Energy Efficiency Recommendations for Beverly Hills - 229, Emirates Realestate Egypt

IKI Project: Accelerating 0-emission building sector ambitions in the MENA region (BUILD_ME)

September 2120

Introduction to the BUILD_ME project

Fund

IKI International Climate Initiative, German Federal Ministry of Environment

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

MENA Region

EGY

JOR

LEB

ALG

MOR

TUN

Team

IDG MATRIX Integrated Development Group

الجمعية العلمية الملكية Royal Scientific Society

LCEC

European Bank for Reconstruction and Development

Guidehouse

TRACK

EGYPT GBC

LGBC

ALCOR

RCREEE

Contents

1 **Introduction**
- Background,
  Objectives and Methodology
- Project Boundary conditions

2 **Analysis**
- Starting Situation -
  Baseline and Current planning
- Investigation of Possible Measures

3 **Results**
- Recommendations
- Comparative overview
- Conclusion

Introduction

Background, Objectives and Methodology

Photo by Scott Graham on Unsplash

Introduction

BUILD_ME Project and the Objectives of Pilot Projects

Approach and Methodology

Steps Towards a Low Energy Building

1 Starting	2 Boundary Conditions	3 Analysis	4 Development	5 Final Recommendations
▪ Introduction of BUILD_ME ▪ Signing of MoU ▪ Kick-off Meeting (s) ▪ Provide Building Info.	▪ Climate Analysis ▪ Economic Aspects ▪ Building Baseline ▪ Definition of packages	▪ Building Envelope ▪ HVAC I Efficiencies ▪ Renewables ▪ Other Measures	▪ Discussion with Developers ▪ Local and Market inputs ▪ Costs and ROI	▪ Final presentation ▪ Final list of recommendations ▪ Site visits support

Week 0	Week1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week10	Week11	Week12	Week13
MoU	Data							Initial recommendations					Final presentation

- **Initial timeline to be adjusted according to the demands and development of the pilot project.**
- **Remain in close exchange of data, information and concepts**
- **Field visits will be coordinated and executed by BUILD_ME National Partners and/or local experts.**

Methodology

Cost Benefit Analysis

HIGLIGHTS

- Besides classic CAPEX/ OPEX cost, it considers residual values
- Hourly based energy calculation
- Detailed local weather data is considered
- Energy price systematic and PV clearing adapted to local situation (Egypt)

ENERGY CALCULATION

- individual building geometries and windows (incl. orientation)
- Hourly based energy calculation using the international ISO 52016 norm
- Based on the energy demand calculation (useful demand) the HVAC systems are sized
- Five efficiency levels for each HVAC system can be selected individually
- Meteonorm data base delivers detailed local weather input (hourly)

GLOBAL COST

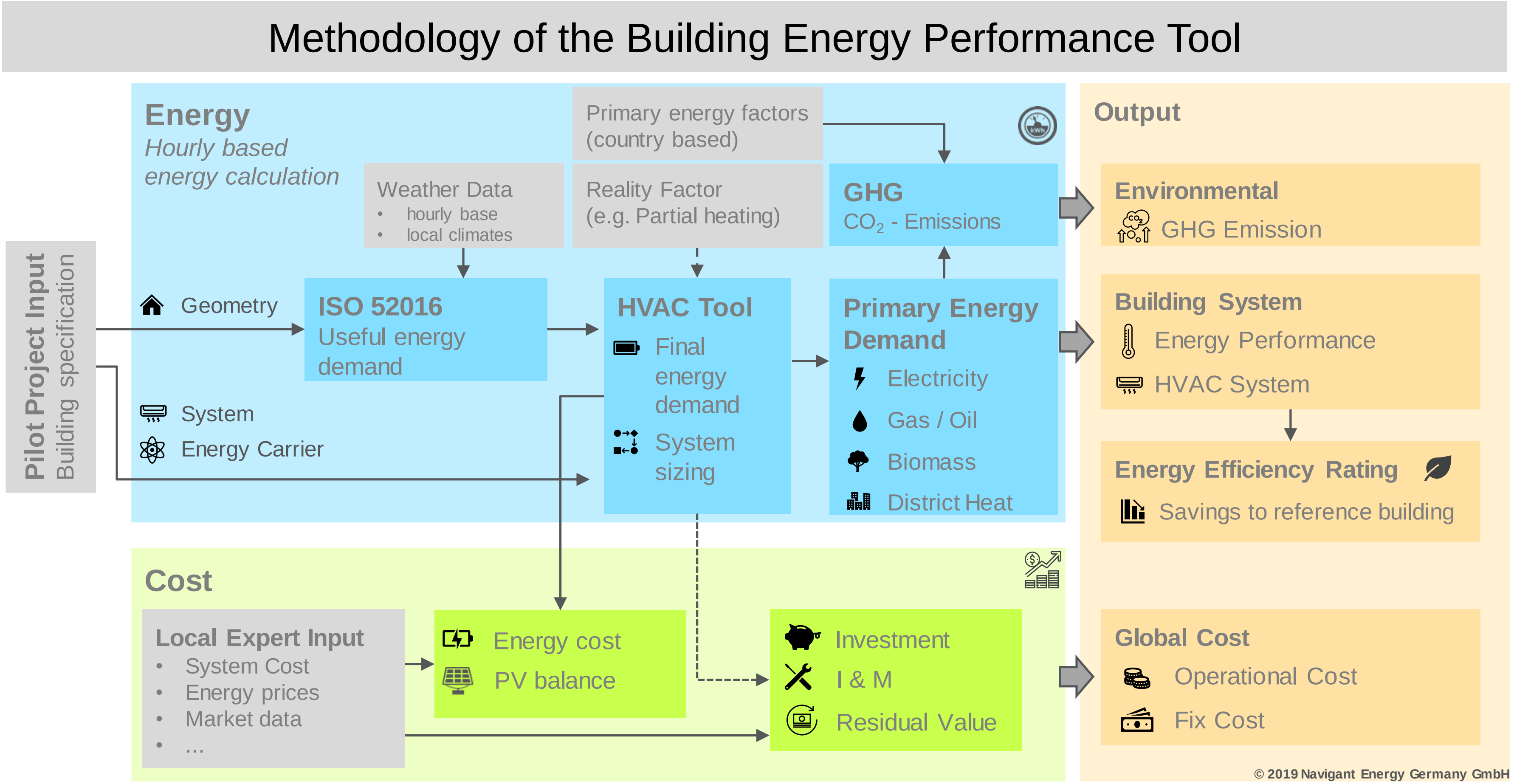
- Calculation of energy cost and investment cost of the systems, based on the HVAC system sized in the energy calculation
- Energy price systematic and PV clearing can be adapted to local situation (here: Jordan)
- Residual values at the end of the calculation period for the systems are considered

Methodology

Cost Benefit Analysis

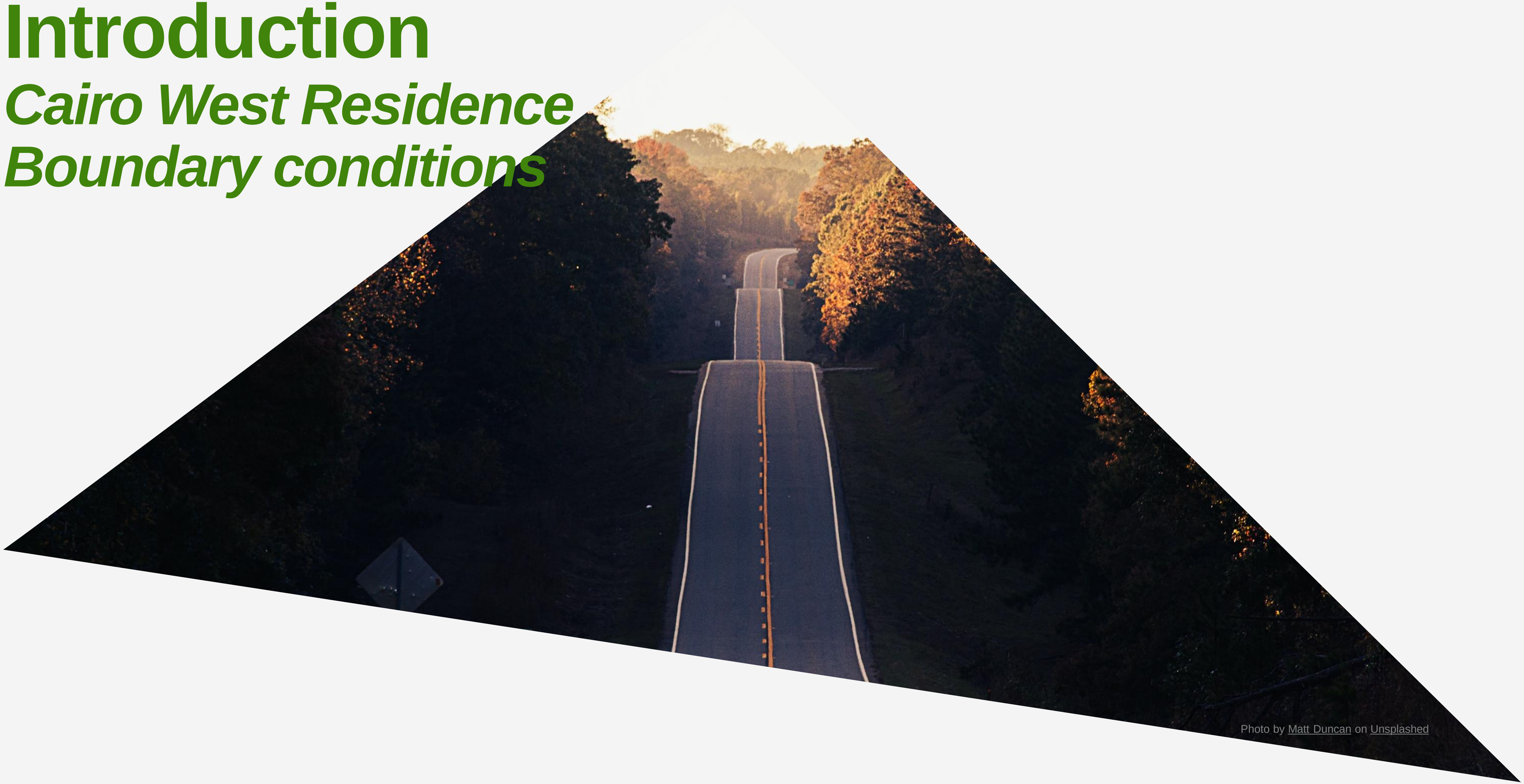
HIGLIGHTS

- Besides classic CAPEX/ OPEX cost, it considers residual values
- Hourly based energy calculation
- Detailed local weather data is considered
- Energy price systematic and PV clearing adapted to local situation (Egypt)



Introduction

Cairo West Residence Boundary conditions



Beverly Hills - 229

Aims

Creating a multifamily house that provides residents with the high levels of thermal comfort and provide an example of the energy efficient buildings in Egypt.

Target Groups

Upper middle class housing for families in Greater Cairo.

Function

A diverse range of residential units that will be offered for both sale and rental.

Size

Total area of around 1200 m2 on 6 floors. The building has 15 housing units with total number of around 60 occupants/users.

