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Energy Audits in Public Buildings

The Project is co-funded by the European Union and by National Funds of the Participating Countries under the IPA Cross-Border Programme "Greece – The former Yugoslav Republic of Macedonia 2007-2013"

Overview

- Activities of PEEBPE project
- Description of Buildings, equipment and procedure of energy audits
- Difficulties during energy audits and measurements processing
- Results

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Activities of PEEBPE project

- Detailed energy audit of 50 public buildings **with in-situ measurements**.
- Energy Efficiency Improvement Study of three public buildings in Prespes and Resen.
- Implementation of the Energy Efficiency Improvement Studies at the three public buildings (Kindergarden, Elementary School, Gymnasium).

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Description of buildings, equipment and procedure of energy audits

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Description of buildings, equipment and procedure of energy audits

Equipment:

- Photography camera
- IR camera - concurrent image saving of IR and real pictures under the same name.
- Distance-meter.
- Thermal conductance measurements device (i.e. Hukseflux TRSys 01)
- Notebook - interface of IR camera and Hukseflux
- GPS device
- Laser mini temperature meter.
- Humidity meter
- Light meter (Lux)
- Digital waste gas analyzer

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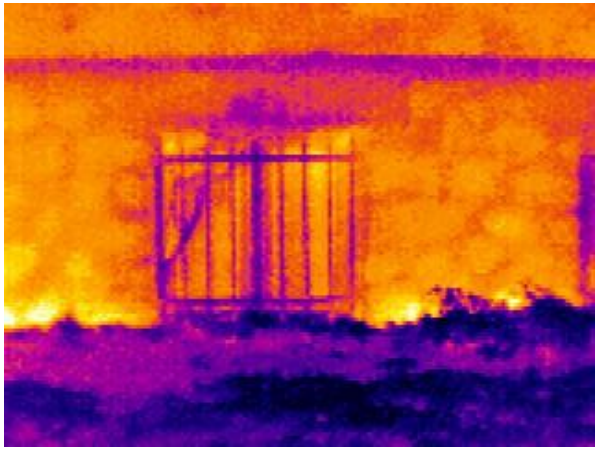
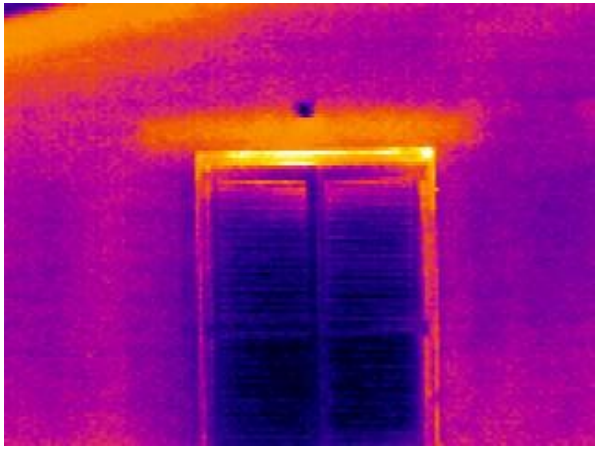
Description of buildings, equipment and procedure of energy audits

Energy Audit procedure:

- Architectural measurements in order to develop the plans of the buildings
- Building's history, usage, invoices.
- Scan with the IR camera to detect thermal bridges (thermography).





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Description of buildings, equipment and procedure of energy audits

Energy Audit procedure:

- Thermal conductance measurements – determined by thermography and history of the building (e.g. Agios Germanos).

