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Using BtrLyf-EDGAR for instant digital green assessment of buildings

Qi Square Pte Ltd | www.BtrLyf.com

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INTRODUCTION

BtrLyf (pronounced 'better life') is an open and unified digital platform that helps the co-creation of sustainable buildings by enabling collaboration and AI-enabled assessment of green buildings, instantly and at super low costs.

Buildings consume 30% of energy and contribute to 40% of carbon emissions globally. By 2050, the world's building stock will double, increasing the impact on climate significantly. Its demand for natural resources accelerates climate change, and inefficient, unhealthy buildings are affecting our livelihoods.

Buildings can save 20% to 60% in operating costs through proven green retrofit measures with an excellent return on investment. However, building industry players do not have the tools to easily identify and quantify energy-saving opportunities, evaluate the latest technological solutions and access financing options. They end up spending a lot of time in the administration of green projects and finding the right partners to work with.

The lack of effective data accessibility and exchange inhibits the growth of the industry. This in turn severely prohibits timely deployment of successful decarbonization strategies that are urgently required to mitigate and limit climate change and global warming impacts of buildings.

BtrLyf gets the industry to work together on green building projects with better data exchange for enhanced productivity and continuous improvements. It provides consistent and systematic data access and instant assessment tools (e.g. BtrLyf-EDGAR) for the industry stakeholders to accelerate decarbonization efforts.

In this paper, we present the BtrLyf-EDGAR digital assessment methodology and validation of its accuracy using actual building energy performance data of more than 100 buildings in Singapore.

GREEN ASSESSMENT

Green Assessment or audit of a building helps determine where specifically and how efficiently the building is using its resources. It's the first step in determining the current performance and then developing improvement plans for efficient resource use.

A good assessment will be able to comprehensively evaluate the building performance and help develop holistic improvement plans. The following are the basic desirable features of a good green assessment

01

Collects and analyses building data holistically

A good energy audit would comprise a review of various facets of building data such as the building overview (e.g. typology, location, total built-up area, space allocation), operational data (e.g. energy use, operation schedule), construction parameters (windows, walls, floor height), lighting and air-conditioning data as well as other elements such as lifts, escalators, pumps, parking fans, controls and on-site energy generation.

02

Develops an accurate performance baseline

By analyzing the collected data, an accurate baseline model of the building has to be generated that is able to calculate its performance parameters such as the Energy Use Intensity (EUI), envelope thermal performance, lighting power density, air-conditioning system efficiency. etc. It should also be able to highlight daily/monthly patterns and breakdown analysis of consumption. These calculations have to be validated against actual performance wherever possible.

03

Leads to performance improvement plans

The main objective of the green assessment would be then to use the baseline model and calculations to recommend and, as much as possible, qualify and quantify the environmental and financial impacts of performance improvement scenarios such as Energy Conservation Measures (ECMs) and achievement of carbon reduction targets.

THE PROBLEM

The lack of a holistic approach, combined with the gaps and the disconnect associated with data access, has made the current green assessment process overly technical, expensive and cumbersome. It makes the low-carbon transition very sluggish.

The data collection, building modelling/simulations, building retrofit analysis, and post-project measurement and verification of actual performance can be expensive and time-consuming activities. They limit the number of analyses that can be done, with costs that can even exceed project savings in some cases. Hence, for Energy Saving Companies (ESCOs), sustainability managers and design consultants, the initial 'exploratory' analysis can be a major drain on resources.

A typical assessment done at the start of any green building project is highly manual and requires specialized skills and resources (e.g. certified auditors) to visit the building and collect the necessary data for assessment through a site inspection. In a pandemic situation, walkthrough audits of building spaces by auditors may not be possible or be very limited due to access restrictions as well as lack of availability of relevant personnel and data sources at the worksite. Overall, a lot of inefficiencies exist in initial assessment of green projects and it hampers progress on decarbonization

Paul Booij
Founder & Managing Director,
Optimulate

> "Consultants spend too much time on collecting data, addressing customer queries on multiple energy and cost saving scenarios and evaluating green products during the initial assessment.

