Scuola universitaria professionale della Svizzera italiana
Dipartimento ambiente costruzioni e design
Istituto sostenibilità applicata all'ambiente costruito

SUPSI

Enhance Energy Efficiency of the housing stock in Ukraine using the PETRA Methodology

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Teacher and researcher

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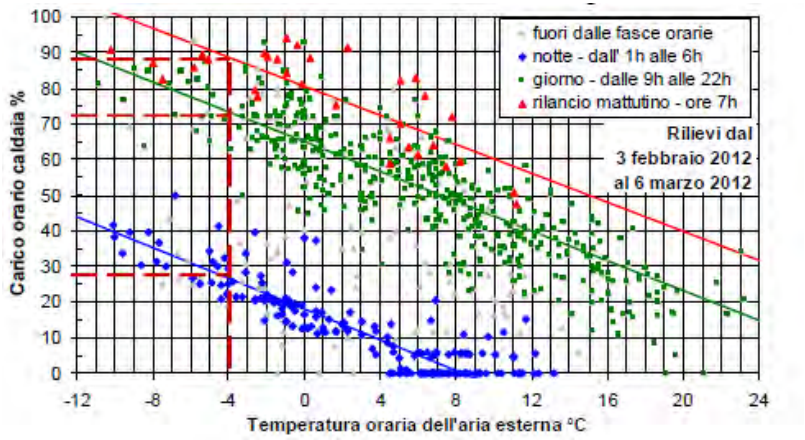
Refurbishment and maintenance of existing Buildings

System optimization and thermal monitoring

- Energy consulting and building sustainability
- Sizing geothermal systems (Geothermie-Suisse)
- Development of monitoring systems for electrical and thermal parameters:
  - Geocooling potential
  - Electrical load and production
  - g-value, U-value evaluation
  - Energetic signature
  - …

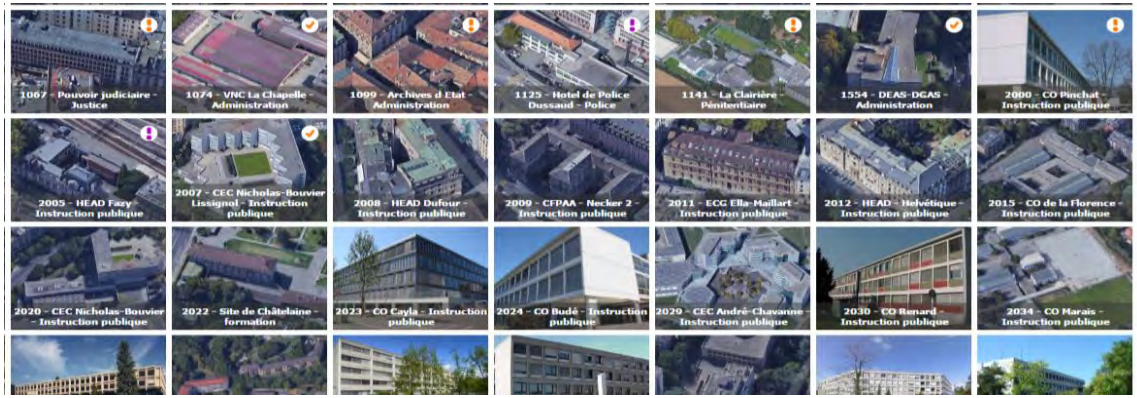


PETRA Platform for Energetic and Technological Refrofit in Architecture

Network computer-based tool for decision-making on maintenance and renovation of a mixed building estates

Platform for energy consumption monitoring and optimisation

energo®
Efficienza energetica
per edifici



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УКРАЇНСЬКИЙ ЦЕНТР СПРИЯННЯ РОЗВИТКУ
ПУБЛІЧНО-ПРИВАТНОГО
ПАРТНЕРСТВА

SUPSI

A project funded by REPIC – Renewable energy and Energy efficiency Promotion in International Cooperation

REPIC
Renewable Energy &
Energy Efficiency
Promotion in
International
Cooperation

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss State Secretariat for Economic Affairs SECO

Swiss Agency for Development and Cooperation SDC

Swiss Federal Office of Energy SFOE

WP0: Background studies – real estate asset

Under former socialist regimes most of the residential housing stock in Eastern Europe was built, owned, and managed by the government. Its quality varies across countries, but has in common that **many of its multi-apartment building were built in the 1970** when technologies and awareness about **energy saving** insulations were still rather **underdeveloped**.