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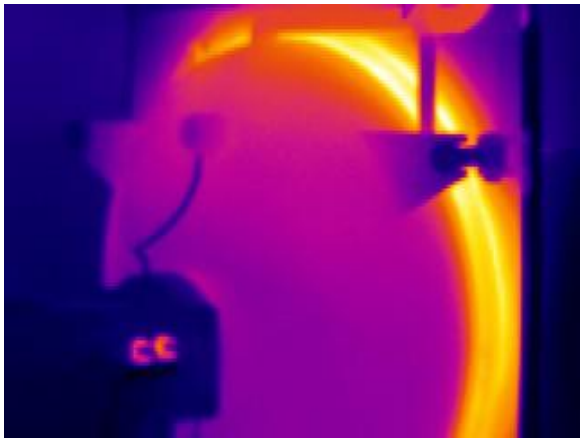
Energy Audit procedure:

Description of buildings, equipment and procedure of energy audits

- Heating system efficiency is estimated by the digital waste gas analyzer, the IR-camera scanning of the heating unit and the grid



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Difficulties during energy audits and measurements processing

DIFFICULTIES

- Refusal of most buildings managers to keep the heating on during the measurements.
- Refusal to proceed to the waste gas analyzer application, since this requires drilling at two points of the waste gas pipe
- Absence of datasheets of fuel consumption of previous years.

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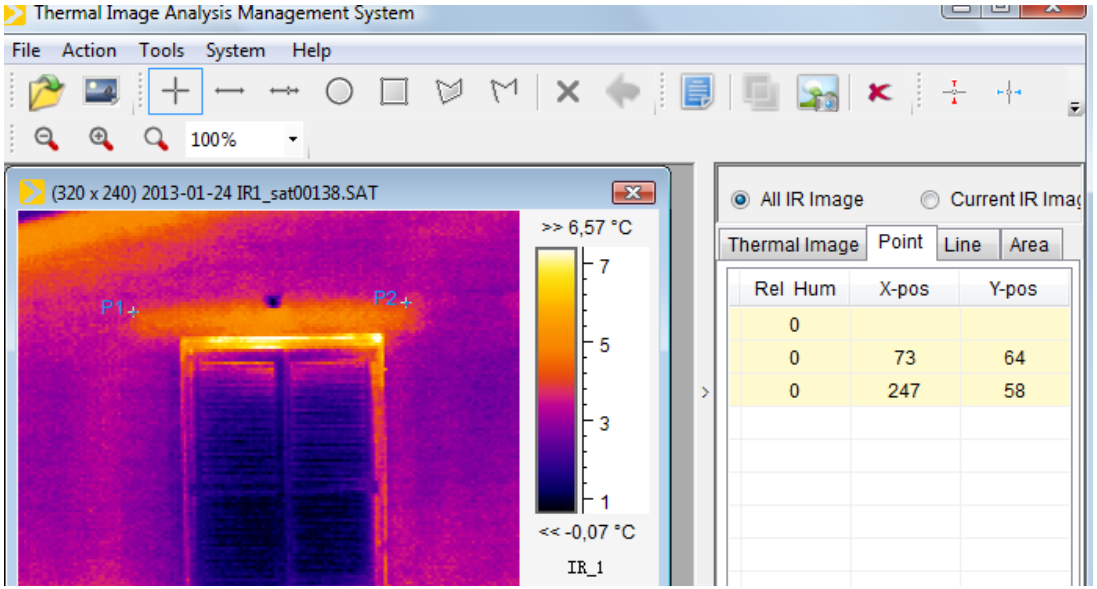
Difficulties during energy audits and measurements processing

MEASUREMENTS PROCESSING

- Derivation of Architectural plans.
- Thermal bridges estimation



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Difficulties during energy audits and measurements processing

MEASUREMENTS PROCESSING

- Thermal conductance calculation.
- Matlab algorithm developed specially for the project and implements the Dynamic Analysis Method, according to ISO 9869

```
load -ASCII neo1.txt
No1=length(neo1);
N=No1-1;
qo1=abs(neo1(2:No1,1));
TI=neo1(1:No1,2);% it has one more element for the derivative
DT=neo1(1:No1,3);% it has one more element for the derivative
Te=TI-DT;
m=3;% this is the maximum value
r=5;%This varies between 3 and 10
M=46;
if M<(2*m+3)
    quit;
end
p=N-M;% from the Te, TI matrices it is obvious that we need p+1 temperat.
Dt=600;
tau_min=Dt/10;
tau_max=(p*Dt)/2;
q=qo1(p+1:N);
tau(1)=tau_min;
kappa=1;
while tau(1)<tau_max
for i=1:m
    tau(m+1-i)=tau_min*(r^(i-1));
end
for i=1:m
    b(i)=exp(-Dt/tau(i));
end
for i=(p+1):N
     for j=1:(2*m+3)
        X(i-p,j)=0;
```

