Case Study

Company name	Toyota Boshoku South Africa Pty Ltd					
Size of company (Based on energy consumption bill)	**SMME** (R250 k – R750 k)		**Medium** (R750 k – R24 m)	**X**	**Large** (Above 24 m)	
Sector	Automotive					
Location	1 Beechgate Crescent, Umbogintwini, KwaZulu-Natal					
Company contact	**Name:** Norman Pillay				**Position:** Production Engineer	
	Email: Norman_Pillay@Toyota-Boshoku.sa.com				**Telephone:** +27 (31) 949 4075	
Year joined project	2012					
Date of implementation	April 2018 to March 2019		**Duration**		12 months	
Utility intervention	Installed energy efficient lighting in the canopy area and perimeter, VSD on extractor fans, master switch for ventilation fans, and replaced the heating ventilation and air-conditioning (HVAC) split-units with inverter model. Upgraded the process plant by installing energy efficient cutting machines, process heating upgrade, and replacing the electrical steam boiler with a smaller decentralised system, Switched off cooling the tower fan, switched off domestic hot water supply (DHWS) to ablutions, and implemented a compressed air leak management programme using a tag system.					
Case study author	Mr Prithum Raggo					
Project manager	Ms Bianca Latchman					

1. BACKGROUND

1.1 Company profile

Although founded in 1918 in Japan, the Toyota Boshoku Corporation was officially established in 1950, and a subsidiary of which was opened in 2006 in South Africa. The site currently employs over 1000 staff members and operates on a three-shift cycle for 24 hours over a six-day period for 40 weeks per annum.

The major manufacturing operations are as follows:

- plastic extrusion
- spray painting
- welding
- sewing
- ironing
- PU & metal press.

Key Products:

Toyota Boshoku South Africa (TBSA) manufacture a variety of car seats and door panels.

1.2 Plant Profile

The TBSA site is located on 1 Beechgate Crescent, South Gate Industrial Park in Umbogintwini, Durban. It is comprised of a single large building, that houses the manufacturing plant, the administration and all associated activities within a 26 000m² footprint. TBSA uses approximately 8 million kWh of electricity annually. The plant's significant energy users (SEU) are the: air compressors, lighting, DHWS, plant processes (welding, sewing, PU, metal press, injection molding etc.), heating, and the HVAC systems. The drivers for reducing TBSA's energy usage and carbon footprint are as follows:

- A directive received from the Toyota Boshoku headquarters in Japan to reduce energy consumption and carbon footprint as part of their global environmental strategy.
- Compliance requirements in accordance with Toyota's main factory. As part of the value chain, Toyota's main factory has initiated a drive to reduce energy consumption of their suppliers with a programme called Go Green.

1.3 Nature of the challenges

Initially, TBSA engaged the National Cleaner Production Centre South Africa (NCPC-SA) through an energy efficiency assessment carried out at their facility in 2012. Like many businesses around the country, they had felt the repercussions of the global recession as well as the rising cost of electricity in South Africa. Toyota Boshoku believed that electricity consumption could be managed effectively if their personnel were well-informed and were guided to identify existing opportunities within their facility for reducing energy consumption, resulting in their participation in the NCPC-SA Industrial Energy Efficiency (IEE) Project.

1.4 IEE capacity building programme

The staff within TBSA underwent training every six-months covering 5S, six sigma, and safety. The aim of the training is to improve production efficiencies. TBSA plan to incorporate environmental training covering energy management and efficiency as part of their ongoing toolbox talks that are held daily. TBSA understands that there is a gap on energy specific systems training, and are keen to engage with the NCPC-SA for assistance.

