The design and analysis of scenarios for multi-purpose solar park 'de Stegenhoek'

Academic Consultancy Training

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Commissioners: bureau Eelerwoude, the landowners & LC Energy

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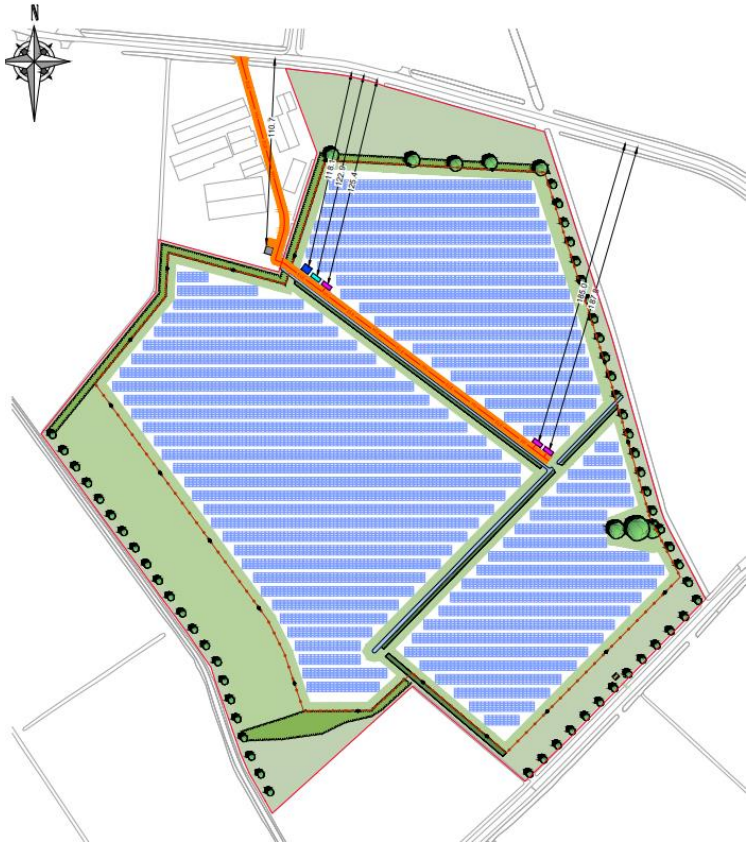
Introduction

- Introduction of study case
- Transitions needed for the future
- Opportunities of solar parks



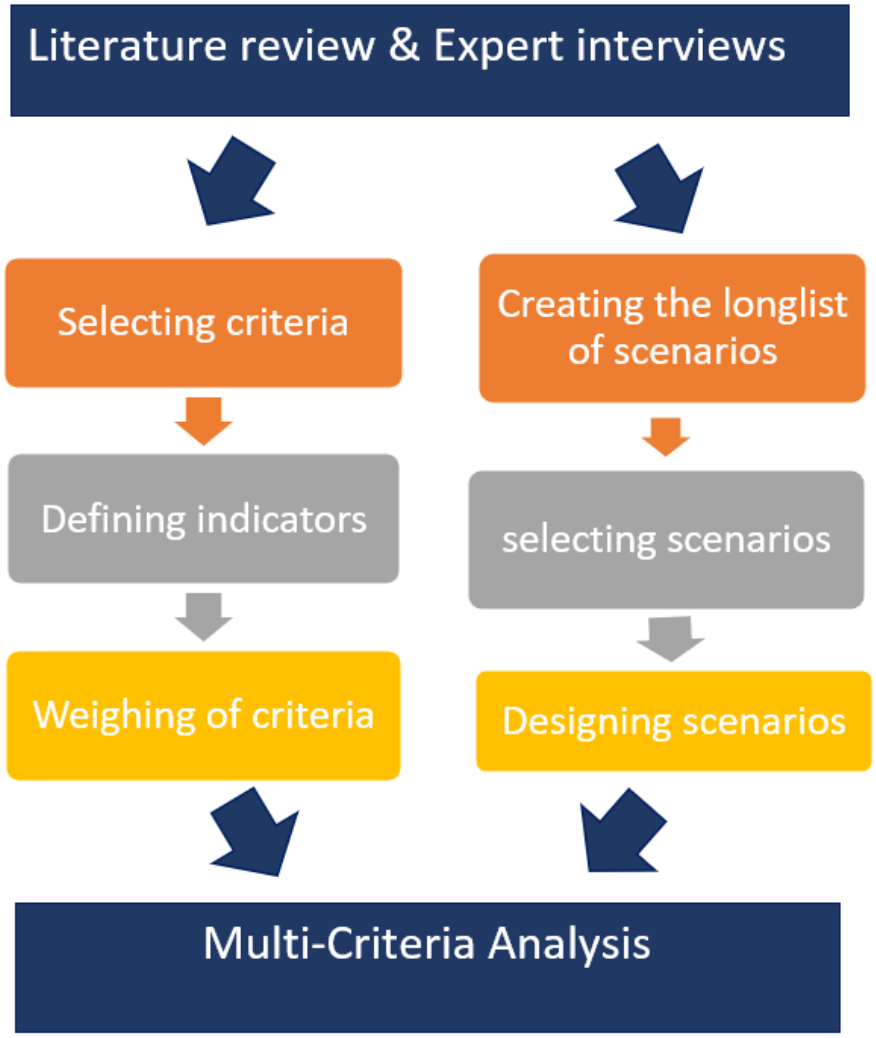
Current planned design of solar park 'de Stegenhoek'.

