Digitising Energy Efficiency through Virtual Audits

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Founder & CEO
Qi Square Pte Ltd

Our Mission

Energy intelligence to simplify decision making in the built environment

Building Owner/Manager

Wants Energy Efficient Buildings

Consultant/Expert

Provides advice

Tech Provider

Provides tech

Financier

Provides funding

We help them with faster access to data and technology know-how

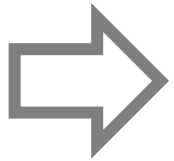
Virtual Audits

Virtual Audits Live

Btr Lyf Digital Built Environment Ecosystem

Market problem

How are Energy Audits done today?



Manual

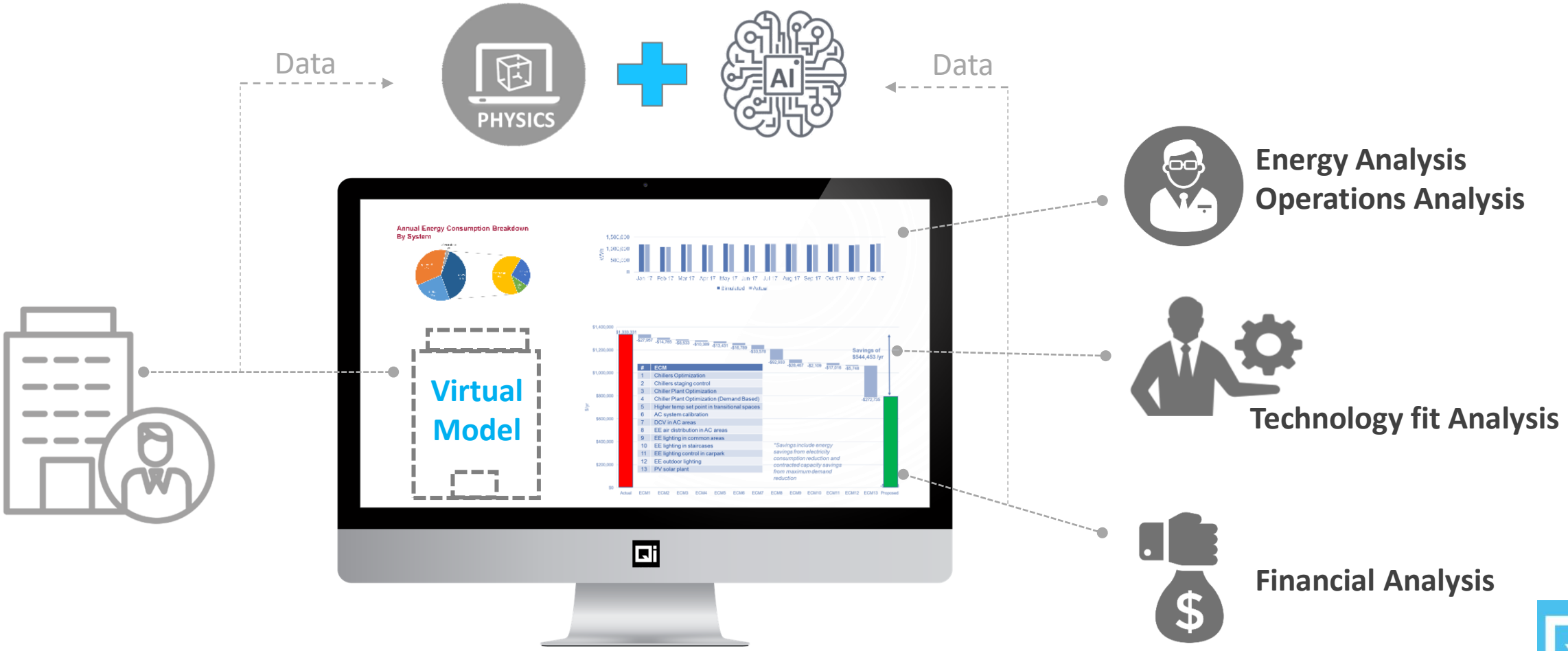
Expensive

Not accessible

Limited

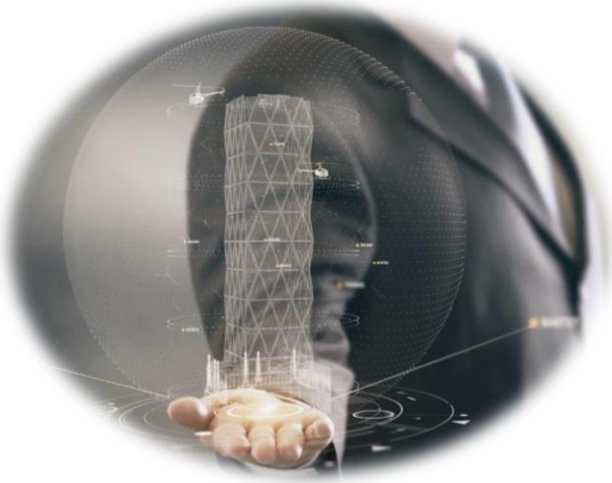
Our Solution: Virtual Audits

AI- powered Remote Energy Assessment Tool



Our Solution: Virtual Audits

Digital Twin



Augmented Intelligence

- Manual Performance Assessment
- Heavy Reliance on Expertise
- Trial & Error Approach
- Limited Stakeholder Engagement

A performance assessment tool to uncover energy efficiency improvements in buildings remotely

Virtual Audits: Value Differentiators

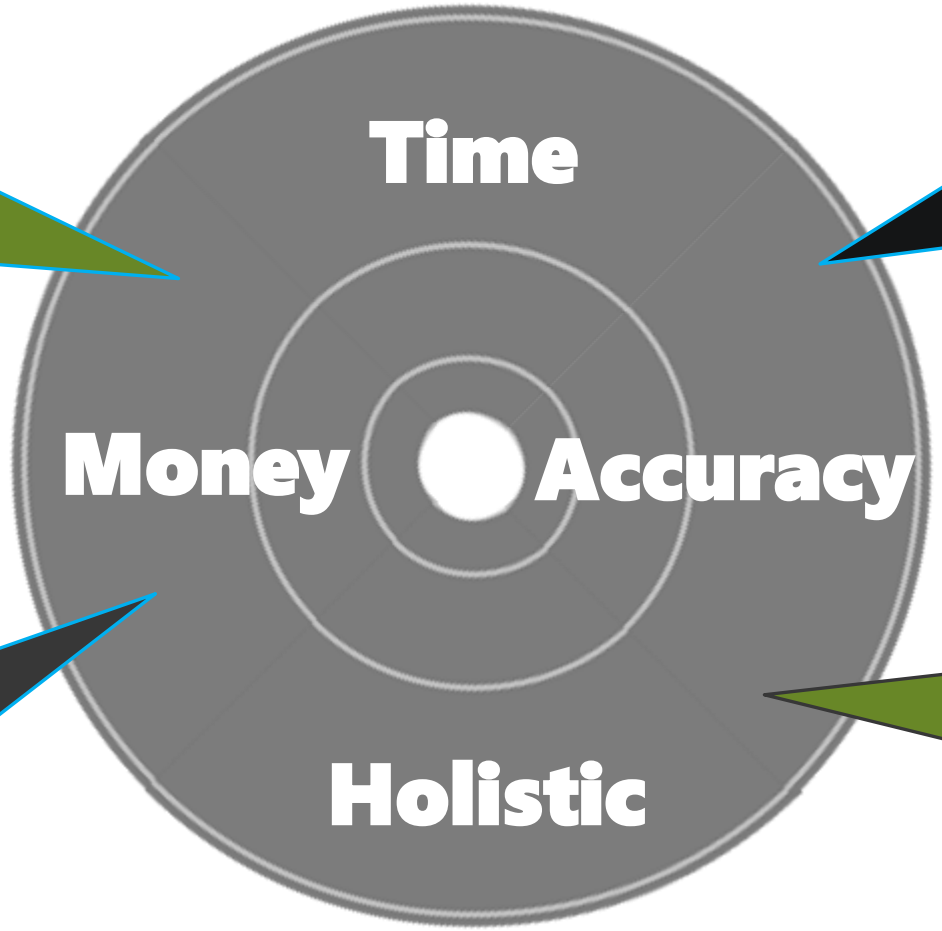
At scale,
<u>across portfolio</u>
in no time

