Lifecycle thermal optimization for data centers

INTRODUCTION

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Data Center Vertical Director

Masters in Energy Engineering

70 patents (architectures, product design, heat transfer…)

34 years global experience

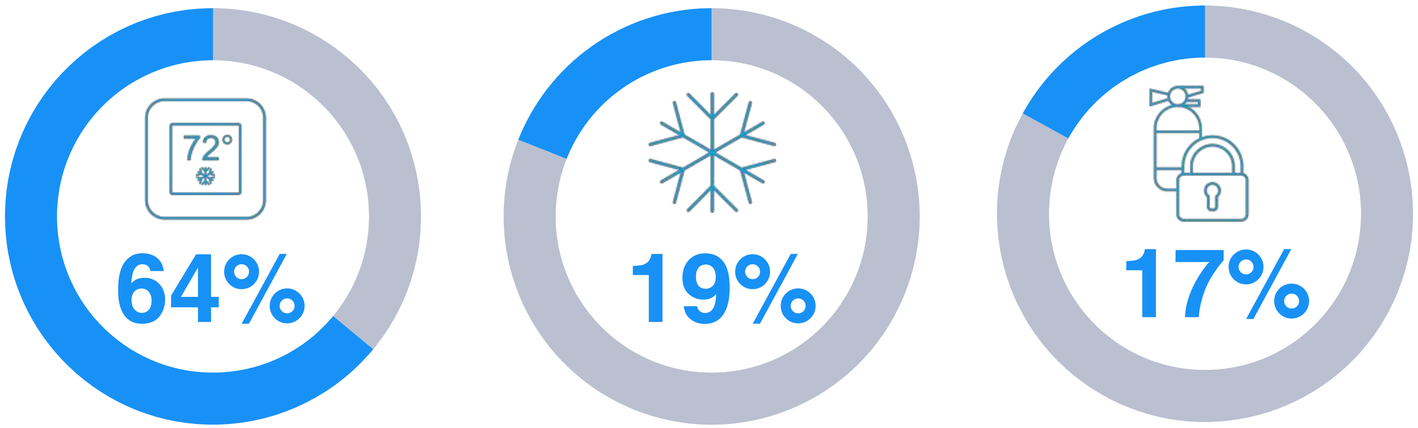
CARRIER WORLD – WHO ARE WE ?

World leader in air conditioning, heating, ventilation, control and automation systems.

52 000
EMPLOYEES

75+
BRANDS

100+
NEW PRODUCTS
for the 8th consecutive year



HVAC
COMMERCIAL & RESIDENTIAL

REFRIGERATION
TRANSPORT & COMMERCIAL

FIRE & SECURITY
PRODUCTS & FIELD

KEY POINTS

1. **Significant energy savings in data centers are possible** using system level optimization – 10%-30% depending on weather and load conditions
2. **Model-based discrete MILP optimization and dynamic analysis** is key to understand energy savings
3. Operate equipment **at peak efficiency** and use free cooling – chiller staging and set-point optimization

