Environmental and economic profile of present greenhouse production systems in Europe. Annex

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ENVIRONMENTAL AND ECONOMIC PROFILE OF PRESENT GREENHOUSE PRODUCTION SYSTEMS IN EUROPE

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1 ABBREVIATIONS

AA	Acidification
AD	Abiotic depletion
CED	Cumulative energy demand
CHP	Combined Heat and Power
CML	Life Cycle Assessment – An Operational Guide to ISO Standards 2001
COD	Chemical Oxygen Demand
DB	Database
EDIP	Environmental Design of Industrial Products
EEFC	Estación Experimental Fundación Cajamar
ELCD	European Life Cycle Database
EPS	Environmental strategies in product development
ERD	Experimental reference data
EU	Eutrophication
GDP	Gross Domestic Product
GW	Global Warmingl
IPM	Integrated Pest Management
IPPC	Intergovernamental Panel on Climate Change
IRTA	Institut de Recerca i Tecnologia Agroalimentàries
ISO	International Organization for Standarization
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory Analysis
LCIA	Life Cycle Impact Assessment
LDPE	Low Density Polyethylene
MRK	Mórakert Vegetables and Fruits Producer and Sales Cooperative
NDL	the Netherlands
OED	Own experimental data
PC	Polycarbonate
PE	Polyethylene
PO	Photochemical Oxidation
PP	Polypropylene
PPO	Applied Plant Research
PS	Polyester
PST	Polystyrene
PVC	Polyvinylchloride
WP	Work package

2 UNITS

eq	equivalent
ha	hectare
kg	kilogram
kWh	kilowatt per hour
l	liter
m	meter
m^2	square meter
m^3	cubic meter
MJ	Mega Joules

3 RESULTS OF LCI & LCIA FOR TOMATO CROP IN SPAIN

Table 3.1. Multi-tunnel greenhouse description

Element	Size	Units
Greenhouse Spans	18	u
Span width	8	m
Span length	135	m
Greenhouse width	144	m
Greenhouse length	135	m
Greenhouse perimeter	558	m
Greenhouse surface	19,440	m^2
Gutter height	4.5	m
Ridge height	5.8	m
Gutter to ridge distance	1.3	m
Greenhouse volume	104,679	m^3
Roof arch	8.55	m
Roof angle to vertical	36	º
Roof surface	20,781	m^2
Front walls surface	1,550	m^2
Side walls surface	1,215	m^2
Nº roof ventilators	2x18	u
Ventilator dimensions	1.6x135	m
Ventilator surface	7,776	m^2
Insect proof screen	8,009	m^2

Table 3.2. Materials and processes multi-tunnel structure inventory (IRTA 2008)

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·ton tomato^{-1}	Unit	Type of data	Source
Concrete	Foundations and main path	123	4.21	0.03	m^3	OED	EEFC
LDPE	Covering and floor	7,361	1,262.2	7.66	kg	OED	EEFC
PC	Walls	3,319	113.8	0.69	kg	OED	EEFC
PE	Insect proof screens and plant gutter system	3,176	326.7	1.98	kg	OED	EEFC
PP	Raffia plant gutter system	206	212.4	1.29	kg	OED	EEFC
PVC	Clips and wedges	2,385	122.7	0.74	kg	OED	EEFC
Steel	Posts, frame reinforcements, gutters, axes, profiles, ventilators arches, high wire system	149,675	5,132.9	31.15	kg	OED	EEFC
Wire	Plant gutter system	2,188	75.0	0.46	kg	OED	EEFC
Processes							
LDPE	Extrusion, plastic film	7,361	1,262.2	7.66	kg	OED	EEFC
PC	Extrusion, plastic film	3,319	113.8	0.69	kg	OED	EEFC
PE	Extrusion plastic, pipes	3,176	326.7	1.98	kg	OED	EEFC
PP	Extrusion, plastic film	206	212.4	1.29	kg	OED	EEFC
PVC	Injection moulding	2,385	122.7	0.74	kg	OED	EEFC
Steel	Manufacturing processes	149,675	5,132.9	31.15	kg	OED	EEFC
Steel	Zinc (steel coating)	9,043	310.1	1.88	m^2	OED	EEFC
Transport	Lorry, 605 km	101,828	4,383.7	26.60	tkm	OED	EEFC
Wire	Wire drawing, steel	2,188	75.0	0.46	kg	OED	EEFC

LDPE: Low Density Polyethylene. PC: Polycarbonate. PE: Polyethylene. PP: Polypropylene. PVC: Polyvinylchloride

Table 3.3 Crop description

Characteristics	Data	Unit	Type of data	Source
Commercial yield	16.5	kg/m^2	OED	EEFC
Crop period	12	months	OED	EEFC
Fresh weight	8	kg/plant	OED	EEFC
Nº bags per row	110	u	ERD	EEFC
Nº plants	22,935	plants	OED	EEFC
Nº plants per bag	3	u	OED	EEFC
Nº rows	70	u	OED	EEFC
Nº stems per plant	2	u	OED	EEFC

Table 3.4. Auxiliary equipment description

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
LDPE	Benches	1.350	231.6	1.41	kg	OED	EEFC
PE	Pipes, drippers, microtubes,	813	83.6	0.51	kg	OED	IRTA
PE	Pickaxes	34	3.5	0.02	kg	OED	EEFC
PE	Fertilizers tanks	62	6.3	0.04	kg	OED	EEFC
Polystyrene	Substrate layers	1,486	254.8	1.55	kg	OED	EEFC
PVC	Distribution system	855	44.0	0.27	kg	OED	EEFC
Steel	Pumps, injectors	155	5.3	0.03	kg	OED	EEFC
Processes							EEFC
LDPE	Extrusion, plastic film	1,350	231.6	1.41	kg	OED	EEFC
PE	Extrusion plastic, pipes	813	83.6	0.51	kg	OED	IRTA
PE	Injection moulding	34	3.5	0.02	kg	OED	EEFC
PE	Blow moulding	62	6.3	0.04	kg	OED	EEFC
Polystyrene	Foaming expanding	1,486	254.8	1.55	kg	OED	EEFC
PVC	Extrusion plastic, pipes	855	44.0	0.27	m^2	OED	EEFC
Steel	Manufacturing processes	155	5.3	0.03	kg	OED	EEFC
Transport	Lorry, 5 km	24	2.4	0.01	tkm	OED	EEFC

LDPE: Low Density Polyethylene. PE: Polyethylene. PVC: Polyvinylchloride

Table 3.5. Substrate description

Substrate	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
LDPE	Perlite bags	534.5	91.7	0.56	kg	OED	EEFC
LDPE	Extrusion plastic film	534.5	91.7	0.56	kg	OED	EEFC
Perlite	Substrate	36,696	6,292.2	38.18	kg	OED	EEFC
Transport	Lorry, 7 km	260.6	44.7	0.27	tkm	OED	EEFC

Table 3.6. Electricity production mix, ES for the production of 1 kWh electricity in 2007 [1]

Materials/Fuels	Quantity	Units
Hard coal	0.243	kWh
Lignite	0.037	kWh
Oil	0.084	kWh
Natural gas	0.195	kWh
Industrial gas	0.004	kWh
Hydropower	0.127	kWh
Nuclear	0.228	kWh
Photovoltaic	0.0004	kWh
Wind	0.058	kWh
Cogeneration	0.021	kWh

Table 3.7. Energy consumption

Energy consumption	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
Electricity	Auxiliary equipment	16,492	8,483.8	51.48	kWh	OED	EEFC
Electricity	Climate system	97	50.0	0.30	kWh	OED	EEFC

Table 3.8. Fertilizer consumption

Nutrient	Greenhouse quantity	Quantity ·ha^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
N	1,485	798.4	4.84	kg	OED	EEFC
P_2O_5	941	505.7	3.07	kg	OED	EEFC
K_2O	2,906	1,562.2	9.48	kg	OED	EEFC

Table 3.9. Fertilizer application emissions

Air emissions	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato $^{-1}$	Unit	Type of data	Source
NH_3-N	44.6	24	0.15	kg	ERD	IRTA
N_2O-N	18.6	10	0.06	kg	ERD	IRTA
NO_X-N	1.9	1	0.01	kg	ERD	IRTA
Water emissions	**Greenhouse quantity**	**Quantity ·ha^{-1}·y^{-1}**	**Quantity·ton tomato $^{-1}$**	**Unit**	**Type of data**	**Source**
NO_3^-	668.5	359.3	2.18	kg	ERD	IRTA
P	0	0	0	kg	ERD	IRTA

Table 3.10. Pesticides consumption

Material	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato $^{-1}$	Unit	Type of data	Source
Application machine	1	0.01	u	ERD	IRTA
Insecticides-Active ingredient	3.77	0.02	kg	OED	EEFC
Fungicides-Active ingredient	28.45	0.17	kg	OED	EEFC

Table 3.11. Disposal treatments estimated for waste materials in tomato production in Spain (IRTA 2008)

Materials		Recycling	Landfill	Incinerator	Compost plant	Others
15 years life materials	Metals	100%				
	PC	100%				
	Concrete	50%	50%			
Plastics	Altogether	90%	10%			
Substrate	Substrate	50%	50%			
	Plastic bags	50%	50%			
	Altogether					
Dry green biomass	40% fresh weight				100%	

Table 3.12. Materials transport and treatments in waste management

Material	Process	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
15 years life materials	Transport to landfill	1,441	49.4	0.30	tkm	ERD	EEFC
Green biomass	Transport to compost plant	367	189	1.15	tkm	OED	EEFC
Plastics	Transport to landfill	16.2	2.3	0.01	tkm	OED	EEFC
Substrate	Transport to landfill	186	31.9	0.19	tkm	OED	EEFC
Processes							
15 years life materials	Emissions landfill	144,080	4,941.0	29.98	kg	OED	EEFC
Plastics	Emissions landfill	1,624	229.3	1.39	kg	OED	EEFC
Substrate	Emissions landfill	18,615	3,191.9	19.37	kg	OED	EEFC

Table 3.13. Transport processes

Material	Origin	Means of transport	Distance (km)	Type of data	Source
Compost plant	Almeria	lorry	5	ERD	EEFC
Frame	Valencia	lorry	605	ERD	EEFC
Landfill	Almeria	lorry	10	ERD	EEFC
Substrate perlite	Almeria	lorry	7	ERD	EEFC
Watering system	Almeria	lorry	5	ERD	EEFC

Table 3.14. LCIA results per FU, for tomato greenhouse crop Spain.