2-5 x faster
than on-site audit

<u>Accurate Results</u>

ASHRAE Level2 equivalent
IPMVP compliant

(Data transparency)



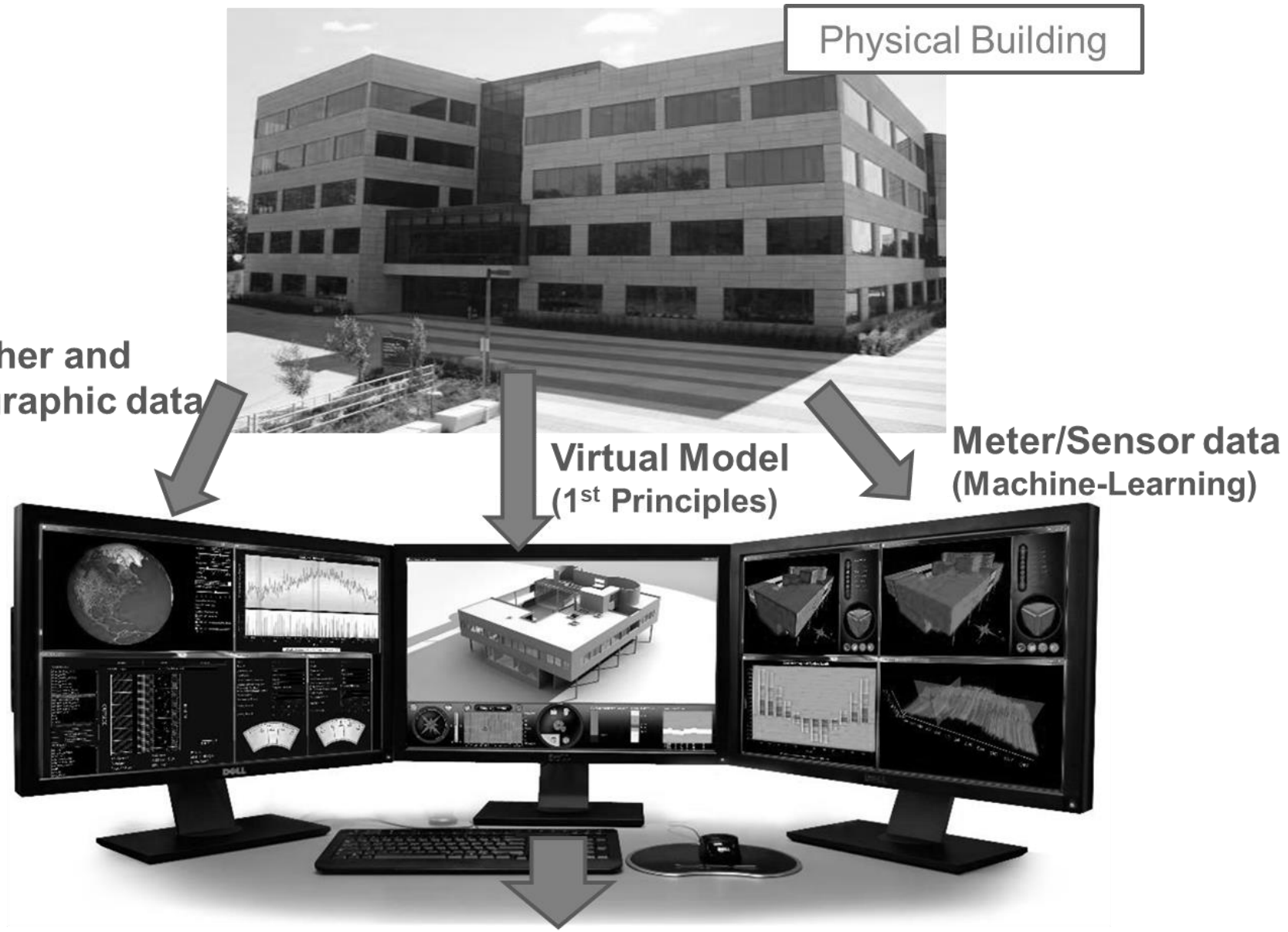
<u>Cost-effective</u>

5-10 x cheaper
than on-site audit
(no-contact, no travel)

<u>Whole Building</u>

System-level interaction
of Energy Conservation
Measures for planning

Virtual Audits: Methodology



Virtual Audits: Part-I

Data Collection

Step-1

- 1 year of energy consumption data
- Building details
- Optional short survey
- Optional sensors placement

Digital Twin setup

Steps-2 &3

- Add weather, GIS, occupancy, etc. data
- Create energy model
- Model calibration
- Data analysis

Energy Conservation Measures (ECMs)

Step-4

- Simulate ECMs
- Assess overall impact
- Retrocomissioning
- Retrofitting
- Calculate Financials (Payback, ROI)
- Prioritisation support

Implement ECMs

Constitutes an ASHRAE Level2 Audit

* ASHRAE: American Society of Heating, Refrigeration Engineers

Virtual Audits: Part-II (post implementation)

