

Original

Open Access

Investigation of the challenges of establishing mandatory standards of building energy consumption criteria Labeling in Iran

Majid Zarezadeh*

Standard administration of Hormozgan, Bandar Abbas, Iran

Abstract

The importance of mandatory installation of energy consumption standard labels in office and residential buildings is clear. Based on this, the Iranian National Standard Organization has provided INSO 14254 and 14253 standards. During the past years, these standards have not been given proper attention, and their establishment has faced problems. Applying the experience of other countries in this field and using their successful policies have been investigated in this research. The results of the studies have shown that by providing financial incentive and punishment systems, the requirement of government organizations to establish the building energy consumption standard management system, as well as the use of modeling systems and finally the establishment of the 5001 energy management system, to a very appropriate extent in establishing the requirements The energy consumption criterion of the building was successful. The establishment of incentive and punishment procedures, the use of renewable energy generating systems, the use of energy quality management systems, and determining the priority of government buildings for the implementation of the standard energy consumption label have been useful and constructive actions of other countries. Based on international experiences, the establishment of mandatory INSO 14254 and 14253 standards along with the establishment of the ISO 5001 energy quality management system can solve the challenges of energy imbalance. The requirement to implement the building consumption standard label based on INSO 14254 and 14253 standards is the basis for approaching the vision of green buildings, zero-energy buildings, and Nearly zero-energy buildings.

Keywords Building energy consumption criteria, energy imbalance, mandatory standards, Topic 19 of the National Building Regulations

Introduction

Energy-related products display labels that enable customers to make informed choices about more energy-efficient and sustainable products, taking into account technological progress. The regulation provides for a new, updated, and clearer scale, from A (most efficient) to G

(least efficient), to be taken up by upcoming delegated regulations. Energy labels provide the end users with the necessary data to make an informed choice and to select more energy-efficient products. In addition, they encourage manufacturers to improve their product's energy performance while keeping the costs as low as possible. A



© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

* Correspondence:
majid_zarezadeh_nu@yahoo.com

well-designed energy labeling program may create positive competition between manufacturers and lead to a reduction in electricity and fuel consumption. As a result, capital investment in energy substructures is reduced and the national economy will be enhanced, in addition to environmental advantages [1]. Energy is the largest polluting sector globally, responsible for two-thirds of greenhouse gas (GHG) emissions. With renewable energy costs falling rapidly, and the growing danger of stranded assets, a clean energy transition is underway. The regulation sets out the basis for the adoption of acts on the energy labeling of energy-related products, providing standard information about energy efficiency – along with the consumption of energy and other resources – to help consumers in their purchasing decisions. It does not cover second-hand products. The Energy Labelling Directive first formalizes eco-design requirements for energy-using appliances and the second defines minimum energy performance requirements and sets the rules for their related energy labels [2]. Due to the high rate of increment, buildings' energy consumption in Iran had increased up to 730.7 TWh. Evaluating the average energy consumption indexes of the buildings indicates that remarkable energy conservation potentials are achievable throughout the country. For instance, the approximate yearly primary energy consumption in residential buildings in Iran is about 450 kWh/m², which is more than twice the indexes in many other countries [3]. The remarkable energy consumption indexes necessitate energy management implementation for controlling the growth and reducing the existing quantities to acceptable values. Many developed and developing countries, such as Germany, England, Spain, etc., have done so by establishing standards for energy consumption in residential, office, and commercial buildings, regarding the importance of productivity and improving the intensity of energy consumption. During the past decades, several valid standards such as DIN EN 832, DIN 4108, DIN 4701, DIN 4710, DIN-v18599 and ASHRAE 90.1, IECC, and BEPS have been developed as the energy consumption standards for buildings. The establishment and application of these standards ultimately led to "Energy Star" and "Energyguide" labels which have been developed and applied to assess the energy performance status of buildings [3]. Energy efficiency measures must be used to reduce demand, and the use of RESs to supply the remaining demand is also notable. As the Directive currently proposes, member states are allowed to adapt the regulations to their specific needs with a progressive tightening of minimum requirements towards an NZEB model. This is an unquestionable advantage in that it allows the use of the specific resources of each country to achieve the common objective of zero consumption. It

has been widely recognized by the scientific community that NZEBs have great potential to reduce energy consumption while increasing renewable energy contribution, thereby alleviating the depletion of energy resources and the deterioration of the environment. Progress is undoubtedly slow, but it can be seen in many member states compared to the initial stages of implementation of European Directives. Although all the MSs analyzed have developed and published their NZEB legislation, many of them are not adequately prepared for the correct and effective implementation of the NZEBs, and there are still many improvements that should be addressed in the coming years [4].

According to the summits of developed countries and the reports of the World Bank, more than 70 countries agree to support the 'Rapid, Fair and Effective' Decarbonization of the Buildings and Construction Sector [5-8].

In the global fight against climate change, buildings stand as both a significant contributor to greenhouse gas (GHG) emissions and a promising solution. Buildings account for 37% of energy-related emissions globally, driven by burgeoning growth in built-up floor areas. Stringency in building energy codes is crucial as it ensures that structures adhere to rigorous energy efficiency standards. The data reveals that stringency varies significantly globally. Based on this, Iran's National Standard Organization, Iranian Fuel Conservation Company, and Construction Engineering Organization also compiled building energy consumption standards using INSO 14254 and 14253 national standards in 2010. These standards have been revised and improved in 2021. As of 2021, the establishment of these standards and paying attention to their functional requirements in government buildings in Iran is mandatory. But this requirement has not worked properly. This research, by comparing the laws and standards established in Iran and comparing it with other countries around the world, to provide operational suggestions for the establishment of these standards. The most important question of this research is whether setting the building energy consumption criteria is an effective parameter in reducing imbalance or not.

Should Iran, which consumes the most energy in the building sector, about 40%, implement this legal requirement quickly or not?

What are the costs and threats in the implementation of the requirement for buildings to obtain the standard energy consumption label?

Successful experiences in implementing this legal requirement have been effective in reducing their energy consumption.

Based on the successful experiences of other countries, what is the best way to implement this legal requirement with the lowest social and economic cost?

Method and material

Energy efficiency helps reduce overall energy consumption and therefore improves the challenges of energy imbalance in Iran. Using these requirements and suitable potential throughout the country, Iran is looking for its roadmap and improving the quality level of providing energy services.

Many requirements and laws have been provided by the Iranian government to improve the energy performance of residential and office buildings. Among other things, in line with the implementation of the mission of the Ministry of Energy for the development of renewable power plants and to implement the approvals of the Supreme Energy Council of the country, all executive bodies subject to Article (5) of the Civil Service Law are obliged to reduce their annual electric energy consumption by five percent until they reach twenty percent of annual consumption. Provide renewable and clean energy. The formulation of the national standard for determining the energy consumption criteria of residential and non-residential buildings to manage energy consumption and increase energy efficiency in residential and non-residential buildings was approved in the 177th meeting of the National Energy Committee. According to this approval letter, it is mandatory to have the energy consumption standard label for administrative and government buildings, and it is evaluated on the topic of green management. Article 19 of this law states: Issuance of the completion certificate by municipalities or other relevant authorities is subject to compliance with the rules, regulations, and by-laws of Article (18) of this law. As of 2022, the submission of final work to newly constructed buildings is subject to compliance with topic (19) of the National Building Regulations, and to inform people about energy losses in buildings, the Ministry of Interior, through the municipalities, is obliged to include the energy category in the completion certificate from the beginning of 1401, newly constructed buildings and installation of its license plate at the entrance of the buildings. Also, according to the executive regulations of the annual budget in Iran, all government organizations and departments are required to reduce a percentage of their energy consumption compared to last year.