No	Unit	Total	Structure	Climate system	Auxiliary equipment	Fertilizers	Pesticides	Waste
AD	kg Sb eq	**1,7E+00**	**7,8E-01**	1,1E-03	6,3E-01	2,0E-01	1,7E-02	2,3E-02
AA	kg SO2 eq	**1,0E+00**	3,9E-01	1,5E-03	**4,2E-01**	2,1E-01	1,9E-02	1,2E-02
EU	kg PO4---eq	**4,9E-01**	1,5E-01	2,7E-04	8,0E-02	**2,5E-01**	6,5E-03	3,9E-03
GW	kg CO2 eq	**2,5E+02**	**8,8E+01**	1,5E-01	7,7E+01	8,2E+01	2,0E+00	3,1E+00
PO	kg C2H4	**5,4E-02**	2,0E-02	5,4E-05	**2,7E-02**	4,9E-03	1,2E-03	1,0E-03
CE	MJ	**4,0E+03**	**1,9E+03**	3,1E+00	1,6E+03	3,9E+02	4,1E+01	5,7E+01

Table 3.15. LCIA results per FU, for structure stage, for tomato greenhouse crop in Spain.

No	Unit	Total	Metals	Concrete	Plastics	Transport
AD	kg Sb eq	**7,8E-01**	2,6E-01	1,5E-02	**4,6E-01**	4,9E-02
AA	kg SO_2 eq	**3,9E-01**	**2,1E-01**	1,1E-02	1,3E-01	3,6E-02
EU	kg PO_4^{---}eq	**1,5E-01**	**1,1E-01**	2,8E-03	2,6E-02	9,6E-03
GW	kg CO_2 eq	**8,8E+01**	**3,9E+01**	6,8E+00	3,6E+01	6,8E+00
PO	kg C_2H_4	**2,0E-02**	**1,2E-02**	4,2E-04	7,4E-03	1,1E-03
CE	MJ	**1,9E+03**	6,2E+02	3,7E+01	**1,1E+03**	1,2E+02

Table 3.16. LCIA results per FU, for auxiliary equipment stage, for tomato greenhouse crop in Spain.

No	Unit	Total	Material Plastics	Manufacture Plastics	Metals	Transport	Electricity	Perlite
AD	kg Sb eq	**6,3E-01**	1,3E-01	1,5E-02	5,3E-04	1,9E-04	1,9E-01	**2,9E-01**
AA	kg SO2 eq	**4,2E-01**	3,3E-02	1,0E-02	2,8E-04	1,1E-04	**2,5E-01**	1,2E-01
EU	kg PO4---eq	**8,0E-02**	3,1E-03	5,0E-03	1,7E-04	3,5E-05	**4,7E-02**	2,5E-02
GW	kg CO2 eq	**7,7E+01**	9,7E+00	2,2E+00	7,2E-02	2,8E-02	2,6E+01	**3,9E+01**
PO	kg C2H4	**2,7E-02**	2,0E-03	**9,6E-03**	1,8E-05	1,1E-05	9,1E-03	5,9E-03
CE	MJ	**1,6E+03**	3,1E+02	4,3E+01	1,3E+00	4,9E-01	5,3E+02	**6,9E+02**

Table 3.17. LCIA results per FU, for fertilizers process, for tomato greenhouse crop in Spain.

No	Unit	Total	Application	N	P_2O_5	K_2O
AD	kg Sb eq	**2.0E-01**	-	**1.2E-01**	2.6E-02	4.9E-02
AA	kg SO_2 eq	**2.1E-01**	9.5E-03	**1.3E-01**	5.7E-02	9.2E-03
EU	kg PO_4^{---}eq	**2.5E-01**	**2.2E-01**	2.2E-02	3.4E-03	1.4E-03
GW	kg CO_2 eq	**8,2E+01**	2,8E+01	**4.4E+01**	3.6E+00	6.3E+00
PO	kg C_2H_4	**4.9E-03**	-	**2.5E-03**	2.0E-03	3.5E-04
CE	MJ	**3.9E+02**	-	**2.4E+02**	5.4E+01	9.9E+01

Table 3.18. LCIA results per FU, for pesticides process, for tomato greenhouse crop in Spain.

No	Unit	Total	Application	Insecticides	Fungicides
AD	kg Sb eq	**1.7E-02**	4.7E-04	1.9E-03	**1.4E-02**
AA	kg SO_2 eq	**1.9E-02**	4.0E-04	2.2E-03	**1.7E-02**
EU	kg PO_4^{---}eq	**6.5E-03**	1.2E-04	7.4E-04	**5.6E-03**
GW	kg CO_2 eq	**2.0E+00**	6.7E-02	2.3E-01	**1.7E+00**
PO	kg C_2H_4	**1.2E-03**	1.5E-05	1.3E-04	**1.0E-03**
CE	MJ	**4.1E+01**	1.1E+00	4.6E+00	**3.5E+01**

Table 3.19. LCIA results per FU, for estimated waste management stage, for tomato greenhouse crop in Spain.

No	Unit	Total	Concrete transport	Plastics transport	Substrate transport	Biomass transport	Concrete landfill	Plastics landfill	Substrate landfill
AD	kg Sb eq	**2,3E-02**	9,9E-04	4,6E-05	2,5E-03	**1,5E-02**	2,6E-03	1,2E-04	1,7E-03
AA	kg SO2 eq	**1,2E-02**	4,1E-04	1,9E-05	1,4E-03	**8,3E-03**	1,3E-03	5,9E-05	8,2E-04
EU	kg PO_4---eq	**3,9E-03**	1,2E-04	5,3E-06	4,7E-04	**2,7E-03**	3,1E-04	1,4E-05	2,0E-04
GW	kg CO2 eq	**3,1E+00**	1,4E-01	6,5E-03	3,7E-01	**2,2E+00**	2,1E-01	9,9E-03	1,4E-01
PO	kg C2H4	**1,0E-03**	1,8E-05	8,2E-07	1,4E-04	**8,1E-04**	4,6E-05	2,2E-06	3,0E-05
CE	MJ	**5,7E+01**	2,4E+00	1,1E-01	6,4E+00	**3,8E+01**	5,9E+00	2,8E-01	3,8E+00

4 RESULTS OF LCI & LCIA FOR TOMATO CROP IN HUNGARY

Table 4.4.1. Greenhouse description

Element	Size	Units
Greenhouse Spans	32	u
Bays per span	2	u
Module width	8	m
Module length	4	m
Span width	8	m
Span length	92	m
Greenhouse width	256	m
Greenhouse length	92	m
Greenhouse perimeter	696	m
Greenhouse surface	23,552	m^2
Gutter height	4,5	m
Ridge height	5,2	m
Gutter to ridge distance	0,7	m
Greenhouse volume	114,227	m^3
Roof slope length	2.12	m
Roof surface	24,953	m^2
Front walls surface	2,846	m^2
Side walls surface	828	m^2
Nº ventilator windows greenhouse	1,472	u
Ventilator dimensions	3.0 x 1.2	m
Ventilator surface	5,299	m^2
Insect proof screen	None	
Side window ventilators	None	

Table 4.2. Materials and processes considered in the greenhouse structure inventory

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·ton tomato^{-1}	Unit	Type of data	Source
Aluminium	Gutters, ridges, bars, ventilators opening mechanism, energy screens	92,645	2,498.6	5.21	kg	OED	MRK
Concrete	Foundations and main path	198	5.3	0.01	m^3	OED	MRK
Glass	Covering and walls	209,922	5,661.5	11.79	kg	OED	MRK
LDPE	Floor	4,506	607.6	1.27	kg	OED	MRK
Paint	Shading screen	4,993	2,019.9	4.21	kg	OED	MRK
PE	Plant gutter system	202	16.3	0.03	kg	OED	MRK
Polyester	Floor and screens	29,591	2,394.2	4.99	kg	OED	MRK
Steel	Roof bars, girders, stability braces, rails, posts, tie beams, foundations reinforcements, ventilators opening mechanism, high wire system	355,216	9,580.0	19.96	kg	OED	MRK
Processes							
Aluminium	Manufacturing processes	92,645	2,498.6	5.21	kg	OED	MRK
Aluminium	Powder coating	10,077	271.8	0.57	m^2	OED	MRK
Glass	Manufacturing process	209,922	5,661.5	11.79	kg	OED	MRK
LDPE	Extrusion plastic film	4,506	607.6	1.27	kg	OED	MRK
PE	Injection moulding	202	16.3	0.03	kg	OED	MRK
Polyester	Extrusion plastic film	29,591	2,394.2	4.99	kg	OED	MRK
Steel	Manufacturing processes	355,216	9,580.0	19.96	kg	OED	MRK
Steel	Zinc (steel coating)	26,741	721.2	1.50	m^2	OED	MRK
Transport	Lorry, 2000 km	1,384,162	37,330.1	77.77	tkm	OED	MRK

Table 4.3. Crop description

Characteristics	Data	Unit	Type of data	Source
Commercial yield	48	kg/m^2	OED	MRK
Crop period	49	weeks	OED	MRK
Fresh weight	5	kg/plant	OED	MRK
Nº bags per row	56	u	ERD	MRK
Nº plants	69,440	plants	OED	MRK
Nº plants per bag	4	u	OED	MRK
Nº rows	310	u	OED	MRK
Nº stems per plant	1	u	OED	MRK

