Internati*onal Symposium "Steel Structures*: *Culture & Sustainability 2010"*
21-23 September 2010, Istanbul, Turkey
Paper No: 61

INTEGRATION OF GREEN BUILDING CERTIFICATION SYSTEMS AND ENERGY PERFORMANCE CERTIFICATES: BREEAM-TURKEY AND BEP-TR

B. KOBAS[1], Prof. Dr. Z. YILMAZ[2]

[1] ITU Faculty of Architecture, Building Science Department
[2] ITU Faculty of Architecture, Building Science Department
Turkish Green Building Association (ÇEDBİK), Scientific Committee

ABSTRACT

There are many tools used to guide one to build and operate an actual green building. Green building certification systems such as LEED, BREEAM; energy performance certificates and computer aided simulation tools such as EnergyPlus, ESP-r, DOE2 or TRNSYS. All three tools cover different parts of guidance to design and operation of a green building: Simulation software helps to evaluate building's energy performance, energy performance certificates use software tools' results to declare a building's energy performance to public, and certification systems expand the investigation further and require more input about the building, but embrace the outputs of simulation software in energy performance related modules of the whole system.

As energy performance certificates became mandatory, European countries had to develop their national calculation methodologies to simulate the building's energy performance. Turkey recently developed a national calculation methodology and its software. Meanwhile, extending the encouragement for green building practices, Turkish Green Building Association is working with BRE to forge BREEAM-Turkey. As explained, seem different as they may, both two studies are connected and should be integrated.

In this article examined are the possibilities of the use of BEP-TR in energy modelling modules of BREEAM-Turkey.
Keywords: BEP-TR, BREEAM, EPBD, EPC, simulation tools.

EPBD IN UK AND BREEAM

The legislation for Energy Performance of Buildings Directive (EPBD) came into force in a phased manner between 6 April 2007 and 4 January 2009 in England (Communities and Local Government, 2010). As of 6 April 2008, it became law to provide an Energy Performance Certificate for all new and newly built homes that are completed after that date and of November 2008, for all commercial buildings, public buildings and existing buildings larger than 1000 m^2 (*Energy Performance Certificates (EPCs) and New Homes: A Builder's Guide*, p. 2. 2007). Regarding this movement, BRE included the EPC's to BREEAM's 2008 update as using CO_2 emissions calculated with NCM (National Calculation Method), SBEM (Simplified Building Energy Model) or DSM (Dynamic Simulation Model) and setting benchmarks for CO_2 emissions to align with the new EPC (BREEAM, 2010).

Current BREEAM schemes cooperate with EPC's in credit Ene 1: Reduction of CO_2 emissions. The nominated project can achieve 15 points off this credit, which is %13.5 of the total, regarding environmental weightings (BREEAM Offices 2008 Assessor Manual, p. 37. 2009). For ratings Excellent and Outstanding, Ene 1 credit has minimum standards of 6 credits for Excellent and 10 credits for Outstanding. It is also possible to earn 2 more Exampler Credits by achieving an emmission rate of 0 or being a True Zero Carbon Building[1].

The number of credits achieved in Ene 1 is determined by comparing the building's CO_2 index[2] (EPC Rating), taken from the Energy Performance Certificate (EPC), with the table of benchmarks given in BREEAM Manual. The building has been modelled using a method compliant with the National Calculation Method (NCM) and an Energy Rating and certificate produced using Approved software by an Accredited Energy Assessor.

BREEAM INTERNATIONAL AND BREEAM COUNTRY SPECIFIC SCHEMES

Between years 2002-2008, BRE developed the BREEAM International scheme to be used in the countries other than UK. BREEAM International is a basic framework preparing groundwork for one off tailored assessments and country specific schemes, in collaboration with regional standard schemes.

Country specific schemes are national green building assessment systems based on BREEAM Bespoke International, shaped with collaboration of BRE and local green building councils. These schemes are based upon comparison against national baseline; they measure the improvement compared to the national building regulations and use national best practice standards or nationally acceptable ones.