Boundary conditions

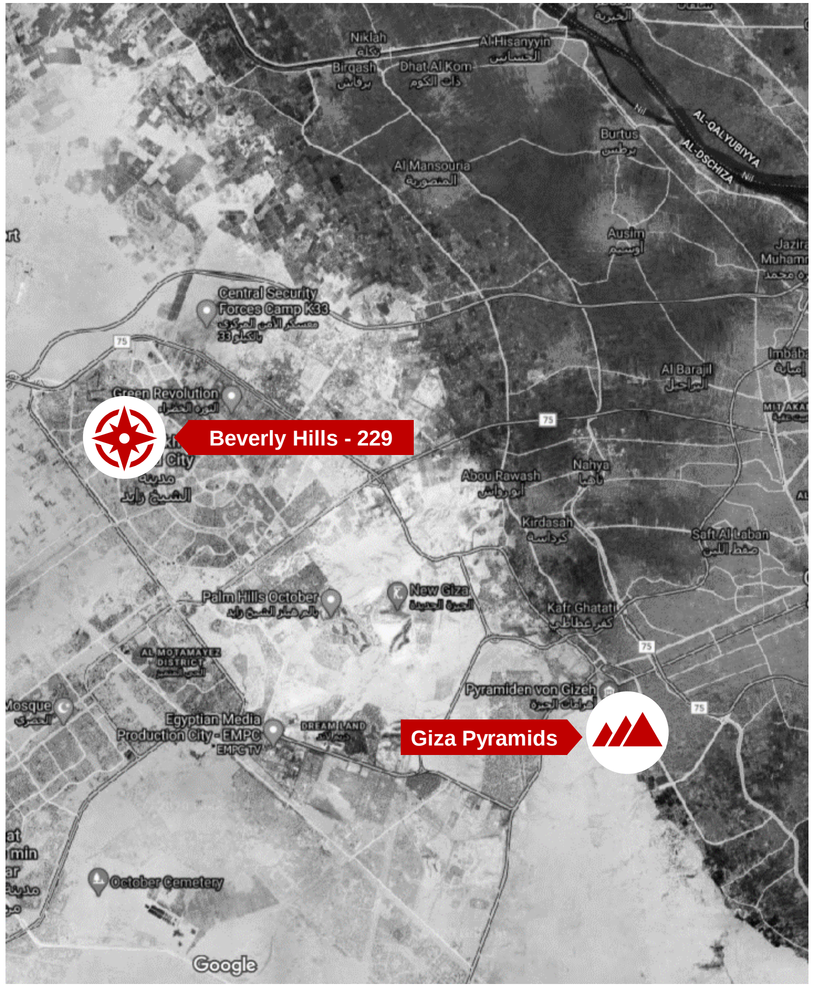
Site : Context matters

City : Giza, Greater Cairo

Location : 36 KM west of Tahrir Sq.

Context

The building located in Beverly Hills, which is a gated community in Al Sheikh Zayed city, Cairo.



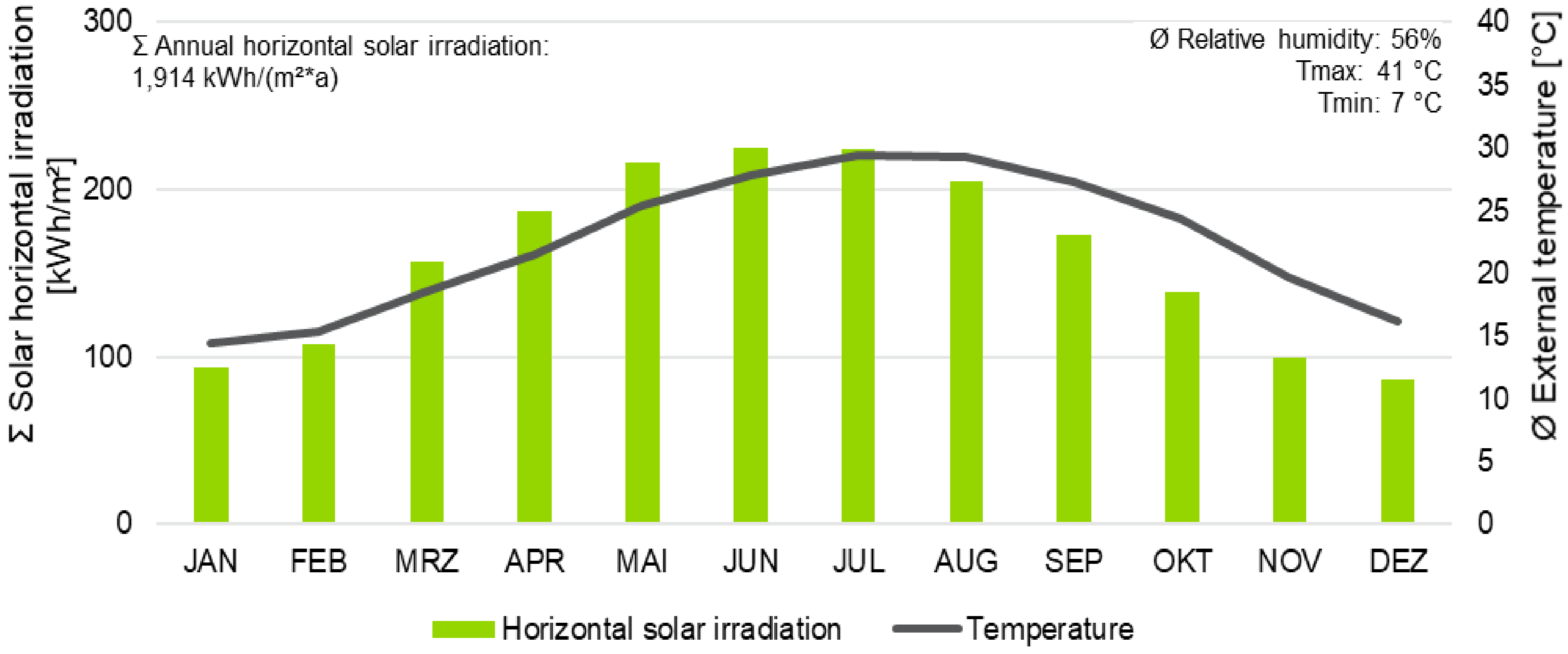
Source: Google Maps

Boundary conditions I Climate Analysis

Temperature and solar radiation, Cairo (Egypt)

Description

The climate in Cairo is primarily hot and reaches an average humidity rate of 56%. External temperatures range from above 13 to 41°C with average temperatures around 24°C.



Boundary conditions I Climate Analysis

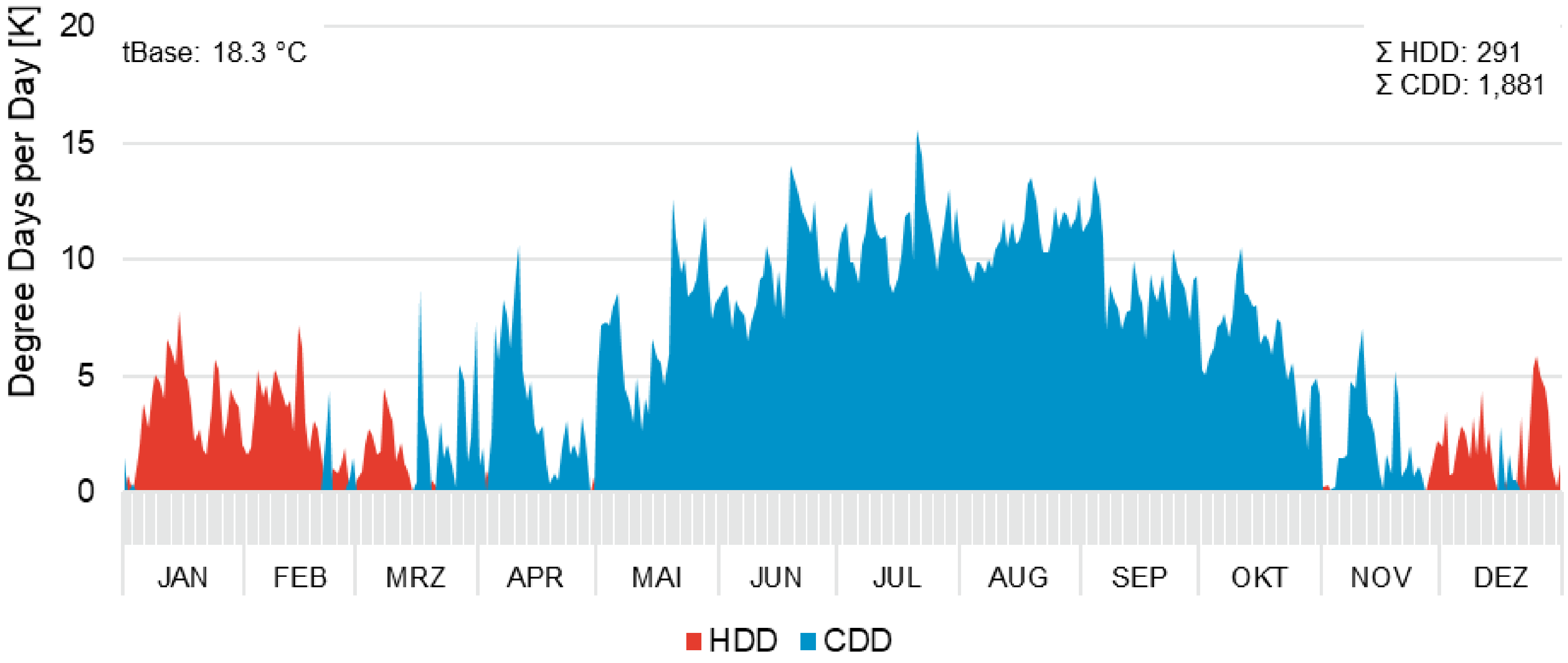
Heating and cooling degree days in Cairo (Egypt)*

Description

High number of >1,800 of CDD cooling degree days and a limited number of 291 of HDD heating degree days.

Challenges and Potentials

The amount of cooling degree days is more than six times higher than the heating degree days. Therefore, major share of the energy demand accumulates for cooling.