Objective

- To develop, analyze and compare second-use purposes of the solar park 'de Stegenhoek',

- Sub goals:
  - Criteria selection, scoring and weight
  - Selection of feasible scenarios
  - Assess performance of scenarios (MCA)

Methods


Literature review & Expert interviews
Selecting criteria
Defining indicators
Weighing of criteria
Creating the longlist of scenarios
selecting scenarios
Designing scenarios
Multi-Criteria Analysis

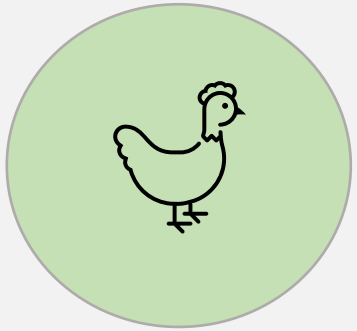
Results - Criteria

All criteria that were used in the MCA and respective weights.

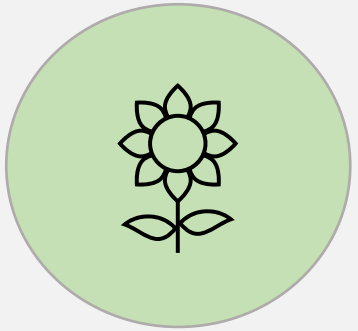
Criteria	Weighing
Feasibility	17.86%
Energy production	16.07%
Labour	10.71%
Soil quality	8.93%
Profitability	8.93%
Biodiversity	7.14%
Circular economy	7.14%
Climate change	7.14%
Agricultural transition	7.14%
Water use	3.57%
Public acceptance	3.57%
Education	1.79%

Results - Scenarios

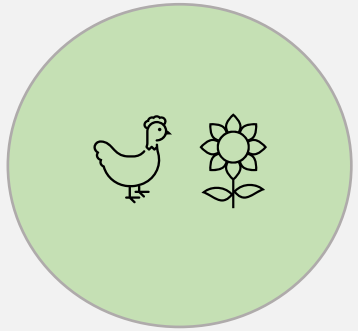
Crops



Animals



Biodiversity



Combination

1. Crop production scenario

- Strip cropping combined with rows of solar panels
- Rotation with strawberry, red beet, winter wheat, broad bean, potato and cabbage

