EFFECT OF ENERGY EFFICIENCY (ECODESIGN AND ENERGY LABELLING) REGULATIONS ON SUSTAINABLE DEVELOPMENT

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

MELİK HÜSEYİN HAMİDİOĞULLARI

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
EARTH SYSTEM SCIENCE

SEPTEMBER 2024

Approval of the thesis:

EFFECT OF ENERGY EFFICIENCY (ECODESIGN AND ENERGY LABELLING) REGULATIONS ON SUSTAINABLE DEVELOPMENT

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ABSTRACT

EFFECT OF ENERGY EFFICIENCY (ECODESIGN AND ENERGY LABELLING) REGULATIONS ON SUSTAINABLE DEVELOPMENT

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September 2024, 174 pages

Energy efficiency is essential in times of energy scarcity. The role of sustainability in every area has a profound effect in terms of energy consumption and production; therefore, energy efficiency should be handled from a sustainability perspective in order to succeed in the competition between the development of the countries.

“Energy Efficiency First” is a fundamental principle for countries implementing energy policies strategically. In order to guarantee that the countries can meet their 2030 aim of decreasing greenhouse gas emissions, product regulation on energy efficiency (Ecodesign and Energy Labelling) should be implemented determinedly.

This study focuses on product regulations from a sustainability perspective since it is a significantly new term, and product regulations have not yet been re-evaluated from a sustainability perspective.

This study examines the extent to which the goals of sustainable development are directly linked to product regulations regarding energy efficiency. It also analyses the challenges and problems that constitute obstacles to the implementation of such regulations in sectors, including white appliances, lighting, and machinery.

Furthermore, the objective was to ascertain the participants’ perspectives on the Sustainable Development Goals (SDGs) and the implications of new sustainability requirements for products. Consequently, the survey results were subjected to analysis, and based on these findings, recommendations were proposed for preparing the industry for the design of sustainable products. These recommendations included the establishment of a design hub, the conducting of collaborative projects with suppliers, the overcoming of institutional gaps, and the enhancement of cooperation between public authorities and the private sector for the transition to a circular economy.

Keywords: Sustainable Development Goals (SDGs), Ecodesign for Sustainable Products Regulation (ESPR), Circular Economy, Energy Efficiency, Ecodesign.

ÖZ

ENERJİ VERİMLİLİĞİ (EKOTASARIM VE ENERJİ ETİKETLEME) DİREKTİFLERİNİN SÜRDÜRÜLEBİLİR KALKINMAYA ETKİSİ

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Eylül 2024, 174 sayfa

Enerji kıtlığının yaşandığı bu dönemlerde enerji verimliliğinin yeri daha da önem kazanmaktadır. Sürdürülebilirliğin yer aldığı tüm alanlarda oynadığı rol, enerji üretimi ve tüketimi açısından kapsamlı bir etki yaratmakta, dolayısıyla ülkelerin kalkınma çabalarında birbirleriyle yaşamış oldukları rekabette başarılı olabilmek için enerji verimliliğini sürdürülebilirlik perspektifinden de ele almak gerekmektedir.

“Önce Enerji Verimliliği” prensibi enerji politikalarını stratejik olarak uygulayan ülkeler için temel ilkedir. Ülkelerin sera gazı emisyonlarını azaltma yönündeki 2030 hedeflerine ulaşabilmelerini garanti altına almak için enerji verimliliğine ilişkin ürün düzenlemelerinin (Ekotasarım ve Enerji Etiketleme) kararlılıkla hayata geçirilmesi büyük önem arz etmektedir.

Bu çalışma, sürdürülebilir kalkınma hedeflerinin enerji verimliliğine ilişkin ürün düzenlemeleriyle ne ölçüde doğrudan bağlantılı olduğunu incelemektedir. Ayrıca beyaz eşya, aydınlatma ve makine gibi sektörlerde bu tür düzenlemelerin uygulanmasının önünde engel teşkil eden zorlukları ve sorunları analiz etmektedir.

Ayrıca, katılımcıların Sürdürülebilir Kalkınma Amaçları (SKA) ve ürünler için yeni sürdürülebilirlik gerekliliklerinin etkileri hakkındaki bakış açılarını tespit etmek hedeflenmiştir. Sonuç olarak, anket sonuçları analize edilmiş ve elde edilen bulgulara dayanarak, endüstriyi sürdürülebilir ürünlerin tasarımına hazırlamak için öneriler sunulmuştur. Bu öneriler arasında yeni bir tasarım merkezinin kurulması, tedarikçilerle ortak projeler yürütülmesi, kurumsal eksikliklerin giderilmesi ve döngüsel ekonomiye geçiş için kamu kurumları ile özel sektör arasındaki işbirliğinin artırılması yer almaktadır.

Anahtar Kelimeler: Sürdürülebilir Kalkınma Amaçları (SKA), Sürdürülebilir Ürünler İçin Ekotasarım Yönetmeliği, Döngüsel Ekonomi, Ekotasarım, Enerji Verimliliği.

To my beloved family

ACKNOWLEDGMENTS

First and foremost, I would like to deepest gratitude to my advisor Prof. Dr. Bülent Gültekin Akınoğlu, and co-advisor Assoc. Prof. Dr. Şiir Kılkış for their support and guidance throughout this study. I also thank them for their contribution and for feedback on the study's problems and concerns.

Then, I would like to thank Dr. M. Hürol Mete and Berker Karagöz for their support during the study, motivation, and encouragement.

I want to thank all participants for their contributions.

And lastly

I am forever grateful for my kind and supportive family.

I would sincerely thank my wife "Havva" who made every effort possible without growing exhausted, and my kids "Zeynep Bilge" & "Berk" for their patience during my endless working intention.

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APS	Announced Pledges Scenario
B2B	Bussiness To Bussiness
B2C	Bussiness To Customer
BEIS	Business, Energy And Industrial Strategy
CAD	Computer-Aided Design
CE	Circular Economy
CEAP	Circular Economy Action Plan
CO2	Carbon Dioxide
DP	Development Plan
EC	European Commission
ED&EL	Ecodesign & Energy Labeling
EEC	European Economic Community
EEI	Energy Efficiency Index
ERP	Energy-Related Products
ESCO	Energy Service Companies
ESPR	Ecodesign For Sustainable Products Regulation
EU	European Union
EUROSTAT	Statistical Office Of The European Communities
GDP	Gross Domestic Product
GHG	Green House Gas

GUNAM	Center For Solar Energy Research And Applications
HVAC	Heating, Ventilation And Air Conditioning
HLPF	High-Level Political Forum On Sustainable Development
ICT	Information And Communication Technology
IEA	International Energy Agency
LCA	Life Cycle Assessment
LED	Light-Emitting Diode
MDG	Millennium Development Goals
MEPS	Minimum Energy Performance Standards
MIT	Massachusetts Institute Of Technology
MSA	Market Surveillance Authorities
MTCO2E	Million Tonnes Of Co2 Equivalent
MV&E	Monitoring, Verification And Enforcement
NDP	National Development Plan
NEEAP	The National Energy Efficiency Action Plan
NGO	Non-Governmental Organization
NZE	Net Zero Emission
OSP	Official Statistical Programme
PSB	Presidency Of Strategy And Budget
PV	Photovoltaic
SD	Sustainable Development
SDGS	Sustainable Development Goals