Implement ECMs

Verification of Savings

Step-5

- Calibrated simulation with implemented ECMs
- Data Analysis

Complies with IPMVP Option-D verification of energy savings

* IPMVP: International Performance Measurement and Verification Protocol

Virtual Audits: Part-III. Live Analytics

http://live.qi-square.com

Real-time data analytics tool focused on energy performance improvement

Move from Excel sheets to cloud convenience

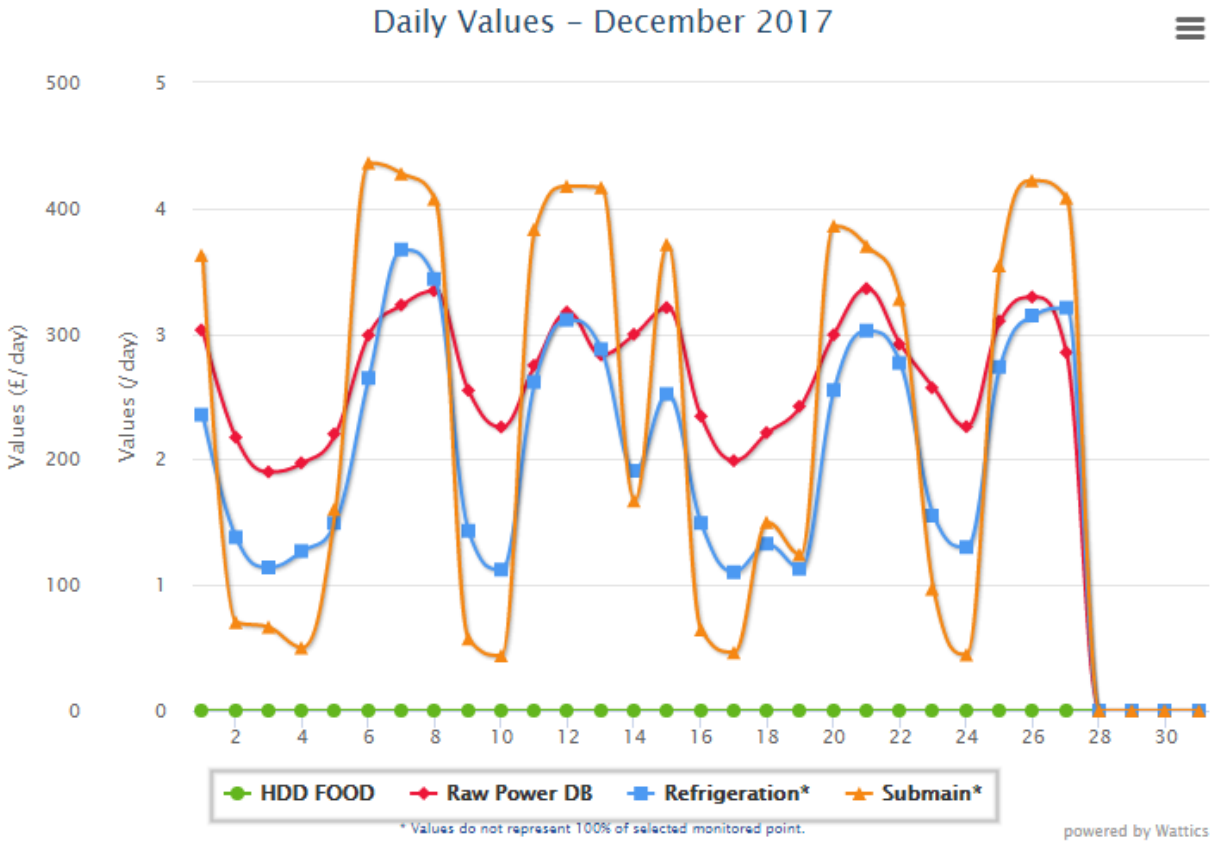
Custom reports and analysis on-the-go

Virtual Audits: Live Analytics

http://live.qi-square.com

Powerful tool for analysis:

1. Stack, spline, column, pie charts
2. Daily, monthly, weekly, yearly, period views
3. Compare each and every parameter
4. Compare multiple sites within a property/building/organization
5. Measure in values, measure in money
6. Notify unexpected energy patterns after 4 weeks of data gathering (using ML based data banding)



Virtual Audits: Live Analytics

Find energy saving opportunities on the go..

1. Identify patterns on activity maps
2. Analyse alerts identifying unusual activity
3. Devise saving strategies based on breakdown graphs
4. Recommend necessary changes for decrease energy/cost savings