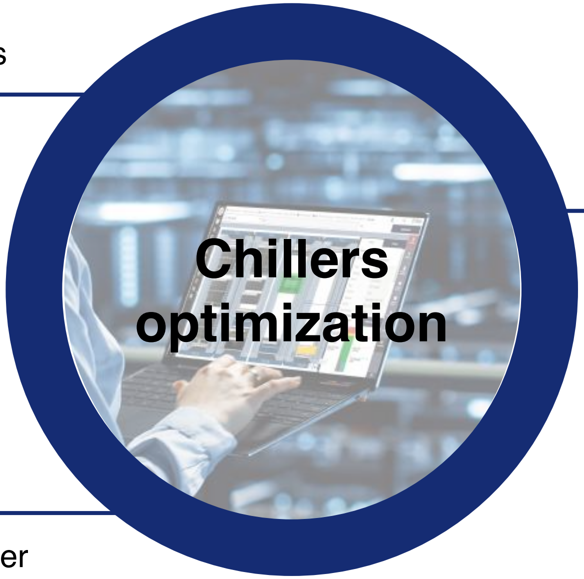
FROM EQUIPMENT TO SYSTEM OPTIMIZATION

DATA CENTERS TECHNICAL SALES SUPPORT TOOL → OPPORTUNITIES – SYSTEMS INTEGRATION

Customers requirements

Annual operating cost – power utilization efficiency

Modular chiller configuration



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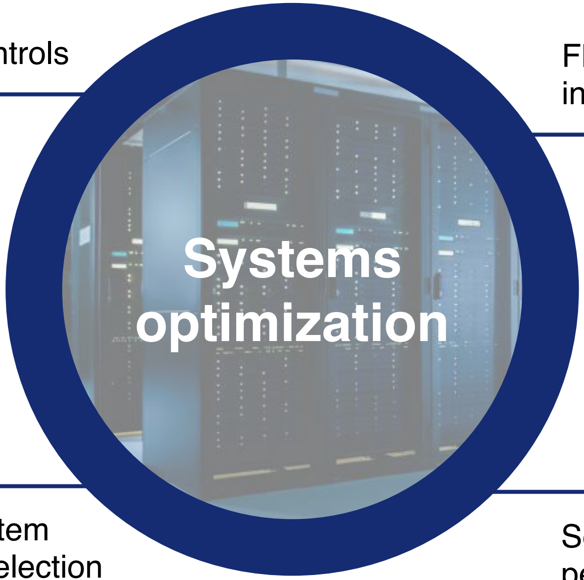
Deliver high performance controls

