Twinning « Improvement of the Energy Efficiency in Turkey »
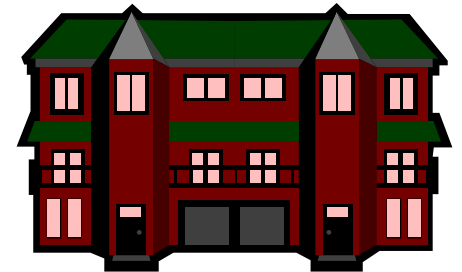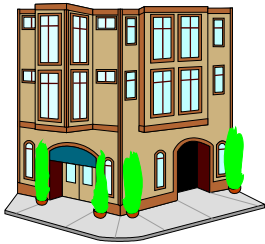
SECTOR BUILDING WORKSHOP
Thermal Rehabilitation in Existing Buildings and Energy Building Code

Energy efficient measures in residential sector: Saving Potential for Ankara Province

By Adel Mourtada

Energy Efficiency Building Expert

General Characteristics of energy consumption in residential sector

Energy and Building in EU

- BUILDING ENERGY CONSUMPTION :

  - 40% of the FINAL ENERGY DEMAND is consumed in buildings (houses o or dwellings, offices, hospitals, hotels,…)

  - 740 millions tones of CO_2 /y (includes small industry) = 25 % of the total

  - (60-80 % is related with heating)

  - Important growth in the service sector

(Data from the EU)

Energy and Buildings

- How can be know.. the energy consumption within a building? →

  - It's NOT immediate
  - Depends on several factors:
    - Difficult prediction (climate, people habits)
    - Variable in time
    - Interrelated

- What means that a building is having a big energy consumption? →

  - ENVIRONMENTAL POLLUTION
  - ECONOMIC COSTS
    - Fuel consumption
    - Installations

- What can be done to reduce the energy consumption in buildings? →

  - **Thermal Rehabilitation**
  - Efficient installations or active systems
  - Renewable Energy Sources

Energy and Buildings

PRIMARY ENERGY

Natural gas
Coal
Nuclear fuel
Diesel oil
Propane
Butane
Wood
others
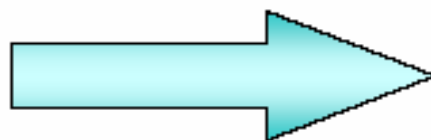
electricity

USEFUL OR FINAL ENERGY

HEATING
COOLING
Domestic Hot Water
Cooking
Lighting
Electrical appliances

- Increase of COOLING due to higher standard of living

How much is the cost of the energy consumed in buildings?
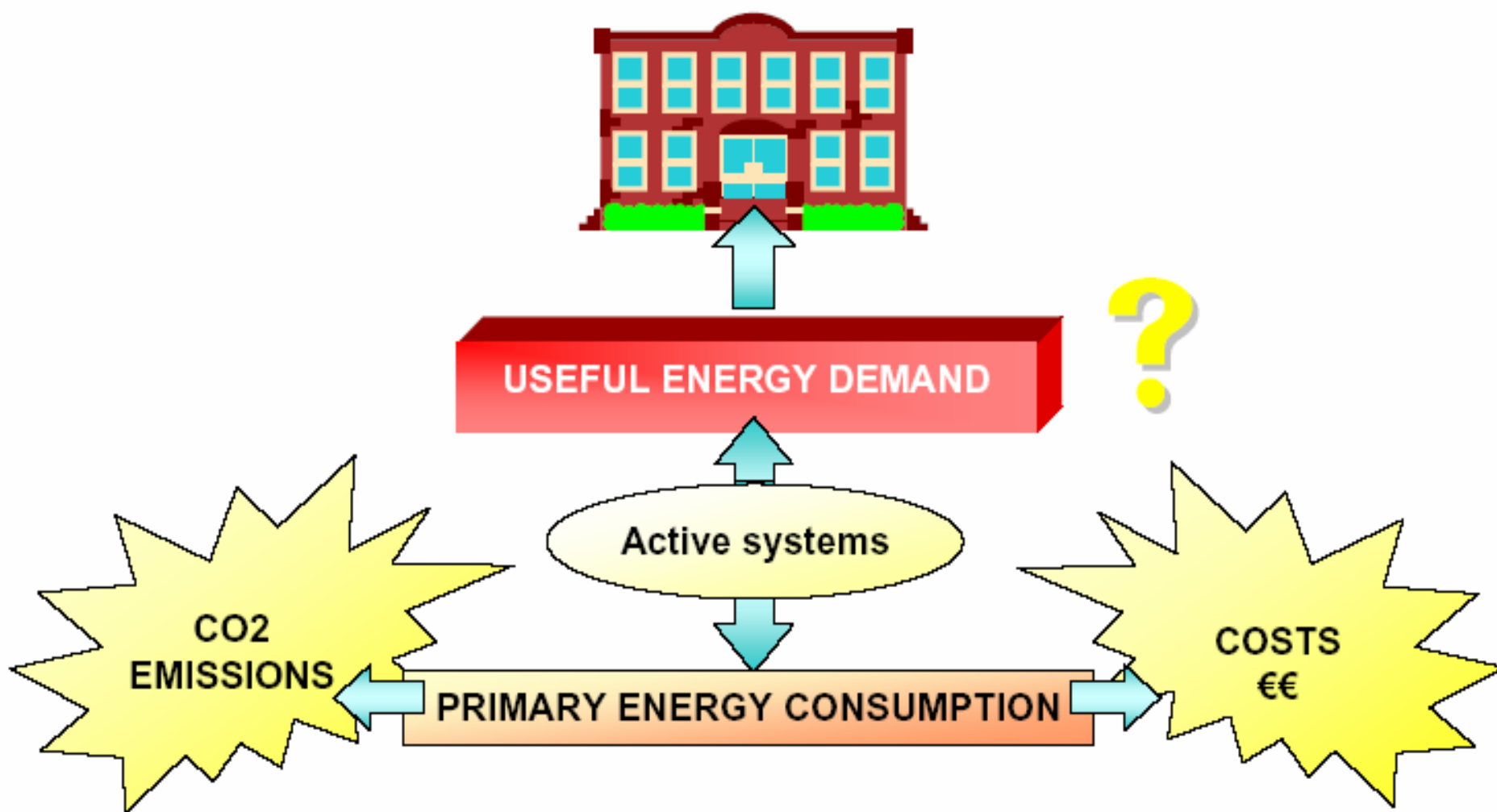
What are the Measures for Energy Savings?