Table 4.4. Auxiliary equipment description

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
PE	Benches, drippers, microtubes, pipes, fertilizers tanks	3,967	320.9	0.67	kg	OED	MRK
Polyester	Inside tanks plastic	94	7.6	0.02	kg	OED	IRTA
Polystyrene	Substrate layers	3,906	316.0	0.66	kg	OED	MRK
PVC	Distribution system	38	1.5	0.003	kg	OED	MRK
Steel	Water tanks, pumps	3,154	85.1	0.18	kg	OED	MRK
Processes							
PE	Injection moulding	3,967	320.9	0.67	kg	OED	MRK
Polyester	Extusion plastic film	94	7.6	0.02	kg	OED	IRTA
Polystyrene	Foaming expanding	3,906	316.0	0.66	kg	OED	MRK
PVC	Injection moulding	38	1.5	0.003	kg	OED	MRK
Steel	Manufacturing processes	3,154	85.1	0.18	kg	OED	MRK
Steel	Zinc (steel coating)	127	3.4	0.01	m^2	OED	MRK
Transport	Lorry, 2000 km	22,317	1,462.3	3.05	tkm	OED	MRK

Table 4.5. Substrate description

Substrate	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
LDPE	Rockwool bags	687	278.1	0.58	kg	OED	MRK
LDPE	Extrusion plastic film	687	278.1	0.58	kg	OED	MRK
Rockwool	Substrate	10,208	4,129.4	8.60	kg	OED	MRK
Transport	Lorry, 15 km	163	66.1	0.14	tkm	OED	MRK

LDPE: Low Density Polyethylene. PVC: Polyvinylchloride

Table 4.6. Electricity production mix, HUN for the production of 1 kWh electricity in 2007

Materials/Fuels	Quantity	Units
Hard coal	0.009	kWh
Lignite	0.233	kWh
Oil	0.023	kWh
Natural gas	0.348	kWh
Industrial gas	0.005	kWh
Hydropower	0.007	kWh
Photovoltaic	0.00032	kWh
Nuclear	0.352	kWh
Cogeneration	0.021	kWh

Table 4.7. Energy consumption

Energy consumption	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
Natural gas	Estimated consumption	2,197,402	933,000	1.943.75	m^3	OED	MRK
Electricity	Greenhouse consumption	194,367	82,527	171.93	kWh	OED	MRK

Table 4.8. Variables estimated to calculate gas consumption for heating greenhouse in Hungary

Variables	Value	Unit
Covering transmition, t	80	%
Developed area	28,276	m^2
Greenhouse area	23,552	m^2
Greenhouse Tª	15	ºC
Greenhouse volume	114,227.2	m^3
Heat needs (Wt/m^2)	162.4	Wt/m^2
Natural gas (MJ/L)	0.02394	MJ/L
Outdoors Tª	-1.1	ºC
Thermal K cover material (glass+ thermal screen)	4.27	$Wt/m^2/ºC^1$

Table 4.9.climate control system description

Material	Element	Greenhouse quantity	Quantity $ha^{-1}·y^{-1}$	Quantity ·ton tomato $^{-1}$	Unit	Type of data	Source
Aluminium	Pipes, piperails supports	16,941	456.9	0.95	kg	OED	MRK
PE	Distribution equipment	1,863	150.8	0.31	kg	OED	MRK
Polyester	Inside tanks plastic	285	23.0	0.05	kg	OED	IRTA
Steel	Thermal water tank, pumps, pipes, snow line, heat storage tank fans, ventilators motors, CO_2 support hook	210,098	5,666.2	11.80	kg	OED	MRK
Processes							
Aluminium	Manufacturing processes	16,941	456.9	0.95	kg	OED	MRK
Aluminium	Powder coating	2,018	54.4	0.113	kg	OED	MRK
PE	Extrusion plastic pipes	1,863	150.8	0.31	kg	OED	MRK
Polyester	Extrusion plastic film	285	23.0	0.05	kg	OED	IRTA
Steel	Manufacturing processes	210,098	5,666.2	11.80	kg	OED	MRK
Steel	Zinc (steel coating)	7,699	207,6	0.43	m^2	OED	MRK

Material	Element	Greenhouse quantity	Quantity $ha^{-1} \cdot y^{-1}$	Quantity ·ton $tomato^{-1}$	Unit	Type of data	Source
Aluminium	Pipes, piperails supports	16,941	456.9	0.95	kg	OED	MRK
Transport	Lorry, 200 km	45,837	1,259.4	2.62	tkm	OED	MRK

4.9.bis. Climate control system for natural gas use.

Material	Element	Greenhouse quantity	Quantity $ha^{-1} \cdot y^{-1}$	Quantity ·ton $tomato^{-1}$	Unit	Type of data	Source
Polyester	Inside tanks plastic	0	0	0	kg		
Steel	Pipes, snow line, heat storage tank fans, ventilators motors, CO_2 support hook	210,098	5,666.2	11.80	kg	OED	MRK
Processes							
Polyester	Extrusion plastic film	0	0	0	kg	OED	IRTA
Steel	Manufacturing processes	162,783	4,390.2	9.15	kg	OED	MRK
Steel	Zinc (steel coating)	7,400	199,6	0.42	m^2	OED	MRK
Transport	Lorry, 200 km	36,317	1,000	2.08	tkm	OED	MRK

Table 4.10. Fertilizers consumption

Nutrient	Greenhouse quantity	Quantity $ha^{-1} \cdot y^{-1}$	Quantity·ton $tomato^{-1}$	Unit	Type of data	Source
N	6,609	2,806	5.85	kg	OED	Nemes, 2007
P_2O_5	4,703	1,997	4.16	kg	OED	Nemes, 2007
K_2O	14,696	6,240	13.00	kg	OED	Nemes, 2007

Table 4.11. Fertilizers application emissions

Air emissions	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
NH_3-N	198	84.2	0.18	kg	ERD	IRTA
N_2O-N	83	35.1	0.07	kg	ERD	IRTA
NO_X-N	8	3.5	0.01	kg	ERD	IRTA
Water emissions	**Greenhouse quantity**	**Quantity ·ha^{-1}**	**Quantity·ton tomato^{-1}**	**Unit**	**Type of data**	**Source**
NO_3^-	2,554	1,084.4	2.26	kg	ERD	IRTA
P	0	0	0	kg	ERD	IRTA

Table 4.12. Pesticides consumption

Material	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
Application of plants protection	1	0.002	u	ERD	IRTA
Insecticides-Active ingredient	798	1.663	kg	OED	MRK
Fungicides-Active ingredient	480	1.000	kg	OED	MRK

Table 4.13. Disposal treatments estimated for waste materials in tomato production

Materials		Recycling	Landfill	Incinerator	Compost plant	Others
15 years life materials	Metals		100%			
	Glass	100%				
	Concrete	70%	30%			
Plastics	Altogether	100%				
Substrate	Substrate	50%	50%			
	Plastic bags	100%				
	Altogether					
Dry green biomass	40% fresh weight				100%	

Table 4.14. Materials for transport and waste treatments

Material	Process	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
15 years life materials	Transport to landfill	32,830	885	1,84	tkm	ERD	MRK
Green biomass	Transport to compost plant	8,333	3,538	7.37	tkm	OED	MRK
Substrate	Transport to landfill	204	83	0.17	tkm	OED	MRK
Processes							
15 years life materials	Emissions landfill	820,744	22,135	46.11	kg	OED	MRK
Substrate	Emissions landfill	5,104	2,065	4.30	kg	OED	MRK

Table 4.14. bis. Materials for transport and waste treatments considering use of natural gas

Material	Process	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
15 years life materials	Transport to landfill	30,937	834	1.74	tkm	ERD	MRK
Processes							
15 years life materials	Emissions landfill	773430	20,859	43.46	kg	OED	MRK

Table 4.15. Transport processes

Material	Origin	Means of transport	Distance (km)	Type of data	Source
Compost plant	Hungary	lorry	60	ERD	MRK
Frame		lorry	2.000	ERD	MRK
Heating system		lorry	200	ERD	MRK
Landfill	Hungary	lorry	40	ERD	MRK
Substrate rockwool	Hungary	lorry	15	ERD	MRK
Watering system		lorry	2.000	ERD	MRK

Table 4.16. LCIA results per FU, for tomato greenhouse crop in Hungary, with thermal water.

No	Unit	Total	Structure	Climate system	Auxiliary equipment	Fertilizers	Pesticides	Waste
ADP	kg Sb eq	**2.8E+00**	1.0E+00	**1.0E+00**	1.6E-01	2.5E-01	3.1E-01	2.0E-02
AAP	kg SO_2 eq	**1.7E+00**	**6.8E-01**	3.7E-01	9.8E-02	2.6E-01	2.4E-01	1.3E-02
EUP	kg PO_4^{---}eq	**1.2E+00**	2.5E-01	**5.1E-01**	2.1E-02	2.6E-01	1.5E-01	3.5E-03
GWP	kg CO_2 eq	**4.4E+02**	**1.4E+02**	1.4E+02	1.6E+01	1.0E+02	3.8E+01	2.6E+00
POP	kg C_2H_4	**8.8E-02**	**3.6E-02**	1.9E-02	9.1E-03	6.2E-03	1.7E-02	4.4E-04
CED	MJ	**6.9E+03**	2.5E+03	**2.8E+03**	3.7E+02	5.0E+02	7.7E+02	4.9E+01

Table 4.17. LCIA results per FU, for tomato greenhouse crop in Hungary, with natural gas estimated consumption for heating system.

No	Unit	Total	Structure	Climate system	Auxiliary equipment	Fertilizers	Pesticides	Waste
ADP	kg Sb eq	**4.2E+01**	1.0E+00	**4.0E+01**	1.6E-01	2.5E-01	3.1E-01	2.0E-02
AAP	kg SO_2 eq	**5.0E+00**	6.8E-01	**3.7E+00**	9.8E-02	2.6E-01	2.4E-01	1.3E-02
EUP	kg PO_4^{---}eq	**1.7E+00**	2.5E-01	1.0E+00	2.1E-02	**2.6E-01**	1.5E-01	3.5E-03
GWP	kg CO_2 eq	**5.0E+03**	1.4E+02	**4.7E+03**	1.6E+01	1.0E+02	3.8E+01	2.6E+00
POP	kg C_2H_4	**4.0E-01**	3.6E-02	**3.3E-01**	9.1E-03	6.2E-03	1.7E-02	4.3E-04
CED	MJ	**8.7E+04**	2.5E+03	**8.3E+04**	3.7E+02	5.0E+02	7.7E+02	4.8E+01

Table 4.18. LCIA results per FU, for structure stage, for tomato greenhouse crop in Hungary.

