ITU A|Z • Vol 20 No 1 • March 2023 • 19- 34

# Financial model adaptation for building energy efficiency retrofits in Turkey

**Begüm DİKER[1]*, Fatih YAZICIOĞLU[2]**
[1] ciloglub@itu.edu.tr • Construction Science Ph.D. Program, Department of Architecture, Graduate School, Istanbul Technical University, Istanbul, Turkey
[2] yaziciogluf@itu.edu.tr • Department of Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Turkey

*Corresponding author
*Received: March 2022 • Final Acceptance: August 2022*

**Abstract**
Energy efficiency (EE) applications in buildings are supported by various financing mechanisms in many countries around the world. However, financial support systems in Turkey, especially in EE applications for residential buildings are quite limited. This research aims to propose a financing system that can be used for energy efficiency improvements of residential buildings in Turkey. The methodological framework of the study is based on literature research with the detailed content analysis. In the first step of the study, implemented or planned financial support systems within the context of energy efficiency are examined and successful case studies presented, especially focusing on Europe where the old building stock is concentrated. In the next step, the current situation in Turkey is examined within the scope of energy efficiency financing. Deficiencies in existing financial support systems and needs have been evaluated. In the third part, a proposal has been made for the financing system which does not include energy efficiency improvements in existing buildings in Turkey, and a financial model adaptation has been made for Turkey's conditions by taking advantage of good practice examples in Europe. While making this adaptation, singular suggestions in the available literature were referred and the obstructions in the current situation were attempted to eliminate with a holistic approach.

**Keywords**
Building energy efficiency, Energy efficiency financing mechanisms, Energy efficiency stakeholders, Financial model, Turkey.

*doi: 10.5505/itujfa.2022.46343*

## 1. Introduction

Nowadays, more than half of the world's population lives in cities, and cities are responsible for approximately 70% of $CO_2$ emissions (International Energy Agency, 2021). Buildings are responsible for approximately 50-70% of emissions in cities and 38% of global emissions (Wei et al., 2021). In the '1.5°C Global Warming' report published by the Intergovernmental Panel on Climate Change (IPCC) in 2018, it is stated that if greenhouse gas emissions continue in their current form global warming will exceed the 1.5°C limits and there is a need for contingency plans to support decarbonization in order not to exceed this limit (IPCC, 2018). In this context, applications for building energy performance improvements have high importance.

Energy efficiency (EE) applications in buildings are supported by various financing mechanisms in many countries around the world. However, financial support systems in Turkey, especially in EE applications for residential buildings are quite limited.

This research aims to propose a financing system that can be used for energy efficiency improvements of residential buildings in Turkey.

In the first step of the study, implemented or planned financial support systems within the context of energy efficiency are examined and successful case studies presented, especially focusing on Europe where the old building stock is concentrated.

In the next step, the current situation in Turkey is examined within the scope of energy efficiency financing. Deficiencies in existing financial support systems and needs have been evaluated. In the third part, a proposal has been made for the financing system which does not include energy efficiency improvements/refurbishments in existing buildings in Turkey, and a financial model adaptation has been made for Turkey's conditions by taking advantage of good practice examples in Europe.

While making this adaptation, singular suggestions in the available literature were referred and the obstructions in the current situation were attempted to eliminate with a holistic approach.

### 1.1. Energy efficiency financing in the world

The financing of energy efficiency (EE) projects is provided by equity or outsourcing. In equity financing, companies carry out EE projects with their capital without any borrowing or interest. The most frequently used financing type is debt financing and outsourcing of energy efficiency projects is generally evaluated under three headings (Taranto et al., 2020).

#### 1.1.1. Energy efficiency funds

Energy efficiency funds are resources specially created for energy efficiency project investments and provide long-term, low-interest capital financing. Examples of these funds are the Climate Investment Funds (CIF), the Global Energy Efficiency and Renewable Energy Fund (GEEREF), and the European Energy Efficiency Fund (EEEF).

In the report titled Energy Efficiency Solution: Financing Mechanisms, prepared by the SHURA Energy Transition Center in 2020, insufficient resources have been reserved for the funds are mentioned. It has been stated that effective planning of fund structuring and support design is required to respond to the need on a global scale and to provide support in the required term and amounts (Taranto et al., 2020).

#### 1.1.2. Financing with ESCO model

Financing the investment is not the only problem with energy efficiency projects. Technical consultancy services are also needed to encourage investment. In this sense, the ESCO (Energy Service COmpany) model plays a key role in both identifying project needs and financing the project. The companies, which are defined as "energy efficiency consultancy companies that are authorized to carry out energy efficiency services" in the Energy Efficiency Law No. 5627 of the law, are currently Energy efficiency consulting firms (EVD) in Turkey and have emerged with the ESCO concept. The most well-known feature of ESCOs is that they guarantee post-investment energy savings with an energy performance contract (EPC). Energy Performance Contract, as

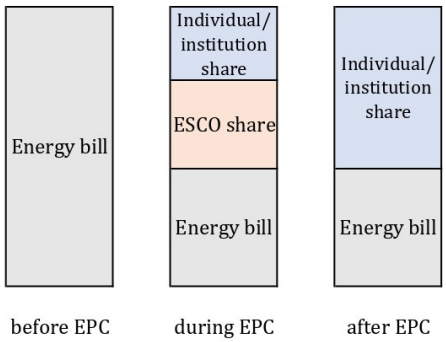


***Figure 1.*** *Financing with ESCO model (Taranto et al., 2020).*

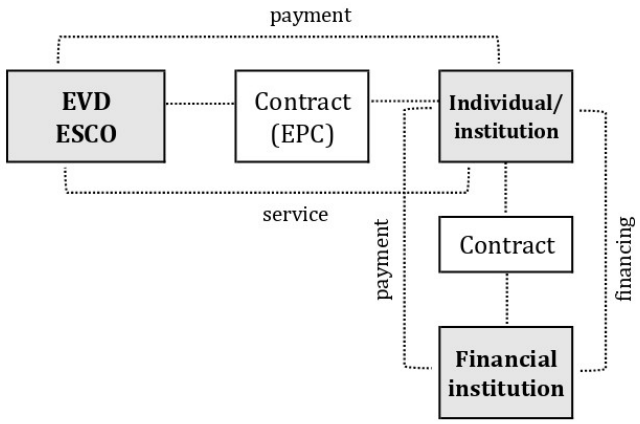


***Figure 2.*** *Guaranteed savings EPC model.*

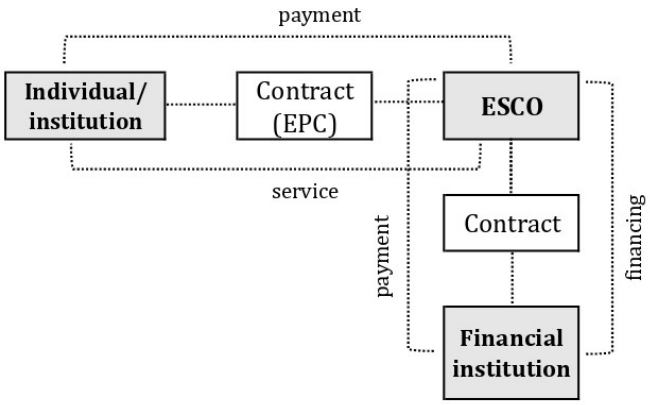


***Figure 3.*** *Shared savings EPC model.*

defined in the law, is a contract based on the principle of "guaranteeing the energy savings to be achieved after the implementation project and paying the expenditures with the savings that will occur as a result of the implementation" (Republic of Turkey Official Gazette, 2007). Accordingly, the institution pays the amount it paid to the energy bill before EPC as a service fee to ESCO for the duration of the contract after the EE investment is made. At the end of the contract term, the amount saved from the energy bill remains with the institution (Figure 1).