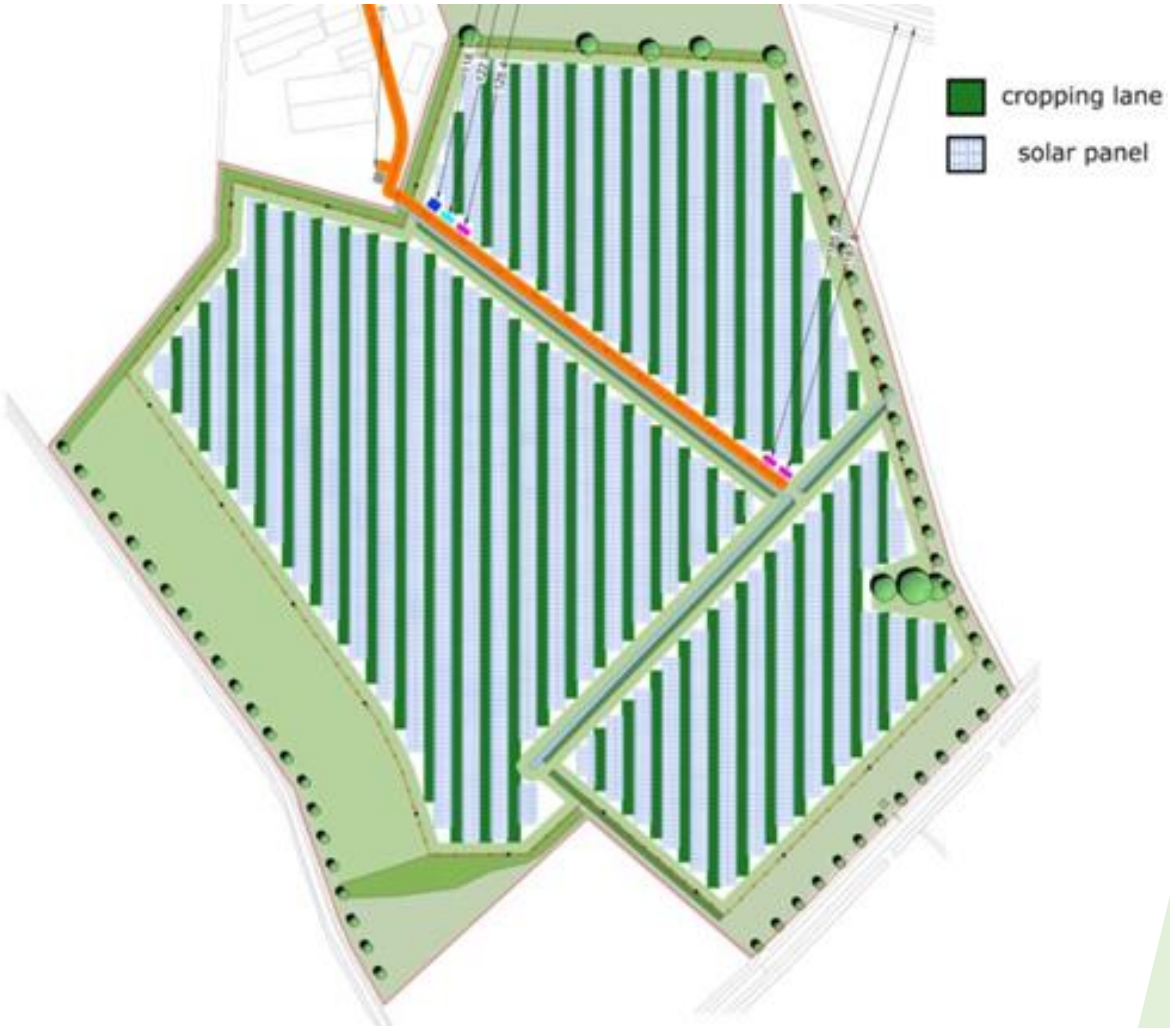
Above: example of strip cropping in the Netherlands. Below: Side view of the Crop scenario design.

