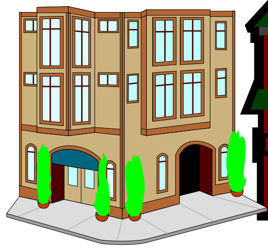
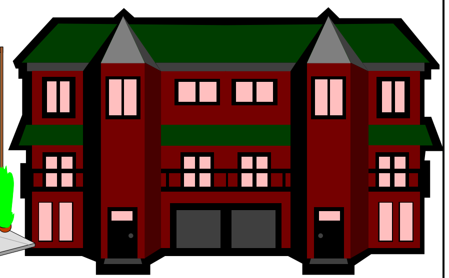
Twinning « Improvement of the Energy Efficiency in Turkey »

Background of Energy Building Codes and Main technical recommendations as a necessary addition to a revised TS 825

By Adel Mourtada

Energy Efficiency Building Expert





Development of Energy Building Code in the world

- **There are activities for development of Energy Building Code in more than 57 countries worldwide.**
- Thermal insulation standards could be considered as the initial form of EBC.
- Prescriptive thermal insulation requirements, “no formal standards”, exist for the construction of buildings in several countries (Eastern Europe…).

Status of Energy Building Codes Worldwide

- **The following tables compiled from data gathered in 2003 and 2005 (Source the Dringer Group) it show actual Enforcement/ Implementation of EBC and Thermal Standards, and Current Market Transformation Activities.**

Status of Energy Codes Worldwide

Region/ Country		Code Developed		Enforcement Policy		Energy Code Implementa-tion Program	Notes of Enforcement or Use of Codes
		Commercial	Residential	Com	Res		
Asia Pacific							
	China	Yes		Mand	Mand		Minimal but growing
	Hong Kong	Proposed					
	Japan	Yes	Yes	Yes	Yes		
	Korea	Yes	Yes	Yes	Yes		
	Taiwan	Yes					
South Asia							
	India	In process				Planned, not funded	
	Sri Lanka	2000				Planned, not funded	Commercial enforcement is possible
	Pakistan	1990		Vol		Yes	Minimal

Region/ Country		Code Developed		Enforcement Policy		Energy Code Implementa-tion Program	Notes of Enforcement or Use of Codes
		Commercial	Residential	Com	Res		
Southeast Asia							
	Indonesia	1989		Vol		None to date	
	Malaysia	1989		Vol		None to date	
	Singapore	1982		Mand		Yes	
	Thailand	1989		Vol		Possible	
	Vietnam	2003		Mand		Planned, not funded	Minimal
	Philippines	1989		Mand			Very Minimal
Oceana							
	Australia	In process					
	Guam	Yes				Yes	
	New Zealand	2001		Mand	Yes		

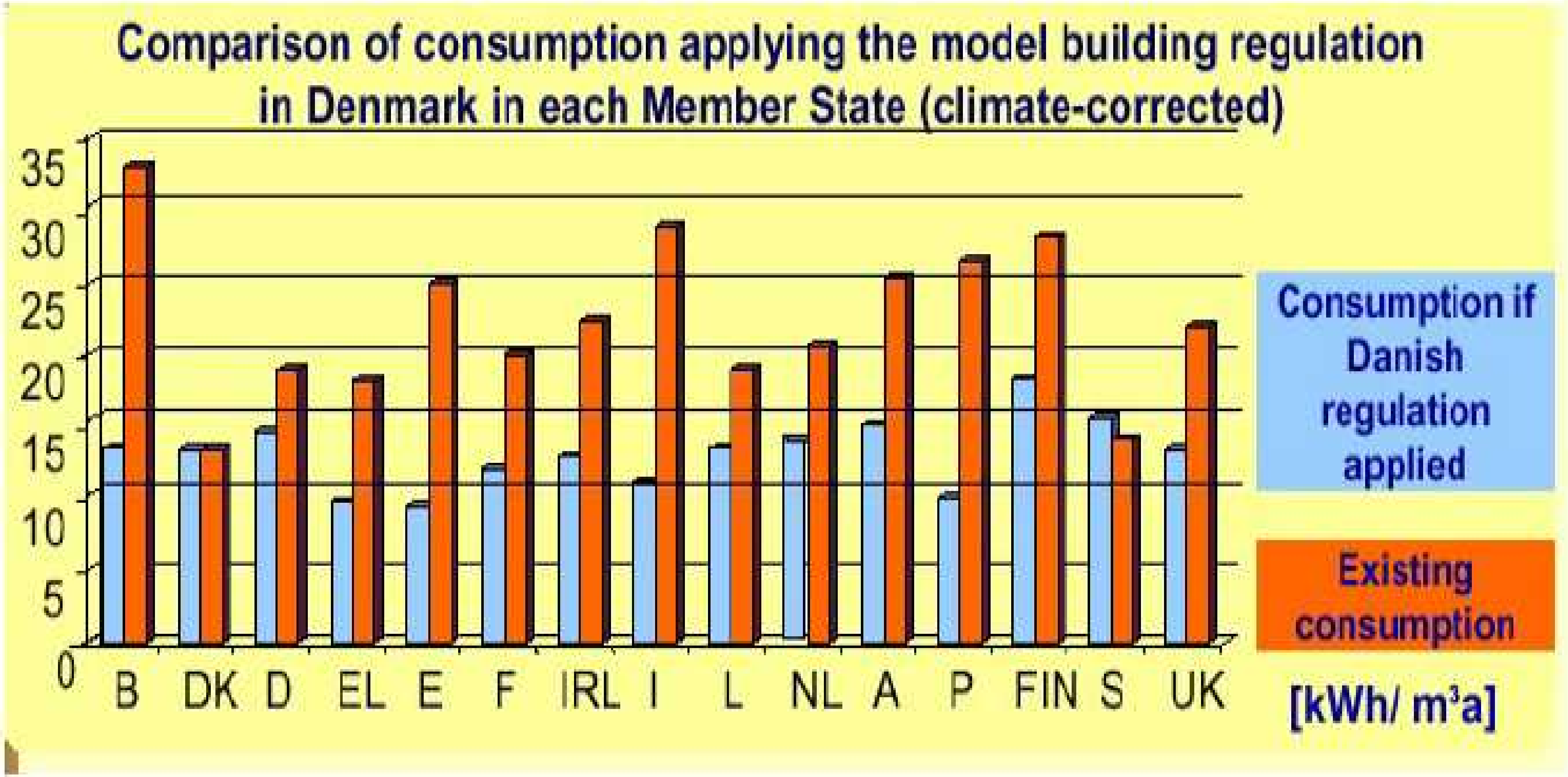
Region/ Country		Code Developed		Enforcement Policy		Energy Code Implementa-tion Program	Notes of Enforcement or Use of Codes
		Commercial	Residential	Com	Res		
North America							
	United States	1975	Similar	Mixed	Yes		
	Canada	1997		Mixed	Yes		
	Mexico	Yes					
Central & South America & Caribbean							
	Chile	Yes		Yes	Yes		
	Colombia	Proposed					
	Jamaica	1994				Yes	Intended to be mandatory for both Com and Res
	Paraguay	Yes					

Region/ Country	Code Developed		Enforcement Policy		Energy Code Implementa-tion Program	Notes of Enforcement or Use of Codes
	Commercial	Residential	Com	Res		
Middle East and North Africa						
Egypt	2005	2003			Planned, not funded	
Israel	2005		Vol			
Kuwait	1983		Yes	Yes		
Saudi Arabia	In process					
Lebanon	2005	2005	Vol	Vol		
Palestine	2005	2005	Vol	Vol		
Jordan	1993	1993	Yes	Yes		
Tunisia	2005	2005	Yes	Yes		
United Arab Emirates		Bld. Thermal Insulation only		Yes		Under the Dubai Municipality (DM