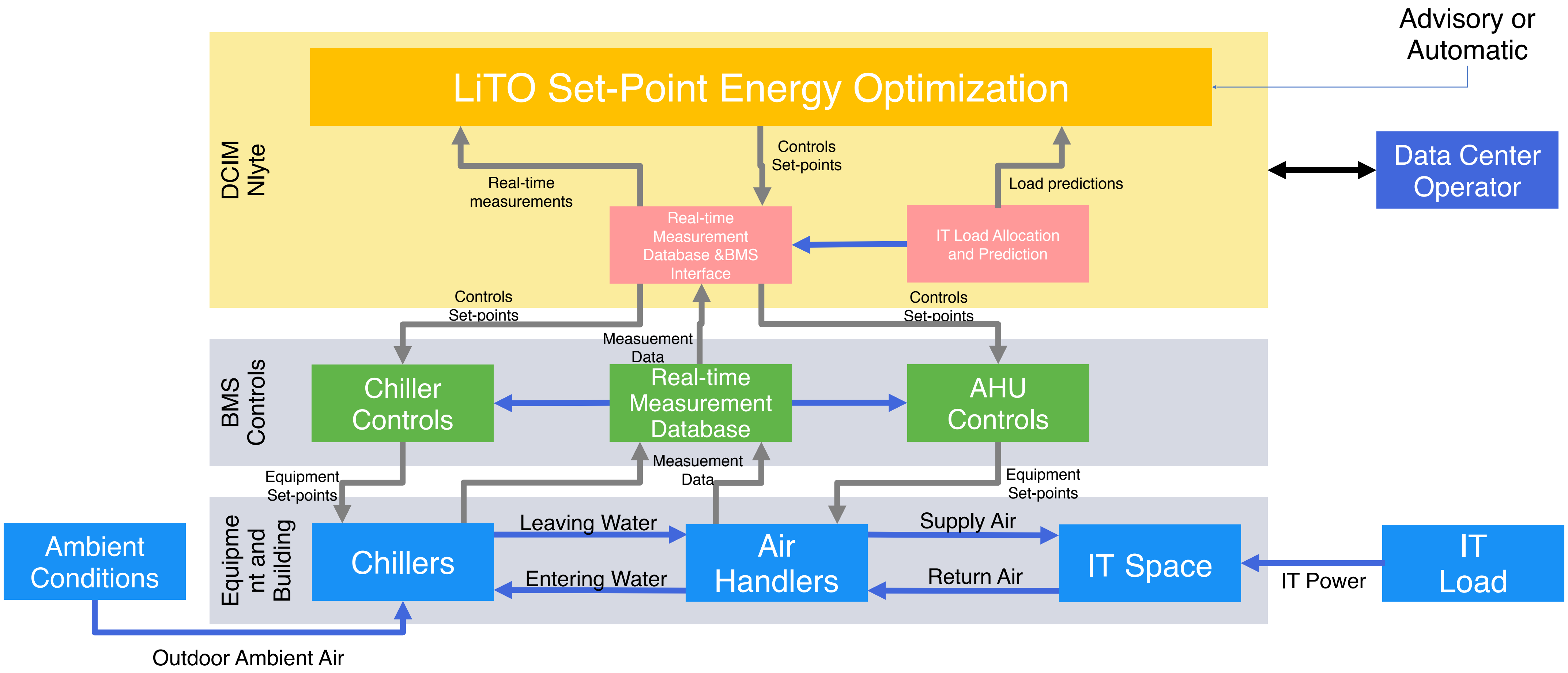
Flawless entry into service

Automated system configuration selection

Service to maintain performance



LITO SYSTEM ARCHITECTURE LAYERS

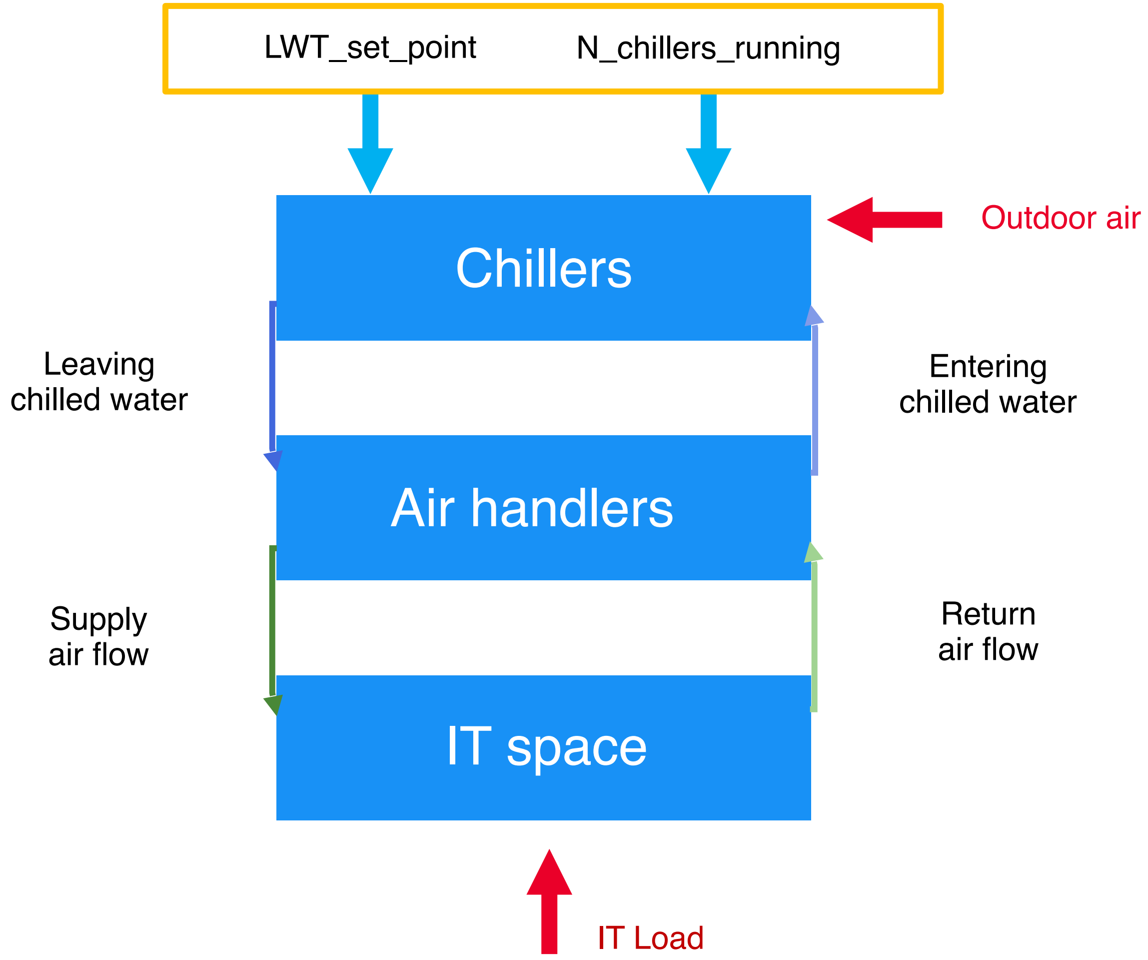


Protocols between communicating layers

Interfaces connecting modules within a layer

HMI

CASE STUDY : ENERGY OPTIMIZATION FOR DATA CENTER IN FRANKFURT, GERMANY



OBJECTIVES :

- Minimize total energy consumption through a year – 8760 hours
- Meet load requirement
- Consider OAT based on geography

WHAT TO OPTIMIZE ?

