

eurac research

**Towards improved feasibility
study of artificial light
efficiency measure in buildings**

Eurac Research



Agenda

1. Background
2. Method
3. Results
4. Conclusions

Background

ITA1084 - IHNES

Interregional Hospital Network for Energy Sustainability

IHNES promotes the topic of energy efficiency and energy management in the health sector through an interregional network of hospital operators, research institutions and engineering offices.

Interreg
Italia-Österreich
European Regional Development Fund



Background

Syneco

Eurac Research

Inewa

Azienda sanitaria Bolzano (SABES)

Landeskrankenhaus Salzburg (SALK)

Krankenhaus Innsbruck (Tirol Kliniken)

Azienda sanitaria Trieste (ASUITS)

Partners



Background

Rewamping of artificial light system



Electricity savings

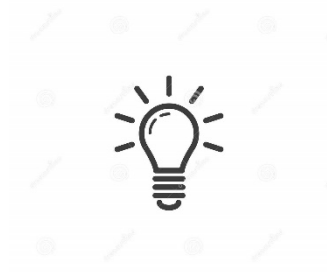


€ savings

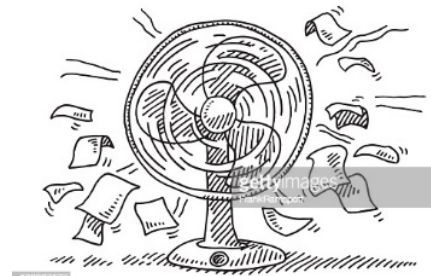


Target

Reducing artificial light
consumption ΔEI



- Effect on heating consumption -> $\Delta H = \Delta EI * C_h$
 $C_h = \Delta H / \Delta EI$



- Effect on cooling consumption -> $\Delta C = \Delta EI * C_c$
 $C_c = \Delta C / \Delta EI$

Method – Hypothesis

Simulation with UNI EN 52016

- 7 types of buildings
- 113 different climates
- 2 levels of efficiency of the building
- 2 thermal mass of the envelope
- 4 levels of light efficiency



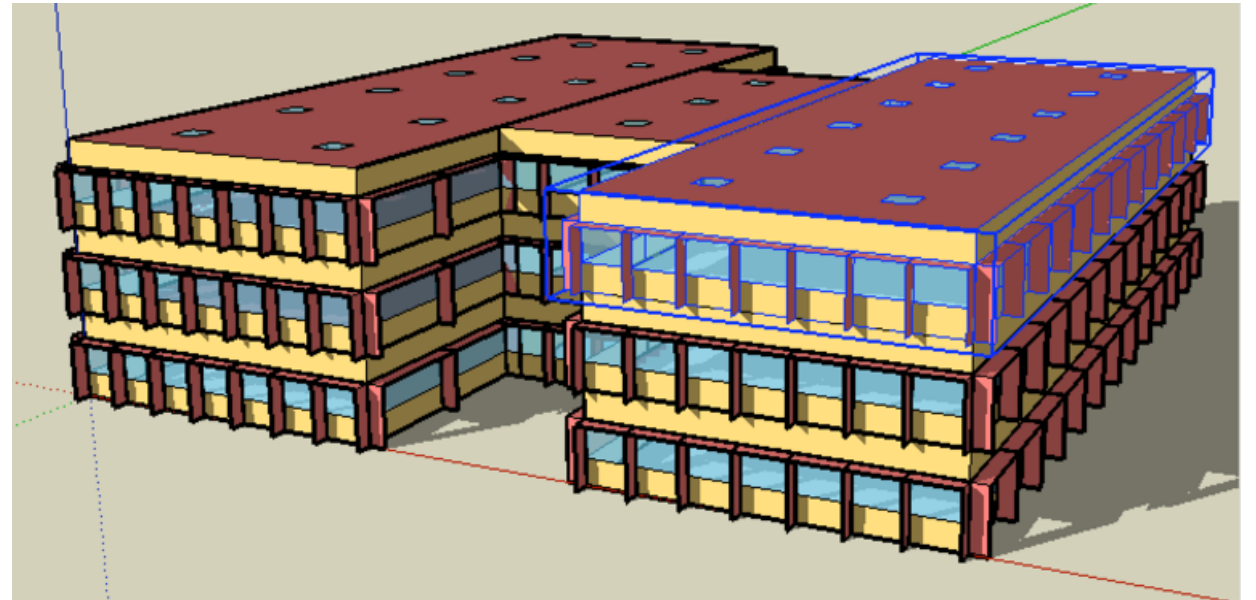
3616 simulations per building
25312 total simulations

