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REPORT

Gauteng Department of Economic Development (GDED)
SME Green Support Incentive Program
ENERGY CONSUMPTION ASSESSMENT FOR JODAM MANUFACTURERS

29 WYNBERG, KEW, SANDTON. GAUTENG

04 March 2022

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Department:
Trade, Industry and Competition
REPUBLIC OF SOUTH AFRICA

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Nomenclature

CDD	Cooling Degree Days
CFL	Compact fluorescent lamp/light
CO_{2e}	Carbon dioxide equivalents
CP	Cleaner Production
Deg.C	Degrees Celsius
Hr	Hours
kL	Kilolitres
kVA	Kilovolt Amperes
kW	Kilowatts
kWp	Kilowatt Peak
kWh	Kilowatt-hours
LED	Light-emitting diode
NCPC-SA	National Cleaner Production Centre of South Africa
R	Rands
PV	Photo-voltaic
RECP	Resource Efficient and Cleaner Production
W	Watts

EXECUTIVE SUMMARY

The CSIR Energy Centre has reviewed the Resource Efficiency & Cleaner Production Assessment Report for Jodam Manufactures CC, based at 29 Wynberg Road, Kew, Johannesburg, Gauteng Province which was conducted in September/October 2021.

The scope of the review covered energy consumption assessment for all sources used on site with a focus on solar PV generation options. Recommendations which were made for energy savings were reviewed for their relevance. Data contained in the assessment report has been used to draw conclusions on the state of energy consumption and recommendations made for renewable energy options on site.

A summary of the main energy and water recommendations made in the assessment report is presented in Table 1.

Table 1: Estimated Quantitative Energy and Water Savings

No.	RECP Opportunities (See corresponding Excel Sheets for details)	Projected Annual Savings			Investment	Payback	Priority Ranking
		Energy	Cost	CO_2 Emissions	(R)	(Years)	
		(kWh)	(R/year)	(tonnes)			
1	Upgrading the existing lighting fixtures to lower wattage LED fixtures with sensors.	11,956.07	28,034.59	12.46	73,712.70	2.63	High
2	Install translucent sheets to make use of natural lighting and save on energy	3,670.00	8,605.42	3.83	25,000.00	2.91	Low
3	Retrofit the existing electric geysers with a heat pump	4,552.93	10,675.71	4.75	55,500.00	5.20	High
4	Replace the old airconditioner with inverter technology AC.	748.80	1,755.79	0.78	17,010.00	9.69	Low
5	Replace the 50L electric geyser with an under-sink instant water heater	1,100.00	2,580.00	1.15	3,500.00	1.36	High
6	Install a solar PV System to suppplement exisiting electrical energy supply to the factory	110,000.00	257,928.00	114.68	1,583,550.00	6.14	High
	Sub-total	**132,027.80**	**309,579.51**	**137.64**	**1,758,272.70**	**5.68**	

No.	Water	Projected Annual Savings		Investment	Payback	
		Water	Cost	(R)	(Years)	
		kL	(R/year)			
1	Install aerators on water taps to reduce amount of water used	97.00	7,780.00	15,000.00	1.93	High
2	Install dual-flush toilets, but this should be accompanies with awareness training on use	128.00	10,300.00	15,600.00	1.51	High
3	Install a counter-current rinsing system to reduce water use. The final effluent should disposed at licensed hazardous waste site	32.40	4,330.00	64,500.00	14.90	High
	Sub-total	**257.40**	**22,410.00**	**95,100.00**	**4.24**	
	TOTAL		**331,989.51**	**1,853,372.70**	**5.58**	

TABLE OF CONTENTS

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1. INTRODUCTION

Jodam Manufacturers CC is a small manufacturing business located in the Wynberg area of Sandton in Gauteng Province. The main business activities are designing and manufacturing of a range of customized promotional bags & packaging. These products are mainly sold on the local South African market and neighbouring countries. The company employs about 120 people working in a single 8-hour shift.

The factory consumes electricity supplied by City Power and has no other sources of energy.

This review forms part of the Gauteng Department of Economic Development (GDED)'s SMMEs Green Support Incentive Program whose objectives are to assist SMMEs based in Gauteng to instal alternative sources of energy to mitigate the high cost of energy and green their operations through reduced carbon emissions. This review report presents the relevant findings contained in the RCEP Assessment Report and information obtained from the site visit relating to energy usage and opportunities for energy performance improvements and renewable energy resources that can supplement grid power. The opportunities are evaluated for technical and financial feasibility. High level investment costs, energy and cost savings and simple payback periods are presented.

2. COMPANY INFORMATION

Table 2: Company Information

Assessment Type	Review of Energy Efficiency and Renewable Energy opportunities
Assessment Period	March 2022
Company Name	Jodam Manufacturers CC
Physical Address	No 29, Wynberg Road, Wynberg, Johannesburg
Phone	011 887 7736
Trading Since (year)	1986
No. of Full time Employees	119
Industrial Processes	Leather & Textile Sector
Company Contact Person:	
Name:	Mrs Jodi Fittinghoff
Designation:	Factory Manager
Telephone: **Mobile:** **E-mail:**	+27 11 887 7736 +27 83 927 7927 jodi@jodam.co.za

3. PLANT PROFILE

Figure 1 shows the location of Jodam Manufacturers factory according to Google Earth's Aerial View. The space occupied by the factory is clearly marked in the figure. The Jodam factory building is approximately 2,000m^2 of floor space on two floors. The building houses a receiving bay, warehouse, factory, sales, car park, waste management area with one skip and dispatch processes. The building has a large north-facing roof, which can be used to mount solar panels for renewable electricity generation. Since the business operates only during the day, a Solar PV system would be ideal and more practical to supplement power supplied by City Power. The integrity of the roof to hold the weight of the panels will have to be investigated before installation.

