



# Alto CERO: AI-Driven Building Automation & Control System

Revolutionizing property management  
with intelligent automation

ESG driven solutions



Up to  
**40%**

On Energy Savings

Up to  
**300%**  
Increased Operational  
Efficiency

Less than  
**3**  
Years of Payback Period



Hotel



Building



Factory



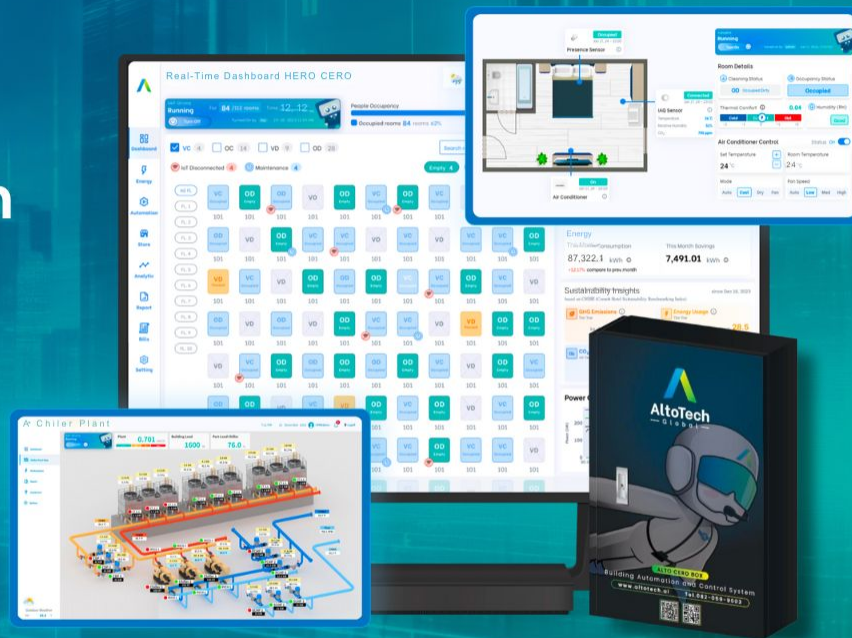
Hospital



Retail



Smart City





# Who are we?

We are the leading climate tech startup in APAC having vision to drive sustainability and Net-Zero economy

With our solutions, we help Hotels, Hospitals, Factories, offices and commercial buildings reducing their carbon footprint and energy consumption with our advanced AI and IoT technologies.

## ALTO HERO



“Transform your operations team into a superhero squad”

## ALTO CERO



“AIoT platforms to optimize your building operational energy and carbon footprint”

## MULTI PROPERTY MANAGEMENT



“All in one platform to monitor and manage properties and facilities altogether at once”





# ALTOTECH IS TRANSFORMING SOUTHEAST-ASIA'S EMISSION LANDSCAPE THROUGH AI-DRIVEN EMS SOLUTIONS



*AltoTech offers intelligent, AI and data-driven solutions to manage air-side and water-side systems, reducing energy consumption, enhancing operational efficiency, and driving sustainability across diverse industries.*

## — EMS & BEYOND —



### USE OF AI TO SUPPORT ENERGY MANAGEMENT

By harnessing the power of AI, Alto Tech is revolutionizing energy management by **automating reporting, benchmarking, and progress tracking**. By leveraging AI, AltoTech not only automates energy reporting but also provide actionable insights for smarter decisions.

### INTEGRATED DECARBONISATION SOLUTIONS

Leveraging IoT, cloud computing, big data, and AI, our solutions **optimize energy use, reduce costs, and lower carbon footprints**, differentiating us from top-tier competitors.



### ADVANCING TOWARDS NET-ZERO BUILDINGS

Driving the global transition towards sustainability through cutting-edge technology and **innovative solutions**.



## — TRANSFORMATIVE IMPACTS & KEY HIGHLIGHTS —

**US\$ 0.7M**

REVENUE (2024)

**68+**

PROPERTIES COMMISSIONED

**3M+ sqm**

AREA MANAGED

**129 GWh**

ENERGY MANAGED

**388%**

YOY GROWTH

**2.8M KgCO<sub>2</sub>eq**

CARBON EMISSION REDUCTION

**95%**

CUSTOMER RETENTION RATE

**25%**

CUSTOMER CONVERSION RATE

## — AWARDS AND CERTIFICATIONS —

### INTERNATIONAL



Top APAC  
Startups 2024



Indo Pacific Climate  
Tech Top 100

### THAILAND



Winner DEPA Smart  
City Batch #2



Winner NIA  
deep tech



Winner of Startup  
Arena Pitch Battle



Top 3 Finalists in  
Digital Startups



# WHY ALTOTECH GLOBAL?

*Trusted by clients for delivering exceptional results, AltoTech Global is poised for expansion, powered by innovative technology and backed by industry-leading investors and partners.*



## PROVEN TRACK RECORD AND ESTABLISHED CLIENTELE

Clients include leading hotels, commercial buildings, hospitals, office buildings, and factories, with multiple projects in pipeline, expanding its presence across Southeast Asia

### Hotels



### Commercials



### Factories



### Buildings



## HIGH IMPACT, QUICK AND SUSTAINABLE RESULTS



Up to **40%**  
potential  
energy savings



**300%**  
operational  
efficiency increase



**<3**  
years of  
payback period



## FUTURE-PROOF TECHNOLOGY ARCHITECTURE



*Petty Patent: For functionality and legal protection for the technological innovations incorporated in the IoT box*

Advanced AI-ready architecture ensures building automation system evolves with technology, delivering long-term value and adaptability.



## TRUSTED AND BACKED BY BLUE CHIP INVESTORS

Empowered by current investors who are leaders across various industries

**BANPUNEXT**

*Also a strategic partner in Thailand*

**INNOPOWER**

**500**  
startups

**Sprint**  
HOLDING

**EENSOL**  
CREATIVE ENERGY

**BBAIR**  
GROUP

**RISE**

**FUTURECON**



## EXPANSIVE NETWORK OF REGIONAL PARTNERSHIPS

**VYKON**  
by TRIDUUM

Only AI and software focused member of Tridium in Thailand

**PEA**

MOU with PEA in Thailand for national energy initiatives

**UOB FINLAB**

Part of UOB FinLab GreenTech Accelerator

**NVIDIA**  
INCEPTION PROGRAM

Part of NVIDIA's program for AI startups

**Microsoft**  
for Startups

Part of Microsoft's growth platform

**carbon neutral**  
network

Part of a Climate Action Initiator in Thailand

**HITACHI**  
**DAIKIN**

Partner with Industry Leaders

**CUSHMAN & WAKEFIELD**

Partnered in Singapore with C&W Services

**TEEM**

Partnered in Hong Kong with Telemax and Hong Kong Science and Technology Park

**HKSTP**  
PARTNER



# A TEAM OF CERTIFIED SPECIALISTS

The first and only company in Thailand to achieve professional engineering certifications in Chiller Plant Testing, Adjusting, and Balancing from the Air Conditioning Association of Thailand (ACAT), establishing our reputation as a respected leader in the energy management and ESCO markets

29 EMPLOYEES  
6 TEAMS



INCEPTION PROGRAM



Microsoft  
for Startups

## WARODOM KHAMPHANCHAI, PHD

Chief Executive Officer & Co-founder



- >10 years of experience in building technology
- Ex-Software developer at Samsung SmartThings, Ex-Researcher at Provincial Electricity Authority of Thailand
- Silicon Valley experience through BEMOSS<sup>1</sup> US\$ 2M funded by US DOE<sup>2</sup>
- Educated in BEng, Meng, and PhD.



## WACHIRA WATANAWONGWORAKULA

Chief Strategy Officer



- Leading the Strategy and Business Development team at Flash Group and its subsidiaries, including Flash Express—Thailand's first unicorn startup
- Extensive experience in corporate strategy, international expansion, M&A, and joint ventures
- Strong foundation in accounting and finance, empowered by Marriott School of Business



## SAM TANSKUL

Advisor



- Ex-Vice President, Bank of Ayudhya,
- Ex-Managing Director, Krungsri Innovate,
- Ex-Head of Innovation&Fintech, Krungsri Consumer
- Ex-Board of Director, TBN (Plc), Finnomena, Wisights, ChocoCRM, 24Solutions
- Educated in MSc, Economics in Finance & Management, University of Bristol, UK



## SITTISAK TONGDEE

Engineering Director



- >10 years of experience in mechanical & electrical construction engineering
- Ex-Chief Engineer of Thai Obayashi (A top 3 construction company in Thailand)
- Involved in major construction projects such as Stock Exchange of Thailand



## JIRAYUT CHATPHET

AI & Data Science Director



- Winner of DENSO Open Innovation Hackathon: Reimagine the future of Manufacturing (2022), winner of Depa Smart City (2021), winner of NIA Deep Tech Hackathon
- Educated in BEng (Mechanical)



## PISITCHAI PANYAPALUNGKUL

HVAC Engineering Expert



- Ex-First Vice President of ACAT Thailand,
- Ex-Vice President of Build land PCL.,
- Ex-Executive Vice President of SECCO Company Limited
- Ex-Project Director of RITTA Company Limited
- Educated in BEng (Mechanical) and MBA



Note: [1] Building Energy Management Open-source Software; [2] United States Department of Energy



# ALTOTECH HOLDS KEY INDUSTRY CERTIFICATIONS



*Thailand's first company certified in Chiller Plant Testing, Adjusting, and Balancing by ACAT, reinforcing its leadership in energy management and ESCO markets*

## Energy Measurement and Verification

### IPMVP & PMVE

Demonstrates certified expertise in energy savings measurement and verification, ensuring reliable ROI outcomes for clients



## AI + Software Capability

### NVIDIA AI Certificate

Demonstrates expertise in AI-driven predictive maintenance, strengthening analytics and optimization for energy management systems



## Smart Building Certification

### WiredScore & SmartScore Accredited Professionals

Certified expertise in smart infrastructure, enabling modern, efficient buildings with advanced, digitally-driven systems



## Building Automation

### Tridium

Certified in automation for energy efficiency, enabling seamless HVAC, lighting, and BMS integration while delivering trusted IoT-based solutions



## Engineering Certifications

### Chiller Plant Testing, Adjusting and Balancing (Thai TAB)

Certified expertise in optimizing chiller plants for energy savings, ideal for buildings with complex cooling requirements



### Air-Conditioning Engineering Association of Thailand (ACAT)

Recognized for HVAC compliance with Thai standards, enhancing credibility in energy engineering and certified solutions



>10

AltoTech employees hold ACAT certification



# AltoTech Global: Awards and Certifications



Thai TAB chilled water optimization certification



Top Score ACAT Training for 2 consecutive years  
Air Conditioning Engineering Association of Thailand (ACAT)



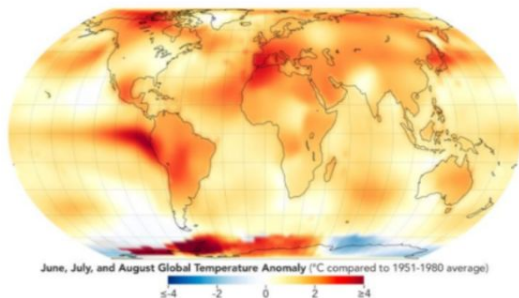
Hotel Management Training by Thai Hotel Standard Foundation and Thai Hotel Association





# RISING TEMPERATURES ARE CREATING A COOLING URGENCY

## EXTREME HEAT IS CAUSING SOCIETAL PROBLEMS

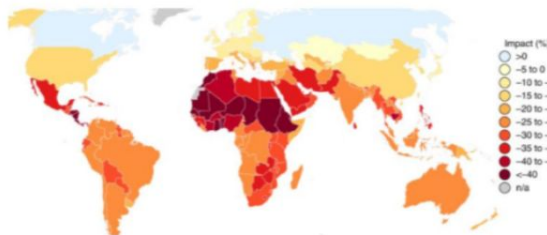


- **3.5 billion** people live in hot climates
- **15%** of people in emerging markets have access to air conditioners
- **300,000** annual heat related deaths

Data sources: [IEA, Lancet Countdown Report on Health and Climate Change](#)

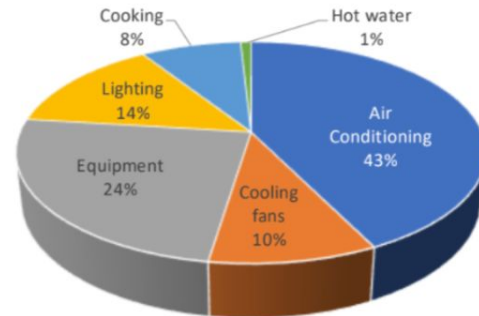
## HEAT IS ERODING PRODUCTIVITY GAINS

- **26-34%** loss in agri productivity since 1961 due to climate change – more acute in warm areas of the world
- **3-7%** loss of agri yields for every 1 C increase in global mean temperatures



Data source: [Nature Climate Change Journal](#)

## HEAT IS CAUSING LARGE UTILITY BILLS



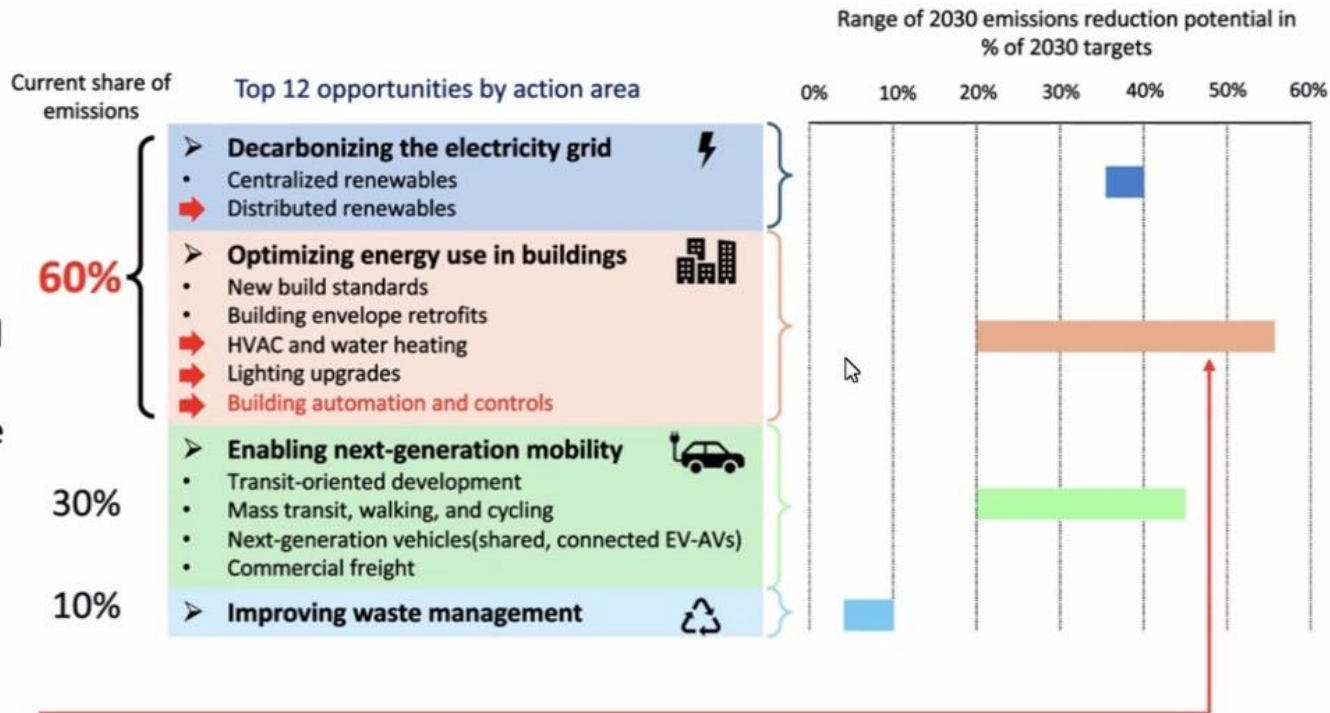
- **30-40%** cooling as portion of energy bills for a commercial building in warm climates

Data source: [EDGE Analysis for an office building in South Asia](#)



# Opportunities in the built environment

- Building sector contributes up to **40%** of the world's final energy and accounts for **30%** of the world's CO2 emissions
- Smart building automation and control (BAC) is a key technology **enabler** to optimise building energy efficiency
- Optimising energy use in buildings harbours the **highest potential** for carbon emissions reduction





TO ACHIEVE  
**NET-ZERO GOALS**  
IN 2050

**3.5 Billions**  
**Tons of CO<sub>2</sub>eq**  
(7% of Global's GHGs  
Emissions)

HAS TO BE REDUCED FROM BUILDINGS

**YET WE MIGHT NOT BE ABLE AS**



## **30-40% of Energy Wasted in Buildings**

results from inefficient energy management practices, systems, and outdated technologies



## **< 2% of Buildings**

has incorporated data into their operation efficiency improvement and for their net-zero targets



## **>95% Manual Operations**

is based on plain rules of thumb because of the harsh difficulties in utilizing crucial information, such as weather or real-time data, to effectively minimize energy usage.



# World's Best Countries to Visit in Your Lifetime, 2024

According to CEOWORLD magazine

	Score
1	 Thailand 72.15
2	 Greece 67.22
3	 Indonesia 65.15
4	 Portugal 64.32
5	 Sri Lanka 60.53
6	 South Africa 59.76
7	 Peru 59.76
8	 Italy 57.77
9	 India 57.65
10	 UAE 57.38
11	 France 56.31
12	 UK 56.29
13	 Bora Bora 56.2
14	 USA 55.98
15	 Spain 55.89

Source: CEOWORLD magazine

Figure 5:

## Competitiveness Ranking of the Thai Tourism Industry

Thailand's Rankings	2019 (n=119)	2021 (n=119)	2024 (n=119)
Travel and Tourism Development Index	41	35	47
Enabling Environment	64	64	66
Policy and Enabling Conditions	41	34	45
Infrastructure and Services	43	44	49
Resources	17	17	20
Sustainability	71	71	107
Environmental Sustainability	60	69	70
Energy Sustainability	63	72	73
Pollution and Environmental Conditions	82	85	83
Preservation of Nature	50	53	59
Socioeconomic Impact	100	103	106
Demand Sustainability	17	10	69

ASEAN's 2024 Rankings	Travel & Tourism Development Index	Environmental Sustainability	Socioeconomic Impact	Demand Sustainability
Singapore	13	55	56	39
Indonesia	22	56	10	5
Malaysia	35	58	116	42
Thailand	47	70	106	69
Vietnam	59	93	115	54
Philippines	69	47	102	18
Cambodia	86	79	110	11
Lao PDR	91	103	8	26

Source: World Economic Forum and Krungsri Research

Source 'Sustainable Tourism' A New Era of Travel Prioritizing Sustainability

<https://www.krungsri.com/.../res.../sustainable-tourism-2024> updated 13 September 2024



# POSITIVE DRIVERS

Brand value, third-party certifications, regulatory compliance, and sustainability initiatives with standardized data and reporting making them critical differentiators for companies



## HOTEL

60% of travelers are ready to pay for sustainability

Domestic



International



## BUILDING

Command higher rent premiums from 3% to 8%



## FACTORY

Regulatory compliance will firstly impact the manufacturing sector

ecovadis  
Business Sustainability Ratings



## SMART CITY

Demand-Response are crucial to managing peak loads in cities

Promote low-carbon city

Urban resource management



Energy monitoring and management



Smart cities



Smart Infrastructures



Cloud service and data center



Data visualization and management

Transform into sustainable city

Regional sustainable development



Demand side management (DSM)

Domestic



International



Dow Jones Sustainability Indexes



S&P Global Ratings



EARTHCheck





# Decarbonization Journey for Green and Sustainable Buildings

We provide Smart Net-Zero Solutions as a Service

1

**Carbon Accounting**

2

**Planning**

3

**Carbon Reduction**

4

**Compensate for Emission**

5

**Disclose and Communicate**

**Assessment**

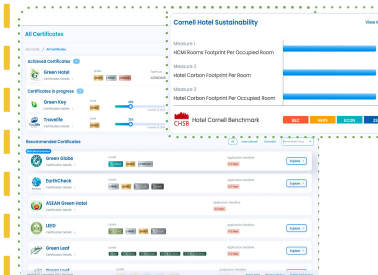
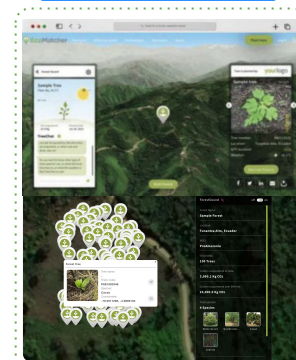
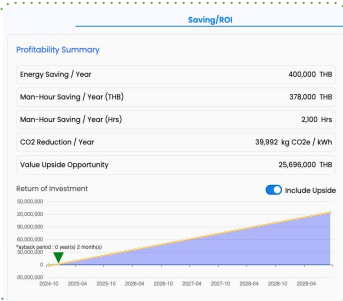
**Develop Actionable Plan**

**Improvement**

**Offset**

**Report**

No.	ประเภทของแหล่งกำเนิดคาร์บอน	ชื่อ	Source
1	11 อาคาร	L	11 อาคาร
2	12 อาคาร	L	12 อาคาร
3	13 The LPG #Volume	kg	13 The LPG #Volume
4	21 อาคาร	L	21 อาคาร
5	22 อาคาร	L	22 อาคาร
6	31 อาคาร	kg	31 อาคาร
7	32 อาคาร	kg	32 อาคาร
8	33 อาคาร	kg	33 อาคาร
9	34 อาคาร	kg	34 อาคาร
10	35 อาคาร	kg	35 อาคาร
11	36 อาคาร	kg	36 อาคาร
12	37 อาคาร	kg	37 อาคาร
13	38 อาคาร	kg	38 อาคาร
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72	97 อาคาร	kg	97 อาคาร
73	98 อาคาร	kg	98 อาคาร
74	99 อาคาร	kg	99 อาคาร
75	100 อาคาร	kg	100 อาคาร



**Create an initial carbon footprint baseline for reduction**

**Plan for energy efficiency projects for carbon reduction**

**AIoT systems to monitor and optimize energy efficiency**

**Purchase verified carbon credits from offset projects**

**Digital reporting tools**

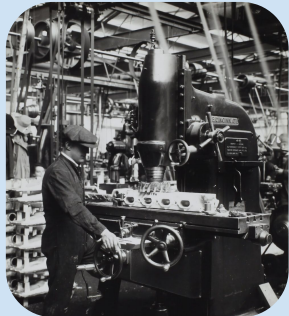


# Six Generations of Building Automation and Control System Technologies



## Building 1.0

Mechanical controlled machine and manual operating



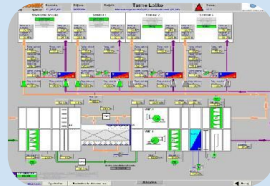
## Building 2.0

Partial automation, Systems in building can be controlled through interface.



