

## Energy Optimization in Buildings: Predictive Modelling for Chiller Equipment Efficiency

### System Setup

#### Step 1: Install Python.

- Head to Python's website, <https://www.python.org/>, and download version 3.10.16
- Follow the installation instructions, make sure to check the option to add Python to your system PATH.

#### Step 2: Install Visual Studio Code (VSC) and Anaconda Navigator.

- Download and install from Visual Studio Code website, <https://code.visualstudio.com/>, and Anaconda Navigator's website, <https://www.anaconda.com/products/navigator>.

#### Step 3: Create New Environment.

- Open Anaconda Navigator and head to the “Environments” tab and click “Create”.
- Name the environment (e.g., Streamlit) and select Python 3.10.16.

#### Step 4: Activate the environment.

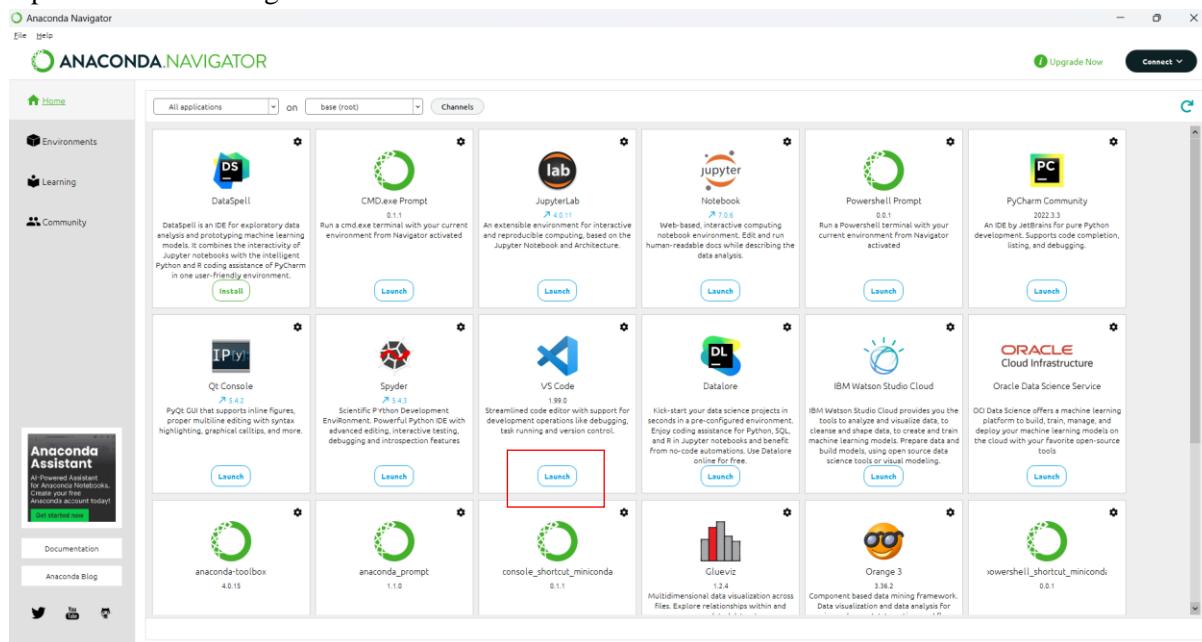
- Launch Anaconda Navigator and activate the environment with the command “conda activate Streamlit” in the integrated terminal.

