GreenCape

‘Greening’ your farm

ENERGY FOCUS

This document aims to **empower farmers to understand the basics of energy resilience**, the cost-benefit of different technologies and provide guidelines in choosing an appropriate service provider.

This booklet is published in partnership with the Friedrich Naumann Foundation for Freedom, in support of a green social market economy for South Africa: resource-efficient, low CO2, decentralised, competitive, socially inclusive with a thriving SMME sector to lift people out of poverty and into jobs.

FRIEDRICH NAUMANN FOUNDATION For Freedom.
South Africa

1 A decision-making guide for farmers looking to become energy-resilient

This is a guide developed to assist in making farms more energy-resilient: that means using less energy, using energy in such a way that it is more cost-effective and implementing generation capacity that makes farms less vulnerable to shocks in energy supply or price fluctuations. This guide aims to provide useful information and resources for those wanting to identify ways of implementing energy-efficient or renewable energy technologies on their farm. The steps may be completed over a length of time, all at once, or even in half measures depending on the time, labour and capital capacity available.

This document hopes to empower farmers to understand the basics of energy resilience, the cost-benefit of different technologies and provide "guidelines" in choosing an appropriate service provider.

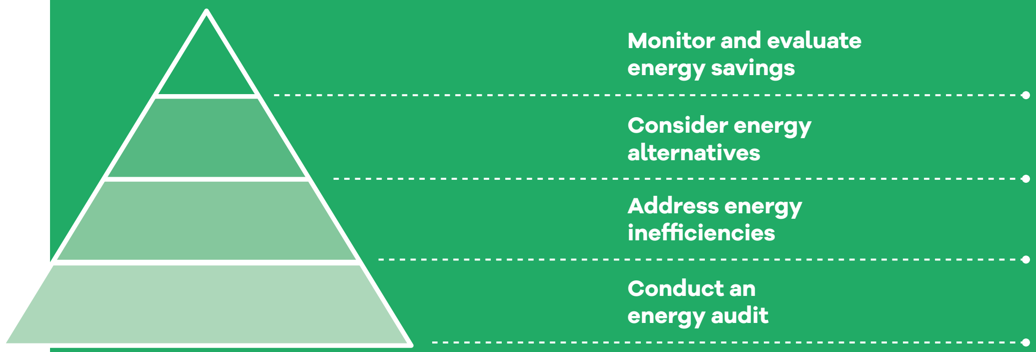


Figure 1: Hierarchy of steps to energy resilience

2 Context

Energy is one of the key consumable inputs for any agricultural endeavour. Currently, electricity and diesel fuel drives operations such as irrigation, lighting, harvesting, tilling etc. Consistent supply at a consistent price is pivotal in ensuring consistent production, and consistent production is key in guaranteeing consistent quality and quantity of produce. The volatility in South Africa's energy sector has made this difficult. In this last decade, energy costs have ballooned whilst the consistency of the supply has waned. The electricity and diesel prices have almost doubled, and loadshedding has become a common feature in South Africa since 2008[1] with little hope that the problem will be solved soon.

Those in the agriculture sector must look into practices that can make production resilient to the energy supply and price shocks.

IN THIS GUIDE, FARMERS CAN FIND INFORMATION ABOUT HOW TO:

- Conduct a brief **energy audit** over farm activities
- Implement **behavioural changes** that can reduce electricity usage and savings
- Consider energy-efficient **alternatives**
- Investigate the **financial feasibility of alternative energy** generation technologies
- **Monitor energy usages** after implementation to verify whether energy savings were fully realised

3 Energy-resilience **guidelines**

3.1. Conduct an energy audit

The first and most important step in implementing energy efficiency is conducting an energy audit - assessing the energy needs on a farm and exploring actions to reduce energy usage while maintaining/increasing farm production[2]. The primary objective of an energy audit is to develop an understanding of the energy flows of a particular facility[3]. These energy flows can be identified using the First Law of Thermodynamics: Conservation of Energy[4]: states plainly, that energy that enters a system should be equal to the energy that leaves it. Figure 2 illustrates some examples of these flows of energy in and out of an agricultural facility.