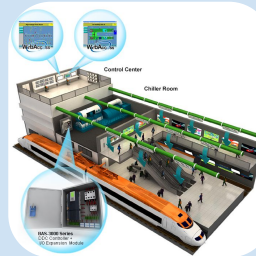
## Building 3.0

Automation and Introduction of computer, Web app local control for manufacturing facilities, Data can be monitored and controlled real-time



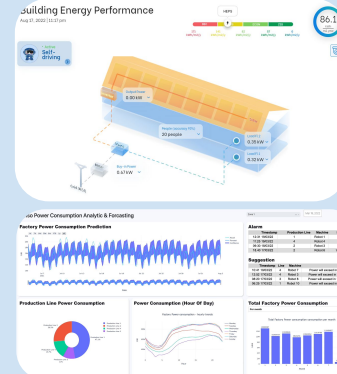
## Building 4.0

Both local and cloud controlled machine through web app Monitor, Control, Automation, Schedule, and Historical Data Visualization are utilized



## Building 5.0

Advanced Robotics, Bionics, and Human Centric Advanced technology are applied with AI and big data creating autopilot outcome



## Building 6.0

Information flow beyond planetary boundaries antifragile manufacturing, Upcoming future technology such as digital twin and metaverse, also AR and VR, are involved.





# Towards Net-Zero Properties



40%

Energy Saving

300%

Increased  
Operational  
Efficiency

## Smart City & Carbon Assessment

Enable IoT infrastructure for Smart City, ESG assessment and certifications. Open integration for 3rd-party developers.



Ontology Data Model



Sustainability  
Certification Copilot



Green Hotel &  
Sustainability Programs



Certification Reports  
Management



PropertyGPT:  
Talk with Your Buildings



Open API for 3rd-  
Party Integrations



## Air-Side Energy Optimization

AI-driven IoT platform that optimizes energy usage based on occupancy for cost savings while maintaining comfort, which controls indoor air quality, adjusts thermal comfort based on tenant feedback and provides supports for demand-response programs.



Autopilot Energy  
Optimization



Non-Intrusive Occupancy  
Detection for Hotel rooms



Demand-Response



Tenant Feedback



## Chiller Plant Energy Optimization

Utilizing AI algorithms and real-time data for monitoring, controlling, and optimizing energy consumption in chiller plants. Seamlessly integrates with existing infrastructure to enhance energy efficiency, reduce costs, and minimize environmental impact.



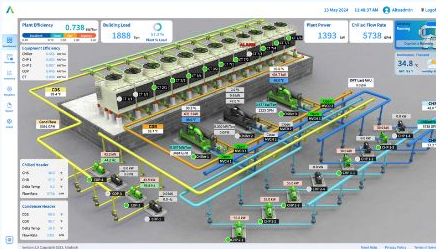
AI-Automated  
Chiller Plant Controls



ML-Driven Data Analytics

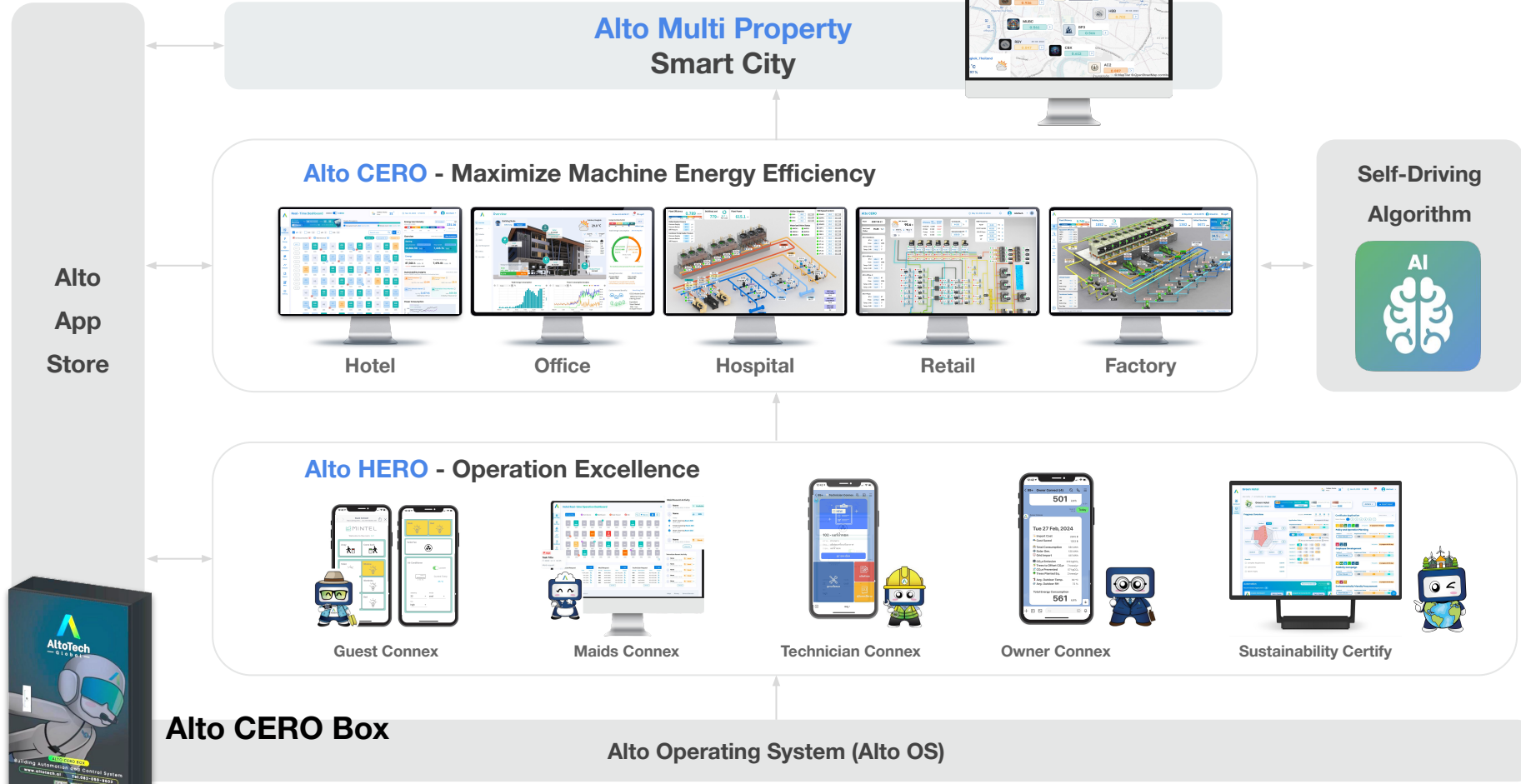


Fault Detection &  
Diagnostics (FDD)



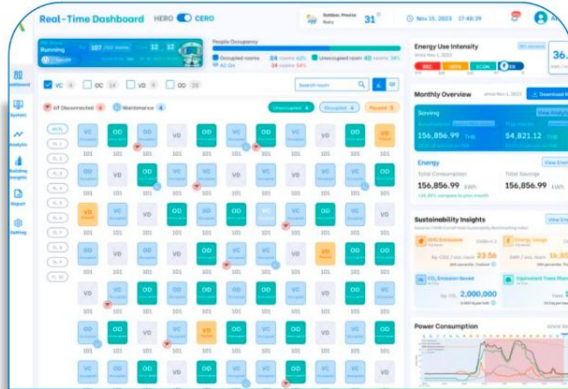


# AltoTech Product Ecosystem - More Than Just Energy Management





# ALTOTECH'S USER FRIENDLY PLATFORM ALLOWS PROPERTY OWNERS TO EASILY REVIEW AND MANAGE THEIR ENERGY CONSUMPTION



## Alto CERO (Air-side)

AltoT platform optimizes HVAC performance for **split-type and VRF systems** by adjusting settings automatically based on occupancy and conditions

### Key Features



Occupancy Detection



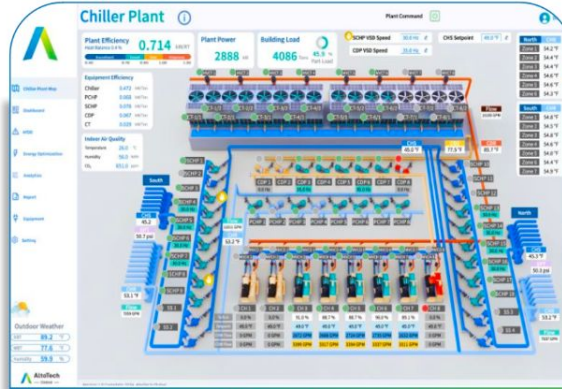
Alto Auto Report



Data Analytics Dashboard



Energy Optimization



## Alto CERO (Water-side)

AltoT platform optimizes HVAC performance for **chiller plant systems** in many large buildings by adjusting settings automatically based on occupancy and condition

### Key Features



Chiller Plant Optimization



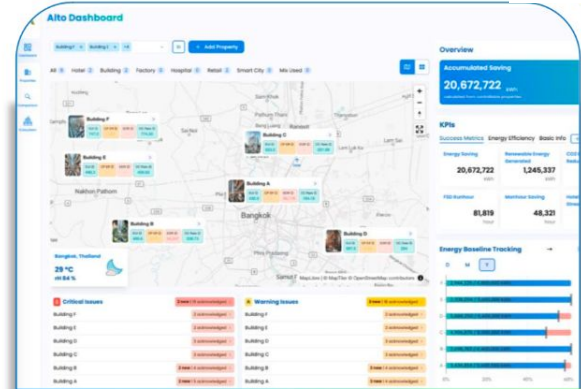
Alto Auto Report



Auto Fault Detection & Diagnosis



Control Playback



## Alto Multi-Property

**Centralized Energy Management Platform** for real-time tracking, monitoring, and control of multi-property assets

### Key Features



Property KPI Tracking



Property/Machine Health Monitoring



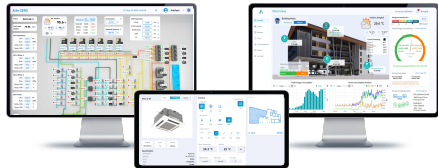
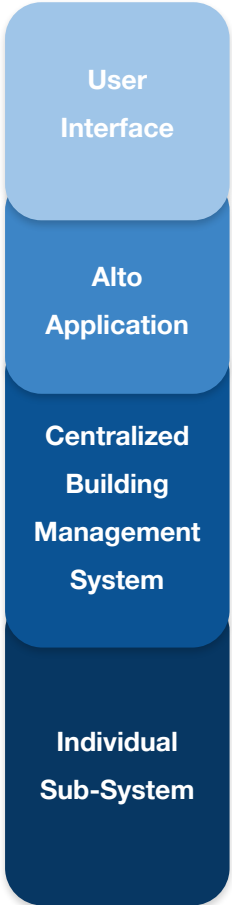
Centralized Management & Controls



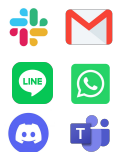
Data Analytics & Report



# Layers of Alto Solution



**Web Application**  
Accessible for both local operators and remotely for monitoring and controls



**Communication Platform**  
For automatic summary, feedback systems and reporting, and fault/alert notifications



Energy Optimization



Alto GPT



Occupancy Detection



Indoor Air Quality Optimization



Automatic Building Report



Predictive Maintenance



Load and Weather Forecast



Fresh Air Optimization

A **centralized system** that integrates and links all the separate systems within a building.



This allows **centralized control and management** and **cross-system integration** that utilizes data from all sub-systems.



Chiller Plant System



Air Conditioning System



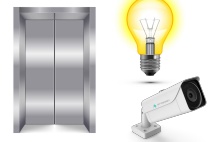
Indoor Air Quality Sensors



Ventilation System



Solar Power System



Other Sub-Systems



# Hardware Architecture

## Alto Multi-Property Web Application



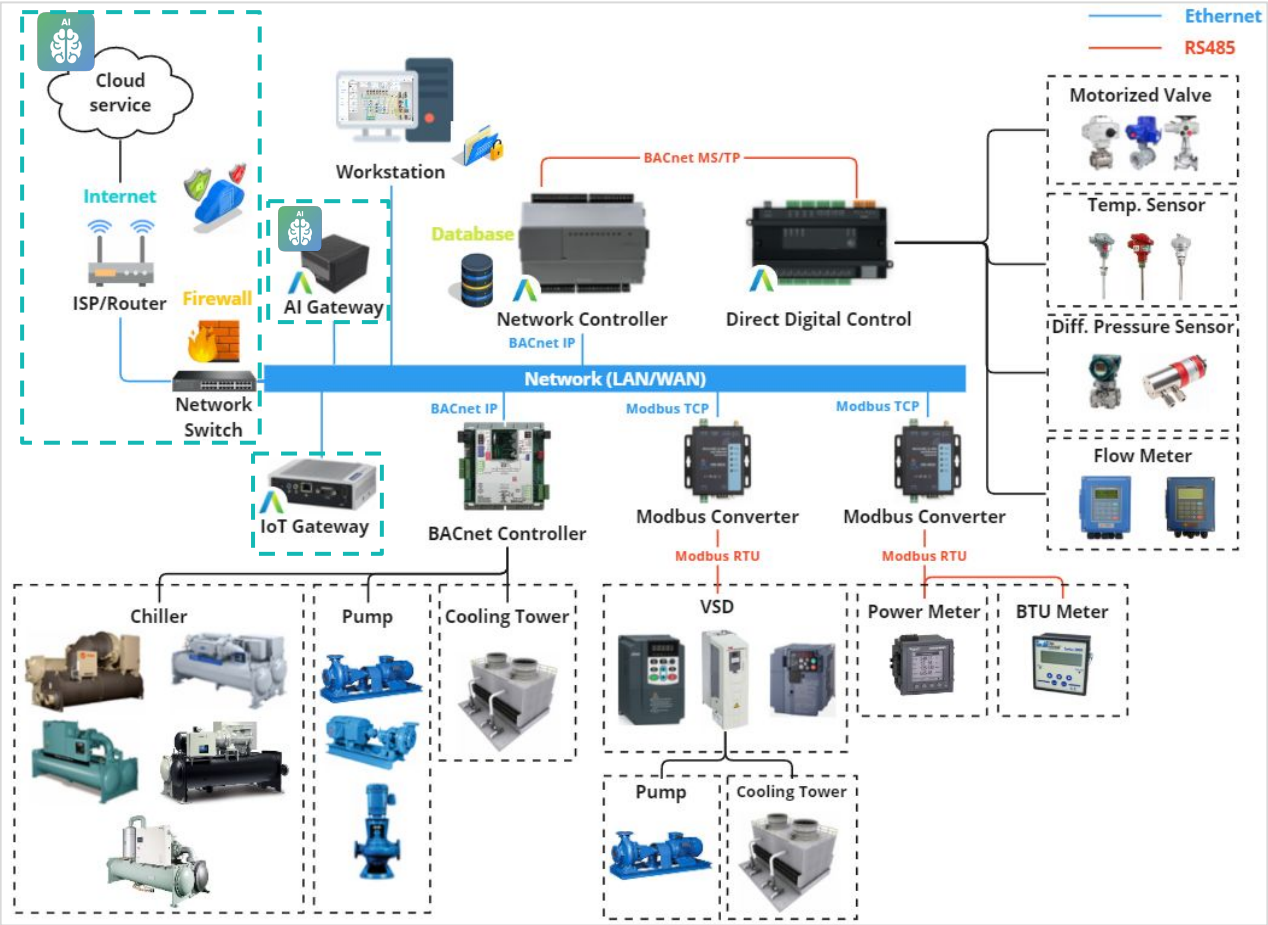
## Centralized Data Platform



Building B

Building C

Building A

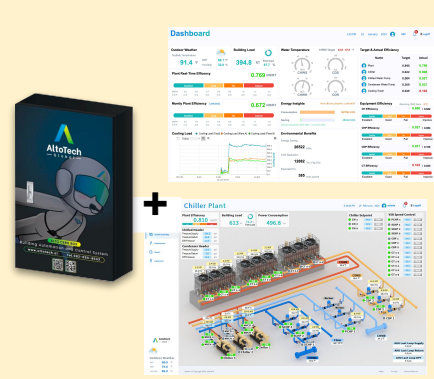




# Project Milestones from Improving Chiller Plant Efficiency to Multi-Properties Management

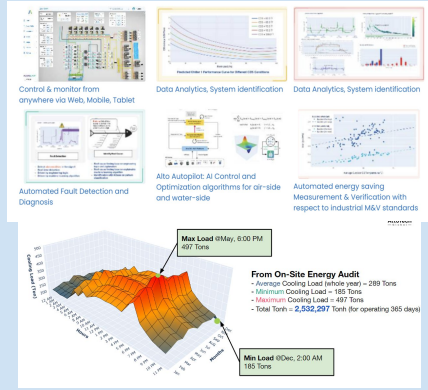


## AI For chiller plant optimization and Basic Analytics Phase 1



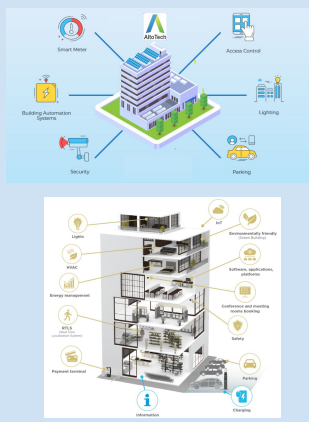
- Upgrade infrastructure to support AI and data analytics for energy performance improvement
- Obtain energy saving by improving energy efficiency of the building, resulting in energy savings compared to established baseline

## Provide AIoT and Data Data analytics platform to Integrate and analyze data from CPMS and BAS Phase 2



- Integrate existing BAS, CPMS, and Alto CERO platform
- Data analytics to obtain insights from both Air-side and Water-side
- Implement additional applications to improve operation efficiency e.g. equipment operation playback, chatGPT etc.