Energy Performance Contracts (EPC) made by ESCOs can be of different models (Taranto et al., 2020). The most common models are the guaranteed savings EPC and the shared-savings EPC. In guaranteed savings EPC, the ESCO is responsible for technical risk (guarantees the amount of savings) while the institution assumes the financial risk (Figure 2). This type of contract is often used in emerging ESCO markets. In shared-savings EPC, ESCO assumes both technical and financial risk (Figure 3). This type of contract requires strong ESCO structures.

The stages that ESCO takes part in an EE project can be listed as follows (Taranto et al., 2020):

- Feasibility study for EE project (Determination of baseline energy consumption).
- Transfer of the guaranteed amount of energy savings to the contract (EPC).
- Taking responsibility for the project, engineering, procurement, construction, operation, and energy performance.
- Determining whether the energy saving is realized at the intended level with measurement& verification.
- Making payment if the performance guaranteed following EPC is achieved as a result of the measurement.
- Implementation of sanctions-penalties and the termination process if the guaranteed performance is not achieved.

By the year 2018, the country with the most ESCOs and the largest EPC market in Europe is Germany (EYODER, 2020). In the world countries, China is in the first place and the USA is in the second.

Even ESCOs have technical knowledge for EE project financing, their inability to provide appropriate financing conditions hinders EE applications. Besides, the stakeholders/ institutions in the energy efficiency sector do not trust the ESCO structure negatively affects the situation.

In this context, commissioning of risk-sharing mechanisms that strength-

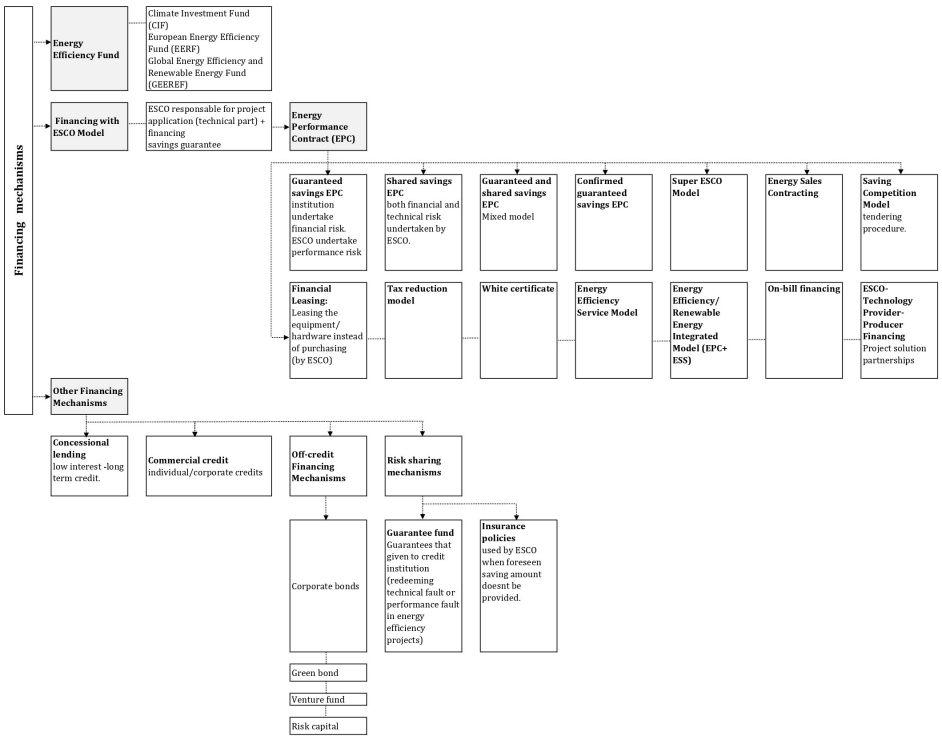


***Figure 4.*** *Energy efficiency financing mechanisms.*

en the financial structure of ESCOs, the improvement of performance contracts in the sense of legal, the authorization and certification of ESCOs by competent bodies to increase confidence in ESCOs, and increasing public financial support systems, concessionary lending and EE funds that can be used by ESCOs are suggested (Taranto et al., 2020).

### 1.1.3. Other financing mechanisms

In this chapter, concessional lending, commercial loans, non-credit financing mechanisms, and risk-sharing mechanisms are examined. Concessional lending is low-interest and long-term loans provided by financial institutions in line with certain targets and can be provided by International Financial Institutions (IFI) such as the World Bank (WB), European Bank for Reconstruction and Development (EBRD), German Development Bank (kfW). Commercial loans, on the other hand, are individual/corporate loans provided by banks from their resources.

Green bonds, venture and venture capitals are discussed in non-credit financing mechanisms. Green bonds are bonds that are issued to support investments in issues such as sustainability and emission reduction. In venture and venture capital, companies with a new project are initially financed in exchange for shares. Once the project starts generating income, shares are offered to the capital markets or sold to those who want to become partners in the company (Taranto et al., 2020).

Risk-sharing mechanisms are an application to reduce financial costs and reduce credit costs. The most widely used of these mechanisms are public guarantee funds and insurance policies specific to EE projects. Public guarantee funds can be given to institutions that provide loans through international financial institutions. Insurance policies, on the other hand, are generally used by ESCOs and are activated if anticipated savings cannot be achieved. The energy efficiency financing mechanisms used in the world – especially in Europe – are summarized in Figure 4.

## 1.2. Energy efficiency financing: Case studies

In this part, case studies well accepted as successful in energy efficiency financing in the world are presented. Especially, application examples within the scope of energy efficiency funds and financing with the ESCO model are given.

The Thailand Energy Efficiency Re-

volving Fund (EERF), which is considered a successful application within the scope of the energy efficiency fund, was launched in 2003. The main objective of the EERF was to ensure that commercial banks in Thailand were willing to finance their investment in EE projects. In this context, ESCOs provided training to banks on how to evaluate EE projects and the payback period. The most important factors in the success of the fund have been the easy application and reporting processes, attractive conditions and interest rates, active promotional activities for the fund to be recognized by all banks, and the communication network established between the stakeholders (banks, private investors and ESCO). The government has primarily used EERF to finance tested products and launched it with almost zero risk as it has generated resources from petroleum taxes (Frankfurt School- UNEP Collaborating Center for Climate & Sustainable Energy Finance, 2012).

Another example of a fund, the Spanish National Energy Efficiency Fund (FNEE), was come into force in 2014. The primary objective of the Fund is to contribute to the achievement of the national energy-saving target set by Article 7 of the Building Energy Performance Directive 2012/27/EU (Spain Energy Efficiency & Trends Policies | Spain Profile | ODYSSEE-MURE, n.d.). In FNEE, EE obligations of energy supply companies constitute the source of funding. The fund is managed by an organization under the Ministry of Energy (IDAE), and the revenues from the fund are used in other energy efficiency programs (Taranto et al., 2020).