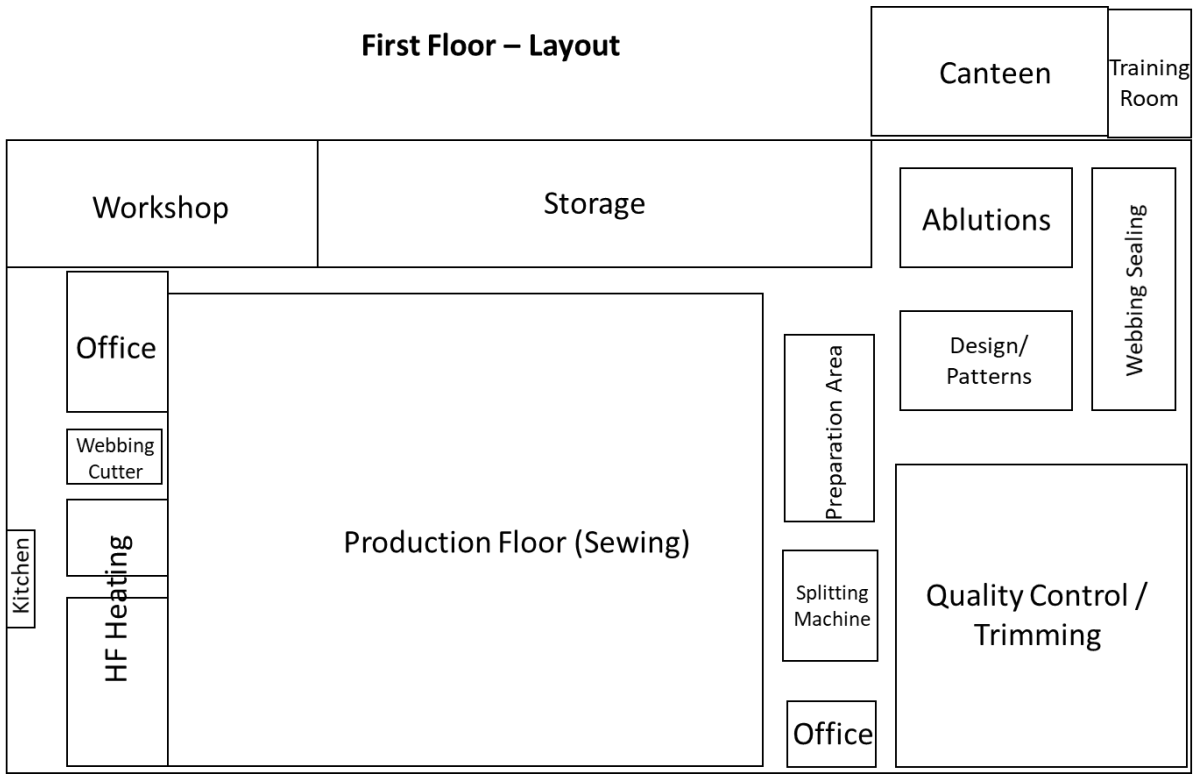
Figure 1: Location of Jodam

3.1 Process Description

As per the RCEP assessment, the factory layout is shown in the schematic below.

