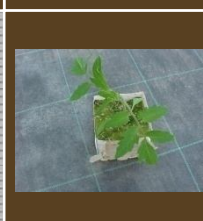
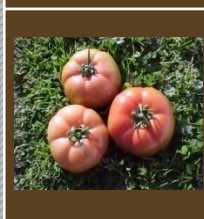
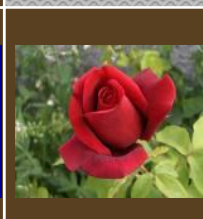


# EUPHOROS

## DELIVERABLE 5. ANNEX

Report on economic and environmental profile of present greenhouse production systems in Europe



December 2010



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**SEVENTH FRAMEWORK PROGRAMME  
THEME KBBE-2007-1-2-04**

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## ANNEXES

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### 4.1 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 WarmingI
IPM	Integrated Pest Management
IPPC	Intergovernmental 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

## 4.2 UNITS

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

### 4.3 RESULTS OF LCI & LCIA FOR TOMATO CROP IN SPAIN

**Table 4.3.1. Multitunnel 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 <sup>2</sup>
Gutter height	4.5	m
Ridge height	5.8	m
Gutter to ridge distance	1.3	m
Greenhouse volume	104,679	m <sup>3</sup>
Roof arch	8.55	m
Roof angle to vertical	36	°
Roof surface	20,781	m <sup>2</sup>
Front walls surface	1,550	m <sup>2</sup>
Side walls surface	1,215	m <sup>2</sup>
Nº roof ventilators	2x18	u
Ventilator dimensions	1.6x135	m
Ventilator surface	7,776	m <sup>2</sup>
Insect proof screen	8,009	m <sup>2</sup>

**Table 4.3.2. Materials and processes multitunnel structure inventory (IRTA 2008)**

Material	Element	Greenhouse quantity	Quantity -ha <sup>-1</sup>	Quantity -ton tomato <sup>-1</sup>	Unit	Type of data	Source
Concrete	Foundations and main path	123	3.15	0.02	m <sup>3</sup>	OED	EEFC
LDPE	Covering and floor	7,361	946.7	5.74	kg	OED	EEFC
PC	Walls	3,319	85.4	0.52	kg	OED	EEFC
PE	Insect proof screens and plant gutter system	3,176	245.0	1.49	kg	OED	EEFC
PP	Raffia plant gutter system	206	159.3	0.97	kg	OED	EEFC
PVC	Clips and wedges	2,385	92.0	0.56	kg	OED	EEFC
Steel	Posts, frame reinforcements, gutters, axes, profiles, ventilators arches, high wire system	149,675	3,849.7	23.36	kg	OED	EEFC
Wire	Plant gutter system	2,188	56.3	0.34	kg	OED	EEFC
<b>Processes</b>							
LDPE	Extrusion, plastic film	7,361	946.7	5.74	kg	OED	EEFC
PC	Extrusion, plastic film	3,319	85.4	0.52	kg	OED	EEFC
PE	Extrusion plastic, pipes	3,176	245.0	1.49	kg	OED	EEFC
PP	Extrusion, plastic film	206	159.3	0.97	kg	OED	EEFC
PVC	Injection moulding	2,385	92.0	0.56	kg	OED	EEFC
Steel	Manufacturing processes	149,675	3,849.7	23.36	kg	OED	EEFC
Steel	Zinc (steel coating)	9,043	232.6	1.41	m <sup>2</sup>	OED	EEFC
Transport	Lorry, 605 km	101,828	3,287.8	19.9	tkm	OED	EEFC
Wire	Wire drawing, steel	2,188	56.3	0.34	kg	OED	EEFC

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



**Table 4.3.3 Crop description**

<b>Characteristics</b>	<b>Data</b>	<b>Unit</b>	<b>Type of data</b>	<b>Source</b>
Commercial yield	16.5	kg/m <sup>2</sup>	OED	EEFC
Crop period	9	months	OED	EEFC
Fresh weight	8	kg/plant	OED	EEFC
N° bags per row	110	u	ERD	EEFC
N° plants	22,935	plants	OED	EEFC
N° plants per bag	3	u	OED	EEFC
N° rows	70	u	OED	EEFC
N° stems per plant	2	u	OED	EEFC

ANNEX 4.3 Results for tomato crop in Spain

**Table 4.3.4. Auxiliary equipment description**

Material	Element	Greenhouse quantity	Quantity -ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	Unit	Type of data	Source
LDPE	Benches	1.350	173.7	1.05	kg	OED	EEFC
PE	Pipes, drippers, microtubes,	813	62.7	0.38	kg	OED	IRTA
PE	Pickaxes	34	2.7	0.02	kg	OED	EEFC
PE	Fertilizers tanks	62	4.8	0.03	kg	OED	EEFC
Polystyrene	Substrate layers	1,486	191.1	1.16	kg	OED	EEFC
PVC	Distribution system	855	33.0	0.20	kg	OED	EEFC
Steel	Pumps, injectors	155	4.0	0.02	kg	OED	EEFC
<b>Processes</b>							EEFC
LDPE	Extrusion, plastic film	1,350	173.7	1.05	kg	OED	EEFC
PE	Extrusion plastic, pipes	813	62.7	0.38	kg	OED	IRTA
PE	Injection moulding	34	2.7	0.02	kg	OED	EEFC
PE	Blow moulding	62	4.8	0.03	kg	OED	EEFC
Polystyrene	Foaming expanding	1,486	191.1	1.16	kg	OED	EEFC
PVC	Extrusion plastic, pipes	855	33.0	0.20	m <sup>2</sup>	OED	EEFC
Steel	Manufacturing processes	155	4.0	0.02	kg	OED	EEFC
Transport	Lorry, 5 km	24	1.8	0.01	tkm	OED	EEFC

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

**Table 4.3.5. Substrate description**

Substrate	Element	Greenhouse quantity	Quantity -ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	Unit	Type of data	Source
LDPE	Perlite bags	534.5	68.7	0.42	kg	OED	EEFC
LDPE	Extrusion plastic film	534.5	68.7	0.42	kg	OED	EEFC
Perlite	Substrate	36,696	4,719.1	28.6	kg	OED	EEFC
Transport	Lorry, 7 km	260.6	33.5	0.20	tkm	OED	EEFC

**Table 4.3.6. 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 4.3.7. Energy consumption**

Energy consumption	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	Unit	Type of data	Source
Electricity	Auxiliary equipment	12,369	6.363	38.61	kWh	OED	EEFC
Electricity	Climate system	97	50	0.30	kWh	OED	EEFC

**Table 4.3.8. Fertilizer consumption**

Nutrient	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	Unit	Type of data	Source
N	1,485	798.4	4.84	kg	OED	EEFC
P	411	220.8	1.34	kg	OED	EEFC
K	2,412	1,296.3	7.87	kg	OED	EEFC

**Table 4.3.9. Fertilizer application emissions**

Air emissions	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity·ton tomato <sup>-1</sup>	Unit	Type of data	Source
NH <sub>3</sub>	44.6	24	0.15	kg	ERD	IRTA
N <sub>2</sub> O-N	18.6	10	0.06	kg	ERD	IRTA
NO <sub>x</sub> -N	1.9	1	0.01	kg	ERD	IRTA
Water emissions	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity·ton tomato <sup>-1</sup>	Unit	Type of data	Source
N-NO <sub>3</sub>	668.5	359.3	2.18	kg	ERD	IRTA
P	0	0	0	kg	ERD	IRTA

**Table 4.3.10. Pesticides consumption**

Material	Quantity ·ha <sup>-1</sup>	Quantity·ton tomato <sup>-1</sup>	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 4.3.11. Disposal treatments estimated for waste materials in tomato production in Spain (IRTA 2008)**