No	Unit	Total	Metals	Concrete	Glass	Plastics	Transport
ADP	kg Sb eq	**1.0E+00**	**4.5E-01**	6.3E-03	8.7E-02	3.3E-01	1.4E-01
AAP	kg SO_2 eq	**6.8E-01**	**3.3E-01**	4.9E-03	1.2E-01	1.2E-01	1.1E-01
EUP	kg PO_4^{---}eq	**2.5E-01**	**1.5E-01**	1.2E-03	1.5E-02	4.8E-02	2.8E-02
GWP	kg CO_2 eq	**1.4E+02**	**6.4E+01**	2.9E+00	1.4E+01	4.3E+01	2.0E+01
POP	kg C_2H_4	**3.6E-02**	**1.8E-02**	1.8E-04	3.9E-03	1.0E-02	3.3E-03
CED	MJ	**2.5E+03**	**1.1E+03**	1.6E+01	1.9E+02	7.8E+02	3.5E+02

Table 4.19. LCIA results per FU, for climate control system stage, for tomato greenhouse crop with thermal water in Hungary.

No	Unit	Total	Metals	Plastics	Transport	Electricity
ADP	kg Sb eq	**1.0E+00**	1.2E-01	1.4E-02	4.8E-03	**9.0E-01**
AAP	kg SO_2 eq	**3.7E-01**	8.4E-02	3.7E-03	3.5E-03	**2.8E-01**
EUP	kg PO_4^{---}eq	**5.1E-01**	4.4E-02	9.1E-04	9.5E-04	**4.6E-01**
GWP	kg CO_2 eq	**1.4E+02**	1.8E+01	1.1E+00	6.7E-01	**1.2E+02**
POP	kg C_2H_4	**1.9E-02**	5.2E-03	3.1E-04	1.1E-04	**1.4E-02**
CED	MJ	**2.8E+03**	3.0E+02	3.3E+01	1.2E+01	**2.5E+03**

Table 4.20. LCIA results per FU, for climate control system stage, for tomato greenhouse crop with natural gas estimated consumption.

No	Unit	Total	Natural gas	Metals	Plastics	Transport	Electricity
ADP	kg Sb eq	**4.0E+01**	**3.9E+01**	1.0E-01	1.1E-02	3.8E-03	9.0E-01
AAP	kg SO_2 eq	**3.7E+00**	**3.4E+00**	7.4E-02	2.7E-03	2.8E-03	2.8E-01
EUP	kg PO_4^{---}eq	**1.0E+00**	**5.5E-01**	3.8E-02	4.7E-04	7.5E-04	4.6E-01
GWP	kg CO_2 eq	**4.7E+03**	**4.6E+03**	1.5E+01	7.2E-01	5.4E-01	1.2E+02
POP	kg C_2H_4	**3.3E-01**	**3.1E-01**	4.4E-03	2.2E-04	8.8E-05	1.4E-02
CED	MJ	**8.3E+04**	**8.0E+04**	2.5E+02	2.7E+01	9.3E+00	2.5E+03

Table 4.21. LCIA results per FU, for auxiliary equipment stage, for tomato greenhouse crop in Hungary.

No	Unit	Total	Material Plastics	Manufacturing Plastics	Metals	Transport	Rockwool
ADP	kg Sb eq	**1.6E-01**	5.0E-02	5.0E-03	1.5E-03	5.6E-03	**1.0E-01**
AAP	kg SO_2 eq	**9.8E-02**	1.2E-02	3.7E-03	1.1E-03	4.1E-03	**7.7E-02**
EUP	kg PO_4^{---}eq	**2.1E-02**	1.2E-03	1.6E-03	5.6E-04	1.1E-03	**1.6E-02**
GWP	kg CO_2 eq	**1.6E+01**	3.6E+00	7.2E-01	1.9E-01	7.8E-01	**1.1E+01**
POP	kg C_2H_4	**9.1E-03**	8.8E-04	**4.1E-03**	6.6E-05	1.3E-04	4.0E-03
CED	MJ	**3.7E+02**	1.1E+02	1.4E+01	3.7E+00	1.4E+01	**2.2E+02**

Table 4.22. LCIA results per FU, for fertilizers process, for tomato greenhouse crop in Hungary.

No	Unit	Total	Application	N	P_2O_5	K_2O
ADP	kg Sb eq	**2.5E-01**		**1.5E-01**	3.5E-02	6.7E-02
AAP	kg SO_2 eq	**2.6E-01**	1.2E-02	**1.6E-01**	7.8E-02	1.3E-02
EUP	kg PO_4^{---}eq	**2.6E-01**	**2.3E-01**	2.6E-02	4.7E-03	2.0E-03
GWP	kg CO_2 eq	**1.0E+02**	3.4E+01	**5.3E+01**	4.9E+00	8.6E+00
POP	kg C_2H_4	**6.2E-03**		**3.1E-03**	2.7E-03	4.8E-04
CED	MJ	**5.0E+02**		**2.9E+02**	7.4E+01	1.4E+02

Table 4.23. LCIA results per FU, for pesticides process, for tomato greenhouse crop in Hungary.

No	Unit	Total	Application	Insecticides	Fungicides
ADP	kg Sb eq	**3.1E-01**	1.6E-04	**2.3E-01**	8.4E-02
AAP	kg SO_2 eq	**2.4E-01**	1.4E-04	**1.9E-01**	5.3E-02
EUP	kg PO_4^{---}eq	**1.5E-01**	4.2E-05	**1.1E-01**	3.6E-02
GWP	kg CO_2 eq	**3.8E+01**	2.3E-02	**2.8E+01**	1.1E+01
POP	kg C_2H_4	**1.7E-02**	5.1E-06	**1.3E-02**	3.9E-03
CED	MJ	**7.7E+02**	3.9E-01	**5.7E+02**	2.0E+02

Table 4.24. LCIA results per FU, for waste management stage, for tomato greenhouse crop in Hungary.

No	Unit	Total	Metals transport	Substrate transport	Biomass transport	Metals landfill	Substrate landfill
ADP	kg Sb eq	**2.0E-02**	2.2E-03	3.1E-04	**1.3E-02**	3.9E-03	3.7E-04
AAP	kg SO_2 eq	**1.3E-02**	9.3E-04	2.3E-04	**1.0E-02**	1.9E-03	1.8E-04
EUP	kg PO_4^{---}eq	**3.5E-03**	2.5E-04	6.2E-05	**2.7E-03**	4.7E-04	4.4E-05
GWP	kg CO_2 eq	**2.6E+00**	3.1E-01	4.4E-02	**1.9E+00**	3.3E-01	3.1E-02
POP	kg C_2H_4	**4.4E-04**	3.8E-05	7.3E-06	**3.1E-04**	7.2E-05	6.7E-06
CED	MJ	**4.9E+01**	5.2E+00	7.7E-01	**3.3E+01**	9.2E+00	8.5E-01

5 RESULTS OF LCI & LCIA FOR TOMATO CROP IN THE NETHERLANDS.

Table 4.5.1. Greenhouse description

Element	Size	Units
Greenhouse Spans	25	u
Bays per span	2	u
Module width	8	m
Module length	5	m
Span width	8	m
Span length	200	m
Greenhouse width	200	m
Greenhouse length	200	m
Greenhouse perimeter	800	m
Greenhouse surface	40,000	m^2
Gutter height	6	m
Ridge height	6.76	m
Gutter to ridge distance	0.76	m
Greenhouse volume	255,200	m^3
Roof slope length	2.14	m
Roof slope angle	23	º
Roof surface	42,791	m^2
Front walls surface	2,552	m^2
Side walls surface	2,400	m^2
Nº ventilator windows greenhouse	2,000	u
Ventilator dimensions	1.325x1.425	m
Ventilator surface	3,776	m^2
Insect proof screen	None	
Side window ventilators	None	

Table 5.2. Materials and processes considered in the greenhouse structure inventory

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·ton tomato^{-1}	Unit	Type of data	Source
Aluminium	Gutters, ridges, bars, ventilators opening mechanism, energy screens	112,439.1	1,868.8	3.31	kg	OED	PPO
Concrete	Foundations and main path	181.9	3.0	0.01	m^3	OED	PPO
Glass	Covering and walls	475,709.0	7,906.8	13.99	kg	OED	PPO
Polyester	Floor material and screens	5,810.1	289.7	0.51	kg	OED	PPO
Steel	Roof bars, girders, stability braces, rails, posts, tie beams, foundations reinforcements, ventilators opening mechanism, high wire system	439,314.8	7,301.8	12.92	kg	OED	PPO
Processes							
Aluminium	Manufacturing processes	112,439.1	1,868.8	3.31	kg	OED	PPO
Aluminium	Powder coating	10,070.5	167.4	0.30	m^2	OED	PPO
Glass	Manufacturing process	475,709.0	7,906.8	13.99	kg	OED	PPO
Polyester	Extrusion plastic film	5,810.1	289.7	0.51	kg	OED	PPO
Steel	Manufacturing processes	439,314.8	7,301.8	12.92	kg	OED	PPO
Steel	Zinc (steel coating)	25,844.6	429.6	0.76	m^2	OED	PPO
Transport	Lorry, 55 km	56,830.0	944.6	1.67	tkm	OED	PPO

Table 5.3 Crop description

Characteristics	Data	Unit	Type of data	Source
Commercial yield	56.5	kg/m^2	OED	PPO
Crop period	1	year	OED	PPO
Fresh weight	8.0	kg/plant	OED	PPO
Nº bags per row	131	u	ERD	PPO
Nº plants	49,000	Plants	OED	PPO
Nº plants per bag	3	u	OED	PPO
Nº rows	125	u	OED	PPO
Nº stems per plant	2	u	OED	PPO