2. KEY ACHIEVEMENTS

Key findings table

Implementation period	April 2018 - March 2019
Total number of project	9
Monetary savings in ZAR	R833 427
Energy savings in GJ	3 571.83
Total investment made ZAR	R3 817 126
Overall % of total consumption saved	12.4%
Total savings from no cost interventions	R348 449
Payback time period in years	3.5
GHG emission reduction (tonne CO_2e)[1]	949.5
Number of females employed prior to implementation	366
Number of females employed after implementation	389

Following the NCPC-SA engagement, nine projects have been implemented as highlighted below:

1. Installation of energy efficient lighting on canopy and perimeter areas
2. Installation of variable speed drive (VSD) on extractor fans for welding areas
3. Installation of master shut-off switch for ventilation fans throughout factory
4. HVAC split units replaced with an inverter type in the clinic
5. Process plant upgrade (installation of new Electra cutting machine that is energy efficient)
6. Process heating upgrade (replace electrical steam boiler with a smaller decentralised system)
7. Switched off cooling tower fan
8. Switched off the DHWS in ablutions and canteen areas, and installed timers on hydro-boils
9. Implemented a compressed air leak management programme via a tag system.

3. IMPLEMENTATION CHALLENGES

Some challenges and delays were experienced with the implementation, due to the need for shutdown of production to effect the changes. As some of the interventions required up to two-days to install, this had to be aligned with planned shut downs to minimise plant disruption.

Measurement and verification of energy savings for the individual projects proved to be a challenge, given that the existing measurement and metering configuration was could not collate the required data to establish baselines for each intervention. As a result, the savings reported reflect the combined total of all the interventions implemented.

The current strained economic climate has also had a significant impact on implementation, with TBSA facing local budget constraints for project implementation. Toyota Boshoku Global is currently running a campaign

[2] Should the kWh rate be unknown use R0.84c /kWh

to reduce their carbon emissions to 0% by 2050 and has assisted the SA project team with funds to implement some of the projects identified.