But with all these requirements, laws, and approvals, Iran still faces many problems and challenges in terms of improving energy quality and energy intensity. This issue is more visible in the hot seasons of the year. In the hot seasons, mainly due to energy imbalance, industries, companies, and factories face planned and unplanned blackouts. This procedure has led to a decrease in the efficiency and productivity of work and production processes and has increased dissatisfaction with industries and mines [9-11]. Examining and studying the method of applying similar

requirements for energy consumption standard labels in other countries can be an effective help to improve this process. Localizing the successful methods in other countries and adapting these methods to the implementation requirements in Iran can lead to the improvement of the energy consumption situation.

Hong Kong is one of the developed countries in East Asia. This country has high energy consumption due to the existence of many large industries, as well as many commercial buildings, and the presence of a large number of tourists. The characteristics of energy consumption of typical residential buildings in Hong Kong have been analyzed. An energy equation for assessing energy consumption of high-rise residential buildings has been established by building energy simulation method and practical design assessment. The final form of the energy equation includes six major factors, namely, the HVAC coefficient of performance, window shading, lighting power density, hot water intensity, other appliance intensity, and refrigerator energy [12]. From the perspective of the managers of Hong Kong, A critical issue in developing building energy label is the rating methods for assessing energy performance of buildings. In general, three approaches can be used to formulate the building energy rating [12]:

- Thermal dynamic simulation tools
- Simplified calculation methods
- Points-based methods

To evaluate building energy performance at design and operation stages, ASHRAE (2009) proposed two types of rating for building energy labels [13]:

- As-designed Rating (asset) provides an assessment of the building based on the components specified in the design. The asset rating is based on the results of a building energy simulation model. It applies to both new and existing buildings.
- In-operation Rating (operational) provides information on the actual energy use of a building and is based on a combination of the structure of the building and how it is operated. It is applicable for existing buildings and after 12-18 months of operation for new buildings.

In principle, the operational rating may also be established concerning the actual energy consumption data obtained from a building energy audit carried out by an energy rating assessor.

Norway is a developed country rich in renewable energies. Since 1 July 2010, it has been mandatory in Norway to hold an energy performance certificate for any building that is constructed, sold or rented out. The energy performance certificates are intended to improve knowledge and awareness of energy use in buildings. Building standards have a long history in Norway, and the first energy requirements for buildings were introduced as far back

as 1949. Inspection of large heating, ventilation and air conditioning systems has also been made mandatory to encourage sound operation and inspection routines. Owners of private homes may choose to use a free on-line system for obtaining energy certificates for buildings, while commercial buildings and new buildings must be certified by an expert [14]. In Norway, production plants are accredited for the guarantee of origin scheme for a five-year period, after which they must obtain new accreditation.

Guarantees of origin are issued by individual countries, but many of the EU and EFTA states, including Norway, have joined forces to ensure that there is an international standardised system for recording trading in guarantees of origin. In Europe this is coordinated by AiB. Statnett is responsible for the Norwegian registry, and the Norwegian Water Resources and Energy Directorate is the supervisory authority for the scheme. Guarantees of origin can be used for marketing purposes, but are not a form of support that can be expected to trigger the development of new production capacity. Some countries, including Norway, have made arrangements for using guarantees

of origin in electricity disclosure (sometimes known as 'electricity labeling'). Requirements for electricity suppliers to provide information on the origin of the electricity they sell, i.e. [15]. By applying data for energy prices, the rate of discount, and the associated demands for the different energy label categories, we calculate the expected price premium that dwellings with better energy labels should achieve compared with similar dwellings with lower energy labels. Then, these price premiums are compared with the actual price premiums estimated in the hedonic models. The analyses show that the actual price premiums are much higher than the expected price premiums based on the energy cost differences. Moreover, we find this difference both before and after the energy label system was introduced. In addition, we find no significant differences in the actual price premium before and after the introduction of the energy labels in 2010. The same results are provided by the robustness check, in which we apply the repeated sales method; that is, we find that the present value of energy costs does not affect the price of dwellings. Figure 1 illustrates the development in energy prices and discount rates over the period 2000–2014 [16].

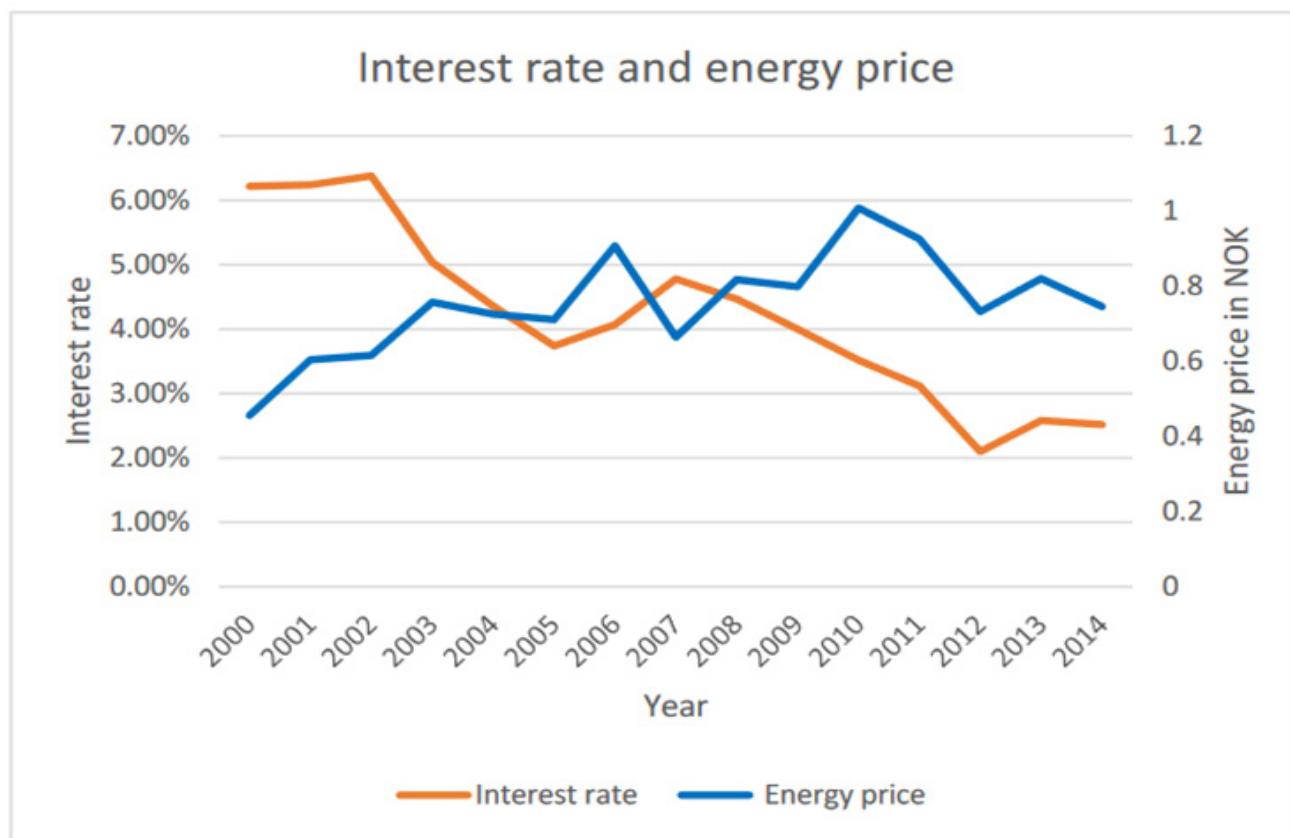


Fig 1: Energy price and interest rate year 2000-2014.