Table 5.4. Auxiliary equipment description

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
LDPE	Benches, drippers, microtubes, pipes,	3,162.5	262.8	0.47	kg	OED	PPO
Polyester	Inside tanks plastic	312.2	15.6	0.03	kg	OED	IRTA
Polystyrene	Substrate layers	3,675.0	183.2	0.32	kg	OED	PPO
PVC	Distribution system	573.0	14.3	0.03	kg	OED	PPO
Steel	Water tanks	14,394.8	239.3	0.42	kg	OED	PPO
Processes							
LDPE	Injection moulding	3,162,5	262,8	0,47	kg	OED	PPO
Polyester	Extusion plastic film	312.2	15.6	0.03	kg	OED	IRTA
Polystyrene	Foaming expanding	3,675.0	183.2	0.32	kg	OED	PPO
PVC	Injection moulding	573.0	14.3	0.03	kg	OED	PPO
Steel	Manufacturing processes	14,394.8	239.3	0.42	kg	OED	PPO
Steel	Zinc (steel coating)	364.2	6.0	0.01	m^2	OED	PPO
Transport	Lorry, 200 km	4,423.5	143.04	0.25	tkm	OED	PPO

LDPE: Low Density Polyethylene. PVC: Polyvinylchloride

Table 5.5. Substrate description

Substrate	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
LDPE	Rockwool bags	1,043	260.16	0.46	kg	OED	PPO
LDPE	Extrusion plastic film	1,043	260.16	0.46	kg	OED	PPO
Rockwool	Substrate	17,905	4,463.89	7.90	kg	OED	PPO
Transport	Lorry, 185 km	3,312	825.82	1.46	tkm	OED	PPO

Table 5.6. Energy consumption and production

Energy consumption	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
Natural gas	CHP	2,588.000	647,000	1,145	m^3	OED	PPO
Natural gas	CHP	81,917,964	20,479,491	36,247	MJ	calculated	
Natural gas	CHP for heating (allocation)	52,782,927	13,195,732	23,355	MJ	calculated	
Electricity	Greenhouse consumption	400,000	100,000	177	kWh	OED	PPO
Electricity	Produced by cogeneration	7,120,000	1,780,000	3,150	kWh	OED	PPO

Table 5.7. Electricity production mix, NDL for the production of 1 kWh electricity in 2007 [1]

Materials/Fuels	Quantity	Units
Hard coal	0.234	kWh
Oil	0.028	kWh
Natural gas	0.606	kWh
Industrial gas	0.027	kWh
Hydropower	0.001	kWh
Nuclear	0.037	kWh
Wind	0.020	kWh
Cogeneration	0.021	kWh

Table 5.8. Climate control system description

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·ton tomato^{-1}	Unit	Type of data	Source
Aluminium	Pipes, piperails	34,166	567.9	1.01	kg	OED	PPO
Paint	Pipes paint	5,882	97.8	0.17	kg	OED	PPO
PE	Tubes	225	11.2	0.02	kg	OED	PPO
Polyester	Inside tanks plastic	153	7.6	0.01	kg	OED	IRTA
PVC	Distribution equipment	859	21.4	0.04	kg	OED	PPO
Steel	Boiler, condensers, pumps, cogenerating system, pipes, CO_2 supporthook	311,069	5,170.3	9.15	kg	OED	PPO
Processes							
Aluminium	Manufacturing processes	34,166	567.9	1.01	kg	OED	PPO
Aluminium	Powder coating	3,266	54.3	0.10	kg	OED	PPO
PE	Extrusion plastic pipes	225	11.2	0.02	kg	OED	PPO
Polyester	Extrusion plastic film	153	7.6	0.01	kg	OED	IRTA
PVC	Extrusion plastic pipes	859	21.4	0.04	kg	OED	PPO
Steel	Manufacturing processes	311,069	5,170.3	9.15	kg	OED	PPO
Steel	Zinc (steel coating)	825	13.7	0.02	m^2	OED	PPO
Transport	Lorry, 55 km	19,056	317.8	0.56	tkm	OED	PPO

Table 5.9. Fertilizers consumption

Nutrient	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
N	6,752	1,688	2.99	kg	OED	PPO
P_2O_5	1,623	406	0.72	kg	OED	PPO
K_2O	7,419	1,855	3.28	kg	OED	PPO

Table 5.10. Fertilizers application emissions

Air emissions	Greenhouse quantity	Quantity $ha^{-1}·y^{-1}$	Quantity ton tomato $^{-1}$	Unit	Type of data	Source
NH_3-N	202.6	50.6	0.09	kg	ERD	IRTA
N_2O-N	84.4	21.1	0.04	kg	ERD	IRTA
NO_X-N	8.4	2.1	0.004	kg	ERD	IRTA

Table 5.11. Pesticides consumption

Material	Quantity ·$ha^{-1}·y^{-1}$	Quantity·ton tomato $^{-1}$	Unit	Type of data	Source
Application of plants protection	1	0.002	u	ERD	IRTA
Insecticides-Active ingredient	3	0.005	kg	OED	PPO
Fungicides-Active ingredient	7	0.012	kg	OED	PPO

Table 5.12. Disposal treatments estimated for waste materials in tomato production

Materials		Recycling	Landfill	Incinerator	Compost plant	Others
15 years life materials	Metals	100%				
	Glass	100%				
	Concrete	50%	50%			
Plastics	Altogether	50%		50%		
Substrate	Substrate	50%	50%			
	Plastic bags	50%	50%			
Dry green biomass	40% fresh weight				100%	

Table 5.13. Materials for transport and waste treatments

Material	Process	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·ton tomato^{-1}	Unit	Type of data	Source
Concrete	Transport to landfill	3,274.81	54.43	0.01	tkm	ERD	PPO
Green biomass	Transport to compost plant	2,352	588.0	1.04	tkm	OED	PPO
Plastics	Transport to incinerator	258	14.1	0.02	tkm	OED	PPO
Substrate	Transport to landfill	142	35.4	0.06	tkm	OED	PPO
Processes							
15 years life materials	Emissions landfill	218,321	3,628.7	6.42	kg	OED	PPO
Plastics	Emissions incinerator	7,385	403.0	0.71	kg	OED	PPO
Substrate	Emissions landfill	9,474	2,362.0	4.18	kg	OED	PPO

Table 5.14. Transport processes

Material	Origin	Means of transport	Distance (km)	Type of data	Source
Compost plant	HvH	lorry	15	ERD	PPO
Frame	Ijmuiden	lorry	55	ERD	PPO
Heating system	Ijmuiden	lorry	55	ERD	PPO
Incinerator	Rozenburg	lorry	35	ERD	PPO
Landfill	HVH/Wateringen	lorry	15	ERD	PPO
Substrate rockwool	Roermond	lorry	185	ERD	PPO
Watering system	DSM	lorry	200	ERD	PPO

Table 5.15. LCIA results per FU, for tomato greenhouse crop in the Netherlands, with cogeneration (production of electricity is considered "avoided electricity")

No	Unit	Total	Structure	Climate system	Auxiliary equipment	Fertilizers	Pesticides	Waste
AD	kg Sb eq	**5.6E+00**	3.4E-01	**5.0E+00**	1.4E-01	9.9E-02	1.6E-03	3.3E-03
AA	kg SO_2 eq	**1.2E+00**	3.0E-01	**6.6E-01**	8.8E-02	1.1E-01	1.8E-03	2.3E-03
EU	kg PO_4^{---}eq	**-1.1E+00**	**9.7E-02**	-1.3E+00	2.1E-02	1.6E-02	6.1E-04	9.1E-04
GW	kg CO_2 eq	**7.8E+02**	5.3E+01	**6.6E+02**	1.4E+01	4.8E+01	2.0E-01	2.1E+00
PO	kg C_2H_4	**1.9E-01**	1.4E-02	**1.6E-01**	6.5E-03	2.2E-03	1.1E-04	7.6E-05
CED	MJ	**1.2E+04**	8.2E+02	**1.1E+04**	3.1E+02	2.0E+02	3.9E+00	7.9E+00

Table 5.16. LCIA results per FU, for tomato greenhouse crop in the Netherlands, with energy allocation of natural gas in CHP

No	Unit	Total	Structure	Climate system	Auxiliary equipment	Fertilizers	Pesticides	Waste
AD	kg Sb eq	**1.5E+01**	3.4E-01	**1.5E+01**	1.4E-01	9.9E-02	1.6E-03	3.3E-03
AA	kg SO_2 eq	**2.9E+00**	3.0E-01	**2.4E+00**	8.8E-02	1.1E-01	1.8E-03	2.3E-03
EU	kg PO_4^{---}eq	**7.2E-01**	9.7E-02	**5.8E-01**	2.1E-02	1.6E-02	6.1E-04	9.1E-04
GW	kg CO_2 eq	**2.0E+03**	5.3E+01	**1.9E+03**	1.4E+01	4.8E+01	2.0E-01	2.1E+00
PO	kg C_2H_4	**2.1E-01**	1.4E-02	**1.9E-01**	6.5E-03	2.2E-03	1.1E-04	7.6E-05
CED	MJ	**3.1E+04**	8.2E+02	**3.0E+04**	3.1E+02	2.0E+02	3.9E+00	7.9E+00

Table 5.17. LCIA results per FU, for structure stage, for tomato greenhouse crop in the Netherlands

No	Unit	Total	Metals	Concrete	Glass	Plastics	Transport
AD	kg Sb eq	**3.4E-01**	**2.1E-01**	3.0E-03	1.0E-01	1.9E-02	3.1E-03
AA	kg SO_2 eq	**3.0E-01**	**1.5E-01**	2.4E-03	1.4E-01	6.0E-03	2.3E-03
EU	kg PO_4^{---}eq	**9.7E-02**	**7.6E-02**	5.8E-04	1.8E-02	2.3E-03	6.1E-04
GW	kg CO_2 eq	**5.3E+01**	**3.2E+01**	1.4E+00	1.7E+01	1.6E+00	4.3E-01
PO	kg C_2H_4	**1.4E-02**	**8.9E-03**	8.6E-05	4.6E-03	3.5E-04	7.1E-05
CED	MJ	**8.2E+02**	**5.3E+02**	7.7E+00	2.3E+02	4.6E+01	7.5E+00

Table 5.18a. LCIA results per FU, for climate control system stage, for tomato greenhouse crop in the Netherlands. Electricity produced by the CHP is entered as an avoided product

No	Unit	Total	Natural gas	Metals	Paint	Plastics	Transport	Electricity
AD	kg Sb eq	**5.0E+00**	**2.1E+01**	9.7E-02	5.9E-03	2.2E-03	1.0E-03	-1.6E+01
AA	kg SO_2 eq	**6.6E-01**	**3.4E+00**	5.7E-02	3.4E-03	6.1E-04	7.6E-04	-2.8E+00
EU	kg PO_4^{---}eq	**-1.3E+00**	**6.7E-01**	3.1E-02	1.3E-03	1.6E-04	2.0E-04	-2.0E+00
GW	kg CO_2 eq	**6.6E+02**	**2.7E+03**	1.4E+01	4.9E-01	1.8E-01	1.4E-01	-2.0E+03
PO	kg C_2H_4	**1.6E-01**	**2.8E-01**	3.9E-03	1.6E-04	3.8E-05	2.4E-05	-1.2E-01
CED	MJ	**1.1E+04**	**4.3E+04**	2.4E+02	1.4E+01	5.5E+00	2.5E+00	-3.3E+04

Table 5.18b. LCIA results per FU, for climate control system stage, for a tomato greenhouse in the Netherlands. Energy allocation of natural gas in CHP.