Region/ Country		Code Developed		Enforcement Policy		Energy Code Implementa-tion Program	Notes of Enforcement or Use of Codes
		Commercial	Residential	Com	Res		
Sub-Sahara Africa							
	Ivory Coast	1995					
	South Africa	Yes		Vol			
Eastern Europe							
	Hungary	Yes					
	Romania	Yes					
	Russia	1979		Yes	Yes		Unknown enforcement policy
	Turkey	Yes	Yes	Yes	Yes		Thermal standard
	Yugoslavia	Yes		Yes	Yes		

Region/ Country		Code Developed		Enforcement Policy		Energy Code Implementa-tion Program	Notes of Enforcement or Use of Codes
		Commercial	Residential	Com	Res		
Western Europe							
	Austria	Yes	Yes	Possible	Possible	Possible	
	Belgium	Yes	Yes	Possible	Yes	Yes	
	Denmark	Yes	Yes	Yes	Yes	Yes	
	Finland	Yes	Yes	Yes	Yes	Yes	
	France	Yes	Yes	Yes	Yes	Yes	
	Germany	Yes	Yes	Yes	Yes	Yes	
	Greece	Yes	Yes		Possible	Possible	
	Ireland	Yes	Yes	Possible	Possible	Possible	
	Italy	Yes	Yes	Yes	Yes	Yes	
	Luxembourg	Yes	Yes	Possible	Possible	Possible	
	Netherlands	Yes	Yes	Yes	Yes	Yes	
	Norway	Yes	Yes	Yes	Yes	Yes	
	Portugal	Yes	Yes	Possible	Possible	Possible	
	Spain	Yes	Yes	Yes	Yes	Yes	
	Sweden	1960	1960	Yes	Yes	Yes	
	Switzerland	Yes	Yes	Yes	Yes	Yes	
	United Kingdom	Yes	Yes	Yes	Yes	Yes	

Building energy regulations



Source: European Union

Development of Energy Building Codes and Thermal Standards in the world

- **Western Europe : Austria, France and Germany have the longer history on thermal standard for buildings. Their methods are adopted by the other countries as a reference model (EN 832). France has developed performance criteria of a whole building rather than specifying materials for its parts (RT2000 and RT2005).**

ANSI/ASHRAE/IESNA Standard 90.1

Purpose :

To provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings.

Why is Standard 90.1 important?

- It is the reference standard for the 2001 IECC
- It is also the commercial energy reference in NFPA's family of codes and other EBC.

Mains features

- Contains separate envelope, HVAC, SWH, and lighting provisions.
- Includes envelope tradeoff software (ENVSTD).
- Contains an energy cost budget tradeoff method.

Climate
CDD and HDD

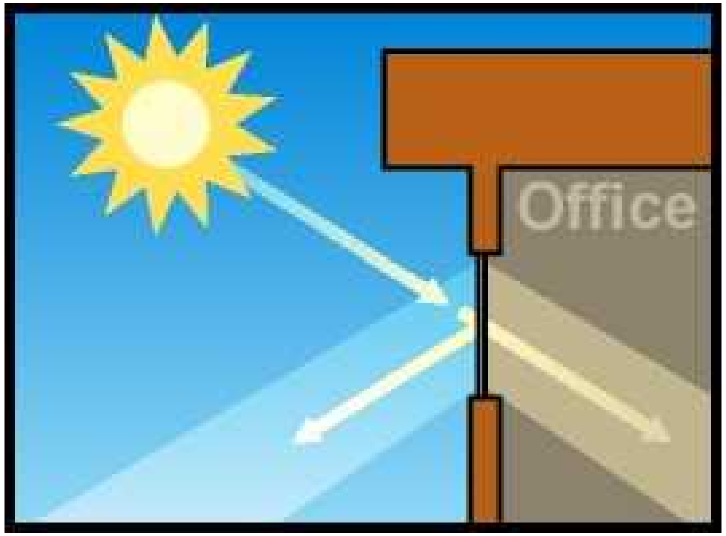
- Bins based on CDD50 and HDD65

- CDD50 = for any one day, when the mean temperature is > 50F (10 °C), there are as many degree-days as degrees F temperature difference between mean temperature and 50F. Annual cooling degree days (CDD) are the sum of the degree-days over a calendar year.

- HDD65 = for any one day, when the temperature is
< 65F (18.3 °C), there are as many degree-days as degrees F temperature difference between mean temperature and 65. Annual heating degree-days (HDD) are the sum of the degree-days over a calendar year.

Solar heat gain coefficient SHGC

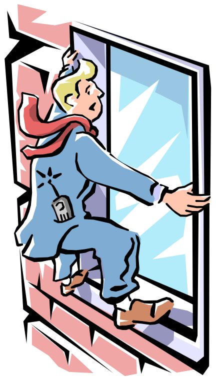
- The glazing’s effectiveness in rejecting solar heat gain
- Part of a system for rating window performance
- Gradually replacing shading coefficient (SC) in product literature and design standards



Mandatory Provisions

Fenestration

(Section 5.2.2)

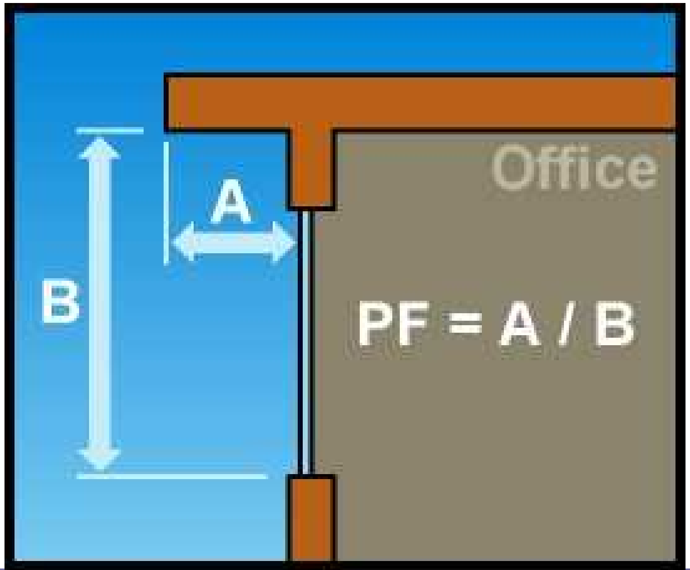


- U-factors
- SHGC

  Solar Heat Gain Coefficient
- "No SHGC requirements for semi-heated spaces or for buildings in climates > 10800 HDD65".
- Visible Light Transmittance
  - When building envelope trade-off option is used.