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

**Table 4.3.12. Materials transport and treatments in waste management**

Material	Process	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity·ton tomato <sup>-1</sup>	Unit	Type of data	Source
15 years life materials	Transport to landfill	1,441	37	0.22	tkm	ERD	EEFC
Green biomass	Transport to compost plant	367	189	1.15	tkm	OED	EEFC
Plastics	Transport to landfill	16.2	8.6	0.05	tkm	OED	EEFC
Substrate	Transport to landfill	186	24	0.15	tkm	OED	EEFC
<b>Processes</b>							
15 years life materials	Emissions landfill	144,080	3,706	22.49	kg	OED	EEFC
Plastics	Emissions landfill	1,624	172	1.04	kg	OED	EEFC
Substrate	Emissions landfill	18,615	2,394	14.53	kg	OED	EEFC

**Table 4.3.13. Transport processes**

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

**Table 4.3.14. LCIA results per FU, for tomato greenhouse crop Spain.**

No	Unit	Total	Structure	Climate system	Auxiliary equipment	Fertilizers	Pesticides	Waste
AD	kg Sb eq	<b>1.3E+00</b>	5.9E-01	1.1E-03	4.7E-01	2.0E-01	1.7E-02	2.1E-02
AA	kg SO <sub>2</sub> eq	<b>8.4E-01</b>	2.9E-01	1.5E-03	3.1E-01	2.1E-01	1.9E-02	1.1E-02
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>4.3E-01</b>	1.1E-01	2.7E-04	6.0E-02	2.5E-01	6.5E-03	3.6E-03
GW	kg CO <sub>2</sub> eq	<b>2.4E+02</b>	6.6E+01	1.5E-01	5.8E+01	1.1E+02	2.0E+00	2.8E+00
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>4.2E-02</b>	1.5E-02	5.4E-05	2.0E-02	4.9E-03	1.2E-03	9.9E-04
CE	MJ	<b>3.1E+03</b>	1.4E+03	3.1E+00	1.2E+03	3.9E+02	4.1E+01	5.2E+01

**Table 4.3.15. LCIA results per FU, for structure stage, for tomato greenhouse crop in Spain.**

No	Unit	Total	Metals	Concrete	Plastics	Transport
AD	kg Sb eq	<b>5.9E-01</b>	1.9E-01	1.1E-02	<b>3.5E-01</b>	3.6E-02
AA	kg SO <sub>2</sub> eq	<b>2.9E-01</b>	<b>1.5E-01</b>	8.6E-03	1.0E-01	2.7E-02
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>1.1E-01</b>	<b>8.2E-02</b>	2.1E-03	2.0E-02	7.2E-03
GW	kg CO <sub>2</sub> eq	<b>6.6E+01</b>	<b>2.9E+01</b>	5.1E+00	2.7E+01	5.1E+00
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.5E-02</b>	<b>8.6E-03</b>	3.1E-04	5.6E-03	8.5E-04
CE	MJ	<b>1.4E+03</b>	4.6E+02	2.8E+01	<b>8.5E+02</b>	8.9E+01

**Table 4.3.16. 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	<b>4.7E-01</b>	1.0E-01	1.1E-02	4.0E-04	1.5E-04	1.4E-01	<b>2.2E-01</b>
AA	kg SO <sub>2</sub> eq	<b>3.1E-01</b>	2.5E-02	7.8E-03	2.1E-04	8.0E-05	<b>1.9E-01</b>	9.2E-02
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>6.0E-02</b>	2.4E-03	3.7E-03	1.3E-04	2.7E-05	<b>3.5E-02</b>	1.9E-02
GW	kg CO <sub>2</sub> eq	<b>5.8E+01</b>	7.2E+00	1.6E+00	5.4E-02	2.1E-02	2.0E+01	<b>3.0E+01</b>
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>2.0E-02</b>	1.5E-03	<b>7.2E-03</b>	1.4E-05	7.9E-06	6.8E-03	4.5E-03
CE	MJ	<b>1.2E+03</b>	2.3E+02	3.2E+01	9.8E-01	3.7E-01	4.0E+02	<b>5.2E+02</b>

**Table 4.3.17. LCIA results per FU, for fertilizers process, for tomato greenhouse crop in Spain.**

No	Unit	Total	Application	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
AD	kg Sb eq	<b>2.0E-01</b>	-	<b>1.2E-01</b>	2.6E-02	4.9E-02
AA	kg SO <sub>2</sub> eq	<b>2.1E-01</b>	9.5E-03	<b>1.3E-01</b>	5.7E-02	9.2E-03
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>2.5E-01</b>	<b>2.2E-01</b>	2.2E-02	3.4E-03	1.4E-03
GW	kg CO <sub>2</sub> eq	<b>1.1E+02</b>	<b>5.6E+01</b>	4.4E+01	3.6E+00	6.3E+00
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>4.9E-03</b>	-	<b>2.5E-03</b>	2.0E-03	3.5E-04
CE	MJ	<b>3.9E+02</b>	-	<b>2.4E+02</b>	5.4E+01	9.9E+01

**Table 4.3.18. LCIA results per FU, for pesticides process, for tomato greenhouse crop in Spain.**

No	Unit	Total	Application	Insecticides	Fungicides
AD	kg Sb eq	<b>1.7E-02</b>	4.7E-04	1.9E-03	<b>1.4E-02</b>
AA	kg SO <sub>2</sub> eq	<b>1.9E-02</b>	4.0E-04	2.2E-03	<b>1.7E-02</b>
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>6.5E-03</b>	1.2E-04	7.4E-04	<b>5.6E-03</b>
GW	kg CO <sub>2</sub> eq	<b>2.0E+00</b>	6.7E-02	2.3E-01	<b>1.7E+00</b>
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.2E-03</b>	1.5E-05	1.3E-04	<b>1.0E-03</b>
CE	MJ	<b>4.1E+01</b>	1.1E+00	4.6E+00	<b>3.5E+01</b>

**Table 4.3.19. 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	<b>2.1E-02</b>	7.4E-04	1.9E-03	3.4E-05	<b>1.5E-02</b>	1.9E-03	8.9E-05	1.2E-03
AA	kg SO <sub>2</sub> eq	<b>1.1E-02</b>	3.1E-04	1.1E-03	1.4E-05	<b>8.3E-03</b>	9.5E-04	4.4E-05	6.1E-04
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>3.6E-03</b>	8.7E-05	3.5E-04	4.0E-06	<b>2.7E-03</b>	2.3E-04	1.1E-05	1.5E-04
GW	kg CO <sub>2</sub> eq	<b>2.8E+00</b>	1.1E-01	2.8E-01	4.9E-03	<b>2.2E+00</b>	1.6E-01	7.4E-03	1.0E-01
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>9.9E-04</b>	1.3E-05	1.0E-04	6.2E-07	<b>8.1E-04</b>	3.5E-05	1.6E-06	2.3E-05
CE	MJ	<b>5.2E+01</b>	1.8E+00	4.8E+00	8.3E-02	<b>3.8E+01</b>	4.5E+00	2.1E-01	2.9E+00

## 4.4 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 <sup>2</sup>
Gutter height	4,5	m
Ridge height	5,2	m
Gutter to ridge distance	0,7	m
Greenhouse volume	114,227	m <sup>3</sup>
Roof slope length	2.12	m
Roof surface	24,953	m <sup>2</sup>
Front walls surface	2,846	m <sup>2</sup>
Side walls surface	828	m <sup>2</sup>
N <sup>o</sup> ventilator windows greenhouse	1,472	u
Ventilator dimensions	3.0 x 1.2	m
Ventilator surface	5,299	m <sup>2</sup>
Insect proof screen	None	
Side window ventilators	None	



