canary grass":8.8},
    "locations":[
        [58.52484941, -3.333502065, 5363.51],
        [55.75714208, -2.777306979, 2437.23],
        [55.86133936, -4.24821144, 1424.52],
        [57.6969384, -3.994933233, 1146.14],
        [56.61848991, -2.753734059, 771.9]
    ],
        "distances": [
            [0, 459.5030865, 439.9434323, 133.5381519, 408.6473783],
                [459.3965115, 0, 108.4317831, 328.1338494, 153.7920867],
                [439.3707724, 108.9753952, 0, 308.1081103, 143.7734353],
                [33.6146824, 328.2624047, 308.7027505, 0, 277.4066965],
                [408.8460172, 153.6887312, 144.6284057, 277.5833551, 0]
        ]
    }}
```


$$R^{F} = \left(\sum_{p}\sum_{u}\sum_{t} X^{PU}_{p,u,t} + \sum_{m}\sum_{u}\sum_{t}\sum_{v} X^{MU}_{m,u,t,v} \right) \cdot \eta^{FU} \cdot p^{F}$$

$$or \qquad (5)$$

$$R^{F} = \left(\sum_{g}\sum_{d}\sum_{t} X^{GD}_{g,d,t} \right) \cdot \eta^{FD} \cdot p^{F}$$

$$R^{C} = \left(\left(\sum_{f}\sum_{p}\sum_{t} X^{FP}_{f,p,t} + \sum_{s}\sum_{p}\sum_{t} X^{SP}_{s,p,t} \right) \cdot \eta^{C-FFP} + \left(\sum_{f}\sum_{m}\sum_{t}\sum_{v} X^{FM}_{f,m,t,v} + \sum_{s}\sum_{m}\sum_{t}\sum_{v} X^{SM}_{s,m,t,v} \right) \cdot \eta^{C-MFP} \right) \cdot p^{C} \qquad (6)$$

$$IC^{FU} = \sum_{bru}\sum_{u} \left(Z^{FU}_{bru,u} \cdot P^{C-FU}_{bru} \right) \qquad (7)$$

$$IC^{FFP} = \sum_{brp}\sum_{p} \left(Z^{FFP}_{brp,p} \cdot P^{C-FFP}_{brp} \right) \qquad (8)$$

$$IC^{FG} = \sum_{brg}\sum_{g} \left(Z^{FG}_{brg,g} \cdot P^{C-FG}_{brg} \right) \qquad (9)$$

$$IC^{FD} = \sum_{brd}\sum_{d} \left(Z^{FD}_{brd,d} \cdot P^{C-FD}_{brd} \right) \qquad (10)$$

$$IC^{MFP} = \sum_{v} B^{V}_{v} \cdot C^{MFP} \qquad (11)$$

$$Z^{FU}_{bru,u} \le Y^{FU}_{bru-1,u} + Y^{FU}_{bru,u} \quad \forall bru \in BRU = \{1,2\}, u \in U \qquad (12)$$

$$Z^{FU}_{bru,u} \le Y^{FU}_{bru-1,u} \quad \forall bru \in BRU = \{3\}, u \in U \qquad (13)$$

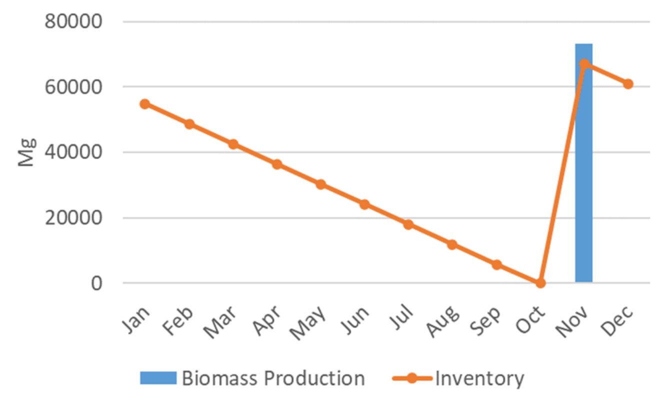
$$\sum_{bru} Y^{FU}_{bru,u} = 1 \quad \forall bru \in BRU = \{1,2\}, u \in U \qquad (14)$$

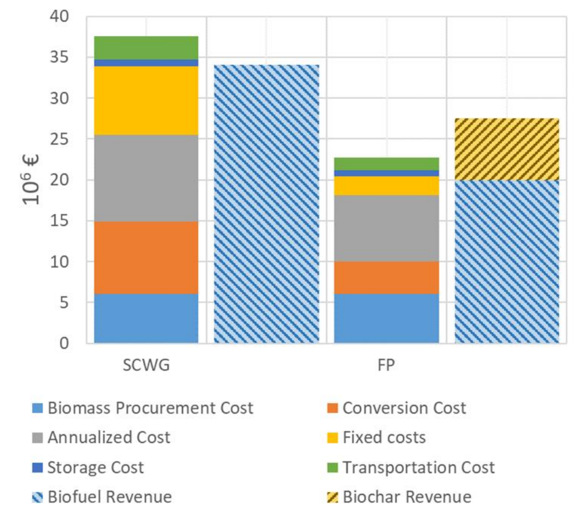
$$\sum_{bru} Z^{FU}_{bru,u} = 1 \quad \forall u \in U \qquad (15)$$

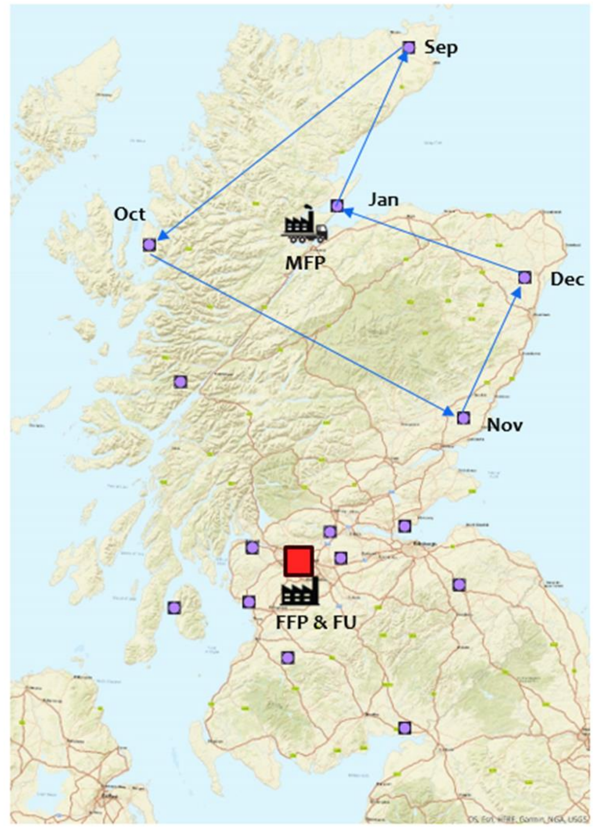
$$K^{FU}_{u} = \sum_{bru} \left(X^{FU}_{bru,u} \cdot P^{K-FU}_{u} \right) \quad \forall u \in U \qquad (16)$$

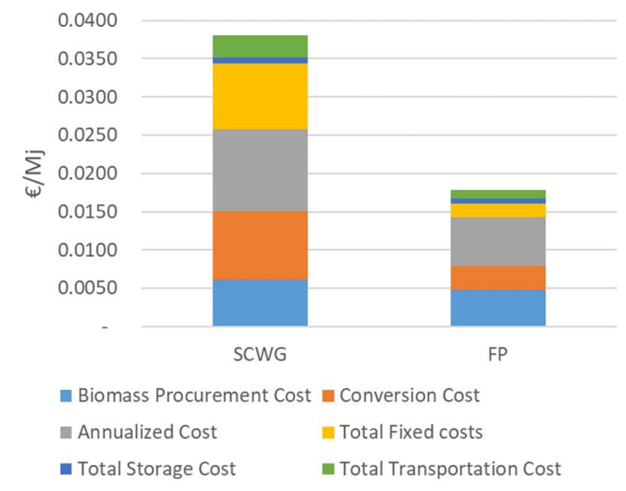
Output

	FP			SCWG		
	NOV	SEP-NOV	AUG-NOV	NOV	SEP-NOV	AUG-NOV
NPV [10^6 €]	40.9	29.3	-7.0	-39.4	-42.5	-53.7
IRR	18.23%	16.16%	8.16%	3.63%	2.39%	-4.36%
TLCC [10^6€]	193.1	174.6	130.6	329.5	295.2	206.9
LCOE [€ /MJ]	0.0178	0.0185	0.0229	0.0392	0.0403	0.0467









Task 4.2: Supply Chain Optimization Implementation

- Optimization conducted over a 12-month operational period
- Investment analysis covers a 20-year timeframe
- Implemented MILP model in Python - SCIP solver (open-source)

Task 4.2: Optimization with Variable Sampling Scheme - Validation

	FP			SCWG		
	NOV	SEP-NOV	AUG-NOV	NOV	SEP-NOV	AUG-NOV
NPV [10^6 €]	40.9	29.3	-7.0	-39.4	-42.5	-53.7
IRR	18.23%	16.16%	8.16%	3.63%	2.39%	-4.36%
TLCC [10^6€]	193.1	174.6	130.6	329.5	295.2	206.9