Name	Value
CI	<1x109 double>
DT	<61x1 double>
Dt	600
I	0.0316
L	0.9040
Lamda	<1x109 double>
M	46
N	60
No1	61
S2	317.3098
S2_store	<1x109 double>
S2min	49.1730
TI	<61x1 double>
Te	<61x1 double>
X	<46x9 double>
XT	<9x46 double>
Y	<9x9 double>
Zest	[0.9040;7.2351e+03;1....
b	[0.8669,0.4895,0.0281]
i	60
j	59
kappa	110
m	3
min	75
neo1	<61x6 double>
p	14
q	<46x1 double>
qest	<46x1 double>
qol	<60x1 double>
r	5

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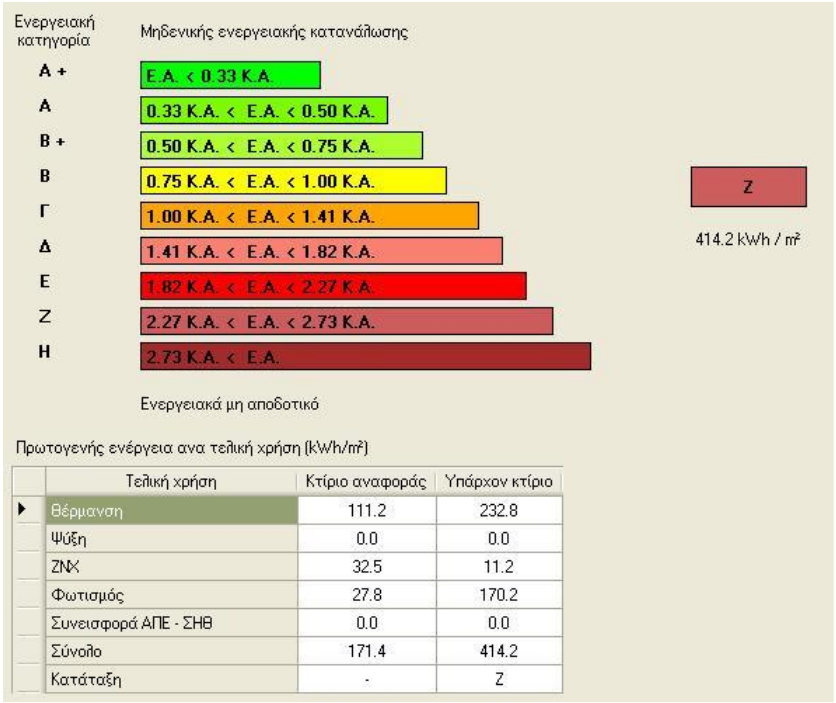
Difficulties during energy audits and measurements processing

MEASUREMENTS PROCESSING

❖Insertion of all data to the relative software that derives the EEC.(Agios Germanos elementary school)



Πρωτογενής ενέργεια ανα τελική χρήση (kWh/m²)

Τελική χρήση	Κτίριο αναφοράς	Υπάρχον κτίριο
Θέρμανση	111.2	232.8
Ψύξη	0.0	0.0
ΖΝΧ	32.5	11.2
Φωτισμός	27.8	170.2
Συνεισφορά ΑΠΕ - ΣΗΘ	0.0	0.0
Σύνολο	171.4	414.2
Κατάταξη	-	Z

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Results

❖Thermal Conductance Coefficients Results

	Thickness (m)	L(W/m^2K)
Stone wall A	0,4	1,1547
Stone wall B	0,7	0,8968
Stone wall C	0,8	0,5846
Old small compact brick	0,7	1,3473

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Results

Upgrade from Z class to B+ (90 % energy saving).