**Table 4.4.2. Materials and processes considered in the greenhouse structure inventory**

Material	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·ton tomato <sup>-1</sup>	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 <sup>3</sup>	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
<b>Processes</b>							
Aluminium	Manufacturing processes	92,645	2,498.6	5.21	kg	OED	MRK
Aluminium	Powder coating	10,077	271.8	0.57	m <sup>2</sup>	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 <sup>2</sup>	OED	MRK
Transport	Lorry, 2000 km	1,384,162	37,330.1	77.77	tkm	OED	MRK

**Table 4.4.3. Crop description**

Characteristics	Data	Unit	Type of data	Source
Commercial yield	48	kg/m <sup>2</sup>	OED	MRK
Crop period	49	weeks	OED	MRK
Fresh weight	5	kg/plant	OED	MRK
N° bags per row	56	u	ERD	MRK
N° plants	69,440	plants	OED	MRK
N° plants per bag	4	u	OED	MRK
N° rows	310	u	OED	MRK
N° stems per plant	1	u	OED	MRK

**Table 4.4.4. Auxiliary equipment description**

Material	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	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
<b>Processes</b>							
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 <sup>2</sup>	OED	MRK
Transport	Lorry, 2000 km	22,317	1,462.3	3.05	tkm	OED	MRK

**Table 4.4.5. Substrate description**

Substrate	Element	Greenhouse quantity	Quantity -ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	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 4.4.6. 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 4.4.7. Energy consumption**

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

**Table 4.4.8. Variables estimated to calculate gas consumption for heating greenhouse in Hungary**

Variables	Value	Unit
Covering transmittance, t	80	%
Developed area	28,276	m <sup>2</sup>
Greenhouse area	23,552	m <sup>2</sup>
Greenhouse T <sup>a</sup>	15	°C
Greenhouse volume	114,227.2	m <sup>3</sup>
Heat needs (Wt/m <sup>2</sup> )	162.4	Wt/m <sup>2</sup>
Natural gas (MJ/L)	0.02394	MJ/L
Outdoors T <sup>a</sup>	-1.1	°C
Thermal K cover material (glass+ thermal screen)	4.27	Wt/m <sup>2</sup> /°C <sup>1</sup>

**Table 4.4.9. climate control system description**

Material	Element	Greenhouse quantity	Quantity ha <sup>-1</sup>	Quantity -ton tomato <sup>-1</sup>	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 <sub>2</sub> support hook	210,098	5,666.2	11.80	kg	OED	MRK
<b>Processes</b>							
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)	7,400	199.6	0.42	m <sup>2</sup>	OED	MRK
Transport	Lorry, 200 km	45,837	1,259.4	2.62	tkm	OED	MRK

**Table 4.4.10. Fertilizers consumption**

Nutrient	Greenhouse quantity	Quantity ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	Unit	Type of data	Source
N	9,420	4,000	8.33	kg	OED	MRK
P <sub>2</sub> O <sub>5</sub>	7,692	3,266	6.80	kg	OED	MRK
K <sub>2</sub> O	22,023	9,351	19.48	kg	OED	MRK

**Table 4.4.11. Fertilizers application emissions**

<b>Air emissions</b>	<b>Greenhouse quantity</b>	<b>Quantity ·ha<sup>-1</sup></b>	<b>Quantity·ton tomato<sup>-1</sup></b>	<b>Unit</b>	<b>Type of data</b>	<b>Source</b>
NH <sub>3</sub>	283	120.0	0.25	kg	ERD	IRTA
N <sub>2</sub> O-N	118	50.0	0.10	kg	ERD	IRTA
NO <sub>x</sub> -N	12	5.0	0.01	kg	ERD	IRTA
<b>Water emissions</b>	<b>Greenhouse quantity</b>	<b>Quantity ·ha<sup>-1</sup></b>	<b>Quantity·ton tomato<sup>-1</sup></b>	<b>Unit</b>	<b>Type of data</b>	<b>Source</b>
NO <sub>3</sub> -N	6,126	2,601.0	5.42	kg	ERD	IRTA
P	0	0	0	kg	ERD	IRTA

**Table 4.4.12. Pesticides consumption**

<b>Material</b>	<b>Quantity ·ha<sup>-1</sup></b>	<b>Quantity·ton tomato<sup>-1</sup></b>	<b>Unit</b>	<b>Type of data</b>	<b>Source</b>
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 4.4.13. Disposal treatments estimated for waste materials in tomato production**

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

**Table 4.4.14. Materials for transport and waste treatments**

Material	Process	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	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
<b>Processes</b>							
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 4.4.15. 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 4.4.16. 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	<b>2.9E+00</b>	1.0E+00	<b>1.0E+00</b>	1.6E-01	3.7E-01	3.1E-01	2.0E-02
AAP	kg SO <sub>2</sub> eq	<b>1.8E+00</b>	<b>6.8E-01</b>	3.7E-01	9.8E-02	3.9E-01	2.4E-01	1.3E-02
EUP	kg PO <sub>4</sub> <sup>---</sup> eq	<b>1.5E+00</b>	2.5E-01	5.1E-01	2.1E-02	<b>5.9E-01</b>	1.5E-01	3.5E-03
GWP	kg CO <sub>2</sub> eq	<b>5.3E+02</b>	1.4E+02	1.4E+02	1.6E+01	<b>1.9E+02</b>	3.8E+01	2.6E+00
POP	kg C <sub>2</sub> H <sub>4</sub>	<b>9.1E-02</b>	<b>3.6E-02</b>	1.9E-02	9.1E-03	9.5E-03	1.7E-02	4.4E-04
CED	MJ	<b>7.2E+03</b>	2.5E+03	<b>2.8E+03</b>	3.7E+02	7.4E+02	7.7E+02	4.9E+01

**Table 4.4.17. 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	<b>4.2E+01</b>	1.0E+00	<b>4.0E+01</b>	1.6E-01	3.7E-01	3.1E-01	2.0E-02
AAP	kg SO <sub>2</sub> eq	<b>5.1E+00</b>	6.8E-01	<b>3.7E+00</b>	9.8E-02	3.9E-01	2.4E-01	1.3E-02
EUP	kg PO <sub>4</sub> <sup>---</sup> eq	<b>2.1E+00</b>	2.5E-01	<b>1.0E+00</b>	2.1E-02	5.9E-01	1.5E-01	3.4E-03
GWP	kg CO <sub>2</sub> eq	<b>5.1E+03</b>	1.4E+02	<b>4.7E+03</b>	1.6E+01	1.9E+02	3.8E+01	2.6E+00
POP	kg C <sub>2</sub> H <sub>4</sub>	<b>4.0E-01</b>	3.6E-02	<b>3.3E-01</b>	9.1E-03	9.5E-03	1.7E-02	4.3E-04
CED	MJ	<b>8.7E+04</b>	2.5E+03	<b>8.3E+04</b>	3.7E+02	7.4E+02	7.7E+02	4.8E+01

**Table 4.4.18. 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	<b>1.0E+00</b>	<b>4.5E-01</b>	6.3E-03	8.7E-02	3.3E-01	1.4E-01
AAP	kg SO <sub>2</sub> eq	<b>6.8E-01</b>	<b>3.3E-01</b>	4.9E-03	1.2E-01	1.2E-01	1.1E-01
EUP	kg PO <sub>4</sub> <sup>---</sup> eq	<b>2.5E-01</b>	<b>1.5E-01</b>	1.2E-03	1.5E-02	4.8E-02	2.8E-02
GWP	kg CO <sub>2</sub> eq	<b>1.4E+02</b>	<b>6.4E+01</b>	2.9E+00	1.4E+01	4.3E+01	2.0E+01
POP	kg C <sub>2</sub> H <sub>4</sub>	<b>3.6E-02</b>	<b>1.8E-02</b>	1.8E-04	3.9E-03	1.0E-02	3.3E-03
CED	MJ	<b>2.5E+03</b>	<b>1.1E+03</b>	1.6E+01	1.9E+02	7.8E+02	3.5E+02