Overhangs

- Standard credits permanent overhangs by adjustment to SHGC
- Size of overhang is determined by projection factor



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Prescriptive Building Envelope Option *(Section 5.3)*

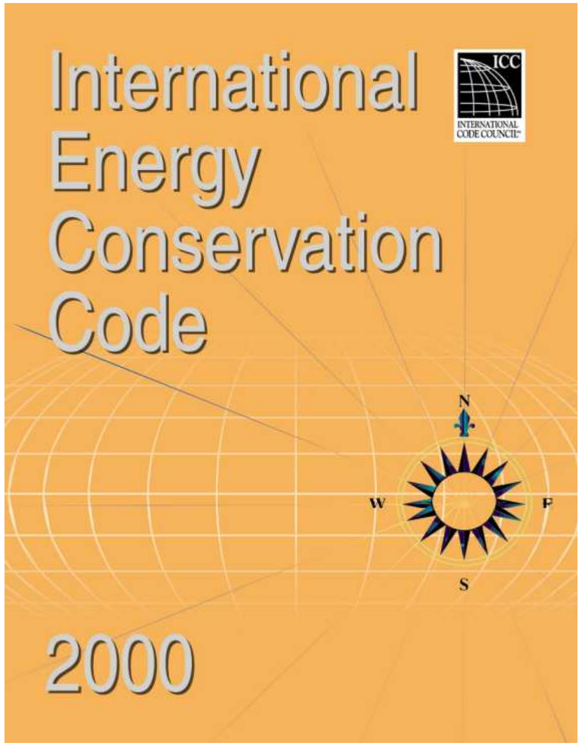
WWR # 50% of gross wall area
Skylight-roof ratio # 5% of roof area
Each envelope component must separately meet requirements

- 26 criteria sets for different climate types
  - Set = single page that summarizes all prescriptive requirements
    - Insulation levels for roofs, walls floors
    - Fenestration criteria

Energy Cost Budget

- Hourly annual energy use simulation to demonstrate that the proposed building uses equal or less energy compared to a "standard" building.
- Usually done through complex software analysis (DOE.2).
- Includes credit for renewable energy.

What is the IECC?



A REQUIRED MINIMUM LEVEL OF ENERGY EFFICIENCY IN NEW CONSTRUCTION

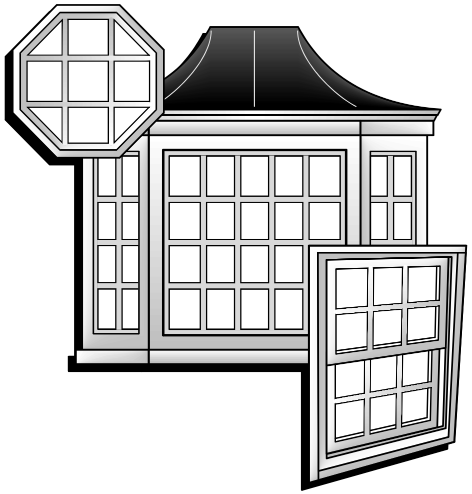
- Enables effective use of energy in new building construction
- Regulates the design and selection of the
  - building envelope
  - mechanical systems
  - electrical systems
  - service water heating systems

Mandatory Requirements

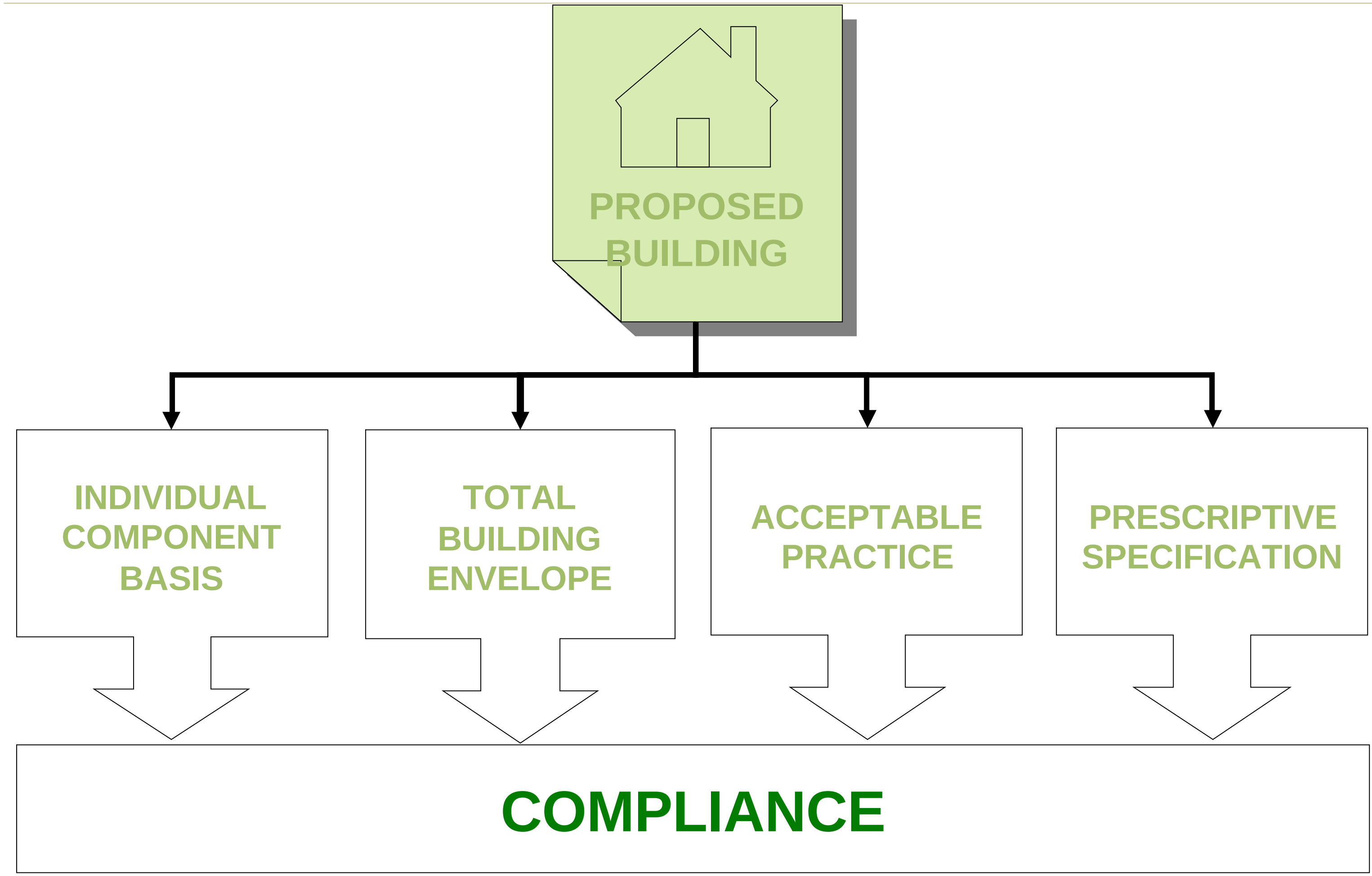
Fenestration Solar Heat Gain Coefficient *(Section 502.1.5)*

- Moisture Control
- Recessed lighting fixtures
- Air leakage
- **Fenestration SHGC**

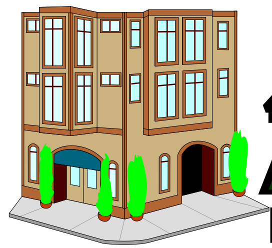
- Locations with heating degrees days (HDD) < 3,500, the combined solar heat gain coefficient (SHGC) must be < 0.4

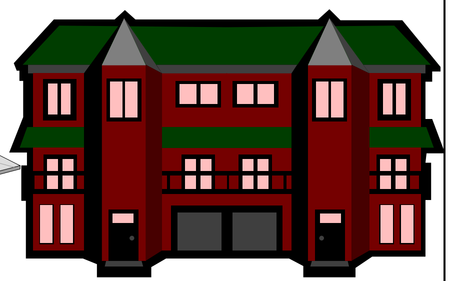


Heating and Cooling Criteria
(Section 502.2)



French Thermal Regulation for Buildings RT2000





Performance Regulation RT2000

- Enables effective use of energy in new building construction
- Regulates the design and selection of the
  - building envelope
  - mechanical systems
  - service water heating systems
  - Thermal Solar Energy

Performance approach

Performance approach is taken to determine the acceptance criteria for RT2000 :

- Performance approach - It sets a maximum allowable energy consumption level without specification of the methods, materials processes to be employed to achieve it, but with a statement of the requirements, criteria and evaluation methods.
- It specifies for each building component and system (heating, air conditioning, Hot water, ventilation) the minimum requirements to satisfy the regulation “garde-fous” (such as minimum insulation levels).