* Calculated according to ASHRAE 2001 methodology

Boundary conditions I Climate

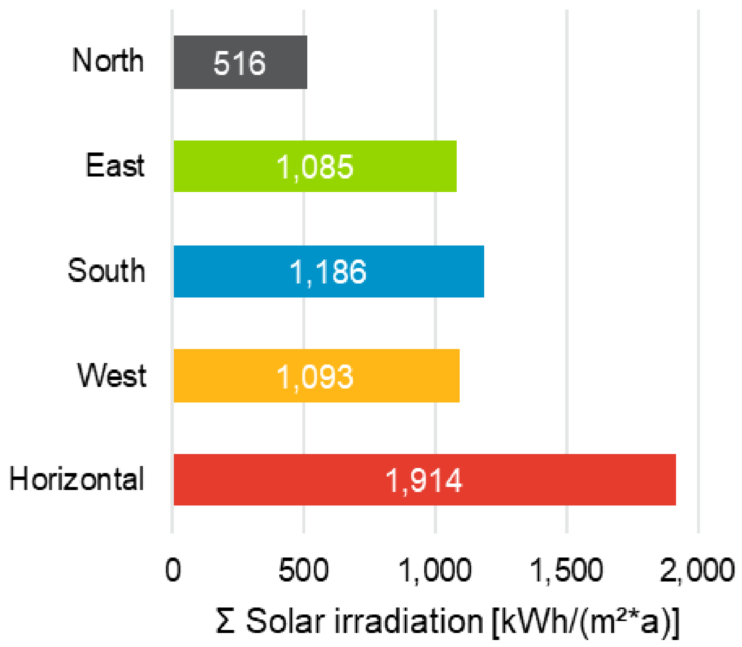
Solar Irradiation in Cairo (Egypt)

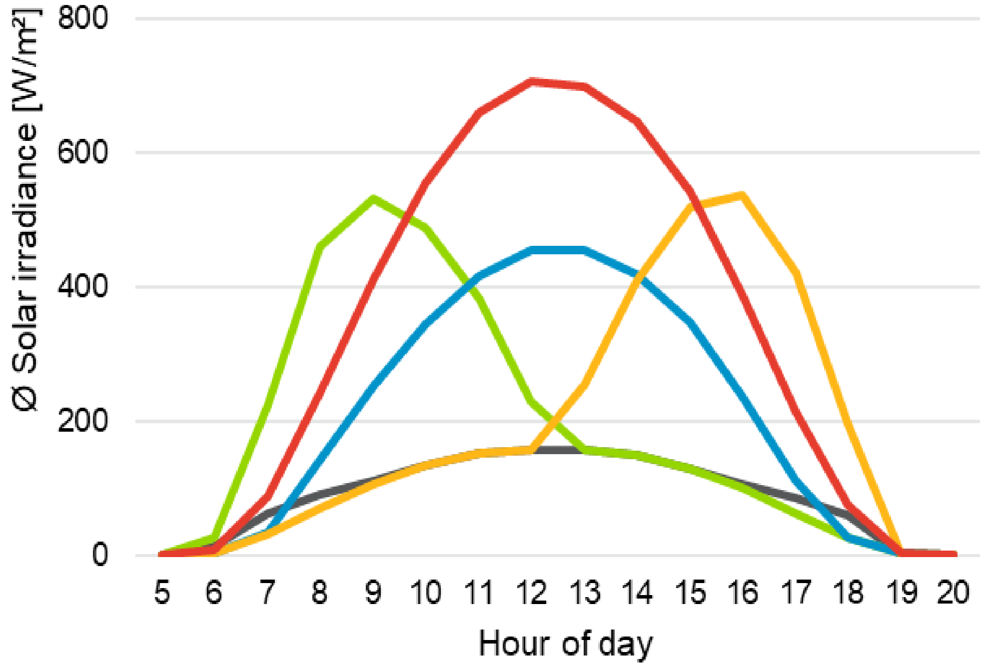
Description

High horizontal irradiation of > 2,000 kWh/(m²*a) and >1000 kWh/(m²*a) for East, South and West orientation.

Challenges and Potentials

Big potentials for energy generation through solar radiation, solar water heaters, PVs and solar cooling could be utilized.





Boundary conditions I Economic and Emissions Inputs

Cost of Energy and Environmental impact

Status

In Egypt, electricity is main source of power in household consumption. Natural gas is also used for cooking purposes.
Energy subsidies will be totally cut in 2023.

Objectives

Energy price increases are assumed in the future and will be calculated in.

Energy prices and CO2 emissions			
Parameter	Unit	Electricity	Natural Gas
Energy price	EG Pound/kWh	Mean 1.0 - 1.45	3.10 per m3
Energy price	EUR/kWh	0.056 – 0.082	0.18 per m3
Price development in the last 5 years	%/year	25%	6%
CO2 emission factor	gCO2/kWh	444	220
Economic parameters			
Interest rate (real)	%/year	9.25	
Calculation period	years	20	

- **Exchange rate: 1 EUR = 17.61 EGP as of 29.05.2020**

Boundary Conditions I Building

Building Data

Status

The multi-family is under construction and it is planned to be delivered before end of 2021.

Specific Challenge

The building in the final phases of construction which leaves a limited room for intervention.

Building Key Information	
Data	Input
Latitude	30.065042,
Longitude	30.946856
Elevation [m]	155
Utilization	MFH
Number of floors	6
Number of apartment	15
Conditioned floor area [m²]	1200
Clear room height [m]	3,1
Conditioned volume [m³]	3720
Number of inhabitants [#]	60
Year of construction	2018-2021

Analysis

Starting Situation - Baseline and Curren planning

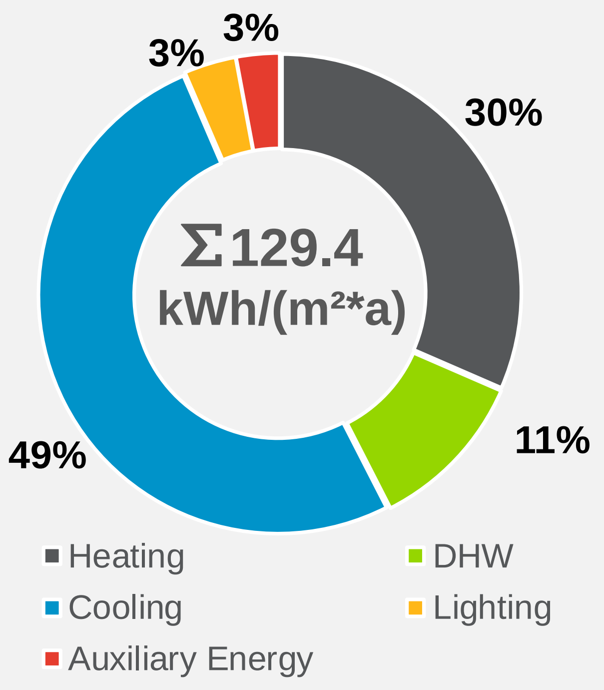
Photo by Jonathan Klok on Unsplashed

Business as Usual

Based on building typology analysis

The key components of the energy concept are illustrated in this table, it shows that the building envelope is in line with the thresholds of the current building code. While no special attention is given to use renewable energy sources.

Parameters	Baseline
Roof insulation (U-Value)	3.2 W/m²K
Wall insulation (U-Value)	2.2 W/m²K
Floor insulation (U-Value)	2.2 W/m²K
Windows (U-Value; G-Value)	5.8 W/m²K; 0.85
Window fraction	Ø 15%
Shading	No
Air tightness	0.25 1/h
Heat supply	Reversible split unit - COP 2.5
Cold supply	Reversible split unit - COP 2.5
Hot water	Gas instantaneous
Ventilation systems	Natural ventilation
Lighting systems	LED
Renewable energy	No
Set temperature cooling/heating	23°C / 23°C



Energy Cost
8.3 EUR / (m²*a)

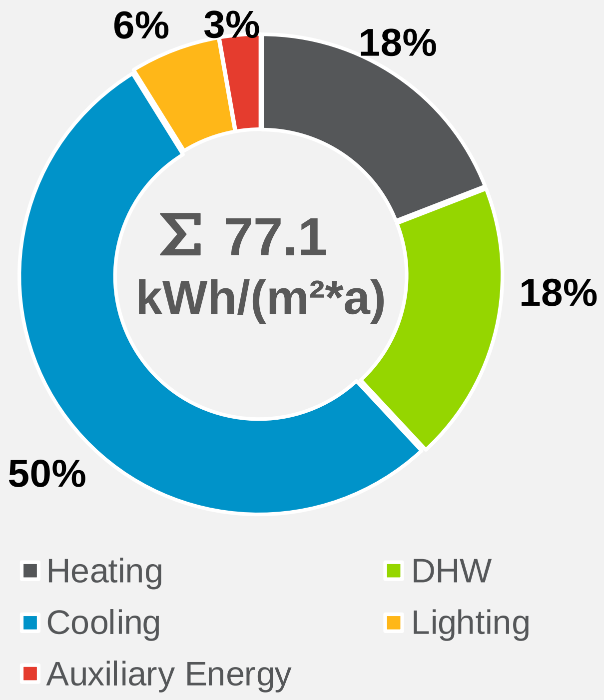
CO_2 - Emission
4.1 kg / (m²*a)

Current Situation

Building Characteristics as currently planned

The key components of the energy concept are illustrated in this table, it shows that the building envelope is in line with the thresholds of the current building code. While no special attention is given to use renewable energy sources.

Parameters	Baseline
Roof insulation (U-Value)	**0.46 W/m²K**
Wall insulation (U-Value)	**1.1 W/m²K**
Floor insulation (U-Value)	2.2 W/m²K
Windows (U-Value; G-Value)	**2.88 W/m²K; 0.7**
Window fraction	Ø 15%
Shading	No
Air tightness	0.25 1/h
Heat supply	Reversible split unit - **COP 3.2**
Cold supply	Reversible split unit - **COP 3.2**
Hot water	Gas instantaneous
Ventilation systems	Natural ventilation
Lighting systems	LED
Renewable energy	No
Set temperature cooling/heating	23°C / 23°C



Energy Cost
4.6 EUR / (m²*a)

CO2 - Emission
2.3 kg / (m²*a)

Comparison: BaU and Current Planning

The proposed design is significantly more energy efficient in comparison to the BAU cases.

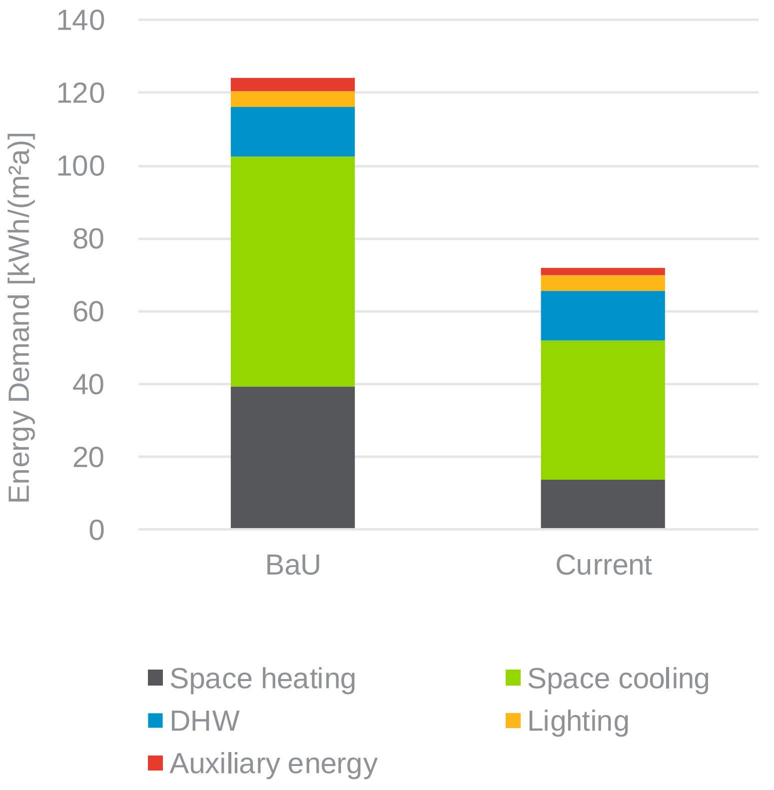
The proposed measures will also result in a cost decrease due to the significantly lower energy cost.

However, the proposed measures do not reach the cost optimal range.

