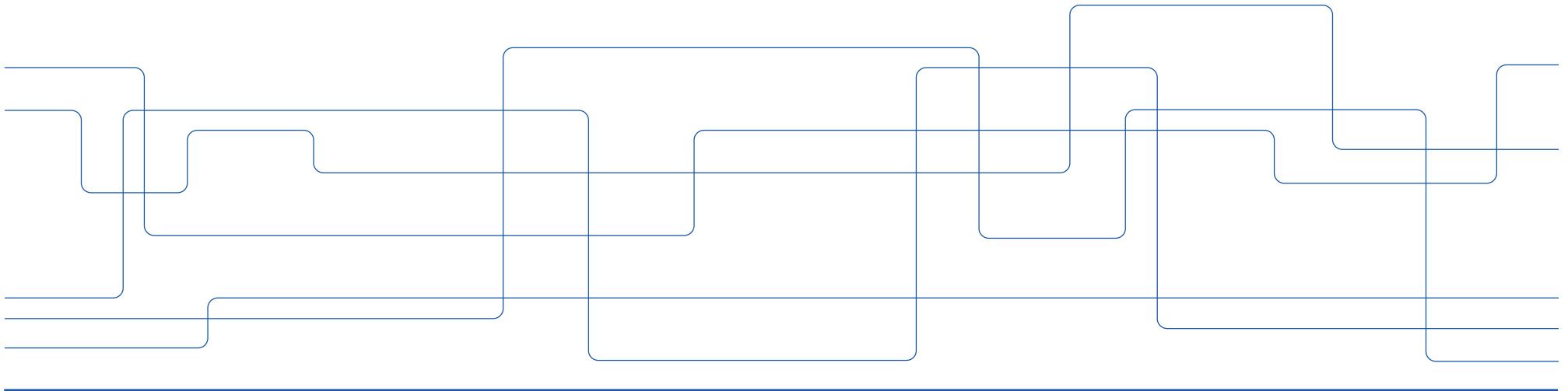




# Benchmarking energy use in supermarket buildings

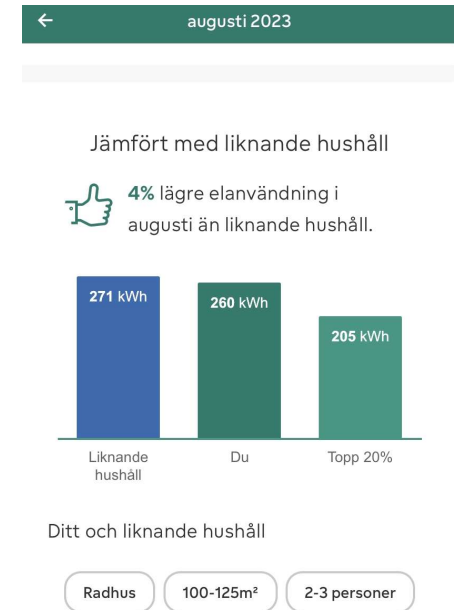
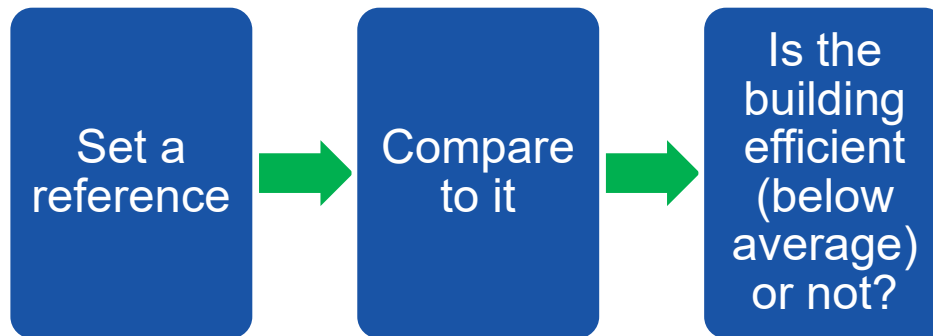
Samer Sawalha and Jaime Arias, KTH





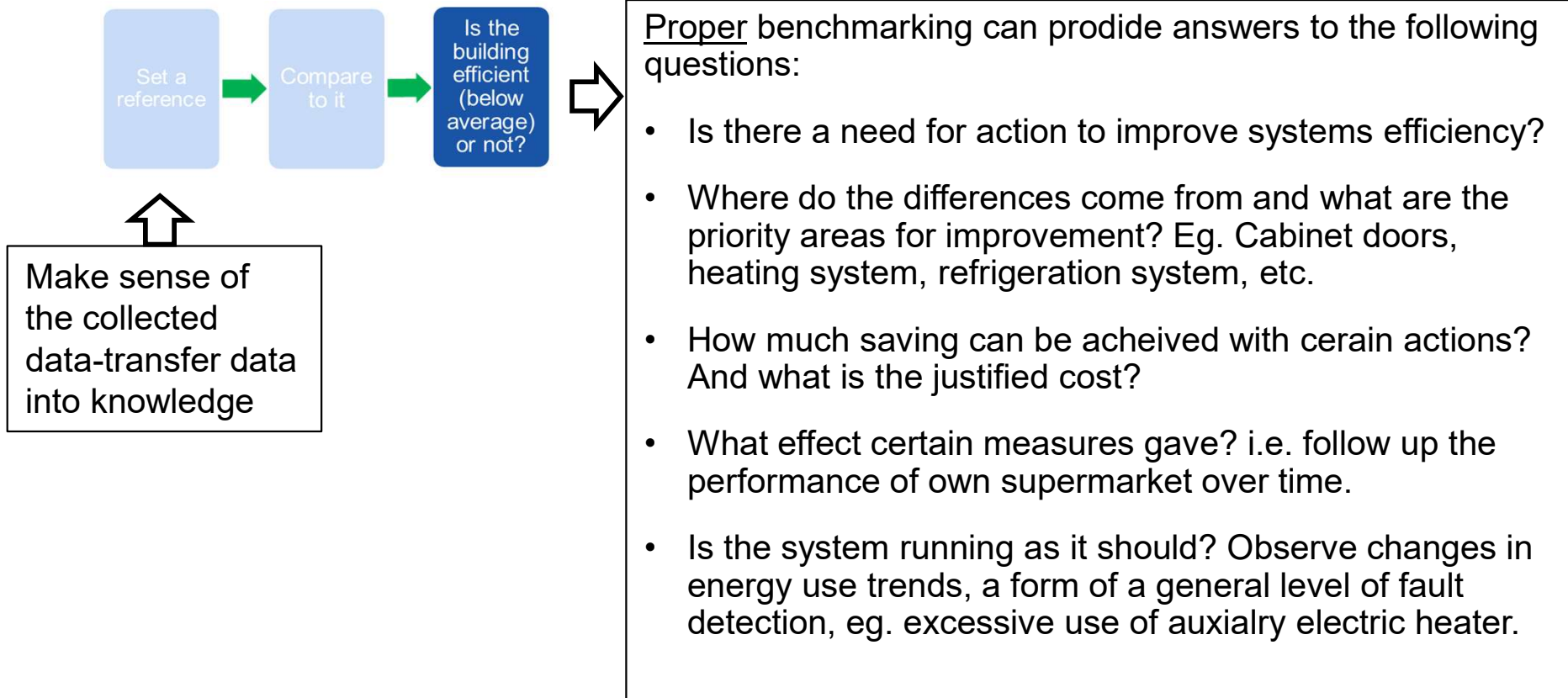
# What is energy benchmarking?

- Energy benchmarking is....the process of comparing the energy use in building or facility against a standard or similar buildings. It involves measuring and analyzing energy consumption patterns to identify areas for improvement in terms of energy efficiency. This helps in understanding how efficiently a building uses energy and can be a crucial step in making informed decisions about energy conservation and sustainability efforts.

