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Analysis and Documentation of Experiments on Cool Roofs and Walls in KwaZulu-Natal

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EXECUTIVE SUMMARY

Through this project, the Energy Partnership aims to support its partner SANEDI in analysing and documenting the experiments on cool roofs and walls done in KwaZulu-Natal at Genkem's Umhlanga premises and at the Saint Lucia Ecolodge along the St Lucia Estuary, so that the gained results can be used for further project development and roll-out of cool roof/cool surface technology in South Africa. The following sections illustrate LowExCo's approach and methodology to achieve this objective.

The assessment process included qualitative (survey-based) and quantitative components enabling a holistic review and analysis of the technology applied, its measurable and perceived effects and acceptance among researchers, manufacturers, and prospective users. The benefit of this approach is that an assessment of the technology was possible even without historic baseline data and that the participants of the project could directly describe the effects/benefits/disadvantages attained through the intervention while at the same time data measurements in experimental environment provide evidence of the effects.

For the St. Lucia experiment the monthly energy consumption driver could not be determined from the utility bills and occupancy as per the methodology that had initially been anticipated in the Terms of Reference (ToR), thus an adapted approach was chosen involving isolated controlled experimental metering. This proved to be successful in determining the effect of the technology by allowing the specific electricity requirement for both the coated and uncoated environment to be recorded. From this, it is clear that over the examined 24-hours period in a controlled environment, a reduction of 1.3 kWh or 5 % was observed under given ambient conditions. A high-level extrapolation to a year using cooling degrees for St. Lucia indicates a potential reduction of cooling energy consumption in the order of 600 and 670 kWh, translating to cost reduction of between R 1,200 and R 1,340[1].

There seem to be issues with lichen growth on the coated surfaces. In order to determine the definite reason for that growth, further analysis of the matter would be required and is not covered within this report. It might be appearing due to insufficient preparation of the surface before applying the paint (explanation of the coating manufacturer) or due to specific climate conditions in the experimental area. The latter could be addressed by utilising different colours of cool coatings. This will however, reduce the emissivity and thereby impact on the overall efficacy of the cool coating and thus may be worth investigating in more detail.

Based on the objectives of the study, both the maximum temperature and the average temperature was selected in the Genkem experiment for analysing the impact of the cool coating technology in reducing indoor temperature, energy consumption and demand. The maximum temperatures are a suitable measure for assessing the efficacy of cool coating in terms of reducing electric peak loads i.e. electricity demand; and the average temperatures are a good indication for the impact of the technology on HVAC energy consumption. Additionally, maximum, minimum and average temperatures have a clear impact on thermal comfort.

The container experiment has shown the efficacy of the cool coating technology by highlighting consistent differences of both average and maximum air temperature profiles between the coated and uncoated containers. Mean average daily temperatures differ by 1.9°C and mean maximum temperatures differ by 7°C. The efficacy of the technology could thus be demonstrated successfully and shows significant potential specifically for reducing electricity demand for cooling and improving thermal comfort during periods of high temperatures in warm coastal climatic conditions. Results are however very dependent on the location and climatic conditions of the application.

Based on this work and other studies referenced here, it can be seen that there is local capacity and capability in South Africa, which can be leveraged to demonstrate the applicability of this technology and support the wide spread application of cool coating in various sectors and building types.

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[1] The calculation assumes an average electricity price of R2.00/kWh and 60,000-67,500 annual cooling degrees per annum.

Content

ANALYSIS AND DOCUMENTATION ON COOL ROOFS AND WALLS IN KWAZULU-NATAL

1 Goals to be achieved by scope of work

Through this project, the Energy Partnership aims to support its partner SANEDI in analysing and documenting the experiments on cool roofs and walls done in KwaZulu-Natal at Genkem's Umhlanga premises and at the Saint Lucia Ecolodge along the St Lucia Estuary, so that the gained results can be used for further project development and roll-out of cool roof/cool surface technology in South Africa. The following sections illustrate LowExCo's approach and methodology to achieve this objective.

2 Methodology to be employed

2.1 Approach and overview of methodology

The work conducted combined expertise in measurement & verification, thermal comfort in buildings, data analysis and stakeholder engagement to enable the analysis, assessment and documentation of the effectiveness of the cool roof/ cool surfaces technology. The assessment process included qualitative and quantitative components enabling a holistic review and analysis of the technology applied, its measurable and perceived effects. The benefit of this approach is that an assessment of the technology will be possible even without historic baseline data through a comparison with similar/identical non-coated buildings and that the participants of the project could directly describe the effects/benefits/disadvantages attained through the intervention while at the same time data measurements provided evidence of the effects.

The technical approach for assessment of the cool coating technology is outlined in Figure 1. A deviation from the steps in the ToR and extension of the project until November 2020 was agreed upon due to unforeseen limitations on account of the Covid-19 restrictions. The approach taken for the St. Lucia Ecolodge was also amended as compared to the steps envisaged in the ToR. The methodology followed allowed the deliverables as specified in the RFP to be produced and is described in more detail in sections 2.2 – 2.7.

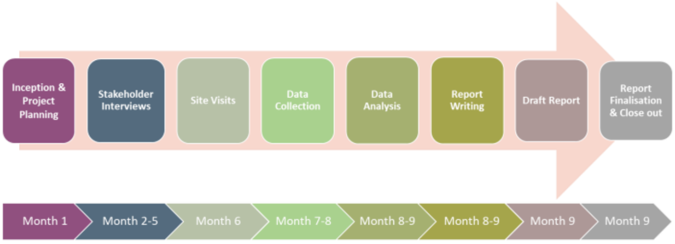

Figure 1: Overview of project steps and timeframe

2.2 Project planning/inception

The project management was set up and risk assessment conducted. A virtual inception meeting was held on the 25 March 2020 with the Energy Partnership Secretariat and SANEDI to discuss in detail the project steps and confirm the timeframes for the assessment and the deliverables. In the course of this meeting the extent of the existing data and metering was discussed. Minutes of the meeting were compiled by the Energy Partnership Secretariat. A list of names of project owners & partners for the stakeholder interviews was provided to the consultant along with the available data.

2.3 Site visit

Site visits were conducted over 2 days on 6 and 7 July 2020. The sites visited are:

1. Genkem, two repurposed shipping containers located at 30-32 Solstice Road, Umhlanga Ridge
2. St Lucia Ecolodge, situated at 135 Hornbill Street, St Lucia Estuary.

During the site visits existing data was collected from the project managers as specified in the ToR and outlined in section 2.4. Beyond this, building architecture (size, roof construction, airflow, natural ventilation, etc), and placement of instrumentation were assessed and documented. At St Lucia Ecolodge the placement and installation of electricity meters was discussed and agreed upon with the site's external electrician. Initially it was planned to oversee and verify the installation, however, delays in shipping metering equipment resulted in the respective meters not yet having arrived when the site-visit was conducted. The individual sites will be described in greater detail in section 3.

2.4 Quantitative data collection

The initial component of the assessment of the effectiveness of the cool coating technology intervention involved collecting and analysing existing data measurements and findings from project managers in the sample and control buildings that can provide quantitative evidence of the effects as per ToR 4.2.1. Data collected includes:

1. Electricity bills/accounts of energy usage for the sites over a period of 12 months (St. Lucia Ecolodge)
2. Manual meter readings of electricity meters installed in the course of the project (St. Lucia Ecolodge)

3. Raw data from 3 data loggers on indoor temperature per test containers (one coated (Ctd), one uncoated (UnCtd))

The approach envisaged in the ToR for St. Lucia Ecolodge involved analysing electricity bills/accounts of energy usage and determining a baseline using historical pre-application data and comparing this to post-application consumption via a Measurement and Verification (M&V) methodology. Following project inception as well as interactions during stakeholder engagement with St. Lucia Ecolodge, it became apparent that this approach would potentially be unfeasible due to the extent of the efficiency upgrades conducted at the Ecolodge and the lack of submetering. This was discussed with GIZ and SANEDI and it was agreed to adapt the methodology by procuring energy meters to monitor the HVAC usage of the two experiment bungalows directly. GIZ was able to procure and deliver the energy meters to St. Lucia Ecolodge during August 2020. Technical difficulties delayed the installation until early September 2020. More detail is provided in the relevant report section discussing the specific experiment.