To take a peek at one of the BREEAM country specific adapted schemes for an example of practice, Netherlands, being one of the earliest adaptation studies would suit fine. DGBC started to work with BRE in April 2008 and pilot projects commenced in February 2009. In March 2009, DGBC launched the beta version of BREEAM-NL New Buildings (Dutch Green Building Council, 2010). In BREAM-NL, the subject to this paper, aforementioned credit Ene 1: Reduction of CO_2 emissions (Ene 1: CO_2 emissiereductie in Dutch document) uses the outputs of Dutch EPC related standards and simulation software.

EPBD IN TURKEY AND BREEAM-TURKEY

BRE is currently working with 12 countries for country specific adaptations: Belgium, Brazil, Emirates, France, Latvia - Baltic Region, Netherlands, Poland, Russia, Scandinavia, Spain and Turkey (BREEAM, 2010).

A memorandum of understanding was signed by CEDBIK (the Turkish Green Building Association) in September 2009 for the adaptation of BREEAM for Turkey. BREEAM was identified by CEDBIK as the most flexible tool to adapt to the local context and local conditions. Adaptation work started in January 2010, working groups have been formed to conduct an analysis and determine the next steps (BREEAM, 2010).

---

[1] The term is defined in as follows: "Where net carbon dioxide emissions resulting from energy consumed in the operation of the space heating/cooling, hot-water systems, ventilation, internal lighting AND process related energy consumption is zero or better." BRE Environmental & Sustainability Standard, BES 5055: ISSUE 3.0, BREEAM Offices 2008 Assessor Manual, Ene 1 Reduction of CO_2 Emissions, page 96. BRE Global Ltd 2009.

[2] CO_2 Index: The energy performance of a building (for England, Wales and Northern Ireland) is shown on the EPC as a Carbon Dioxide (CO2) based index. It is this index that is used to determine where the building falls on the A+ to G rating scale and the number of BREEAM credits that can be awarded.

Meanwhile, despite not being a European country, Turkey is implementing EPBD requirements since December 2008, which is when The Regulation of Energy Performance of Buildings first came into force. According to the regulation, in one year a national calculation methodology for calculation energy performance of buildings was going to be developed and announced. The calculation methodology BEP-TR (Binalarda E*nerji Performansı Hesaplama Yöntemi*, Calculation Methodology for Energy Performance of Buildings) was, as required by regulation, developed before the end of 2009 and officially presented in December 2009.

According to the official announcement from Turkish Ministry of Public Works and Settlement, who is in charge of the EPBD practices in Turkey, in the following months a software tool (BEP-TR) will be released ready for use of accredited assessors and the obligatory EPC process will begin on July 1st, 2010.

Now the two progresses proceed separately. But it is obvious that the two system should cooperate as aforementioned earlier, like in the best practices around the world. As NCM, SBEM and DSM are used for EPC's and EPC's used in BREEAM, BEP-TR will be used for EPC's and EPC's should be used in BREEAM-Turkey.

INTEGRATION OF BEP-TR AND BREEAM-TURKEY

The credit under consideration, Ene 1: Reduction of CO_2 emissions is Ene 1: Energy Efficiency in BREEAM International[3]. BREEAM International Manual indicates:

1. Where there is a National Calculation Methodology in place in the country of assessment, the number of credits achieved is based on the percentage improvement in the assessed designs' predicted Building Energy Performance Index (BEPI) over the Current Standards Building Energy Performance Index (CSBEPI), as defined for the local Energy Performance Certificate.

2. The building has been modelled using software compliant with the National Calculation Methodology (NCM) and an energy rating and certificate produced by a suitably qualified energy modelling engineer and/or accredited expert.

3. The percentage improvement is used to allocate the number of credits, as illustrated in the table given in the Manual (BREEAM Europe Commercial 2009 Assessor Manual, 2009).