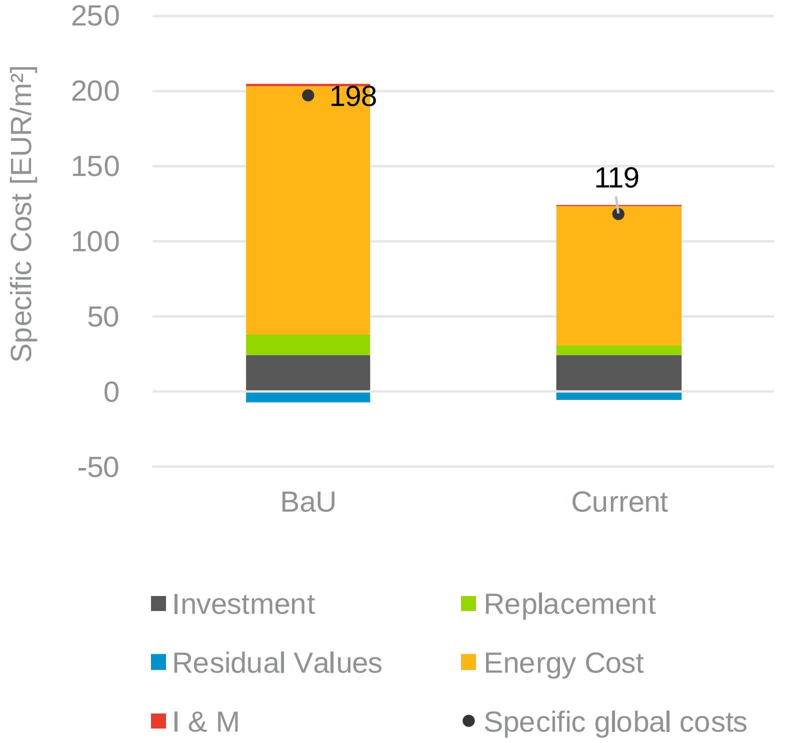
Energy savings: 43%

Global cost savings: 40%

Final Energy Demand



Global Cost



Analysis

Investigation of Possibl Measures

Photo by Dan Dimmock on Unsplashed

Building Envelope I External wall
Results

BaU
No insulation (U-Value = 2.2 W/m²K)

Var 1
Double wall, no insulation (U-Value = 0.73 W/m²K)

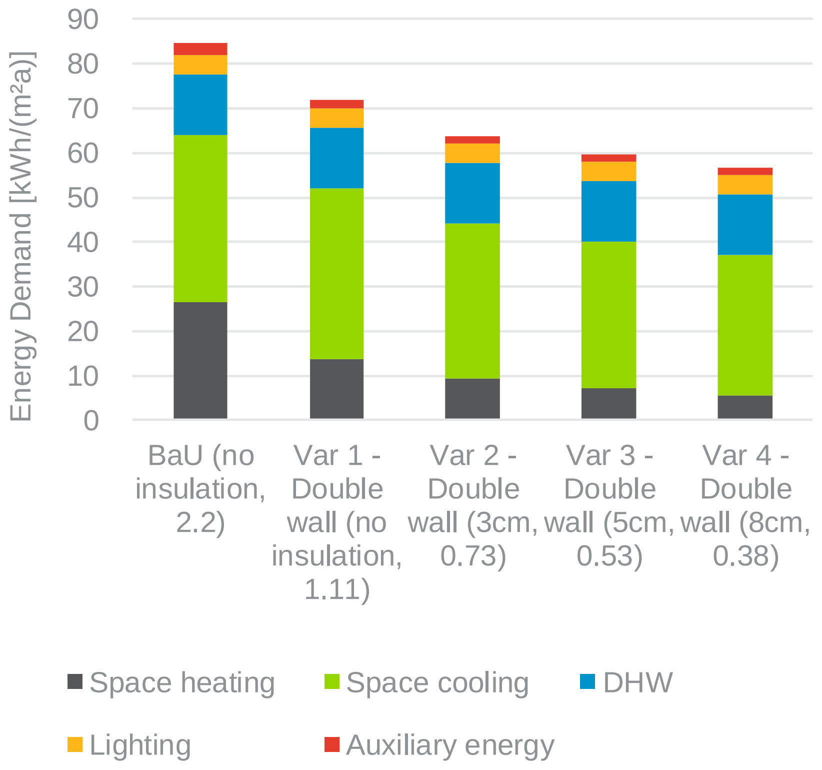
Var 2
3 cm insulation (U-Value = 0.73 W/m²K)

Var 3
5 cm insulation (U-Value = 0.53 W/m²K)

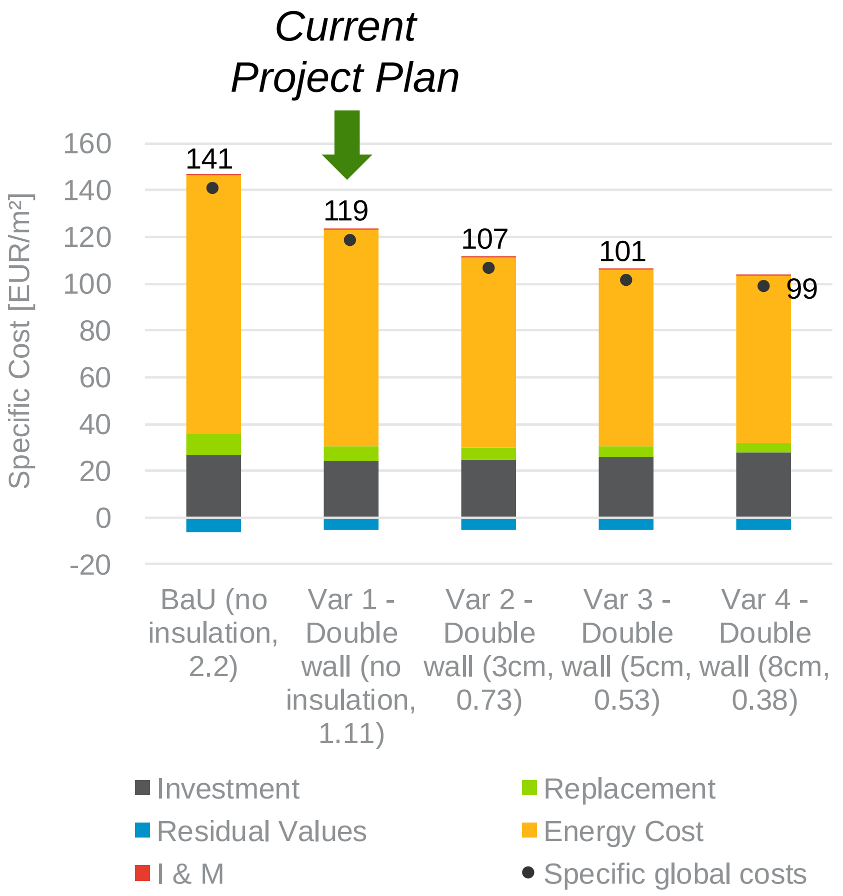
Var 4
8 cm insulation (U-Value = 0.38 W/m²K)

Result: Var 4 is the most cost effective measure

Final Energy Demand



Global Cost



Guidehouse

BUILD_ME

Building Envelope I Roof

Results

BaU

no insulation

Current

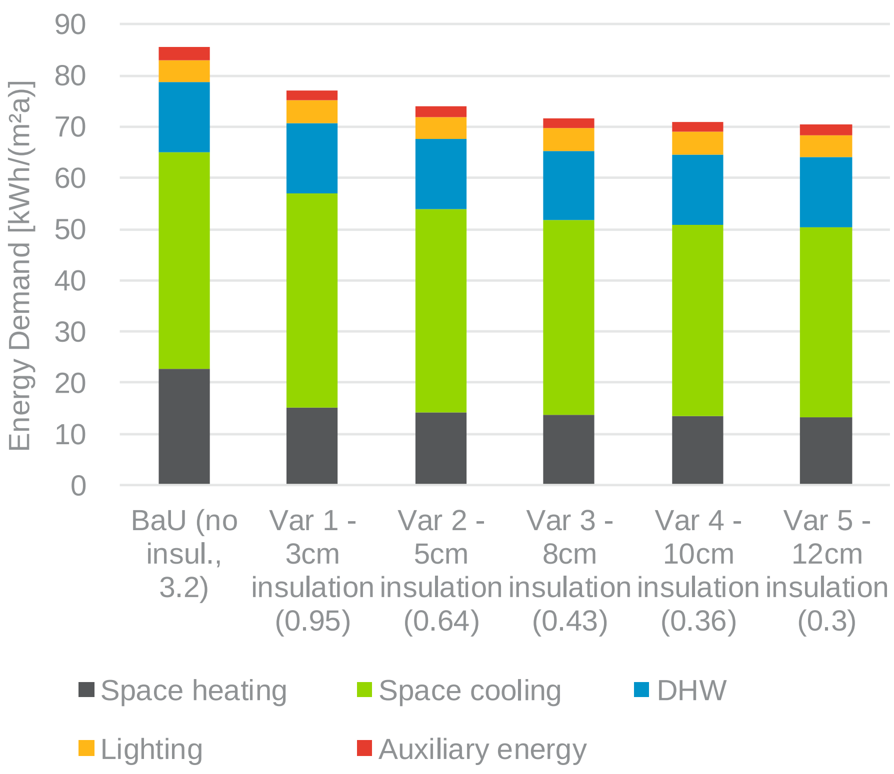
7 cm insulation (U-Value = 0.46 W/m²K)

Var 1 - 5

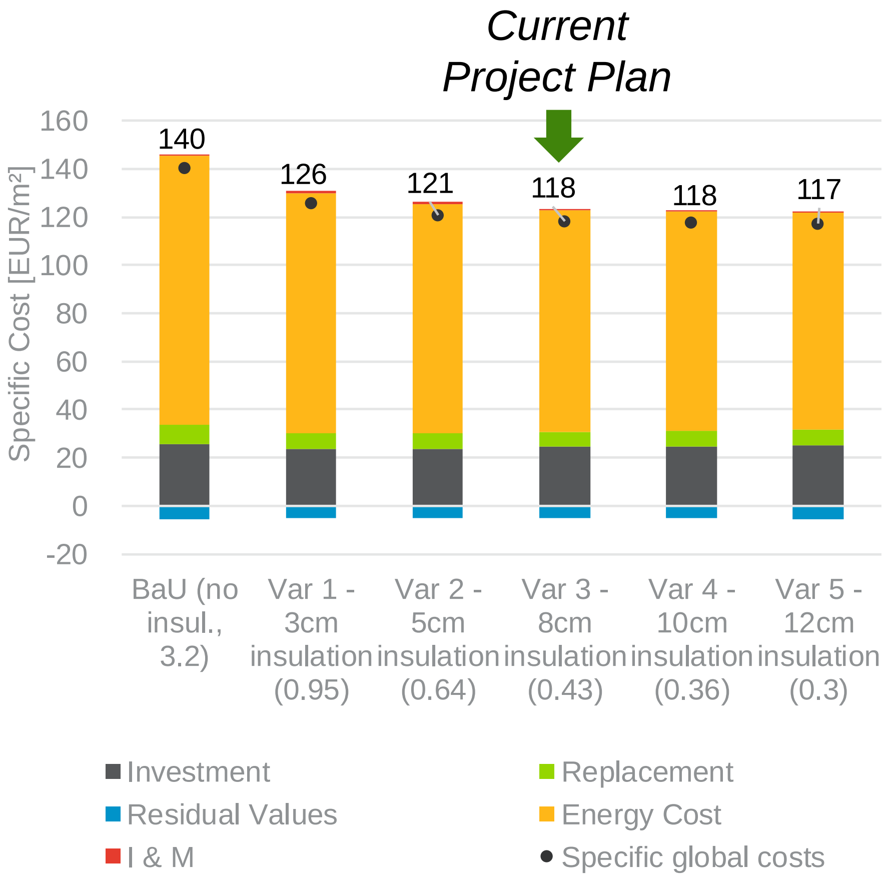
3 – 12 cm insulation (U-Value = 0.92 – 0.25 W/m²K)

Result: Var 5 with 12 cm is the most cost effective measure. However, the current project plan is already close.