In France Government Grant, zero-interest loans, tax refunds, and third-party financing options are available. France has established an energy conversion guarantee fund. In residential buildings over 2 years old, 30% of the investment amount can be deducted from income tax in thermally insulated windows-doors, insulation, boiler replacement, heat pump, cogeneration, and solar water heating system (Schneller & Hennig, 2018).

The USA, China, and Germany come to the fore in successful ESCO applications in the world. Energy Performance Contracts (EPC) are widely used in the ESCO model, which is widely seen in the public sector in the USA. On the other hand, in China, which follows USA in the model initiated by the government, the Global Environment Facility (GEF), and the World Bank provided financial support by the national energy-saving information dissemination center has been established. The development bank, on the other hand, gave partial risk guarantees to commercial banks. This support model has been a substantial step for commercial banks to adapt to ESCO financing (Republic of Turkey Ministry of Energy and Natural Resources, 2017).

Germany, which has been applying the ESCO model since the 1990s, has strengthened its ESCO structure, especially with the awareness-raising activities of regional energy agencies that act as independent intermediaries (Republic of Turkey Ministry of Energy and Natural Resources, 2017). Apart from this, in the Digital Energy Sales Contract project (Thermondo Case) developed in 2016 to ensure energy efficiency in residences, a boiler-combi heating, and hot water system is installed in residential buildings by subscription-rental method over the internet. It is stated that 2.5 million EUR contracts have been made so far and with these optimization studies, 5% energy savings per residence has been achieved (Thermondo – Die Wärme von morgen, n.d.).

When various application examples within the scope of energy efficiency financing in the world are examined, it is seen that the financial support systems carried out with government support from the very beginning of the process are more effective and the fossil fuel taxes are used as a resource for the national energy efficiency funds. Besides, risk guarantee funds provided by the public have critical importance in terms of being adopted easier by financial institutions and other stakeholders, especially in financing with the ESCO model.

### 1.3. Market based policy mechanism tools in energy efficiency

A market-based policy mechanism is defined as policies that use the market to achieve certain environmental

goals. The most well-known of these policy mechanism tools are Energy Efficiency Obligation System (EEOS), energy efficiency competitions, and energy efficiency networks. As of 2017, 46 countries/states in the world are implementing the EEOS system, and three countries are in the transition process. Six countries use energy efficiency competitions (Stavins, 2003). In this study, EEOS and carbon tax have been examined in detail.

### 1.3.1. Energy efficiency obligation scheme (EEOS)

The Energy Efficiency Obligation System (EEOS) offers an approach that requires the commissioning of the entire energy system for cost-effective energy efficiency targets. In general, EEOS determines the energy-saving targets and the obligated parties for achieving this saving (Sarı et al., 2020).

Three actors take part in EEOS. These; responsible body, system manager, and obligated parties. The responsible body is an institution that sets EE targets and relays information. The system manager is responsible for the course of the proceeding. Obligated parties are the parties responsible for achieving the EE targets (Cin, 2018). The relationship between the main actors is given in Figure 5.

In the EU between 2014 and 2016, the most savings (33%) within the scope of the 2012 Energy Performance Directive was achieved with the energy efficiency obligation system (EEOS). Energy and carbon taxes were effective 23%, financial solutions and measures 18% (Figure 6). The contribution of the standard formation is also quite well (12%) (EYODER, 2020).

EEOS in France can be examined as an application that is already in progress. France has been implementing EEOS since 2006 and holding obliged for all energy retail and supply companies that produce above a certain volume. Energy efficiency measures are implemented in residential buildings (76%), public and commercial buildings (14%), and industry (7%). Savings are generally obtained from condensing boilers, roof insulation, and wall insulation. Obligated parties also benefit from the energy renewal fund,

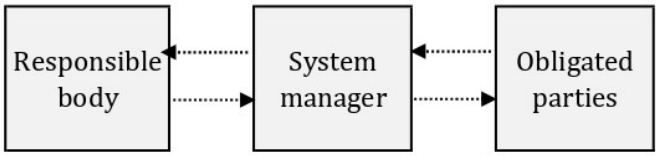


***Figure 5.*** *Primary stakeholders of EEOS.*

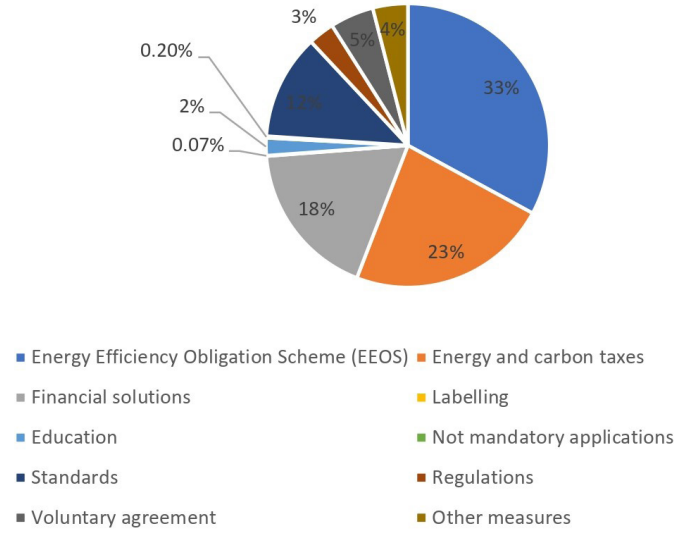


***Figure 6.*** *Contribution of various financing mechanisms to energy efficiency in the EU (EC, 2019).*

which was put into practice in 2015 and provides loans for EE projects (Sarı et al., 2020).

There is no EEOS mechanism currently implemented in Turkey. However, in the National Action Plan published in 2018, the EEOS mechanism is mentioned under the title of Action Y11: Obligation Program for Energy Distribution and Retail Companies, and it is stated that the obligation program will be implemented between 2020-2022 (Republic of Turkey Ministry of Energy and Natural Resources, 2018). However, obligation program has not started by year of 2022.

Within the scope of a master thesis conducted by Cin in 2018, responsible body, system manager, and obliged parties in European countries that are currently implementing EEOS are examined (Cin, 2018). In this context, best practice examples are given, and a model proposal has been developed for the EEOS in Turkey, in which the responsible body is the Ministry of Energy and Natural Resources, the system manager is the energy agency to be established new, and the obligated parties are distribution and supplier com-

panies in all energy types (Cin, 2018).

It is stated that the efficiency of the system can be increased with the punishment and reward approach to be engaged in cases where the EEOS targets are exceeded or not been reached. In addition, in the studies conducted by the International Energy Agency (IEA), it is stated that it should be supported by legislation containing quantitative targets such as an annual measurement verification system to the long-term effectiveness of EEOS (Sarı et al., 2020).

### 1.3.2. Carbon tax in practice

Administrative sanctions and penal policies can also be a financial driving force in addition to the incentives and grants applied within the scope of EE in countries. The idea of benefiting from taxes in solving environmental problems dates back to Pigou in the 1920s (Sandmo, 2008). The carbon tax, which aims to reduce the negative effects on the environment, started from the "*polluter pays*" principle and was first applied in Finland in 1990 and was discussed in the Rio Environment and Development Declaration in 1992. The Kyoto Protocol, published in 1997, also has aimed to establish tax systems such as "excess taxation from those who produce too much carbon".