Customers- 1 Mil. Square Meters Assessed Globally

20-50%

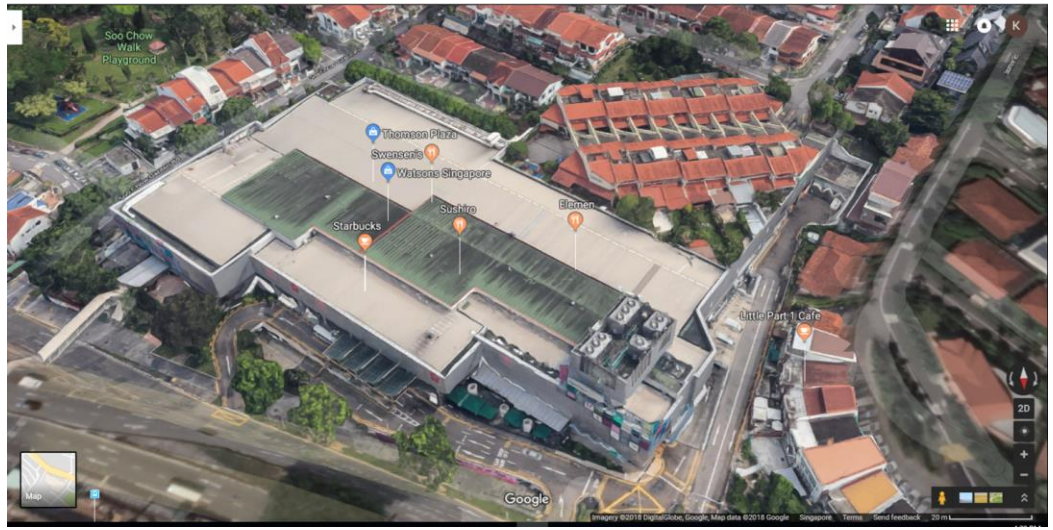
energy savings

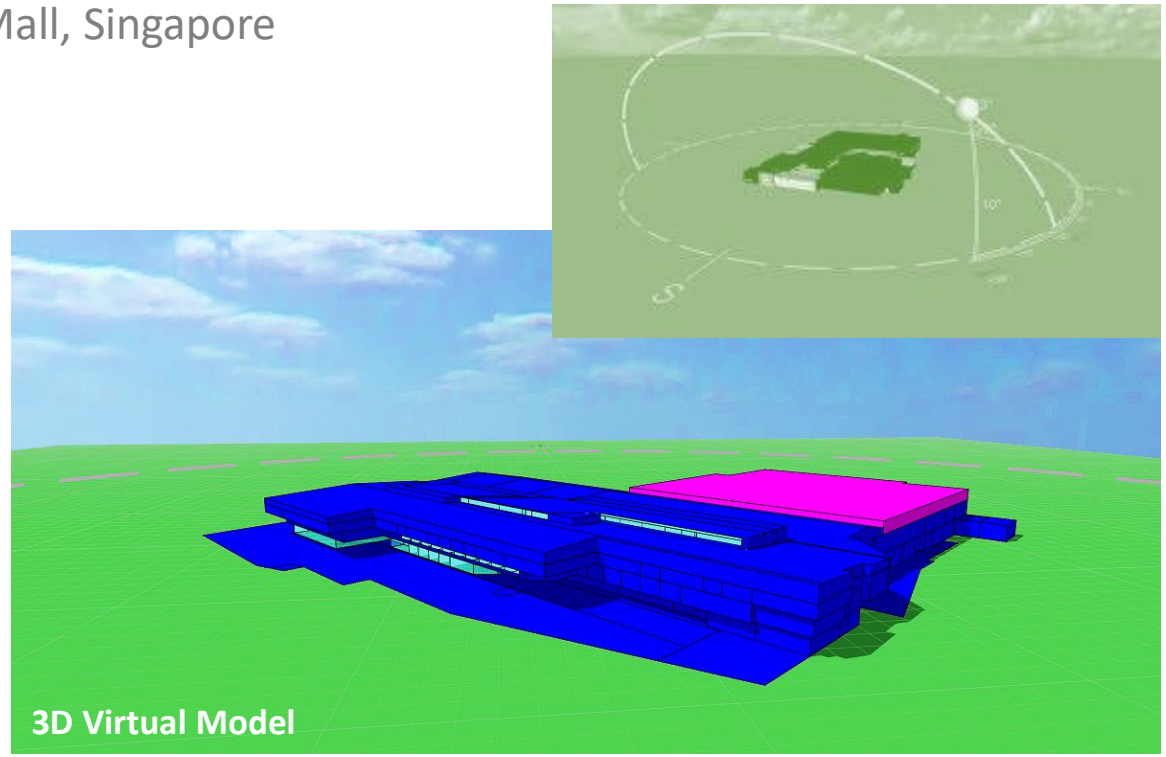
Singapore

International

Case Study: Virtual Audits

Step-1: Digital Twin Creation: Suburban Shopping Mall, Singapore



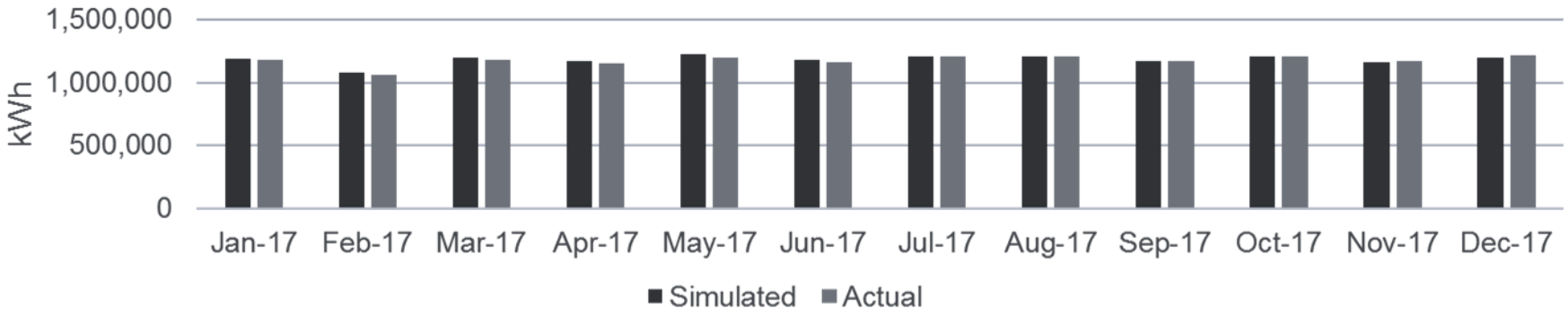


- Building data
  - Overall: address, GFA, function
  - Architectural, Structural: CAD drawings, BIM
  - Mechanical & Electrical: layouts, equipment specs
  - Operational data: schedules, profiles
- Energy Consumption data

- Multiphysics Dynamic Simulation
- Integrated with Weather Data
- Building data integrated

Case Study: Virtual Audits

Step-2: Digital Twin Calibration



Calibration Metric/Errors	Achieved	Required- ASHRAE	Required- IPMVP
Normalised Mean Bias Error (**MBE)- Overall Monthly**	**0.73%**	± 5%	± 20%
Coefficient of Variation of the Root Mean Square Error (**CVRMSE)- Overall Monthly**	**1.38%**	15	--
NMBE- Overall Hourly	**0.01%**	± 10%	± 5%
CVRMSE- Overall Hourly	**12.01%**	30%	20%
NMBE- Cooling Energy Monthly	**1.33%**		
CVRMSE- Cooling Energy Monthly	**2.56%**		