**Table 4.4.19. LCIA results per FU, for climate control system stage, for tomato greenhouse crop with thermal water in Hungary.**



ANNEX 4.4 Results for tomato crop in Hungary

No	Unit	Total	Metals	Plastics	Transport	Electricity
ADP	kg Sb eq	<b>1.0E+00</b>	1.2E-01	1.4E-02	4.8E-03	<b>9.0E-01</b>
AAP	kg SO <sub>2</sub> eq	<b>3.7E-01</b>	8.1E-02	3.7E-03	3.5E-03	<b>2.8E-01</b>
EUP	kg PO <sub>4</sub> <sup>---</sup> eq	<b>5.1E-01</b>	4.3E-02	9.1E-04	9.5E-04	<b>4.6E-01</b>
GWP	kg CO <sub>2</sub> eq	<b>1.4E+02</b>	1.7E+01	1.1E+00	6.7E-01	<b>1.2E+02</b>
POP	kg C <sub>2</sub> H <sub>4</sub>	<b>1.9E-02</b>	5.1E-03	3.1E-04	1.1E-04	<b>1.4E-02</b>
CED	MJ	<b>2.8E+03</b>	2.9E+02	3.3E+01	1.2E+01	<b>2.5E+03</b>

**Table 4.4.20. 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	<b>4.0E+01</b>	<b>3.9E+01</b>	1.0E-01	1.1E-02	3.8E-03	9.0E-01
AAP	kg SO <sub>2</sub> eq	<b>3.7E+00</b>	<b>3.4E+00</b>	7.2E-02	2.7E-03	2.8E-03	2.8E-01
EUP	kg PO <sub>4</sub> <sup>---</sup> eq	<b>1.0E+00</b>	<b>5.5E-01</b>	3.7E-02	4.7E-04	7.5E-04	4.6E-01
GWP	kg CO <sub>2</sub> eq	<b>4.7E+03</b>	<b>4.6E+03</b>	1.5E+01	7.2E-01	5.4E-01	1.2E+02
POP	kg C <sub>2</sub> H <sub>4</sub>	<b>3.3E-01</b>	<b>3.1E-01</b>	4.3E-03	2.2E-04	8.8E-05	1.4E-02
CED	MJ	<b>8.3E+04</b>	<b>8.0E+04</b>	2.5E+02	2.7E+01	9.3E+00	2.5E+03

**Table 4.4.21. 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	<b>1.6E-01</b>	5.0E-02	5.0E-03	1.5E-03	5.6E-03	<b>1.0E-01</b>
AAP	kg SO <sub>2</sub> eq	<b>9.8E-02</b>	1.2E-02	3.7E-03	1.1E-03	4.1E-03	<b>7.7E-02</b>
EUP	kg PO <sub>4</sub> <sup>---</sup> eq	<b>2.1E-02</b>	1.2E-03	1.6E-03	5.6E-04	1.1E-03	<b>1.6E-02</b>
GWP	kg CO <sub>2</sub> eq	<b>1.6E+01</b>	3.6E+00	7.2E-01	1.9E-01	7.8E-01	<b>1.1E+01</b>
POP	kg C <sub>2</sub> H <sub>4</sub>	<b>9.1E-03</b>	8.8E-04	<b>4.1E-03</b>	6.6E-05	1.3E-04	4.0E-03
CED	MJ	<b>3.7E+02</b>	1.1E+02	1.4E+01	3.7E+00	1.4E+01	<b>2.2E+02</b>

**Table 4.4.22. LCIA results per FU, for fertilizers process, for tomato greenhouse crop in Hungary.**

No	Unit	Total	Application	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
ADP	kg Sb eq	<b>3.7E-01</b>	-	<b>2.1E-01</b>	5.8E-02	1.0E-01
AAP	kg SO <sub>2</sub> eq	<b>3.9E-01</b>	1.7E-02	<b>2.3E-01</b>	1.3E-01	1.9E-02
EUP	kg PO <sub>4</sub> <sup>---</sup> eq	<b>5.9E-01</b>	<b>5.5E-01</b>	3.8E-02	7.6E-03	2.9E-03
GWP	kg CO <sub>2</sub> eq	<b>1.9E+02</b>	<b>9.7E+01</b>	7.6E+01	8.0E+00	1.3E+01
POP	kg C <sub>2</sub> H <sub>4</sub>	<b>9.5E-03</b>	-	4.4E-03	<b>4.4E-03</b>	7.3E-04
CED	MJ	<b>7.4E+02</b>	-	<b>4.2E+02</b>	1.2E+02	2.0E+02

**Table 4.4.23. LCIA results per FU, for pesticides process, for tomato greenhouse crop in Hungary.**

No	Unit	Total	Application	Insecticides	Fungicides
ADP	kg Sb eq	<b>3.1E-01</b>	1.6E-04	<b>2.3E-01</b>	8.4E-02
AAP	kg SO <sub>2</sub> eq	<b>2.4E-01</b>	1.4E-04	<b>1.9E-01</b>	5.3E-02
EUP	kg PO <sub>4</sub> <sup>---</sup> eq	<b>1.5E-01</b>	4.2E-05	<b>1.1E-01</b>	3.6E-02
GWP	kg CO <sub>2</sub> eq	<b>3.8E+01</b>	2.3E-02	<b>2.8E+01</b>	1.1E+01
POP	kg C <sub>2</sub> H <sub>4</sub>	<b>1.7E-02</b>	5.1E-06	<b>1.3E-02</b>	3.9E-03
CED	MJ	<b>7.7E+02</b>	3.9E-01	<b>5.7E+02</b>	2.0E+02

**Table 4.4.24. 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	<b>2.0E-02</b>	2.2E-03	3.1E-04	<b>1.3E-02</b>	4.0E-03	3.7E-04
AAP	kg SO <sub>2</sub> eq	<b>1.3E-02</b>	9.4E-04	2.3E-04	<b>1.0E-02</b>	2.0E-03	1.8E-04
EUP	kg PO <sub>4</sub> <sup>---</sup> eq	<b>3.5E-03</b>	2.5E-04	6.2E-05	<b>2.7E-03</b>	4.8E-04	4.4E-05
GWP	kg CO <sub>2</sub> eq	<b>2.6E+00</b>	3.1E-01	4.4E-02	<b>1.9E+00</b>	3.3E-01	3.1E-02
POP	kg C <sub>2</sub> H <sub>4</sub>	<b>4.4E-04</b>	3.8E-05	7.3E-06	<b>3.1E-04</b>	7.2E-05	6.7E-06
CED	MJ	<b>4.9E+01</b>	5.2E+00	7.7E-01	<b>3.3E+01</b>	9.2E+00	8.5E-01

## 4.5 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 <sup>2</sup>
Gutter height	6	m
Ridge height	6.76	m
Gutter to ridge distance	0.76	m
Greenhouse volume	255,200	m <sup>3</sup>
Roof slope length	2.14	m
Roof slope angle	23	°
Roof surface	42,791	m <sup>2</sup>
Front walls surface	2,552	m <sup>2</sup>
Side walls surface	2,400	m <sup>2</sup>
N° ventilator windows greenhouse	2,000	u
Ventilator dimensions	1.325x1.425	m
Ventilator surface	3,776	m <sup>2</sup>
Insect proof screen	None	
Side window ventilators	None	