The interest rate is given by the Norwegian 10-year government bond and the energy price is from the energy price area of Oslo

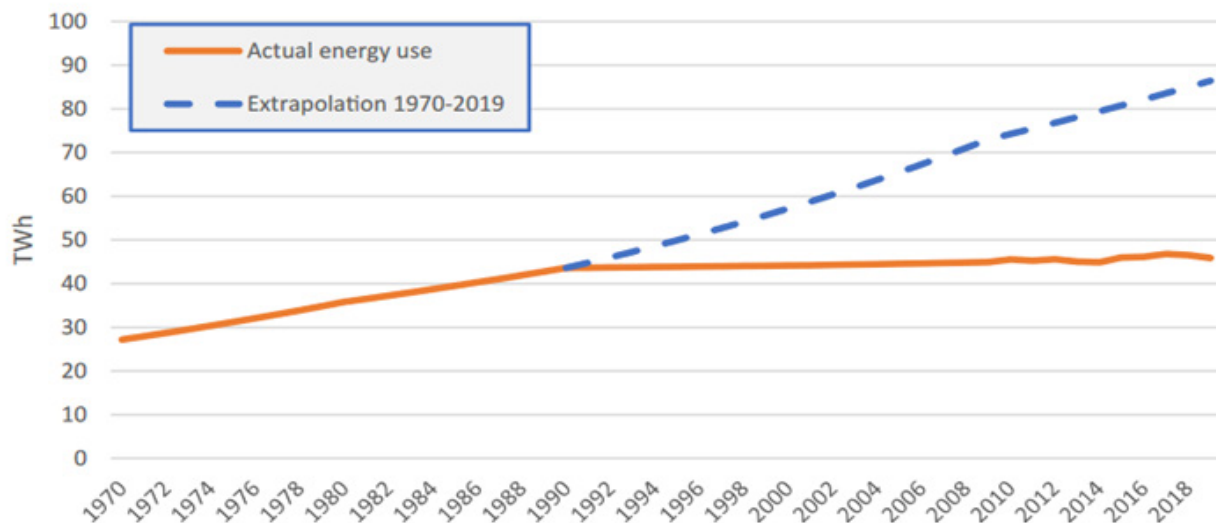


Fig 2: Actual versus projected stationary temperature-adjusted household energy use in Norwegian households 1970–2019 [17]

In Norway, the goal is to reduce energy use by 10 TWh in existing buildings by 2030, compared with the 2016 level. Should the housing sector take its share this imply a 5 TWh reduction by 2030. To achieve a reduction of 5TWh by 2030, we conclude that we need to utilize very different policy instruments. The living area per person need to decline and a redistribution of area from detached houses to apartment blocks, thus indicating that an effective policy will be maximum standards for housing consumption per capita. Renovation of existing buildings will also have a major effect and should be applied to reduce gross heating demand and energy for water heating, thus instruments to create supply and demand and new business opportunities for renovation and energy efficiency should be promoted [17]. The importance of the label of the building consumption standard in Norway is evident since after it became mandatory, the process of energy consumption in the building has undergone significant changes.

The countries of the Persian Gulf region, especially the United Arab Emirates, have invested a lot in the past years in the field of improving energy performance and reducing energy intensity. In July 2014, the Ministry of Energy and Infrastructure established a new department for energy conservation and energy efficiency. One of the goals of this department is to establish a database of energy consumption by different sectors across the UAE, which allows comparisons between the performance of establishments within a sector. The UAE promotes the use of efficient electrical equipment. It launched an efficiency-labeling scheme for window and split-unit air-conditioning systems, eliminating highly inefficient units from the

market. Since July 2014, the UAE has also banned the import of inefficient incandescent light bulbs. The scheme is expected to cut energy use by 500MW per year. Dubai Supreme Council of Energy (DSCE) set a governance framework to streamline existing energy practices across the DSCE entities to optimize synergy and energy efficiency. The council identified policies and regulations to steer demand-side management in the emirate in three areas: power, water, and transportation fuel. Efforts in this regard include [18]:

- implementing demand abatement and energy efficiency measures,
- evaluating energy consumption,
- developing intensity mapping for the emirate,
- introducing abatement technologies for water,
- power and transportation fuel.

The UAE school sector impacts several Sustainable Development Goals of the UAE Vision 2021. The sector is designed according to a standardized system of Model buildings, repeated several times throughout the country, comprising facilities that are often obsolete at both functional and technological levels; hence, frequently presenting poor energy performances. energy audit of the public school sector in the UAE, using the Emirate of Sharjah as a case study. A detailed survey, mapping, and analysis of the schools' construction and pedagogical features allowed classifying the buildings according to different indicators, which were initially investigated using linear regression analysis to understand their contribution to energy consumption and then included in the elaboration of multiple regression [19]. Descriptive statistical analysis is performed to analyze the data from 2018–2019

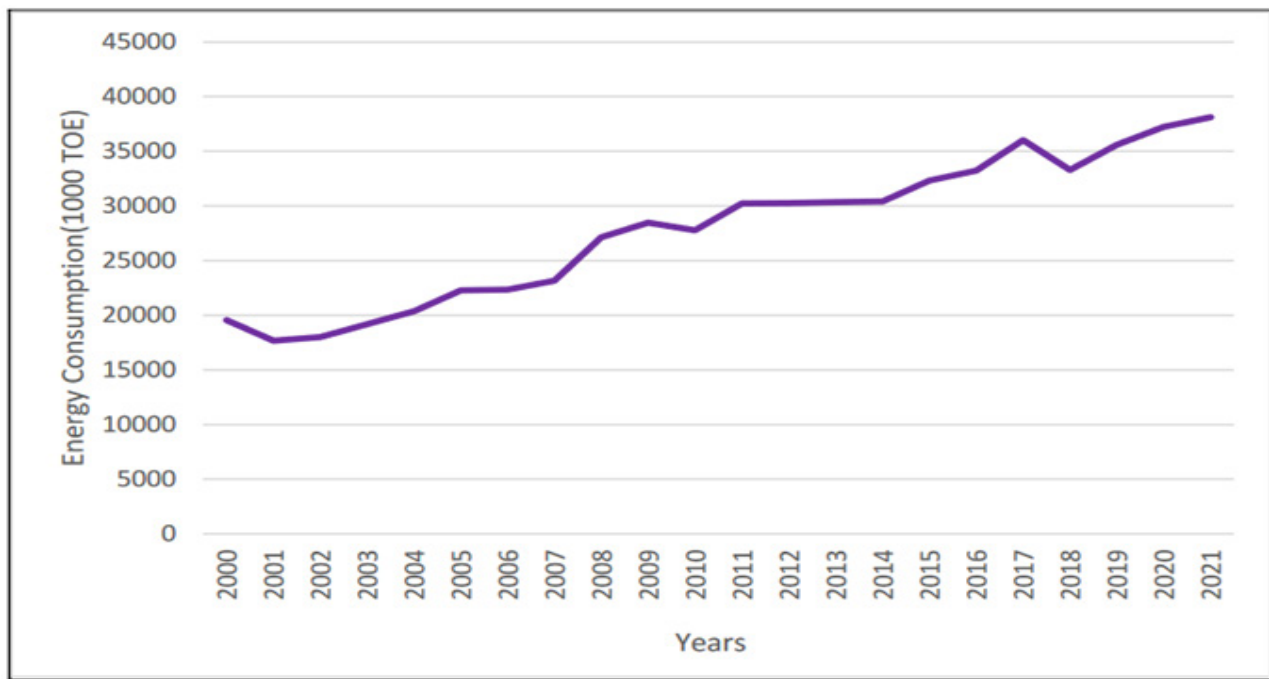


Fig 3: Energy consumption in buildings and services sector in Turkey [21]

