Design of a solar thermal-biogas hybrid vapour absorption milk chiller for small scale dairy farms in Zimbabwe

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Introduction

- About 50% of the population directly depends on Agricultural (livestock and plants) activities as a means of survival (ZimStat, 2012).
- Agriculture also provides important raw materials for the manufacturing industry.
- Agricultural products are perishable and small scale farmers' lose value of product (FAO, 2016).
- Need for refrigeration systems to preserve value, but high energy costs and availability of electrical energy makes use of conventional vapour compression refrigeration systems difficult.
- Solar thermal-biogas hybrid refrigeration systems have potential because of the high irradiance in Zimbabwe as well as biogas production from agricultural wastes

Methodology and set up

1

Determination of market requirements

- Refrigeration consumes the most of the energy in dairy (90 %) of the total [2]
- Milk is harvested at 30-35 °C but should be kept at 4-5 °C [3]
- About 200L capacity per Farmer

2

Concept Selection for hybridisation

- Alternative refrigeration systems (vapour compression, steam jet, evaporative, absorption cycle)
- Chose the absorption cycle

3

Detailed design

- Design of solar thermal system
- Design of biogas system
- Integration points for hybridisation

4

Fabrication and Testing

- Testing the system

Summary of results

Item	Qnty	Unit Price USD	Total Price USD	%
Chillers	2	750.00	1500.00	20.0 %
Solar collectors	2	1226.25	2452.50	32.7 %
Biogas	15 m^3		2482.50	33.1 %
Maintenance & Installation			1065.00	14.2 %
TOTAL			7500.00	100%

- Chilling temp of 5deg C achieved
- Payback 3-5 years est.