POWEROPTIMAL
THE FUTURE OF ENERGY

elon SMART HOT WATER SYSTEM

PowerOptimal Elon® Smart Thermostat

User Manual

Version number: 1.14

Version date: 2024/12/19

Enquiries: info@poweroptimal.com

Address: 88 12th Avenue
Kleinmond
7195

Patented: GB2583814, ZA2019/02129, ZA2022/08516, EP4100979

Patents pending: US 17/797977, PCT/ZA2023/050022, GB2618349

SAFETY WARNING

- The Elon® Smart should **only be installed in standard Kwikot electric geysers**. It is NOT compatible with other geyser brands.
- **This is NOT the Installation Manual**. Installers should read and follow the Installation Manual instructions. The Installation Manual can be downloaded from https://poweroptimal.com/manuals.
- We strongly recommend that the Elon Smart is only installed by a qualified plumber or electrician.
- If you are installing solar PV together with the Elon Smart, we strongly recommend that you use a reputable and experienced solar photovoltaic (PV) system installer to install your solar PV modules, and strictly according to the installation instructions in the full Elon Smart installation manual, which is available for download from the PowerOptimal website.
- Installers should wear the appropriate safety and personal protective equipment (for example a safety harness and/or fall protection equipment when working at height).
- **The solar PV modules and wiring installation must be signed off by an electrical contractor registered with the Department of Labour** (the so-called “wireman’s licence”) The electrician must provide you with a **supplementary Certificate of Compliance (CoC)** once installation is completed. (A supplementary CoC is not required if only the Elon Smart is installed with no solar PV.)
- **Solar PV modules exposed to the sun are live** (i.e. will produce electricity) and can give an electric shock. Special care should be taken and only trained solar PV installers should install the modules.
- **Do not attempt to** alter or service the electrical installation, or open the Elon® Smart unit or controller for any purpose.
- Use the Elon® Smart **only for its intended purpose**.
- **Always** make sure that every wiring connection is **properly tightened**.
- **Do not earth** either of the solar module wires (but do earth the frames).
- All installation wiring should be at least 2.5mm^2.

- Avoid coiling, since DC switching can create damaging spikes.
- Keep all wires as short as possible.

Refer to the PowerOptimal website for the following:

	Elon® Smart Installation Manual	www.poweroptimal.com/manuals
	Training videos for electricians	www.poweroptimal.com/training

Table of Contents

1. Elon Smart User Guide

A. Installing and using the Elon Smart app

1. **Install the Elon Smart app** on your smart phone by searching for "Elon Smart Water" in the Google Play Store (Android) or Apple App Store (iPhone). Alternatively, scan one of the QR codes provided below.

Elon Smart App for Android:

Google Play Store

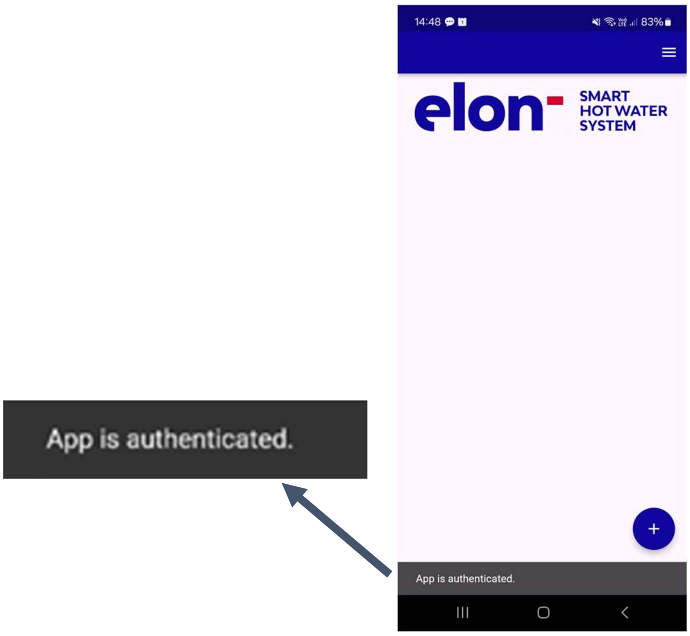
Scan this QR code with your Android phone to install the app from the Google Play Store

Elon Smart App for iPhone:

Apple App Store

Scan this QR code with your iPhone to install the app from the Apple App Store

2. Open the Elon Smart app on your phone. Wait until it says "App is authenticated" at the bottom of the screen.



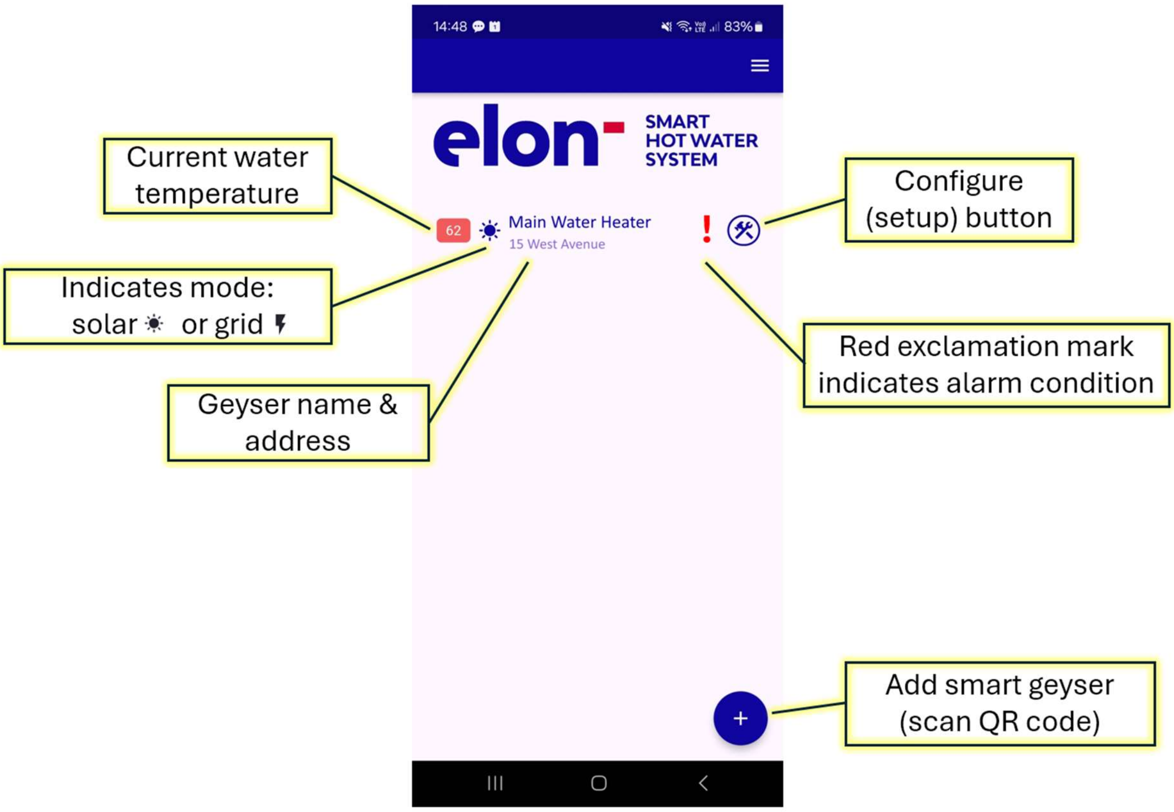
3. If the installer has not configured your thermostat and connected it to your WiFi network yet, please follow the instructions in Chapter 4E before continuing.
4. Your installer will have stuck an Elon Smart QR code sticker to the inside of your distribution board (DB) that looks like this:

ELON0000-0071

Install the ***ElonSmart*** app via the Apple or Android app store.

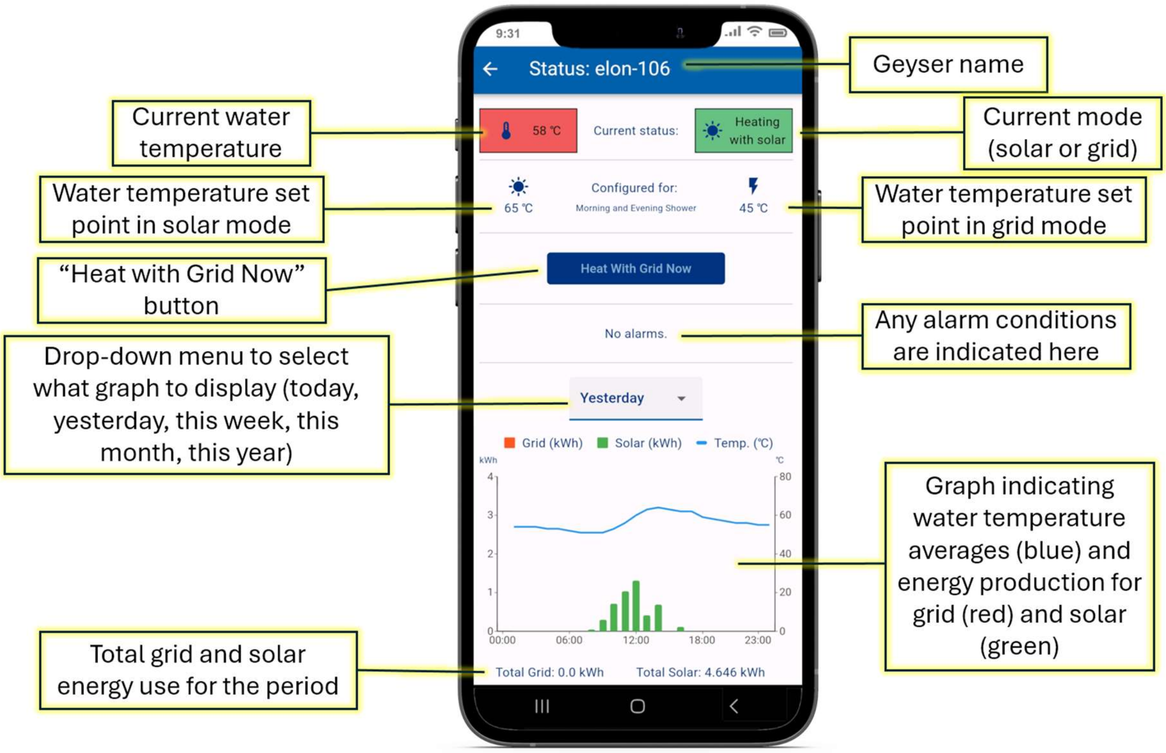
Scan this QR code in the app to get access to your Elon Smart Hot Water System

5. Tap the **(+)** **button** on the bottom right to add the Smart thermostat.
6. The app will display the scanning screen called “**Add Thermostat**”. Scan the QR code by placing it horizontal and centred on the screen. (If the code does not want to scan, try moving the phone closer and further from the QR code. Try rotating the phone into landscape mode.)
7. The app should take you back to the main screen after the thermostat has been added:



You can now see your smart geyser in the app. You can see the current temperature 63 and whether it is in solar or grid mode.

8. Tap anywhere on the geyser name to go to a screen with more information:



9. Use the grey drop-down menu to view graphs for "Today", "Yesterday", "This Week", "This Month" or "This Year".

10. You can press the **"Heat With Grid Now"** button to heat the geyser to its temperature set point with grid power (for example on a rainy day when there was too little solar energy production).