#### Step 5: Install Necessary Libraries and Dependencies from Table 10 in the environment.

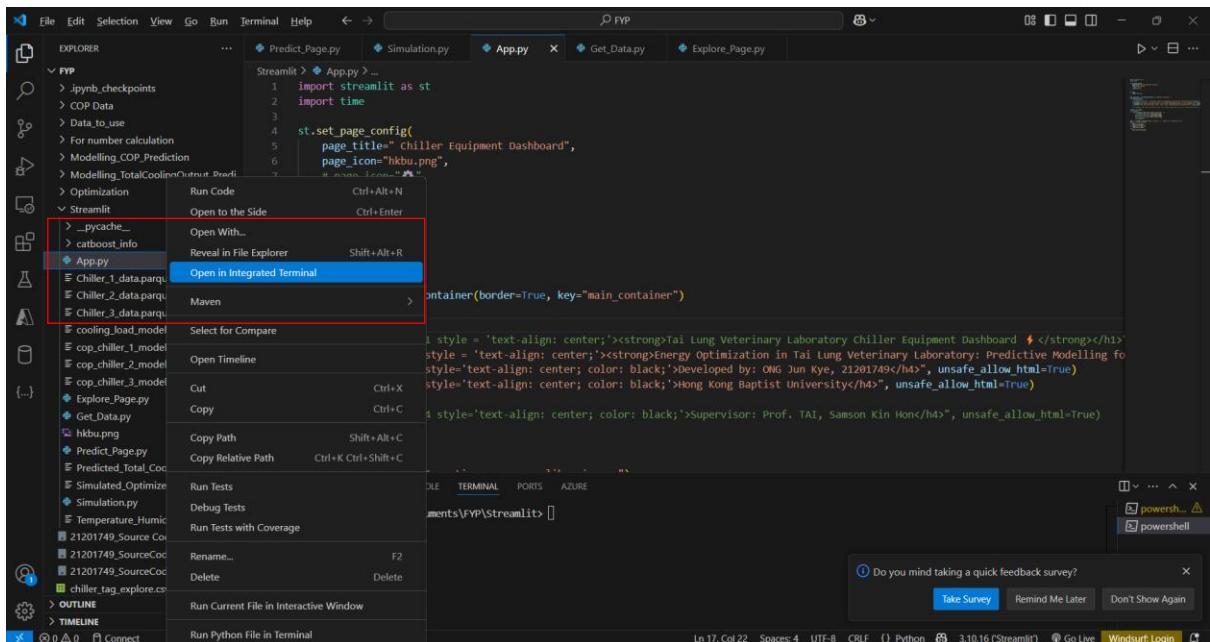
#### Step 6: Organize all the necessary files, scripts, machine learning model files and data files, in a single project folder.

#### Step 7: Launch Visual Studio Code

- Open Anaconda Navigator and launch Visual Studio Code from there.

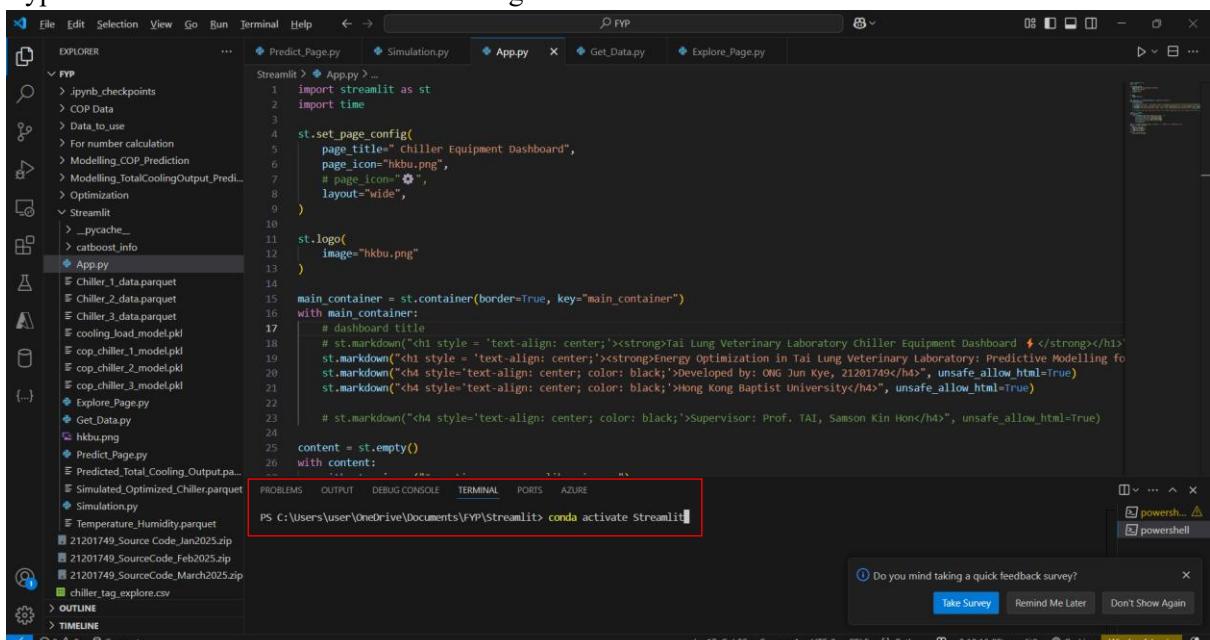


#### Step 8: Open project and right click on “App.py” and click on “Open in Integrated Terminal”



### Step 9: Activate Python Environment in the integrated terminal.

- Type “conda activate Streamlit” in the integrated terminal.