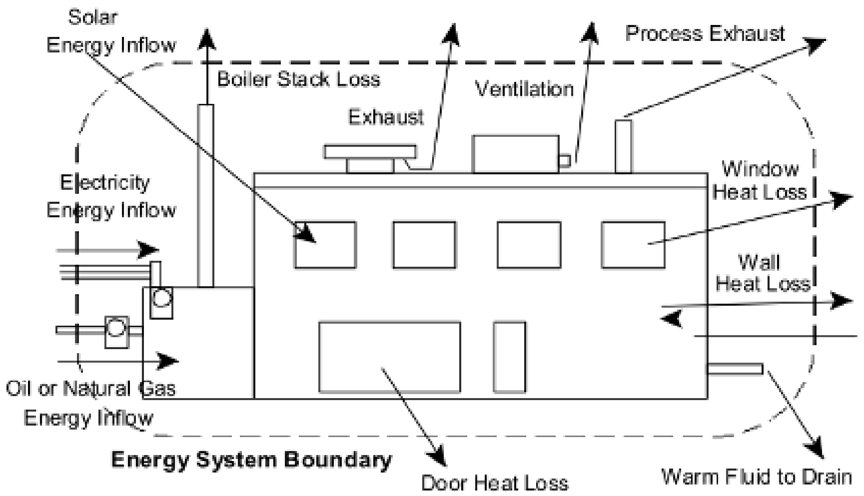


Figure 2: Common energy inputs and outputs[4]

If a farmer wants to do a self-audit, the most basic first step is to walk around the farm, noting the energy flows for each building and piece of equipment. Energy flows on farms vary from enterprise to enterprise, but most can be identified around the common high energy-consuming activities listed in Table 2:

DAIRY FARMING	PIGGERY	POULTRY	FIELD CROPPING	HORTICULTURE (Greenhouse)
Milk cooling machinery	Heating	Lighting	Cold storage	Heating
Lighting	Ventilation	Feeding machinery	Tilling machinery	Ventilation
Milking machinery	Lighting	Ventilation	Irrigation	Lighting
Feeding machinery	Feeding machinery	Heating		
	Slurry storage			

Table 2: Common high energy-consuming activities at farm-level[2]

Farmers who are on time-of-use (TOU) tariffs can immediately realise monetary savings by shifting the operating hours for their heaviest energy-consuming activities from peak hours to off-peak (Figure 3).

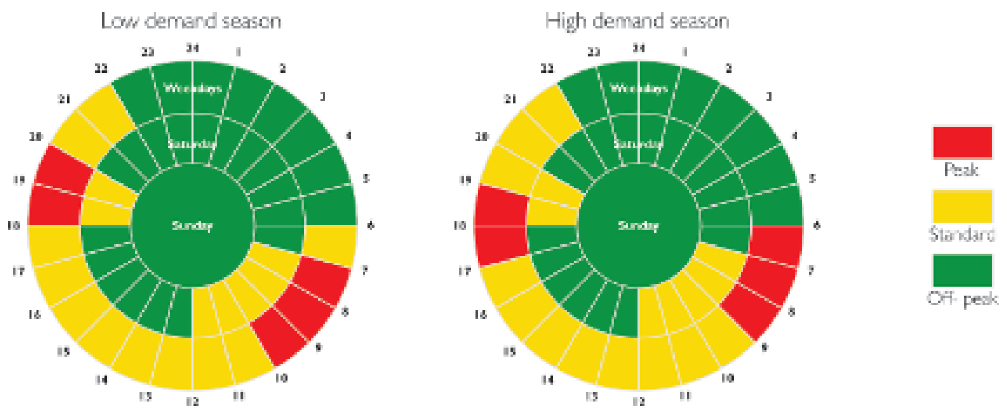


Figure 3: Time-of-use periods for Ruraflex[5]

