ClearVuePV

CLEARVUE TECHNOLOGIES LIMITED

ClearZero ARCHETYPE OFFICE ENERGY MODEL REPORT

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Say hello to ClearZero

Artist's impression of ClearZero Archetype (front view).

Artist's impression of ClearZero Archetype (rear view).

Introduction

ClearVue commissioned energy efficiency and sustainability specialists, Footprint[1] to develop an energy efficient archetype model office building named 'ClearZero' (the *Archetype*) to demonstrate how ClearVue's world-leading window integrated photovoltaic products can be used to assist in the design of highly energy efficient, energy neutral buildings.

The objective of development of the ClearZero Archetype was to explore the energy performance of selected energy and design strategies to achieve a net zero energy building design using ClearVue product.

Highlights

- ClearVue has completed design of an Archetype model building of 15,000 m² to demonstrate how ClearVue product can achieve a Net Zero or Near Zero energy-use building
- Modelling was completed on a design in Toronto, Canada, benchmarked against the Toronto Green Standard (TGS) from 2030 - one of the world's highest standards of building performance
- The Archetype was shown to achieve the highest level of performance under the TGS from 2030 and an ENERGY STAR score in the top 1% of Canadian office buildings for energy performance
- The Archetype – a computer simulation and detailed thermal model – will support ClearVue's sales teams when engaging with architects and engineers seeking to design Net Zero buildings

Toronto Green Standard (TGS)

The TGS has building code requirements that are tiered in nature with performance requirements increasing progressively in the period to 2030. The Standard contains 3 key requirements

1. **Total Energy Use Intensity (TEUI)**, which measures the buildings total energy use.
2. **Thermal Energy Demand Intensity (TEDI)**, which measures the energy used for heating and cooling the structure and is a measure of a building's thermal envelope energy efficiency. Only benchmarked in Canada.
3. **Greenhouse Gas Emissions Intensity (GHGI)**, which measures the carbon emitted by the building.

Historically windows and other fenestration are the weak link in a building's thermal performance. Typically, low carbon buildings have reduced window to wall ratios to hit energy use and carbon emission targets. Clearvue has achieved the 2030 TGS benchmarks while maintaining window to wall ratios of 90/70/70/40 percent on the respective elevations of the building. Making more natural light available to the end users of the structure without compromising on the carbon footprint of the building.

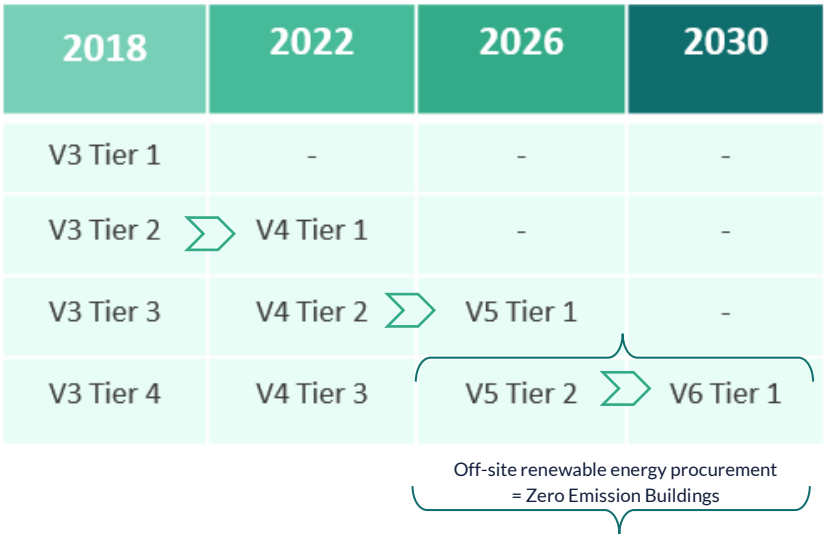
[1] See 'About Footprint' on page 9.

Archetype Building Key Points

Building Size	15,000 m^2
Storeys	6
Construction	Wood and low concrete (Lightweight Construction) as defined in Canada
Energy	40% of the building energy use is produced by CPV and traditional PV within the building footprint
Net Zero	Canadian Code requires 400 car parks for this structure. Net Zero can be achieved by applying traditional solar panels to 37% of the car park area
Location Climate	Location climate model is set as Toronto Canada. The performance of the Archetype in more temperate climates such as those in Australia will lead to better performance than modelled
Fenestration Rate	South Elevation 90% East & West Elevations 70% North Elevation 40%

Toronto Green Standard (TGS)

The Archetype was measured in line with the Toronto Green Standard. This is one of the toughest standards in the world with building code requirements in relation to energy use stepping up requirements in stages until 2030.



A Pathway to Zero Emission Buildings, Image via City of Toronto

The TGS Tiers are planned to step up such that version 3 Tier 4 requirements will become Tier 1 requirements by 2030.