Final Energy Demand



Global Cost



Guidehouse

BUILD_ME

Building Envelope I Windows

Results

BaU – Single glazing

U value 5.7 W/m²K
G-Value 0.85

Double glazing | low E (Var 1|2)

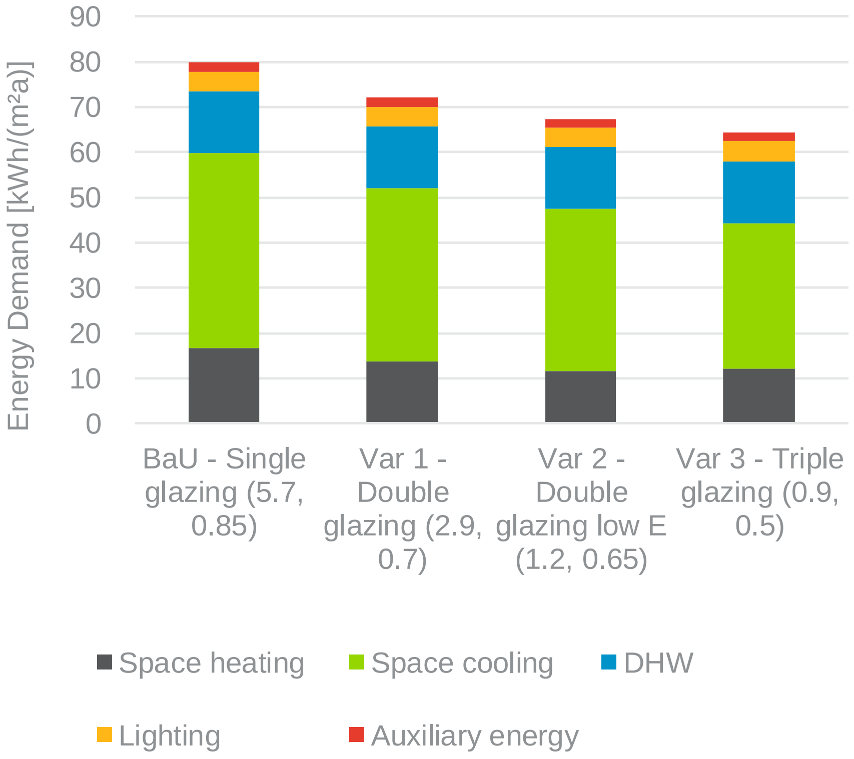
U value 2.8 | 1.2 W/m²K
G-Value 0.7 | 0.65

Triple glazing (Var 2)

U value 0.9 W/m²K,
G-Value 0.5

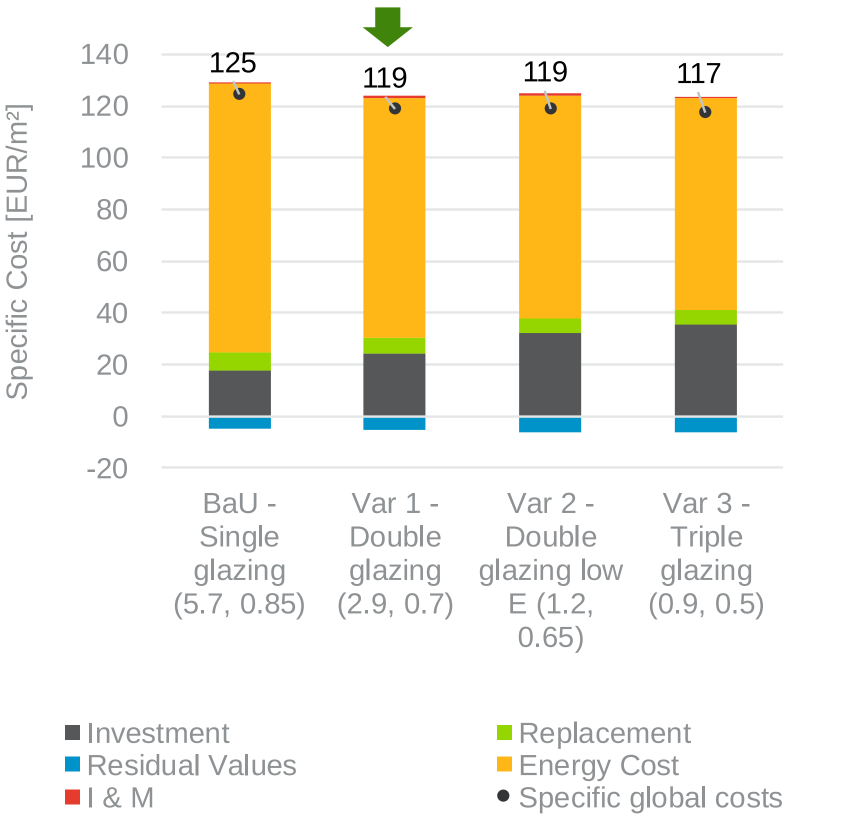
Var 3 is the more cost-effective case.

Final Energy Demand



Global Cost

Current Project Plan



Window Fraction

Analysis

Var 1

Window fraction 40 %

Var 2

Window fraction 30 %

Var 3

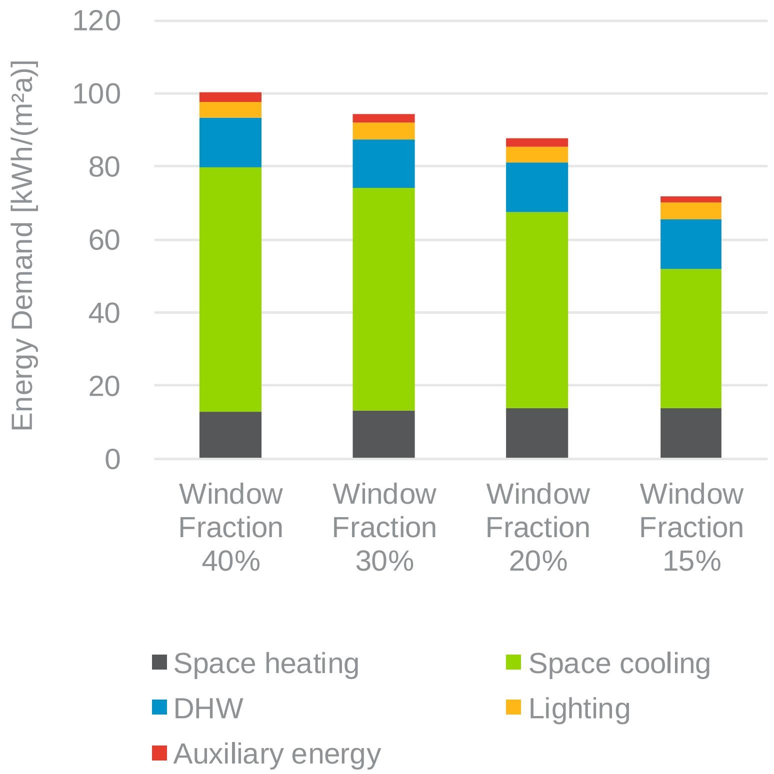
Window fraction 20 %

Var 4

Window fraction 15 %

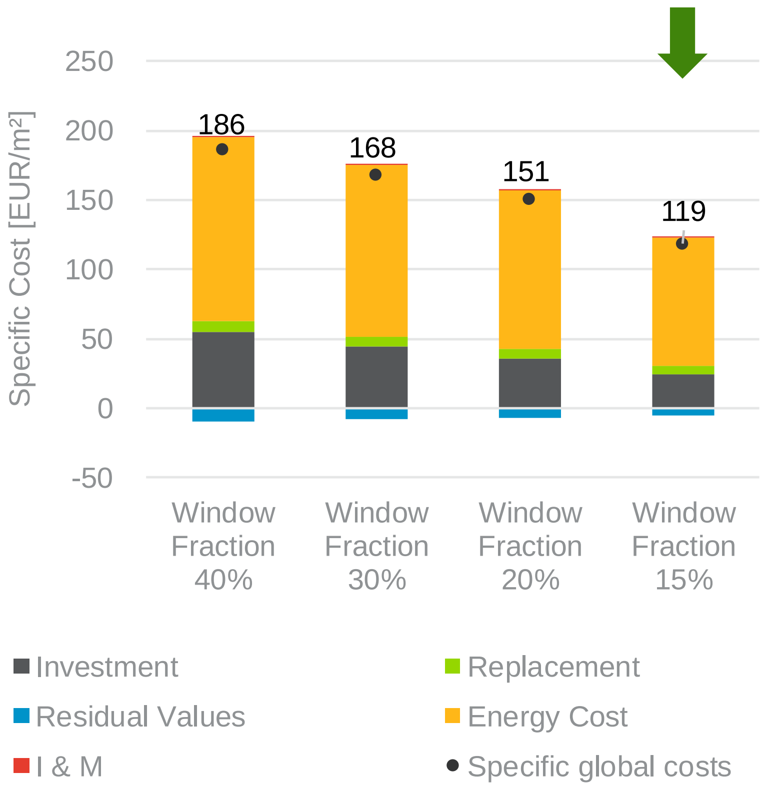
The current with the least window fraction has the lowest energy consumption and lowest global cost.

Final Energy Demand



Global Cost

Current Project Plan



Air Tightness

What is the effect of air tightness?