CASE STUDY 1

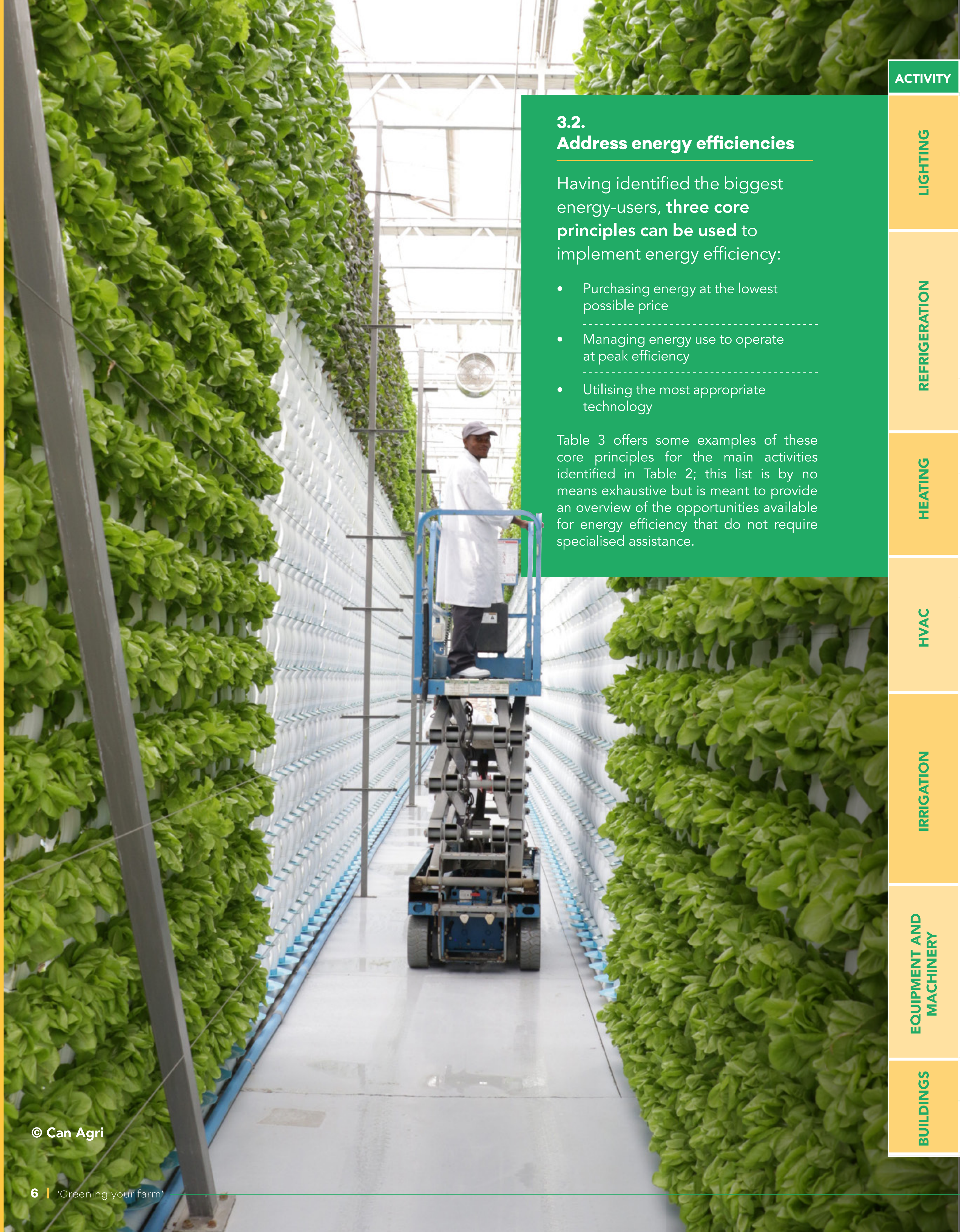
In 2012 – 2015, Durbanville Hills wine farm invested in a number of energy efficiency concepts of **Energy Management Systems (EnMS) and Energy Systems Optimisation (ESO) that resulted in annual savings of R342 000**[6].

One of the immediate saving opportunities realised were in **Demand Management**, where the five electrically heated geysers were rescheduled to operate during off-peak periods. **With no financial investment made, the total annual savings was R71 000.**

For a more comprehensive, technical audit, farmers can reach out to The National Cleaner Production Centre (NCPC), which conducts free energy assessments to identify savings and provides recommendations for government incentives to reduce capital costs. You can complete an application to undergo an assessment by visiting **industrialefficiency.co.za/enquiries/** or email **ncpc@csir.co.za**.

Another option is Eskom's **Energy Advisory Service**, which supports customers in reviewing their current energy strategy and provides guidance that fits their business needs[7].

Eskom Advisors conduct a **Level I energy audit**, which involves an analysis and audit of electricity usage. This audit can assist in establishing the need for a larger or smaller supply point, recommended potential for load management or a tariff review. Advisors also provide information and contact details regarding several available external funding mechanisms, including tax allowances and incentives for customers. The service is **free of charge** and conducted at the premises – for more details, visit **eskom.co.za/idm** or call **08600 37566** or email **advisoryservice@eskom.co.za**.