SEAI	Sustainable Enrgy Authority Of Ireland
SME	Small And Medium-Sized Enterprise
STEPS	Stated Policies Scenario
SV	Sustainability Valley
TURKSTAT	The Turkish Statistical Institute
UN	United Nations
UNCHE	United Nations Conference On The Human Environment
UNEP	United Nations Environment Programme
UNFCC	Un Framework Convention On Climate Change
WCED	World Commission On Environment And Development
WM	Washing Machine
WSSD	World Summit On Sustainable Development

CHAPTER 1

INTRODUCTION

The 21st century compels the world to confront a formidable challenge: achieving sustainable development. This multifaceted concept embodies not only economic prosperity but also environmental responsibility and social equity. As we navigate this complex landscape, energy efficiency emerges as a crucial pillar for a sustainable future. Minimizing energy consumption without compromising on essential services can pave the way for a world characterized by reduced environmental impacts, long-term resource security, and sustained economic growth.

Responsible and sustainable consumption and production have become worldwide consideration issues affecting people, governments, and businesses. There is an enormous resource problem and environmental threat facing the planet today. Global population increase and rising production demand have put pressure on the world's finite natural resources. Although raw material output has increased due to the growing human population, it is still insufficient to meet the demands without an effective and dedicated solution to this issue. Identifying applicable strategies and implementing tools and preventive measures for reducing consumption and increasing production effectiveness is critical.

Because of the recent sharp rises in both energy demand and CO_2 emissions, energy efficiency has emerged as one of the keystones of energy-related areas and products that use energy and resources like water. Rapidly-developing technological advancements have increased energy efficiency, lowering energy consumption, resource optimization and greenhouse gas emissions. Energy-related activity savings are strongly correlated with advancements in technology and modifications in human behavior.

The majority of energy savings resulting from technology advancements are attributable to increases in energy efficiency through the instrument of regulations and voluntary agreements.

The International Energy Agency (IEA) has a high situational awareness of that and supports the idea of "Energy Efficiency First." It also encourages countries to take action and develop strategies based on this philosophy. Product regulations on energy efficiency (Ecodesign and Energy Labelling) should be applied firmly to ensure that the countries can accomplish their target of minimizing greenhouse gas emissions and resource consumption.

1.1 Problem Definition and Novelty

This thesis explores the vital role of energy efficiency regulations (ecodesign and energy labeling) in Türkiye while pursuing sustainable development. Türkiye, a nation experiencing rapid economic expansion and urbanization, faces the significant challenge of balancing its growing energy needs with environmental protection. Against this backdrop, this research delves into the national policies, regulations, and initiatives aimed at promoting energy efficiency.

Are products adequately sustainable or not? Moreover, to what extent do these technical regulations contribute to sustainable development?

While navigating through these questions, this study finds out the sectoral shortcomings, obstacles that they meet and difficulties in Turkish industry has encountered in implementing the legislation, especially in leading industries like white goods, Türkiye's most significant manufacturing sectors for turnover and employment[1], Electric Motor, lighting sector and HVAC with a considerable impact

[1] Türkiye is the largest white goods producer in Europe and 2nd largest in the world with a total of almost 60,000 employees (The Investment Office of the Presidency Report, March 2024)

on our economies. Emerging sustainable development with ecodesign and energy labeling regulations and understanding the approach of the private sector in this area are essential to developing strategies. According to this perspective, governments and the sector will benefit from the results of this research and its suggestions.

This study aims to fill the gap regarding the lack of studies that specifically focus on investigating the relationship between specific SDGs and product regulations, such as ecodesign and energy labelling. In order to understand the impact of ecodesign and energy label regulations on sustainable development, it is essential to consider the three main pillars of the SDGs: economy, society and environment. Our study addresses this gap in the literature, providing a more comprehensive perspective for understanding the impact of product regulation.

1.2 Research Methods

These study issues are addressed through the use of qualitative research methods. The study's data collection method, semi-structured interviews, was conducted with representatives of several product regulations' stakeholders, experts specifically those involved in the technical regulation harmonization, who have a background and experience in eco-design and energy labeling legislation, and sustainability.

Given the variety of the target groups, sectoral differences, size of the sectors, and product range, semi-structured interviews comprising open-ended questions were deemed the optimal method for data collection.

This approach allows both the researcher and participants the opportunity of delving more deeply into a specific topic, understanding the point of view and how they address this issue in their business life.

The interviews were conducted using question sets prepared for three clusters and product categories. Outcomes, analysis, and data obtained from participants will be shared in Chapter 4. These question sets were sent to the participants before the interview, most of them done via remote meeting platform, and most of the interviews were recorded to make analysis and gather outcomes afterward.

This interview was structured to reflect the opinions of the private sector, including manufacturers, importers, OEMs, and consumers. The number of people who expressed their opinion was 21, but statistical outputs were acquired from 17 participants because the interviews were made on a specific date, one to one meeting, and got permission to record the interview (except one of the participants' opinion, P9, delivered by e-mail). Nevertheless, all participants' opinions were reflected somehow in the discussion and results section, so were benefited from all the valuable participants' remarks.

1.3 Structure of the Thesis

After the introduction part, the thesis begins by establishing a foundational understanding of sustainable development and examining its core principles, tracing its historical evolution from its early conceptualizations to its concrete articulation through the Sustainable Development Goals (SDGs) adopted by the United Nations in 2015. It also highlights the interconnected nature of the SDGs, highlighting their relevance to Türkiye's development trajectory.

Chapter Two also delves into the critical relationship between energy efficiency and sustainability and explores how optimizing energy use diminishes environmental burdens, including greenhouse gas emissions, air and water pollution, and resource depletion. This chapter will then examine how energy efficiency fosters economic growth by reducing energy costs for businesses and consumers.

Chapter Three provides an overview of the nation's energy policy and highlights the evolution of the policy framework and its strategic priorities. This chapter then examines the national energy efficiency policy framework, focusing on the National Energy Efficiency Action Plan (NEEAP) and Development Plans of Türkiye in shaping the nation's energy efficiency goals. Also investigates Türkiye's journey towards harmonizing its regulations with the European Union’s (EU) Ecodesign and Energy Labeling Framework. Also in this chapter we explore the introduction of the Ecodesign for Sustainable Products Regulation (ESPR) as a game-changer in the ecodesign landscape and examines the broader scope and potential impact of ESPR compared to the existing Ecodesign Regulation. Life Cycle Assessment (LCA) is mentioned as a pivotal instrument for assessing the environmental consequences of products at each stage of their life cycle. Understanding the environmental footprint of products is critical for informing ecodesign practices and achieving a more circular economy.

The final part of this chapter briefly introduces the concept of a Circular Economy (CE) as a potential future vision for sustainable resource management. A circular economy emphasizes closed-loop systems, minimizing waste and maximizing resource recovery. It demonstrates how ecodesign and energy efficiency can contribute to a more sustainable future for Türkiye.