BTRLYF- EDGAR

EDGAR (Enhanced Digital Green Assessor), has an open and user-friendly non-technical interface that triggers alignment of priorities, enables data sharing and increases productivity of a green assessment by 10-50x

EDGAR is best suited for building owners/facility managers, sustainability managers, ESCOs and Environmental Sustainable Design (ESD) consultants, who would like to do initial assessment of buildings for planning their sustainability efforts and developing low-carbon roadmaps. Below are some of the helpful features of EDGAR that can solve the problems associated with a traditional green assessment.

01 Open Access Digital Twins for Green Assessment

Users can explore digital twins of tens of thousands of buildings in a city, search for specific buildings and get a quick overview of its baseline performance and energy-saving potential. The digital twins are pre-populated with data available from open sources, user inputs and processed through machine-learning for data standardization. EDGAR is available anytime, anywhere through a secure cloud access.

02 Add Data to Buildings

see demo :

If required, users can securely collect and add data in an intuitive and well-organized format using the 'Add Data' feature, which is accessible to specifically authorized users on the platform. After adding basic or advanced data, EDGAR generates a baseline performance report for the building instantly. It shows the energy breakdown analysis, monthly and daily consumption pattern as well as key performance indicators.

03 Auto & Manual Performance Simulation

see demo :

In a first-of-its-kind on-cloud performance simulation using building physics and machine-learning, users then get to know how building performance can be improved through auto-suggested or manually selected sustainable solutions ranging from building envelope, lighting to air-conditioning, controls and renewable energy. EDGAR has access to a wide range of sustainable products for inclusion in the digital green assessment and allows effective engagement of subject matter experts and financiers for collaboration on green projects.

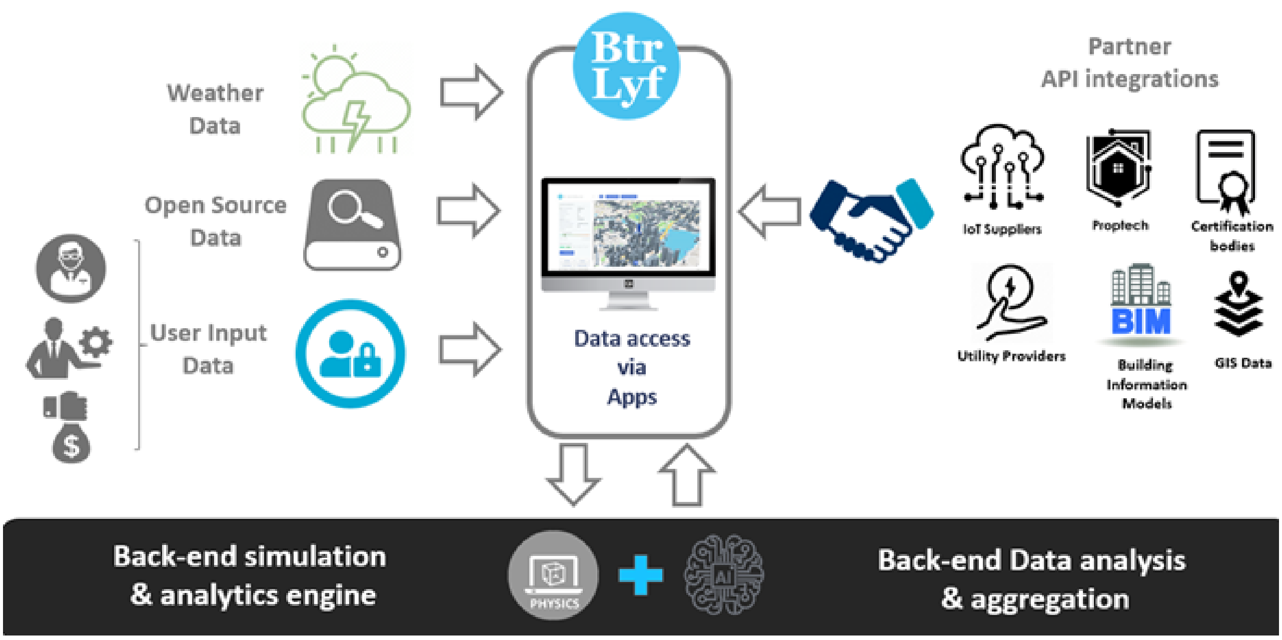
ASSESSMENT METHODOLOGY

The AI-powered building simulation engine of EDGAR has been developed through several years of Research & Development by Qi Square, a spin-off company of the Nanyang Technological University (NTU), Singapore.