1. Design Crop scenario

- East-west design with single axis tracking solar panels

Pro: Respecting environment and biodiversity with sufficient profit

Con: The use of single axis rotating solar panels



Above view of the Crop scenario design

2. Animal scenario

- 5400 Layer hens & 22 sheep

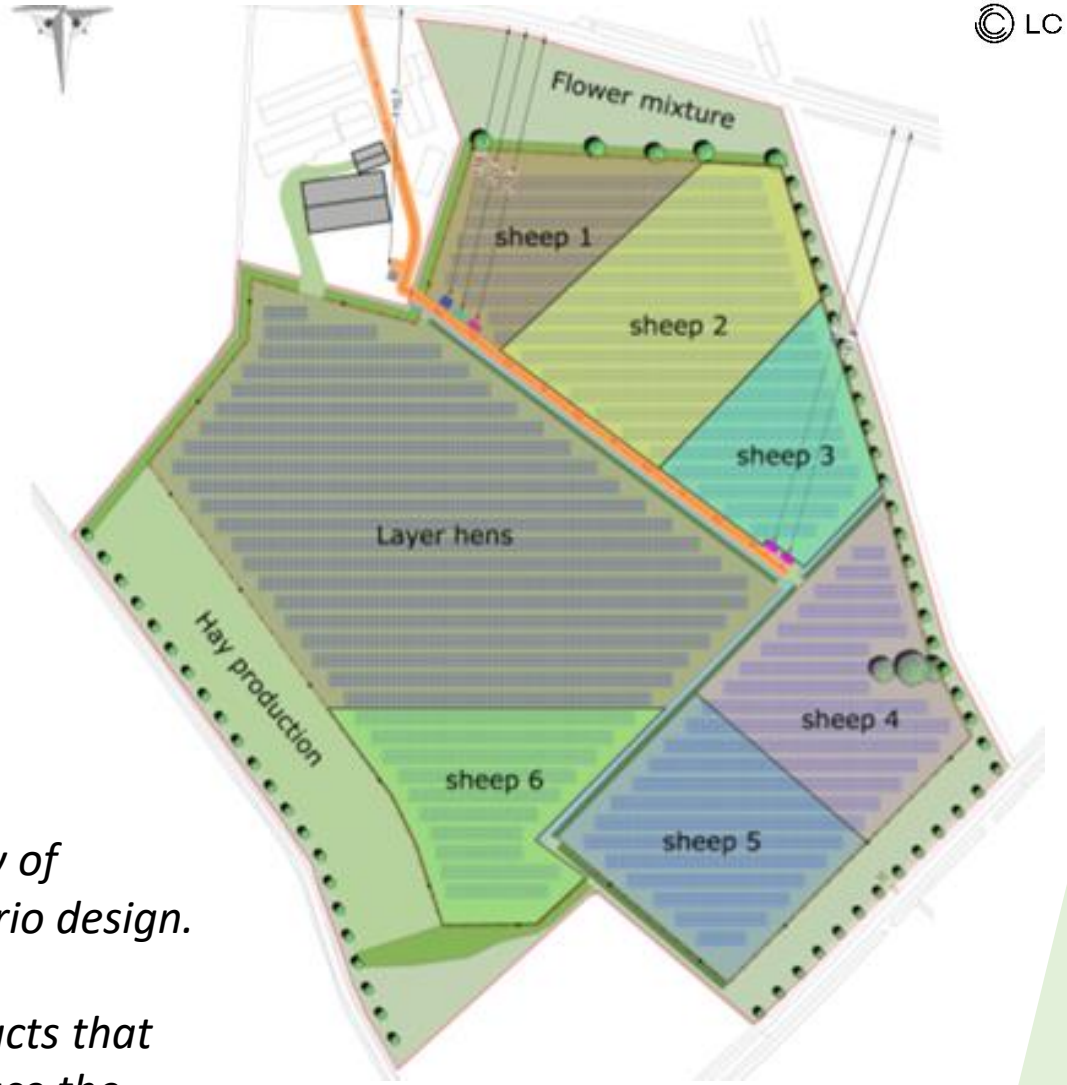
Left: example of chickens in combination with solar panels
Right: example of sheep in combination with solar panels

2. Design Animal scenario

- Layer hens as waste converters

Pro: High profitability and feasibility

Con: Not fully circular and little focus on biodiversity



Right: Above view of the Animal scenario design.

Left: Waste products that are used to produce the chicken feed.

3. Biodiversity scenario

- Ecological bottom-up approach: from soil to consumers

- Activities to decrease nutrient richness:
  1. Silage maize
  2. Grazing by sheep

Example of silage maize production.