No	Unit	Total	Natural gas	Metals	Paint	Plastics	Transport	Electricity
AD	kg Sb eq	**1.5E+01**	**1.4E+01**	9.7E-02	5.9E-03	2.2E-03	1.0E-03	9.6E-01
AA	kg SO_2 eq	**2.4E+00**	**2.2E+00**	5.7E-02	3.4E-03	6.1E-04	7.6E-04	1.7E-01
EU	kg PO_4^{---}eq	**5.8E-01**	**4.3E-01**	3.1E-02	1.3E-03	1.6E-04	2.0E-04	1.2E-01
GW	kg CO_2 eq	**1.9E+03**	**1.7E+03**	1.4E+01	4.9E-01	1.8E-01	1.4E-01	1.2E+02
PO	kg C_2H_4	**1.9E-01**	**1.8E-01**	3.9E-03	1.6E-04	3.8E-05	2.4E-05	7.0E-03
CED	MJ	**3.0E+04**	**2.8E+04**	2.4E+02	1.4E+01	5.5E+00	2.5E+00	1.9E+03

Table 5.19. LCIA results per FU, for auxiliary equipment stage, for tomato greenhouse crop in the Netherlands

No	Unit	Total	Material Plastics	Manufacturing Plastics	Metals	Transport	Rockwool
AD	kg Sb eq	**1.4E-01**	3.0E-02	7.0E-03	7.4E-03	4.6E-04	**9.4E-02**
AA	kg SO_2 eq	**8.8E-02**	7.7E-03	3.7E-03	4.3E-03	3.4E-04	**7.2E-02**
EU	kg PO_4^{---}eq	**2.1E-02**	7.7E-04	1.9E-03	2.5E-03	9.2E-05	**1.5E-02**
GW	kg CO_2 eq	**1.4E+01**	2.2E+00	8.9E-01	1.0E+00	6.5E-02	**1.0E+01**
PO	kg C_2H_4	**6.5E-03**	4.3E-04	2.1E-03	2.6E-04	1.1E-05	**3.7E-03**
CED	MJ	**3.1E+02**	7.0E+01	1.9E+01	1.8E+01	1.1E+00	**2.0E+02**

Table 5.20. LCIA results per FU, for fertilizers process, for tomato greenhouse crop in the Netherlands

No	Unit	Total	Application	N	P_2O_5	K_2O
AD	kg Sb eq	**9.9E-02**	-	**7.6E-02**	6.1E-03	1.7E-02
AA	kg SO_2 eq	**1.1E-01**	6.1E-03	**8.3E-02**	1.3E-02	3.2E-03
EU	kg PO_4^{---}eq	**1.6E-02**	1.6E-03	**1.3E-02**	8.0E-04	4.9E-04
GW	kg CO_2 eq	**4.8E+01**	**1.7E+01**	2.7E+01	8.5E-01	2.2E+00
PO	kg C_2H_4	**2.2E-03**	-	**1.6E-03**	4.6E-04	1.2E-04
CED	MJ	**2.0E+02**	-	**1.5E+02**	1.3E+01	3.4E+01

Table 5.21. LCIA results per FU, for pesticides process, for tomato greenhouse crop in the Netherlands

No	Unit	Total	Application	Insecticides	Fungicides
AD	kg Sb eq	**1.6E-03**	1.4E-04	4.5E-04	**1.0E-03**
AA	kg SO_2 eq	**1.8E-03**	1.2E-04	5.2E-04	**1.2E-03**
EU	kg PO_4^{---}eq	**6.1E-04**	3.5E-05	1.7E-04	**4.0E-04**
GW	kg CO_2 eq	**2.0E-01**	1.9E-02	5.3E-02	**1.2E-01**
PO	kg C_2H_4	**1.1E-04**	4.3E-06	3.1E-05	**7.3E-05**
CED	MJ	**3.9E+00**	3.3E-01	1.1E+00	**2.5E+00**

Table 5.22. LCIA results per FU, for estimated waste management stage, for tomato greenhouse crop in the Netherlands

No	Unit	Total	Concrete transport	Plastics transport	Substrate transport	Biomass transport	Concrete landfill	Plastics incinerator	Substrate landfill
AD	kg Sb eq	**3.3E-03**	1.1E-04	4.6E-05	1.1E-04	**1.9E-03**	5.5E-04	2.0E-04	3.6E-04
AA	kg SO_2 eq	**2.3E-03**	4.9E-05	3.4E-05	8.5E-05	**1.4E-03**	2.7E-04	3.1E-04	1.8E-04
EU	kg PO_4---eq	**9.1E-04**	1.3E-05	9.0E-06	2.3E-05	3.8E-04	6.6E-05	**3.8E-04**	4.3E-05
GW	kg CO_2 eq	**2.1E+00**	1.6E-02	6.4E-03	1.6E-02	2.7E-01	4.6E-02	**1.7E+00**	3.0E-02
PO	kg C_2H_4	**7.6E-05**	2.0E-06	1.1E-06	2.7E-06	**4.4E-05**	1.0E-05	1.0E-05	6.5E-06
CED	MJ	**7.9E+00**	2.7E-01	1.1E-01	2.8E-01	**4.7E+00**	1.3E+00	5.1E-01	8.3E-01

6 RESULTS OF LCI & LCIA FOR ROSE CROP IN THE NETHERLANDS.

Table 4.6.1. Greenhouse description

Element	Size	Units
Greenhouse Spans	21	u
Bays per span	2	u
Module width	9.6	m
Module length	5	m
Span width	9.6	m
Span length	200	m
Greenhouse width	201.6	m
Greenhouse length	200	m
Greenhouse perimeter	803.2	m
Greenhouse surface	40,320	m^2
Gutter height	6	m
Ridge height	6.76	m
Gutter to ridge distance	0.76	m
Greenhouse volume	257,242	m^3
Roof slope length	2.56	m
Roof slope angle	23	º
Roof surface	43,008	m^2
Front walls surface	2,572	m^2
Side walls surface	2,400	m^2
Nº ventilator windows greenhouse	1,680	u
Ventilator dimensions	1.325x1.25	m
Ventilator surface	2,782	m^2

Table 6.2. Materials and processes considered in the greenhouse structure inventory

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·1000 stems^{-1}	Unit	Type of data	Source
Aluminium	Gutters, ridges, bars, ventilators opening mechanism, energy screens	126,602.2	2,093.2	0.76	kg	OED	PPO
Concrete	Foundations and main path	181.0	3.0	0.001	m^3	OED	PPO
Glass	Covering and walls	479,172.6	7,922.8	2.87	kg	OED	PPO
Polyester	Floor material and screens	15,593.1	773.5	0.28	kg	OED	PPO
Steel	Roof bars, girdens, stability braces, rails, posts, tie beams, foundations reinforcements, ventilators opening mechanism, high wire system	539,972.0	8,928.1	3.23	kg	OED	PPO
Processes							
Aluminium	Manufacturing processes	126,602.2	2,093.2	0.76	kg	OED	PPO
Aluminium	Powder coating	15,239.2	252.0	0.09	m^2	OED	PPO
Glass	Manufacturing process	479,172.6	7,922.8	2.87	kg	OED	PPO
Polyester	Extrusion plastic film	15,593.1	773.5	0.28	kg	OED	PPO
Steel	Manufacturing processes	539,972.0	8,928.1	3.23	kg	OED	PPO
Steel	Zinc (steel coating)	37,679.9	623.0	0.23	m^2	OED	PPO
Transport	By lorry, 55 Km	63,873.7	1,056.1	0.38	tkm	OED	PPO

Table 6.3. Main futures of rose crop

Characteristics	Data	Unit	Type of data	Source
Commercial yield	276	roses/m^2	OED	PPO
Crop period	1	year	OED	PPO
Fresh weight	0.125	kg/plant	OED	PPO
Nº bags per row	131	u	ERD	PPO
Nº plants	335,866	plants	OED	PPO
Nº plants per bag	3	u	OED	PPO
Nº rows	210	u	OED	PPO

Table 6.4. Materials and processes considered in the auxiliary equipment inventory

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·1000 stems^{-1}	Unit	Type of data	Source
LDPE	Benches, drippers, microtubes, pipes,	12,597.1	1,041.4	0.38	kg	OED	PPO
Polyester	Inside tanks plastic	719.3	35.7	0.01	kg	OED	IRTA
Polysterene	Substrate layers	4,939.2	245.0	0.09	kg	OED	PPO
PVC	Primary pipe	575.3	14.3	0.01	kg	OED	PPO
Steel	Water tanks	14,522.3	240.1	0.09	kg	OED	PPO
Processes							
LDPE	Injection moulding	8,058.4	666.2	0.24	kg	OED	PPO
LDPE	Extrusion plastic pipes	4,538.7	375.2	0.14	kg	OED	PPO
Polyester	Extusion plastic film	719.3	35.7	0.01	kg	OED	IRTA
Polystyrene	Foaming expanding	4,939.2	245.0	0.09	kg	OED	PPO
PVC	Injection moulding	575.3	14.3	0.01	kg	OED	PPO
Steel	Manufacturing processes	14,522.3	240.1	0.09	kg	OED	PPO
Steel	Zinc (steel coating)	728.9	12.1	0.004	m^2	OED	PPO
Transport	Lorry, 200 km	6,670.6	315.3	0.11	tkm	OED	PPO

Table 6.5. Inventory data for substrate

Substrate	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·1000 stems^{-1}	Unit	Type of data	Source
Rockwool	Substrate	50,386.7	12,496.7	4.53	kg	OED	PPO
LDPE	Rockwool bags	2,671.3	662.5	0.24	kg	OED	PPO
LDPE	Extrusion plastic film	2,671.3	662.5	0.24	kg	OED	PPO
Transport	Lorry, 185 km	9,815.7	2,434.4	0.88	tkm	OED	PPO

LDPE: Low Density Polyethylene.