Management of solar gains

Rehabilitation
Construction
Materials
Insulation

PRIMARY ENERGY

USEFUL ENERGY

Efficient installations

Renewable energy sources

DYNAMIC SIMULATION OF THE BUILDING THERMAL BEHAVIOUR

Advantages of the Thermal Rehabilitation

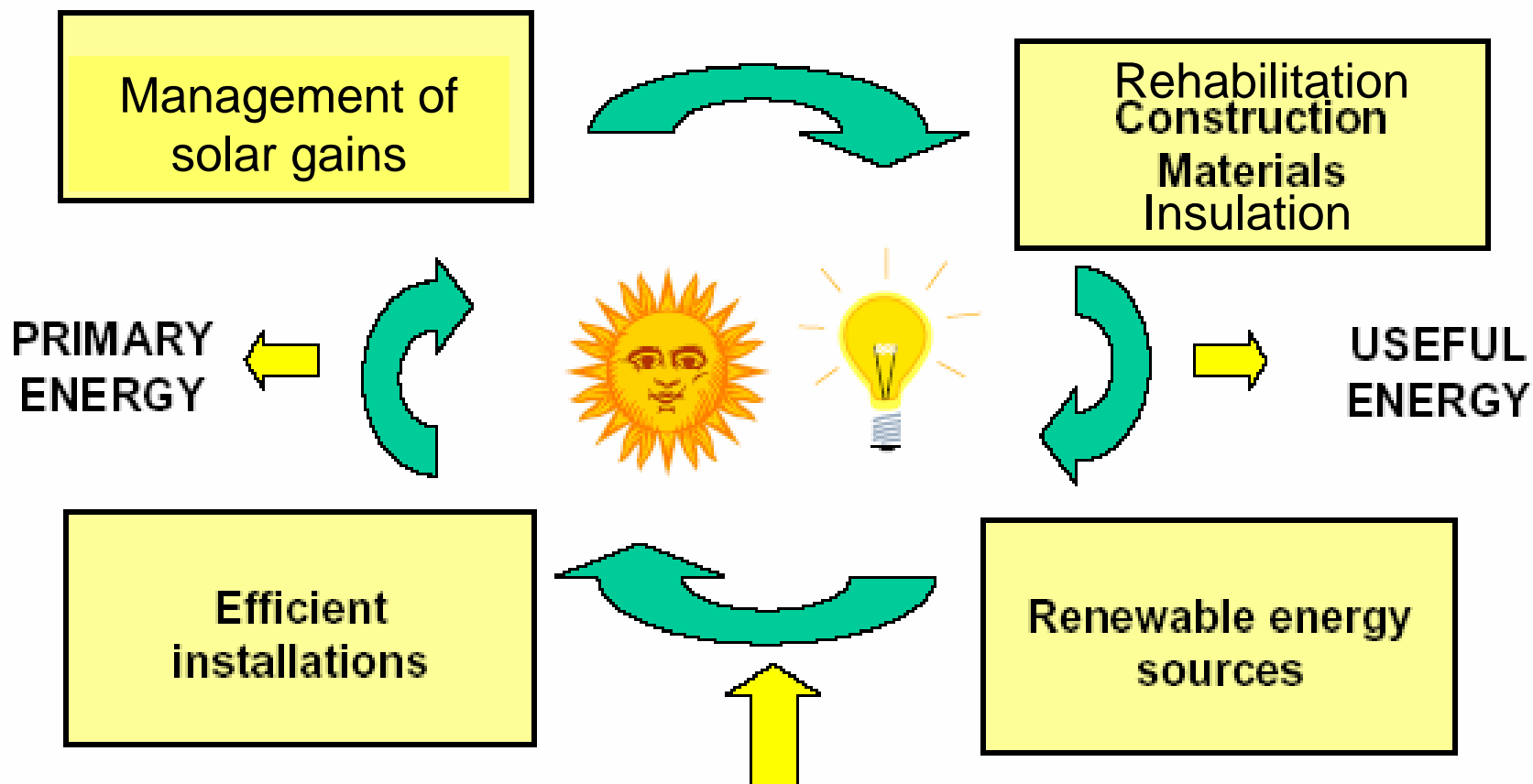**SAVINGS FOR THE USER: Reduction of the energy bills.**

COMFORT: Assuring of the comfort with natural conditions during more hours per year, reducing the primary energy consumption.

SOCIAL AND ENVIRONMENTAL BENEFITS: Primary energy savings and reduction of pollutants and CO2 emissions.

How to start thermal rehabilitation programmes of existing buildings? Key Questions

- Understanding the Existing Residential Sector in Ankara

- Why has relatively little priority been given to residential energy efficiency in existing buildings?

  - What are the key issues and barriers to expand residential energy efficiency such as: Insulation, energy management, ownership, maintenance, heating service contracts…

  - Policy & Regulatory Frameworks

How to start thermal rehabilitation programmes of existing buildings? Key Questions

- Energy Efficiency Results

  – What is the net financial gain/loss to households and governments that adopt and invest in retrofit residential energy efficiency?

  – Do Energy Efficiency Programs target and benefit low income households? Are they a effective alternative to payment of subsidies?