Toronto Green Standard (TGS) Compliance

Model	TEUI ($ekWh/m^2$)	TEDI (kWh/m^2)	GHGI ($kg{\cdot}eCO_2/m^2$)	Complies
CPV Archetype	62.7	14.4	3.1	TGS v3 Tier 4
CPV Archetype +Roof PV	39.8	14.4	2.0	TGS v3 Tier 4
CPV Archetype + Roof+Car Park PV	0.0	14.4	0.0	TGS v3 Tier 4 & Net Zero Energy
TGS v3 Tier 4 Requirement	65.0	15.0	4.0	2030
TGS v3 Tier 3 Requirement	100.0	22.0	8.0	2026 - 2030
TGS v3 Tier 2 Requirement	130.0	30.0	15.0	2022 – 2026
TGS v3 Tier 1 Requirement	175.0	70.0	20.0	2018 - 2022

The Archetype complies to the Toronto (Tier 4) standard for buildings constructed from 2030.

Archetype Performance compared to Current Average Energy Use & Carbon Production

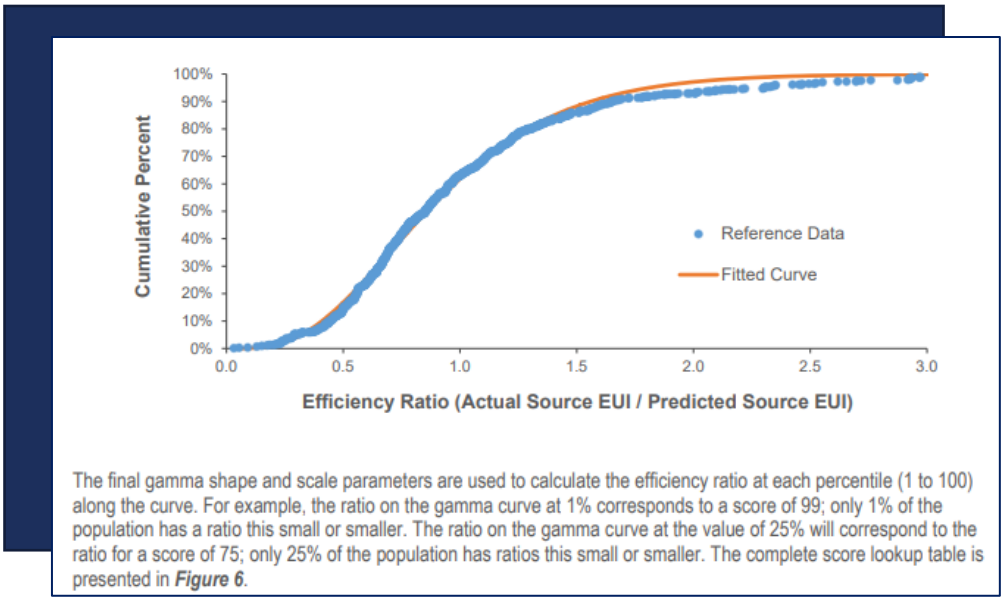
Total Energy Use Intensity (TEUI)	CPV TEUI	Canadian Median TEUI	% Reduction from Current Canadian Median
	($ekWh/m^2$)	($ekWh/m^2$)	
CPV Windows Only	62.7	228	-72.5%
CPV Windows + Roof PV	39.8	228	-82.5%
CPV + Roof+Car Park to Net Zero	0	228	-100%

Greenhouse Gas Emissions Intensity (GHGI)	CPV GHGI	Canadian Median GHGI	% Reduction from Current Canadian Median
	($kg\ eCO_2/m^2$)	($kg\ eCO_2/m^2$)	
CPV Windows Only	3.2	74.2	-95.7%
CPV Windows + Roof PV	2	74.2	-97.3%
CPV + Roof+Car Park to Net Zero	0	74.2	-100%

USA / Canada

Energy Star

The Energy Star matrix is a measure of building performance relative to current energy efficiency of existing buildings in USA and Canada. This is a percentile measure with the CPV Archetype achieving a score of 99 out of 100. This means the Archetype would be in the top 1% of the buildings in these countries in relation to energy performance and low carbon emissions.



The final gamma shape and scale parameters are used to calculate the efficiency ratio at each percentile (1 to 100) along the curve. For example, the ratio on the gamma curve at 1% corresponds to a score of 99; only 1% of the population has a ratio this small or smaller. The ratio on the gamma curve at the value of 25% will correspond to the ratio for a score of 75; only 25% of the population has ratios this small or smaller. The complete score lookup table is presented in ***Figure 6***.