## AI control for Air-Side optimization Phase 3



- Optimize building energy efficiency by using and coordinating data from both Air-Side with Water-Side to obtain best performance efficiency

## Alto Multi-Properties Management Phase 4



- Manage all of your properties
- Make Your Asset to the Big Data
- Monitoring Performance
- Lead of Energy Sustainability



# Instrumentation and Methodology for Baseline Calculation

## Methodology for baseline calculation to saving finding and estimation

### 1. Measurement and initial Baseline calculation

### 2. Adjusted Baseline calculation from operational data (take into account seasonality)

### 3. Estimation of energy performance improvement

### 4. Quantify financial and sustainability benefits



#### 6.2 Chiller Specification

Model	1201	1202	1203	1204
Capacity (kW)	120	120	120	120
Capacity (ton)	34.4	34.4	34.4	34.4
Power (kW)	45	45	45	45
Power (hp)	60	60	60	60
Condensing Temp (°C)	55	55	55	55
Condensing Temp (°F)	131	131	131	131
Evaporating Temp (°C)	5	5	5	5
Evaporating Temp (°F)	41	41	41	41
Flow Rate (m³/hr)	100	100	100	100
Flow Rate (gpm)	260	260	260	260
Weight (kg)	1000	1000	1000	1000
Weight (lb)	2200	2200	2200	2200
Height (m)	2.0	2.0	2.0	2.0
Height (ft)	6.6	6.6	6.6	6.6
Length (m)	1.0	1.0	1.0	1.0
Length (ft)	3.3	3.3	3.3	3.3
Width (m)	0.5	0.5	0.5	0.5
Width (ft)	1.6	1.6	1.6	1.6
Depth (m)	0.5	0.5	0.5	0.5
Depth (ft)	1.6	1.6	1.6	1.6

Operating Condition	Time
10:00 am - 12:00 pm (Day)	10
12:00 pm - 1:00 pm (Day)	10
1:00 pm - 2:00 pm (Day)	10
2:00 pm - 3:00 pm (Day)	10
3:00 pm - 4:00 pm (Day)	10
4:00 pm - 5:00 pm (Day)	10
5:00 pm - 6:00 pm (Day)	10
6:00 pm - 7:00 pm (Day)	10
7:00 pm - 8:00 pm (Day)	10
8:00 pm - 9:00 pm (Day)	10
9:00 pm - 10:00 pm (Day)	10
10:00 pm - 11:00 pm (Day)	10
11:00 pm - 12:00 pm (Day)	10
12:00 pm - 1:00 pm (Night)	10
1:00 pm - 2:00 pm (Night)	10
2:00 pm - 3:00 pm (Night)	10
3:00 pm - 4:00 pm (Night)	10
4:00 pm - 5:00 pm (Night)	10
5:00 pm - 6:00 pm (Night)	10
6:00 pm - 7:00 pm (Night)	10
7:00 pm - 8:00 pm (Night)	10
8:00 pm - 9:00 pm (Night)	10
9:00 pm - 10:00 pm (Night)	10
10:00 pm - 11:00 pm (Night)	10
11:00 pm - 12:00 pm (Night)	10

This is the operating schedule and running hours which is used to calculate the total energy consumption summary.

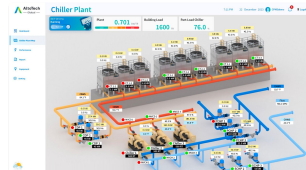
Given that the facility serves as a government office, its standard operating hours align with the usual government business hours, which are from **06:00 AM to 23:59 PM**.

Under typical conditions, it is found that one or two chillers are sufficient to meet the building's cooling requirements.

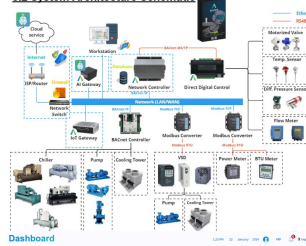


Operation Condition	Time
10:00 am - 12:00 pm (Day)	10
12:00 pm - 1:00 pm (Day)	10
1:00 pm - 2:00 pm (Day)	10
2:00 pm - 3:00 pm (Day)	10
3:00 pm - 4:00 pm (Day)	10
4:00 pm - 5:00 pm (Day)	10
5:00 pm - 6:00 pm (Day)	10
6:00 pm - 7:00 pm (Day)	10
7:00 pm - 8:00 pm (Day)	10
8:00 pm - 9:00 pm (Day)	10
9:00 pm - 10:00 pm (Day)	10
10:00 pm - 11:00 pm (Day)	10
11:00 pm - 12:00 pm (Day)	10
12:00 pm - 1:00 pm (Night)	10
1:00 pm - 2:00 pm (Night)	10
2:00 pm - 3:00 pm (Night)	10
3:00 pm - 4:00 pm (Night)	10
4:00 pm - 5:00 pm (Night)	10
5:00 pm - 6:00 pm (Night)	10
6:00 pm - 7:00 pm (Night)	10
7:00 pm - 8:00 pm (Night)	10
8:00 pm - 9:00 pm (Night)	10
9:00 pm - 10:00 pm (Night)	10
10:00 pm - 11:00 pm (Night)	10
11:00 pm - 12:00 pm (Night)	10

Chiller Unit	Model	Size	Unit
Chiller Unit	1201	120	kW
Chiller Unit	1202	120	kW
Chiller Unit	1203	120	kW
Chiller Unit	1204	120	kW
Chiller Unit	1205	120	kW
Chiller Unit	1206	120	kW
Chiller Unit	1207	120	kW
Chiller Unit	1208	120	kW
Chiller Unit	1209	120	kW
Chiller Unit	1210	120	kW
Chiller Unit	1211	120	kW
Chiller Unit	1212	120	kW
Chiller Unit	1213	120	kW
Chiller Unit	1214	120	kW
Chiller Unit	1215	120	kW
Chiller Unit	1216	120	kW
Chiller Unit	1217	120	kW
Chiller Unit	1218	120	kW
Chiller Unit	1219	120	kW
Chiller Unit	1220	120	kW



#### 3.2 System Architecture Schematic



#### 2. Chiller Plant Energy Audit

#### Saving Projection

##### Estimated Energy Saving Calculation

การคำนวณการประหยัดพลังงานและต้นทุนจากการลงทุน Software และการปรับปรุงพลังงาน

AI Chiller Plant Optimization

This is an estimate of energy savings for the proposal.

Therefore, the kWh and savings will be reduced.

However, it is very dependent on the RTN. If RTN is lower, the kWh will be reduced.

\* At minimum of Savings are around 16%

\* Approximately Savings 0.726 kW/Ton from 0.859 kW/Ton

\* Base on 2,532,297 RTN, The Saving approximately is 1,920,386 Bahr

RefPower	Unit	Baseline	Proposed	Savings
Chiller	kWh	1,000	840	160
Primary Chilled Water Pump	kWh	100	85	15
Condenser Water Pump	kWh	100	85	15
Cooling Tower	kWh	100	85	15
Water Loop	kWh	100	85	15
Heat Recovery	kWh	100	85	15
Chiller	kWh	1,000	840	160
Primary Chilled Water Pump	kWh	100	85	15
Condenser Water Pump	kWh	100	85	15
Cooling Tower	kWh	100	85	15
Water Loop	kWh	100	85	15
Heat Recovery	kWh	100	85	15
Chiller	kWh	1,000	840	160
Primary Chilled Water Pump	kWh	100	85	15
Condenser Water Pump	kWh	100	85	15
Cooling Tower	kWh	100	85	15
Water Loop	kWh	100	85	15
Heat Recovery	kWh	100	85	15

Baseline and Savings Proposed

Projections 1.3 Year

#### Total Existing Energy Consumption Profile

Item/Year	Unit	Energy/Year	Energy/Month	Energy/Day
Chiller	kWh	1,000,000	83,333	2,778
Primary Chilled Water Pump	kWh	100,000	8,333	278
Condenser Water Pump	kWh	100,000	8,333	278
Cooling Tower	kWh	100,000	8,333	278
Water Loop	kWh	100,000	8,333	278
Heat Recovery	kWh	100,000	8,333	278
Total	kWh	1,400,000	116,667	3,730

#### Total Proposed Energy Consumption Profile

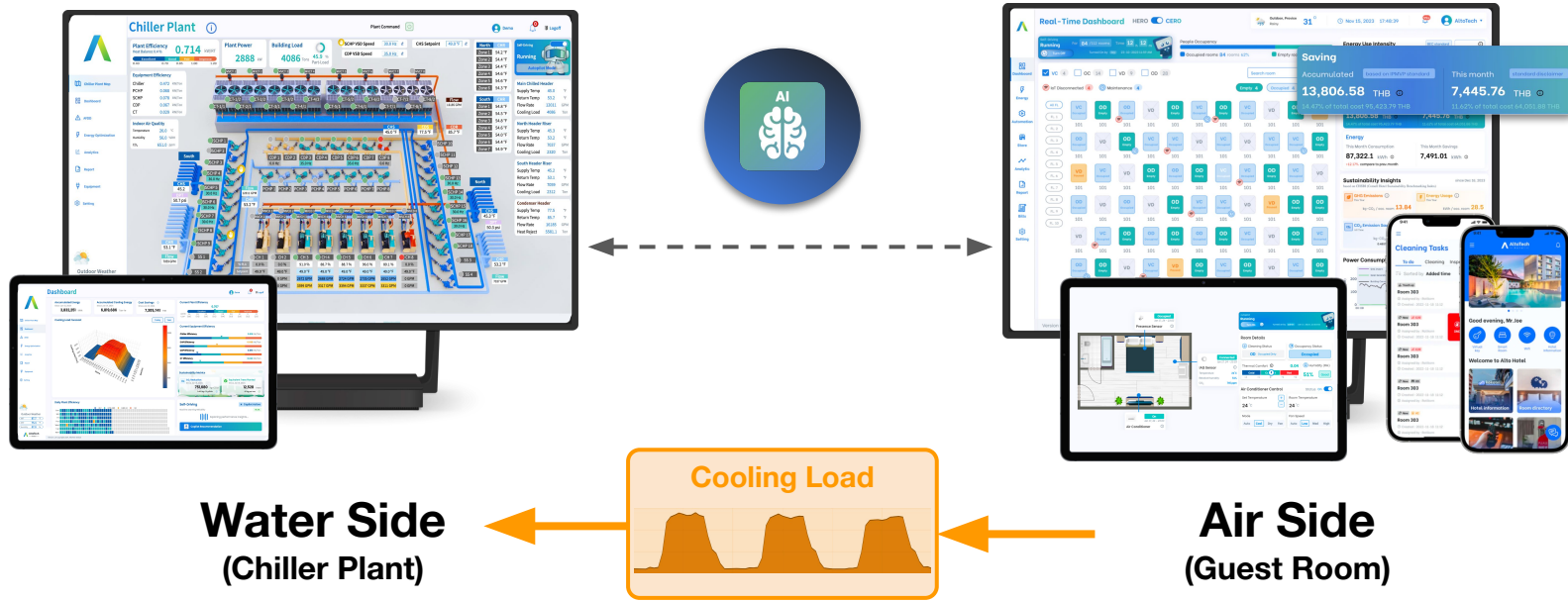
Item/Year	Unit	Energy/Year	Energy/Month	Energy/Day
Chiller	kWh	840,000	70,000	2,290
Primary Chilled Water Pump	kWh	85,000	7,083	230
Condenser Water Pump	kWh	85,000	7,083	230
Cooling Tower	kWh	85,000	7,083	230
Water Loop	kWh	85,000	7,083	230
Heat Recovery	kWh	85,000	7,083	230
Total	kWh	1,180,000	97,250	3,167

Investment and Payback	Value
Baseline	1,400,000
Proposed	1,180,000
Savings	220,000
Payback Period	1.3 Year

- At minimum of Savings are around 16%
- Approximately Savings 0.726 kW/Ton from 0.859 kW/Ton
- Base on 2,532,297 RTN The Saving approximately is 1,920,386 Bahr



# AI-Driven Airside - Waterside Integration for Overall Efficiencies Optimization



**The Alto CERO combines air-side and water-side system data for overall optimization.**

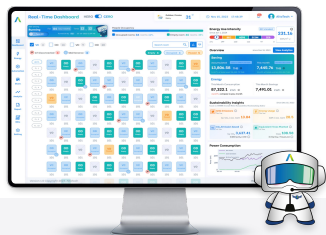
It uses past performance data to predict how load changes affect chiller efficiency, considering how machines age over time. **Unlike conventional systems, it does not blindly cut loads**, which often leads to minimal energy savings not worth the effort, but instead focuses on guest comfort. By using real-time room data, AltoTech **keeps chillers running efficiently while confidently ensuring rooms stay cool**. This method saves energy without sacrificing comfort and allows for clear measurement of savings.



# Solution Overview



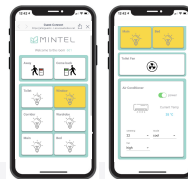
## User Interface



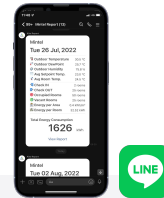
Dashboard for **Front Office**



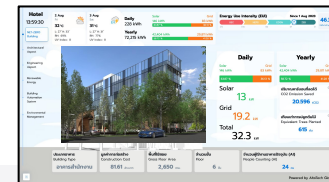
Dashboard for **Operation Engineer and Technician**



Mobile Website for **Guest**



**LINE Bot Summary** for **GM / Owner**



Visitor Dashboard at **Hotel Reception Area**

## Alto Apps

### CERO Apps



**Occupancy Detection**

99% Accuracy



**Energy Optimization**

Up to 30% Energy Saving



**Analytics Dashboard**



**Auto Report**

20% Man Hour Saving



**Smart Assign**

20% Man Hour Saving

AFDD

### HERO Apps

Maid Connex

Auto Certificate

Technician Connex



**Guest Connex**

100% Improved Guest Experience



**Owner Connex**

200% Less Meeting

## BAS



**Alto Operating System (Alto OS)**

**with PMS Integration**

Continuous OTA update



## Hardware

### Guest Room



**Life Being Sensor**



**IAQ Sensor**



**Balcony Contact sensor**



**Smart Thermostats Controller**



### Guest Room Service Chamber

**KNX Bridge**  
KNX IP interface



**Universal Module**



**Zigbee IoT Gateway** for Life Being Sensor

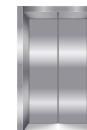
### Main System



**Chiller Plant System**



**AHU & FCU**



**Other Sub-Systems**

### Main Server Room and Riser Server Room



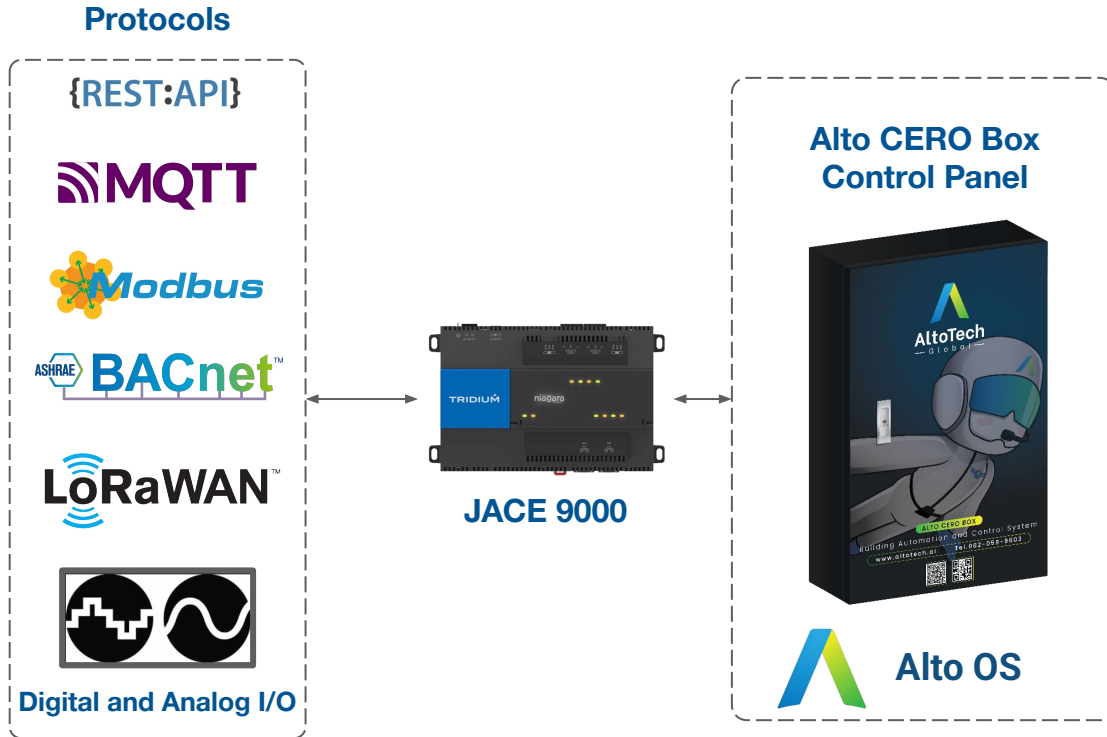
**BACnet Interface**  
KNX IP to BACnet

**Alto CERO Box IoT Gateway**





# Intelligent Applications on Top of Typical BACS



## “On-Top” Applications



ML-Based Energy Optimization



Alto Data Analytics



Alto Automatic Fault Detection and Diagnosis (AFDD)



Alto Playback



Alto Automatic Reports



Alto Messaging App Summary & Notification



Alto GPT

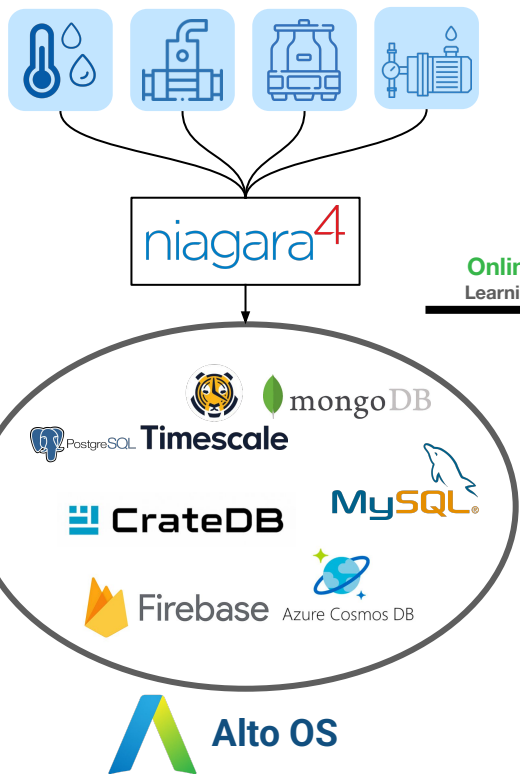


Alto Multi-Property

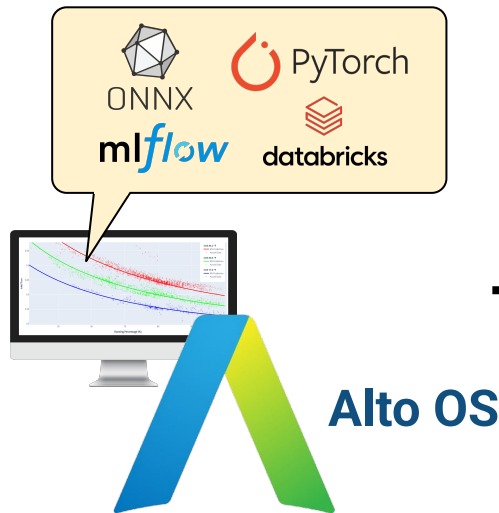


# APP1: Alto AI Chiller Plant Optimization

## Step 1: Data Collection

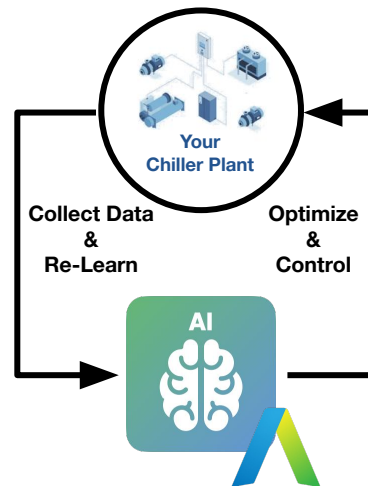


## Step 2: Learn The System with Machine Learning



Connected with databases which harvests data from the system through **Niagara 4** Platform, Alto OS integrates machine learning frameworks and cloud services, enabling you to build models for optimizing chiller plant energy usage and performance.

