

Appendix 1. Original output data of all farms

Type of vegetable	EEQ (MJ t ⁻¹) ¹	CSA1 (t)	CSA2 (t)	CSA3 (t)	F1 (t)	F2 (t)	F3 (t)	Proxy
Apple	2,710		0.227					
Atriplex seeds	1,110		0.003					Atriplex plant
Autumn turnip	1,350			0.654				
Baby-Leaf	970			0.051				Leaf lettuce
Basil	1,970	0.136	0.079	0.030				
Beetroot	1,950	1.865	0.377	4.760				
Beetroot leaf	1,540	0.185						Turnip leaf
Black salsify	2,260	0.250						
Bok choy	690		0.014	1.584				
Broccoli	1,420	0.408		1.170	0.333			
Brussels sprout	1,850	0.602	0.104		1.100			
Brussels sprout (whole plant)	925			1.511				50 % cabbage estimated

Type of vegetable	EEQ	CSA1	CSA2	CSA3	F1	F2	F3	Proxy
	(MJ t ⁻¹) ¹	(t)	(t)	(t)	(t)	(t)	(t)	
Buck's-horn plantain	2,530	0.016		0.064				Kitchen herbs
Bunch of (tea-)herbs	2,310		0.189					Mixed herbs
Bunch of celery ²	1,090		0.012					
Bunching onion	1,430	0.075	0.052					
Carrots	1,630	4.638	0.337	11.231	40.000			
Cauliflower	1,180	0.540		2.867	0.777			
Celery	1,130	0.550		1.447			0.354	
Chard	880	1.282	0.360	1.906				
Chervil	2,430	0.012						
Chili	1,880	0.009						
Chives	1,670	0.031	0.005	0.147				
Claytonia perfoliata	700	0.293	0.415	0.311				
Collard	690		0.035					
Coriander	2,530	0.047						Kitchen herbs

Type of vegetable	EEQ	CSA1	CSA2	CSA3	F1	F2	F3	Proxy
	(MJ t ⁻¹) ¹	(t)	(t)	(t)	(t)	(t)	(t)	
Coriander root	1,630		0.003					Roots and tubers
Cucumber	590	1.813	0.608	1.796	3.600		1.236	
Dill	2,740	0.095						
Edamame	6,250			0.043				Soy beans
Eggplant	830	0.060		0.497				
Endive	770			0.799				
Fennel	970	0.477		1.509				
Garlic	6,070	0.221	0.137	0.192			0.058	
Garlic chives	2,530	0.014	0.003					Kitchen herbs
Kale	1,890	0.979	0.029	1.000	1.220			
Kohlrabi	1,160	1.243	0.140	1.759				
Lacinato kale	1,890			0.494				Kale
Leaf Lettuce	970	0.223	0.150	0.491				
Leek	1,220	1.819	0.272	2.529				

Type of vegetable	EEQ	CSA1	CSA2	CSA3	F1	F2	F3	Proxy
	(MJ t ⁻¹) ¹	(t)	(t)	(t)	(t)	(t)	(t)	
Lemon balm	2,010	0.002						
Lettuce	590	1.953	0.437	2.822			0.061	
Malabar spinach	930			0.046				Spinach
May turnip	1,350	0.044	0.004	0.035				
Napa Cabbage	690	0.075		0.588	1.880			
New Zealand spinach	920		0.166					
Onion	1,270	1.942		0.607	1.000		1.743	
Oregano	3,000	0.013						
Paprika ³	1,590	0.702		0.698	1.750		0.320	
Parsley	2,530	0.162	0.002	0.537			0.030	
Parsley root	2,000	0.000						
Parsnip	2,660	0.800	0.197	2.255				
Pascal celery	900	0.194						
Pea	3,820					397.646		

Type of vegetable	EEQ	CSA1	CSA2	CSA3	F1	F2	F3	Proxy
	(MJ t ⁻¹) ¹	(t)	(t)	(t)	(t)	(t)	(t)	
Pea sprouts	1,520	0.059	0.002					Germed peas
Peppermint	2,080	0.005						
Pointed cabbage	1,160	0.663		2.193				
Pole bean	1,530	0.352	0.281	0.860		173.618		
Potato	3,170	8.355	3.122	14.699	30.000			
Pumpkin	1,220	3.795	0.984	5.184				
Radicchio	690			0.517				
Radish	750	0.080		0.434				
Ramson	960		0.005				0.008	
Red cabbage	1,150	0.400	0.066	2.956	2.300		0.624	
Rhubarb	820	0.623	0.158	0.270		691.542		
Rucola	1,240	0.113	0.104	0.348				
Rutabaga	1,500	0.110						
Sage	2,470	0.022						

Type of vegetable	EEQ	CSA1	CSA2	CSA3	F1	F2	F3	Proxy
	(MJ t ⁻¹) ¹	(t)	(t)	(t)	(t)	(t)	(t)	
Savory	2,250	0.017		0.066				
Savoy	1,330	0.431	0.096	1.508				
Small radish	730	0.583	0.203	0.773				
Snow pea	2,890	0.144						
Spaghetti bean	1,380			0.148				Common bean
Spinach	930	0.460	0.393	0.899				
Spring onion	1,960	0.341	0.051	0.222				
Sugar loaf	690	0.150		1.246				
Sweet corn	3,960	0.443		1.047				
Tatsoi	690		0.107					Bok choy
Tomato	840	2.988	0.689	2.588	8.290		1.613	
Valerianella	770	0.343	0.020	0.261				
Vicia faba	3,770	0.042						
White cabbage	1,270	0.530	0.194	4.838	17.000			

Type of vegetable	EEQ (MJ t ⁻¹) ¹	CSA1 (t)	CSA2 (t)	CSA3 (t)	F1 (t)	F2 (t)	F3 (t)	Proxy
Wintercress	1,730		0.007					
Zucchini	950	2.004	1.055	4.152	0.200			
TOTAL		46.997	11.894	91.639	109.450	1,262.806	6.047	

¹ EEQs according to Hartmann, Schmidt & Sandfuchs (2014); ² Estimated compositions of 70% tuber, 20% rods, 10% leafs; ³ Estimated compositions of 60% red, 20% yellow and 20% green paprika