Schematic 1: Ground Floor Schematic

Schematic 2: Ground Floor Schematic

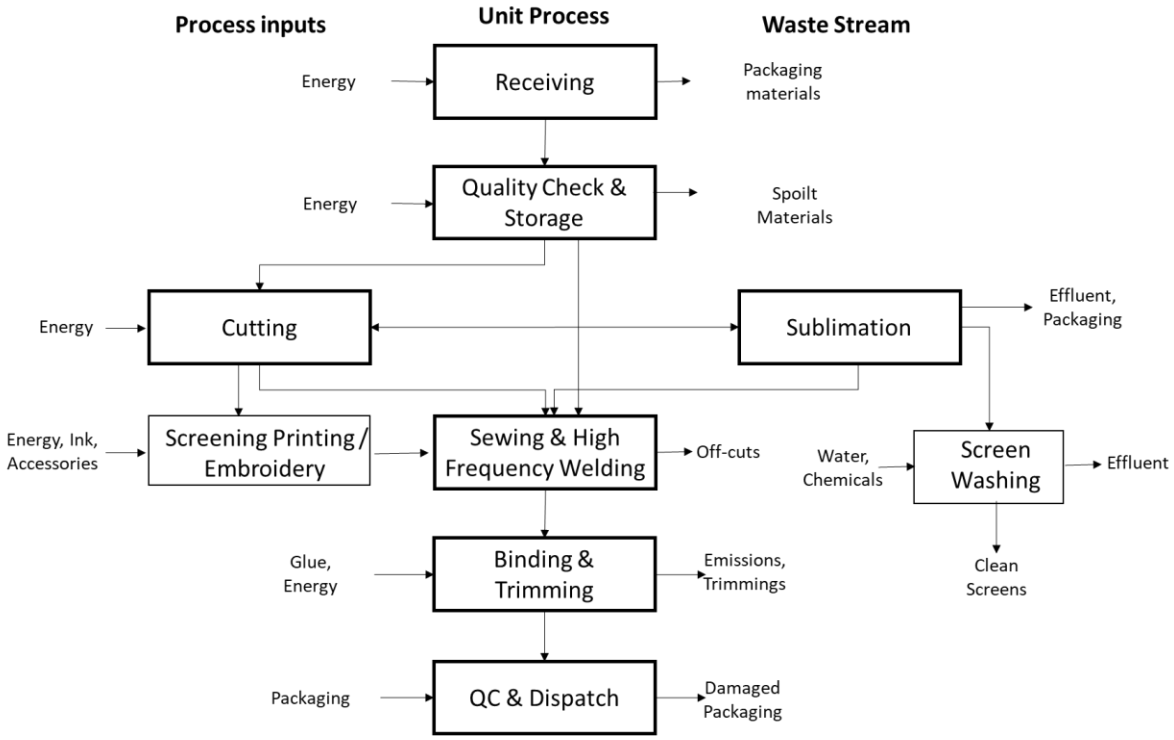


As shown in the two (2) schematics above the production flow process is not optimum. The main reason for this is that the company grew from a simple operation with one sewing machine and one operator to a total of 119 employees at peak capacity. There is an opportunity to rearrange the various operations to optimise production flow. However, this is not a priority for the company considering that the premises are rented, and permission will have to be sought from the building owner to make any space alterations.

3.2 Production process flow chart

The manufacturing process in this plant is quite simple and it begins with material cutting according to the design or pattern of the bags to be sewn followed by screen printing or sublimation as it is referred to and then finally the sewing of the cut material is done to create the product. The finished product is subjected to quality checks to ensure compliance with the set quality standards.

Chart 1: Process flow Chart



4. ENERGY CONSUMPTION

Electricity consumption data was provided by Jodam Manufacturers for the period September 2019 to May 2021. Due to the nature of the business where the company makes so many different products as ordered by customers, quantifying production figures is a challenge. These products include a large variety of bags (toiletry, cosmetic, school and shopper's bags).

4.1 Electricity

Electricity is the only energy source used at the factory. Table 3 below shows electricity consumption values and cost for 20 months starting from September 2019 to May 2021.

Table 3: Electricity consumption

Item No	Meter Reading Dates		Energy Consumption								
			6404 E2		0651 E2		0286 E2		Service	Subtotal	
	Date	Days	kWh	ZAR	kWh	ZAR	kWh	ZAR	Charge (ZAR)	kWh	ZAR
1	12 Apr - 12 May 2021	30	3,713.00	9,862.84	1,033.00	2,743.96	3,921	10,415.35	1,076.63	8,667	24,098.78
2	09 Mar - 12 Apr 2021	34	3,005.00	7,982.18	917.00	2,435.83	3,868	10,274.57	1,076.63	7,790	21,769.21
3	10 Feb - 09 Mar 2021	27	2,785.00	7,397.80	831.00	2,207.39	3,790	10,067.38	1,076.63	7,406	20,749.19
4	08 Jan - 10 Feb 2021	33	1,590.00	4,223.52	332.00	881.89	1,373	3,647.10	1,076.63	3,295	9,829.14
5	08 Dec 20 - 08 Jan 21	31	3,102.00	8,239.84	944.00	2,507.55	4,049	10,755.36	1,076.63	8,095	22,579.38
6	09 Nov - 08 Dec 2020	29	2,926.00	7,772.33	1,003.00	2,664.27	3,904	10,370.20	1,076.63	7,833	21,883.43
7	09 Oct - 09 Nov 2020	31	3,006.00	7,984.84	988.00	2,624.42	4,037.00	10,723.48	1,076.63	8,031.00	22,409.38
8	09 Sep - 09 Oct 2020	30	3,075.00	8,168.12	749.00	1,989.57	3,813.00	10,128.47	1,076.63	7,637.00	21,362.79
9	11 Aug - 09 Sep 2020	29	3,837.00	10,480.77	876.00	2,392.79	3,988.00	10,893.22	1,076.63	8,701.00	24,843.41
10	10 Jul - 11 Aug 2020	32	4,015.00	10,966.97	890.00	2,431.04	3,662.00	10,002.75	1,076.63	8,567.00	24,477.39
11	04 Jun - 10 Jul 2020	36	5,111.00	13,676.01	1,052.00	2,814.94	4,365.00	11,679.87	1,013.49	10,528.00	29,184.31
12	11 May - 04 Jun 2020	24	3,590.00	9,341.54	983.00	2,557.86	2,746.00	7,145.37	1,013.49	7,319.00	20,058.26
13	07 Apr - 11 May 2020	34	2,075.00	5,399.36	407.00	1,059.05	1.00	2.60	1,013.49	2,483.00	7,474.50
14	12 Mar - 07 Apr 2019	29	3,287.00	7,638.66	942.00	2,189.11	3,835.00	9,979.05	896.34	8,064.00	20,703.17
15	10 Feb - 11 Mar 2020	30	3,587.00	9,333.73	1,090.00	2,836.29	4,244.00	11,043.31	1,013.49	8,921.00	24,226.82
16	14 Jan - 10 Feb 2020	27	2,901.00	7,548.69	757.00	1,969.79	3,767.00	9,802.11	1,013.49	7,425.00	20,334.08
17	06 Dec 19 - 14 Jan 20	39	1,579.00	4,108.72	438.00	1,139.72	2,059.00	5,357.72	1,013.49	4,076.00	11,619.65
18	11 Non - 06 Jan 2019	25	2,943.00	7,657.98	1,012.00	2,633.33	3,895.00	10,135.18	1,013.49	7,850.00	21,439.98
19	11 Oct - 11 Nov 2019	31	3,441.00	8,953.83	1,236.00	3,216.20	4,462.00	11,610.57	1,013.49	9,139.00	24,794.08
20	11 Sep - 11 Oct 2019	30	3,778.00	9,830.73	1,467.00	3,817.28	4,179.00	10,874.18	1,013.49	9,424.00	25,535.68
Average		**31**	**3,167.30**	**8,328.42**	**897.35**	**2,355.61**	**3,497.90**	**9,245.39**	**1,039.20**	**7,562.55**	**20,968.63**
Total			**63,346.00**	**166,568.46**	**17,947.00**	**47,112.27**	**69,958.00**	**184,907.84**	**20,784.05**	**151,251.00**	**419,372.63**