## Step 3: Optimize Controls



**Self-Driving Algorithm**

**Constrained Optimization from the discovered system model**





# Chiller Plant



Plant Command



9:02:55 AM

9 October 2024

Demo



Logout

**Plant Efficiency**  
Heat Balance 1.4 %  
**0.713** kW/RT  
Excellent Good Fair Improve

**Plant Power**

**2889** kW

**Building Load**

**4052** Tons  
46.1 %  
Part-Load

SCHP VSD Speed **37.7 Hz**

CDP VSD Speed **35.0 Hz**

CHS Setpoint **49.0 °F**

**Equipment Efficiency**

Chiller	0.471	kW/Ton
PCHP	0.068	kW/Ton
SCHP	0.077	kW/Ton
CDP	0.068	kW/Ton
CT	0.030	kW/Ton

**Indoor Air Quality**

Temperature	26.0	°C
Humidity	56.0	%RH
CO <sub>2</sub>	651.0	ppm

Self-Driving

**Running**

Autopilot Mode



**Main Chilled Header**

Supply Temp	45.1	°F
Return Temp	53.2	°F
Flow Rate	12015	GPM
Cooling Load	4052	Ton

**North Header Riser**

Supply Temp	45.3	°F
Return Temp	53.1	°F
Flow Rate	7025	GPM
Cooling Load	2292	Ton

**South Header Riser**

Supply Temp	45.2	°F
Return Temp	53.1	°F
Flow Rate	7075	GPM
Cooling Load	2307	Ton

**Condenser Header**

Supply Temp	77.7	°F
Return Temp	85.2	°F
Flow Rate	16361	GPM
Heat Reject	5089.3	Ton

Chiller Plant Map

Dashboard

AFDD

Energy Optimization

Analytics

Report

Equipment

Setting



**Outdoor Weather**

DBT **86.4** °F

WBT **74.5** °F

Humidity **57.6** %

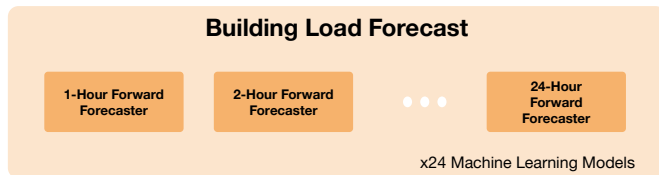


Global

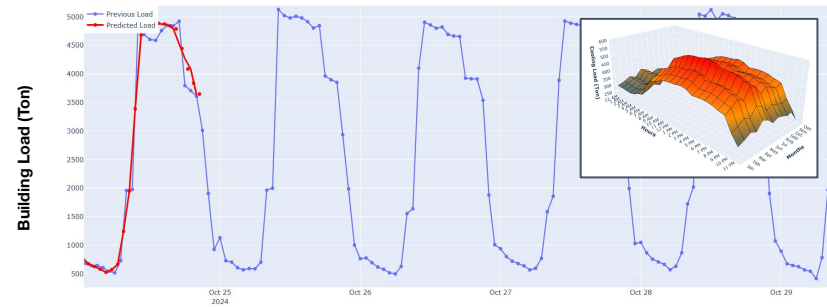


# Data-Driven Chiller Plant Control Algorithm: Model Predictive Control

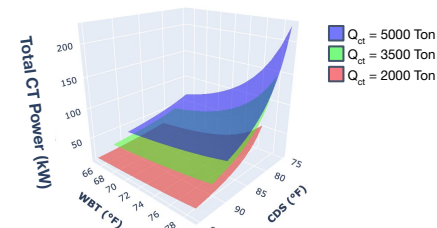
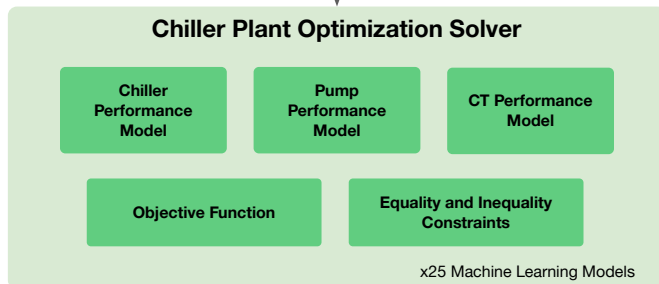
## High-Level Controller



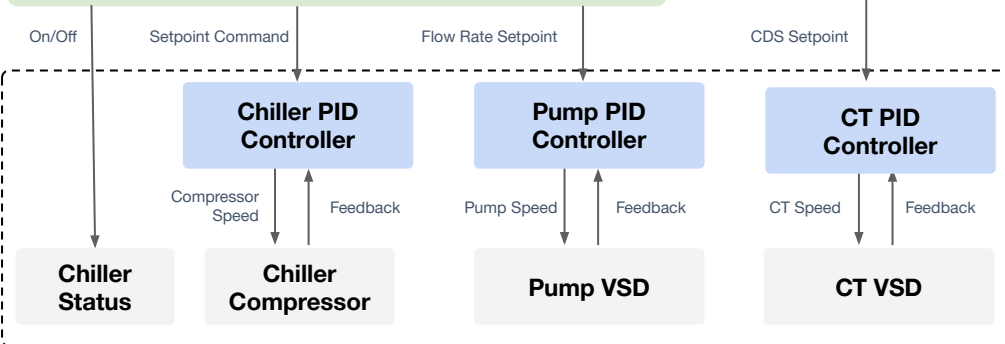
24-Hour Forward Building Load Forecasting



## Mid-Level Controller



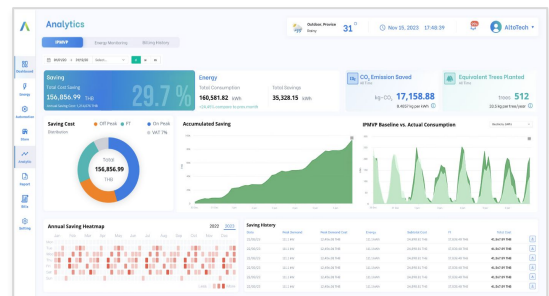
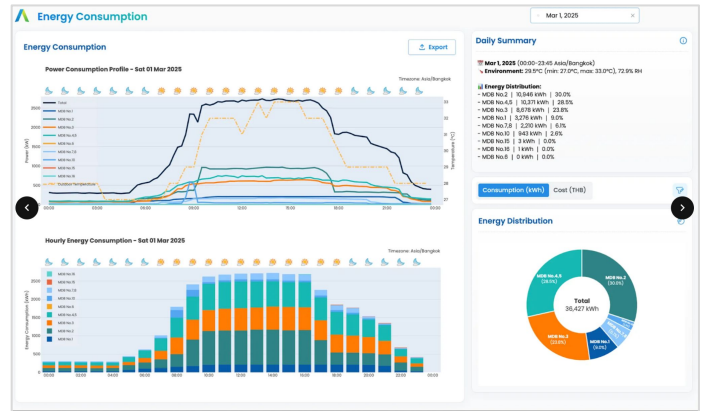
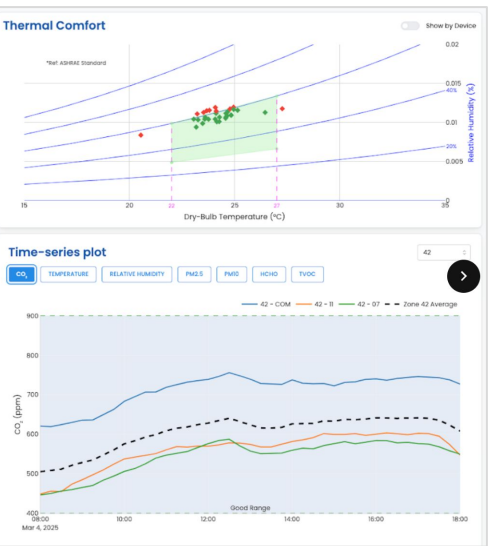
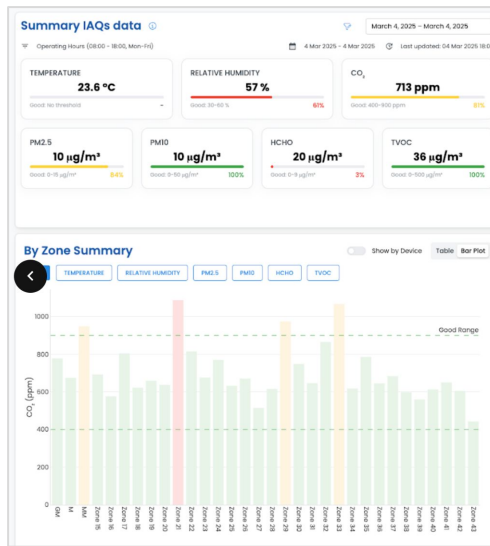
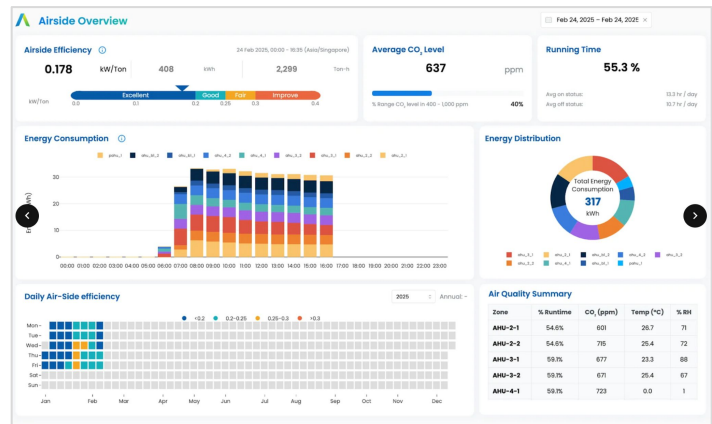
## Low-Level Controller



## Chiller Plant Field Devices

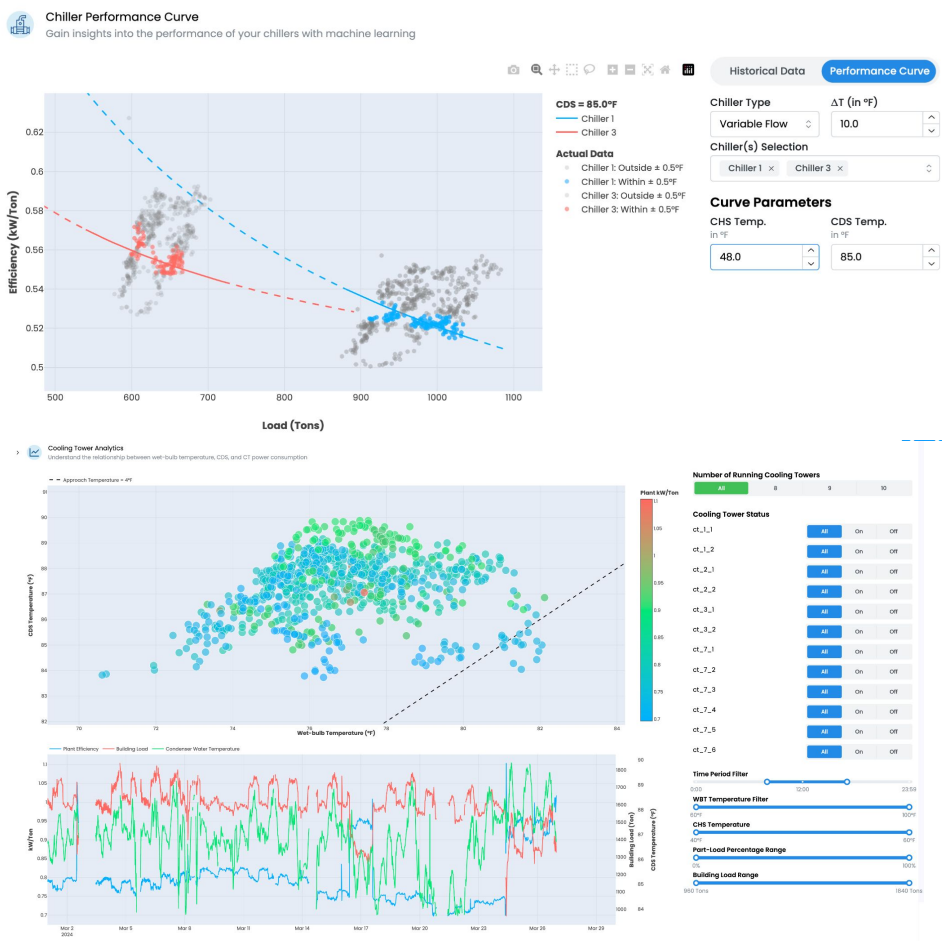
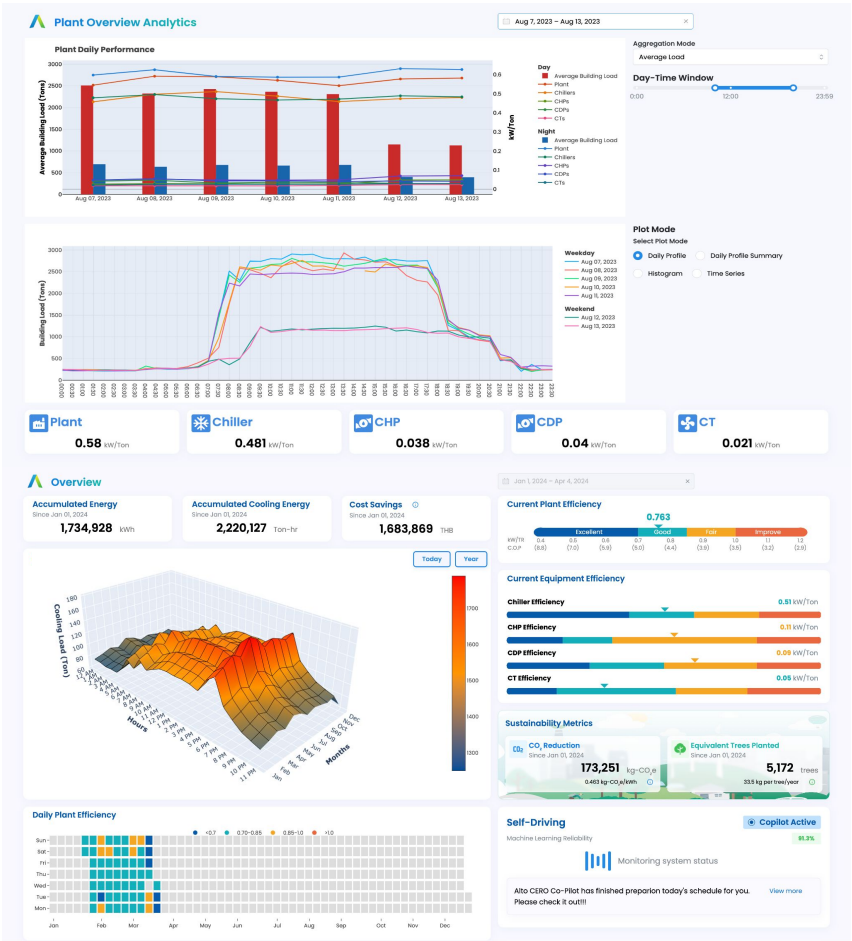


# App 2: Alto Analytics and Insights for Buildings (Airside)



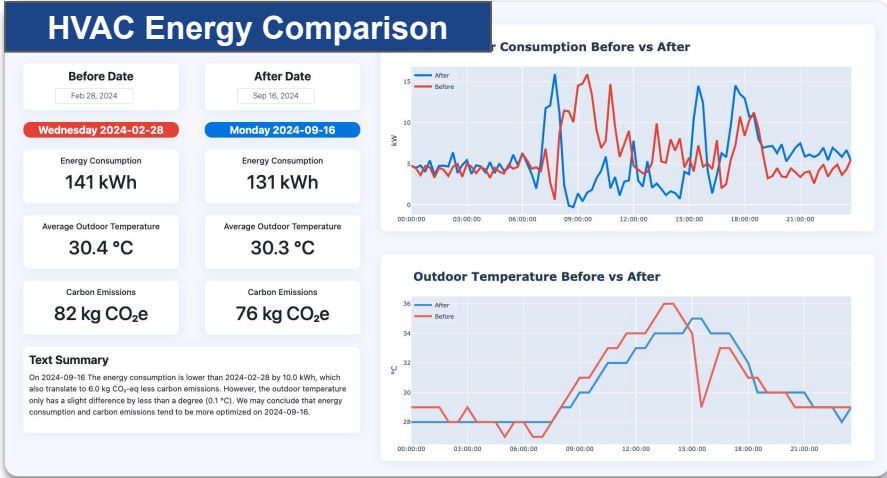
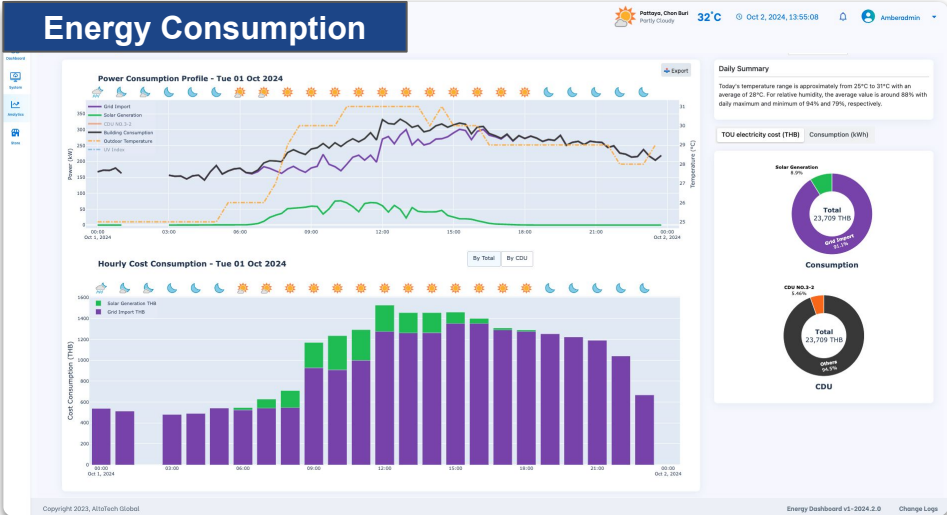


# App 2: Alto Analytics and Insights for Buildings (Waterside)





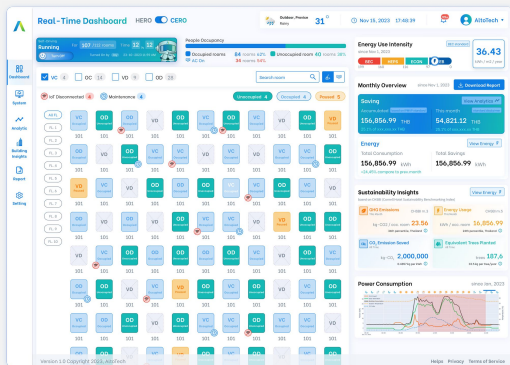
# App 2: Alto Analytics and Insights for Buildings (Savings)





# App 3: Alto Air-Side Energy Management

## Alto CERO (Air-side)



AIoT platform optimizes HVAC performance for **split-type and VRF systems** by adjusting settings automatically based on occupancy and conditions



Cost-effectiveness in reducing GHG emissions by over 10%














Emphasis on innovation, such as AI, IoT, and Big Data systems

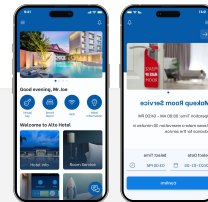






Enhancing hotel staff capabilities and increasing work efficiency

## CERO App Features




- C1  Occupancy Detection
- C2  Energy Optimization
- C3  Humidity Control
- C4  Data Analytics Dashboard
- C5  Alto Auto Report
- C6  Smart Assign
- C7  Automatic Fault Detection & Diagnosis
- C8  Predictive Maintenance
- C9  PMS Integration
- C10  CPMS Integration
- C11  Visitor Dashboard

## HERO App Features



- H1  Tenant Connex
- H2  Maid Connex
- H3  Technician Connex
- H4  Owner Connex

## Impact

-  Up to 40% Energy Savings
-  <3 years Payback Period
-  100% Improved Guest Experience



# 3 Definitions of Savings

$$1. \text{ kW/RT reduction/plant efficiency improvement (\%)} = \frac{\frac{kW}{RT} \text{ before} - \frac{kW}{RT} \text{ after}}{\frac{kW}{RT} \text{ before}}$$