### Step 10: Run the Streamlit Application

- Type “streamlit run App.py” in the integrated terminal.

```

STREAMLIT > App.py > ...
1 import streamlit as st
2 import time
3
4 st.set_page_config(
5     page_title="Chiller Equipment Dashboard",
6     page_icon="hkbu.png",
7     # page_icons="⚙️",
8     layout="wide",
9 )
10
11 st.logo(
12     image="hkbu.png"
13 )
14
15 main_container = st.container(border=True, key="main_container")
16 with main_container:
17     # dashboard title
18     st.markdown("<h1 style = 'text-align: center;'><strong>Tai Lung Veterinary Laboratory Chiller Equipment Dashboard </strong></h1>")
19     st.markdown("<h4 style='text-align: center; color: black;'>Developed by: ONG Jun Kye, 21201749</h4>", unsafe_allow_html=True)
20     st.markdown("<h4 style='text-align: center; color: black;'>Hong Kong Baptist University</h4>", unsafe_allow_html=True)
21
22     # st.markdown("<h4 style='text-align: center; color: black;'>supervisor: Prof. TAI, Samson Kin Hon</h4>", unsafe_allow_html=True)
23
24     content = st.empty()
25     with content:
26         st.write("Welcome to the Chiller Equipment Dashboard!")
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## Explore Page

Choose your chiller

Chiller 1

Chiller 1 Data

record_timestamp	COP_Data	Water Flow Data (L/s)	Return Water Temp	Supply Water Temp	Power Supply (kW)	Current Cooling Output (kW)	Percentage of Loading (%)	COP_Own	Air Temperature (Celsius)	Relatf
2022-07-14 13:49:00	2.4345	4.6444	14	7.2	54.4861	132.174	88.116	2.4258	36	
2022-07-14 14:04:00	2.5061	4.65	12.6	7.3	41.144	103.1413	68.7608	2.5068	35	
2022-07-14 14:19:00	2.1983	7.2583	14.2	9	72.8644	157.9588	105.3058	2.1678	35	
2022-07-14 14:34:00	2.4353	7.2583	14.5	8.7	72.5771	176.1848	117.4565	2.4276	36	
2022-07-14 14:49:00	1.8212	5.1028	14.3	8.3	69.2877	128.1332	85.4222	1.8493	35	
2022-07-14 15:04:00	2.6114	4.6333	12.8	6.9	42.5552	114.406	76.2707	2.6884	35	