© Can Agri

3.2. Address energy efficiencies

Having identified the biggest energy-users, **three core principles can be used** to implement energy efficiency:

- Purchasing energy at the lowest possible price
- Managing energy use to operate at peak efficiency
- Utilising the most appropriate technology

Table 3 offers some examples of these core principles for the main activities identified in Table 2; this list is by no means exhaustive but is meant to provide an overview of the opportunities available for energy efficiency that do not require specialised assistance.

ACTIVITY	COMPONENTS	INTERVENTION #1	INTERVENTION #2	INTERVENTION #3
LIGHTING	**Bulbs**	Replacing CFL bulbs with LED alternatives	Install larger windows/ to supplement lighting	-
	Timers	Install timers to only use lighting outside of daylight	-	-
	Sensors	Install light sensors to vary lighting intensity in response to daylight hours	-	-
REFRIGERATION	**Condenser/ compressor**	Install a heat exchanger to take advantage of the heat generated by refrigeration	Check that sufficient gas is present	-
	Cold room	Do not overload – allow for sufficient airflow	-	-
	Temperature control	Maintain temperature control by regularly calibrating the temperature probe	-	-
	Insulation	Install insulation to reduce heat losses – particularly at the edge of doors	Replace any worn insulations	-
HEATING	**Heater**	Install insulation to reduce heat losses	-	-
	Motor	Schedule operating times outside of Eskom peak hours	Ensure load and the motor specifications match	Replace old motors with "high efficiency" electric motors
	Insulation	Replace any worn insulation	-	-
HVAC	**Fans**	Replace any worn impellers	-	-
	Control systems	Increase the setpoint to the highest temperature that the process can tolerate	-	-
	Ducts and pipes	Install continuous insulation to reduce heat losses	Install air filters at inlets to reduce airflow resistance	-
IRRIGATION	**Motors/engines**	Install a capacitor bank	-	-
	Pumps	Schedule operating times outside of Eskom peak hours	Ensure pumps operate at 70% maximum – running full loads for long periods requires significantly more power	Install a Variable Speed Drive (VSD) to control pressure
	Pipes and nozzles	Replace a 90° elbow with two 45° bends to reduce pipe frictions	Mend any leaks – regular checking and maintenance can reduce power costs and water savings	Ensure the correct pipe and nozzle size is used – smaller diameters result in higher friction levels and greater electricity requirements
EQUIPMENT AND MACHINERY	**Tyres**	Optimise traffic patterns on the field – reducing the frequency of turns and overlaps saves fuel	Pump tyres up to recommended tyre pressure	-
	Tilling	Convert to reduced tillage or no-tillage planting systems that use less energy	-	-
	Engine	Replace gasoline engines with diesel engines – diesel engines require less maintenance and 10% less fuel	Regularly check and clean oil and water reserves	-
BUILDINGS	**Temperature control**	Paint the roof silver to reflect more heat off the structure	-	-
	Ventilation	Ensure buildings are no wider than 12 metres for optimum ventilation	-	-

Table 3: Effective energy management tools for farm activities[8–16]

CASE STUDY 2

Kromme Rivier Poultry Farm decided to invest in energy-efficient lighting for its eight 15 000-broiler chicken sheds, where each shed was illuminated by thirty-two 60W incandescent lightbulbs[17]. The 256 incandescent lights and two floodlights were **retrofitted with energy-efficient Light Emitting Diode (LED) lighting at an investment cost of approximately R70 700**[18]. In the first year, the farm saw a reduction in energy usage, resulting in **savings of R60 053 per year**, giving the investment a payback period of just over a year.

CASE STUDY 3

The Ceres franchise of Pick 'n' Pay (PnP) was experiencing an increasingly inefficient and costly refrigeration system that prompted the owners to explore cost effective alternatives[19]. Using a shared saving model, Cooling as a Service (CaaS), PnP Ceres benefited from an improved refrigeration system with a **reduction of 35% in average refrigeration electricity consumption**[19].

3.3. Consider alternative renewable energy technologies

Several renewable energy (RE) technologies have been used to supplement or completely replace non-renewable energy on farms. The technology types (and items to consider) can be found below.

3.3.1 SOLAR PV

Solar PV installations have become a popular renewable energy alternative explored in the agriculture sector – around 10% of solar PV installations in SA have been in the agricultural sector[20]. The financial viability of solar PV installations is largely dependent on: i.) installation size; ii.) location, roof type and roof direction; iii.) financial model selected; iv.) client's current electricity tariff; v.) client's consumption patterns[21]. Three common solar PV applications in agricultural settings have been solar-powered irrigation systems (SPIS), ground mounted agri-PV panels and rooftop installations on packhouses.