The best use case of the BtrLyf-EDGAR tool is to produce a consistent and reliable evaluation and analytics of energy demand for initial building assessment purposes. While it assists decision-makers by providing energy, cost, and financial analysis of their design choices, it does not replace complex modelling software and is not envisaged to be used for system sizing. The calculations done are based on the following principles:

a) Laws of thermodynamics
b) Building specific physics (e.g. location, orientation, envelope, internal loads etc.)
c) Established international standards (ASHRAE, CIBSE, IEC) and local building codes.

The BtrLyf platform aggregates multiple sources of building data, including open-source information, design data, standards, API linked data from third-party providers, and user-entered data to create useful 'digital assets' or 'digital twins'. This data is then processed through physics-based simulation and machine-learning-based analytics engines to deliver building-specific as well as city-wide aggregate insights to improve the performance of buildings.



VALIDATION OF ACCURACY

BTRLYF-EDGAR is a relatively new tool in the market for performing green assessment (launched 1st Sept 2021). We are presenting here a case study for 120 buildings in Singapore where the baseline report generated by BTRLY-EDGAR was validated for accuracy using actual building data.

The following steps were followed as a validation methodology for establishing the accuracy of performance prediction through EDGAR. The annual energy use or the energy use intensity (EUI) is used as the key parameter to check the overall accuracy.

01

Add basic data to buildings

Data from the latest Building Energy Benchmarking Report from the Building Energy Submission System (BESS) of the Building & Construction Authority (BCA), Singapore was used. It was entered into the platform using the 'Add Data' feature of the BtrLyf-EDGAR tool for each of the chosen buildings. The following parameters were extracted from the report and entered into the respective sections. For all other required inputs, the platform default values were used.

Add Data section on BtrLyf to input data	Parameters extracted from the BESS Report to over-ride default values
Overview	• Building Type • Gross Floor Area (m^2) • Building Certification
Operational Data	• Annual Energy Consumption (kWh)- derived from the latest Energy Use Intensity (EUI) (kWh/m^2/yr) data
Construction	• Percentage of Air-conditioned Floor Area (%)
Lighting	• Percentage Usage of LED (%): If >70% select LED
HVAC	• Type of Air-conditioning System • Centralized Air-conditioning Plant Efficiency (kW/RT)
Miscellaneous	None- Platform defaults were used

02

Generate Baseline Report

After adding all the inputs as above, the 'Generate Report' button is clicked to generate the instant baseline report for each building. The generated 'Baseline Energy Analysis Report' from the platform shows the Annual Energy Consumption and cost data along with the following building performance parameters:

- Energy Usage Index (EUI in KWh/sq.m/year))
- Envelope Thermal Transmittance Value (ETTV w/sq.m)
- Roof Thermal Transmittance Value (RTTV w/sq.m)
- Lighting power density (LPD w/sq.m)
- HVAC efficiency (COP or KW/TR)
- Equipment Load Density (w/sq.m)
- % of renewable energy

Whilst the EUI is used as the overall performance metric for validating annual energy consumption, the other performance metrics further validate the correctness of the digital twin model. If actual data on these metrics is available it can be used to improve the accuracy of the digital model even further. In this case study, no such data was available and hence the annual energy consumption was used as the main accuracy determining parameter.

03

Review Digital Twin Accuracy

As discussed above, the Annual Energy Consumption (AEC) is the only parameter used for determining the accuracy of the digital model in this study. The baseline report generated on the platform already shows the 'Deviation In Annual Energy Consumption - User specified (or actual) Vs. Platform Calculated (or simulated)'. This value is used as the Digital Twin Accuracy for the purpose of this study and its calculation is done as follows:

$$\text{Deviation (\%)} = \frac{[\text{ Actual AEC - Simulated AEC }]}{[\text{ Actual AEC }]} \times 100$$

Digital Twin Accuracy (%) = 100 - | Deviation (%) |

The full result of the validation exercise is presented in Annex-1 and a summary of the results in terms of different building types and the average digital twin accuracy achieved for each type is shown here.