Analysis templates for the indoor temperature measurement data from the container experiment were developed and tested on sample data made available and subsequently applied to the full dataset. The procedure for analysis of consumption data of the St. Lucia Ecolodge bungalows was developed based on the anticipated relevant variables identified. It was ensured that this data (e.g. detailed occupancy data for the St. Lucia Ecolodge experiment bungalows and corresponding electricity consumption values) could be made available as required.

It had been agreed upon that data collection at both sites should continue until end of September 2020 in order to incorporate the most comprehensive dataset possible while allowing for the deadlines for draft and final reports as determined by GIZ and SANEDI. In the case of the St. Lucia Ecolodge it was decided to continue data collection in October mainly due to low occupancy rates and unusually low temperatures in the region in September. In the case of the Genkem container experiment no data for the period after July 2020 could be obtained due to technical difficulties with the loggers resulting in an overall measurement period from October 2019 to July 2020.

Energy usage data was analysed and compared on a monthly, seasonal (summer and winter profile) as well as annual basis for the sites. The measured indoor data was compared to meteorological data for the measurement period. The measurement data was aggregated to hourly, daily, weekly and monthly averages as required for reporting. These datasets include minimum and maximum values for the averaged intervals.

The datasets of the indoor and ambient temperatures were contrasted between coated and control containers and discrepancies analysed based on the interviews and other data gathered during the site visits. These averaged datasets were analysed to establish systematic differences between them in order to establish the quantitative effects of the cool coating technology.

The datasets and analysis is suitably documented in further sections of this report. Raw and analysed data will also be made available in MS Excel form as specified in the ToR.

2.5 Qualitative data collection and analysis

In order to assess the perceived effects, acceptance and market potential of the cool coating technology, it was envisaged to conduct interviews with occupants of coated as well as uncoated control buildings.

During the site visits by the project team, the St. Lucia Ecolodge experiment bungalows were not occupied by guests, as such no interviews could be conducted. In general, guest feedback on this specific aspect is limited. An additional factor to be considered is that guest feedback will be of limited use due to a lack of comparative reference for the guest perception and because thermal comfort will be guided by heating/AC usage and set points rendering a qualitative analysis regarding thermal comfort meaningless in the context of this project. However, the overall perception is included in the stakeholder interview conducted with the lodge owner. No further qualitative analysis regarding guest perception of the technology could be conducted.

Genkem's experiment consist purely of empty test containers with temperature logging equipment installed. These containers were specifically procured for the purpose of this experiment. They are not otherwise used or occupied, and serve solely for comparative experimental purposes. As such no qualitative data collection was possible.

2.6 Stakeholder interviews

The consultant has conducted interviews with the relevant personnel of the project owners & partners in order to ascertain the perceived impact and assessment of the project based on the project partners respective aims, objectives and expectations as per 4.3 of the ToR (see Appendix 2).

Table 1: List of stakeholders identified and interviewed

First Name	Last Name	Organisation	Position/Role
Gerhard	Gross	N/A	Consultant
Kian	Barker	St. Lucia Eco Lodge	Owner/MD
Donald	Perry	Genkem	CEO
Ross	Stembridge	Master Builder Association KZN	Building Services Manager
Rajesh	Haripersad	Durban University of Technology	Lecturer

The interviews with the stakeholders listed in Table 1 highlight broad support for cool coating technology from various perspectives encompassing commercial, academic as well as development impact considerations. The key point agreed upon by all being that demonstrating reduced indoor temperatures or reduced energy consumption for cooling can lead to successfully commercialising the technology.

Although concerned about the scientific evidence, the stakeholders have no doubt that once more widely adopted, the technology will be successful on the market as it is perceived that the end user will experience the high value benefits of this low-cost technology ("value of money"). The scope of application of the technology is seen to be broad with uses in different environments: such as schools, commercial buildings, offices, and accommodation sector. Cool coating offers benefits for different end users by ultimately reducing the indoor temperature without mechanical-electrical components, or reducing energy consumption and costs for artificial cooling.

The stakeholder interviews show clearly that all stakeholders involved perceive cool coatings to be a viable and easily accessible technology to increase thermal comfort and reduce energy consumption for cooling. Additionally, it becomes evident that some stakeholders attribute a lack of adoption of the technology to missing dissemination of case-studies and efficacy data but all stakeholders would support a further large-scale roll-out/pilot application or commercialisation of the technology.

2.7 Reporting

The information provided, interviews conducted and data measured and provided in the course of the project was analysed and interpreted. The pertinent analysis and narrative conclusions are documented in this report. The comprehensive raw and analysed data, interviews and media data related to the project were provided to the client in digital and editable form. On the 30th of October 2020 a draft report was submitted to GIZ and SANEDI which was finalised and approved a month later. The outcome of the experiment suitable as a scientific report is detailed per experiment in the following section.

3 Cool coating experiment

3.1 Background and context

Cool coatings are characterised by a high solar reflectance and high infrared emittance. Through the higher reflectance and emittance compared to conventional paints especially on the roof and wall, temperature is lowered resulting in less heat conduction into the building. Emissivity is defined in relation to an ideal body (commonly known as "blackbody") that absorbs the emitted energy (Wattage). This can further be described by a material's ability to release energy, mathematically expressed as:

$$Emissivity = \frac{radiant\ flux\ emitted\ by\ a\ surface\ \ per\ unit\ area\ (W \cdot m^{-2})}{radiant\ flux\ emitted\ by\ a\ black\ body\ \ per\ unit\ area\ \ (W \cdot m^{-2})}$$

With the emissivity of different materials ranging from 0.03 (Aluminium foil) to 0.99 (Human skin), a white aluminium-based coating for example can raise the solar reflectance to more than 0.5[2]. Conventional non-metal roof materials have a solar reflectance of between 0.05 and 0.25, while reflective coatings can increase this value to more than 0.6[3]. Special reflective and emissive coatings and paints are particularly useful for metal roofs. Most non-metal roof materials have high infrared emissivities (0.85 or higher), where metal roofs have an emissivity of around 0.25. Despite the high reflectance of metal roofs (0.6 or higher) metallic roof surfaces and coatings become very hot as they cannot emit the heat absorbed through radiation[3]. With special coatings the emissivity of metal roofs can be increased significantly. By selecting appropriate roof coatings depending on the roof material, the solar reflectance or the infrared emissivity can be increased thereby lowering the roof surface temperature.

A case study with six different building types in California showed that through the application of white high reflectance coating, the peak temperatures of the roof surface was lowered by 33-42 °C and cooling load savings of 5-40% were achieved[4]. In South Africa a pilot cool coating project in uncooled homes in the Northern Cape was able to demonstrate consistent 3-4°C lower indoor temperatures[5] and as a result the project is being scaled-up and expanded. In the study of potential energy savings from cool roofs in South Africa Tartibu et al. reported benefit of lowering the indoor temperature to reduce energy consumption of artificial cooling to be possible with the technology. This was seen in different cities around South Africa with Durban showing a reduction of 8.83 kWh/m^2y (square meter year) in energy consumption[6].

The efficacy of the technology was demonstrated by Kimemia et al. using daily maximum temperatures as the scale of analysis. The underlying rationale being that lower indoor temperatures reduce indoor cooling demand and increase thermal comfort at high ambient temperatures[7]. The latter study was designed to look at passive cooling for thermal comfort in informal housing, where the cool coating technology was able to achieve a reduction of daily maximum indoor temperature of up to 4.3°C.