Method – Building types

Geometry defined by the U.S. Department of Energy (DOE)

The building category studied:

1. Hospital
2. Large Office
3. Medium Office
4. Outpatient Health Care
5. Midrise Apartment
6. Secondary School
7. Small Hotel



Method – Climates

HeatingDegreeDays

From 6 HDD (La Frontera)
to 5600 HDD (Warth)

CoolingDegreeDays

From 0 CDD (Alps & Nord Sea)
to 647 CDD (Arnesano)

Global Radiation

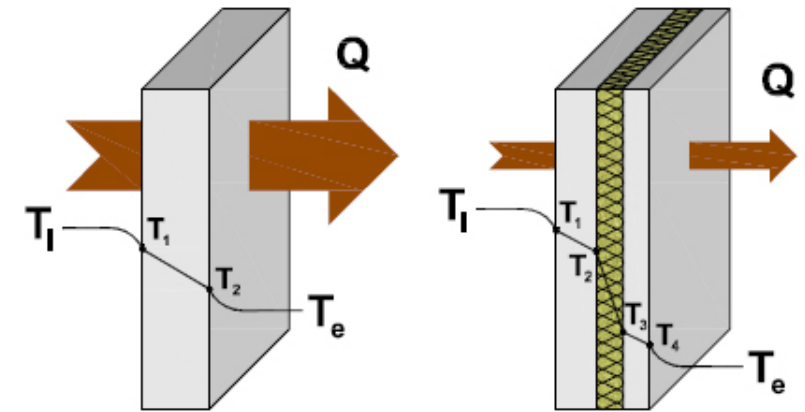
From 948 kWh/m²a (Enschede)
to 1969 kWh/m²a (Zahara)



Method – building efficiency

Two different configuration: high - low

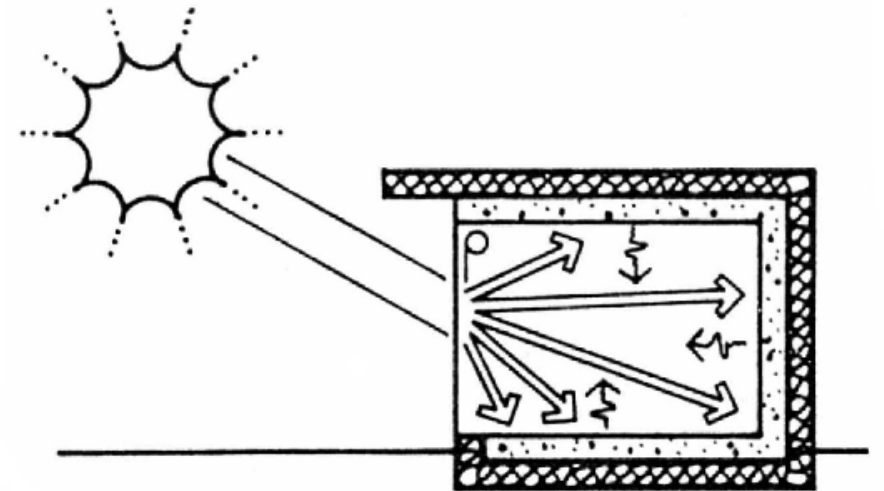
Building efficiency				
	low		high	
Trasmittance of envelope				
Ground floor	0.42	W/(m ² K)	0.14	W/(m ² K)
Walls	0.56	W/(m ² K)	0.19	W/(m ² K)
Windows	2.49	W/(m ² K)	1.10	W/(m ² K)
g value windows	0.90	W/(m ² K)	0.70	W/(m ² K)
Roof	0.88	W/(m ² K)	0.29	W/(m ² K)
Ventilation				
Heat recovery	0	%	50	%