Building type	Entries	Digital Twin Accuracy (%)
Office	47	95%
Hospitality	29	94%
Mixed Development	25	95%
Retail	19	93%
All buildings	120	94%

94 %

The validation results for the 120 buildings chosen for this study show that BtrLyf-EDGAR digital twin model has an average prediction accuracy of 94% across different types of buildings

CONCLUSION

A well designed, operated and maintained building promotes health, ensures profitability, and reduces carbon emissions. Green assessment plays a very important role in discovering performance improvement opportunities in a building. The current manual approach to green assessment however is time-consuming, expensive and often leads to inadequate analysis of the holistic performance. It also lacks thorough exploration of the best possible solutions in the market and their integration in the building towards achieving resource optimization and ambitious decarbonization targets.

The BtrLyf-EDGAR tool offers a way to perform a holistic yet very low-cost and remote instant digital assessment of buildings to identify energy and carbon reduction opportunities. By providing some basic building data, users can leverage on the platform AI to get a 'Baseline Energy Analysis' report at the click of a few buttons. The platform aggregates multiple sources of data to create useful ‘digital assets’ or ‘digital twins’ of buildings for performance assessment. The calculations done on the platform are based on well known international standards and local building codes wherever applicable.

A validation study was done for 120 buildings in Singapore to review the accuracy of prediction of annual energy consumption (viz. Digital Twin Accuracy) by the BtrLyf-EDGAR tool. This was done using data from the latest Building Energy Benchmarking Report from the Building Energy Submission System (BESS) of the Building & Construction Authority (BCA), Singapore. The relevant available building data was entered into the tool using the 'Add data' feature and an instant Baseline Energy Analysis Report was generated on the platform for each of the buildings. The difference between the actual Annual Energy Consumption (AEC) and platform calculated AEC was then derived. The study concluded that the BtrLyf-EDGAR tool is able to achieve an average accuracy of 94% across the different building types included in the study (viz. Office, Hospitality, Retail and Mixed development buildings).

With an accurate Digital Twin model developed for buildings on the BtrLyf platform, the energy and carbon reduction opportunities can then be simulated. This will help in quickly establishing the potential for any building to achieve 'Super Low Energy', 'Zero Energy', 'Carbon Neutral', or other similar performance targets. It will also help in qualifying and quantifying the performance impacts of any green building solutions to be adopted in the building in future retrofits or refurbishments projects. The digital twin open access allows for collaboration, alignment of goals and exploration of wide range of solutions. Thus, BtrLyf-EDGAR is a handy digital tool providing fairly accurate, instant and very low-cost green assessments. We believe this will empower the building industry to accelerate its decarbonization efforts and create a 'better life' for all of us.