**Table 4.5.2. Materials and processes considered in the greenhouse structure inventory**

Material	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·ton tomato <sup>-1</sup>	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 <sup>3</sup>	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
<b>Processes</b>							
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 <sup>2</sup>	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 <sup>2</sup>	OED	PPO
Transport	Lorry, 55 km	56,830.0	944.6	1.67	tkm	OED	PPO

**Table 4.5.3 Crop description**

Characteristics	Data	Unit	Type of data	Source
Commercial yield	56.5	kg/m <sup>2</sup>	OED	PPO
Crop period	1	year	OED	PPO
Fresh weight	8.0	kg/plant	OED	PPO
N° bags per row	131	u	ERD	PPO
N° plants	49,000	Plants	OED	PPO
N° plants per bag	3	u	OED	PPO
N° rows	125	u	OED	PPO
N° stems per plant	2	u	OED	PPO

**Table 4.5.4. Auxiliary equipment description**

Material	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	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
<b>Processes</b>							
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 <sup>2</sup>	OED	PPO
Transport	Lorry, 200 km	4,423.5	143.04	0.25	tkm	OED	PPO

LDPE: Low Density Polyethylene. PVC: Polyvinylchloride

**Table 4.5.5. Substrate description**

Substrate	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	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 4.5.6. Energy consumption and production**

Energy consumption	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	Unit	Type of data	Source
Natural gas	CHP	2,588,000	647,000	1,145	m <sup>3</sup>	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 4.5.7. Electricity production mix, NDJ 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 4.5.8. Climate control system description**

Material	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·ton tomato <sup>-1</sup>	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 <sub>2</sub> supporthook	311,069	5,170.3	9.15	kg	OED	PPO
<b>Processes</b>							
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 <sup>2</sup>	OED	PPO
Transport	Lorry, 55 km	19,056	317.8	0.56	tkm	OED	PPO

**Table 4.5.9. Fertilizers consumption**

Nutrient	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·ton tomato <sup>-1</sup>	Unit	Type of data	Source
N	6,752	1,688	2.99	kg	OED	PPO
P <sub>2</sub> O <sub>5</sub>	1,623	406	0.72	kg	OED	PPO
K <sub>2</sub> O	7,419	1,855	3.28	kg	OED	PPO

**Table 4.5.10. Fertilizers application emissions**

Air emissions	Greenhouse quantity	Quantity ha <sup>-1</sup>	Quantity ton tomato <sup>-1</sup>	Unit	Type of data	Source
NH <sub>3</sub>	202.6	50.6	0.09	kg	ERD	IRTA
N <sub>2</sub> O-N	84.4	21.1	0.04	kg	ERD	IRTA
NO <sub>x</sub> -N	8.4	2.1	0.004	kg	ERD	IRTA

**Table 4.5.11. Pesticides consumption**

Material	Quantity -ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	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 4.5.12. Disposal treatments estimated for waste materials in tomato production**

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



**Table 4.5.13. Materials for transport and waste treatments**

Material	Process	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity-ton tomato <sup>-1</sup>	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
<b>Processes</b>							
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 4.5.14. 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 4.5.15. 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	<b>5.6E+00</b>	3.4E-01	<b>5.0E+00</b>	1.4E-01	9.9E-02	1.6E-03	3.3E-03
AA	kg SO <sub>2</sub> eq	<b>1.2E+00</b>	3.0E-01	<b>6.6E-01</b>	8.8E-02	1.1E-01	1.8E-03	2.3E-03
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>-1.1E+00</b>	<b>9.7E-02</b>	-1.3E+00	2.1E-02	1.6E-02	6.1E-04	9.1E-04
GW	kg CO <sub>2</sub> eq	<b>8.0E+02</b>	5.3E+01	<b>6.6E+02</b>	1.4E+01	6.5E+01	2.0E-01	2.1E+00
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.9E-01</b>	1.4E-02	<b>1.6E-01</b>	6.5E-03	2.2E-03	1.1E-04	7.6E-05
CED	MJ	<b>1.2E+04</b>	8.2E+02	<b>1.1E+04</b>	3.1E+02	2.0E+02	3.9E+00	7.9E+00

**Table 4.5.16. 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	<b>1.5E+01</b>	3.4E-01	<b>1.5E+01</b>	1.4E-01	9.9E-02	1.6E-03	3.3E-03
AA	kg SO <sub>2</sub> eq	<b>2.9E+00</b>	3.0E-01	<b>2.4E+00</b>	8.8E-02	1.1E-01	1.8E-03	2.3E-03
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>7.2E-01</b>	9.7E-02	<b>5.8E-01</b>	2.1E-02	1.6E-02	6.1E-04	9.1E-04
GW	kg CO <sub>2</sub> eq	<b>2.0E+03</b>	5.3E+01	<b>1.9E+03</b>	1.4E+01	6.5E+01	2.0E-01	2.1E+00
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>2.1E-01</b>	1.4E-02	<b>1.9E-01</b>	6.5E-03	2.2E-03	1.1E-04	7.6E-05
CED	MJ	<b>3.1E+04</b>	8.2E+02	<b>3.0E+04</b>	3.1E+02	2.0E+02	3.9E+00	7.9E+00

**Table 4.5.17. 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	<b>3.4E-01</b>	<b>2.1E-01</b>	3.0E-03	1.0E-01	1.9E-02	3.1E-03
AA	kg SO <sub>2</sub> eq	<b>3.0E-01</b>	<b>1.5E-01</b>	2.4E-03	1.4E-01	6.0E-03	2.3E-03
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>9.7E-02</b>	<b>7.6E-02</b>	5.8E-04	1.8E-02	2.3E-03	6.1E-04
GW	kg CO <sub>2</sub> eq	<b>5.3E+01</b>	<b>3.2E+01</b>	1.4E+00	1.7E+01	1.6E+00	4.3E-01
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.4E-02</b>	<b>8.9E-03</b>	8.6E-05	4.6E-03	3.5E-04	7.1E-05
CED	MJ	<b>8.2E+02</b>	<b>5.3E+02</b>	7.7E+00	2.3E+02	4.6E+01	7.5E+00

**Table 4.5.18. 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	<b>5.0E+00</b>	<b>2.1E+01</b>	9.7E-02	5.9E-03	2.2E-03	1.0E-03	-1.6E+01
AA	kg SO <sub>2</sub> eq	<b>6.6E-01</b>	<b>3.4E+00</b>	5.7E-02	3.4E-03	6.1E-04	7.6E-04	-2.8E+00
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>-1.3E+00</b>	<b>6.7E-01</b>	3.1E-02	1.3E-03	1.6E-04	2.0E-04	-2.0E+00
GW	kg CO <sub>2</sub> eq	<b>6.6E+02</b>	<b>2.7E+03</b>	1.4E+01	4.9E-01	1.8E-01	1.4E-01	-2.0E+03
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.6E-01</b>	<b>2.8E-01</b>	3.9E-03	1.6E-04	3.8E-05	2.4E-05	-1.2E-01
CED	MJ	<b>1.1E+04</b>	<b>4.3E+04</b>	2.4E+02	1.4E+01	5.5E+00	2.5E+00	-3.3E+04

**Table 4.5.18. 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	<b>1.5E+01</b>	<b>1.4E+01</b>	9.7E-02	5.9E-03	2.2E-03	1.0E-03	9.6E-01
AA	kg SO <sub>2</sub> eq	<b>2.4E+00</b>	<b>2.2E+00</b>	5.7E-02	3.4E-03	6.1E-04	7.6E-04	1.7E-01
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>5.8E-01</b>	<b>4.3E-01</b>	3.1E-02	1.3E-03	1.6E-04	2.0E-04	1.2E-01
GW	kg CO <sub>2</sub> eq	<b>1.9E+03</b>	<b>1.7E+03</b>	1.4E+01	4.9E-01	1.8E-01	1.4E-01	1.2E+02
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.9E-01</b>	<b>1.8E-01</b>	3.9E-03	1.6E-04	3.8E-05	2.4E-05	7.0E-03
CED	MJ	<b>3.0E+04</b>	<b>2.8E+04</b>	2.4E+02	1.4E+01	5.5E+00	2.5E+00	1.9E+03