BaU
0.25

Var 1
0.20

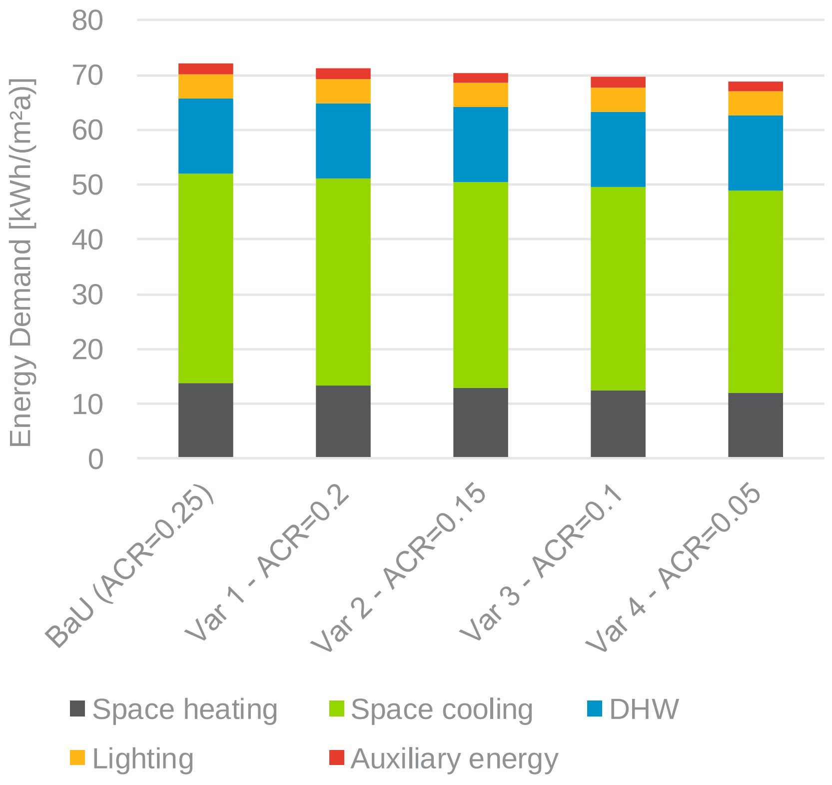
Var 2
0.15

Var 3
0.1

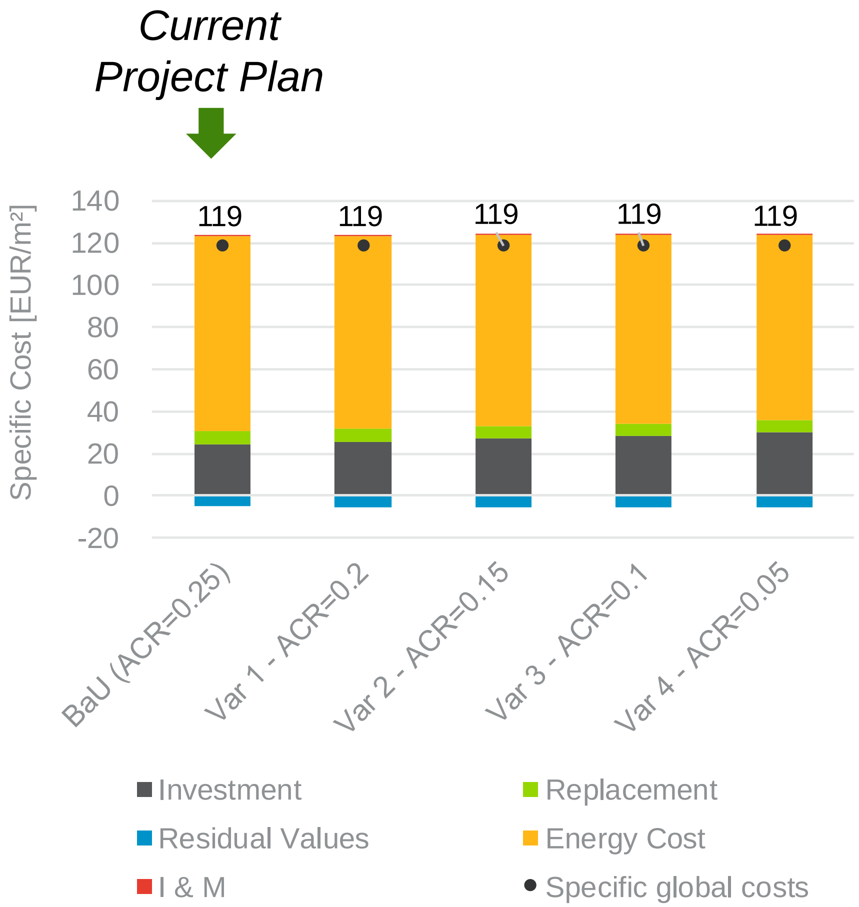
Var 4
0.05

BaU (current) is the most cost effective measure.

Final Energy Demand



Global Cost



Guidehouse

BUILD_ME

Shading concept

Analysis

BaU
No shading

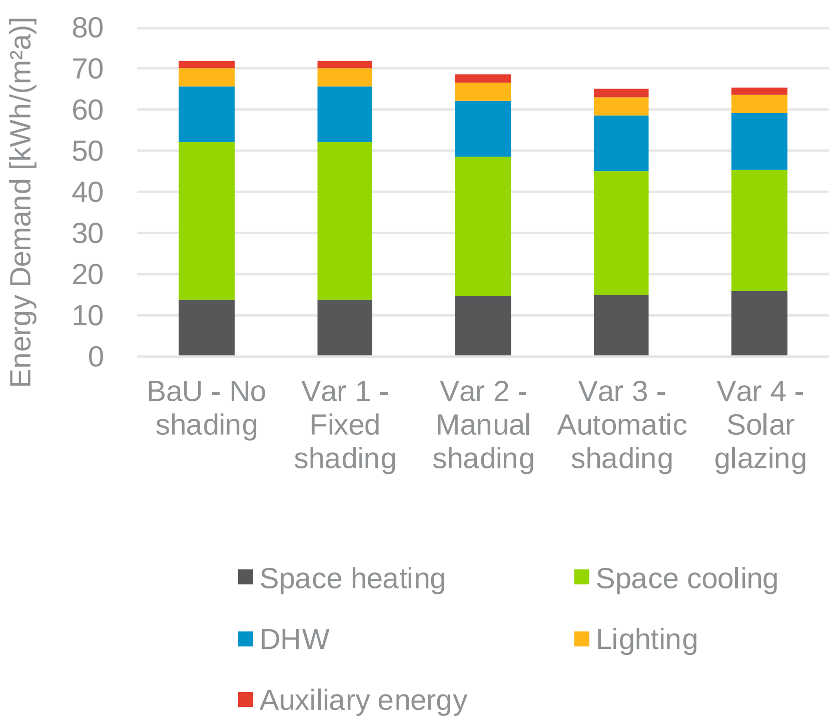
Var 1
Fixed Overhangs

Var 2
Manual Shading

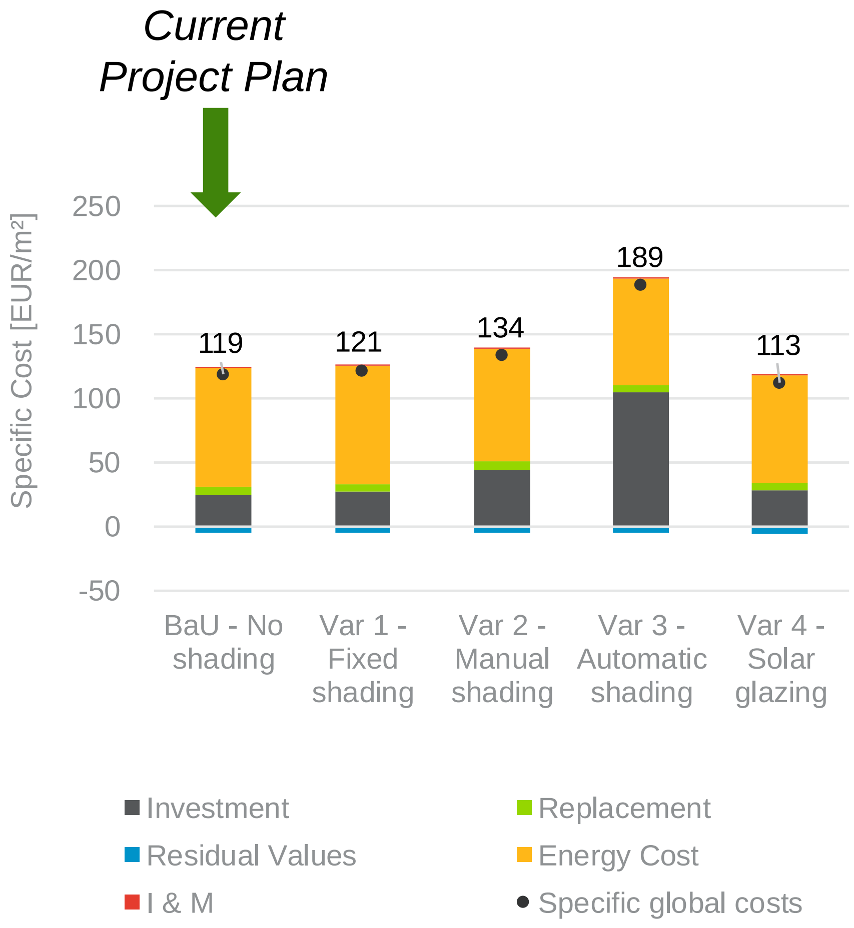
Var 3
Automatic Shading

Var 4
Solar Glazing

Final Energy Demand



Global Cost



Var 4 is the most cost effective measure.

HVAC I Efficiencies

Analysis

BaU

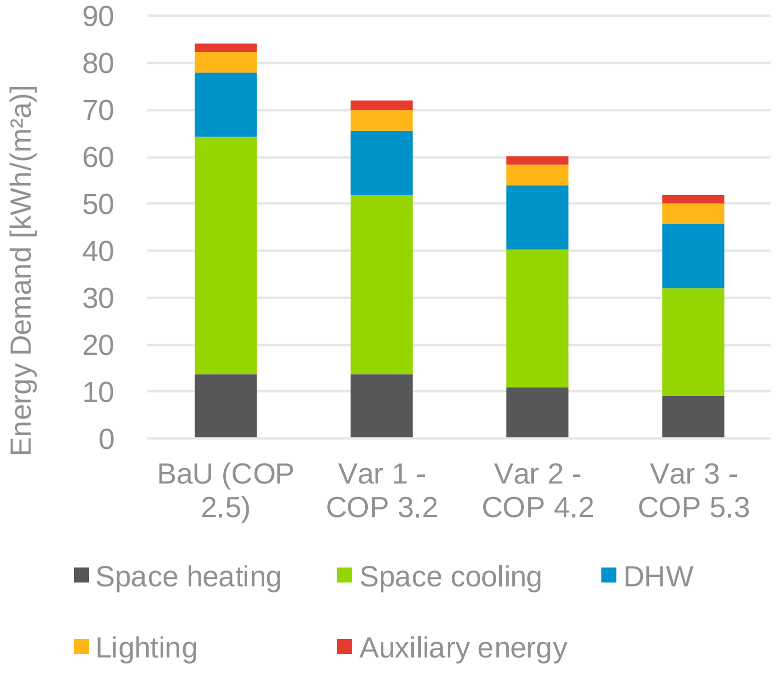
Cooling/Heating: 2.5 COP

Var 1 | 2 | 3

Reversible Split Unit with increased efficiency (COP: 3.2 | 4.2 | 5.3)

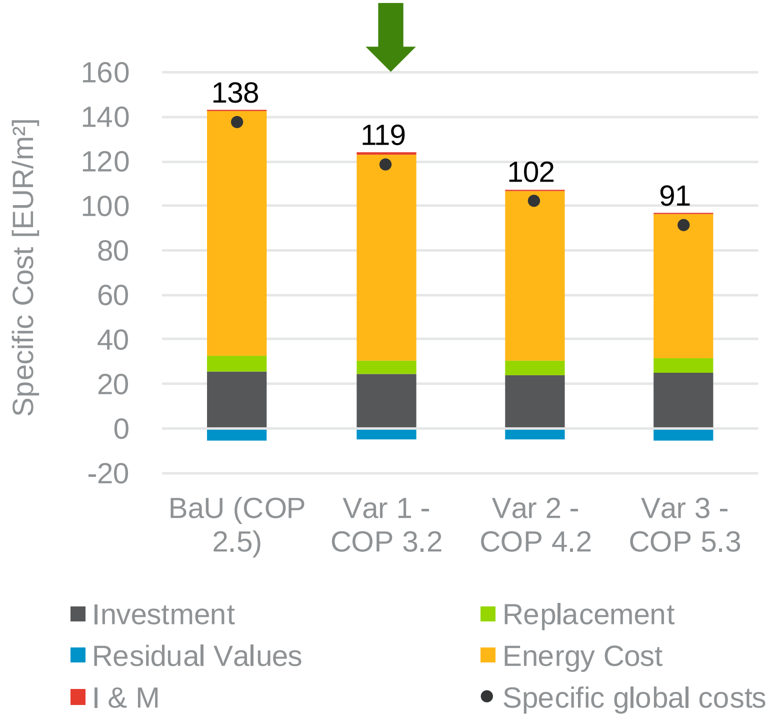
Var 3 (System with best COP) has the highest effect and is very cost-effective.