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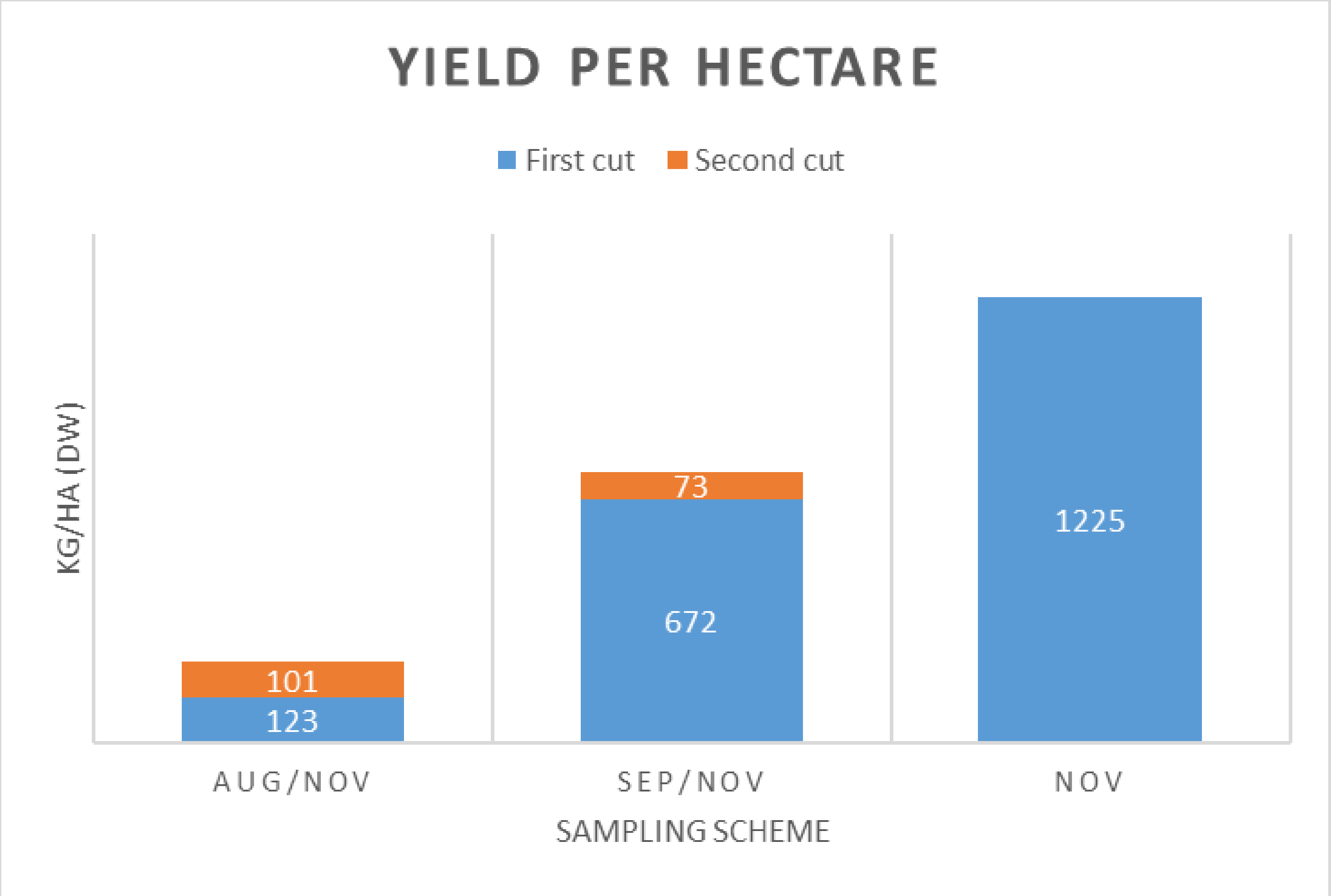
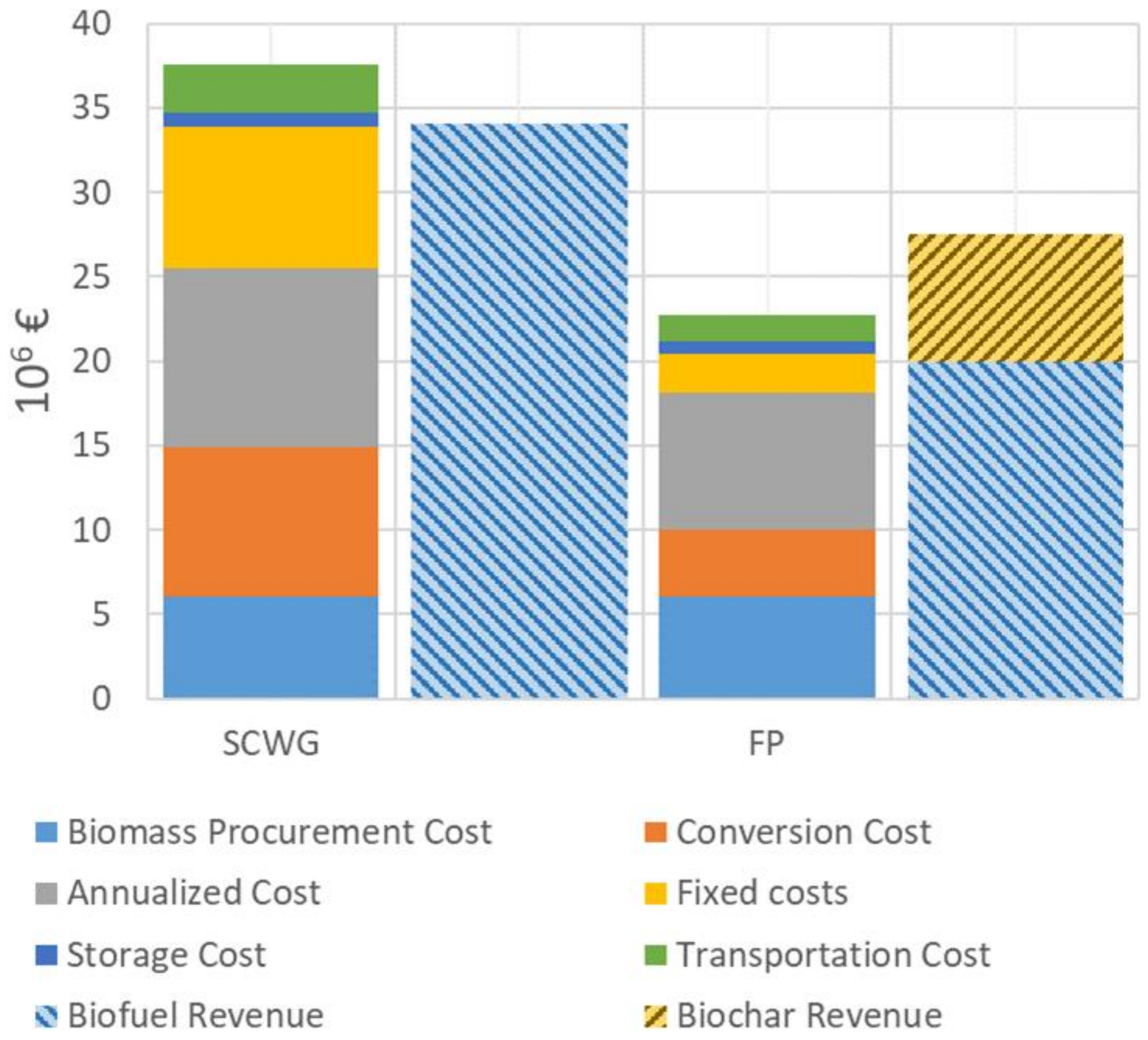


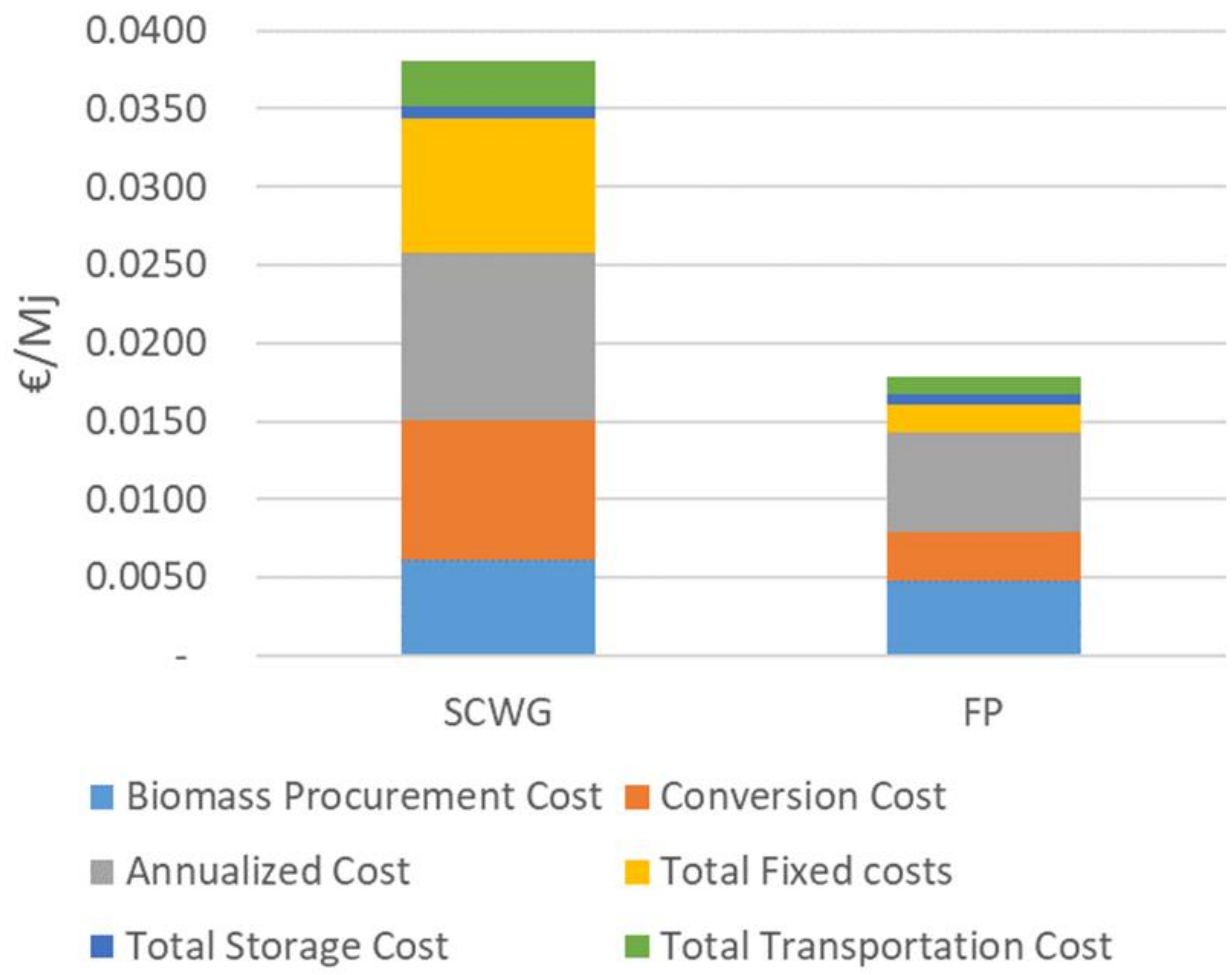
Task 4.2: Optimization with Indicative Cost & Revenue Breakdown

- FP profitable, unlike SCWG
- Biomass procurement, storage and transportation costs the same
- Rest of the costs is higher is SCWG
- Revenue is lower in FP, but is profitable due to low costs



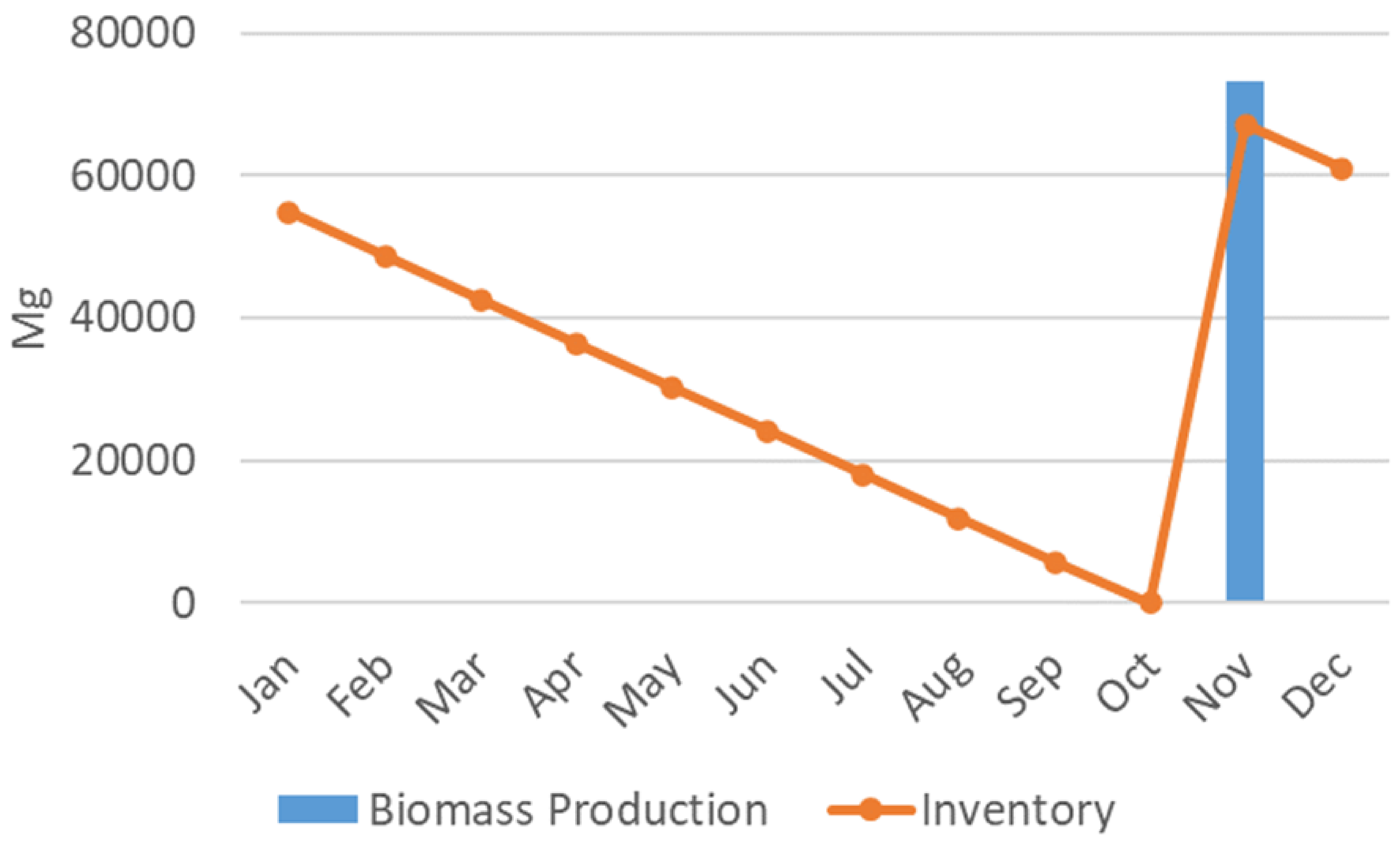
Task 4.2: Optimization with Indicative Cost breakdown of energy production

- Focus solely on the energy production aspect
- Cost of producing 1 Mj of energy
- FP outperforms SCWG-FTS in cost-effectiveness (LCOE: 0.0178 €/MJ compared to 0.0392 €/MJ).



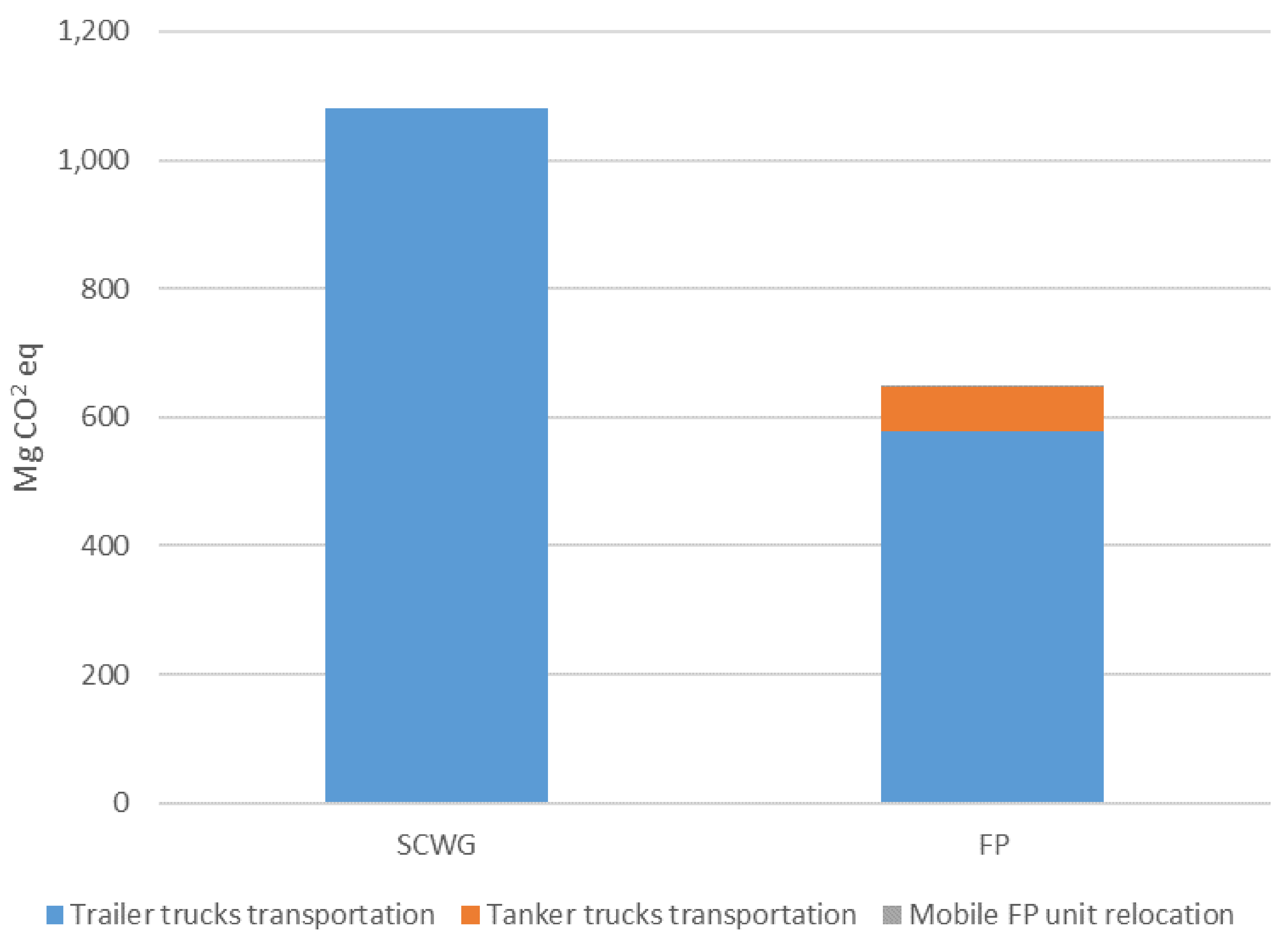
Task 4.2: Optimization with Indicative Biomass Production-Inventory Balance

- Biomass harvested in November
- Steady biomass conversion throughout the year
- Removes the need for high-capacity capital-intensive facilities
- Works only under the assumption of no biomass storage limitations



Task 4.2: Optimization with Indicative Transportation Environmental Impact

- FP lower transportation environmental impact than SCWG
- Mobile processing facilities mitigate logistical challenges by moving the facility to the biomass rather than the biomass to the facility



T4.2: Conclusion & Next steps

- The centralized facilities are economically favorable compared to the decentralized options.
- The single-stage harvesting in November is the optimal case.
- FP outperforms SCWG-FTS in cost-effectiveness (LCOE: 0.0178 €/MJ compared to 0.0392 €/MJ).
- FP mobile processing units mitigate logistical challenges in spatially dispersed locations.
- Next steps → Collaborating with DSS partners to apply the model in the CERESiS use cases

Task 4.3: Assessment of integrated solution pathways with S-KPIs

- **Partners participating:** [NTUA], INTRA, KF, EXE.
- **Task overview - Aim:** To make the life cycle energetic / environmental / economic and social impacts of the CERESiS concept measurable and visible. (M19-M39)
- **Partners involved and role:**
  - NTUA (TL): compile and process the necessary data & will lead the LCA tool structure definition;
  - INTRA: contribute with the visualization of S-KPI values and the development of a cloud-based IT tool for simulating various assessment scenarios
  - KF, EXE: support the Social KPIs development and quantification

Final activities between M37-M39

- Environmental KPIs for SCWG refined
  - Incorporation of Soil Carbon Accumulation Bonus according to Regulation EU 2022/996)
  - Consistency check with D3.7 and D4.2 – Necessary adaptations.
  - Two variations calculated for SCWG: Maximum and minimum external heat demand
- Completion of KPI results
  - FP pathway finalized
  - Economic indicators provided by D4.2
  - “Job creation” indicator was calculated according to reference bioenergy cases.
  - Incorporation of feedback received from social assessment questionnaires – Calculation of a compound “Social Acceptability” KPI.