In the concluding chapters synthesize the key findings of the thesis, highlighting how energy efficiency serves as a cornerstone for Türkiye’s pursuit of sustainable development. The chapter outlines remaining challenges and potential opportunities for policy improvements, technological advancements, and consumer behavior shifts. Finally, the paper sets out a research and development agenda for the future, with the objective of achieving greater energy efficiency and thus facilitating a more sustainable future for Türkiye.

CHAPTER 2

LITERATURE REVIEW

This chapter aims to explore the concept of sustainable development. Begins with discussing the broader concept of sustainable development before delving into the topic of energy efficiency from a narrower perspective. The chapter provides a comprehensive literature review that covers the definition and evolution of sustainable development, as well as methods for assessing. Also this chapter explores the relationship between sustainable development and energy efficiency, sustainable energy indicators, and how to approach energy efficiency from a sustainability perspective. The objective of this chapter is to enhance comprehension of the role of energy efficiency in accomplishing sustainable development goals. From energy efficiency perspective, eco design and energy labeling play vital role for products, this chapter dive into deeply this two terms and explain their direct and indirect linkages with SDGs.

2.1 Definition of Sustainable Development

For those engaged in the formation of policy at the global level, the concepts of sustainable development and the interdependence of the economy and the environment represent a fundamental considerations. These concepts originated in the "Limits to Growth" debate of the early 1970s. that questioned whether continued economic growth would necessarily cause global environmental destruction and social disruption. The concept of sustainable development was first popularized by the World Conservation Strategy. It has since become a key concept in thinking about environment and development, and has been endorsed by many world leaders.

Acceptable definition come from the report of the World Commission on Environment and Development (WCED) that known as “Brundtland Report” and the World Bank’s pioneering paper “Environment, Growth and Development” in 1987. The Brundtland Report strongly advocates the concept of sustainable development, which it defines as development that addresses the desires of today’s society without jeopardizing future generations’ ability to fulfill their own needs and the World Bank was devoted to promoting sustainability and the concept that economic expansion, poverty alleviation, and effective environmental management are often mutually reinforcing goals (Pezzey, 1989).

Pearce et al. (1998) mentioned that “First of all, sustainable development asks us to look for assurances that progress will be sustainable as well as to contemplate a larger temporal horizon than overlapping generations may deem suitable.”

The definition of sustainable development was emphasized by Berkhout et al. (2003) as a need for our generation to manage the resource base so that future generations may be able to share the average quality of the life we guarantee for today.

The notion of sustainable development is anticipated to evolve continually throughout time and comprises the following essential components: "augmentations in real income per capita, enhancements in health status, academic accomplishment, equitable income distribution, and enhancements in fundamental liberties." (Topçuoğlu, 2011).

Carr et al. (2021) explained that sustainable development necessitates understanding of mutually positive connections between targets and goals related to the environment and non-environment. Comprehending how favorable advancements in non-environmental development domains can impact the environment, positively or negatively, can assist legislators and development organizations in averting unfavorable outcomes and leveraging reciprocal opportunities.

UN Genereal Assembly in 2015, Transforming our world: the 2030 Agenda for Sustainable Development mentioned that: "We acknowledge that the most pressing global challenge is ending poverty in all of its manifestations, including extreme poverty, and that doing so is essential to sustainable development." (UN Genereal Assembly, A/RES/70/L.1., 2015)

The term "sustainable development" has become more and more common in political speeches, NGOs, public agencies, and organizations over time. A precise definition of "sustainable development" that is widely acknowledged by social actors with disparate political and economic agendas is lacking. The economic, social, and environmental components must all be integrated and balanced, although this phrase has a broad and inclusive viewpoint.

The goals and targets identified under sustainable development will inspire action over the next generations in areas of critical importance to humanity and the planet. These "three components" (*economic, social,* and *environmental*) contain "five dimension" 5P's (people, planet, prosperity, peace, partnership), constitute "Sustainable Development" to create awareness and lead (UN Genereal Assembly, A/RES/70/L.1., 2015).

- People

Committed to eradicating hunger and poverty in all of its aspects and to providing that everyone has access to a healthy, respectable, and equitable environment in which to fulfill their potential.

- Planet

Focusing on preventing environmental deterioration in order to preserve the ability of the earth to satisfy the requirements of both the present and the future. This consists of managing the planet's natural resources responsibly, consuming and producing in a sustainable manner, and acting quickly to combat climate change.

- Prosperity

Devoted to making sure that all people can live wealthy and satisfying lives and that advancements in technology, society, and the economy happen in a way that respects the environment.

- Peace

Dedicated to promoting societies that are inclusive, just, and free from conflict and fear; without peace, sustainable development is impossible, and without sustainable development, peace cannot exist.

- Partnership

Enhanced international solidarity with the involvement of all nations, all relevant parties, and all individuals, with a particular emphasis on the needs of the most vulnerable and poor (UN Genereal Assembly, A/RES/70/L.1., 2015) .

The objectives and targets set out in the definition of "sustainable development" are a guiding principle capable of contributing to development centred on human beings and the environment.

2.2 Historical Background of Sustainable Development

The necessity for environmental considerations to be taken into account arose from the damage caused by the rapid economic growth that occurred in the post-Second World War period. In response to the pressure imposed by their citizens, governments established environmental ministries and agencies with the objective of addressing the issue.

A considerable number of these organisations have achieved notable success within the scope of their mandates, demonstrating positive outcomes in the improvement of air and water quality, as well as the enhancement of other assets. However, a significant part of their work was necessarily after-the-fact repair: reforestation, recovery of desert lands, reconstruction of urban environments, restoration of natural areas, and rehabilitation of wilderness areas.

In 1962, Rachel Carson, an American biologist, published her book ‘Silent Spring’, which raised awareness of the environmental effects of chemical pesticides and triggered the global environmental movement. ‘Silent Spring’ is widely regarded as the most influential environmental book of the 20th century (Ghorbanı, 2020).

But the human related environmental issues not mentioned enough to draw attention. In 1968 the UN Secretary-General U Thant issued a stark warning in the report titled “Activities of United Nations Organizations and Programmes Relevant to the Human Environment”, that life on Earth could be at risk if current trends persist”. The report called for the establishment of the UN Conference on the Human Environment (UNEP, 2023).