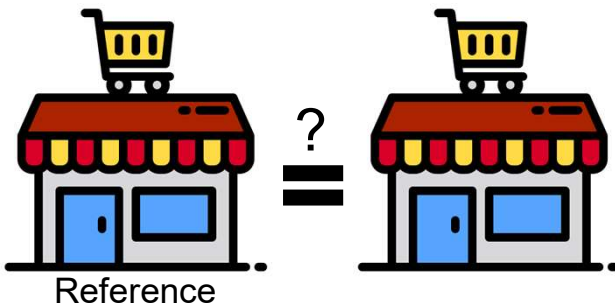
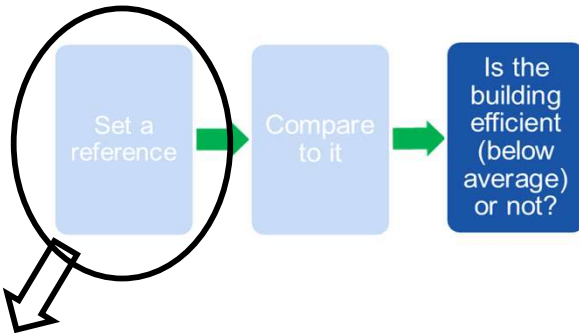


Example from Fortum app

# What is the importance of benchmarking?



# Why is it challenging to benchmark energy use in supermarkets?



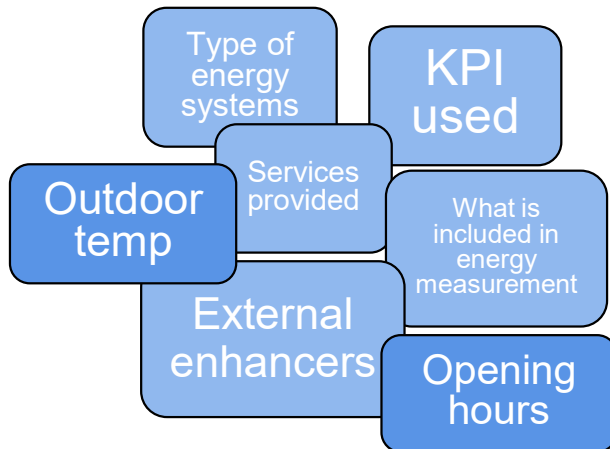
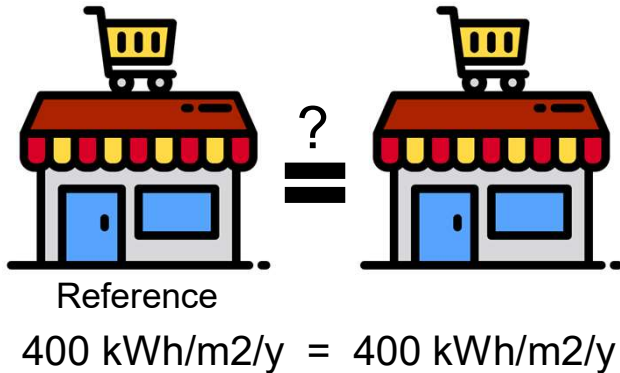
Two supermarkets equal in:

- Size
- opening hours
- and outdoor temperature (same geographical location)

Use typical performance indicator for the comparison

**kWh/m<sup>2</sup>/y**

# Why is it challenging to benchmark energy use in supermarkets?



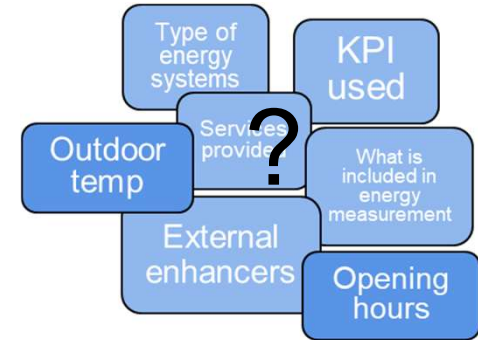
## What if?

- District heating is used vs heat recovery or heat pump
  - kWh<sub>el</sub>/m<sup>2</sup>/y will be lower for DH system
  - Or shall we use kWh of primary energy?
- District cooling vs chiller
- One system has PV's on the roof
- Another system has car charging service
- With or without bakery
- Has pharmacy and cafe in the same building
- In one system the refrigeration system is connected to geothermal loop



# How to do the benchmarking?

- IEA Annex 31, Canada, USA, Germany, Sweden (KTH and RISE), 2012
- IEA Annex 44: The Netherlands, Denmark, Sweden (KTH and RISE), 2017
- Included data for 146 supermarkets from 2000 +13 newer from 2014
- **Most of the data are about 25 years old**



## Annex 44

Performance indicators for energy efficient supermarket buildings

Final Report

Annex 31

ie on  
:P)

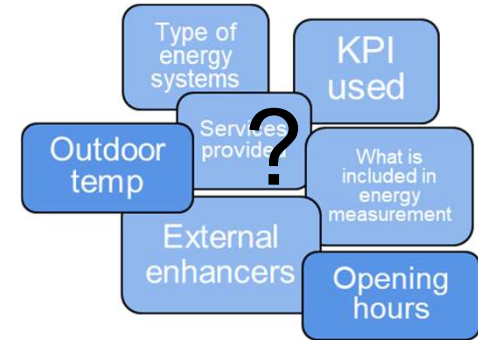
Advanced Modeling and Tools  
for Analysis of Energy Use in  
Supermarket Systems

Final Report



# How to do the benchmarking?

- Two MSc thesis projects at KTH in 2021 and 2023
- Working on detailed measurements of selected supermarkets and new data from large number of supermarkets



DEGREE PROJECT IN ENERGY AND ENVIRONMENT,  
SECOND CYCLE, 30 CREDITS  
STOCKHOLM, SWEDEN 2021

## State-of-the-art Bålsta



DEGREE PROJECT IN ENERGY AND ENVIRONMENT,  
SECOND CYCLE, 30 CREDITS  
STOCKHOLM, SWEDEN 2023

Analysis of Energy Performance  
Indicators for Supermarket Buildings

KTH THESIS Report

Sahar Shaghiasl

## Analysis of Energy Performance Indicators for Supermarket Buildings

ABHAY MENON SREEKANDATH



## Data used

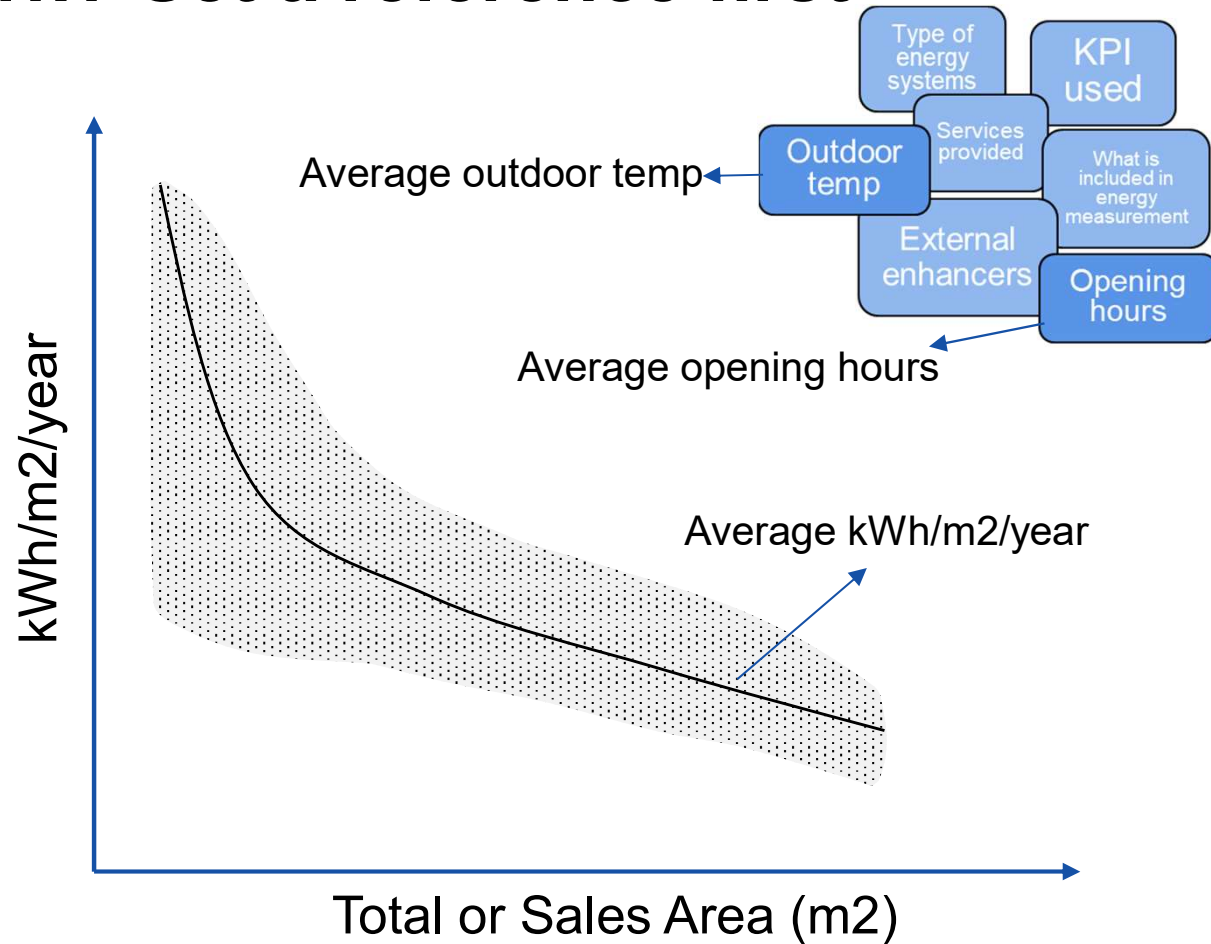
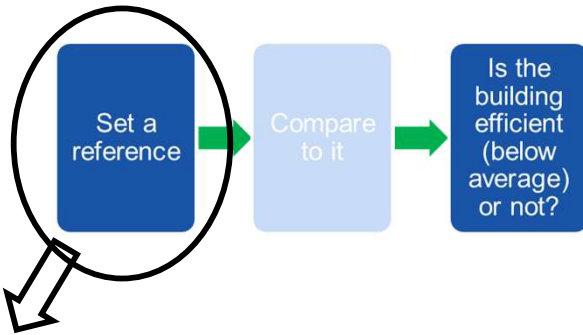
- Thanks to the data contribution to develop the benchmarking approach



