Project: Eco-Friendly Sustainable Campus

Objective: Modelling the building aiming to meet the desired needs of user comfort (heating, cooling, visual and acoustic) and sustainable practices (electricity, water consumption).

EULIST

Each group developed the project for different building according to its function

Group A → Office

Multidisciplinary team / members:

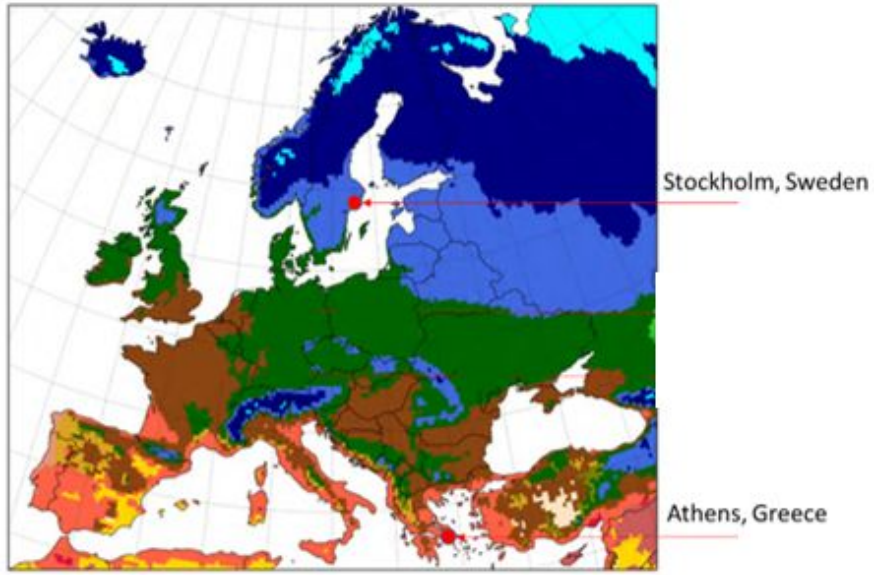
Akshay Gera (India) - energy technology ;
Renáta Kaščáková (Slovakia) - spatial planning;
Evangelia-Pinelopi Mylona (Greece) - chemical engineering;
Thodoris Papingiotis (Greece) - mechanical engineering;
Vanessa Tomei (Italy) - environmental engineering.

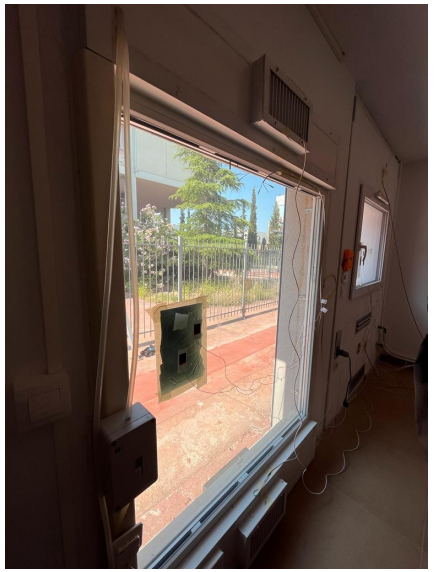
Modelling of the Base Case building

was focused on simulating the optimal building properties in two different climatic zones:

- **(3A) GREECE-ATHENS**
- **(6A) SWEDEN-STOCKHOLM**

→ with the aim to understand and compare how the different climate affects the building's energy consumption.





Methodology

- **Data collection:** Configuration of weather data, design days, construction materials, insulation levels, glazing characteristics for different building elements, simulation settings -the simulation period, time step, and output variables.

- **Approach:** Division of the building to smaller spaces of multiple rooms with similar thermal properties: Orientation of the space; Occupancy profile; Internal Loads; Desired Temperature Setpoint.

- **Configuration of data within the OpenStudio Interface:** Defining the constructions, materials and U-values of walls, roofs, floors and windows of the building; Validating the total U-values for each climate zone and building's intended use according to the compliance values from Ashrae's Standard 189.1. Modelling of the Base Case building for two different climate zones and with multiple Constructions, HVAC systems, RES.