to determine the most significant factors related to energy inefficiency in mosque buildings in the UAE and to determine the most cost-effective and energy-saving corrective measures for energy and water conservation. The findings further enhance the standard of experience for mosque visitors (social aspect); reduce energy bill expenses, provide an acceptable return on investment from the proposed energy conservation measures for stakeholders (economic); and reduce the overall energy consumption, which can reduce the total CO₂ emissions from mosque buildings (environmental) [20].

Turkey, a country with a suitable climate, high rainfall, and a sustainable development process, has separated itself from other neighboring countries and has followed the process of industrialization. The proper interaction of this country with European countries, suitable climatic conditions for attracting tourists, and the low costs of providing services compared to other European countries, have made this region attractive to foreign investors. This shows the need for a sustainable energy supply in this country. Figure 3 shows the energy consumption in then buildings and services sector in Turkey between 2000 and 2021. Energy consumption in this sector was 19.556 thousand TOE in 2000 and 38.121 thousand TOE in 2021 [21].

The main drivers behind residential energy consumption in Turkey are examined between 2000 and 2018 using the LDML-I decomposition analysis. Energy consumption of the Turkish residential sector has increased by 21.3 %,

from 17.72 mtoe in 2000 to 21.3 mtoe in 2018, as shown in Fig. 10. Although 2018 was the hottest year during the analysis period, space heating consumption had the largest share in total residential consumption with 48 %, followed by domestic hot water with 22 %, white goods [22]. The EPC system and calculation problems, problems in the regulation and inspection process and, finally, the perspective on the construction industry to the EPC system is examined in the case of Turkey. Deficiencies in the rating system and calculation, regulation and inspection, and perspective of the EPC system in Turkey were identified. Suggestions for the development of EPC in Turkey were made to make it comparable with the systems in EU countries. As one of the outcomes of the study, Turkey should focus on the use of renewable energy, taking into account its geographical advantage. In addition, a more detailed micro-zoning that focuses on regional differences should be carried out, and the authorities should introduce a better control mechanism for the EPC system [23]. The enactment of the Federal Law on Energy Efficiency in 2009 gave considerable impetus to the development of the legislative framework on energy efficiency in Russia. This has greatly improved the position of Russia in the ranking of countries implementing energy efficiency measures recommended by the IEA. However, the Russian energy-saving measures focused mainly on state-funded organizations and residential buildings and lighting, while transport and industry were mostly not

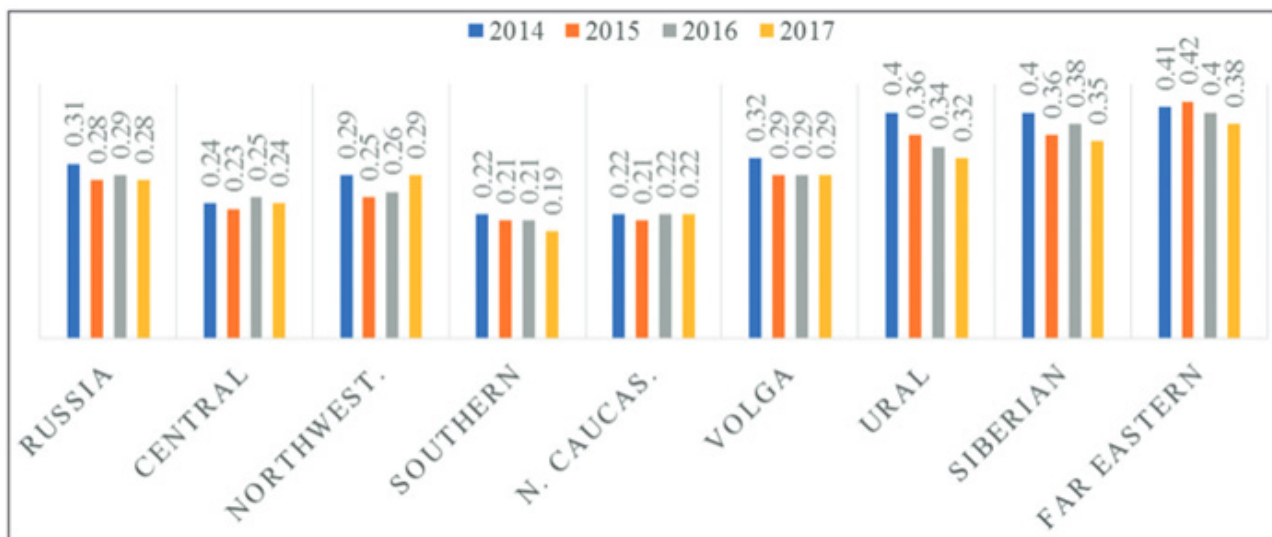


Fig 4: Specific consumption of thermal energy in apartment buildings, Gcal/m² [25]

covered by the law. The buildings sector (including residential and services) accounted for 32% of the Russian final energy consumption in 2011, making it the second largest energy end-use sector after industry but having the greatest energy-saving potential, equal to 77.4 mtoe. Mandatory building energy codes and minimum energy performance. The Federal Law on Energy Efficiency established requirements to update building codes on energy efficiency standards for new buildings at least once every five years. The law also introduced mandatory labeling of buildings and established a target for reducing energy consumption in public buildings annually by 3%. A package of measures to promote energy efficiency in small and medium-sized enterprises is lacking. Lack of long-term financial capital is considered to be the main obstacle to the implementation of energy-efficiency projects in Russia. This situation is mostly due to stringent bank policies that offer short-term credit lines with high interest rates. Thus, banks are ready to finance projects up to 5–6 years with interest rates of 13–17 percent in rubles. Under these circumstances, the government should create the necessary conditions to increase the availability of investment resources for businesses using financial instruments such as tax exemptions, accelerated depreciation, target bonds and grants for R&D. The law on energy efficiency contains several measures, but they are not sufficient. A possible solution could be equal co-financing of projects by municipal authorities. In this case, companies could take smaller loans, the payback period would be shorter and the modernized system would be able to work at least five years without additional investments [24]. Finally, the requirements contained in the standards of energy

consumption in Russia have shown that the amount of energy consumption and its intensity in apartments have been significantly reduced (Fig4).