4. HIGHLIGHTS OF OPERATIONAL/ESO INTERVENTIONS

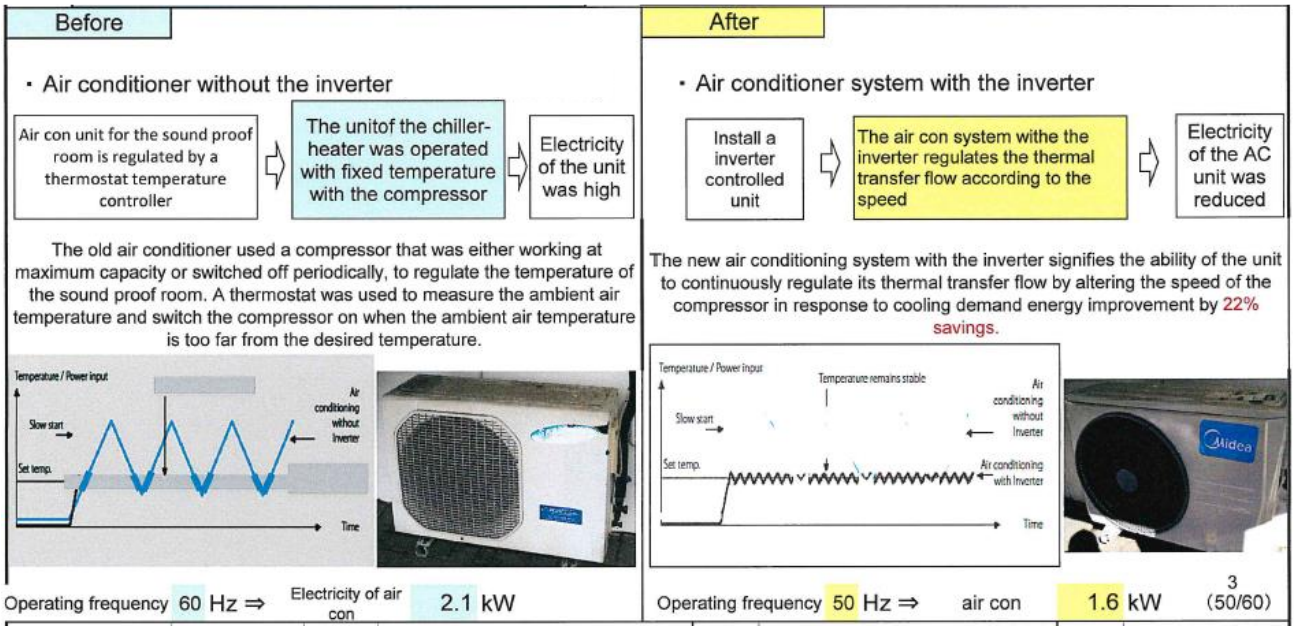
4.1 Interventions Implemented

1. **Energy efficient lighting**
    - A total of 48 fixtures were replaced towards the end of February 2019 after the plant changed canopy lighting from 5ft, 2x54 W T5 linear fixtures to a single 5ft, 60 W LED linear fixture that is controlled via photocells.
    - The plant replaced perimeter bulkheads comprising of 2x20 W CFL with new single 15 W LED bulkheads. Implementation was completed towards the end of September 2018.

2. **VSD control**
    - A VSD control was installed on the welding area extractor fan (approx. 11 kW). The welding process has the capability of operating six welding bays simultaneously. However, at any given time, only three welding bays are operational. The welding bays have an extraction fan running at full-speed based on all six bays operating. Following a review of the welding area operation, TBSA installed a VSD control on the extractor fan motor to adjust the speed and maintain sufficient draught to remove unwanted fumes from the welding process area, and based on the number of welding machines that are operational. This project was implemented in July 2018.

3. **Master shut-off switch**
    - A centralised master shut-off switch was installed for all 25 industrial ventilation fans (rated at 180 W each) that are located throughout the factory. The initial arrangement was for the ventilation fans to run 24/7. Following the master switch installation, the ventilation fans are shut down after each production shift, reducing the run time to 16 hours per day. This project was implemented in July 2018.

4. **HVAC retrofit**
    - The HVAC split unit (18000 btu) located in the clinic was replaced with an equivalent inverter type HVAC split unit (18000 btu). The project was implemented in October 2018. The synopsis of the project implementation follows:



5. **Process plant upgrade**
    - Installed energy efficient cutting machines. Two new Electra cutting machines were installed at the TBSA plant. They each rated at 27 kW compared with the previous models at 38.5 kW. This project was implemented in September 2018.

6. **Process heating upgrade**
    - Replaced the electrical steam boiler with a smaller decentralised system. The original 90 kW electrical steam boiler, which operated 232 days per annum (24 hours for six days per week) servicing 12 ironing points, was replaced by seven 5.5kW irons operating 232 days per annum (16 hours for 6 days per week). This project was implemented in August 2018.

7. **Cooling circuit optimisation**
    - Switched off redundant cooling tower fan. The cooling tower has 2x11 kW fans which are used to provide the heat rejection from the cooling tower. Upon review of the cooling requirements, TBSA was able to shut off one of the 11 kW fans. This project was implemented in April 2018.

8. **Hot water supply optimisation**
    - Switched off two redundant 3 200 litre DHWS tanks with 48 kW resistive heating element.
    - Switched off three of the four high-pressure geysers (150 L) with 3 kW resistive elements and retained one operational for canteen requirements.
    - Installed timers on hydro boil units (4 x 25 litre) with 3 kW heating elements. Timers are set to initiate heating 15 minutes before tea and lunch breaks and shut off afterwards.

    This project was implemented in November 2018.

9. **Compressed air leak management**
    - Introduced a leak tagging system on site for rapid response by the maintenance team. This project was implemented in June 2018.

10. **On-line monitoring and metering**
    - Installed an online monitoring system to compare electrical consumption with production output.

4.2 Savings determination (for each intervention separately if possible and then a whole facility savings determination as well)

Month	Year	Product shipped (Tonnes)	Actual consumption (kWh)
Apr	2017	6 217	567 352
May	2017	11 313	749 784
Jun	2017	12 168	752 048
Jul	2017	10 191	729 816
Aug	2017	13 989	839 240
Sep	2017	11 932	785 104
Oct	2017	8 592	716 112
Nov	2017	13 829	827 328
Dec	2017	7 218	580 248
Jan	2018	12 435	806 576
Feb	2018	12 032	776 272
Mar	2018	11 202	761 296

Table 1: TBSA data for regression

The data illustrated within the table has been modelled to develop the baseline for the TBSA site. The model was developed using the principal of regression analysis.