Appendix 2: Original data for energy input of CSA 1

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Seeds & Seedlings								
Seeds, various, organic	1.03	kg	Market for carrot seed			43.77	25.86	1
Seeds, maize, organic	0.66	kg	Market for maize seed, organic			30.55	12.91	1
Seeds, pea, organic	1.72	kg	Market for pea seed, organic			22.48	5.81	1
Seed beans, organic	4.71	kg	Market for fava bean seed, organic			21.51	4.90	1
Seed potatoes, organic	900	kg	Market for potato seed, organic			7.92	4.08	1
Seedlings, various, organic	44,916	Items	Market for tomato seedling			0.46	0.46	1
Seedlings, onion, organic	10,430	Items	Market for onion seedling			0.05	0.04	1
Potting soil	2.590	L	-			-	-	
Fertilizers								
				AM				
Grass silage	5,635	kg	Market for ammonium nitrate, as N	0.08		60.25	4.73	1
			Phosphate fertilizer, as P2O5	0.02		32.14	2.53	1

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
			Market for potassium chloride, as K2O	0.08		7.98	0.63	1
Horse manure	3,900	kg	Market for ammonium nitrate, as N	0.003		60.25	21.87	1,2
			Phosphate fertilizer, as P2O5	0.001		32.14	11.66	1
			Market for potassium chloride, as K2O	0.0025		7.98	2.90	1
KleePura (clover)	602	kg	Market for ammonium nitrate, as N	0.035		60.25	3.43	1
			Phosphate fertilizer, as P2O5	0.01		32.14	1.83	1
			Market for potassium chloride, as K2O	0.035		7.98	0.45	1
	13.5	km	Transport, by truck, t km ⁻¹	0.602		4.21	4.19	3
FloraPell (wool)	632	kg	Market for ammonium nitrate, as N	0.12		60.25	20.94	1
			Market for potassium chloride, as K2O	0.06		7.98	2.77	1
Lime	194	kg	Lime to generic market, as CaCO3			0.61	0.51	1
Crop protection				AM; kg				
Iron(III) phosphate	0.2	kg	no			-	-	

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
			Formulation, Packaging & Transport			31.00	30.00	3
Potassium salt	0.3	L	Mining of Potassium salt	0.51		0.80	0.80	4
			Formulation, Packaging & Transport			31.00	30.00	3
Bacillus thuringiensis	7.2	L	no			-	-	
			Formulation, Packaging & Transport			31.00	30.00	3
Neem oil	0.006	L	Azadirachtin production	0.01		1.48	1.45	5
			Formulation, Packaging & Transport			31.00	30.00	3
Nets	9,190	sqm	Market for ethylvinylacetate foil	0.07	20	91.40	88.10	1
Fleeces	2,050	sqm	Market for horticultural fleece		15	2.86	2.79	1
Beneficial organisms			-			-	-	
Fuels				L > kg				
Diesel	483.40	L	Market for diesel	0.83		57.32	57.14	1, 6

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Lubricants				L > kg				
Oil	60	L	Market for lubricating oil	0.928		82.52	81.72	1, 7
Electricity								
Consumption	7,198	kW/h	Market for electricity medium voltage, DE			11.35	10.28	1
Production	23,694	kW/h	Electricity production, PV			1.36	1.18	1 (ad.)
Margin	-16,496	kW/h	kWh to MJ			3.60	3.60	
Infrastructure	23.53	Panel	Market for PV panel production, single SI wafer, per kWp		30	18,100.21	15,476.28	1 (ad.), 8, 9
Infrastructure	23.53	Panel	Market for PV flat roof installation, per kWp		30	41,113.17	35,650.59	1 (ad.), 8, 9
Irrigation infrastructure								
Open land	2.8	ha	Surface without IRRS infrastructure, per year			490.88	485.56	3
greenhouse	0.07	ha	Trickle infrastructure, per year			2,029.98	2,003.43	3

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Labor								
Per Group of people								
Permanent	6,573	h	Dietary energy consumption			2.82	2.82	10 (ad.)
Volunteers	2,697	h	Dietary energy consumption			2.82	2.82	10 (ad.)
Per type of activity								
Field Work	7,594	h	Dietary energy consumption			2.82	2.82	10 (ad.)
Administration	1,675	h	Dietary energy consumption			2.82	2.82	10 (ad.)
Vehicles & Machinery								
				HP > kW				
Tractor, 45 HP	18	h	Hourly use of self-propelled machinery, per 1 kW	33.08823529		1.25	1.19	3 (ad.)
Tractor, 90 HP	168	h	Hourly use of self-propelled machinery, per 1 kW	66.17647059		1.25	1.19	3 (ad.)
Wheeled loader, 45 HP, rented	2.73	h	Hourly use of self-propelled machinery, per 1 kW	33.08823529		1.25	1.19	3 (ad.)

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Greenhouses								
Tunnel 1 & 2								
Plastic	0.027	ha	Tunnel Austria	812	5	58.46	57.85	3 (ad.),11
Iron-based	0.027	ha	Tunnel Austria	15,620	44	32.19	31.69	3 (ad.),11
Manufacture	0.027	ha	Tunnel Austria	15,620	44	21.03	19.24	3 (ad.),11
Transport	0.027	ha	Tunnel Austria	20	44	2,317.67	2,293.49	3 (ad.),11
Maintenance	0.027	ha	Tunnel Austria			8,313.16	7,955.55	3 (ad.),11
Tunnel 3								
Plastic	0.05	ha	Tunnel Austria	812	5	58.46	57.85	3 (ad.),11
Iron-based	0.05	ha	Tunnel Austria	15,620	28	32.19	31.69	3 (ad.),11
Manufacture	0.05	ha	Tunnel Austria	15,620	28	21.03	19.24	3 (ad.),11
Transport	0.05	ha	Tunnel Austria	20	28	2,317.67	2,293.49	3 (ad.),11
Maintenance	0.05	ha	Tunnel Austria			8,313.16	7,955.55	3 (ad.),11