- **Simulation:** Running the simulation with modificating data (changing parameters) if needed and possible.

- **Comparison of results:** Athens, Greece vs Stockholm, Sweden.

Climatic information for both cities

Athens:

- hot-summer Mediterranean climate;
- sunny summer days, high temperatures (36-40 °C);
- annual precipitation mostly concentrates during winters;
- mild autumns and mild to warm springs.

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	8.2 °C (46.8) °F	9 °C (48.3) °F	11.7 °C (53) °F	15.3 °C (59.5) °F	20.3 °C (68.6) °F	25.1 °C (77.3) °F	27.7 °C (81.9) °F	27.4 °C (81.4) °F	23.3 °C (73.9) °F	18.5 °C (65.4) °F	14 °C (57.3) °F	9.9 °C (49.8) °F
Min. Temperature °C (°F)	5 °C (41) °F	5.4 °C (41.8) °F	7.5 °C (45.5) °F	10.5 °C (51) °F	15.1 °C (59.3) °F	19.6 °C (67.3) °F	22.1 °C (71.8) °F	22.1 °C (71.7) °F	18.8 °C (65.8) °F	14.7 °C (58.5) °F	10.8 °C (51.4) °F	6.9 °C (44.4) °F
Max. Temperature °C (°F)	11.6 °C (52.8) °F	12.7 °C (54.9) °F	15.9 °C (60.7) °F	20 °C (68) °F	25.3 °C (77.6) °F	30.2 °C (86.4) °F	32.8 °C (91.1) °F	32.5 °C (90.6) °F	28 °C (82.3) °F	22.7 °C (72.9) °F	17.6 °C (63.7) °F	13 °C (55.5) °F
Precipitation / Rainfall mm (in)	53 (2)	49 (1)	49 (1)	28 (1)	24 (0)	11 (0)	6 (0)	5 (0)	16 (0)	28 (1)	49 (1)	60 (2)
Humidity(%)	78%	75%	70%	63%	55%	48%	46%	48%	58%	67%	75%	78%
Rainy days (d)	6	5	5	4	3	2	1	1	2	3	5	6
avg. Sun hours (hours)	5.7	6.5	8.3	10.5	12.0	12.9	12.8	12.0	10.2	7.9	6.3	5.5

Fig: Annual variation of climate in Athens (Souce: climate-data.org)

Stockholm:

- humid continental climate;
- mild summers (temperature around 20-25 °C);
- cloudy cold winters;
- autumns and springs cool to mild.

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	-1.8 °C (28.8) °F	-1.7 °C (29) °F	0.5 °C (33) °F	5.4 °C (41.7) °F	10.6 °C (51) °F	14.8 °C (58.7) °F	18 °C (64.3) °F	17 °C (62.6) °F	13.1 °C (55.5) °F	7.6 °C (45.6) °F	3.6 °C (38.4) °F	0.2 °C (32.4) °F
Min. Temperature °C (°F)	-3.7 °C (25.4) °F	-3.9 °C (25) °F	-2.3 °C (27.9) °F	2 °C (35.7) °F	7 °C (44.6) °F	11.4 °C (52.5) °F	14.8 °C (58.6) °F	14.2 °C (57.6) °F	10.6 °C (51.1) °F	5.7 °C (42.2) °F	2 °C (35.6) °F	-1.6 °C (29.2) °F
Max. Temperature °C (°F)	-0.1 °C (31.8) °F	0.4 °C (32.7) °F	3.5 °C (38.2) °F	9 °C (48.3) °F	14 °C (57.3) °F	18.1 °C (64.5) °F	21 °C (69.9) °F	19.9 °C (67.8) °F	15.8 °C (60.4) °F	9.5 °C (49.2) °F	5 °C (41) °F	1.8 °C (35.2) °F
Precipitation / Rainfall mm (in)	44 (1)	37 (1)	34 (1)	36 (1)	45 (1)	67 (2)	72 (2)	73 (2)	56 (2)	52 (2)	53 (2)	50 (1)
Humidity(%)	84%	83%	78%	73%	69%	70%	74%	76%	79%	84%	87%	85%
Rainy days (d)	7	7	7	6	7	8	9	9	7	8	8	8
avg. Sun hours (hours)	2.4	3.5	5.9	8.9	11.1	12.3	11.4	9.8	6.9	4.2	2.5	2.3

Fig: Annual variation of climate in Stockholm (Souce: climate-data.org)

Building definition & data collection

01

Functionality: Office

The model is simulated for office functionality

02

Climate Zones

Simulation run for Climate zone 3A(Athes) & 6A(Stockholm)

03

Future Weather Data

Weather data file configured for 2050 scnerio for both climate zone

04

Thermal Envolope

Idnetification of construction material, insulation, glazing etc.