**Table 4.5.19. 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	<b>1.4E-01</b>	3.0E-02	7.0E-03	7.4E-03	4.6E-04	<b>9.4E-02</b>
AA	kg SO <sub>2</sub> eq	<b>8.8E-02</b>	7.7E-03	3.7E-03	4.3E-03	3.4E-04	<b>7.2E-02</b>
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>2.1E-02</b>	7.7E-04	1.9E-03	2.5E-03	9.2E-05	<b>1.5E-02</b>
GW	kg CO <sub>2</sub> eq	<b>1.4E+01</b>	2.2E+00	8.9E-01	1.0E+00	6.5E-02	<b>1.0E+01</b>
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>6.5E-03</b>	4.3E-04	2.1E-03	2.6E-04	1.1E-05	<b>3.7E-03</b>
CED	MJ	<b>3.1E+02</b>	7.0E+01	1.9E+01	1.8E+01	1.1E+00	<b>2.0E+02</b>

**Table 4.5.20. LCIA results per FU, for fertilizers process, for tomato greenhouse crop in the Netherlands**

No	Unit	Total	Application	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
AD	kg Sb eq	<b>9.9E-02</b>	-	<b>7.6E-02</b>	6.1E-03	1.7E-02
AA	kg SO <sub>2</sub> eq	<b>1.1E-01</b>	6.1E-03	<b>8.3E-02</b>	1.3E-02	3.2E-03
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>1.6E-02</b>	1.6E-03	<b>1.3E-02</b>	8.0E-04	4.9E-04
GW	kg CO <sub>2</sub> eq	<b>6.5E+01</b>	<b>3.5E+01</b>	2.7E+01	8.5E-01	2.2E+00
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>2.2E-03</b>	-	<b>1.6E-03</b>	4.6E-04	1.2E-04
CED	MJ	<b>2.0E+02</b>	-	<b>1.5E+02</b>	1.3E+01	3.4E+01

**Table 4.5.21. LCIA results per FU, for pesticides process, for tomato greenhouse crop in the Netherlands**

No	Unit	Total	Application	Insecticides	Fungicides
AD	kg Sb eq	<b>1.6E-03</b>	1.4E-04	4.5E-04	<b>1.0E-03</b>
AA	kg SO <sub>2</sub> eq	<b>1.8E-03</b>	1.2E-04	5.2E-04	<b>1.2E-03</b>
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>6.1E-04</b>	3.5E-05	1.7E-04	<b>4.0E-04</b>
GW	kg CO <sub>2</sub> eq	<b>2.0E-01</b>	1.9E-02	5.3E-02	<b>1.2E-01</b>
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.1E-04</b>	4.3E-06	3.1E-05	<b>7.3E-05</b>
CED	MJ	<b>3.9E+00</b>	3.3E-01	1.1E+00	<b>2.5E+00</b>

**Table 4.5.22. 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	<b>3.3E-03</b>	1.1E-04	4.6E-05	1.1E-04	<b>1.9E-03</b>	5.5E-04	2.0E-04	3.6E-04
AA	kg SO <sub>2</sub> eq	<b>2.3E-03</b>	4.9E-05	3.4E-05	8.5E-05	<b>1.4E-03</b>	2.7E-04	3.1E-04	1.8E-04
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>9.1E-04</b>	1.3E-05	9.0E-06	2.3E-05	3.8E-04	6.6E-05	<b>3.8E-04</b>	4.3E-05
GW	kg CO <sub>2</sub> eq	<b>2.1E+00</b>	1.6E-02	6.4E-03	1.6E-02	2.7E-01	4.6E-02	<b>1.7E+00</b>	3.0E-02
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>7.6E-05</b>	2.0E-06	1.1E-06	2.7E-06	<b>4.4E-05</b>	1.0E-05	1.0E-05	6.5E-06
CED	MJ	<b>7.9E+00</b>	2.7E-01	1.1E-01	2.8E-01	<b>4.7E+00</b>	1.3E+00	5.1E-01	8.3E-01

## 4.6 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 <sup>2</sup>
Gutter height	6	m
Ridge height	6.76	m
Gutter to ridge distance	0.76	m
Greenhouse volume	257,242	m <sup>3</sup>
Roof slope length	2.56	m
Roof slope angle	23	°
Roof surface	43,008	m <sup>2</sup>
Front walls surface	2,572	m <sup>2</sup>
Side walls surface	2,400	m <sup>2</sup>
N° ventilator windows greenhouse	1,680	u
Ventilator dimensions	1.325x1.25	m
Ventilator surface	2,782	m <sup>2</sup>

**Table 4.6.2. Materials and processes considered in the greenhouse structure inventory**

Material	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·1000 stems <sup>-1</sup>	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 <sup>3</sup>	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
<b>Processes</b>							
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 <sup>2</sup>	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 <sup>2</sup>	OED	PPO
Transport	By lorry, 55 Km	63,873.7	1,056.1	0.38	tkm	OED	PPO

**Table 4.6.3. Main futures of rose crop**

Characteristics	Data	Unit	Type of data	Source
Commercial yield	276	roses/m <sup>2</sup>	OED	PPO
Crop period	1	year	OED	PPO
Fresh weight	0.125	kg/plant	OED	PPO
N° bags per row	131	u	ERD	PPO
N° plants	335,866	plants	OED	PPO
N° plants per bag	3	u	OED	PPO
N° rows	210	u	OED	PPO

**Table 4.6.4. Materials and processes considered in the auxiliary equipment inventory**

Material	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·1000 stems <sup>-1</sup>	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
<b>Processes</b>							
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 <sup>2</sup>	OED	PPO
Transport	Lorry, 200 km	6,670.6	315.3	0.11	tkm	OED	PPO

**Table 4.6.5. Inventory data for substrate**

Substrate	Element	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·1000 stems <sup>-1</sup>	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 4.6.6. Water used features**

Water	Element	Greenhouse quantity	Quantity -ha <sup>-1</sup>	Quantity -1000 stems <sup>-1</sup>	Unit	Type of data	Source
Water	Source water	18,144	4,500	1.63	m <sup>3</sup>	OED	PPO
Water	Rain water	18,245	4,525	1.64	m <sup>3</sup>	OED	PPO

**Table 4.6.7. Energy consumption and production in climate control system stage**

Energy consumption	Element	Greenhouse quantity	Quantity -ha <sup>-1</sup>	Quantity-1000 stems <sup>-1</sup>	Unit	Type of data	Source
Natural gas	Cogeneration and heating	4,100,544	1,017,000	369	m <sup>3</sup>	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 4.6.8. 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		
		copper	0.050		



**Table 4.6.9. Materials and processes considered in the climate control system inventory**

Material	Element	Greenhouse quantity	Quantity -ha <sup>-1</sup>	Quantity -1000 stems <sup>-1</sup>	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 <sup>2</sup>	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
<b>Processes</b>							
Aluminium	Manufacturing processes	54,868	907.2	0.33	kg	OED	PPO
Aluminium	Powder coating	2,744	45.4	0.02	kg	OED	PPO
Copper	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 <sup>2</sup>	OED	PPO
Transport	By lorry, 55 km	21,136	362.3	0.13	tkm	OED	OED

