Energy Partnership
Energiepartnerschaft
South Africa - Deutschland

mineral resources & energy
Department:
Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

An Overview of Energy Efficient Lighting Research in South Africa

SMEC
Member of the Surbana Jurong Group

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by:
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Agenda

- Introduction
- Methodology
- Data Collection
- Data Analysis
- Data Classification
- Comparison of Results
- Potential gaps in research
- Conclusion

Introduction

- Provide an overview of current EE lighting research being carried out at South African Universities, Universities of Technology, Eskom, public and private research institutions:
  - To determine common themes
  - To identify possible gaps that are not being covered and compile a profile of the EE lighting researchers actively working in the field in
  - To make recommendations on possible future EE lighting research focal areas for South Africa
- Supports the establishment of an EE lighting energy research platform which will operate in close cooperation with the EE lighting energy industry and service providers in South Africa.
- All energy efficient lighting applications across all sectors have been covered by the research.

Methodology

To achieve this goal, collection of various data of a qualitative nature had been collected.

This included:

- Conducting primary research in the form of questionnaires
- Reviewing secondary research from relevant published research articles

Data collection (Primary)

- Participants for questionnaires were found and selected by contacting all key stakeholders
- South African Universities, South African Universities of Technology, Eskom, the private sector, and other research organisations
- Published research articles - list of references was analysed to further expand the search.
- The main methods of contact to researchers were via:

➢ Emails,

➢ Telephonic discussions, and

➢ Zoom/MS Teams meetings

Questionnaire (Part 1)

No.	Question	Response by researcher
1	Are you currently involved with any research projects pertaining to energy efficiency lighting projects? If yes, please continue to fill out the full questionnaire. If no, please respond to item 2 only.	
2	Do you see any gaps where research should be conducted in energy efficient lighting?	
3	Which sector does your research fall under? (a) Public sector and research facilities (b) Academic institutions (c) Private sector (d) If other, please specify	
4	Which category does your research fall under? (a) Daylighting design (b) Photometric measurement systems (c) Lighting simulation (d) Materials/nanotechnology (e) Surge protection (f) Lifespan, Lumen maintenance / L70 (g) Standardised techniques for lifespan testing / warranties / standards (h) Colour shifts with ageing (i) Improvements in energy efficiency, (j) LED Chip (k) Emission spectrum (l) Drivers (m) Heatsink (n) Lens / diffuser improvements (o) Smart control (p) If other, please specify	
5	To what type of lighting applicable would you classify your research as most relevant to? (a) Retail and commercial (b) Stadium / Sports lighting (c) Public lighting (road lighting and high mast area lighting) (d) Traffic signals (e) Industrial / warehousing (f) Domestic (g) If other, please specify	

Table 1: Questionnaire (part 1)

Questionnaire (Part 2)

No.	Question	Response by researcher
6	Please provide your details. Are you a rated researcher? If so, please provide your NRF rating.	Name: Position: Organisation: Cell number: Email: NRF rating:
7	Please provide a short biography (3-6 lines).	
8	Please provide a short description of the focus of your research. 1. Summarise the topic. 2. What aspect of lighting are you focused on? 3. What are the potential impacts of your research?	
9	Please provide a list of all recent (from 2015) published papers or articles of which you are an author.	
10	Please provide references to any other researchers/organisations in South Africa in the energy efficiency lighting research field. Are you collaborating with any international institutions/universities?	Name: Email address:

Table 2: Questionnaire (part 2)

Data collection (Primary)