Current Turkish EPC system actually works quite parallel with these specifications:

In Turkish EPC system, on a building's EPC there are two indices to show the building's energy efficiency; overall energy consumption index and CO_2 index. Both two indices are determined with the same method described above; the building's energy consumption and related CO_2 emission is calculated using BEP-TR, Turkish National Calculation Methodology, and then compared to a notional building which fulfills the minimum requirements defined in current regulations. This way, the terms Building Energy Performance Index (BEPI) and the Current Standards Building Energy Performance Index (CSBEPI) are already defined.

The compliant software tool, aforementioned BEP-TR is the only officially approved software in Turkey, which can be used only by accredited EPC assessors.

[3] In UK, energy efficiency of a building is determined by comparing the building's CO_2 emissions to a notional reference building's, which meets the minimum requirements defined in regulations. Regarding that different countries may use indicators other than CO_2 emissions, title of the credit is changed to Ene 1: Energy Efficiency.

As for the percentage improvement table that is used to allocate the number of credits, BREEAM International already offers a table, but some changes in this table may be brought into question both in data and in format. For example, the format of the table in original BREEAM Manuals is shaped according to CO_2 emission index format in EPC's in United Kingdom and different than the format in BREEAM International. Original manuals for UK uses a range from 0 to 63 for new buildings, and 0 to 100 for refurbishments, as BREEAM International uses percentage improvement with a range from %1 to %100 for new buildings and %1 to -%50 for refurbishments. Turkish EPC system uses percentage improvement factor to determine the energy class of the building assessed. Thus, the format given in BREEAM International Manuals seems accordingly.

Focusing on the other note, the data in table (the credits for percentages of improvement) should be re-organised regarding the current facts of Turkey at the time or in future. After the new building regulation came in force in December 2009 and with the information of upcoming EPC's after July 2010, the economic structure of building and energy sector evolves rapidly. In a very close future, amendments in buildings, energy improvements may be easily made thanks to the bank loans and government incentives, so maybe the percentage given in BREEAM Turkey might be even stricter than in BREEAM International, so a green building assessment system can drive the building owners to build much better than standard.

QUALIFICATIONS AND VALIDATION OF BEP-TR

Calculation Methods in United Kingdom

United Kingdom developed three calculation methods with different levels of advancement:

a. SAP (The Government's Standard Assessment Procedure for Energy Rating of Dwellings)
A simplified calculation method for small residential buildings;

b. SBEM (Simplified Building Energy Model)
SBEM calculates monthly energy use and carbon dioxide emissions of a building given a description of the building geometry, construction, use and HVAC and lighting equipment (Building Research Establishment, 2010). It is a quasi-steady state calculation method, used for low-level complexity non residential buildings;

c. DSM (Dynamic Simulation Model)
A Dynamic Simulation Model is a software tool that models energy inputs and outputs for different types of building over time. In certain situations, SBEM, will not be sophisticated enough to provide an accurate assessment of a building's energy efficiency. In these cases Government-approved proprietary dynamic simulation models may be used (Communities and Local Government, 2010).

As simulation tools differ, energy assessors also vary in United Kingdom due to complexity levels of buildings:
- Level 3 can undertake energy assessments of existing non residential buildings using the SBEM method
- Level 4 can undertake energy assessments of new and existing non residential buildings using the SBEM method
- Level 5 can undertake energy assessments of new and existing non residential buildings using the DSM method.

BEP-TR

Turkish National Calculation Methodology is used to assess the energy performance of residential buildings, office buildings, health care buildings, education buildings, hotels, shopping centers. Methodology is applicable for both new and existing buildings.

BEP-TR calculates;

a. Net energy demand for heating and cooling of a building;
b. Total energy consumption of a building considering the losses and system efficiencies of the installed systems;
c. Energy consumption for ventilation;
d. Energy consumption for lighting regarding the daylight effect;
e. Energy consumption for sanitary hot water.