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Inventory				Kg				
Transport boxes (NAPF)	775	Items	Polyethylene production, high density, granulate	1.285	10	77.27	76.37	1
Transport boxes (NAPF)	775	Items	Market for injection molding	1.285	10	24.77	22.05	1
Transport boxes (IFCO)	220	Items	Polypropylene production, granulate	1.73	10	75.09	74.61	1
Transport boxes (IFCO)	220	Items	Market for injection molding	1.73	10	24.77	22.05	1

¹ Ecoinvent (2016); ² Breuer et al. (2014); ³ Aguilera et al. (2019); ⁴ Fritsche (2000); ⁵ Tajane et al. (2017); ⁶ Conversion factor retrieved from Bundesverband der Deutschen Bioethanolwirtschaft e.V. (2024); ⁷ Conversion factor retrieved from Zerbe (1952); ⁸ Average yield from PV, per region retrieved from SFV (2024); ⁹ Useful life of PV infrastructure retrieved from Rauei, Fullana-i-Palmer & Fthenakis (2012); ¹⁰ Approach by Pimentel et al. (1973) (own adjustment); ¹¹ Conversion factor adjusts useful life of the original data set

Appendix 3: Original data for energy input of CSA 2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Seeds & Seedlings								
Seeds, various, organic	0.50	kg	Market for carrot seed			43.77	25.86	1
Seed beans, organic	1.5	kg	Market for fava bean seed, organic			21.51	4.90	1
Seedlings, cucumber, organic	180	Items	Market for tomato seedling			0.46	0.46	1
Potting soil	1,260	L	-			0.00	0.00	
Fertilizers								
				AM				
Compost from organic waste	25,500	kg	Market for ammonium nitrate, as N	0.009		60.25	43.64	1,2
			Phosphate fertilizer, as P2O5	0.0038		32.14	23.28	1
			Market for potassium chloride, as K2O	0.0085		7.98	5.78	1
	54	km	Transport, by truck, t km ⁻¹	51		4.21	4.19	3
Fava bean grist	75	kg	Market for ammonium nitrate, as N	0.047		60.25	58.78	1,4
			Phosphate fertilizer, as P2O5	0.007		32.14	30.76	1,4

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
			Market for potassium chloride, as K ₂ O	0.015		7.98	7.56	1,4
Organic Plant Feed	11.5	L	Market for ammonium nitrate, as N	0.07		60.25	58.78	1,4
			Phosphate fertilizer, as P ₂ O ₅	0.07		32.14	30.76	1,4
			Market for potassium chloride, as K ₂ O	0.03		7.98	7.56	1,4
Provita® Pflanzfein	12	kg	Market for ammonium nitrate, as N	0.06		60.25	58.78	1,4
			Market for potassium chloride, as K ₂ O	0.01		7.98	30.76	1,4
			Market for potassium chloride, as K ₂ O	0.04		7.98	7.56	1,4
Meat and bone meal	20	kg	Market for horn meal			1.27	1.21	1
Stone meal	140	kg	Market for stone meal			1.06	0.89	1
Algae lime	20	kg	Lime production, algae			2.85	1.99	1
			Transport, by truck, per kg	20		1.68	1.68	3
Effective microorganisms	40	kg	-			0.00	0.00	
Sheep's wool	13	kg	-			0.00	0.00	5
Nettle manure	820	kg	-			0.00	0.00	5

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Liquid manure from chicken	480	kg	-			0.00	0.00	5
Composted manure	135,000	kg	-			0.00	0.00	5
Leaf compost	2,250	kg	-			0.00	0.00	5
Crop protection				AM; kg				
Iron(III) phosphate	4.45	kg	no			0.00	0.00	
			Formulation, Packaging & Transport			31.00	30.00	3
Neem oil	30	L	Azadirachtin production	0.01		1.48	1.45	6
			Formulation, Packaging & Transport			31.00	30.00	3
Fleeces	1,840	sqm	Market for horticultural fleece		15	2.86	2.79	1
Beneficial organisms			-			0.00	0.00	
Fuels				L > kg				
Diesel	269.26	L	Market for diesel	0.83		57.32	57.14	1,7

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Propane gas	0.20	kg	Market for propylene			68.49	68.29	1
Lubricants				L > kg				
Oil	0.46	L	Market for lubricating oil	0.928		82.52	81.72	1,8
Grease	0.20	kg	Market for lubricating oil			82.52	81.72	1
Electricity								
Consumption	7,755	kW/h						
Production	2,714	kW/h	Electricity production, PV			1.36	1.18	1 (ad.)
Margin	5,041	kW/h	Market for electricity medium voltage, DE			11.35	10.28	1
Infrastructure	2.65	Panel	Market for PV panel production, single SI wafer, per kWp		30	18,100.21	15,476.28	1 (ad.),9, 10
Infrastructure	2.65	Panel	Market for PV flat roof installation, per kWp		30	41,113.17	35,650.59	1 (ad.),9, 10

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Irrigation infrastructure								
Open land	0,8	ha	Surface without IRRS infrastructure, per year			490.88	485.56	3
greenhouse	0.0609	ha	Trickle infrastructure, per year			2,029.98	2,003.43	3
Labor								
Per Group of people								
Permanent	3,324	h	Dietary energy consumption			2.82	2.82	11 (ad.)
Volunteers	5,154	h	Dietary energy consumption			2.82	2.82	11 (ad.)
Per type of activity								
Field Work	7,843	h	Dietary energy consumption			2.82	2.82	11 (ad.)
Administration	636	h	Dietary energy consumption			2.82	2.82	11 (ad.)
Vehicles & Machinery								
				HP > kW				
Multicar, 70 kW	52	h	Hourly use of self-propelled machinery, per 1 kW	75		1.25	1.19	3 (ad.)