Time	Organisation Name	Title	Initia	Name	Surname	Contact Number	Call Status	Email	Email Stat	Questionnaire Sta	Date	Time	Date	Time	Research	Notes
09:00:00	ESKOM			Andre	Blignaut			blignaa@eskom.co.za	follow up	returned	Monday, 06 September 2021	13:00:00				SANEDI forwarded email Follow up 1 - email sent
15:00:00	ASSAf			Roseanne	Diab			roseanne@assaf.org.za	invalid email							
13:00:00	saee confederation			Thieda	Ferreira	0840115500	na	secgen@saeeconfed.org.za	reply received	returned	Tuesday, 07 September 2021	09:00	Wednesday, 08 September 2021	13:00	FALSE	Follow up 1 - called and no answer Follow up 2 - called and no answer email sent again - will reply by end of the day
13:00:00	CSIR			Jeremy	Gibberd				sent							Contacted through website
10:00:00	SANi	Dr	E	Edward	Nxumalo			edwardnxumalo@gmail.com	sent	meeting arranged	Thursday, 26 August 2021	16:00:00			FALSE	Chair of SANi (SA nano initiative)
09:00:00	NMISA			Natasha	van Der Walt			nvdwalt@nmisa.org	sent	returned	Friday, 10 September 2021	08:00:00				Sanedi forwarded email Follow up 1 - email sent Will submit Friday
12:00:00	ESKOM					0860037566		advisoryservice@eskom.co.za	reply received	sent						Documents were forwarded to Andre
09:00:00	CSIR							CCarterBrown@csir.co.za	follow up	sent	Monday, 06 September 2021	13:00:00	Friday, 10 September 2021	08:00		ASSAf forwarded email Follow up 1 - email sent Follow up 2 - email sent
12:00:00	CEF					0102014700		cefcomms@cefgroup.co.za	sent	sent	Monday, 13 September 2021	08:00:00				Follow up 1: email sent
12:00:00	ASSAf					0123496617		communications@assaf.org.za	reply received	sent						CSIR will respond directly
12:00:00	CSIR					0128412911		Enquiries@csir.co.za	sent	sent						
12:00:00	DMRE					0124443000	na	enquiries@dmr.gov.za	sent	sent	Wednesday, 08 September 2021	13:00:00	Monday, 13 September 2021	08:00:00		Follow up 1 - called and no answer e sent
12:00:00	NRF					0124814000		info@nrf.ac.za	sent	sent	Monday, 13 September 2021	08:00:00				Follow up 1 - email sent
12:00:00	SAIEE					0114873003		info@saiee.org.za	sent	sent	Monday, 13 September 2021	08:00:00				Follow up 1 - email sent
12:00:00	DSI					0128436300		webmaster@dst.gov.za	sent	sent	Monday, 13 September 2021	08:00:00				Follow up 1 - email sent
09:00	UCT - Energy Research Centre					0216502825		info@gsb.uct.ac.za	sent		Monday, 13 September 2021	08:00:00				Follow up 1 - email sent
09:00	UCT - Energy Research Centre							researchvisibility@uct.ac.za	sent		Monday, 13 September 2021	08:00:00				Follow up 1 - email sent
09:00	SANi	Prof		Vincent	Nyamori			Nyamori@ukzn.ac.za	sent	sent						
09:00	SANi			Laila	Smith	0612823477		Laila.Smith@wits.ac.za	reply received	sent					FALSE	
11:00	IESSA			Daniel	Kasper	0826805127		president@iessa.org.za	sent	returned	Monday, 13 September 2021	08:00:00				Follow up 1: email sent will receive submission max 2 weeks
14:00	DMRE							xolile.mabusela@dmre.gov.za	sent		Monday, 27 September 2021	08:30:00				
14:00	DMRE							maphuti.legodi@dmre.gov.za	sent		Monday, 27 September 2021	08:30:00				
14:00	DMRE							lebogang.nkhwashu@dmre.gov.za	sent		Monday, 27 September 2021	08:30:00				

Figure 2: Extract of the contact log

Data collection (Secondary)

- Published texts collected from web search engines and electronic academic libraries
- Selection was refined using key search terms (energy efficiency, lighting, South Africa, etc.) relating to the goal of the research.
- Texts published before 2015 were excluded to ensure that data was relevant and the research current.
- All contacts were logged in a MS Excel spreadsheet to keep track of all communication

Data analysis

- Thematic analysis was conducted on the selected literature and questionnaire responses. This included:

  - Dividing the data into its respective categories of lighting
  - Examining the data for the identification of patterns and repeated ideas that emerged.
  - Identification of gaps where no research is being undertaken.

- After emerging themes were established, the data was compiled in a spreadsheet in MS Excel.
- Columns in this spreadsheet included the research themes, the category of lighting, the main researcher, and the organisation/group the organisation falls into (e.g., Universities, suppliers, etc.).
- This data was then further analysed per sector, research category and lighting application

Data classification

- This data was then further broken down per sector, research category and lighting application.
- The data is analysed accordingly by identifying trends and gaps in research for Energy Efficient lighting in South Africa.

Data classification (cont.)