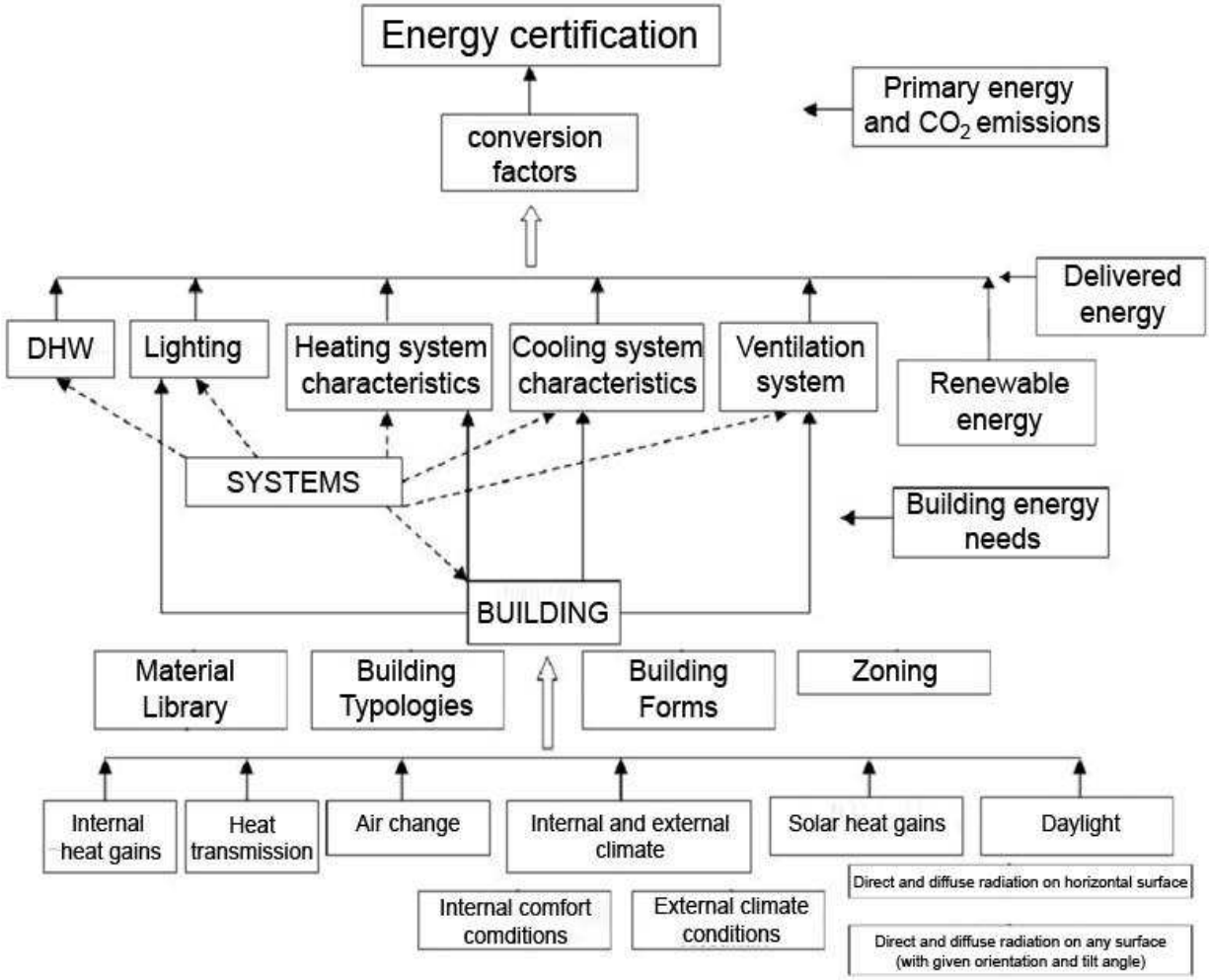

Figure 1. Data flow and calculation steps of BEP-TR

BEP-TR is based on simple hourly method, which is a semi-dynamic calculation method. Using hourly meteorological data and hourly schedules for occupancy, lighting power, it can demonstrate building's hourly thermal behaviour in a realistic way using RC (resistance-capacity) model. Comparing to monthly/seasonal static method, simple hourly method gives much more coherent results, especially in transition periods in which meteorological data show serious changes in time intervals much smaller than a whole month or season.