Sheep grazing

3. Biodiversity scenario

Pro: Beneficial for biodiversity and environment

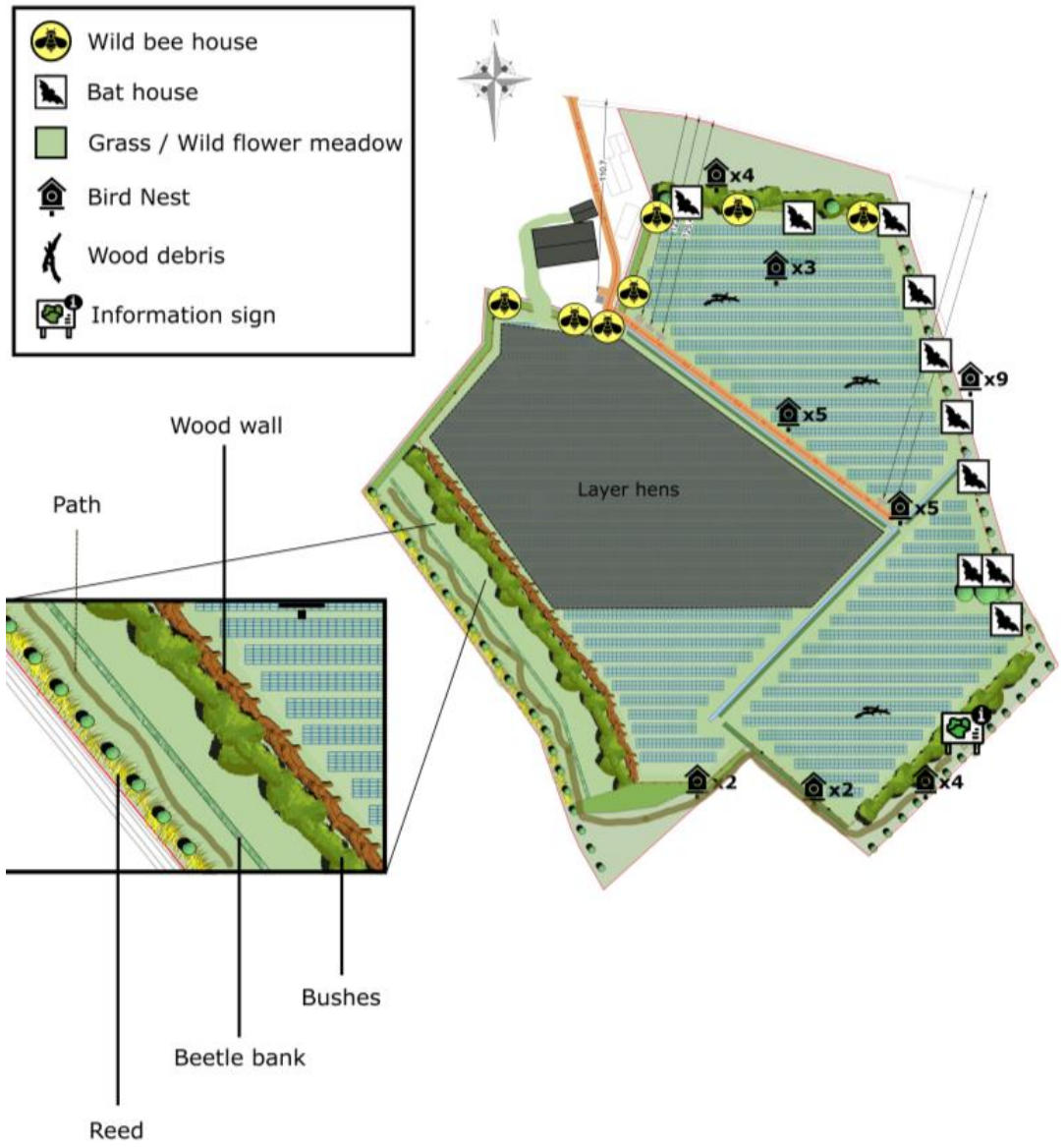
Con: Agricultural purpose of the farm will be lost

Above view of the Biodiversity scenario design.