05

Detailed charateristics

Ocupancy schedule, load profile has been updated as per standard

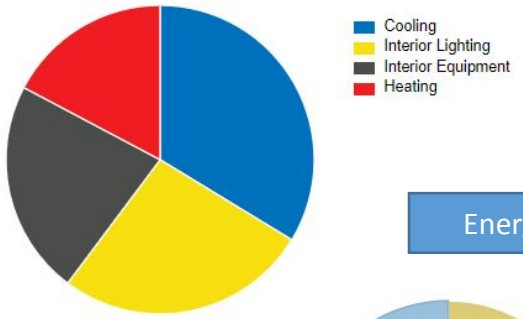
Comparison of results: Athens, Greece vs Stockholm, Sweden

Athens: current climatic data (2020)

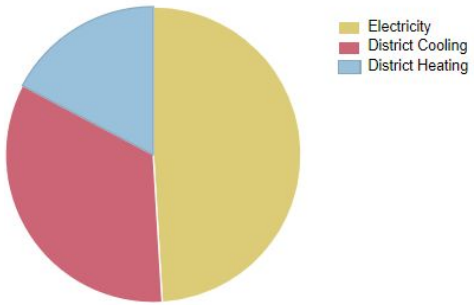
No changes

Total site energy: 8,706 kWh

End use



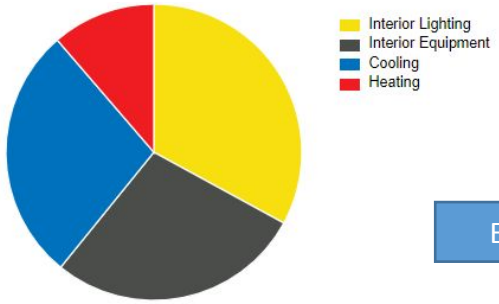
Energy use



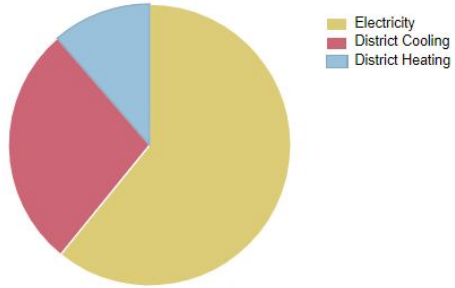
U covering specifications: U=0.701 for opaque elements; U=2.26 for fenestration