Table 4 below provides a summary of total energy consumption and cost for 20 months and further estimates energy performance for 12 months for the purpose of Solar PV System sizing.

Table 4: Estimated annual consumption

Energy usage data	20 months		Monthly Ave	12 months Estimate	
Energy	151,251.00	kWh	7,562.55	90,750.60	
Energy Cost	398,588.58	ZAR	19,929.43	239,153.15	
Fixed Service Charge	20,784.05	ZAR	1,039.20	12,470.43	

4.2 Baseline Establishment

Due to the challenges of non-availability of production figures, the baseline analysis could not be determined using the regression analysis tool.

4.3 Identification of Significant Energy Users

Significant energy users installed in the factory with their estimated capacities are presented in Table 5 below. Data to determine the installed capacities was obtained from the nameplates of the equipment. Normally, actual demand and energy use is lower because equipment is not switched on all the time and when running, it is loaded between 50 and 75% of its rated capacity.

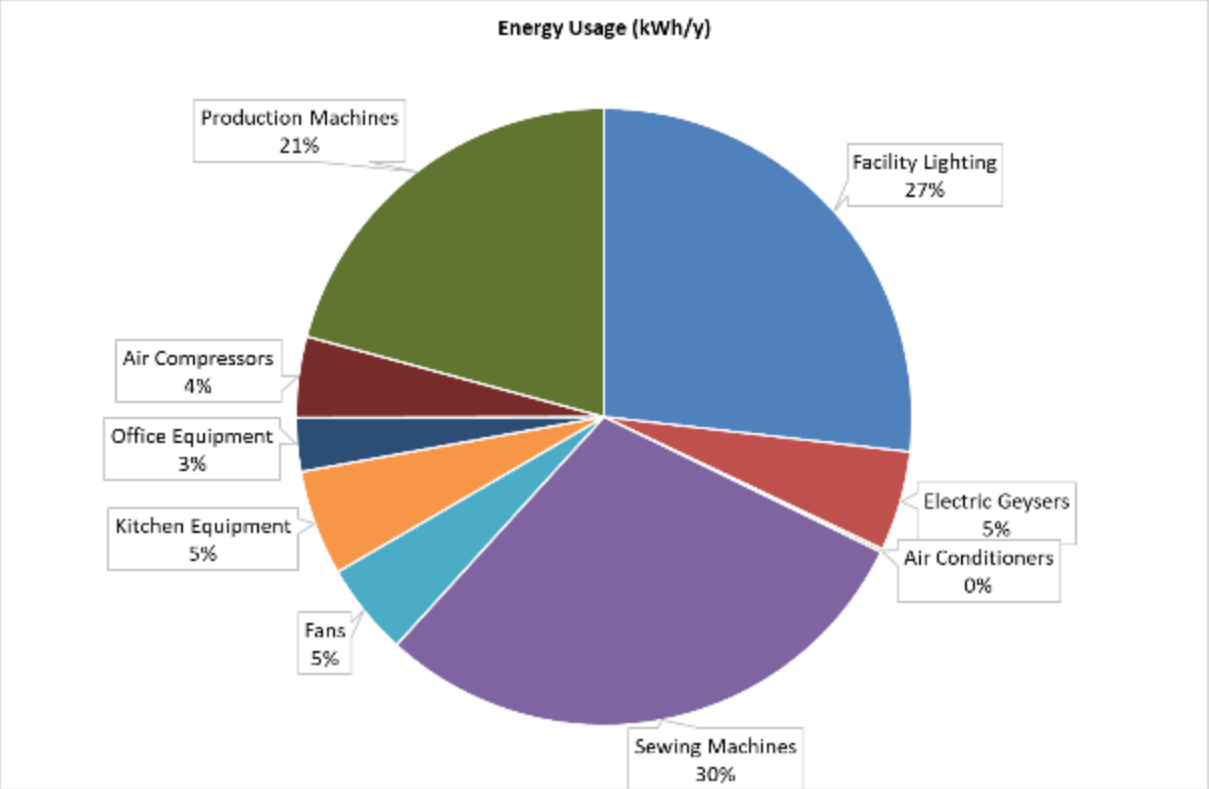
Table 5: Installed capacity & estimated energy usage