- Formulation of corresponding equations to be incorporated in the DSS

Task 4.3: Assessment of integrated solution pathways with S-KPIs

Methodology of Sustainability Assessment

	#	Name	Info	Units
Energy	KPI_1	Non-Renewable Primary Energy Demand	Description: [20] (Section 3.2.1) Methodology: Current document (Section 4.1) Results: Current document (Section 5.1)	MJ_{eq} / $MJ_{Final\_Biofuel}$
	KPI_2	Productivity	Description: [20] (Section 3.2.1) Methodology: Current document (Section 4.2) Results: Current document (Section 5.1)	$MJ_{Final\_Biofuel}$/ha
Environmental	KPI_3	Global Warming Potential	Description: [20] (Section 3.2.2) Methodology: Current document (Section 4.1) Results: Current document (Section 5.2)	g CO_2-eq / MJ_{Final_Biofu}
	KPI_4	Acidification Potential	Description: [20] (Section 3.2.2) Methodology: Current document (Section 4.1) Results: Current document (Section 5.2)	g SO_2-eq / MJ_{Final_Biofu}
	KPI_5	Off-take of contaminants	Description: [20] (Section 3.3) Methodology: Current document (Section 4.2) Results: Current document (Section 5.2)	g_{heavy_metals}/(ha*year
	KPI_6	Decontamination efficiency	Description: [20] (Section 3.3) Methodology: Current document (Section 4.2) Results: Current document (Section 5.2)	% of contaminant captured
	KPI_7	Land under phytoremediation	Description: [20] (Section 3.3) Methodology: Current document (Section 4.2) Results: Current document (Section 5.2)	ha
Economic	KPI_8	Total Life Cycle Cost	Description: [20] (Section 3.2.3) Methodology: [20] (Section 3.2.3); [13] (Section 4.1.2) Results: [13] (Section 4.1.2)	Euros (€)
	KPI_9	Net Present Value	Description: [20] (Section 3.2.3) Methodology: [20] (Section 3.2.3); [13] (Section 4.1.2) Results: [13] (Section 4.1.2)	Euros (€)
	KPI_{10}	Internal Rate of Return	Description: [20] (Section 3.2.3) Methodology: [20] (Section 3.2.3); [13] (Section 4.1.2) Results: [13] (Section 4.1.2)	(%)
	KPI_{11}	Levelized Cost of (bio) Energy	Description: [20] (Section 3.2.3) Methodology: [20] (Section 3.2.3); [13] (Section 4.1.2) Results: [13] (Section 4.1.2)	Euros (€)/MJ_{Final_Biofu}
Social	KPI_{12}	Jobs Creation	Description: [20] (Section 3.2.4) Methodology: Current document (Section 4.4) Results: Current document (Section 5.4)	Number of jobs/$MJ_{Final\_Biofuel}$
	KPI_{13}	Social acceptability	Description: [20] (Section 3.2.4) Methodology: Current document (Section 4.4) Results: Current document (Section 5.4)	Qualitatively assesse

- Category 1 - KPIs calculated through the implementation of Life Cycle Assessment (LCA)
  - KPI1 “Non-Renewable Primary Energy Demand”
  - KPI3 “Global Warming Potential”
  - KPI4 “Acidification Potential”
- Category 2 - KPIs quantified from WP2/3 technical data
  - KPI2 “Productivity”
  - KPI5 “Off-take of contaminants”
  - KPI6 “Decontamination efficiency”
  - KPI7 “Land under phytoremediation”
- Category 3 - KPIs calculated from the output of T4.2

Task 4.3: Assessment of integrated solution pathways with S-KPIs

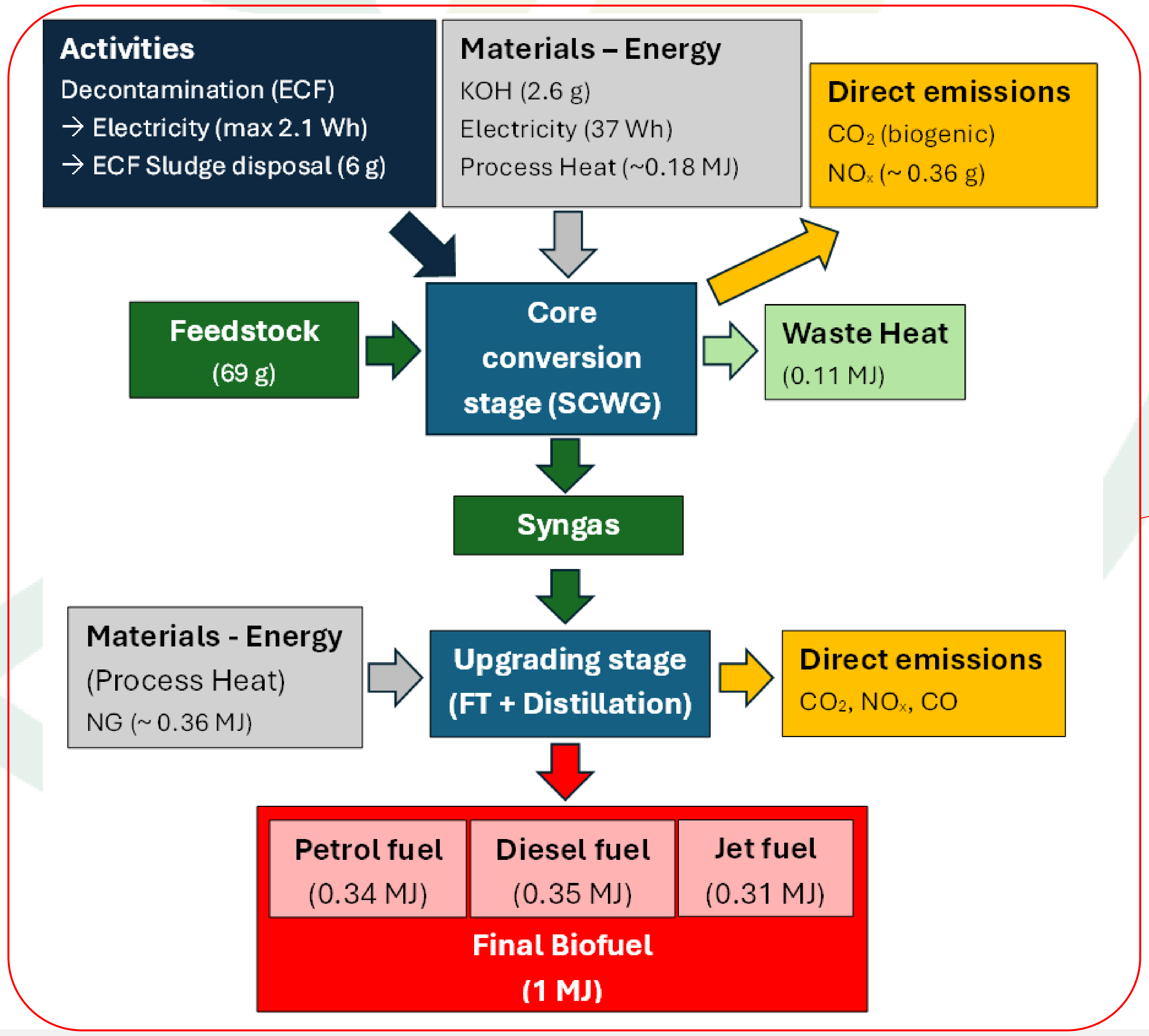
Methodology of Sustainability Assessment - Category 1: KPIs calculated through the implementation of LCA

Task 4.3: Assessment of integrated solution pathways with S-KPIs

Methodology of Sustainability Assessment - Category 1: KPIs calculated through the implementation of LCA

Task 4.3: Assessment of integrated solution pathways with S-KPIs

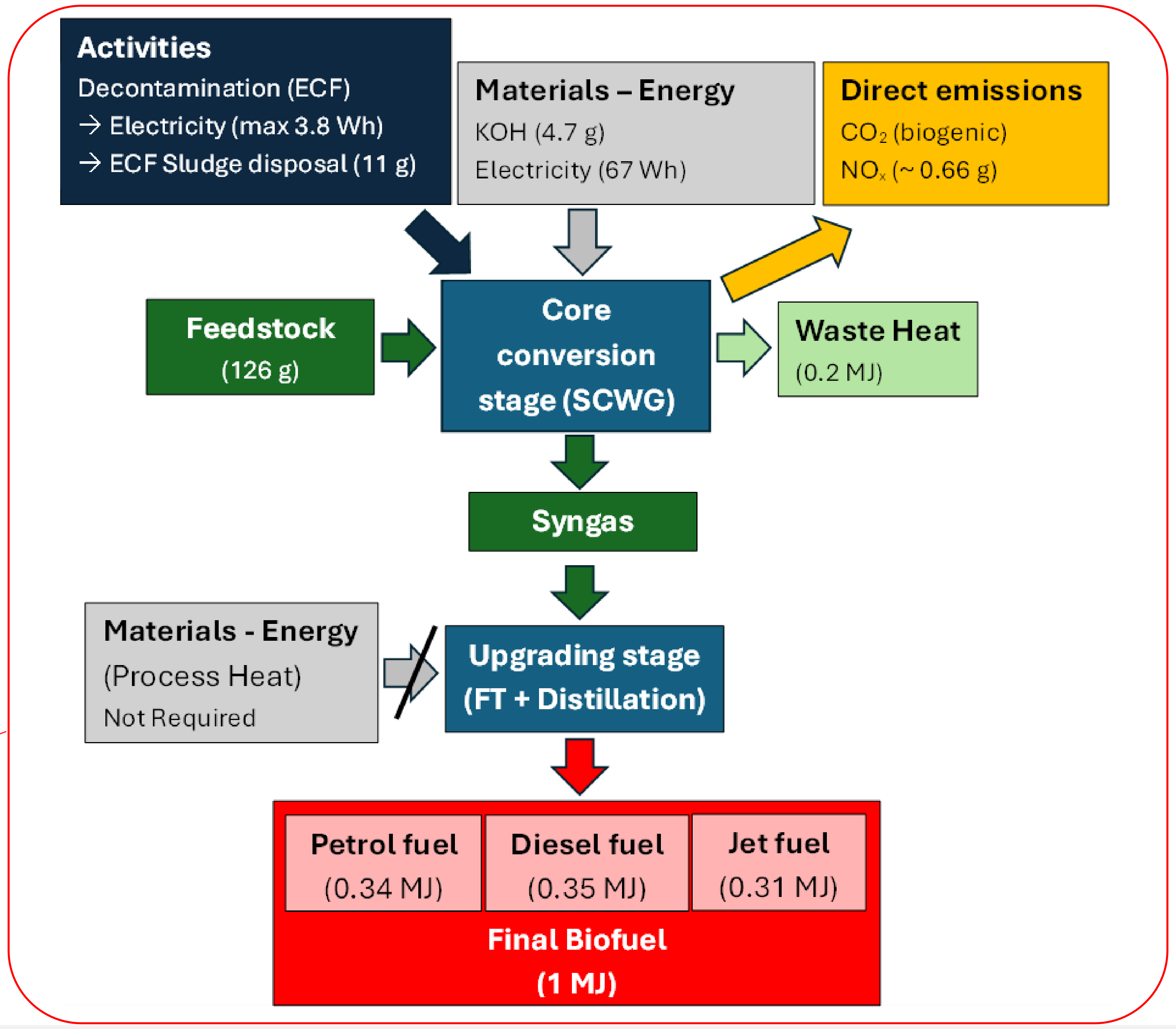
Methodology of Sustainability Assessment - Category 1: KPIs calculated through the implementation of LCA



SCWG Pathway

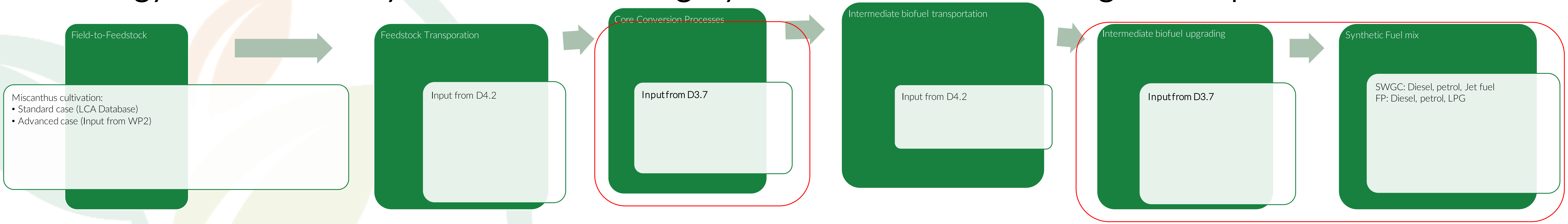
Two cases considered, due to large difference in calculated conversion yield (D3.7):

- Maximum external heat
  - Worst case: Heat provided from NG
  - Best case: Waste/renewable heat
- Zero external heat (self-sustained conversion)



Task 4.3: Assessment of integrated solution pathways with S-KPIs

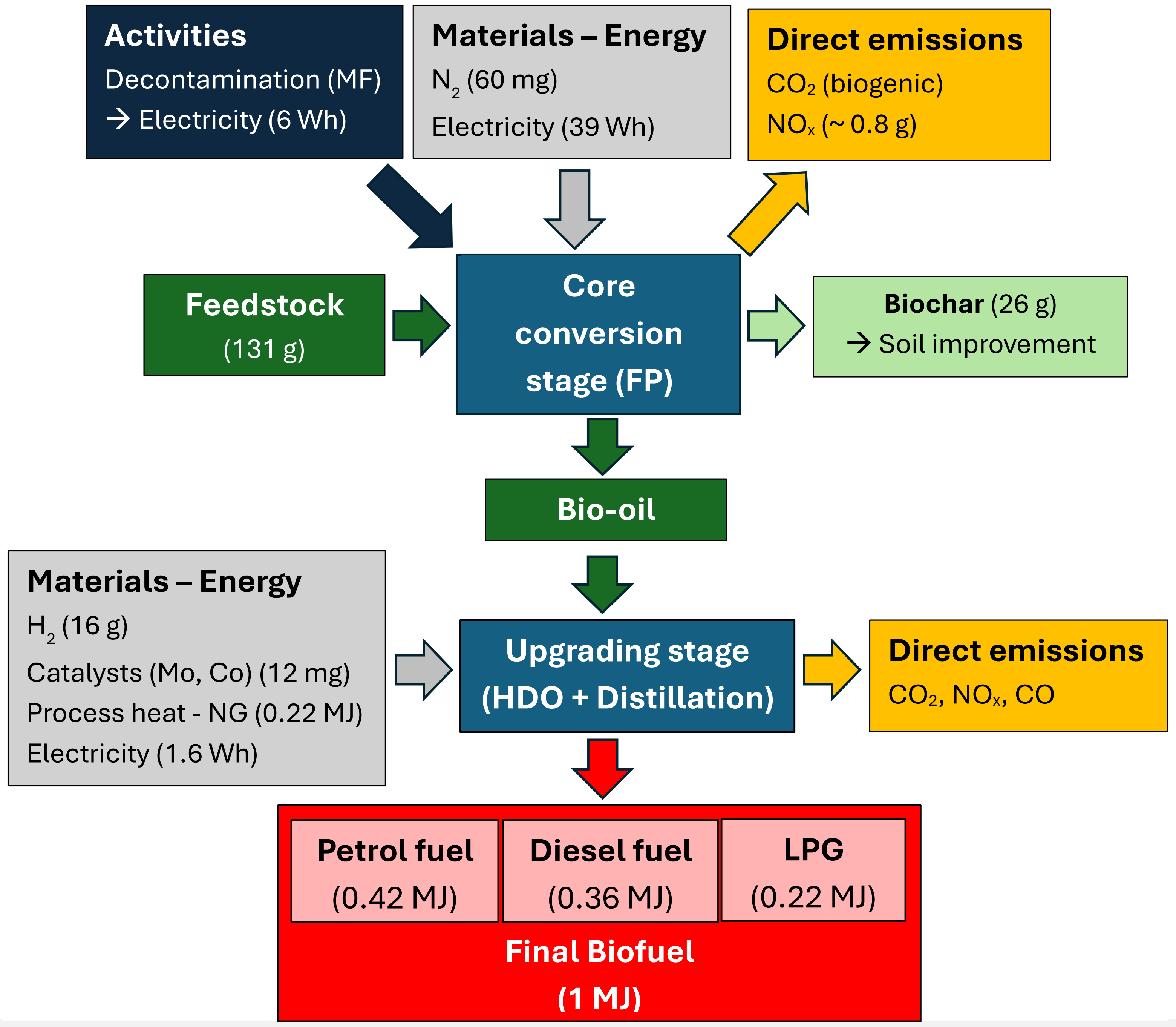
Methodology of Sustainability Assessment - Category 1 - KPIs calculated through the implementation of LCA



FP Pathway

In parallel to SCWG, two cases of heat and H_2 supply are considered:

- Worst case
  - External heat provided from NG
  - Conventional (grey) H_2 supply
- Best case
  - Waste / renewable external heat
  - Renewable (green) H_2 supply



Task 4.3: Assessment of integrated solution pathways with S-KPIs

Results - Category 1

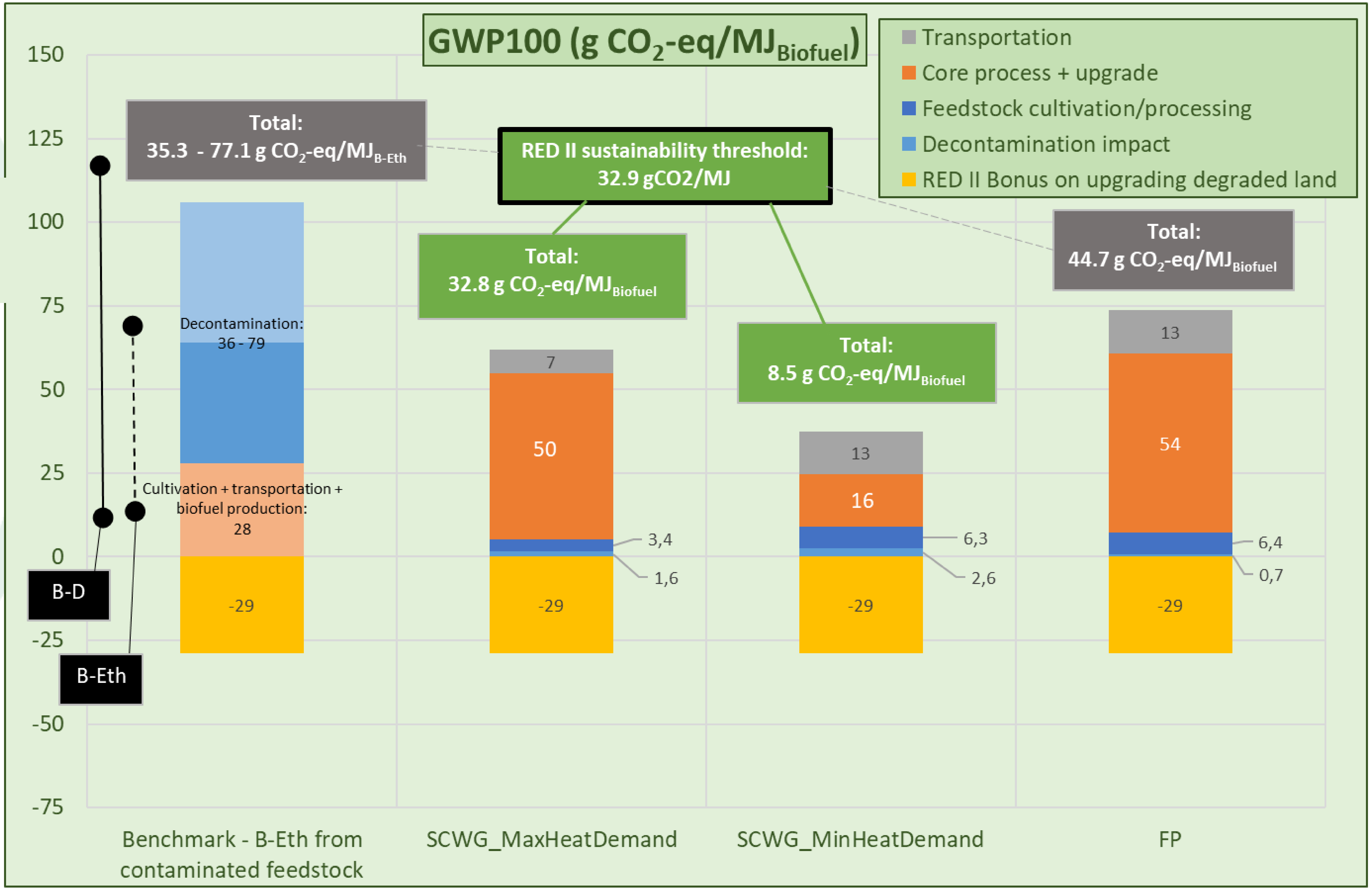
KPI3 "Global Warming Potential"

- Standard Cultivation practices
- External heat from fossil fuels
- Conventional (grey) H_2 supply (FP)

Pre-treatment with acid/alkali solutions can prove more carbon intensive than electric driven decontamination.

The sustainability threshold is marginally achieved with maximum external heat requirements.

Fossil generated heat and grey H_2 supply contribute considerably.