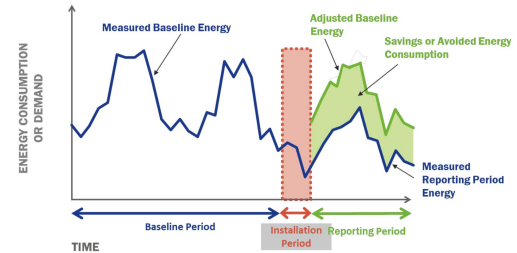
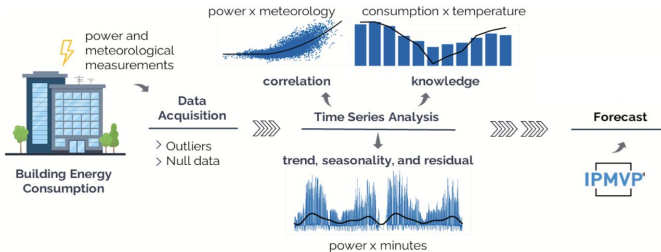
$$2. \text{ IPMVP Energy savings (\%)} = \frac{\int_t^T (P_{fcst-baseline} - P_{real})t}{\int_t^T (P_{fcst-baseline})t}$$

$$3. \text{ Monetary savings (baht/\$)} = \begin{cases} (P_{fcst-baseline} - P_{real-1})t_1 * E_{price1} & t_1, E_{price1} \in H_{peak} \\ (P_{fcst-baseline} - P_{real-2})t_2 * E_{price2} & t_2, E_{price2} \in H_{off-peak} \\ (P_{fcst-baseline} - P_{real-3})t_3 * E_{price3} & t_3, E_{price3} \in H_{holiday} \end{cases}$$



INTERNATIONAL  
PERFORMANCE  
MEASUREMENT  
& VERIFICATION  
PROTOCOL

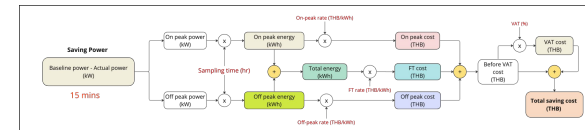
kW/RT reduction (%) != Energy savings % != Monetary savings (%)



$P_{fcst-baseline}$  Regression model built with IV(s)  
> To pass the test, here are the conditions  
1. Prediction values error < 0.005%  
2. R2 > 0.75  
3. CVrmse < 0.2  
4. Preferred: satisfies all LINE tests

## Requirements for Independent Variables (IVs)

1. There is an engineering explanation as to why changes in this variable cause energy usage to change
2. Values of the IV do not change as a result of EEM(s)
3. (When use in regression model) tstat > |2|



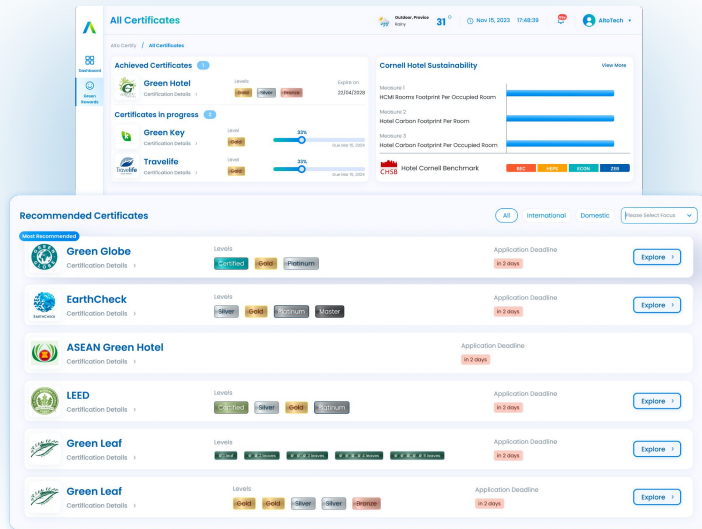


# App 4: Alto Auto Sustainability Certification Generation

Centralize all required documents for standards in one platform

## 1 Recommended Certificates

Discover and explore a recommended of green certificates tailored to your sustainability goals.



## 2 Benchmark your sustainability progress for continuous improvement.

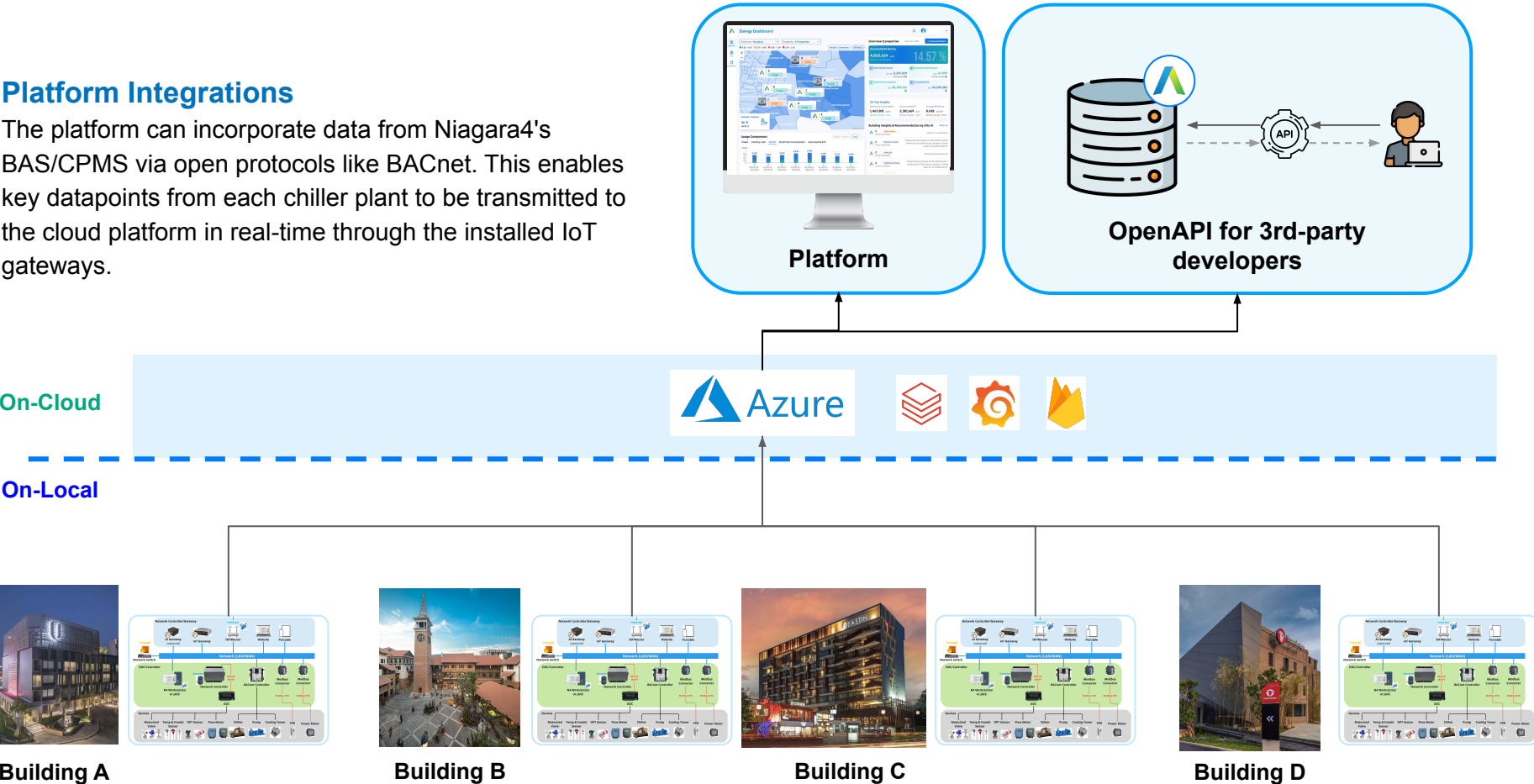




# App 5: Alto Multi-Property Management

## Platform Integrations

The platform can incorporate data from Niagara4's BAS/CPMS via open protocols like BACnet. This enables key datapoints from each chiller plant to be transmitted to the cloud platform in real-time through the installed IoT gateways.





# App 5: Alto Multi-Property Management

## Commercial Buildings



Alto Operating System  
(Alto OS)

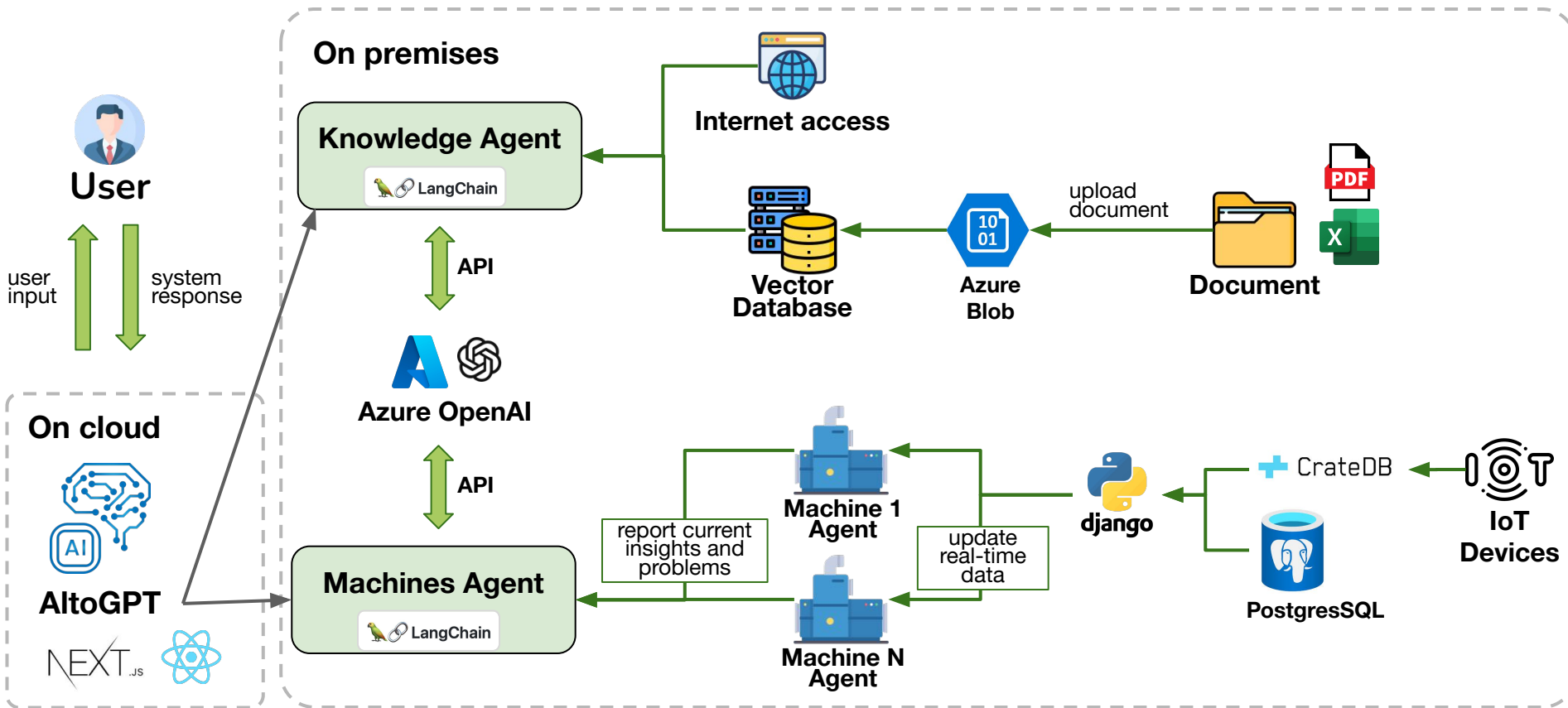


Centralized Data Platform





# App 6: Alto GPT as Virtual Chief Sustainability Engineer





Claude 3.5 Sonnet ▾



## AltoGPT

- Information about JW Marriott Bangkok's air-side and water-side systems from Alto CERO.
- Get real-time insights about energy usage, tenant comfort, and system performance.
- Ask me about building operations, and I'll help diagnose issues and provide suggestions.

Type your message...



## Analysis & Visualizations

Charts and detailed analysis will appear here as you chat

Room Condition Building Utilization Load Profile Chiller Efficiency





# App 6: Alto GPT as Virtual Chief Sustainability Engineer



**Before:** manual data export, manual data analytics, and insights extraction by expert

**After:** Software Automation for Auto-Retrieval and Summary



Chiller Plant Analytics @1 Feb 2024					
Metric	Building A	Building B	Building C	Building D	Building E
Chiller Plant Efficiency	0.816	0.541	0.621	0.622	0.553
Chiller Efficiency	0.664	0.459	0.515	0.51	0.463
CHP Efficiency	0.042	0.033	0.014	0.031	0.019
CDP Efficiency	0.045	0.026	0.062	0.045	0.044
CT Efficiency	0.064	0.022	0.033	0.036	0.027
Dry Bulb Temp (DBT)	85.5°F	89.2°F	88.7°F	87.8°F	88.7°F
Wet Bulb Temp (WBT)	74.5°F	76.7°F	75.3°F	75.0°F	76.5°F
Humidity	60.3%	56.5%	54.0%	55.5%	57.9%
Cond Temp (F)	80.8-89.2°F	81.5-91.6°F	80.8-86.8°F	81.3-89.2°F	81.7-87.6°F
Chilled Water Temp (F)	45.7-54.5°F	45.7-60.7°F	45.7-55.2°F	44.7-54.6°F	45.7-55.2°F

Chat

Compare my chiller plants (Building A, B, C, D) and analyze their operations on energy management in September 2024

เพื่อเปรียบเทียบระบบทำความเย็นของอาคาร (อาคาร A, B, C, D) และวิเคราะห์การดำเนินงานด้านการจัดการพลังงานในเดือนกันยายน 2024 เรามาสังเคราะห์ข้อมูลต่อไปนี้:

อาคาร	อุณหภูมิเปียก (°F)	การใช้พลังงาน	การใช้พลังงานในการทำความเย็น	ประสิทธิภาพ (kW/RT)	CHR (°F)	CHS (°F)	CDR (°F)	CDS (°F)
อาคาร A	77.6	955750	1518765	0.629	54.5	46.0	89.1	82.7
อาคาร B	76.5	785366	1073516	0.732	52.5	44.7	91.6	82.9
อาคาร C	78.5	439410	794483	0.553	52.9	46.0	89.9	82.7
อาคาร D	80.6	108252	182246	0.594	56.5	47.0	87.7	81.7

**การวิเคราะห์:**

- การเปรียบเทียบประสิทธิภาพ:
  - อาคาร A: ประสิทธิภาพอยู่ที่ 0.629 kW/RT ซึ่งอยู่ในเกณฑ์ "ดี" (0.7 - 0.85 kW/RT) ตามมาตรฐาน ASHRAE 90.1
  - อาคาร B: ประสิทธิภาพอยู่ที่ 0.732 kW/RT ซึ่งอยู่ในเกณฑ์ "ดี"
  - อาคาร C: ประสิทธิภาพอยู่ที่ 0.553 kW/RT ซึ่งต่ำกว่าเกณฑ์ "ดี" แสดงถึงการดำเนินงานที่มีประสิทธิภาพมาก
  - อาคาร D: ประสิทธิภาพอยู่ที่ 0.594 kW/RT ซึ่งต่ำกว่าเกณฑ์ "ดี" แสดงถึงการดำเนินงานที่มีประสิทธิภาพ
- การใช้พลังงาน:
  - อาคาร A มีการใช้พลังงานสูงสุดที่ 955750 หน่วย โดยมีการใช้พลังงานในการทำความเย็นที่ 1518765 หน่วย
  - อาคาร B มีการใช้พลังงานที่ 785366 หน่วย และการใช้พลังงานในการทำความเย็นที่ 1073516 หน่วย
  - อาคาร C มีการใช้พลังงานที่ต่ำกว่าอยู่ที่ 439410 หน่วย และการใช้พลังงานในการทำความเย็นที่ 794483 หน่วย
  - อาคาร D มีการใช้พลังงานต่ำสุดที่ 108252 หน่วย โดยมีการใช้พลังงานในการทำความเย็นที่ 182246 หน่วย
- พารามิเตอร์อุณหภูมิ:
  - อาคาร A: CHR (54.5°F), CHS (46.0°F), CDR (89.1°F), CDS (82.7°F)
  - อาคาร B: CHR (52.5°F), CHS (44.7°F), CDR (91.6°F), CDS (82.9°F)
  - อาคาร C: CHR (52.9°F), CHS (46.0°F), CDR (89.9°F), CDS (82.7°F)
  - อาคาร D: CHR (56.5°F), CHS (47.0°F), CDR (87.7°F), CDS (81.7°F)

**สรุป:**

- อาคาร C และ อาคาร D มีประสิทธิภาพสูงสุดในการจัดการพลังงาน โดยมีประสิทธิภาพที่ 0.553 kW/RT และ 0.594 kW/RT ตามลำดับ ซึ่งต่ำกว่าเกณฑ์ "ดี"
- อาคาร A และ อาคาร B ถือว่าอยู่ในเกณฑ์ "ดี" แต่มีประสิทธิภาพน้อยกว่าเมื่อเทียบกับอาคาร C และ D
- อาคาร A มีการใช้พลังงานสูงสุด ซึ่งอาจบ่งบอกถึงภาระการทำงานที่หนักหรือการดำเนินงานที่มีประสิทธิภาพน้อยกว่าเมื่อเทียบกับอาคารอื่น ๆ
- อาคาร D มีการใช้พลังงานต่ำสุด ซึ่งบ่งบอกถึงภาระการทำงานที่เบาหรือการดำเนินงานที่มีประสิทธิภาพมากขึ้น

โดยรวมแล้ว อาคารทั้งหมดดำเนินงานอยู่ในเกณฑ์ "ดี" หรือดีกว่า แต่ยังมีพื้นที่สำหรับการปรับปรุงการใช้พลังงาน โดยเฉพาะอย่างยิ่งสำหรับอาคาร A

Total tokens for generating this: 4048 tokens, time spent: 25.68 sec



## อาคารศูนย์เรียนรู้สุขภาพ

สำนักงานกองทุนสนับสนุนการส่งเสริมสุขภาพ



### เป้าหมายที่สำคัญ

เปรียบเทียบการใช้พลังงานรวมกับปีที่ผ่านมา

94.4%

เปรียบเทียบการใช้พลังงานประเภทระบบปรับอากาศกับปีที่ผ่านมา

94.6%

เปรียบเทียบการใช้พลังงานประเภทระบบแสงสว่างกับปีที่ผ่านมา

94%

PM 2.5 โดยเฉลี่ย

2  $\mu\text{g}/\text{m}^3$

ยอดเยี่ยม

ยอดเยี่ยม	0 - 15
ดี	16 - 25
ปานกลาง	26 - 65
ไม่ดีต่อสุขภาพ	66 - 150
ไม่พึงประสงค์	150 - 999

CO<sub>2</sub> โดยเฉลี่ย

440 ppm

ยอดเยี่ยม

ยอดเยี่ยม	0 - 800
ดี	801 - 1,000
ปานกลาง	1,001 - 1,500
ไม่ดีต่อสุขภาพ	1,501 - 2,000
ไม่พึงประสงค์	2,001 - 10,000

PM 10 โดยเฉลี่ย

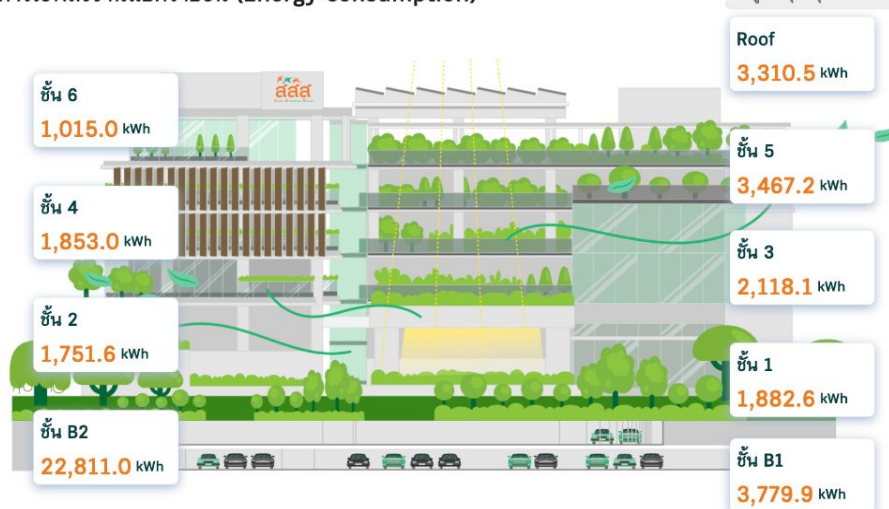
2  $\mu\text{g}/\text{m}^3$

ยอดเยี่ยม

ยอดเยี่ยม	0 - 50
ดี	51 - 100
ปานกลาง	101 - 250
ไม่ดีต่อสุขภาพ	251 - 350
ไม่พึงประสงค์	350 - 9,999

