UK PACT
COUNTRY PROGRAMMES

3 PART TRAINING: FROM EPC TO NET ZERO
SESSION 2: ENERGY EFFICIENCY
In support of the project: *Operationalising Energy Performance Certificates in South Africa*

The Carbon Trust in partnership with the GBCSA are working on a 24-month project entitled "Operationalising energy performance certificates (EPCs)in South Africa." The project is made possible by grant funding from the UK PACT (Partnering for Accelerated Climate Transitions).

JUNE 28 2022

CARBON TRUST · GREEN BUILDING COUNCIL SOUTH AFRICA · GBCSA ACADEMY

SCENE SETTING – UK PACT

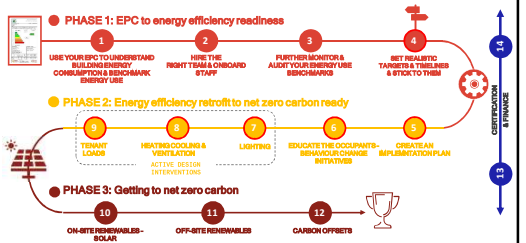
- UK PACT (Partnering for Accelerated Climate Transitions) is a **£70m flagship programme under the International Climate Finance (ICF) portfolio** and forms a part of the UK's £11.6bn commitment to International Climate Finance by 2027 to tackle climate change.
- The current three-year programme (2018-2022) is **funded by BEIS**
- UK PACT works with partner countries, supporting them to **accelerate their clean growth transitions and to implement and increase for carbon emissions reductions in line with their NDCs**
- UK PACT **responds directly to demand** identified by partner governments by providing grants to implementing partners (such as NGOs, businesses and academia).

China · Indonesia · Columbia · Kenya · Malaysia · Mexico

South Africa-UK PACT funding

EPC TO NET ZERO CARBON (NZC) ROADMAP FOR EXISTING OFFICE BUILDINGS

THIS ROADMAP IS A STEP BY STEP GUIDE AIMED AT GETTING A TYPICAL OFFICE BUILDING TO NET ZERO CARBON OPERATIONAL ENERGY.



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Events manager; Green Building Council SA.

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Intern; Green Building Council SA.

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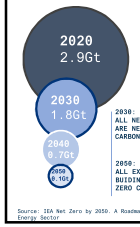
KEY PROJECT STAKEHOLDERS

Project funders & management	Project consortium	Primary beneficiaries	Secondary beneficiaries
Foreign, Commonwealth & Development Office; British High Commission Pretoria; Palladium MAKE IT POSSIBLE; SOUTH AFRICA UK PACT	CARBON TRUST; GREEN BUILDING COUNCIL SOUTH AFRICA	sanedi; mineral resources & energy (Department: Mineral Resources and Energy, REPUBLIC OF SOUTH AFRICA)	forestry, fisheries & the environment; public works & infrastructure; Property funds

WHY NET ZERO? WHAT IMPACT CAN BUILDINGS MAKE?

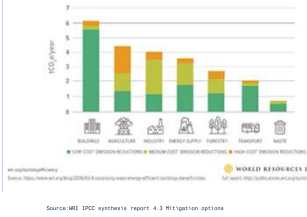
UNDERSTANDING THE BIG PICTURE AND HOW BUILDINGS CAN ASSIST IN OVERALL GHG REDUCTION

Global building sector decarbonisation pathway required to achieve NZC by 2050 targets



Source: IEA Net Zero by 2050. A Roadmap for the Global Energy Sector

Climate change mitigation: Building efficiency is one of the most affordable ways to cut emissions



Source: WRI IPCC synthesis report 4.3 Mitigation options

SESSION 2: Energy efficiency to net zero carbon ready

1. High level overview, including international and national 2030 \ 2050 targets
2. Net zero roadmap – high level
3. Tools that assist in driving net zero + Pathways to achievement
4. Energy modelling / the first fuel: passive design retrofitting
5. Energy consumption in buildings / trends in building sector. What they are and where we need to be
   1. Lighting
   2. HVAC
   3. Tenant loads
6. Financing
7. Energy efficient case study
8. Next session

SESSION 1: Getting an EPC 02 August

SESSION 2: From EPC to net zero carbon ready 16 August

SESSION 3: Getting to net zero carbon 25 August

The UK PACT EPC project is delivering outputs and foundational support to SANEDI and the market with the aim to increase the uptake of EPCs

PHASE 1 : 2021

1. EPC international best practice and identification of opportunities and barriers for the local mechanism
2. EPC register user needs, functionality and technical outline
3. Development of the NBEPR register
4. Issuing of EPCs for sample of 30 buildings
5. Recommendations for improving the EPC process, and development of EPC roadmap for building owners
6. EPC mechanism awareness raising and register training
7. Policy recommendations for further driving EE through the EPC mechanism

PHASE 2 : 2022

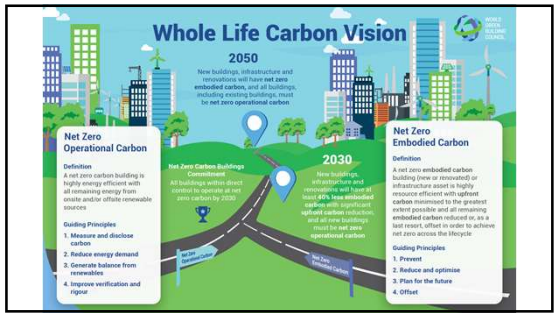
1. Support for 250 building owners in data gathering for EPCs
2. Support for 5 SMMEs to become SANAS IBs
3. Training sessions from EPCs to Net Zero
4. Case studies
5. NBEPR oversight & sustainability
6. Private sector alignment
7. Final policy recommendation

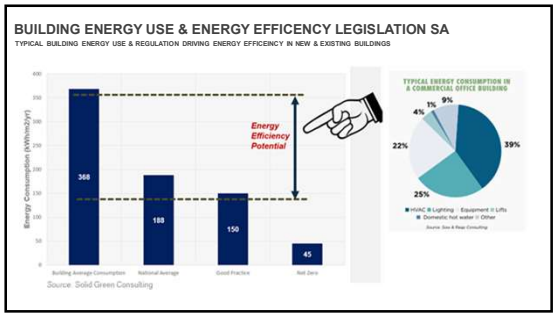
Foundational outputs · Key outputs · Incomplete · This deliverable

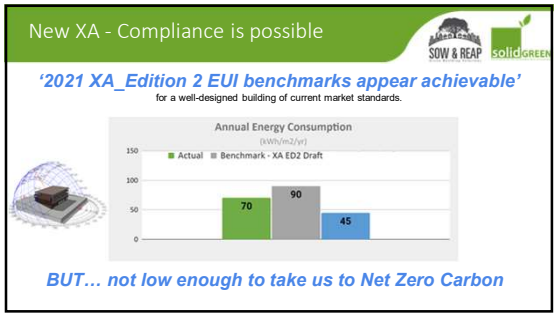
GBCSA ACADEMY

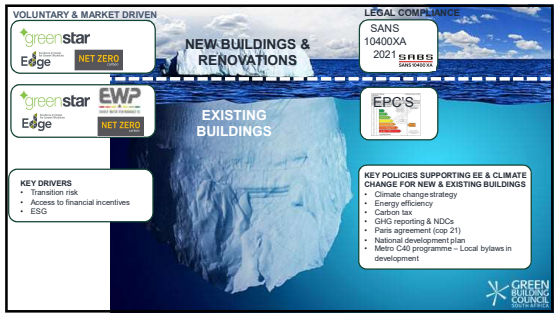
South Africa's Climate Change Targets

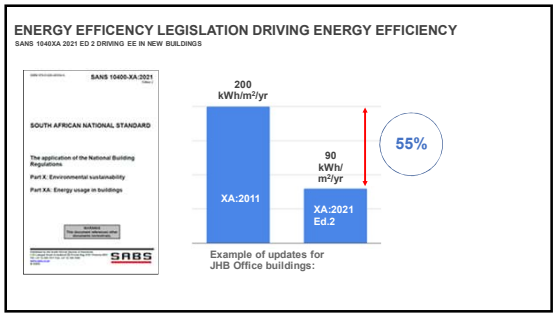
- Following the 26th global COP26 that took place in 2021, South Africa agreed to these adjusted climate change targets to join the fight against climate change.
- South Africa needs to meet its net zero emission target by 2050 and set more ambitious nearer term emissions targets in order to play an equitable role in limiting global temperature increases to well below 2C, and preferably to below 1.5°C – as per the Paris Agreement's targets
- Accounting for ~15% of the country's GHG inventory, buildings are a key part of South Africa's decarbonisation strategy; building emissions will need to decrease by 34% in relation to the International Energy Agency's Reference Technology Scenario by 2050 (or by 82% below current emissions) if South Africa is to align itself to a 2°C scenario – i.e. most buildings will need to be at or near to net zero carbon (NZC)
- In most instances, improved EE reduces building operational expenditure and thus comes with strong economic arguments. However, the need to improve EE is increasingly being led by the net zero imperative, this is especially relevant in South Africa where grid electricity is highly carbon intensive
- The Post-2015 National Energy Efficiency Strategy (NEES), also requires that state-owned buildings reduce specific energy consumption by 50%, and commercial buildings by 37%, by 2030, off 2015 benchmarks.
- Additionally, the construction and use of buildings accounts for significant scope 2 and scope 3 emissions

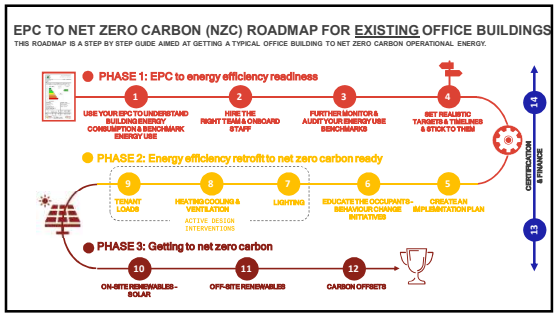

Whole Life Carbon Vision
2050
New buildings, infrastructure and renovations will have net zero embodied carbon, and all buildings, including existing buildings, must be net zero operational carbon
Net Zero Operational Carbon
Definition
A net zero carbon building is highly energy efficient with all remaining energy from onsite and/or offsite renewable sources
Guiding Principles
1. Measure and disclose carbon
2. Reduce energy demand
3. Generate balance from renewables
4. Improve verification and rigour
Net Zero Carbon Buildings Commitment
All buildings within direct control to operate at net zero carbon by 2030
2030
New buildings, infrastructure and renovations will have at least 40% less embodied carbon with significant upfront carbon reduction, and all new buildings must be net zero operational carbon
Net Zero Embodied Carbon
Definition
A net zero embodied carbon building (new or renovated) or infrastructure asset is highly resource efficient with upfront carbon minimised to the greatest extent possible and all remaining embodied carbon reduced or, as a last resort, offset in order to achieve net zero across the lifecycle
Guiding Principles
1. Prevent
2. Reduce and optimise
3. Plan for the future
4. Offset

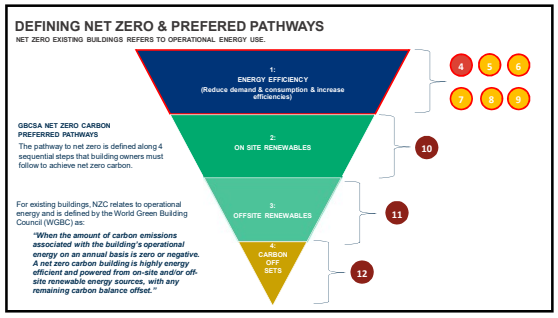

BUILDING ENERGY USE & ENERGY EFFICENCY LEGISLATION SA
TYPICAL BUILDING ENERGY USE & REGULATION DRIVING ENERGY EFFICIENCY IN NEW & EXISTING BUILDINGS
Energy Efficiency Potential
368
188
150
45
Source: Solid Green Consulting
TYPICAL ENERGY CONSUMPTION IN A COMMERCIAL OFFICE BUILDING
39%
25%
22%
4%
1%
9%

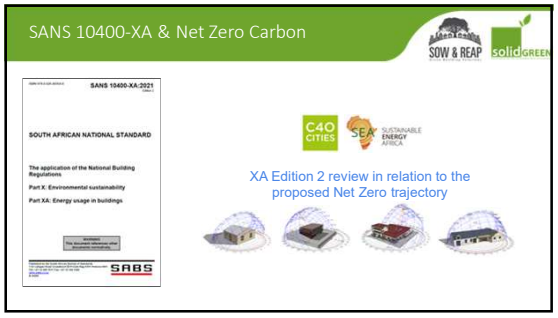

New XA - Compliance is possible
SOW & REAP
solidGREEN
'2021 XA_Edition 2 EUI benchmarks appear achievable'
for a well-designed building of current market standards.
Annual Energy Consumption
(kWh/m2/yr)
Actual
Benchmark - XA ED2 Draft
70
90
45
BUT... not low enough to take us to Net Zero Carbon