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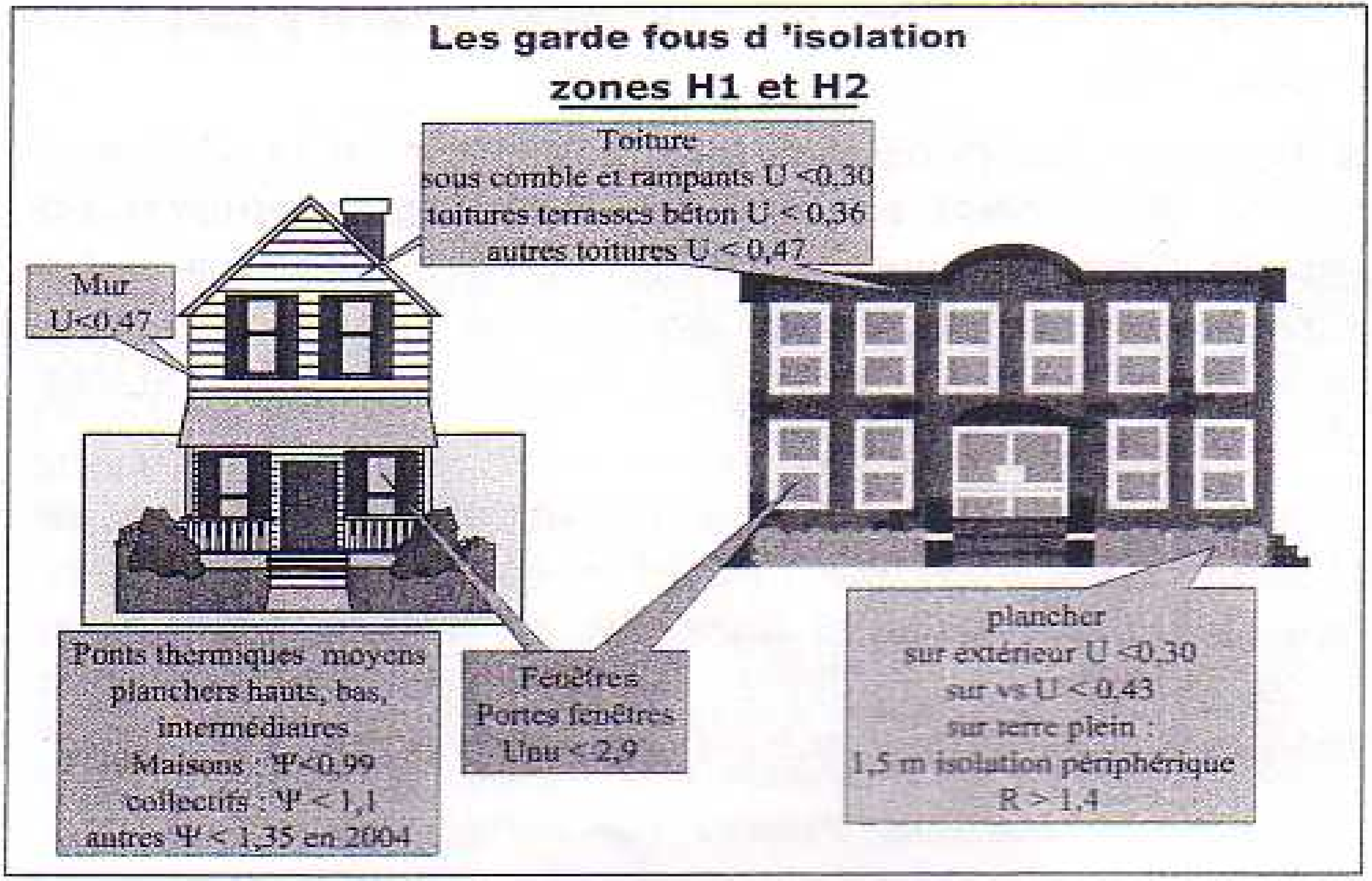
« Garde-fous » of insulation



Performance approach

Energy Consumption $C \leq C_{ref}$

C(kwh) = C(heating)+(Cclim)+C(shw)+C(lighting)+Caux

RT2000 specifications :

- **The methods, materials processes to be employed to achieve calculation of C et Cref « Règles de calcul TH-C » (EN 832)**
- **The minimum required (garde-fous).**

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Summer Confort

Interior Operative Temperature without cooling
Tic≤ Ticref
(average on 3 hours)

RT2000 specifications :

- **The methods, materials processes to be employed to achieve calculation of** Tic≤ Ticref **« Règles de calcul TH-E »**
- **The minimum required (garde-fous)** Ticref ≤26°C

Protection from Solar Heat Gains

- The French thermal regulation (RT2000) assumes that for relatively low **window to wall area ratio** (*Ratio d'ouverture solaire equivalente*) **WWR** ≤ **WWR-req** one can be satisfied without low shading coefficient SC and fixed shading devices like side fins and Overhangs. WWR-req (*Rose Maximal*) varies from 0.25 to 0.35 according to building type and climatic zone.

Protection from Solar Heat Gains

- For other WWR, WWR-eq (equivalent window to wall ratio) is calculated according to Eqn. 1, by multiplying WWR by the shading coefficient, SC (defined as the amount of the solar gain through the glazing to the total solar gain) and by an orientation factor (Fai), which is related to the projection factor of the fixed shading device and to the orientation of the window.

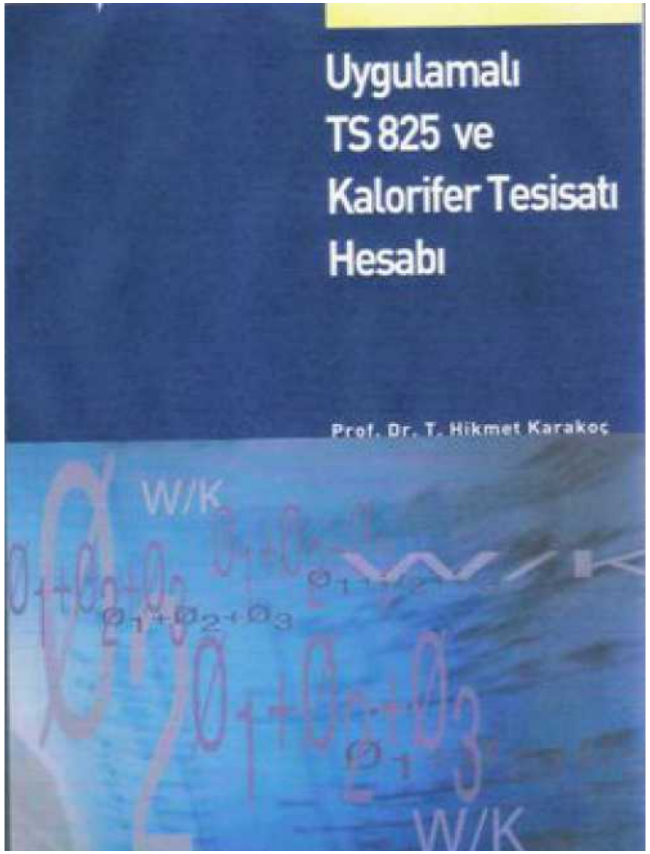
Protection from Solar Heat gains

WWR-eq should be ≤ WWR-req.