11. On the home screen, tap the **Configure** (hammer & spanner) button to access the **Configure Thermostat** screen, where you can change the geyser name, configure the WiFi and change the **solar temperature set point** and the **grid temperature set point**, as well as the **Heating Profile**:

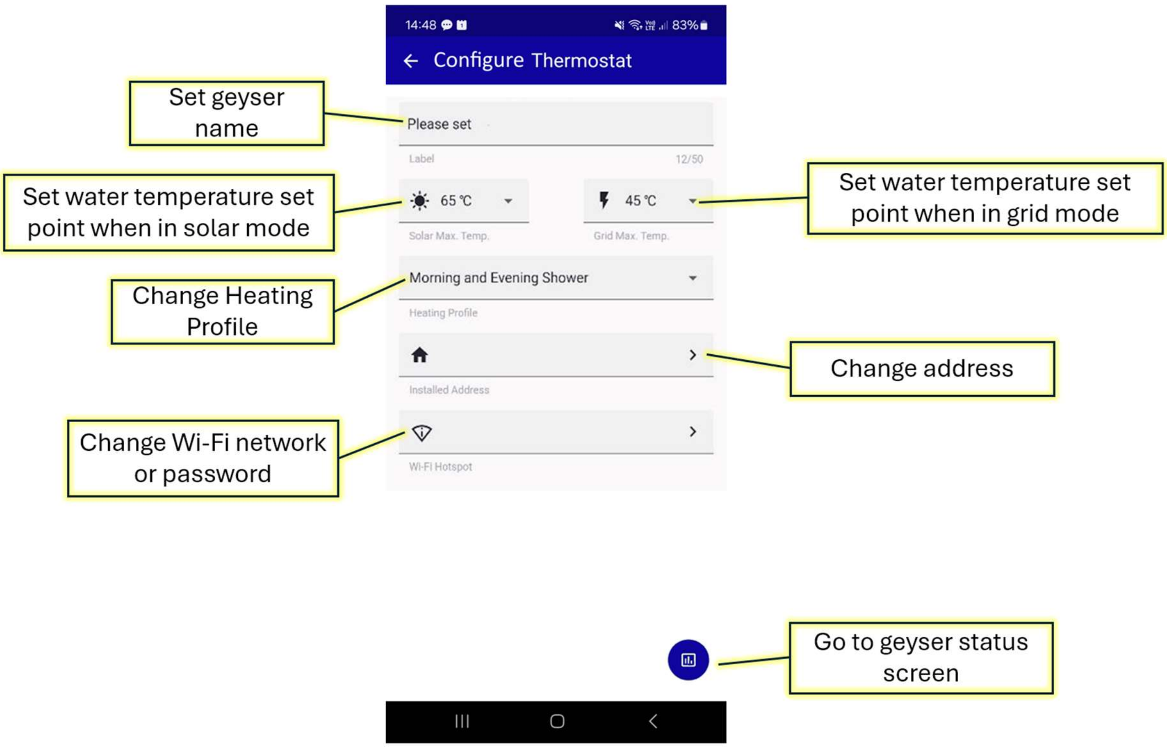
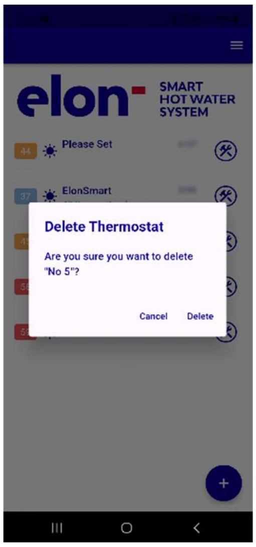


Table 1.1 Heating Profile options

Heating Profile option	Solar power use	Grid power use	Comments
Grid Only	Never	Always	Select this option if you don’t have any solar panels installed.
Solar Only	Always	Never	ONLY use solar power. NEVER use grid power.
Morning Shower	Always except for 3 am – 5 am	3 am – 5 am	Solar power will be used whenever available, and grid power will only be used early in the morning to boost water temperature to the Grid set point if the temperature is lower than that.
Evening Shower	Always except for 5 pm – 7 pm	5 pm – 7 pm	Solar power will be used whenever available, and grid power will only be used in the late afternoon to boost water temperature to the Grid set point if the temperature is lower than that.
Morning and Evening Shower	Always except for 3 am – 5 am & 5 pm – 7 pm	3 am – 5 am & 5 pm – 7 pm	Solar power will be used whenever available, and grid power will only be used in the early morning and late afternoon to boost water temperature to the Grid set point if the temperature is lower than that.

To delete a smart geyser from the app, tap and hold on the device that you want to delete on the home screen.

A prompt will pop up for you to confirm whether you want to delete the device, as shown on the screenshot to the right.



To see the current version of the app and the current versions of all software on the Elon Smart Thermostat, tap on the hamburger menu ☰ in the top right of the home screen and then tap "**About**".

B. How to maximise your savings

Here are some **general water-, energy- and money-saving tips**, whether you have solar PV modules installed with your Elon Smart or not:

- Install water-saving (low-flow) showerheads. This can reduce your hot water use by 20 to 40%. (You will also save on your water bill!)
- Shower, don’t bath.
- Reduce shower duration.
- Check that your geyser is well insulated. This includes the inlet and outlet pipes!

If you have solar PV modules connected to your Elon Smart thermostat, here are some **additional money-saving tips**:

- The best way to maximise your savings is to set the **Heating Profile** to “**Solar Only**”. This will ensure that the unit will never use grid (mains) power for heating water. You can still boost with grid power (for example on a cloudy day) by pressing the “**Heat With Grid Now**” button. This will heat with grid power once, before returning to the previous setting.
- However, the "Solar Only" setting will only be feasible if you have enough solar PV modules for your household’s level of hot water use. Even if you have a smaller system, you might be able to run it on “Solar Only” for most of the year, depending on your location.
- If “Solar Only” doesn’t work for your household, select the “**Morning Shower**” or “**Evening Shower**” Heating Profile and see if this works for you. You can also adapt your showering habits to solar power availability.
- It is generally best to shower in the mornings for maximum savings, since then the water can be reheated during the day.
- A bigger geyser (200L vs 150L or 100L) is better for maximising savings, since more energy from the sun can be stored in the bigger volume of water.

C. Maintenance

The Elon® Smart has been designed to last for a very long time and has no moving parts aside from three electrical relays. No maintenance is required on the Elon® Smart thermostat.

C1 Solar PV module maintenance

It is recommended that a qualified electrician inspect your solar PV installation at least once a year.

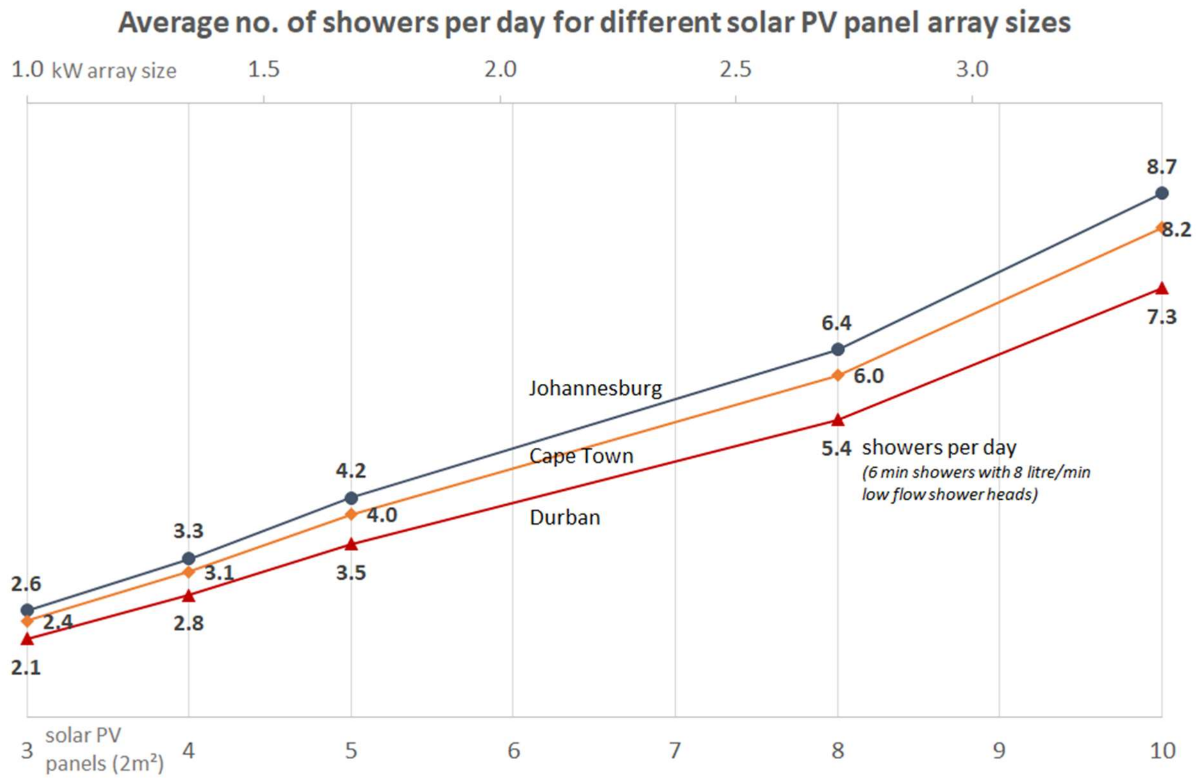
1. Perform regular visual checks (at least once a year). Check for soiling or any visible damage to any of the modules.
2. If the modules have been soiled by dirt, dust, debris, bird droppings or any other materials, use water only and a sponge or soft cloth to clean them. Do the cleaning early in the morning or late in the afternoon, as the modules are hot during the day. Avoid using a water jet that may leave streaks on the modules.
3. Visually inspect cables for any degradation or loose fittings.
4. Look for any shading problems, such as trees that may have grown.
5. An electrician can check solar power production on a sunny day to ensure that the system is still producing power at expected levels. A thermal imaging camera can be used to inspect modules for hot spots.
6. Follow any specific maintenance instructions from the solar PV module manufacturer.

D. What to expect in terms of performance

D1 Hot water production

Heating water takes a LOT of energy. A household geyser can use up to 40% of a house's electricity. Heating a single 200 litre geyser from 15 °C to 60 °C will use over 10 kWh. This is about the same amount of energy burnt by a person running a distance of over 100 km at 10 km/hr, or enough energy to watch more than 120 hours of TV[1].

The more solar panels you have on your roof, the faster the Elon® Smart system will heat your water. Typically, the number of panels has been selected to heat water over most of the sunlight hours (from morning to afternoon). This will be slower than heating water using grid electricity. So you can expect **a gradual temperature rise from morning to afternoon**.

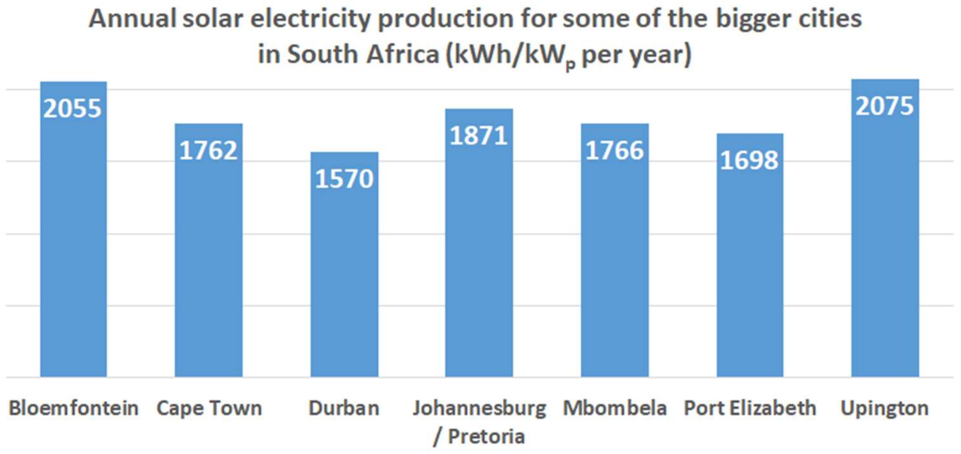


As one would expect, hot water production increases with increase in number of solar panels. Keep in mind that these numbers are averages over the year. This means that you should expect a lower number in winter and a higher number in summer.