The data is classified according to the following sectors:

- Public sector and research facilities
- Academic institutions
- Private sector
- Other

The data is classified according to the following categories:

- Daylighting design
- Photometric measurement systems
- Lighting simulation
- Materials/nanotechnology
- Surge protection
- Lifespan, lumen maintenance/L70
- Standardised techniques for lifespan testing/warranties/standards
- Colour shifts with ageing
- Improvements in energy efficiency,
- LED Chip
- Emission spectrum
- Drivers
- Heatsink
- Lens / diffuser improvements
- Smart control
- Other

The data is classified according to lighting applications:

- Retail and commercial
- Stadium / Sports lighting
- Public lighting (road lighting and high mast area lighting)
- Traffic signals
- Industrial / warehousing
- Domestic
- Other

Questionnaires received

- A total of 65 questionnaires were issued to potential researchers.

- A total of 23 questionnaires were received:
  - Public sector and research facilities = 4
  - Academic institutions = 13
  - Private sector = 6

- A total of 31 relevant articles were analysed.

Questionnaires received

Institution	Researcher
ESKOM	André Blignaut
NMISA	Edwin Mofokeng Pieter du Toit
IESSA	Henk Rotman
SAEE Confederation	Thieda Ferreira

Table 3: List of researchers from public sector and research facilities

Institution	Researcher
GreenX	Jason Samuels
OrbitX	Frans Rossouw
Genlux Lighting	Sello Joseph Tsoai
Bergstrom Lighting	Graham van den Berg
Beka Schréder	Gordon Arons
LED Light Consult SA (PTY) LTD	Paul Nel

Table 4: List of researchers from the private sector

Institution	Researcher
Stellenbosch University	MJ (Thinus) Booysen
University of the Free State	HC Swart
Nelson Mandela University	Ernest van Dyk
Central University of Technology	Stephen Tangwe
University of KwaZulu-Natal	Freddie Inambao
University of Witwatersrand	Alex Quandt
University of Cape Town	Richard Larmour
Tshwane University of Technology	Olawale Popoola
	OD Dintchev
	Giscard Binini
University of South Africa	Mokhotjwa Simon Dhlamini
North-West University	Johan Rens
University of Johannesburg	Arnold de Beer

Table 5: List of researchers from academic institutions

Articles Collected

	Article	Authors
A	Passive Solar and Conventional Housing Design: A Comparative Study of Daylighting Energy Efficiency Potential	Ochuko K. Overen, Edson L. Meyer and Golden Makaka
B	Maintenance optimization incorporating lumen degradation failure for energy-efficient lighting retrofit projects	Alice Ikuzwe, Xiaohua Xia, Xianming Ye
C	LED there be light: The impact of replacing lights at schools in South Africa	M.J. Booysen, J.A. Samuels, S.S. Grobbelaar
D	Smart streetlights using power line communication	P. du Toit; C. Kruger; G. P. Hancke; T. D. Ramotsoela
E	A Sensor for Monitoring the Lifespan of Color-LEDs in Traffic Lights	C. E. Ngene; T. Shongwe
F	Influence of LED tubes on the throughput of an indoor broadband PLC channel	Arnold S. de Beer; Allan Emleh; Hendrik C. Ferreira
G	Light-years apart: Energy usage by schools across the South African affluence divide	M.J. Booysen, J.A. Samuels, S.S. Grobbelaar
H	Enhanced orange-red emission from KSrVO4: Sm3+ nanophosphor for possible application in blue light-emitting diode based white LED	OM Ntwaeaborwa and HC Swart
I	White light emitting LaGdSiO5:Dy3þ nanophosphors for solid state lighting applications	Simon N. Ogugua, OM Ntwaeaborwa and HC Swart
J	Advances in phosphors based on organic materials for light emitting devices	HC Swart
K	Structural, surface and luminescence properties of Ca3B2O6:Dy3þ phosphors	OM Ntwaeaborwa and HC Swart
L	Rare Earth Doped Zinc Oxide Nanophosphor Powder: A Future Material for Solid State Lighting and Solar Cells	OM Ntwaeaborwa and HC Swart
M	Surface and spectral studies of Sm3þ doped Li4Ca (BO3)2 phosphors for white light emitting diodes	HC Swart
N	Phosphor Polymer Nanocomposite: ZnO: Tb3+ Embedded Polystyrene Nanocomposite Thin Films for Solid-State Lighting Applications	HC Swart
O	Recent advances in rare earth doped alkali-alkaline earth borates for solid state lighting applications	HC Swart

Table 6: List of articles reviewed (part 1)