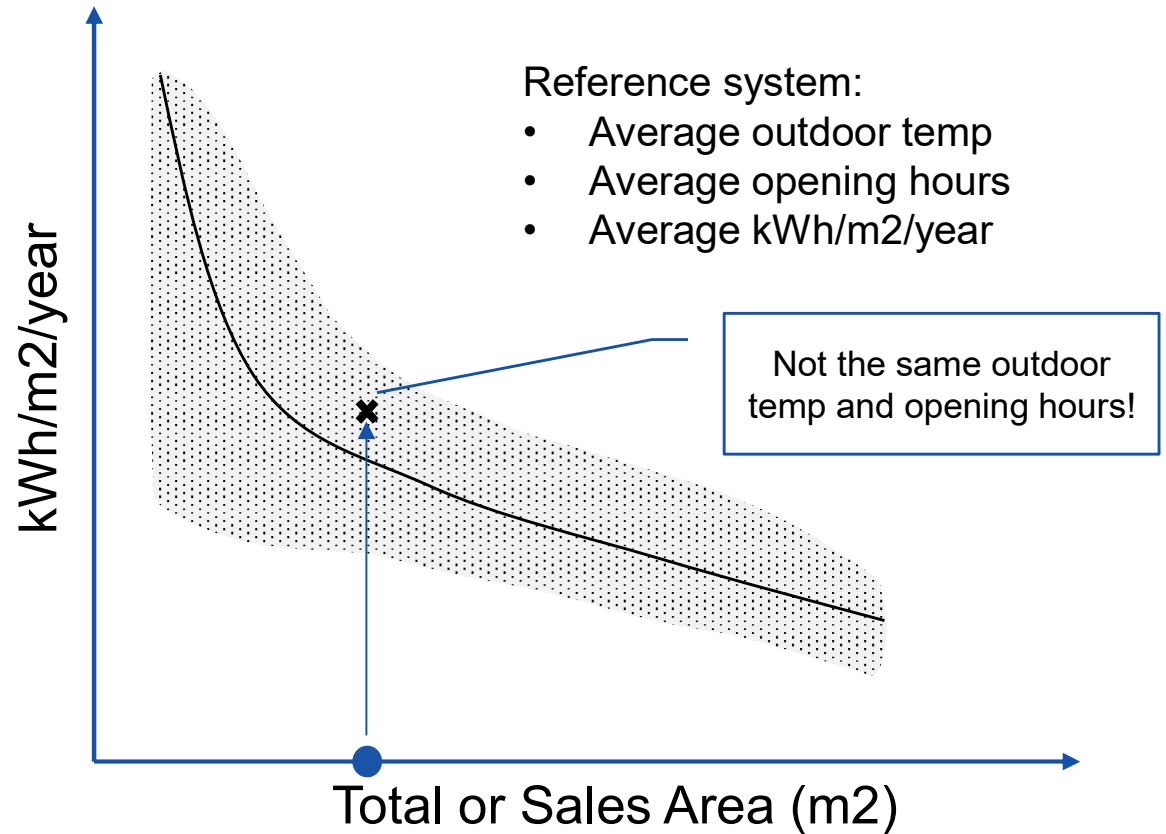
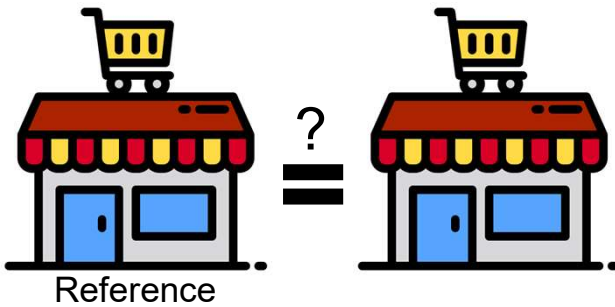
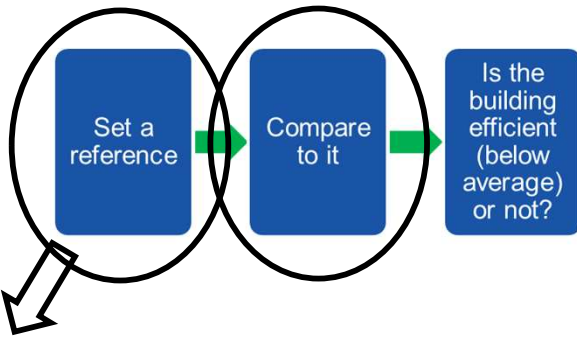




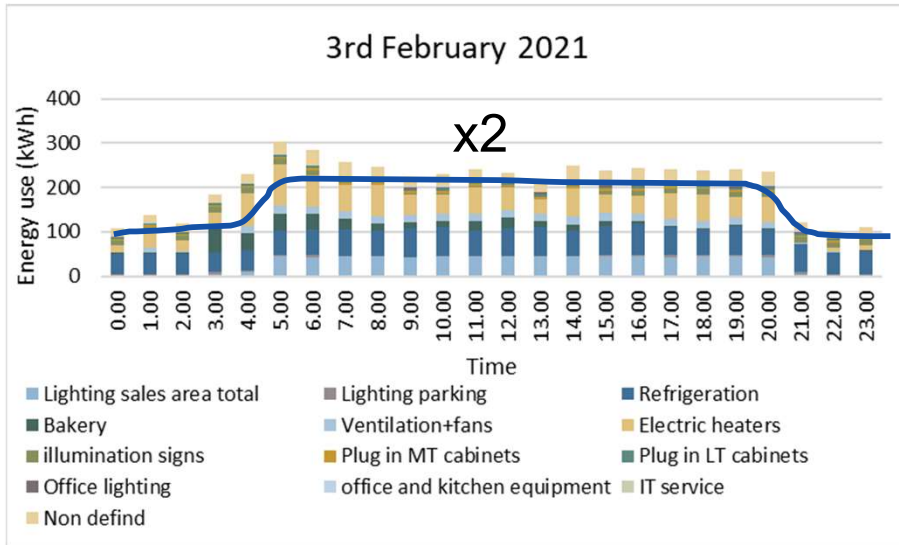
# How to benchmark? Set a reference first