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Single axle, 7 kW	55	h	Hourly use of self-propelled machinery, per 1 kW	7		1.25	1.19	3 (ad.)
Passenger car	860	km	Transport, passenger car, small size, diesel, EUR5			4.03	3.59	1
Passenger car	1,075	km	Transport, passenger car, small size, diesel, EUR5			4.03	3.59	1

Greenhouses

Tunnel 1

Plastic	0.051	ha	Tunnel Austria	812	13	58.46	57.85	3 (ad.),12
Iron-based	0.051	ha	Tunnel Austria	15,620	13	32.19	31.69	3 (ad.),12
Manufacture	0.051	ha	Tunnel Austria	15,620	13	21.03	19.24	3 (ad.),12
Transport	0.051	ha	Tunnel Austria	20	13	2,317.67	2,293.49	3 (ad.),12
Maintenance	0.051	ha	Tunnel Austria			8,313.16	7,955.55	3 (ad.),12

Inventory

Kg

Transport boxes (IFCO 10)	27	Items	Polypropylene production, granulate	1.17	10	75.09	74.61	1
---------------------------	----	-------	-------------------------------------	------	----	-------	-------	---

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Transport boxes (IFCO 10)	27	Items	Market for injection molding	1.17	10	24.77	22.05	1
Transport boxes (IFCO 13)	63	Items	Polypropylene production, granulate	1.24	10	75.09	74.61	1
Transport boxes (IFCO 13)	63	Items	Market for injection molding	1.24	10	24.77	22.05	1
Transport boxes (IFCO 16)	34	Items	Polypropylene production, granulate	1.46	10	75.09	74.61	1
Transport boxes (IFCO 16)	34	Items	Market for injection molding	1.46	10	24.77	22.05	1
Transport boxes (IFCO 18)	46	Items	Polypropylene production, granulate	1.73	10	75.09	74.61	1
Transport boxes (IFCO 18)	46	Items	Market for injection molding	1.73	10	24.77	22.05	1
Transport boxes (IFCO 20)	44	Items	Polypropylene production, granulate	1.77	10	75.09	74.61	1
Transport boxes (IFCO 20)	44	Items	Market for injection molding	1.77	10	24.77	22.05	1
Transport boxes (IFCO 24)	4	Items	Polypropylene production, granulate	2.095	10	75.09	74.61	1
Transport boxes (IFCO 24)	4	Items	Market for injection molding	2.095	10	24.77	22.05	1
Transport boxes (NAPF)	52	Items	Polyethylene production, high density, granulate	1.42	10	77.27	76.37	1
Transport boxes (NAPF)	52	Items	Market for injection molding	1.42	10	24.77	22.05	1
Transport boxes (EPS)	87	Items	Polyethylene production, high density, granulate	1.98	10	77.27	76.37	1

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Transport boxes (EPS)	87	Items	Market for injection molding	1.98	10	24.77	22.05	1

¹ Ecoinvent (2016); ² Breuer et al. (2014); ³ Aguilera et al. (2019); ⁴ NRE not adjusted; ⁵ Self-produced; ⁶ Tajane et al. (2017); ⁷ Conversion factor retrieved from Bundesverband der Deutschen Bioethanolwirtschaft e.V. (2024); ⁸ Conversion factor retrieved from Zerbe (1952); ⁹ Average yield from PV, per region retrieved from SFV (2024); ¹⁰ Useful life of PV infrastructure retrieved from Raugei, Fullana-i-Palmer & Fthenakis (2012); ¹¹ Approach by Pimentel et al. (1973) (own adjustment); ¹² Conversion factor adjusts useful life of the original data set

Appendix 4: Original data for energy input of CSA 3

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Seeds & Seedlings								
Seeds, various, organic	10.28	kg	Market for carrot seed			43.77	25.86	1
Seed potatoes, organic	650	kg	Market for potato seed, organic			7.92	4.08	1
Seed garlic, organic	10	kg	Market for potato seed, organic			7.92	4.08	1
Seedlings, various, organic	1,875	Items	Market for tomato seedling			0.46	0.46	1
Potting soil	283	€	-			-	-	
Fertilizers								
				AM				
Bioagenasol®	1,150	kg	Market for ammonium nitrate, as N	0.06		60.25	59.02	1
			Phosphate fertilizer, as P2O5	0.03		32.14	31.48	1
			Market for potassium chloride, as K2O	0.02		7.98	7.82	1
			Transport, by truck, per kg	1,150		1.68	1.68	2
Composted horse manure	55,000	kg	Manure, solid, cattle			0.38	0.14	1,3

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Crop protection				AM; kg				
Potassium salt	0.8	L	Mining of Potassium salt	0.51		0.80	0.80	4
			Formulation, Packaging & Transport			31.00	30.00	2
Bacillus thuringiensis	2.9	L	no			-	-	
			Formulation, Packaging & Transport			31.00	30.00	2
Neem oil	1.65	L	Azadirachtin production	0.01		1.48	1.45	5
			Formulation, Packaging & Transport			31.00	30.00	2
Nets	5,504	sqm	Market for ethylvinylacetate foil	0.07	20	91.40	88.10	1
Fleeces	3,931	sqm	Market for horticultural fleece		15	2.86	2.79	1
Beneficial organisms	189,200	Items	-			-	-	
Fuels				L > kg				
Diesel	1,680	L	Market for diesel	0.83		57.32	57.14	1,6
Propane gas	123	kg	Market for propylene			68.49	68.29	1

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Lubricants				L > kg				
Oil	40	L	Market for lubricating oil	0.928		82.52	81.72	1,7
Grease	10	kg	Market for lubricating oil			82.52	81.72	1
Electricity								
Consumption	6,786	kW/h	Market for electricity medium voltage, DE			11.35	10.28	1
Irrigation infrastructure								
Open land	4.71	ha	Surface without IRRS infrastructure, per year			490.88	485.56	2
greenhouse	0.06	ha	Trickle infrastructure, per year			2,029.98	2,003.43	2
Labor								
Per Group of people								
Permanent	6,839	h	Dietary energy consumption			2.82	2.82	8 (ad.)