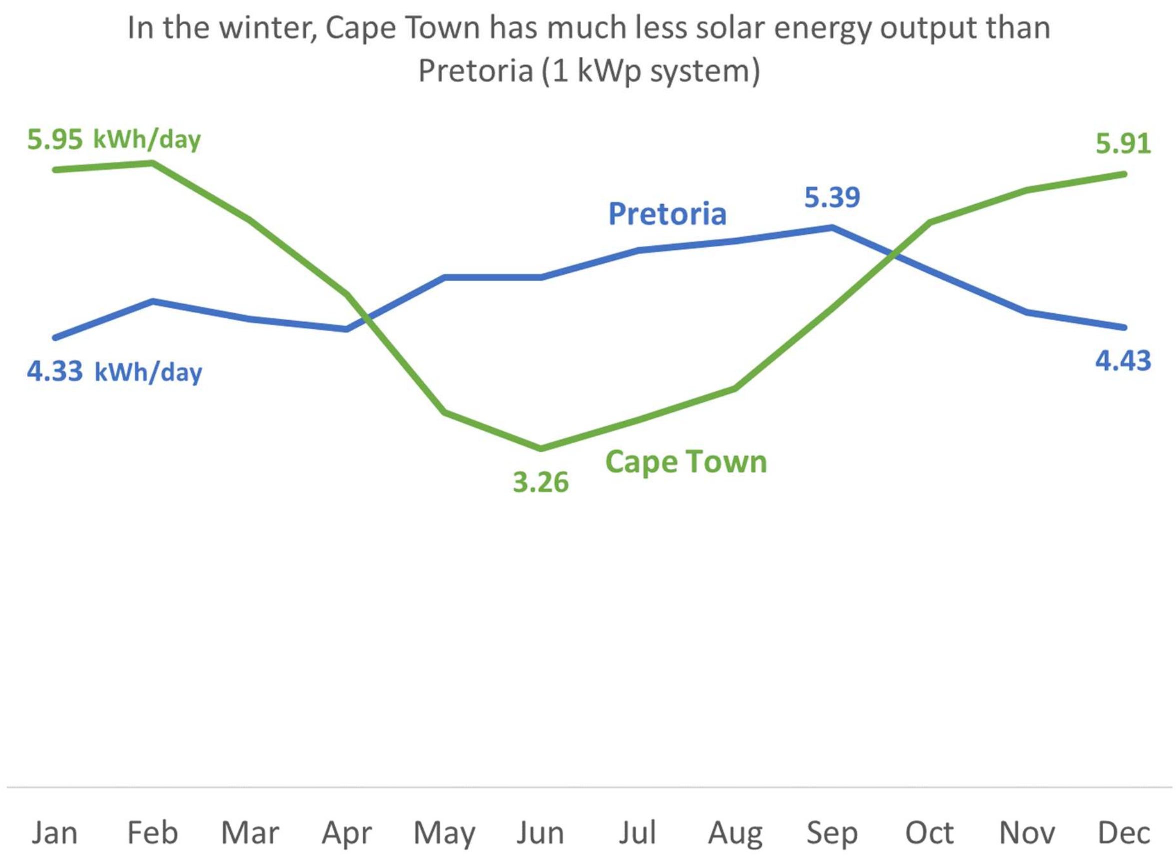
[1] 46" OLED TV at 82W.

D2 Impact of location and seasons

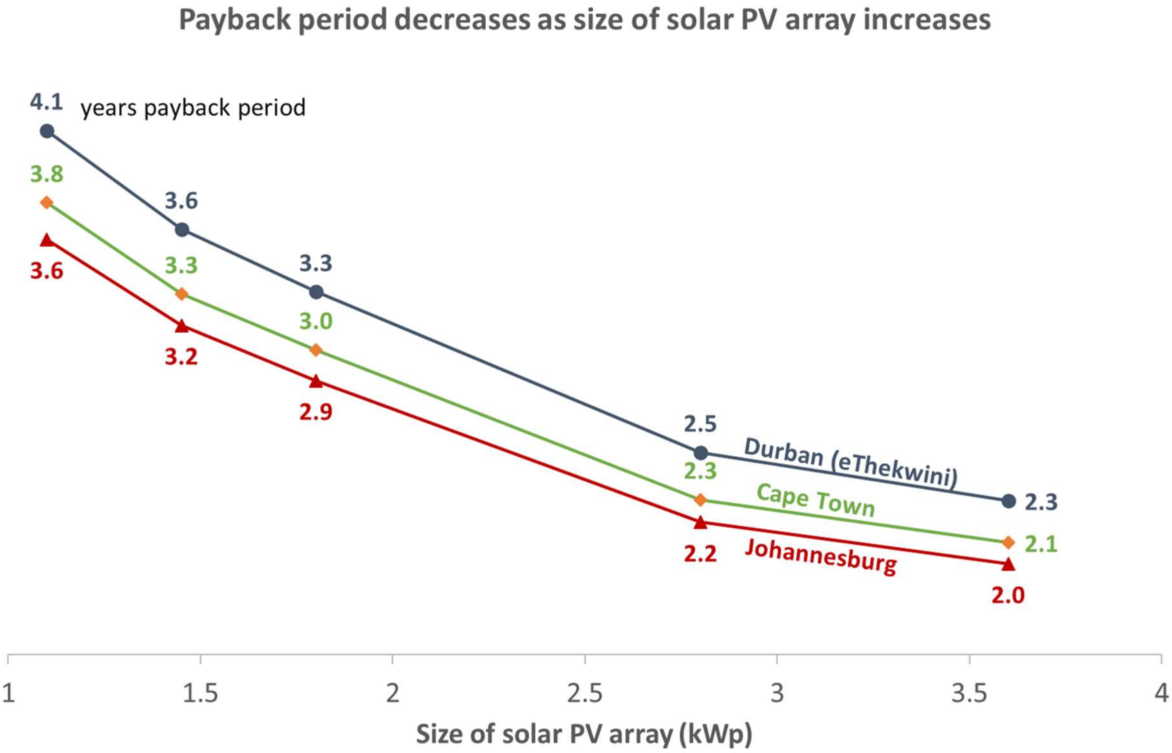
The amount of energy from the sun depends on your location, the time of year as well as the orientation of your solar panels. The best direction for panels in South Africa is to face north, at an angle of about 25 to 35° from horizontal.



Although Gauteng (Johannesburg / Pretoria) & Cape Town may seem quite similar in terms of total solar energy per year, Cape Town has winter rainfall and Gauteng has summer rainfall. This leads to Cape Town having much lower solar electricity production than Gauteng in winter (see the below graph).



D3 Payback period



As can be seen from the graph above, payback period decreases as number of solar panels increases, and is also different for Johannesburg, Cape Town and Durban[2].

The reason that payback period improves (decreases) as number of solar panels increases, is because there are some fixed costs (such as engineering design & safety components) and some costs that do not scale linearly with array size (such as labour, wiring, mounting kit costs, etc.).

[2] Calculations based on actual Elon performance, assuming a 20% reduction due to non-optimal user behaviour, an initial electricity tariff of R3/kWh and an annual electricity price increase of 8%.

Appendix A. Configuring your Elon Smart Thermostat

Please note: You need to be at home and within Wi-Fi distance from your Elon Smart to change configuration settings.

1. Open the Elon Smart App.
2. Tap the **Configure** **(hammer & spanner) button** on the right of your Elon Smart thermostat.
3. The application requests confirmation to switch to the Smart Thermostat's hotspot (**Figure A1**).
4. Select "**CONNECT**"
5. The application should display the "Configure Thermostat" screen (**Figure A2**)
6. If the Wi-Fi network has **not been configured yet**, tap the right arrow (**>**) next to the Wi-Fi Hotspot entry. Otherwise skip to **Step 12**.

7. The application searches for the available networks and displays them in a list (**Figure A3**).

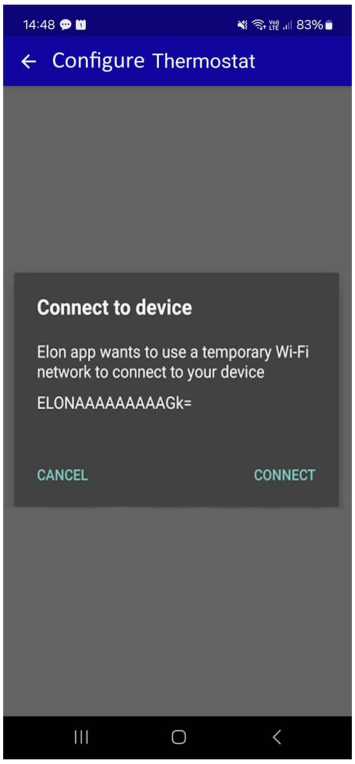


Figure A1 Network change

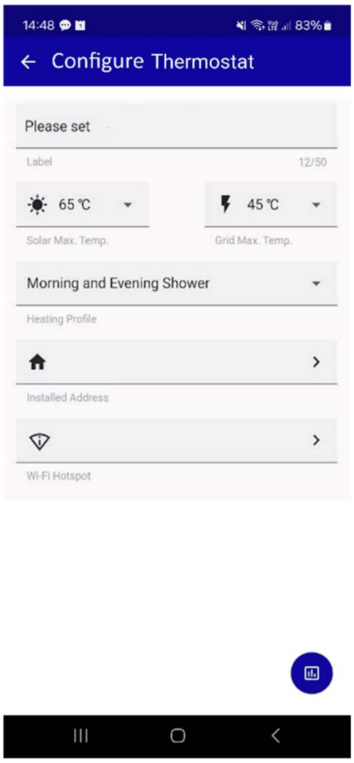


Figure A2 Configure screen

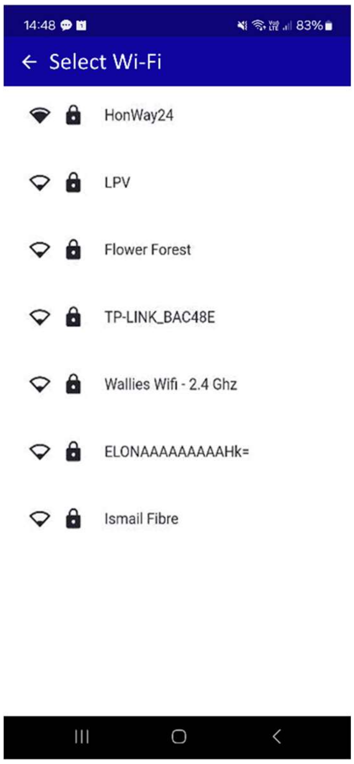


Figure A3 Select Wi-Fi

8. Tap on the Wi-Fi network you want the Smart Thermostat to use.
9. The application will ask for a password for the network you selected (**Figure A4**).
10. Enter the password and tap "**Test Connection**".
11. If you entered the password correctly the application should take you back to the configuration screen and the network should be green.

12. Next configure the address. Click on the right arrow (**>**) next to the address field.

13. The app should connect to the server and obtain a list of addresses corresponding to your GPS co-ordinates (**Figure A5**). (You might need to switch on your phone GPS and allow the app to use your location services.)
14. Select the correct address.
15. The app should take you back to the "**Configure Thermostat**" screen (**Figure A6**).
16. Go to the top field called "**Label**" and enter a new name for the smart thermostat. This will be used to identify this smart thermostat in your app.

17. Now set the "**Solar Max. Temp.**" and "**Grid Max. Temp.**" temperature set points. It is best for savings and optimal solar power usage to select a lower temperature set point for grid power than for solar power. **65 °C** on **Solar** and **50 °C** on **Grid** are good set points.

