



eco-innovation
WHEN BUSINESS MEETS THE ENVIRONMENT

**CIP Eco-innovation
Pilot and market replication projects
Call 2012**

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Report on environmental parameters D2.4

Ecoponics

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REPORT ON MASS BALANCES

This report includes the results obtained, in relation to the balance sheets of energy and mass calculation, and to the cost and life-cycle assessment (LCA) of products generated, as vegetables and tilapias.

Energy consumption

The BREEN demonstration plant uses electricity for the control systems (feed automatic system, water pumps, temperature and climatic control lights).

There is also a direct use of renewable energy and waste heat from a cogeneration system next to the demonstration plant. This energy is used to control the fish containers temperature at aprox 25°C for optimal growth rates.

LIGHTING

About the lighting these are the calculations performed:

LED fotoperiod lights WINTER

15 lamps of 12 Watt and are lit 8hours/day

Consumption of light: 15units x 12W x 8hours: 1440Wh/day=1.44 kWh/day, of fotoperiod light

1.44 kWh/day x 6 months: **259.20 kWh**

ELECTRICITY CONSUMPTION	kW	h/day	Quantity	kWh/ day	kWh /year
LED fotoperiod lights WINTER	0.35	8	1	1.44	259.20
LED fotoperiod lights SUMMER	0.35	0	1	0.00	0.00

PUMPS

These pumps are the pumps that are used:

Mechanical filter pump

Recirculation pump: for fish and vegetables (plants)

Return pump to plant

ELECTRICITY CONSUMPTION	kW	h/day	Quantity	kWh/ day	kWh /year
2 external water pumps (0.25HP)	0.184	9	2	3.31	1,207.24
2 external water pumps (0.25HP)	0.184	1.5	2	0.55	201.21
2 internal water pumps (0.33HP)	0.243	24	2	11.64	4,249.48

2 submarine water pumps (450W)	0.45	2	2	1.80	657.00
3 submarine water pumps (450W)	0.45	24	3	32.40	11,826.00

AERATOR

For the oxygenation of the water are used:

2.16 kWh/day of aeration, oxygenation of the water.

ELECTRICITY CONSUMPTION	kW	h/day	Quantity	kWh/ day	kWh /year
Aerator	0.09	24	1	2.16	788.40

The total 12 month period electricity consumption is about 22,400 kWh.

TABLE CALCULATION OF FEED

Fish feeding and growth

The fish has been fed during this period with Biomar, Efico Alfa 845F fish feed. The daily feeding is on average 3% of the fish biomass with a particle size of 1.5 mm, 3.0 mm and 4.5 mm depending on the fish size 4-15g, 15-60g, 60-400g.

Fish size (g)	Feed – pellet size (mm)	Temperature (°C)								
		17	19	21	23	25	27	29	31	33
8 - 15	1.9	1.77	2.66	3.40	4.25	4.67	7.64	6.78	3.50	1.54
15 - 25	1.9	1.63	2.53	3.26	4.07	4.26	7.41	6.48	3.35	1.47
25 - 35	3.0	1.58	2.38	3.16	3.95	4.17	7.10	6.39	3.25	1.43
35 - 60	3.0	1.34	2.06	2.68	3.34	3.62	5.53	4.99	2.75	1.21
60 - 100	4.5	1.23	1.85	2.46	3.08	3.31	3.63	3.20	2.53	1.12
100 - 160	4.5	1.06	1.58	2.11	2.64	2.84	2.91	2.74	2.17	0.96
160 - 300	4.5	0.90	1.35	1.80	2.25	2.42	2.48	2.33	1.85	0.81
300 - 400	4.5	0.76	1.14	1.52	1.90	2.04	2.09	1.97	1.56	0.69



Feeding indicative (kg feed per day for 100 kg of fish)

Automatic feeding system.

The total 12 month period tilapia production is about 2,000 kg.

BROODSTOCK

100gr were bought, and this purchase suits for 3 years.

PLANT SEED

We buy the seeds in envelopes /dose.

DIRECT OUTPUT

We have calculated the productions for a period of 12 months, of 23/07/2014 - 23/07/2015

PRODUCTION IN 12 MONTH OPERATING		
FISH	Tilapia	2,000 kg
VEGETABLES	768 lettuce (300gr/lettuce)=230kg 250kg tomatoes 2kg Basil 3kg Parsley 20kg Chilli pepper 10kg Pepper	515 kg
VERMICOMPOST	From 988kg/year of sludge, 1,25m3 of vermicompost is obtained (700 kg/m3)	875 kg

The results of this study showed the environmental impact associated with the BREEN Aquaponics technology system operation in the demonstration plant located in Hondarribia (Spain), during a 12 months period.