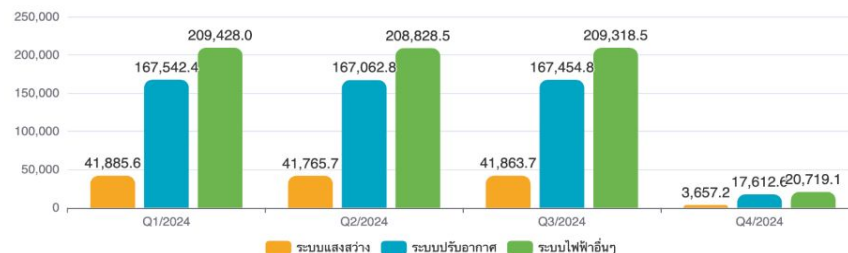
## การใช้พลังงานแยกรายชั้น (Energy Consumption)

ข้อมูลล่าสุด: ตุลาคม 2024



## การเปรียบเทียบการใช้พลังงานรายไตรมาส

Unit: กิโลวัตต์ชั่วโมง, kWh



## ค่าความเข้มข้นการใช้พลังงาน (EUI)

since Jan 1, 2024

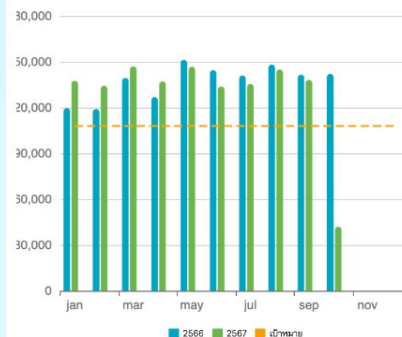


ตัวเลขด้านบน (171, 141, 82, 57) แสดงระดับประสิทธิภาพพลังงานต่างๆ:

- REF (271): อาคารอ้างอิง ใช้เป็นมาตรฐานเปรียบเทียบ
  - BEC (171): ประสิทธิภาพต่ำสุด อาคารใช้พลังงานมาก
  - HEPS (141): ดีขึ้นเล็กน้อย แต่ยังใช้พลังงานมาก
  - ECON (82): ประสิทธิภาพสูงขึ้น ใช้พลังงานน้อยลง
  - ZEB (57): ประสิทธิภาพสูงมาก ใช้พลังงานเกือบเป็นศูนย์
- 149.9 kWh/m²-y: การใช้พลังงานจริงของอาคารอยู่ในระดับประสิทธิภาพพลังงานสูง (HEPS) แสดงถึงประสิทธิภาพการใช้พลังงานที่ดีกว่ามาตรฐาน BEC แต่ยังมีศักยภาพในการพัฒนาให้ประหยัดพลังงานมากขึ้น

## การใช้พลังงานต่อปี

Unit: กิโลวัตต์ชั่วโมง, kWh



พลังงานแสงอาทิตย์ (Solar Cell) : ผลิตจากแผงโซลาร์เซลล์ที่เปลี่ยนแสงอาทิตย์เป็นไฟฟ้า ซึ่งเป็นพลังงานสะอาดและหมุนเวียน

พลังงานจากโครงข่ายไฟฟ้า (กริด): มาจากระบบจ่ายไฟฟ้าแบบดั้งเดิม ซึ่งรวมไฟฟ้าจากถ่านหิน ก๊าซธรรมชาติ นิวเคลียร์ ระบบกักเก็บไฟฟ้าใช้ตลอดเวลา แต่ยังมีทั้งข้อดีและข้อเสีย





## Bhiraj Tower at EmQuartier



1000+

tenants breathing healthier

December 18  
Monday

Phrom Phong 20m from building 20 °C

Now



Rainy

13:00



Semi cloudy

18:00



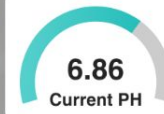
Sunny

1000+

tenants drinking qualitative water



## Water Quality Insights



Total Dissolved Solids

Good

196.31

Threshold  
500 µg/m³

42%

## Air Quality Insights

CO2

Good

697.6

Threshold  
800 ppm

83%

Can affect cognitive functions

TVOC

Good

196.31

Threshold  
500 µg/m³

42%

Can cause respiratory irritation

PM2.5

Good

1.43

Threshold  
15 µg/m³

12%

Can cause respiratory issues

Formaldehyde

Good

17.33

Threshold  
27 µg/m³

83%

Known carcinogen

Carbon Monoxide

Bad

9.68

Threshold  
9 mg/m³

89%

Highly toxic gas

Ozone

Good

26.75

Threshold  
100 µg/m³

27%

Can cause respiratory issues



For Building access scan QR Code

contact@bhirajburi.co.th | +66 202 20 20 222 | Bhiraj Tower at EmQuartier





Total Carbon Footprint  
Calculated since the  
beginning of the event

**46.39**  
tCO<sub>2</sub>e

**Carbon Footprint** The total amount of greenhouse gases produced by the event.



Scope 1  
Scope 2  
Scope 3

Day 1 Day 2 Total



Average Carbon Footprint per person-day

Estimate **51.3** kgCO<sub>2</sub>e  
Actual **33.3** kgCO<sub>2</sub>e

Attendees

**1393**  
person-day

Carbon Footprint

Calculated since the beginning of the event

**46.39**  
tCO<sub>2</sub>e

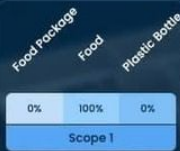
**Carbon Offset**

Actions balancing event emissions.

Purchased Credits **82**  
from estimate footprint tCO<sub>2</sub>e

**Carbon Offset Project**

7.5 Megawatt Biomass Based Power Plant  
Betong Green Power (TVERs)



Food \*3.93 kgCO<sub>2</sub>e / set  
**340.22** kgCO<sub>2</sub>e

Food Package \*0.131 kgCO<sub>2</sub>e / set  
**0** kgCO<sub>2</sub>e

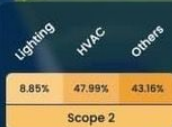
Plastic bottle \*0.1596 kgCO<sub>2</sub>e / set  
**0** kgCO<sub>2</sub>e

Eco Tip  
Finish your food, minimize food waste

Floor 3

Scope 1

**340.22** kgCO<sub>2</sub>e



Air-Side \*0.4999 kgCO<sub>2</sub>e / kWh  
**538.44** kgCO<sub>2</sub>e

Water-Side \*0.4999 kgCO<sub>2</sub>e / kWh  
**2,332.42** kgCO<sub>2</sub>e

Lighting \*0.4999 kgCO<sub>2</sub>e / kWh  
**529.2** kgCO<sub>2</sub>e

Others \*0.4999 kgCO<sub>2</sub>e / kWh  
**2,582.2** kgCO<sub>2</sub>e

Using Real-time energy monitoring system

Eco Tip  
Use Real-time energy monitoring system

Scope 2

**5,982.26** kgCO<sub>2</sub>e

Floor 2

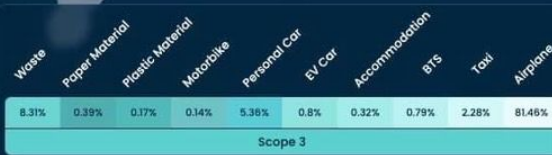
Plastic Material \*6.7071 kgCO<sub>2</sub>e / kg  
**66.8** kgCO<sub>2</sub>e

Cloth Material \*11.5 kgCO<sub>2</sub>e / kg  
**154.56** kgCO<sub>2</sub>e

Waste \*2.3896 kgCO<sub>2</sub>e / person-day  
**3,328.71** kgCO<sub>2</sub>e

Scope 3

**40,065.37** kgCO<sub>2</sub>e



**8**  
ppl

Accommodation  
**129.6** kgCO<sub>2</sub>e  
\*8.1 kgCO<sub>2</sub>e / night - person

**79**  
ppl

Airplane  
**32,638.37** kgCO<sub>2</sub>e  
\*0.1143 kgCO<sub>2</sub>e / km



**446**  
ppl

BTS  
**316.88** kgCO<sub>2</sub>e  
\*0.7102 kgCO<sub>2</sub>e / trip

**222**  
ppl

Taxi  
**911.96** kgCO<sub>2</sub>e  
\*0.1893 kgCO<sub>2</sub>e / km



Eco Tip  
Ride public transportation

**453**  
ppl

Personal Car  
**2,145.63** kgCO<sub>2</sub>e  
\*0.1622 kgCO<sub>2</sub>e / km

**75**  
ppl

Motorbike  
**54.31** kgCO<sub>2</sub>e  
\*0.0579 kgCO<sub>2</sub>e / km

**117**  
ppl

EV Car  
**318.55** kgCO<sub>2</sub>e  
\*0.0756 kgCO<sub>2</sub>e / km

Waiting  
**71** ppl

Bicycle  
**8** ppl

Eco Tip  
Share Rides



Eco Tip  
Go Electric

**CORPORATE INNOVATION SUMMIT 2024**  
Help Us  
Track Carbon Emissions!



\*The Emission Factor (EF) is referenced from Thailand Greenhouse Gas Management Organization (TGO). Carbon footprint figures are cumulative from the event start and being updated as new data arrives.



# Related Sustainability and Environmental Impact – Standards & Certifications

## Certification Criteria Supported by AltoTech



### LEED

Energy & Atmosphere, Indoor Environmental Quality



### TREES

Energy Efficiency, Environmental Quality



### ISO 50001

Energy Monitoring & Analysis, Continuous Improvement



### ISO 14064

Carbon Footprint Reporting, Emission Verification



### SmartScore / WiredScore

Digital Infrastructure, Intelligent Controls



### Green Key / Green Hotel

Resource Efficiency, Environmental Management



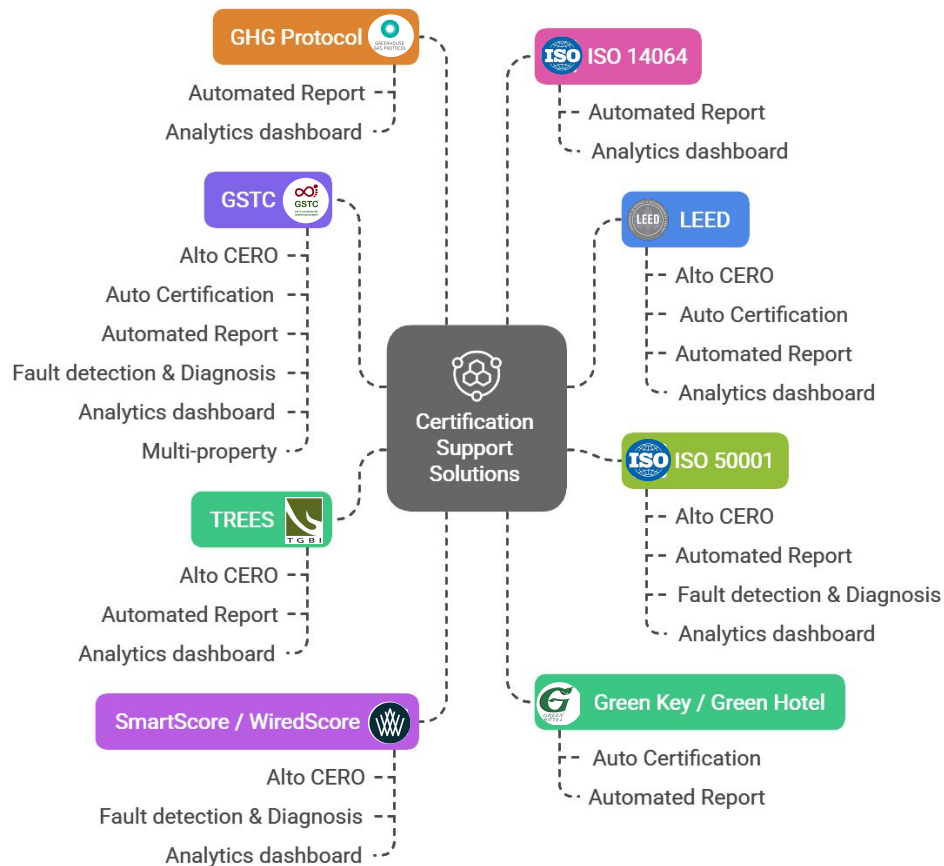
### GHG Protocol

GHG Measurement & Reporting



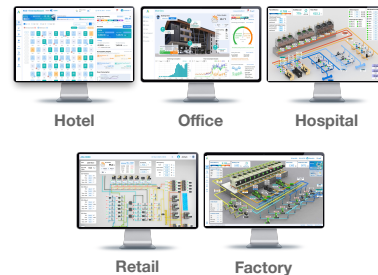
### GSTC

Sustainable Management, Environmental Sustainability



## AltoTech Implement Solutions

### Alto CERO - Maximize Machine Energy Efficiency



### AFDD - Automatic Fault Detection & Diagnosis



### Analytics Dashboard



### Auto Certification



### Multi Property



### Auto Report





# ALTOTECH'S FLEXIBLE BUSINESS MODEL CAN BE LEVERAGED BY BOTH PROPERTY OWNERS AND INVESTORS



## ALTOTECH PRODUCT & SERVICES

CAPEX  
(One-time payment)

OFFERINGS

EXAMPLES

**IOT Devices**



**Initial Software Cost**



**Alto Apps (Basic and Extended)**

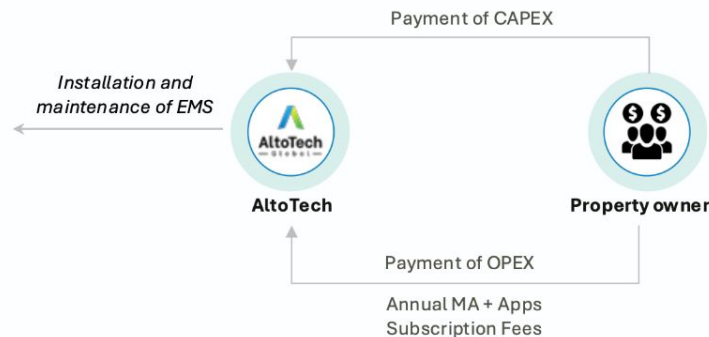


**Subscription**

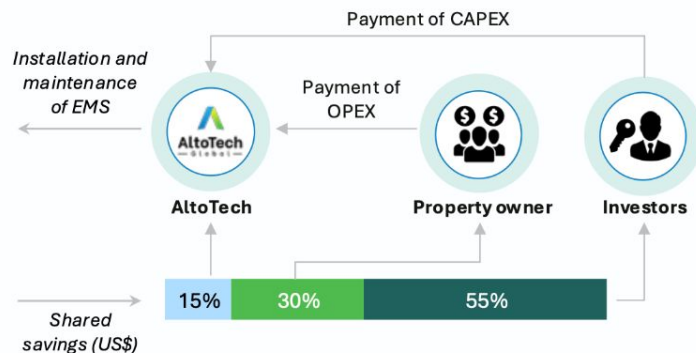


OPEX  
(Recurring payment)

## OWNER-FUNDED MODEL



## INVESTOR-FUNDED MODEL







2024  
Performance



AltoTech Global Co., Ltd

<https://altotech.ai>

[sales@altotech.ai](mailto:sales@altotech.ai)

TOTAL CO<sub>2</sub> REDUCTION \*1 kWh = 0.4999 kgCO<sub>2</sub> eq

kgCO<sub>2</sub> eq

2,875,849

EQUIVALENT TREES PLANTED\*

\*40 Trees = 1 TCO<sub>2</sub> eq



115,033

Trees

"Energy management solutions have significantly reduced operational costs, improved building performance and indoor air quality."

BUILDING  
OPERATOR



TOTAL AREA  
MANAGED



3,939,745 m<sup>2</sup>

PROPERTIES  
COMMISSIONED



68

Properties

ENERGY  
CONSUMPTION  
REDUCTION

5,752,849

kWh

RENEWABLE ENERGY  
GENERATED

483,747

kWh



MBK Center



BHIRAJ TOWER at EmQuartier

DATA MANAGED

5,441 GB

I/O POINTS CONNECTED

25,547 Points

IoT  
DEVICES INSTALLED

2,024  
Devices

ENERGY OPTIMIZATION  
AUTOPILOT HOURS

774,440

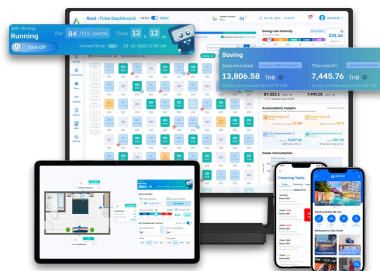
Hours



OUR CERTIFICATIONS



## Hotel



300K

Work orders  
streamlined

3,400

Hotel room  
managed

## VRV/VRF



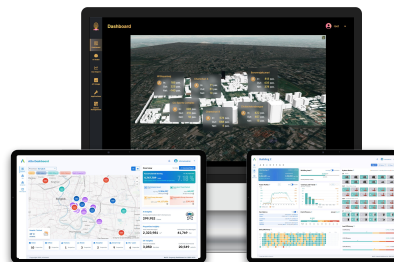
36,000

Man-hours saved

4,000 m<sup>2</sup>

Air quality  
maintained area

## Multi Property



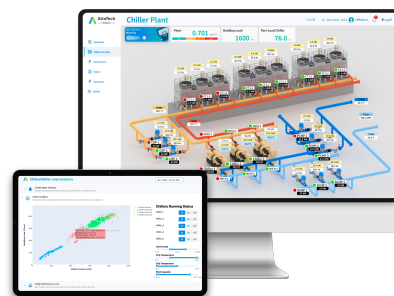
23

Properties  
managed

\$150K

Saved from manual  
operations

## Chiller Plant



30

Chillers  
optimized

10,000

Hours of manual  
operation saved



# Selected 2024 Site References

## Alto CERO (Air-side)



**BHIRAJ TOWER at  
EmQuartier**



**BITEC Bangna**



**DEDE Netzero  
Building**



**Synhub Digi-Tech**



**Hotel, Pattaya**



**True Digital Park**

## Alto CERO (Water-side)



**MBK Shopping Mall**



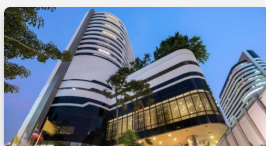
**Chamchuri Square**



**St. Regis Hotel**



**Central Rama 9**



**JW Marriott**



**Thammasat Hospital**



**Plenary Mall**



**The Crystal Ratchapruk**

## Alto Multi Property & App



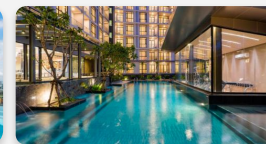
**Chulalongkorn  
University**



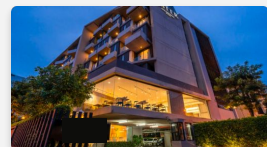
**Great Eastern,  
Singapore**



**Hotel, Pattaya**



**Hotel, Pattaya**



**Hotel, Pattaya**



**Thai Health  
Promotion Building**



**VENCO: Centralized  
Chiller Plant  
Management Platform**



- **Energy Saving up to 40%**
- **Operational Efficiency Improvement 300%**



# Projects & Opportunities

Bangkok, Thailand

68+  
Managed  
Buildings

100+  
Upcoming  
Projects 2025

## Bank and Financial institutions



## Commercial Building



## Hotels



## Factory



## Hospitals



## Central Rama 9

- 95,988 sqm Managed
- CO2 reduced 350 tco2/Yr
- Fully Automatic Controls



## MBK

Siam

- Efficiency 17.2% Improved
- 140,000 sqm Managed
- CO2 reduced 1,476 tco2/Yr
- Fully Automatic Controls



## Bhiraj Tower @Emquartier

Phrom Phong

- 20% Man-Hour saving
- Achieved WELL Standard
- 49,732 sqm Managed





# Start **Net-Zero journey** for your Hotel with Smart Solutions Today!



## Renewable Energy System



Reduce your carbon footprint and saved energy costs with solar power and energy storage solutions.