The calculation method is applicable to every geometry, but due to the limitations of a web-based software, which BEP-TR is, there are 7 key forms to define the building geometry and user should select one of them.

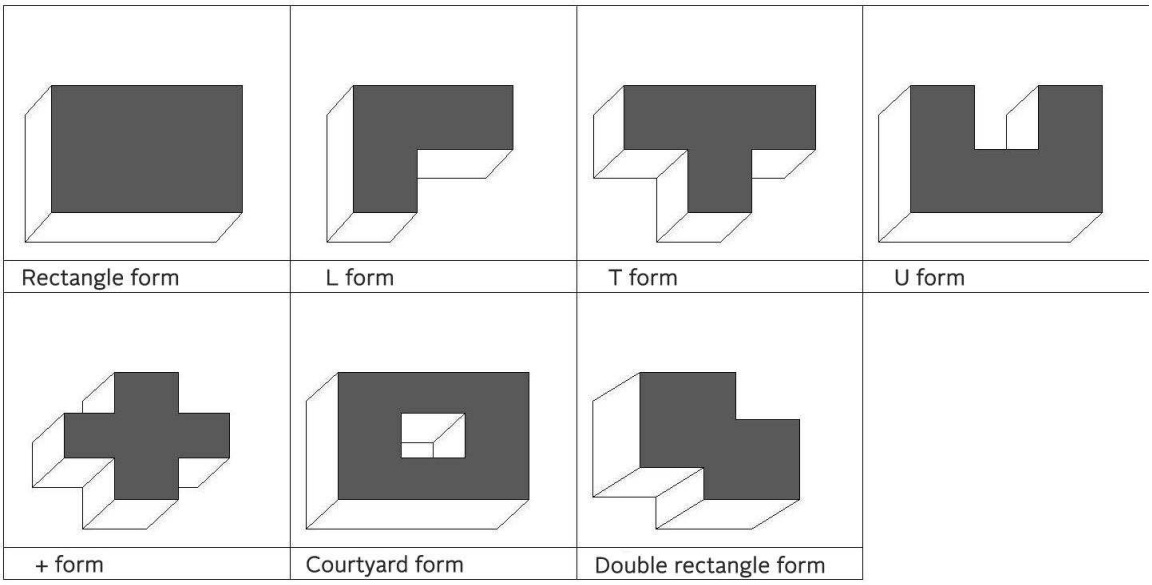

Figure 2. Key forms in BEP-TR

BEP-TR can calculate multi zones, but for multi-zone calculation without thermal coupling which is used in this method, heat transfer by convection, conduction, ventilation or infiltration between zones is not taken into account. Calculation is made separately for each zone and zones are considered as uncoupled zones. There are reduction factors used between conditioned and unconditioned zones. Energy demand for heating and cooling is the sum of calculated energy demand of each independent zone.

Zoning criteria depends on the building typology. But in all typologies each floor is taken as a different zone, due to the changes in shading factors, solar incident angles, even though the setpoint temperatures, internal heat gains and mechanical systems are the same.

For different building typologies, zoning criteria is as follows:

a. In detached residential buildings, the conditioned spaces in each floor are taken as a single zone.
b. In apartment-blocks, each separate unit is a different zone.
c. In office buildings, there is an artificial outer zone that is affected from solar gains from windows and an inner zone; independent of physical walls or partitions. Therefore solar gains from windows and infiltration effects are omitted in inner zone.
d. For hotels, education buildings, healthcare buildings and shopping centers, each floor is taken as a single zone. Setpoint temperatures and internal gains are calculated on an average.