The United Nations (UN) played a essential role in the emergence of sustainable development (SD) as a policy objective. Although the concept was not entirely new, the UN was instrumental in disseminating the term and shaping the modern form of the concept. The Sustainable Development Goals (SDGs) remain to be a driving force in global efforts to implement this idea into policy. The UN’s dominant role in this area is not accidental. It possesses significant strengths in both problem recognition and problem-solving. In the context of climate change, biodiversity loss, and a shrinking ozone layer, as well as significant economic inequality, as reflected in a Gini coefficient of 0.7, the issues at hand often only become apparent when viewed from a global perspective. In a globalized world, economic policies in one part of the world have an impact on social and environmental developments in other parts of the world, and there is a danger that these links will remain unrecognized unless affected groups serve to raise awareness on the issues they represent and to provide a platform from which their voices can be heard. Nevertheless, the efficacy of such arguments is contingent upon their ability to engage in a forum that is conducive to global debate, negotiations, and, ideally, practical cooperation (Borowy, 2018). The In 1972 **“UNCHE-Conference on the Human**

Environment", Stockholm, was the first UN member state conference (UNCHE) to acknowledge the collision course between the economy and the environment. Despite the fact that a considerable number of individuals in the Northern hemisphere viewed the meeting as a significant step towards integrating environmental concerns onto the global agenda, policymakers in the Southern hemisphere initially expressed reservations about the initiative. They perceived a hidden agenda, which they believed was designed to impede their industrialisation and economic growth under the pretext of environmental protection(Borowy, 2018). Human actions were increasingly impacting nature, creating environmental risks on an unprecedented scale (Ghorbanı, 2020). Within the same year, the Club of Rome collaborated with the Massachusetts Institute of Technology (MIT) to launch "The Limits to Growth", which shocked the world. This study was the first computer model to explain that if economic expansion simply continued with the technologies available at the time, after a few decades of geometric growth, the size of the global economy would become so large that the strain on the physical systems of the Earth would become unsustainable (SDG academy, 2019).

The fundamental tenets of environmental stewardship were articulated and debated. A set of principles and an action plan were collectively agreed upon by all participating countries at UNCHE, marking the inaugural instance of the term 'eco-development' being used as a precursor to the concept of sustainable development (Barbosa, 2014). Furthermore, the conference resulted in the establishment of the "UNEP-United Nations Environment Programme" (UNEP, 2023), which is also a noteworthy outcome.

In May 1984, the **Brundtland Commission**, also known as the World Commission on Environment and Development (WCED), convened in Geneva for the first of eight meetings over a three-year period. The commission was chaired by Gro Brundtland Halen. The commissioners, hailing from 21 countries across the world, the majority from the South, all had experience working in or with international agencies.

At that time, the tensions between economic growth, urban expansion, technological progress and environmental conservation were becoming more apparent.

In 1987, the commission published a report entitled “Our Common Future.” This document has since become more commonly known as the Brundtland Report. The objective of the report was to address the concept of sustainable development and also highlight impact on the environment and society. This report presents the findings of three-year research and analysis conducted by the committee, with a focus on social issues such as “education”, “land use”, “occupation”, “social services”, “water supply”, “shelter”, “health”, and “urban growth management”.

The notion of sustainable development can be delineated as follows, a process that ensures the fulfillment of current demands but this should be accomplished without adversely affecting the ability of future generations to meet their own needs (Almaghlouth, 2022). However, the concept of sustainable development is inherently multifaceted, and therefore a singular, all-encompassing concept will always be incomplete.

In 1992, **the Earth Summit, also known as “Rio 92”**, convened in Rio de Janeiro, was a first attempt to develop policies and strategies for sustainable development for countries. covering economic and social dimensions such as combating poverty, changing consumption patterns, promoting health, managing population growth, and promoting sustainable settlements. The conservation and management of resources for development wat the one of the topic of the conference, including atmospheric conservation, the fight against deforestation, the preservation of fragile environments and biodiversity, and the control of pollution. Furthermore, the document addressed the necessity of enhancing the involvement of pivotal stakeholders, including “children and youth”, “women”, “local authorities”, “enterprises, and workers”. Additionally, the tools for implementation (science, technology, education, international organizations, and financial instruments) were discussed. And lastly the concept of sustainable energy was also a topic of discussion. The report promotes the idea that a healthy environment is crucial for ensuring sustained economic growth, and vice versa (Topçuoğlu, 2011).

The publication of Agenda 21, a document originating from the Rio 92 meeting that established a pact via the changing form of global growth for the next century, was a significant point for the topic.

There has been a growing interest in creating sustainable communities, with a focus on involving all human activities in the process, particularly in urban planning and architecture. The concept of Sustainable Development, SD, as outlined in Agenda 21, has been integrated into other global development and human rights agendas (Barbosa, 2014).

In order to prepare for the 2002 World Summit on Sustainable Development, the UN issued brief assessments on the state of implementation of key chapters or groups of chapters of Agenda 21 during the Commission on Sustainable Development meetings in 1997, Rio+5 (IISD, 2010).

Rio +10, also known as the **"World Summit on Sustainable Development"** was held in Johannesburg in 2002, following the release of the Johannesburg Declaration. At the national, regional, and international levels, sustainable development was pledged in this declaration.

It emphasized the importance of "social and economic" development and trading activities that are need to be the ruled. As in Rio, it was confirmed that economic growth is essential for environmental development. In WSDD, sustainable development is primarily concerned with social equity, efficient resource use, and the conservation of natural resources. Additionally, WSDD is crucial because it emphasizes the importance of energy sustainability and calls for concrete measures to be taken to promote sustainable energy. In order to realize sustainable development, industrialized nations should expand development assistance, open their markets, and permit private businesses to operate without restrictions. This was the main point of the "Johannesburg Declaration" (Topçuoğlu, 2011).

At the Millennium Summit in New York, all Member States unanimously adopted the Millennium Declaration, marking the next major turning point after the Earth Summit and Agenda 21. The dawn of a new millennium offered a singular chance to develop a fresh approach tailored to the most recent realities and demands of the global community in the twenty-first century.

The largest-ever assembly of leaders of state and government was held during the Summit in September 2000. This led to the development of the eight “Millennium Development Goals-(MDGs).”

The Agenda drew states and nations together, promoting advancement in a number of fields and igniting international movements and projects to address global health concerns. The two primary goals of the 2012 **United Nations Conference on Sustainable Development (Rio+20)**, which took place twelve years after the MDGs were adopted, were creating an institutional framework for sustainable development and growing a green economy.

In order to bring the ideas of sustainable development to life, high-, middle-, and low-income countries were asked to consider the declaration "The Future We Want," which included several recommendations and actions. In Rio de Janeiro, it was also decided to organize the "UNHLPF-High-level Political Forum on Sustainable Development" and to begin the process of transitioning the MDGs into a set of SDGs. (Virchow Foundation, 2023)

The "UN Member States adopted Transforming Our World: Agenda for Sustainable Development (Agenda 2030)" in September 2015 set 169 targets and 17 Sustainable Development Goals, SDGs, that all nations and stakeholders must meet by 2030.

Two months later, 195 countries gathered in Paris as parties to the “UNFCC-Framework Convention on Climate Change” to agree on the world’s first universal climate agreement. Both agreements demonstrate the desire of leaders and people worldwide to enhance the quality of life and the future of our planet (UNDP, 2016).

2.3 Sustainable Development Goals

The United Nations established the 17 goals known as the SDGs in 2015. They aim to end “poverty”, “protect the planet”, and ensure “peace” and “prosperity” for all people by 2030. SDGs encompass a wide range of areas including affordable and clean energy, clean water and sanitation, climate action, decent work and economic growth, education, gender equality, hunger, health, industry, innovation and infrastructure, justice and strong institutions, life below water, life on land, peace, poverty, reduced inequalities, responsible consumption and production, sustainable cities and communities, and partnerships for the goals.