## Solar Energy System



Specializes in advanced nano coatings designed to enhance the efficiency, durability, and functionality of surfaces across various industries, including solar energy and construction.

## Smart HVAC System



Innovation energy-saving solutions for a sustainable future in water heating and air conditioning.

## Carbon Footprint Monitoring System



Turn reduced carbon into maximum benefits by submitting data on assessment platforms to apply for environmental certifications.

## Forest-Planting-as-a-Service Platform



Helps property owners achieve sustainability objects and engage with customers and other stakeholders at the same time.

## Electric Vehicle (EV) Charging Stations



Liquid-cooled Ultra Fast Charging, the fastest electric vehicle charging in the world, delivers a maximum power output of 720 KW. With just 5 minutes of charging, it provide a driving range of up to 200 km.

## Electric Mobility System



Transform your mobility journey to the cleanest one.

## Building Automation & Control System



Up to **40%** Energy Savings

"Alto CERO" to help hotels to effectively consume energy and cut carbon emission with IoT and AI algorithms.

## Sustainable Water Management System



An advanced green and climate technology that offers the lowest operation cost for severely polluted wastewater.

## AI-powered Smart Waste Water Treatment Management System



Utilizing IoT and Big data for efficient monitoring, optimizing up to 30% energy savings.

## Waste Management and Recyclin System



Digital Waste Platform that helps companies to shift from "dispose of" to "manage" their waste successfully.

## Urban Mobility



Muvmi, an on-demand microtransit service with 700+ EVs, powered by AI dynamic route pooling, serving over 10 Mn passengers and saving over 2,700 tons of CO2 (certified).



✉ [sales@altotech.ai](mailto:sales@altotech.ai)

🌐 <https://altotech.ai>

📘 [altotech.ai](https://altotech.ai)

🗣️ [@altotechglobal](https://altotech.ai)





# ALTOTECH IS IN A STRONG POSITION TO TAKE ADVANTAGE OF A SUBSTANTIAL UNTAPPED MARKET







"JOIN US IN PIONEERING THE FUTURE OF ENERGY  
WITH AI. TOGETHER, WE CAN ACHIEVE  
SUSTAINABILITY AND EXCEED NET-ZERO  
TARGETS"



PRESENTED BY

**DR. WARODOM  
KHAMPHANCHAI**

CEO AND CO-FOUNDER

[WWW.ALTOTECH.AI](http://WWW.ALTOTECH.AI)  
[KWARODOM@ALTOTECH.AI](mailto:KWARODOM@ALTOTECH.AI)

AFFILIATED ASSOCIATIONS



Thai  
**ESCO** Association  
สมาคมอนุรักษ์พลังงานและสิ่งแวดล้อมไทย



# Backup Slides



# Global Research Activity

In Building Energy Management System

## NA

Leaders in technologies and AI but not specialized in Hot & Humid climate.



Research Activity: **High**



Real-World Implementation: **Low**



## EU

Relative to other areas, there is a scarcity of scholarly research focused on optimizing HVAC systems



Research Activity: **Moderate**



Real-World Implementation: **Low**



## APAC

Highly active in the academic research field, yet not many real-world implementations.



Research Activity: **High**



Real-World Implementation: **Low**



**Huge Opportunity**

## Technologies



AI Optimization



Smart Report



IoT Integration



Data Ontology



Data Analytics



Certification Facilitation



ML-Based Data Analytics



## AltoTech

Superior in terms of features and real-world implementation, especially in hot and humid regions. Not only pushes the boundaries of deep research but also consistently pioneers practical applications in real-world settings.



\*Statistical data were derived from the review of 209 research papers.

[1] A Review of HVAC System Optimization and Its Effects on Saving Total Energy Utilization of a Building

[2] A review of optimization approaches for controlling water-cooled central cooling systems



# INVESTMENT TIMELINE AND FUNDRAISING OBJECTIVES

*AltoTech Global is seeking US\$ 8M in equity as part of its Series A fundraising round to advance its AI research and development and expand further in SEA*

*Our fundraising journey focuses on building a sustainable future, evolving from single-building management to multi-property solutions, and ultimately to smart city management initiatives*

Expand into the Thai market and develop a new platform for demand response and energy trading

**Pre-Series A Round** **US\$ 2.1M Raised**  
Valuation US\$10 M  
BANPUNEXT  
INNOPOWER

SEP 2022

Completed product for hotels, small buildings, smart cities, and field Hospital

**Seed Round** **US\$ 250K Raised**  
500 startups  
ENSOL  
Sprint  
HOLDING

SEP 2021

Developed POC<sup>1</sup> product for hotels

**Founders Round** **US\$ 50K Raised**  
FUTURECON  
BBAIR GROUP  
RISE  
SYN

NOV 2019

Series A



**US\$ 8M**  
by 1Q 2025

*Proceeds will be strategically deployed to develop **cutting-edge AI capabilities** that will serve as the foundation for our **global growth strategy***





# GROWTH THROUGH A MULTI-PRONGED APPROACH OF PARTNERING WITH LOCAL SERVICE PROVIDERS AND SYSTEM INTEGRATORS



## REGIONAL EXPANSION



### HONG KONG: ASIA'S BUSINESS GATEWAY

Many high-rise buildings, >70% of projects under construction, enterprises are looking to implement ESG practices and have high willingness to try AI solutions

- Engage with property management groups managing multi-property portfolios for market validation and regulatory alignment

### SINGAPORE: GREEN BUILDING PIONEER

A global leader in smart city development, high concentration of buildings with mandatory sustainability standards, high energy costs and strong government support

- Focus on high-end commercial buildings and green-certified projects due to strong regulatory incentives

### THAILAND: DOMESTIC CHAMPION

Headquarter with established clientele and growing demand due to government support and incentives, rapid urbanization and construction, and a green building trend due to having one of the highest energy costs regionally

- **Target:** > 20% - 30% market share in the energy efficiency and smart building sector
- **Key regions:** Bangkok, Pattaya, Chiang Mai, Phuket, and Koh Samui
- **Partnerships:** Strengthen collaboration with local SIs to expand service offerings

## EXPANSION STRATEGY

### 1 SCALING INTO NEW GEOGRAPHIES THROUGH PARTNER NETWORK

AltoTech Global plans to accelerate market entry into new geographies by collaborating with trusted local partners, such as C&W Services in Singapore, who will provide market access, compliance support and quick scalability



### 2 SCALING AS A TECHNOLOGY PROVIDER TO SI PARTNERS











AltoTech Global aims to leverage its strategic partnerships with Banpu Next and other System Integrators (SI) to become their Tech provider and thus, highlight its advanced capabilities in building automation and drive adoption of its technology





# ADOPTION OF SUPPORTIVE POLICIES WILL AID ALTOTECH'S GROWTH

Legend: ■ Favorable ■ Modest ■ In development

TARGET REGION	 Energy Efficiency	 Building Emissions	 Building Codes	 Energy conservation	 Net Zero Buildings
<b>THAILAND</b> 	<ul style="list-style-type: none"> <li>Drafted the <b>Energy Efficiency Plan (EEP) 2022-37</b> aiming to promote its energy efficiency. The EEP2022 specifies a target of <b>36% energy intensity reduction</b> by 2037 – base year 2010</li> </ul>	<ul style="list-style-type: none"> <li>Aims to reduce 5,316 Ktoe in the <b>commercial and residential sector</b>, contributing <b>15% to total energy saving</b> by 2037</li> </ul>	<ul style="list-style-type: none"> <li>Thailand's BEC 4.0 covers <b>903 government and private buildings<sup>1</sup></b>, featuring web-based tools and promoting equipment standards and labeling for capacity buildings</li> </ul>	<ul style="list-style-type: none"> <li>The EEP2022 includes <b>voluntary and complementary programs</b> to promote energy-efficient appliances and develop HR for hiring Energy Auditors and Managers</li> </ul>	<ul style="list-style-type: none"> <li>Thailand's Energy Ministry piloted a <b>Net Zero Energy Building (ZEB) within the DEDE<sup>2</sup> building</b>, utilizing innovations like IoT, smart technology, AI, and big data</li> </ul>
<b>SINGAPORE</b> 	<ul style="list-style-type: none"> <li>Singapore targets to <b>reduce its emissions intensity by 36% from 2005 levels by 2030</b>, and to stabilise emissions to peak around 2030</li> </ul>	<ul style="list-style-type: none"> <li><b>Launched SGBMP<sup>3</sup> in 2021</b> with the target to have at least <b>80% of buildings</b> (by floor area) in Singapore to be green by 2030</li> </ul>	<ul style="list-style-type: none"> <li>In 2021, <b>BCA<sup>4</sup> Green Mark Certification Scheme</b> is updated and became mandatory for buildings over 5,000 m<sup>2</sup></li> </ul>	<ul style="list-style-type: none"> <li>The Energy Conservation Act <b>mandates industry sectors to report energy efficiency</b> and grants training for energy managers</li> </ul>	<ul style="list-style-type: none"> <li>Since 2018, BCA has promoted ZEB under the <b>Super Low Energy Programme</b>, but adoption remains under 2%</li> </ul>
<b>HONG KONG</b> 	<ul style="list-style-type: none"> <li>Developed <b>Climate Action Plan 2050</b> that targets to be carbon neutral by 2050, <b>promoting adoption of energy-efficient technology in buildings</b></li> </ul>	<ul style="list-style-type: none"> <li><b>Developing legal frameworks</b> to enhance energy efficiency in buildings and appliances while promoting systematic decarbonization efforts</li> </ul>	<ul style="list-style-type: none"> <li>Introduced <b>BEAM Plus Certification</b>, a voluntary private sector initiative administered and recognized by the Hong Kong Green Building Council (HKGBC)</li> </ul>	<ul style="list-style-type: none"> <li>To <b>reduce commercial buildings' electricity consumption</b> by 30% to 40% and that of residential buildings by 20% to 30% from the 2015 level by 2050</li> </ul>	<ul style="list-style-type: none"> <li>Hong Kong's Climate Action Plan 2050 targets <b>net-zero carbon emissions for new public buildings by 2030 and all new buildings by 2050</b></li> </ul>
<b>INDONESIA</b> 	<ul style="list-style-type: none"> <li>Launched the new <b>Energy Efficiency and Electrification Working Group (E3WG)</b> in May 2024, focusing on the Industry, supply side efficiency, buildings and appliances, and transport</li> </ul>	<ul style="list-style-type: none"> <li>Targeting emission reductions of <b>1.9 Mt of CO<sub>2</sub> in the commercial building and 25.9 Mt of CO<sub>2</sub> in the residential building</b> sub-sector through energy efficiency efforts by 2030</li> </ul>	<ul style="list-style-type: none"> <li><b>Limited incentives exist</b>, highlighting the need for stronger policies to prioritize green buildings in the future</li> </ul>	<ul style="list-style-type: none"> <li>Launched in 2023 under government regulation, the <b>Energy Conservation Program</b> promotes energy-efficient technology and investment</li> </ul>	<ul style="list-style-type: none"> <li>Net Zero Buildings regulations <b>lack recent updates</b>, with ongoing challenges in market readiness and technical guidance</li> </ul>
<b>VIETNAM</b> 	<ul style="list-style-type: none"> <li>The Vietnam Energy Efficiency Program (VNEEP 3), issued in 2019, aims for <b>90% of cities and provinces to develop energy-saving and efficient programs</b> by 2025</li> </ul>	<ul style="list-style-type: none"> <li>Vietnam launched the <b>NDC Roadmap for a low-carbon, climate-resilient building sector</b>, targeting a 8% reduction in GHG emissions by 2030 (11.84 Mt CO<sub>2</sub>)</li> </ul>	<ul style="list-style-type: none"> <li>In 2010, VGBC introduced <b>LOTUS, the only certification fully compliant with Vietnamese building codes</b>, with no recent developments</li> </ul>	<ul style="list-style-type: none"> <li>Developing <b>Voluntary Agreement Program (VAS)</b> to encourage the use of energy saving and efficiency in the industrial sector</li> </ul>	<ul style="list-style-type: none"> <li>Local progress in low-carbon building development has <b>been relatively slow</b> without specific mandatory regulations</li> </ul>

Note: [1] from 2009-22; [2] Department of Alternative Energy Development and Efficiency; [3] Singapore Green Building Master Plan; [4] Building and Construction Authority

Source: AWR Lloyd analysis, Government website, Press



# RISING DEMAND FOR SUSTAINABLE BUILDINGS AND ENERGY EFFICIENCY WILL UNLOCK RAPID GROWTH OPPORTUNITIES

## ASEAN'S ENERGY DEMAND SURGE



ASEAN's energy demand is projected to **grow almost 2x by 2050**, driven by urbanization, population growth, and rising living standards. **Buildings will account for nearly 50%** of electricity demand growth by 2025

## GOVERNMENT REGULATIONS AND POLICIES



**Southeast Asian governments are tightening energy efficiency standards and building codes.** For instance, Thailand's Power Development Plan 2024-2037 features an updated energy efficiency strategy

## RISING COOLING TECHNOLOGIES DEMAND



With strong growth in the number of buildings and rising appliance ownership, the stock of **air conditioners in SEA projected to grow ninefold**, from around 30 M units in 2020 to 275 M units in 2040. Introducing energy efficiency appliance can temper rising carbon emissions

## RISING ENERGY PRICES



According to FTI<sup>1</sup>, the industrial sector faces a **20% rise in production costs due to higher energy prices**. Energy management systems are key to reducing costs, providing long-term value investment and net-zero goals

## CORPORATE COMMITMENTS TO NET-ZERO



**Many companies are setting ambitious net-zero targets**, investing in energy-efficient building designs and operations to reduce their carbon footprints and implementing green building certifications such as LEED<sup>2</sup>

## PUBLIC DEMAND FOR SUSTAINABLE BUILDINGS



**Growing environmental concerns and increased awareness of climate change** are leading people to seek for eco-friendly living spaces, prompting developers to prioritize sustainability in building designs

## ADOPTION OF GREEN BUILDING STANDARDS



**Green-certified buildings in ASEAN show 20-70% lower energy use** than uncertified ones. All ASEAN countries now enforce or develop energy performance standards for air conditioners and other appliances

## RETROFITTING EXISTING BUILDINGS



Companies are upgrading buildings for energy efficiency. **Keppel's renovation of Keppel Bay Tower in Singapore cut energy use by 30%**, making it the country's first zero-energy commercial building with smart HVAC

## GROWTH IN ENERGY EFFICIENCY TECHNOLOGY

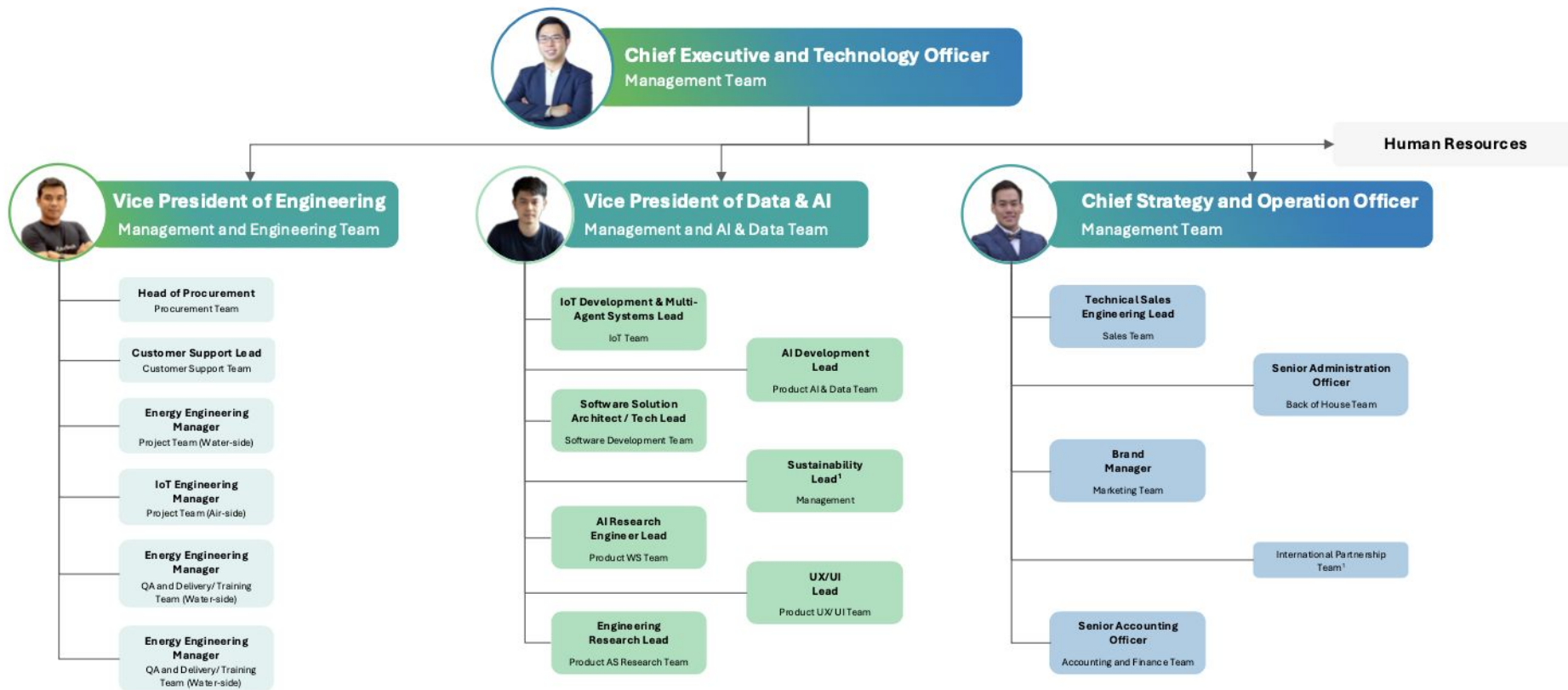


The ASEAN building digitalization market, though still in its early stages, is expected to grow significantly. In 2022, about **30 M smart meters were installed across the region**, and many pilot projects are underway



# ALTOTECH ORGANIZATIONAL STRUCTURE

**Team and capabilities:** 29 professionals skilled in Engineering, AI, and business development



Note: [1] Sustainability and International partnership department led by Chief Executive and Technology Officer (Management team)



# OUR AWARDS



We're proud to be the **winners** of many awards and being trusted by well recognized judges, investors, and partners



## Tech in Asia

Secured the Grand Prize at the Startup Arena Pitch Battle Finals, triumphing over more than 300 participating startups



## Info Pacific Climate Tech 2024

Received Top 100 award at Indo Pacific Climate Tech by Holon IQ (Quacquarelli Symonds)



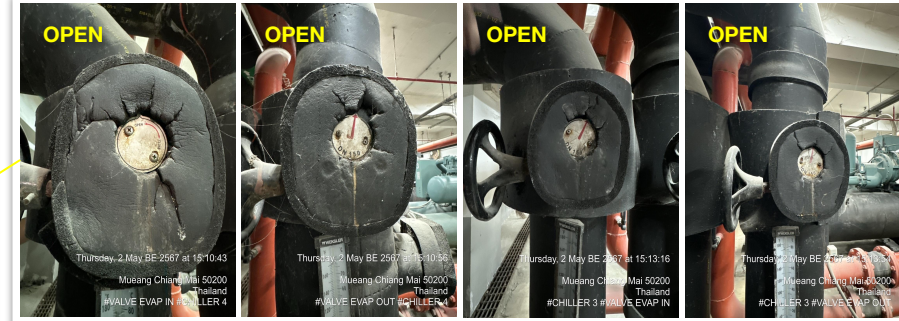
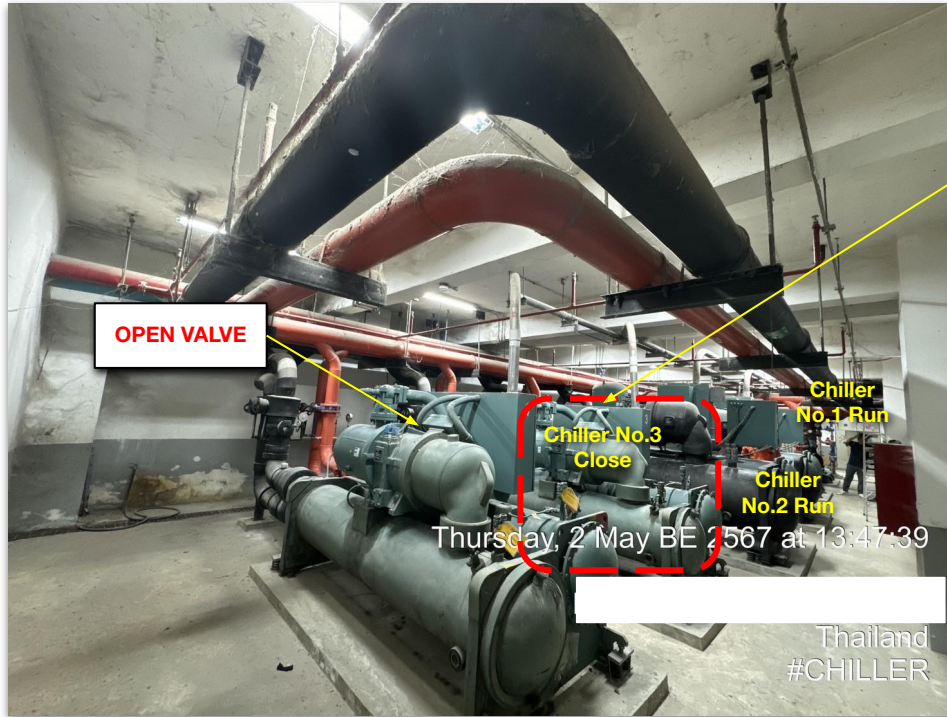
## Echelon X Top 100 Startup