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[2] Liu, K. K. Y. (2006). Green, reflective, and photovoltaic roofs. *Construction Canada, 48(5),* 44-54.

[3] Sadineni, S. B., Madala, S., & Boehm, R. F. (2011). Passive building energy savings: A review of building envelope components. *Renewable and sustainable energy reviews, 15(8),* 3617-3631

[4] Akbari, H., Levinson, R., & Rainer, L. (2005). Monitoring the energy-use effects of cool roofs on California commercial buildings. *Energy and Buildings, 37(10),* 1007-1016.

[5] Sanedi (2019], Kheis Cool Coating Project. *Private communications.*

[6] Tartibu, L.K., & Bakay-Kyahurwa, E. (2017). Potential energy savings from cool roofs in South Africa. *International Conference on the Industrial and Commercial Use of Energy (ICUE),* 1-6. IEEE.

[7] Kimemia, D., Van Niekerk, A., Annergarn, H., Seedat, M. (2020). Passive cooling for thermal comfort in informal housing. *Journal of Energy in Southern Africa, 31(1)*. 28-29

Tartibu et al. and Kimemia et al. highlight large scale benefits of the technology both from reduced artificial cooling demand (energy costs savings from mechanical-electrical cooling components) and lower indoor temperatures (no mechanical-electrical cooling components) respectively.

A number of the studies referenced have been implemented using paints produced or mixed in South Africa applied by trained local staff. Based on these studies, it can be seen that there is capacity and capability in South Africa, which can be leveraged to demonstrate the applicability of this technology to other types of building and support the wide spread application.

3.2 Experiment 1: St. Lucia Ecolodge overview

St Lucia Ecolodge is located on the outskirts of St. Lucia which falls under sub-tropical coastal South African climate zone according to SANS 10400-XA. St Lucia Ecolodge offers 29 en-suite rooms accommodating a total of 72 guests. The bungalows consist of a large bedroom, lounge, full bathroom and shower, fully kitted out kitchenette and veranda with garden furniture. Additionally, two conference facilities, an 80 seater bistro, executive lounge and swimming pool are available on site.

Since the purchase of the Ecolodge the owner has progressively invested in eco-wise refurbishments including LED lighting, inverter air conditioners and solar reflecting paint[8] (cool coating) on roofs and outside walls. In order to demonstrate the effect of the cool coating, two identical bungalows lying next to each other were chosen. One bungalow was coated entirely inside and out (roof and walls) with Sandtex white cool coating paint (application site) whereas the other bungalow was left in the original state (reference site). Both bungalows are heated/cooled using identical split units. The application was done in March 2017.

Figure 2: View of adjoining application and reference bungalow

The bungalows are utilised by guests on recreational or business travel. In most cases guests will not remain in the rooms during the day but will only return from business or leisure activities in the afternoon or early evenings. Staff service the rooms mid-morning and part of the standard operating procedure is to switch off AC units that have been left on by guests.

During the course of this demonstration experiment, reception staff had been instructed to only allocate the two rooms to guests concurrently to avoid imbalances in occupancy impacting on HVAC energy consumption. HVAC operation and control however, are the guest’s prerogative and as such differences in individual behaviour patterns and thermal comfort perception levels will naturally occur, resulting in variable set-points and operating hours.

It is however, anticipated that through the monitoring period and the relatively short guest stays, the individual differences in thermal comfort perception and behaviour regarding heating/cooling usage will average out over all the guests in the period resulting in an average guest perception and heating/cooling requirement for the application and reference bungalows respectively.

The project has already been implemented more than 3 years ago. As far as is known, best practice implementation was followed. As mentioned previously the application site was painted both on the exterior and interior. The current state of the cool coating is satisfactory, and it is being considered to repaint the application bungalow. Lichen growth has been observed on the coated roofs as shown within the highlights of Figure 3 (b). A possible explanation can be insufficient preparation of the surface before applying the paint (explanation of the coating manufacturer) or favouring conditions for growth due to the reduced surface temperatures of the cool coated roofs in the very warm and humid coastal climate of St. Lucia.

(a) (b)

Figure 3: (a)-lichen growth on upper coated roof surface; (b)-lichen growth on lower coated roof surface

As the surfaces were coated some time ago the rate of lichen growth is unclear, however it stands to reason that the high average ambient temperatures and humidity combined with the lower surface temperatures of the cool coated roof have led to the growth. The non-coated roofs (see Figure 3 (a)) painted with standard green paint exhibit no signs of lichen growth. It may be worth exploring whether different colours of cool coatings could resolve this issue.

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[8] The standard application of cool coating paint is exterior. In the case of the ecolodge, the site project manager applied it internally to investigate the impact of artificial lumens benefit in utilizing the reflective properties of the paint to increase the lighting levels.

3.3 Experiment 1: St. Lucia Ecolodge data collection

The approach envisaged in the ToR for St. Lucia Ecolodge involved analysing electricity bills/accounts of energy usage and determining a baseline using historical pre-application data and comparing this to post-application consumption via M&V methodology. Following project inception as well as interactions during stakeholder engagement with St. Lucia Ecolodge, it became apparent that this approach would potentially be unfeasible due to the extent of the efficiency upgrades conducted at the Ecolodge and the lack of sub metering. The applicable incomer for which utility data is available encompasses the laundry, employees' quarters, 12 bungalows, and the caretaker's house. This was discussed with GIZ and SANEDI and it was agreed to adapt the methodology by procuring energy meters to monitor the HVAC usage of the two experiment bungalows directly. GIZ was able to procure and deliver the energy meters to St. Lucia Ecolodge during August 2020.

A comprehensive assessment would require the monitoring of the installation for at least a 12-month continuous cycle in order to incorporate the effects of the different seasons into the analysis. The comparative performance tracking approach was used as historical data is not readily available for the HVAC consumption specifically. In the comparative approach using a reference site, energy consumption data for heating and cooling is required separately for both the application site and the reference site. It is best used when no or insufficient historic data is available.

This data was to be supplied using single-phase electronic energy meters (Class 1) installed at each bungalow to meter the consumption of the HVAC units specifically. Anomalies in the electrical reticulation discovered during an initial attempt to install the meters necessitated the external electrician to deviate from the agreed upon approach of metering the HVAC directly to metering the sub-distribution as a whole (including other electricity consumption of the respective bungalow). Metering the HVAC directly would have required re-wiring the sub-distribution, which St. Lucia Ecolodge management did not agree to. These delays resulted in the meters finally being installed on the 7th of September 2020. It was further detailed how the required data (e.g. detailed occupancy data for the St. Lucia Ecolodge experiment bungalows and corresponding electricity consumption values) would be monitored and documented by staff in order to ensure a dataset with sufficient granularity. To enable adequate analysis, manual meter readings were to be taken at regular intervals (weekly or twice weekly) at set times depending on occupancy levels.

Initially data collection was set to be completed end of September. However, for St. Lucia Ecolodge it was decided to continue data collection in October as a combination of low occupancy and unusually low temperatures in the region had resulted in very limited data in regard to guest cooling consumption. Despite the prolonged data collection period, the obtained data did not allow for the analysis of guest cooling consumption mainly due to the continued colder ambient temperatures. The lower temperatures had resulted in guests infrequently, or not using the air-conditioning units at all, leading to the electricity consumption being dominated by other appliances/uses such as lighting, kettle, hot plates or microwave ovens. Consequently, the option of conducting an isolated controlled experiment (as outlined in the progress meeting held on 07 August 2020) was chosen. This experiment was conducted on 27-28 October over a period of 24 hours.

3.4 Experiment 1: St. Lucia Ecolodge data analysis

Analysis of electricity bills pre and post application enabled no conclusions to be drawn in regard to the effect of the cool coating on heating/cooling demand as monthly consumption of HVAC units is overshadowed by other electricity consumers on the same incomer.