Task 4.3: Assessment of integrated solution pathways with S-KPIs

Results - Category 1

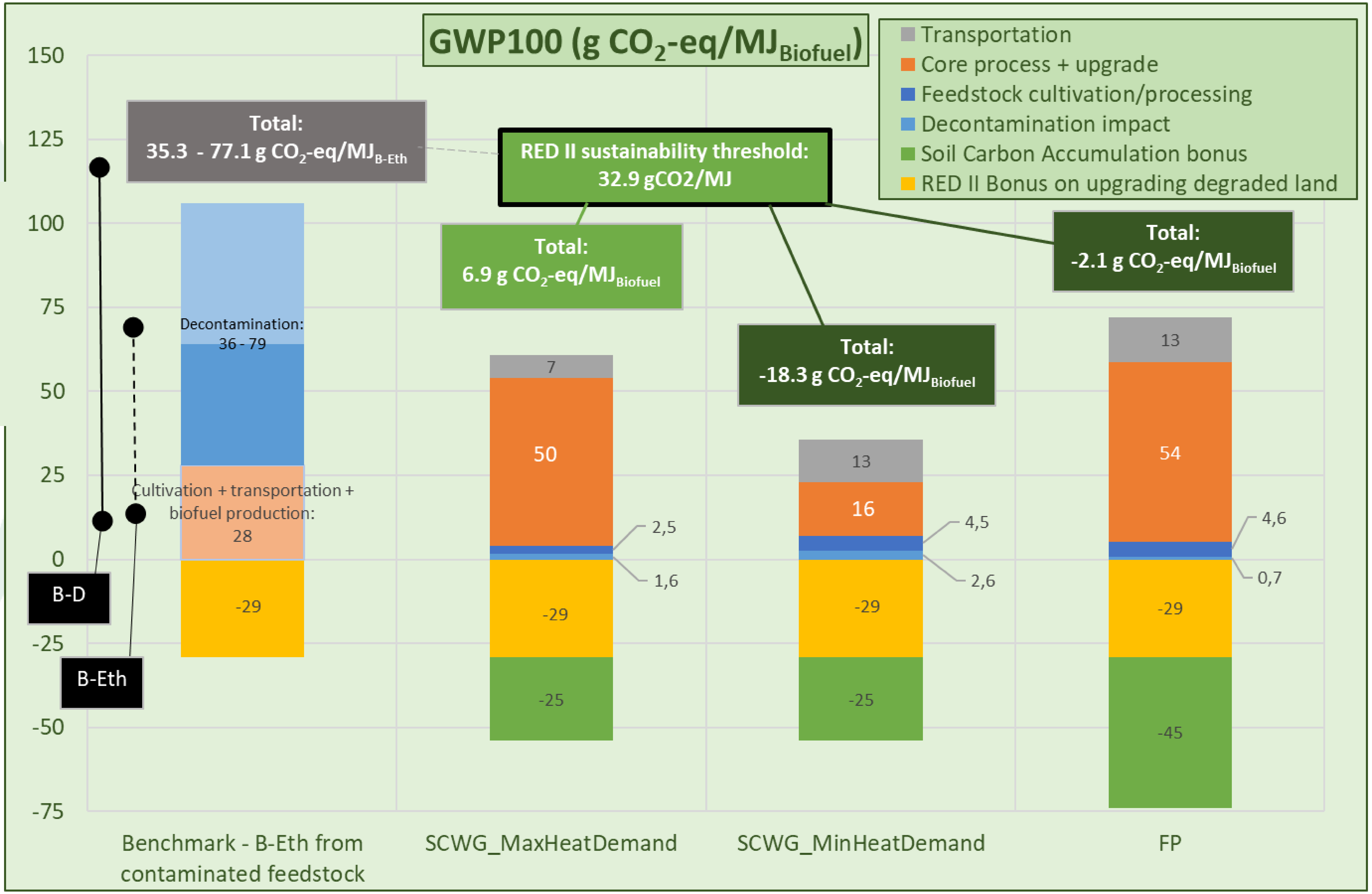
KPI3 "Global Warming Potential"

- Advanced Cultivation practices
  - No Tillage
  - GWC and Biochar (FP) replacing common fertilizers
- External heat from fossil fuels
- Conventional (grey) H_2 supply

Decisive impact reduction from applying GWC and biochar (FP).

Soil carbon accumulation values are the maximum claimable according to Regulation EU 2022/996.

Biochar application is additionally promoted.



Task 4.3: Assessment of integrated solution pathways with S-KPIs

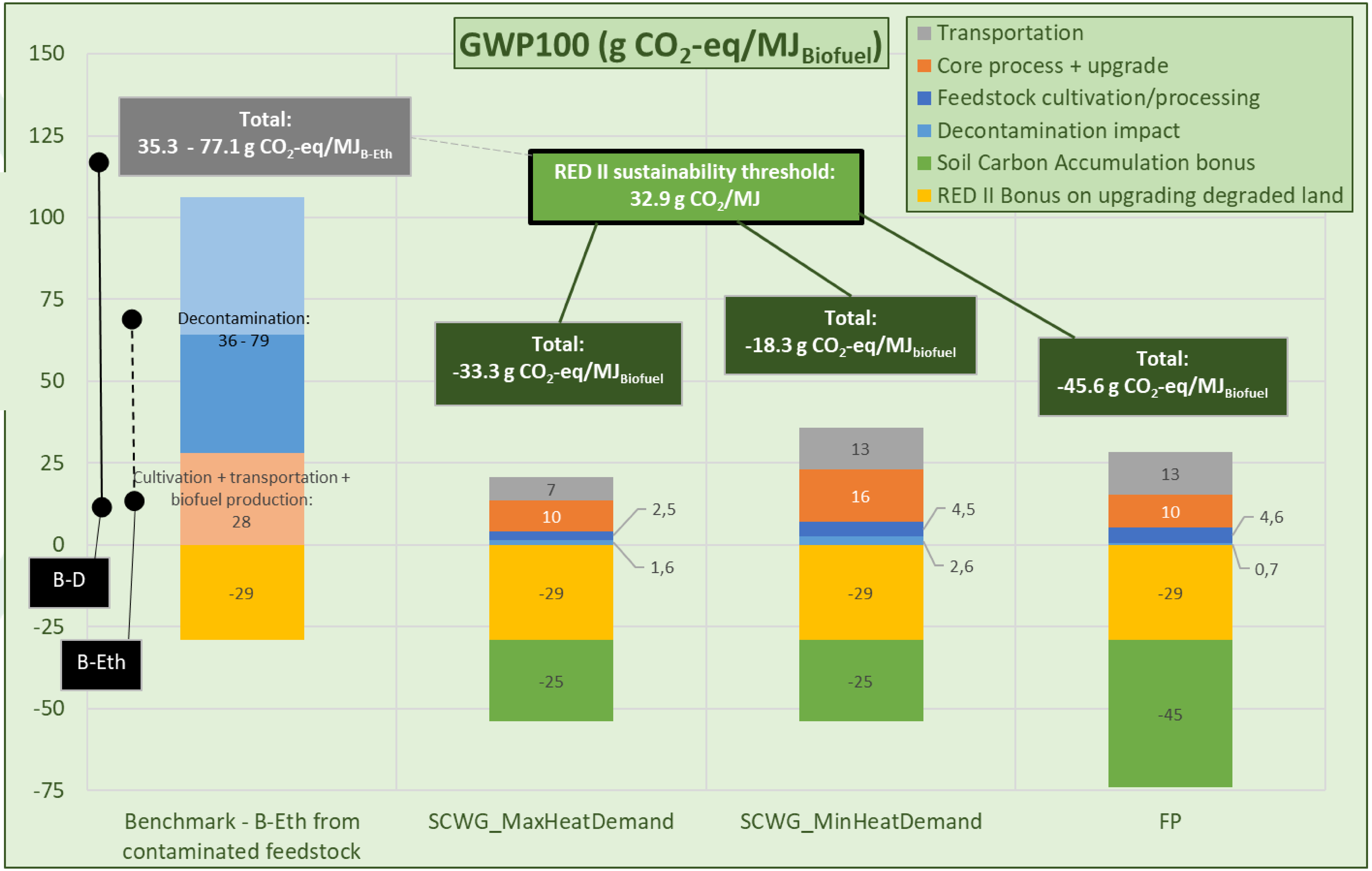
Results - Category 1

KPI3 "Global Warming Potential"

- Advanced Cultivation practices
  - No Tillage
  - GWC and Biochar (FP) replacing common fertilizers
- Renewable or waste external heat
- Renewable (green) H_2 supply

If the availability of renewable or waste heat and green H_2 is additionally assumed, negative GWP impacts emerge.

Under these assumptions, external heat is beneficial (SCWG).



Task 4.3: Assessment of integrated solution pathways with S-KPIs

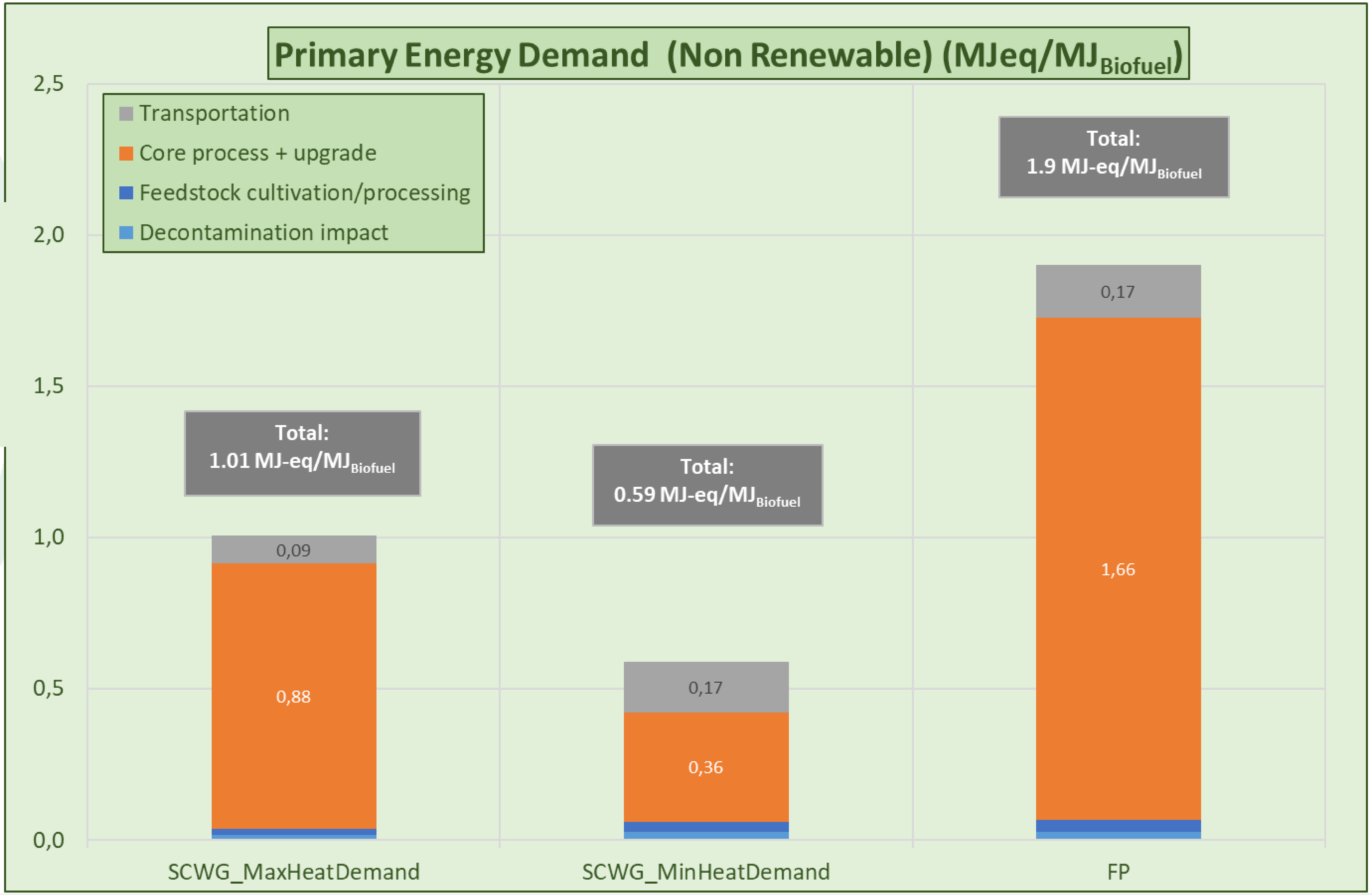
Results - Category 1

KPI1 “Non-Renewable Primary Energy Demand”

- Advanced Cultivation practices
    - No Tillage
    - GWC and Biochar (FP) replacing common fertilizers
- External heat from fossil fuels
- Conventional (grey) H_2 supply

Reference fossil diesel value:
1.29 MJ-eq/MJ_{Diesel}

Reference rapeseed biodiesel value:
0.39 MJ-eq/$MJ_{Biodiesel}$



Task 4.3: Assessment of integrated solution pathways with S-KPIs

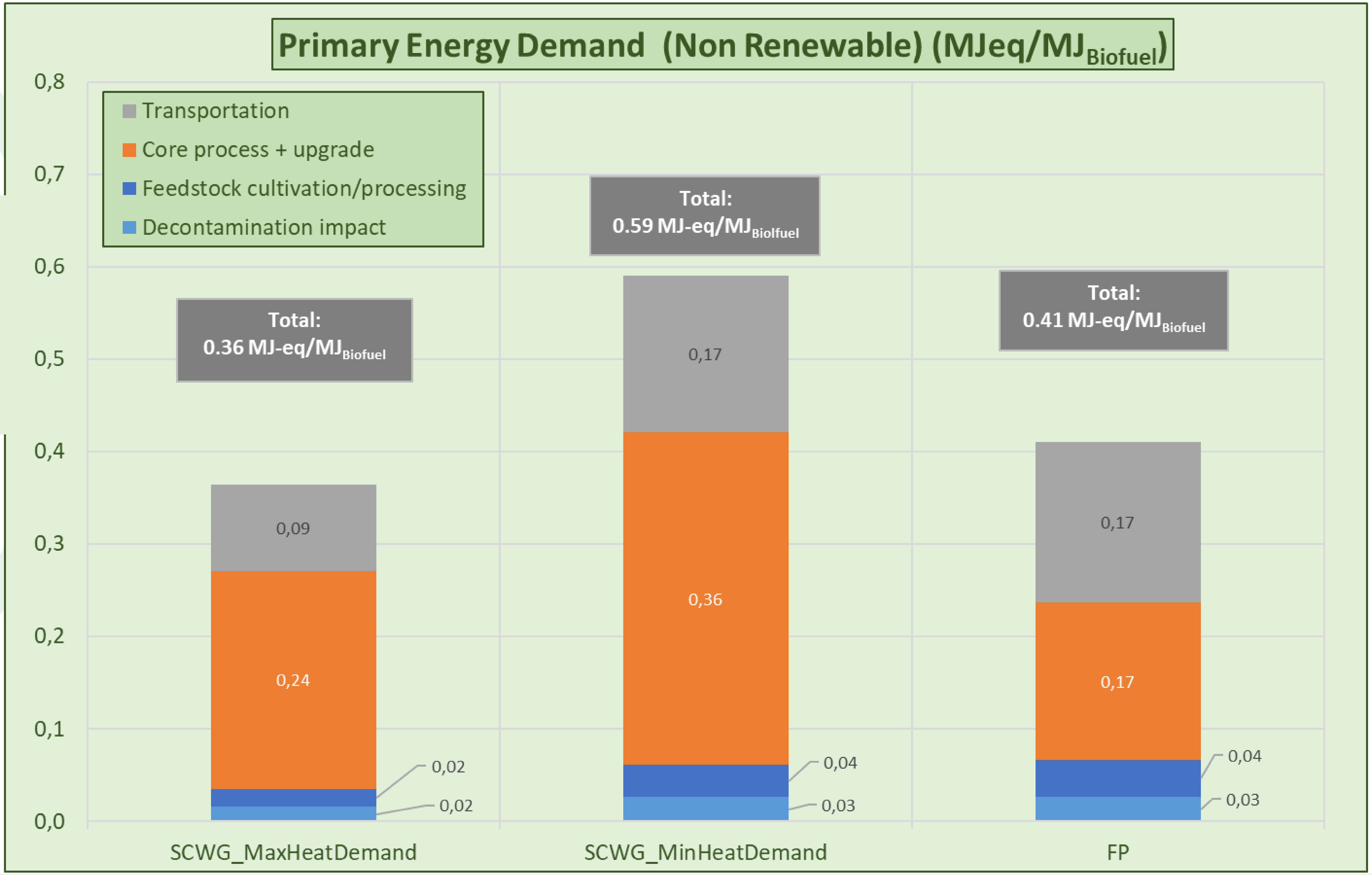
Results - Category 1

KPI1 "Non-Renewable Primary Energy Demand"

- Advanced Cultivation practices
  - No Tillage
  - GWC and Biochar (FP) replacing common fertilizers
- Renewable or waste external heat
- Renewable (green) H_2 supply

Reference fossil diesel value:
1.29 MJ-eq/MJ_{Diesel}

Reference rapeseed biodiesel value:
0.39 MJ-eq/$MJ_{Biodiesel}$



Task 4.3: Assessment of integrated solution pathways with S-KPIs

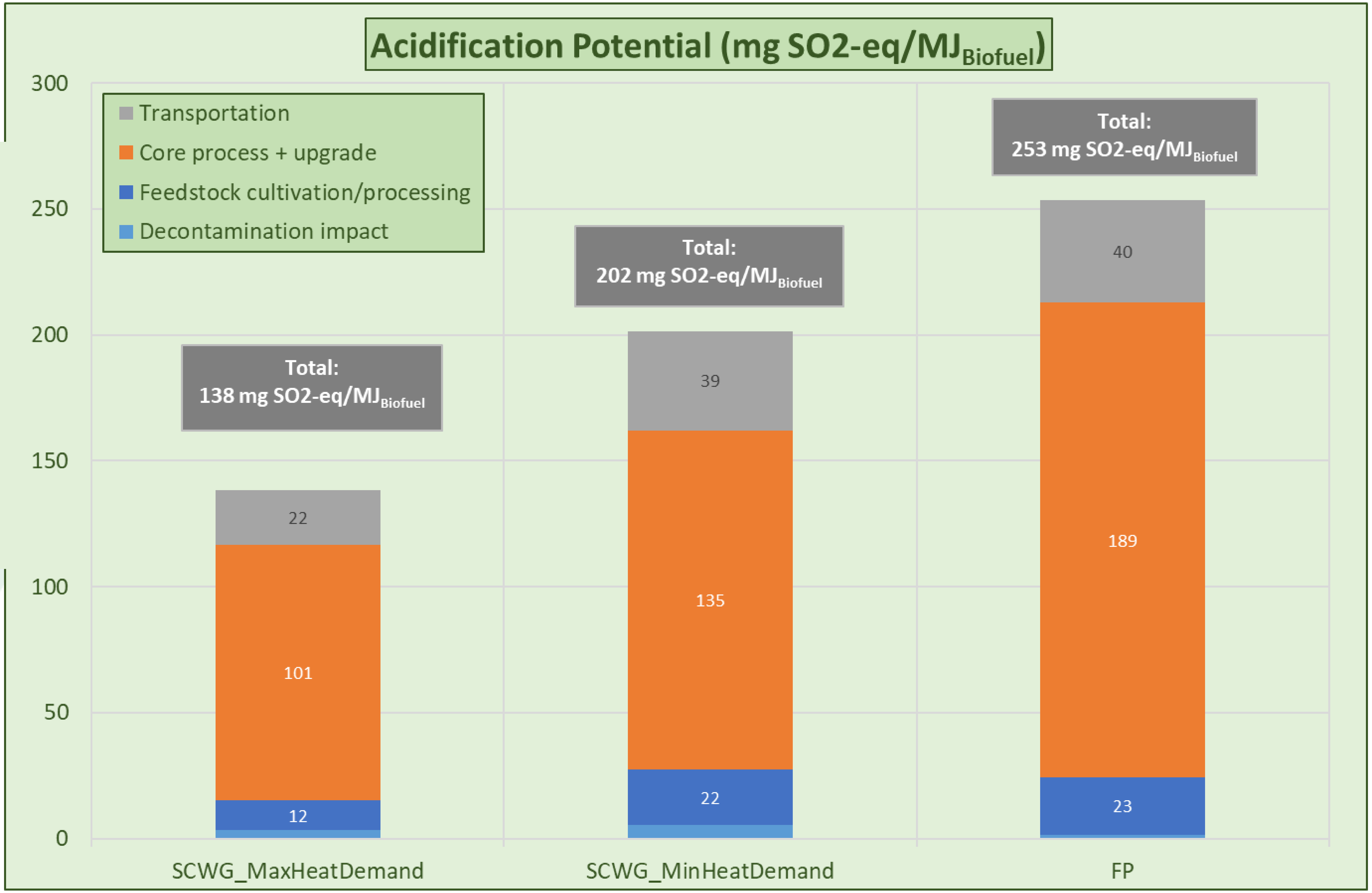
Results - Category 1

KPI4 "Acidification Potential"

- Advanced Cultivation practices
  - No Tillage
  - GWC and Biochar (FP) replacing common fertilizers
- External heat from fossil fuels
- Conventional (grey) H_2 supply

Reference fossil diesel value:
85 mg SO_2-eq/MJ_{Diesel}

Reference rapeseed biodiesel value:
677 mg SO_2-eq/$MJ_{Biodiesel}$



Task 4.3: Assessment of integrated solution pathways with S-KPIs

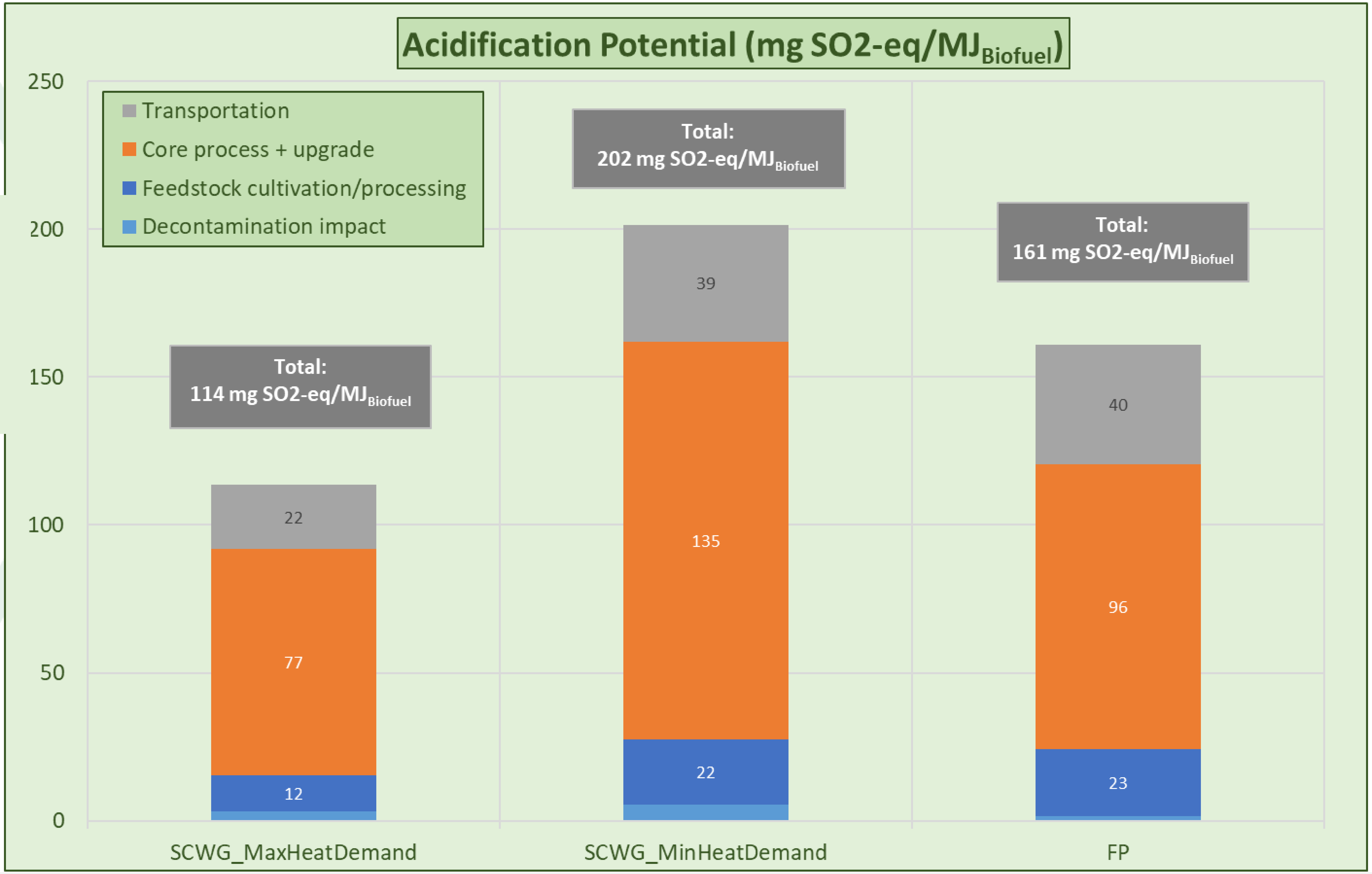
Results - Category 1

KPI4 "Acidification Potential"

- Advanced Cultivation practices
  - No Tillage
  - GWC and Biochar (FP) replacing common fertilizers
- Renewable or waste external heat
- Renewable (green) H_2 supply

Reference fossil diesel value:
85 mg SO_2-eq/MJ_{Diesel}

Reference rapeseed biodiesel value:
677 mg SO_2-eq/$MJ_{Biodiesel}$



Task 4.3: Assessment of integrated solution pathways with S-KPIs

Methodology of Sustainability Assessment - Category 2: KPIs quantified from WP2/3 technical data

Quantified either directly or through simple equations from WP2/3 technical data

#	Name	Equation	Units
KPI_2	Productivity	$(BiomassYield) / (SBC_{SCWG\ or\ FP})$, where BiomassYield: Dry feedstock production [t/(ha*y)] $SFC_{SCWG\ or\ FP}$: Specific Feedstock Consumption [$kg_{DryBiomass}/MJ_{Final\_Biofuel}$]	$GJ_{Final\_biofuel}/(ha*y)$
KPI_5	Off-take of contaminants	$(BiomassYield) \cdot (HMC)$, where BiomassYield: Dry feedstock production [t/(ha*y)] HMC: Sum of heavy metal concentrations in feedstock [$mg_{HeavyMetalsTotal}/kg_{DryBiomass}$]	$g_{HeavyMetals}/(ha*y)$
KPI_6	Decontamination efficiency	Direct input from D3.2 (SCWG) or D1.7 (FP)	% of contaminant captured
KPI_7	Land under phytoremediation	Direct input from DSS user or specific Use Case	ha

Results - Category 2: KPIs quantified from WP2/3 technical data

#	Name	Result			Units
		SCWG_MaxHeatDemand	SCWG_MinHeatDemand	FP	
KPI_2	Productivity	245	135	131	$GJ_{Final\_biofuel}/(ha*y)$
KPI_5	Off-take of contaminants	2.1	2.1	2.1	$kg_{HeavyMetals}/(ha*y)$
KPI_6	Decontamination efficiency	99%	99%	95%	% of contaminant captured
KPI_7	Land under phytoremediation	Case dependent			ha

Biomass yield: 17 t/ha*y; SFC: 0.0694 - 0.1262 - 0.1297 kgdb/MJBiof.; HMC: 124 mgHM/kgdb

S. Rusinowski, J. Krzyzak, J. Clifton-Brown, E. Jensen, M. Mos, R. Webster, K. Sitko, M. Pogrzeba
New Miscanthus hybrids cultivated at a Polish metal-contaminated site demonstrate high stomatal regulation and reduced shoot Pb and Cd concentrations
Environ. Pollut., 252 (2019), pp. 1377-1387

Task 4.3: Assessment of integrated solution pathways with S-KPIs

Methodology of Sustainability Assessment - Category 3 - KPIs calculated from the output of T4.2

- KPI8 "Total Life Cycle Cost"

The total expenditure over the whole project's life and discounts this amount to a present value.

- KPI9 "Net Present Value"

The sum of discounted annual savings for the investment.

- KPI10 "Internal Rate of Return"

The discount rate that sets the NPV of an investment equal to zero.

- KPI11 "Levelized Cost of (bio) Energy"

Comparison of energy generation technologies in term of their cost competitiveness.

Results - Category 3 - KPIs calculated from the output of T4.2

#	Name	Result		Units
		SCWG	FP	
KPI_8	Total Life Cycle Cost	206.9 – 329.5	130.6 – 193.1	M€
KPI_9	Net Present Value	(-53.7) - (-39.4)	(-7) – 40.9	M€
KPI_{10}	Internal Rate of Return	(-4.4%) – 3.6%	8.2% – 18.2%	(-)
KPI_{11}	Levelized Cost of (bio) Energy	1.78 – 2.29	3.92 – 4.67	c€/MJ

Task 4.3: Assessment of integrated solution pathways with S-KPIs

Category 4 - KPIs calculated through the implementation of social assessment methodology

KPI12 "Job Creation"

- **Direct jobs:** The result of bioenergy plant activities (operation, maintenance, management, among others). Activities carried out by bioenergy producing enterprises (for example, soybean production in integrated plants).
- **Indirect jobs:** Created along the value chain, in those sectors that supply goods or services to the bioenergy chain (production of agricultural inputs, construction of parts necessary for plant operation, outsourced activities)
- **Induced jobs:** Created by purchases made by direct and indirect employees of the activity in question with the income received for their work.

Indirect jobs created are higher from direct by a factor of 6.19, while induced jobs are estimated to be 2.39 times higher than direct.

Plant type	Worker productivity (Direct jobs per ton of biofuel produced * year)
Biodiesel – large	1 job per 4238 t/year
Biodiesel – medium	1 job per 1103 t/year
Biodiesel – small	1 job per 1005 t/year

FAO. 2020. A handbook on a methodology for estimating green jobs in bioenergy. Tools for investigating the effects of bioenergy production on employment at provincial level.

#		Result	
		SCWG	FP
	Direct	6.0	4.2
	Indirect	36.9	26.3
	Induced	14.2	10.1
KPI_{12}	Total Jobs Created/year	57.1	40.7

Task 4.3: Assessment of integrated solution pathways with S-KPIs

