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A transdisciplinary approach on the energy efficient retrofitting of a historic building in the Aegean Region of Turkey

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ABSTRACT

Buildings account for 40% of total energy consumption in the European Union, yet at the same time they have considerable energy saving potentials. Historic buildings should be treated different from contemporary ones when it comes to energy improvements. The specifications which underline historical, sociocultural and architectural values require certain care during realization of energy saving implementations to sustain these values. The purpose of this study is to demonstrate how the energy efficient retrofitting in historic buildings should be managed in a transdisciplinary approach with a case study conducted on the historic building in İzmir—Turkey. A detailed building energy simulation tool was used to determine the impacts of energy efficient retrofits. The actual energy consumption of case building was based on the utility bills regarding electricity and heating fuel consumption. Building energy simulation tool was calibrated by comparing the measured and simulated indoor air temperatures and total energy consumptions. The inappropriate retrofits, which contradict to the cultural heritage values, were eliminated with a transdisciplinary approach. Later appropriate retrofits were gathered into three packages to evaluate their effects on the energy consumption. The results show that energy saving of more than 34% can be obtained without damaging the heritage values.

Nomenclature

MBE	mean bias error (%)
RMSE	root-mean-squared-error (%)
CV(RMSE)	coefficient of variance of the root-mean-squared-error (%)
t_i	simulated value
o_i	measured value
n	number of observations
A_{period}	average of the measured values

1. Introduction

The total primary energy consumption in the world has risen with developing technology and increasing population. From 1992 to 2012, it sharply rose by 52% [1]. Finding alternative strategies have become an essential issue to overcome this increasing energy demand. Generally European countries have been seeking and investing on alternative energy sources such as wind, solar and bio fuels to substitute the share of fossil-fuel-driven energy sector while promoting on the efficient use of energy [2].

Turkey officially began paying more attention to energy efficiency in buildings with the standard on "TS825—Thermal Insulation Requirements for Buildings" in 2000 [3]. The Directive on Building Energy Performance (BEP-TR) accelerated the energy certification procedure which obligates that the walls, floors, windows and roofs of the buildings built after 2000 must have lower overall heat transfer coefficient [4]. Considering that 67% of Turkish population live in the buildings built before 2000 and the buildings account for 35% of primary energy consumption of

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Turkey, one can assert that buildings have considerable energy saving potential [5,6].

The BEP-TR refers to existing and new buildings. However, almost no specific attention on energy efficient retrofitting of historic buildings has been paid. The authority, who is responsible for the preservation of cultural and architectural heritage in Izmir, is the 'Number 1—İzmir Regional Board for the Conservation of Cultural and Natural Assets' connected to the 'Ministry of Culture and Tourism, Conservation Council of Immobile Cultural and Natural Assets'. The Board prioritizes the preservation of original characteristics of the heritage buildings and stipulates the minimum intervention in case they will be re-used or given a new function. In terms of historical, architectural, structural and material properties, high variety of historic buildings in the country makes difficult to constitute regulations for their energy performance to meet contemporary comfort conditions. Therefore, Clause 2/ç of BEP-TR simply says that energy efficient retrofits and interventions in buildings having heritage value ought to be done in cooperation with authorized official authorities and without affecting the historical heritage value of the buildings, reflecting the Energy Performance of Buildings Directive (EPBD) [2]. Nevertheless, this is a general statement and does not provide any further instructions regarding the way historic buildings should be treated. Therefore, energy efficiency applications in historic buildings require special attention since the number of studies in Turkey is relatively insufficient [7].

The building stock in any country has a range from the monumental to contemporary buildings. A key step is to give a definition of historic buildings in order to identify those buildings that should be treated separately and with awareness. At this point, giving an answer to the question "What is the heritage value?" can clarify and enlighten the possible misunderstandings behind it. Historic buildings have a significance regarding the tangible and intangible heritage such as prominent architectural and aesthetic values, connections with historic communities and events, evidences of technical progression, characteristics of social history and associations with other building heritage values [8]. Basically, any tangible and intangible element giving identity and character to the building can be counted as a heritage value, which is primarily categorized as evidential, historical, aesthetic and communal value [8].