Evaluation of the Energy Saving Potential

By using dynamic simulation Tools
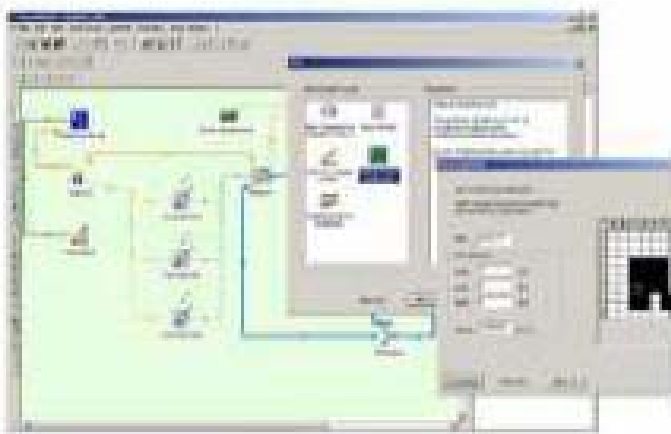
- **CONCEPT**

  - Numeric calculation method

  - Simulation of the building thermal behavior during 8.760 hours, analyzing the transitory phenomena of heat and mass transfer

- **TOOLS: TRNSYS,DOE2, Others**

WHAT IS VISUALDOE 3.1?

VisualDOE 3.1 is a green building design tool that helps users quickly and accurately evaluate energy and demand impacts of design alternatives using the powerful DOE-2 simulation engine developed by Lawrence Berkeley National Laboratory. The program covers major building systems, including building envelope, lighting, daylighting, service water heating, HVAC and central plant. VisualDOE runs on PCs with the Microsoft

VisualDOE 3.1 Main Form

VisualDOE emphasizes the balance between the ease-of-use and the flexibility for users with different levels of simula-

REQUIRED INFORMATION :
Construction elements, occupancy (profile heating use) and interior conditions

LAYER PROPERTIES

OPAQUE ELEMENT

- Thickness (mm)
- Conductivity (W/m/°C)
- Density (kg/m³)
- Specific heat (J/kg/°C)
- Convection coefficient (air chamber) (W/m²/°C)
- Moisture diffusion coefficient

TRANSPARENT ELEMENT

- Radiation transmission
- Radiation reflection
- Long wave radiation reflection
- Light transmission
- Light reflection
- Conductivity (W/m/°C)
- Moisture diffusion coefficient

Dynamic simulations

Performing hourly weather file for the software DOE.3 requires a very professional approach.
EIE has recently obtained from the DG of Meteorology the hourly climatic data for 6 stations. We performed DOE.3 weather file 2005 for Ankara for the purpose of this study.

ENERGY EFFICIENT MEASURES FOR RESIDENCES IN ANKARA PROVINCE
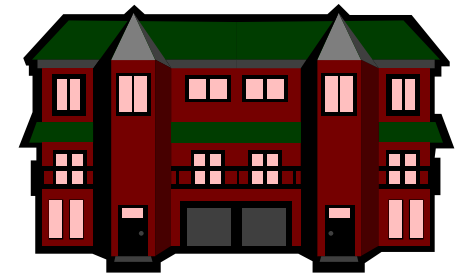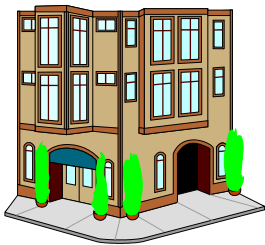
Climatic zones of Turkey

| | 1.Bölge | | 2.Bölge | | 3.Bölge | | 4.Bölge |
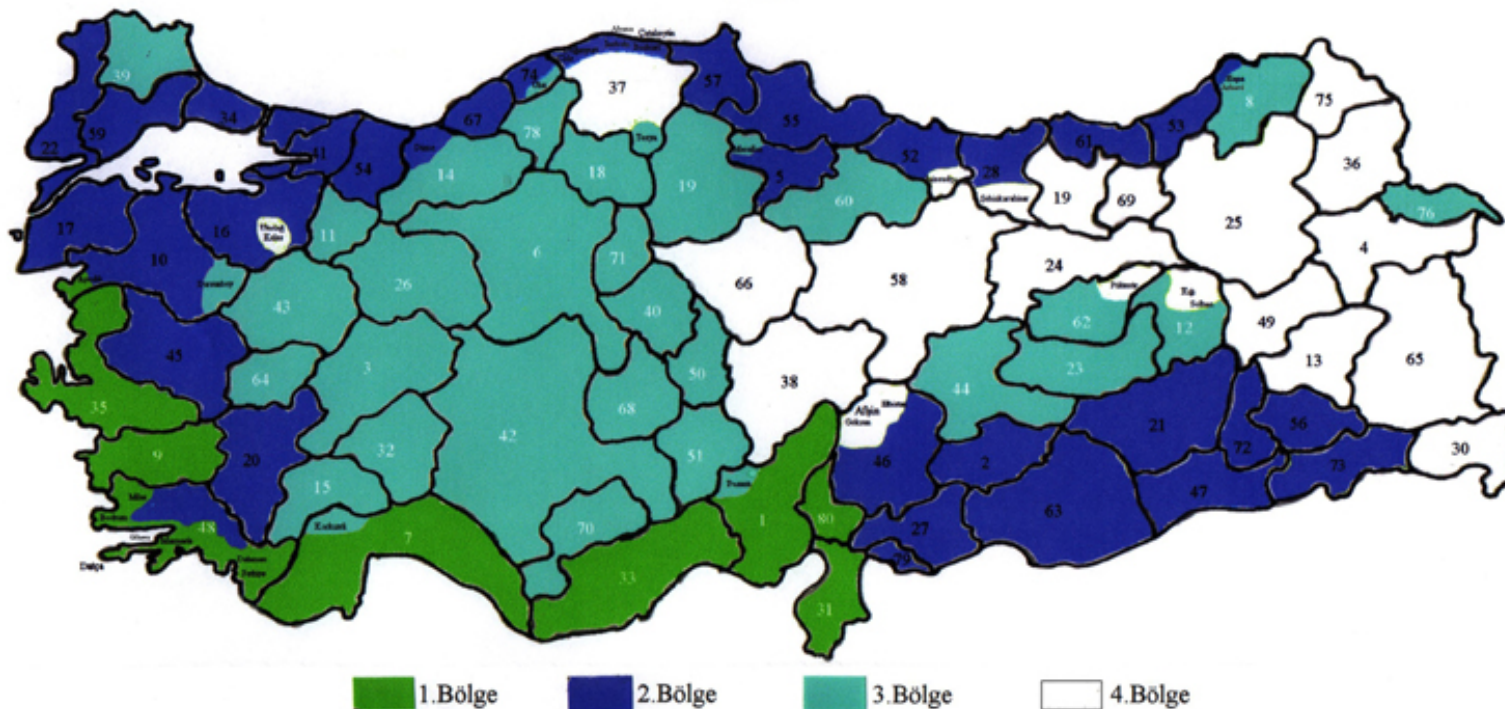
SELECTED MEASURES for EVALUATION