The SDGs are interdependent, and to ensure inclusivity, it is crucial to attain all of them by 2030. SDGs are inter-related, and in order to leave no one behind, it is important that we achieve all of them by 2030. The SDGs are supported by specific targets and indicators to help countries develop policies and strategies, monitor progress, identify gaps, and report results to international society. Achieving the SDGs requires action from regions, governments, civil society, communities, companies, and in particular young and vulnerable people.

MDGs launched by the UN, just before the adoption of the SDGs, in September 2000. The MDGs launched an innovative partnership and an enormous commitment that attracted global attention. The MDGs demonstrated the importance of setting ambitious targets. World leaders signed the eight MDGs to combat poverty, hunger, and discrimination against women. Some of the eight goals have a substantial concentration on health, and the member states of the UN agreed to attain the goals by 2015. Although not all MDGs were met by the deadline, much progress has been made overall, with global poverty being halved since 1990 and access to clean water increased.

As illustrated in Figure 1, they represent a global agenda for poverty reduction and sustainable development for planet, prosperity, people, peace and partnerships, comprising 17 definite and concrete goals.

Figure 1. Sustainable Development Goals with icons

(Source: United Nations, communications materials, 2023)

The SDGs are more inclusive, comprehensive, and ambitious than the MDGs because all countries are taking action. The main difference between the two sets of goals is that the SDGs apply to all UN member states, whereas the MDGs only covered just developing countries. Furthermore, the SDGs take a more holistic approach to all dimensions of sustainable development, including economic, social and environmental sustainability. No goal should be prioritized over another. All SDGs are interconnected and equally important. Achieving the SDGs requires the collaboration of regions, states, decision-makers, and citizens (Koli, 2021).

2.3.1 Correlation between SDGs and 5Ps

An integrated approach is required to implement the 2030 Agenda and sustainable development. Finding the connections between the SDGs and its aims is essential to achieving it. In order to implement the SDGs, it is necessary to characterize the different components and gain a better understanding of them as a whole. The 2030

Agenda's five pillars are used to categorize targets, which helps better grasp the complicated SDGs.

Tremblay et al. (2020) made concrete contribution by providing the classification of targets according to the five pillars as shown in Figure 2.

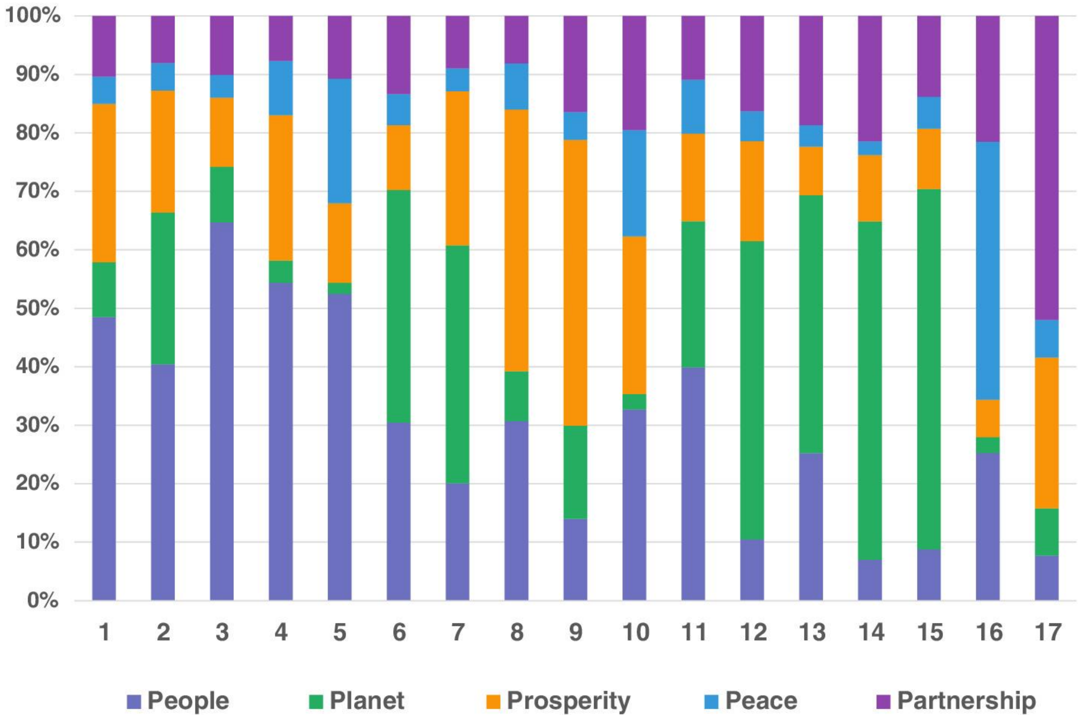


Figure 2. Distribution of the 5P's among the SDGs

In the same study done by Tremblay et al. (2020), publicized that how organizations, relevant with UN, grouping of SDGs according to the five pillars (5Ps) illustrated in Table 1.

Table 1. Classification[2] of the 5P's among the SDGs by Organizations

SDG	People	Planet	Prosperity	Peace	Partnership
SDG 1—No poverty	90.5%		9.5%	4.8%	
SDG 2—Zero hunger	95.2%	9.5%	14.3%		
SDG 3—Good health and well-being	100%	4.8%			
SDG 4—Quality education	100%				
SDG 5—Gender equality	95.2%			4.8%	
SDG 6—Clean water and sanitation	38.1%	66.7%	4.8%		
SDG 7—Affordable and clean energy	9.5%	28.6%	66.7%		
SDG 8—Decent work and economic growth	4.8%		100%		
SDG 9—Industry, innovation and infrastructure		4.8%	100%		
SDG 10—Reduce inequalities	33.3%	4.8%	66.7%	9.5%	4.8%
SDG 11—Sustainable cities and communities	9.5%	23.8%	61.9%	9.5%	4.8%
SDG 12—Responsible consumption and production	4.8%	76.2%	23.8%		
SDG 13—Climate action	0%	100%			
SDG 14—Life below water		100%			
SDG 15—Life on land		100%			
SDG 16—Peace, justice and strong institutions	4.8%			90.5%	9.5%
SDG 17—Partnership for the goals			5%	5%	100%

The complicated networks of connections that exist between the SDGs and the five pillars. Need to be take into consideration that, this is not a linear process, but rather a dynamic interplay where actions in one area affect across and create impact in others. While balancing economic development with environmental protection and ensuring that everyone benefits from increased prosperity can be challenging, we can move towards a more equitable and sustainable future by actively seeking solutions that address multiple pillars at the same time.

Comprehending these correlations is critical to effective policymaking because forcing to go beyond classic approaches and develop comprehensive strategies that take into account the spillover effects. By figuring out this obstacle, it could be possible to map a route towards a future in which improvements in one area support—rather than undermine—our efforts in all others. However, it is not just correlations between SDGs and 5Ps; it is essential to understand linkages between SDGs. In the next part, these linkages will be considered.