No	End-Use Equipment	Estimated Installed Capacity (kW)	Energy Usage (kWh/y)	%
1	Facility Lighting	18.12	24,354.62	26.8%
2	Electric Geysers	11.00	4,752.00	5.2%
3	Air Conditioners	0.88	158.40	0.2%
4	Sewing Machines	53.75	26,832.00	29.5%
5	Fans	3.40	4,411.58	4.9%
6	Kitchen Equipment	24.92	5,023.87	5.5%
7	Office Equipment	1.70	2,545.92	2.8%
8	Air Compressors	13.37	3,850.56	4.2%
9	Production Machines	112.87	18,897.31	20.8%
	Total	**127.15**	**90,826.27**	**100.0%**

The energy usage figures are based on estimated time the machines are running. These considered operating schedules, demand factor[1] and estimated percentage of sewing motor loading. Motor loading is usually assumed to be 75%. Although the machines, other than sewing machines, have the highest installed capacity, they are not operated all the time. In this factory, it is mainly the lights and sewing machines which are used more.

[1] Demand factor is the ratio of the sum of the maximum demand of a system to the total connected load on the system. Demand factor is always less than one

Chart 2 : Significant Energy User Breakdown



Since sewing machines and lighting consume about 60% of total energy consumed, focus should be on these significant users. On sewing machines, the focus is only on the machines which use conventional motors. Electric geysers, although they have a small contribution, can still be replaced with either solar water heaters or heat pumps.

4.4 Site Energy Consumption

This section provides an analysis of the energy consumption data at the factory in order to establish a relationship between consumption and the relevant variables (drivers) that influence this consumption. In an ideal world, the product output volumes of cheese and yoghurt would be the primary drivers of energy consumption. However, there is sometimes an added complexity where one or more other factors may influence energy consumption. Where there is significant heating and cooling equipment, these additional factors may include weather data such as cooling degree days (CDD) and heating degree days (HDD). In this case, there is no significant heating and cooling as part of production. The high frequency heaters use induction heating technology which is efficient.

Table 6: Summary of energy consumption (July 2019-June 2020)

Item No	Meter Reading Dates		Energy Consumption								
			6404 E2		0651 E2		0286 E2		Service	Subtotal	
	Date	Days	kWh	ZAR	kWh	ZAR	kWh	ZAR	Charge (ZAR)	kWh	ZAR
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16	14 Jan - 10 Feb 2020	27	2,901.00	7,548.69	757.00	1,969.79	3,767.00	9,802.11	1,013.49	7,425.00	20,334.08
17	06 Dec 19 - 14 Jan 20	39	1,579.00	4,108.72	438.00	1,139.72	2,059.00	5,357.72	1,013.49	4,076.00	11,619.65
18	11 Non - 06 Jan 2019	25	2,943.00	7,657.98	1,012.00	2,633.33	3,895.00	10,135.18	1,013.49	7,850.00	21,439.98
19	11 Oct - 11 Nov 2019	31	3,441.00	8,953.83	1,236.00	3,216.20	4,462.00	11,610.57	1,013.49	9,139.00	24,794.08
20	11 Sep - 11 Oct 2019	30	3,778.00	9,830.73	1,467.00	3,817.28	4,179.00	10,874.18	1,013.49	9,424.00	25,535.68
Average		**31**	**3,167.30**	**8,328.42**	**897.35**	**2,355.61**	**3,497.90**	**9,245.39**	**1,039.20**	**7,562.55**	**20,968.63**
Total			**63,346.00**	**166,568.46**	**17,947.00**	**47,112.27**	**69,958.00**	**184,907.84**	**20,784.05**	**151,251.00**	**419,372.63**

Table 7: Estimated Annual Consumption Figures

Energy usage data	20 months		Monthly Average	12 months Estimate
Energy	151,251.00	kWh	7,562.55	90,750.60
Energy Cost	398,588.58	ZAR	19,929.43	239,153.15
Fixed Service Charge	20,784.05	ZAR	1,039.20	12,470.43

The regression analysis would ideally have been done comparing energy used against the main energy drivers. However, this was not possible. Electricity figures are accurately measured, but production data is not, due to the large variety of products made.

The limitations on the available data include.

- **Production data** – Jodam Manufacturers makes a large variety of products, and it was impossible to collate these figures on a month-to-month basis. The alternative was collating the main input materials, i.e., paper, plastic, fabric, and PVC. Unfortunately, this also was not possible since materials are only purchased for the specific product being made. This does not follow a regular pattern also. This makes regression analysis impossible.
- **Weather data-** Weather data is also used where there is significant heating and cooling. There is no such in the production process. The weather driver will also not be used.