Articles Collected

	Article	Authors
P	Blue photons excited highly chromatic red light emitting K3La (PO4)2: Pr3+ phosphors for white light emitting diodes	HC Swart
Q	Red emitting non-rare earth doped LiMgBO3 phosphor for light emitting diodes	HC Swart
R	Structural and spectral studies of highly pure red-emitting Ca3B2O6:Eu3+ phosphors for white light emitting diodes	HC Swart
S	RESIDENTIAL ELECTRICITY CONSUMPTION IN SOUTH AFRICA	Alison Hughes, Richard Larmour
T	Residential lighting load profile modelling	O. Popoola, J. Munda
U	Comparative analysis and assessment of ANFIS-based domestic lighting profile modelling	O. Popoola, J. Munda
V	Modeling of residential lighting load profile using adaptive neuro fuzzy inference system (ANFIS)	O. Popoola
W	Residential lighting load profile modelling: ANFIS approach using weighted and non-weighted data	O. Popoola
X	NMISA and the new LED national measurement facility – Lighting design & application (Vector) 2017	Edwin Mofokeng, Pieter du Toit
Y	LED Street Lighting for Eskom Properties	André Blignaut
Z	An overview of colour LED & CFL lighting interference on the low voltage PLC network	Allan Emleh, Arnold S. de Beer, Ling Cheng, Hendrik Ferreira
AA	Considerations for lighting in manufacturing – EE Publishers	Brandon Topham, Turck Banner
AB	Extending the efficiency and lifetime of LEDs - EE Publishers	Edwin Brown, Vepac Electronics
AC	How electrochemical compounds protect LEDs from environmental conditions - EE Publishers	Edwin Brown, Vepac Electronics
AD	Lighting emergency gear – what waveform should we use? - EE Publishers	Stirling Marais, Cosine Developments

Table 7: List of articles reviewed (part 2)

Comparison of Results per Sector

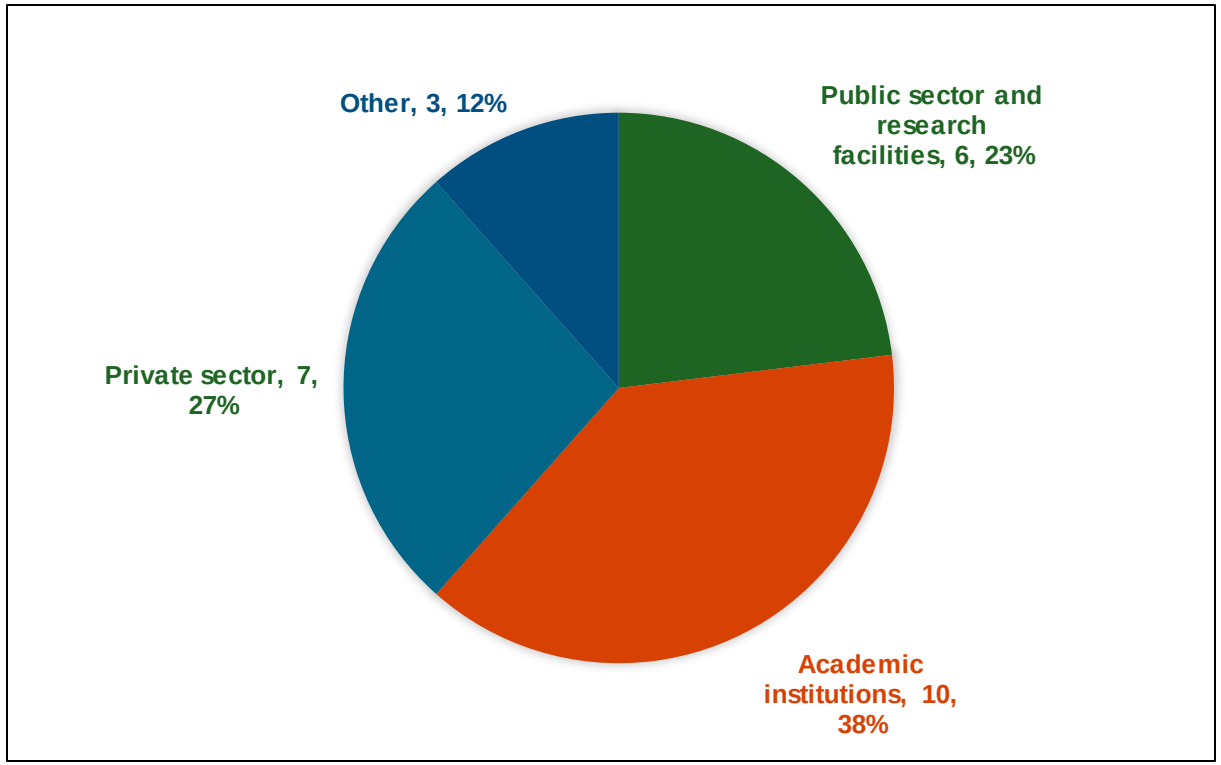

Figure 3: Questionnaire responses based on Sector of research (total 23)