Carbon taxes directly affect the costs of using fossil fuels due to be market-based taxes. For this reason, individuals or institutions are encouraged to use fewer fossil fuels and turn to alternative energy sources (Hotunluoğlu & Tekeli, 2007).

The carbon tax is currently applied in various world countries such as Finland (1990), Netherlands (1990), Norway (1991), Sweden (1991), Denmark (1992), France (2014), Singapore (2019), Canada (2019). The money collected from carbon taxes has been transferred to the climate fund. This taxation system aims to reduce the global warming-pollution problems caused by fossil fuel users.

Studies are showing that the emission volume has decreased in countries that apply carbon tax. In a study conducted by the Swedish Ministry of Environment, it was estimated that there would be 15% more $CO_2$ emissions for 1995 and %20-25% more for 2000 in the scenario where there was no carbon tax (Johansson, 2000). Some studies have the view that this taxation system does not have a sufficient effect on emission reduction. In the study conducted by Hotunluoğlu and Tekeli (2007), the economic effects of the carbon tax in 18 European countries were examined and it was determined that it did not have a significant effect on emission reduction. It has been stated that the most important reason for this is the exemptions granted to those who use more fossil fuels (Hotunluoğlu & Tekeli, 2007).

Therefore, it is concluded that the legal framework must be well-drawn and exemptions in energy-intensive sectors must be kept to a minimum for the carbon tax to have a significant impact on emission reduction.

The European Union is planning to be gradually engaged the Carbon Border Adjustment Mechanism (CBAM) application, which was launched on 14 July 2021 as part of the European Green Deal, as of 01/01/2023. In practice, it has been stated that an additional taxation system will be applied to five products (cement, iron-steel, aluminum, fertilizer, and electricity) with a high risk of carbon leakage during the import process into the EU. In the regulation, it is stated that the CBAM declaration containing the embodied emission values and country of origin carbon costs of the relevant products will be sought (European Commission & Directorate-General for Taxation and Customs Union, 2021). Turkey, which has foreign business with the EU, has aimed to create a roadmap for this arrangement with the Green Agreement Action Plan published in 2021 (The Republic of Turkey Ministry of Commerce, 2021).

## 2. Energy efficiency financing in Turkey

In this section, the existing financial support systems in Turkey are examined, and the authorities and responsibilities of the stakeholders involved in this context are explained. An evaluation has been made on the limitations and deficiencies in the process of the current system.

Ministry of Energy and Natural Resources (MENR) has the primary authority and responsibility for energy efficiency in Turkey. There are two types of support that MENR currently carries out. These are Productivity Enhancement Project (PEP) supports and Voluntary Agreements. Industrial enterprises with an annual total energy consumption of 500 the ton of oil equivalent (TOE) and above and producing all kinds of goods can apply for the PEP support (MENR, 2008). Voluntary agreements, on the other hand, support institutions and individuals who, as an industrial enterprise with an average annual energy consumption of 500 TOE for the last three years, undertake to reduce their energy intensity by at least 10% within three years to make a voluntary agreement with the Ministry. In the *Implementation Procedures and Principles on Energy Efficiency Supports* published by MENR in 2020, a support payment of 30% (not exceeding one million Turkish Liras) of the energy expenditure of the year of the agreement is made to the enterprise that reaches the targeted energy intensity at the end of the agreement period (EVÇED, 2020). As defined in the law, the supports are mostly aimed at industrial enterprises, and EVD companies are assigned to carry out energy efficiency services in the feasibility and consultancy processes of these projects.

International Financial Institutions (IFI) provide funds for energy efficiency projects in Turkey as well as in other countries around the world. The concessional lending given by IFI is transferred to local financial institutions through the Development Bank of Turkey. The course of proceeding is shown in Figure 7.

Within the scope of energy efficiency financing, there is the Turkish Housing Energy Efficiency Financing Facility (TuREEFF) for projects funded by IFI through the Development Bank. The program, developed by the European Bank for Reconstruction and Development (EBRD) and supported by the Clean Technology Fund (CTF) and the European Union (EU), has provided financing for energy efficiency in residences.

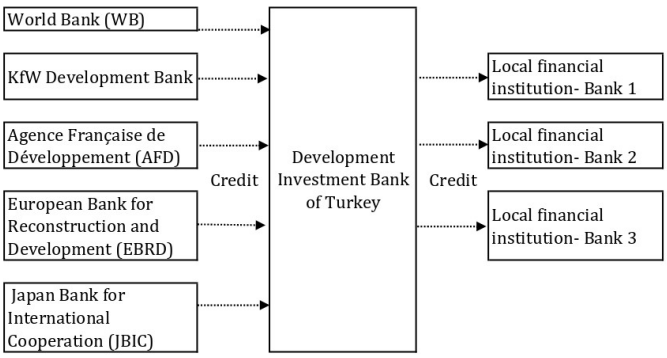


***Figure 7.*** *Loan/credit transfer process.*

Turkey Sustainable Energy Financing Program (TurSEFF), also provided by the same fund, was established to meet EE investments in the public and private sectors. In the general process of TURSEFF, while the EU and CTF constitute the main source of capital, the loans offered through the World Bank were made available through local banks. Small and medium-sized enterprises (SMEs) and residences in the industrial and commercial sectors constitute the target market of the project (Climate Investment Fund & Carbon Trust, 2018).

There are seen bank loans for energy efficiency in residential buildings when the fields of activity of local financial institutions serving in the sector are analyzed. While mortgage loans are a suitable financing option in the purchasing process of energy-efficient buildings, existing buildings' insulation, replacement of window systems are not suitable for energy efficiency investments. Mostly, 5-year maturity restrictions and financing approximately 50% more costly than mortgage loans do not make it possible to repay the loan with savings on investment (Yakut, 2020).

Currently, these loans are loaded on the end-user or property owner and are not supported by any government incentives or grants. Therefore, it can be said that the state-led financial support for energy efficiency investments in existing buildings is quite limited. However, according to article 4.1.e of the Economic Reforms Action Plan published in March 2021, it is aimed to include buildings, agriculture, and service sector in the PEP supports with the amendment to be made in the Energy Efficiency Law (The Republic of Minis-