5. DETAILED ASSESSMENT FINDINGS AND RECOMMENDATIONS

5.1 Installation of an Uninterruptible Power Supply (UPS)

Due to frequent loadshedding, a 60kVA UPS system was recommended to lessen the impact on electronic equipment in the plant. The cost for the system is given below:

- 1 x 60kVA UPS R196,800
- Delivery and rigging R8,750
- Modular battery cabinet, + internal batteries R390,600

Total investment cost is R587,670. Alternatively, a normal surge protector could be procured at a lesser cost to protect the equipment from damage when power comes back.

5.2 Upgrade Lights to lower wattage LEDs

The current lights are a mix of LEDs and fluorescent tubes. The table below gives a summary of the lighting inventory, as well as the proposed replacements. It is recommended that all lights be upgraded to LED lighting technology to reduce energy costs.

Table 8: Summary of lighting fixtures

Qty	Description	Watts/Fixture	Description	Watts/Fixture
Existing Fixtures			**Proposed Fixtures**	
11	1 x 11W CFL bulb	13	1x 5W LED bulb	5
4	2 x 18W, Fluo tube, 2ft (600mm)	40	2 x 9W, LED tube, 2ft (600mm)	18
9	1 x 28W 2D Lamp	30	1 x 16W 2D Lamp	16
14	1 x 36W, Fluo, 4ft (1200mm)	40	1 x 18W LED tube, 4ft (1200mm)	18
110	2 x 58W, Fluo, 5ft (1500mm)	124	2 x 22W LED tube, 5ft (1500mm)	44
7	3 x 36W, Fluo, 4ft (1200mm)	120	3 x 18W LED tube, 4ft (1200mm)	54
11	4 x 36W, Fluo, 4ft (1200mm)	160	1x 60W Panel LED + Sensor	60
166				

It is recommended that the light upgrade be done inhouse as it is not complicated and if done at once, the impact will be greater. The energy savings and CO_2 emission reduction are given below:

- Power reduction 11.3kVA
- Energy reduction 11,960kWh/y
- Energy cost reduction R28,030/y
- Investment R73,710
- Payback period 2.6
- Carbon dioxide (CO_2) reduction 12.5ton/r

5.3 Natural Lights: Skylights or Translucent Sheets

Skylights or translucent sheets are recommended for the sewing room which is on the first floor of the building to reduce on energy consumption. With a combination of light intensity sensors and natural lighting, the energy consumption can be reduced considerably.

According to Google Earth, the roof area is 740m^2, assume that 10% can be covered with translucent sheets at an estimated cost of 10 x R500, plus installation at R20,000 for accessories and labour. Since the lighting load for the top floor is estimated at 12,240kWh/y, a 30% reduction will be about 3,672kWh/h translating into R8,610/y savings at R2.3448/kWh. The potential savings are summarised below:

- Energy reduction 3,670kWh/y
- Energy cost reduction 8,610/y
- Investment + installation R25,000
- Simple payback period 2.9y
- Carbon dioxide (CO_2) reduction 3.8ton/y

According to the suppliers, the lifespan of the sheets is estimated to be 10-15years. This option may not be possible if the recommendation for solar PV installation is considered at the same time.

5.4 Water Heating: Heat Pump Option

The provision of hot water mainly for the toilets/bathroom is by electric geysers. There is an option of solar water heaters or heat pumps to be considered for energy savings. The solar water heating option has a requirement for additional plumbing due to the roof height and distance from application areas. The list of installed geysers is given in the table below.

Table 9: Inventory of electric geysers

Area	Geyser Capacity	Qty	Existing Geyser Element Size (kW)	Water Usage per geyser (L/day)[1]
Production Floor Toilets	150	1	3	200
Toilet	150	1	3	200
First Floor Supervisor Kitchen	50	1	2	
Reception geyser	150	1	3	200
Total		**4**	**11**	

Heat pumps are ideal for the water heating application, and it is recommended to instal 3 x 3.2kW heat pumps to supply hot water for the change rooms. The 50L electric geyser in the in the kitchen on the first floor can be replaced with an under-sink water heater.

The estimated savings are summarised below:

- Electrical demand reduction 3.6kVA
- Electrical energy savings 4,550kWh/y
- Electrical energy cost reduction R10,680/y
- Investment R55,500
- Payback period 5.2 years
- Carbon dioxide CO_2 reduction 4.7 ton/y

5.5 Install a Grid-Tied Solar PV System

Since Jodam manufacturers operate only during the day, renewable energy can be generated and be used to supply some, or all the energy required to operate the plant. There is an estimated 320m^2 north-facing roof space which can utilised to install solar PV panels. Based on the estimated 12-month energy consumption of 90,750.60 kWh calculated earlier, it is

possible to run the entire plant on renewable energy, considering that about 110,000 kWh/y energy can be supplied from the available roof space.