Method – Building thermal mass

Two different walls thermal mass

	High thermal mass		Low thermal mass	
Walls thermal mass	476000	J/(m ² K)	178512	J/(m ² K)



Method – Artificial light

Efficiency

4 levels of efficiency

Control strategy, light on when:

1. Building occupied
2. Occupants are not sleeping
3. Average radiation in the façade $< 400 \text{ W/m}^2$



Results

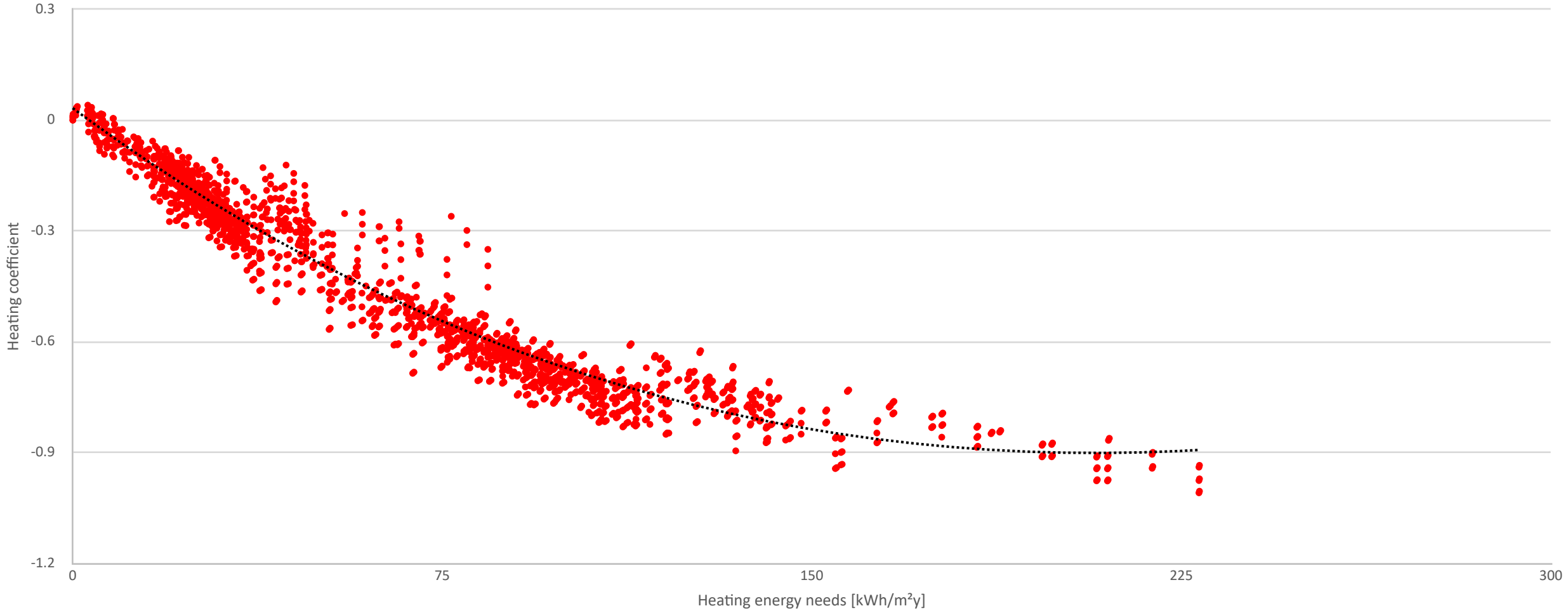
We calculated 2 coefficient:

1. $C_h = \Delta H / \Delta EI$ -> Heating Energy Need Savings/Electricity savings
2. $C_c = \Delta C / \Delta EI$ -> Cooling Energy Need Savings/Electricity savings

$$y = -1.994E-8x^3 + 3.024E-5x^2 - 0.0099x + 0.0327$$

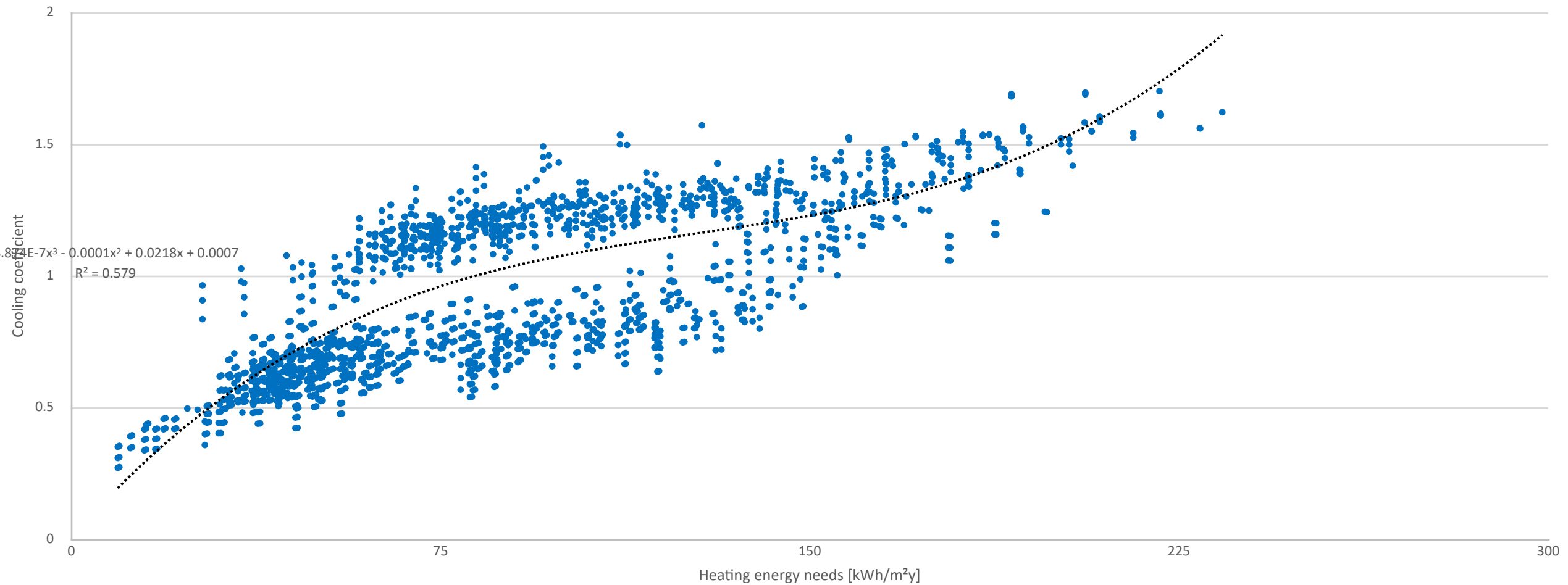