The average age of buildings in Ukraine is relatively **old**, and many of these, characterized by the use of **cheap materials**, **poor quality** and **unproven industrial materials** and **lack of maintenance**, are now in poor general conditions.

Life in these buildings is very unhealthy due to the low thermal comfort and exposure to inexpensive and environmentally hazardous building materials

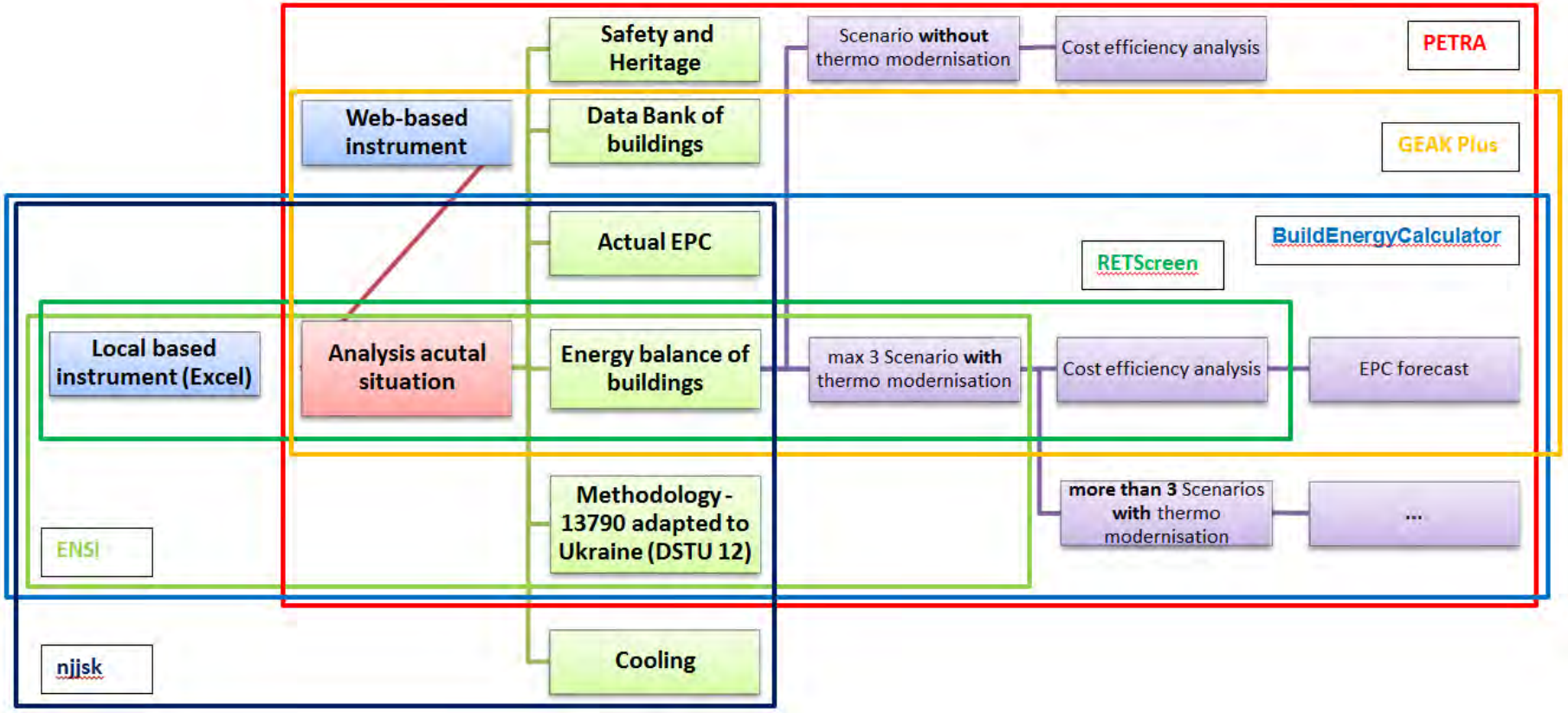
WP1: PETRA tool

The purpose of the project is the transfer of methodology in the field of building renovation, thanks to the Swiss instrument PETRA, which contains the following stages:

- the diagnosis of **existing real estate assets**, including collection of relevant data;
- actual **heat balance** and forecast;
- analysis and forecasting of **operational energy**;
- **economic analysis** and forecasting;
- definition and comparison of **refurbishment scenarios**.

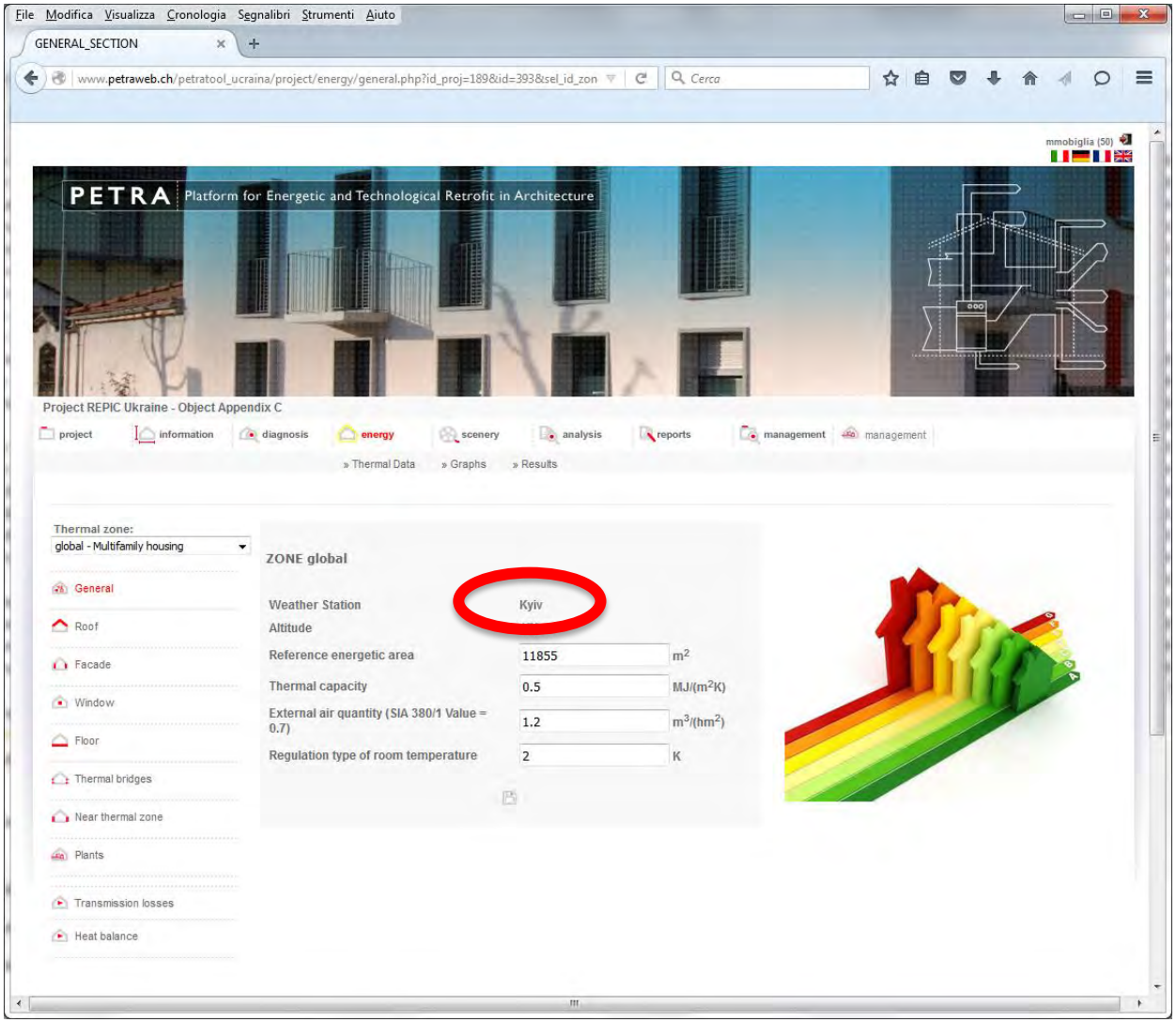
WP1: Comparison

PETRA	Tool for refurbishments analysis with EPC
GEAK PLUS	Swiss official web based tool for EPC and refurbishments analysis
ENSI	Private local tool used by Kiev Esco
Njjsk	Private local tool in development by The State Research Institute of Building Constructions, Laboratory and Scientific and technical centre for EE
BuildEnergy Calculator	Private, local tool of association of Energy Auditors of Ukraine