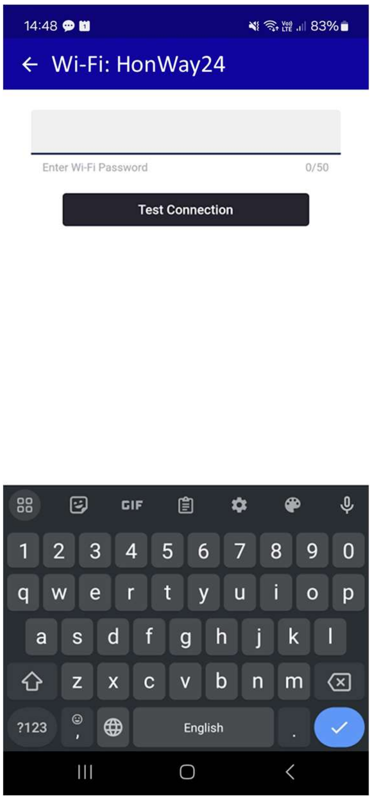


Figure A4 Enter Wi-Fi password

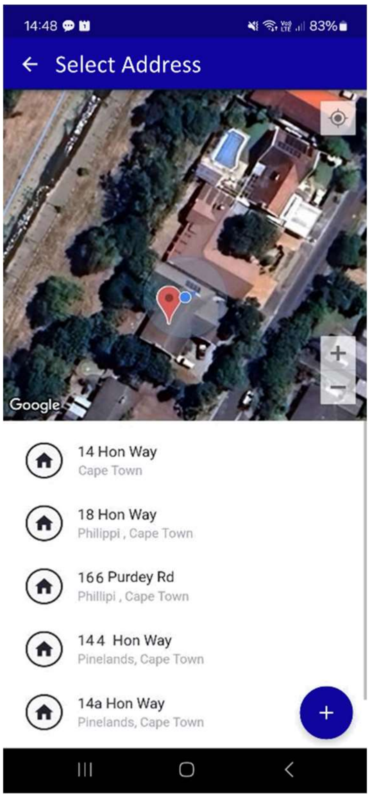


Figure A5 Select address

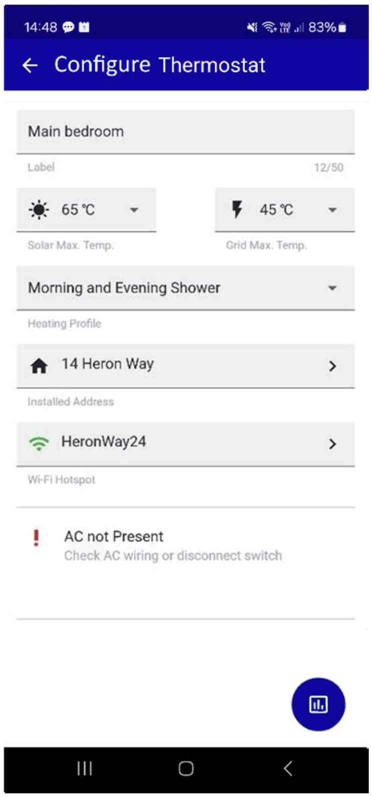


Figure A6 Heating settings

18. Next you can set the "**Heating Profile**" according to your preference. Select how the household wishes to use the hot water generated by the Smart thermostat (refer back to **Table 1.1**). It is typically best to start with the "**Morning and Evening Shower**" profile.

Appendix B. Alarms and Basic Troubleshooting

The Elon Smart has a helpful alarm system that detects and reports common issues. See the below list for the various alarms and how to resolve them.

Please note: general users should NOT attempt to carry out the actions for installation technicians / electricians (the right-most column).

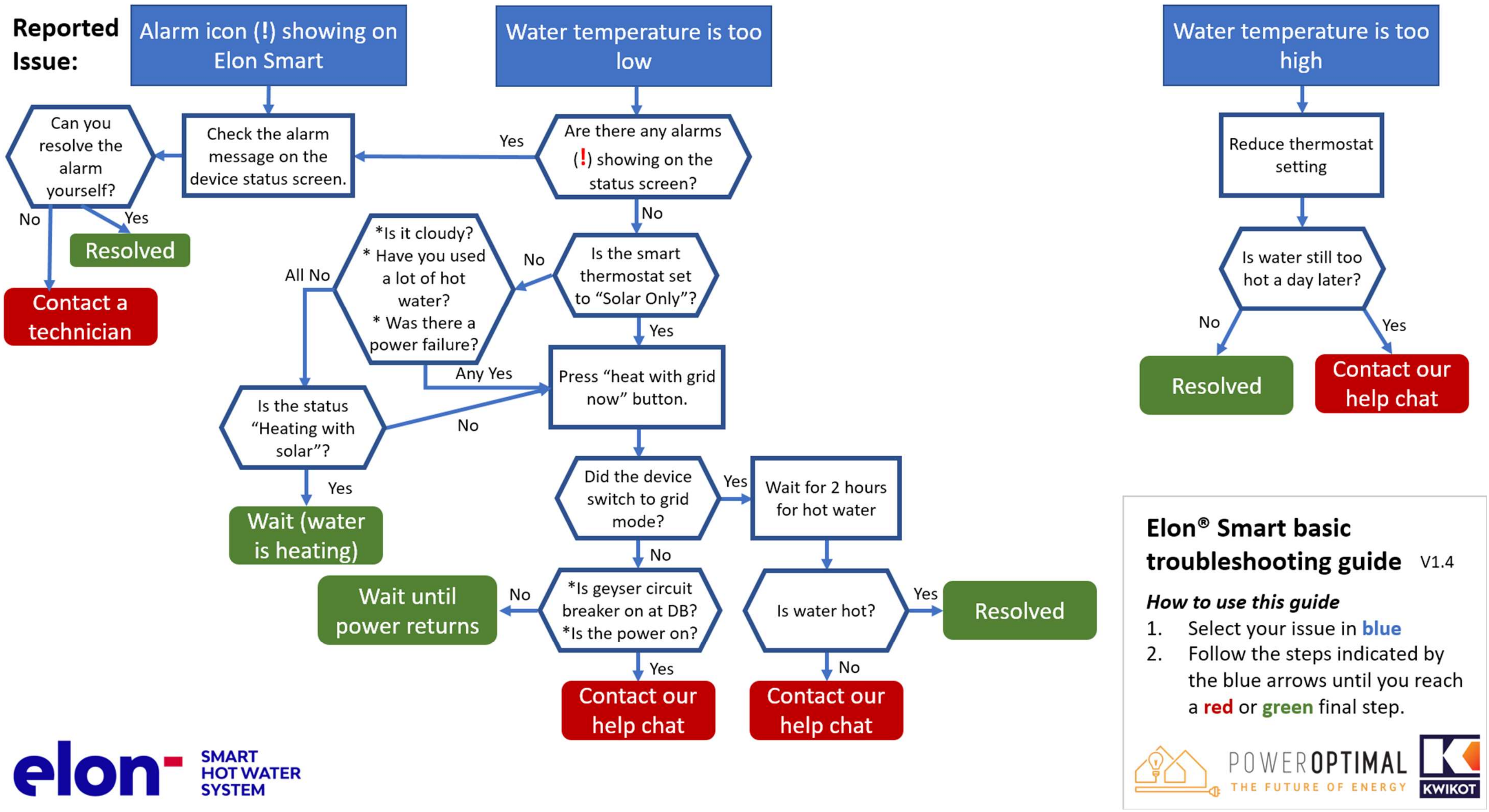
Always check that you have the **latest version of the app** by going to the “Elon Smart Water” app in your app store.

ID	Alarm message	How to resolve the alarm: USERS	How to resolve the alarm: TECHNICIANS / ELECTRICIANS
0	Element Faulty	Contact your installer / electrician	a. Check that the thermostat is inserted correctly. b. If that does not clear the alarm, measure element resistance and replace if necessary.
1	Switch Failed	Contact technical support	Contact technical support
2	DC Disconnect Failed	Contact technical support	Contact technical support
3	No Power on AC Input	This can be due to several reasons: a. There is no AC power connected to the Elon Smart b. AC power is off at the circuit breaker in the DB board or at the AC isolator close by the Elon Smart unit. c. There is a power failure or loadshedding. This alarm won’t prevent the Elon Smart unit from functioning and heating water with solar (DC) power as long as there is solar power available. You can clear the alarm by switching the AC power on (where applicable), setting the Elon Smart heating policy to *Solar Only* (see Table 1.1) or you can leave it until AC power returns.	See to the left
4	Measurement Failure	Contact technical support	Contact technical support

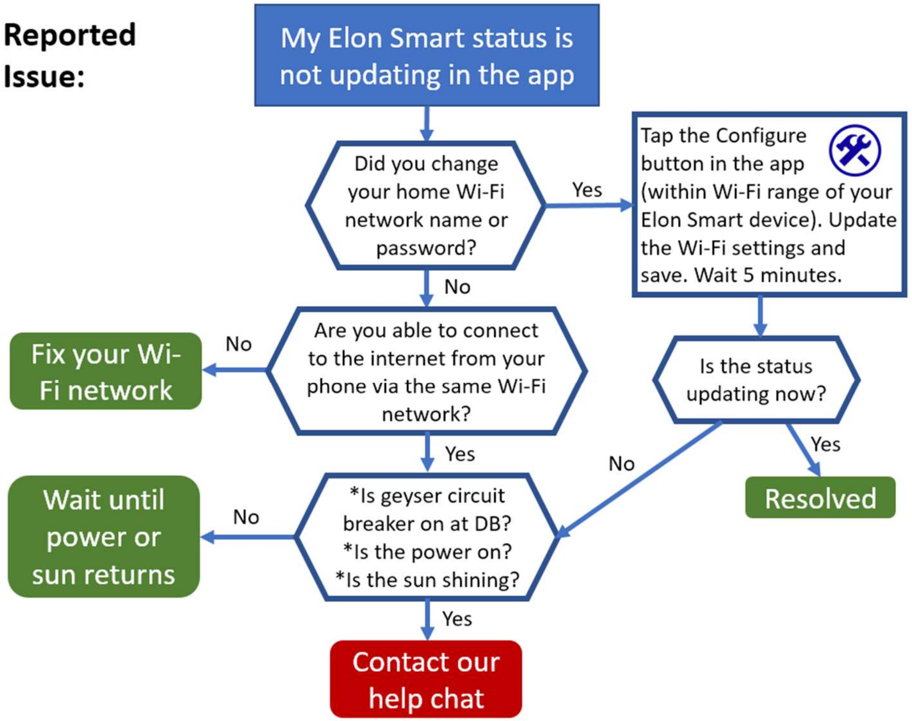
ID	Alarm message	How to resolve the alarm: USERS	How to resolve the alarm: TECHNICIANS / ELECTRICIANS
5	Disconnected for Safety	When there is a safety-related alarm condition, the Elon Smart will disconnect power from the geyser. To clear this alarm, you need to clear the other safety-related alarm(s).	See to the left
6	Water Temperature Measurement Failure	Contact technical support	Contact technical support
7	Ambient Temperature Exceeded	a. Check the installation. If the geyser is installed in direct sunlight, see if you can provide shade to the geyser end space area where the Elon Smart is located. b. Reduce temperature set point by 5 degrees. c. Wait until temperatures cool down. The Elon Smart will start up again. d. Contact technical support if the above doesn't clear the alarm.	See to the left
8	DC Wiring Insulation Failure	Contact your installer / electrician. To operate the Elon Smart whilst the insulation fault has not been located and resolved, you can set the heating profile to *Grid Only* or switch off the DC disconnect switch.	a. Check solar panels and DC wiring for insulation faults. b. To operate the Elon Smart whilst the insulation fault has not been located and resolved, you can set the heating profile to *Grid Only* or switch off the DC disconnect switch.
9	Insulation Self-Test Failed	Contact your installer / electrician	Check earth wiring. Make sure both earth straps are connected securely to the geyser earth stud.
10	AC Wired to DC Input	Contact your installer / electrician	Wire AC to correct input (see Chapter 4 in the Installation Manual).
11	DC Wired to AC Input	Contact your installer / electrician	Wire DC to correct input (see Chapter 4 in the Installation Manual).