Total site energy: 7,019 kWh

End use



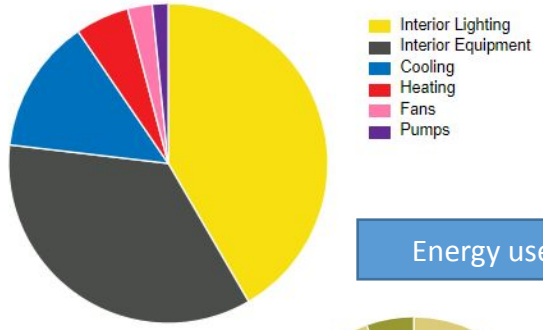
Energy use



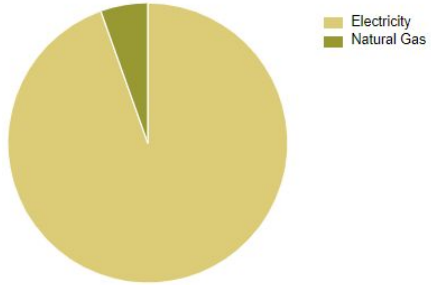
HVAC system activated

Total site energy: 5,503 kWh

End use



Energy use



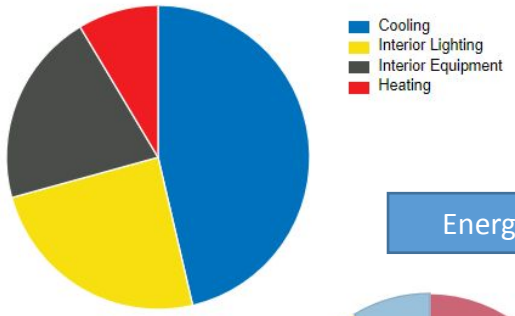
NATIONAL TECHNICAL UNIVERSITY OF ATHENS
Leibniz Universität Hannover
STU SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA
LUT University
JÖNKÖPING UNIVERSITY
Institut Mines-Télécom
RÉPUBLIQUE FRANÇAISE

Athens: future climatic data (2050)

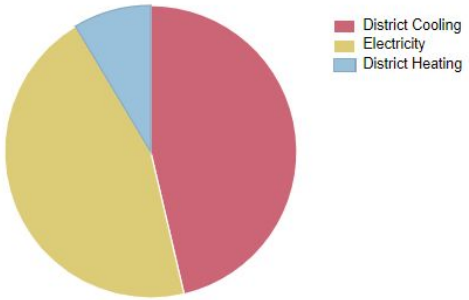
No changes

Total site energy: 9,472 kWh

End use



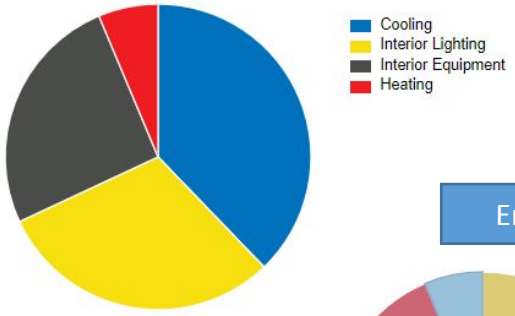
Energy use



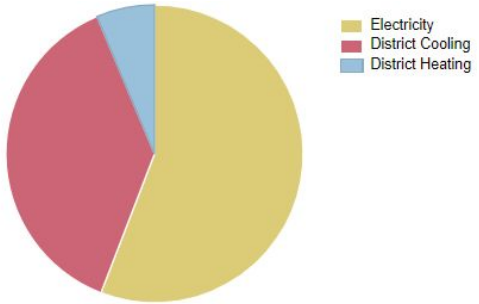
U covering specifications: U=0.701 for opaque elements; U=2.26 for fenestration

Total site energy: 7,642 kWh

End use



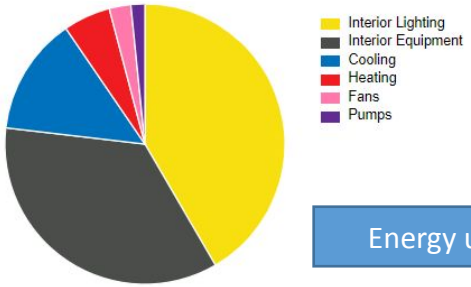
Energy use



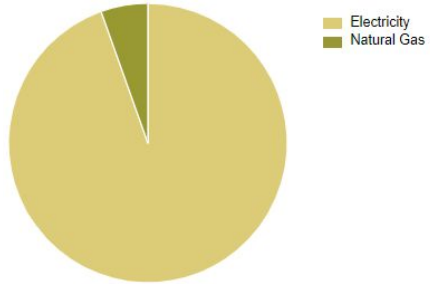
HVAC system activated

Total site energy: 5,556 kWh

End use



Energy use

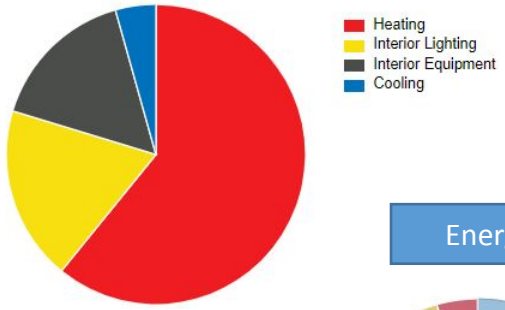


Stockholm: current climatic data (2020)