ANNEX-1 FULL RESULTS TABLE: OFFICE BUILDINGS

OFFICE BUILDINGS										
Building Type	Gross Floor Area (m2)	Air-conditioned Area (%)	Air-conditioning System type	Air-conditioning Plant Efficiency COP	Air-conditioning Plant Efficiency (kW/RT)	LED usage (%)	EUI (KWh/sq.m/year)	Energy Consumption (KWh/year)	BTRLYF estimate (KWh/year)	Accuracy %
Office 1	95,992	89%	District Cooling Plant	6.0	0.59	90%	201	19,333,275	21,256,693	90%
Office 2	20,180	90%	Water Cooled Chiller	6.0	0.59	10%	114	2,303,404	2,507,170	91%
Office 3	4,164	96%	Unitary systems	3.1	1.13	0%	148	615,213	667,087	92%
Office 4	40,312	90%	Water Cooled Chiller	5.1	0.69	0%	121	4,885,268	5,293,017	92%
Office 5	58,450	91%	Water Cooled Chiller	5.2	0.68	20%	466	27,250,223	25,022,289	92%
Office 6	33,736	80%	Water Cooled Chiller	5.1	0.69	0%	158	5,324,808	5,709,874	93%
Office 7	27,069	61%	Water Cooled Chiller	6.5	0.54	95%	132	3,564,849	3,320,325	93%
Office 8	27,699	100%	Water Cooled Chiller	5.4	0.65	35%	137	3,806,334	4,058,121	93%
Office 9	102,356	80%	Water Cooled Chiller	6.0	0.59	4%	183	18,730,339	17,635,740	94%
Office 10	18,451	73%	Water Cooled Chiller	5.5	0.64	30%	159	2,937,680	3,128,330	94%
Office 11	25,200	93%	Water Cooled Chiller	5.4	0.65	0%	261	6,569,555	6,961,627	94%
Office 12	22,540	95%	Water Cooled Chiller	5.3	0.66	90%	211	4,762,643	4,479,334	94%
Office 13	17,068	90%	Unitary systems	3.1	1.13	25%	182	3,106,496	3,284,351	94%
Office 14	95,696	84%	Water Cooled Chiller	5.9	0.60	41%	142	13,578,012	14,350,671	94%
Office 15	15,590	83%	Water Cooled Chiller	5.1	0.69	0%	114	1,775,193	1,676,768	94%
Office 16	28,533	91%	Water Cooled Chiller	6.4	0.55	80%	160	4,571,574	4,322,179	95%
Office 17	15,153	82%	Water Cooled Chiller	5.1	0.69	0%	151	2,289,377	2,412,055	95%
Office 18	25,044	97%	Water Cooled Chiller	6.3	0.56	10%	139	3,478,570	3,663,428	95%
Office 19	28,378	98%	Water Cooled Chiller	4.1	1.17	75%	118	3,341,682	3,516,924	95%
Office 20	357	90%	Unitary systems	3.1	1.13	95%	212	75,693	79,299	95%
Office 21	28,835	100%	Water Cooled Chiller	5.1	0.69	5%	161	4,647,669	4,858,986	95%
Office 22	24,895	80%	Water Cooled Chiller	5.9	0.60	100%	124	3,084,006	2,947,560	96%
Office 23	37,281	90%	Unitary systems	4.0	0.89	0%	252	9,412,496	9,007,090	96%
Office 24	11,608	100%	Water Cooled Chiller	5.1	0.69	80%	161	1,873,975	1,797,267	96%
Office 25	116,055	95%	Water Cooled Chiller	4.1	0.86	65%	181	20,959,379	20,078,630	96%
Office 26	4,225	77%	Water Cooled Chiller	5.2	0.67	0%	212	893,993	925,659	96%
Office 27	16,122	71%	Water Cooled Chiller	4.0	0.88	30%	138	2,226,086	2,161,180	97%
Office 28	16,026	90%	Unitary systems	3.1	1.13	70%	323	5,182,903	5,038,094	97%
Office 29	16,450	99%	Water Cooled Chiller	5.1	0.69	0%	163	2,677,629	2,746,328	97%
Office 30	41,363	90%	Water Cooled Chiller	2.8	1.27	0%	231	9,569,462	9,814,613	97%
Office 31	10,852	90%	Water Cooled Chiller	5.7	0.62	0	205	2,229,550	2,286,329	97%
Office 32	13,539	96%	Water Cooled Chiller	5.1	0.69	1	201	2,716,674	2,781,675	98%
Office 33	5,800	90%	Unitary systems	3.1	1	1	87	504,283	504,844	99%
Office 34	10,418	100%	Water Cooled Chiller	4.4	0.80	1	141	1,468,435	1,469,467	99%
Office 35	4,225	77%	Water Cooled Chiller	5.2	0.67	0	212	893,993	925,659	96%

ANNEX-1 FULL RESULTS TABLE: OFFICE BUILDINGS CONTD.

