

Master Thesis Overview

Feasibility of a PV-powered community-scale aquaponic system for tropical regions, with Venezuela as a case of study

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Abstract

Thesis aims to analyze the feasibility of decentralized of an off-grid PV-powered aquaponic system providing a food supply for circa. 30 persons in Venezuela. All of the power supply will come from photovoltaic energy. The system will be off-grid, designed to have less possible amount of batteries. The aquaponic system will supply a range of foodstuffs required for healthy balanced nutrition, and will be designed to provide fresh vegetable and fruits on a weekly basis and fish on a 6-week basis.

Motivation

To research the possibility a PV-powered aquaponic system as a relatively autonomous means for meeting the basic intrinsic human need for a sustainable food supply. Food insecurity, population growth and increasing living standards are currently important issues. In the foreseeable future, we will face global challenges that will jeopardize our living conditions. Food insecurity currently affects millions, population is expected to increase 40% by 2050, and living standards expected to increase in developing countries where most population growth will occur, leading to increased energy and food demand. Also, traditional agriculture is currently one of the biggest contributors of CO2 emissions and consumer of fresh water globally. PV-powered aquaponic systems may be able to make a contribution to addressing these issues.

Goal

To examine and assess PV-powered aquaponic systems as a possible solution to meeting local food demand by empowering communities to be 'prosumers' and enabling them to cultivate fresh and organic food in a cheap and self-sustaining way.

PLACE Las Palmitas, Carora City, Venezuela

SIZE Total Farm Area **4.880 m²**
Tank 580 m²
GrowBed 890 m²
Vertical Tower 3360 m²
Equipment Room 50 m²
PV 44 m²

COST Total Farm Cost **130.017,23 US \$**

PV Module 10.878 US \$
MPPT Charge Controller 650 US \$
DC-DC Converters 400 US \$
Battery 70.800 US \$
Mounting System 400 US \$
Cabling 387,3 US \$
BoS 1.005,55 US \$
Total PV **84.520,85 US \$**

AO Aquaponic System 20.310,85 US \$
Water Pump 700 US \$
Air Pump 250 US \$
LED 400 US \$
Total AO **21.660,38 US \$**

C PV Construction 22.900 US \$
AQ Construction 896 US \$
Total C **23.896 US \$**

PRODUCTION					
FISH	# Fishes / Year	kg / Month	kg / Week	kg / Day	
Tilapia	24.416	1.144,57	264,13	37,63	
VEGETABLES					
	# Plants / Year	kg / Month	kg / Week	kg / Day	
Tomato	2.717	570,57	131,67	18,76	
Romaine Lettuce	12.203	572,92	132,21	18,84	
Arugula	1.436.084	72,27	16,68	2,38	
Radichio	4.309	80,80	18,65	2,66	
Bell Peppers	2.019	272,54	62,89	8,96	
Cabbage	4.264	415,74	95,94	13,67	
Cilantro	23.488	45,21	10,43	1,49	
Basil	1.703	31,57	7,28	1,04	
Squash	3.541	1.912,11	441,26	62,86	
Spring Onion	96.382	180,72	41,70	5,94	
Sweet Corn (Ripe)	6.032	46,60	10,75	1,53	
Sweet Corn (Dry)	30.160	85,96	19,84	2,83	
Black Beans	8.008	318,11	73,41	10,46	
Strawberry	5.616	305,85	75,43	10,75	
Total Veggies		4.931,95	1.138,14	162,15	

TANKS

Fish 4 x 35.000 liter
Fingerling 1 x 12.000 liter
Buffer 1 x 35.000 liter
Sump 1 x 35.000 liter
Solid Removal 2 x 5.000 liter
Degass 1 x 2.000 liter
Base Addition 1 x 100 liter

GROWBED

8 x 93.000 liter

VERTICAL TOWER

886 Vertical Towers x 44 slots each

WATER CIRCULATION

Total Water System 234.100 liter
Day 67.500 liter / hour
Night 45.000 liter / hour

AERATION

For Fish, Fingerling, Buffer & Degass T. 96,46 CFM

PIPING

Water 3.447,2 m, 95 x Elbows, 23 x T's
Air 90 m, 26 x Elbows

PRODUCTION

	Yearly	
Tomato	6.846,84	kg
Romaine Lettuce	6.874,98	kg
Arugula	867,25	kg
Radichio	869,54	kg
Bell Peppers	3.270,49	kg
Cabbage	4.988,88	kg
Cilantro	542,51	kg
Basil	378,79	kg
Squash	22.945,37	kg
Spring Onion	2.168,60	kg
Sweet Corn (Ripe)	559,17	kg
Sweet Corn (Dry)	1.031,47	kg
Black Beans	3.817,29	kg
Strawberry	3.922,21	kg
Total Vegetables	59.183,40	kg
Tilapia	13.734,84	kg

LOCATION

10,13 N, -70,11 W

ORIENTATION

Azimuth = 0°, Inclination = 10°

MODULE

Carmanah CT1-160, 160W, mono

PV Installed 6,72 kWp
Configuration 6 x 7 = 42 (Series x Parallel)

BATTERY

Hoppecke VRL-2-2000, 2V

Capacity 2.082 Ah @ C24, 199,86 kWh @ 96V
Configuration 48 in Series

MPPT CHARGE CONTROLLER

Deming, 9600 W, 100A, 96 VDC

DC-DC CONVERTER 1

Absopulse BHR 65X28-4U2NF, 1000W

in: 96V, out: 24V (For LED)

DC-DC CONVERTER 2

Absopulse BAP 319-F7, 500W

in: 96V, out: 24V (For Air Pump)

SYSTEM VOLTAGE

96 VDC (BattBank, Water Pump)
24 VDC (LED & Air Pump)

CABLING

Total **239,42m**

1m - 2,5 mm
42,8m - 4mm
10,1m - 6mm
33,1m - 10mm
128m - 16mm
10,32m - 25mm
14m - 50mm

LOADS

Water Pump	2 x Surat Exim SEPL-18001
Air Pump	1 x Ametek 122173-18
LED	16 x Luxint LX-TG50
	50W, 24V

LOAD CONSUMPTION

Daily	26,04 kWh
Yearly	9.503,15 kWh

ENERGY YIELD

Daily Average	27,84 kWh
Yearly	10.159,84 kWh