- Selected measures will include energy efficiency improvements of <u>residential dwellings</u>. These will include:

  i) double glazing,

  ii) insulation of walls/floors/roofs,

  iii) efficient heaters/boilers,

  iv) solar water heaters,

  v) efficient gas boilers.

- Important source of energy savings come from users switching for gas and solar.

- Cogeneration and district heating.

- Most of the potential (70%) is related to insulation.

Recommended U values for Regions
as used for simulation (TS 825 draft revision)

	U_D (W/m²K)	U_T (W/m²K)	U_t (W/m²K)	U_P (W/m²K)
1. Region	0.70	0.45	0.70	2.4
2. Region	0.60	0.40	0.60	2.4
3. Region	0.50	0.30	0.45	2.4
4. Region	0.40	0.25	0.40	2.4

U: heat transfer coefficient

U_D : **Wall,** U_T : **Roof,** U_t : **Floor ,** U_p : **window**

Impact of envelop insulation and windows double glazing
on useful (final) energy heating & cooling demand *if 24C indoor*
for a Residential dwelling type (94 m2) in ANKARA
Indoor Temperature at heating season: 22 C without insulation 20 C after insulation

■ Energy Heatng
■ Energy Cooling
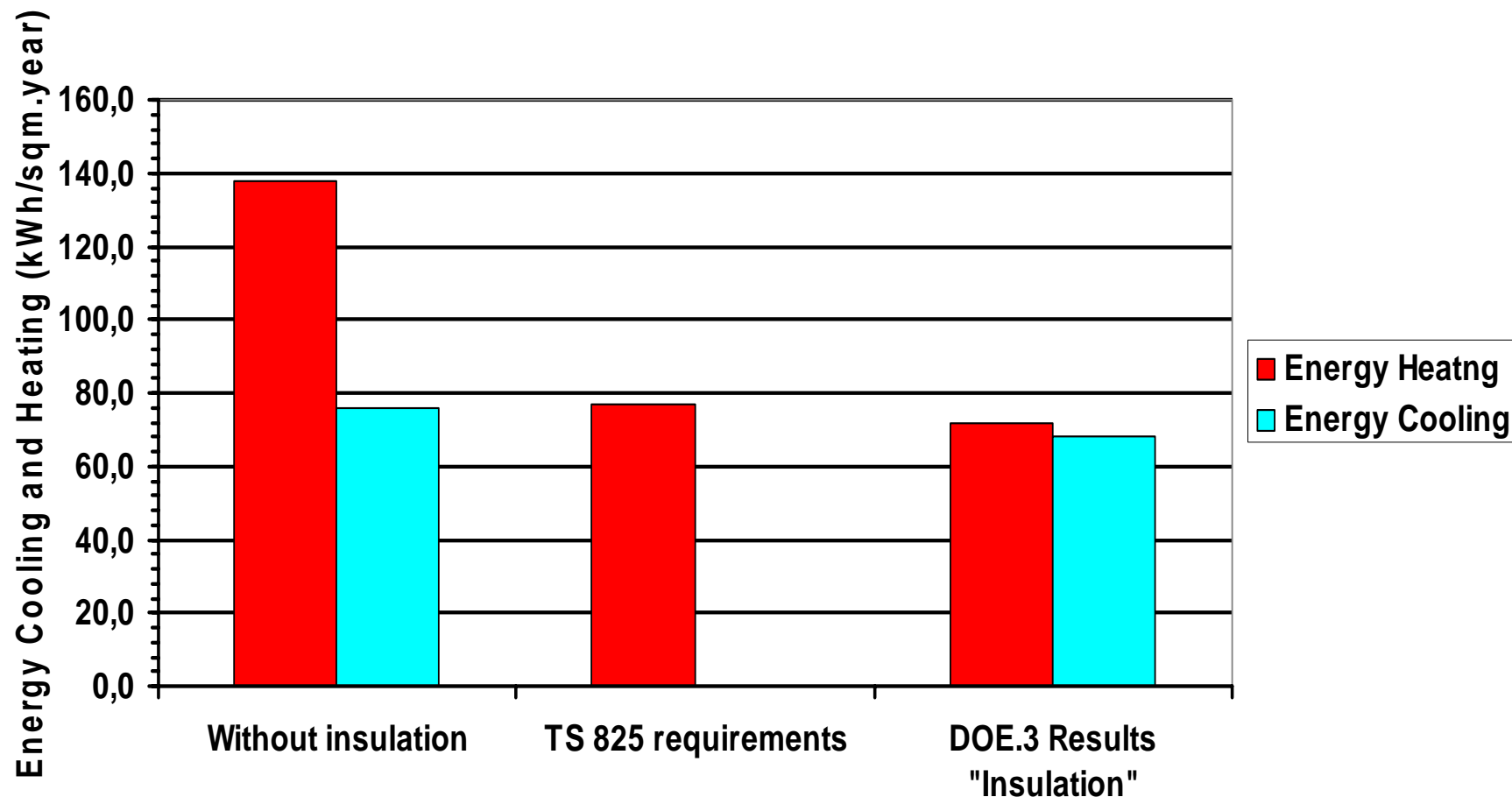
Energy Saving from Thermal Measures for Typical dwelling with roof. Apartment of 94 m2. Ankara
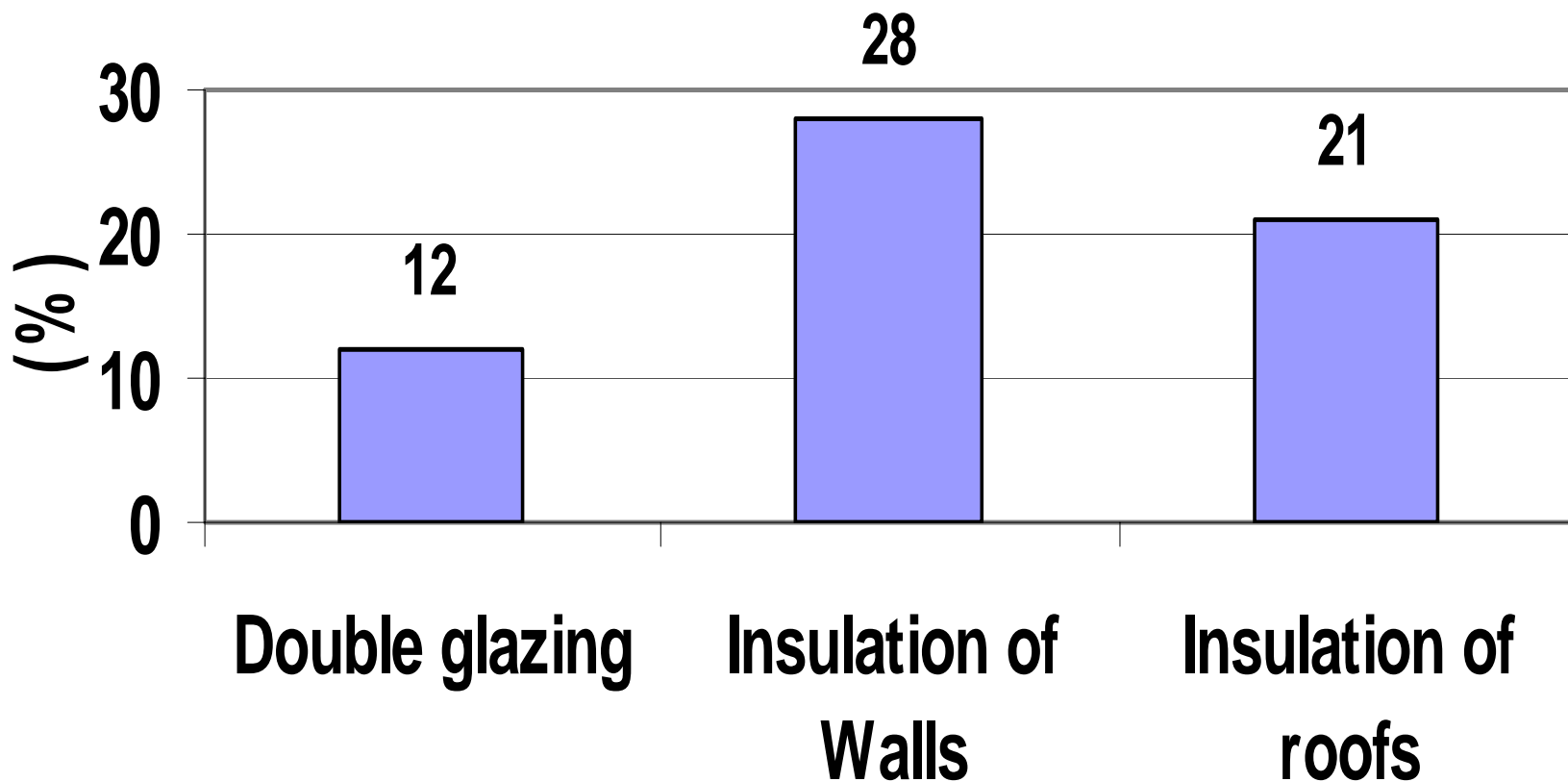
Prices of Energy in Turkey, taxes included

Last Up Date: July 2006 Compiled by RTA Bernard CORNUT

Energy type	Unit	Local Prices per unit in TRY, taxes included	Rate for 1 EURO= (web inforeuro)	Prices in Euro per Unit	Prices per toe
Electricity - households	kWhe	0,1583 TRY/kWhe	2,0115	0, 0787 Euro/kWhe	915 Euro/toe
Natural gas - Households	kWhth	0,0472 TRY/kWh	2,0115	0,0235 Euro/kWh	300 Euro/toe
Heating oil = Fuel 4 in TR	Ton	1,60 TRY/kg	2,0115	0,0684 Euro/kWh	795 Euro/toe