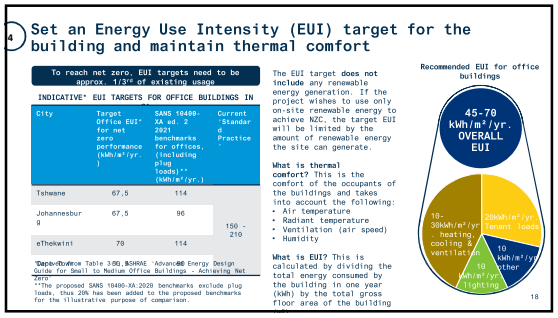

VOLUNTARY & MARKET DRIVEN
LEGAL COMPLIANCE
greenstar Edge
NET ZERO
greenstar EWP Edge
NET ZERO
NEW BUILDINGS & RENOVATIONS
EXISTING BUILDINGS
SANS 10400XA 2021
EPC'S
KEY DRIVERS
Transition risk
Access to financial incentives
ESG
KEY POLICIES SUPPORTING EE & CLIMATE CHANGE FOR NEW & EXISTING BUILDINGS
Climate change strategy
Energy efficiency
Carbon tax
GHG reporting & NDCs
Paris agreement (cop 21)
National development plan
Metro C40 programme – Local bylaws in development
GREEN BUILDING COUNCIL SOUTH AFRICA


ENERGY EFFICENCY LEGISLATION DRIVING ENERGY EFFICIENCY
SANS 1040XA 2021 ED 2 DRIVING EE IN NEW BUILDINGS
SANS 10400-XA:2021
SOUTH AFRICAN NATIONAL STANDARD
SABS
200 kWh/m²/yr
90 kWh/ m²/yr
55%
XA:2011
XA:2021 Ed.2
Example of updates for JHB Office buildings:


EPC TO NET ZERO CARBON (NZC) ROADMAP FOR EXISTING OFFICE BUILDINGS
THIS ROADMAP IS A STEP BY STEP GUIDE AIMED AT GETTING A TYPICAL OFFICE BUILDING TO NET ZERO CARBON OPERATIONAL ENERGY.
PHASE 1: EPC to energy efficiency readiness
1 USE YOUR EPC TO UNDERSTAND BUILDING ENERGY CONSUMPTION & BENCHMARK ENERGY USE
2 HIRE THE RIGHT TEAM & ONBOARD STAFF
3 FURTHER MONITOR & AUDIT YOUR ENERGY USE BENCHMARKS
4 SET REALISTIC TARGETS & TIMELINES & STICK TO THEM
PHASE 2: Energy efficiency retrofit to net zero carbon ready
9 TENANT LOADS
8 HEATING/COOLING & VENTILATION
ACTIVE DESIGN INTERVENTIONS
7 LIGHTING
6 EDUCATE THE OCCUPANTS- BEHAVIOUR CHANGE INITIATIVES
5 CREATE AN IMPLEMENTATION PLAN
PHASE 3: Getting to net zero carbon
10 ON-SITE RENEWABLES - SOLAR
11 OFF-SITE RENEWABLES
12 CARBON OFFSETS
CERTIFICATION & FINANCE
14
13


DEFINING NET ZERO & PREFERED PATHWAYS
NET ZERO EXISTING BUILDINGS REFERS TO OPERATIONAL ENERGY USE.
1: ENERGY EFFICIENCY (Reduce demand & consumption & increase efficiencies)
2: ON SITE RENEWABLES
3: OFFSITE RENEWABLES
4: CARBON OFF SETS
GBCSA NET ZERO CARBON PREFERRED PATHWAYS
The pathway to net zero is defined along 4 sequential steps that building owners must follow to achieve net zero carbon.
For existing buildings, NZC relates to operational energy and is defined by the World Green Building Council (WGBC) as:
"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."


SANS 10400-XA & Net Zero Carbon
SOW & REAP
solidGREEN
SANS 10400-XA:2021
SOUTH AFRICAN NATIONAL STANDARD
SABS
C40 CITIES
SEA SUSTAINABLE ENERGY AFRICA
XA Edition 2 review in relation to the proposed Net Zero trajectory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Set an Energy Use Intensity (EUI) target for the building and maintain thermal comfort
To reach net zero, EUI targets need to be approx. 1/3rd of existing usage
INDICATIVE* EUI TARGETS FOR OFFICE BUILDINGS IN
City
Target Office EUI* for net zero performance (kWh/m²/yr.)
SANS 10400-XA ed. 2 2021 benchmarks for offices, (including plug loads)** (kWh/m²/yr.)
Current 'Standard Practice'
Tshwane 67,5 114
Johannesburg 67,5 96
eThekwini 79 114
150 - 210
The EUI target does not include any renewable energy generation. If the project wishes to use only on-site renewable energy to achieve NZC, the target EUI will be limited by the amount of renewable energy the site can generate.
What is thermal comfort? This is the comfort of the occupants of the buildings and takes into account the following:
• Air temperature
• Radiant temperature
• Ventilation (air speed)
• Humidity
What is EUI? This is calculated by dividing the total energy consumed by the building in one year (kWh) by the total gross floor area of the building
Recommended EUI for office buildings
45-70 kWh/m²/yr. OVERALL EUI
10-30kWh/m²/yr - heating, cooling & ventilation
20kWh/m²/yr Tenant loads
10 kWh/m²/yr other
10 kWh/m²/yr lighting
18

PREDICTED MEAN VOTE (PMV): MEASURING THERMAL COMFORT

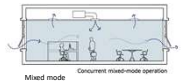
The predicted mean vote (PMV) and predicted percentage of dissatisfied (PPD) are the most widely used thermal comfort indices

Scale	Thermal Sensation
+3	Hot
+2	Warm
+1	Slightly Warm
0	Neutral
-1	Slightly Cool
-2	Cool
-3	Cold

- Applies to conditioned spaces
- Uses six factors to predict comfort

DESIGN STRATEGIES TO ACHIEVING ADAPTIVE COMFORT

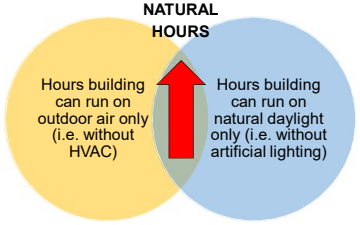
- **Envelope design** i.e. shade in summer & allow winter sun in.
  - Shutters & shading (horizontal on north & south; vertical on the west & east)
- **Natural Ventilation** i.e. openable windows
- **Mixed Mode Systems:** a hybrid approach to space conditioning that uses a combination of natural ventilation from operable windows (either manually or automatically controlled), and mechanical systems that include air distribution equipment and refrigeration equipment for cooling.
- **De-coupling heating / cooling from fresh air**
- **Radiant heating / cooling strategies**
  - **Chilled beams (active & passive)**
  - **Chilled ceilings**



Mixed mode
Source: CBE

Radiant cooling
Source: ASHRAE decoupled cooling

OPTIMISED NATURAL HOURS



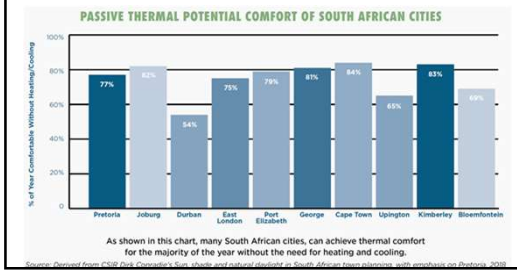
Designing for Comfort not air-conditioning

Access the tool here

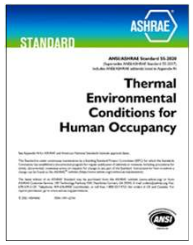
ENERGY MODELLING & SIMULTIONS TO PREDICT BUILDING PERFORMANCE METRICS

- Energy Modelling
- Artificial Lighting Quality
- Daylighting & Glare
- Solar Performance
- Thermal Comfort

ITS ABOUT TURNING IT OFF!

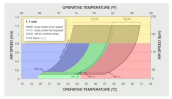


ASHRAE Standard 55



ASHRAE Standard 55 specifies conditions for acceptable thermal environments and is intended for use in design, operation, and commissioning of buildings and other occupied spaces

"that condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation".



What needs to change?

The first rule of sustainability is to align with natural forces, or at least try not to defy them.

Paul Hawken

5 Plan EE interventions along the building lifecycle and align them with the long-term maintenance/refurbishment strategy

- For an EE plan to be commercially viable, interventions need to be woven into the long-term business plan for an asset and aligned with maintenance and refurbishment works
- Buildings typically have a 60-year lifespan; depending on the age of the building, there may be several upgrades and refurbishment cycles required during its remaining lifespan
- Careful sequencing of the interventions to achieve energy demand reduction is important. Timing of interventions can be planned around factors such as plant replacement, refurbishment and leasing. This will allow for extra costs associated with carbon reduction to be minimized alongside disruption to operations
- However, as the requirement to reduce carbon emissions becomes more pressing, in many instances, the sequencing of interventions will need to be compressed (and sometimes fall outside of regular refurbishment patterns) in order to meet carbon targets
- Opportunities to improve the EE of a building are primarily found in 1 of 3 buildings

EE opportunities are primarily found in one of 3 building areas/functions

1. **Central operations & controls** upgrading or changes to centrally controlled items such as HVAC; lighting, access and even leasing
2. **Local spaces** interventions that work directly where people occupy the buildings, involving energy efficient equipment use and behaviour change work
3. **Building envelope** addressing aspects of the building skin such as creating natural ventilation, adding shading or insulation:

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8 Active intervention: HVAC

Average use: 40% kWh/m²/yr. — Target use: 10-30% kWh/m²/yr.

AIM
- NZC buildings should aim to operate without air conditioning for the majority of the year
- Interventions in this category will need to be competently modelled to understand the best strategy for your building

HVAC LOAD BENCHMARKS
- 3.8 ISCOP*DX: Heat pump efficiency
- 5.5 SEER* Chiller efficiency
- Use EC plug fans a standard design specification
- 20°C winter & 26°C summer set point for indoor temperatures**

*Integrated Seasonal Coefficient of Performance (ISCOP) and Seasonal Energy Efficiency Ratio (SEER) are indices which designers use to gauge the efficiency of cooling and heating plant.
**ASHRAE: assuming slow air movement, 50% humidity & limited radiant heat

STRATEGIES:
Elements involved in heating, cooling and ventilation of a building , such as chillers, boilers, cooling towers, fans, pumps, and packaged heating and cooling equipment need to be run as efficiently as possible in a NZC building. Coupled with passive strategies to keep the spaces well ventilated and cool in the hot summer months, the aim needs to be to limit the use of air conditioning as much as possible

Interventions can be split into 2 main groups; active and passive interventions and include all or some of the following

PASSIVE STRATEGIES:

Passive and low-energy solutions should be prioritised based on the local climatic conditions. These include:

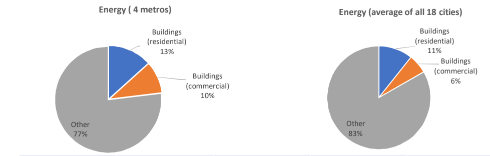
- Installing shading to the interior or exterior of the building with the aim to prevent heat load entering the building
- Optimising and creating natural ventilation flows
- Appropriate insulation, particularly on the roof.
- Installing double or performance glazing where applicable

ACTIVE STRATEGIES:

- Adjust the set point for indoor temperature:(e.g. 20/26°C)
- Install heat pumps: these are a more efficient way of heating and cooling air (and water) in a building.
- Pre-cooling of thermal mass: allows the building to be cost effectively cooled in preparation for the next days heat.
- HVAC operating times and optimizing the running of existing equipment
- Replacing existing HVAC systems with more efficient equipment and recommissioning the entire building

POTENTIAL SAVINGS & PAYBACK PERIOD:
Payback periods will depend on the building specifics. The impact of all interventions should be competently modelled with the associated savings based on the modelled results.

SHARE OF ENERGY CONSUMED IN BUILDINGS IN SOUTH AFRICAN CITIES



	Cape Town	EThekwini	Johannesburg	Tshwane
Buildings (total)	28%	23%	19%	20%
Buildings (residential)	13%	12%	14%	15%
Buildings (commercial)	15%	11%	5%	5%

6 Raise awareness and encourage behavioural change with building occupants with the aim to reduce energy consumption

- The role of behaviour change in driving down consumption is critical in achieving NZC
- The implementation of behaviour change initiatives typically generates electricity bill savings of up to 10%
- Increasingly digitized building environments enable occupants to provide ongoing energy and comfort feedback, further driving EE
- An effective communication plan that considers the timing and channels of messages and conveys accessible and impactful messages to encourage behaviour change is
- Physical posters and stickers should be used to support communication. Many organizations offer 'off the shelf' posters resources that could be used
- Good behaviour should be rewarded, and inter-departmental competitions encouraged
- Building occupants should be regularly updated on progress made towards targets and goals, and on proposed plans to encourage buy in to the process

Examples of posters to encourage behaviour change

Source: https://www.postertemplate.co.uk/posters/workplace/save-energy-

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9 Active intervention: tenant/plug loads

Average use: 25% kWh/m²/yr. — Target use: 10% kWh/m²/yr.

AIM
Efficiency in plug loads is driven by 2 aspects:
1. Specify use of energy efficient equipment
2. Equipment set to power off when not in use

PLUG LOAD BENCHMARKS
- 8 W/m²: Overall tenant loads*
- 0.5 W/m² :ICT plug loads
- 2 W/m² :After-hours plug loads*

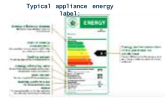
*Source - LETI Climate Emergency Design Guide.