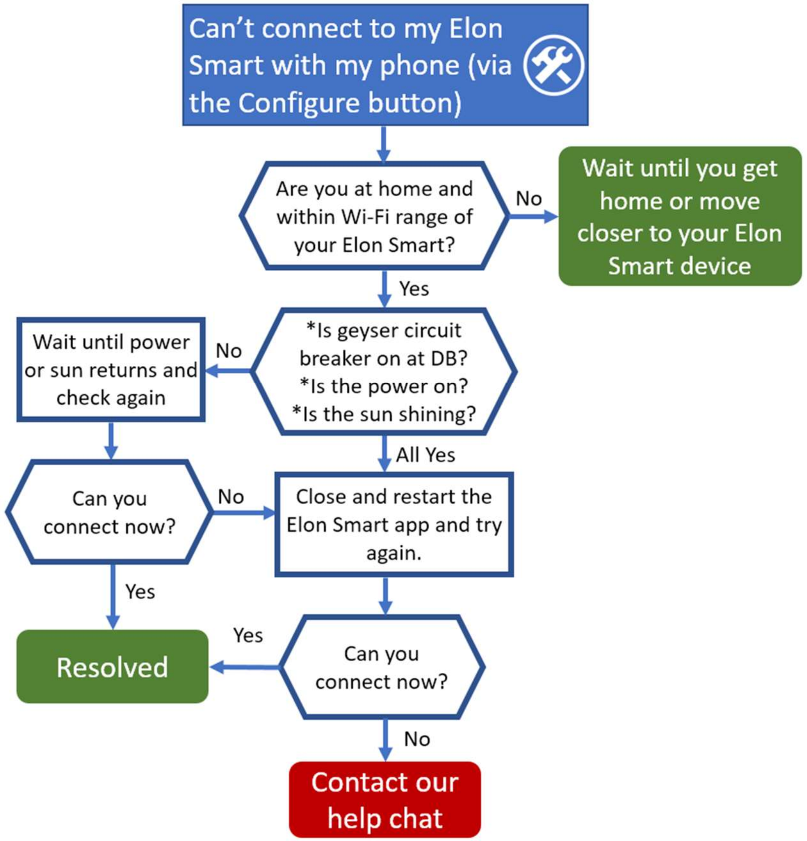
ID	Alarm message	How to resolve the alarm: USERS	How to resolve the alarm: TECHNICIANS / ELECTRICIANS
12	No Power on DC Input	This can be due to several reasons: a. There is no DC power connected to the Elon Smart b. DC power is off at the DC disconnect switch close by the Elon Smart unit. c. There is an issue with the DC wiring or solar PV installation. d. It is extremely dark and overcast during daytime. (The alarm is not active when the sun is less than 15 degrees above the horizon.) This alarm won't prevent the Elon Smart unit from functioning and heating water with grid (AC) power as long as there is grid power available. You can clear the alarm by: i. switching the DC power on (where applicable); ii. setting the Elon Smart heating policy to *Grid Only* (see Table 1.1); iii. leaving it until DC power returns; or iv. contacting your installer / electrician to inspect and fix the DC wiring and/or solar PV installation.	See to the left
13	DC Input Reversed	Contact your installer / electrician.	The wiring on the Solar input has been installed incorrectly (in reverse). The DC+ (positive) wire has been connected to the DC- (negative) terminal on the Elon Smart and the DC- (negative) wire has been connected to the DC+ (positive) terminal on the Elon Smart. Swap the DC wires around (see Chapter 4 in the Installation Manual).

ID	Alarm message	How to resolve the alarm: USERS	How to resolve the alarm: TECHNICIANS / ELECTRICIANS
14	Hot Connection	Contact your installer / electrician.	Elon Smart not correctly inserted into geyser element. Switch off all power to the Elon Smart and re-seat (reinsert) the Elon Smart.

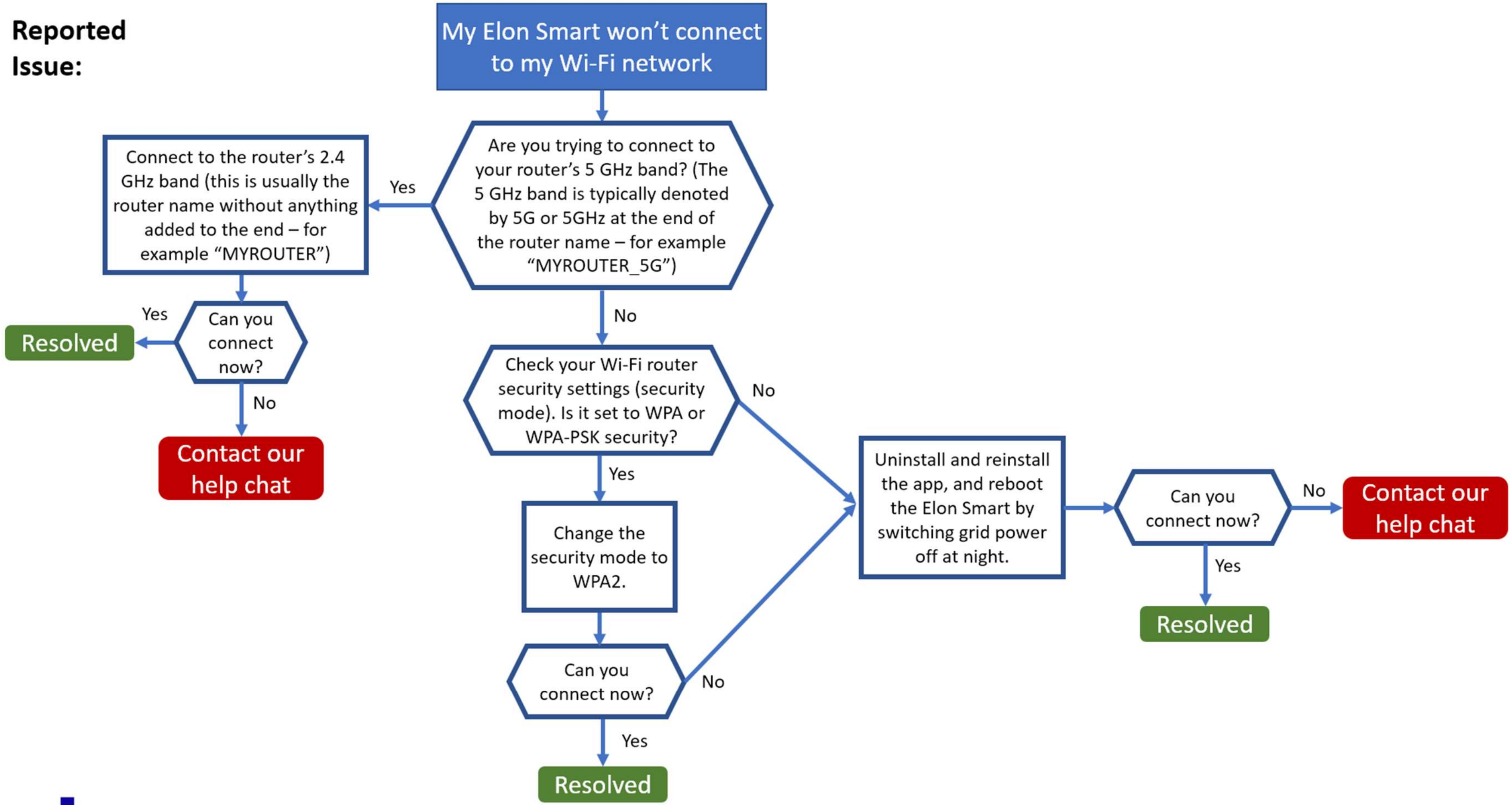

Reported Issue:
Alarm icon (!) showing on Elon Smart
Water temperature is too low
Water temperature is too high
Check the alarm message on the device status screen.
Can you resolve the alarm yourself?
No
Yes
Resolved
Contact a technician
Are there any alarms (!) showing on the status screen?
Yes
No
Is the smart thermostat set to "Solar Only"?
No
Yes
*Is it cloudy?
* Have you used a lot of hot water?
* Was there a power failure?
All No
Any Yes
Is the status "Heating with solar"?
No
Yes
Wait (water is heating)
Press "heat with grid now" button.
Did the device switch to grid mode?
Yes
No
Wait for 2 hours for hot water
Is water hot?
Yes
No
Resolved
Contact our help chat
*Is geyser circuit breaker on at DB?
*Is the power on?
No
Yes
Wait until power returns
Contact our help chat
Reduce thermostat setting
Is water still too hot a day later?
No
Yes
Resolved
Contact our help chat
Elon® Smart basic troubleshooting guide V1.4
How to use this guide
1. Select your issue in blue
2. Follow the steps indicated by the blue arrows until you reach a red or green final step.
POWEROPTIMAL
THE FUTURE OF ENERGY
KWIKOT
elon SMART HOT WATER SYSTEM

Reported Issue:





Reported Issue:



elon SMART HOT WATER SYSTEM

Appendix C. Solar yield

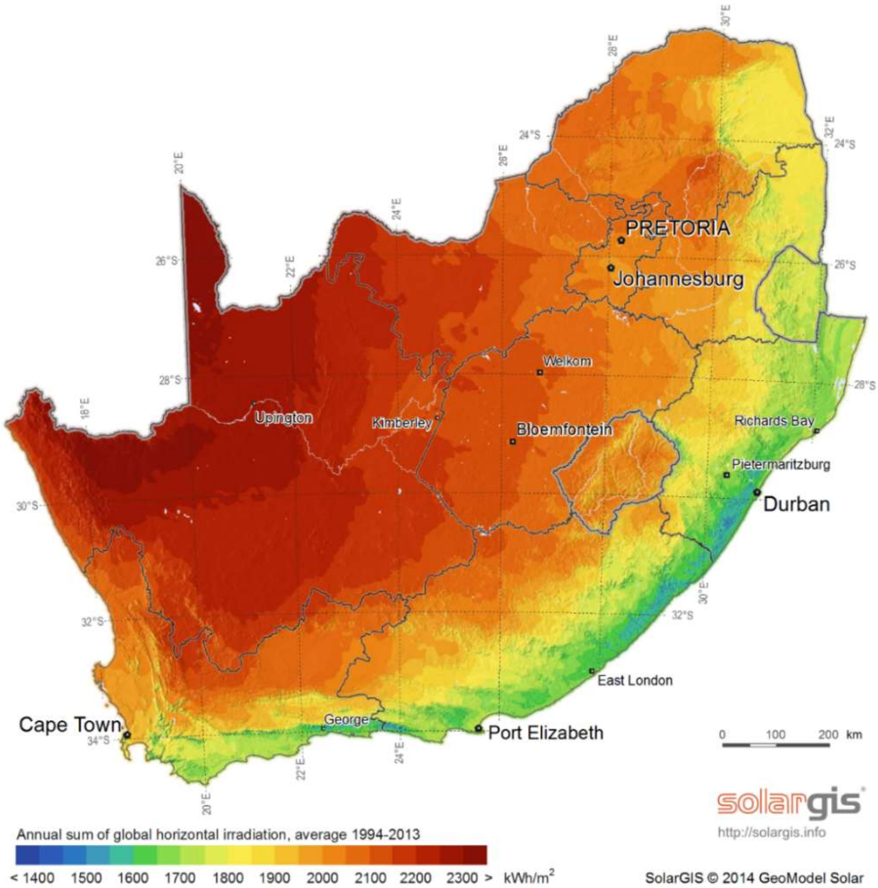
Note: only basic information is provided here. Your solar PV installation design engineer or technician should advise on the best configuration for your specific location, roof structure, etc.