As of 2019, India had the fifth-largest economy in the world, and it aspires to have the third-largest by 2025. The Economic Survey 2019-20 has attempted to craft a framework of policies to foster wealth creation in India. This is particularly critical at this stage, as India aspires to become a United States Dollar (USD) 5 trillion economy by 2025, an ambitious vision that should create wealth that extends to the lowest socioeconomic groups. India will continue on the path towards the USD 5 trillion economy, while simultaneously ensuring that impacts on the environment are limited, in line with the various international agreements to which India is a signatory. Given that the growth rate in the commercial building sector is amongst the highest across all consumer categories, BEE introduced the ECBC to set standards for energy consumption in new buildings. ECBC defines norms of energy performance for various building components, considering the climatic region. The emphasis has been on developing a standardized enforcement model for uniform implementation throughout the country. To improve EE in the commercial building sector, the ECBC was updated in 2017 and sets minimum energy standards for new commercial buildings having a connected load of 100 kilowatts (kW) or contract demand of 120 kilo-volt- amperes (kVA) or more. ECBC 2017 is forward-looking, pragmatic, and easy to implement. ECBC 2017 has three levels of compliance: ECBC, ECBC+, and Super ECBC. The two additional levels have been defined to recognize buildings that exceed the basic ECBC standards. Before the implementation of the

requirements of the energy consumption standard, the intensity of energy consumption in different parts of India is presented in Figure 5 [26].

After that, India focuses on improving efficiency in urban infrastructure, mechanisms for service delivery, community participation, and accountability of urban Local Authorities. Another major housing scheme, Bharat Nirman, focuses on the provision of basic amenities, such as drinking water, roads, irrigation facilities, electricity, and the construction of houses in rural areas.

But how did India succeed in the field of energy efficiency? The targets were set by carrying out the baseline audits in the PAT cycle I. The baseline audits were carried out by BEE-empaneled agencies having certified energy auditors and energy managers. The audits were carried out to assess the potential of energy efficiency and what the consumption was at the time. This audit was termed a baseline audit, and based on them the targets were set for the Designated Consumers (DCs) in PAT cycle I. The second phase of the PAT Scheme (PAT cycle II) runs from 2016-2019, covering 707 units from the 11 energy-intensive sectors. PAT cycle II focuses on deepening and widening PAT cycle I - i.e. the inclusion of 61 new DCs from the existing 8 sectors, and the addition of 170 DCs from 3 new sectors, namely: Railways, Refineries, and Electricity distribution companies [27]. BEE is undertaking the Standards & Labelling Program to provide consumers with information about energy saving and, thereby, the cost-saving potential of household goods and other equipment. The appliances are rated with one to five stars, with five stars indicating the most energy-efficient model. The labels note the amount of electricity consumed by the appliance and its energy efficiency. This is expected to impact energy savings in the medium and long run, while at the same time positioning the domestic industry to compete in markets where norms for energy efficiency are mandatory [27]. Every year, an independent evaluation is carried out which assesses the penetration of starred products using the data from such evaluations; penetrations of different starred products have been worked out. Also, BEE periodically revises its rating system to reflect the best global technologies. Using information for households from India's official data agency, the National Sample Survey Organization (NSSO), BEE has attempted a calculation of energy savings made from the star labeling scheme of four common energy-consuming appliances in households [27].

In a developing economy like India, improved energy efficiency is a primary goal that could be achieved through the promotion of higher performance in buildings. Building rating and verification systems are an effective measure to encourage building owners to go beyond the

minimum, and creating an awareness of these systems would add substantial momentum to promote energy efficiency in buildings. The buildings sector is the largest energy consumer of all end-use sectors, accounting for one-third of total energy demand. The good practices mentioned above could be replicable in the buildings, which would result in a substantial amount of savings, as well as GHG emission reductions. EESL has carried out the implementation of energy efficiency measures in many government buildings like Yojna Bhawan and NITI Ayog and achieved around 20% savings. EESL is also implementing the changes according to the ECBC norms in other buildings. Moreover, EESL has signed a MoU with the Central Public Work Department (CPWD) for 1,000 government buildings for implementation according to ECBC norms; implementation in 18 buildings has already started. This clearly shows that measures implemented earlier in buildings have both replicability and scaling-up potential [28].

From the first Chinese Design Standards for Civil Buildings in 1986 to the recently released National Standard of Green Buildings Assessment, policy on energy efficiency and carbon emissions of buildings, including retrofitting old ones and constructing new ones, has undergone significant changes in the past decades in China. The government financing mode refers to the fiscal subsidies provided by the central government and the subsidies provided by the local government. The fiscal support promotes the energy-saving transformation of buildings, which is conducive to bringing into the leverage effect of fiscal policies and guiding more social capital investment. But the problem is that once the fiscal subsidy fund shrinks, it will be difficult to promote the energy-saving transformation to continue to carry out. The central government set up an incentive fund in 2010 to promote EPC and the development of the energy service industry. For retrofit projects that employ EPC, the fund award RMB 240 per tonne of coal equivalent saved, while matching incentive programs run by provincial governments add another RMB 60 or more per tonne of coal equivalent saved. The effectiveness of these incentive policies, however, was diminished by the rigorous qualification reviews for ESCOs, strict filing and review standards, and time-consuming application processes. As a result, less than 10% of the projects that received the funding were building retrofit projects [29-30]. In May 2015, the State Council canceled the EPC fund, marking the end of these incentive policies. Developers or building owners of the energy-saving transformation project act as the main actors of the transformation, raise the incremental investment of the energy-saving projects and recoup the investment through the incremental income of the energy-saving projects. In

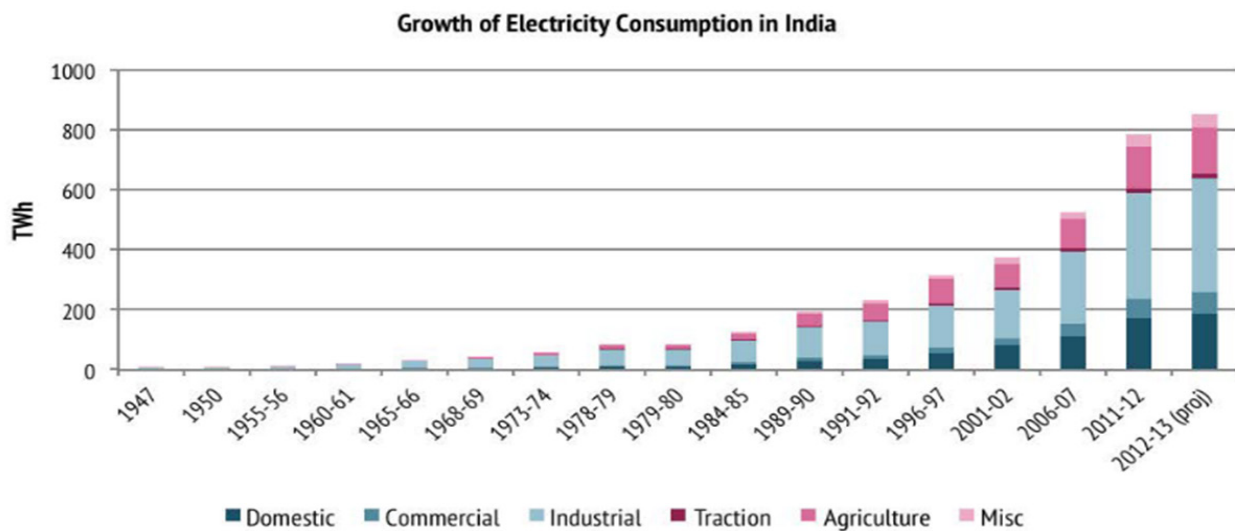


Fig 5: Specific consumption of thermal energy in apartment buildings, Gcal/m² [25]