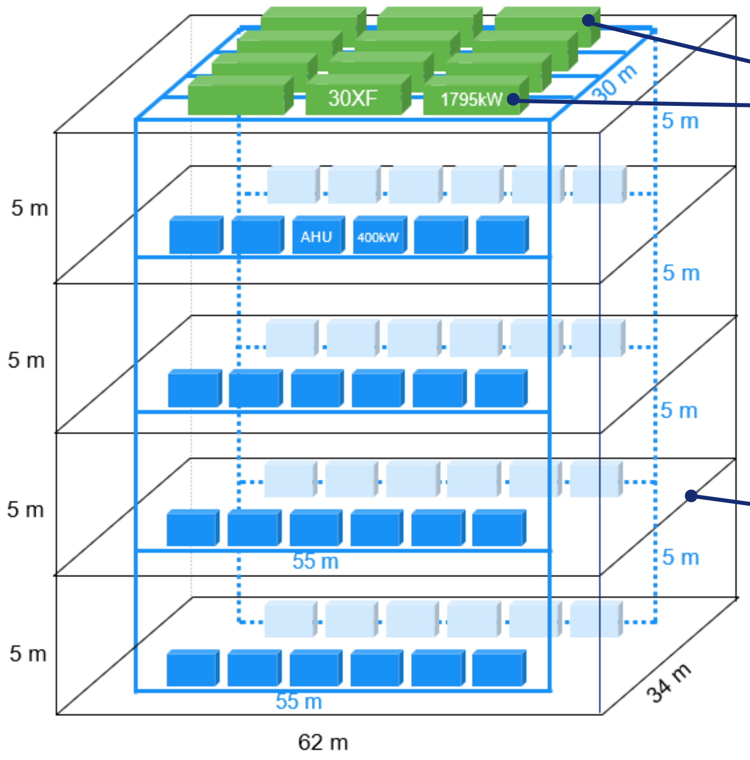
- Chillers on/off choices and cooling capacity set point
- Leaving chilled water temperature (LWT) set-point

MODELING ASSUMPTIONS :

- 30XF BOLT chiller model + equipment performance from data sheets
- Steady-state models

SYSTEM ARCHITECTURE

- 12 30XF chillers (air-cooled)
- 4x24 = 96 AHUs (200 kW each) for IT equipment
- 4 IT rooms (floors)



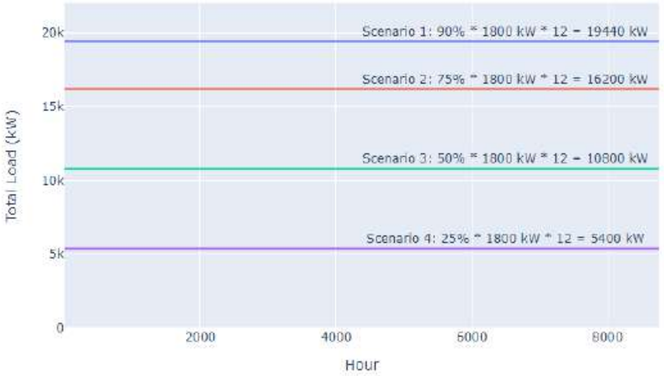
CHILLER STAGING OPTIMIZATION WORKFLOW

1. EXHAUSTIVES SIMULATIONS → BOLT steady state model
2. **PERFORMANCE MAPS**
3. USER REQUIREMENT → Load profile & weather data
4. PREPROCESS → Create and compute piece-wise linear functions
5. MILP OPTIMIZATION → Set, parameters, variables, objectives and constraints
6. POSTPROCESS → Energy analysis of optimization and baseline energy assumption & results visualization

CASE STUDY LOAD AND WEATHER DATA

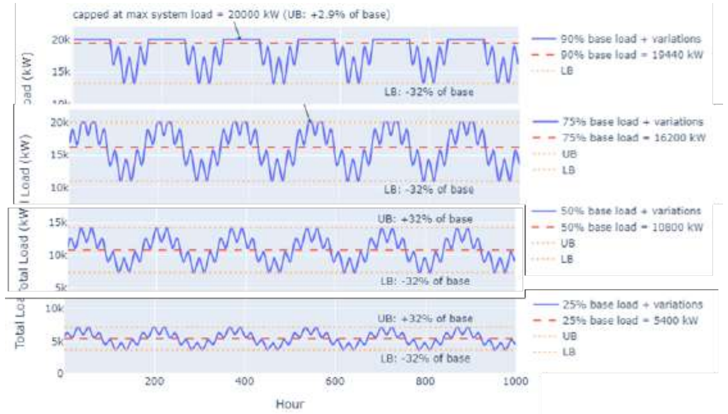
Constant load :