Figure 4 shows the monthly electricity consumption from April 2019 until May 2020 together with the occupancy and the Cooling Degree Days (CDD). The reason for the significantly higher consumption in July and October 2019 could not be ascertained, but the months do not show out of the ordinary occupancy levels or weather phenomena.

In line with the original approach the relevant drivers for energy consumption from April 2019 until May 2020 were determined by analysing the Cooling Degree Days (CDD) and Heating Degree Days (HDD), and occupancy of the 12 bungalows. This period was chosen as occupancy data was made available until April 2019. A statistical multi-regression model was developed and iterated and the relevant driver(s) determined through P-value analysis. The resultant best fit model correlating monthly energy consumptions with occupancy for the 12 bungalows on the incomer is shown in Figure 5.

It should be noted that the R^2 value is a statistical measure that represents the proportion of the variance for a dependent variable that is explained by an independent variable in a regression model. Considering the low R^2 value of the model it is clear that the vast majority of the observed variation cannot be explained by the changing occupancy. This serves to underline that as anticipated the monthly utility bill data was not instrumental in demonstrating a potential reduction in energy consumption of HVAC through cool coating and that the alternative approach using isolated metering of the HVAC units of the two respective bungalows was indeed necessary.

In order to demonstrate the potential for cool coating in reducing energy consumption for space cooling, the option of conducting an isolated controlled experiment (as outlined in the progress meeting held on 07 August 2020) was chosen. This experiment was conducted on 27-28 October over a period of 24 hours, where the air conditioning units in both the coated and uncoated bungalows were operated continuously. Both bungalows have identical split type air conditioner units installed, rated at a cooling capacity of 12,000 Btu/h (3.5 kW) as shown in Figure 6. The set-points of both AC units was set at an identical 18°C throughout. To capture solely the HVAC electricity consumption in a comparable way, both bungalows were locked, windows and curtains closed and all appliances and lights switched off. Data was recorded at specified intervals, namely 10am and 6pm. The recorded meter readings and resulting consumption of the controlled experiment is shown in Table 2.

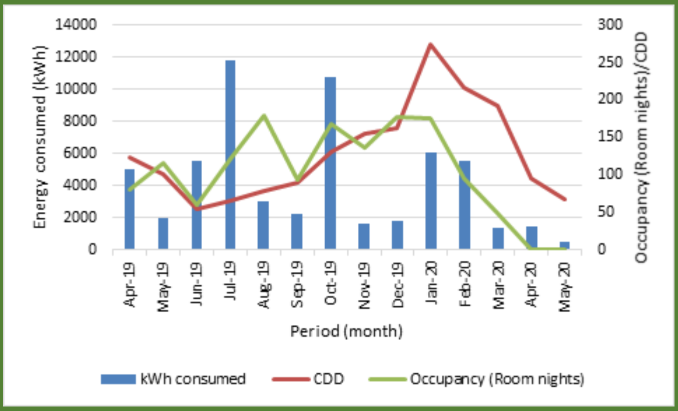

Figure 4: Consolidated overall energy consumption data from billing invoices

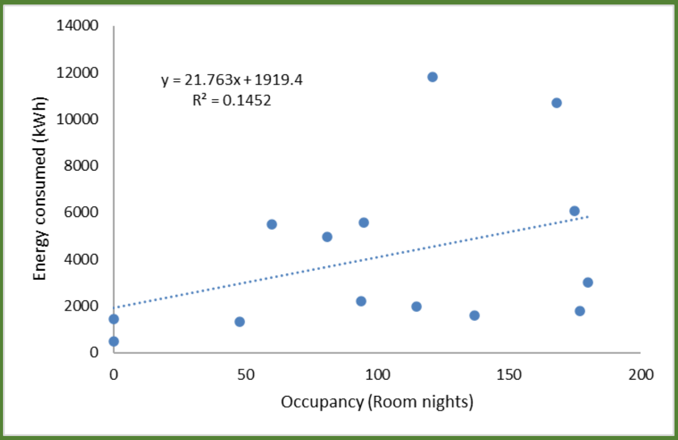

Figure 5: Regression model for occupancy as a relevant driver

TCL

SPLIT TYPE AIR CONDITIONER

Model		TAC-12CHSA/Z	
	Indoor	TAC-12CHSA/Z	
	Outdoor	TAC-12CHSA/Z	
		Cooling	Heating
Capacity		12000Btu/h	12500Btu/h
Current		5.8A	5.8A
Rated Current (IEC/EN60335)		7.5A	7.5A
Power Input		1280W	1270W
Rated Power Input (IEC/EN60335)		1660W	1650W
Indoor Air Volume		530m³/h	530m³/h
Max.Pressure	Discharge	4.5MPa	
	Suction	1.9MPa	
Noise	Indoor	39dB(A)	
	Outdoor	55dB(A)	
Weight	Indoor	8kg	
	Outdoor	30kg	
Rated Voltage		220-240V~	
Rated Frequency		50Hz	
Refrigerant/Charge		R410A/0.670kg	
Outdoor Unit Water Proof Protection		IPX4	

Figure 6: Nameplate of HVAC units installed in experiment bungalows

Table 2: Recorded experimental data

Date	UnCoated					
	Meter readings					Mode: Cooling
	Time start	Time end	Start units	End units	Units consumed	Temperature setting
2020/10/27	10:00	18:00	262,10	271,90	9,80	18°C
2020/10/28	18:00	10:00	271,90	289,90	18,00	18°C
Total kWh consumption	27,80					
Date	Coated					
	Meter readings					Mode: Cooling
	Time start	Time end	Start units	End units	Units consumed	Temperature setting
2020/10/27	10:00	18:00	243,70	253,20	9,50	18°C
2020/10/28	18:00	10:00	253,20	270,20	17,00	18°C
Total kWh consumption	26,50					

The Efficacy of the technology can be seen from Table 2 in that the HVAC in the uncoated bungalow requires more electricity for cooling than the HVAC in the coated bungalow. The air conditioning unit in the coated bungalow uses 1.3 kWh less at identical conditions over the 24h period resulting in a 5 % reduction in electricity consumption which can be attributed to the effect of the cool coating.

Figure 7 shows a cooling degree map of South Africa developed from historical weather data. Using the corresponding cooling degrees for the St Lucia region (60,000-67,500 cooling degrees per annum) to extrapolate annual performance, it is estimated that assuming constant air conditioning annually, the electricity consumption for cooling can be reduced between 600 and 670 kWh by cool coating. At a current indicative rate of R2.00/kWh this would result in a reduction of electricity costs in the order of between R 1,200 and R 1,340 attributed to the application of cool coating respectively, that is, electricity cost multiplied by the related electricity consumption.

It should be noted that these figures represent a very rough estimate due to the short period of the controlled experiment (24h) and the significant influence of occupant behaviour on air conditioning demand and consumption.

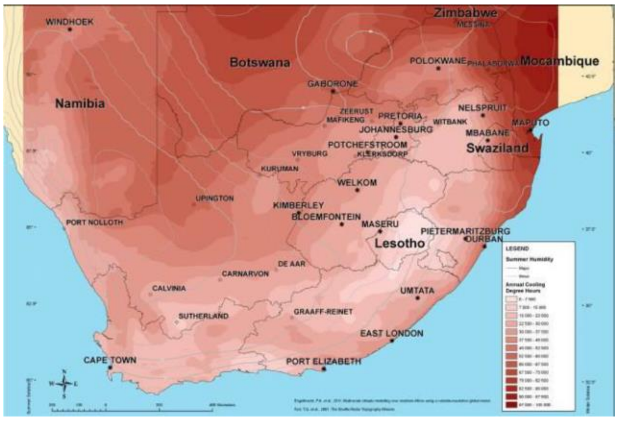

Figure 7: Cooling degree map for South Africa using historical weather data and a base temperature of 18°C. (Source: Conradie et al.)[9]

3.5 Experiment 1: St. Lucia Ecolodge summary and conclusion

While the monthly energy consumption driver could not be determined from the utility bills and occupancy as per the methodology that had initially been anticipated in the ToR, the chosen approach of isolated controlled experimental metering showed to be useful in determining the effect of the technology by allowing the specific electricity requirement for both the coated and uncoated environment to be recorded.