For those interested in getting a sense of whether solar PV is a feasible solution for their farm production, GreenCape has developed a solar PV calculator tool available on the GreenAgri website. Users can input their appliance energy loads and times of use to calculate the suggested system size, the capital cost of such a system, as well as the payback period.

To find a service provider, farmers should visit the South African Photovoltaic Industry Association (SAPVIA) website (pvgreencard.co.za/customers/) and make sure that their service provider has a South African PV GreenCard.

The South African PV GreenCard is a safety certification, a quality assurance standard and a training programme for solar PV installers. Farmers can also verify their quotes against the market price benchmarks seen in Table 3.

PROCUREMENT OPTIONS/ SYSTEM SIZE	<100 KWP	100 KWP – 500 KWP	500 KWP – 1 MW	> 1 MW
Direct Investment (per kWp)	R11 000 – 15 000	R10 500 – 13 000	R10 000 – 12 000	R8 000 – 9 500
Debt Finance (5 – 10 year period)	Above amortised plus 5 – 8% interest pa			
Lease-to-Own (per month excl. escalation pa)	R7 000 – 147 500	R12 000 – 60 000	R50 000 – 100 000	R85 000 – 250 000
Power Purchase Agreement (PPA) (per kWh)	R0.90 – R1.20	R0.80 – R1.00	R0.60 – R0.90	R0.56 – R0.70

Table 3: Market Price Benchmarks 2021/2022[21]

CASE STUDY 4

In 2016, GreenCape investigated the business case for installing solar PV systems on packhouses: modelling different sized solar PV installations, different electricity tariff structures and different financing solutions[22].

The brief demonstrated **a potential saving of 15% of electricity costs**. It was validated against real-life examples such as Ceres Koelkamers (which experienced an 11% reduction in annual electricity costs), Ceres Fruit Growers (6% reduction); Stellenpak Fruit Packers (15% reduction) and ArbeidsVreugd Fruit Packers (R38 million savings over 25 years)[22].

3.3.2. WIND POWER

Wind power is another popular RE alternative in South Africa – it has been stated that about 80% of South Africa's landmass has enough wind for economically viable wind farms[23]. Currently, small-scale installations do not make financial sense in comparison to other RE alternatives. Farmers who are able to invest in large-scale projects should visit the South African Wind Energy Association's (SAWEA) Members Directory (sawea.org.za/members/directory/) for a comprehensive database of accredited wind power installers and wind farm developers.

Additional Insights
Farmers living in particularly windy areas with large tracts of land can consider hosting a wind farm. Through long-term lease arrangements with wind farm developers, farmers can earn revenue whilst incurring no construction, installation or maintenance costs. The minimum viable size is 140 MW for a wind farm, which covers an area of approximately 130 ha[23].

3.3.3. HYDROELECTRICITY

Hydroelectricity is not a very common renewable energy alternative in South Africa, let alone in SA's agriculture sector, due to the lack of sites with access to water sources with sufficient water flow to produce enough power (water flows require a height of about 100m)[18]. But some farmers have been able to capitalise on this technology.