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Seasonal	205	h	Dietary energy consumption			2.82	2.82	8 (ad.)
Volunteers	4,859	h	Dietary energy consumption			2.82	2.82	8 (ad.)
Per type of activity								
Field Work	10,649	h	Dietary energy consumption			2.82	2.82	8 (ad.)
Administration	1,254	h	Dietary energy consumption			2.82	2.82	8 (ad.)
Vehicles & Machinery								
				HP > kW				
Tractor (Case Farmall), 75 HP	478	h	Hourly use of self-propelled machinery, per 1 kW	55.15		1.25	1.19	2 (ad.)
Tractor (Fendt GT 275), 70 HP	155	h	Hourly use of self-propelled machinery, per 1 kW	51.47		1.25	1.19	2 (ad.)
Mower (Grillo), 13.2 kW	314	h	Hourly use of self-propelled machinery, per 1 kW	13.2		1.25	1.19	2 (ad.)
Van (Iveco Daily)	1,800	km	Transport, by truck, t km ⁻¹			4.21	4.19	2

Greenhouses

Tunnel 1

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Plastic	0.03	ha	Tunnel Austria	812	14	58.46	57.85	2 (ad.),9
Iron-based	0.03	ha	Tunnel Austria	15,620	14	32.19	31.69	2 (ad.),9
Manufacture	0.03	ha	Tunnel Austria	15,620	14	21.03	19.24	2 (ad.),9
Transport	0.03	ha	Tunnel Austria	20	14	2,317.67	2,293.49	2 (ad.),9
Maintenance	0.03	ha	Tunnel Austria			8,313.16	7,955.55	2 (ad.),9
Tunnel 2								
Plastic	0.03	ha	Tunnel Austria	812	13	58.46	57.85	2 (ad.),9
Iron-based	0.03	ha	Tunnel Austria	15,620	13	32.19	31.69	2 (ad.),9
Manufacture	0.03	ha	Tunnel Austria	15,620	13	21.03	19.24	2 (ad.),9
Transport	0.03	ha	Tunnel Austria	20	13	2,317.67	2,293.49	2 (ad.),9
Maintenance	0.03	ha	Tunnel Austria			8,313.16	7,955.55	2 (ad.),9

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Inventory								
Transport boxes			Calculated as the mean of the other farms, with highest and lowest values not considered					

¹ Ecoinvent (2016); ² Aguilera et al. (2019); ³ Miniscule transport distance; ⁴ Fritsche (2000); ⁵ Tajane et al. (2017); ⁶ Conversion factor retrieved from Bundesverband der Deutschen Bioethanolwirtschaft e.V. (2024); ⁷ Conversion factor retrieved from Zerbe (1952); ⁸ Approach by Pimentel et al. (1973) (own adjustment); ⁹ Conversion factor adjusts useful life of the original data set

Appendix 5: Original data for energy input of Farm 1

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Seeds & Seedlings								
Seeds, various	1.62	kg	Market for carrot seed			43.77	25.86	1
Seed potatoes	3,000	kg	Market for potato seed			12.80	3.82	1
Fertilizers								
				AM				
Nutri-Phite Magnum S	0.66	kg	Market for ammonium nitrate, as N	0.05		60.25	4.73	1
			Phosphate fertilizer, as P2O5	0.38		32.14	2.53	1
			Market for potassium chloride, as K2O	0.15		7.98	0.63	1
Dairy stillage	620	kg	Market for ammonium nitrate, as N	0.0053		60.25	3.43	1
			Phosphate fertilizer, as P2O5	0.0168		32.14	1.83	1
			Market for potassium chloride, as K2O	0.0411		7.98	0.45	1
			Transport, by truck, per kg	620		1.68	1.68	2
Lebosol Bor	0.65	kg	Market for borax, anhydrous, powder	0.11		23.97	22.75	1

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
			Market for ammonium nitrate, as N	0.0346		60.25	58.78	1
Potassium sulfate	342	kg	Potassium sulfate production	0.5		25.98	24.29	1
P35	237	kg	Monoammonium phosphate production	0.35		32.14	30.76	1
Borci acid	7	kg	Market for boric acid, anhydrous, powder	0.17		18.63	17.69	1
Manganese sulfate	19.1	kg	Market for manganese sulfate	0.32		17.47	16.45	1
Copper sulfate	11.1	kg	Market for copper sulfate	0.23		88.16	78.14	1
Zinc sulfate	16.8	kg	Market for zinc monosulfate	0.36		21.96	21.27	1
ASL	1,362	kg	Market for ammonium sulfate, as N	0.1		26.31	24.43	1
Calium borate	1.5	kg	Market for calcium borates			2.19	2.11	1
Biolit	4	kg	Market for stone meal			1.06	0.89	1
Horse manure	1,800	kg	Market for manure, solid, cattle			0.38	0.14	1
Crop protection				AM; kg				
Kantor	3.98	L	Alkoxylated soy bean oil	0.79		1.00	1.00	2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
			Formulation, Packaging & Transport			31.00	30.00	2
Durano TF	2.48	L	Glyphosat	0.36		479.00	467.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Stomp Aqua	2.28	L	Pendimethalin	0.3827		175.00	171.00	2
			Formulation, Packaging & Transport			31.00	29.00	2
Butisan Kombi	1.08	L	Dimethenamid-P	0.2		789.00	769.00	2
			Metazachlor	0.2		393.00	383.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Centium	0.135	L	Clomazone	0.36		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Bandur	4.888	L	Aclonifen	0.6		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Spectrum	0.37	L	Dimethenamid-P	0.64		681.00	664.00	2
			Formulation, Packaging & Transport			31.00	29.00	2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Lontrel 720SG	0.0153	kg	Clopyralid	0.72		473.00	426.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Select 240 EC	0.075	L	Clethodim	0.24		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Radiamix	0.1	L	Esterified rapeseed oil	0.842		1.00	1.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Folicur	0.18	L	Tebuconazol	0.25		556.00	542.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Agil-S	0.9	L	Propaquizafop	0.1		566.00	552.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Effigo	0.18	L	Clopyralid	0.267		437.00	426.00	2
			Picloram	0.067		681.00	664.00	2
			Formulation, Packaging & Transport			31.00	29.00	2
Karate Zeon	0.12	L	Lambda-Cyhalothrin	0.094		534.00	521.00	2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
			Formulation, Packaging & Transport			31.00	30.00	2
Mavrik Vita	0.12	L	Tau-Fluvalinat	0.24		491.00	479.00	2
			Formulation, Packaging & Transport			31.00	29.00	2
Mospilan SG	0.195	kg	Acetamiprid	0.2		681.00	664.00	2
			Formulation, Packaging & Transport			31.00	29.00	2
Tanos	1.4	kg	Cymoxanil	0.25		447.00	436.00	2
			Famoxadone	0.25		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Shirlan	1.6	L	Fluazinam	0.5		599.00	584.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Minecto One	0.1405	kg	Cyantraniliprole	0.4		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Askon	0.5	L	Azoxystrobin	0.2		620.00	605.00	2
			Difenoconazol	0.125		789.00	769.00	2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
			Formulation, Packaging & Transport			31.00	30.00	2
Movento OD 150	0.368	L	Spirotetramat	0.15		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Spintor	0.15	L	Spinosad	0.48		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Steward	0.046	kg	Indoxacarb	0.3		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Shark	1	L	Carfentrazone (Ethylester)	0.05592		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Signum	0.2	kg	Boscalid	0.267		718.00	700.00	2
			Pyraclostrobin	0.067		707.00	689.00	2
			Formulation, Packaging & Transport			31.00	29.00	2
Sencor Liquid	0.18	L	Metribuzin	0.6		225.00	219.00	2
			Formulation, Packaging & Transport			31.00	29.00	2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Nets	276	sqm	Market for ethylvinylacetate foil	0.07	20	91.40	88.10	1
Fleeces	200	sqm	Market for horticultural fleece		15	2.86	2.79	1
Floor film	1,575	sqm	Market for ethylvinylacetate foil	0.01038	1	91.40	88.10	1
Beneficial organisms			-			-	-	
Bio stimulants			-			-	-	
Fuels				L > kg				
Diesel	192	L	Market for diesel	0.83		57.32	57.14	1,3
Gasoline	15	L	Market for petrol, 5% ethanol by volume from biomass	0.74		60.56	58.52	1,3
Wood chips	2,062	kg	Market for bundle, energy wood			19.98	-	1,4
Lubricants				L > kg				
Oil	15	L	Market for lubricating oil	0.928		82.52	81.72	1,5