RETScreen	International, local, quick tool with Ukraine Module



WP1: PETRA for Ukraine

- DUMP
- Comparison SIA 380/1 and Ukr. Norms
- Algorithm for EE
- Climatic data Kiev
- Weighting coefficients
- Ratio
- Ukr. Costs



WP1: PETRA for Ukraine

Sample building: school #216

WP1: Sample building

Sample building school #216

General School n.216 **Scenario analysis**

Table for Scenarios comparison

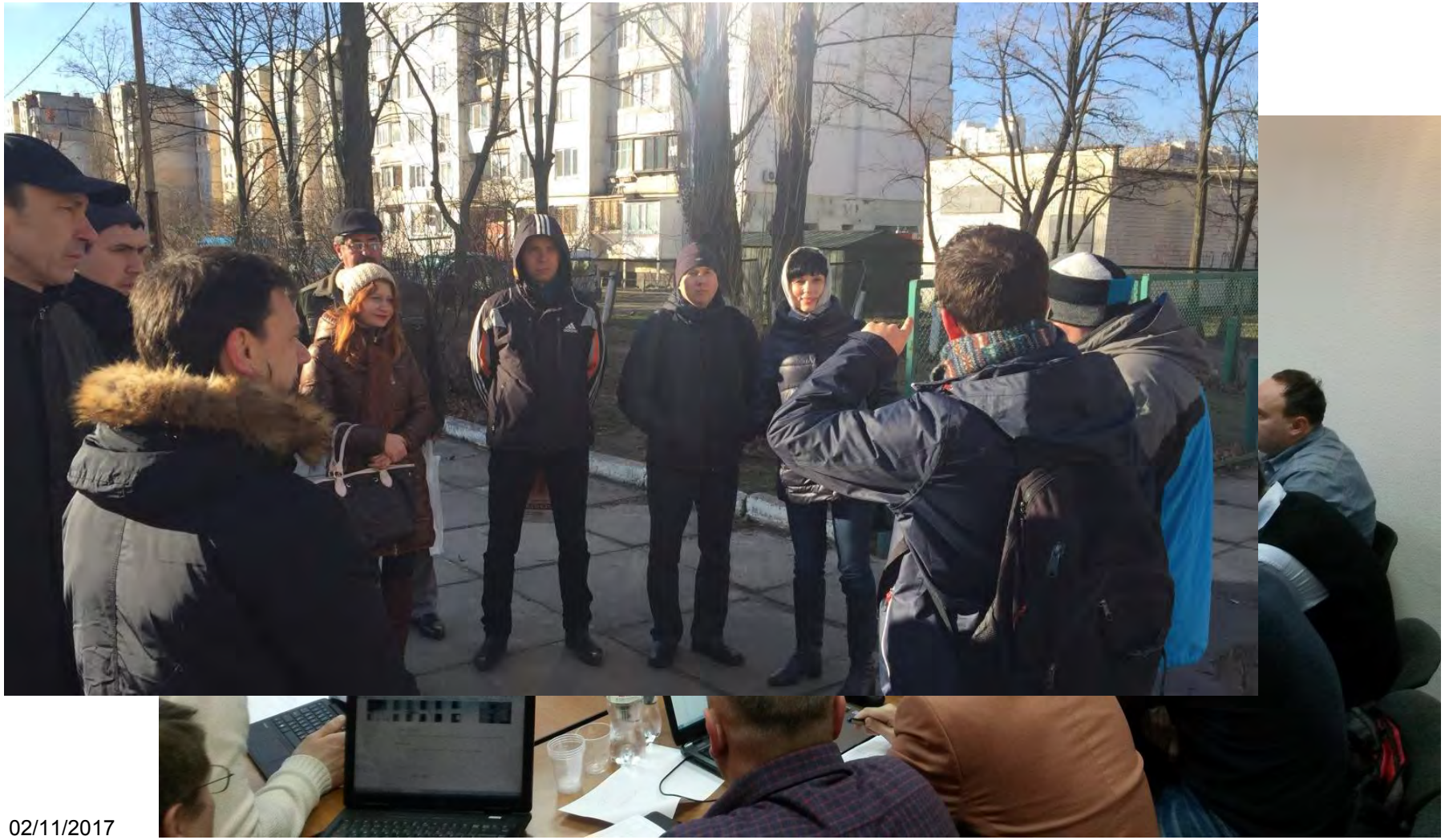
Name	Costs [kUAH]	Qh [MJ/m2]	Efficiency class of envelope (EPC)	Ehwe [MJ/m2]	Global efficiency class	Ehwe [%]
Status	---	542	G	785	G	0
1 - Basic proposals	21903	416	F	637	G	18.9
2 - Intermediate proposals	40210	216	C	401	E	49
3 - Advanced proposals	74109	140	B	283	C	64