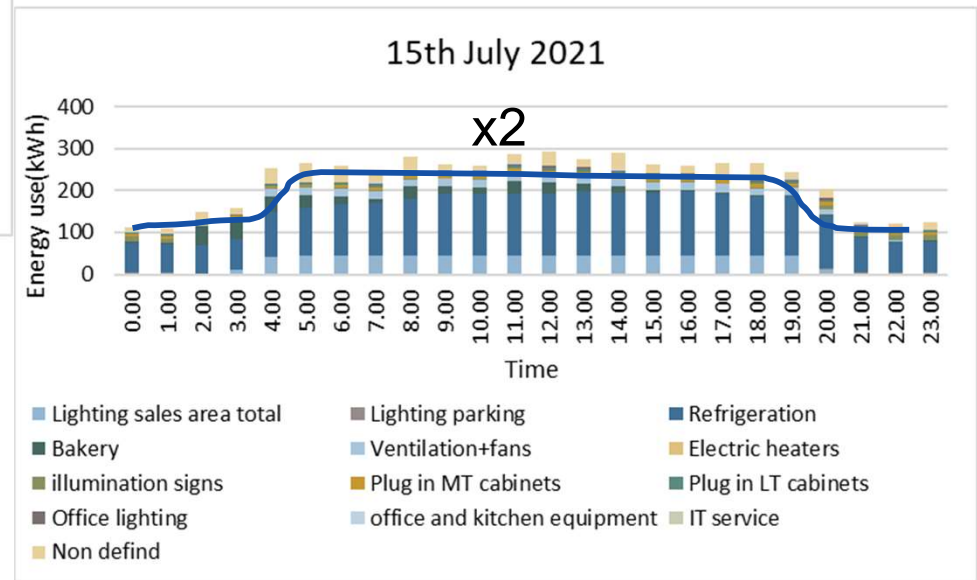
# How to benchmark? Set a reference first



# Correcting for the opening hour



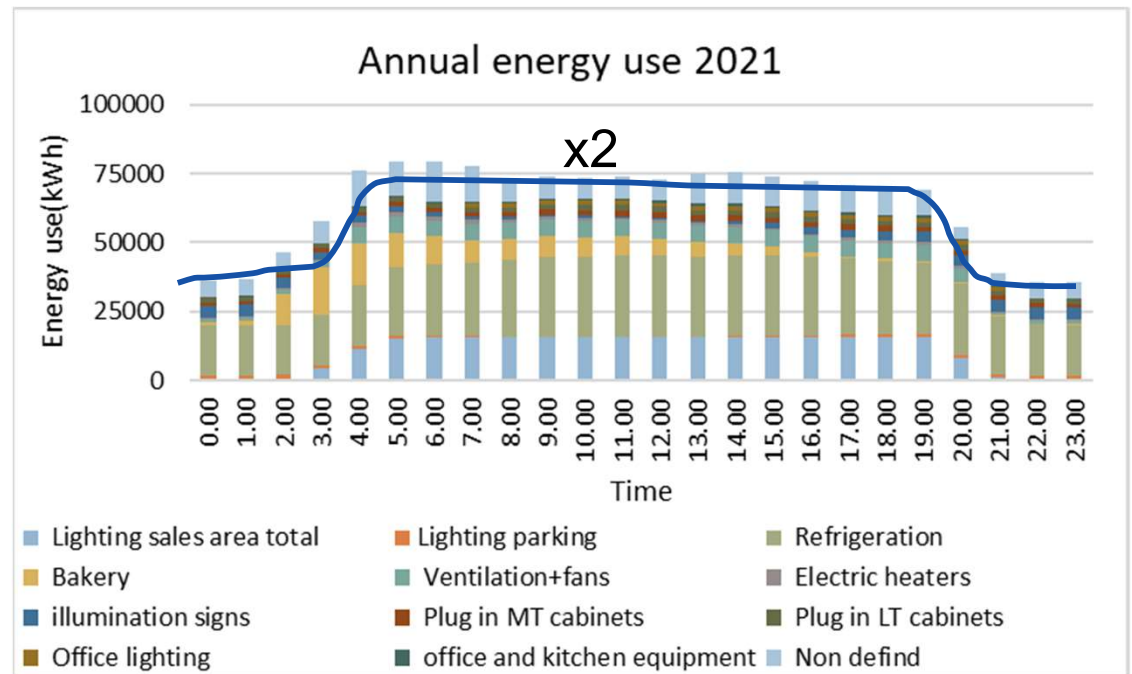
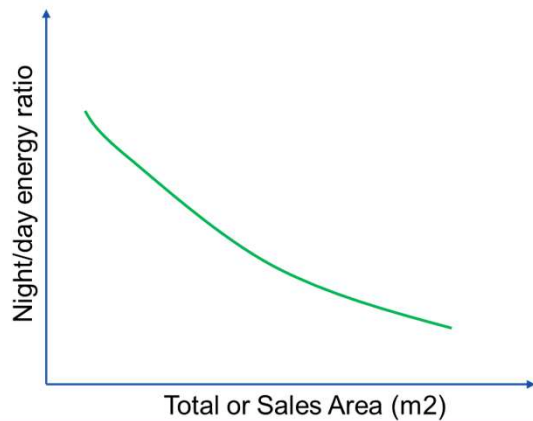
## Supermarket 1



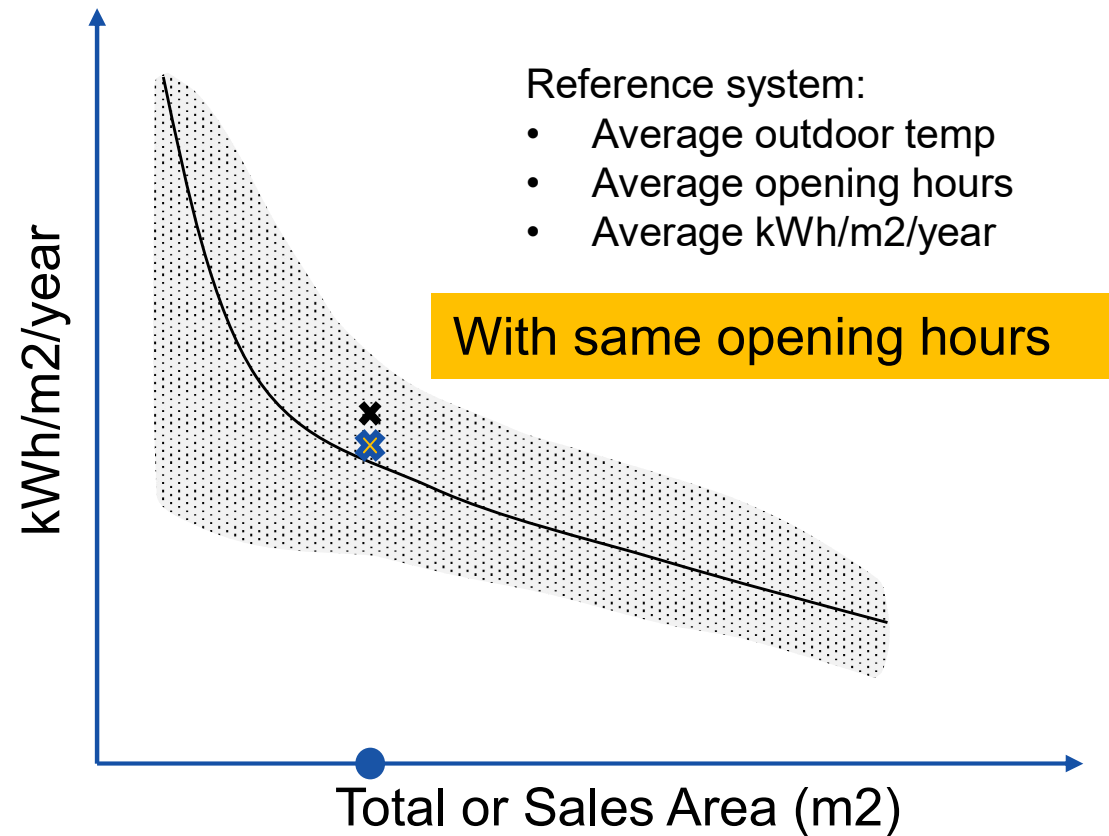
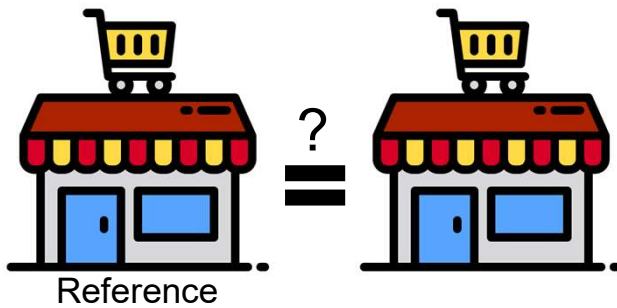
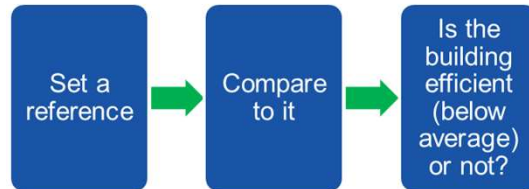
# Correcting for the opening hour