Table 6.6. Water used features

Water	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·1000 stems^{-1}	Unit	Type of data	Source
Water	Source water	18,144	4,500	1.63	m^3	OED	PPO
Water	Rain water	18,245	4,525	1.64	m^3	OED	PPO

Table 6.7. Energy consumption and production in climate control system stage

Energy consumption	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·1000 stems^{-1}	Unit	Type of data	Source
Natural gas	Cogeneration and heating	4,100,544	1,017,000	369	m^3	OED	PPO
Natural gas	Cogeneration and heating	129,794,519	32,191,101	11,663	MJ	Calculated	
Natural gas	CHP for heating (allocation)	72,876,036	18,074,414	6,548	MJ	Calculated	
Electricity	Greenhouse consumption	25,522,560	6,330,000	2,293	kWh	OED	PPO
Electricity	Produced by cogeneration	13,910,400	3,450,000	1,250	kWh	OED	PPO
Electricity	Public grid	11,612,160	2,880,000	1,043	kWh	OED	PPO

Table 6.8. Lamps characteristics in climate control system inventory

Lamp type	Rated power (W)	Materials	Weight (kg)	Units	Operating time (h)
High-pressure Sodium	1,000		4.700	4,200	5,900
		LDPE	0.500		
		aluminium	4.000		
		glass	0.150		
		cupper	0.050		

Table 6.9. Materials and processes considered in the climate control system inventory

Material	Element	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·1000 stems^{-1}	Unit	Type of data	Source
Aluminium	Piperails, lamps	54,868	907.2	0.33	kg	OED	PPO
Glass	Lamps	630	10.4	0.004	kg	OED	PPO
LDPE	Lamps	2,100	173.6	0.06	kg	OED	PPO
Paint	Pipes paint	1,346	22.2	0.08	m^2	OED	PPO
Polyester	Inside tanks plastic	360	17.9	0.01	kg	OED	IRTA
PVC	Roof cooling, distribution equipment	9,892	245.3	0.09	kg	OED	PPO
Steel	Boiler, condensers, pumps, cogenerating system, pipes	307,361	5,082.0	1.84	kg	OED	PPO
Processes							
Aluminium	Manufacturing processes	54,868	907.2	0.33	kg	OED	PPO
Aluminium	Powder coating	2,744	45.4	0.02	kg	OED	PPO
Cupper	Lamps conductor cable Roof cooling sprinkles	9,083	150.2	0.05	kg	OED	PPO
Glass	Manufacturing process	630	10.4	0.004	kg	OED	OED
LDPE	Injection moulding	2,100	173.6	0.06	kg	OED	OED
Polyester	Extrusion plastic film	360	17.9	0.01	kg	OED	IRTA
PVC	Extrusion plastic pipes	9,892	245.3	0.09	kg	OED	PPO
Steel	Manufacturing processes	307,361	5,082.0	1.84	kg	OED	PPO
Steel	Zinc (steel coating)	2,631	43.5	0.02	m^2	OED	PPO
Transport	By lorry, 55 km	21,136	362.3	0.13	tkm	OED	OED

Table 6.10 N, P and K amount for rose crop

Nutrient	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·1000 stems^{-1}	Unit	Type of data	Source
N	4,689	1,163	0.421	kg	OED	PPO
P_2O_5	1,113	276	0.100	kg	OED	PPO
K_2O	5,161	1,280	0.464	kg	OED	PPO

Table 6.11 Air emissions fertilizers

Air emissions	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity·1000 stems^{-1}	Unit	Type of data	Source
NH_3-N	141	34.9	0.013	kg	ERD	IRTA
N_2O-N	59	14.5	0.005	kg	ERD	IRTA
NO_X-N	6	1.5	0.001	kg	ERD	IRTA

Table 6.12 Phytosanitary treatments

Material	Quantity·ha^{-1}·y^{-1}	Quantity ·1000 stems^{-1}	Unit	Type of data	Source
Application of plants protection products	1	0.0004	u	ERD	IRTA
Active ingredient	42	0.015	kg	OED	PPO

Table 6.13 Waste treatments for waste management stage in rose's production.

		Recycling	Landfill	Incinerator	Compost plant	Others	Data
15 years life materials	Metals	100%					Estimated
	Glass	100%					Estimated
	Concrete	50%	50%				Estimated
Plastics	Alltogether	50%		50%			Estimated
Substrate	Substrate	50%	50%				Estimated
	Plastic bags	50%	50%				Estimated
Green biomass	40% weight				100%		Estimated

Table 6.14. Transport and emissions in waste management stage

Material	Process	Greenhouse quantity	Quantity ·ha^{-1}·y^{-1}	Quantity ·1000 stems^{-1}	Unit	Type of data	Source
Concrete	Transport to landfill	3,258	53.9	0.02	tkm	ERD	PPO
Green biomass	Transport to compost plant	252	62.5	0.02	tkm	OED	PPO
Plastics	Transport to incinerator	819	44.6	0.016	tkm	OED	PPO
Substrate	Transport to landfill	398	98.7	0.04	tkm	OED	PPO
Processes							
Concrete	Emissions landfill	217,230	3,591.8	1.30	kg	OED	PPO
Plastics	Emissions incinerator	23,388	1,273.3	0.46	kg	OED	PPO
Substrate	Emissions landfill	26,529	6,579.6	2.38	kg	OED	PPO

Table 6.15 Transport processes

Material	Origin	Means of transport	Distance (km)	Type of data	Source
Compost plant	HvH	lorry	15	ERD	PPO
Frame	Ijmuiden	lorry	55	ERD	PPO
Heating system	Ijmuiden	lorry	55	ERD	PPO
Incinerator	Rozenburg	lorry	35	ERD	PPO
Landfill	HVH/Wateringen	lorry	15	ERD	PPO
Substrate rockwool	Roermond	lorry	185	ERD	PPO
Watering system	DSM	lorry	200	ERD	PPO

Table 6.16 LCIA results per FU, for rose greenhouse crop in the Netherlands, with cogenerataion (production of electricity is considered "avoided electrity")

No	Unit	Total	Structure	Climate system	Auxiliary equipment	Fertilizers	Pesticides	Waste
AD	kg Sb eq	**1.3E+01**	8.7E-02	**1.2E+01**	7.5E-02	1.4E-02	1.3E-03	6.0E-04
AA	kg SO_2 eq	**2.3E+00**	7.2E-02	**2.1E+00**	4.8E-02	1.5E-02	1.5E-03	4.7E-04
EU	kg PO_4^{---}eq	**9.6E-01**	2.5E-02	**9.2E-01**	1.1E-02	2.3E-03	5.0E-04	3.1E-04
GW	kg CO_2 eq	**1.6E+03**	1.3E+01	**1.6E+03**	7.5E+00	6.7E+00	1.6E-01	1.1E+00
PO	kg C_2H_4	**1.4E-01**	3.4E-03	**1.3E-01**	3.0E-03	3.0E-04	9.0E-05	1.6E-05
CED	MJ	**2.6E+04**	2.1E+02	**2.5E+04**	1.7E+02	2.8E+01	3.2E+00	1.4E+00

Table 6.17 LCIA results per FU, for rose greenhouse crop in the Netherlands, with energy allocation of natural gas from CHP.

No	Unit	Total	Structure	Climate system	Auxiliary equipment	Fertilizers	Pesticides	Waste
AD	kg Sb eq	**1.6E+01**	8.7E-02	**1.6E+01**	7.5E-02	1.4E-02	1.3E-03	6.0E-04
AA	kg SO_2 eq	**3.0E+00**	7.2E-02	**2.8E+00**	4.8E-02	1.5E-02	1.5E-03	4.7E-04
EU	kg PO_4^{---}eq	**1.7E+00**	2.5E-02	**1.6E+00**	1.1E-02	2.3E-03	5.0E-04	3.1E-04
GW	kg CO_2 eq	**2.1E+03**	1.3E+01	**2.1E+03**	7.5E+00	6.7E+00	1.6E-01	1.1E+00
PO	kg C_2H_4	**1.5E-01**	3.4E-03	**1.4E-01**	3.0E-03	3.0E-04	9.0E-05	1.6E-05
CED	MJ	**3.3E+04**	2.1E+02	**3.3E+04**	1.7E+02	2.8E+01	3.2E+00	1.4E+00

Table 6.18 LCIA results per FU, for structure stage, for rose greenhouse crop in the Netherlands

No	Unit	Total	Metals	Concrete	Glass	Plastics	Transport
AD	kg Sb eq	**8.7E-02**	**5.4E-02**	6.2E-04	2.1E-02	1.1E-02	7.0E-04
AA	kg SO_2 eq	**7.2E-02**	**3.9E-02**	4.8E-04	2.8E-02	3.3E-03	5.2E-04
EU	kg PO_4^{---}eq	**2.5E-02**	**1.9E-02**	1.2E-04	3.6E-03	1.3E-03	1.4E-04
GW	kg CO_2 eq	**1.3E+01**	**8.0E+00**	2.8E-01	3.5E+00	9.0E-01	9.8E-02
PO	kg C_2H_4	**3.4E-03**	**2.2E-03**	1.7E-05	9.5E-04	1.9E-04	1.6E-05
CED	MJ	**2.1E+02**	**1.3E+02**	1.6E+00	4.7E+01	2.5E+01	1.7E+00