A plug load is the amount of energy drawn by devices from an electrical outlet. The actual plug load of a building depends on numerous factors and no two buildings are exactly alike. In commercial office spaces the majority of "plug in" equipment is likely to be computers, screens and printers with oven and fridge to a lesser degree. Plug loads can average up to 30% of electricity use in office settings, much of which can be attributed to parasitic loads (or the power draw of a plug-load that is not performing useful work).

STRATEGIES:

MAKE USE OF MORE EFFICIENT EQUIPMENT. Electrical devices are more efficient than those manufactured just a few years ago and labelling of appliances is now mandated in South Africa (although largely focused on home appliances but including air conditioners) However, the amount of electrical equipment in use in offices is increasing, making driving down plug loads challenging. i.e.. laptops and flat screens are more efficient than desktops but people make use of multiple flat screens at one

Typical appliance energy label:



Source: www.savingenergy.org.za

CONTROLLING PLUG LOAD BY TURNING OFF EQUIPMENT.

- **Automated switching**: using timers and "smart" power strips to power off non-critical equipment and office equipment. Beyond the timing function, these devices provide no power management capability.
- **Central power management** systems that use software to perform specific tasks, such as enabling sleep settings on all computers on the network.
- **Total control systems** that provide fully integrated management controls.

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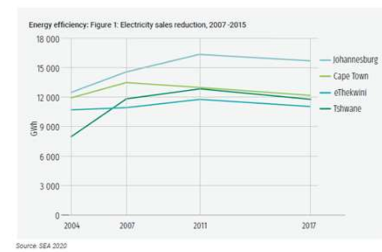


Source: SEA 2020

7 Active intervention: retrofit your lighting

Average use: 25% kWh/m²/yr. — Target use: 10% kWh/m²/yr.

AIM
- Net zero carbon buildings need to ensure that lighting is provided as efficiently as possible
- This can be achieved by retrofitting lights with the latest lighting and sensor technology, eliminating redundant lighting, reducing LUX levels, managing controls and making the most out of natural daylight

LIGHTING BENCHMARKS
- **4 W/m²** :Cellular office lighting power density
- **2 W/m²** :Basement parking lighting
- **0.5 W/m²**:Outdoor and after-hours lighting

Occupancy & Photocell sensors required with efficient control strategies

Source: ASHRAE's Achieving Zero Energy - Advanced Energy Design Guide for Small to Medium Office Buildings.

STRATEGIES:

OPTIMISE DAYLIGHTING: By rearranging internal layouts, the amount of natural light in the building can be maximized, minimising the need for electrical lighting. It should, however, be achieved without increasing the heat gain in the building

REDUCE POWER CONSUMPTION: Light-emitting diode (LED) technology has transformed lighting energy efficiency in recent years. While many fitting options are available to achieve certain lux levels, the power efficiency thereof is then targeted in terms of watts per m² - referred to as lighting power density (LPD)

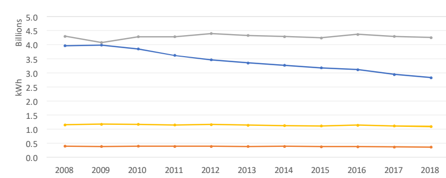
INCORPORATE REFLECTANCES & LUX LEVELS: Higher lux levels (the unit measuring the intensity of light hitting a surface) are generally required in an office where reading, for example, will take place. The choice of interior materials, paints and surface coverings play a large part in determining LUX levels with lighter and reflective surfaces offering more light and dark surfaces absorbing more light

LIGHTING CONTROL STRATEGIES: Aside from the actual efficiency of the light fixtures, lighting controls can help realise significant energy savings:

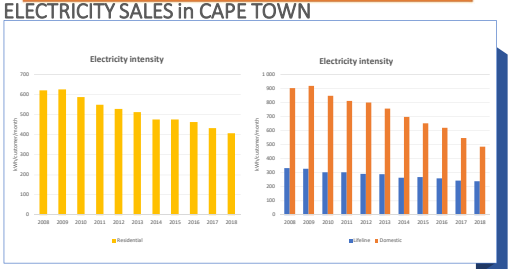
- **Manual switching**: occupants empowered to switch off lights
- **Manual dimming**: combined with an on/off switch, a dimmer allows for light levels to be tailored to requirements with resultant savings
- **Occupancy / vacancy sensor**: Provides automatic ON/OFF control with associated savings
- **Daylight sensor**: Automatic control that adjusts the lighting in response to available daylighting in the space. Provides additional energy savings to those outlined above
- **Luminaire level lighting control**: Daylight and occupancy controls are integrated into each luminaire. Due to the granularity of the controls these systems have the highest potential energy savings
- **Exterior lights**: Daylight sensor that turns the light on around down and off around dusk. Should be a minimum

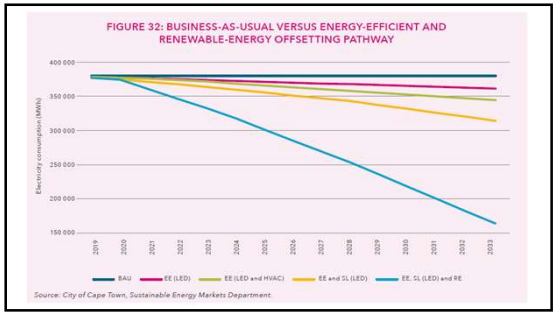
POTENTIAL SAVINGS & PAYBACK PERIOD: A well designed and controlled lighting scheme using LED lighting can reduce the associated lighting load by 70% when compared to incandescent and some fluorescent alternative designs.

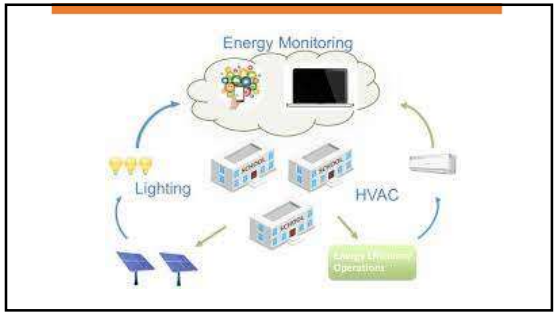
ELECTRICITY SALES in CITY OF CAPE TOWN



ELECTRICITY SALES in CAPE TOWN

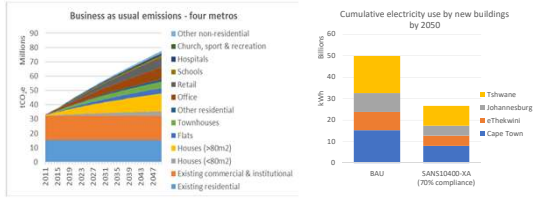






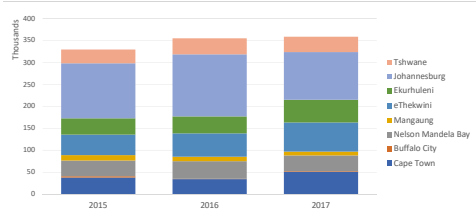
IMPACT OF EFFICIENT LIGHTING

IMPACT OF SANS 10400-XA NATIONAL STANDARD FOR ENERGY EFFICIENCY

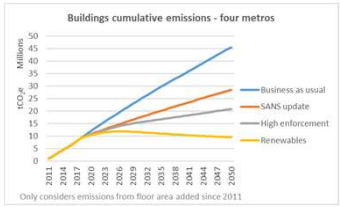


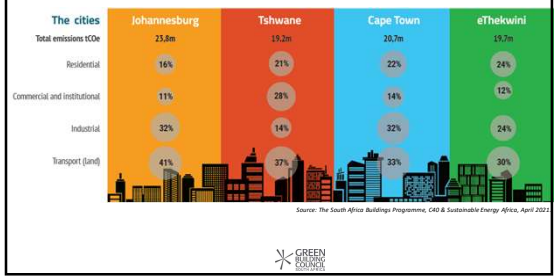
To accelerate the development and implementation of transformational energy efficiency policies and programmes for new buildings in South African cities by **2020**

SOLAR WATER HEATERS IN METROS OVER TIME



POLICY PATHWAY: IMPACTS INTO THE FUTURE





Occupancy	Class of occupancy or building	Occupancy description	Energy Use Intensity (EUI) kWh/m2/annum				
			2030	2035	2050	2040	2050
			SANS 10400 XA V2	SANS 10400 XA + 30% EE	SANS 10400 XA + 50% EE	SANS 10400 XA + 65% EE To be reviewed before 2040	SANS 10400 XA + 75% EE
Public gathering / entertainment	A1	Venues for sedentary behaviour	80	56	56	28	28
	A1	Venues for non-sedentary behaviour	120	84	84	42	30
Theatrical	A2	Theatres and cinemas	95	67	48	33	24
	A2	Sport performance	120	84	84	42	30
Places of instruction	A3	Conference halls, auditoria, lecture halls, laboratories, etc	95	67	48	33	24
Schools	A3	Urban, suburban, rural	55	39	28	19	14
Worship	A4	Large venues	50	35	25	18	13
	A4	Small venues	45	32	23	16	11
Detention	E1	Place of detention	55	39	28	19	14
Hospitals	E2	Large and medium hospital	176	123	70	61	44
	E2	Day hospitals, clinics	90	63	41	32	23
	E3	Institutional (residential)	120	84	84	42	30
	E4	Health care	85	60	38	30	21
Retail	F1	Large shop >250m2	145	102	65	51	36
	F2	Small shop <250m2	80	56	36	28	20
Offices	G1	Large multi-storey office	95	67	48	33	24
	G1	Standalone bldg in office parks	80	56	36	28	20
	G1	Call centres	145	102	65	51	36
Hotel	H1	Hotel	145	102	65	51	36
	H2	Dormitory	70	49	32	25	18
	H3	Domestic residence	70	49	32	25	18
Dwelling houses	H4	Low income houses < R450k	70	49	49	49	49
	H4	Middle income/luxury houses >R450k	70	49	32	25	18
	H5	Hospitality	70	49	32	25	18

Table 1: Energy Use Intensities for different building types

Source: CSIR summary report on net zero pathway tabs for cities Nov 2020

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2022 version

Energy Efficiency Financing

A Guide for C&I Facilities Managers

GreenCape Sector Development Agency

GreenCape

Types of Finance

Type	Description	Mechanisms
Debt	Acquisition of funds by borrowing; a lender provides capital to borrower for a defined purpose over a fixed period of time.	Corporate or project loans under recourse or limited recourse structures, leasing arrangements and full or limited guarantees
Equity	Acquisition of funds by issuing shares of common or preferred stock in anticipation of income from dividends and capital gain as the value of stock rises	Venture capital
Mezzanine	Subordinated debt structured so that it is repaid from project revenues after all operating costs and senior debt service has been paid.	Complementary or alternative solution to portfolio guarantees. Improves the loan-to-value ratio and the debt service coverage ratio for the senior lender
Project / Cash-Flow	The project is financed on its own merits based on the projected cash flows of the project rather than the balance sheets of the project sponsors.	Collateral

C40 CITIES NZC BYLAWS

Tshwane

Revision of existing Green Building policy and bylaw – close to final approval

City of Cape Town

Climate Change Strategy 2021
Working towards development of bylaw

City of Joburg

Policy approved
Public participation

eThekwini

Policy approved
Public participation
NZC buildings incentive – rates rebate up to 35%

Contents

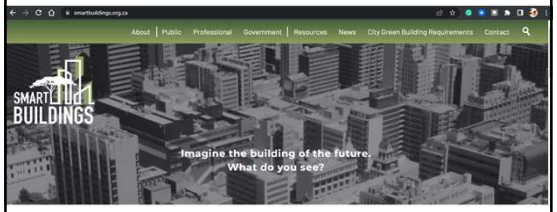
- Business Case
- Financing Overview
- Tax Incentives & Offsets
- Funding Sources

GreenCape

Notable Instruments

Instrument Type	Potential Instrument
Cost and Availability of Debt	Green Bond
	Sustainability Linked Loan (SLL)
	Concessional Loan
	Concessional Loan (Small Scale)
	Budget Financing with Capital Recovery
	On-Bill Financing
Cost and Availability of Equity	'Up-Type' Structure
	Private Equity Impact Fund
Risk Reduction	Loan Guarantee
	Performance Guarantees or Insurance
Incentive Schemes	Prescriptive or Standardised Offers
	Custom Energy Efficiency programmes (direct pay-to-save or results-based financing)
	Reverse Auction Scheme
	13L Revision
	Payment for Results (national level)
Other	Leasing Agreements
Mechanisms (incorporate g more than one financial instrument)	Mechanisms
	Utility energy efficiency obligations
	Private ESCOs
	Super-ESCO
	Project Development Facility
	Revolving Fund
	Concessional Credit Line

Source: Energy Partners / Carbon Trust (2021) – Contact for Workshop Report



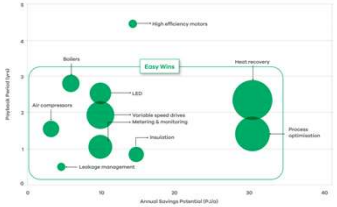
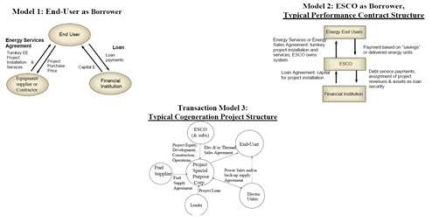