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Grease	5	L	Market for lubricating oil	0.88		82.52	81.72	1,5
Electricity								
Consumption	12,600	kW/h	Market for electricity medium voltage, DE			11.35	10.28	1
Irrigation infrastructure								
Open land	2.24	ha	Surface without IRRS infrastructure, per year			490.88	485.56	2
greenhouse	0.1	ha	Trickle infrastructure, per year			2,029.98	2,003.43	2
Labor								
Per Group of people								
Permanent	2,998	h	Dietary energy consumption			2.82	2.82	6 (ad.)
Seasonal	153	h	Dietary energy consumption			2.82	2.82	6 (ad.)
Per type of activity								

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Field Work	2,832	h	Dietary energy consumption			2.82	2.82	6 (ad.)
Administration	319	h	Dietary energy consumption			2.82	2.82	6 (ad.)
Vehicles & Machinery				HP > kW				
Tractor (Kubota), 113 HP	360	h	Hourly use of self-propelled machinery, per 1 kW	83.09		1.25	1.19	2 (ad.)
Tractor (Zetor), 42 HP	116	h	Hourly use of self-propelled machinery, per 1 kW	30.88		1.25	1.19	2 (ad.)
Greenhouses								
Tunnel 1								
Plastic	0.1	ha	Tunnel Austria	812	10	58.46	57.85	2 (ad.),7
Iron-based	0.1	ha	Tunnel Austria	15,620	32	32.19	31.69	2 (ad.),7
Manufacture	0.1	ha	Tunnel Austria	15,620	32	21.03	19.24	2 (ad.),7
Transport	0.1	ha	Tunnel Austria	20	32	2,317.67	2,293.49	2 (ad.),7
Maintenance	0.1	ha	Tunnel Austria	1	1	8,313.16	7,955.55	2 (ad.),7

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Services								
Wood chipping	8.5	h	Market for wood chipping, chipper, mobile, diesel, at forest road			4,293.10	4,257.77	1
Inventory								
Transport boxes (NAPF 4)	250	Items	Polyethylene production, high density, granulate	1.8	10	77.27	76.37	1
			Market for injection molding	1.8	10	24.77	22.05	1
Transport boxes (NAPF 1)	120	Items	Polyethylene production, high density, granulate	0.72	10	77.27	76.37	1
			Market for injection molding	0.72	10	24.77	22.05	1
Storage boxes	50	Items	Mean of Polyethylene production, high density, granulate & Polypropylene production, granulate	35	10	76.18	75.49	1
			Market for injection molding	1.8	10	24.77	22.05	1
Wood chip stove	1	Items	Market for furnace, wood chips, average storage area, 50kW	1	20	113,018.10	107,491.19	1

¹ Ecoinvent (2016), ² Aguilera et al. (2019); ³ Conversion factor retrieved from Bundesverband der Deutschen Bioethanolwirtschaft e.V. (2024); ⁴ Derived from 8,5 h of wood chipping according to Wittkopf, Hömer & Feller (2003), including 5 km of transport; ⁵ Conversion factor retrieved from Zerbe (1952); ⁶ Approach by Pimentel et al. (1973) (own adjustment); ⁷ Conversion factor adjusts useful life of the original data set

Appendix 6: Original data for energy input of Farm 2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Seeds & Seedlings								
Seeds, pea	1.72	kg	Market for pea seed			21.70	5.40	1
Seed beans	4.71	kg	Market for fava bean seed			21.57	4.96	1
Fertilizers								
				AM				
60er Kali	49,141	kg	Market for potassium chloride, as K ₂ O	0.6		7.98	7.56	1
P 38	9,782	kg	Monoammonium phosphate, as P ₂ O ₅	0.38		32.14	30.76	1
AHL	3,911	L	Ammonium nitrate, as N	0.14		58.96	57.54	1
			Market for urea, as N	0.14		61.71	60.47	1
SSA	1,222	kg	Ammonium sulfate, as N			5.68	5.36	1 (ad.)
KAS	28,886	kg	Calcium ammonium nitrate, as N			16.02	15.58	1 (ad.)