Calibration to well-known industry standards

Case Study: Virtual Audits

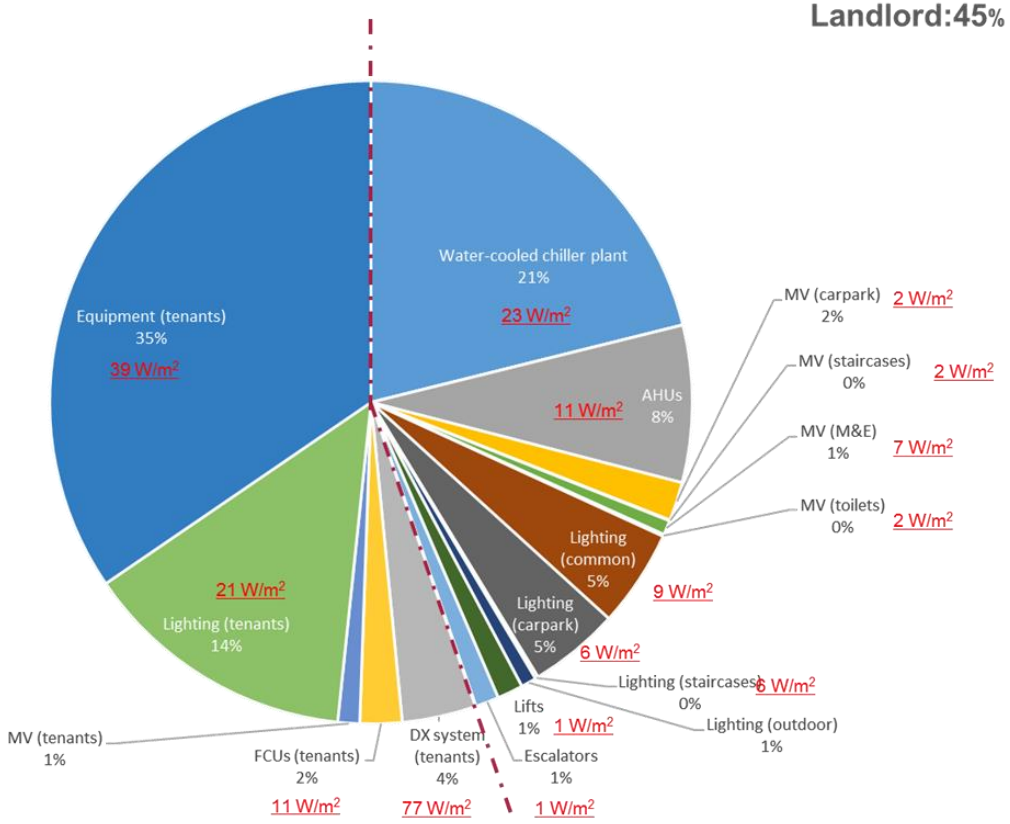
Step-3: Energy Breakdown Analysis

Tenants: 55%

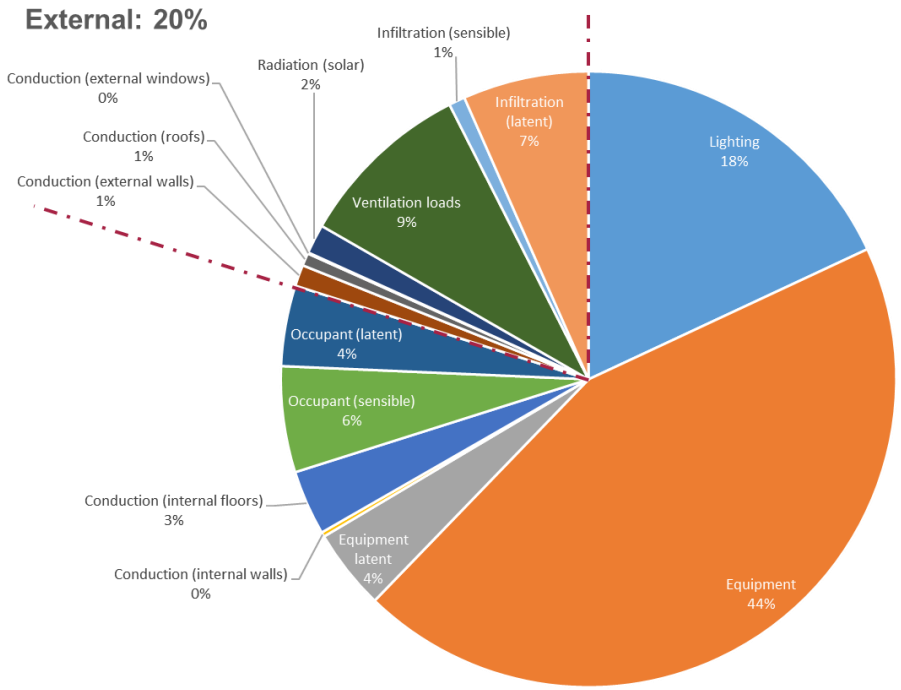
Landlord:45%

Notes:

1. AHUs serving common and tenants areas are powered by landlord's distribution boards



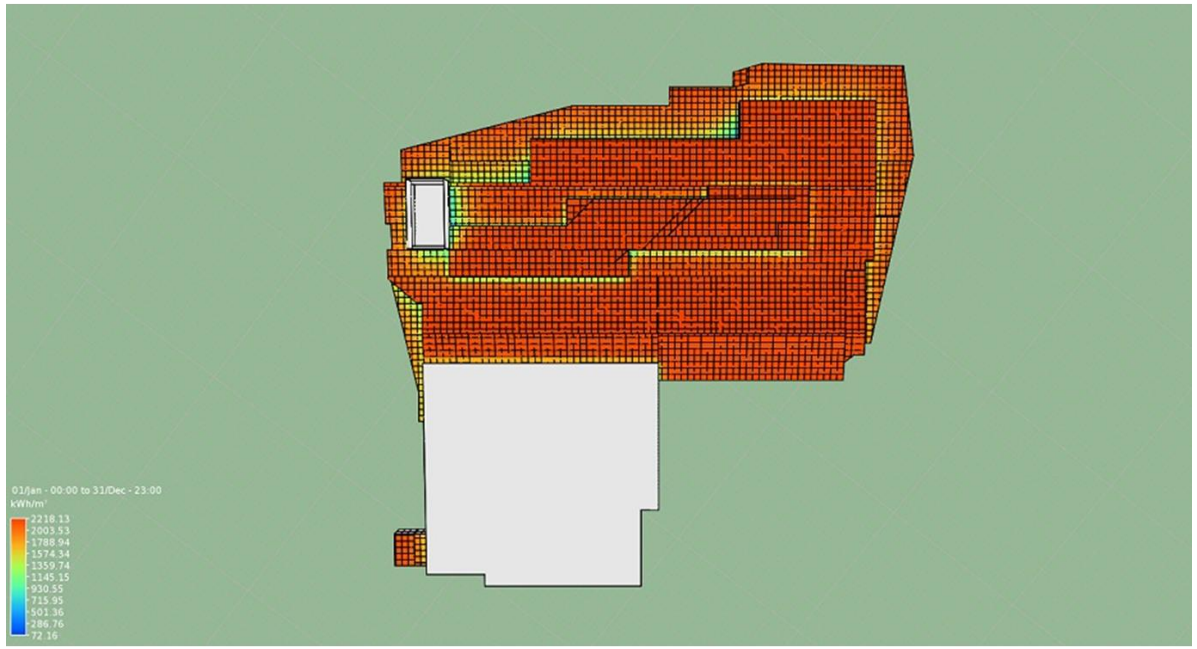
Annual Cooling Load Breakdown



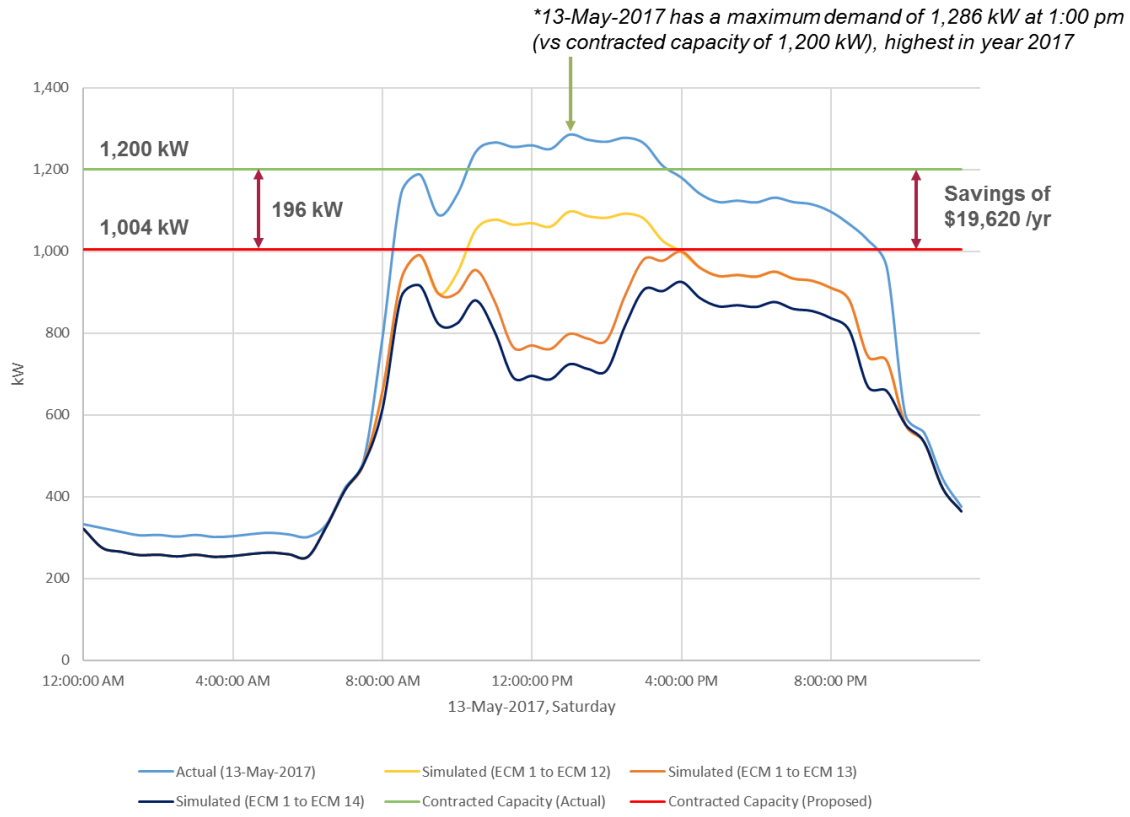
Case Study: Virtual Audits

Step-3: Energy Demand & Renewables Integration Analysis

- Irradiance Image simulated with shading analysis

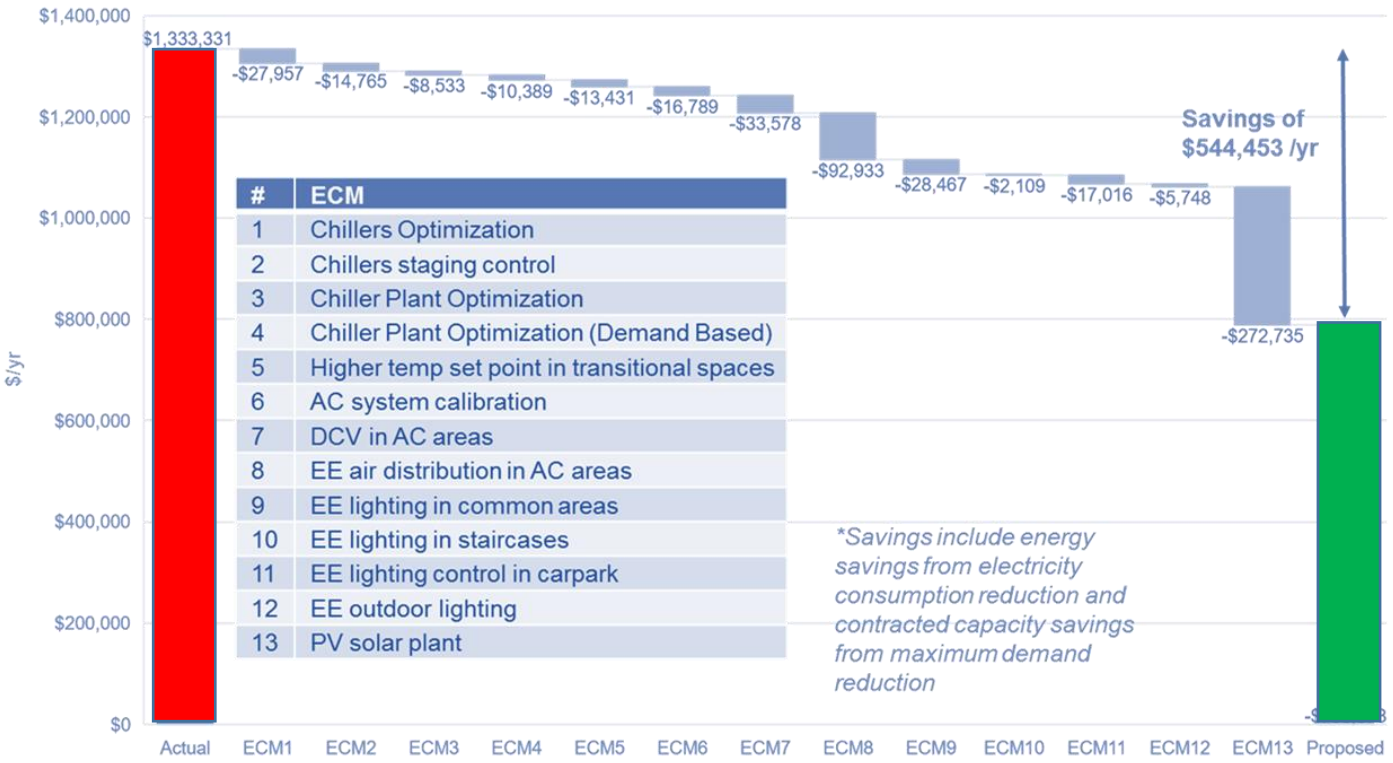


No shading from residential building nearby in the early morning and late afternoon!



Case Study: Virtual Audits

Step-4: Energy Conservation Measures (ECM) Scenarios Simulation/Quantification



#	ECM
1	Chillers Optimization
2	Chillers staging control
3	Chiller Plant Optimization
4	Chiller Plant Optimization (Demand Based)
5	Higher temp set point in transitional spaces
6	AC system calibration
7	DCV in AC areas
8	EE air distribution in AC areas
9	EE lighting in common areas
10	EE lighting in staircases
11	EE lighting control in carpark
12	EE outdoor lighting
13	PV solar plant

Savings %	Capex	Payback
10%	$ 0.7 mil.	4.2 yrs
20%	$ 2 mil.	3.8 yrs
30%	$ 3.3 mil.	4.5 yrs
40%	$ 5.3 mil.	5.7 yrs
50%	$ 8.2 mil.	6.7 yrs

Energy Conservation Measures are a mix of

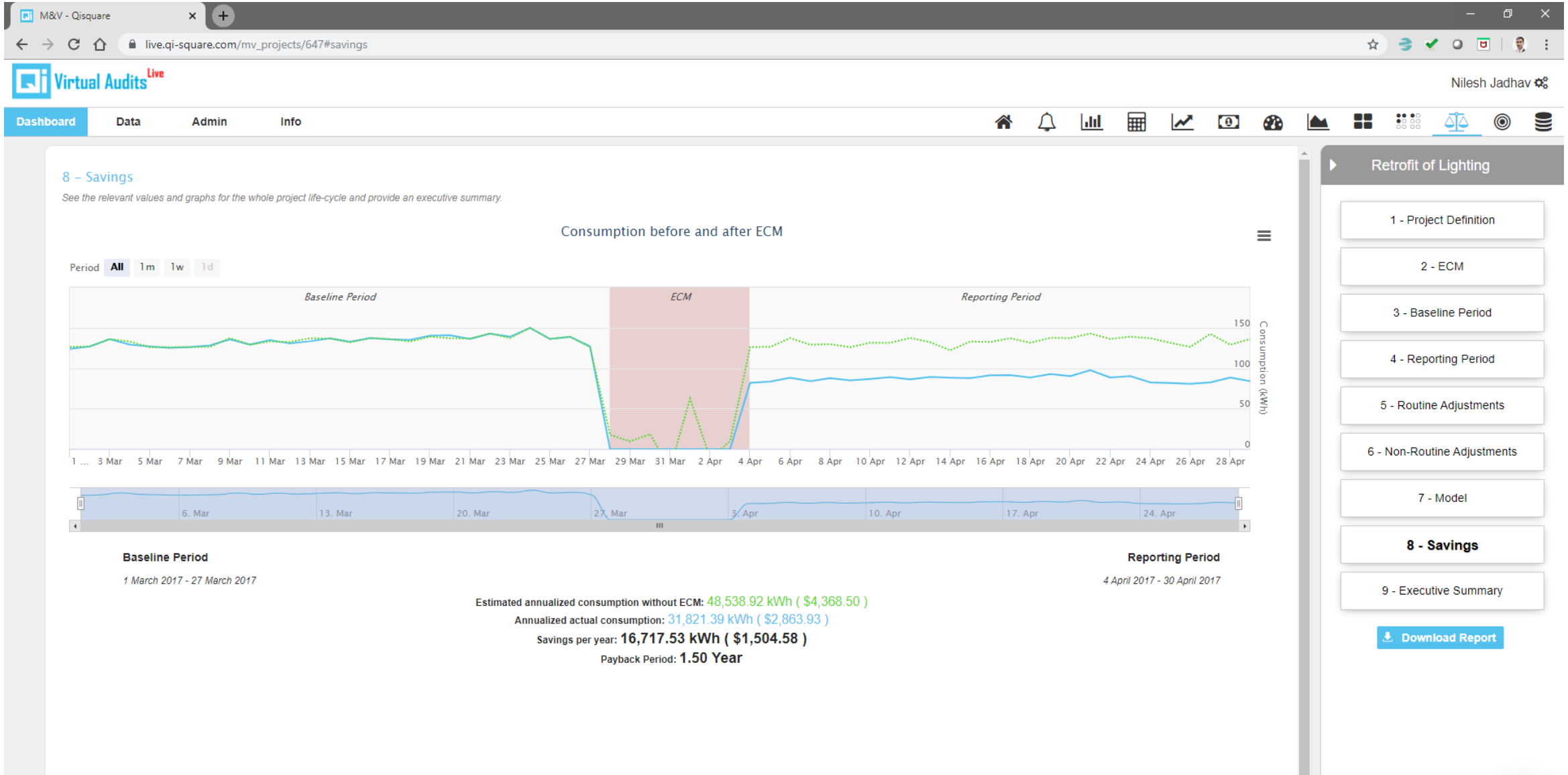
a) Retrocomissioning: operational changes