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[9] Conradie, D. C., Van Reenen, T., & Bole, S. (2015). The creation of cooling degree (CDD) and heating degree day (HDD) climatic maps for South Africa.

From this, it is clear that over the examined 24-hour period in a controlled environment a reduction of 1.3 kWh or 5% was observed under given ambient conditions. A high level extrapolation to a year using cooling degrees for St. Lucia indicates a potential reduction of cooling energy consumption in the order of 600 and 670 kWh translating to cost reduction of between R 1,200 and R 1,340. Although there seem to be issues with lichen growth on the coated surfaces under specific climate conditions, these may be addressed by utilising different colours of cool coatings. This will however, reduce the emissivity and thereby impact on the overall efficacy of the cool coating.

3.6 Experiment 2: Genkem containers overview

Genkem is a manufacturer and supplier of paints and has developed a cool paint which was tested in this experiment (details of Genkem's Sandtex cool paint are provided in Appendix 1). Additionally, Durban University of Technology and the KwaZulu-Natal Master Builders Association were involved in the experiment for independent, third party technical assistance (part of the interviewed stakeholders).

The COVID-19 pandemic and the associated restrictions, led to difficult conditions in the implementation and realization of the experimental setup. Nevertheless, usable data were obtained through the efforts of all involved parties.

The experiment consists of two identical refurbished empty containers (Figure8) which were placed in the parking lot of Genkem's headquarters at Umhlanga Ridge, Durban. One container was coated with Sandtex white cool paint on outside roof and walls and the other one was not coated. Both containers were fitted with temperature and humidity measuring equipment where data was being captured on an hourly basis throughout the experimental period.

Figure 8: Genkems experimental metal containers

3.7 Experiment 2: Genkem containers data collection

Genkems test containers were fitted with data logging equipment in October 2019. Data loggers were supplied by Testo SA. Each container was fitted with a total of 3 loggers (2x Testo 174H -wall & ceiling, 1 x Testo 174T – free hanging). The centre logger was suspended from the ceiling using a string at 1.1 m above the floor in line with measurement practices for thermal comfort. The configuration of the data loggers per containers is shown in Figure 9.

Although initially data collection was planned to continue until September in order to obtain a full year of data, no data for the period after July 2020 could be obtained due to technical difficulties with the loggers resulting in an overall measurement period from October 2019 to July 2020.

During the site visit it was noticed that the logger batteries were running low and Genkem subsequently agreed to change the batteries on all loggers with the unintended result that a reinitialization of the recording process became necessary, which however did not take place.

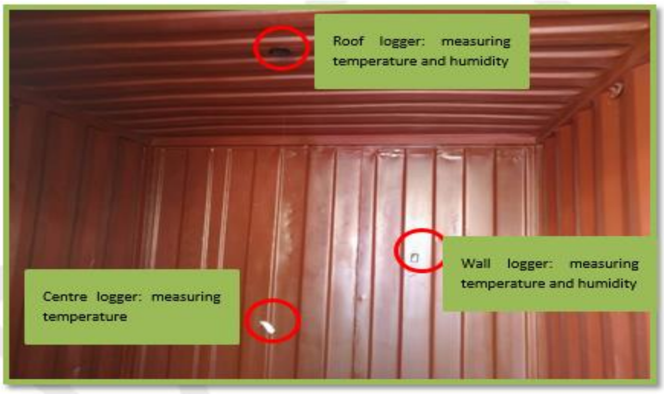

Figure 9: Configuration of logger placement in the container

3.8 Experiment 2: Genkem containers data analysis

The hourly temperature logs from the installed meters were available from 7th of October 2019 to 8th of July 2020, whereby analysis with a fair data representation for each season was done until the 30th of June 2020. Corresponding 3 hourly weather data was available for the period[10]. Data was aggregated to hourly, daily, weekly and monthly averages as required for the analysis. These datasets include minimum and maximum values for the averaged intervals. The respective centre loggers were selected as the basis of analysis as their configuration best represents the indoor temperature an occupant would experience. The configuration of a suspended logger in the centre of a room at 1.1m above the floor is in line with accepted thermal comfort measurement practices.

Table 3: Minimum, average and maximum temperatures recorded in the entire measurement period

Scale	Room Centre-Ctd	Wall-Ctd	Roof-Ctd	Room Centre-UnCtd	Wall-UnCtd	Roof-UnCtd
	[°C]					
Minimum	7,60	6,20	7,30	7,40	5,80	7,00
Average	22,67	22,96	22,86	24,52	24,95	25,19
Maximum	40,40	45,40	46,30	48,90	56,50	59,70

Table 3 shows the minimum, average and maximum temperatures recorded by the individual loggers in the entire measurement period.

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[10] www.worldweatheronline.com; Umhlanga Rocks; Historical observed weather data.

It can clearly be seen that the roof and wall mounted loggers exhibit significantly higher maximum temperatures as they are directly attached to the metal surfaces of the containers which naturally heat up excessively in direct sunlight. An occupant would not normally be exposed to those temperatures, which is why the centre logger is a suitable choice. However, the differences between coated and uncoated containers in the maximum temperatures recorded by the wall and roof mounted loggers is worth noting with 11,1°C and 13,4°C difference in maximum temperatures respectively. This alone already highlights the effectiveness of cool coating in increasing emissivity.

Based on the objectives of the study, both the maximum temperature and the average temperature was selected for analysing the impact of the technology in reducing indoor temperature, energy consumption and demand. The maximum temperatures are a suitable measure for assessing the efficacy of cool coating in terms of reducing electric peak loads i.e. electricity demand; and the average temperatures are a good indication of the impact of the technology on HVAC energy consumption. Additionally, both maximum, minimum and average temperatures have a clear impact on thermal comfort. Table4 shows the monthly and seasonal minimum, maximum and average temperature for the selected loggers and the differences between the coated and uncoated container.

Table 4: Monthly and seasonal minimum, maximum and average temperature with resultant difference between coated and uncoated containers

Season	Period	Scale	Room Centre-Ctd	Room Centre-UnCtd	ΔTemperature (UnCtd-Ctd)
			[°C]		
Spring	Oct-19	Minimum	13,5	13,4	-0,1
		Average	21,8	24,2	2,4
		Maximum	34,0	43,5	9,5
	Nov-19	Minimum	16,1	16,1	0,0
		Average	22,7	24,8	2,0
		Maximum	36,6	46,0	9,4
Summer	Dec-19	Minimum	14,0	14,2	0,2
		Average	23,1	25,1	1,9
		Maximum	37,9	47,9	10,0
	Jan-20	Minimum	17,7	17,6	-0,1
		Average	26,8	29,2	2,5
		Maximum	40,4	48,5	8,1
	Feb-20	Minimum	16,7	16,7	0,0
		Average	26,1	28,4	2,3
		Maximum	38,5	46,0	7,5
Autumn	Mar-20	Minimum	16,7	16,6	-0,1
		Average	25,2	27,3	2,2
		Maximum	36,3	44,2	7,9
	Apr-20	Minimum	15,3	15,3	0,0
		Average	22,1	23,7	1,6
		Maximum	39,7	48,9	9,2
	May-20	Minimum	8,7	8,5	-0,2
		Average	19,8	21,0	1,2
		Maximum	36,5	44,7	8,2
Winter	Jun-20	Minimum	7,6	7,4	-0,2
		Average	17,4	18,3	0,9
		Maximum	32,8	40,2	7,4
	Jul-20	Minimum	11,1	11,1	0,0
		Average	18,0	19,0	0,9
		Maximum	29,7	36,8	7,1

It can be seen that compared to the minimum and average, the maximum temperature shows remarkable differences over the experimental period throughout the seasons ranging from 7°C to 10°C. Also, the differences in average temperatures are shown to be around 2°C or higher in spring and summer whereas the difference drop to around 1°C in winter.