[2] The percentages show which organizations have categorized an SDG (row) based on one or more associated pillars, or on a corresponding pillar and corresponding column. Because of this, the total percentage for an SDG could be higher than 100%.

2.3.2 Interlinkages between SDGs

Understanding the multifaceted relationships between the SDGs and driving through positive synergies, where progress in one goal triggers another, like renewable energy fostering clean water access; as for trade-offs, where advancements in one area can come at the cost of another, such as increased agricultural yield potentially straining water resources; and changing strategies and lessening adverse effects, has a paramount effect on fulfilling these goals.

There are two different kinds of linkages: negative (trade-offs) and positive (synergies). When advancements in one area potentially obstruct advancements in another, trade-offs arise. For instance, there may be a trade-off between SDG8 and “SDG12 and SDG7” if attaining economic growth requires increased energy and resource use.

Conversely, synergies are advantageous interactions between objectives and targets that arise when reaching one—such as the EU's target of 20% renewable energy can also help achieve another, like reducing greenhouse gas emissions (Eurostat, 2022).

“Monitoring Reports on Sustainable Development” is published by Eurostat, which offer a numerical evaluation of the EU's advancement toward the SDGs within the EU, to demonstrate this connection and their effect in Figure 3 and 4.

Figure 3. SDG interlinkage

The percentage of positive links between the two SDGs in question is indicated by the line's thickness in Figure 4, which shows the positive linkages between the SDGs. Out of all conceivable relationships between these two aims, the percentage of favorable correlations varied from 12% to 54%.

However, connections between goals with fewer than 30% of favorable interlinkages are not depicted in the picture. Put another way, the number does not represent the favorable relationships that some goals, such SDG 15, have with other goals.

Figure 4 clearly shows how closely related several areas are to how we live, create, and consume. Resource and energy efficiency, SDG7, is greatly impacted by both production and consumption patterns, SDG12.

Climate, SDG13, and infrastructure, SDG9, are significantly impacted by reliable and sustainable energy systems since they are essential to the transition to more sustainable transport systems and an environmentally friendly low-carbon society.

It is commonly acknowledged that human health, SDG3, is significantly impacted by climate change, SDG13. Due to their effects on the environment from "land usage (soil sealing)", "transportation", "housing", "mobility", "food supply", and "waste creation", "urban areas", SDG11, also have a significant impact on the "climate", SDG13. (Eurostat, 2022).

Figure 4. SDG interlinkage

The negative correlations between the SDGs display less fluctuation than the positive correlations, with negative correlations ranging from 7 % to 22 %. SDG pairs with negative correlations that are more significant than 18% are illustrated in Figure 5. Reducing poverty in the EU (SDG1) appears to have adverse effects on sustainable consumption and production (SDG12), climate change (SDG13), energy (SDG7), and gender equality (SDG5). Progress towards social goals, such as SDG1 and SDG10, can result in more material consumption (SDG12) and energy consumption (SDG7), carbon emissions and other environmental burdens (SDG13). Material usage, in turn, is one of the main drivers of environmental pressure. Therefore, protecting and enhancing the EU's natural capital while ensuring the well-being of citizens is a key policy challenge (Eurostat, 2022).

2.4 Progress & Monitoring the SDGs

In 2015, the world stood at a crossroads. Recognizing the intertwined challenges of poverty, inequality, and environmental degradation, 193 United Nations member states implemented the SDGs roadmap for transformation by 2030. This ambitious agenda outlined 17 interconnected goals across social, economic, and environmental spheres, aiming to create a more just, equitable, and sustainable future for all.

However, translating aspirations into reality demands not just commitment but also rigorous monitoring and evaluation. Tracking progress across diverse countries and contexts helps pinpoint successes, illuminate gaps, and inform course corrections.

Monitoring these goals could be possible with reliable information, data and statistics. National statistical offices, are responsible for the collection and analysis of data gathered from ministries, and other government agencies, pertaining to the SDGs. The data demand generated by the 2030 Agenda has led to data innovation. For instance, household surveys, a traditional source of data, are now utilizing new tools and current technology, like web and phone data collection techniques, satellite imagery, mapping infrastructure, (World Bank, 2017) mobile data collection, to improve inclusivity and efficiency.

The worldwide SDG database contains 225 indicators as of 2023, up from 115 in 2016. Furthermore, as of May 2023, the database has 2.7 million data records, up from 330,000 in 2016. In just seven years, this indicates a major development of the worldwide SDG database. (UN Sustainable Development Report-Special Edition, 2023).

The Development Report states that the methodology for creating SDG indicators has advanced significantly as well. 39% of the SDG indicators in 2016 lacked internationally recognized criteria or methodology. But by March 2020, these indicators were created using a standardized approach that has been accepted globally, guaranteeing the utility, precision, reliability, and comparability of the measures acquired.

The indicator framework has become more robust due to continuous refinement and harmonization of methodologies. These methodological advancements provide a strong basis for monitoring the performance of the SDGs. Moreover, the proportion of indicators that are conceptually unambiguous and encompass comprehensive country coverage has markedly increased from 36% in 2016 to 66% in 2022, as illustrated in Figure 5.

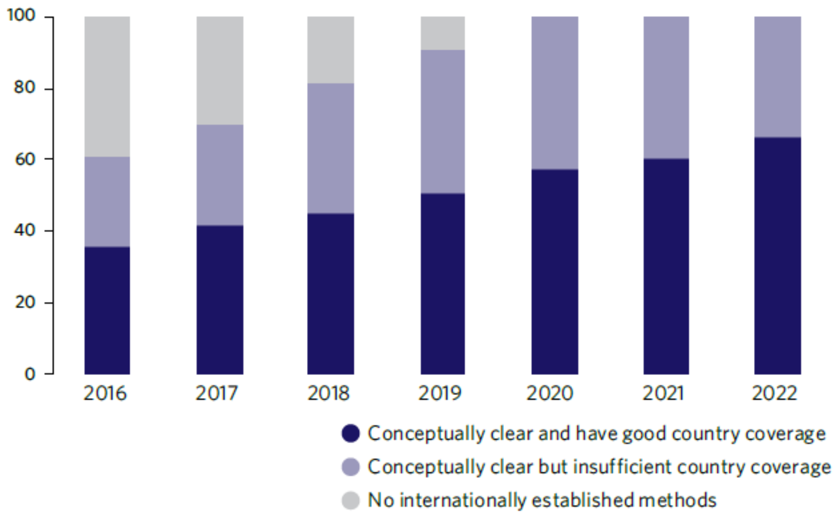


Figure 5. Share of global SDG indicators, by availability of standards and national data

A review of the progress made towards the achievement of the SDGs by 2030 reveals significant challenges. According to the most up-to-date global data and evaluations from the relevant agencies, approximately 140 targets can be assessed. Of these, approximately 50% are found to deviate from the desired trajectory to a moderate or severe extent. Furthermore, over 30% of these targets have demonstrated no advancement or, conversely, have exhibited a decline below the 2015 baseline. As illustrated in Figure 6, the progress of the SDGs demonstrates the necessity for augmented efforts to guarantee the SDGs remain on course and facilitate progress towards a sustainable future for all (UN, SDG Special Edition, 2023).