CONCLUSION

Building energy simulation tools may be used for various purposes. For buildings in design phase, they can be used to estimate how much energy the building will consume in future and how much CO_2 it will emit, or for existing buildings, to simulate and select the possible scenarios for refurbishment.

Improving a building's energy performance by estimating the building's energy consumption and simulating different improvement scenarios is an indispensable step of design phase now. But the important point here is, defining the intention, choosing the tool and using it all correctly. Choosing the wrong tool or misuse of them would bring nothing but waste of resources.

Unlike advanced simulation tools such as EnergyPlus, ESP-r, TRNSYS or DOE2; BEP-TR is a software tool developed mainly for EPBD purposes and not a dynamic model to fully evaluate a

building's energy consumption. For small scale and/or less complex buildings, results of the simulation may be satisfactory enough but regarding the simplifications in geometry defining, zoning and calculation principles, it is obvious that BEP-TR won't be a very efficient tool for sophisticated buildings. Therefore, like in UK, for large, multi-zoned, high-tech, complex buildings, where BEP-TR will be insufficient, use of dynamic energy simulation tools instead is highly recommended.

Green building certification systems not only should cooperate with existing systems and tools but also encourage people to use them in the most proper way. In this paper, how and under which conditions BREEAM-Turkey can cooperate with BEP-TR is examined. For conditions over BEP-TR's range, more advanced tools should be required.

REFERENCES

BRE Environmental & Sustainability Standard BES 5055: ISSUE 3.0, BREEAM Offices 2008 Assessor Manual (2009). BRE (Building Research Establishment) Global Ltd., Garston, Watford, Hertfordshire, UK. p. 37.

BRE Environmental & Sustainability Standard SD 5066A: ISSUE 1.1, BREEAM Europe Commercial 2009 Assessor Manual (2009). BRE (Building Research Establishment) Global Ltd., Garston, Watford, Hertfordshire, UK. p. 101.

BRE Environmental & Sustainability Standard SD 5066A: ISSUE 1.1, BREEAM Europe Commercial 2009 Assessor Manual (2009). BRE (Building Research Establishment) Global Ltd., Garston, Watford, Hertfordshire, UK. p. 102.

BRE Environmental & Sustainability Standard SD 5066A: ISSUE 1.1, BREEAM Europe Commercial 2009 Assessor Manual (2009). BRE (Building Research Establishment) Global Ltd., Garston, Watford, Hertfordshire, UK. p. 106.

Energy Performance Certificates (EPCs) and New Homes: A Builder's Guide (2007). The Department for Communities and Local Government. p. 2.

BREEAM 2008 Update. Retrieved March 2010, from official website of Building Research Establisment Environmental Assessment Method (BREEAM). http://www.breeam.org/page.jsp?id=104.

Country Specific Schemes. Retrieved March 2010, from official website of Building Research Establisment Environmental Assessment Method (BREEAM). http://www.breeam.org/page.jsp?id=197.

Country Specific Schemes, Turkey. Retrieved March 2010, from official website of Building Research Establisment Environmental Assessment Method (BREEAM). http://www.breeam.org/page.jsp?id=245.

DGBC English Introduction. Retrieved March 2010, from official website of Dutch Green Building Council (DGBC). http://www.dgbc.nl/wat_is_dgbc/dgbc_english.

Energy Performance of Buildings, Energy Assessment, Assessment methodology and software. Retrieved March 2010, from official website of The Department for Communities and Local Government (CLG).

www.communities.gov.uk/planningandbuilding/theenvironment/energyperformance/energyassessment/methodologysoftware.

Frequently asked questions on the energy performance of buildings. Retrieved March 2010, from official website of The Department for Communities and Local Government (CLG). http://www.communities.gov.uk/planningandbuilding/theenvironment/energyperformance/energyperformancefaqs/generalfaqs.

National Calculation Method. Retrieved March 2010, from official website of BRE (Building Research Establishment). http://www.ncm.bre.co.uk.