Figure 20: Feasibility efficiency technologies for the C&I sectors

Source: Energy Partners / Carbon Trust (2021) – Contact for Workshop Report

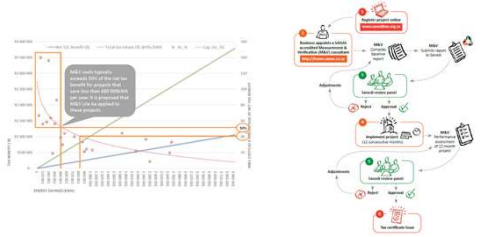
Business Models



Source: EU Energy Research Centre (2010)

Tax Incentives & Offsets

12L – Measurement & Verification (M&V)



Source: SANEDI (2016)

Argon Poorun – Energy Services Analyst

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2019

Tax Incentives & Offsets

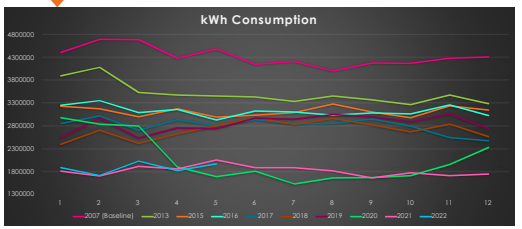
Carbon Trading

- *The finance minister announced an increase to the **carbon tax rate to R144** effective from 1 January 2022. To uphold South Africa's COP26 commitments, the rate will increase each year by at least R15 until it reaches R300. From 2026, government intends to escalate the carbon price more rapidly every year to reach at least R450 by 2030, and R1800 beyond 2050.*
- *The carbon tax is being implemented in three phases, with the 2nd phase originally scheduled to start in January 2023. But the finance minister extended the 1st phase by three years until 31 December 2025. As a result of delaying the 2nd phase, some sectors will remain beyond the reach of the carbon tax for now. These include the agriculture, forestry and waste sectors.*

When can I benefit from carbon credits?:

- *Understanding "additionality" - renewable energy & energy efficiency projects do not qualify on international standards, but standalone battery storage would.*
- *Feasible on international registries when 100 000+ ton CO2eq pa*
- *Feasible on local voluntary market when 1000+ ton CO2eq pa*

15 year journey



Funding Sources

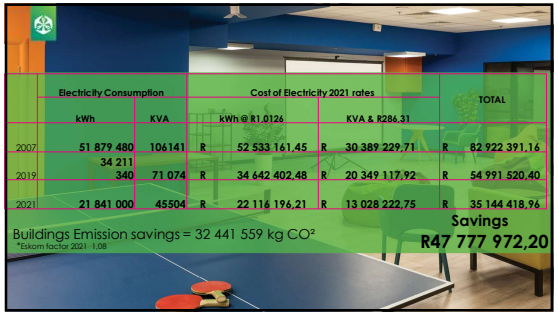
Green Finance Database

- The database contains information on funding opportunities, the types of funding and institutions providing the funding and contact details with a South African focus. Includes commercial banks, private equity, venture capital & private lenders

Open access: https://www.greencape.co.za/content/focusarea/green-finance-databases

1954

How the building has evolved over the years



	Electricity Consumption		Cost of Electricity 2021 rates		TOTAL
	kWh	KVA	kWh @ R1,0126	KVA & R286,31	
2007	51 879 480	106141	R 52 533 161,45	R 30 389 229,71	R 82 922 391,16
	34 211				
2019	340	71 074	R 34 642 402,48	R 20 349 117,92	R 54 991 520,40
2021	21 841 000	45504	R 22 116 196,21	R 13 028 222,75	R 35 144 418,96

Buildings Emission savings = 32 441 559 kg CO^2

*Eskom factor 2021 - 1,08

Savings

R47 777 972,20

Lighting Journey

2008 • Existing 4 foot 36W and 5 foot 58W Magnetic Ballast

2011 • Lascon x2 54W T5 Motion Sensor & Daylight harvesting

2013 • Lascon RCO-228/54-ELBx2 28W & Tridonic Smart Sensor

R10 million +

2016 • Lascon RCM-28W-LEDx1 28W & Tridonic Smart Sensor

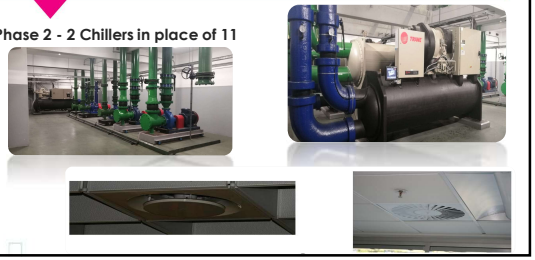
PEOPLE:

Changing behaviour

Ensuring sustainable practices

District Cooling Phase 2

Phase 2 - 2 Chillers in place of 11

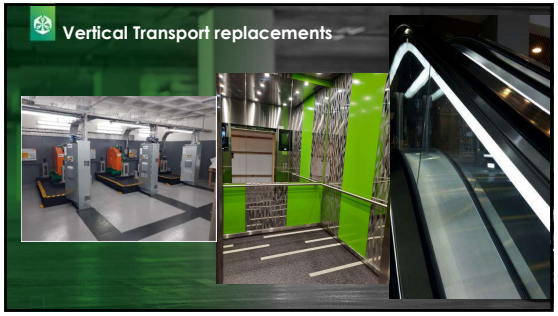


Lighting Audit 2008

50% difference

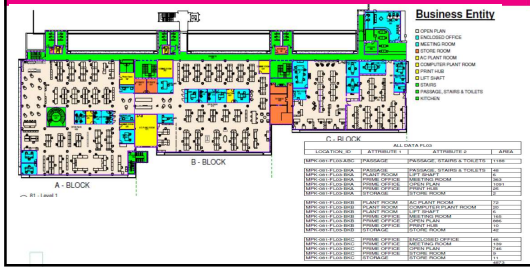
Existing Description	Watts	Quantity	Operating Hours Time on	Time off	No. Days	No. Weeks	Proposed Description	Watts	Cost Inc. Instl	Quantity	Current Kw Demand	New Kw Demand
Quad 4ft T8 H	180	45	6	19	6	52	T5 4ft Save & Easy	32	R 137	180	7.2	5.8
Single 4ft T8 E	40	34	6	19	6	52	T5 4ft Save & Easy	32	R 137	34	1.4	1.1
Double 4ft T8 E	80	24	6	19	6	52	T5 4ft Save & Easy	32	R 137	48	1.9	1.5
Double 4ft T8 E	134	327		24	7	52	T5 4ft Save & Easy	58	R 142	654	40.5	24.7
Triple 2ft T8 E	63	1	6	19	6	52	T5 4ft Save & Easy	15	R 132	3	0.1	0.0
Triple 4ft T8 E	120	18	6	19	6	52	T5 4ft Save & Easy	32	R 137	54	2.2	1.7
Hal 50w 12v	57	1478	6	19	6	52	LED 7w 12v	8	R 240	1478	84.2	11.4
Hal 50w 12v	57	602	6	19	6	52	LED 7w 12v	8	R 240	602	34.3	4.6
PL55	70	1493	6	19	6	52	LED 7w 12v	8	R 240	1493	85.9	11.5
PL55	40	74	6	19	6	52	LED 2L 15	17	R 600	74	3.0	1.3
PL55	28	359	6	19	6	52	LED 2L 15	17	R 600	359	10.1	6.1
PL55	80	682	6	19	6	52	LED 2L 15	17	R 600	682	38.2	11.6
PL55	116	821	6	19	6	52	LED 2L	36	R 1 550	821	95.2	29.7
Halo 20	20	179	6	19	6	52	Halostar	14	R 15	179	3.6	2.5
Mini Fl	70	55	6	19	6	52	LED 2L 45	50	R 1 300	55	4.1	2.8
Incandescent 60	60	127	6	19	6	52	LED 3	9	R 35	127	7.6	1.1
PL36W	70	368	6	19	6	52	LED 2L 15	17	R 600	368	25.5	4.4
		16325								19281	1049.0	550.4

Vertical Transport replacements



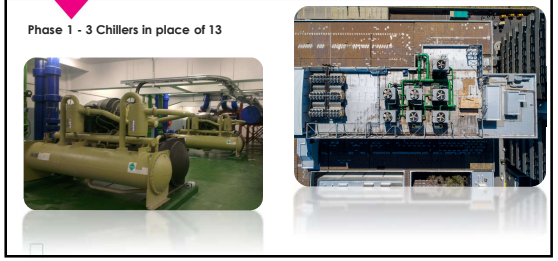
Typical HVAC Summer month profile

Understanding Floor Space

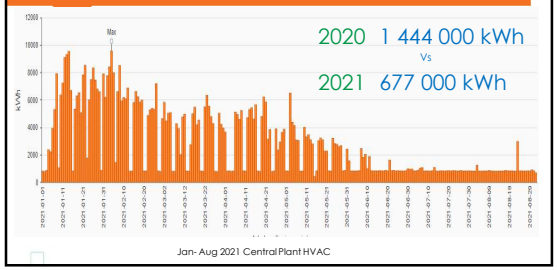


District Cooling Phase 1

Phase 1 - 3 Chillers in place of 13

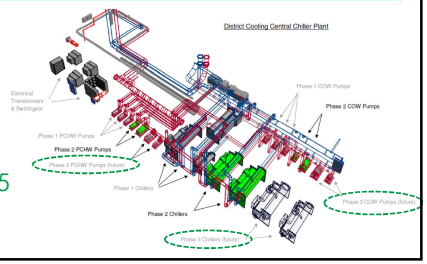


Active Energy Management during COVID



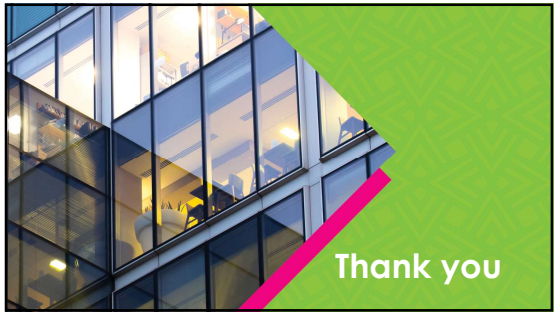
Phase 3 District Cooling Central plant

West Campus Planned 2024/2025



2016 Energy Efficiency Forum

- Pre solar installation
- Lighting changes
- Centralised Chiller plant room
- Floor controls space temperature



Metering

- 126 Energy meters

2019 Achieved 6 Star rating

1MW Solar

EWP

Inputs		
Total Energy Usage	34 276 466	kWh/annum
Total Mains Electricity Equivalent	34 276 466	kWh/annum
Total Emissions	41 131 760	$kgCO_2/annum$
Results		
Energy Intensity	206,48	$kWh/m^2/annum$
Benchmark Building Energy Intensity	430,40	$kWh/m^2/annum$
Total Emissions	247,78	$kgCO_2/m^2/annum$
Benchmark Building Total Emissions	516,48	$kgCO_2/m^2/annum$

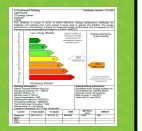
2015 Achieved 5 Stars

Without any Solar

EWP

Total Energy Usage	37 775 215	kWh/annum
Total Mains Electricity Equivalent	37 775 215	kWh/annum
Total Emissions	45 330 258	$kgCO_2/annum$
Results		
Energy Intensity	227,56	$kWh/m^2/annum$
Benchmark Building Energy Intensity	391,72	$kWh/m^2/annum$
Total Emissions	273,07	$kgCO_2/m^2/annum$
Benchmark Building Total Emissions	470,06	$kgCO_2/m^2/annum$

Next Step?



EWP

ENERGY WATER PERFORMANCE X1

NET ZERO carbon

UK PACT
COUNTRY PROGRAMMES

3 PART TRAINING: FROM EPC TO NET ZERO
SESSION 3: GETTING TO NET ZERO CARBON
In support of the project: *Operationalising Energy Performance Certificates in South Africa*

The Carbon Trust in partnership with the GBCSA are working on a 24-month project entitled "Operationalising energy performance certificates (EPCs)in South Africa." The project is made possible by grant funding from the UK PACT (Partnering for Accelerated Climate Transitions).

07 July 2022

CARBON TRUST · GREEN BUILDING COUNCIL SOUTH AFRICA · GBCSA ACADEMY


Georgina Smit:
Green Building Council SA


Argon Poorun:
GreenCape

James Beatty
Enpower


Chilu Lombe:
Solid Green Consulting

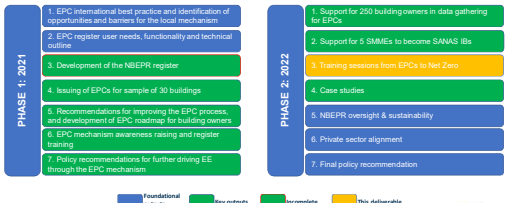

Jono Booth:
Carbon Trust


Anja Thompson:
Events manager;
Green Building Council SA.


Manti Seleka:
Intern;
Green Building Council SA.