Figure 10 to Figure 12 show the profiles of the minimum, average and maximum temperatures respectively over the measurement period. Supported by Table4, shows almost no difference between coated and uncoated minimum temperatures although there are slight differences to the ambient temperatures. As the minimum temperatures occur at night and the principle of the reflective coating will only have a measurable effect when there is sunshine, this is to be expected. Also, as the containers contain no furniture or other items and the surfaces are made of metal, there is very little thermal mass, which could potentially lead to the coated container exhibiting lower minimum temperatures.

Figure 11 shows the daily average temperatures over the measurement period. The difference in the mean temperatures between the uncoated and coated average daily air temperatures is 1.9°C over the entire period. The differences between the profiles can be clearly seen with the seasonal changes outlined in Table 4 also apparent and differences in the coated and uncoated profiles more apparent in summer and spring than in winter.

Figure 12 outlines the profiles of the daily maximum temperature of the ambient, coated and uncoated air temperatures. The highest air temperatures were recorded in April and on this day the ambient temperature and coated air temperature had differences of 17.9 and 9.2°C respectively to the uncoated air temperature which reached 48.9 °C. It is easy to note the impact of the technology between the coated and uncoated air temperatures as there are consistently significant difference between the profiles throughout the experimental period. Also, worth noting is that the seasonal variations of the maximum air temperatures is less pronounced than that of the average or minimum temperatures shown in

Figure 13 shows the cumulative frequencies of daily maximum temperatures over the measurement period of 268 days. It can clearly be seen that at frequencies of 70% or lower (i.e. at higher respective daily maximum container air temperatures) there is a consistent difference of 6-7°C between the two profiles. A frequency of 70% at 26°C means that 70% of days will have a maximum temperature that is higher than 26 °C. At higher frequencies (i.e. lower daily maximum temperatures) the gap between the profiles closes, which accounts for rainy and overcast days with little solar irradiation.

The underlying cumulated data over the measurement period is shown in Table 5**Error! Reference source not found.**. The uncoated profile has a mean of 37°C with a standard deviation of 6°C compared to the coated with a mean of 30°C and a standard deviation of 4°C. The intervals for cumulation are chosen to be 3°C over a range of 10°C to 52°C. Also, in the table it can be clearly seen that the uncoated container has its daily maximums at noticeably higher temperatures.

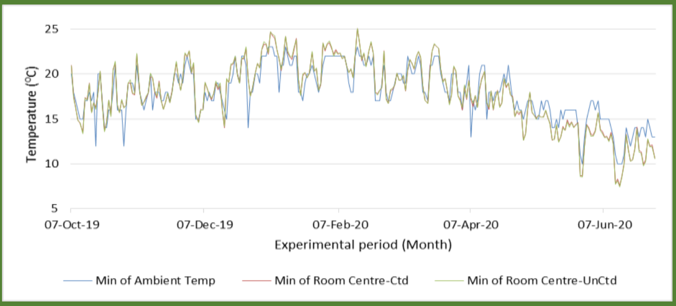

Figure 10 : Daily minimum temperature of the ambient, coated and uncoated air temperatures

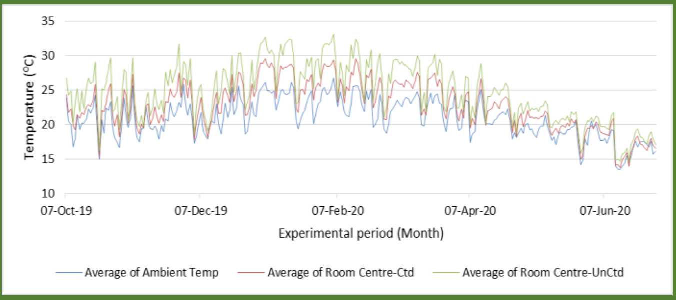

Figure 11: Daily average temperature of ambient, coated and uncoated air temperatures

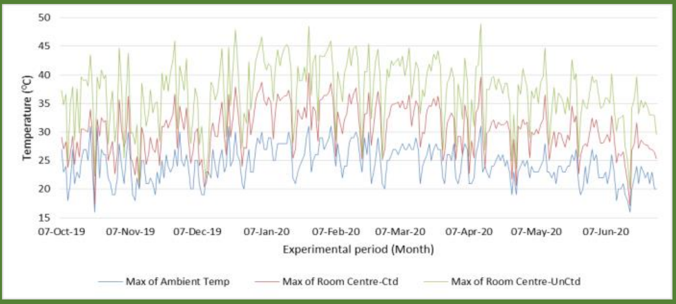

Figure 12: Daily maximum temperature of the ambient, coated and uncoated air temperatures

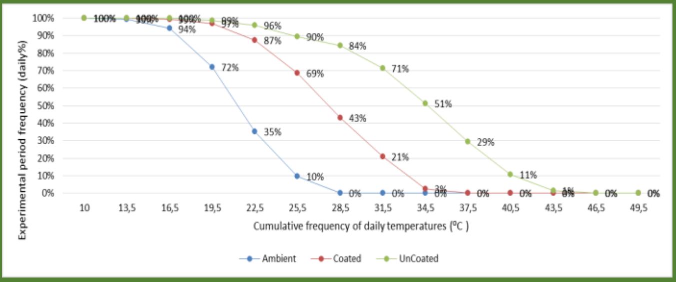

Figure 13: Cumulative experimental frequencies of daily maximum temperatures

Table 5: Cumulative analysis of a temperature range exceeding the specified value

Range	Ambient			Coated			UnCoated		
ºC	Count days	Cumulative days	Cumulative %	Count days	Cumulative days	Cumulative %	Count days	Cumulative days	Cumulative %
10 >=10;<13,5	0	0	100%	0	0	100%	0	0	100%
13,5 >=13,5;<16,5	2	2	99%	0	0	100%	0	0	100%
16,5 >=16,5;<19,5	14	16	94%	2	2	99%	0	0	100%
19,5 >=19,5;<22,5	59	75	72%	6	8	97%	4	4	99%
22,5 >=22,5;<25,5	99	174	35%	26	34	87%	7	11	96%
25,5 >=25,5;<28,5	68	242	10%	50	84	69%	17	28	90%
28,5 >=28,5;<31,5	26	268	0%	69	153	43%	14	42	84%
31,5 >=31,5;<34,5	0	268	0%	59	212	21%	35	77	71%
34,5 >=34,5;<37,5	0	268	0%	49	261	3%	54	131	51%
37,5 >=37,5;<40,5	0	268	0%	7	268	0%	58	189	29%
40,5 >=40,5;<43,5	0	268	0%	0	268	0%	50	239	11%
43,5 >=43,5;<46,5	0	268	0%	0	268	0%	25	264	1%
46,5 >=46,5;<49,5	0	268	0%	0	268	0%	4	268	0%
49,5 =49,5;<=52,5	0	268	0%	0	268	0%	0	268	0%
Total count	268			268			268		
Mean	24			30			37		
Standard deviation	3			4			6		
Total number of days				268					

The seasonal averaged 24-hour profiles are highlighted in Figure 14. These profiles show a mean average air temperature difference between coated and uncoated of 2.21 and 2.23°C for spring and summer respectively and of 1.65 and 0.91 ^{o}C for autumn and winter respectively.