Yearly Heating Expenses by Energy Source
Household Type of 94 m2
heating space = 54 m2
(year 2005 in Ankara)
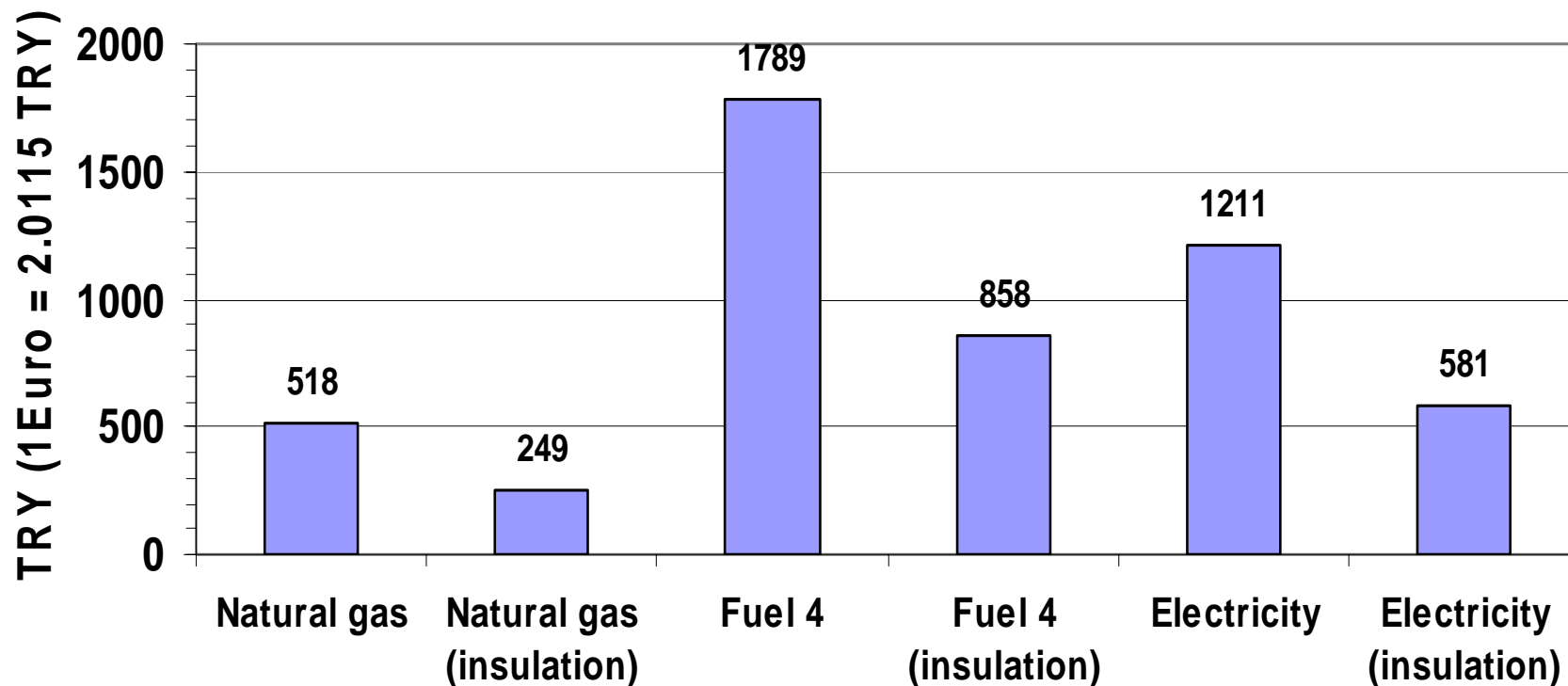
Yearly Heating Expenses by Energy Source
Household Type of 94 m2
All living space heated
(year 2005 in Ankara)

Bar chart — TRY (1Euro = 2.0115 TRY):

- Natural gas: 908
- Natural gas (insulation): 437
- Fuel 4: 3138
- Fuel 4 (insulation): 1506
- Electricity: 2126
- Electricity (insulation): 1020
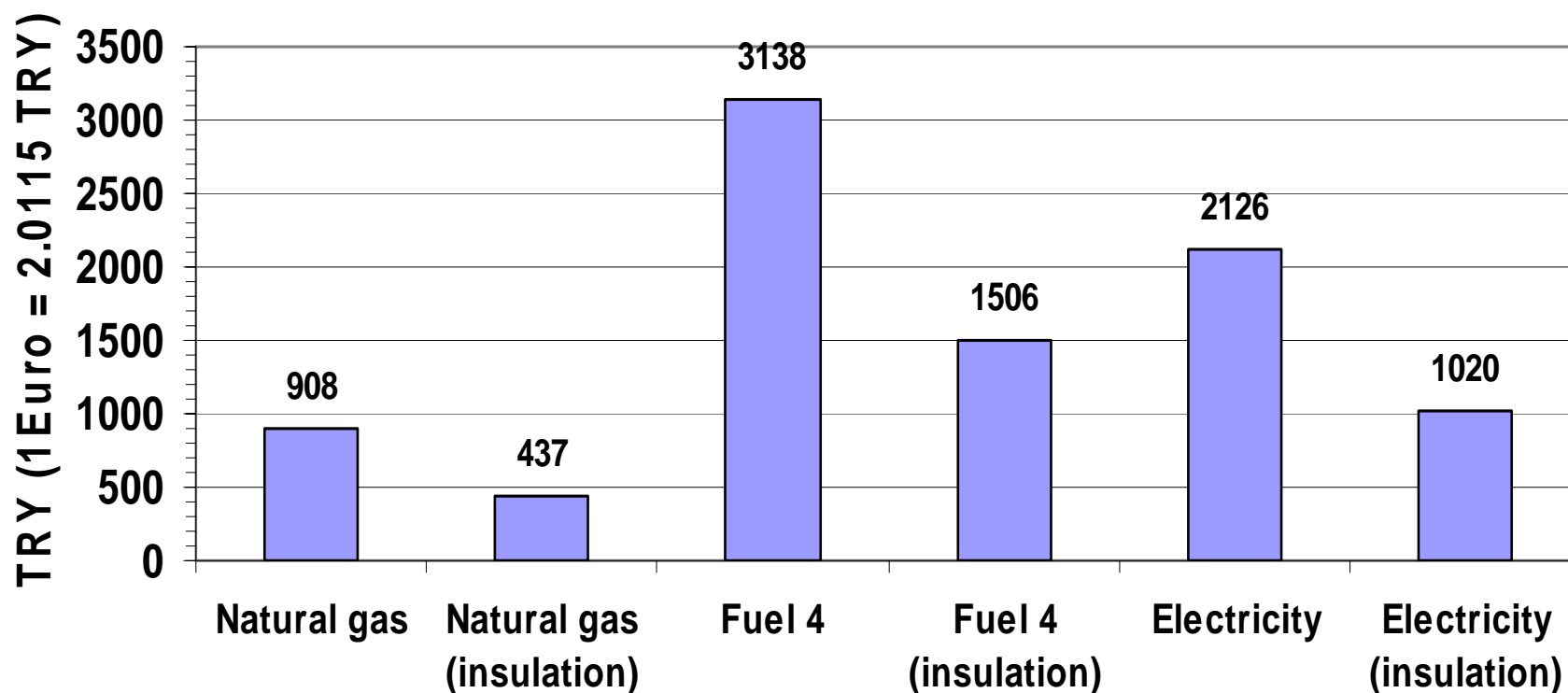
FINDINGS OF THE ENERGY CONSUMPTION SURVEY (1998)

- In the residential area, about:
- 700.000 flats, would need additional insulation of walls,
- 128.000 flats, would need additional insulation of roofs,
- 625.000 flats, would need double glazed doors and windows.
- Then, a potential of connecting more dwellings to the gas grid, substituting oil and stove heating systems. *Mid 2006, 855000 households are gas connected.*
- There is a potential for solar water heater.