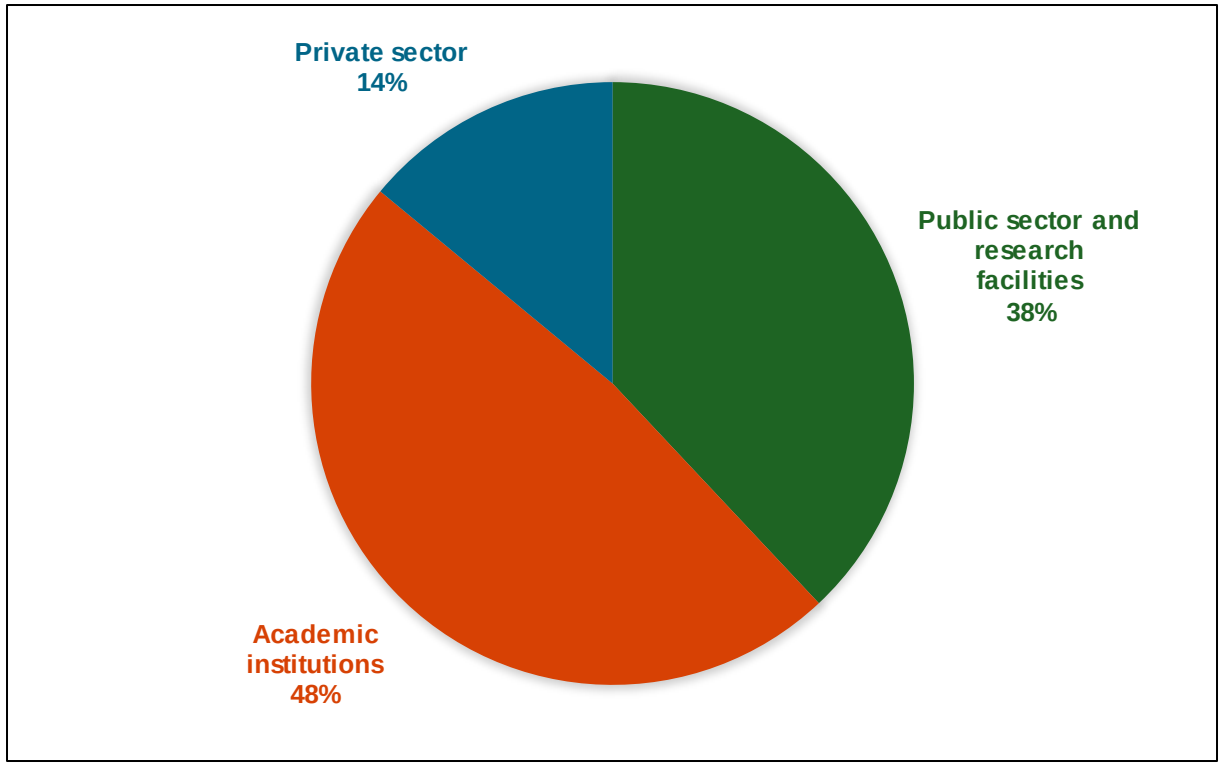

Figure 4: Articles based on Sector of research (total 31)