$R^2 = 0.9508$

Hospital - Heating

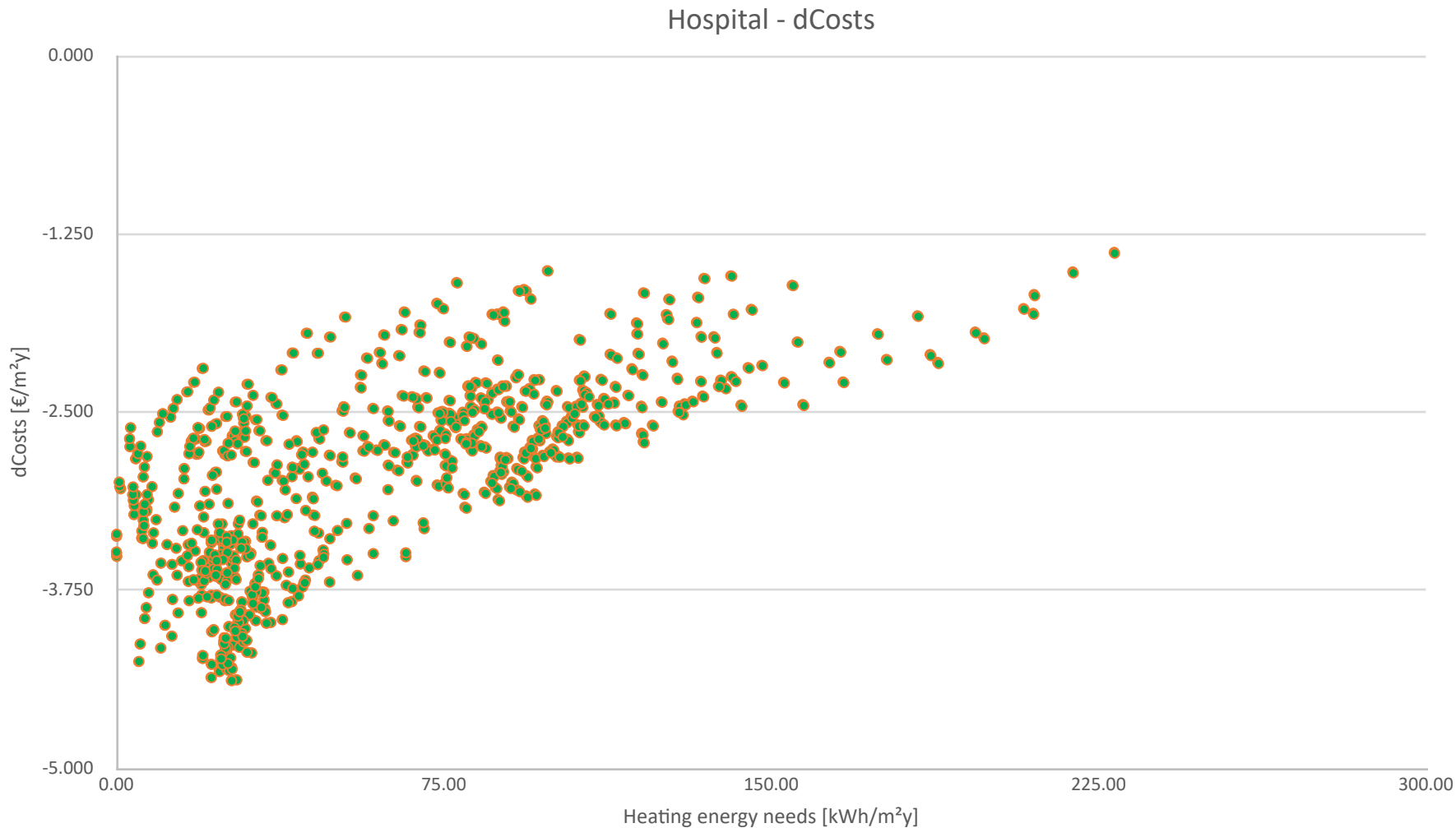


Results - Hospitals

Hospital - Cooling



Results - Hospitals



Hypotesis			
SCOP	0.80		
SEER	3.00		
Price thermal energy	0.10	€/kWh	
Price eletricity	0.25	€/kWh	

We considered:

1. Electricity saving for lightning;
2. Increase of heating energy needs;
3. Decrease of cooling energy needs;

Results - Costs

dCosts considering lightning - heating - cooling [€/m²y]

	heating energy need										
from [kWh/m ² y]	0	15	30	45	60	75	90	105	120	135	150
to [kWh/m ² y]	15	30	45	60	75	90	105	120	135	150	5000
Hospital	-3.26	-3.48	-3.35	-2.94	-2.58	-2.55	-2.57	-2.37	-2.21	-2.11	-1.95
Large office	-0.54	-0.35	-0.43	-0.41	-0.32						
Medium office	-0.46	-0.35	-0.32	-0.40	-0.40	-0.40	-0.35	-0.30			
Midrise Apartment	-0.12	-0.11	-0.10	-0.10	-0.09	-0.09	-0.08	-0.07			
OutPatient	-0.54	-0.52	-0.51	-0.41							
School	-0.25	-0.36	-0.32	-0.22	-0.25	-0.27	-0.35	-0.31	-0.32	-0.33	-0.24
Hotel	-1.31	-0.95	-0.92	-0.86	-0.84	-0.82	-0.71				

Hypotesis

SCOP	0.80	
SEER	3.00	
Price thermal energy	0.10	€/kWh
Price eletricity	0.25	€/kWh

dCosts considering only lightning [€/m²y]

	heating energy need										
from [kWh/m ² y]	0	15	30	45	60	75	90	105	120	135	150
to [kWh/m ² y]	15	30	45	60	75	90	105	120	135	150	5000
Hospital	-2.22	-2.64	-2.73	-2.58	-2.51	-2.69	-2.95	-2.94	-2.68	-2.77	-2.74
Large office	-0.49	-0.47	-0.62	-0.61	-0.52						
Medium office	-0.49	-0.45	-0.46	-0.60	-0.62	-0.62	-0.55	-0.52			
Midrise Apartment	-0.14	-0.14	-0.14	-0.14	-0.14	-0.14	-0.15	-0.14			
OutPatient	-0.49	-0.63	-0.63	-0.54							
School	-0.30	-0.51	-0.47	-0.35	-0.40	-0.45	-0.62	-0.55	-0.57	-0.59	-0.45
Hotel	-1.02	-0.98	-1.02	-1.06	-1.07	-1.10	-1.09				

Results - Costs

Difference in rewards [€/m ² y]												
		heating energy need										
from [kWh/m ² y]	0	15	30	45	60	75	90	105	120	135	150	
to [kWh/m ² y]	15	30	45	60	75	90	105	120	135	150	5000	
Hospital	47%	32%	23%	14%	3%	-5%	-13%	-19%	-17%	-24%	-29%	
Large office	10%	-26%	-31%	-33%	-38%							
Medium office	-6%	-22%	-31%	-34%	-36%	-36%	-36%	-42%				
Midrise Apartment	-9%	-21%	-24%	-31%	-37%	-41%	-45%	-47%				
OutPatient	9%	-16%	-20%	-25%								
School	-17%	-29%	-32%	-36%	-39%	-39%	-43%	-43%	-43%	-44%	-47%	
Hotel	28%	-3%	-9%	-18%	-22%	-26%	-35%					

Hypotesis			
	SCOP	0.80	
	SEER	3.00	
Price thermal energy	0.10	€/kWh	
Price eletricity	0.25	€/kWh	

Conclusions

1. Rewamping of artificial light in a building has effect on heating and cooling consumption;
2. Each type of building has its own coefficient curves;
3. Cooling coefficient can be greater than 1 ;
4. Thermal mass does not influence the coefficient curves;
5. Buildings with low heating energy needs (hot climate, high efficiency) save more money than other buildings
6. In most of the cases that we considered the rewards are lower than expected considering only lighting

Conclusions – the CERPlan tool



A tool to manage the energy requalification of a building stock considering energy saving and synergies with maintenance.