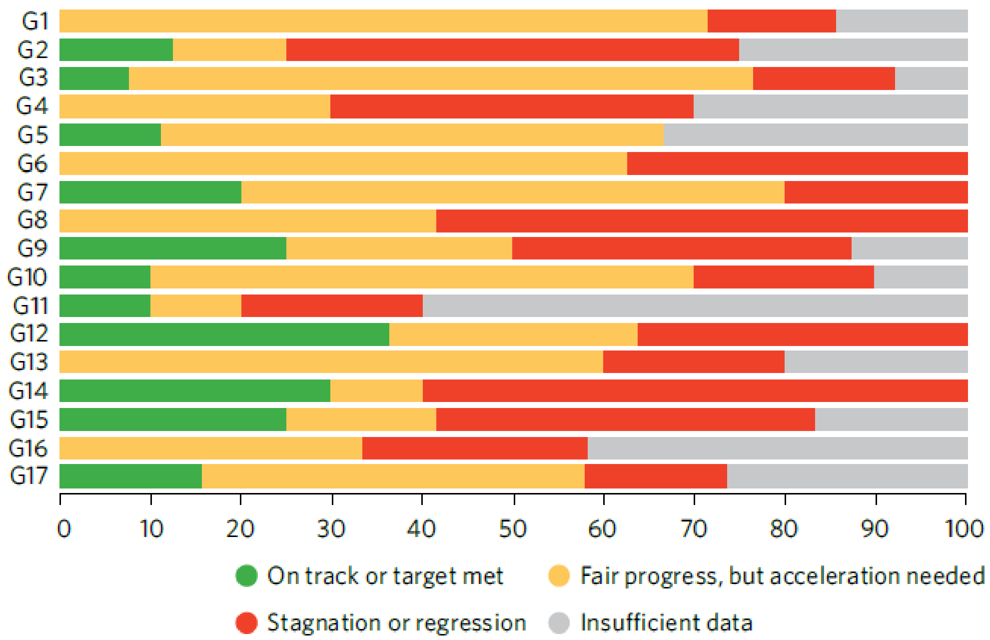


Figure 6. Progress towards the SDGs will be based on evaluated targets

(UN, Sustainable Development Report, Special Edition, 2023)

Examining official reports like the UN Sustainable Development Report provides a global snapshot. It reveals areas of tangible progress, such as the decline in extreme poverty and the improved access to safe drinking water. However, it also paints a broad picture of persistent challenges, including rising inequality, climate change threats, and energy scarcity issues.

One critical aspect of monitoring is understanding the role of national ownership and leadership. Each country faces unique circumstances and must adapt the SDGs to their specific context. Analyzing national development plans, policies, and implementation strategies reveals not only the commitment towards the goals but also the challenges of translation into concrete action.

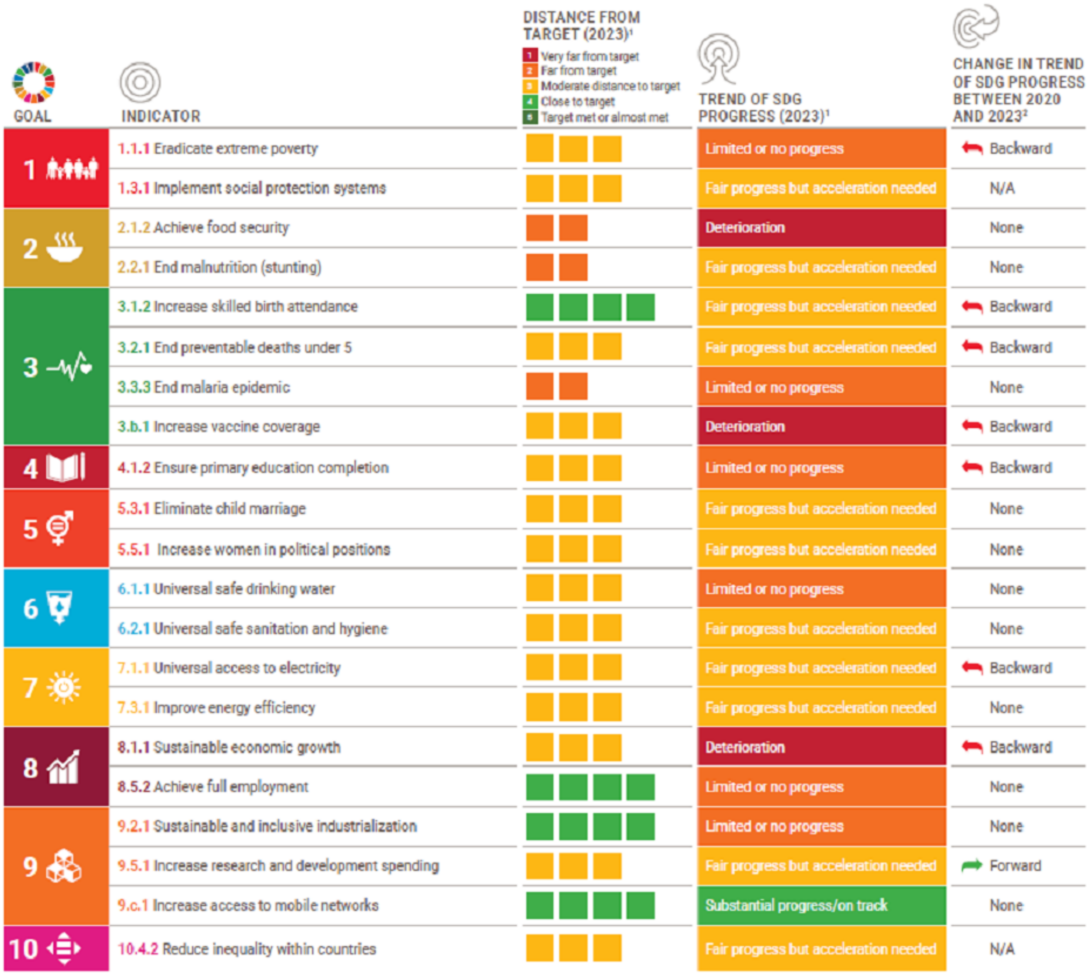
Monitoring progress also necessitates examining financing mechanisms. The resource gap remains a significant hurdle, particularly for developing nations. Analyzing investment trends, both public and private, paints a picture of resource allocation and highlights potential shortfalls that hinder progress.

Energy independence, technology and innovation play a crucial role in accelerating progress. Assessing the adoption and impact of new technologies across different sectors sheds light on their potential to overcome challenges and accelerate SDG achievement. Partnerships are central to success. Examining the collaborative efforts of governments, civil society, and the private sector reveals strengths and weaknesses in joint initiatives, highlighting areas where collaboration can be further strengthened. Monitoring environmental progress requires careful analysis of indicators like greenhouse gas emissions, biodiversity loss, and land degradation. Assessing trends and their impact on ecosystems and human well-being helps inform policy decisions and identify areas for transformative change.

Peace and security are critical foundations for sustainable development. Examining progress towards reducing violence and conflict, strengthening institutions, and promoting human rights reveals interconnected challenges and their impact on achieving other SDG goals.