1 - BASIC PROPOSALS	
Annual energy needs	1'014'392 KWh
Energy saving	289'486 KWh
Scenario costs	21903 KUAH
Total incentives	0 KUAH
Total investment	28913 KUAH
Years	25 Anni
Total costs	45247 [KUAH]
Gain	38729 [KUAH]
Economic return ratio	85.6 [%]
Net Present Value	3799 [KUAH]
Payback time	22.7 Year
Internal Rate of Return	0.84 [%]

2 - INTERMEDIATE PROPOSALS	
Annual energy needs	553'025 KWh
Energy saving	750'854 KWh
Scenario costs	40210 KUAH
Total incentives	0 KUAH
Total investment	53079 KUAH
Years	25 Anni
Total costs	83068 [KUAH]
Gain	100481 [KUAH]
Economic return ratio	121 [%]
Net Present Value	31794 [KUAH]
Payback time	18.1 Year
Internal Rate of Return	3.36 [%]

3 - ADVANCED PROPOSALS	
Annual energy needs	322'463 KWh
Energy saving	981'416 KWh
Scenario costs	74109 KUAH
Total incentives	0 KUAH
Total investment	97824 KUAH
Years	25 Anni
Total costs	153093 [KUAH]
Gain	131358 [KUAH]
Economic return ratio	85.8 [%]
Net Present Value	13126 [KUAH]
Payback time	22.7 Year
Internal Rate of Return	0.85 [%]

WP2: Teaching Workshop



WP2: Case studies

12 case studies:

- 10 public buildings (Kindergarten, School, Gymnasium)
- 2 residential buildings

WP2: Case studies

Table for Scenarios comparison

Name	Costs [kUAH]	Qh [MJ/m2]	Building envelope efficiency (EPC)	Ehwe [MJ/m2]	Global energy efficiency (EPC)	Ehwe [%]
Status	---	548	G	890	G	0
full	33740	177	C	388	D	56.5
Windows	23144	426	F	719	G	19.2
Without roof and flour	25946	263	D	501	E	43.7

FULL	
Annual energy needs	637'869 KWh
Energy saving	1'167'633 KWh
Scenario costs	33740 KUAH
Total incentives	0 KUAH
Total investment	42514 KUAH
Years	25 Anni
Total costs	84388 [KUAH]
Gain	312336 [KUAH]
Economic return ratio	**370.1 [%]**
Net Present Value	**115289 [KUAH]**
Payback time	**7.2 Year**
Internal Rate of Return	**13.62 [%]**