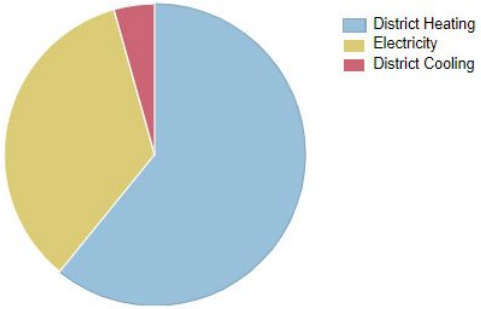
No changes

Total site energy: 12,281 kWh

End use



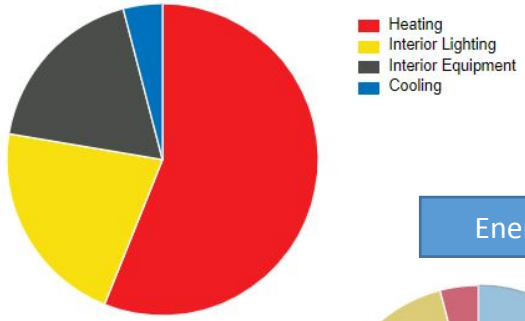
Energy use



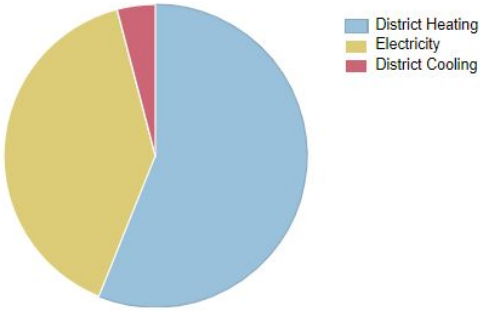
U covering specifications: U=0.432 for opaque elements; U=1.83 for fenestration

Total site energy: 10,711 kWh

End use



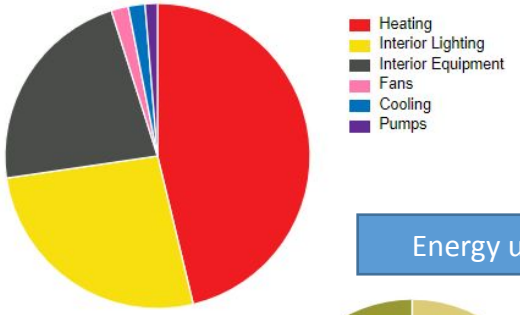
Energy use



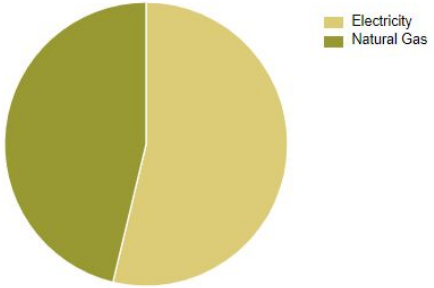
HVAC system activated

Total site energy: 8,736 kWh

End use



Energy use

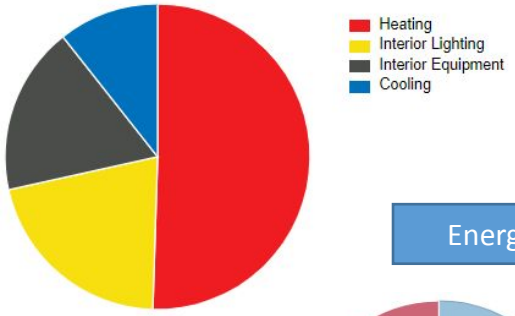


Stockholm: future climatic data (2050)