ENVIRONMENTAL IMPACT MASS ALLOCATION	TOTAL	Fish 59%	Vegetables 15.2%	Vermicompost 25.8%	>>	1kg Fish	1kg Vegetables	1kg Vermicompost
Global Warming kg CO ₂ eq.	6,383.41	3,766.21	572.46	147.70	>>	1.88	1.11	0.15
Acidification kg SO ₂ eq.	51.76	30.54	4.64	1.20	>>	0.02	0.01	0.00
Fresh Water Eutrophication kg PO ₄ eq.	21.22	12.52	1.90	0.49	>>	0.01	0.00	0.00
Ozone layer destruction kg CFC-11 eq.	1.95E-04	0.00	0.00	0.00	>>	5.76E-08	3.40E-08	4.57E-09
Human Toxicity kg 1.4-DCB eq.	2,263.71	1,335.59	203.01	52.38	>>	0.67	0.39	0.05
Abiotic resource deployment kg Antimonio eq.	42.44	25.04	3.81	0.98	>>	0.01	0.01	0.00
ReCiPe Endpoint (H.A) Points	870.88	513.82	78.10	20.15	>>	0.26	0.15	0.02
Direct Electricity consumption	22,400.00	13,216.00	2,008.83	518.28	>>	6.61	3.90	0.52

This allocation shows that 1kg of fish production by the BREEN aquaponic technology produces 1.88 kg CO₂ eq. and consumes 6.61 kWh of direct electricity.

In the case of vegetables and vermicompost, the results are 1.11 kg CO₂ eq and 0.15 kg CO₂ eq respectively and 3.9 kWh and 0.52 kWh respectively.

Price analysis for the BREEN aquaponic technology products showed a total of 9,887.50€ worth of fish. Vegetables and vermicompost were produced based on current market price (www.mercamadrid.es . www.mercasa.es). Net tilapia product was worth 8,420€ (4.21€/kg). Net vegetables were worth 1,030€ (2€/kg) and net vermicompost was worth 437.50€ (0.5€/kg).

This allocation method indicates 85.2% of net impacts are attributed to fish. 10.4% to vegetables and 4.4% to vermicompost.

ENVIRONMENTAL IMPACT ECONOMIC ALLOCATION	TOTAL	Fish 85.2%	Vegetables 10.4%	Vermicompost 4.4%	>>	1kg Fish	1kg Vegetables	1kg Vermicompost
Global Warming kg CO ₂ eq.	6,383.41	5,438.67	663.87	280.87	>>	2.72	1.29	0.28
Acidification kg SO ₂ eq.	51.76	44.10	5.38	2.28	>>	0.02	0.01	0.00
Fresh Water Eutrophication kg PO ₄ eq.	21.22	18.08	2.21	0.93	>>	0.01	0.00	0.00
Ozone layer destruction kg CFC-11 eq.	1.95E-04	0.00	0.00	0.00	>>	8.31E-08	3.94E-08	8.69E-09
Human Toxicity kg 1.4-DCB eq.	2,263.71	1,928.68	235.43	99.60	>>	0.96	0.46	0.10
Abiotic resource deployment kg Antimonio eq.	42.44	36.16	4.41	1.87	>>	0.02	0.01	0.00

ReCiPe Endpoint (H.A) Points	870.88	741.99	90.57	38.32	>>	0.37	0.18	0.04
Direct Electricity consumption	22.400.00	19.084.80	2329.60	985.60	>>	9.54	4.52	1.00

This allocation shows that 1kg of fish production by the BREEN aquaponic Technology produces 2.72 kg CO₂ eq. and consumes 9.54 kWh of direct electricity from the point of view of an economic aspect allocation.

In the case of vegetables and vermicompost. this results are 1.29 kg CO₂ eq and 0.28 kg CO₂ eq respectively, and 4.52 kWh and 1 kWh respectively.

Conclusions

No pesticides nor hormones are used in the production system. The system is closed-loop and all nutrients are fully utilized. No synthetic fertilizers are used. By implementing healthy eco-systems with polyculture even the input of extra phosphate, Fe, K and Ca can almost be excluded.

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TABLE OF DIRECT INPUTS AND OUTPUTS

Small scale BREEN

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