Table 10: Solar PV System Sizing

Factory Annual Energy Consumption					**90,750.60**	**kWh**
Canadian Solar 450W Monocrystalline Solar Panel	Size	Performance Factor	Peak Sun Hours	Daily Energy		Annual Energy
	Wp	%	H	Wh	kWh	kWh/y
	450	75%	5.63	1,900.13	1.90	653.64
Energy supply by 170 panels, plusu 20%, is estimated at					110,000.00	kWh/y
Required solar PV modules					168.30	
Required solar PV modules (rounded figure)					170.00	
Peak power, kWp					76.50	kWp
Roof space required (rounded figure)			417+163+325		340	m2
Estimated installation costs (grid-tied system)					18,000	R/kWp
Total estimated installaiton costs					1,377,000	Rands
Estimated energy reduction					110,000	kWh/y
Demand reduction					76.5	kVA
Energy						
Electricity Tariff					R2.3448	R/kWh
Total estimated cost savings					257,928	ZAR/y
Estimated investment (materials)					1,377,000	ZAR
Installation costs @				15%	206,550	ZAR
Total estimated costs					1,583,550	ZAR
Estimated payback					**6.14**	years

The estimated energy savings and required investments are summarised below, based on a 75kW PV system. This is limited by the available north-facing roof.

- Energy savings (alternative energy) 110,000kWh/y
- Energy cost savings R257,930/y
- Investment with R1,583,550
- Payback period 6.1y
- Carbon dioxide (CO_2) reduction 115ton/y

The bill of quantities of this system are estimated in the table below.

Table 11: Bill of Quantities

JODAM MANUFACTURING			
PRODUCT DESCRIPTION	**QUANTITY**	**Item cost in Rand**	**Total Cost**
SOLAR COMPONENTS			
Solar Panels - Solarworld 320W XL Mono	170	R3,712.00	R631,040.00
Solar Bracket Mounting Kit (IBR Roof)	170	R500.00	R85,000.00
Dc Combiners / Surge Arrestors / Panel fusing	8	R5,950.00	R47,600.00
Cabling & connectors	2860	R21.19	R60,603.40
Consumables, trunking / cable securing	10	R16,923.75	R169,237.50
Earthing cable, fittings, etc	340	R21.35	R7,259.00
Total for Solar Components			R1,000,739.90
INVERTER & AC COMPONENTS			
ABB PRO-33.0-TL-OUTD-SX400 inlcuding VSN logger Card	2	R82,124.25	R164,248.50
3 Phase Board / Cabling % Isolators	2	R21,001.25	R42,002.50
Total for Inverter & Ac components			R206,251.00
METERING & REMOTE ADMINISTRATION			
Anti - Reflux with shine web box	1	R17,924.00	R17,924.00
Wireless Router	1	R3,500.00	R3,500.00
Network Cabling provision	320	R11.33	R3,625.60
Total for Metering & Remote Administration			R25,049.60
Installing & Comisoning			
Installation of Pv Mounting Rails and Panels	170	R988.38	R168,024.60
Mounting Inverters, enclosures and AC wiring	2	R15,877.50	R31,755.00
Plant hire provision / Sundries	2	R45,000.00	R90,000.00
Applications / COC	2	R30,787.50	R61,575.00
Total for installation			R351,354.60
Total for the supply and installation of Grid-tied PV system Excluding VAT			**R1,583,395.10**

5.6 Production Machines (Sewing & Forming)

The machines used in the factory are listed in the annexures. Some are new and others are quite old. Of interest are older version of sewing machines and vacuum forming machine.

5.6.1 Sewing Machines

There is a total of 95 sewing machines. Two (2) main issue is related to these machines, energy usage and harmonic interference. On harmonic interference, this affects machine close to a high frequency heater. This can be addressed by installing a harmonic filter. This has not been done yet since as it requires doing the measurements first. The cost of measurements was not budgeted for. The Consultant could have used own power and harmonic analyser, but it required opening the power supply point which wasn't safe to do. The second issue is the 2 different kinds of motor drives for the sewing machines. One type uses the conventional motors and the other are energy savings motors.

Recommendations 1: Measure the harmonics from the high frequency heater and appropriately size the required filter. Harmonics cause the malfunction of some of the machines close to the HF heater. If these machines breakdown, it is a loss of production and the machines themselves. Sewing machine costs range from R5,000 to R10,000 or higher. This measurement of harmonics was priced at about R9300. A 100A active filter costs about R24,000. See attached quotation, Annexure 04: Harmonic Survey Quotation

APF 100A Active Power Filters, 97% harmonic wave. R24,000 including installation. Survey, R9300.	

Excluding production loss, if 2 x R10,000 sewing machines fail, that is R20,000 loss. Installation and measurement costs are about R33,300. The simple payback period of investing in harmonic filter is 1.7y. This is much lower is production loss is included.

Recommendations 2: For sewing machines, 50 of the 95 sewing machines use conventional motors and the balance of 45 use energy efficient motors. The principle of operation of standard motors versus energy efficient motors is shown in the graph below. This is based on manufacturer's literature. Annexure 04: Inventory of Sewing Machines