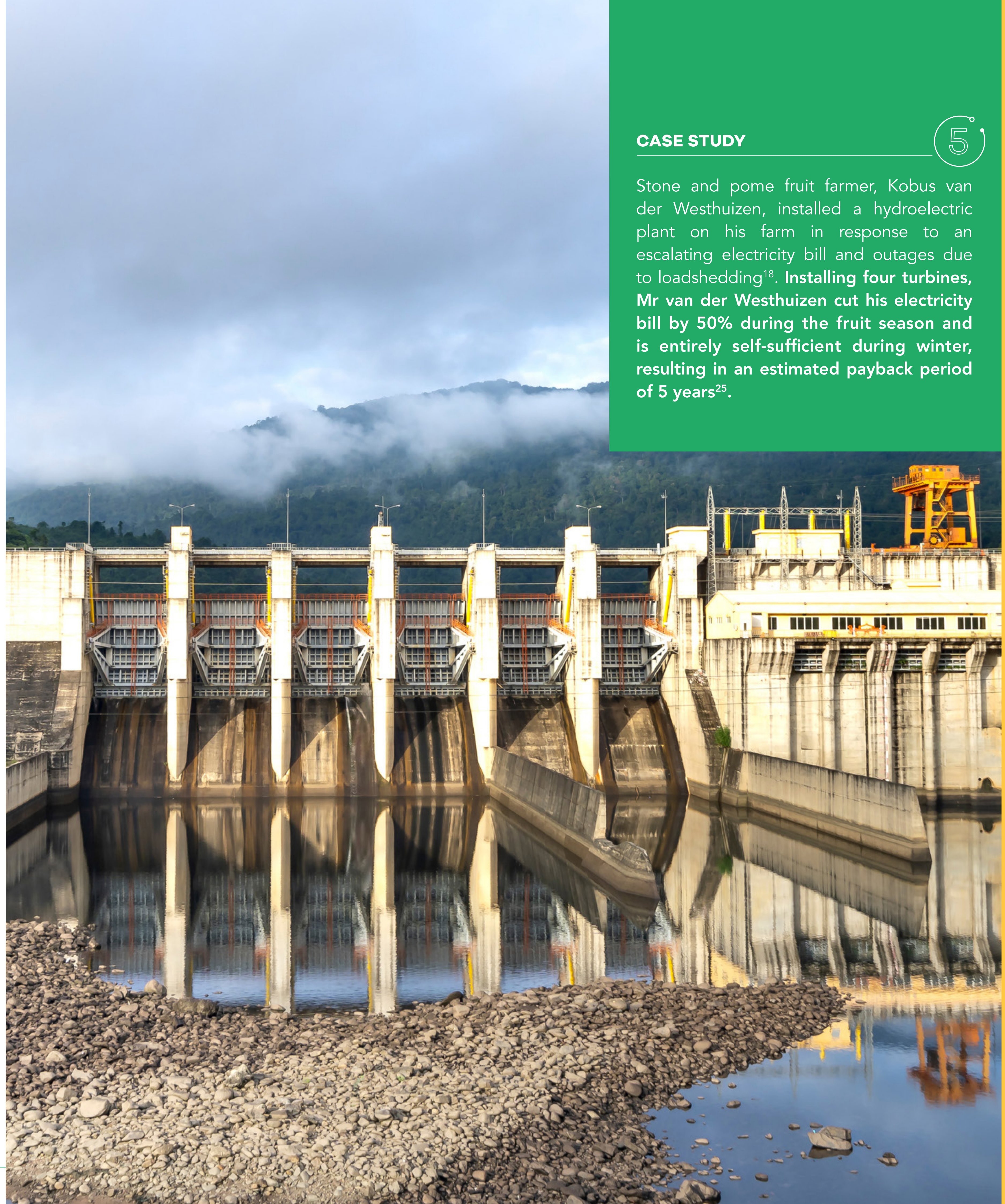
3.3.4. BATTERY STORAGE

Energy storage is of particular importance for those intending to go off-grid – investing in solar PV or wind power alone can still leave a farm vulnerable to loadshedding. Battery storage remains a high upfront cost to going completely off-grid. Whilst RE technologies such as solar PV and wind turbines have seen dramatic decreases in cost that makes them competitive, battery storage – particularly lithium-ion – can still cost significantly more than a diesel generator over the 20-year battery lifetime.

TECHNOLOGY	PROS	CONS	COST RANGE (R/KWH)
Lithium-Ion	• Low operating and maintenance cost	• High upfront cost • Recharge time • The lifespan of 3 500 cycles (10 years depending on use)	**Upfront:** R4 000 – 10 000
Diesel Generator	• Higher energy density – 27 x Li-ion • The lifespan of 20 000 hrs (20 years depending on use)	• Rising diesel prices • Chance of breakdown • Potential carbon tax on emissions	**Upfront:** R2 000 – 2 500 Fuel: R4.00 – 5.00 O&M: R0.20 – 0.50

Table 4: Off-grid options[21]

However, increased manufacturing of batteries in South Africa could see the cost of Li-ion batteries decrease in the medium to long term[26]. Furthermore, farmers should consider the indirect costs of remaining on-grid, such as production losses during loadshedding.



CASE STUDY 5

Stone and pome fruit farmer, Kobus van der Westhuizen, installed a hydroelectric plant on his farm in response to an escalating electricity bill and outages due to loadshedding[18]. **Installing four turbines, Mr van der Westhuizen cut his electricity bill by 50% during the fruit season and is entirely self-sufficient during winter, resulting in an estimated payback period of 5 years[25].**

3.4. Monitoring and Evaluation

These interventions have many benefits and, in most cases, result in[3]:

- Direct (and indirect) energy and financial savings
- Increased productivity (particularly for equipment operating at peak efficiency)
- Reductions in operating and maintenance costs
- Reductions in environmental impact.