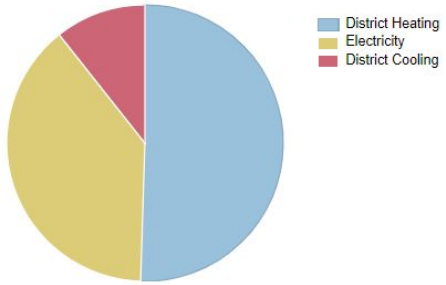
No changes

Total site energy: 10,983 kWh

End use



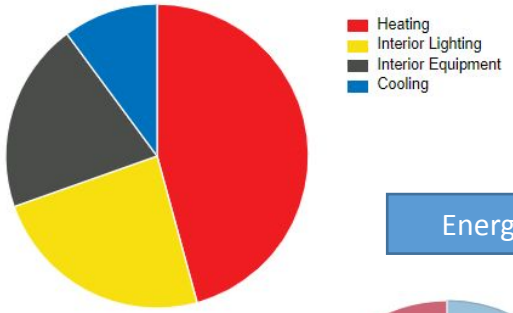
Energy use



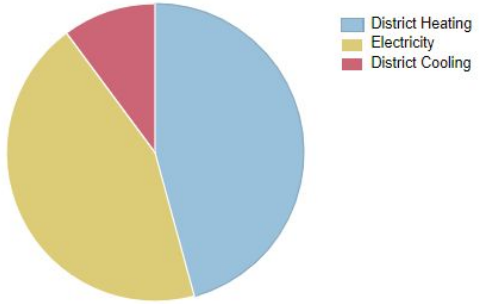
U covering specifications: U=0.432 for opaque elements; U=1.83 for fenestration