b) Retrofits: involve capex

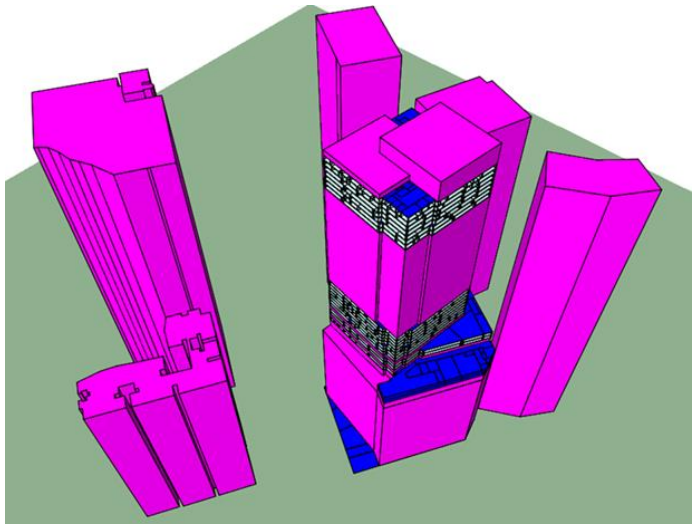
c) Combination of ECMs can be simulated, e.g. Solar PV effect on heat reduction

Case Study: Virtual Audits[Live] Verification

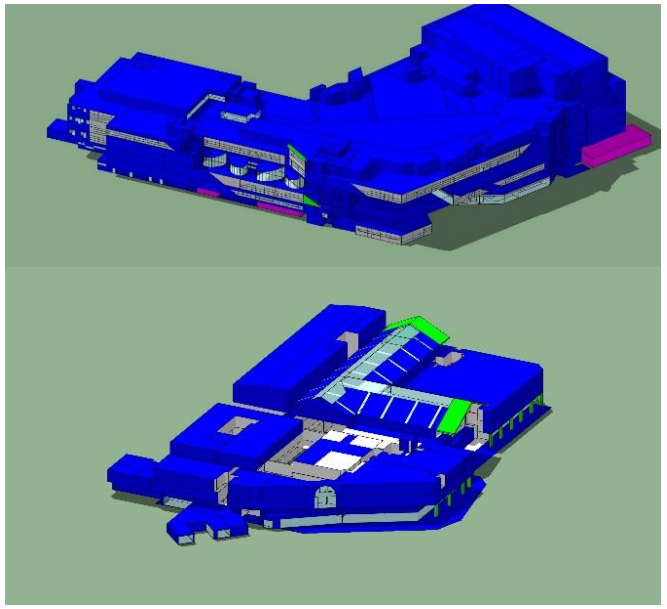
Step-5: Measurement & Verification using actual live data from buildings



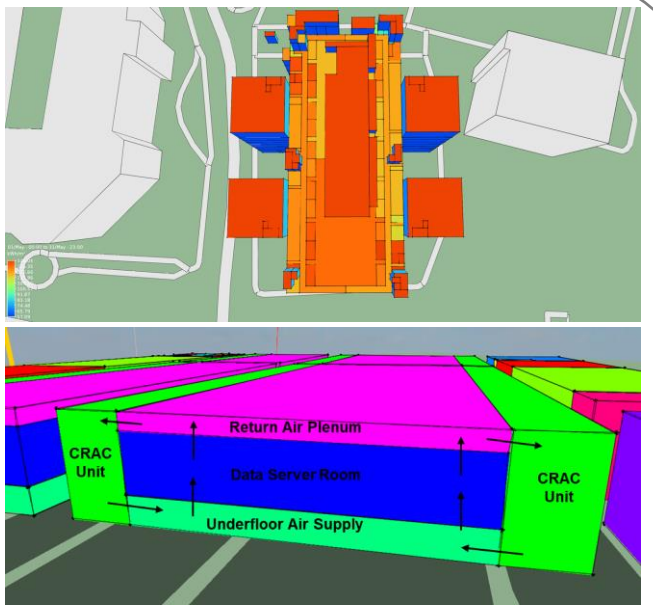
Summary: Singapore Case Studies



Client: **Large Private Bank**
No. of Buildings: **15**
Building Type: **Mixed-use**
Location: **Singapore**
Assessed GFA: **111,000 Sq.m.**
Savings Potential: **28%; $1.2 mil./yr**

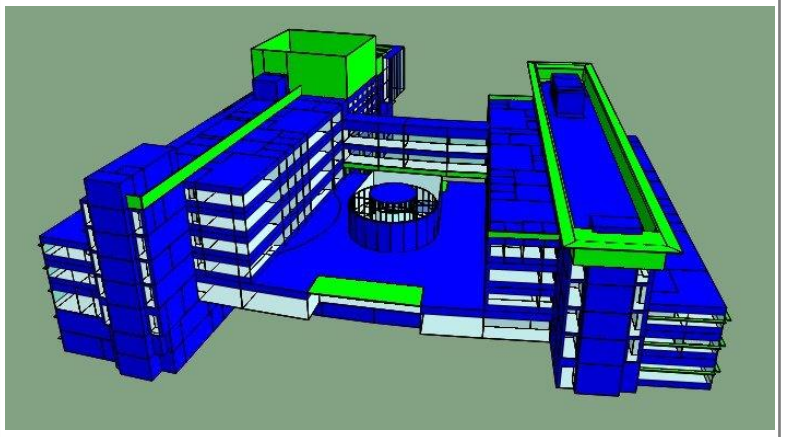


Client: **Shopping Mall Operator**
No. of Buildings: **6**
Building Type: **Retail**
Location: **Singapore**
Assessed GFA: **310,000 Sq.m.**
Savings Potential: **32%; $4.7 mil./yr**