WINDOWS	
Annual energy needs	1'420'753 KWh
Energy saving	384'748 KWh
Scenario costs	23144 KUAH
Total incentives	0 KUAH
Total investment	29161 KUAH
Years	25 Anni
Total costs	43342 [KUAH]
Gain	102802 [KUAH]
Economic return ratio	**237.2 [%]**
Net Present Value	**67257 [KUAH]**
Payback time	**11.1 Year**
Internal Rate of Return	**9.57 [%]**

WITHOUT ROOF AND FLOUR	
Annual energy needs	906'794 KWh
Energy saving	898'707 KWh
Scenario costs	25946 KUAH
Total incentives	0 KUAH
Total investment	32692 KUAH
Years	25 Anni
Total costs	64895 [KUAH]
Gain	240410 [KUAH]
Economic return ratio	**370.5 [%]**
Net Present Value	**88772 [KUAH]**
Payback time	**7.2 Year**
Internal Rate of Return	**13.63 [%]**

WP3: integrated and comparative analysis

Team UA	Building	Reference area (m2)	Result Qh kWh/m2y	Actual EPC	EPC 1	Qh	Energy saving (kWh)	Investement (HRV)	Investement (SFr)	Payback (years)
2	Lyceum of Kyiv Polytechnic Institute, 41-A I. Lepse str.	1.252	162,00	GE	DF	72,4	81.466	2.217.000	87.352	4,8
5	Kindergarten #104, 58 Polkova str.	1.692	232,60	GG	CD	50,8	341.814	7.880.000	310.481	4,6
4	Kindergarten #523, 8-B Layosha Gavro str.	1.944	216,50	GF	DD	80,7	293.341	12.562.000	494.957	7,1
8	Residental building, 27-A Shchorsa str.	3.300	119,80	GF	CD	37,8	360.771	9.503.000	374.429	4,6
6	Residental building, 27 Shchorsa str.	3.543	155,40	GE	CD	48,9	419.732	7.051.000	277.817	3,1
1	School #196, 22 Zodchykh str.	5.432	155,80	GE	DD	81,7	402.417	14.745.000	580.969	5,3
3	Gymnasium #257, 7-B Gongadze str.	6.531	172,00	GF	CC	65,3	827.200	12.693.000	500.118	3
7	School #84, 32-A L. Ukrainki str.	7.031	169,30	GE	CC	58,8	492.489	14.250.000	561.466	3,5
9	School #167, 12-V Vozyednannia Prosp.	7.031	98,40	FE	CD	45,9	7.023	13.504.000	532.072	
10	Gymnasium #39, 17-G Lisovyi Prosp.	8.505	152,30	GG	CD	49,3	1.167.633	42.514.000	1.675.099	7,2
12	School #252, 10-V Zoya Gayday str.	9.342	136,10	GG	BD	41,2	1.182.003	33.090.000	1.303.783	4,9
11	Gymnasium #315, 27-A Dragomanova str.	11.489	120,30	GE	CC	48,2	829.160	16.863.000	664.421	3,7

WP3: integrated and comparative analysis

The quantification of the foreseeable short-term impact of the energy conservation of the **ten school** buildings analysed in this project is as follows:

- Reduction of annual energy consumption of **5.6 GWh** (improvement of 67%);
- Decrease of annual emissions of **1'125 tons CO_2**.

At the same time as the qualitative level, the comfort conditions of these stables will obviously be better, reducing pupil illness rates, improving learning conditions and increasing the desire to go to school. The positive experience of scholars can also convince many parents to take energy-saving measures in their own home.

In a longer-term perspective, the energy refurbishment of **all the schools in Kiev** would lead to the following quantitative impact:

- Reduced annual energy consumption of **5'600 GWh**;
- Reduction of annual emissions of **1'125'000 tons CO_2**.

WP3: integrated and comparative analysis

Relationship between pay-back and energy savings of the 12 stables analyzed