4. Combination scenario

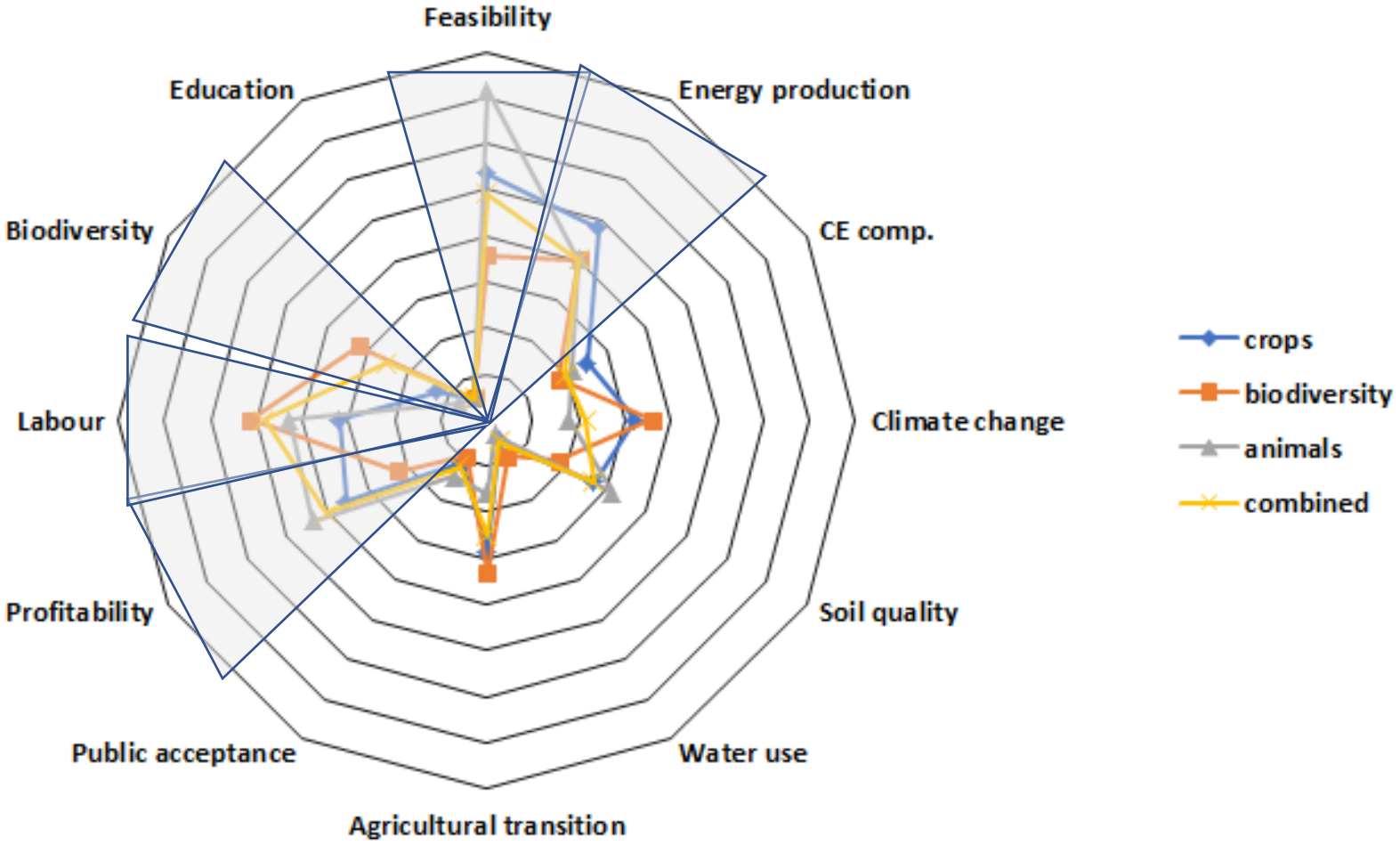
- Layer hens and biodiversity

Pro: Combining the benefits of the animal scenario with the benefits of the biodiversity scenario



Above view of the Combination scenario design.

Weighted MCA results



A spider graph with the weighted scores per criteria for each scenario.

Results - MCA

Results of total weighted values per scenario.