Comparison of Results per Research Category

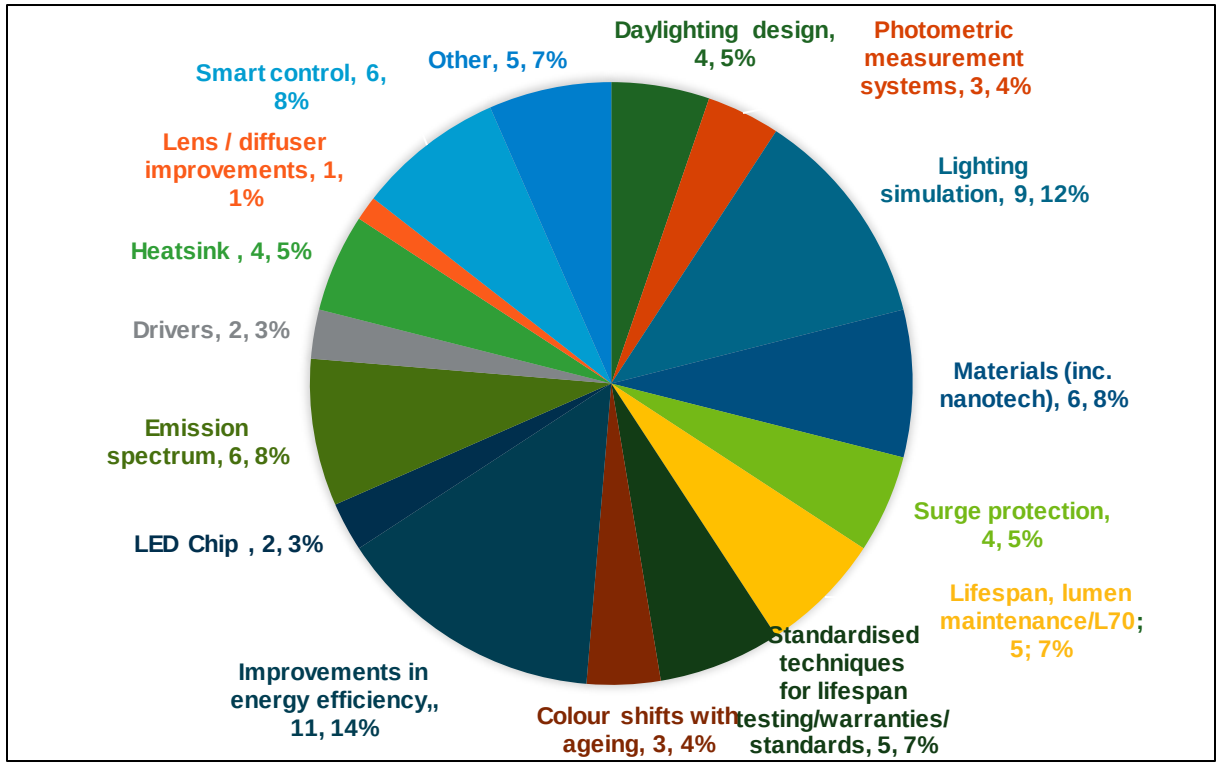

Figure 5: Questionnaire responses based on category of research (total 23)