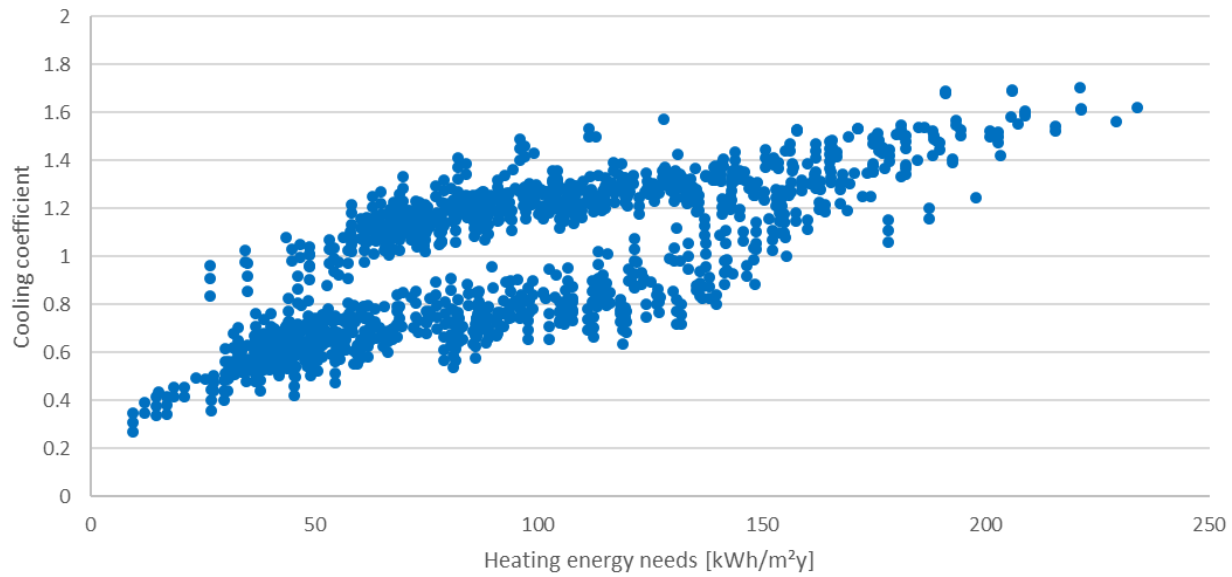
The screenshot shows the CERPlan web application interface. At the top, a dark grey header contains the CERPlan logo and the name "CERPlan" on the left, and the user name "Emily Hill" with a profile icon on the right. A vertical sidebar on the left lists navigation options: Home, Audit, Hints, Saving, and Planning. The main content area is titled "Get started" and contains four interactive cards. Each card has an icon, a title, a brief description, and a button. The cards are: 1. "Audit" with a building icon, description "Add building data and track your building stock status.", and button "ADD DATA". 2. "Hints" with a line graph icon, description "Check the suggested interventions to maximize your resources.", and button "CHECK INTERVENTIONS". 3. "Saving" with a battery icon, description "Add quotation data and lay the basis for the planning of interventions.", and button "ADD QUOTATION". 4. "Planning" with a line graph icon, description "Set your budget to start planning the most convenient set of interventions.", and button "SET BUDGET". A "CLOSE" button is located at the bottom right of the "Get started" section. Below the cards is a map showing a geographical area with labels for "Cologna di Sotto", "GRIES - S. QUIRINO", "Via Merano", "Viale Druso", "B...no", "Signato", and "Daune". The map includes a red location pin and a zoom control.