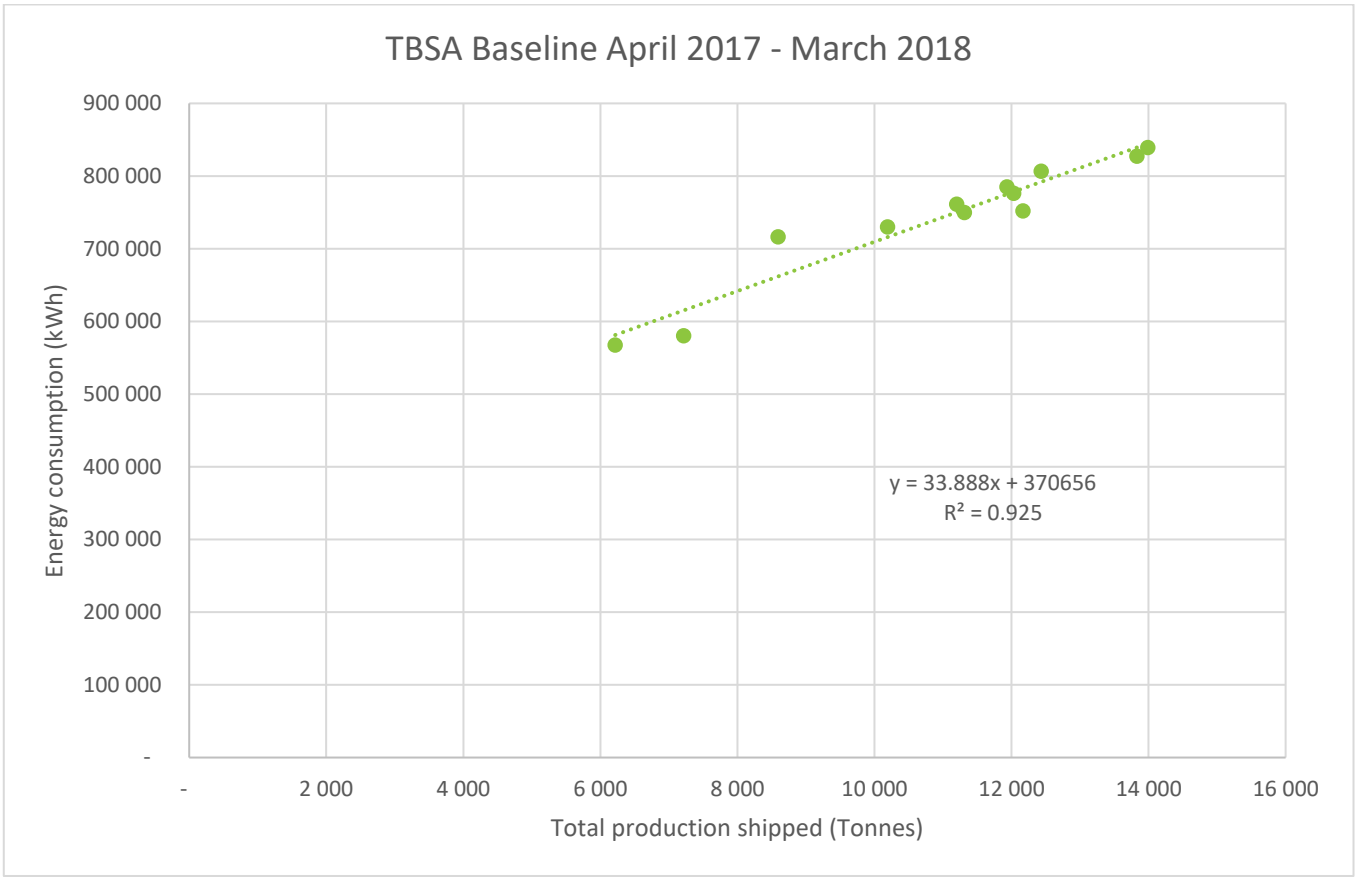


Figure 1: Regression analysis baseline for the TBSA plant

Figure 1 provides a graphical representation of the production shipped versus energy consumed. The best-fit line regression analysis yielded a coefficient of determination (R^2) of 0.9249. The R^2 provides a measure of how well the best-fit line is able to predict the energy consumption for a given production shipped. Typically, an $R^2 > 0.75$ would be considered acceptable.