Category 4 - KPIs calculated through the implementation of social assessment methodology

KPI13 "Social Acceptance "

Social or public acceptance is generally defined, as a positive attitude towards a technology or measure, which leads to supporting behaviour if needed or requested, and the counteracting of resistance by others

- **Development of an interview template:** Introduction of the CERESiS concept to local communities and assessment of views, perceptions, and expectations of various stakeholders on the social aspects of the overall CERESiS concept
- **Conduct interviews with the local community in selected countries:** During December 2023 and January 2024 several interviews with the local community in selected countries (Brazil, Ukraine, Italy, and Greece) were organised
- **Assess the results and quantify the social acceptance of the CERESIS concept**: Social acceptance indicators were assessed and quantified using a 5-point Likert scale (anticipated level of acceptance towards the CERESiS concept, where 1 is the lowest – and 5 the highest).
- **Calculation of an overall "Social Acceptance" metric**. The feedback received from the interviews was utilized as "weighting factors (WF)" in a customized equation providing an overall "social acceptability" result for a specific biomass/conversion pathway, scaled from 1 (worst) to 10 (best)

Task 4.3: Assessment of integrated solution pathways with S-KPIs

Category 4 - KPIs calculated through the implementation of social assessment methodology

KPI13 “Social Acceptance ”

Topic	Anticipated level of satisfaction towards the CERESiS concept (1 lowest – 5 highest)	Anticipated level of acceptance towards the CERESiS concept (1 lowest – 5 highest): Total	Europe	Brazil
4.1 Local Environmental Impacts	How do you rate the following **potential local environmental impacts**?			
	To what extent are the **potential biomass transportation related impacts** (increased traffic, emissions from truck operation) important to you?	3,4	3,5	3,2
	To what extent are the **potential biomass plant operation related impacts** (emissions) important to you?	3,8	4,0	3,6
4.2 Local benefits	How do you rate the following **local benefits** of the CERESIS concept?			
	To what extent is **the decontamination period (measured in years)** of potentially contaminated land important to you?	4,2	3,8	4,6
	To what extent is **the productivity (kg produced per hectare) of energy crops** to be cultivated in any potentially contaminated important to you?	4,1	3,7	4,6
	To what extent is **the potential reduction of building heating costs** (due to using free heat from the biomass plant in a district heating network) important to you?	4,5	4,2	5,0
	To what extent is **the potential usage of locally produced solid bio-products** (biochar from the biomass plant as soil improver or biofuel) important to you?	4,3	3,8	4,8
	To what extent is **the potential usage of locally produced liquid biofuels** (substitutes of diesel and petrol from the biomass/upgrading plant as transportation fuels) important to you?	4,6	4,5	4,8
	To what extent is **the number of local jobs created from agricultural/transport/biomass plant operation activities** important to you?	4,5	4,7	4,8

Weighting factors (WF) of CERESiS local impacts/benefits ➔ Level of importance for local communities

Task 4.3: Assessment of integrated solution pathways with S-KPIs

Category 4 - KPIs calculated through the implementation of social assessment methodology

KPI13 "Social Acceptance "

$$KPI13 = \left(\frac{10}{\sum_{1}^{8} WF_i}\right) \cdot \left[\left(WF_1 \cdot \frac{(Minimum\ mass\ of\ feedstock\ transported\ annually\ for\ all\ examined\ cases)}{(Feedstock\ annually\ transported\ for\ specific\ biomass\ and\ conversion\ case)} \right) + \left(WF_2 \cdot \frac{(Minimum\ value\ of\ KPI\#4 - Local\ emissions\ for\ all\ examined\ cases)}{(KPI\#4\ value\ for\ specific\ biomass\ and\ conversion\ case)} \right) + \left(WF_3 \cdot \frac{(KPI\#5\ value\ for\ specific\ biomass\ and\ conversion\ case)}{(Maximum\ value\ of\ KPI\#5 - Offtake\ of\ contaminants)} \right) + \left(WF_4 \cdot \frac{\left(Biomass\ Feedstock\ yield - \frac{t}{ha} \cdot y - of\ specific\ biomass\ and\ conversion\ case\right)}{(Maximum\ value\ of\ Biomass\ Feedstock\ yield\ for\ all\ examined\ cases)} \right) + WF_5 \cdot (1.0\ for\ SCWG\ pathway\ OR\ 0.5\ for\ FP\ pathway) + WF_6 \cdot (0.5\ for\ SCWG\ pathway\ OR\ 1.0\ for\ FP\ pathway) + WF_7 \cdot (1.0\ for\ SCWG\ pathway\ OR\ 0.66\ for\ FP\ pathway) + \left(WF_8 \cdot \frac{(KPI\#12\ value\ for\ specific\ biomass\ and\ conversion\ case)}{(Maximum\ value\ of\ KPI\#12 - Job\ creation)} \right) \right]$$

SCWG:
8.3 - 8.9/10

FP:
7.4 – 8.5/10

Task 4.3: Assessment of integrated solution pathways with S-KPIs

Major findings – Conclusions

- The task has reflected the output of many different tasks and identifying critical parameters and aspects.
- The sustainability threshold is not (or marginally) achieved without a) minimizing external heat requirements, b) claiming soil carbon accumulation from replacing conventional fertilizers with GWC/biochar and c) available renewable heat and H_2 .
- Soil carbon accumulation is influential enough to counterbalance most of the impact by fossil generated external heat.
- If the availability of renewable/waste heat and green H_2 is additionally assumed, negative GWP impacts emerge.
- The FP chain shows potential for economic viability.
- Higher chain productivity, lower environmental impacts and better potential for creating jobs promote the SCWG social indicator.

Limitations

- Compromises regarding the level of value chain integration:
  - Different scale of sub-systems (experimental vs pilot vs industrial).
  - Downstream fuel upgrading and heat integration with core conversion stage has been assessed through literature.
- Compromises regarding input data:
  - Highly contaminated biomass not considered; Aspects remaining not intensively examined (e.g. MF efficiency and consumables, GWC NOx emissions, possible utilization of ECF/EO sludge); “Hard” inputs from EU regulations.

Nevertheless, the sustainability assessment completed in T4.3 has fulfilled the overarching objective of assessing the overall performance of CERESiS value chains, in a transparent and convincing way.

- **Partners participating:** [NTUA], KF.
- **Task overview - Aim:** Assess the corresponding sustainability aspects in terms of the life cycle energetic/environmental/economic and social impacts and develop decision support schemes in order to establish a justified solution in favor of the proposed concept. (M25-M39)
- **Partners involved and role:**
  - NTUA (TL): Implementation of multicriteria assessment methodology in order to provide a ranking of the solution pathways identified in T1.7. Integration of "objective" KPIs and "subjective" information towards providing a decision support scheme.
  - KF: Incorporation of stakeholder needs and priorities, towards formulating the "subjective" part of the multicriteria decision support approach.