Based on the Energy Star Rating System, the Archetype achieves a score of 99 out of 100

Singapore & South-East Asia

BCA Green Mark

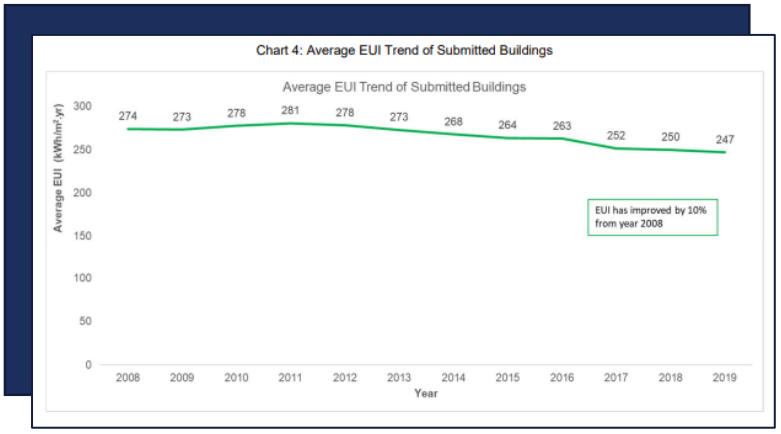
This Standard originated in Singapore and is used in several SE Asian nations for the rating of buildings.

The standard addresses

1. Energy Efficiency	116 Points
2. Water Efficiency	17 Points
3. Environmental Protection	42 Points
4. Indoor Environment	6 Points
5. Other Green Features	7 Points

Benchmarks

Certified	50 - 74 Points
Gold	75 – 84 Points
Gold Plus	85 – 90 Points
Platinum	90 Plus Points



Total Energy Use Intensity (TEUI)	CPV TEUI	2019 BCA Mark Average	% Reduction from BCA Green Mark Avg	BCA Mark
	(ekWh/m^2)	(ekWh/m^2)		
CPV Windows Only	62.7	247	-74.6%	
CPV Windows + Roof PV	39.8	247	-83.9%	Platinum
CPV + Roof+Car Park to Net Zero	0	247	-100%	

Greenhouse Gas Emissions Intensity (GHGI)	CPV GHGI	2020 Singapore CO_2 per kWh generated	% Reduction from BCA Green Mark Avg	BCA Mark
	(kg eCO_2/m^2)	(kg eCO_2/m^2)		
CPV Windows Only	3.2	100.8	-96.8%	
CPV Windows + Roof PV	2	100.8	-98.0%	Platinum
CPV + Roof+Car Park to Net Zero	0	100.8	-100%	

Based on Energy use parameters, Archetype will qualify for Platinum Level BCA Green Mark

Australia / New Zealand

National Australian Build Environment Rating System (NABERS)

NABERS Energy for office ratings are based on consumption data for the building (electricity and gas bills) analysed by accredited assessors considering building size, hours of occupation, location climate and occupation density. This data is then input into the NABERS calculator delivering a score between Zero Star (very poor) and Six Star (Market Leading) by comparing the buildings performance to the building's peers.

Total Energy Use Intensity (TEUI)	CPV TEUI	NABERS 6 Star Benchmark	% of NABERS Benchmark	NABERS Rating
	(ekWh/m^2)	(ekWh/m^2)		
CPV Windows Only	62.7	41.1	52.6%	
CPV Windows + Roof PV	39.8	41.1	-3.2 %	6 Star
CPV + Roof+Car Park to Net Zero	0	41.1	-100%	

Greenhouse Gas Emissions Intensity (GHGI)	NABERS 6 Star Benchmark	% of NABERS Benchmark	NABERS Rating	NABERS 6 Star Benchmark
	(kg eCO$_2$/m^2)	(kg eCO$_2$/m^2)		
CPV Windows Only	3.2	40.0	-92.0%	
CPV Windows + Roof PV	2	40.0	-95.0%	Platinum
CPV + Roof+Car Park to Net Zero	0	40.0	-100%	

The Archetype will qualify for a 6 Star NABERS rating with Rooftop PV

About Footprint

Footprint are leading sustainability specialists across a broad range of sustainability related disciplines. At Footprint, our goal is simple: how do we get to less? Less costs…less stress…less waste…these are achievements that truly make a difference for our clients, our colleagues, and, ultimately, the world.

Taking a more integrated approach to sustainability services, we work side-by-side with project teams, providing an informed perspective of sustainable opportunities and considerations for design and construction decisions.

Our goal is to act as a catalyst for balance – to ask the right questions and provide possible solutions that point in the right direction. How do we know what the right direction is? It's always the direction that points toward less energy, less time, less impact, and more sustainable developments.

Our services include: Energy Modelling & Strategy, Performance Verification, Existing Building Optimization, Climate Change & Resilience, Sustainability Consulting & Certification, Commissioning and Building Wellness.

footprint

To learn more visit: http://sa-footprint.com/

Notes

Comparatives of archetype data (in the above Annexure) are made and supplied for context purposes. Actual Archetype performance, if built, will vary depending on building site location(s) including local climate, local grid greenhouse gas intensity, building azimuth and other factors.

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