2022-07-14 15:19:00	2.7264	4.65	12.5	7.3	37.2227	101.1952	67.4635	2.7186	36	
2022-07-14 15:34:00	2.8427	4.6611	12.5	7.2	36.9748	103.3877	68.9251	2.7962	35	
2022-07-14 15:49:00	2.4973	7.2583	14.3	8.4	71.8879	179.2224	119.4816	2.4931	35	
2022-07-14 16:04:00	2.5161	7.2583	14.4	8.5	71.7785	179.2224	119.4816	2.4969	35	

Three Chillers Operation Timeline

Date range starts from July 2022 to March 2024

Year: 2022

Month: July

Plot

TVLV Chiller Operational Timeframe - July 2022

Chillers: Chiller 1 (Blue), Chiller 2 (Red), Chiller 3 (Blue line)

Tai Lung Veterinary Lab Chiller Operation Strategy Breakdown

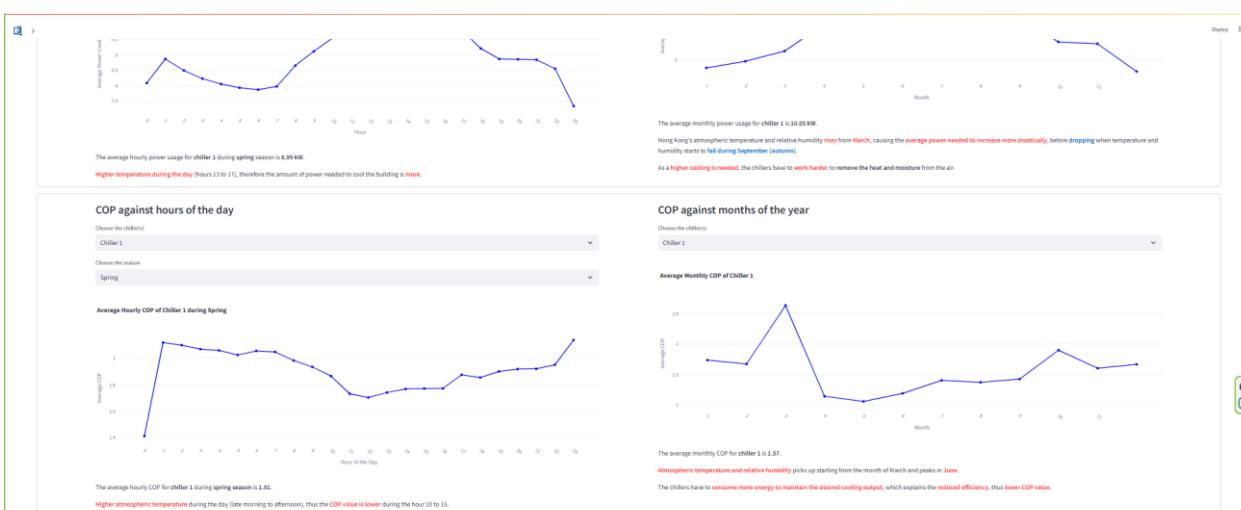
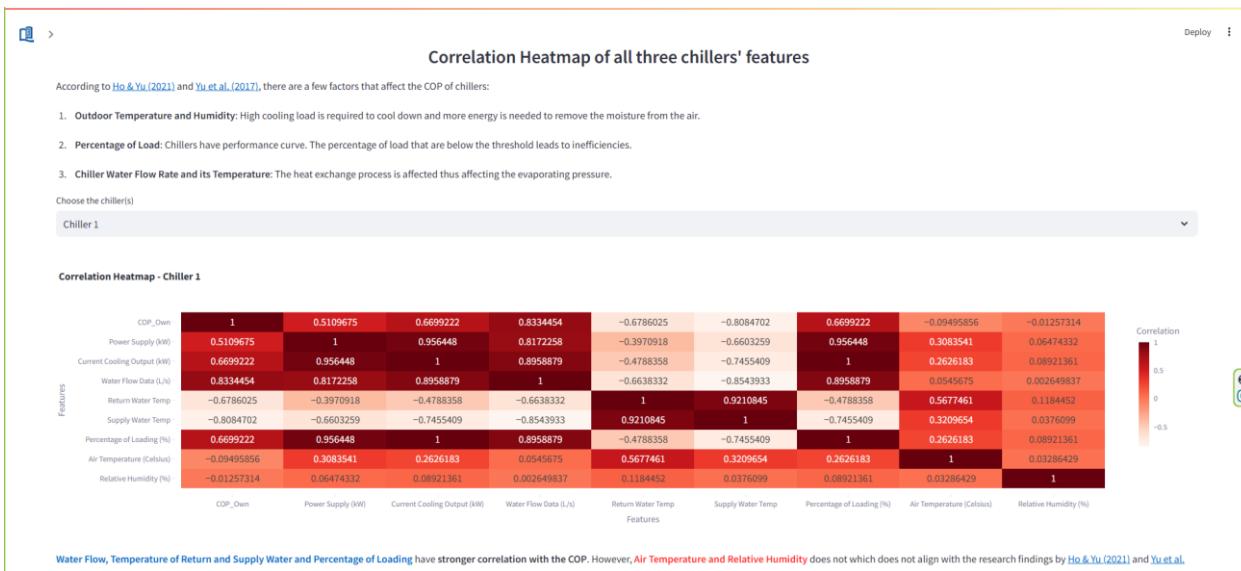
TVLV Chiller Strategy Analysis

Main Strategy

Count: 45518, 2370, 1663, 3

Here is the detailed breakdown:

- One Chiller Used: 45518
  - Chiller 1: 16378
  - Chiller 3: 15028
  - Chiller 2: 14112
- No Chillers Used: 2370
- Two Chillers Used: 1663
  - Chiller 1, Chiller 3: 705
  - Chiller 1, Chiller 2: 566



## Predict page

Total Cooling Output and Coefficient of Performance Prediction 🌡️

Real-Time/Custom Input Strategy Prediction

Please input relevant information for prediction. Date range starts from 2022-07-01 00:00:00 to 2025-04-06 13:00:00

Date: 2025/04/02

Time: 21:15

Temperature (°C): 18.40

Humidity (%): 64

**Predict** 🚧

Total Cooling Output and Coefficient of Performance Prediction 🌡️

Real-Time/Custom Input Strategy Prediction

Please input relevant information for prediction. Date range starts from 2022-07-01 00:00:00 to 2025-04-06 13:00:00

Date: 2025/04/02

Time: 21:15

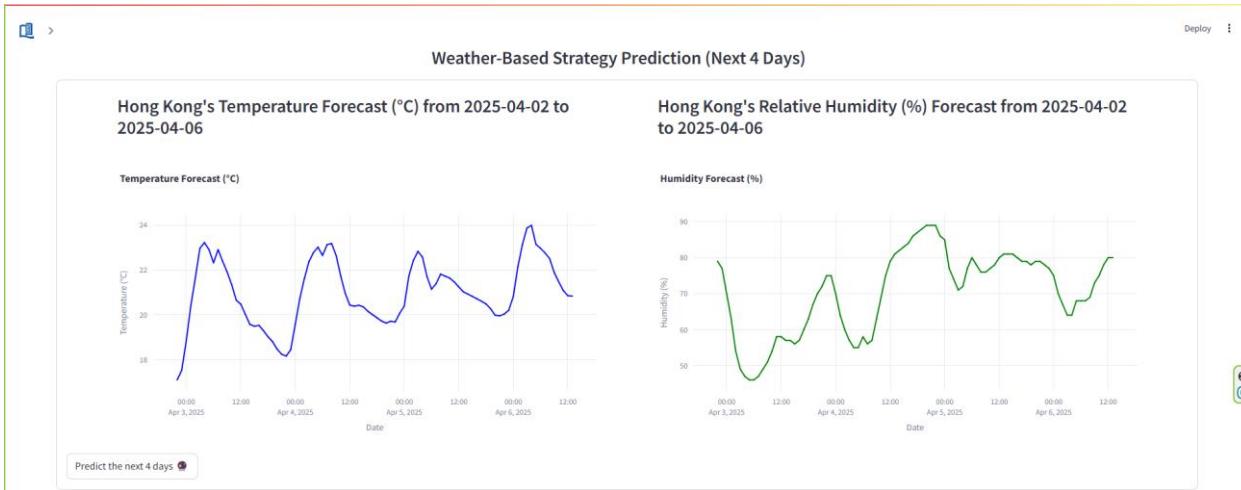
Temperature (°C): 18.40

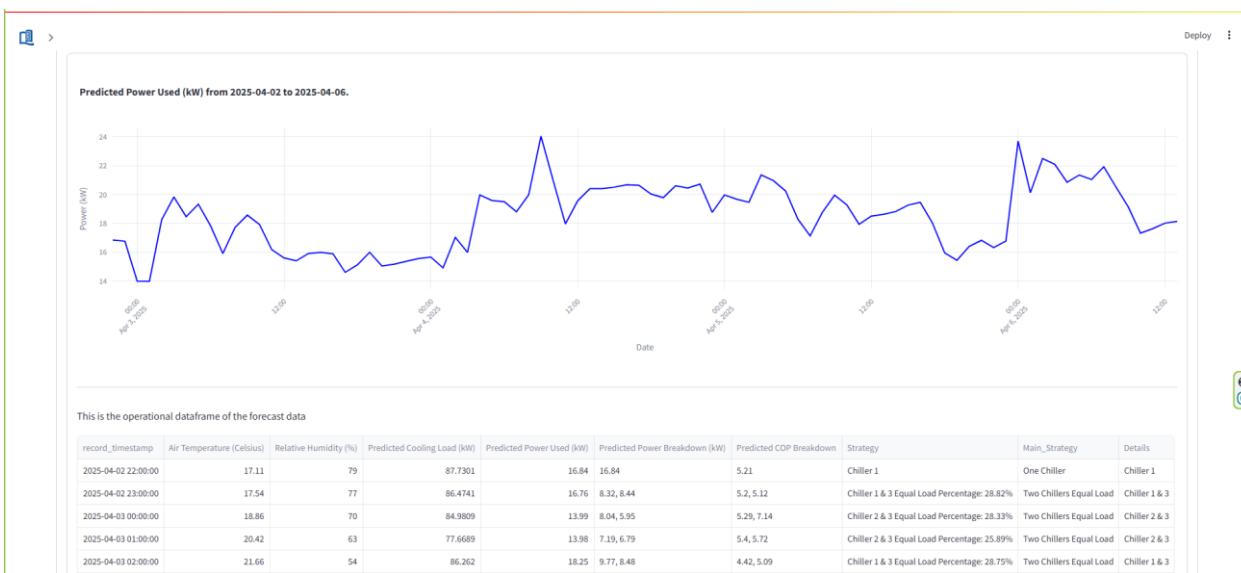
Humidity (%): 64

**Predict** 🚧

Amount of Cooling Output needed (kW): 65.05  
Estimated Total Power Used (kW): 11.72  
Estimated COP Breakdown: 5.55