WWR-eq = Σ(Awi x SCwi x Fai) / ΣAv + 2 Σ(Awhi x SCwhi) / ΣAh

- **Awi** = Area of the individual window (m2).
- **SCwi** = Shading coefficient of window
- **Fai** = Architectural shading factor.
- **Av, Ah** = Area of all vertical surfaces (opaque walls + windows) and area of horizontal surfaces (roofs + skylights) (m2).
- **Awhi** = Area of the individual skylight (m2).
- **SCwhi** = Shading coefficient of skylight

What is the TS 825?

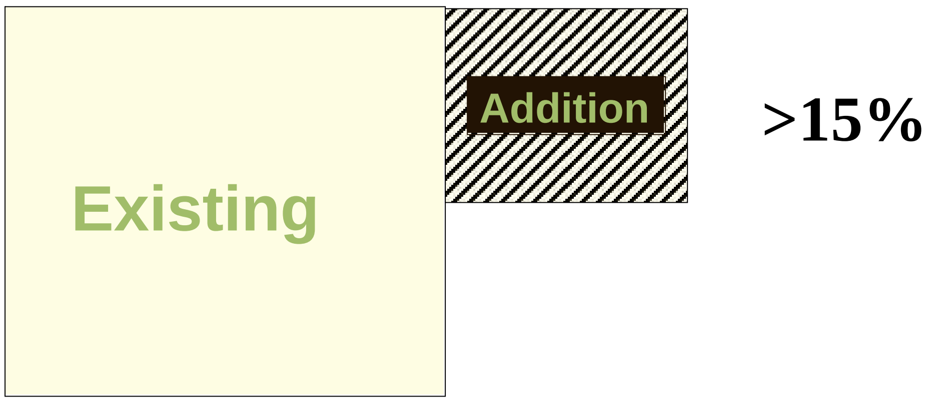


This standard is related with rules of calculation of the heating energy requirements of buildings and the determination of the maximum heating energy allowed

- Regulates the design and selection of the:
  - building envelope (Yes)
  - mechanical systems (No)
  - electrical systems (No)
  - service water heating systems (No)

New Buildings and Additions

- It sets thermal insulation for new buildings and at renovations of existing buildings with 15% ratio or more.



scope

- This standard sets forth the rules for the calculation methods of the heating energy requirements and the determination of highest heating energy permitted.
- Energy needs for other purposes are outside the scope of this standard.
- It divides Turkey into four climatic zones (depending on average temperature and degree-days of heating).
- Its mandatory application started in June 2000.

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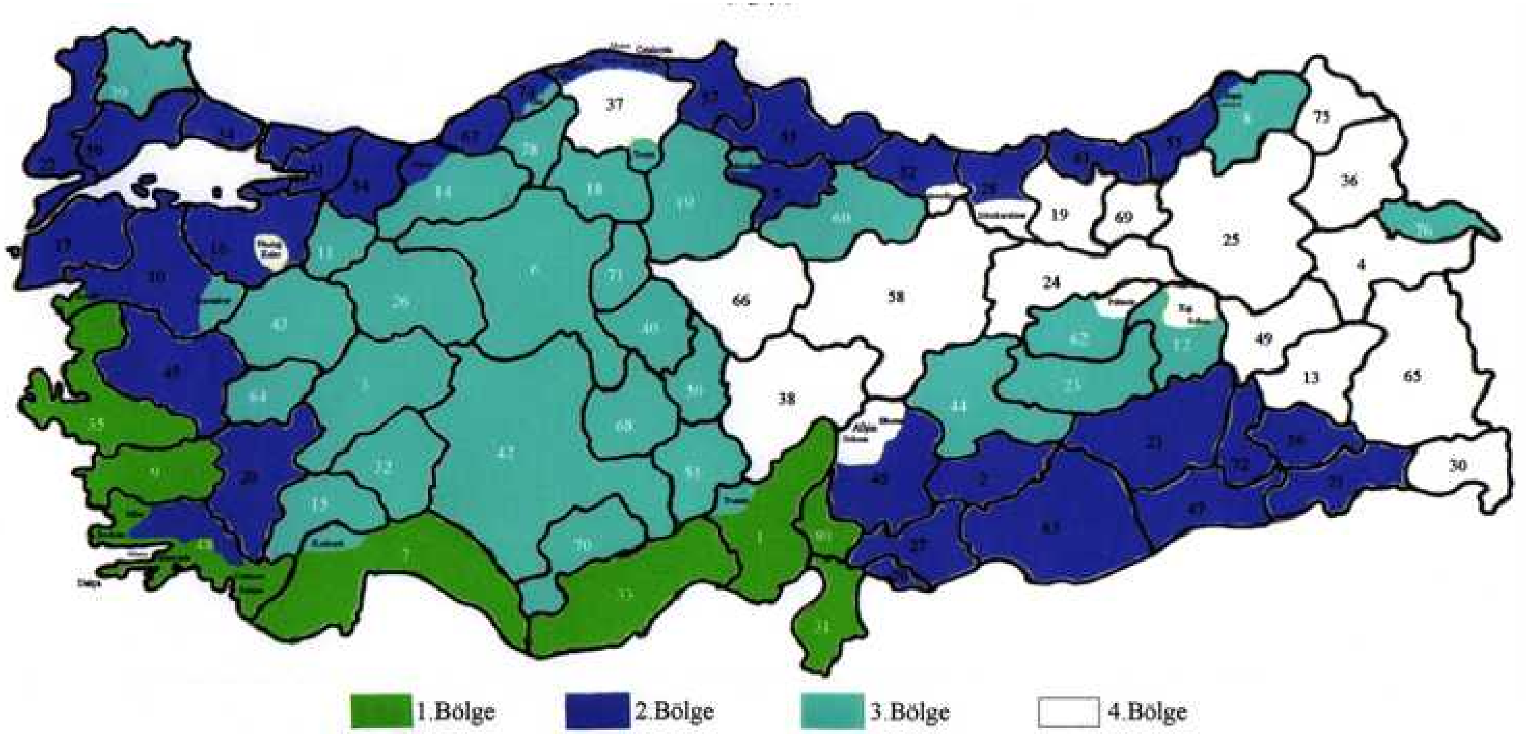
Climatic zones of Turkey



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SINGLE ZONE CALCULATION FOR ANNUAL SPACE HEATING NEEDS

- Total annual heating energy requirement is calculated by adding the monthly heating energy requirements in the heating period.
- The annual heating requirement (Qyıl) is calculated by subtracting the solar (ϕg,ay) and internal gains (ϕi,ay) from the total heat losses H(Ti internal temp – T outside temp.).

$$Q_{y\imath l} = \Sigma Q_{ay}$$

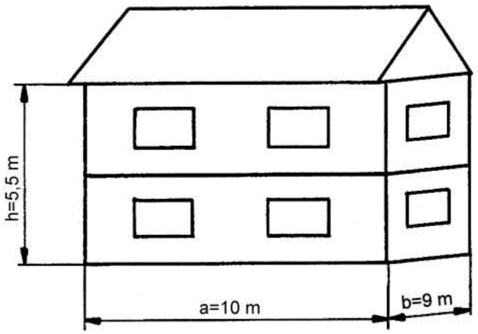
$$Q_{ay} = [H(T_i - T_d) - \eta_{ay} (\phi_{i,ay} + \phi_{g,ay})] \cdot t$$

SINGLE ZONE CALCULATION FOR ANNUAL SPACE HEATING NEEDS

Σ AU = UDAD + Up.Ap + 0,8 UT.AT + 0,5 UtAt + UdAd +....