GBCSA ACADEMY

The UK PACT EPC project is delivering outputs and foundational support to SANEDI and the market with the aim to increase the uptake of EPCs



GBCSA ACADEMY

UK PACT
COUNTRY PROGRAMMES

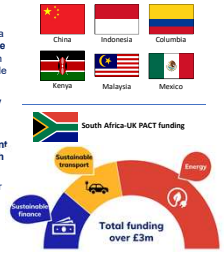
WELCOME AND INTRODUCTIONS


Jo Anderson
GBCSA
Research

CARBON TRUST · GREEN BUILDING COUNCIL SOUTH AFRICA · GBCSA ACADEMY

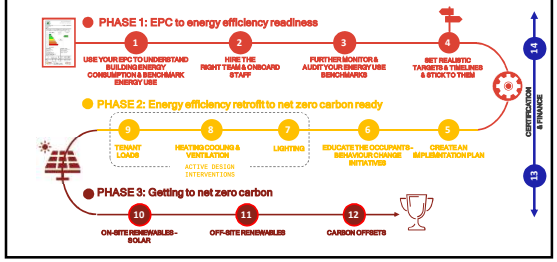
SCENE SETTING – UK PACT

- UK PACT (Partnering for Accelerated Climate Transitions) is a **£70m flagship programme under the International Climate Finance (ICF) portfolio** and forms a part of the UK's £11.6bn commitment to International Climate Finance by 2027 to tackle climate change.
- The current three-year programme (2018-2022) is **funded by BEIS**
- UK PACT works with partner countries, supporting them to **accelerate their clean growth transitions and to implement and increase for carbon emissions reductions in line with their NDCs**
- UK PACT **responds directly to demand** identified by partner governments by providing grants to implementing partners (such as NGOs, businesses and academia).



EPC TO NET ZERO CARBON (NZC) ROADMAP FOR EXISTING OFFICE BUILDINGS

THIS ROADMAP IS A STEP BY STEP GUIDE AIMED AT GETTING A TYPICAL OFFICE BUILDING TO NET ZERO CARBON OPERATIONAL ENERGY.



SESSION 3: Getting to net zero carbon

1. Welcome and Introductions
2. Net zero certification & levels (GBCSA & EDGE)
3. On site renewables
4. Off-site renewables
5. Offsets
6. Case study: net zero carbon building
7. Net zero carbon – what's next: embodied carbon

Next session dates

SESSION 1: Getting an EPC 02 August

SESSION 2: From EPC to net zero carbon ready 16 August

SESSION 3: Getting to net zero carbon 25 August

KEY PROJECT STAKEHOLDERS

Project funders & management	Project consortium	Primary beneficiaries	Secondary beneficiaries
Foreign, Commonwealth & Development Office; British High Commission Pretoria; Palladium MAKE IT POSSIBLE; SOUTH AFRICA UK PACT	CARBON TRUST; GREEN BUILDING COUNCIL SOUTH AFRICA	sanedi; mineral resources & energy	forestry, fisheries & the environment; public works & infrastructure; Property funds

UK PACT
COUNTRY PROGRAMMES

NET ZERO CERTIFICATION IN SOUTH AFRICA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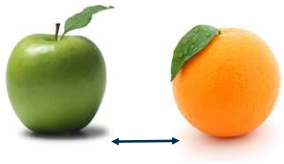
CARBON TRUST · GREEN BUILDING COUNCIL SOUTH AFRICA · GBCSA ACADEMY

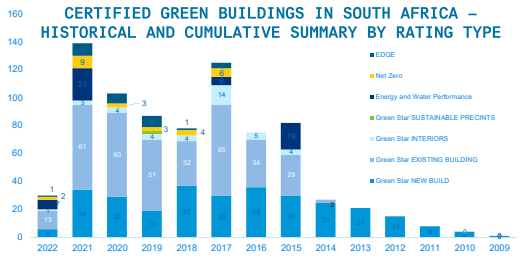
WHAT IS GREEN BUILDING CERTIFICATION?



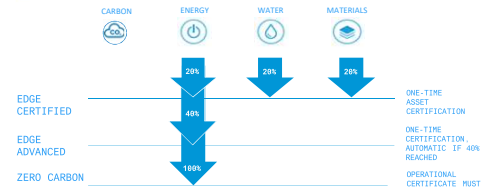
Green building certification systems are a set of rating systems and tools that are used to assess a building or a construction project's performance from a sustainability and environmental perspective. They essentially create a metric that allow the market to compare apples with apples and facilitate the understanding of :

- How green is green?
- How to compare buildings?
- Who says its green?

CERTIFIED GREEN BUILDINGS IN SOUTH AFRICA – HISTORICAL AND CUMULATIVE SUMMARY BY RATING TYPE



Certifying buildings over 3 key categories. Building owners choose level of savings depending on aspirations



CERTIFICATION ALLOWS BUILDING OWNERS TO VERIFY AND DEMONSTRATE CLIMATE AND SUSTAINABILITY CREDENTIALS ON A VOLUNTARY BASIS

Green Star SA is a suite of is a rating tools operated by the GBCSA for new and existing buildings that certify green buildings over 9 different categories

- Adopted by the Green Building Council South Africa in 2007 these in depth rating tools focus on rating commercial buildings in South Africa giving the market a better understanding and comparative metric of what a green building is.
- Project owners and green building consultants choose the level of certification based on budget and building type. Certification is available for all building typologies
- A suite of 4 tools focus on new buildings and rewards projects via a point system of credits achieved that illustrate
  - 4 stars: best practice
  - 5 stars: South African excellence
  - 6 stars: Global leadership
- New building ratings are an asset / once off rating given at design and as built stage,
- The Existing building performance tool (EBP) that take buildings on a journey to better performance, reward 1-6 stars. This is an operational rating and expires after 3 years.
- The Interiors tool focuses on rating interior fit outs with a focus on materials and indoor air quality.
- The sustainable precincts tool rates precincts with a focus on developing sustainable infrastructure like storm water, planting and roads
- To date there have been over 800 green star certified projects in South Africa with the majority being new and existing buildings
- Useful link: Green Star rated case studies

Net Zero is a rating tool developed and operated by the GBCSA that certifies net zero and net positive buildings over 4 categories

- Developed by the GBCSA in 2010 under the Advancing Net Zero campaign driven by the WGBC this local tool is used to certify net zero and net positive buildings. The GBCSA Net Zero/Net Positive Certification scheme awards projects which go beyond the partial reductions recognised in the current GBCSA tools, and have taken the initiative to reach the endpoint of completely neutralising or positively redressing their carbon emissions; water consumption; solid waste to landfill and their negative ecological impacts.
- Building owners can choose certification in carbon, waste, water and or ecology for new or existing buildings of any typology
- The recommended pathways across all aspects are:
  - Energy efficiency
  - On site renewables and or solutions
  - Off site renewables and or solutions
  - Carbon offsets
- There are 27 Net zero/ net positive certified projects to date in SA. See slide 8 for examples
- Useful link: Net Zero Case studies

There are several certification tools for all building typologies and different stage in a buildings lifecycle

- Commercial building tools
- Suite of 4 tools for new building typologies that reward 4,5 & 6 stars
- Existing building performance tool that take buildings on a journey to better performance, reward

- For offices only
- Benchmarking tool for energy & water

- All building typologies
- EDGE CERTIFIED
- EDGE ADVANCED
- EDGE NET ZERO

- Net zero carbon, water, waste & ecology
- Both net positive and net zero
- All building

EDGE (Excellence in Design for Greater Efficiencies) is a rating tool developed by IFC that addresses resource intensity of a building and focuses on energy, water and embodied carbon.

- Developed by the IFC and the World Bank in 2011, EDGE is an internationally recognized certification system that aims to make it fast and easy to verify the resource efficiency of a project
- Certifying buildings over 3 key categories. Building owners choose level of savings depending on aspirations. There are 3 levels of EDGE certification:
  - **EDGE Certified** (prelim and final) shows a 20% improvement off a benchmark* on energy; water and embodied carbon. This is a once off asset rating and does not need to be renewed.
  - **EDGE Advanced** (prelim and final) shows a 40% improvement off a benchmark* on energy; and 20% improvement for water and embodied carbon. This is a once off asset rating and does not need to be renewed.
  - **EDGE Zero Carbon**. This is an operational certificate that must be renewed every 2 years. Projects targeting zero carbon must FIRST reach EDGE Advanced with 100% carbon being reached by renewables and then offsets.
- There are EDGE agencies that facility third party, independent process of verification.
- Some commercial banks offer beneficial finance to EDGE certified projects, these are mainly linked to residential developments in South Africa.
- There are 3 506 116m2 of EDGE certified spaces in South Africa.
- Useful link: https://edgebuildings.com/certify/certification/

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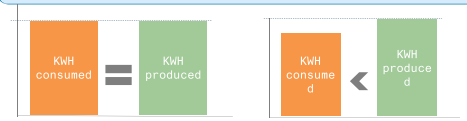
- Useful link: Net Zero Case studies

What is Net Zero Operational Carbon?

CARBON: Net Zero and/or Positive as per GBCSA

"A building that is highly energy-efficient, and the remaining energy use is from renewable energy, preferably on-site but also off-site where absolutely necessary, so that there are zero net carbon emissions on an annual basis (Net Zero), or if the energy from renewable energy results in more energy being produced than what is used on site (Net Positive)".



NET ZERO NET POSITIVE

- Different resources
- Different scopes of a building's lifecycle
- Different scales of development
- Net Zero & Net Positive certifications - valid for 3 years from the date of certification
- Modelled (Design & As Built) AND Measured (existing building) options availa
- Based on principle of efficiency f

NET ZERO carbon

NET ZERO carbon AFRICA South Africa 79 CORLETT DRIVE

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TWO DAM SUSTAINABLE

Size: 359m2
Year certified: 2017
Net zero certification achieved:
Net zero carbon level 2 Measured
Offsets: incl 13.6% offsets purchased
Location: Montagu, Western Cape

Most of the renewable energy required is supplied by a 31kWp solar array. A 1kWp high pressure low volume pelton wheel turbine provides hydropower. A battery bank of 72 batteries has a capacity of 172.8 kWh of which only 50% should be depleted. Batteries are charged by solar, hydro and gas if necessary.

Access the case study here

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WHAT THINGS MUST I CONSIDER TO ACHIEVE NET ZERO?

NET ZERO carbon

- Preferred Pathway 1 Energy Efficiency
- Preferred Pathway 2 On-site Renewables
- Preferred Pathway 3 Off-site Renewables
- Preferred Pathway 4 Carbon Offsets

NET ZERO CARBON BUILDING STANDARD & CERTIFICATION LEVELS:

CERTIFICATION TOOLS AVAILABLE AS 3RD PARTY VERIFICATION OF A BUILDINGS PERFORMANCE

NET ZERO carbon

LEVEL 1: BASE BUILD	LEVEL 2: BASE BUILD + OCCUPANT EMISSIONS	LEVEL 3: EMBODIED CARBON	LEVEL 4: RENOVATION EMISSIONS	LEVEL 5: DEMOLITION EMISSIONS
• Heating • Cooling • Ventilation • Fixed Lighting (non-Tenant) • Miscellaneous fans & pumps • Hot water • Vertical Transportation	• Electrical appliances • Tenant lighting • Plug loads • Operational and process energy	• Extraction and processing of raw materials • Manufacturing of materials and equipment for use in the building • Transport of materials and equipment to the site • Construction and installation of the building structure, systems and equipment		

Offsets disclosed on certificate

Modelled or measured data disclosed on certificate

VLEIHUIS DEVELOPMENT

Size: 1350m2
Year certified: 2018
Net Zero certifications achieved:
Net Zero Carbon- (Pilot) Level 2; Net Zero Water- (Pilot) Level 2;
Net Positive Ecology - (Pilot) Level 1;
Occupant Emissions (modelled) & Occupant Consumption (modelled) & Site Ecology - Brownfield (modelled).
Offsets: Including 0% Offset Purchased
Location: Linden, Johannesburg

The lightweight, low Portland cement concrete construction adds good thermal mass and showcases a fresh precedent for the "brick and mortar" domination of the South African construction industry.

Access the case study here

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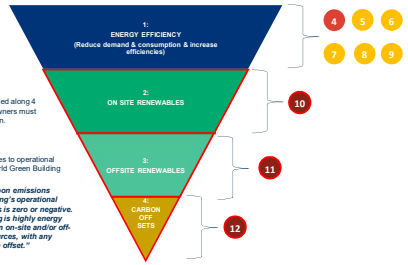
DEFINING NET ZERO CARBON & PREFERED PATHWAYS

NET ZERO EXISTING BUILDINGS REFERS TO OPERATIONAL ENERGY USE.

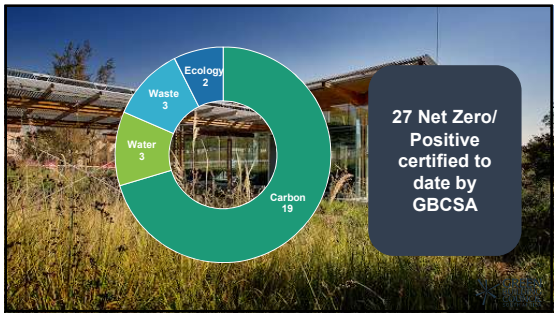


GBCSA NET ZERO CARBON PREFERRED PATHWAYS

The pathway to net zero is defined along 4 sequential steps that building owners must follow to achieve net zero carbon.