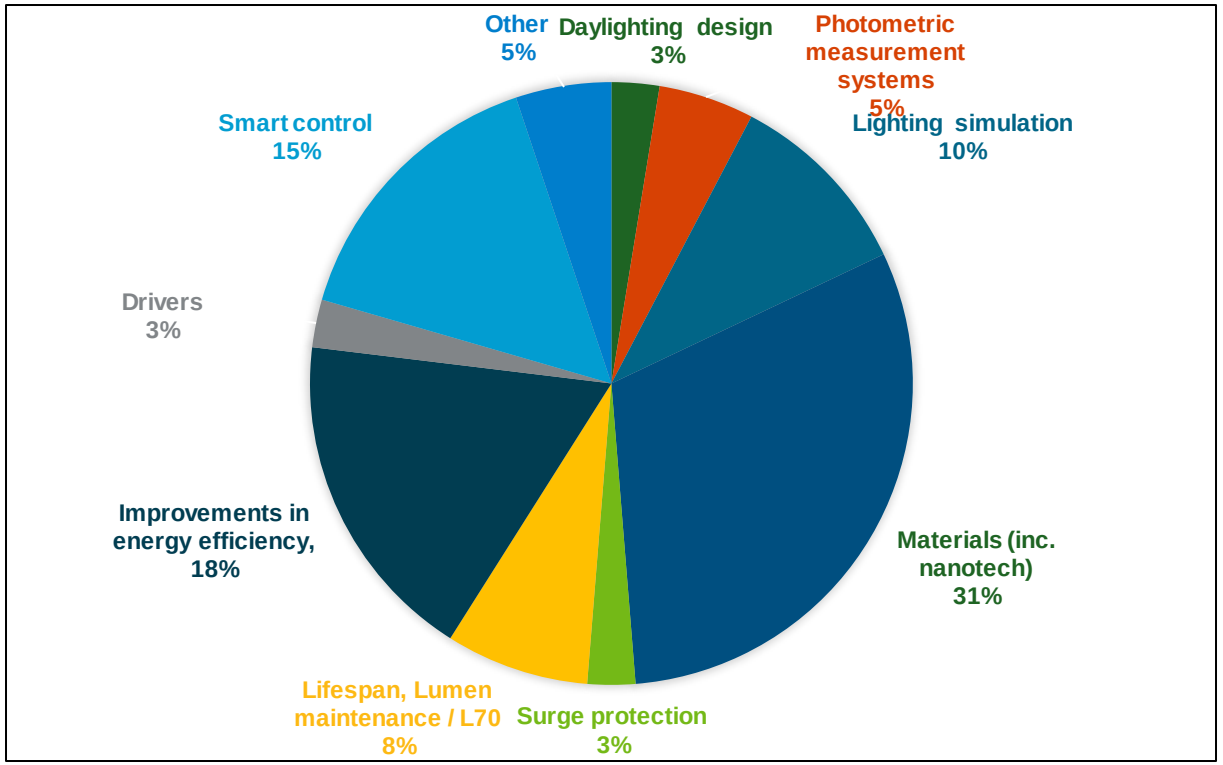

Figure 6: Articles based on category of research (total 31)

Comparison of Results per Lighting Application

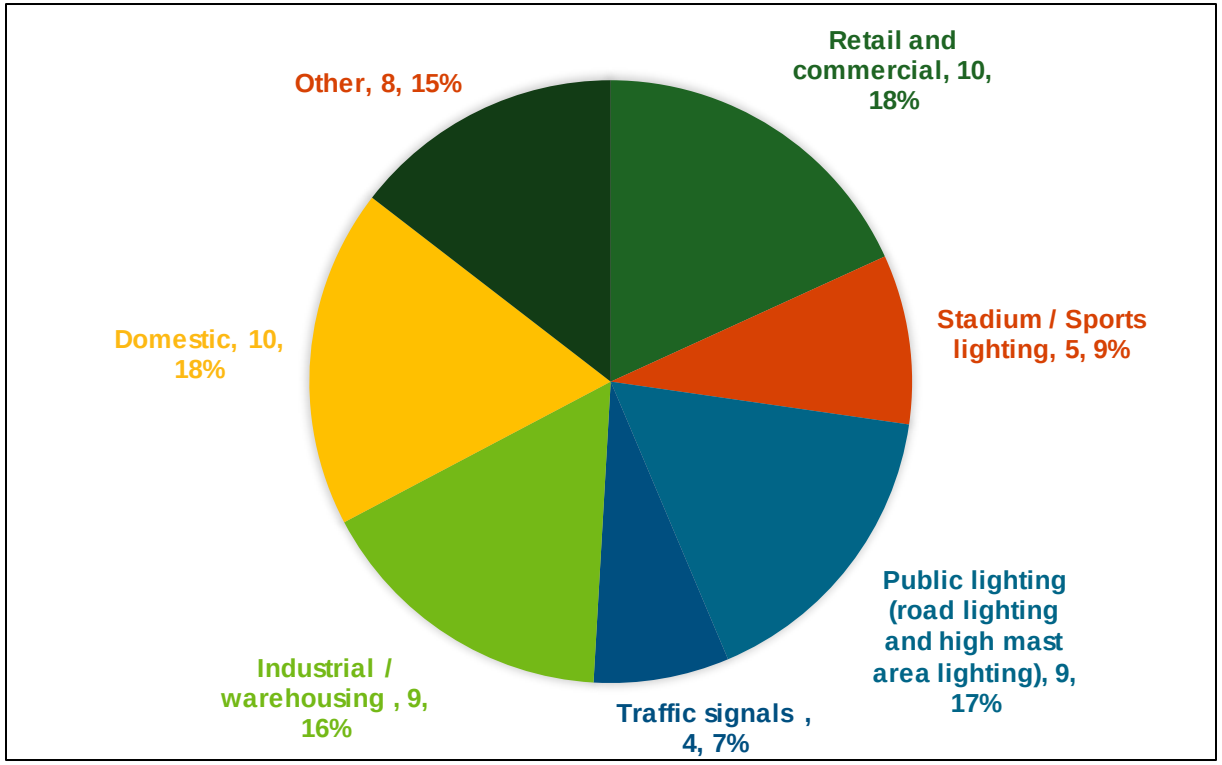

Figure 7: Questionnaire responses based on Lighting Application (total 23)