Best Strategy: Chiller 2  
Estimated Power Breakdown (kW): 11.72  
Estimated Cost (HK\$ per hour): 17.85





This is the strategy summary of the forecast data

Main_Strategy	Details	count	avg_power
One Chiller	Chiller 1	8	16.98
One Chiller	Chiller 2	3	21.44
Two Chillers Equal Load	Chiller 1 & 2	5	16.32
Two Chillers Equal Load	Chiller 1 & 3	26	17.9
Two Chillers Equal Load	Chiller 2 & 3	46	19.01

**Most Used Strategy: Two Chillers Equal Load Chiller 2 & 3**  
Average Power Used: 19.01 kW

**Most Cost Saving Strategy: Two Chillers Equal Load Chiller 1 & 2**  
Average Power Used: 16.32 kW

**Least Used Strategy: One Chiller Chiller 2**  
Average Power Used: 21.44 kW

**Least Cost Saving Strategy: One Chiller: Chiller 2**  
Average Power Used: 21.44 kW

### File Upload Prediction

Upload CSV or Excel file with date, time, temperature and humidity to see the optimised operations

Here is a sample data file. You may download it for reference.

record_timestamp	Temperature	Humidity	
0	2024-04-01 00:00:00	27	83
1	2024-04-01 00:10:00	27	83
2	2024-04-01 00:20:00	27	83
3	2024-07-19 14:40:00	29	92
4	2024-07-19 14:50:00	29	91
5	2024-08-06 03:40:00	29	87
6	2024-08-06 03:50:00	28	87
7	2024-08-06 04:00:00	28	88
8	2024-08-06 04:10:00	28	88
9	2025-01-31 23:10:00	18	83

Upload your CSV or Excel file

Drag and drop file here  
Limit 200MB per file • CSV, XLSX

Browse files

Open

Eric - Personal > Documents > FYP >

Organize New folder

Name	Status	Date modified	Type	Size
Modelling_Iotail_CoolingOutput_Prediction	Green	3/12/2025 4:39 PM	File folder	
Optimization	Green	3/18/2025 11:26 PM	File folder	
Streamlit	Green	3/30/2025 11:04 PM	File folder	
chiller_tag_explore	Green	2/19/2025 10:14 PM	Microsoft Excel Co...	355 KB
sample_upload_data.csv	Green	3/18/2025 5:06 PM	Microsoft Excel Co...	3 KB
sample_upload_data.xlsx	Green	3/18/2025 5:06 PM	Microsoft Excel W...	7 KB