Özgül ısı kaybı ; H = HT + Hv

İletim ve taşınım yoluyla gerçekleşen ısı kaybı ; HT = Σ AU + l Ul



Havalandırma yoluyla gerçekleşen ısı kaybı

Hv = 0,33 . n_h . Vh

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Maximum annual space heating needs according to(A/V)ratios

	A/V ≤ 0.2	A/V ≥ 1.05	
$Q^{l}_{1.DG}$ =	27 19.2	66 56.2	kWh/m²
	8.5 6.2	21 18.2	kWh/m³
$Q^{l}_{2.DG}$ =	48 38.4	104 97.9	kWh/m²
	14.7 12.3	33 31.3	kWh/m³
$Q^{l}_{3.DG}$ =	64 51.7	121 116.5	kWh/m²
	20.4 16.5	39 37.3	kWh/m³
	104 67.3	175 137.6	kWh/m²
$Q^{l}_{4.DG}$ =	33.4 21.6	56 44.1	kWh/m³

Q: Space heating need of building, DG: Degree days (4Regions) A: floor area of building, V: Volume of building

Draft Revision

Calculation of space heating for regions according to(Atop/Vbut) ratios

A_N related	$Q'_{1.DG}$ =	46,62 44.1	A/V	+	17,38 10.4	[kWh/m²]
$V_{brüt}$ related	$Q'_{1.DG}$ =	14,92 14.1	A/V	+	5,56 3.40	[kWh/m³]
A_N l related	$Q'_{2.DG}$ =	68,59 70.0	A/V	+	32,30 24.4	[kWh/m²]
$V_{brüt}$ related	$Q'_{2.DG}$ =	21,95 22.4	A/V	+	10,34 7.80	[kWh/m³]
A_N related	$Q'_{3.DG}$ =	67,29 76.3	A/V	+	50,16 36.4	[kWh/m²]
$V_{brüt}$ related	$Q'_{3.DG}$ =	21,74 24.4	A/V	+	16,05 11.7	[kWh/m³]
A_N related	$Q'_{4.DG}$ =	82,81	A/V	+	87,70 50.7	[kWh/m²]
$V_{brüt}$i related	$Q'_{4.DG}$ =	26,5	A/V	+	28,06 10.3	[kWh/m³]

Draft Revision

Recommended U values for Regions

	U_D (W/m²K)	U_T (W/m²K)	U_t (W/m²K)	U_P (W/m²K)
1. Region	0.80 0.70	0.50 0.45	0.80 0.70	2.80 2.4
2. Region	0.60	0.40	0.60	2.80 2.4
3. Region	0.50	0.30	0.45	2.80 2.4
4. Region	0.40	0.25	0.40	2.80 2.4

U: heat transfer coefficient

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

Draft Revision

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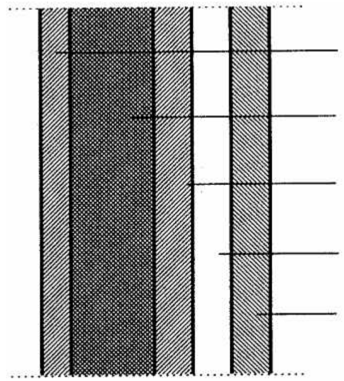
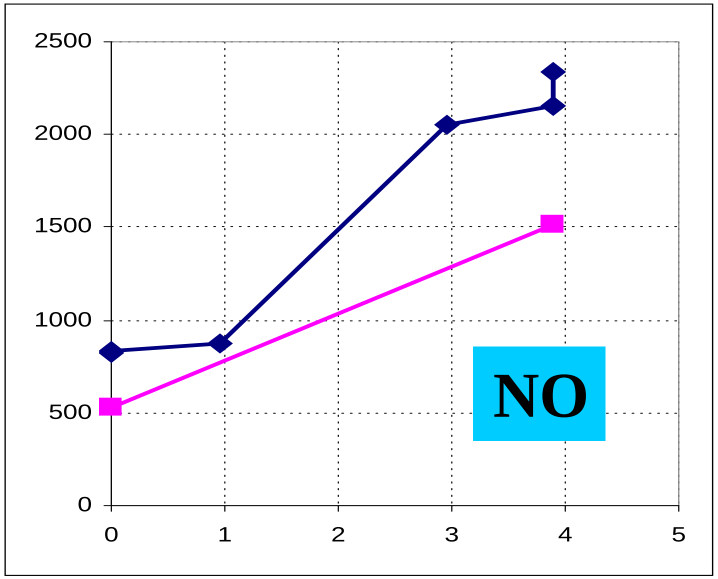
Recommended U values for Regions usually not respected

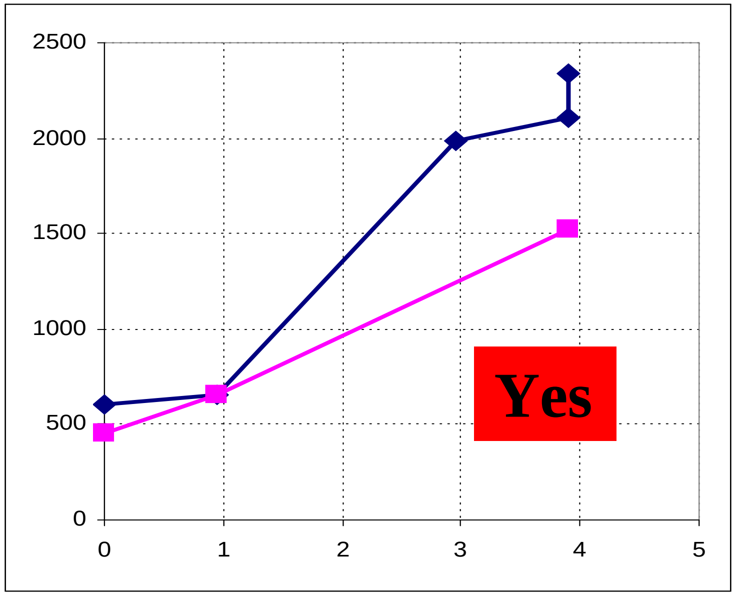
Limiting the Diffusion of Water Vapour Through The Construction and Insulation Materials

The risk of water vapour condensation in the building elements should be checked and permissible limits are specified in the standard



Risk of vapor condensation



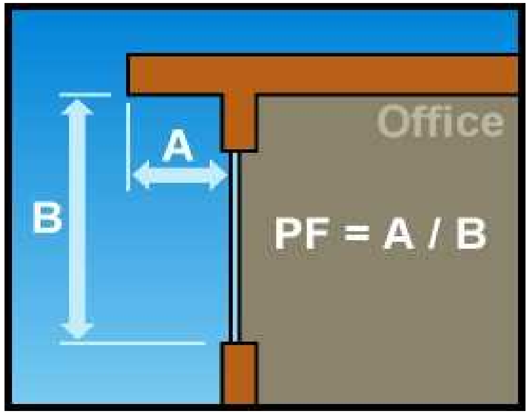


Analysis of the Thermal Standard for Building TS 825

Artificial air conditioning, which absorbs a growing portion of energy in the buildings, in particular in the coastal zone, is not dealt with in an in-depth analysis

Analysis of the Thermal Standard for Building TS 825

The protection of windows against direct solar radiation is an important limiting factor for the thermal inflows to air-conditioned buildings. The standard gives no indication on how these protections should be implemented.