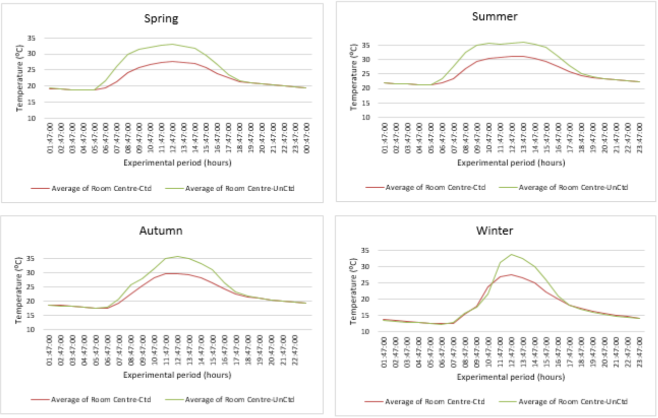

Figure 14: Averaged 24-hour profile of average temperature per season

This means that on an average day in summer there is a bigger gap between the coated and uncoated profiles than in winter or autumn, thus highlighting the efficacy of the technology during the specified period, which is to be expected due to the higher temperatures due to the elevation angle of the sun. Interestingly the mean for spring is almost as high as for summer. This is in part attributed to a particularly warm November and the fact that the spring average is made up of October and November but is missing September as this was outside of the measurement period.

Regarding specifically the winter profile in Figure 14 it is worth noting that the profiles are very similar for most of the morning and only start exhibiting more pronounced differences from around 11:30 am. Based on the elevation angle of the sun this is attributed to a shading effect from a neighbouring building that is most pronounced in winter.

The photo shown in Figure 8 was taken at around 10:30 am in early July and shows the uncoated container shaded by a neighbouring building whereas the coated container is already exposed to sunshine. As the uncoated container is benefiting longer from the shading effect this is not seen as problematic in terms of a conservative assessment of the efficacy of the technology.

The difference in temperature between the coated and uncoated container air temperatures is further emphasized by the average 24-hour temperature profiles shown in Figure 15. During midday the differences are greatest (more than 5°C) but at night no difference can be observed. The latter corresponds to what is seen in Figure 10.

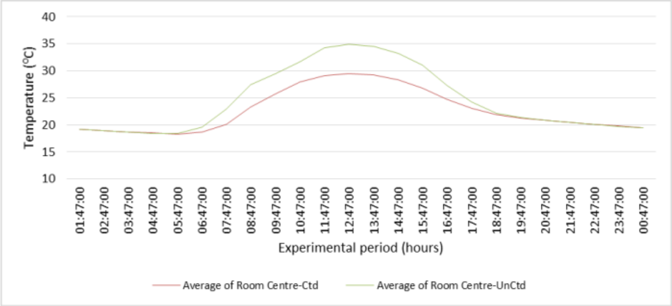

Figure 15: Averaged 24-hour profile of average temperature over measurement period

3.9 Experiment 2: Genkem containers summary and conclusion

Based on the objectives of the study, both the maximum temperature and the average temperature was selected for analysing the impact of the cool coating technology in reducing indoor temperature and energy consumption and demand. The maximum temperatures are a suitable measure for assessing the efficacy of cool coating in terms of reducing electric peak loads i.e. electricity demand and the average temperatures are a good indication of the impact of the technology on HVAC energy consumption. Additionally, both maximum, minimum and average temperatures have a clear impact on thermal comfort.

The container experiment has shown the impact of the cool coating technology by highlighting consistent differences of both average and maximum air temperature profiles between the coated and uncoated containers. Mean average daily temperatures differ by 1.9°C and mean maximum temperatures differ by 7°C. The efficacy of the technology could thus be demonstrated successfully and shows significant potential specifically for reducing electricity demand for cooling and improving thermal comfort during periods of high temperatures in warm coastal climatic conditions. Results are however very dependent on the location and climatic conditions of the application.

4 Appendices

4.1 Appendix 1: Cool coating paint description

Sandtex Cool Roof is the no-mess, no-fuss answer to environmentally friendly roof coatings that provides performance, durability and energy saving benefits. Sandtex Cool Roof exhibits the unique property of Total Solar Reflectance (TSR). This unsurpassed coating reflects and emits the sun's heat, keeping a roof cooler, as well as reducing the amount of heat transferred into the home. The unique property of TSR allows for an extremely durable, weather resistant coating. The acrylic formulation offers excellent no-peel adhesion. Its UV and water resistance gives long lasting, colour fast protection to corrugated fibre cement sheets, cement or clay roof tiles, and galvanized iron.

Sandtex Cool Roof has the following unique features:

- UV and water resistant for long lasting protection
- The coating has a minimum Total Solar Reflectance (TSR) of 30-32%
- Reduces the temperature of your roof by approximately 8-12 °C
- Cools your home's interior by up to 10°C
- So versatile it can be used on windowsills, fascias and gutters
- Easy application by brush, roller or spray
- Dries quickly so you can overcoat in just one hour
- Up to 15 years durability

4.2 Appendix 2: Stakeholder interviews

Stakeholder interview questionnaire template

Stakeholder Questionnaire: KZN Cool Roof Experiments

Name:

Organisation:

Position/Role:

Cool Roof Experiment ID:

Date of Interview: Time of Interview:

1. *What is your role in the Cool Roof Experiment(s)?*
2. *Since when and until when were you involved in the project?*
3. *What are your organisation's mandates, aims and objectives in participating in the project?*
4. *What were your expectations before commencing the project?*
5. *How would you perceive the results of the project and on what have you based this assessment on?*
6. *If you had to sum up the project in one sentence, what would that be?*
7. *Would you support a further roll-out or large-scale pilot project on Cool Roofs? What should the next step be?*
8. *Do you have any specific data or information that you could provide in order to document the results of the Cool Roof experiments?*
9. *Further points of discussion:*

Participant 1 telephone response

Name : Ross Stembridge

Organisation: Master Builder Association (MBA) KZN

Position/Role: Building Services Manager

Cool Roof Experiment: Container Experiment/St. Lucia Ecolodge

Date of Interview: 19.06.2020 Time of Interview: 12:40-12:55

1. What is your role in the Cool Roof Experiment(s)?

Initially had contact with Gerhard and Donald in regard to an insulation project. The idea was discussed to apply cool paints to roofs and walls. Gerhard has kept Ross informed of developments at the St. Lucia Ecolodge demonstration project and later of Genkem's container experiment (Cool coating on roof and walls of containers).

2. Since when and until when were you involved in the project?

Ross has been involved/informed of the projects since the initial idea was formulated 5 years ago.

3. What are your organisation's mandates, aims and objectives in participating in the project?

MBA is interested in publishing and disseminating project results. MBA is interested in providing more economic life cycle of buildings which can be achieved through cool paints by reducing air-con costs. MBA is looking to promote this product/technology based on a study showing verified savings/benefits.

4. What were your expectations before commencing the project?

Ross had hoped for (anticipated) a 5-10% reduction in electricity consumption for A/C usage.

5. How would you perceive the results of the project and on what have you based this assessment on?

Provisional results and data point to the expectations being exceeded.

6. If you had to sum up the project in one sentence, what would that be?

Cool paints is a very affordable product, exceeding expectations and delivering value far exceeding the cost of the product.

7. Would you support a further roll-out or large scale pilot project on Cool Roofs? What should the next step be?

MBA would support further roll-out especially as contractors and architects are loath to spend additional money and this technology achieves large long-term savings at negligible additional cost. MBA is bullish on this product.

8. Do you have any specific data or information that you could provide in order to document the results of the Cool Roof experiments?

In order to publish and disseminate findings, MBA requires verified savings over a month.

9. Further points of discussion:

Participant 2 telephone response

Name:	Kian Barker
Organisation:	St. Lucia Eco Lodge
Position/Role:	Owner/MD
Cool Roof Experiment:	St. Lucia Eco Lodge

Date of Interview: 24.04.2020 Time of Interview: 9:30-10:00

1. *What is your role in the Cool Roof Experiment(s)?*

Kian is the owner of St. Lucia Eco Lodge and initiated and executed the cool painting project.