Regression Statistics	
Multiple R	0.961755244
R Square	0.92497315
Adjusted R Square	0.917470465
Standard Error	24795.08942
Observations	12

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	75795560971	75795560971	123.2856173	6.0426E-07
Residual	10	6147964592	614796459.2		
Total	11	81943525563			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	370656.2147	34107.39822	10.86732598	7.37912E-07	294660.1956	446652.2339	294660.1956	446652.2339
Total production shipped/per set	33.88780658	3.052019138	11.10340566	6.0426E-07	27.08748416	40.688129	27.08748416	40.688129

Figure 2: Results of the regression analysis

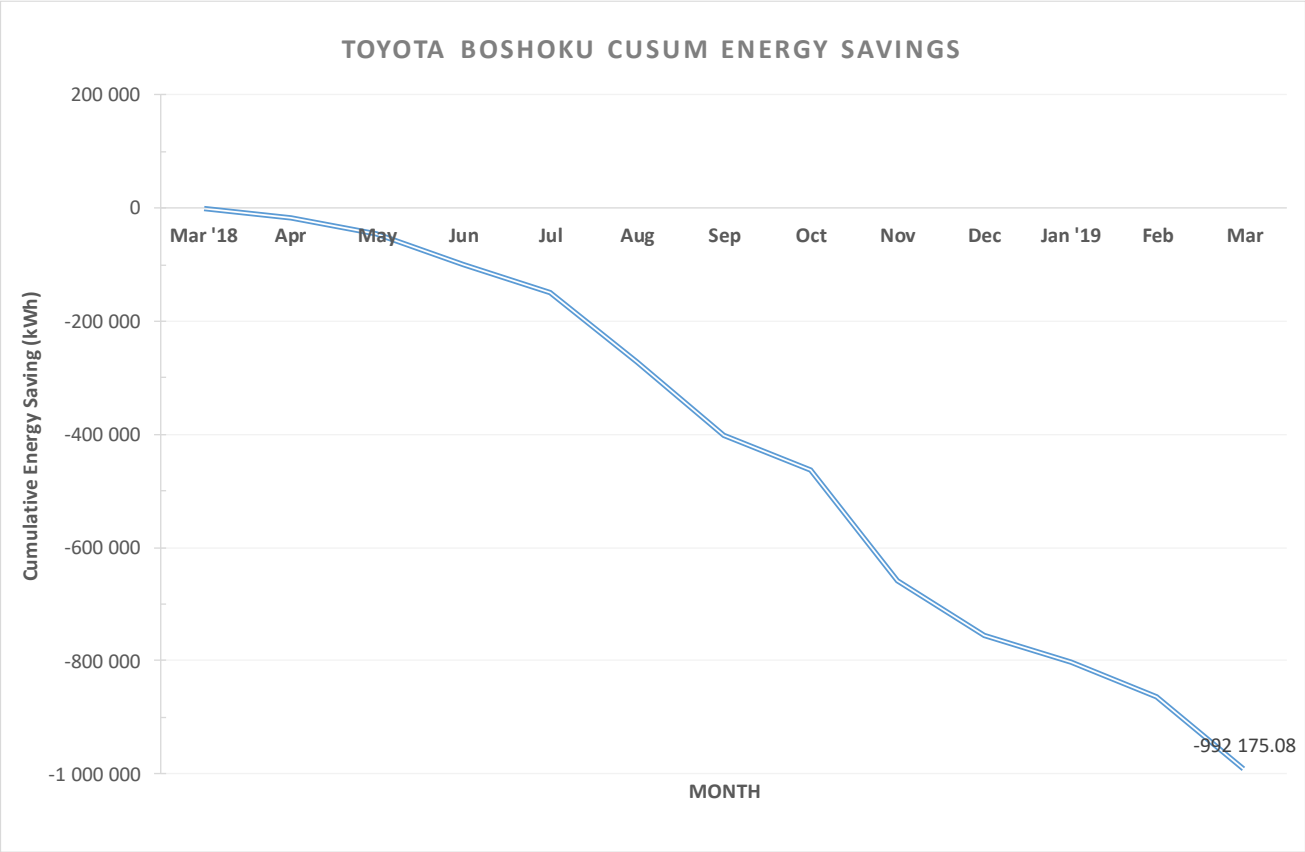


Figure 3: Cusum energy saving.[2]

Project implementation began in April 2018. Figure 3 illustrates the cumulative savings derived from the difference between actual energy consumption and the baseline expected energy consumption. The total savings realised from April 2018 to March 2019 amounted to 992 175 kWh, which translated to a 12.4% energy reduction (calculated against the baseline period April 2017 to March 2018).

4.3 Summary of all interventions

Energy uses/users	Energy sources	Intervention	Utility saving Period	Investment (ZAR)	Savings (ZAR/yr)	Payback (Yrs)	Utility saving (GJ)	GHG emission reduction (tonnes CO_2e/yr)
Canopy lighting	Electrical	Linear florescent to LED	2018					
Security/ Perimeter lighting	Electrical	Bulkheads CFL to LED	2018	37 890			3 572	950
VSD on extractor	Electrical	VSD on extractor welding area	2018	19 836				

[2] Negative cumulative value reflects an energy reduction or saving based on difference between actual measured energy consumption and expected baseline model consumption

Energy uses/users	Energy sources	Intervention	Utility saving Period	Investment (ZAR)	Savings (ZAR/yr)	Payback (Yrs)	Utility saving (GJ)	GHG emission reduction (tonnes CO_2e/yr)
Ventilation fans	Electrical	Master switch for ventilation fans	2018	13 500				
HVAC	Electrical	DX split to DX split with inverter	2018	4 500				