Results of weighted values	MCA	Feasibility	Future proof	Economic
Crop production	0.631	0.623	0.632	0.640
Biodiversity	0.619	0.575	0.645	0.640
Animal production	0.630	0.637	0.585	0.671
Combination	0.636	0.608	0.625	0.679

Discussion

- Knowledge gaps: on soil quality and animal welfare
- Public acceptance: little survey responses
- MCA only allows for relative comparison

People discussing multiple land-use solar parks

Conclusion & advice

- Our advice is to select the Combination scenario
- Example for future solar parks

- The MCA provides a basis to evaluate and compare other second land-use scenarios

Questions

Tables with Results

	MCA	Sensitivity scheme		
		Feasibility	Future proof	Economic
Feasibility	17.86%	26.67%	12.66%	14.93%
Energy production	16.07%	24.00%	11.39%	13.43%
CE comp.	7.14%	5.33%	10.13%	5.97%
Climate change	7.14%	5.33%	10.13%	5.97%
Soil quality	8.93%	6.67%	12.66%	7.46%
Drought mitigation	3.57%	2.67%	5.06%	2.99%
Agricultural transition	7.14%	5.33%	10.13%	5.97%
Public acceptance	3.57%	2.67%	2.53%	2.99%
Profitability	8.93%	6.67%	6.33%	14.93%
Labour	10.71%	8.00%	7.59%	17.91%
Biodiversity	7.14%	5.33%	10.13%	5.97%
Education	1.79%	1.33%	1.27%	1.49%
Results of weighted values	MCA	Feasibility	Future proof	Economic
Crop production	0.631	0.623	0.632	0.640
Biodiversity	0.619	0.575	0.645	0.640
Animal production	0.630	0.637	0.585	0.671
Combined	0.636	0.608	0.625	0.679

Tables with scoring scenarios

			Scenario			
Criteria	**Weight**	**Relative Weight**	**Crops**	**Biodiversity**	**Animal production**	**Combination**
Feasibility	10	17.86%	0.6 (0.107)	0.4 (0.071)	0.8 (0.143)	0.55 (0.098)
Energy production	9	16.07%	0.6 (0.096)	0.5 (0.080)	0.5 (0.080)	0.5 (0.080)
CE comp.	4	7.14%	0.7 (0.050)	0.5 (0.036)	0.6 (0.043)	0.55 (0.39)
Climate change	4	7.14%	0.9 (0.064)	1 (0.071)	0.5 (0.036)	0.6 (0.043)
Soil quality	5	8.93%	0.6 (0.054)	0.4 (0.036)	0.7 (0.063)	0.6 (0.054)
Water use	2	3.57%	0.3 (0.011)	0.5 (0.018)	0.2 (0.007)	0.3 (0.011)
Agricultural transition	4	7.14%	0.8 (0.057)	0.93 (0.066)	0.45 (0.032)	0.7 (0.050)
Public acceptance	2	3.57%	0.6 (0.021)	0.5 (0.018)	0.8 (0.029)	0.65 (0.023)
Profitability	5	8.93%	0.79 (0.071)	0.5 (0.045)	0.977 (0.087)	0.9 (0.080)
Labour	6	10.71%	0.6 (0.064)	0.956 (0.102)	0.8 (0.086)	0.9 (0.096)
Biodiversity	4	7.14%	0.35 (0.025)	0.9 (0.064)	0.2 (0.014)	0.7 (0.050)
Education	1	1.79%	0.6 (0.631)	0.6 (0.011)	0.6 (0.011)	0.6 (0.011)
Total Weighted score			0.631	0.619	0.630	0.636

Results - Criteria

LC ENERGY

Criteria	Criteria indicators	Weighing
Feasibility	The number and importance of constraints	17.86%
Energy production	Energy production of the solar panels	16.07%
CE compatibility	Contribution to the transition to circular economy	7.14%
Climate change	CO2 equivalent emissions	7.14%
Soil quality	The abiotic and biotic soil content	8.93%
Water use	The total amount of water used	3.57%
Agricultural transition	Animal welfare, pest control and fertilizer use	7.14%
Public acceptance	Neighbour acceptance in the survey and neighbour meeting	3.57%
Profitability	Profit from the second purpose	8.93%
Labour	Amount of labour	10.71%
Biodiversity	Amount of land for biodiversity and species richness on that land	7.14%
Education	Possibilities for education	1.79%