Total site energy: 9,681 kWh

End use



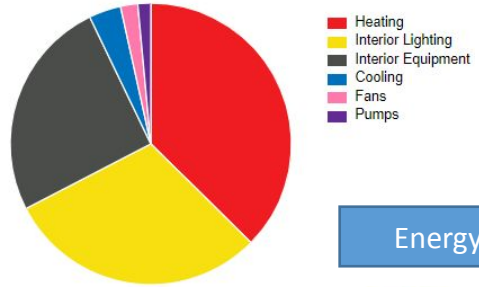
Energy use



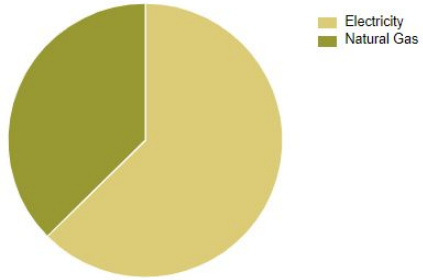
HVAC system activated

Total site energy: 7,694 kWh

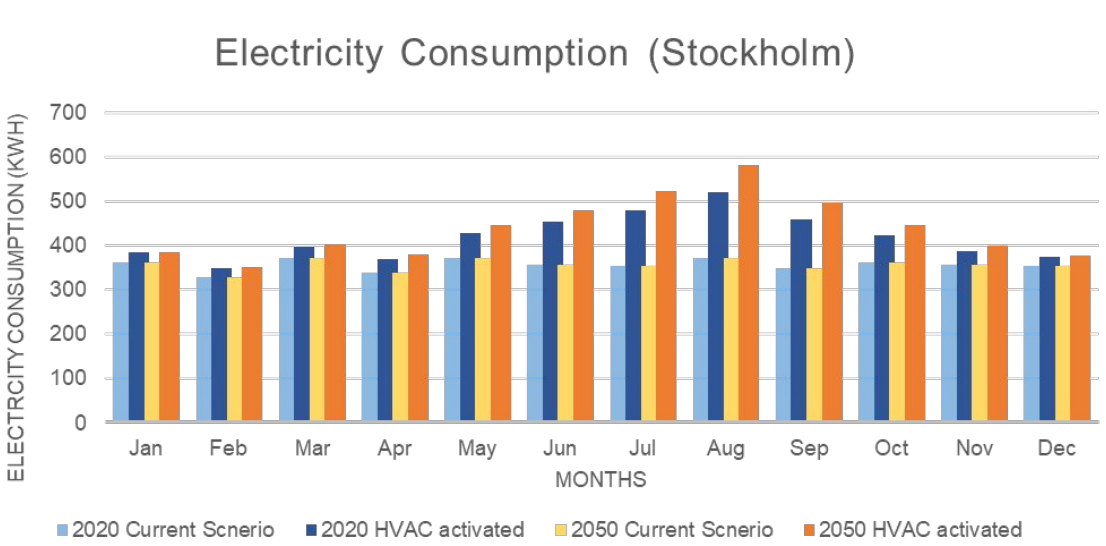
End use

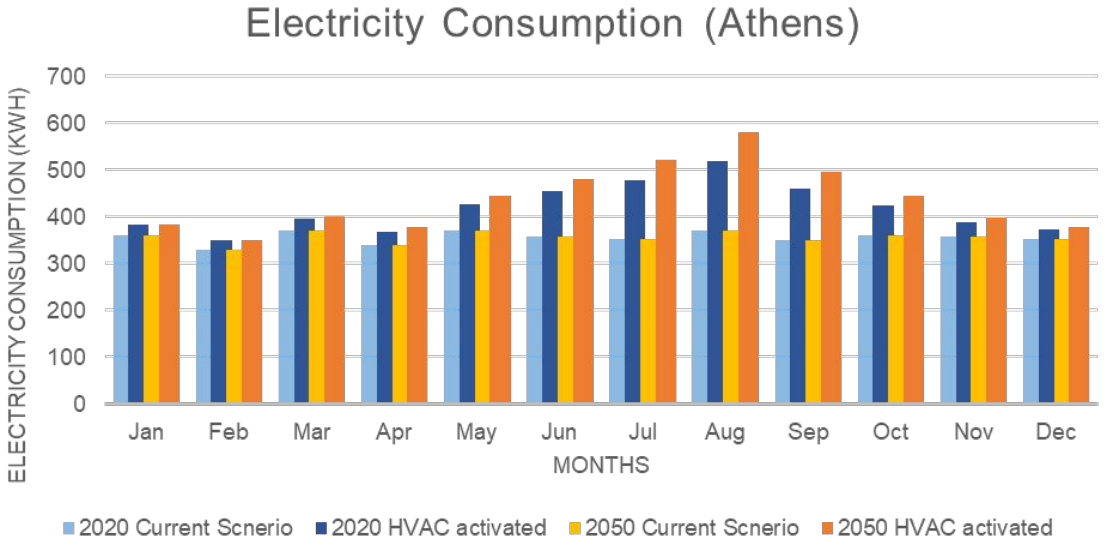


Energy use



Monthly Electricity Consumption (Comparison)





Observations

With the implementation of HVAC measures the total electricity consumption increased while the total energy consumption reduced in 2050. In future, renewable electricity will become a cheap commodity so results are favorable.

Summary

We made evaluation of 4 comparisons in total end site energy use:

ATHENS	2020		2050
No changes	8 706 kWh	<	9 472 kWh
U specifications	7 019 kWh	<	7 642 kWh
HVAC activated	5 503 kWh	<	5 556 kWh

2020	ATHENS		STOCKHOLM
No changes	8 706 kWh	<	12 281 kWh
U specifications	7 019 kWh	<	10 711 kWh
HVAC activated	5 503 kWh	<	8 736 kWh

STOCKHOLM	2020		2050
No changes	12 281 kWh	>	10 983 kWh
U specifications	10 711 kWh	>	9 681 kWh
HVAC activated	8 736 kWh	>	7 649 kWh

2050	ATHENS		STOCKHOLM
No changes	9 472 kWh	<	10 983 kWh
U specifications	7 642 kWh	<	9 681 kWh
HVAC activated	5 556 kWh	<	7 649 kWh