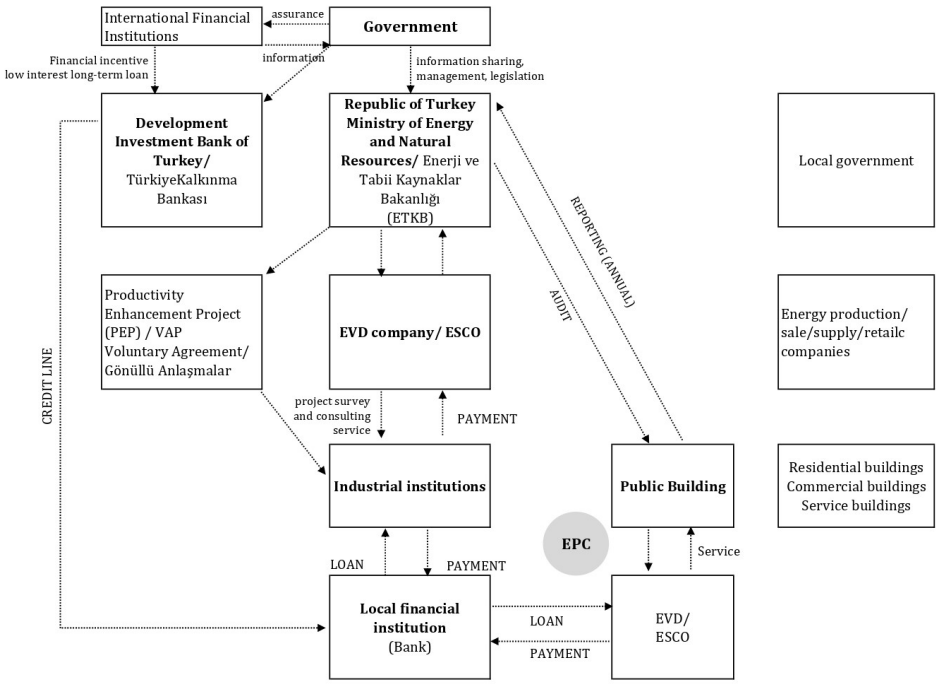


***Figure 8.*** *Energy efficiency stakeholders: Current situation in Turkey.*

try of Treasury and Finance, 2021).

Recently, energy efficiency studies for public buildings have accelerated. With the *Presidential Circular on Energy Saving in Public Buildings* published in 2019, a target of minimum 15% energy savings has been set with the improvements to be made in public buildings until 2023 (Republic of Official Gazette, 2019). Within the scope of the decision on the *Procedures and Principles Regarding Energy Performance Contracts in the Public* published in 2020, it is stated that EPCs can be used for energy efficiency investments in public buildings (Republic of Turkey Official Gazette, 2020). It is foreseen that the use of these contracts will become widespread for the next few years.

The network of relations between the stakeholders involved in energy efficiency financing in Turkey (current situation) is shown in Figure 8.

As is seen from the figure, many stakeholders have duties and responsibilities within the scope of EE in Turkey. The current situation is summarized below:

- The government provides support mostly to industrial enterprises with concessional lending and grants from international financial institutions (PEP and Voluntary Agreements).
- EVDs have been providing feasibility and project consultancy. They currently have not assumed the technical performance risk of the projects as ESCO structures.
- EPC applications in the public sector, which came into effect as of 2020 with the 15% savings target required until 2023 with the Presidential circular published in 2019 accelerated the improvements in EE in this context.
- EE support for residential, commercial and service buildings is quite limited.
- Energy distribution and supply companies that directly affect the energy sector do not have any obligation in the process.
- Local governments, which act as a bridge between the end-user (individual/institution) and the ministry, have limited powers and activities within the scope of EE.
- Awareness-raising activities of MENR within the scope of EE are limited or insufficient.
- As of 2007, no action is taken for the verification/audit of the Energy Performance Certificate (EPC'), which is mandatory for new buildings and existing buildings as of 2020, by MENR. Measurement& validation and monitoring procedures are lacking. (For example, a building

registered as Class C does not have a control mechanism for how much energy it consumes).

Considering that energy performance improvements in buildings are discussed all over the world, and the concept of almost zero energy (even the concept of positive energy) is put into practice, different instruments and incentive mechanisms should be established to implement a major renovation wave like in the EU. In particular, the improvement processes and operation of residential buildings which constitute approximately 84% of the building stock in Turkey, should be clearly defined and supported by the government.

In this context, ESCO structures have a substantial role in energy efficiency investments in the world, especially in small-scale projects is known. ESCOs are firms made up of technical and financial experts that provide services for the financing of Energy Performance Contracts (EPC) and energy efficiency projects (Keskin, 2009). The feature that distinguishes ESCO from EVD is that their contracts are performance-based (EYODER, 2020). In previous studies, it was emphasized that the ESCO concept should be integrated into the existing financing system in Turkey (MENR, 2017; Taranto et al., 2020). In the ESCO Development Roadmap report published in 2017, it was stated that existing EVDs do not have sufficient equipment and experienced specialist personnel to provide ESCO-type services, and they are limited in terms of implementation and financial basis (MENR, 2017). In this context, the short, medium, and long-term actions determined to make the necessary transformation are summarized below (EYODER, 2020):

*Short-term actions (1-2 years)*

- Entry of the ESCO definition into the Energy Efficiency Law as "companies applying energy performance-based contracts".
- EVD companies to have initial ESCOs for capacity-building activities.
- Training of ESCOs continuously and specialization under the leadership of MENR.
- Creating simple contract types that contain basic information about the transaction to be made instead of the long and complex contracts currently applied.
- Standardization and implementation of measurement& verification procedures. (The International Performance Measurement and Verification Protocol should be adopted).
- Guaranteeing the pilot projects to be realized with the ESCO model with grants and guarantees to be given by the government. Adopting an approach that focuses on knowledge sharing.
- Small-scale ESCO projects: Supporting EE projects that focus on a simple, straightforward, single technology with short payback periods in the first place, for ESCOs to increase their business portfolio and gain experience in implementation.
- Capacity building and training programs for lenders: The problem is that lenders are not familiar with EE projects and are not competent to understand ESCO agreements. For this purpose, it is recommended that banks carry out training and awareness-raising activities for their employees and gain technical expertise on EE.
- Grant programs, tax rebates/rebates, subsidies (VAT reduction/exemption), tax measures (users with low energy consumption demand tax relief, those with high energy / $CO_2$ consumption pay more tax), low interest, and interest-free loans are suggested.
- To popularize EPC applications in the public sector, ESCO-public can jointly carry out promotional projects.

*Medium-term actions (3-5 years)*

- Identification of Market Developers: The Energy Efficiency Agency to be established within the MENR can act as a market developer. It can provide information sharing and support on technical and financial issues.
- Existing EVD firms can act as market facilitators and support ESCOs.
- Establishing an independent dedicated mechanism for use in dispute resolution, which is already separated from long and complex court processes, and consultation with relevant experts.
- Establishing a control mechanism

that will increase confidence in ESCOs in the EE market. MENR can determine the criteria and international certification standards can be used in this context.
- Utilizing EE networks in the industry, voluntary industry groups can be formed that will persuade them to make EPC investments. Sharing of knowledge and experience.

*Long-term actions (5+ years)*
- Tradable white certificates may be introduced to the market in order not to limit the existing incentives for ESCOs in long-term applications. The white certificate is given to organizations where energy savings are verified.
- The complexity of residential buildings/impact on long-term performance and ownership issues (multiple households) are barriers for ESCOs. A new regulation that contains EE measures with binding/ mandatory provisions for landlords and tenants is recommended for this building typology.
- Establishment of ESCO database: Establishment of a national database for processing implemented ESCO projects.

The ESCO transformation mentioned in the report can only be possible with a determined and transparent senior management approach. For this reason, it is concluded that government-supported financing mechanisms should be engaged as soon as possible and the stakeholders in the process should act with a holistic approach with binding legislation.