- 25%
- 50%
- 75%
- 90%



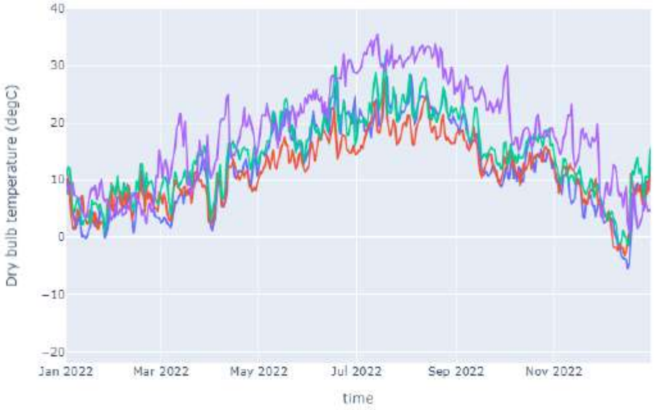
Variant load :

- 25%
- 50%
- 75%
- 90%



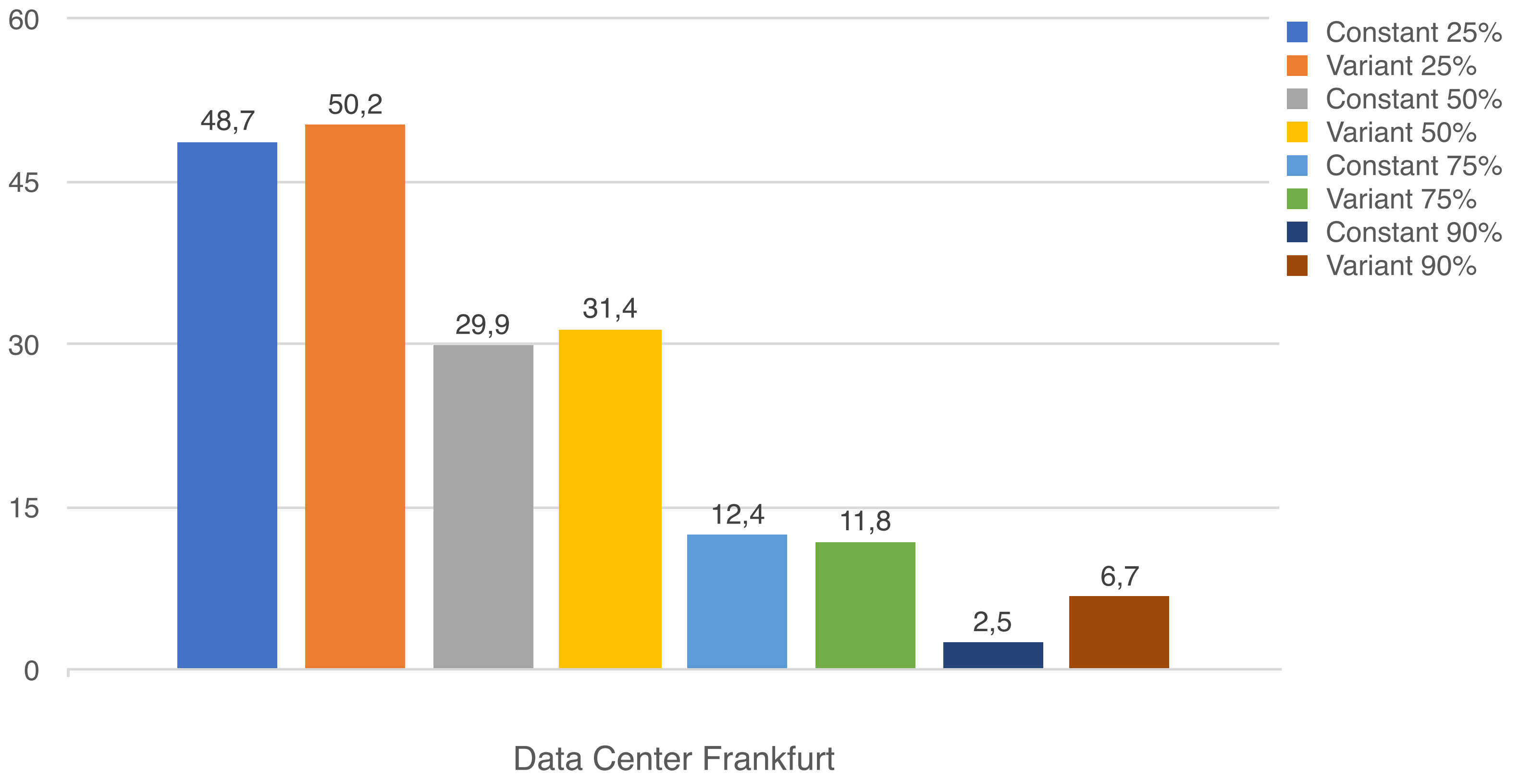
Results :