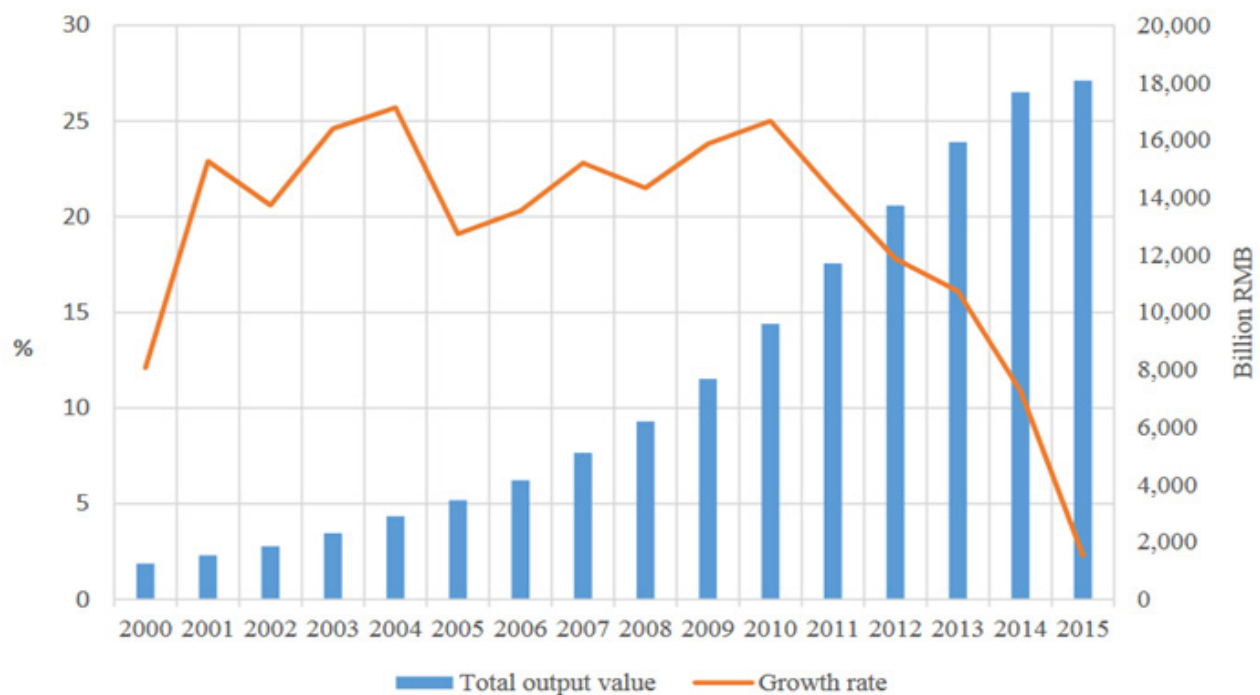


Fig 6: The output value and growth rate of building in China from 2000 to 2015 [32]

China's current financial system, bank loans are the most important way to provide funds to the market. No exception in the energy-saving service industry, Bank loans are the most widely used financing channel for ESCO, including mortgage loan and secured loan. Based on traditional business, many banks have launched a variety of new financial products and updated their credit evaluation system according to the characteristics of EMC and ESCO.

Therefore, Banks are paying more and more attention to the financing of energy-saving projects. The term of payment shall be determined by the term of collection of the project, and the future profit rights of the project shall be used as the repayment source of the loan [31]. Using these control policies in the field of energy, the growth rate of energy consumption has been significantly controlled (Figure 6).

The importance of energy consumption benchmark standards in African countries is also understood. In the countries of the African continent, which are more developed and have more stable political systems, compliance with energy consumption standards by these governments is well implemented. These countries also have good cooperation with international standardization, energy, and economic organizations.

Due to climate changes among cities and household forms, residential energy consumption varies greatly across geographical Regions. In Nigeria, Climate and the availability of local building materials are important natural variables that influence and define the planning and implementation of architecture in various zones or places [33]. According to the BEEC, middle-income and high-income households consume energy in varying capacities. In Nigeria, residential households account for the largest share of energy consumption amounting to about 65% of energy usage with an estimate by the Nigerian Energy Commission that 72% of the population depends on fuel, wood, and 70% of other traditional forms of energy sources for household energy supply. there is a need to reduce energy consumption to boost energy use efficiency. For effective energy management and efficiency in energy consumption, certain factors such as the architectural design practice, appliance efficiency in use, and tenant behavior are to be considered. To develop sustainable management of housing, energy-conscious plans and designs must be made within the built environment, improving energy use efficiency through better planning and design from construction to occupancy while considering the environment [33]. Based on this, buildings under construction in Nigeria are required to comply with building materials standards at the beginning of the process, and energy consumption standards at the end.

The building sector is the second consumer of electricity after the industrial sector in Morocco and is ranked the third emitter after the energy sector and transportation sector. Using Ifrane as a case study, this paper examines and reviews the city's energy use and the initiatives taken to improve building efficiency. The findings showed that, during the analyzed period, i.e., from 2014 to 2022, Ifrane's annual electricity consumption climbed steadily from 35 to 43 GWh. The government of Morocco has implemented effective laws, guidelines and regulations, as well as publicized ways to reduce energy consumption and increase energy efficiency. However, gathered data and survey results revealed opportunities and challenges for enhancing Ifrane's efficient energy use. A benchmark evaluation and potential ideas are offered to guide energy policies and improve energy efficiency in Ifrane and other cities within the same climate zone [34].

Results

About 40% of the energy produced in the country is used in the building sector. Energy consumption in Iran is more than three times the world average. The amount of energy wasted from the walls with government subsidies for each Iranian household during ten years with average inflation (30% annually) is 1600 dollars, calculated for a 6-unit building, amounting to 10000 dollars. This amount of energy waste reaches more than 400 dollars for these 6 households at world prices (not including government subsidies). Therefore, we must prevent the wastage of this national capital in addition to using standard and safe materials for our houses.

The results of the review of the actions of other countries show that most of them pay special attention to optimizing energy consumption, especially in the construction field. A correct understanding of the concepts of energy consumption standards and consumption standards labels is a requirement for progress and investment in these countries. The interesting point in this review is that many countries with different climates, economic levels, political stability, and extensive energy resources pay attention to the importance of energy consumption criteria. From the point of view of all of them, it is possible to solve the problem of energy imbalance, only with optimal and correct use of energy.

The results of these surveys had common points that can be presented as follows to improve the current situation in Iran and move towards optimizing energy consumption and applying the successful experience of these countries:

- In all the countries under review, the governments have started requiring government buildings to have energy consumption standards and optimal use of energy in their buildings. With this method, they have been a good example for other citizens in the country. A point that is also required in Iran according to the mandatory standards and topic 19 of the National Building Regulations, but it is not taken very seriously.
- Providing incentive packages for builders who follow the topics of saving and optimal use of buildings. and serious penalties for buildings that do not comply.
- Realization of energy prices for buildings subject to the mandatory energy consumption standard label and not providing any government, banking, etc. services with the owners of these buildings. An issue that is also mentioned in the law is strengthening and developing the standard system. Taking this law seriously is an effective help for the owners of these buildings.
- The requirement to simulate energy consumption and reduce the uncertainty of calculations related to energy consumption using software such as EnergyPlus

and DesignBuilder. The use and accurate estimations of this software will effectively help to reduce the existing problems in the proper distribution of energy, heat, and air supply inside the building.