## 3. Financial model adaptation for building energy efficiency retrofits in Turkey

In this part of the research, a financial model adaptation has been made to be used in energy efficiency improvements of residential buildings in Turkey. In this model, it is suggested that singular applications proposed in the energy efficiency financing of buildings in previous literature studies should be handled with a holistic approach.

The financial instruments proposed to be integrated to be used in energy efficiency improvements of existing residential buildings are listed below:
- Establishment of the Turkish Energy Agency (TEA).
- Financing with the ESCO model.
- Energy Efficiency Obligation System (EEOS) implementation.
- Establishment of the National Energy Efficiency Fund
- Carbon tax practice.
- Establishment of a guarantee fund.
- Tax exemptions for special applications.

### 3.1. Establishment of the Turkish Energy Agency (TEA)

The advantages of establishing a national energy agency within the MENR have also been reported in previous studies (MENR, 2017; Taranto et al., 2020 and EYODER, 2020). The institution, which will become operational after the necessary legislative arrangements are made, can be the system manager that will contribute to the development of the ESCO market. The TEA should act as a controller to take an active role in the annual reporting, measurement& verification, and monitoring procedures.

#### 3.1.1. Financing with ESCO model

It is recommended that ESCOs, which play a key role in energy efficiency investments in the world, should be included in the system with the necessary legislative arrangements. The success of ESCO in small and medium-sized projects has also been seen in previous applications. Although issues such as the complexity of the ownership status of multi-story residential buildings and the long-term impact of the improvements to be made show that residential buildings are not very suitable for initial applications (MENR, 2017), it is predicted that this problem can be overcome with pilot projects to be supported by the government.

#### 3.1.2. Energy efficiency obligation scheme (EEOS)

Following the targets set in the action plan, the savings targets can be achieved by increasing the obligation of energy distribution/supply companies in Turkey with the EEOS mechanism. Supporting the EEOS to be created with reward-penalty mechanisms and measurement& verification

requirements and transferring the penal sanction practices to the national energy efficiency fund to be allocated to be used in EE projects can accelerate energy efficiency projects. In this system, the responsible body is MENR, the system manager is TEA, and the obliged parties are energy generation, sales, supply, and retail companies.

### 3.1.3. National energy efficiency fund

The existence of a similar fund was discussed in the National Energy Efficiency Action Plan (UEVEP) report. However, there is no implemented system as of yet. Within the scope of the study, it is planned to transfer the fines to be applied as a result of the commissioning of the EE fund and various sanctions (such as failure to meet obligations, excessive $CO_2$ consumption) to this fund.

### 3.1.4. Carbon tax practice

Previous studies have shown that, in addition to the incentives and grants applied, administrative sanction and penalty policy applications can also be a financial driving force. It would be more meaningful to implement this tax system in the energy-intensive industry sector in the first place in Turkey and to gradually include the building and other sectors in this application. Carbon taxes are considered a source for the national energy efficiency fund.

### 3.1.5. Guarantee fund

Guaranteeing energy efficiency investments before the government is an important step towards reducing investment risks and building public confidence for a system that is still new. The guarantee fund may engage during the initial capital formation of ESCOs or in case the promised energy savings cannot be achieved (In this context, special insurance policies for EE can also be created).

### 3.1.6. Tax exemptions

The property owners may be exempted from some/all of VAT and/or income tax for applications such as thermal insulation, boiler replacement, insulated window-glass systems in the building EE retrofits. There are similar applications in the world. In this context, the government can manage and monitor EE retrofits through the necessary legislative arrangements and local governments. To increase the contribution and responsibility of local governments in the EE retrofits, a process proposal has been introduced by authors. According to this;

- The owners are informed about the EE retrofits through the local administration and the Ministry of Urbanization.
- Owners/end-users apply for building EE retrofit.
- According to the region applied, an ESCO firm is assigned through the database.
- ESCO conducts feasibility studies for the existing building. (EE savings feasibility study)
- Feasibility study and other required technical projects are submitted to the municipality.
- Building EÊ retrofit approval takes place (Fees and tax exemptions are provided for the property owners and end-users).
- EE retrofit permit is obtained by the municipality.
- The share obtained from the savings is paid to ESCO. (A similar progress payment system applied to building audit companies can be adapted).
- A savings verification report is submitted to the municipality on an annual basis. Measurement& verification procedure is applied by an independent organization.
- Data of the renovated building is processed on a database by the municipality (before/after energy consumption data, implemented technologies)
- Energy consumption data before and after renovations should be shared as open access.

Selecting a pilot area for building energy efficiency renovations and realizing EE projects with the government-local government-ESCO partnership will accelerate publicity and awareness activities. A fee exemption before the EE retrofit and an income/VAT tax exemption after the modification should be provided to the property owners and end-users.

For financial model adaptation to become reality, the following stake-

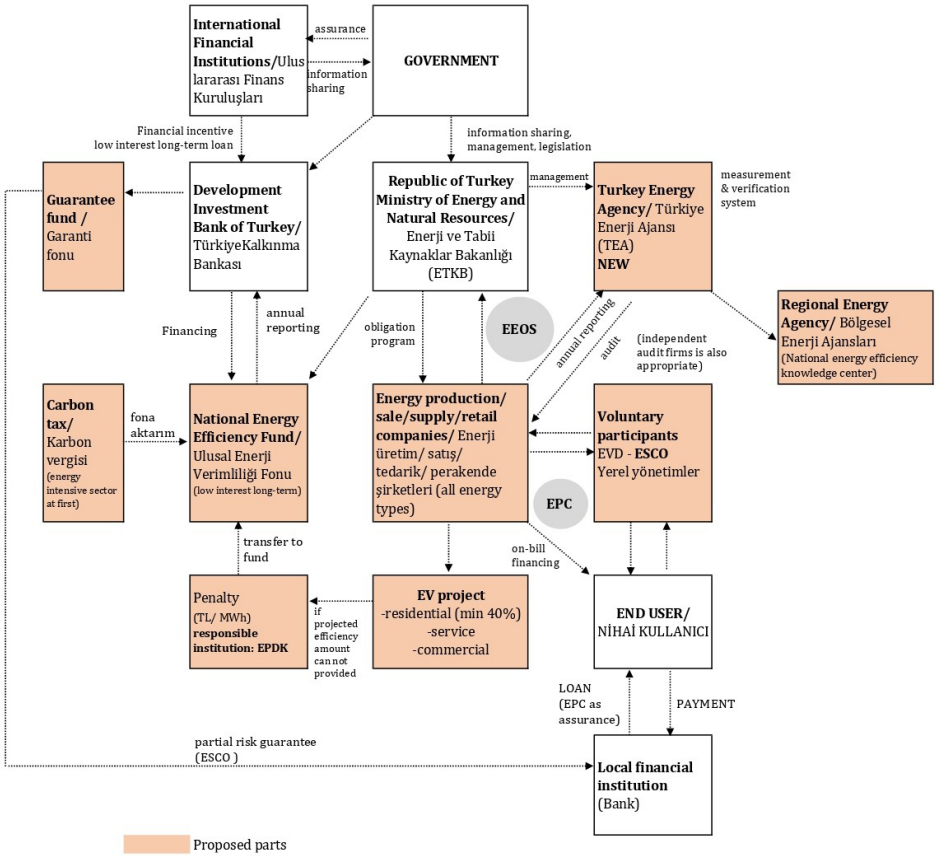


***Figure 9.*** *Relation between stakeholders in financial model adaptation.*

holders should take an active role in the process:

1. International Financial Institutions (IFI)
2. Government
3. Ministry of Energy and Natural Resources (MENR)
4. Turkish Energy Agency (TEA) – newly established
5. Regional energy agencies
6. Financial institutions (Bank)
7. Energy Distribution Companies
8. EVD-ESCO
9. Investor
10. Supplier companies
11. Local governments (municipalities, non-governmental organizations)
12. End-user (owner, tenant)

The proposed relationship network between stakeholders is shown in Figure 9.