Office 36	17,068	90%	Unitary systems	3.1	1	0	182	3,106,496	3,284,351	94%
Office 37	10,403	90%	Air Cooled Chilled Water Plant	4.1	1	0	188	1,952,095	2,148,719	90%
Office 38	19,720	90%	Water Cooled Chiller	5.1	0.69	1	308	6,069,934	6,088,161	99%
Office 39	25,200	93%	Water Cooled Chiller	5.4	0.65	0	261	6,569,555	6,961,627	94%
Office 40	22,540	95%	Water Cooled Chiller	5.3	0.66	1	211	4,762,643	4,479,334	94%
Office 41	10,938	90%	Air Cooled Chilled Water Plant	4.1	1	0	398	4,352,067	4,352,121	99%
Office 42	23,225	90%	Air Cooled Chilled Water Plant	4.3	1	1	151	3,516,687	3,516,730	99%
Office 43	16,222	82%	Water Cooled Chiller	5.2	0.68	1	113	1,832,909	1,832,924	99%
Office 44	38,774	89%	District Cooling Plant	NA	NA	1	322	12,487,842	12,487,942	99%
Office 45	337	100%	Unitary systems	3.1	1	0	163	54,971	54,971	99%
Office 46	6,359	90%	Unitary systems	3.1	1	0	337	2,141,173	2,141,190	99%
Office 47	10,880	90%	Water Cooled Chiller	5.1	0.69	1	616	6,703,775	6,703,821	99%

ANNEX-1 FULL RESULTS TABLE: HOSPITALITY BUILDINGS

HOSPITALITY BUILDINGS										
Building Type	**Gross Floor Area (m2)**	**Air-conditioned Area (%)**	**Air-conditioning System type**	**Air-conditioning Plant Efficiency COP**	**Air-conditioning Plant Efficiency (kW/RT)**	**LED usage (%)**	**EUI (KWh/sq.m/year)**	**Energy Consumption (KWh/year)**	**BTRLYF estimate (KWh/year)**	**Accuracy %**
Hospitality 1	40,379	90%	Water Cooled Chiller	4.8	0.73	0%	276	11,157,854	11,057,676	99%
Hospitality	28,548	85%	Water Cooled Chiller	6.5	0.54	95%	240	6,839,149	6,533,998	96%
Hospitality	12,565	92%	Water Cooled Chiller	2.8	1.24	90%	230	2,894,261	3,044,088	95%
Hospitality	127,860	100%	Water Cooled Chiller	4.4	0.80	100%	217	27,700,579	25,572,000	92%
Hospitality	23,554	90%	Water Cooled Chiller	4.1	0.86	0%	184	4,340,095	4,710,800	91%
Hospitality	16,872	100%	Water Cooled Chiller	4.1	0.86	60%	254	4,290,869	4,883,140	86%
Hospitality	592	81%	Water Cooled Packaged Unit	4.1	0.86	0%	92	54,318	61,133	87%
Hospitality	2,845	87%	Air Cooled Chilled Water Plant	4.1	0.86	0%	105	297,750	327,140	90%
Hospitality	1,126	75%	Unitary systems	3.1	1.13	100%	290	326,419	357,789	90%
Hospitality	462	100%	Unitary systems	3.1	1.13	20%	112	51,733	56,632	91%
Hospitality	2,022	93%	Unitary systems	3.1	1.13	100%	261	528,176	574,849	91%
Hospitality	1,998	98%	Unitary systems	3.1	1.13	0%	410	818,473	750,555	92%
Hospitality	793	90%	Unitary systems	3.1	1.13	70%	190	150,715	162,364	92%
Hospitality	975	91%	Unitary systems	3.1	1.13	80%	548	534,198	571,258	93%
Hospitality	8,922	100%	Water Cooled Chiller	5.1	0.69	70%	326	2,910,369	2,710,920	93%
Hospitality	493	76%	Unitary systems	3.1	1.13	100%	178	87,928	93,740	93%
Hospitality	1,440	100%	Unitary systems	3.1	1.13	100%	223	320,845	341,328	94%
Hospitality	2,531	90%	Air Cooled Chilled Water Plant	4.1	0.86	100%	285	720,113	674,564	94%
Hospitality	2,631	70%	Unitary systems	3.1	1.13	100%	223	586,458	620,737	94%
Hospitality	11,050	100%	Water Cooled Chiller	5.1	0.69	85%	314	3,468,158	3,277,612	95%
Hospitality	7,262	93%	Unitary systems	3.1	1.13	75%	394	2,861,020	3,015,291	95%
Hospitality	2,324	86%	Unitary systems	3.1	1.13	70%	394	914,839	867,169	95%
Hospitality	1,906	84%	Unitary systems	3.1	1.13	20%	217	414,310	395,057	95%
Hospitality	1,379	98%	Unitary systems	3.1	1.13	13%	180	247,742	258,285	96%
Hospitality	2,185	90%	Unitary systems	3.1	1.13	100%	373	813,977	843,833	96%
Hospitality	2,102	100%	Unitary systems	3.1	1.13	95%	318	668,677	692,903	96%
Hospitality	2,162	100%	Unitary systems	3.1	1.13	80%	253	546,850	530,040	97%
Hospitality	270	100%	Unitary systems	3.1	1.13	0%	251	67,852	69,772	97%
Hospitality	3,499	70%	Air Cooled Chilled Water Plant	4.1	0.86	0%	215	753,522	742,110	98%