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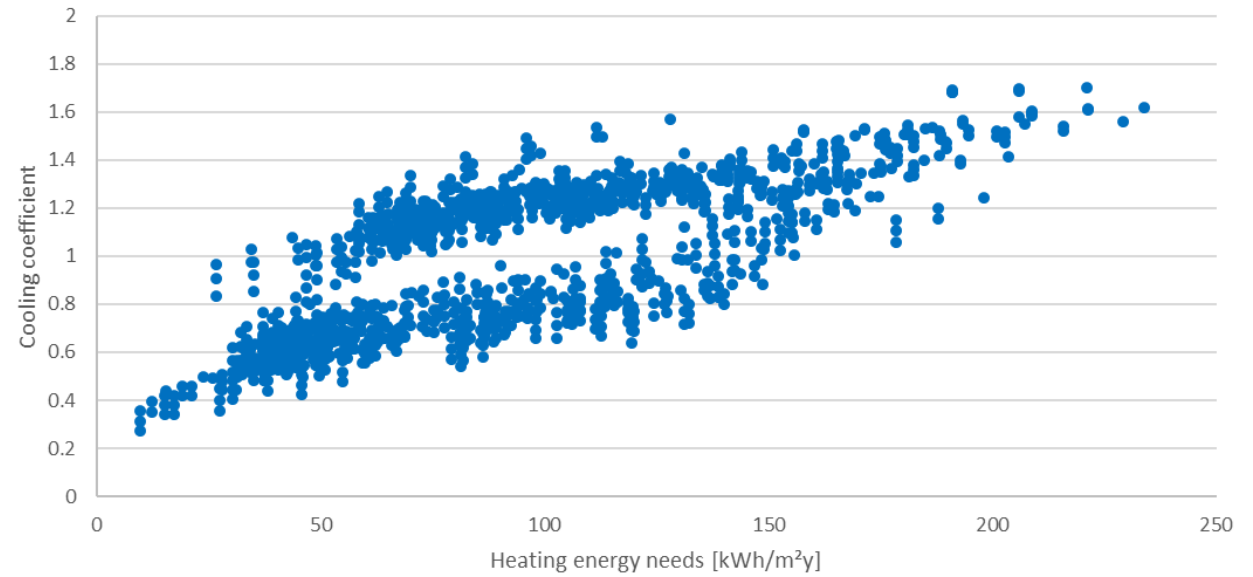
marco.castagna@eurac.edu
www.eurac.edu

Results - Hospitals

Hospital - High thermal mass

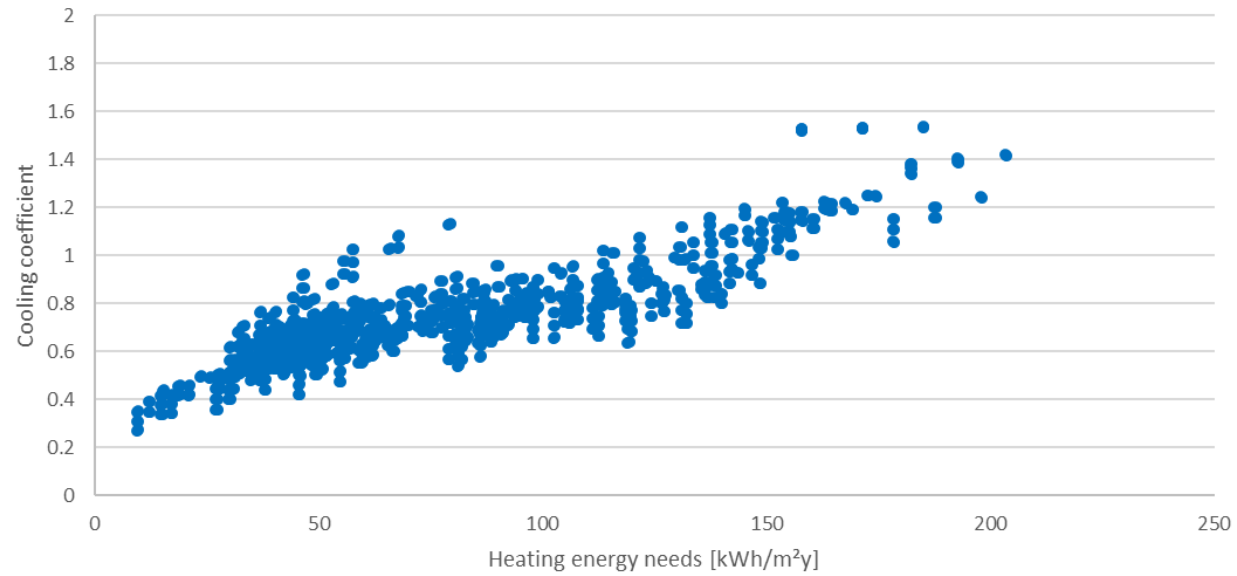


Hospital - Low thermal mass



Results - Hospitals

Hospital - Low efficiency



Hospital - High efficiency