simulation results breakdown	Green	4/2/2025 4:31 PM	Microsoft Excel W...	18 KB
TLVL_All_Data_merged_new	Green	11/2/2024 2:02 PM	Microsoft Excel W...	8,567 KB
TLVL_All_Data_merged_new_no_impute	Green	12/16/2024 6:15 PM	Microsoft Excel W...	9,051 KB

File name: sample\_upload\_data.xlsx

Custom Files

Open Cancel

Upload your CSV or Excel file

Drag and drop file here

Limit 200MB per file • CSV, XLSX

Browse files

Deploy

sample\_upload\_data.xlsx 6.7KB

This is the operational dataframe of the uploaded data file.

record_timestamp	Air Temperature (Celsius)	Relative Humidity (%)	Predicted Cooling Load (kW)	Predicted Power Used (kW)	Predicted Power Breakdown (kW)	Predicted COP Breakdown	Strategy	Main_Strategy	Details
2025-03-18 10:00:00	18.66	41	29.118	7.35	7.35	3.96	Chiller 1	One Chiller	Chiller 1
2025-03-18 11:00:00	18.46	44	24.6158	7.01	7.01	3.51	Chiller 1	One Chiller	Chiller 1
2025-03-18 12:00:00	18.36	46	27.0125	7.37	7.37	3.66	Chiller 1	One Chiller	Chiller 1
2025-03-18 13:00:00	18.31	48	30.3793	7.3	7.3	4.16	Chiller 1	One Chiller	Chiller 1
2025-03-18 14:00:00	17.54	54	33.3405	7.48	7.48	4.46	Chiller 1	One Chiller	Chiller 1
2025-03-18 15:00:00	16.86	59	43.2371	8.19	8.19	5.28	Chiller 1	One Chiller	Chiller 1
2025-03-18 16:00:00	16.57	63	43.598	8.61	8.61	5.07	Chiller 1	One Chiller	Chiller 1
2025-03-18 17:00:00	16.31	66	37.7218	7.02	7.02	5.37	Chiller 1	One Chiller	Chiller 1
2025-03-18 18:00:00	16.14	68	34.6332	6.64	6.64	5.22	Chiller 1	One Chiller	Chiller 1
2025-03-18 19:00:00	16.04	69	26.1376	6.05	6.05	4.32	Chiller 2	One Chiller	Chiller 2

This is the strategy summary of the uploaded data file.

Main_Strategy	Details	count	avg_power
One Chiller	Chiller 1	66	6.96
One Chiller	Chiller 2	22	6.36
Two Chillers Equal Load	Chiller 1 & 2	4	1.53
Two Chillers Equal Load	Chiller 1 & 3	4	1.79

Deploy

2025-03-19 10:00:00 18.59 51 25.78 6.67 6.67 3.86 Chiller 1 One Chiller Chiller 1