For existing buildings, NZC relates to operational energy and is defined by the World Green Building Council (WGBC) as:

"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."



GREENCREEK GREENBARN

Project Floor Area: 897m2
Year Certified: 2021
Certifications achieved:
Net Zero Carbon level 1 Modelled
Offsets: Including 0% Offset Purchased
Location: Johannesburg

Situated within Greencreek Riverwalk estate, developed by Balwin Properties, the leisure project with a plethora of amenities such as outdoor gym , laundromat , food garden and an art gallery. The design of a traditional rustic farmhouse rooted in nature, peacefulness and simplicity consists of simple initiatives which contribute to the sustainability of the entire estate.

Access the case study here

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CASE STUDY: IN2FOOD BONAERO

Project Floor Area: 22281m2
Year Certified: 2021
Certifications achieved:
4 star Custom industrial +
Net Zero Carbon level 1 (modelled)
Offsets: Including 0% Offset Purchased
Location: Johannesburg

In2food – Bonaero is a facility that manufactures food for Woolworths and various airlines situated within close proximity to the OR Tambo airport. The factory boasts an impressive solar PV system which annually yields more power than the factory utilises thereby making the facility net zero carbon energy.

Access the case study here

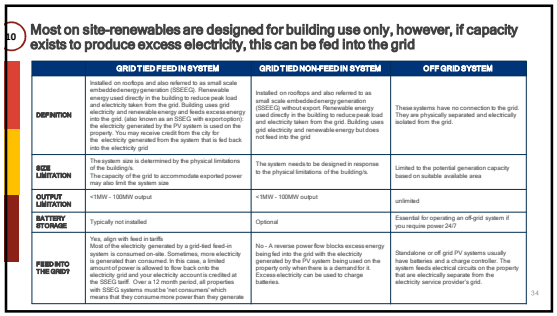
CITY INDUSTRIAL PROPERTY

Project Floor Area: 13606m²
Year Certified: 2021
Certifications achieved:
Net Zero Carbon – Level 1
Building Emissions (modelled)
Including 0% Offset Purchased
Location: Belleville Cape Town

City Industrial Property - Bellville Facility is the flagship facility for City Logistics based in Cape Town South Africa. The building is an industrial typology building comprising of a warehouse space and ground and first floor office spaces.

A number of the interventions range from mixed-mode ventilation, low VOC internal finishes, low flow sanitary ware fittings, rainwater harvesting, LED light fittings and efficient lighting control system, fuel efficient parking and cyclist facilities and zero ODP insulation to name a few. The project also has a PV system installed in order to reduce the main power usage and in the case of CIPF-Bellville Facility, a system sized for the project to target and achieve a Net Zero Carbon certification.

Access the case study here

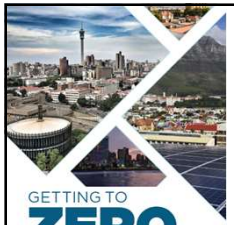


BALWIN HQ JHB

Project Floor Area: 7265m2
Year Certified: 2022
Certifications achieved:
6 star Office v1.1 +
Net Zero Carbon level 1 (modelled)
Including 0% Offset Purchased
Location: Johannesburg

In order to target Net Zero energy the project had to focus on energy efficiency first. This is achieved through sub-metering and effective monitoring, through the provision of motion sensors to designated zones, and improved lighting power density through efficient lighting design.

Access the case study here



"Technically, it is absolutely possible to achieve net zero carbon buildings. It requires determination and enabling building standards, bylaws and policies to make it happen at scale. Critical mass of net zero carbon buildings is required to meet political and planetary climate goals. The building sector has the potential for significant greenhouse gas emissions reduction at a lower cost than other sectors."

GBCSA blog article and guide link.

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ON SITE SOLUTIONS

Argon Poorun
GreenCape
Energy sector lead

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HOTEL NIEU

Project Floor Area: 1513m2
Year Certified: 2020
Certifications achieved:
Net Positive - Carbon – Level 2: Occupant Emissions (modelled)
Including 0% Offset Purchased
Location: Pretoria

Hotel Nieu aims to produce more energy on site than it will use. In addition to applying good passive design principles, this will be achieved through a rational design process that includes specifying high performance materials and active energy-producing systems like solar PV with battery back-up.

With a north orientation for good passive heating, the pod has a standardised ablution module (factory assembled and fitted); solar panels linked to Endless Power control modules; and an insulated hot water solar-powered vessel that was sized to accommodate water-based (in slab) heating in winter.

Access the case study here

- Advancing_Net_Zero_Status report_2021
- WGBC_Case_study_library

"The greenest building is the one that is already built" (Elefants, 2007). Half the buildings built by 2050 already exist and retrofitting them is key to achieve decarbonisation targets. Whilst technically challenging, renovating existing buildings to net zero standards brings many co-benefits, including better internal comfort levels and extending the building's useful life. The Phenix building by Lemay in Montreal, Canada, features the deep retrofit of a three-storey, 9,264 sqm industrial structure that was originally built in 1950. The building is CaGBC Zero Carbon Standard compliant and LEED Platinum certified, and is now a low-carbon, net zero energy workspace for 350 employees. The retrofit resulted in a reduction in carbon footprint of more than 86% compared to new construction, and diverted 93% of the construction and demolition waste from landfill. It also features energy efficiency measures and onsite renewable energy production

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Who we are

GreenCape is a non-profit organisation that drives the widespread adoption of economically viable green economy solutions.

We work with businesses, investors, academia and government to help unlock the **investment** and **employment** potential of green technologies and services, and to support a transition to a resilient **green economy**.

Link: 2022 Market Intelligence Reports

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Defining the Problem

- ❑ Rising Tariffs
- ❑ Loadshedding

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Defining the Problem

Best case scenario: Loadshedding for another 3-5 years

Year	Duration of outages (hours)	Energy shed (GWh)
2007	-	176
2008	-	476
...	...	...
2014	121	203
2015	852	1325
2016	-	-
2017	-	-
2018	127	192
2019	530	1352
2020	859	1798
2021 (YTD)	1136	2455

Source: CSIR Study - Utility Scale Statistics 2021

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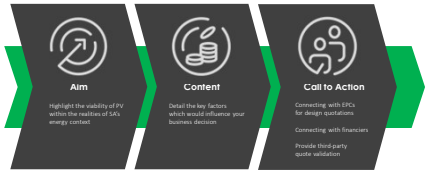
Executive Decision Support Pack

Providing all the information you need to make an informed investment



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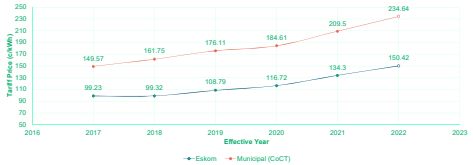
Defining the Problem

Rising Electricity Tariffs - Up approx. 40% 2017-2021



Period 2017-2021 increase: ~40% | Average per annum increase: 11%
Bulk price analysis, expect variance between municipalities

Source: GreenCape analysis

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Why PV makes sense now

- ❑ Cheaper c/kWh
- ❑ Flexible procurement options
- ❑ Technology & support

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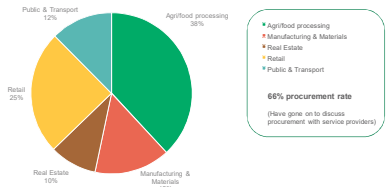
Current Progress 2017-2021

140 PV Engagements with Decision-makers



- Agri/food processing
- Manufacturing & Materials
- Real Estate
- Retail
- Public & Transport

66% procurement rate

(Have gone on to discuss procurement with service providers)

Source: GreenCape analysis

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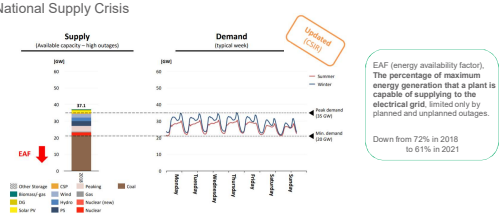
Defining the Problem

National Supply Crisis



EAF (energy availability factor), **The percentage of maximum energy generation that a plant is capable of supplying to the electrical grid**, limited only by planned and unplanned outages.

Down from 72% in 2018 to 61% in 2021

Source: CSIR Study - Setting Up for the 2020s

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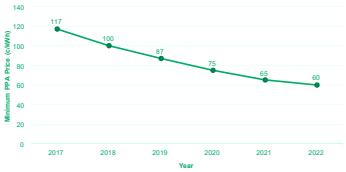
Why does PV makes sense now?

Declining PV Costs



Key Drivers

- Mass production of PV panels have driven manufacturing costs down 82% since 2010
- Progress in inverter and ancillary component technology has had a further cost reduction effect
- Reduced perceived risk on PV development allows for cheaper project finance

Source: GreenCape analysis

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Solar PV Procurement Options

Why does PV makes sense now?

Option	Description
Balance Sheet	The solar PV system is funded by the customer, the cost is high but in return the client gets all of the savings benefit. The client takes ownership of the annual costs of running the solar PV system
Debt Finance	Banks offer loans for solar PV installations for a period of between 5-10 years and monthly payments are a fixed fee. The collateral requirement for the debt funding is often taken against the underlying property or the system (asset).
Lease agreement Rent-to-Own	The installation, maintenance and management of the solar panel and its components is paid for by the solar PV provider, while the business pays a fixed monthly lease payment for the duration of the lease term. The fixed monthly payment is determined based on the estimated annual production of the solar system and not on the solar energy produced or consumed.
Power Purchase Agreement (PPA)	The solar PV system is installed at no upfront cost. The installation, O&M of the system are fully covered by the solar services provider. This funding mechanism includes insurance and performance guarantees, with the biggest advantage being reduced electricity costs from day one.

Costing

- ❑ Market price benchmarks
- ❑ Expected ROI
- ❑ Implications of storage

Project Model – Solar PPA

System size (kW): 100 kW$_p$

Electricity generated in a year: 255 500kWh

Yearly electricity consumption: 180 100kWh+

% of generation for own use: 80%

Source: GreenCape analysis

Additional Benefits

Why does PV makes sense now?

Benefit	Description
12B Tax Incentive	Section 12B of the Income Tax Act makes provision for a capital allowance for movable assets used in the production of renewable energy. The incentive makes allowances **100% asset accelerated depreciation** in first financial year that the asset is brought online. This equates to a **28% deduction on the business' income tax.**
Carbon Intensity Reduction Less Carbon Tax	The first phase has a carbon tax rate of **R120 per ton of carbon dioxide equivalent emissions**. This rate will increase annually by inflation plus 2 per cent until 2022, and annually by inflation thereafter. Affected industries: Energy, manufacturing & construction, mining, chemical
Roof Rental	The owner rents their rooftop to a solar provider who builds a solar system and enters into a PPA to sell the energy from the system. The company entering into the PPA does not necessarily need to be the same as the company leasing the rooftop. **Market rate per m2: R 5.00 - 7.00**
PV Resale to Tenants	The owner installs solar PV system benefiting from a reduced power purchase agreement rate and then 'on-sells' the electricity generated by the PV system to tenants at a rate equivalent to the higher municipal tariff

Costing

Market Price Benchmarks 2021/22

Procurement Options / System Size	<100 kWp	<500 kWp	>500 kWp	>1 MW
Balance Sheet (per kWp)	R 11 000 - 15 000	R 10 500 - 13 000	R 10 000 - 12 000	R 8 000 - 9 500
Debt Finance (5 - 10 year period)	Above amortized plus 5-8% interest pa			
Lease-to-Own (per month excl. escalation pa)	R 7 000 - 14 500	R 12 000 - 60 000	R 50 000 - 100 000	R 85 000 - 250 000
Power Purchase Agreement (PPA) (per kWh)	0.90c - R 1.20	0.80c - R 1.00	0.60c - 0.90c	0.56c - 0.70c

Source: GreenCape analysis

Costing

Energy Storage

Technology	Pros	Cons	Cost Range R/kWh
Lithium - Ion	Low operating and maintenance cost	High upfront cost Recharge time Lifespan of 3500 cycles (10 yrs depending on use)	Upfront: R 4 000 – 10 000
Diesel Generator	Higher energy density - 27x Li-ion Lifespan of 20000 hrs (20 yrs depending on use)	Rising diesel prices Chance of breakdown Potential carbon tax on emissions	Upfront: R 2000 – 2500 (Per kW) Operating: - 1. Fuel: R 4 – 5 - 2. O&M: 0.20c-0.50c

Over the course of a 20 year period Li-ion will still cost upwards of 5 times more than diesel genset.
Battery lifetime and resulting replacement costs are highly dependent on the nature of usage

Source: GreenCape analysis

Why does PV makes sense now?