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Crop protection				AM; kg				
Cantus	3.68	kg	Boscalid	0.5		718.00	700.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Ortiva	4.80	L	Azoxystrobin	0.232		620.00	605.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
SWITCH	8.48	kg	Cyprodinil	0.375		642.00	626.00	2
			Fludioxonil	0.25		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
FRESCO	49.50	L	Metobromuron	0.4		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Spectrum	5.47	L	Dimethenamid-P	0.64		681.00	664.00	2
			Formulation, Packaging & Transport			31.00	29.00	2
Karate Zeon	3.83	L	Lambda-Cyhalothrin	0.094		534.00	521.00	2
			Formulation, Packaging & Transport			31.00	30.00	2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Pirimor Granulat	20.44	kg	Pirimicarb	0.5		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Cyperkill Max	4.26	L	Cypermethrin	0.4746		605.00	590.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Bandur	198.51	L	Aclonifen	0.6		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Spectrum Plus	77.49	L	Pendimethalin	0.2311		175.00	171.00	2
			Dimethenamid-P	0.1966		789.00	769.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Stomp Aqua	37.86	L	Pendimethalin	0.3827		175.00	171.00	2
			Formulation, Packaging & Transport			31.00	29.00	2
Kerb FLO	6.53	L	Propyzamid	0.4		415.00	405.00	2
			Formulation, Packaging & Transport			31.00	29.00	2
Roundup PowerFlex	83.41	L	Glyphosat	0.48		479.00	467.00	2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
			Formulation, Packaging & Transport			31.00	30.00	2
Herbalit Agraröl	2.21	L	Emulsifiable oil			20.00	20.00	2
			Formulation, Packaging & Transport			36.00	35.00	2
Fuels				L > kg				
Diesel	6,860	L	Market for diesel	0.83		57.32	57.14	1,3
Gasoline	240	L	Market for petrol, 5% ethanol by volume from biomass	0.74		60.56	58.52	1,3
Lubricants				L > kg				
Oil	100	L	Market for lubricating oil	0.928		82.52	81.72	1,4
Grease	12	L	Market for lubricating oil	0.88		82.52	81.72	1,4
Electricity								
Consumption	75,452.25	kW/h						

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Production	68,067.57	kW/h	Electricity production, PV			1.36	1.18	1 (ad.)
Margin	7,384.68	kW/h	Market for electricity medium voltage, DE			11.35	10.28	1
Infrastructure	67.59	Panel	Market for PV panel production, single SI wafer, per kWp		30	18,100.21	15,476.28	1 (ad.),5,6
Infrastructure	67.59	Panel	Market for PV flat roof installation, per kWp		30	41,113.17	35,650.59	1 (ad.),5,6
Irrigation infrastructure								
Open land	155.08	ha	Surface without IRRS infrastructure, per year			490.88	485.56	2
Labor								
Per Group of people								
Permanent	2,614	h	Dietary energy consumption			2.82	2.82	7 (ad.)
Seasonal	13,280	h	Dietary energy consumption			2.82	2.82	7 (ad.)
Per type of activity								

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Field Work	15,082	h	Dietary energy consumption			2.82	2.82	7 (ad.)
Administration	812	h	Dietary energy consumption			2.82	2.82	7 (ad.)
Vehicles & Machinery				HP > kW				
Tractor (JD 7310), 310 HP	33	h	Hourly use of self-propelled machinery, per 1 kW	227.94		1.25	1.19	2 (ad.)
Tractor (JD 8245), 245 HP	49	h	Hourly use of self-propelled machinery, per 1 kW	180.15		1.25	1.19	2 (ad.)
Tractor (JD 7810), 185 HP	43	h	Hourly use of self-propelled machinery, per 1 kW	136.03		1.25	1.19	2 (ad.)
Tractor (JD R4040i), 165 HP	50	h	Hourly use of self-propelled machinery, per 1 kW	121.32		1.25	1.19	2 (ad.)
Tractor (Kubota), 35 HP	657	h	Hourly use of self-propelled machinery, per 1 kW	25.74		1.25	1.19	2 (ad.)
Mower (JD), 18 HP	41	h	Hourly use of self-propelled machinery, per 1 kW	13.24		1.25	1.19	2 (ad.)
Tractor (Belarus), 80 HP	82	h	Hourly use of self-propelled machinery, per 1 kW	58.82		1.25	1.19	2 (ad.)
Wheel Loader, 45 HP	100	h	Hourly use of self-propelled machinery, per 1 kW	33.09		1.25	1.19	2 (ad.)

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Inventory								
Transport boxes (EPS / IFCO)	41,828	Items	Mean of Polyethylene production, high density, granulate & Polypropylene production, granulate	1.855	10	76.18	75.49	1
Transport boxes (EPS / IFCO)	41,828	Items	Market for injection molding	1.855	10	24.77	22.05	1
Storage boxes	1,110	Items	Mean of Polyethylene production, high density, granulate & Polypropylene production, granulate	35	10	76.18	75.49	1
Storage boxes	1,110	Items	Market for injection molding	35	10	24.77	22.05	1
Box covers, LDPE	5,000	Stk.	Polyethylene production, low density, granulate	0.01755		79.52	78.21	1,8
Box covers, LDPE	5,000	Stk.	Market for thermoforming of plastic sheets	0.01755		9.26	7.63	1,8
Banding film	900	sqm	Polypropylene production, granulate	0.0884		75.09	7.46	1
Banding film	900	sqm	Market for thermoforming of plastic sheets	0.0884		9.26	7.63	1
Banding paper	1,198	sqm	Market for kraft paper, bleached	0.13		67.44	23.50	1
Thermal transfer film	15,000	m				-	-	
EPAL	938	Items				-	-	

¹ Ecoinvent (2016); ² Aguilera et al. (2019); ³ Conversion factor retrieved from Bundesverband der Deutschen Bioethanolwirtschaft e.V. (2024); ⁴ Conversion factor retrieved from Zerbe (1952); ⁵ Average yield from PV, per region retrieved from SFV (2024); ⁶ Useful life of PV infrastructure retrieved from Rauei, Fullana-i-Palmer & Fthenakis (2012); ⁷ Approach by Pimentel et al. (1973) (own adjustment); ⁸ Derived from LDPE proxy