The general aim of this study is to investigate energy efficient retrofitting (EER) interventions in historic case study building while taking into account of heritage values. The building that was chosen as case study is *Basmane Neighborhood Centre* (*Basmane Semt Merkezi*), which is located at Basmane district in İzmir, Turkey. The building was built by Tabak Family in İzmir by the end of the 19th century. Later it was donated to the Prime Ministry General Directorate of Social Services and Child Protection to serve as a dormitory for the orphans. Konak Municipality financially undertook a restoration project which was prepared and supervised by Architectural Restoration Department of İzmir Institute of Technology, İzmir–Turkey. The restoration work was completed in 2007. Currently, *Basmane Semt Merkezi* is used to educate illiterate women and deliver training courses of handcrafts, embroidery, marbling etc.

This study primarily contributes to the current literature by showing how the energy retrofits in historical buildings should be managed using a validated and calibrated building energy simulation tool integrated with a systematic and transdisciplinary strategy. Furthermore, the proposed method will be applied in a case study and interpreted from the perspective of energy saving, impact on heritage value and overall heat transfer coefficient requirement of "TS825—Thermal Insulation Requirements for Buildings" standard. This study will be the first in Turkey which considers energy efficient retrofitting in historical buildings via a transdisciplinary approach.

2. The case building: Basmane neighborhood centre (Basmane Semt Merkezi)

The building of *Basmane Semt Merkezi* is placed in the Basmane district of İzmir which was the commercial center of İzmir when the Levantine population highly existed between the beginning of the 17th up to the end of 19th century [9]. Therefore, the area reflects representative examples of the 19th century residential architecture in İzmir [10]. Fig. 1(a) illustrates the position of *İzmir* and Fig. 1(b) shows the approximate location of *Basmane Semt Merkezi* [11].

Basmane District was an important commercial area located close by the train station in the 19th century. After that a majority of the hotels around the seaside of İzmir were totally demolished by the 1922 fire, the Hotels Street in Basmane gained significance as a group of hotels reflecting the characteristics of an important period [12].

In the early 19th century, the buildings on the street were designed as residences of merchant class and noble families but used as hotels and accommodation facilities for middle and low income people in the last few decades. Due to the insufficient maintenance and inappropriate interventions over time, the street lost its architectural importance while facing security and social problems. For this reason İzmir-Konak Municipality took a series of decisions and conducted restoration projects to vitalize Hotels Street and emphasize its importance and heritage value [12]. Following the approval of the restoration project by the 'Number 1—İzmir Regional Board for the Conservation of Cultural and

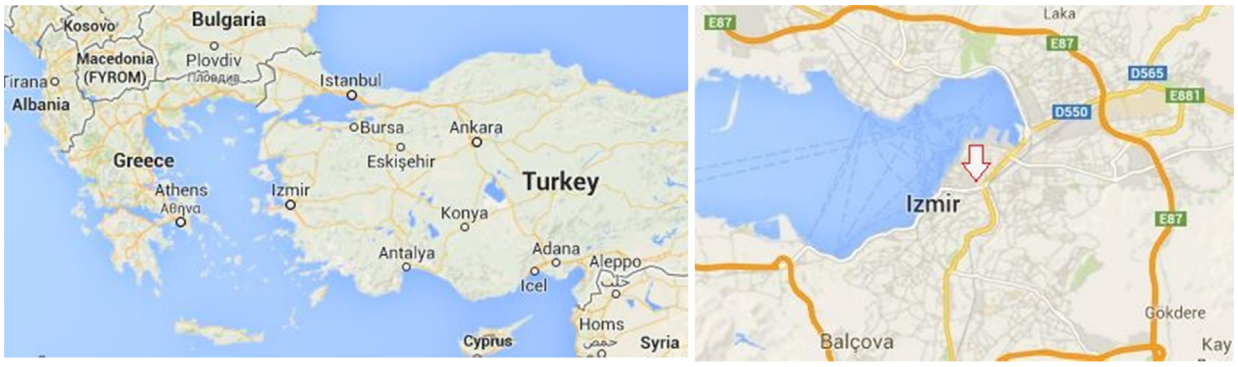

Fig. 1. Location of (a) İzmir and (b) the location of *Basmane Semt Merkezi*.