The yield produced by solar PV modules depends on several factors:

- Solar irradiance levels at your location (which varies with time of day, season and weather conditions)
- Geographic features at your location (e.g. mountains or buildings causing morning or afternoon shade)
- Azimuth and tilt of the modules
- Shading
- Ambient temperature (also influenced by wind)

C1. Solar irradiance levels

The map below shows the general solar irradiance levels (GHI or Global Horizontal Irradiance) in South Africa[3]:



[3] CRSES (Centre for Renewable and Sustainable Energy Studies). Website: http://www.crses.sun.ac.za/files/research/publications/SolarGIS_GHI_South_Africa_width15cm_300dpi.png. Last accessed: 07/04/2017.

You can expect the following approximate energy generation from solar modules for various locations[4]:

Location	Electricity generated kWh/kWp per year
Bloemfontein	2055
Cape Town	1762
Durban	1570
Johannesburg / Pretoria	1871
Mbombela	1766
Port Elizabeth	1698
Upington	2075

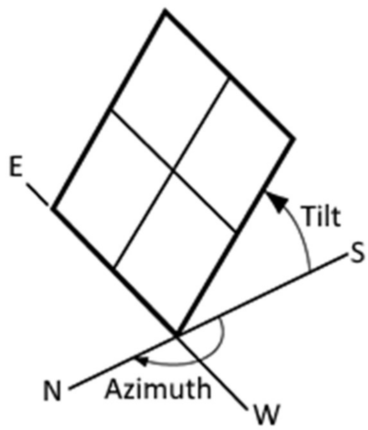
C2. Geographic features

Major geographical features (such as hills or mountains) can reduce the total solar yield.

C3. Azimuth / horizontal angle

The **azimuth** refers to the horizontal orientation of the modules – in the Southern Hemisphere, by how many degrees they are oriented away from north

Due north is best in the Southern hemisphere. Modules should preferably not be oriented more than 15º away from due north.



C4. Inclination or tilt angle

The **tilt angle** refers to the vertical orientation of the modules – a rough guide is that the modules should be tilted at the site's latitude. For example, Musina is 22º S, Pretoria & Johannesburg are 26º S, Bloemfontein is 29º S, Durban is 30º S and Cape Town & Gqeberha (Port Elizabeth) are 34º S.

To optimise winter performance, one can add 15º to the tilt angle. (**Note:** as long as you are within about 15º of the optimal latitude, the loss in efficiency is not substantial.)

C5. Shading

Solar modules lose a lot of efficiency if even a small part of the module is shaded. For example, just 3% shading can cause a 25% loss in power! Shaded cells on a module also causes hotspots, which will reduce module lifetime.

[4] Urban Energy Support. Website: http://www.cityenergy.org.za/uploads/resource_274.pdf. Last accessed: 07/04/2017.

It is thus **important** to place the solar modules on a rooftop area that is **free from shading** for as much as possible of the day (and throughout the year).

C6. Ambient temperature

Solar PV modules' performance decreases with increasing temperature. Wind will reduce the temperature of the solar array and will thus improve performance. Thus, it is important to install rooftop solar modules with an air gap of at least 40 mm between the modules and roof[5].

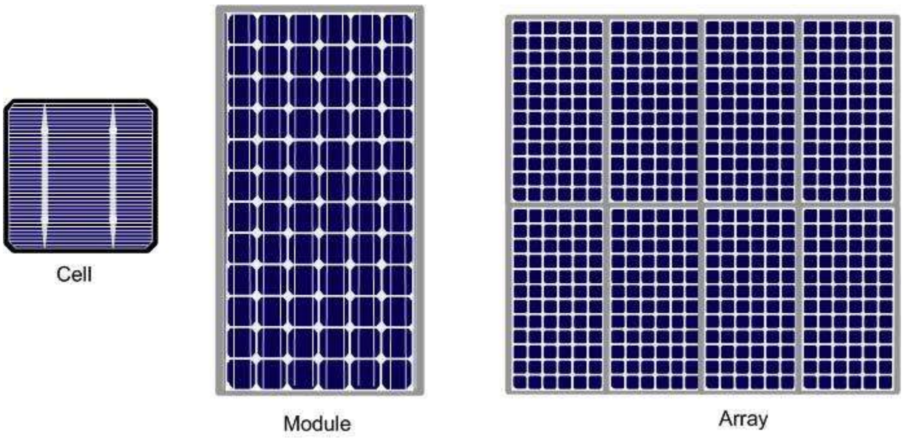
C7. Minimum distance from roof edges

Your solar PV design engineer should prescribe minimum clearance from roof edges that should be maintained for your area based on climatic and wind conditions. Typically, a minimum clearance of 20 to 30 cm should be maintained.

[5] D'Orazio M *et al*. 2013. Performance assessment of different roof integrated photovoltaic modules under Mediterranean Climate.

Appendix D. Deciding on Size of Solar Array

Terminology used



Solar power is generated by solar **cells**, which are arranged in framed **modules**, typically of 60, 72, 120, 144 or 156 cells each. The total set of solar PV modules installed is referred to as a solar PV **array**[6].

The table below provides a basic guide to selecting the size of the solar PV array based on number of people in the household and/or hot water use. Minimum recommended size is 1 kW_p. Read on for a more detailed guide.

Solar PV array size (kW_p)	Showers per day*	50%+ of daily hot water use provided for how many people?	How many people off-grid for hot water?	Typical number of solar PV modules
1 – 1.2	💧💧💧	👤 (👤)	👤	2 - 3 modules
1.2 – 1.6	💧💧💧💧	👤👤 (👤)	👤 (👤)	3 - 4 modules
1.5 – 2	💧💧💧💧💧	👤👤👤 (👤)	👤👤 (👤)	4 - 5 modules
2.4 – 3.2 (two parallel PV strings)	💧💧💧💧💧💧💧💧	👤👤👤👤👤	👤👤👤 (👤)	6 - 8 modules
3 – 4 (two parallel PV strings)	💧💧💧💧💧💧💧💧💧💧	👤👤👤👤👤👤	👤👤👤👤👤	8 - 10 modules

* 6-minute showers at 40 °C with 8 litre/min (low-flow) showerheads

[6] Image source: http://ohioline.osu.edu/factsheet/AEX-652-11.

TABLE D1. ANNUAL AVERAGE LITRES OF WATER HEATED PER DAY

The below example table indicates the average number of litres of water per day that the system will heat from 15 to 60 °C over a year period for different solar array peak power ratings. (The amount of water heated will vary with weather conditions, by geographic location and by season. Water heated per day will be significantly lower in winter and significantly higher in summer. These numbers indicate heating capacity – i.e. if no hot water is used on a given day, there will be less water heated on that day. This is only an **approximate** guide.)

	Solar + Elon®	Annual average litres of water heated per day for X kW_p installed solar capacity									
Location	**$kWh/kW_p/yr$**	**0.8 kW_p**	**1 kW_p**	**1.2 kW_p**	**1.4 kW_p**	**1.6 kW_p**	**1.8 kW_p**	**2 kW_p**	**2.5 kW_p**	**3 kW_p**	**3.5 kW_p**
Bloemfontein	1894	80	99	119	139	159	179	199	249	298	348
Cape Town	1624	68	85	102	119	136	154	171	213	256	299
Durban	1447	61	76	91	106	122	137	152	190	228	266
Jhb/Pretoria	1724	72	91	109	127	145	163	181	226	272	317
Mbombela	1627	68	85	103	120	137	154	171	214	256	299
Port Elizabeth	1565	66	82	99	115	132	148	164	205	247	288
Upington	1912	80	100	121	141	161	181	201	251	301	352
Saldanha	1623	68	85	102	119	136	153	170	213	256	298

Example:
For a **solar array of 1.2 kW_p**, an installation in **Johannesburg** would yield about 1724 $kWh/kW_p/yr$, or 1724 x 1.2 kW_p = **2069 kWh/yr**. This would be sufficient to heat on average **109 litres of water per day**. For a family of 2 each using 80 litres of hot water per day, this would provide about 109 ÷ (80 x 2) or **68% of the annual hot water requirement**.

TABLE D2. ANNUAL AVERAGE NUMBER OF SHOWERS PER DAY

The below table indicates the average number of showers per day for which the system will supply hot water over a year period for different solar array peak power ratings. (The amount of water heated will vary with weather conditions, by geographic location and by season. Water heated per day will be significantly lower in winter and significantly higher in summer. These numbers indicate heating capacity – i.e. if no hot water is used on a given day, there will be less water heated on that day. This is only an approximate guide.)

	Solar + Elon®	Number of showers per day (based on annual average) for X kW_p installed solar capacity								
Location	**$kWh/kW_p/yr$**	**0.8 kW_p**	**1 kW_p**	**1.2 kW_p**	**1.4 kW_p**	**1.6 kW_p**	**1.8 kW_p**	**2 kW_p**	**2.5 kW_p**	**3 kW_p**
Bloemfontein	**1894**	**2.4**	**3.0**	**3.6**	**4.2**	**4.8**	**5.4**	**6.0**	**7.5**	**9.0**
Cape Town	**1624**	**2.0**	**2.6**	**3.1**	**3.6**	**4.1**	**4.6**	**5.1**	**6.4**	**7.7**
Durban	**1447**	**1.8**	**2.3**	**2.7**	**3.2**	**3.6**	**4.1**	**4.6**	**5.7**	**6.8**
Jhb/Pretoria	**1724**	**2.2**	**2.7**	**3.3**	**3.8**	**4.3**	**4.9**	**5.4**	**6.8**	**8.2**
Mbombela	**1627**	**2.1**	**2.6**	**3.1**	**3.6**	**4.1**	**4.6**	**5.1**	**6.4**	**7.7**
Port Elizabeth	**1565**	**2.0**	**2.5**	**3.0**	**3.5**	**3.9**	**4.4**	**4.9**	**6.2**	**7.4**
Upington	**1912**	**2.4**	**3.0**	**3.6**	**4.2**	**4.8**	**5.4**	**6.0**	**7.5**	**9.0**
Saldanha	**1623**	**2.0**	**2.6**	**3.1**	**3.6**	**4.1**	**4.6**	**5.1**	**6.4**	**7.7**

The table is based on **6-minute** showers at **40 °C** and **8 litres/min** low flow showerheads. Old showerheads can use up to 15 litres/min and would substantially reduce the number of showers.

Example:
For a solar PV array of **2.5 kW_p**, an installation in Johannesburg would yield about 1724 $kWh/kW_p/yr$, or 1724 x 2.5 kW_p = **4 310 kWh/yr**. This would be sufficient for about **6 to 7 showers per day**.

TABLE D3. PERCENTAGE OF ANNUAL HOT WATER REQUIREMENT

The below example table indicates what % of the annual hot water requirement will on average be supplied by the system for **2 people each using 80 litres of hot (60 °C) water per day**. (The amount of water heated will vary with weather conditions, by geographic location and by season. Water heated per day will be significantly lower in winter and significantly higher in summer. These numbers indicate heating capacity – i.e. if no hot water is used on a given day, there will be less water heated on that day. This is only an **approximate** guide.)