- Requiring building owners to provide energy audit inspection certificates, for the initial time of building handover, periodic time intervals, and inspection certificates after major building repairs. This issue has been accepted by the owners for the inspection of building elevators in Iran. However independent and organized energy audits can also be an effective help to monitor the existing situation and investigate energy consumption trends in buildings.
- One of the important points in the experience of successful countries in the field of establishment of building energy consumption benchmark standards has been the coordination between government agencies in charge of the establishment and development of this process. The synergy of government organizations and avoiding internal conflict has led to the improvement of the quality of service delivery. A subject that may be less noticed, but one of the major problems in Iran and the main causes of failure in the field of establishment of building consumption standard label standards in Iran can be said.
- The establishment and monitoring of national, regional, or international energy quality management systems, especially ISO 50001, is an effective help in maintaining the energy consumption situation in buildings. Energy quality management systems, using continuous monitoring and improvement in energy systems, and fixing the inconsistencies in those management systems, will lead to improving the quality level of energy consumption and reducing the intensity of consumption. Applying the Deming circle is an effective help to improve the system and an incentive to improve the energy management system.
- Emphasis on the use of renewable energy in buildings to compensate for the energy imbalance and improve the environmental situation. Many countries have declared it mandatory to install solar panels on the roof of the building. For example, Germany during the SolarPLUS program, which aims to help companies and families to finance solar installations, including in listed buildings. All new houses in Tokyo built by mass builders after April 2025 must be equipped with solar energy panels, according to new regulations passed by the Japanese capital's local assembly on December 15. This law was passed to reduce domestic carbon emissions. Currently, only 4% of the buildings that can install solar panels in the city of Tokyo have installed the panels. The order, the first of its kind for a Japanese municipality, requires about 50 major building developers to equip homes up to 2,000 square meters (21,500 square feet) with renewable energy sources, mostly solar panels.

Comparing these programs and successful experiences in establishing building energy consumption standard labels in other countries and comparing them with Iran, we can point out these things. Topic 19 of the National Building Regulations in Iran was approved by the Board of Ministers in 1991, and its implementation was mandatory in the country's buildings. This topic was revised several times; After the review, its implementation was mandatory and prescribed for all government and public buildings; On the other hand, compliance with these regulations has been mandatory for all private sector buildings located in Tehran since 2004, and it should be mandatory in other provinces of the country as well according to the schedule, but because it does not have a trustee, it has not been implemented in the country so far. In line with the task stipulated in the law of the sixth development plan to reduce annual energy losses by 5% in the building sector, as the largest energy-consuming sector in the country, energy-saving standards in buildings have been approved. Based on this, it was decided that from the beginning of 2023, all the buildings that started to be built, and receiving their completion permit depend on having an energy grade. Therefore, considering the issue of energy crisis that has arisen in the last few years, the issue of optimal energy consumption has attracted the attention of all experts in the world, and they decided to seriously consider the issue of optimizing energy consumption in the main centers of energy consumption, i.e. industry and construction, and for several years, countries such as Italy, Germany, Sweden, and England have formulated special laws regarding building construction and the use of thermal insulation, heating and cooling methods, and the general structure of the building to optimize energy consumption in it. To prevent excessive consumption of energy in the country, basic measures should be taken by the government in the form of public laws. The implementation of energy consumption optimization requires incentive policies from the government.

Conclusion and discussion

Mandatory and mandatory labeling of building consumption criteria in Iran is an issue that should be implemented due to the wide disharmony of the last few years. The lack of attention of governments in Iran to this issue and delaying this process will only increase the energy challenge. This process should be done first for government and commercial buildings so that this procedure becomes a model for other owners. To oblige government organizations and ministries to implement this plan, similar experience can be used in SADA systems, cadastre plans for government property, systems related to salaries and wages, etc. in government organizations. The bottlenecks

of the government organizations to oblige the standard label of building consumption are issues related to the budget and financial credibility. In case of making any expenditure and maintenance of government buildings conditional on improving the status of energy consumption and obtaining energy consumption standard labels, these organizations will be forced to keep up with this process.

Basic energy supply is the basis of any investment, and failure to solve this challenge leads to the reduction of investments and their transfer to other countries. As it has been investigated, Iran's neighboring countries have improved significantly by improving the status of energy consumption and changing the approach to renewable resources. If you don't pay attention to this issue, these problems will accumulate over time, and it will be very difficult to fix them.

The requirement to implement the building consumption standard label based on INSO 14254 and 14253 standards is the basis for approaching the vision of green buildings, zero-energy buildings, and Nearly zero-energy buildings. The most important challenges and limitations of building energy consumption standards are:

- 1- Lack of correct understanding and cultural background regarding the importance of energy consumption standards in buildings.
- 2- Failure to accompany municipalities and supervising engineers.
- 3- Lack of certified inspection companies in the field of building energy system audits.
- 4- Inconsistency between government organizations,
- 5- Unrealistic prices of energy carriers in Iran.
- 6- Increase in construction cost due to the requirement to comply with standards,

In this regard, recommendations and suggestions are provided to improve the status of building energy consumption standards in Iran:

- 1- Tax incentives are a set of measures to reduce the taxes paid by consumers who invest in energy efficiency. These incentives include accelerated depreciation, tax credits, and tax reductions in the rate of value-added tax) in many countries it is planned.
- 2- Increasing the cost of completion of work for buildings that do not have an energy consumption standard label and providing cost reduction incentives for buildings with an energy consumption standard label.
- 3- Stepwise increase in energy consumption costs in buildings without energy consumption standard labels.
- 4- Confirming the qualification of consulting companies in the field of establishment of INSO 14254 and 14253 energy consumption standards.

- 5- Cooperation and coordination between the National Standard Organization of Iran, municipalities, and the Organization of the Engineering System of Iran is a condition for the proper deployment of this legal requirement.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: Sep. 2024 Accepted: Oct. 2024

Published online: Oct. 2024

DOI: 10.22034/ASAS.2024.479813.1064

References

- [1] M. H. Saidi, B. Saajadi, P. Sayyadi, "Energy consumption criteria and labeling program of wet cooling towers in Iran", *Energy and Buildings*, vol. 43, Issue 10, pp. 2712-2717. , October 2011. <https://doi.org/10.1016/j.enbuild.2011.06.016>.
- [2] A. C. Russo, M. Rossi, M. Germani, C. Favi, "Energy Label Directive: current limitations and guidelines for the improvement", 25th CIRP Life Cycle Engineering (LCE) Conference, 30 April ± 2 May 2018, Copenhagen, Denmark, doi:10.1016/j.procir.2017.11.136.
- [3] F. Bagheri, V. Mokarizadeh, M. Jabbar, "Developing energy performance label for office buildings in Iran", *Energy and Buildings*, Volume 61, June 2013, Pages 116-124. <https://doi.org/10.1016/j.enbuild.2013.02.022>.
- [4] P. Olasolo-Alonso, L. M. Lopez-Ochoa, J. Las-Heras-Casas, L. M. Lopez-Gonzalez, "Energy Performance of Buildings Directive implementation in Southern European countries: A review", *Energy and Building*, 281, 2023. <https://doi.org/10.1016/j.enbuild.2022.112751>.
- [5] P. Macallister, I. Nase, "Minimum energy efficiency standards in the commercial real estate sector: A critical review of policy regimes", *Journal of Cleaner Production* 393 (2023) 136342. <https://doi.org/10.1016/j.jclepro.2023.136342>.