Monitoring these interventions (with the use of energy meters, conducting energy audits intermittently etc.) over some time can ensure that farmers pinpoint these spaces for improvement. However, the full benefits can only be realised with behavioural changes among those working on the farm. Instilling a shared responsibility for using energy efficiently across a farm is as important as the financial investment in energy efficiency itself [25].

4 Next Steps

For more information about implementing energy efficiency and renewable energy, please visit the GreenAgri website (**greenagri.org.za**). A wider pool of resources can be found on the site under the Energy section of the Agri Resilience tab.

Moreover, feel free to contact us at GreenCape's Sustainable Agriculture sector desk: agri@green-cape.co.za, for further information and support on any of the content provided here.

References

1. Bloomberg. South Africa's emergency plan to end load shedding has turned into a fiasco. BusinessTech. Published 2021. https://businesstech.co.za/news/energy/498949/south-africas-emergency-plan-to-end-load-shedding-has-turned-into-a-fiasco/
2. Hill H, Mumma T, Kurki A. *Farm Energy Audits.*; 2009.
3. Energy D of M and. Overview of Building Energy Audits. In: *Building Energy Auditing Course.* ; 2004:3.1-3.22.
4. Department of Minerals and Energy. A Context for Building Energy Audits. In: *Building Energy Auditing Course.* ; 2014:1-6. http://www.energy.gov.za/EEE/Projects/Building Energy Audit Training/Training Modules/Building Energy Auditing Module 1_final.pdf
5. Eskom. *Eskom Tariffs for the Agriculture Sector.*; 2020.
6. Joseph J. Industrial Energy Efficiency Project in South Africa Case Study – EnMS. 2013;(May 2010):1-8.
7. Eskom. *Eskom Energy Advisory Service.*; 2020.
8. Initiative NB. South African Wine Sector Energy Efficiency Guideline. Published online 2015:1-26.
9. Energy. Agribook.digital. Published 2020. https://agribook.co.za/issues-here-and-beyond-our-borders/energy/
10. Eskom. *Eskom Energy Savings on Farms: Fact Sheet.*; 2020.
11. Centre NCP. *Best Practice Guide: Steam and Process Heating.*
12. Centre NCP. *Best Practice Guide: Pumps.*
13. Centre NCP. *Best Practice Guide: Motors.*
14. Centre NCP. *Best Practice Guide: Heating Ventilation Air Conditioning and Cooling Circuits.*
15. Centre NCP. *Best Practice Guide: Compressed Air System.* doi:10.1016/s0026-0576(02)81009-1
16. Gellings CW. Energy efficiency in agricultural equipment. *Effic Use Conserv Energy.* 1992;II.
17. Eskom. Agricultural sector : Kromme Rivier Poultry Farm.
18. Blignaut A. *How to Reduce Your Carbon Emissionns.*; 2017.
19. Poorun A. *Improving Energy Efficiency through Cooling as a Service (CaaS) Case Study.*; 2021.
20. Kuschke I, Shai T. *Sustainable Agriculture: Market Intelligence Report 2021.*; 2021.
21. Poorun A. *Solar PV Business Case Executive Support in the Western Cape GreenCape Sector Development Agency.*; 2021.
22. Vuuren PJ van. *Solar PV on Packhouses.*; 2016.
23. Walt J van der. Wind farms: a massive opportunity for SA's farmers. Farmer's Weekly. Published 2019. Accessed July 17, 2021. https://www.farmersweekly.co.za/farm-basics/how-to-business/wind-farms-a-massive-opportunity-for-sas-farmers/
24. *Wind Energy Overview.; 2012.* http://www.geograph.org.uk/%0Ahttp://re.energybel.by/en/renewable-energy-technologies/wind/#!prettyPhoto
25. Kriel G. Hydro electricity: all the power, half the cost. Farmer's Weekly. Published 2015. Accessed August 20, 2021. https://www.farmersweekly.co.za/agri-business/agribusinesses/hydro-electricity-all-the-power-half-the-cost/
26. Mkhize M, Radmore J. *Utility-Scale Renewable Energy Market Intelligence Report.*; 2021.