This is the strategy summary of the uploaded data file.

Main_Strategy	Details	count	avg_power
One Chiller	Chiller 1	66	6.96
One Chiller	Chiller 2	22	6.36
Two Chillers Equal Load	Chiller 1 & 2	4	1.53
Two Chillers Equal Load	Chiller 1 & 3	4	1.79

**Most Used Strategy: One Chiller Chiller 1**  
Average Power Used: 6.96 kW

**Most Cost Saving Strategy: Two Chillers Equal Load Chiller 1 & 2**  
Average Power Used: 1.53 kW

**Least Used Strategy: Two Chillers Equal Load Chiller 1 & 2**  
Average Power Used: 1.53 kW

**Least Cost Saving Strategy: One Chiller: Chiller 1**  
Average Power Used: 6.96 kW

## Simulation page

Developed by: ONG Jun Kye, 21201749

Hong Kong Baptist University

## Simulation and Visualization 🚀📈

Please select the desired month for simulation

Date range starts from 07/2022 to 03/2024

Which period would you like to simulate?

Whole period

**Run simulation 🚀**

**Run simulation 🚀**

Running simulation for the whole period (2022 July to 2024 March)!

### Actual vs Simulation Comparison

Actual Power Supply (2022 July to 2024 March)  
1274785.51 kW

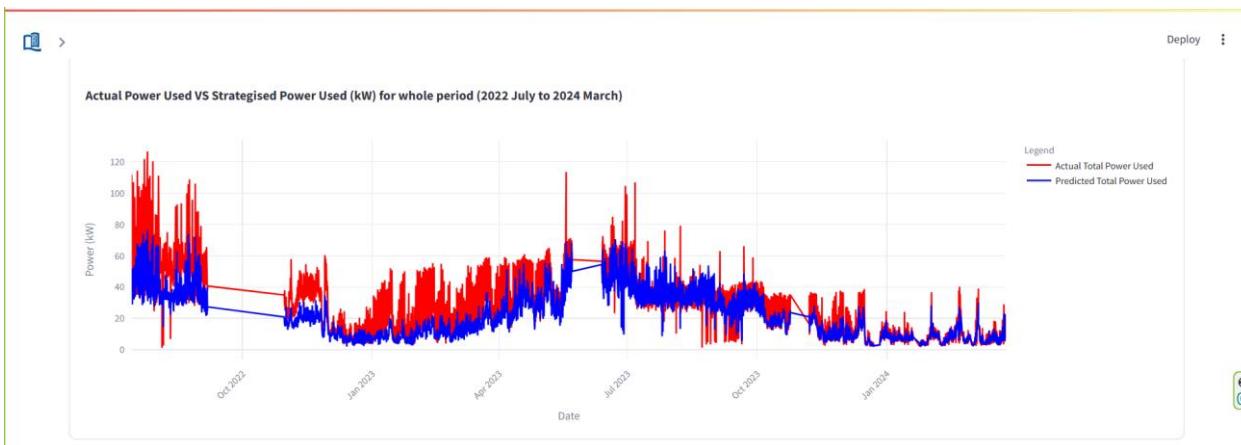
Predicted Power Supply (2022 July to 2024 March)  
1007756.63 kW

### Power Savings

Amount of Power Saved: 267028.88 kW

Percentage of Power Saved: 20.95%

Estimated Savings: HK\$ 101671.25



This is the operational dataframe of the simulated data

record_timestamp	Air Temperature (Celsius)	Relative Humidity (%)	Total Cooling Output (kW)	Predicted Total Cooling Output (kW)	Total Power Supply (kW)	Predicted Total Power Used (kW)	Predicted Power Break
2022-07-14 13:49:00	36	53	264.9806	173.7402	111.7019	43.79	[21.45, 22.34]
2022-07-14 14:04:00	35	51	210.5584	172.8172	79.5526	46.52	[23.49, 23.03]
2022-07-14 14:19:00	35	51	157.9588	172.8172	72.8644	46.52	[23.49, 23.03]
2022-07-14 14:34:00	36	52	176.1848	176.9406	72.5771	44.89	[21.58, 23.31]