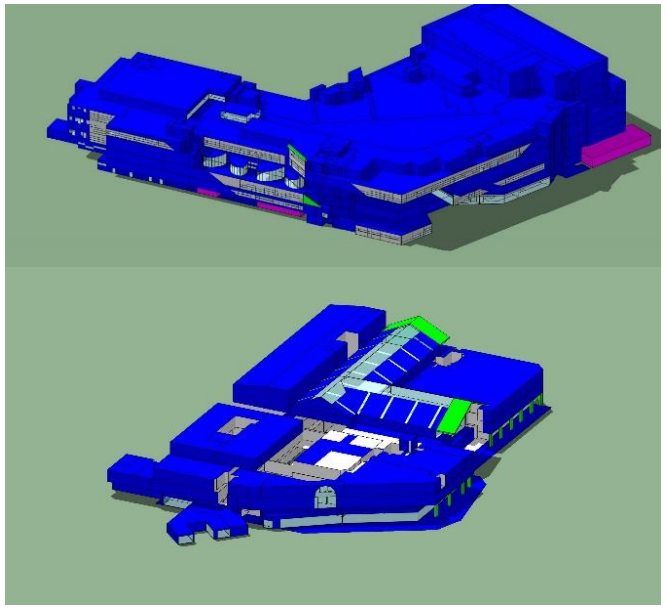


Client: **Telecom Provider**
No. of Buildings: **2**
Building Type: **Data Centres**
Location: **Singapore**
Assessed GFA: **86,000 Sq.m.**
Savings Potential: **27%**

Summary: Singapore Case Studies



Client: **Technological University**
No. of Buildings: **20**
Building Type: **Diverse**
Location: **Singapore**
Assessed GFA: **250,000 Sq.m.**
Savings Potential: **35%**



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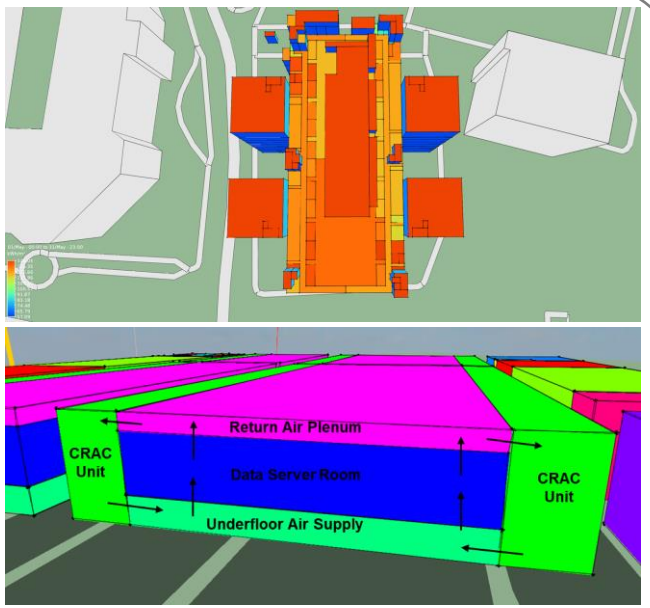

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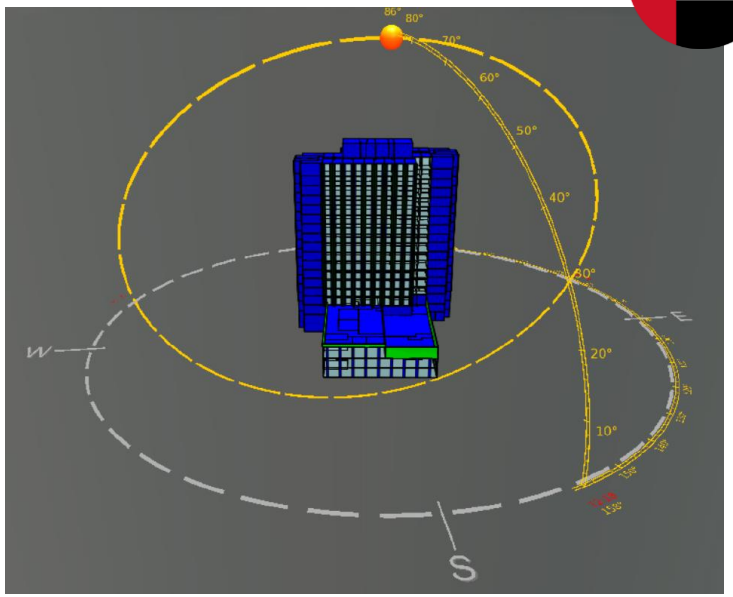
No. of Buildings: **2**
Building Type: **Data Centres**
Location: **Singapore**
Assessed GFA: **86,000 Sq.m.**
Savings Potential: **27%**

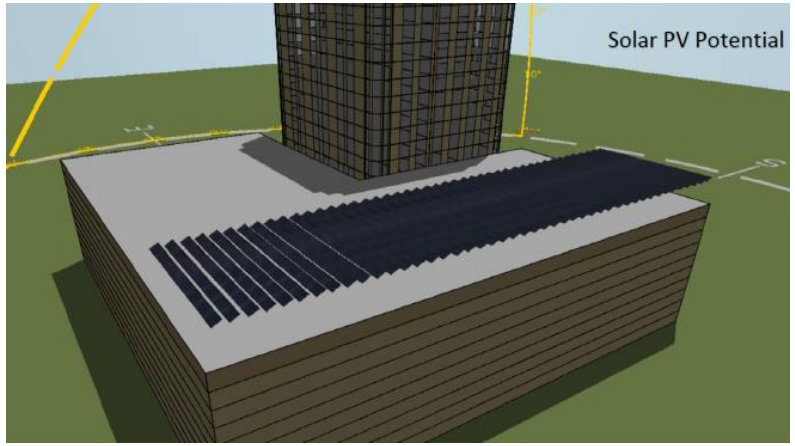
Summary: Global Case Studies

UAE



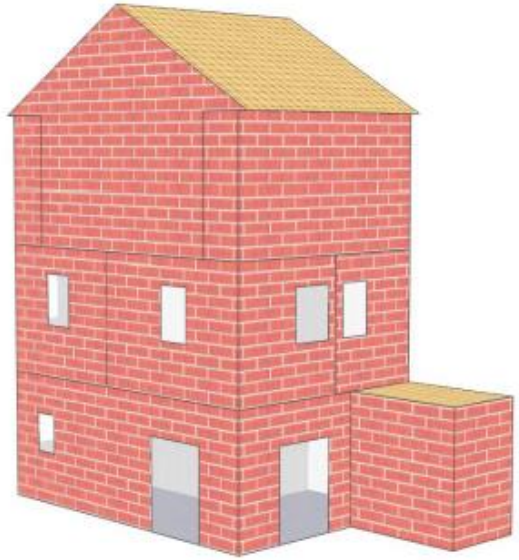
Client: **Hotel Group**
No. of Buildings: **2**
Building Type: **Hotel**
Location: **Dubai, UAE**
Assessed GFA: **22,500 Sq.m.**
Savings Potential: **30%; $175,000/yr**

USA



Client: **Certification Consultant**
No. of Buildings: **1**
Building Type: **Office Plaza**
Location: **Georgia, USA**
Assessed GFA: **52,000 Sq.m.**
Savings Potential: **30%; $290,00/yr**

Europe



Client: **Engineering Consultant**
No. of Buildings: **10**
Building Type: **Residential**
Location: **Netherlands**
Assessed GFA: **2,400 Sq.m.**
Savings Potential: **35%**

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