- Installation of external thermal insulation – thickness 10cm.
- Redesign and construction of the heating network.
- Heat pump water-air.
- Installation of a smart heating management system (developed by the Technological Educational Institute of Western Macedonia)
- Replacement of illuminants with type led.
- Building energy management system (KNX).

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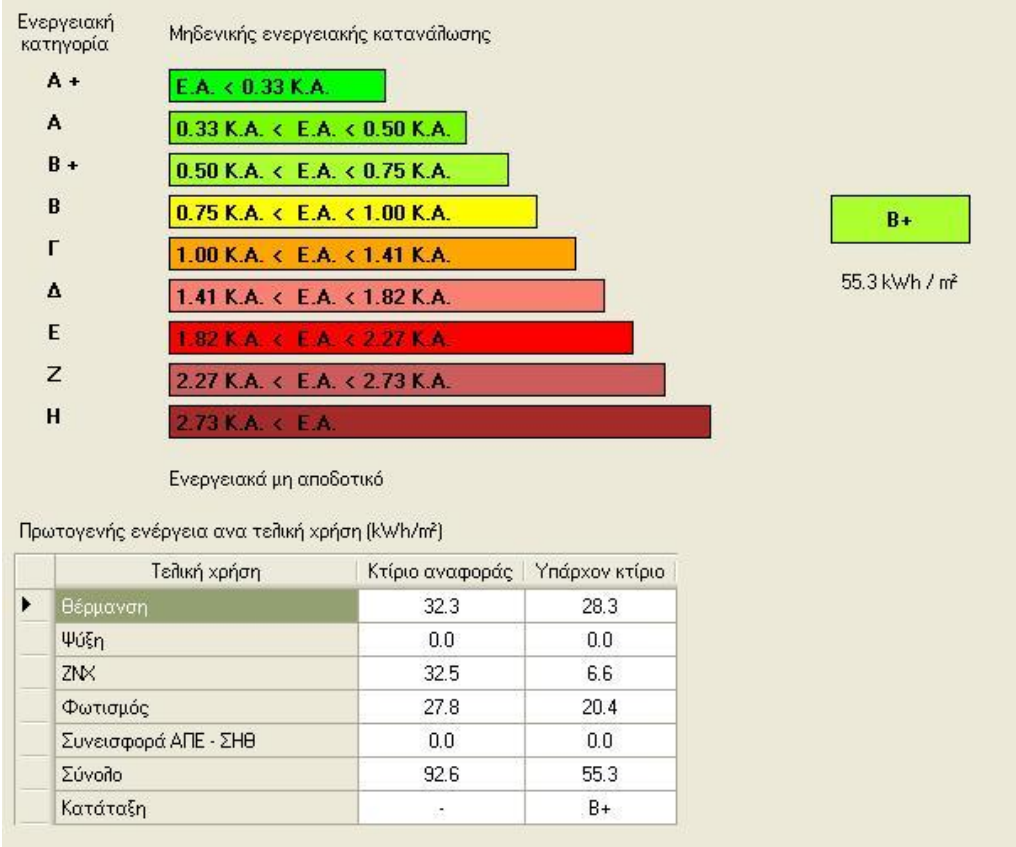
Results

Upgrade from Z class to B+ (90 % energy saving).



Πρωτογενής ενέργεια ανα τελική χρήση (kWh/m²)

Τελική χρήση	Κτίριο αναφοράς	Υπάρχον κτίριο
Θέρμανση	32.3	28.3
Ψύξη	0.0	0.0
ΖΝΧ	32.5	6.6
Φωτισμός	27.8	20.4
Συνεισφορά ΑΠΕ - ΣΗΘ	0.0	0.0
Σύνολο	92.6	55.3
Κατάταξη	-	B+

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PEEBPE project

THANK YOU!

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