When the proposed financial model is analyzed through the input-output relationship, the contributions of the stakeholders that involved in the process to the system are shown in Figure 10.

Necessary actions and maturities for the foreseen financial model to be applicable are given in Table 1.

## 4. Conclusion

Energy and resource efficiency applications in cities and buildings are of critical importance in this period when worldwide has been dramatically faced the consequences of global warming. These applications impose an additional financial burden on the investment, especially if the building is not in the early design phase. It is known that energy efficiency practices in the world are supported by various financing mechanisms. The financial support systems currently implemented in Turkey are mostly for industrial enterprises and do not provide an adequate solution for EE applications of residential buildings.

In this research, a financial model adaptation has been made to be used in energy efficiency improvements of residential buildings in Turkey. In this model, it has been suggested that the singular applications proposed in previous literature research within the scope of EE financing of buildings should be handled with a holistic approach. Applications/systems that will work together are the Turkish Energy

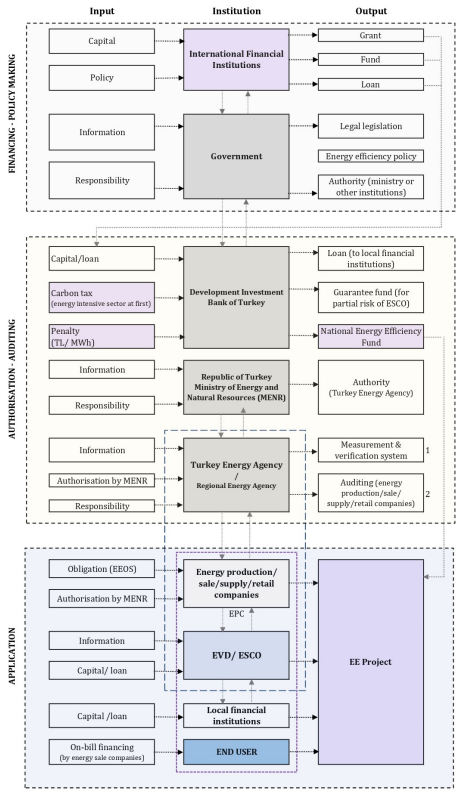


***Figure 10.*** *Input-output relationship in the proposed financial model adaptation.*

Agency (TEA), ESCO, EEOS, the national energy efficiency fund, carbon tax practice, guarantee fund, and tax exemptions.

Although each part of the proposed financial model adaptation has been examined and evaluated in individual studies, there is no comprehensive study that deals with the system with a holistic approach. While creating a holistic approach within the scope of the study, it is planned to create a set up in the light of the suggestions in the individual applications in question. An evaluation will be made in the later stages of the study on the reliability of the research. In order to provide a holistic approach, it is necessary to implement some verification systems, such as the regulation of the relevant protocols and standards by the government to measure the efficiency of the system, and the periodic gathering of all active stakeholders in the model to evaluate the positive and negative aspects of the system.

It is thought that if the actions within this scope are implemented within the suggested terms, it will make a difference in the energy efficiency practices of residential buildings.

***Table 1.*** *Actions and maturities required for financial model adaptation.*

| Action Name | Responsible Body |
|---|---|
| ***First stage (1-3 years)*** | |
| Establishment of the Turkish Energy Agency (TEA). | Government (should make necessary legislative arrangements). |
| Establishment of National Energy Efficiency Fund. | Government, MENR |
| Establishment of public guarantee fund. | Government, Development Bank |
| Enforcement of carbon tax (primarily on energy-intensive sectors) | Government (should make necessary legislative arrangements). |
| Implementation of EEOS. Inclusion of energy distribution/supply companies in all energy types into the system. | Government (should make necessary legislative arrangements). MENR, TEA |
| Determination of pilot regions where energy companies responsible for implementing the EE target will implement EE projects. | Ministry of Urbanization, TEA |
| ***Second Stage (3-5 years)*** | |
| Enforcement of carbon tax (building sector). | Government (should make necessary legislative arrangements). |
| ***Creation of building inventory-database*** | |
| Inventory of existing residential building stock in Turkey (TABULA project example). | TEA, Ministry of Urbanization, local governments. |
| ***Primary measures for ESCOs*** | |
| Making necessary legislative arrangements in order to support financial of ESCOs. | Government |
| Organizing the necessary training in the process of converting EVDs to ESCO (training of the nondiscretionary employees within ESCO). | MENR |
| ***Measurement& Verification Procedures*** | |
| Financial incentive arrangements for independent auditors to access the necessary technological infrastructure for measurement& verification procedures. | MENR, TEA |
| Inclusion of measurement and verification procedures into all EE projects (Mandatory). | TEA, MENR |
| Translation and implementation of IPMVP (International Measurement and Verification Protocol) published by EVO (Efficiency Valuation Organization). | TEA, MENR |
| ***Third Stage (5-10 years)*** | |
| Integrating residential buildings into the ENVER portal *(transferring the measurement, verified/reported buildings to the database)* | TEA, Ministry of Urbanization. |
| Making the ENVER portal open access that is currently only open to Ministry personnel. | |

## References

Cin, R. (2018). *Türkiye'de enerji verimliliği yükümlülükleri sisteminin yapılandırılması analizi [Configuration analysis of energy efficiency obligation scheme in Turkey].* [Master's Thesis, Istanbul Technical University]. Council of Higher Education Thesis Center.

Climate Investment Fund & Carbon Trust. (2018). *Lessons from the CIF experience in scaling up energy efficiency: Case study report.* https://www.climateinvestmentfunds.org/sites/cif_enc/files/knowledge-documents/lessons_from_the_cif_experience_in_scaling-up_energy_efficiency_-_case_study_report_web.pdf

EC 2019, 9.4.2019 COM (2019). 224, 2018 assessment of the progress made by Member States towards the national energy efficiency targets for 2020 and towards the implementation of the En-

ergy Efficiency Directive 2012/27/EU.

Republic of Turkey Ministry of Energy and Natural Sources. (2008). Enerji Kaynaklarının ve Enerjinin Kullanımında Verimliliğin Artırılmasına Dair Yönetmelik [Regulation on Increasing Efficiency in the Use of Energy Resources and Energy]. *Republic of Turkey Official Gazette, 27035*, 25th October 2008.

EYODER. (2020). *Enerji Verimliliği, Enerji Yönetimi, Enerji Etütleri ve Enerji Performans Sözleşmeleri Öneri Raporu*: *Enerji Verimliliği Paydaşları Arasında İletişim ve Veri Paylaşım Ağının Geliştirilmesi* [Energy Efficiency, Energy Management, Energy Audits and Energy Performance Contracts Proposal Report: Development of Communication and Data Sharing Network among Energy Efficiency Stakeholders]. (2020). Yıldız Matbaa ve Dijital Baskı.