Process optimisation	Electrical	New cutting machine installed	2018/2019	3 490 000				
Process optimisation	Electrical	Replaced electrical steam boiler with a smaller decentralised system	2018	210 000				
Process optimisation	Electrical	Switched off cooling tower fan	2018	0				
Water heating	Electrical	DHWS supplying the canteen, north end ablutions and main change rooms have been switched off.	2018	0				
Compressed air management	Electrical	Leak tagging system	2018	3 000				
TOTAL				**3 817 126**	**1 091 393**	**3.5**	**3 572**	**950**

5. BENEFITS AND LESSONS LEARNED

5.1 Benefits

- Impact of the savings on direct and indirect job retention/creation has been realised as local contractors were sourced to implement the identified projects.
- Impact of savings on socio-economic factors were realised when items removed during the project implementation were recycled wherever possible.
- Other unintended consequences arising from the savings include improved product quality, improved staff comfort conditions and overall morale.

5.2 Lessons

- The importance of the co-ordination of services and disciplines is one of the lessons learned, as well as the crucial element of engaging all stakeholders in the decision-making process.

- The company's future consideration is to carry out monitoring and verification of savings and impacts of all the projects undertaken.
- The implementation of the IEE Project impacted on the company's competitiveness, and business culture has improved, increasing their competitive edge. TBSA now has a better understanding of the energy impact on their product and a culture has been created where energy optimisation is the responsibility of all of TBSA personnel on site.

6. FUTURE PLANS

TBSA has made positive strides in improving their energy efficiency within their site, and are now considering implementing: photo voltaic solar interventions to augment their energy sources, electrical smart metering for monitoring and targeting, power factor correction, and installing a borehole and rainwater harvesting system with appropriate water treatment.