Final activities between M37-M39

- Formulation of Decision Matrix according to output of T4.2 and T4.3
  - Selection of consistent KPI values (economic and environmental results to refer to same value chain configuration)
- Elaboration of feedback regarding weight factors for the KPIs
- Implementation of multicriteria analysis methodology
  - Calculation of various decision-making aspects (economically, environmentally and socially driven)
- Formulation of corresponding equations to be incorporated in the DSS

Decision matrix (“Objective” information flow)

Formulation of Decision Matrix:

- Three alternative cases (SCWG_max_heat; SCWG_min_heat; FP)
- 13 assessment criteria (KPIs)
- External heat from fossil fuels and conventional (grey) H_2 supply considered
- Data from D4.2 used to estimate the economic KPIs of value chain “SCWG with minimum (zero) external heat demand)

	#	Name	Info	Units
Energy	KPI_1	Non-Renewable Primary Energy Demand	Description: [20] (Section 3.2.1) Methodology: Current document (Section 4.1) Results: Current document (Section 5.1)	MJ_{eq} / $MJ_{Final\_Biofuel}$
	KPI_2	Productivity	Description: [20] (Section 3.2.1) Methodology: Current document (Section 4.2) Results: Current document (Section 5.1)	$MJ_{Final\_Biofuel}$/ha
Environmental	KPI_3	Global Warming Potential	Description: [20] (Section 3.2.2) Methodology: Current document (Section 4.1) Results: Current document (Section 5.2)	g CO_2-eq / MJ_{Final_Biofu}
	KPI_4	Acidification Potential	Description: [20] (Section 3.2.2) Methodology: Current document (Section 4.1) Results: Current document (Section 5.2)	g SO_2-eq / MJ_{Final_Biofu}
	KPI_5	Off-take of contaminants	Description: [20] (Section 3.3) Methodology: Current document (Section 4.2) Results: Current document (Section 5.2)	g_{heavy_metals}/(ha*year
	KPI_6	Decontamination efficiency	Description: [20] (Section 3.3) Methodology: Current document (Section 4.2) Results: Current document (Section 5.2)	% of contaminant captured
	KPI_7	Land under phytoremediation	Description: [20] (Section 3.3) Methodology: Current document (Section 4.2) Results: Current document (Section 5.2)	ha
Economic	KPI_8	Total Life Cycle Cost	Description: [20] (Section 3.2.3) Methodology: [20] (Section 3.2.3); [13] (Section 4.1.2) Results: [13] (Section 4.1.2)	Euros (€)
	KPI_9	Net Present Value	Description: [20] (Section 3.2.3) Methodology: [20] (Section 3.2.3); [13] (Section 4.1.2) Results: [13] (Section 4.1.2)	Euros (€)
	KPI_{10}	Internal Rate of Return	Description: [20] (Section 3.2.3) Methodology: [20] (Section 3.2.3); [13] (Section 4.1.2) Results: [13] (Section 4.1.2)	(%)
	KPI_{11}	Levelized Cost of (bio) Energy	Description: [20] (Section 3.2.3) Methodology: [20] (Section 3.2.3); [13] (Section 4.1.2) Results: [13] (Section 4.1.2)	Euros (€)/MJ_{Final_Biofu}
Social	KPI_{12}	Jobs Creation	Description: [20] (Section 3.2.4) Methodology: Current document (Section 4.4) Results: Current document (Section 5.4)	Number of jobs/$MJ_{Final\_Biofuel}$
	KPI_{13}	Social acceptability	Description: [20] (Section 3.2.4) Methodology: Current document (Section 4.4) Results: Current document (Section 5.4)	Qualitatively assesse

	SCWG-maxH	SCWG-minH	FP
PED	1,01	0,59	1,9
Product.	245	135	131
GWP	6,9	-18,3	-2,1
AP	138	202	253
Offtake	2,1	2,1	2,1
Decont.	99	99	95
Area	10000	10000	10000
LCC	330	267	193
NPV	-39,4	-51	40,9
IRR	3,6	2,5	18,2
LCOE	3,9	5	1,8
Jobs	57	57	41
Social	8,5	8,3	8,2

Weight factors ("Subjective" information flow)

Reflecting stakeholder priorities on weight factors:

- Online questionnaire developed by NTUA and EXE, available since June 2023.
- Feedback, triggered by physical interaction with EUBCE23 participants and targeted e-mails.
- Active until Dec 2023

CERESiS - Questionnaire on Key Performance Indicators

CERESiS (ContaminatEd land Remediation through Energy crops for Soil improvement to liquid biofuel Strategies) is a H2020 Project (https://ceresis.eu/) aiming to facilitate land decontamination through phytoremediation and subsequently utilize the biomass grown towards the production of clean liquid biofuels.

https://www.surveymonkey.com/r/H7WKZ5F

most appropriate cultivation and harvesting methods, conversion and separation technologies and supply chain design.

This questionnaire (as part of the DSS development) aims to assess the priorities of various stakeholders - expressed through a series of Key Performance Indicators (KPIs) - , through the quantification of the significance of various parameters affecting the potential implementation of the phytoremediation-to-biofuel value chains proposed in CERESiS.

- You are asked to assess the significance of the Key Performance Indicators (KPIs) selected for the evaluation of the CERESiS concept.
- The goal is to provide values (from 1 to 10) for each one of the KPIs presented herewith. The values should represent the level of significance of each KPI (1-lowest; 10-highest).
- When assessing the significance of a specific KPI, please ignore possible implications with other KPIs.
- Please provide your assessment, according to your judgement based on relevant experience.
- You may propose additional KPIs, if appropriate
- Estimated time to complete the questionnaire: 5 - 10 min

OK

			Default Values of Significance Coefficient (SC_KPI_i)
KPI_1	Environmental	Primary Energy Demand	8.15
KPI_2		Productivity	8.08
KPI_3		Global Warming Potential	9.08
KPI_4		Emissions / Impacts related to non-GHG air pollutants	6.62
KPI_5		Off-take of contaminants	7.46
KPI_6		Decontamination efficiency	7.00
KPI_7		Avoided land-use change/ land under phytoremediation	6.69
KPI_8	Economic	Total Life Cycle Cost	7.54
KPI_9		Net Present Value	7.08
KPI_10		Internal Rate of Return	7.00
KPI_11		Levelized Cost of (bio) Energy	7.77
KPI_12	Social	Jobs Creation	6.69
KPI_13		Social acceptability	7.46

Weight factor calculation according to seven (7) decision making aspects:

a. Economically driven (i. Extreme and ii. Moderate)
b. Environmentally driven (i. Extreme and ii. Moderate)
c. Socially driven (i. Extreme and ii. Moderate)
d. Balanced between environmental, economic and social aspects

Multicriteria assessment results – Economically driven decision making

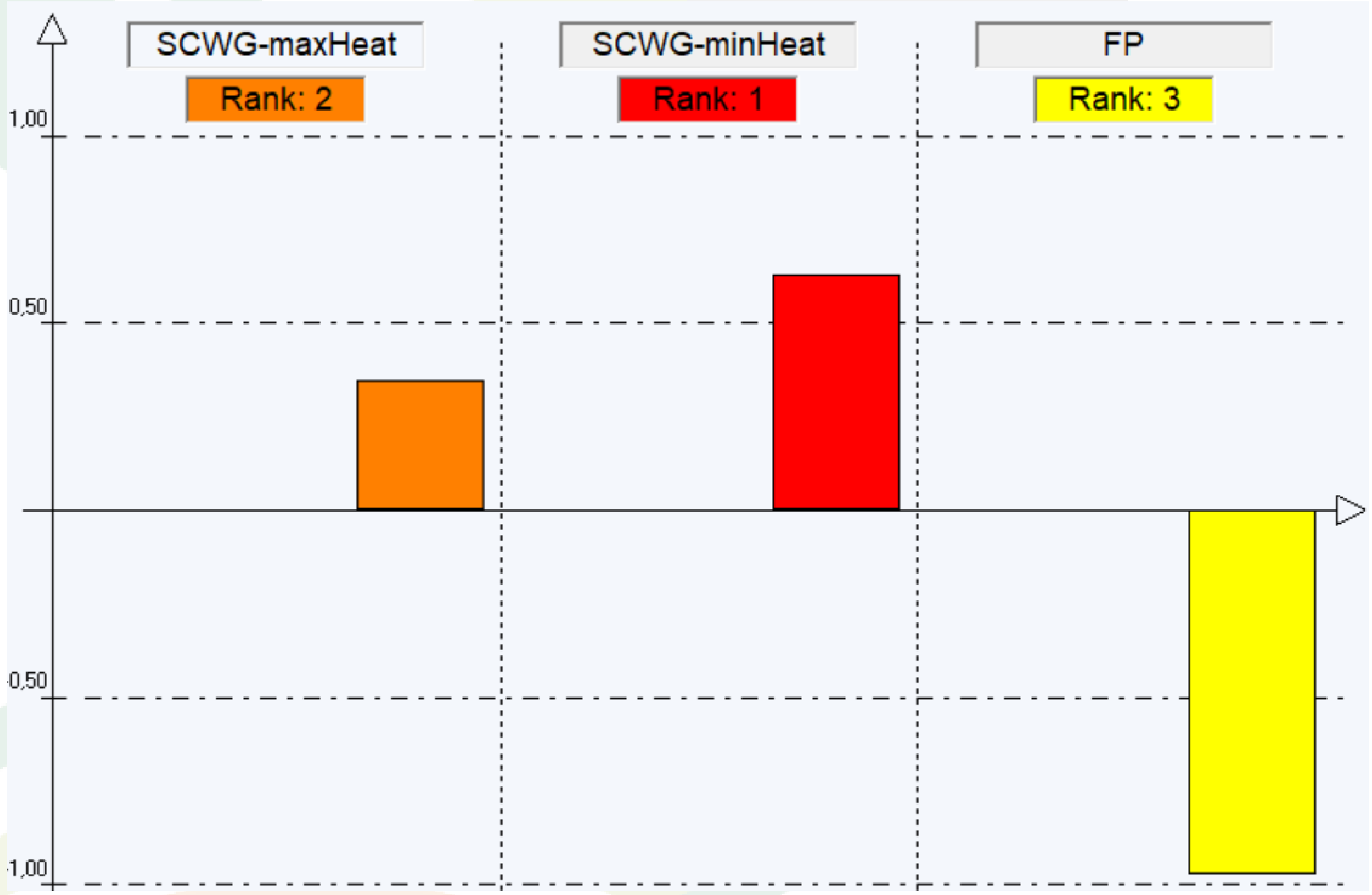
Extreme economic:
Economic : 100% – Environmental: 0% - Social: 0%

Moderate economic:
Economic : 50% – Environmental: 25% - Social: 25%

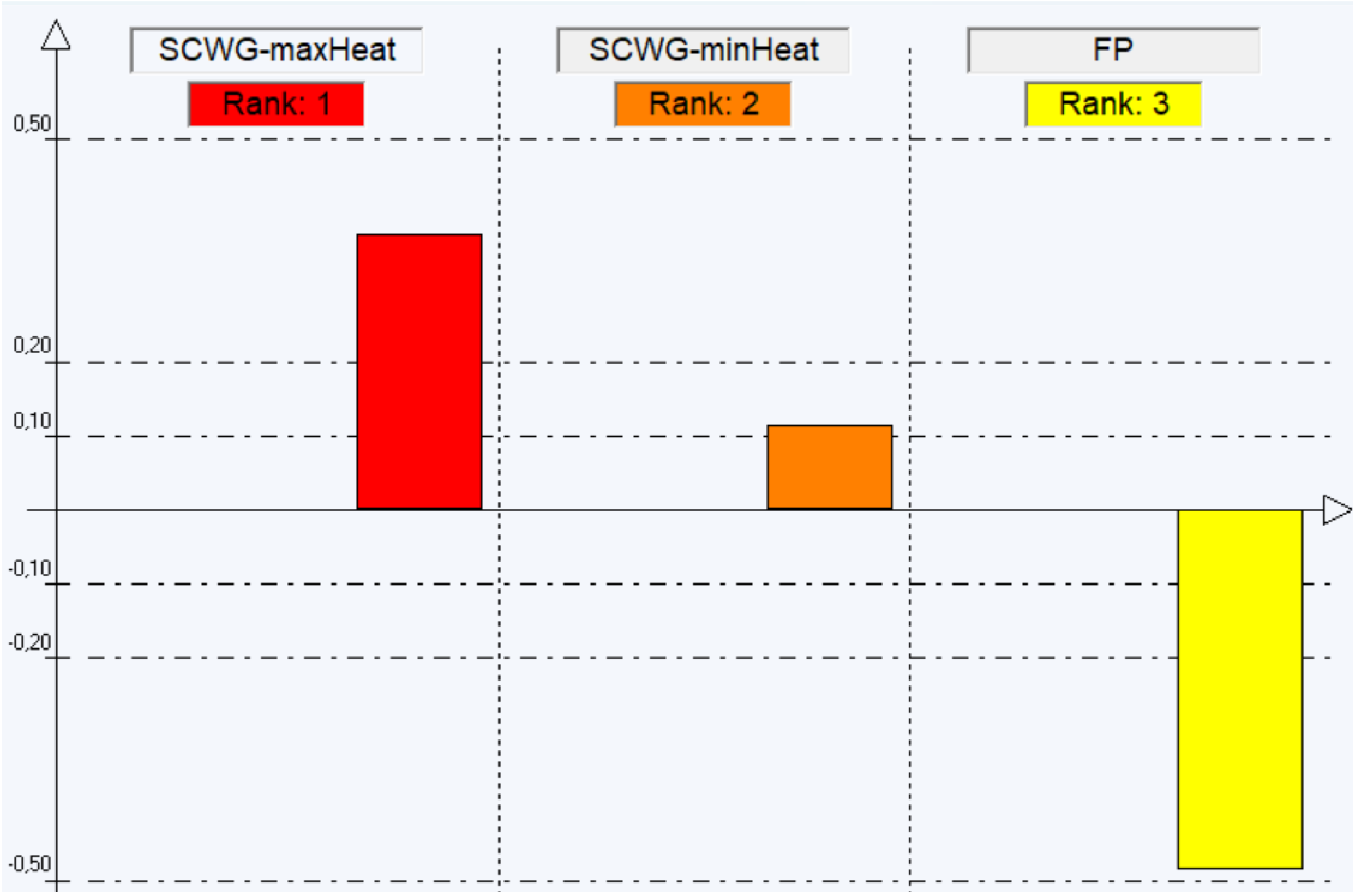
- As expected from D4.2, FP is the prevailing alternative when economic criteria are assigned the highest weight.
- The decision is not that straightforward when environmental and social aspects gain importance.

Multicriteria assessment results – Environmentally driven decision making

Extreme environmental:
Economic : 0% – Environmental: 100% - Social: 0%



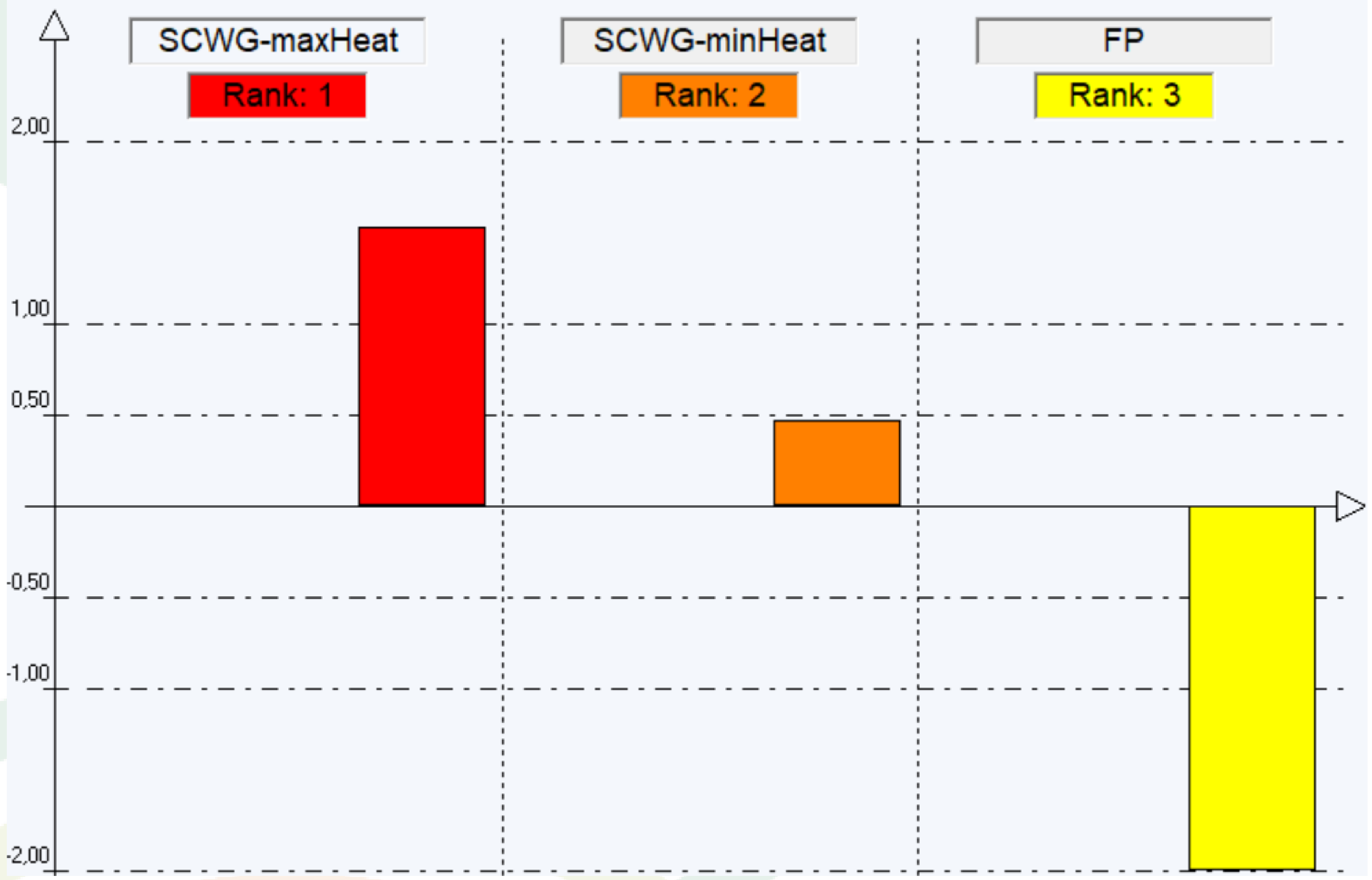
Moderate environmental:
Economic : 25% – Environmental: 50% - Social: 25%



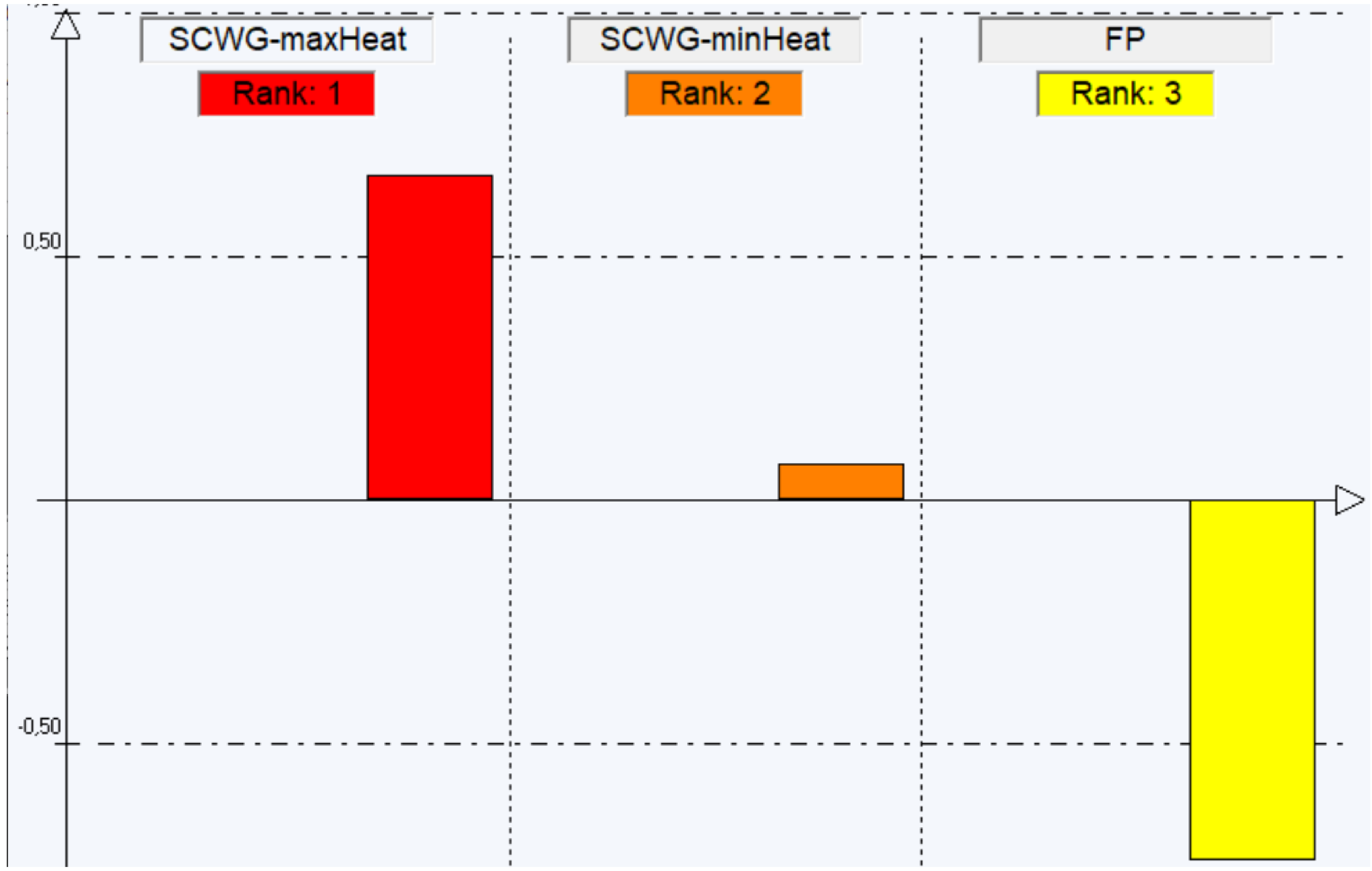
- SCWG cases perform better in terms of environmental criteria, especially the zero external heat case.