Recognized as Top 100 Startup award at Echelon X





# Chiller Plant Operation : Manual Operated

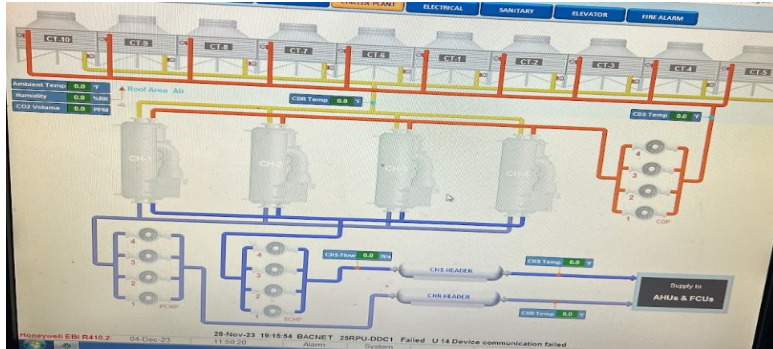


- Chiller 4 Sets :
  - CH-01,02 Capacity 250 RT = 2 sets is **Running**
  - CH-03,04 Capacity 130 RT = 2 sets **off**
- Valve CH-01,02 on status follow CH-01,02 on (Ok)
- Valve CH-03 on status but CH-03 off (Not Ok)
- Valve & Chiller : CH-04 status off (Ok)

“การที่เปิดวาล์วหน้า Chiller ที่ ในขณะที่ Chiller ปิดอยู่”  
ส่งผลให้น้ำเกิดการ By Pass ไปผ่าน Chiller ที่ปิด มีอุณหภูมิ  
“Chilled Water Supply สูงขึ้น”



# Chiller Plant Operation : Auto Control by CPMS



## ข้อดี

- มองเห็น Parameter และ status ของอุปกรณ์ต่างๆที่ทำงานอยู่ใน Chiller Plant
- สามารถควบคุมการเปิดปิดการทำงานของอุปกรณ์ต่างๆใน Chiller Plant ได้

## ข้อเสีย

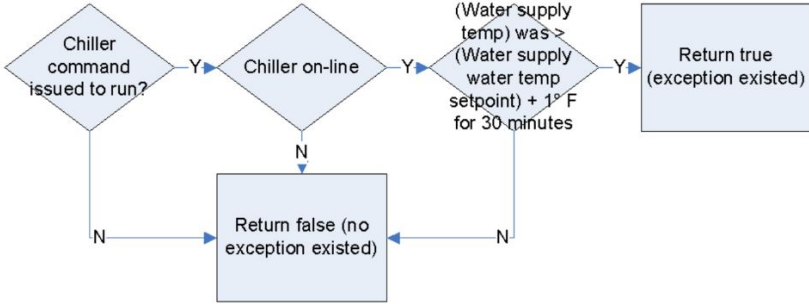
- ไม่สามารถตรวจจับความผิดปกติของอุปกรณ์แต่ละตัว กรณีอุปกรณ์อุปกรณ์ตัวนั้นใกล้ถึงเวลาการ PM, Repair และ Overhaul
  - ไม่สามารถควบคุมการทำงานแบบ “Full Automatic Control”
- (ยังต้องให้ user เป็นคนตัดสินใจในการควบคุมเปิดปิดอุปกรณ์นั้นๆตามความเหมาะสม)



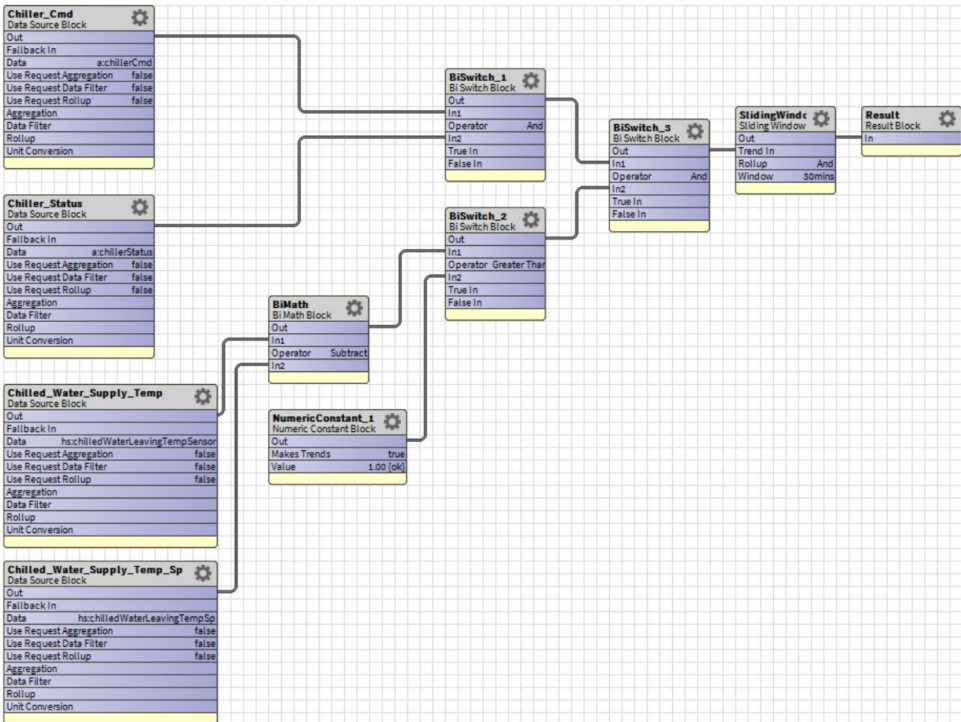
Traditional control logics for BAS, CPMS

Need explicit program e.g. PID, On/Off, or Float Control

Flowchart



Too High Chilled Water Supply Temp algorithm Flowchart

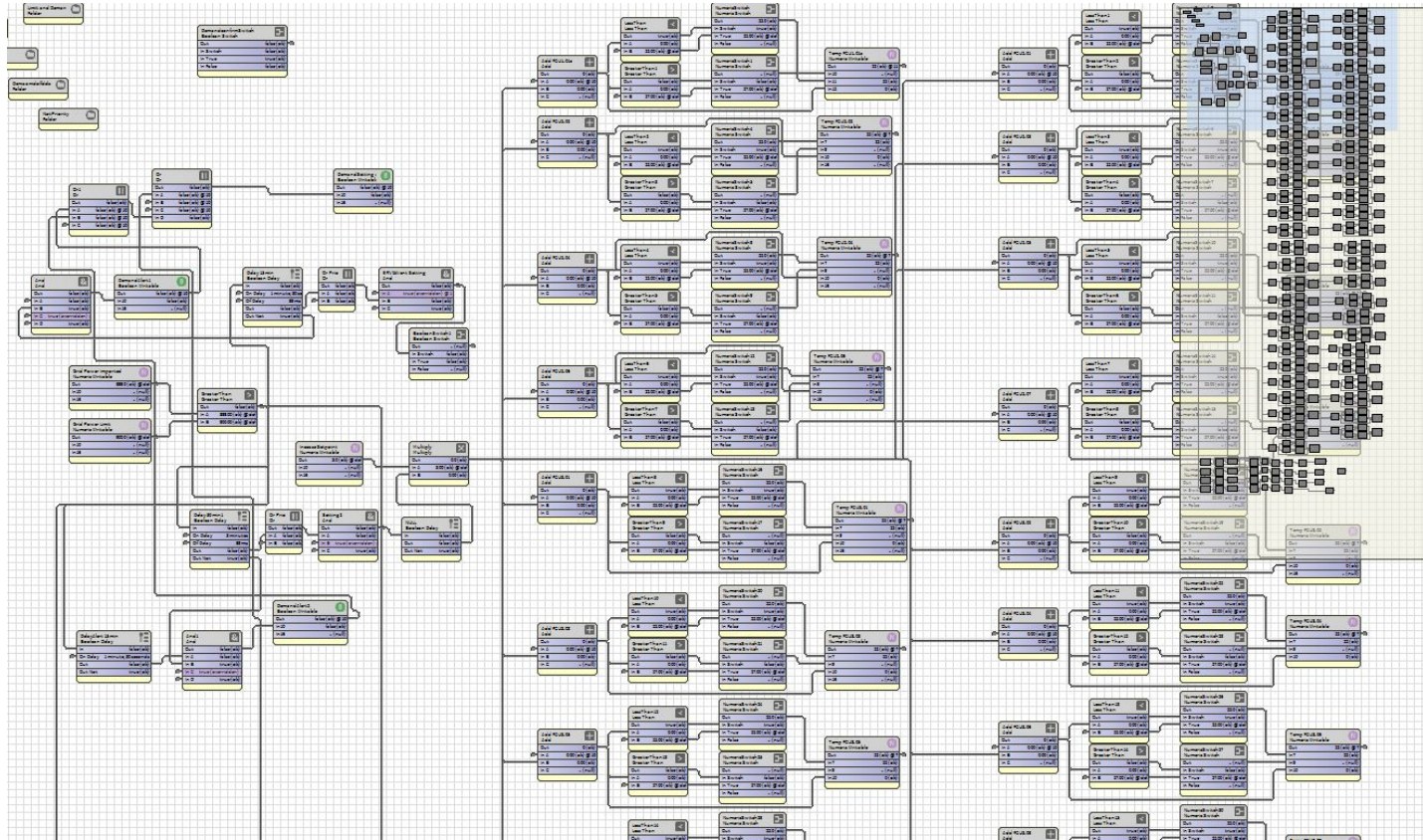


Logic Blocks



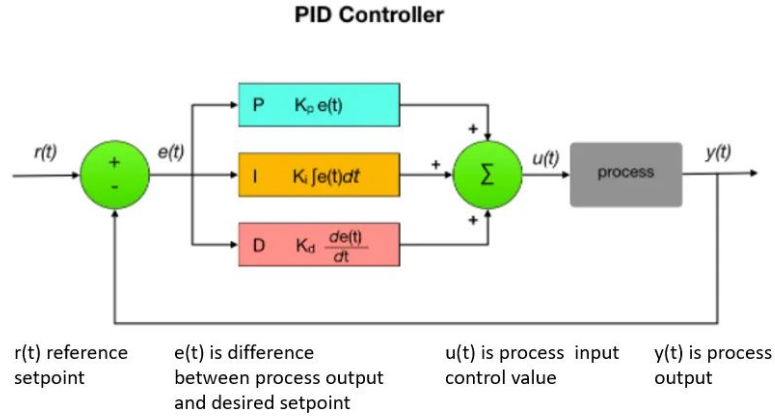
Traditional control logics for BAS, CPMS  
Need explicit program e.g. PID, On/Off, or Float Control

## Demand Limit Algorithms

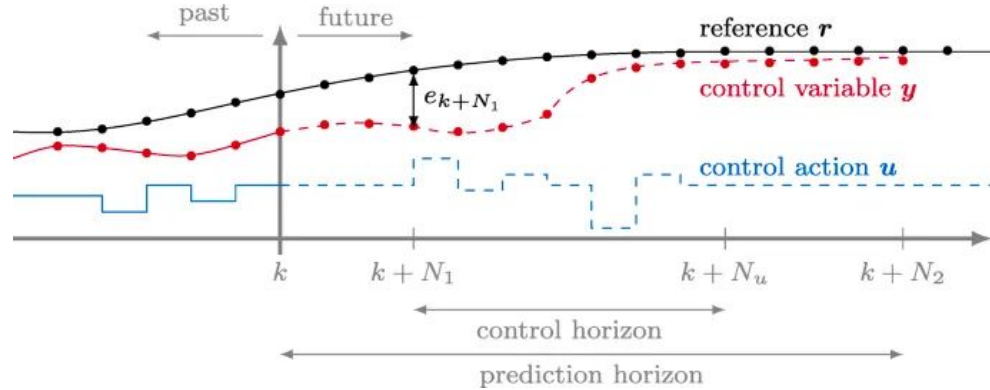




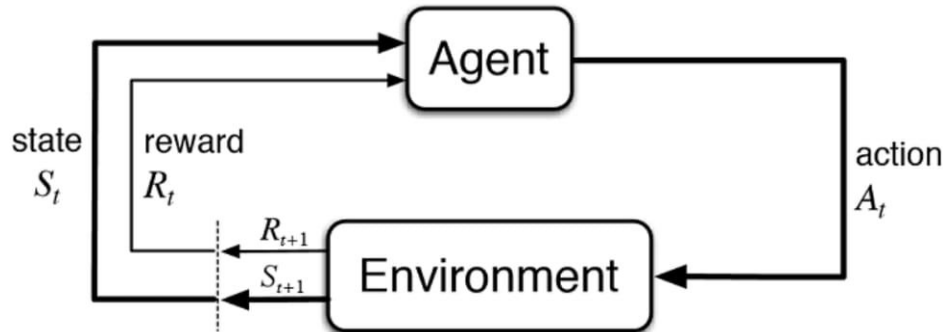
# PID vs MPC vs RL



## Proportional – Integral – Derivative



## Model Predictive Control



## Reinforcement Learning



## Smart Energy Management System

Strategies	Technologies	Description	Potential Energy Performance
Smart Energy Management System	ACMV Optimization	Holistically optimize the sequence control and set points control of each equipment of ACMV system to minimize the system energy consumption.	H
	Continuous commissioning	An ongoing process to resolve operating problems, improve comfort, and optimize energy use.	M
	Retro-commissioning	A systematic process to improve an existing building's performance. Using a whole-building systems approach, retro-commissioning seeks to identify operational improvements that will increase occupant comfort and save energy.	M
	Building Energy Management System (BEMS)	An integrated building energy management system that helps measure, monitor and manage the building performance and empower stakeholders to drive energy smart behaviour.	H
	Fault detection and diagnosis system (FDD)	A measurement science that enables automatic detection and diagnosis of equipment faults, sensor failures, and control errors in the ACMV systems of buildings. The resulting fault detection and diagnosis (FDD) software ("FDD tools") will utilize existing sensors and controller hardware, and will employ artificial intelligence, deductive modelling, and statistical methods to automatically detect and diagnose deviations between actual and optimal ACMV system performance.	H
	Demand ventilation controls	An integral part of a building's ventilation design. It adjusts outside ventilation air based on the number of occupants from the occupancy sensors, and the ventilation demands that those occupants create.	M
	Weather sensing and adaptive controls	An integral part of an ACMV Optimization. It enables the system to take predictive or proactive action necessary to properly adapt to the variable volatility in weather to reset the operation set points to save energy consumption.	L-M

Model-Predictive Control	An intelligent control system that can analyse a building's energy efficiency so that developers can optimise the building's energy performance and its occupants can enjoy a better indoor air quality.	M
IoT integration with BMS	A system that collects real-time information on a building's energy and water consumption and analyses it with patterns of human activities so that energy consumption from its fixtures and appliances can be optimised.	H
Personality-based EMS	An energy management system for a building that takes into consideration its occupants/users' behaviours and personalities. The results of the analysis will determine the pattern of energy use and optimise energy savings.	M
BIM Integration with Energy MM&V	This system will "merge" or "integrate" a virtual three-dimensional model of a building with a model of its energy consumption using a series of measuring tools. By putting both models together, building professionals can analyse the measurements as well as patterns of energy consumption and create simulations that attempt to reduce the energy consumption to a minimum	H
Data-Driven Modelling and Real-Time Optimisation for Chiller Plant	A model that optimises the energy performance / consumption of an air-con chiller plant by tracking and analysing real-time data, and then identifying the patterns of human usage for optimal energy performance	H
Machine Learning Model	A system that tracks building occupants' thermal comfort with wearable devices (e.g., wristband and smart watches) to sense their vital signs (e.g., heart rate and skin temperature). With the collected data, the system can then adjust the building's air-condition system and room temperature for better energy efficiency without compromising its occupants' comfort.	M



Filter

### Green Mark Rating

- ☐ Certified
- ☐ Gold
- ☐ GoldPlus
- ☐ Legislated
- ☐ Platinum
- ☐ Uncertified

### Building Type

- ☐ Hotel
- ☐ Mixed Development
- ☐ Office
- ☐ Retail

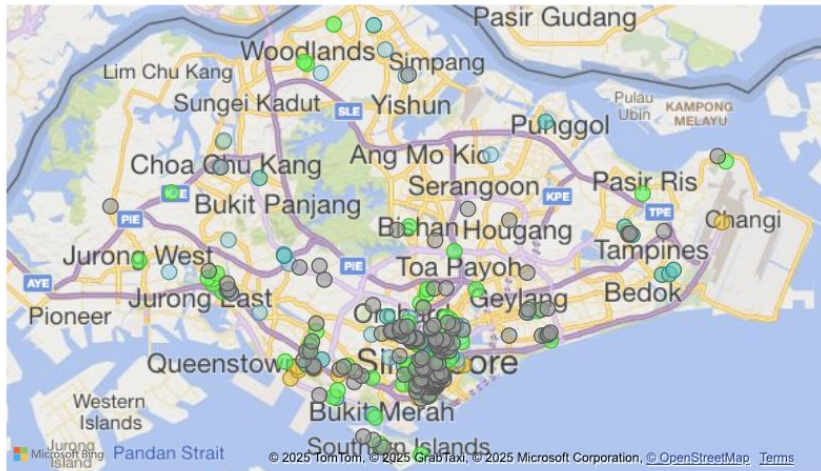
### Building Size

- ☐ Large
- ☐ Small

## Overview of Buildings

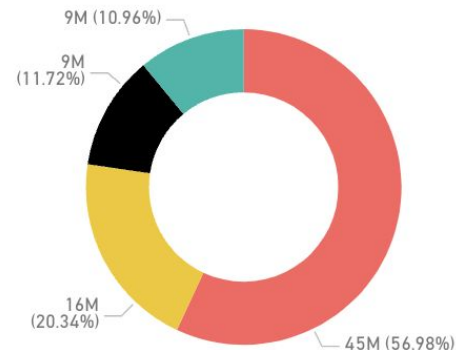
### Geospatial Map of Building from BESS 2020

Green Mark Rating ● Certified ● Gold ● GoldPlus ● Legislated ● Platinum ● Uncertified



### Gross Floor Area by Building Type

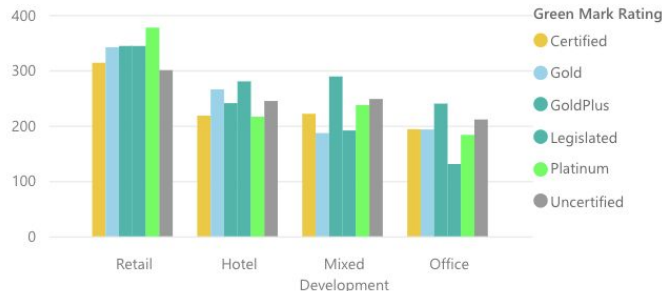
Building Type ● Office ● Retail ● Mixed Development ● Hotel



### Average Building EUI From 2017 - 2020



### Average Building EUI in 2020



### BESS Building by Building Type