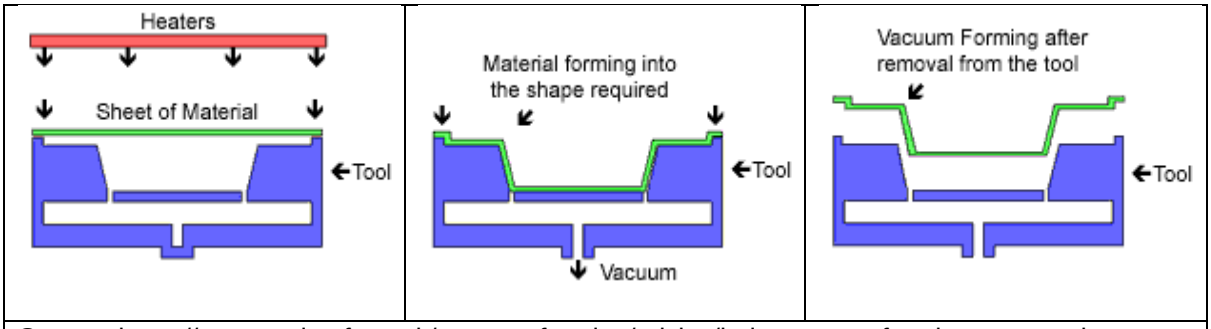
Graph 2: Energy use comparison

Energy saving motors are estimated to reduce energy consumption by 40 – 60%. Based on estimated energy usage, the machines with conventional motors are estimated to use 16,848kWh/y. A 40% energy saving will be 6,740kWh. If these are replaced with energy efficient ones at R6,500 each, the total investment is R325,000 and energy cost savings of R15,240/y. The payback period is rather too long at 21years. This is not economical, and the recommendation is to replace them on a gradual basis each time a machine fails.

5.6.2 Vacuum Forming Machine

The vacuum forming machine was initially installed in 1974 by the previous owner. The machine is used to make different types of shapes from a plastic. The process involves placing a plastic sheet on a die or tool. A 4,73kW heater bank is placed on top and a vacuum is created beneath the heated sheet using compressed air to take the desired shape. Cooling is by means 2 x 0.75kW fans.

Figure 3: Vacuum forming process



Source: https://www.toolcraft.co.uk/vacuum-forming/advice/help-vacuum-forming-process.htm

Figure 4: Old Vacuum Machine

Plastic from the roller is placed on a die and the heating bank is place on top. The 2 cooling fans on either side

The main challenge of the machine is frequent breakdowns and a high number of defects generated. Due to the large variety of products made, it was not possible estimate, the cost of breakdowns and defects. One reason being that the machine makes semi-products which feed into the main product being produced. For example, a particular shape could only be 15% input material for a bag.

The general recommendation is to replace this machine with a newer energy efficient one. Quotations were obtained from High Frequency Heating (Pty) Ltd, a company which supplies such machines. The 2 prices were R270,000 for a semi-automatic machine and R534,750 for a fully automatic machine. An attempt to get a replica replacement from the original manufacturer did not yield any positive results.

6. IMPLEMENTATION PLAN

6.1 Quantitative measures

No.	RECP Opportunities (See corresponding Excel Sheets for details)	Projected Annual Savings			Investment	Payback	Priority Ranking
		Energy	Cost	CO_2 Emissions	(R)	(Years)	
		(kWh)	(R/year)	(tonnes)			
1	Upgrading the existing lighting fixtures to lower wattage LED fixtures with sensors.	11,956.07	28,034.59	12.46	73,712.70	2.63	High
2	Install translucent sheets to make use of natural lighting and save on energy	3,670.00	8,605.42	3.83	25,000.00	2.91	Low
3	Retrofit the existing electric geysers with a heat pump	4,552.93	10,675.71	4.75	55,500.00	5.20	High
4	Replace the old airconditioner with inverter technology AC.	748.80	1,755.79	0.78	17,010.00	9.69	Low
5	Replace the 50L electric geyser with an under-sink instant water heater	1,100.00	2,580.00	1.15	3,500.00	1.36	High
6	Install a solar PV System to suppplement exisiting electrical energy supply to the factory	110,000.00	257,928.00	114.68	1,583,550.00	6.14	High
	Sub-total	**132,027.80**	**309,579.51**	**137.64**	**1,758,272.70**	**5.68**	

No.	Water	Projected Annual Savings		Investment	Payback	
		Water	Cost	(R)	(Years)	
		kL	(R/year)			
1	Install aerators on water taps to reduce amount of water used	97.00	7,780.00	15,000.00	1.93	High
2	Install dual-flush toilets, but this should be accompanies with awareness training on use	128.00	10,300.00	15,600.00	1.51	High
3	Install a counter-current rinsing system to reduce water use. The final effluent should disposed at licensed hazardous waste site	32.40	4,330.00	64,500.00	14.90	High
	Sub-total	**257.40**	**22,410.00**	**95,100.00**	**4.24**	
	TOTAL		**331,989.51**	**1,853,372.70**	**5.58**	

7. CONCLUSION

The general conclusion is that there are energy saving opportunities within the Jodam Manufacturers operations that can reduce energy savings and carbon emissions if implemented. Excluding Solar PV, electricity savings are estimated at 24% of current usage (22,030kWh/).

Since Jodam manufacturers operate only during the day, renewable energy can be generated and be used to supply some, or all the energy required to operate the plant. There is an estimated 320m^2 north-facing roof space which can utilised to install solar PV panels. Based on the estimated 12-month energy consumption of 90,750.60 kWh calculated earlier, it is possible to run the entire plant on renewable energy, considering that about 110,000 kWh/y

energy can be generated from the installation of solar PV using the available roof space. The investment required is estimated at around R1.6m with a payback period of about 6.14 years. This is a good opportunity for the company since electricity is the only energy source consumed on site.