Appendix 7: Original data for energy input of Farm 3

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Seeds & Seedlings								
Seeds, various	0.3	kg	Market for carrot seed			43.77	25.86	1
Seedlings, various	2,160	Items	Market for tomato seedling			0.46	0.46	1
Potting soil	4,320	kg	-			-	-	
Fertilizers								
				AM				
Urea, 46 %, grained	25	kg	Market for urea, as N	0.46		61.71	60.47	1
Floramid® Permanent	25	kg	Market for ammonium nitrate, as N	0.021		60.25	58.78	1
			Market for ammonium nitrate, as N	0.079		60.25	58.78	1
			Market for urea, as N	0.024		61.71	60.47	1
			Market for urea, as N	0.036		61.71	60.47	1
			Market for potassium chloride, as K2O	0.15		7.98	7.56	1
			Market for magnesium oxide	0.02		3.95	3.63	1

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
			Market for sulfite	0.08		30.43	28.20	1
Hakaphos red	25	kg	Market for ammonium nitrate, as N	0.03		60.25	58.78	1
			Market for ammonium nitrate, as N	0.05		60.25	58.78	1
			Monoammonium phosphate, as P2O5	0.12		32.14	30.76	1
			Market for potassium chloride, as K2O	0.24		7.98	7.56	1
			Market for magnesium oxide	0.04		3.95	3.63	1
Horse manure	5,000	kg	Market for manure, solid, cattle			0.38	0.14	1
Horn meal	25	kg	Market for horn meal			1.27	1.21	1
Crop protection				AM; kg				
Funguran progress	0.2	L	Copper	0.537		13.00	12.00	2
			Formulation, Packaging & Transport			36.00	35.00	2
Ortiva Gold	0.4	L		0.232		620.00	605.00	2
			Formulation, Packaging & Transport			31.00	30.00	2

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Iron(III) phosphate	8	kg				-	-	2
			Formulation, Packaging & Transport			31.00	30.00	2
Substral Celaflor	0.25	L	Rapeseed oil	0.017		1.00	1.00	2
			Formulation, Packaging & Transport			31.00	30.00	2
Fleeces	750	sqm	Market for horticultural fleece		15	2.86	2.79	1
Floor film	600	sqm	Market for ethylvinylacetate foil	0.01038	1	91.40	88.10	1
Fuels				L > kg				
Diesel	74	L	Market for diesel	0.83		57.32	57.14	1,3
Gasoline	19	L	Market for petrol, 5% ethanol by volume from biomas	0.74		60.56	58.52	1,3
Wood	8,229	kg	Market for bundle, energy wood			21.12	1.13	1,4
Coke	2,850	kg	Market for coke			23.32	22.96	1

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Lubricants				L > kg				
Oil	9.5	L	Market for lubricating oil	0.928		82.52	81.72	1,5
Grease	4.75	kg	Market for lubricating oil			82.52	81.72	1
Electricity								
Consumption	1,140	kW/h	Market for electricity medium voltage, DE			11.35	10.28	1
Irrigation infrastructure								
Open land	0.26	ha	Sprinkler average infrastructure, per year			1,788.44	1,681.53	2
greenhouse	0.01	ha	Trickle infrastructure, per year			2,029.98	2,003.43	2
Labor								
Per Group of people								
Permanent	1,035	h	Dietary energy consumption			2.82	2.82	6 (ad.)

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Per type of activity								
Field Work	1,035	h	Dietary energy consumption			2.82	2.82	6 (ad.)
Vehicles & Machinery								
				HP > kW				
Tractor (Mc Cormick), 15 HP	162	h	Hourly use of self-propelled machinery, per 1 kW	11.03		1.25	1.19	2 (ad.)
Trailer	38	h	Hourly use of self-propelled machinery, two-wheel trailer	30.88		26.02	24.85	2 (ad.),7
Passenger car, 190 HP	1,944	km	Transport, passenger car, medium size, diesel, EURO 5			4.77	4.65	1
Greenhouses								
Tunnel 1								
Glass	0.05	ha	Glass greenhouse Austria	100,544	113	10.28	9.84	2 (ad.),8
Iron-based	0.05	ha	Glass greenhouse Austria	110,000	113	32.19	31.69	2 (ad.),8
Manufacture	0.05	ha	Glass greenhouse Austria	135,000	113	21.03	19.24	2 (ad.),8

Indicator	Value	Unit	Proxy	Conversion factor	Useful life	EEQ (MJ f. U. ⁻¹)	EEQ NRE (MJ f. U. ⁻¹)	References
Concrete	0.05	ha	Glass greenhouse Austria	504,060	113	0.69	0.68	2 (ad.),8
Transport	0.05	ha	Glass greenhouse Austria	20	113	48,614.91	48,248.17	2 (ad.),8
Maintenance	0.05	ha	Glass greenhouse Austria		1	128,781.64	122,112.77	2 (ad.),8

Inventory

Transport boxes (EPS)	67	Items	Polyethylene production, high density, granulate	1.98	10	77.27	76.37	1
			Market for injection moulding	1.98	10	24.77	22.05	1
Boiler	1	Item	Market for oil boiler, 10kW		65	6,803.17	6,081.90	1
Boiler	1	Item	Market for oil boiler, 10kW		65	6,803.17	6,081.90	1
Kanuk	1	Item	Market for coal stove, 5-15kW		30	9,343.73	8,810.38	1

¹ Ecoinvent (2016); ² Aguilera et al. (2019); ³ Conversion factor retrieved from Bundesverband der Deutschen Bioethanolwirtschaft e.V. (2024); ⁴ Conversion to kg according to Wittkopf, Hömer & Feller (2003), 50 % pine and 50% spruce estimated; ⁵ Conversion factor retrieved from Zerbe (1952); ⁶ Approach by Pimentel et al. (1973) (own adjustment); ⁷ Adapted from four-wheel trailer; ⁸ Conversion factor adjusts useful life of the original data set

Appendix 8: Energy input by CSA's, farmgate to supply station ¹

Indicator	CSA1	CSA2	CSA3
Unit	MJ kg ⁻¹	MJ kg ⁻¹	MJ kg ⁻¹
Labor	0.11	0.50	0.06
Vehicle usage	0.30	0.42 ²	0.27
Fuel	0.50	2.01	0.19
Total	0.91	2.93	0.53
Output carried	1.65	1.75	1.62
EROI (MJ)	1.80	0.60	3.05

¹ No further information given regarding last kilometer from supply station to consumer (e. g. transport by foot, bike, train or car); ² Relatively low value in vehicle usage for CSA2 due to low transport weights