2. *Since when and until when were you involved in the project?*

Kian was involved from the outset (end of 2017)

3. *What are your organisation's mandates, aims and objectives in participating in the project?*

Kian first came into contact with cool paints as an owner of a B&B taking part in the B&B Green awards. Since he has taken over the Eco Lodge, he has progressively set about implementing energy efficiency measures (also including retrofitting of LED lighting, inverter AC units, PV and SWH). The aim was to enhance the eco lodge concept and at the same time reduce costs.

4. *What were your expectations before commencing the project?*

It was expected that the cool paint would reduce the AC usage and keep the building cool, thereby increasing the thermal comfort in the rooms in line with eco awareness which is appreciated especially by international guests.

5. *How would you perceive the results of the project and on what have you based this assessment on?*

The guest are happy with the thermal comfort and reduction of AC usage. A reduction of the electricity consumption for air conditioning is perceived by the lodge.

6. *If you had to sum up the project in one sentence, what would that be?*

Cool paints stand for a better lifestyle with an improved comfort zone and an improved eco footprint.

7. *Would you support a further roll-out or large scale pilot project on Cool Roofs? What should the next step be?*

Kian has rolled out cool paints to the other buildings of the lodge about 1.5 years ago. Especially in the lounge which is used for Yoga, the reduced temperatures due to the paint are very noticeable. For future projects Kian suggest to utilise the paint indoors as well and also specifically on west-facing walls. He would support a larger scale roll-out of the technology and encourages people and businesses in the vicinity to use cool paints especially since St. Lucia has a very warm climate and the effects are more pronounced than in colder parts of the country.

8. *Do you have any specific data or information that you could provide in order to document the results of the Cool Roof experiments?*

St. Lucia Eco Lodge can provide electricity bills and occupancy data.

9. *Further points of discussion:*

The incomer which feeds the experiment also feeds the staff quarters, laundry and 12 other units. As such it is unclear if the effects of the cool coated bungalow can be established from the electricity bills. Options for permanent or mobile sub-metering to establish effect of cool paint on AC consumption were discussed.

Participant 3 telephone response

Name:	Gerhard Gross
Organisation:	N/A
Position/Role:	Consultant
Cool Roof Experiment:	Container Experiment

Date of Interview: 01.04.2020 Time of Interview: 14:00-15:00

1. *What is your role in the Cool Roof Experiment(s)?*

Gerhard conceived, organised, facilitated and incepted the container experiment gaining support from and bringing all of the partners on board in their various roles.

2. *Since when and until when were you involved in the project?*

From the outset.

3. *What are your organisation's mandates, aims and objectives in participating in the project?*

As an independent consultant, Gerhard's aim is to reliably demonstrate the benefits of the technology to facilitate wider spread application. He sees schools as one of the greatest potential benefactors of this technology.

4. *What were your expectations before commencing the project?*

To be able to demonstrate the temperature effects of the technology in a comparable and controlled environment through two as far as possible identical experiment and reference buildings/containers

5. *How would you perceive the results of the project and on what have you based this assessment on?*

Results are seen as brilliant so far, with 13.4°C peak temperature reduction.

6. *If you had to sum up the project in one sentence, what would that be?*

N/A

7. *Would you support a further roll-out or large scale pilot project on Cool Roofs? What should the next step be?*

Yes, although Gerhard is not sure whether he would still be involved. Next steps should be publication and dissemination of results as widely as possible.

8. *Do you have any specific data or information that you could provide in order to document the results of the Cool Roof experiments?*

Temperature profiles, theoretical background information on function of Cool Roofs

9. *Further points of discussion:*

Lead up to project and roles of individual stakeholders.

Participant 4 telephone response

Name:	Rajesh Haripersad
Organisation:	Durban University of Technology
Position/Role:	Lecturer
Cool Roof Experiment:	Genkem Container Experiment

Date of Interview: 14.07.2020 Time of Interview: 15:30-5:00

1. *What is your role in the Cool Roof Experiment(s)?*

The role has been to help with the initial setup of the project, the data extraction and conduct trial surrounding the ideal positioning and comparability of logger setups in both containers.

2. *Since when and until when were you involved in the project?*

Rajesh has been involved since the trial period in October. Initially he was also involved at an earlier stage when it was considered to do measurements at St. Lucia Ecolodge but then the project moved to Umhlanga as Genkem was involved.

3. *What are your organisation's mandates, aims and objectives in participating in the project?*

Rajesh academic interest is around energy optimisation and this is why he was approached by the German collaboration. DUT would like to use this as a first step to initiating trials in real-life buildings. The objective is to publish data, create collaborations and ultimately run out projects with cool coating nationally and internationally.

4. *What were your expectations before commencing the project?*

It was presumed that an energy efficiency improvement could be shown that could be utilised in industrial, commercial and residential passive cooling interventions.

5. *How would you perceive the results of the project and on what have you based this assessment on?*

Good results have thus far been obtained and by the end a holistic look at data considering seasonal and humidity conditions will be possible.

6. *If you had to sum up the project in one sentence, what would that be?*

The system can be used on different components of the building, not just roofs increasing the effect and enabling terrific results.

7. *Would you support a further roll-out or large scale pilot project on Cool Roofs? What should the next step be?*

Rajesh would support a further roll-out and would like to see pilots extended to real-life scenarios.

8. *Do you have any specific data or information that you could provide in order to document the results of the Cool Roof experiments?*

DUT has the raw data from the initial project period and the trial phase.

9. *Further points of discussion:*

It is discussed what the way forward with this analysis project will be and how further collaboration is possible. It is agreed to facilitate engagement with SANEDI on this.

Participant 5 written response

Name: Donald Perry

Organisation: GENKEM

Position/Role: CEO

Cool Roof Experiment: SANDTEX COOL ROOF AND COOL WALLS

Date of Interview: 17 July 2020 **Time of Interview:**09-44AM

What is your role in the Cool Roof Experiment(s)? ***I have been involved from inception on this project – to formulate a world class COOL ROOF and COOL WALL system for the South African/African – climatic conditions.***

Since when and until when were you involved in the project? **The projected started in 2015**

What are your organisations mandates, aims and objectives in participating in the project? ***To formulate a Cool Roof and Cool Wall coating that is world class by any measure and the product launched to market will be of a standard better than current products on the market.***

What were your expectations before commencing the project? ***From inception of this project it has been our technical divisions aim to formulate a product that will outperform current standard products being offered to the consumer. Value for money and a product that that has been scientifically formulated with proven long-term independent testing. It is of paramount importance - we only launch a product that will have proven scientific results offering LONG LASTING DURABILTY.***

How would you perceive the results of the project and on what have you based this assessment on?

To date the results being obtained from independent experts – clearly show our product to be above current opposition products being offered.

If you had to sum up the project in one sentence, what would that be?

A World Class Product has been developed – offering Cool Roof and Cool Wall properties that outperformed our expectations.

Would you support a further role out or large scale pilot project on Cool Roofs? What should the next step be? ***Genkem will without a doubt support large scale projects - Genkem would look for projects that are requiring Cool Roof properties – especially Rural Schools were so many children – go to school and have lessons in classrooms – with temperatures above 30 Degrees Celsius. Genkem as a company has and will continue to support projects that benefit and assist our future generations.***

Do you have any specific data or information that you could provide in order to document the results of the Cool Roof experiments? ***Data that is/will be available is all independently evaluated by Energy Experts and companies – University of Natal and Master Builders Association.***

Further points of discussion: ***Once all the results have correlated and verified by our independent experts – Genkem will gladly enter into further points of discussion.***

4.3 GENKEM CONTAINER EXPERIMENT

Raw data, aggregated data and data analysis are provided in separate excel files made available to GIZ and SANEDI as part of project documentation.

4.4 ST. LUCIA ECOLODGE EXPERIMENT

Raw data, aggregated data and data analysis are provided in separate excel files made available to GIZ and SANEDI as part of project documentation.

www.bmwi.de