2022-07-14 14:49:00	35	53	128.1332	172.2929	69.2877	46.02	[23.26, 22.76]
2022-07-14 15:04:00	35	57	236.715	189.7381	81.2118	45.78	[20.33, 25.45]
2022-07-14 15:19:00	36	55	204.5829	199.7827	71.7194	51.94	[21.93, 30.01]
2022-07-14 15:34:00	35	57	103.3877	189.7381	36.9748	45.78	[20.33, 25.45]
2022-07-14 15:49:00	35	55	179.2224	186.0482	71.8879	45.52	[21.33, 24.19]
2022-07-14 16:04:00	35	55	179.2224	190.3498	71.7785	46.38	[20.1, 26.28]

This is the strategy summary of the simulated data

Main_Strategy	Details	count	avg_power
One Chiller	Chiller 1	4,011	6.94
One Chiller	Chiller 2	8,611	12.44
One Chiller	Chiller 3	9,098	8.94
Three Chillers Equal Load	Chiller 1, 2 & 3	1,953	37.35
Two Chillers Equal Load	Chiller 1 & 2	2,250	28.12
Two Chillers Equal Load	Chiller 1 & 3	3,443	20.79
Two Chillers Equal Load	Chiller 2 & 3	16,745	32.33
Two Chillers One Full Load, One Part Load	Chiller 1 Full, Chiller 2 Part	107	41.98
Two Chillers One Full Load, One Part Load	Chiller 1 Full, Chiller 3 Part	75	41.66
Two Chillers One Full Load, One Part Load	Chiller 1 Part, Chiller 2 Full	502	38.92

Deploy ⋮

Two Chillers One Full Load, One Part Load	Chiller 1 Full, Chiller 2 Part	107	41.98
Two Chillers One Full Load, One Part Load	Chiller 1 Full, Chiller 3 Part	75	41.66
Two Chillers One Full Load, One Part Load	Chiller 1 Part, Chiller 2 Full	502	38.92

**Most Used Strategy (2022 July to 2024 March): Two Chillers Equal Load Chiller 2 & 3**    **Most Cost Saving Strategy (2022 July to 2024 March): One Chiller Chiller 1**

Average Power Used: 32.33 kW

Average Power Used: 6.94 kW

**Least Used Strategy (2022 July to 2024 March): Two Chillers One Full Load, One Part Load Chiller 1 Part, Chiller 3 Full**

Average Power Used: 54.18 kW

**Least Cost Saving Strategy (2022 July to 2024 March): Two Chillers One Full Load, One Part Load: Chiller 1 Part, Chiller 3 Full**

Average Power Used: 54.18 kW