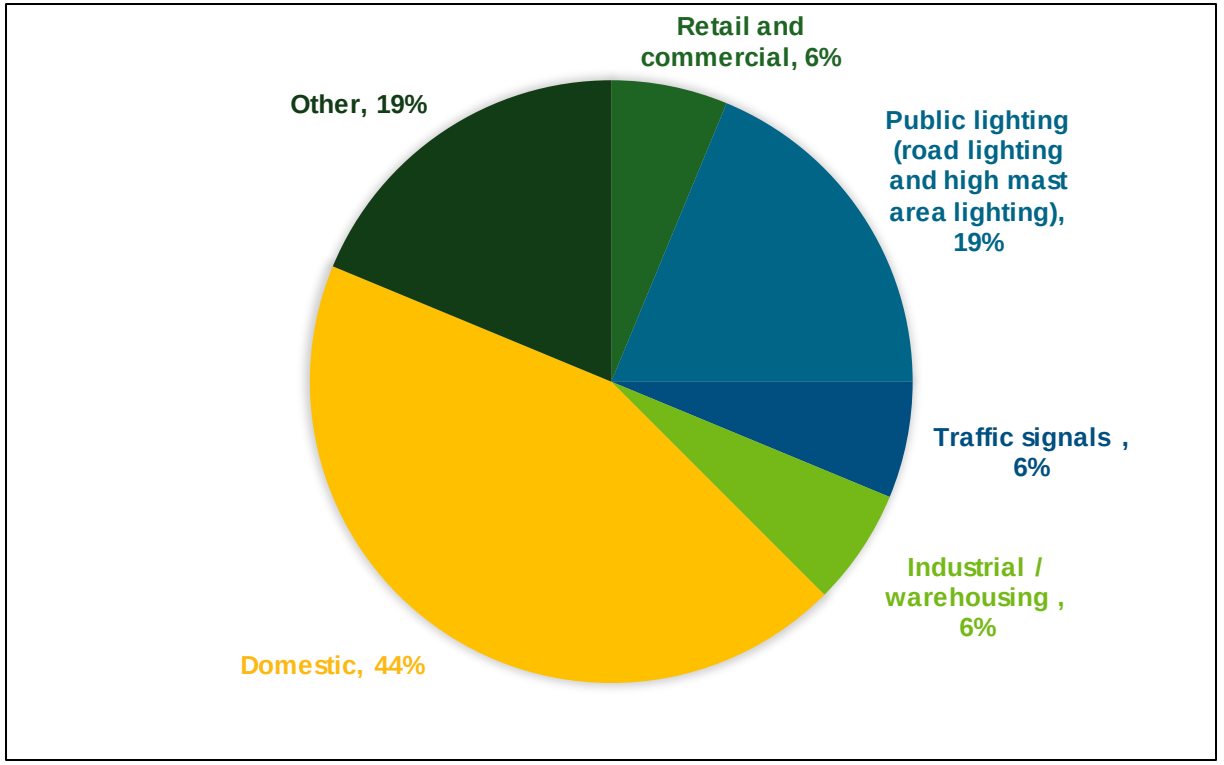

Figure 8: Articles based on Sector of Lighting Application (total 31)

Potential gaps in research

- *Implementation* of conducted research into practical applications, roll outs of programmes, etc. rather than just conducting research on the specific topics.
- *Efficiency benchmarks* - Standard methodology to compute the savings and mathematical models to predict the techno-economic potentials of the EE lighting technologies.
- *Awareness Creation* - Appropriate Motivation of the efficient lighting technologies is a key factor for driving and sustaining of initiatives in this field.
- *Electronic Drivers* - The efficiency and characteristics of the power electronics drivers for lamps is a topic which should be thoroughly investigated.
- *Electrical network interference* – Power electronics of Energy Efficient lighting can cause Electromagnetic Interference (EMI).
- *Perception of no gaps* (15%) - It was expressed that there is not a lack of research into the different aspects of the lighting

Conclusion

- A comprehensive study has been undertaken to catalogue the current status of Energy Efficient Lighting research in South Africa
- The most research (by a small margin) relates to domestic lighting (18% of research topics, 44% of articles).
- 23 profiles of researchers in EE lighting researchers actively working in the field have been created, which will assist future EE lighting research coordination in South Africa.