- When other aspects come into play, the maximum external heat option prevails (due to higher productivity and economic indicators)

Multicriteria assessment results – Socially driven decision making

Extreme social:
Economic : 0% – Environmental: 0% - Social: 100%



Moderate social:
Economic : 25% – Environmental: 25% - Social: 50%



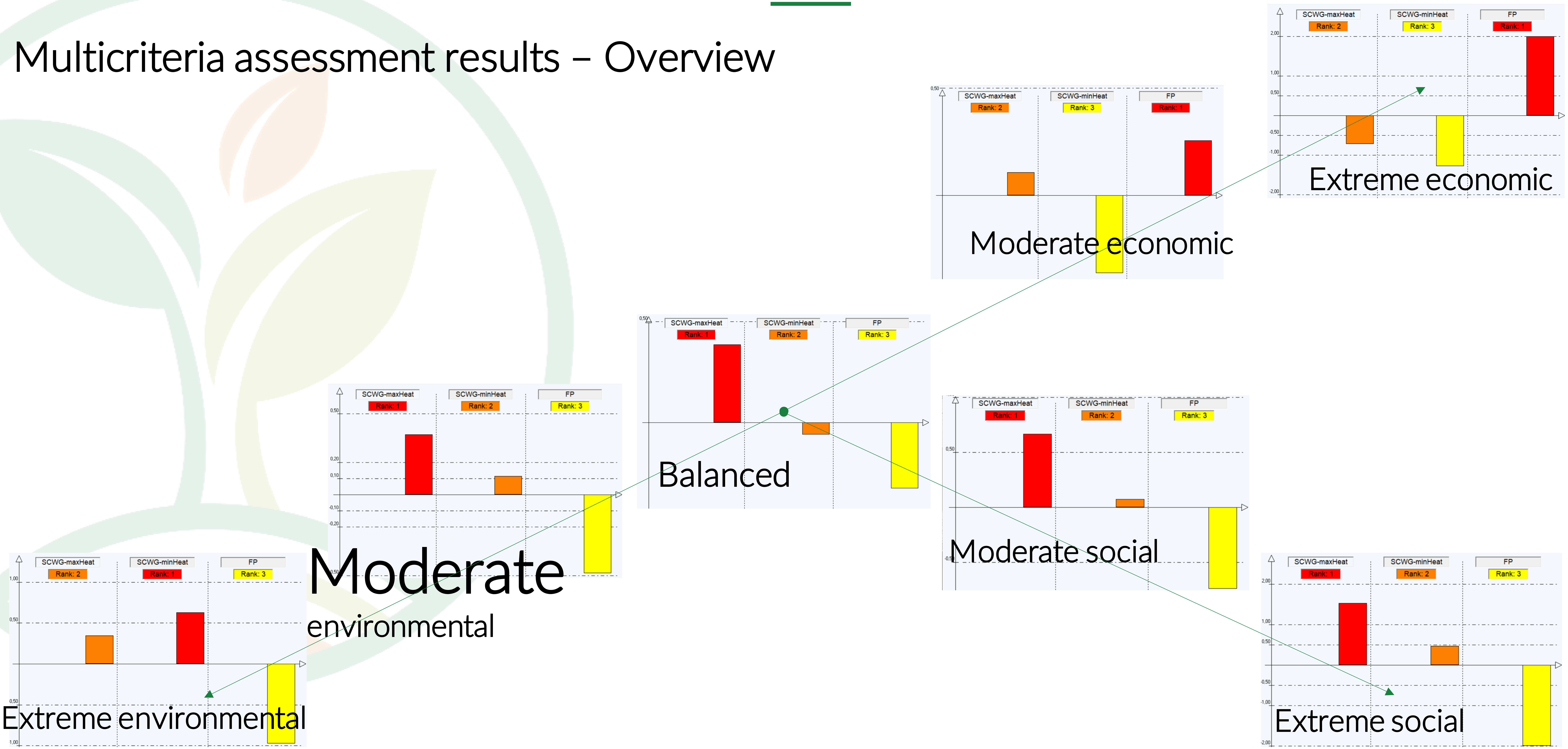
- SCWG cases perform better also in terms of social criteria, due to higher job creation potential and lower local impacts. especially the zero external heat case.
- The result does not change much when environmental and economic aspects gain importance.

Multicriteria assessment results – Balanced decision making

Balanced:
Economic : 33.3% – Environmental: 33.3% - Social: 33.3%

- Balanced results resemble to moderate environmental and moderate social, however all alternatives are quite close to each other.

Multicriteria assessment results – Overview

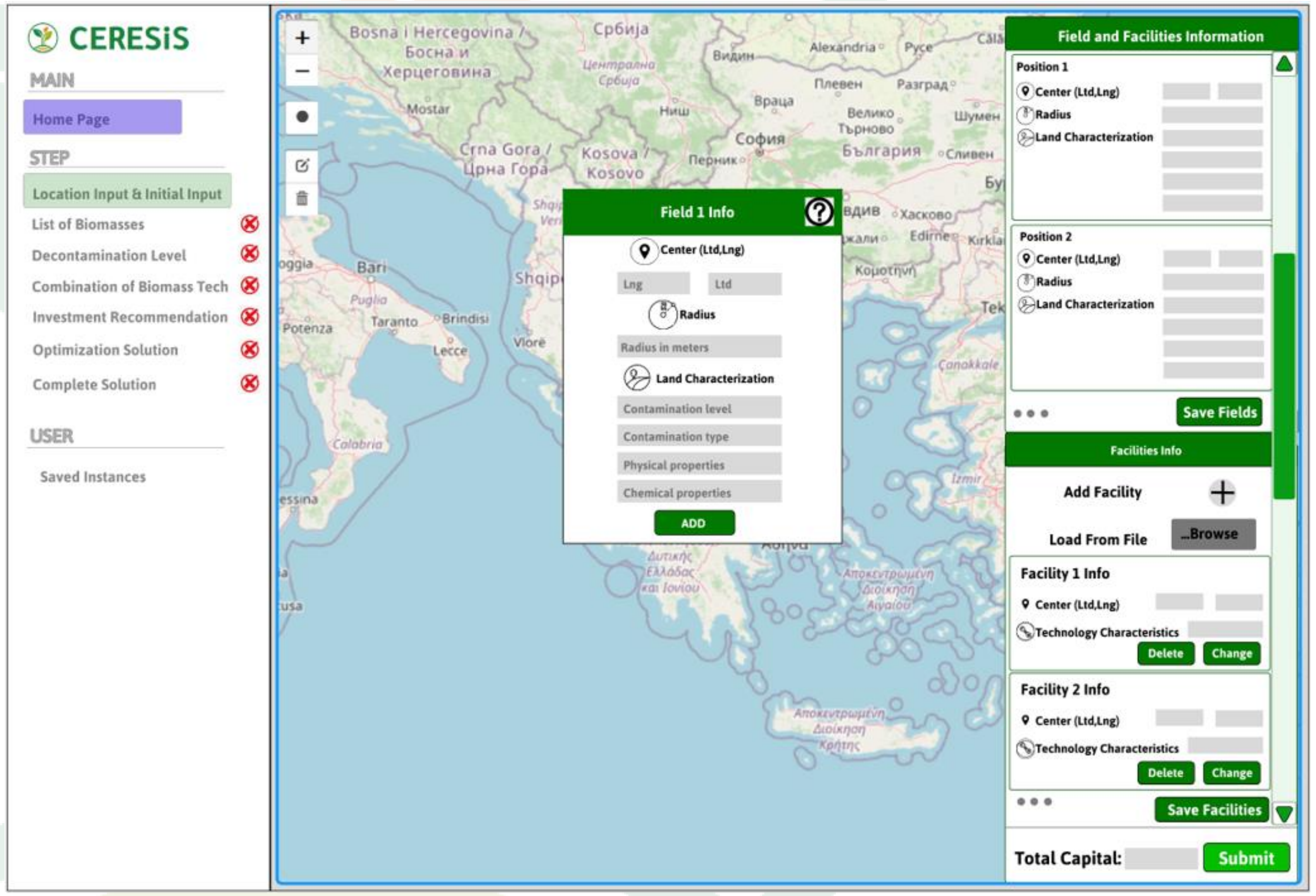


Major findings – Conclusions

- All three alternatives can be selected as the “best” option, depending on the decision-making priorities.
- The FP alternative is dominant in economic driven scenarios (2 out of 7).
- SCWG with external heat provision prevails in 4 out of 7 scenarios (both social, moderate environmental and balanced).
- The other SCWG option (self sustained conversion with zero external heat demand) wins only under extreme environmental decision-making priorities (1 out of 7).

- The task has successfully provided valuable insight on how variable decision aspects lead to different prevailing technologies

Task 4.5: CERESiS DSS platform



dss.ceresis.eu

Release of D4.5 - DSS web-based platform implementation

The CERESiS Decision Support System

What type of decisions can the CERESiS DSS support?

1. Which biomass types are suitable for particular contaminated land conditions?
2. What are the expected yields and contaminant uptake?
3. Which combinations of technologies - biomass types are suitable?
4. Which is the optimal supply chain design (facilities location, capacities, structure)?
5. Which is the optimal value chain configuration considering the specific case study conditions (i.e. selection of biomass type – technology – supply chain structure)?
6. What is the performance of the value chain against economic – environmental – social KPIs?

The CERESiS DSS – Key Characteristics

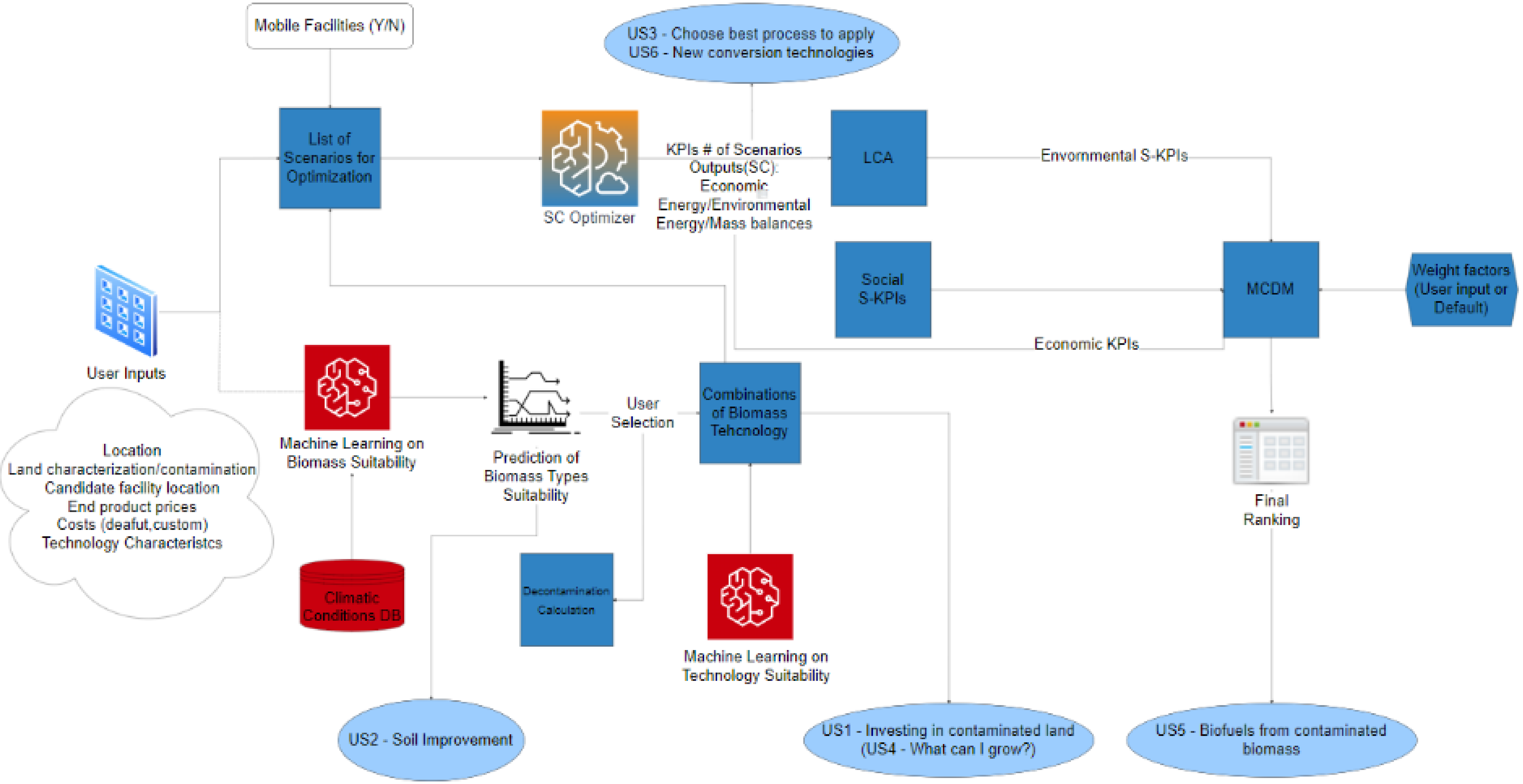
1. To allow full value-chain assessment (rather than partial view)
2. To incorporate the sustainability dimensions in the assessment (environmental, social, economic)
3. To adopt novel methods (Machine Learning) for predicting the performance of biomass species on contaminated land (yield & contaminant uptake)
4. To be a practical tool for pre-feasibility assessment
5. To support the needs of various stakeholders involved in the value chains
6. To have generic applicability in Europe
7. To include the findings/learnings from the CERESiS project
8. To be a modular and expandable platform
9. To allow saving of scenarios and results in a database for each user
10. Novel concept: to allow consideration of mobile Fast Pyrolysis plants

The CERESiS Decision Support System

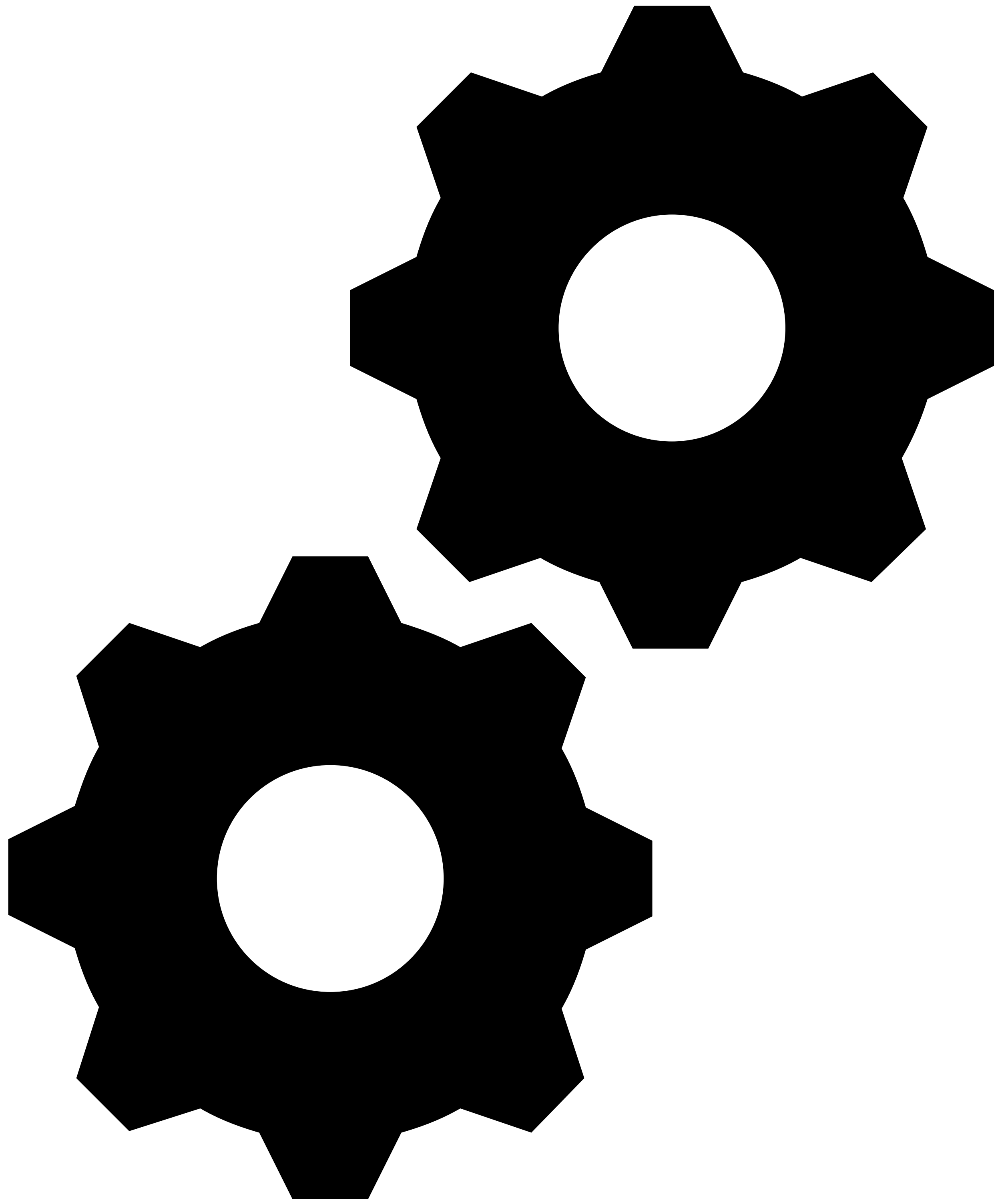
Development and implementation of a dedicated DSS platform providing critical information to decision makers on the suitability of pathways consisting of combinations of energy crops and biofuel conversion technologies for specific applications

<u>Key elements included</u>

→ Machine Learning for Biomass Suitability
→ Technology suitability assessment
→ Supply Chain optimization
→ Life Cycle Analysis
→ Social impact
→ Multi-criteria analysis



The CERESiS DSS: Logic



User defines the set of scenarios (pathways) to be considered.