Analysis of the Thermal Standard for Building TS 825

At lest in climatic zones 1 and 2 in Turkey the cooling energy during the summer far exceeds heating energy during winter. A large part of cooling energy is due to solar heat gains through glazing, which are often large (double glazing don't reduce solar heat gains).

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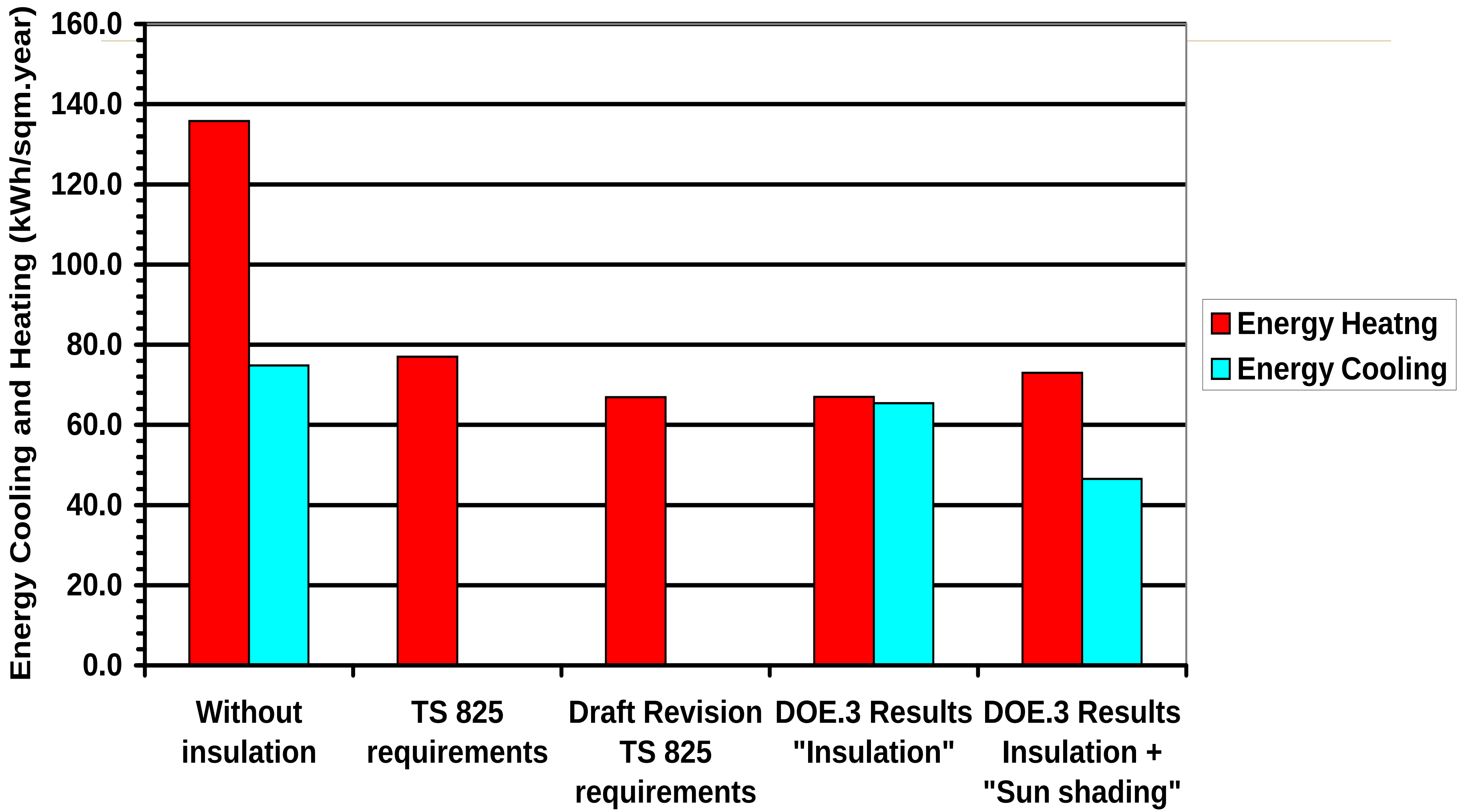
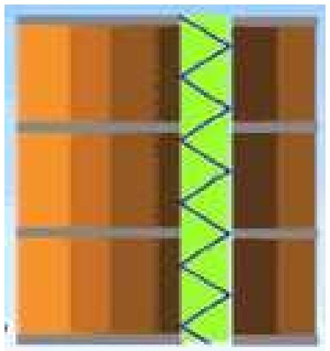
Comparison TS 825 Requirements and DOE.3 Results for a Residential Building in ANKARA



Analysis of the Thermal Standard for Building TS 825

- **The standard gives no indication on how to reduce thermal bridges.**
- **No precisions are given on the position of insulation material in the wall and its impact on the inertia class (to avoid overheating risks in summer)**



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Analysis of the Thermal Standard for Building TS 825

There is no reference to summer conditions, which are very diverse according to the construction location, taking into account the geographic and topographic configurations of Turkey.

Analysis of the Thermal Standard for Building TS 825 : Conclusion

Knowing that the means to mobilize in order to ensure thermal quality are the following:

- insulation of roof, walls and openings,
- relation with sun, position, orientation, dimensions and nature of openings, protection of openings, wall reflexivity,
- level of inertia of the building
- ventilating system and its modalities of use,

The standard only deals with the thermal insulation. Relations with sun radiation are not sufficiently dealt with.

The performances of devices such as lighting, air conditioning or heating equipment, service water heating systems are not dealt with in the standard (the performances of equipment are an important factor in the energy balance of the building).

Analysis of the Thermal Standard for Building TS 825 : Conclusion

It is necessary:

⇒ **to extend in a short term, the thermal standard to the limitation of cooling loads. The French approach (Window to wall ratio “rose maximal”) could be adopted in a revised version of the TS 825,**

⇒ **in the medium term, Energy Efficiency Building Code EEBC should be developed to cover all energy uses in the building (related lighting, heating, ventilation, cooling systems, heating water service and energy management).**