Mains indicators of space heating energy consumption in residential buildings in Ankara (1998)

Number of persons living at the residences	nbr.	3106012
Total net used area	m2	73446870
Total heated area	m2	42219800
Average living area per person	m2	23.647
average heated area per person	m2	13.6
Ratio heated area to living area	%	57.5
Total primary energy consumption for space heating (65% of total)	TOE	991800
Energy consumption per person	TOE	0.319
Primary Energy consumption per living area (not insulated building)	kWh/m2	190.8
Finaly Energy Consumption per leving area (EE 71%) (not insulated)	kWh/m2	135.5
Primary Energy consumption per living area	TOE/m2	0.014
Primary Energy consumption per heated area	TOE/m2	0.023

Source : Calculated by Mourtada based on data from **Turkish Statistical Institute**

Potential of Energy Saving from Thermal Rehabilitation of Residences For Ankara Province (Total* = 346 000 TOE per year)

(* taking into account combination of measures)
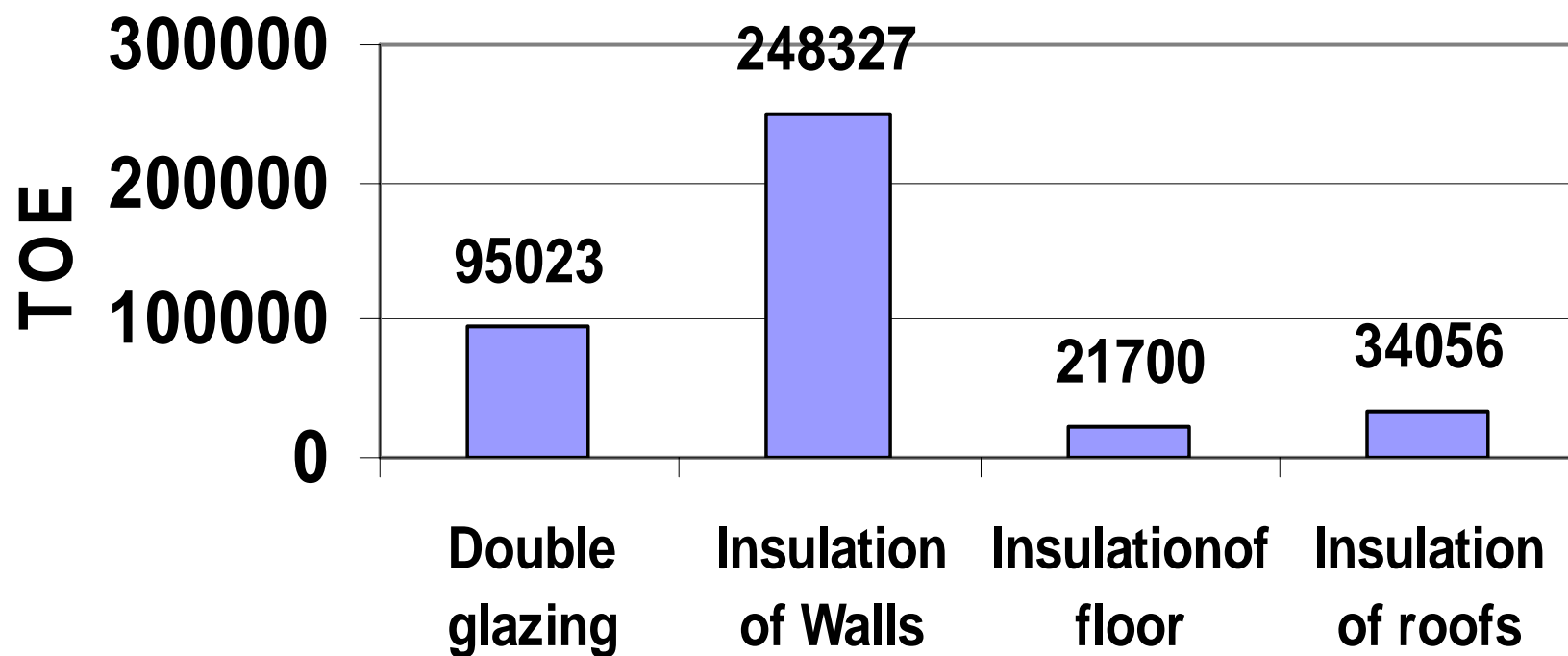
Reduction of CO2 emissions from thermal rehabilitation of residential buildings in Ankara Province

- On the basis of the saving potential of primary energy 346 000 TOE, CO2 Emissions reductions can be calculated as following :

- Total reduction CO2 emission = 845 000 tCO2/year

Fuels	Primary Energy TOE	Emission Factor tCO2/TOE	Emission reduction tCO2
Natural Gas	294 100	2.33	686 233
Fuel 4	51 900	3.06	158 785