Technology

- Most Municipalities in the Western Cape and NERSA have approved list of inverters that comply with grid connection requirements
- It is recommended that service providers implement tier 1 components
- Tier 1 suppliers generally offer longer warranties and have an option of warranty extension

Support

- Projects are implemented quicker due to increase in expertise and availability of components. On average turnaround is 3 months from signing to commissioning.
- Most EPC companies have O&M agreements with clients to service the solar system
- The PV Green Card is becoming a key regulatory certification for installers nationally

Project Model – Outright Purchase

System size (kW): 100 kW$_p$

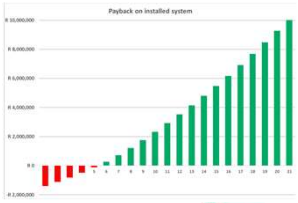
Cost of system: R 1.4 million

Electricity generated in a year: 255 500kWh

Yearly electricity consumption: 180 100kWh+

% of generation for own use: 80%

Payback period: 5 years



Source: GreenCape analysis

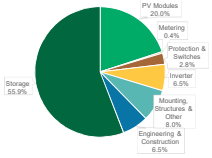
Costing

Example Li - Ion Case

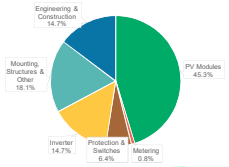
300 kWp System LS = Stage 2 | **850 kWh 2 hrs per day**

Takeaway
Storage is a significant portion
Consider underlying opportunity costs

% Investment with Storage [R 7 Mil]



% Investment without Storage [R3.2 Mil]



Source: GreenCape analysis

Regulations

- Licensing
- Registration & feed-in tariffs

GreenCape

System Sizing

Regulations

Beyond the site-specific design elements that influence the achievable size of the PV system, there are also limitations based on the connection to local infrastructure:

Shared LV Feeder
The maximum individual generation limit in a shared LV feeder is 25 % of the customer's notified maximum demand (NMD), up to a maximum of 20 kVA (generators greater than 20 kVA should be connected through a dedicated LV feeder).

Dedicated LV Feeder
The maximum generator size is limited to 75 % of the NMD.

The NMD for a site will have been determined upon initial connection to the grid.

Source: Grid Interconnection of Embedded Generation - NRS 097-2-3: 2014

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Thank You

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Licensing & Registration

Regulations

	Activity	<100kW	100kW-1MW	1MW-100MW
NERSA	Registration	[1]	✔	✔
	Licensing			
Municipality /Eskom	Application for connection	✔	✔	✔

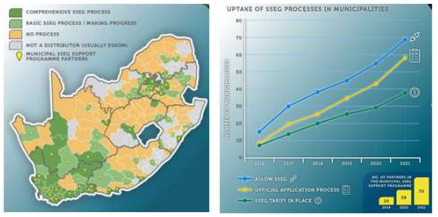
[1] Not required when there is already an existing point of connection. The local distribution utility must keep a register of such installations and must prescribe the conditions for connection.

Source: GreenCape analysis

GreenCape | 56

SSEG Processes

Regulations



Source: Sustainable Energy Africa

GreenCape | 59

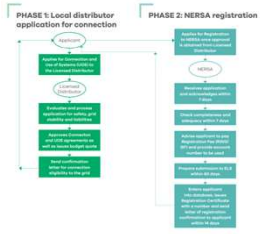
UK PACT
COUNTRY PROGRAMMES

OFF SITE SOLUTIONS & WHEELING

James Beatty /
Adam Griffin
Enpower

CARBON TRUST · GREEN BUILDING COUNCIL SOUTH AFRICA · GBCSA ACADEMY

Licensing & Registration



The service provider should facilitate these processes. We are available to assist if this becomes a project bottleneck.

Source: GreenCape analysis

GreenCape | 57

Tariff Information

Regulations

Link: SSEG Tariff Map

Consult in conjunction with your local municipalities most recent tariff book

Source: GreenCape analysis

GreenCape | 60

enpower TRADING

enpower TRADING

07 July 2022

ENPOWER TRADING has signed **USE OF SYSTEM AGREEMENTS** with two Western Cape Municipalities and has a national electricity trading licence from the **National Energy Regulator of South Africa (NERSA).**

SolarAfrica Energy
a rooftop solar finance and development company

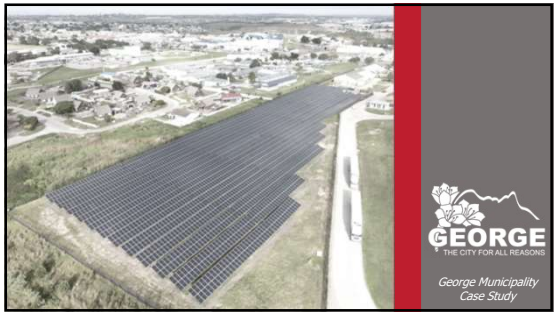
SA's Leading IPP

Industry Expertise

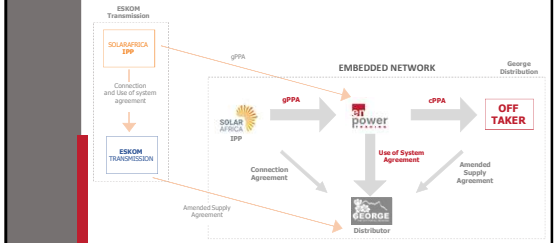
Enterprise Power Ltd
a pan-African power development and trading firm.

Trading Licence

NATIONAL ENERGY REGULATOR OF SOUTH AFRICA

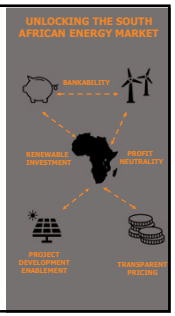


GEORGE MUNICIPALITY:
FUTURE ADDITIONS

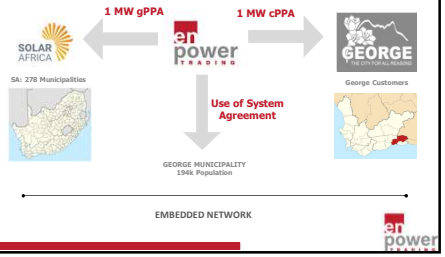


ENPOWER TRADING'S business model is built on these THREE BASES:

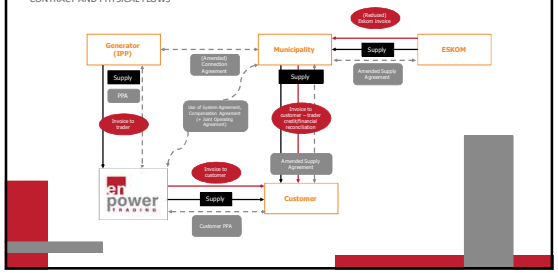
- Sourcing competitive IPP and embedded generation;
- Proving bankable offtake opportunities for project developers and IPP's
- Utilising a transparent pricing model for municipalities and customers:
  - The **CUSTOMER** pays the normal municipal tariff minus a discount,
  - The municipality receives the UoS charge **AND** the surcharge/'Unachieved Revenues' (municipal tariff – Eskom cost) and **REMAINS SURPLUS/PROFIT NEUTRAL.**



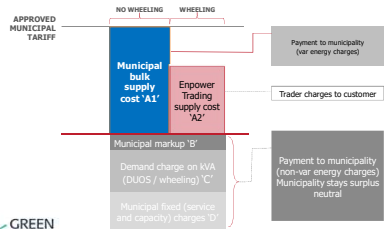
GEORGE MUNICIPALITY:
CASE STUDY



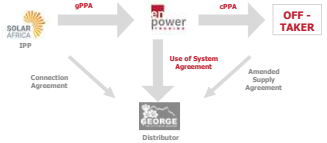
ENPOWER TRADING:
CONTRACT AND PHYSICAL FLOWS



PRICING MODEL:
DISCOUNTED APPROVED MUNICIPAL TARIFF

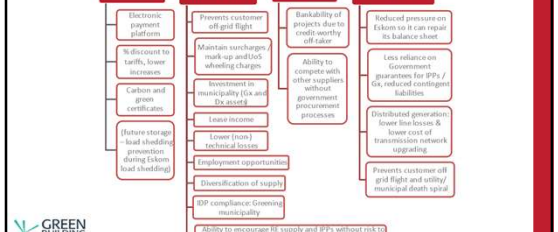


GEORGE MUNICIPALITY:
DISTRIBUTION CONTRACTS



- **ENPOWER** has entered into a **PPA FOR 1MW WITH** SolarAfrica to purchase solar energy generated inside the **GEORGE** distribution grid;
- Entered into **RENEWABLE ENERGY PPAs** for the offsite energy with **4 small customers across George** – at a discount to their existing municipal tariff
- Enpower signed **Use of System agreement with George municipality** on basis of wheeling fees equalling difference between Eskom Megaflex tariff (rate at which municipalities buy from Eskom) and customer tariff (i.e., **MARGIN PROTECTION** for municipalities).

Stakeholder Benefits summary



ENPOWER:
ELECTRICITY TRADER VS IPP

Contracting directly with an Electricity Trader has multiple advantages for off-takers and project developers / IPP's

1 **GENERATION RESOURCE VARIETY**

In the current market municipalities only allow wheeling from one single third-party supplier.

A trader can source generation from wind, solar and gas generation assets, etc. and bundle energy to an off-taker through one supply contract with the off-taker. This gives the off-taker the opportunity to attain greater renewable energy penetration. Signing a PPA with a single source generator is a massive long term risk.

2 **RISK MITIGATION FOR THE OFF-TAKER**

An off-taker contracting with a single supplier not only carries the risk of the generation resource, but also carries the opportunity cost in a market that is constantly evolving. A trader can add multiple sources to its portfolio and provide term flexibility, thus reducing the market risk and opportunity costs to the off-taker by not restricting the generation to a single generation facility or IPP for an inflexible term.

3 **RISK MITIGATION FOR THE PROJECT DEVELOPER**

EnPower trading engages in a mix off guaranteed long and short term power purchase options.

Pooling of customers and generators allows for attractive investment opportunities with reduced risk.

ENPOWER:
IMPLEMENTING THE TRADE

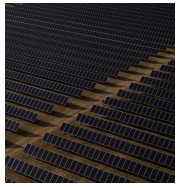
*The trade will be implemented via a combination of smart meters and integration into the **Open Access Energy trading platform***

- The **OPEN ACCESS** Energy platform provides following services:
  - Allowing for secure and automatic exchange of metering information by reading and sharing data of meters owned by the Municipality and privately – this service is provided to municipalities for **FREE**
  - **Metering data** is then fed into the platform in real time, to match electricity generation and consumption in 30 minute intervals (or as required)
  - The platform will allocate the traders credits from GENERATION to nominated customer
  - At the end of the billing cycle the platform will invoice off-takers based on their consumption; and
  - Settle the generators based on their **AGREED** pricing.

Renewable energy can be purchased from off-site generators through a wheeling arrangement; electricity is 'wheeled' from a renewable facility to a commercial consumer over the grid

- Wheeling is defined as the transfer of electrical power via a utility's transmission or distribution system between different grid or network service areas
- The main advantages of wheeling is that a customer's full power demand can be met regardless of ground or roof space restrictions in the immediate vicinity of the building
- As off-site generators of renewables are in optimal production areas (i.e.. high wind or solar resources), and in areas where environmental and social impacts can be minimized, wheeling allows for lower-cost, lower-impact, cleaner energy to be utilised when needed.
- Practically wheeling has 3 main parties: the client, a large energy user; the suppliers / installers of the solar farm, and Eskom. The client agrees to a power purchase agreement with the supplier/installers and Eskom, as the Grid Operator, signs a connection and Use-of-System Agreement with the suppliers/ installers to commit to transporting the power on its grid

Wheeled electricity is typically generated in areas that are optimal for the generation technology



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UK PACT COUNTRY PROGRAMMES

OFFSETS

Jonathan Booth
Carbon Trust

Carbon offsets are used to offset residual emissions remaining after EE and renewables options have been exhausted

- So long as grid electricity remains carbon intensive, there will always be residual emissions resulting from building operations
- Residual carbon emissions can be offset through purchasing carbon offsets (1 offset = 1 tonne of CO_2) through a voluntary carbon trading scheme
- Not all carbon offsets are equal however, and only those schemes that apply rigorous certification and audit processes should be considered
- Carbon Offsets have been defined by GBCSA as those carbon emissions traded through well established, trusted voluntary carbon trading schemes that include rigorous audits and certification processes. The GBCSA has approved the following schemes to date :
  - Credible Carbon
  - Gold Standard
  - Climate, Community and Biodiversity Standard (CCBS)
  - Verified Carbon Standard (VCS)
  - ImpactChoice

Carbon offset schemes recognised by South Africa's carbon tax regulations

Clean Development Mechanism (CDM), a UN administered scheme that is being replaced by Article 6 of the Paris Agreement

Gold Standard
An offset scheme for non-governmental emission reductions projects in the CDM, the Voluntary Carbon Market and other climate and development interventions

Verified Carbon Standard
A VERRA STANDARD
An internationally recognised standard for certifying carbon emissions reductions, administered by VERRA

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There are important differences to note between reaching Net Zero at the building level and Net Zero at the organisation level

The Science Based Target initiative (SBTi) sets the standard for organisational level Net Zero targets, and requires for sectoral, science aligned decarbonisation trajectories to be followed and residual emissions to be offset through carbon removal offsets

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

More than one standard exists for Net Zero at the building level, however, for the most part, carbon reduction offsets are allowable in meeting the criteria

GREEN BUILDING COUNCIL SOUTH AFRICA
UK GBC

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Carbon reductions are not enough to meet Paris Agreement goals, and reaching Net Zero at the global level will require for all offsets to eventually be carbon removals

*Most offsets available today are **emission reductions**, which are necessary but not sufficient to achieve net zero in the long run. Carbon removals scrub carbon directly from the atmosphere.*

***Users of offsets should increase the portion of their offsets that come from carbon removals, rather than from emission reductions**, ultimately reaching 100% carbon removals by mid-century to ensure compatibility with the Paris Agreement goals.*

Creating demand for carbon removal offsets today will send the necessary market signal to increase supply.