EVÇED. (2020). *Enerji Verimliliği Destekleri Hakkında Uygulama Usul ve Esasları [Implementation Procedures and Principles on Energy Efficiency Supports]*. Ankara: MENR. https://www.yatirimadestek.gov.tr/pdf/assets/upload/dosyalar/uygulama_usul_ve_esaslari_enerji_verimliligi_destekleri.pdf

European Commission & Directorate-General for Taxation and Customs Union. (2021). *Carbon border: Adjustment mechanism*. https://op.europa.eu/publication/manifestation_identifier/PUB_KP0521215ENN

Frankfurt School- UNEP Collaborating Centre for Climate & Sustainable Energy Finance. (2012). Case Study: The Energy Efficiency Revolving Fund, http://www.fs-unep-centre.org/.

Hotunluoğlu, H., & Tekeli, R. (2007). Karbon Vergisinin Ekonomik Analizi ve Etkileri: Karbon Vergisinin Emisyon Azaltıcı Etkisi Var Mı? [Economic Analysis and Effects of Carbon Tax: Does Carbon Tax Have an Emission Reducing Effect?], *Sosyoekonomi*, 3(6), 107-125.

International Energy Agency. (2021). *World Energy Outlook 2021*, IEA, Paris. https://www.iea.org/reports/world-energy-outlook-2021

IPCC. (2018). Global Warming of 1.5°C.An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press

Johansson, B. (2000). *Economic Instruments in Practice 1: Carbon Tax in Sweden*, Innovation and the Environment, OECD: Paris.

Keskin, T. (2009). *Enerji verimliliği projelerinin finansmanı [Financing of energy efficiency projects]*. *Tesisat Mühendisliği Dergisi,* 111, 17-24.

https://mmo.org.tr/sites/default/files/6a1c98f7556cc91_ek.pdf

Republic of Turkey Ministry of Energy and Natural Resources (MENR). (2017). *ESCO Gelişim Yol Haritası.* Avrupa Birliği / Katılım Öncesi Mali Yardım Aracı (IPA) Enerji Sektörü Teknik Yardım Projesi [*ESCO Development Roadmap*. European Union / Instrument for Pre-Accession Assistance (IPA) Energy Sector Technical Assistance Project]. (Publ. No. TF 016532 –TR). Ankara. https://ipaee2012.enerjiprojeleri.eu/Dosyalar/Download/Dokumanlar/tr/Proje%20%C3%87%C4%B1kt%C4%B1lar%C4%B1/ESCO%20Geli%C5%9Fim%20Yol%20Haritas%C4%B1.pdf

Republic of Turkey Ministry of Energy and Natural Resources. (2018). *Enerji verimliliği ulusal eylem planı 2017-2023 [National energy efficiency action plan 2017-2023]*. http://www.yegm.gov.tr/document/20180102M1_2018.pdf

Republic of Turkey Official Gazette. (2007). Enerji verimliliği kanunu [Energy efficiency law]; Law No. 5627, *Republic of Turkey Official Gazette, 26510*, Ankara, 2007.

Republic of Turkey Official Gazette. (2019). Kamu Binalarında Enerji Tasarrufu Konulu Cumhurbaşkanlığı Genelgesi [Presidential Circular on Energy Saving in Public Buildings]; No. 2019/18, *Republic of Official Ga-*

*zette, 30860,* 16th August 2019.

Republic of Turkey Official Gazette. (2020). 2850 sayılı Kamuda Enerji Performans Sözleşmelerine İlişkin Usul ve Esaslar Hakkında Karar [Decision on the Procedures and Principles Regarding Energy Performance Contracts in the Public Sector]; Law no. 2850, *Republic of Turkey Official Gazette, 31220,* 20th August 2020.

Republic of Turkey Ministry of Treasury and Finance. (2021, March 12th). *Ekonomi Reformları [Economy Reforms]*. https://ms.hmb.gov.tr/uploads/2021/03/Ekonomik-Reformlar-Kitapcigi.pdf.

Republic of Turkey Ministry of Trade. (2021). *Yeşil Mutabakat Eylem Planı 2021 [Green Deal Action Plan 2021]*. https://ticaret.gov.tr/data/60f1200013b876eb28421b23/MUTABAKAT%20YE%C5%9E%C4%B0L.pdf

Sandmo, A. (2008). Pigouvian taxes. In S. N. Durlauf & L. E. Blume (Eds.), *The New Palgrave Dictionary of Economics: Volume 1 – 8* (pp. 4947–4948). Palgrave Macmillan UK. https://doi.org/10.1007/978-1-349-58802-2_1286

Sarı, A. C., Düşmez Tek, E., Çakmak, M. Y., Seefeldt, F., & Langreder, N. (2020). *Enerji Verimliliği Çözümü: Piyasa Temelli Politika Mekanizması Araçları [Energy Efficiency Solution: Market Based Policy Mechanism Tools]*. SHURA Energy Transition Center.

Schneller, A., & Hennig, C. (2018). *The Energy Transition Tax Credit (CITE) in France* [Fact sheet]. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). https://www.euki.de/wp-content/uploads/2018/09/fact-sheet-energy-transition-tax-credit-fr.pdf

*Spain energy efficiency & Trends policies | Spain profile | ODYSSEE-MURE*. (n.d.). Retrieved March 4, 2022, from https://www.odyssee-mure.eu/publications/efficiency-trends-policies-profiles/spain.html

Stavins, R. N. (2003). Chapter 9—Experience with Market-Based Environmental Policy Instruments. In K.-G. Mäler & J. R. Vincent (Eds.), *Environmental Degradation and Institutional Responses* (Vol. 1, pp. 355–435). Elsevier. https://doi.org/10.1016/S1574-0099(03)01014-3

Taranto, Y., Sarı, A. C., Künar, A., Düşmez Tek, E., Çakmak, M. Y., Seefeldt, F., & Langreder, N. (2020). *Enerji Verimliliği Çözümü: Finansman Mekanizmaları* [Energy Efficiency Solution: Financing Mechanisms]. SHURA Energy Transition Center.

Thermondo – Die Wärme von morgen. (n.d.). Wir sind Ihr Heizungsbauer vor Ort | thermondo. Retrieved March 4, 2022, from https://www.thermondo.de/

TUIK. (n.d.). *Building permit statistics*. Turkish Statistical Institute. Retrieved March 6, 2022, from https://biruni.tuik.gov.tr/yapiizin/giris.zul.

Wei, T, Wu, J. & Chen, S. (2021). Keeping Track of Greenhouse Gas Emission Reduction Progress and Targets in 167 Cities Worldwide, *Frontiers in Sustainable Cities, 3,* 696381. https://doi.org/10.3389/frsc.2021.696381.

Yakut, Ö. (2020, July 29). *Enerji verimliliğinde kullanılan en yaygın finansman mekanizmaları neler? [What are the most common financing mechanisms used in energy efficiency?* Clean Energy. https://temizenerji.org/2020/07/29/enerji-verimliliginde-kullanilan-en-yaygin-finansman-mekanizmalari-neler/