## Supermarket 1

- Correction factor can be implanted for opening hours
- This need to be generated for supermarkets of different sizes



# Correcting for the opening hour



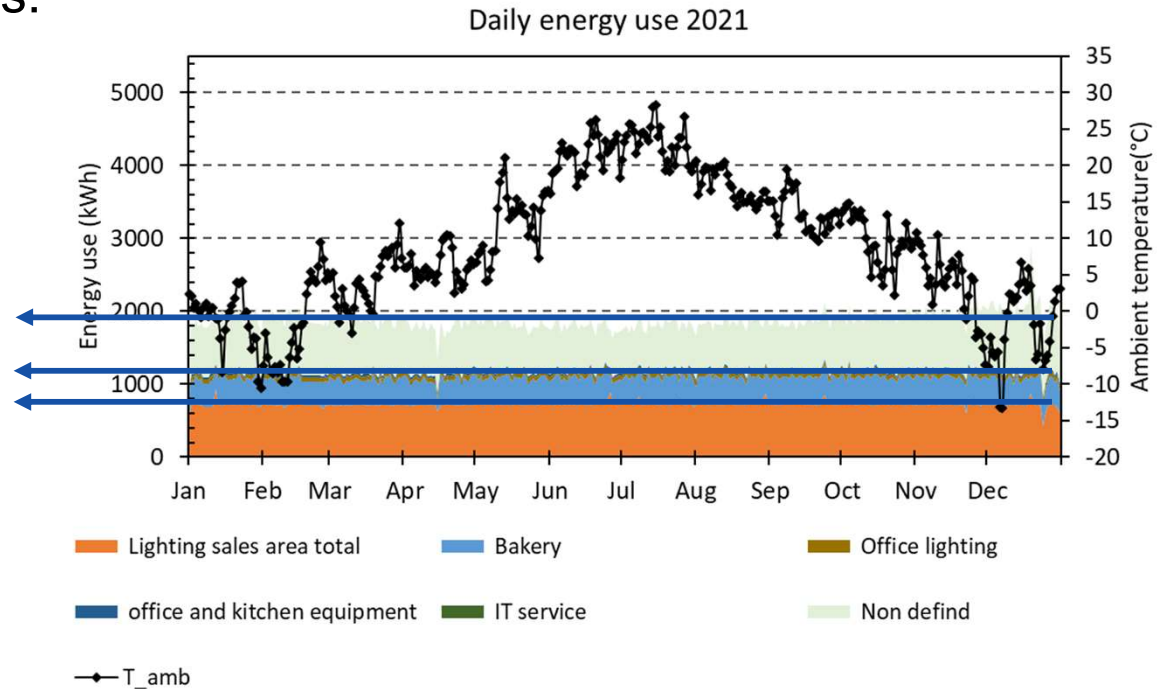
# Correcting for outdoor temperature

Separate the dependent and independent variable

Main dependent parameters:

- Refrigeration
- Space heating
- Air conditioning

Independent

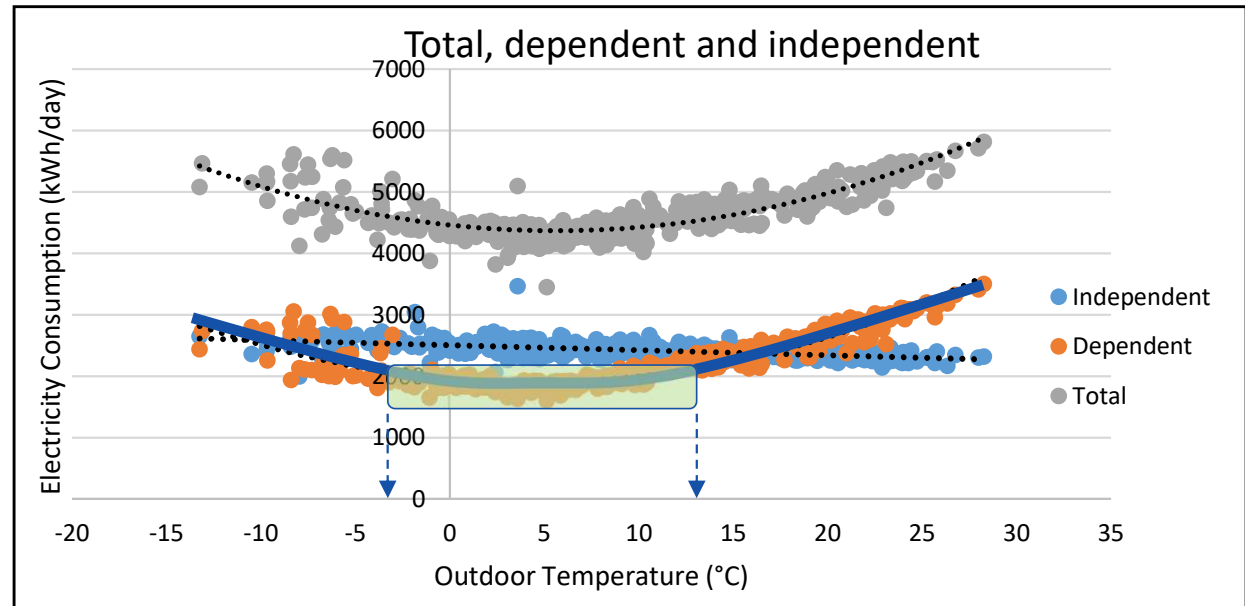


# Correcting for outdoor temperature

Separate the dependent and independent variable

Main dependent parameters:

- Refrigeration
- Space heating
- Air conditioning

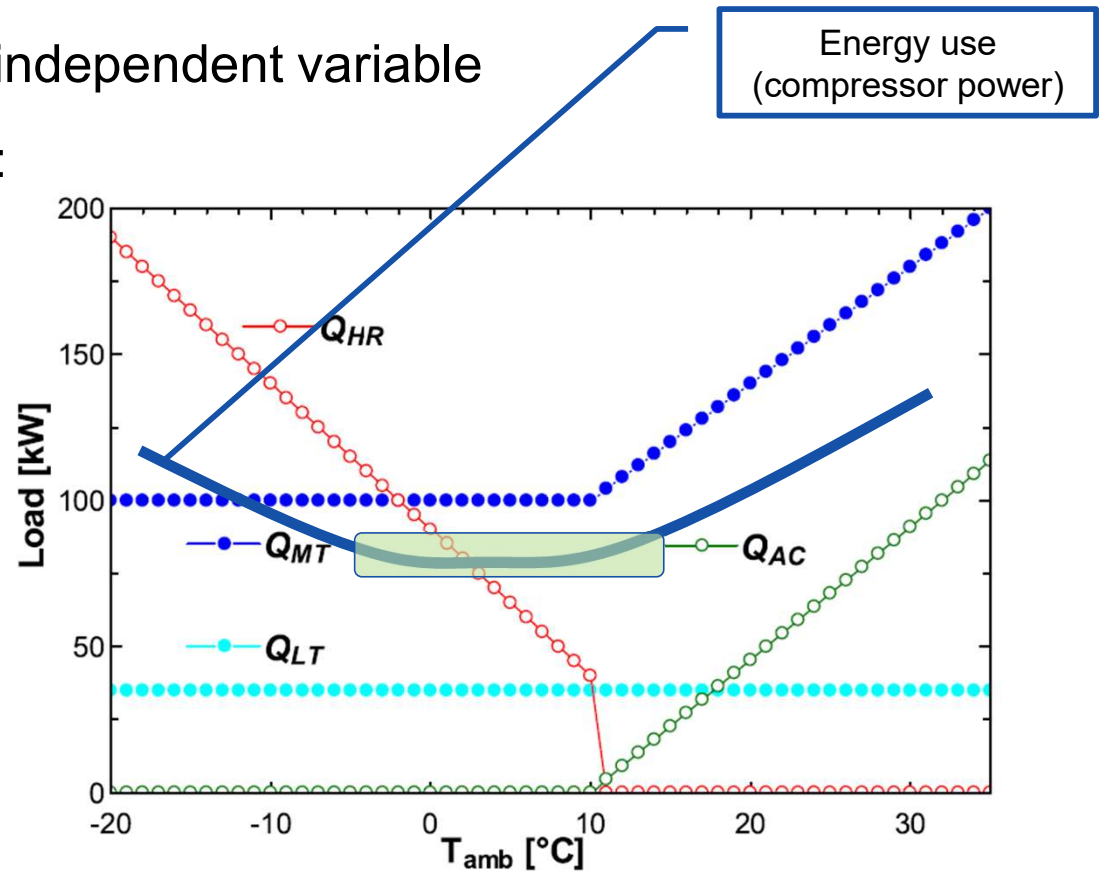


# Correcting for outdoor temperature

Separate the dependent and independent variable

Main dependent parameters:

- Refrigeration
- Space heating
- Air conditioning



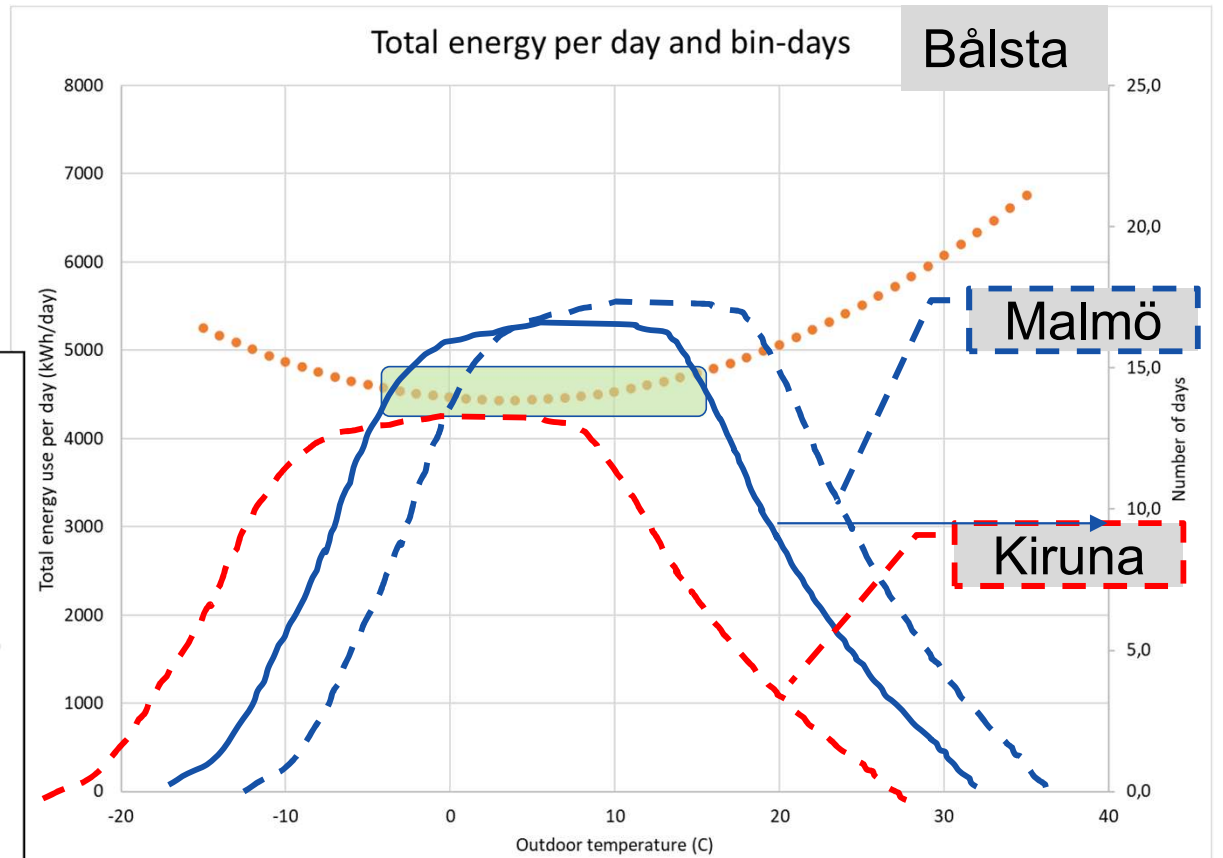
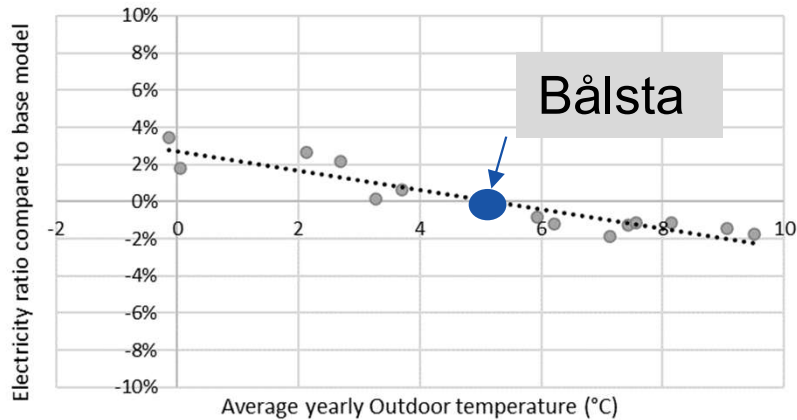




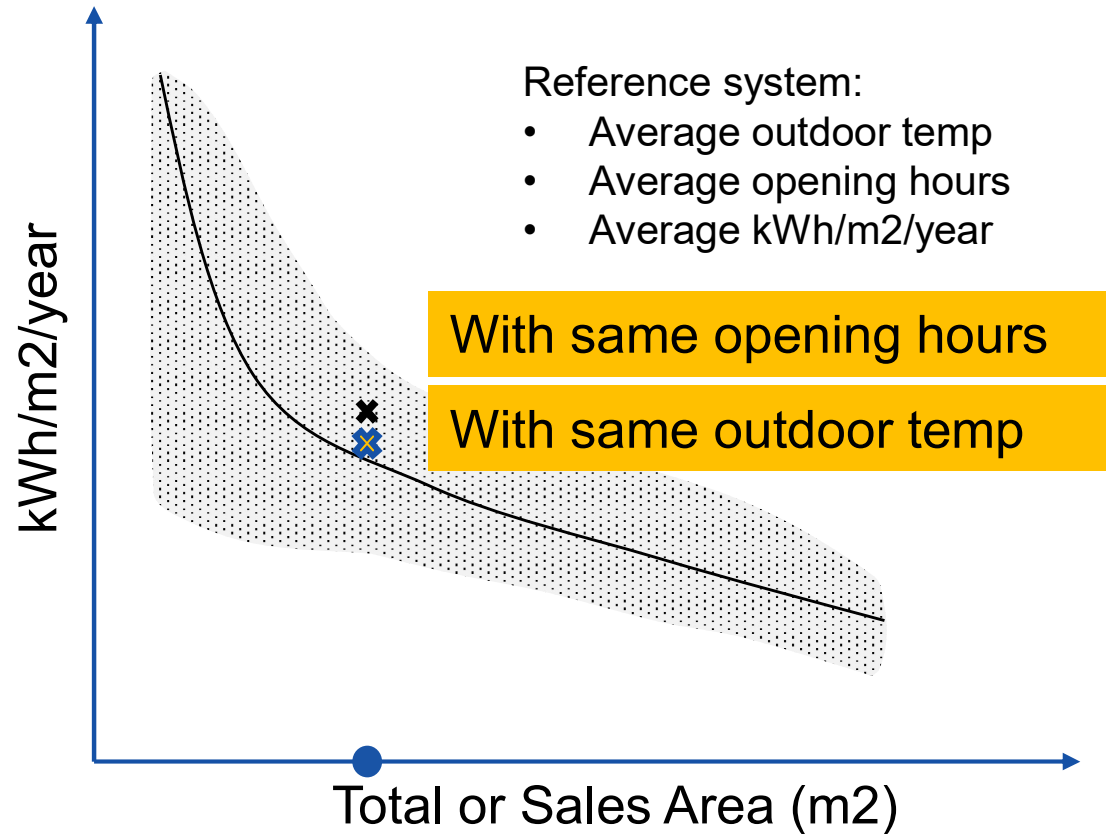
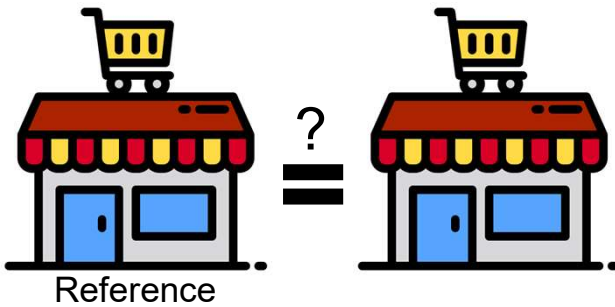
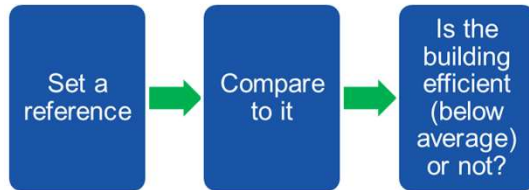
# Correcting for outdoor temperature