	Solar + Elon®	**Annual average % of hot water requirement supplied for 2 people each using 80 litres of hot water per day for X kW_p installed solar capacity**								
Location	$kWh/kW_p/yr$	**0.8 kW_p**	**1 kW_p**	**1.2 kW_p**	**1.4 kW_p**	**1.6 kW_p**	**1.8 kW_p**	**2 kW_p**	**2.5 kW_p**	**3 kW_p**
Bloemfontein	1894	**50%**	**62%**	**75%**	**87%**	**99%**	**112%**	**124%**	**155%**	**187%**
Cape Town	1624	**43%**	**53%**	**64%**	**75%**	**85%**	**96%**	**107%**	**133%**	**160%**
Durban	1447	**38%**	**47%**	**57%**	**66%**	**76%**	**85%**	**95%**	**119%**	**142%**
Jhb/Pretoria	1724	**45%**	**57%**	**68%**	**79%**	**91%**	**102%**	**113%**	**142%**	**170%**
Nelspruit	1627	**43%**	**53%**	**64%**	**75%**	**85%**	**96%**	**107%**	**134%**	**160%**
Port Elizabeth	1565	**41%**	**51%**	**62%**	**72%**	**82%**	**92%**	**103%**	**128%**	**154%**
Upington	1912	**50%**	**63%**	**75%**	**88%**	**100%**	**113%**	**126%**	**157%**	**188%**
Saldanha	1623	**43%**	**53%**	**64%**	**75%**	**85%**	**96%**	**107%**	**133%**	**160%**

Examples:

An array of **1.2 kW_p** will provide approximately **64%** of the annual hot water requirement for a family of **two people in Cape Town**.

An array of **2 kW_p** will provide approximately 124% x (2 people / 4 people) = **62%** of the annual hot water requirement for a family of **four people in Bloemfontein**.

Appendix E. PV array and geyser (water heater) element matching

It is important to match PV array specifications and heating elements for maximum power transfer efficiency. See the below table for the recommended heating element power rating for different solar array sizes.

Contact PowerOptimal for advice on module-element matching if module properties are significantly different to typical values or **for advice on bifacial, high current & high voltage modules**.

TABLE E1. GUIDE: PV ARRAY AND GEYSER (WATER HEATER) ELEMENT MATCHING

Solar PV array size (kW_p)	Best matching geyser element size (kW)	2nd choice geyser element size* (kW)	Geyser (water tank) size (litres)
1 – 1.2	**4**	3	100 - 200
1.2 – 1.6	**3**	4 or 2	100 - 200
1.6 – 2	**2**	3	150 – 300
2 – 4 (two parallel PV strings)	**4**	NA	200+

** Second choice element size would reduce efficiency by 10 – 20%.*

DO NOT DEVIATE FROM THE RECOMMENDED MODULE-ELEMENT MATCHING CONFIGURATIONS WITHOUT CONSULTING POWEROPTIMAL.

Maximum allowed solar PV array specifications at Standard Test Conditions (**STC**):
I_{sc} < 15A **V_{oc} < 230V** **Power < 3 kW_p**

Appendix F. Technical Specification Summary: Elon® Smart

Refer to the PowerOptimal website for the full Technical Specification
www.poweroptimal.com/specifications

Rated input voltage	230V AC, 230V DC
Rated input current	18A AC, 15A DC
Mains (AC) voltage range	230V +10% -15%
System power supply	Solar PV DC or 230V AC mains
Power consumption	3W on either AC or DC (solar) power
Data retention on device	2 weeks for high-resolution server data, 1 year for mobile app data
Solar voltage	30 – 230 V DC
Thermostat	Electronic thermostat with 0.5 °C accuracy
Safety	Electromechanical thermal cutout
Reverse polarity protection	For solar PV connections
Lightning protection	8 kA
Self-tests	Component failure, wiring failure, element failure, insulation failure, hot connections
Enclosure ingress protection rating	IP40
Annual energy production compared to inverter-based system	> 90% when solar PV array and geyser element are matched correctly
Standards conformance	SANS 60730-1, SANS 60730-2-7, SANS 60730-2-9, SANS / EN 301 489-1, SANS / EN 301 489-17, ICASA Type Approval, LoA from NRCS
Dimensions & weight	23 x 12 x 11 cm, 0.3 kg
Patents	ZA 2019/02129 (granted), GB2583814B (granted), ZA 2022/08516 (granted), EP 4100979 (granted), US 17/797,977 (pending), GB2206504.9 (pending)
Registered Designs	ZA F2022/00962 (granted), F2022/00963 (granted)
Communications link	Wi-Fi Client, Wi-Fi Hotspot (2.4 GHz)
Measurements	AC energy, voltage, current (5%) DC energy, voltage, current (5%) Temperature: water & ambient
Data logging	15-second data retained for 14 days 5-minute data retained for 366 days
Other features	Mobile app for installers and users Full installation self-check Remote firmware upgrades 50 000+ switching operations on thermostat

It is important to match modules and heating elements for maximum power transfer efficiency. See the tables in **Appendix E** for the recommended heating element power rating for different solar module specifications and array configurations.

Appendix G. Surge Protection Device (SPD) Recommendations

This Appendix outlines under which circumstances a Surge Protection Device should be installed as part of a solar PV system installation such as the Elon® Smart.

G1. SANS 10142-1 The wiring of premises Part 1: Low-voltage installations

Please note: compliance with SANS 10142-1 is compulsory for all electrical installations as per the Occupational Health & Safety Act.

SANS 10142-1 states the following with regards to surge protection:

6.7.6 Surge protection

6.7.6.1 Surge protective devices (SPDs) ***may be installed*** *to protect an installation against transient overvoltages and surge currents such as those due to switching operations or those induced by atmospheric discharges (lightning). NOTE A risk assessment may be performed in accordance with annex Q. The Installation of SPDs is necessary where structures are equipped with external lightning protection systems (LPS) as in accordance with SANS 10313.*

As can be seen above, surge protection is optional and based on a risk assessment as per Annex Q.

The risk assessment is as per the following table from SANS 10142-1 (2020):

Table Q.1.1 — Surge Protection Requirements for residential Buildings

Surge protection requirements for RESIDENTIAL buildings									
Lightning Flash Density (Ng)	RURAL ENVIRONMENT			SUBURBAN ENVIRONMENT			URBAN ENVIRONMENT		
	Service Line (l)	Type of SPD Required		Service Line (l)	Type of SPD Required		Service Line (l)	Type of SPD Required	
0 ≤ Ng < 3	> 62 m	T2	5 kA	> 85 m	T2	5 kA	> 425 m	T2	5 kA
3 ≤ Ng < 7	> 26 m	T2	5 kA	> 36 m	T2	5 kA	> 182 m	T2	5 kA
7 ≤ Ng < 11	> 17 m	T2	20 kA	> 23 m	T2	20 kA	> 115 m	T2	20 kA
Ng ≥ 11	> 13 m	T2	20 kA	> 17 m	T2	20 kA	> 85 m	T2	20 kA

Note that the "Service Line" referred to above is the incoming (AC) line for the house.

Here is a lightning density map for South Africa as provided in SANS 10142-1:

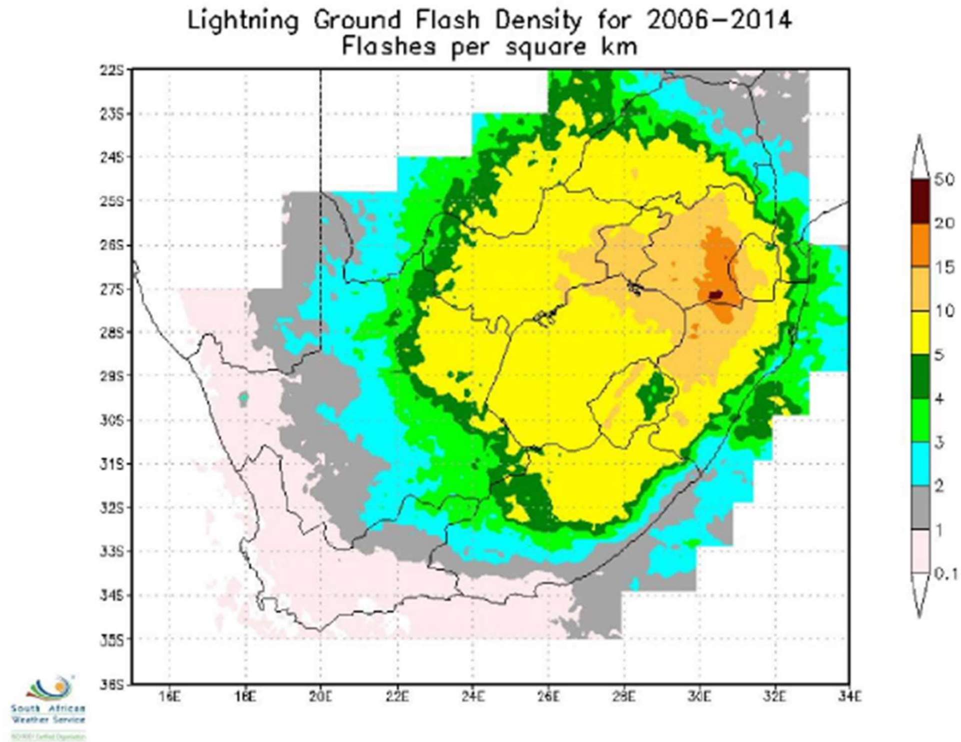


Figure Q.2 — Lightning ground flash density

Drg.1122h

G2. SANS 60364-7-712 (2018) Low Voltage Electrical Installations: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems

Section 712.443.5.101 of SANS 60364-7-712 requires a Surge Protection Device to be installed on the DC side of the installation where the length (**L**) of the DC cables (from PV array to Elon® Smart or inverter) exceeds the critical length **Lcrit** as follows:

A Surge Protection Device is required where **L ≥ Lcrit**

The critical length **Lcrit** depends on the type of PV installation and is calculated according to the following table:

Type of installation	Individual residential premises	Terrestrial production plant	Service / Industrial / Agricultural Buildings
Lcrit (in meter)	115/Ng	200/Ng	450/Ng

where Ng = lightning strike density (number of strikes/km²/yr)

The length of DC cables **L** is the **sum** of:

- distances between the inverter(s) and the junction box(es), while observing that the lengths of cable located in the same conduit are counted only once, and

- distances between the junction box and the connection points of the photovoltaic modules forming the string, observing that the lengths of cable located in the same conduit are counted only once.