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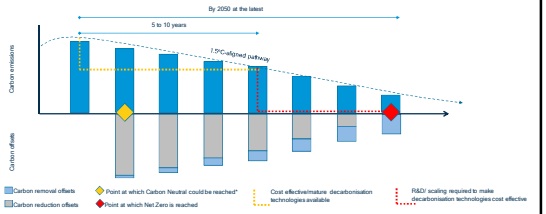
Due to this, at the organisation level, many companies target Carbon Neutral before Net Zero



*Whilst Carbon Neutral can be achieved on Scope 1 & 2 emissions alone, Net Zero must incorporate Scope 3 emissions, if Scope 3 accounts for >40% of total carbon emissions. Further, Net Zero requires for value chain emissions to be reduced in line with sectoral decarbonisation pathways, and for residual emissions to be offset through carbon reduction offsets only.

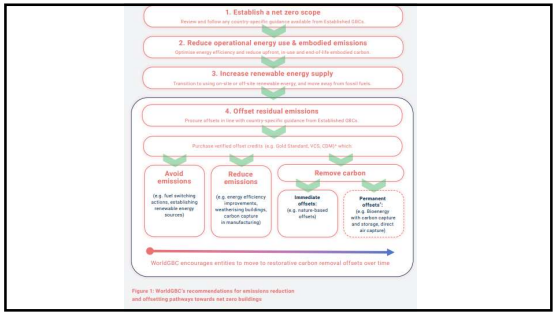
Organisations could develop their own offsets projects, or purchase offsets from the market

Develop own offset projects

Pro's	Con's
Ability to forward plan and lock in carbon prices	Requires extensive internal resources and new skillsets, and long term planning
Ability to create additional shared/societal value through the business model	Limits flexibility and ability to capitalise on carbon price swings
Ability to create an additional revenue stream, if surplus credits are generated	Exposure to unintended consequences/unforeseen risks arising from mitigation projects

Purchase carbon offsets from the market

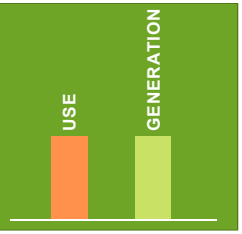
Pro's	Con's
Offsets can be purchased as and when needed	Limited ability to create additional shared/business model value
No forward planning of offset projects required	Missed opportunity to develop additional revenue sources
Minimal internal resources/new skillsets required	Long term uncertainty over carbon prices on the market



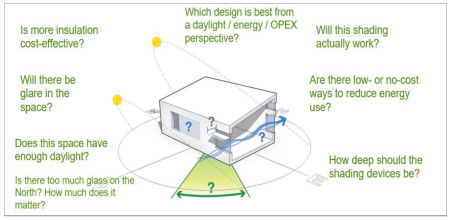
ENERGY
ENERGY & NET ZERO

WHAT IS NET-ZERO?

BUILDING ENERGY USE
=
BULDING ENERGY GENERATION



High Performance Buildings



UKPACT
COUNTRY PROGRAMMES

NET ZERO CASE STUDY

Chilu Lombe
Solid Green
Consulting

CARBON TRUST · GREEN BUILDING COUNCIL SOUTH AFRICA · GBCSA ACADEMY

SANS10400-XA to NET-ZERO CARBON
UNDERSTANDING THE DIFFERENCE

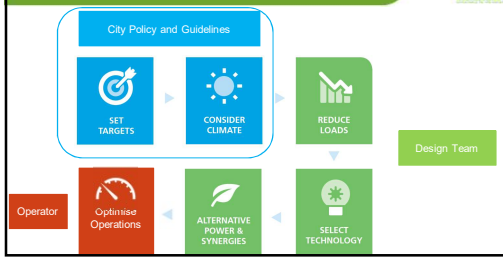
SANS10400-XA

- **Improve the national average (design)**

Net-Zero Carbon
Net-Zero By-Law

- **Removes operational impact**

MODELLING FOR DESIGN– NEW BUILDINGS



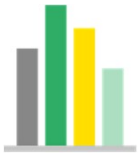
MDA LAW CASE STUDY

Energy Efficiency

Net-Zero Carbon is about energy efficiency

Key Considerations
Measurable Buildings

Measurable
Ability to track real world performance



Key Considerations
Maximise use of nature

Powered by nature

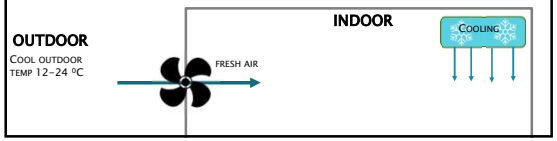
Daylight | Outdoor air | Sunlight



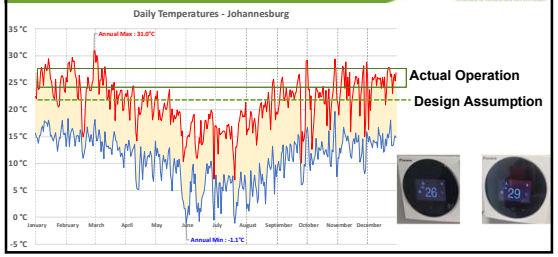
Key Considerations

DECOUPLE COOLING FROM VENTILATION

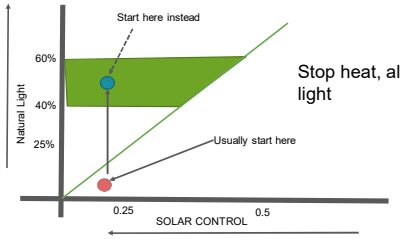
Most cooling systems mix air for cooling and air for ventilation.
Keeping them separate will allows buildings to use outdoor air only to maintain comfort.



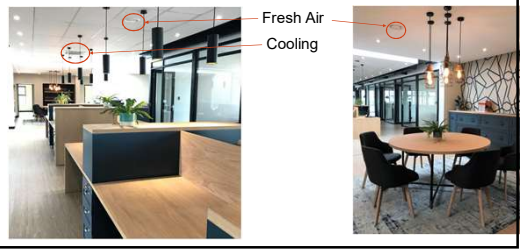
Investigate Climate



Key Considerations
Net-Zero Glass



Fresh Air Decoupled

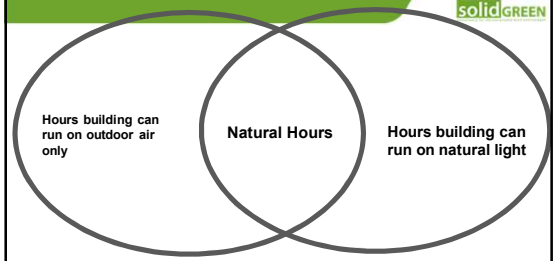


Key Considerations
Simplicity

Being energy efficient doesn't always have to be a complex solution

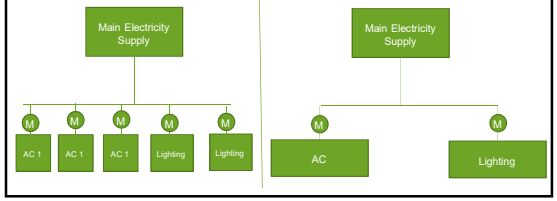
Key Considerations
Net-Zero Glass

POWERED BY NATURE



Technology Consideration

DESIGN FOR SUB-METERING



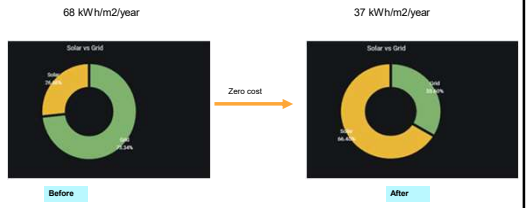
Technology Consideration

Net-Zero ≠ Off-Grid

Grid feed in is key to achieve net-zero

Energy by Sub-Meter

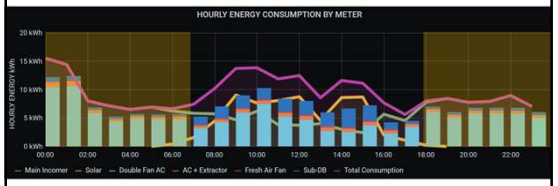
Operational Saving Outcome



Technology Consideration

The road to net-zero is paved with data

Where was the energy going



Where to from here

Next Steps – Net-Zero

- **Investigating wheeling**

Next Steps – Energy Security

- **Investigating batteries**

Net-Zero process reduces battery requirement by 45%

Post Occupancy Performance

Simple Fix

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NET ZERO EMBODIED CARBON – WHATS NEXT?

Georgina Smit
GBCSA Head of Technical

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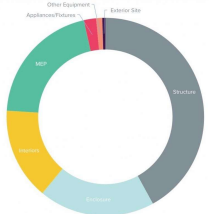
Whole Life Carbon Vision

Embodied carbon vs operational carbon

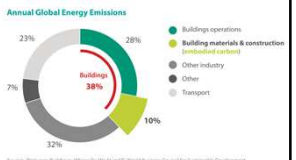
What part of the building has the most embodied carbon?.



Source: Simonen, K. (2015) "Testing Whole Building LCA: Research and Practice".

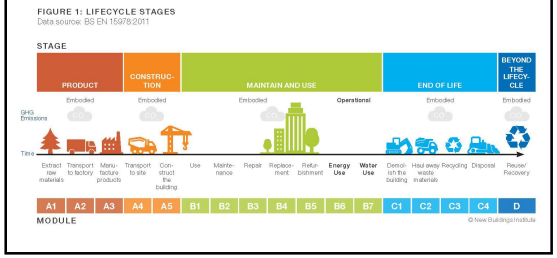
We cannot "net zero energy" our way out of the climate crisis.

Buildings are currently responsible for 39% of global energy related carbon emissions: 28% from operational emissions, from energy needed to heat, cool and power them, and the remaining 11% from materials and construction.
Towards the middle of the century, as the world's population approaches 10 billion, the ***global building stock is expected to double in size****. Carbon emissions released before the built asset is used, what referred to as 'upfront carbon', will be responsible for half of the entire carbon footprint of new construction between now and 2050, threatening to consume a large part of our remaining carbon budget.*

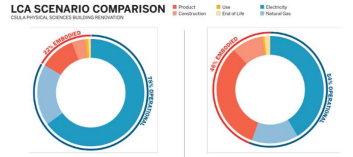


CARBON TRUST · GREEN BUILDING COUNCIL

Embodied carbon is measured through a life cycle assessment (LCA) that addresses the entire life cycle of products along 5 life stages.



LCA SCENARIO COMPARISON



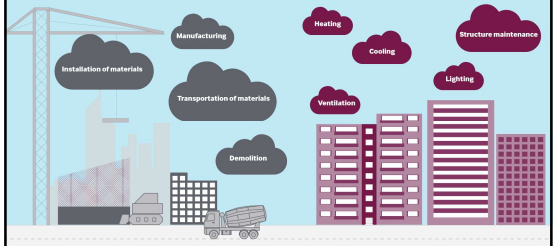
THE LCA of Atelier Ten's California State University project reveals that, over 60 years, embodied emissions account for 22 percent of total carbon. Shorten that to 20 years, and embodied emissions shoot up to 46 percent, reinforcing the importance of embodied carbon in achieving near-term reduction goals.

Strategies to Reduce Embodied Carbon Across Typologies

1. Choose low carbon materials
2. Design for re-use & disassembly
3. Use less materials
4. Design for adaptability
5. Perform a Whole Building Life Cycle Analysis
6. Implement a low embodied carbon procurement policy

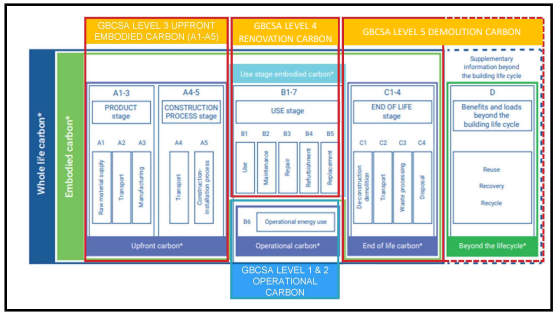
GREEN BUILDING COUNCIL

EMBODIED CARBON VS OPERATIONAL CARBON



EMBODIED – the carbon footprint of construction materials

OPERATIONAL – the building energy consumption when in use

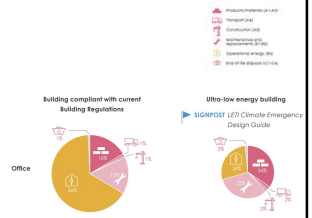


Setting targets for embodied carbon reduction

2017 Embodied Carbon Benchmark (ECB) Study: "This research establishes an expected order of magnitude and range for building initial embodied carbon: the initial embodied carbon of buildings is typically less than 1,000 kgCO2e/m2 and commonly ranges between 200 and 500 kgCO2e/m2 for commercial office buildings."

London Energy Transformation Initiative **(LETI)** – sets absolute targets (KgCO2e/m²) with phased targets

Architecture 2030 Embodied Carbon challenge – relative reduction

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