Table 6.19 LCIA results per FU, for climate control system stage, for rose greenhouse crop in the Netherlands, with cogeneration. Electricity produced by the CHP is entered as an avoided product

No	Unit	Total	Natural gas	Metals	Plastics	Lamps	Transport	Electricity
AD	kg Sb eq	**1.2E+01**	**6.8E+00**	2.3E-02	5.3E-03	1.6E-03	2.4E-04	5.6E+00
AA	kg SO_2 eq	**2.1E+00**	**1.1E+00**	1.4E-02	1.6E-03	4.2E-03	1.8E-04	9.9E-01
EU	kg PO_4^{---}eq	**9.2E-01**	2.2E-01	7.4E-03	4.2E-04	4.7E-03	4.8E-05	**6.9E-01**
GW	kg CO_2 eq	**1.6E+03**	**8.6E+02**	3.3E+00	4.5E-01	1.4E-01	3.4E-02	7.1E+02
PO	kg C_2H_4	**1.3E-01**	**8.9E-02**	9.0E-04	8.1E-05	1.7E-04	5.6E-06	4.1E-02
CED	MJ	**2.5E+04**	**1.4E+04**	5.7E+01	1.4E+01	3.8E+00	5.9E-01	1.1E+04

Table 6.20. LCIA results per FU, for climate control system stage, for rose greenhouse crop in the Netherlands. with energy allocation of natural gas from CHP.

No	Unit	Total	Natural gas	Metals	Plastics	Lamps	Transport	Electricity
AD	kg Sb eq	**1.6E+01**	3.8E+00	2.3E-02	5.3E-03	1.6E-03	2.4E-04	**1.2E+01**
AA	kg SO_2 eq	**2.8E+00**	6.2E-01	1.4E-02	1.6E-03	4.2E-03	1.8E-04	**2.2E+00**
EU	kg PO_4^{---}eq	**1.6E+00**	1.2E-01	7.4E-03	4.2E-04	4.7E-03	4.8E-05	**1.5E+00**
GW	kg CO_2 eq	**2.1E+03**	4.9E+02	3.3E+00	4.5E-01	1.4E-01	3.4E-02	**1.6E+03**
PO	kg C_2H_4	**1.4E-01**	5.0E-02	9.0E-04	8.1E-05	1.7E-04	5.6E-06	**9.0E-02**
CED	MJ	**3.3E+04**	7.8E+03	5.7E+01	1.4E+01	3.8E+00	5.9E-01	**2.5E+04**

Table 6.21 LCIA results per FU, for auxiliary equipment stage, for rose greenhouse crop in the Netherlands

No	Unit	Total	Material Plastics	Manufacturing Plastics	Metals	Transport	Rockwool
AD	kg Sb eq	**7.5E-02**	1.7E-02	3.5E-03	1.6E-03	2.1E-04	**5.3E-02**
AA	kg SO_2 eq	**4.8E-02**	4.1E-03	1.9E-03	1.0E-03	1.5E-04	**4.1E-02**
EU	kg PO_4^{---}eq	**1.1E-02**	3.9E-04	9.9E-04	5.7E-04	4.1E-05	**8.8E-03**
GW	kg CO_2 eq	**7.5E+00**	1.1E+00	4.5E-01	2.2E-01	2.9E-02	**5.7E+00**
PO	kg C_2H_4	**3.0E-03**	2.2E-04	6.1E-04	5.8E-05	4.8E-06	**2.1E-03**
CED	MJ	**1.7E+02**	3.9E+01	9.5E+00	4.0E+00	5.1E-01	**1.2E+02**

Table 6.22 LCIA results per FU, for fertilizers process, for rose greenhouse crop in the Netherlands

No	Unit	Total	Application	N	P_2O_5	K_2O
AD	kg Sb eq	**1.4E-02**	0.0E+00	**1.1E-02**	8.5E-04	2.4E-03
AA	kg SO_2 eq	**1.5E-02**	9.6E-04	**1.2E-02**	1.9E-03	4.5E-04
EU	kg PO_4^{---}eq	**2.3E-03**	2.5E-04	**1.9E-03**	1.1E-04	7.0E-05
GW	kg CO_2 eq	**6.7E+00**	**2.4E+00**	3.8E+00	1.2E-01	3.1E-01
PO	kg C_2H_4	**3.0E-04**	0.0E+00	**2.2E-04**	6.5E-05	1.7E-05
CED	MJ	**2.8E+01**	0.0E+00	**2.1E+01**	1.8E+00	4.9E+00

Table 6.23 LCIA results per FU, for pesticides process, for rose greenhouse crop in the Netherlands

No	Unit	Total	Application	Pesticides
AD	kg Sb eq	**1.3E-03**	2.8E-05	**1.3E-03**
AA	kg SO_2 eq	**1.5E-03**	2.4E-05	**1.5E-03**
EU	kg PO_4^{---}eq	**5.0E-04**	7.3E-06	**4.9E-04**
GW	kg CO_2 eq	**1.6E-01**	4.0E-03	**1.5E-01**
PO	kg C_2H_4	**9.0E-05**	8.8E-07	**8.9E-05**
CED	MJ	**3.2E+00**	6.8E-02	**3.1E+00**

Table 6.24 LCIA results per FU, for estimated waste management stage, for rose greenhouse crop in the Netherlands

No	Unit	Total	Concrete transport	Plastics transport	Substrate transport	Biomass transport	Concrete landfill	Plastics incinerator	Substrate landfill
AD	kg Sb eq	**6.0E-04**	2.3E-05	2.9E-05	6.5E-05	4.1E-05	1.1E-04	1.3E-04	**2.0E-04**
AA	kg SO_2 eq	**4.7E-04**	9.9E-06	2.2E-05	4.8E-05	3.1E-05	5.5E-05	**2.0E-04**	1.0E-04
EU	kg PO_4---eq	**3.1E-04**	2.6E-06	5.8E-06	1.3E-05	8.2E-06	1.3E-05	**2.4E-04**	2.5E-05
GW	kg CO_2 eq	**1.1E+00**	3.3E-03	4.1E-03	9.2E-03	5.8E-03	9.2E-03	**1.1E+00**	1.7E-02
PO	kg C_2H_4	**1.6E-05**	4.0E-07	6.9E-07	1.5E-06	9.6E-07	2.0E-06	**6.6E-06**	3.7E-06
CED	MJ	**1.4E+00**	5.5E-02	7.2E-02	1.6E-01	1.0E-01	2.6E-01	3.3E-01	**4.7E-01**

7 ANNEX FOR FINANCIAL RESULTS

7.1: Financial result scenario 1: tomato greenhouse in Spain

Farm results for a multi-tunnel greenhouse (Almería) of 10,000 m^2

Farm results			
	farm	per m2	
Benefits			
Turnover tomatoes	95584	9,56	
Other output	0	0,00	
Total output	95584	9,56	

Costs		farm	per m2	in %
Seeding and planting materials		5580	0,56	6
Fertilizers		6000	0,60	7
Water		1950	0,20	2
Crop protection agents		3500	0,35	4
Other crop assets		7975	0,80	9
Energy		2120	0,21	2
Tangible assets	*depreciation and maintenance*	29975	3,00	33
Paid labour		24570	2,46	27
Contractors		0	0,00	0
Interest payments		6406	0,64	7
General costs		2000	0,20	2
Total costs		90076	9,01	100
Net financial result		**5508**	**0,55**	

7.2: Financial result scenario 2: tomato greenhouse in Hungary

Farm results for a Venlo type greenhouse of 23,500 m^2

Farm results

		farm	per m2	
Benefits				
Turnover tomatoes		737501	31.31	
Other output		0	0.00	
Total output		737501	31.31	
Costs		farm	per m2	in %
Seeding and planting materials		73080	3.10	10
Fertilizers		60449	2.57	8
Water		628	0.03	0
Crop protection agents		25797	1.10	4
Other crop assets		28527	1.21	4
Energy		90146	3.83	12
Tangible assets	*depreciation and maintenance*	226505	9.62	31
Paid labour		139960	5.94	19
Contractors		0	0.00	0
Interest payments		54785	2.33	8
General costs		23552	1.00	3
Total costs		723429	30.72	100
Net financial result		**14073**	**0.60**	

7.3: Financial result scenario 3: tomato greenhouse in the Netherlands

Farm results for a Venlo type greenhouse of 40,000 m^2

Farm results

		farm	per m2	
Benefits				
Turnover tomatoes		1864500	46,61	
Other output		468000	11,70	
Total output		2332500	58,31	

Costs		farm	per m2	in %
Planting materials		65000	1,63	3
Fertilizers		36000	0,90	2
Water		800	0,02	0
Crop protection agents		20000	0,50	1
Other crop assets		120799	3,02	5
Energy		732000	18,30	31
Tangible assets	*depreciation and maintenance*	545459	13,64	23
Paid labour		602000	15,05	26
Contractors		20000	0,50	1
Interest payments		115870	2,90	5
General costs		74000	1,85	3
Total costs		2331928	58,30	100
Net financial result		**572**	**0,01**	

7.4: Financial result scenario 4: rose greenhouse in the Netherlands

Farm results for a Venlo type greenhouse of 40,000 m^2

Farm results

		farm	per m2	
Benefits				
Turnover roses		4195200	104,88	
Other output		300000	7,50	
Total output		4495200	112,38	

Costs		farm	per m2	in %
Seeding and planting materials		131750	3,29	3
Fertilizers		46000	1,15	1
Water		4800	0,12	0
Crop protection agents		120000	3,00	3
Other crop assets		257500	6,44	6
Energy		1653000	41,33	36
Tangible assets	*depreciation and maintenance*	1007805	25,20	22
Paid labour		997600	24,94	22
Contractors		14000	0,35	0
Interest payments		185977	4,65	4
General costs		120000	3,00	3
Total costs		4538432	113,46	100
Net financial result		**-43232**	**-1,08**	