Summary

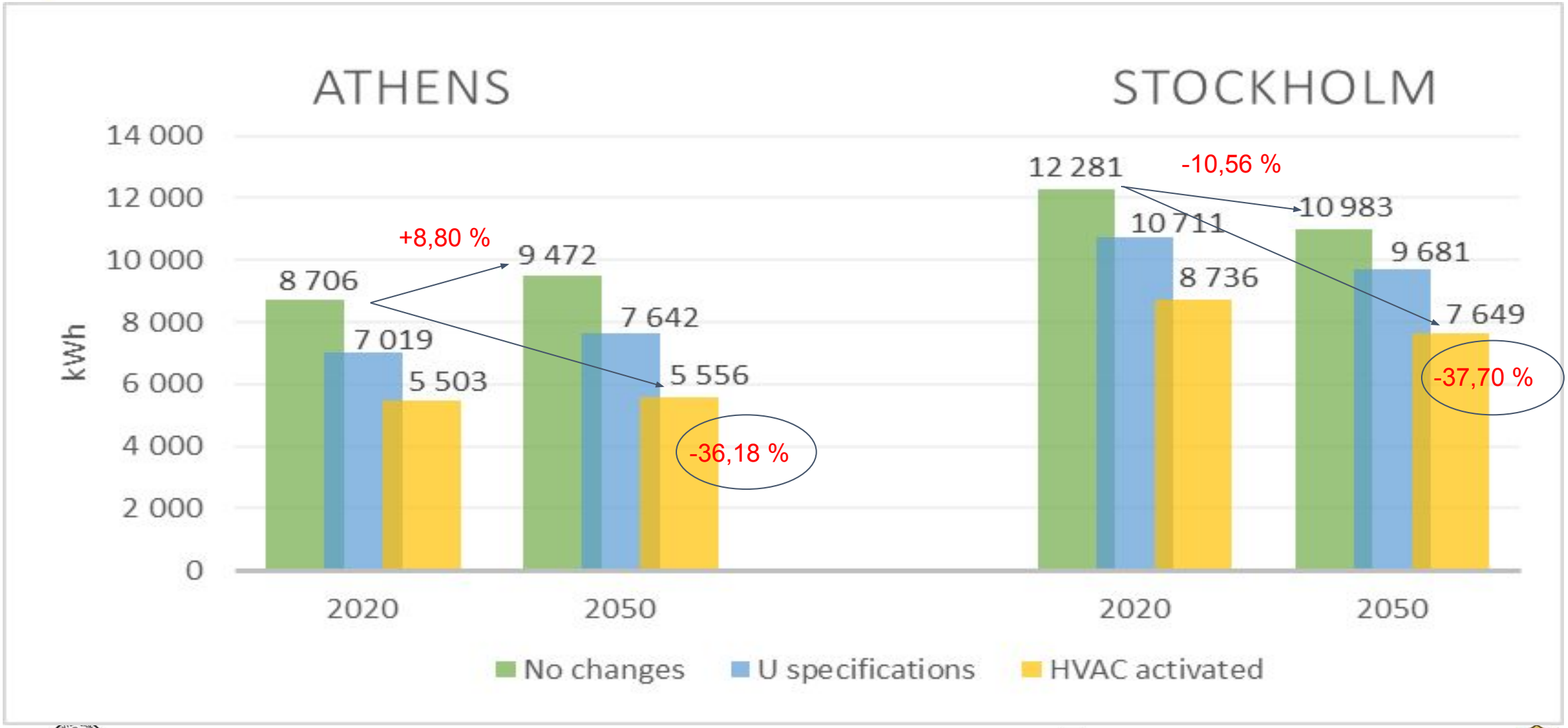
We made evaluation of 4 comparisons in total end site energy use:

ATHENS	2020		2050
No changes	**8 706 kWh**	**<**	**9 472 kWh**
U specifications	-19,37%		-19,32%
HVAC activated	-36,79%		-41,34%

2020	ATHENS		STOCKHOLM
No changes	**8 706 kWh**	**<**	**12 281 kWh**
U specifications	-19,37%		-12,78%
HVAC activated	-36,79%		-28,86%

STOCKHOLM	2020		2050
No changes	**12 281 kWh**	**>**	**10 983 kWh**
U specifications	-12,78%		-11,85%
HVAC activated	-28,86%		-30,35%

2050	ATHENS		STOCKHOLM
No changes	**9 472 kWh**	**<**	**10 983 kWh**
U specifications	-19,32%		-11,85%
HVAC activated	-41,34%		-30,35%


ATHENS
STOCKHOLM
14 000
12 000
10 000
8 000
6 000
4 000
2 000
0
kWh
8 706
7 019
5 503
+8,80 %
9 472
7 642
5 556
-36,18 %
12 281
10 711
8 736
-10,56 %
10 983
9 681
7 649
-37,70 %
2020
2050
2020
2050
No changes
U specifications
HVAC activated

Thank you for this interesting experience

Thank you for your attention