ANNEX-1 FULL RESULTS TABLE: MIXED DEVELOPMENT BUILDINGS

MIXED DEVELOPMENT BUILDINGS										
Building Type	**Gross Floor Area (m2)**	**Air-conditioned Area (%)**	**Air-conditioning System type**	**Air-conditioning Plant Efficiency COP**	**Air-conditioning Plant Efficiency (kW/RT)**	**LED usage (%)**	**EUI (KWh/sq.m/year)**	**Energy Consumption (KWh/year)**	**BTRLYF estimate (KWh/year)**	**Accuracy %**
Mixed Development 1	42,809	88%	Water Cooled Chiller	5.8	0.61	35%	173	7,414,395	7,333,490	99%
Mixed Development 2	65,933	98%	Water Cooled Chiller	4.1	0.61	3%	277	18,252,023	17,601,544	96%
Mixed Development 3	7,000	90%	Unitary systems	3.1	1.13	0%	77	537,653	591,386	90%
Mixed Development 4	3,309	90%	Unitary systems	3.1	1.13	25%	84	279,090	302,579	92%
Mixed Development 5	16,902	87%	Unitary systems	3.1	1.13	80%	360	6,091,755	5,692,357	93%
Mixed Development 6	6,533	90%	Unitary systems	3.1	1.13	0%	51	335,014	356,898	93%
Mixed Development 7	619	90%	Unitary systems	3.1	1.13	100%	160	99,258	105,541	94%
Mixed Development 8	18,893	90%	Unitary systems	3.1	1.13	0%	173	3,263,599	3,108,535	95%
Mixed Development 9	12,595	90%	Air Cooled Chilled Water Plant	4.5	0.78	65%	392	4,932,029	4,705,106	95%
Mixed Development 10	22,482	90%	Water Cooled Chiller	6.1	0.58	70%	285	6,398,294	6,662,868	96%
Mixed Development 11	8,269	90%	Unitary systems	3.1	1.13	0%	216	1,785,212	1,712,345	96%
Mixed Development 12	5,091	90%	Unitary systems	3.1	1.13	75%	58	295,170	283,271	96%
Mixed Development 13	2,000	93%	Water Cooled Packaged Unit	0.0	0.61	30%	94	188,051	181,003	96%
Mixed Development 14	12,098	90%	Water Cooled Chiller	5.1	0.69	50%	111	1,344,995	1,296,674	96%
Mixed Development 15	4,250	90%	Unitary systems	4.1	0.85	50%	116	492,131	475,924	97%
Mixed Development 16	9,764	90%	Unitary systems	3.1	1.13	25%	477	4,661,952	4,549,728	98%
Mixed Development 17	10,139	99%	Unitary systems	3.1	1.13	80%	82	828,115	847,270	98%
Mixed Development 18	5,340	90%	Unitary systems	3.1	1.13	70%	461	2,464,045	2,480,195	99%
Mixed Development 19	1,945	90%	Unitary systems	3.1	1.13	0%	14	27,576	27,024	98%
Mixed Development 20	7,895	90%	Water Cooled Chiller	2.3	1.52	91%	473	3,735,182	3,563,452	95%
Mixed Development 21	3,065	90%	Unitary systems	3.1	1.13	0%	73	222,265	228,403	97%
Mixed Development 22	19,209	74%	Water Cooled Chiller	6.0	0.59	100%	239	4,589,780	4,160,738	91%
Mixed Development 23	15,123	90%	District Cooling Plant	N/A	N/A	90%	82	1,236,744	1,351,717	91%
Mixed Development 24	29,752	90%	Unitary systems	3.1	1.13	0%	101	3,013,771	3,283,642	91%
Mixed Development 25	14,595	90%	Unitary systems	3.1	1.13	95%	224	3,275,706	3,467,730	94%