Small influence of most locations in Sweden

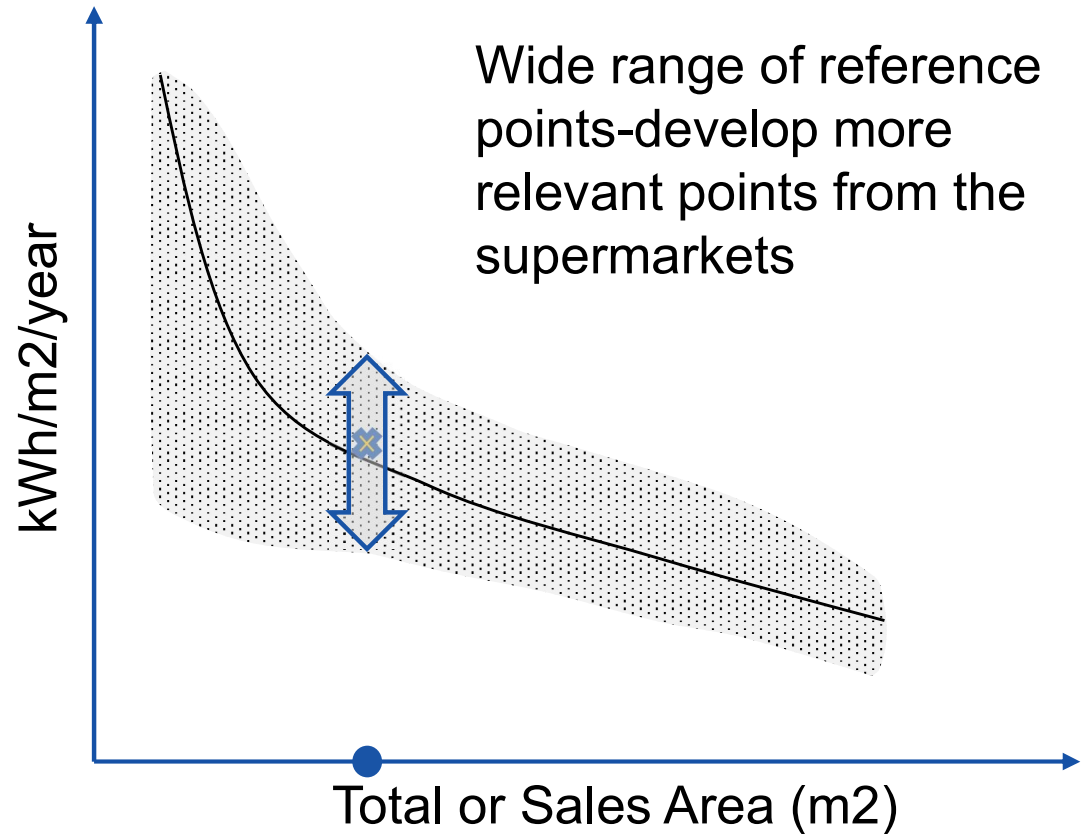
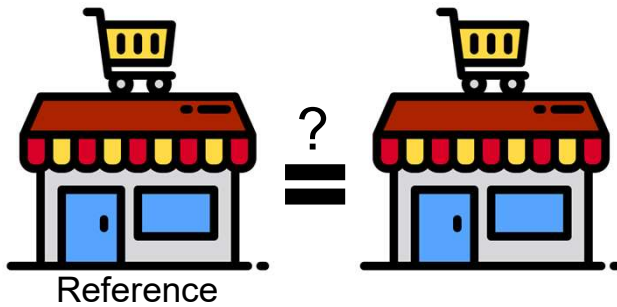
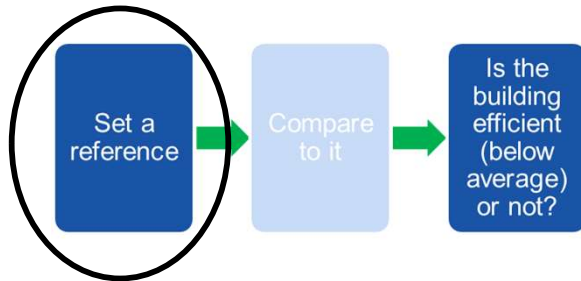
Total Electricity Consumption Ratio (Base Model: Bålsta)



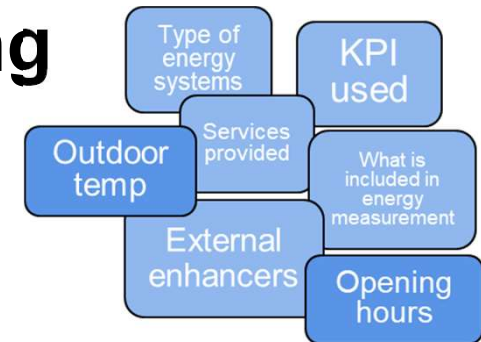
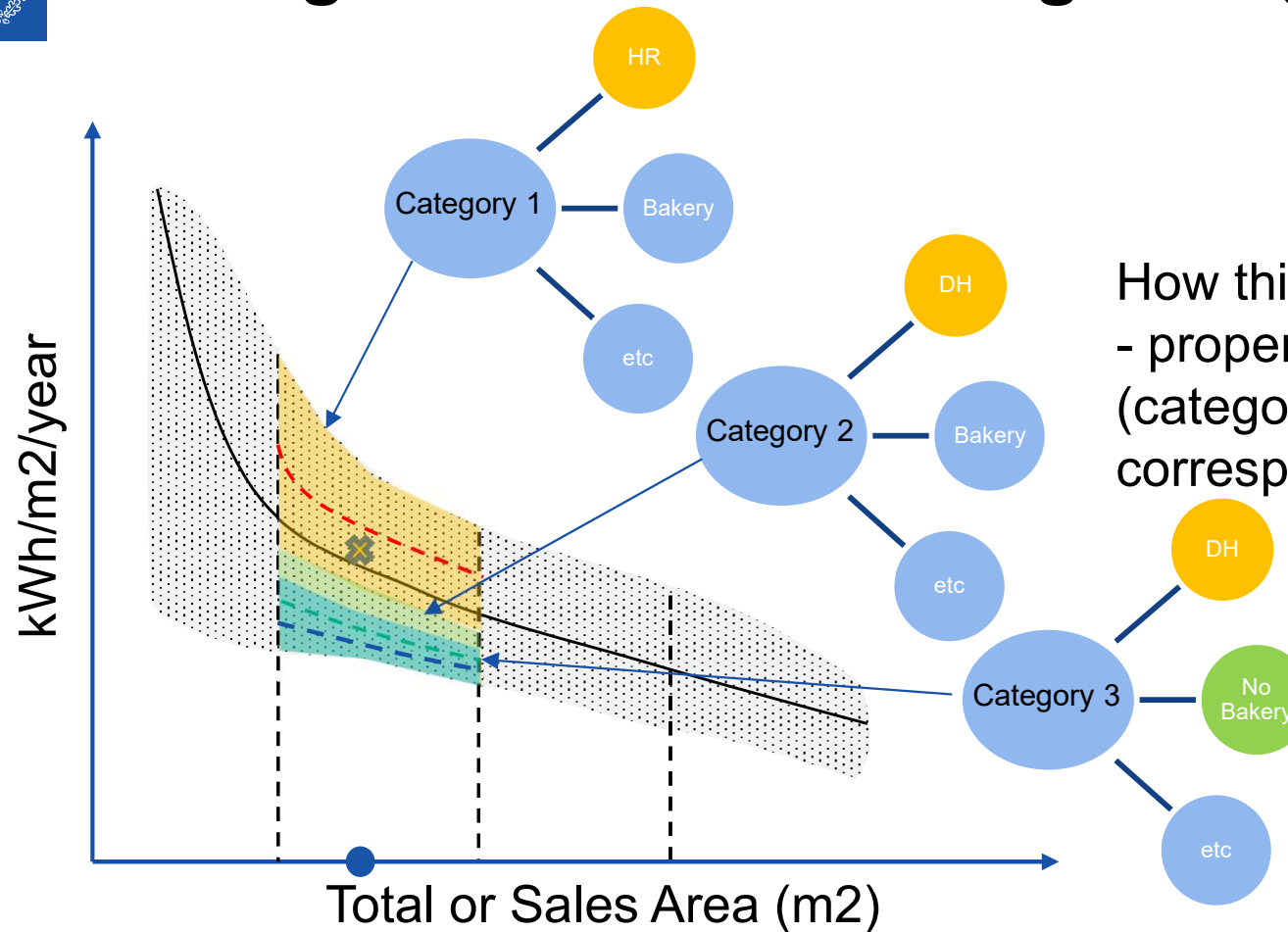
# Correcting for outdoor temperature