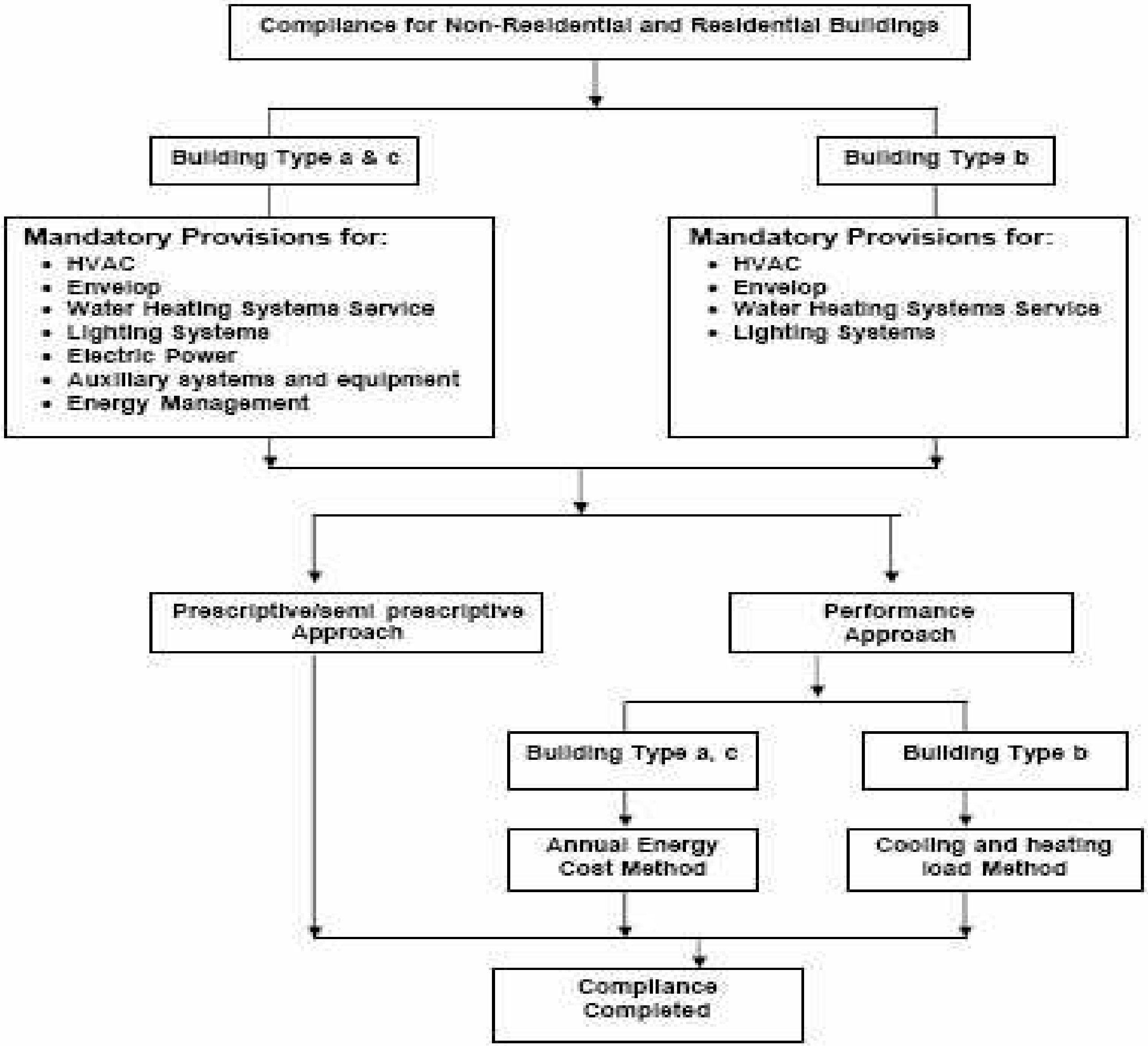
Analysis of the Thermal Standard for Building TS 825 : Conclusion

⇒to propose appropriate outdoor design conditions (winter and summer) for the most important of the 270 meteorological stations in Turkey.

⇒to revise the existing climatic zones in Turkey by taking into considerations the climatic conditions for summer,

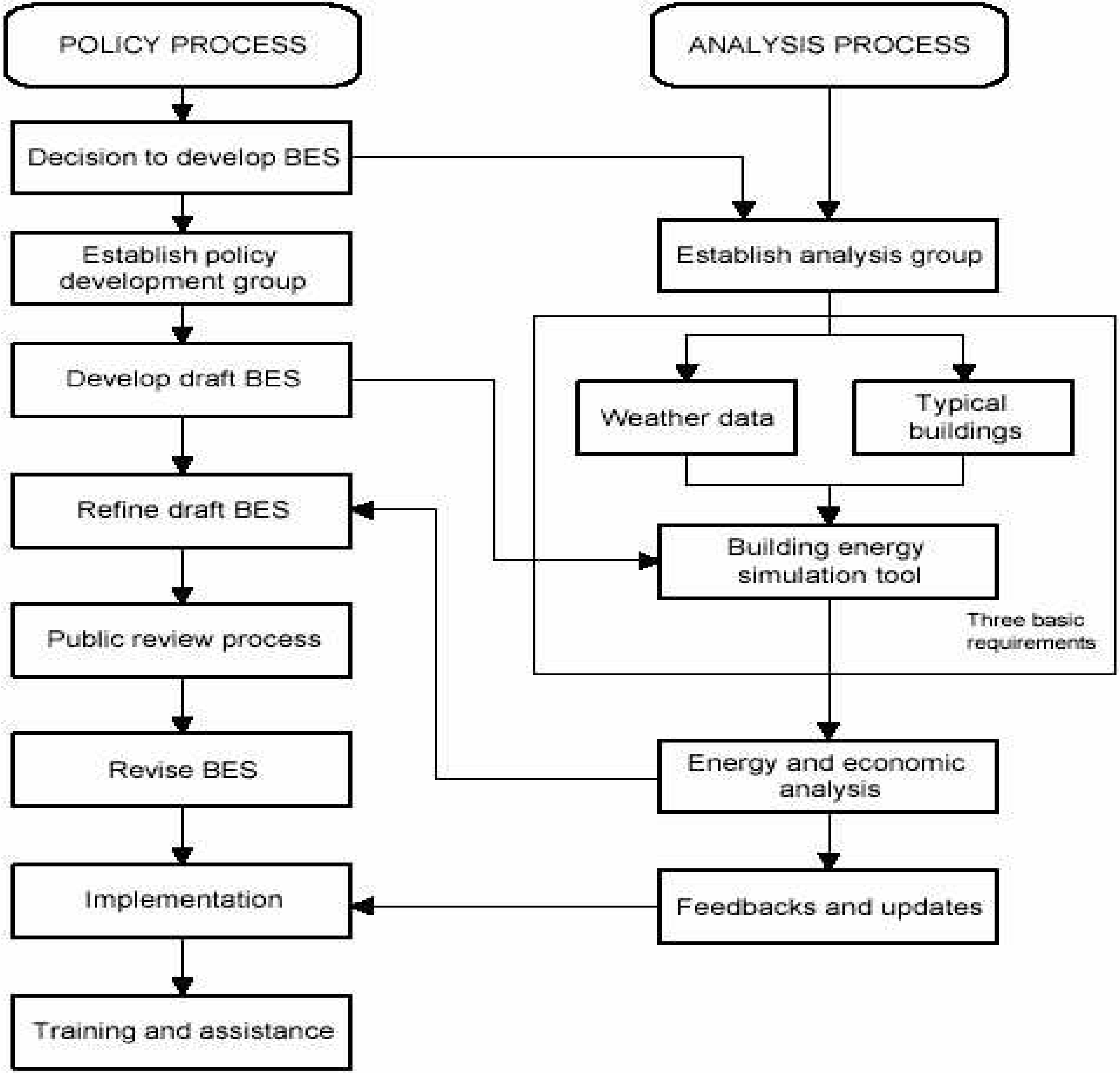
⇒ to develop typical year hourly climate data (weather files) for different climatic zones in Turkey.

FROM THERMAL STANDARD FOR BUILDINGS IN TURKEY TO ENERGY BUILDING CODE



Development Process of Energy Building Codes

EBC



Analysis of the Thermal Standard for Building TS 825 : Conclusion

With this point of view, the improving of envelop design, thermal insulation, fenestration, heating/cooling loads and systems and daylighting must be considered together. The use of simulation tools (such us: DOE.3, EnergyPlus, Blast, CODYBA, ECOTECT, ESP, TRNSYS) to perform these tasks are necessary. For this purpose:

⇒ capacity building training sessions related to the use of simulation tools for the development of the requirements of the future Energy Efficiency Building Code should be organised by EIE in coordination with the twinning project.

Thank you

Questions ?