- [6] F. Liu, A. S. Meyer, J. F. Hogan, "Mainstreaming Building Energy Efficiency Codes in Developing Countries", The World Bank Publication, Washington D.C. DOI:10.1596/978-0-8213-8534-0.
- [7] C. Zepeda-Gil, S. Natarajan, "A Review of Green Building Regulations, Laws, and Standards in Latin America", *Buildings* 2020, 10, 188; doi:10.3390/buildings10100188.
- [8] F. Silvero, F. Rodriguez, S. Montelpare, "Energy Efficiency Policies to Face Buildings' Climate Change Effects in Paraguay", *Appl. Sci.* 2020, 10, 3979; doi:10.3390/app10113979.
- [9] M. Zarezadeh, "Estimation of Sustainable Energy Supply in Bandar Abbas Industrial Estate No. 2 Using Solar Panel Installed on the Roof of the Building", *Journal of Sustainable Energy systems*, Volume 2, Issue 2, April 2023. Pages 167-181. 10.22059/ses.2024.369849.1047.
- [10] M. Zarezadeh, "Modeling the Required Energy Supply in the Frozen Area of Bandar Abbas Using Solar Panels Installed On the Roofs of Buildings", *Journal of Sustainable Energy Systems*, Volume 2, Issue 3 July 2023, Pages 215-235. 10.22059/ses.2024.372473.1051.
- [11] M. Zarezadeh, "Providing sustainable energy to solve the energy shortage in Hormozgan province using solar power plants", *Journal of Sustainable Energy Systems*, Volume 3, Issue 1, January 2024, Pages 23-38. 10.22059/ses.2024.376591.1067.
- [12] S. C. M. Hui, R. K. H. Lee, "Development of Energy Labels for Residential Buildings in Hong Kong", 10th Asia Pacific Conference on the Built Environment Green Energy for Environment,
- [13] C. H. Yip, W. Y. Ho, "Enhancing Building Energy Efficiency -A Concerted Effort of the Trade and the Government",
- [14] N. Nord, S. F. Sjothun, "Success factors of energy efficiency measures in buildings in Norway", *Energy and Buildings* · June 2014, DOI: 10.1016/j.enbuild.2014.03.010.
- [15] J. O. Olaussen, A. Oust, J. T. Solstad, L. Kristiansen, "Energy Performance Certificates—The Role of the Energy Price", *Energies* 2019, 12, 3563; doi:10.3390/en12183563.
- [16] I. Allard, G. Nair, T. Olofsson, "Energy performance criteria for residential buildings: A comparison of Finnish, Norwegian, Swedish, and Russian building codes", *Volume 250*, 1 November 2021, 111276. <https://doi.org/10.1016/j.enbuild.2021.111276>.
- [17] M. Simonsen, C. Aall, H. J. Walnum, B. K. Sovacool, "Effective policies for reducing household energy use: Insights from Norway",
- [18] W. A. Friess, K. Rakhshan, "A review of passive envelope measures for improved building energy efficiency in the UAE", *Renewable and Sustainable Energy Reviews* Volume 72, May 2017, Pages 485-496. <https://doi.org/10.1016/j.rser.2017.01.026>.
- [19] V. Belpoliti, A. A. Saleem, M. W. Yahia, R. Nassif, "The decreasing trend of energy consumption in buildings in the United Arab Emirates", *Energy and Buildings* Volume 320, 1 October 2024, 114599. <https://doi.org/10.1016/j.enbuild.2024.114599>.
- [20] M. AlAli, Y. Mattar, M. A. Alzaim, S. Beheiry, "Analysis of Electricity and Water Consumption in Existing Mosque Buildings in the UAE", *Buildings* 2023, 13, 1007. <https://doi.org/10.3390/buildings13041007>.
- [21] N. Yilankirkan, E. N. Icme, "ENERGY CONSUMPTION FORECAST FOR THE BUILDING SECTOR IN TURKEY UNTIL 2030", *International Journal of Innovative Engineering Applications* vol. 7, issue 2 (2023). <https://doi.org/10.46460/ijiea.1352958>.
- [22] B. Duzgun, M. A. Koksall, R. Bayindir, "Energy consumption in buildings and services sector in Turkey", *Volume 70*, October 2022, Pages 371-386. <https://doi.org/10.1016/j.esd.2022.08.016>.
- [23] D. G. Yilmaz, F. Cesur, "A Study for the Improvement of the Energy Performance Certificate (EPC) System in Turkey", *Sustainability* 2023, 15, 14074. <https://doi.org/10.3390/su151914074>.
- [24] W. Strielkowski, A. sherstobitova, P. Rovny, T. Evteeva, "Increasing Energy Efficiency and Modernization of Energy Systems in Russia: A Review", *Energies* 2021, 14(11), 3164; <https://doi.org/10.3390/en14113164>.
- [25] A. N. Alekseev, S. V. Lobova, A. V. Bogoviz, Y. V. Ragulina, "A Critical Review of Russia's Energy Efficiency Policies in the Construction and Housing Sector", *International Journal of Energy Economics and Policy*, 2019, 9(4), 166-172. <https://doi.org/10.32479/ijeeep.7608>.
- [26] Sh. Yu, Q. Tan, M. Evans, P. Kyle, L. Vu, P. L. Patel, "Improving Building Energy Efficiency in India: State-level Analysis of Building Energy Efficiency Policies", *Energy Policy*,
- [27] A. Grag, S. Dhar, B. Kankal, P. Mohan, "Good Practice and Success Stories on Energy Efficiency in India", *Copenhagen Centre on Energy Efficiency, UNEP DTU Partnership*. SBN: 978-87-93458-12-3.
- [28] P. Tarkar, "Energy Efficient Buildings in India: Key Area and Challenges", *ICSEEGT 2022, IOP Conf. Series: Earth and Environmental Science*, doi:10.1088/1755-1315/1084/1/012076.
- [29] G. Zhang, Ch. Zhang, H. Nie, "An Overview of China's Energy Labeling Policy Portfolio: China's Contribution to Addressing the Global Goal of Sustainable Development", *SAGE Open*, January-March 2021: 1 –12. <https://doi.org/10.1177/2158244020988858>.
- [30] J. Zhang, "Building energy consumption analysis and measures: a case study from an administration building in Chengdu, China", *Zhang Energy Informatics* (2024) 7:78. <https://doi.org/10.1186/s42162-024-00384-6>.
- [31] S. Guo, D. Yan, Sh. Hu, Y. Zhang, "Modelling building energy consumption in China under different future

scenarios", Energy Volume 214, 1 January 2021, 119063. <https://doi.org/10.1016/j.energy.2020.119063>.

[32] X. Yuan, X. Zhang, J. Liang, Q. Wang, J. Zuo, "The Development of Building Energy Conservation in China: A Review and Critical Assessment from the Perspective of Policy and Institutional System", Sustainability 2017, 9, 1654; doi:10.3390/su9091654.

[33] D. E. Okonta, "Investigating the impact of building materials on energy efficiency and indoor cooling in Nigerian homes", Heliyon, Volume 9, Issue 9, September 2023, e20316. <https://doi.org/10.1016/j.heliyon.2023.e20316>.

[34] H. El Hafdoui, A. Khallaayoun, K. Ouazzani, "Activity and efficiency of the building sector in Morocco: A review of status and measures in Ifrane", AIMS Energy, Volume 11, Issue 3, pp.454-485. <https://doi.org/10.3934/energy.2023024>.

Submit your manuscript to Advances in the standards and applied sciences journal and benefit from:

- Convenient online submission
- Rigorous peer review
- Open Access: articles freely available online
- High visibility within the field
- Retaining the copyright to your article

**Submit your next manuscript at:
journal.standards.ac.ir**