Frankfurt



STAGING OPTIMIZATION VS. BASELINE & STAGING RESULTS COMPARISON

Total energy consumption % difference between **staging optimization** and **baseline**

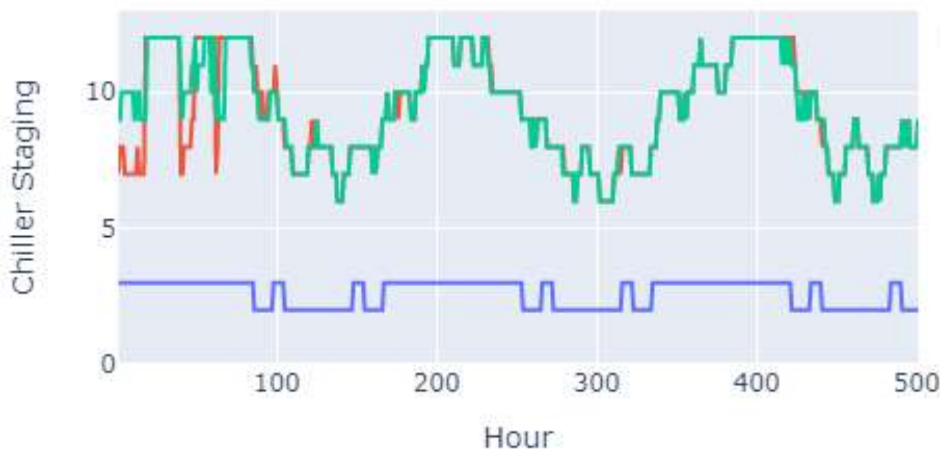


Averaged energy saving : 22,9%

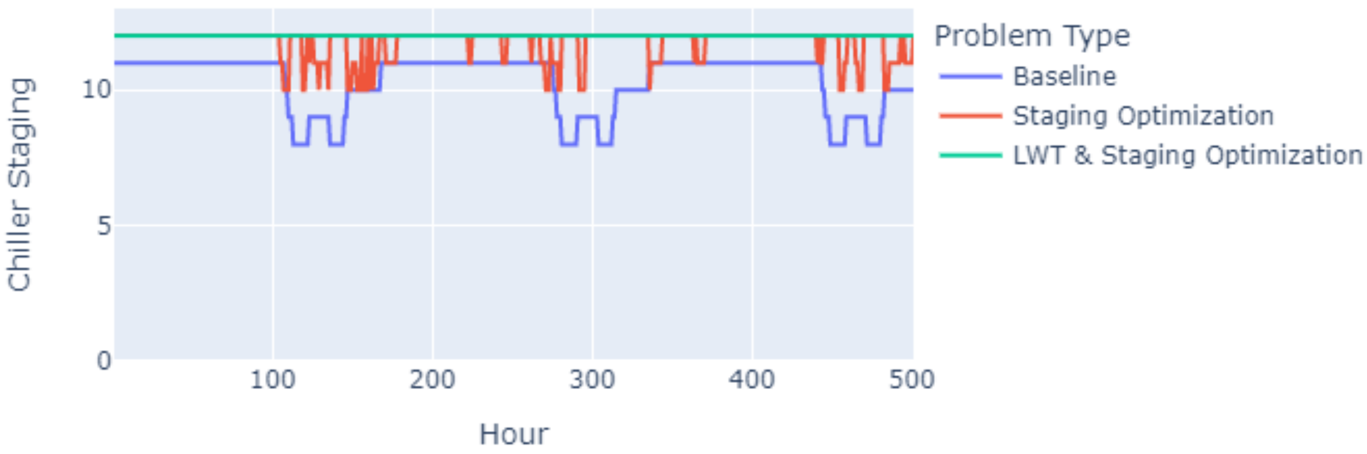
STAGING RESULTS COMPARISON

- Optimized solution tends to run **more chillers than baseline staging rules.**
- Optimized staging **varies more frequently** than baseline at low load condition.
- Optimized solution tends to **run maximum number of chillers at high load condition.**