**Table 4.6.10 N, P and K amount for rose crop**

Nutrient	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·1000 stems <sup>-1</sup>	Unit	Type of data	Source
N	4,689	1,163	0.421	kg	OED	PPO
P <sub>2</sub> O <sub>5</sub>	1,113	276	0.100	kg	OED	PPO
K <sub>2</sub> O	5,161	1,280	0.464	kg	OED	PPO

**Table 4.6.11 Air emissions fertilizers**

Air emissions	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·1000 stems <sup>-1</sup>	Unit	Type of data	Source
NH <sub>3</sub>	141	34.9	0.013	kg	ERD	IRTA
N <sub>2</sub> O-N	65	16.0	0.006	kg	ERD	IRTA
NO <sub>x</sub> -N	6	1.6	0.001	kg	ERD	IRTA

**Table 4.6.12 Phytosanitary treatments**

Material	Quantity ·ha <sup>-1</sup>	Quantity ·1000 stems <sup>-1</sup>	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 4.6.13 Waste treatments for waste management stage in rose's production.**

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

**Table 4.6.14. Transport and emissions in waste management stage**

Material	Process	Greenhouse quantity	Quantity ·ha <sup>-1</sup>	Quantity ·1000 stems <sup>-1</sup>	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
<b>Processes</b>							
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 4.6.15 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 4.6.17 LCIA results per FU, for rose 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	<b>1.3E+01</b>	8.7E-02	<b>1.2E+01</b>	7.5E-02	1.4E-02	1.3E-03	6.0E-04
AA	kg SO <sub>2</sub> eq	<b>2.3E+00</b>	7.2E-02	<b>2.1E+00</b>	4.8E-02	1.5E-02	1.5E-03	4.7E-04
EU	kg PO <sub>4</sub> <sup>3-</sup> eq	<b>9.6E-01</b>	2.5E-02	<b>9.2E-01</b>	1.1E-02	2.3E-03	5.0E-04	3.1E-04
GW	kg CO <sub>2</sub> eq	<b>1.6E+03</b>	1.3E+01	<b>1.6E+03</b>	7.5E+00	9.7E+00	1.6E-01	1.1E+00
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.4E-01</b>	3.4E-03	<b>1.3E-01</b>	3.0E-03	3.0E-04	9.0E-05	1.6E-05
CED	MJ	<b>2.6E+04</b>	2.1E+02	<b>2.5E+04</b>	1.7E+02	2.8E+01	3.2E+00	1.4E+00

**Table 4.6.16 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	<b>1.6E+01</b>	8.7E-02	<b>1.6E+01</b>	7.5E-02	1.4E-02	1.3E-03	6.0E-04
AA	kg SO <sub>2</sub> eq	<b>3.0E+00</b>	7.2E-02	<b>2.8E+00</b>	4.8E-02	1.5E-02	1.5E-03	4.7E-04
EU	kg PO <sub>4</sub> <sup>3-</sup> eq	<b>1.7E+00</b>	2.5E-02	<b>1.6E+00</b>	1.1E-02	2.3E-03	5.0E-04	3.1E-04
GW	kg CO <sub>2</sub> eq	<b>2.1E+03</b>	1.3E+01	<b>2.1E+03</b>	7.5E+00	9.7E+00	1.6E-01	1.1E+00
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.5E-01</b>	3.4E-03	<b>1.4E-01</b>	3.0E-03	3.0E-04	9.0E-05	1.6E-05
CED	MJ	<b>3.3E+04</b>	2.1E+02	<b>3.3E+04</b>	1.7E+02	2.8E+01	3.2E+00	1.4E+00

**Table 4.6.18 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	<b>8.7E-02</b>	<b>5.4E-02</b>	6.2E-04	2.1E-02	1.1E-02	7.0E-04
AA	kg SO <sub>2</sub> eq	<b>7.2E-02</b>	<b>3.9E-02</b>	4.8E-04	2.8E-02	3.3E-03	5.2E-04
EU	kg PO <sub>4</sub> <sup>3-</sup> eq	<b>2.5E-02</b>	<b>1.9E-02</b>	1.2E-04	3.6E-03	1.3E-03	1.4E-04
GW	kg CO <sub>2</sub> eq	<b>1.3E+01</b>	<b>8.0E+00</b>	2.8E-01	3.5E+00	9.0E-01	9.8E-02
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>3.4E-03</b>	<b>2.2E-03</b>	1.7E-05	9.5E-04	1.9E-04	1.6E-05
CED	MJ	<b>2.1E+02</b>	<b>1.3E+02</b>	1.6E+00	4.7E+01	2.5E+01	1.7E+00

**Table 4.6.19 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	<b>1.2E+01</b>	<b>6.8E+00</b>	2.3E-02	5.3E-03	1.6E-03	2.4E-04	5.6E+00
AA	kg SO <sub>2</sub> eq	<b>2.1E+00</b>	<b>1.1E+00</b>	1.4E-02	1.6E-03	4.2E-03	1.8E-04	9.9E-01
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>9.2E-01</b>	2.2E-01	7.4E-03	4.2E-04	4.7E-03	4.8E-05	<b>6.9E-01</b>
GW	kg CO <sub>2</sub> eq	<b>1.6E+03</b>	<b>8.6E+02</b>	3.3E+00	4.5E-01	1.4E-01	3.4E-02	7.1E+02
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.3E-01</b>	<b>8.9E-02</b>	9.0E-04	8.1E-05	1.7E-04	5.6E-06	4.1E-02
CED	MJ	<b>2.5E+04</b>	<b>1.4E+04</b>	5.7E+01	1.4E+01	3.8E+00	5.9E-01	1.1E+04

**Table 4.6.20. 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	<b>1.6E+01</b>	3.8E+00	2.3E-02	5.3E-03	1.6E-03	2.4E-04	<b>1.2E+01</b>
AA	kg SO <sub>2</sub> eq	<b>2.8E+00</b>	6.2E-01	1.4E-02	1.6E-03	4.2E-03	1.8E-04	<b>2.2E+00</b>
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>1.6E+00</b>	1.2E-01	7.4E-03	4.2E-04	4.7E-03	4.8E-05	<b>1.5E+00</b>
GW	kg CO <sub>2</sub> eq	<b>2.1E+03</b>	4.9E+02	3.3E+00	4.5E-01	1.4E-01	3.4E-02	<b>1.6E+03</b>
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.4E-01</b>	5.0E-02	9.0E-04	8.1E-05	1.7E-04	5.6E-06	<b>9.0E-02</b>
CED	MJ	<b>3.3E+04</b>	7.8E+03	5.7E+01	1.4E+01	3.8E+00	5.9E-01	<b>2.5E+04</b>

**Table 4.6.21 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	<b>7.5E-02</b>	1.7E-02	3.5E-03	1.6E-03	2.1E-04	<b>5.3E-02</b>
AA	kg SO <sub>2</sub> eq	<b>4.8E-02</b>	4.1E-03	1.9E-03	1.0E-03	1.5E-04	<b>4.1E-02</b>
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>1.1E-02</b>	3.9E-04	9.9E-04	5.7E-04	4.1E-05	<b>8.8E-03</b>
GW	kg CO <sub>2</sub> eq	<b>7.5E+00</b>	1.1E+00	4.5E-01	2.2E-01	2.9E-02	<b>5.7E+00</b>
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>3.0E-03</b>	2.2E-04	6.1E-04	5.8E-05	4.8E-06	<b>2.1E-03</b>
CED	MJ	<b>1.7E+02</b>	3.9E+01	9.5E+00	4.0E+00	5.1E-01	<b>1.2E+02</b>