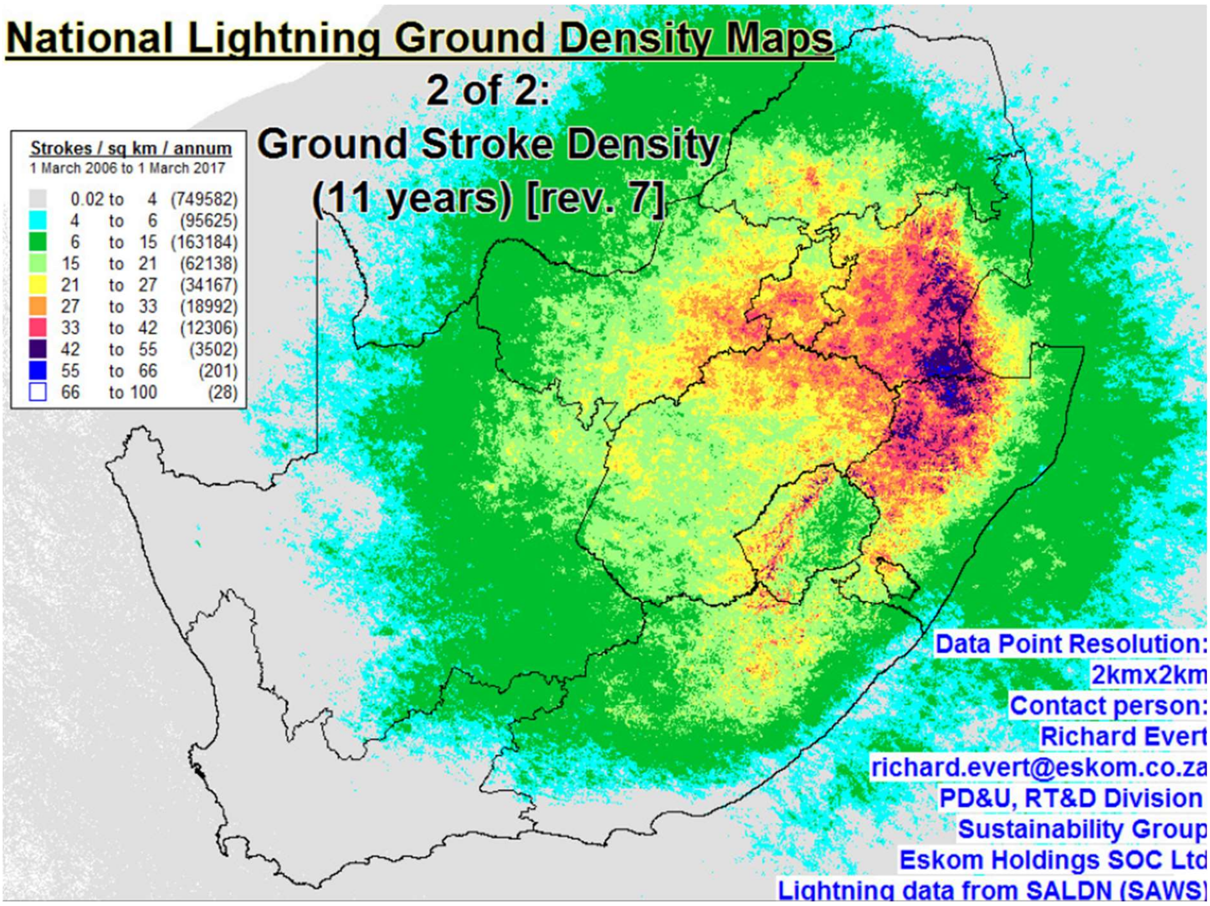
For the Elon® Smart, distance **L** is the length of DC cables from PV array to the Elon® Smart.

On the next page is a national lightning ground stroke density map for South Africa[7].

From this map, the lightning strike density (Ng) range for major cities are as follows:

City	Lightning strike density Ng (strikes/km²/yr)	Lcrit (m)	
		Individual residential premises	Service / industrial / agricultural buildings
Cape Town	0.02 to 4	29	113
Stellenbosch	0.02 to 4	29	113
Worcester	0.02 to 4	29	113
George	0.02 to 4	29	113
Saldanha	0.02 to 4	29	113
Port Elizabeth	0.02 to 4	29	113
East London	4 to 6	19	75
King Williams Town	4 to 6	19	75
Beaufort-West	4 to 6	19	75
Musina	4 to 6	19	75
Britstown	6 to 15	8	30
Durban	6 to 15	8	30
Upington	6 to 15	8	30
Pietermaritzburg	15 to 21	5	21
Greytown	15 to 21	5	21
Polokwane	15 to 21	5	21
Bloemfontein	15 to 21	5	21
Queenstown	15 to 21	5	21
Vryburg	15 to 21	5	21
Mahikeng	15 to 21	5	21
Mbombela (Nelspruit)	15 to 21	5	21
Kimberley	21 to 27	4	16
Pretoria	21 to 27	4	16
Vereeniging	21 to 27	4	16
Welkom	21 to 27	4	16
Johannesburg	27 to 33	3.5	13
Ermelo	33 to 42	2.5	10
Newcastle	33 to 42	2.5	10

[7] Evert CR, Gijben M. 2017. Official South African Lightning Ground Flash Density Map 2006 to 2017.



From Evert & Gijben (2017).

Appendix H. IEC/SANS and EMC Test Certificates: Elon® Smart

TEST Africa

Building 33, Scientia
Room S166
Meiring Naudé Road
Pretoria

PO Box 36335
Menlopark
Pretoria, 0102
South Africa

sanas
T0146

WCT (PTY) LTD T/A T.E.S.T. Africa
reg #: 2000/024600/07
vat reg #: 4620192684

Tel.: (+27 12) 349 114
Fax.: (+27 12) 3491249
E-mail: info@testafrica.co.za
Internet : http://www.testafrica.co.za

ilac-MRA

Test Report

IEC 60730-2-9

Automatic electrical controls - Part 2-9: Particular requirements for temperature sensing controls

REPORT # : WCT 24/0519A

CLIENT:	*Electrolux SA (Pty) Ltd* *PO B ox 389* *Benoni* *1500* *Attention: Ughard De Clercq* *Order #: Application Form* *Date of Order: 04 April 2024*
SAMPLE:	*Smart Thermostat*
TEST SPECIFICATION:	*SANS 60730-2-9:2013, IEC 60730-2-9:2011 in conjunction with SANS 60730-1:2016, IEC 60730-1:2013*
SUMMARY OF RESULTS:	*Complied*
DATE STARTED:	*2024-04-25*
DATE COMPLETED:	*2024-05-28*
DATE OF ISSUE:	*2024-05-28*

TESTED & APPROVED: GH Holtzhausen (Technical signatory)

REVIEWED: LP Kuisis (Test Engineer)

NOTE: This report relates only to the specific sample(s) tested as identified herein. The test results do not apply to any similar items that has not been tested.

Page 1 of 118

Room S166, Building 33
CSIR Grounds
Scientia, Pretoria
0135

PO Box 36335
Menlopark
Pretoria, 0102
South Africa

T0146

WCT (PTY) LTD T/A T.E.S.T. Africa
reg #: 2000/024600/07
vat reg #: 4620192684

Tel.: (+27 12) 349 114
Fax.: (+27 12) 3491249
E-mail: info@testafrica.co.za
Internet : http://www.testafrica.co.za

Test Report

IEC 62368-1
Audio / video, information and communication technology equipment
Part 1: Safety requirements

REPORT # : WCT 24/0519

CLIENT:	*Electrolux SA (Pty) Ltd* *PO B ox 389* *Benoni* *1500* *Attention: Ughard De Clercq* *Order #: Application Form* *Date of Order: 04 April 2024*
SAMPLE:	*Smart Thermostat – Communication Module*
TEST SPECIFICATION:	*SANS 62368-1:2020/ IEC 62368-1:2018*
SUMMARY OF RESULTS:	*Complied*
DATE STARTED:	*2024-04-10*
DATE COMPLETED:	*2024-05-27*
DATE OF ISSUE:	*2024-05-27*

TESTED & APPROVED: GH Holtzhausen (Technical signatory)

REVIEWED: LP Kuisis (Test Engineer)

NOTE: This report relates only to the specific sample(s) tested as identified herein. The test results do not apply to any similar items that has not been tested.

Page 1 of 44

EMC TEST REPORT

TEST STANDARD(S)	:	ETSI EN 301 489-1: V2.2.3 ETSI EN 301 489-17: V3.2.4 EN 60730-1:2016+A1+A2:2022 EN 60730-2-9:2019+A1+A2:2020
CLIENT / APPLICANT	:	PowerOptimal (Pty) Ltd.
CLIENT ADDRESS	:	88 12th Avenue Kleinmond 7195
TEST SAMPLE (EUT)	:	Smart Thermostat for Powering a Standard Electrolux Geyser
MODEL NUMBER	:	Elon Smart
VARIANTS	:	None
RESULT	:	Pass
REPORT NUMBER	:	TRE02653/24
DATE ISSUED	:	02/05/2024
REVISION	:	1.0

iSERT (Pty) Ltd. Test reports apply only to the specific sample(s) tested under stated conditions. All samples tested were in good operating condition throughout the entire test program. It is the manufacturer's responsibility to ensure that additional production units of this model are manufactured with identical electrical and mechanical components. iSERT (Pty) Ltd. Shall have no liability for any deductions, inference or generalizations drawn by the client or others from our Issued test reports. This report shall not be used to claim, constitute or imply a product endorsement from iSERT (Pty) Ltd.

This test report was prepared by: ***Name:*** *DF Joubert* ***Title:*** *Junior EMC Engineer*

This test report was approved by: ***Name:*** *CJ Deysel* ***Title:*** *Technical Signatory*

Testing Laboratory
T0812

This test report is issued in accordance with SANAS accreditation requirements. SANAS is a signatory to the ILAC Mutual Recognition arrangement for the mutual recognition of the equivalence of testing and calibration reports

Appendix I. Warranty

If the PowerOptimal Elon® Smart ("the Product") is found to be defective, you will be entitled to a repair or replacement within 2 (two) year of the date of delivery of the Product to you. **Please keep your receipt as proof of purchase or register the Elon Smart online.** If you are a consumer as defined in the Consumer Protection Act No. 68 of 2008 ("the CPA"), you will be entitled to such remedies as are made available under the CPA in relation to the return of goods.

PowerOptimal will not have any liability or obligation to you where the Product has been subjected to abuse, misuse, improper use, improper testing, negligence, accident, alteration, tampering or repair by a third party.

To the maximum extent permitted by applicable law, in no event shall PowerOptimal be liable for any special, incidental, indirect, or consequential damages whatsoever, including, without limitation, damages for loss of business profits or business interruption, arising out of the use or inability to use this product.

Please note that this unit must be installed by an electrical contractor registered with the Department of Labour. Failure to do so may invalidate this warranty. Please keep the CoC (Certificate of Compliance) issued by the electrical contractor on completion of the installation.

Register your Elon Smart online to get an extended 5-year warranty here:

https://poweroptimal.com/elon-extended-warranty/

Appendix J. Terminology

AC	Alternating Current – an electric current that reverses its direction many times a second at regular intervals, with voltage typically varying in the form of a sine wave.
CoC	Certificate of Compliance – to be issued by the electrician installing your Elon® Smart system
CPA	Consumer Protection Act No. 68 of 2008
DB	Distribution board – the main electrical distribution board / panel in your home, containing circuit breakers and switches.
DC	Direct Current – an electric current flowing in one direction only. Solar PV modules produce direct current electricity.
Geyser	South African term for a water heater
IEC	International Electrotechnical Commission
I_{mpp}	The solar module current at maximum power point (MPP). Manufacturers usually report two I_{mpp} values: one at STC and one at NOCT.
kWh	A derived unit of energy equal to 3.6 MJ (megajoules). The amount of energy used by a 1 kW electrical device over a period of 1 hour.
kW_p or W_p	The peak power rating in kilowatt (kW) or watt (W) of a solar module or array – i.e., the output power achieved under full solar radiation. This is usually reported at STC and NOCT.
MPP	Maximum power point. This is the point on a solar cell, module or array's power or I-V (current-voltage) curve that has the highest power output.
NOCT	Nominal Operating Cell Temperature (also sometimes referred to as NMOT or Nominal Module Operating Temperature). This refers to the temperature that open circuited solar PV modules will reach under conditions that more closely match actual field operational conditions than STC. The modules are tested at 800 W/m² simulated solar irradiance, 20 °C ambient temperature, 1 m/s wind velocity and open back side mounting. Depending on the quality of the cell / module design, the NOCT can reach anything from 33 to 58 °C[8]. Since solar PV cell power output reduces with increase in temperature, a lower NOCT is better.
PV	Photovoltaic – referring to the production of electric current at the junction of two materials exposed to light.
SANS	South African National Standards
STC	Standard Test Conditions for solar cells – 1000 W/m² simulated solar irradiance and 25 °C solar cell temperature, and an air mass 1.5 spectrum (AM1.5).
V_{mpp}	The solar module voltage at maximum power point (MPP). Manufacturers usually report two V_{mpp} values: one at STC and one at NOCT.

[8] Source: http://pveducation.org/pvcdrom/modules/nominal-operating-cell-temperature.

Notes