# Set a good reference- categorizing

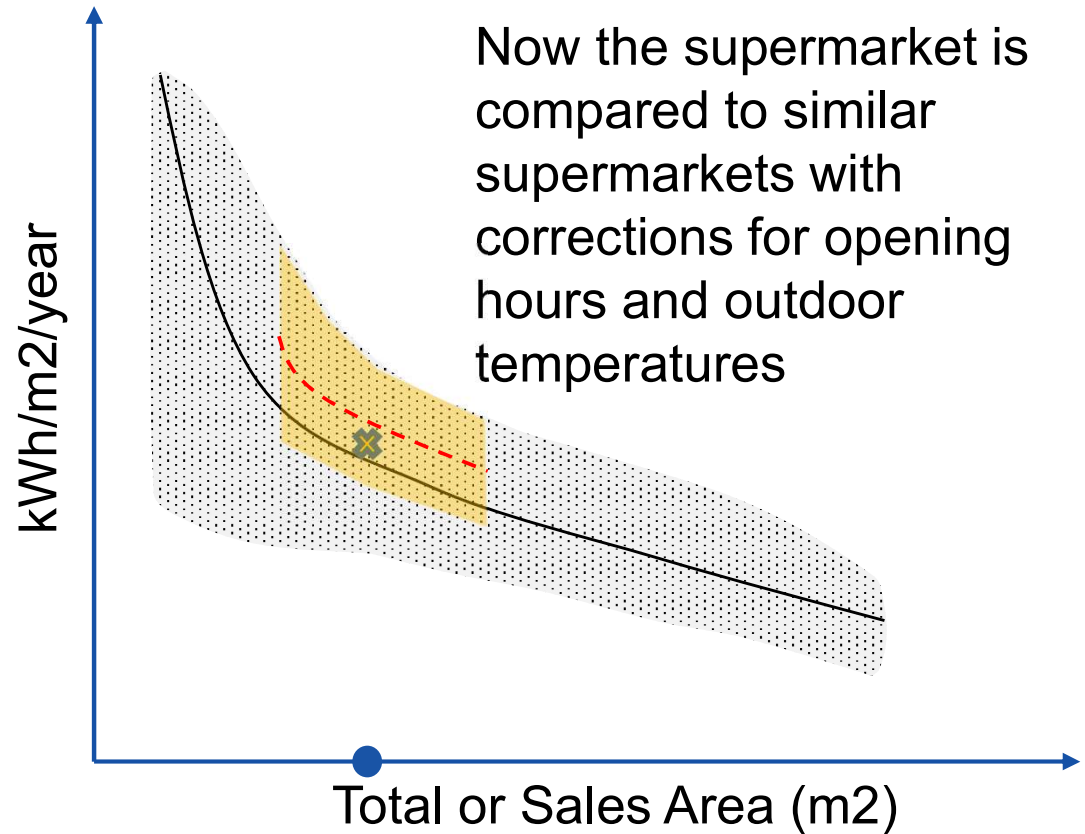
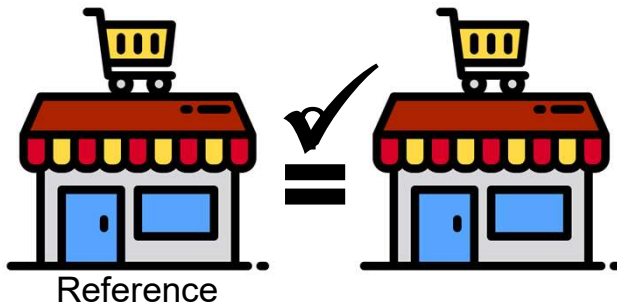
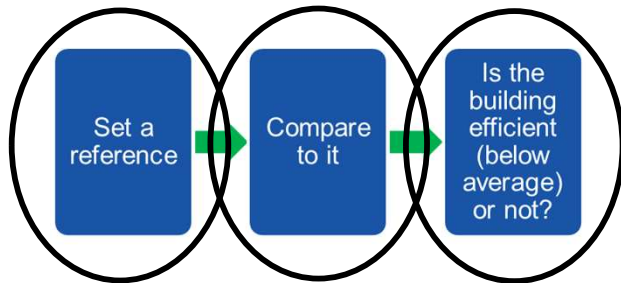


# Set a good reference- categorizing



How this can be done?  
 - proper information (categorization) and corresponding data collection

# Set a good reference- categorizing





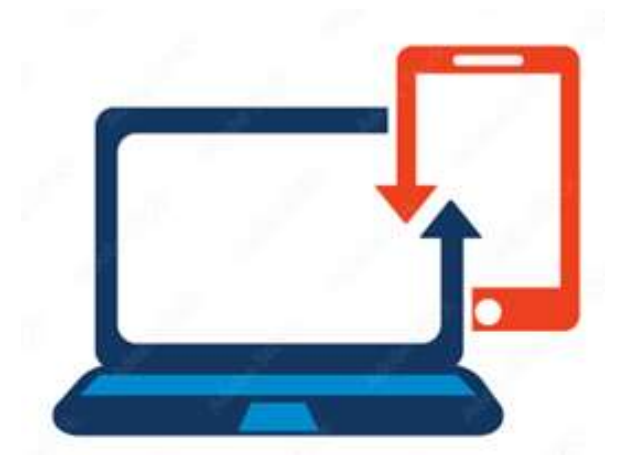
# Conducted and future research

- We developed the benchmarking approach through access to few supermarkets with detailed measurements, and many more supermarkets with less level of details
- Many more supermarket with properly categorized data and information on each case is needed. Example of what is needed can be found on [the data collection survey](#) we published together with CIT.
- There is a need to develop reliable and accurate benchmarking for supermarkets for:
  - Owners (Decision making using proper KPI's, such as SEK/m2/year or potential SEK savings/year)
  - Designers
    - > *kWh/m2/year for each category: refrigeration, heating, AC, lighting, bakery, etc*
    - > *Calibrate the building modelling tools*
  - Operators for monitoring
  - System manufacturers to decide on the best technologies
  - Decision makers: Swedish Energy Agency can have convenient access to information anytime, no need for extensive projects to conduct data collection survey



# Proposed final product in the research application

- Up-to-dated web platform and app for benchmarking
- Where:
  - The input supermarkets are automatically categorized
  - The reference is continuously updated with every new supermarket input
  - Correction factors and the curve fits are continuously adjusted- i.e. the benchmarking method is always tuned
  - Tailor made information display for: owners, supermarket chains, operators, designers, researchers, decision makers, etc.
  - Guidelines for data collection and benchmarking





# Project proposal

- Ongoing call from Energimyndigheten:

Bidra med nya lösningar, kunskap och perspektiv för resurseffektiv bebyggelse

- Deadline 4<sup>th</sup> of October
- 100 MSEK, max 8 MSEK per project
- Max project period: March 2024 to December 2028 (58 months)
- KTH and CIT are teaming up for a project application and looking for partners. We aim to apply for 4 years project.
- If interested in joining as partner in the project, please contact us at KTH or CIT





**Thank you!**