Scenarios = Feasible combinations of:

- ✓ Biomass types suitable for particular location
- ✓ Technologies considered in the platform

The CERESiS DSS: challenges to achieve vision

1. Very ambitious tool due to wide scope – needs simplifications to keep complexity low
2. Still needs some basic key information from user that may not be easily available (e.g. contamination in land)
3. Provides better results when trained on large datasets
   - Very limited results on Phytoremediation published
   - no systematic reporting of outcomes
   - Extremely limited long-term trials
4. CERESiS results are TRL 4-5; how to scale up results to represent higher TRLs

FAPEG
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Fonds de recherche Société et culture
Québec

ML in the CERESiS DSS

Predicting the biomass yield, the moisture of the harvested biomass, or the level of the contaminants harvested from the given dataset was a challenge

<u>Methods Attempted</u>

→Support Vector Regression

→Artificial Neural Networks (both shallow and deep)

→Linear Regression

→Decision Stumps

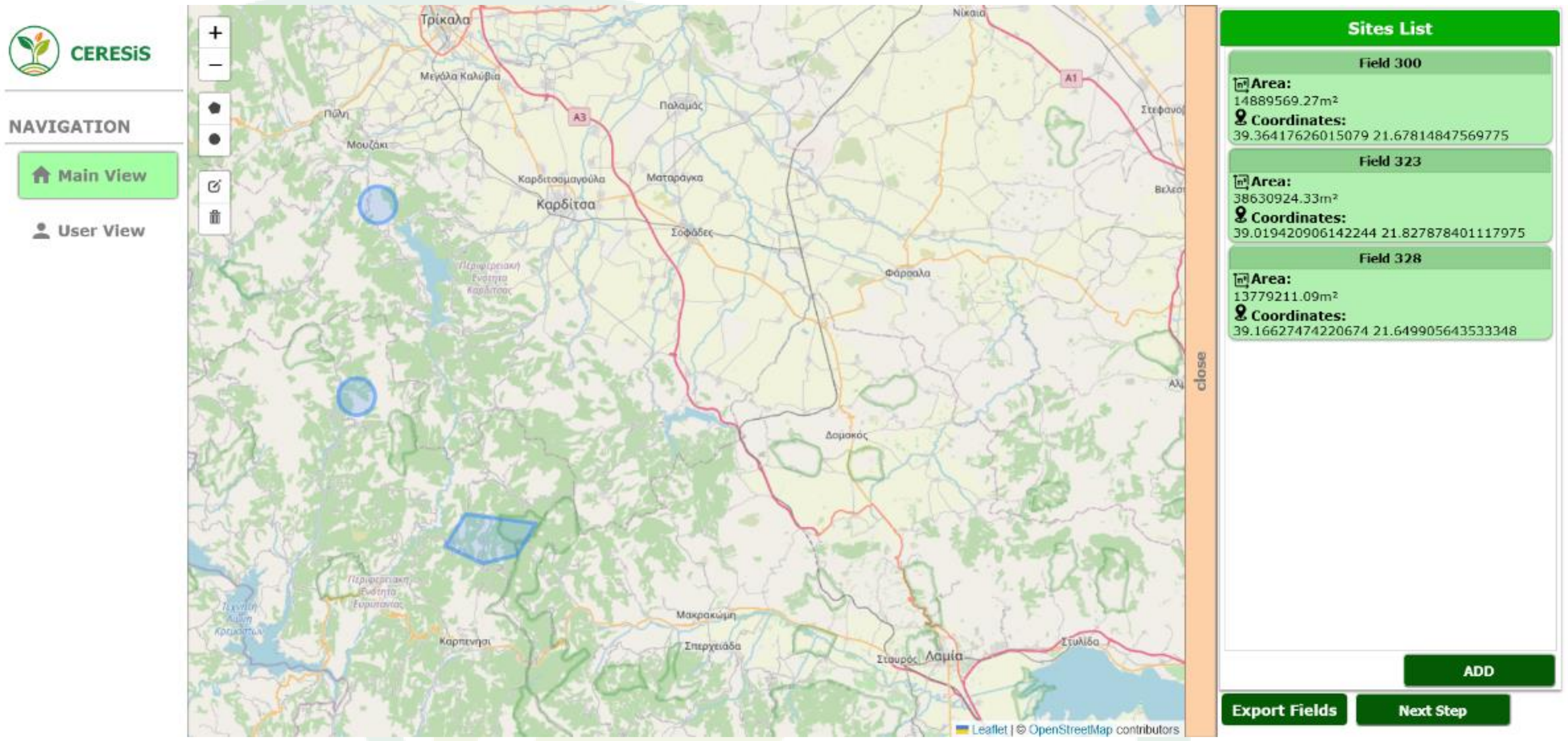
→Bagging

→K-Nearest Neighbors

All methods initially resulted in biomass yield MSE above 2.E+05 on the training set!

Best method is a custom-made weighted 1-NN method that selects the rows that match a plant type, and penalizes heavily any climatic zone mismatch (equal weights for contaminants)
MAPE% ~ 3.4%, MAE ~ 100, RAE ~ 0.48 on the training set!

The CERESiS DSS: start by importing fields

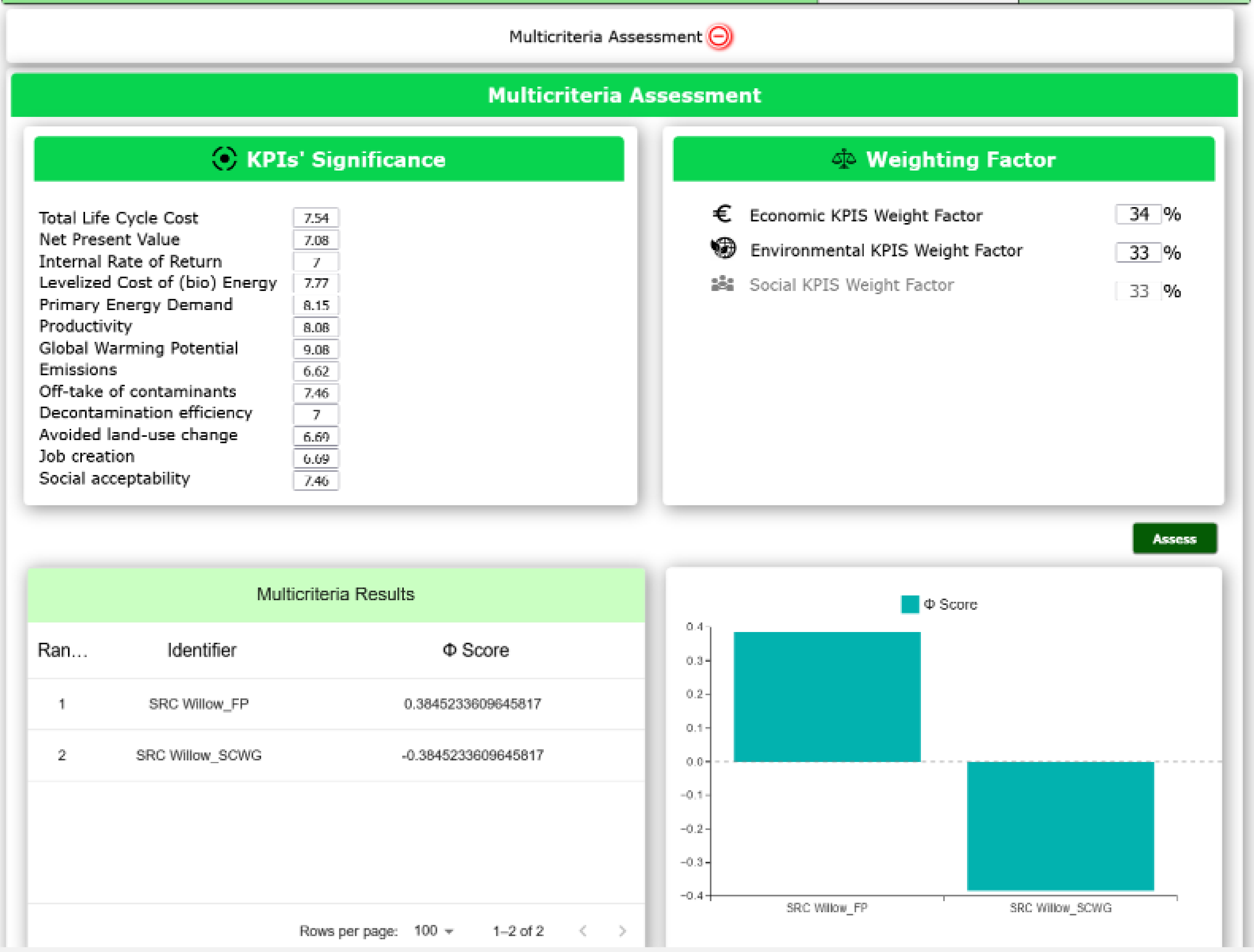


The CERESiS DSS: outputs

Economic KPIs

- Environmental sustainability KPIs
- Social sustainability KPIs
- Multicriteria assessment → ranking of scenarios based on user-specific weights
- Details on
  - Costs & revenues breakdown
  - Transportation emissions
  - LCA on full system
  - Supply chain design (facility locations, transportation activities)

KPI	SRC Willow_FP	SRC Willow_SCWG
Total Life Cycle Cost [€]	75,130,445	128,946,541
Net Present Value [€]	-61,682,779	-112,698,910
Internal Rate of Return [%]	0	0
Levelized Cost of (bio) Energy [€/MJ]	0	0
Primary Energy Demand [MJ_fossil_primary_energy/MJ_final_fuel]	1.758	3.088
Productivity [MJ_final_fuel/ha]	45.559	84.942
Global Warming Potential [kg CO2_eq/MJ_final_fuel]	-11.309	165.983
Emissions [mg SO2_eq / MJ_final_biofuel]	229.008	628.951
Off-take of contaminants [g_heavy_metals/(ha*year)]	7,083.966	2,224.755
Decontamination efficiency	0.95	0.99
Avoided land-use change [ha]	1,629.021	1,629.021
Job creation [jobs/year]	9.504	8.088
Social acceptability	10	7.964

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Git
ML For DT
NGINX & Docker & JE...
ELK stack
Ubuntu Staff
PLURAL
JAVA + Spring
IOT and Communicati...
Projects-Sites
Keycloak
DS_Application
CERESiS
CERESiS
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User View
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Stirling
Edinburgh
Glasgow
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Belfast
Great Britain
Guidelines & Steps
1. Choose your fields using the markers on the left
OK
close
Sites List
Export Fields
Next Step
Leaflet | © OpenStreetMap contributors

Task 4.5: CERESiS DSS platform

Next steps:

- Send a survey within the consortium to collect feedback
- Finalize the fine tuning of the platform based on input from NTUA
- ….
- Release of Del. 4.7

T4.6: Progress

- Delayed – due to DSS development delay.
- Template Factsheet form for Use Case description distributed to WP2 partners – Completed forms received– still pending UFG
- Received stakeholders list from earlier work of KF – starting point
- Will need some (minor) support from WP2 partners to approach local stakeholders

Task 4.6: Updated time plan

Task	Subtask	Action	May 2023	June 2023	July 2023	Aug 2023	Sept 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024
			M31	M32	M33	M34	M35	M36	M37	M38	M39	M40	M41	M42
T4.6.1		**Engagement with local stakeholders in use case areas. (M25-M42)**												
	T4.6.1.1	Finalisation of Use Case areas selection												Almost There
	T4.6.1.2	Establishment of Engagement with local stakeholders in selected use case areas												✗
		Engagement with local stakeholders in selected use case areas												✗
T4.6.2		**Data Collection. (M27-M35).**												
	T4.6.2.1	Specification of data types and format for input in DSS platform												OK
	T4.6.2.2	Data Collection from Use Cases												Just started
T4.6.3		**Use cases application in DSS platform. (M35-M38)**												
	T4.6.3.1	Application of DSS model												✗
	T4.6.3.2	Updating databases												✗
T4.6.4		**Feedback from stakeholders. (M39-M42)**												
	T4.6.4.1	Presentation of DSS platform's outcomes to local stakeholders												✗
	T4.6.4.2	Feedback collection												✗
	T4.6.4.3	Validation and refinement of DSS platform												✗

T4.6: Immediate actions & next steps

- Contact WP2 partners for local stakeholders proposal (next week)
- Initiate engagement with local/regional stakeholders to ensure buy-in
- Define data types required (NTUA) and communicate requirements to Use Case leaders (UoS, UFG, UoT, REA)

WP4: Risks & Contingency Plans

	Risk/challenges	Mitigation Plan
1	Lack of data coming from WP2 & WP3 to apply ML	Strong communication/collaboration to identify any issues in order to seek for other data sources
2	Availability of data from past projects of the project partners (e.g. BioReGen, EcoREMED, Derwent Reservoir, SURICATES, and RIZOBIOREM)	We should identify early if there is a need to seek other data sources beyond the project
3	Insufficient data or poor quality data for model derivation	Seek other data sources beyond the project
4	Models proving too hard to solve optimally Models not representing reality	Use better solvers, try heuristics, try parallel/distributed computing on the cloud, decompose models using divide-and-conquer to produce (sub-)optimal solutions
5	Bugs in the developed s/w	Test model on test-data with known outputs (test-driven modeling & development)
6	M39 – too many deliverables – materialized	Early and efficient planning – amendment resolved this
7	the limited timeframe for T4.6 (Use case applications) -6M	earlier identification & engagement of use case stakeholders & problem owners, as well as local partners (possibly 12M before the official task start date)
8		

WP4: Next steps & concluding remarks

D4.3	Sustainability assessment with Life Cycle Methodologies	Evaluation of economic, environmental and social KPIs for the integrated solution pathways examined versus benchmark and target values. D4.3 reports the activities of Task 4.3	NTUA
D4.4	Multicriteria sustainability evaluation of CERESiS concept	A synthesis of the objective information generated within CERESiS (KPI values) with subjective decision making aspects, implementing fuzzy multicriteria methodologies. D4.4 reports the activities of Task 4.4	NTUA
D4.6	DSS platform	The final version of the online platform with open access for various users, implementing the DSS is linked to activities of Task 4.5	INTRA
D4.7	DSS web-based platform & use cases	Linked to task 4.6	NTUA

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Our partners

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