**Table 4.6.22 LCIA results per FU, for fertilizers process, for rose greenhouse crop in the Netherlands**

No	Unit	Total	Application	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
AD	kg Sb eq	<b>1.4E-02</b>	0.0E+00	<b>1.1E-02</b>	8.5E-04	2.4E-03
AA	kg SO <sub>2</sub> eq	<b>1.5E-02</b>	9.6E-04	<b>1.2E-02</b>	1.9E-03	4.5E-04
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>2.3E-03</b>	2.5E-04	<b>1.9E-03</b>	1.1E-04	7.0E-05
GW	kg CO <sub>2</sub> eq	<b>9.7E+00</b>	<b>5.4E+00</b>	3.8E+00	1.2E-01	3.1E-01
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>3.0E-04</b>	0.0E+00	<b>2.2E-04</b>	6.5E-05	1.7E-05
CED	MJ	<b>2.8E+01</b>	0.0E+00	<b>2.1E+01</b>	1.8E+00	4.9E+00

**Table 4.6.23 LCIA results per FU, for pesticides process, for rose greenhouse crop in the Netherlands**

No	Unit	Total	Application	Pesticides
AD	kg Sb eq	<b>1.3E-03</b>	2.8E-05	<b>1.3E-03</b>
AA	kg SO <sub>2</sub> eq	<b>1.5E-03</b>	2.4E-05	<b>1.5E-03</b>
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>5.0E-04</b>	7.3E-06	<b>4.9E-04</b>
GW	kg CO <sub>2</sub> eq	<b>1.6E-01</b>	4.0E-03	<b>1.5E-01</b>
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>9.0E-05</b>	8.8E-07	<b>8.9E-05</b>
CED	MJ	<b>3.2E+00</b>	6.8E-02	<b>3.1E+00</b>

**Table 4.6.24 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	<b>6.0E-04</b>	2.3E-05	2.9E-05	6.5E-05	4.1E-05	1.1E-04	1.3E-04	<b>2.0E-04</b>
AA	kg SO <sub>2</sub> eq	<b>4.7E-04</b>	9.9E-06	2.2E-05	4.8E-05	3.1E-05	5.5E-05	<b>2.0E-04</b>	1.0E-04
EU	kg PO <sub>4</sub> <sup>---</sup> eq	<b>3.1E-04</b>	2.6E-06	5.8E-06	1.3E-05	8.2E-06	1.3E-05	<b>2.4E-04</b>	2.5E-05
GW	kg CO <sub>2</sub> eq	<b>1.1E+00</b>	3.3E-03	4.1E-03	9.2E-03	5.8E-03	9.2E-03	<b>1.1E+00</b>	1.7E-02
PO	kg C <sub>2</sub> H <sub>4</sub>	<b>1.6E-05</b>	4.0E-07	6.9E-07	1.5E-06	9.6E-07	2.0E-06	<b>6.6E-06</b>	3.7E-06
CED	MJ	<b>1.4E+00</b>	5.5E-02	7.2E-02	1.6E-01	1.0E-01	2.6E-01	3.3E-01	<b>4.7E-01</b>

## 4.7 ANNEX FOR FINANCIAL RESULTS

### 4.7.1: Financial result scenario 1: tomato greenhouse in Spain

Farm results for a multitunnel greenhouse (Almería) of 10,000 m<sup>2</sup>

#### Farm results

	farm	per m2	
<b>Benefits</b>			
<i>Turnover tomatoes</i>	95584	9,56	
<i>Other output</i>	0	0,00	
<i>Total output</i>	95584	9,56	
<b>Costs</b>	farm	per m2	in %
<i>Seeding and planting materials</i>	5580	0,56	6
<i>Fertilizers</i>	6000	0,60	7
<i>Water</i>	1950	0,20	2
<i>Crop protection agents</i>	3500	0,35	4
<i>Other crop assets</i>	7975	0,80	9
<i>Energy</i>	2120	0,21	2
<i>Tangible assets depreciation and maintenance</i>	29975	3,00	33
<i>Paid labour</i>	24570	2,46	27
<i>Contractors</i>	0	0,00	0
<i>Interest payments</i>	6406	0,64	7
<i>General costs</i>	2000	0,20	2
<i>Total costs</i>	90076	9,01	100
<b>Net financial result</b>	<b>5508</b>	<b>0,55</b>	

**4.7.2: Financial result scenario 2: tomato greenhouse in Hungary**Farm results for a Venlo type greenhouse of 23,500 m<sup>2</sup>**Farm results**

	farm	per m2	
<b>Benefits</b>			
<i>Turnover tomatoes</i>	820416	34,83	
<i>Other output</i>	0	0,00	
<i>Total output</i>	820416	34,83	
<b>Costs</b>	farm	per m2	in %
<i>Seeding and planting materials</i>	73080	3,10	9
<i>Fertilizers</i>	154556	6,56	19
<i>Water</i>	628	0,03	0
<i>Crop protection agents</i>	25797	1,10	3
<i>Other crop assets</i>	28527	1,21	3
<i>Energy</i>	90146	3,83	11
<i>Tangible assets depreciation and maintenance</i>	226505	9,62	28
<i>Paid labour</i>	139960	5,94	17
<i>Contractors</i>	0	0,00	0
<i>Interest payments</i>	54785	2,33	7
<i>General costs</i>	23552	1,00	3
<i>Total costs</i>	817536	34,71	100
<b>Net financial result</b>	<b>2880</b>	<b>0,12</b>	



### 4.7.3: Financial result scenario 3: tomato greenhouse in the Netherlands

Farm results for a Venlo type greenhouse of 40,000 m<sup>2</sup>

#### Farm results

	farm	per m2	
<b>Benefits</b>			
<i>Turnover tomatoes</i>	1864500	46,61	
<i>Other output</i>	468000	11,70	
<i>Total output</i>	2332500	58,31	
<b>Costs</b>	farm	per m2	in %
<i>Planting materials</i>	65000	1,63	3
<i>Fertilizers</i>	36000	0,90	2
<i>Water</i>	800	0,02	0
<i>Crop protection agents</i>	20000	0,50	1
<i>Other crop assets</i>	120799	3,02	5
<i>Energy</i>	732000	18,30	31
<i>Tangible assets</i> <i>depreciation and maintenance</i>	545459	13,64	23
<i>Paid labour</i>	602000	15,05	26
<i>Contractors</i>	20000	0,50	1
<i>Interest payments</i>	115870	2,90	5
<i>General costs</i>	74000	1,85	3
<i>Total costs</i>	2331928	58,30	100
<b>Net financial result</b>	<b>572</b>	<b>0,01</b>	

**4.7.4: Financial result scenario 4: rose greenhouse in the Netherlands**Farm results for a Venlo type greenhouse of 40,000 m<sup>2</sup>**Farm results**

	farm	per m2	
<b>Benefits</b>			
<i>Turnover roses</i>	4195200	104,88	
<i>Other output</i>	300000	7,50	
<i>Total output</i>	4495200	112,38	
<b>Costs</b>	farm	per m2	in %
<i>Seeding and planting materials</i>	131750	3,29	3
<i>Fertilizers</i>	46000	1,15	1
<i>Water</i>	4800	0,12	0
<i>Crop protection agents</i>	120000	3,00	3
<i>Other crop assets</i>	257500	6,44	6
<i>Energy</i>	1653000	41,33	36
<i>Tangible assets      depreciation and maintenance</i>	1007805	25,20	22
<i>Paid labour</i>	997600	24,94	22
<i>Contractors</i>	14000	0,35	0
<i>Interest payments</i>	185977	4,65	4
<i>General costs</i>	120000	3,00	3
<i>Total costs</i>	4538432	113,46	100
<b>Net financial result</b>	<b>-43232</b>	<b>-1,08</b>	