Final Energy Demand



Global Cost

Current Project Plan



Guidehouse

BUILD_ME

Operational Temperatures

Analysis

BaU

Cooling Temperature: 23°C
Heating Temperature: 23°C

Var 1 - 3

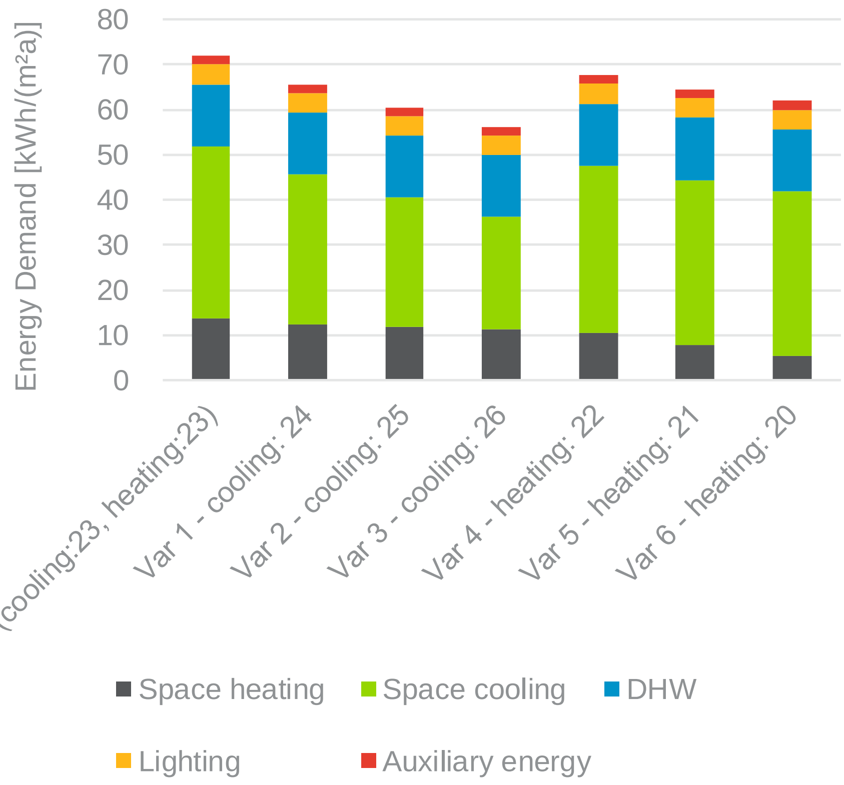
Cooling Temperature adapted (24°C - 26°C)

Var 4 - 6

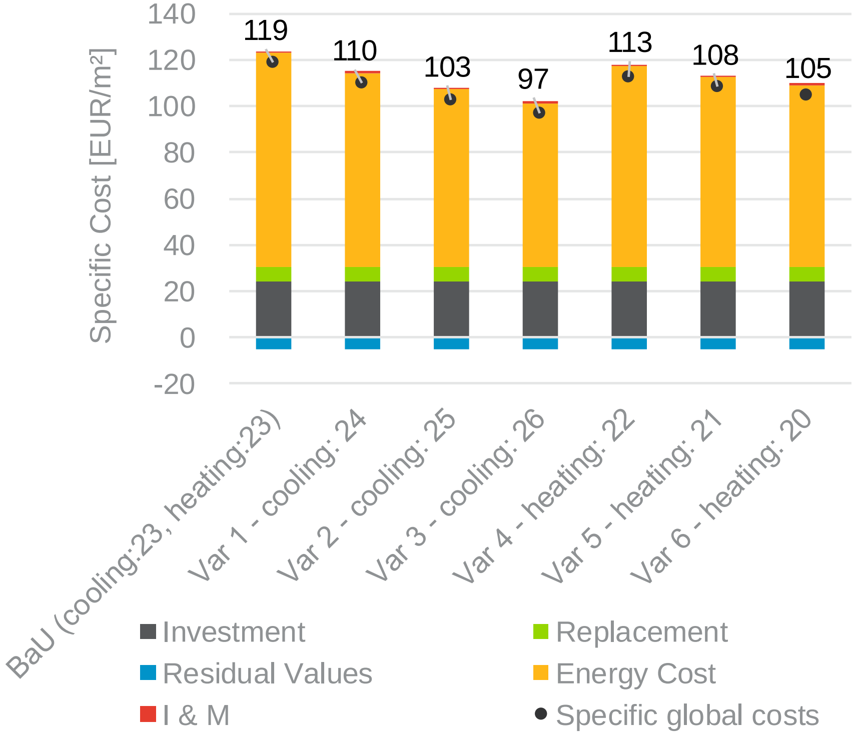
Heating Temperature adapted (22°C - 20°C)

This measure is very effective and not related to any cost

Final Energy Demand



Global Cost



Renewables I Solar Thermal

Analysis

Current

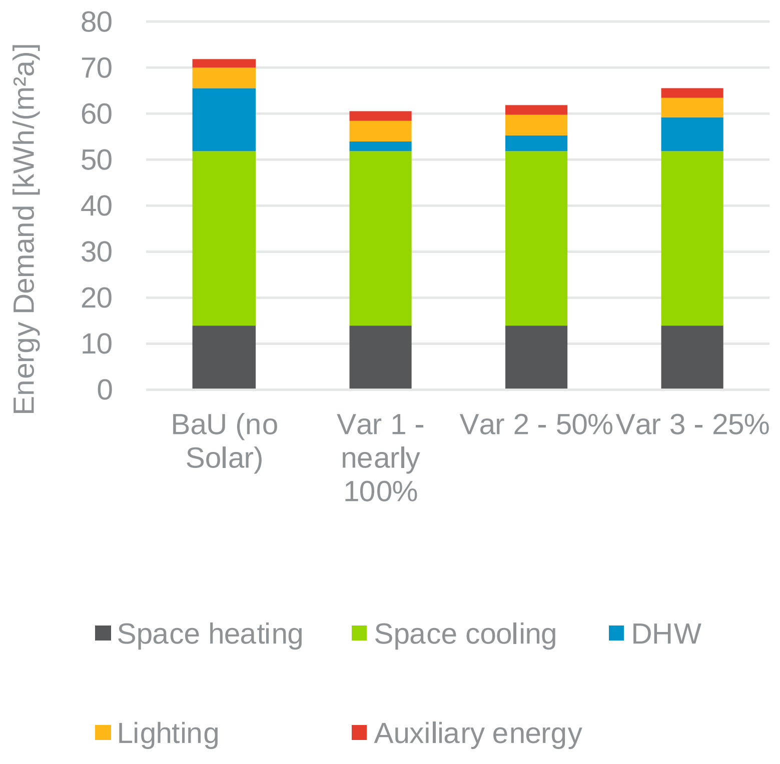
No solar hot water generation

Var 1 | 2 | 3

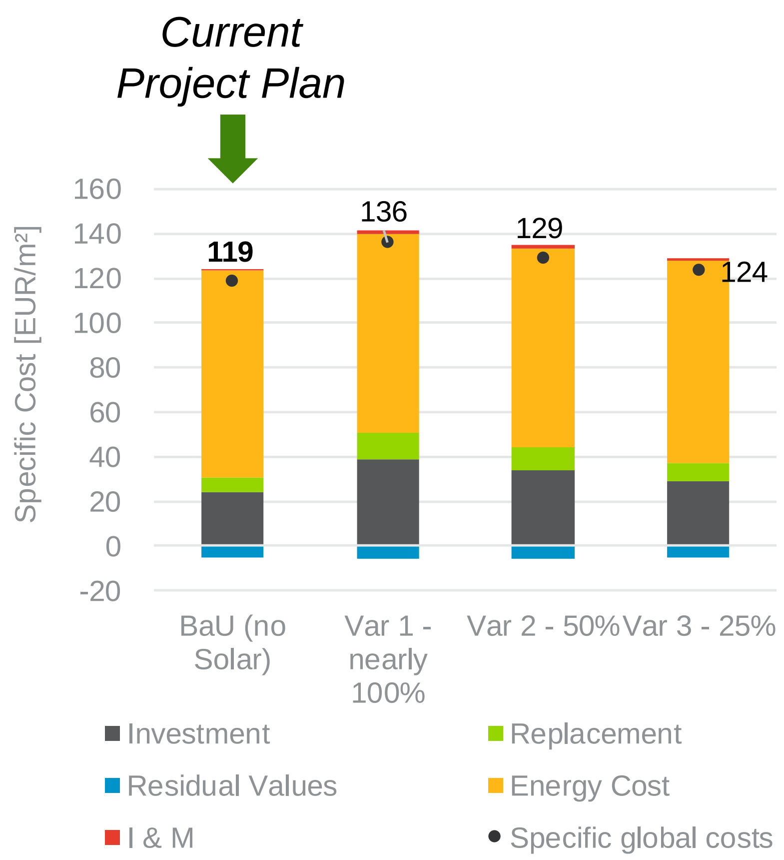
30 | 20 | 10 m² solar collector area installed, which is about 100% | 50% | 25% of the DHW demand covered by solar.

BaU with **no solar** is the most cost effective measure.

Final Energy Demand



Global Cost



Renewables I PV
Analysis

Sizing (net metering as assumption)

Current

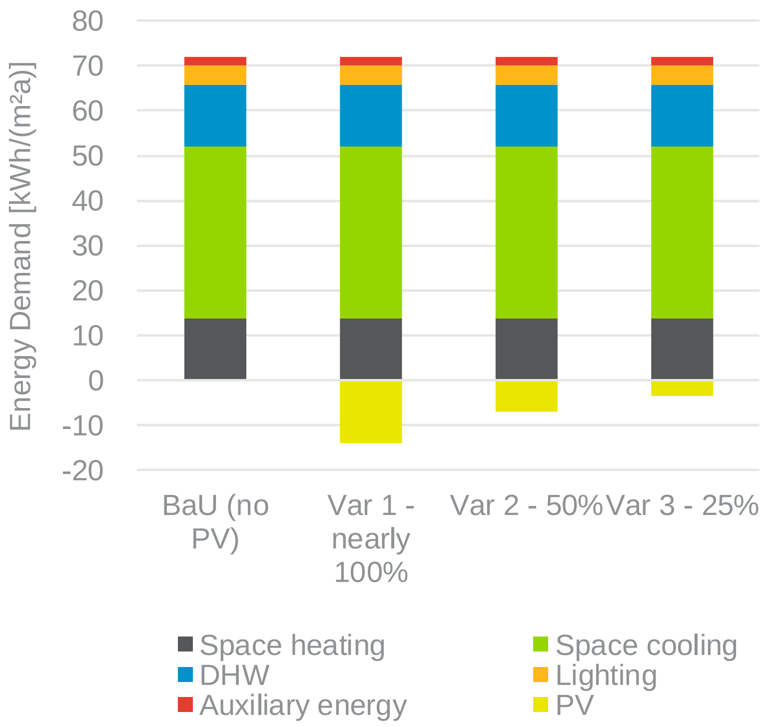
no PV

Var 1 | 2 | 3

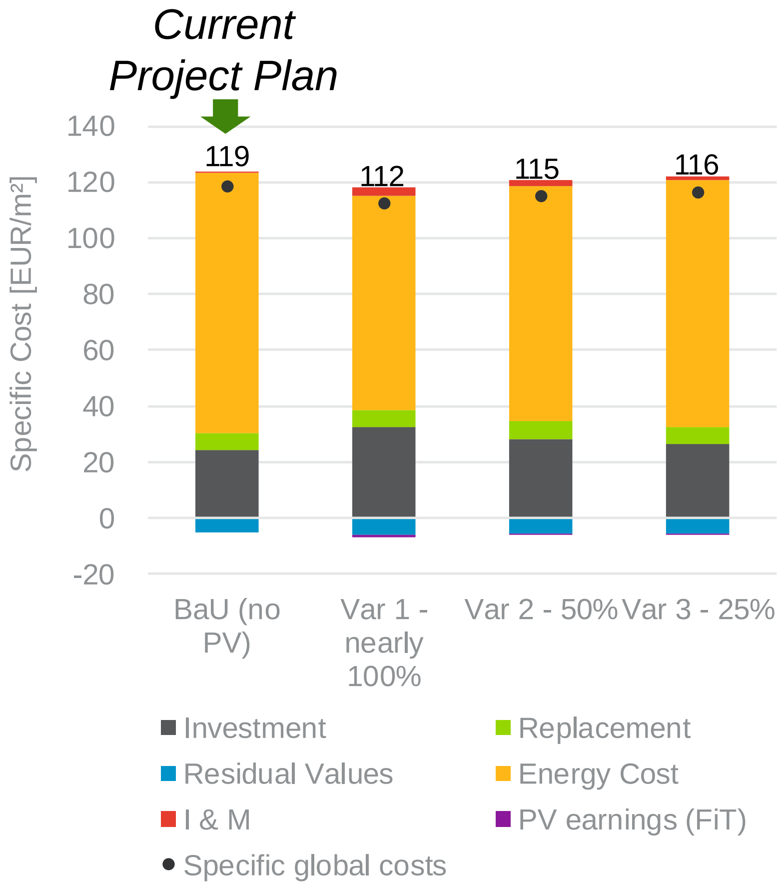
PV 2.5 | 5 | 10 kWp
(Roof area 60 | 90 | 140 m²)

Var 3 with **10 kWp** PV is the most cost effective measure. (based on the electricity consumption of the Current!)