25% Variant Load

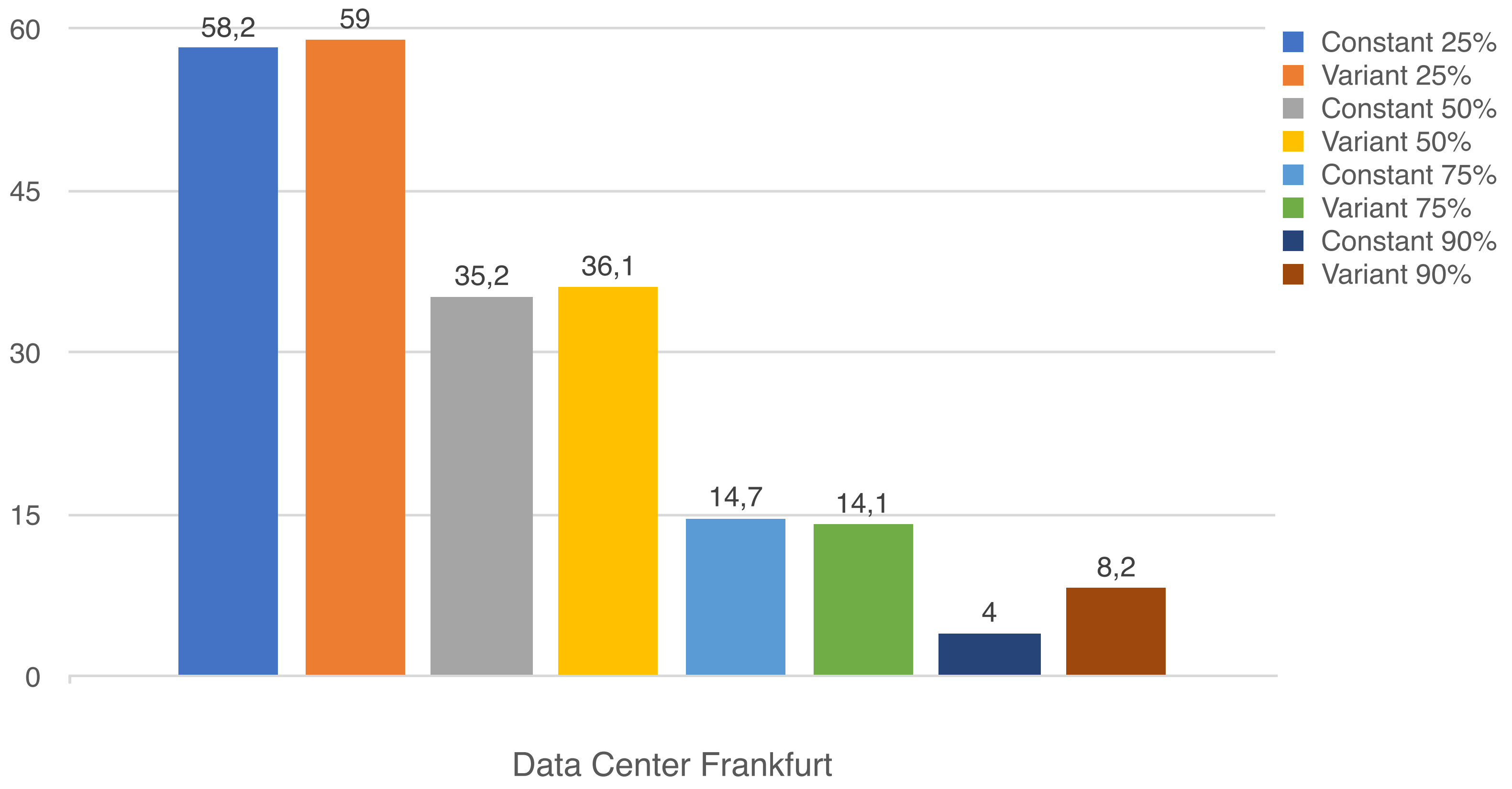


90% Variant Load



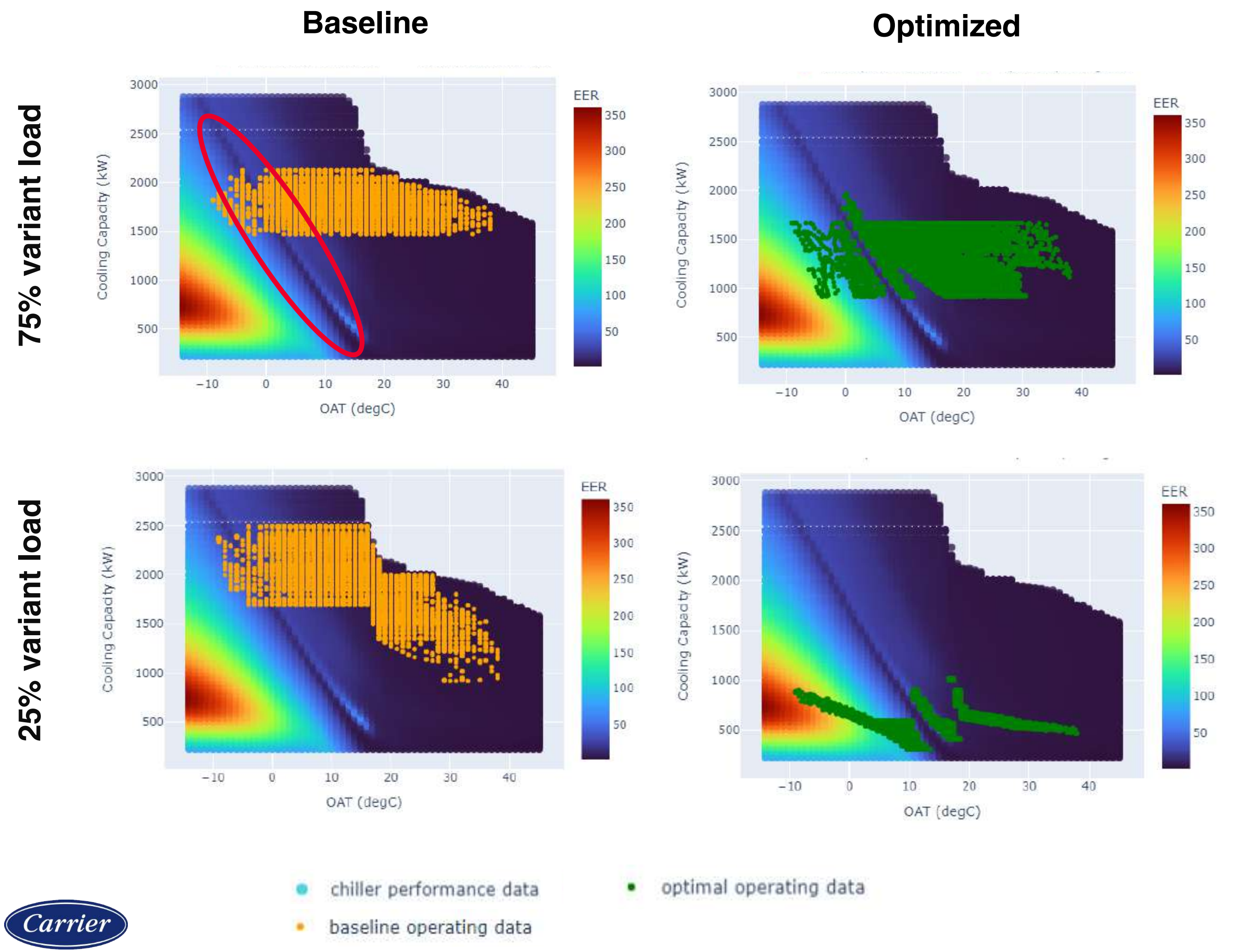
LWT & STAGING OPTIMIZATION VS. BASELINE

Total energy consumption % difference between **LWT & staging optimization** and **baseline**



Averaged energy saving : 27,1 %

EER PERFORMANCE COMPARISON AT ALL POINTS



OBSERVATIONS

- Optimized performance avoids “valley” on EER performance map
- Optimized performance tends to use less cooling capacity per chiller, especially at low load condition

BY-MONTH RESULTS ANALYSIS

Frankfurt 50% variant load case

OBSERVATIONS

- Optimization delivers higher EER, higher fraction of free cooling and consumes less energy than baseline
- EER improvement is more obvious at colder months.
- Majority of energy saving comes from warmer months

For any questions

MEET US AT

STAND J60