ECONOMIC EVALUATION OF ENERGY EFFICIENT MEASURES FOR THERMAL REHABILITATION OF RESIDENCES IN ANKARA
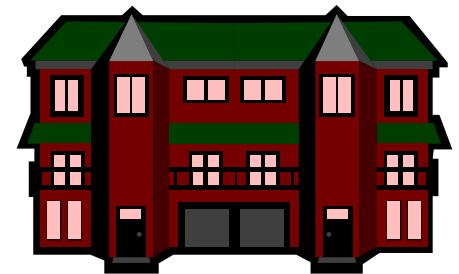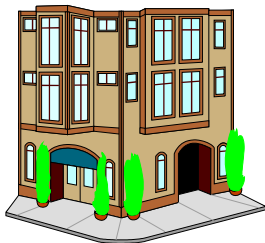
RESIDENTIAL ENERGY EFFICIENCY: EE MEASURES FOR TYPICAL APARTEMENT OF 94 m2

Estimated Cost parameters

Thermal measures	Range of price per m2, mid 2006, including installation costs	Average Area (m2)	Total cost per concerned flat
Double-glazing	130 TRY	13.5	1755 TRY
Insulation of walls	35 TRY	84	2940 TRY
Insulation of roof	26 TRY	94	2444 TRY
Insulation of floor	17 TRY	94	1598 TRY
Thermostatic valves	240 TRY		240 TRY
Solar Water heater	1200 TRY		1200 TRY

Note: One Wall between adjacent apartments is not insulated.
Here Windows to walls ratio = 0.12 % but it might be more for some Ankara` Buildings.

RESIDENTIAL BUILDING in ANKARA: **COST of HEATING**

TYPICAL APARTEMENT OF 94 m2

Description	Specific heating need simulation model slide 20	Boiler & heating system efficiency	Specific heating energy use at boiler	Natural gas consumption at boiler per flat	Price of gas VAT incl. included	Total heating cost VAT incl.
Unit	kWh/m2 per year		kWh/m2 per year	kWhth per year * flat	TRY/kWhth	TRY per year* flat
Not rehabilitated	**138**	*0,675*	*204,5*	*19230*	**0,0472**	**908**
Rehabilitated	**72**	*0,73*	*98,6*	*9268*	**0,0472**	**437**

Primary heating energy before rehabilitation *204* kWh/m2
Primary heating energy after rehabilitation *98* kWh/m2
Efficiency of Natural gas heating system = *0.675 then 0.73*
One Wall between adjacent apartments is not insulated
All living area heated.   1 m3 (natural gas) = 10.56 kWh/m3 (EGO)
Price of gas for households, July 06 : 0.04 TRY/kWh + 18% VAT =
0,0472 TRY/kWh tax incl., that is approx. 0.5 TRY/m3 VAT incl.

EVALUATION of RECOMMENDED EE MEASURES
AVERAGE APARTEMENT 94 m2 ANKARA in a 5 levels Building

Measures to be applied	Cost estimate	Savings	Existing heating system Annual cost in TRY		
			Fuel		Gas
Pay back in years if			3140		**908**
Double-glazing	1755 TRY/flat	12%	4,7		*16,1*
Insulation of walls	2940 TRY/flat	28%	3,3		*11,6*
Insulation of roof	2444 TRY/5flats	21 % top	3,7		*12,8*
Insulation of floor	1598 TRY/5flats	14 %floor	3.6		*12.6*
Thermostatic w. valves	240 TRY/flat	3%	2,5		*8,8*
Interior temperature lower if insulation: 22C > 20C	No cost	14 %			
Total all measures combined	**5743** TRY/flat	50,5 %	3,6		*12,5*
Solar Water Heater for 200 l/day	1200 TRY/flat	2760 kWh/y	3,2		9.1

RESIDENTIAL ENERGY EFFICIENCY: THE COST of EE MEASURES FOR ANKARA PROVINCE

- Investment in Thermal Rehabilitation from 5000 to 6000 TRY per dwelling.
- 20 to 40% of households could have access to financing (proper resources, loan).
- Investment in Thermal rehabilitation in existing residential building could be 1360 millions TRY for the next 5 years.

REHABILITATION OF EXISTING BUILDINGS FOR SAVING ENERGY: BARRIERS, KEY QUESTIONS & RECOMMENDATIONS
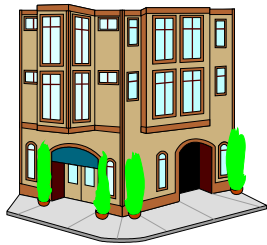
Mains Barriers

- **capacity barrier**: lack of capabilities to evaluate energy efficiency options and to seek out advice;

- **institutional barrier:** lack of initiatives; only 2 pilot projects (Erzurum & Yenimahalle); need for amendment of the joint ownership law;

- **information barrier:** the market does not provide transparent access to information on energy efficiency options available. End-users need to be made aware of the benefits of energy efficiency and need to be motivated to take action;

- **financial barrier**: end-users may not always be able to finance energy efficiency measures from own resources or properly identify available third party sources. Banks are not yet communicating on loans for thermal rehabilitation, which makes saving in current expenditures.

Technical barriers for Solar Water Heater ?

Problem of place on the roof for individual SWH

Solution:
Collective solar water heaters
with back-up boiler + individual meters for billing

What factors could support energy efficiency investments in residential existing buildings?

- Grant for 10-30%: a resource must be built up !
- Reform of energy tariffs (Indexation on intl prices, rebalancing industry & low voltage tariffs, pollution tax, seasonality, kVA Component..)
- Feasibility study: free of charge ? If resource is …
- Professionals mobilised for preparation of…:
- Information, reference specifications & contracts
- Easy access to standard financing conditions
- Energy performance service companies activated
- Others?

Types of Data Sought for Further Analysis for Ankara Province

- **Survey** for a sample of households (income level stratified)
- **Actual** annual household expenditures for energy
- **Estimate** of rehabilitation costs for ref. buildings

- Households survey of **Willingness to Pay & to Borrow** in relation to incomes, costs and expected savings from energy efficiency improvements.

Summing up: Recommendations

- Institutional measures (amendment of EE Law, Joint ownership law, construction law).
- Demonstration project(s) in existing buildings.
- Credit line for energy efficiency measures in existing residential buildings.
- Market survey "Availability and Cost of Energy Efficiency Technologies for thermal rehabilitation".
- Energy consumption survey in dwellings.