Final Energy Demand



Global Cost



Guidehouse

BUILD_ME

Results & Conclusion

Photo by Xan Griffin on Unsplash

Overview of recommended measures

Four steps to reduce energy demand significantly

Building envelope

- External wall -> U-Value 0.38 (8 cm insulation)
- Roof -> U-Value 0.3 (12 cm insulation)
- Windows -> double glazing low E (U-Value 1.2 W/m²K, G-Value 0.65)
- Shading -> solar glazing (G-Value 0.3)

HVAC

- Reversible Split Unit heating / cooling with high efficiency (COP ~5)

Renewable (Solar) Energy

- PV 10 kWp (with maximised use of available roof area of 140 m²)

Behavior

- Change set temperature from Cooling 23°C/ Heating 23°C to Cooling 26°C/ Heating 20°C

Optimized Solution

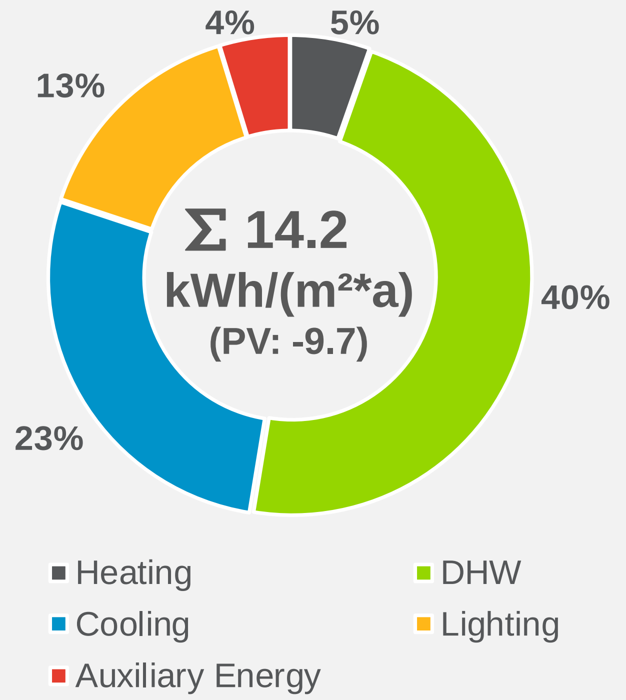
Results

The key components of the energy concept are illustrated in this table, it shows that the building envelope is significantly enhanced to the current building code.

Special attention is given to the use of renewable energy sources in terms of PV (for electricity).

This leads to energy savings and emission reduction.

Parameters	Optimized Building
Roof insulation (U-Value)	**0.3 W/m²K**
Wall insulation (U-Value)	**0.38 W/m²K**
Floor insulation (U-Value)	2.2 W/m²K
Windows (U-Value; G-Value)	2.88 W/m²K; **0.3**
Window fraction	Ø 15%
Shading	Solar Glazing
Air tightness	0.25 1/h
Heat supply	Reversible split unit - **COP 5.3**
Cold supply	Reversible split unit - **COP 5.3**
Hot water	Gas instantaneous
Ventilation systems	Natural ventilation
Lighting systems	LED
Renewable energy	**10 kWp (PV)**
Set temperature cooling/heating	**26°C / 20°C**



Energy Cost
1.0 EUR / (m²*a)

CO2 - Emission
0.5 kg / (m²*a)

Comparative overview

BaU vs. Current vs. Optimized

Conclusion

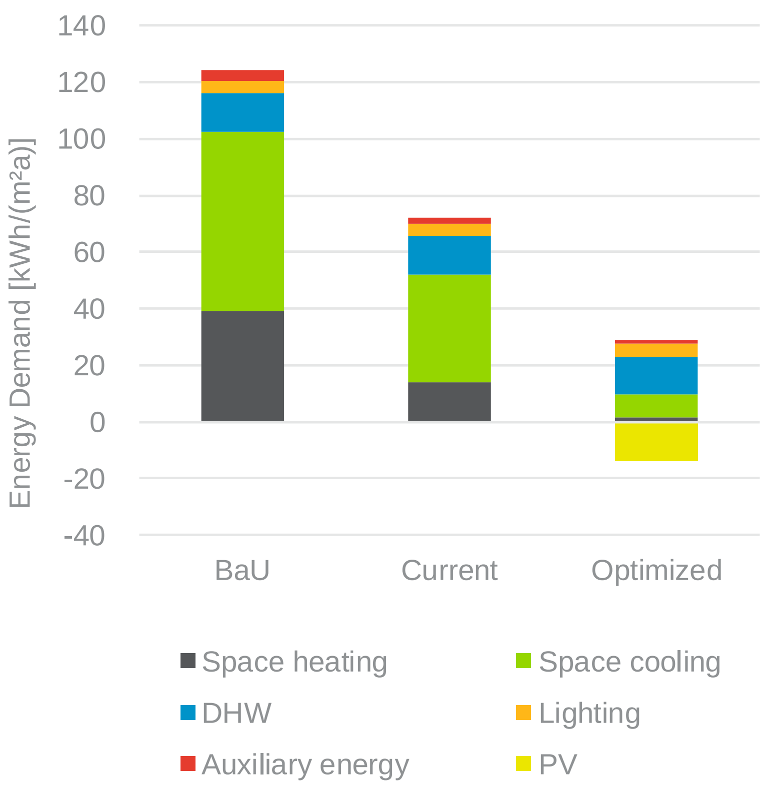
- The suggested measures and the current situation lead to a **significant decrease in energy demand**
- The optimized solution, detected **the most cost effective efficiency measures**

Savings

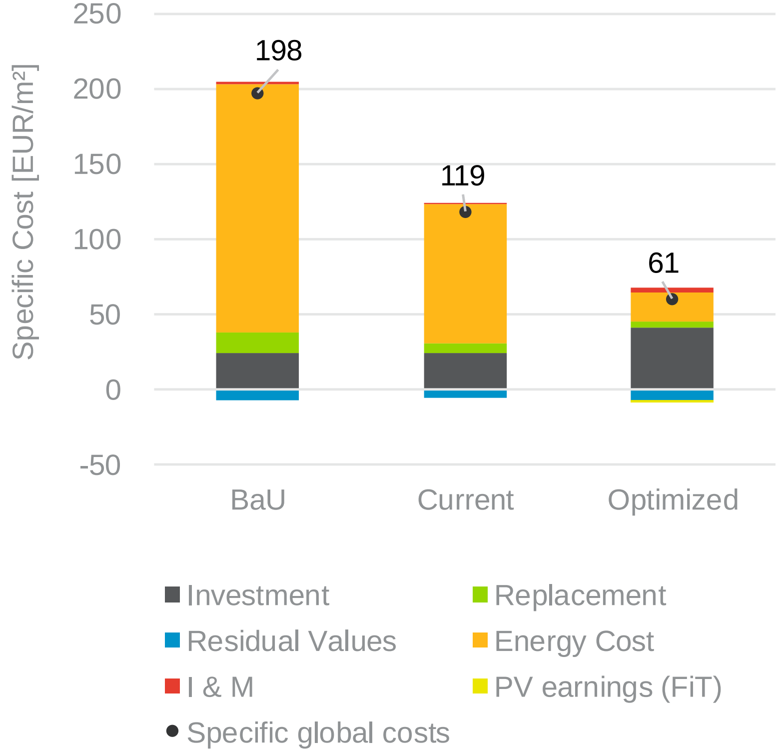
Energy: 89 %

Cost: 69%

Final Energy Demand



Global Cost



Optimized vs. current

Payback of single measures and whole package

Parameters	Optimized	Investment (optimized-current) [EUR]	Energy cost savings* [EUR / year]	Payback [years]	Lifetime [year]
Roof insulation (U-Value)	0.3 W/m²K	1,323	-138	10	40
Wall insulation (U-Value)	0.38 W/m²K	7,698	-1,560	5	40
Windows (U-Value; G-Value)	0.9 W/m²K; 0.5	14,508	-783	19	30
Window fraction	Ø 15%	0	0	-	30
Shading	Solar glazing	3,990	-658	7	30
Air infiltration through leakages	0.25 1/h	0	0	-	-
Heat/Cold supply	reversible split unit - COP 5.3	620	-2,028	1	20
Renewable energy	10 kWp (PV, maximum)	17,460	-1,421	13	20
Set temperature cooling/heating	26°C / 20°C	0	-1,586	immediately	-
Total (current to optimized)**		**45,599 (4%)*****	**-8,174 (-60%)**	**6**	

* Remark: The energy cost savings have been calculated conservatively based on the current electricity starting price (appr. 8 Cent/kWh).

** Remark: Investment and savings of single measure savings cannot be summed up due to synergies between the measures (e.g. lower window fraction leads to lower cooling supply costs).

*** Remark: Compared to costs of current case and overall construction costs assumptions of 500 Euro/m² (4 % additional costs).

Key conclusion

Main take aways for the Beverly Hills Project

Improve further the building envelope

- Increase the insulation thickness of roof and external wall -> **energy savings up to 25 % are possible**
- Utilize low-E Windows with a U-Value better or equal than 1.3 W/m²K -> **energy savings up to 35 % are possible**

Use Top performer - HVAC

- Use Top performer in the market as the price increase compared to inefficient, cheaper appliances will be recompensated throughout is lifetime

Size renewable (Solar) to demand

- The use of a PV system on the maximum available roof area is cost effective.
- Enable one clearly defined area for PV on the roof (avoid distorted small areas)

Behavior – Buy in User

- Buy in the user to utilize the appropriate set temperature, too low set temperature in the summer could consume too much energy -> 1K equals roughly 10% of energy

Contact

Riadh Bhar
Managing Consultant
riadh.bhar@guidehouse.com

Eslam Mahdy
Senior Consultant
eslam.mahdy@guidehouse.com

Rana Abouzeid,IDG
Main Local Partner
rana.abouzeid@idg.com.eg

Guidehouse