ANNEX-1 FULL RESULTS TABLE: RETAIL BUILDINGS

RETAIL BUILDINGS										
Building Type	Gross Floor Area (m2)	Air-conditioned Area (%)	Air-conditioning System type	Air-conditioning Plant Efficiency COP	Air-conditioning Plant Efficiency (kW/RT)	LED usage (%)	EUI (KWh/sq.m/year)	Energy Consumption (KWh/year)	BTRLYF estimate (KWh/year)	Accuracy %
Retail 1	28,938	100%	Water Cooled Chiller	5.7	0.62	31%	396	11,459,884	11,463,610	99%
Retail 2	42,262	43%	Water Cooled Chiller	6.1	0.58	17%	124	5,248,438	5,463,197	96%
Retail 3	33,782	71%	Water Cooled Chiller	4.1	0.86	100%	170	5,737,631	5,985,283	96%
Retail 4	65,640	62%	Water Cooled Chiller	5.4	0.65	77%	365	23,981,250	22,711,069	95%
Retail 5	16,747	87%	Water Cooled Chiller	4.1	0.86	38%	256	4,291,560	4,729,590	90%
Retail 6	22,331	87%	Water Cooled Chiller	6.8	0.52	95%	218	4,858,531	4,278,366	88%
Retail 7	25,772	93%	Water Cooled Chiller	5.2	0.68	80%	366	9,424,183	8,257,008	88%
Retail 8	11,820	90%	Unitary systems	3.1	1.13	3%	404	4,769,791	4,481,731	94%
Retail 9	9,899	90%	Unitary systems	3.1	1.13	0%	448	4,437,080	4,126,218	93%
Retail 10	25,642	71%	Water Cooled Chiller	5.1	0.69	100%	422	10,809,272	11,235,857	96%
Retail 11	24,182	87%	Water Cooled Chiller	5.4	0.65	75%	483	11,690,279	10,801,204	92%
Retail 12	4,059	89%	Unitary systems	3.1	1.13	2%	266	1,081,399	1,181,399	91%
Retail 13	1,323	99%	Unitary systems	3.1	1.13	50%	400	529,559	519,557	98%
Retail 14	20,713	85%	Water Cooled Chiller	5.1	0.69	50%	419	8,672,179	8,572,119	99%
Retail 15	10,000	90%	Unitary systems	3.1	1.13	0%	233	2,331,819	2,408,943	97%
Retail 16	12,412	90%	Water Cooled Chiller	5.9	0.60	20%	294	3,644,203	3,544,163	97%
Retail 17	5,369	99%	Unitary systems	3.1	1.13	0%	380	2,039,439	1,939,415	95%
Retail 18	1,505	70%	Unitary systems	3.1	1.13	90%	189	284,737	274,731	96%

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Qi Square Pte Ltd is a Singapore based company, focusing on the digitalization of sustainable built environment. As a spin-off company of the Nanyang Technological University (NTU), Singapore, it has a strong technological background and its founders have more than two decades of experience each in the domains of green buildings, energy modelling and simulation, performance assessment/auditing and project financing.

The company recently (on 1st September 2021) officially launched its ‘BtrLyf- Digital Built Environment Ecosystem' platform in the backdrop of the need for urgent global climate action and the Singapore Green Plan 2030, which calls for buildings in Singapore to achieve aggressive performance improvement targets and green certification by 2030. BtrLyf is available on an open cloud-based platform with applications specifically designed to enhance the workflow, and significantly lower the costs and time required to do activities such as energy/carbon analysis, technology fit analysis, green certification assessment and financial due diligence for green projects. These applications are provided to the industry in a Software-as-a-Service (SaaS) model at very affordable monthly plans.

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