Significant point is recognizing of the SDGs are not linear and progress is irregular, analyzing success stories from diverse nations can provide valuable lessons. Finding innovative approaches, overcoming local challenges, and replicating successful models can accelerate progress for others.

Figure 7 shows the progress made toward achieving all of the SDGs for the halfway point of the 2030 objectives. Member states resolved to prepare the Global Sustainable Development Report 2023 every four years in the Ministerial Declaration of the 2016 Forum.



[1] Distance from target (2023) and trend of Sustainable Development Goasprogress (2023) refer to current level and trend information for the latest available data utilizing the calculation methodology from the Sustainable Development Goals 2022 Progress Chart Technical Note. Latest available data as of May 2023 from the SDG global indicator database. Please note that information for indicators 1.1.1, 10.4.2, 13.2.2, 17.2.1 and 17.18.3 are from the Sustainable Development Goals Progress Chart 2022.

[2] To capture the impacts of the COVID-19 pandemic on progress of the Sustainable Development Goals, a comparison of the trend assessment from the Sustainable Development Goals 2020 Progress Chart and the trend of progress of the Goals (2023) was made, with some indicators showing reversal or slowed progress.

N/A: trend comparisons unavailable due to: i) lack of trend analysis from insufficient data; ii) indicator not included in the 2020 Progress Chart; or iii) indicator has changed between progress charts.
Source: Calculations based on United Nations Department of Economic and Social Affairs, 2023b.

Figure 7. Progress of SDGs based on select targets

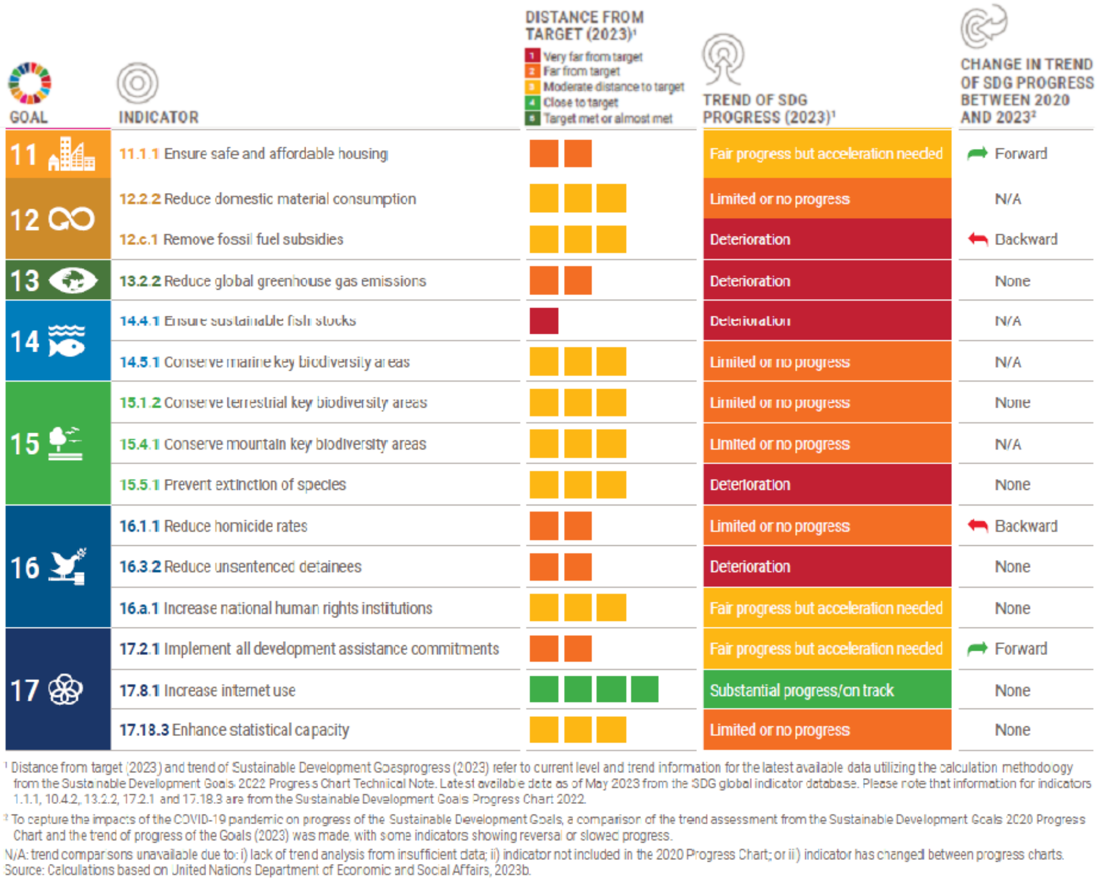


Figure 7. (Continued) Progress of SDGs based on select targets

The 2019 Global Sustainable Development Report evaluated the progress made towards achieving the SDGs. The report's conclusions were disappointing since they said that, given the current course, it is improbable that the world can meet its goals by 2030.

However, in order to achieve the majority of the remaining targets, it is necessary to accelerate the pace of progress, particularly in relation to the eradication of poverty and hunger, the reduction of maternal mortality, the expansion of access to drinking water and sanitation, and the achievement of gender equality. It is concerning that the world is regressing on climate action and biodiversity, as well as reducing inequality (UN Global Sustainable Development Report, 2023).

Figure 7 assesses select targets with sufficient data and demonstrates that achieving Sustainable Development Goals targets in 2023, at the midpoint towards 2030, the situation is considerably more critical.

The column "Distance from Target" shows that most other targets are either moderately close or far from the goal post. According to the available data on targets, Goal 2, Goal 11, Goal 13, Goal 16, and Goal 17 are particularly far from reaching the 2030 ambitions. In order to evaluate the influence of recent crises on the advancement of the SDGs, Figure 7 also contrasts the trends for each target as evaluated in 2020 with those observed in 2023.

The analysis indicates a decline in progress towards many of the Goals from 2020 to 2023. Reduction of extreme poverty, which had been steadily improving through 2018/2019, impeded by the occurrence of recent crises. Although poverty is declining, recent cost-of-living and climate crises have slowed down progress in poverty reduction.

Progress has also slowed down in several other areas where good progress was made in 2018/2019, such as goal 7, 8 and 12. In cases where progress towards the Goals was slow in 2019, countries have generally failed to accelerate enough. However, progress towards some targets is now faster than it was in 2018/19 (indicated by Forward). Targets for reducing global greenhouse gas emissions continue to decline. The slowdown or halt in progress can be attributed to a combination of crises, in addition to the ongoing pandemic, the rise in inflation and cost of living, the environmental and economic distress experienced by our planet, and the unrest, conflicts, and natural disasters occurring at the regional and national levels. These crises are not independent events, and their overlapping nature is unlucky.

Numerous physical, economic, and social aspects link, each fueling the intensities of the others. In addition, freshwater, terrestrial, and marine ecosystems are changing due to climate change, which is also affecting biodiversity, uprooting livelihoods, and increasing inequality. These factors result in water stress and food insecurity (UN Global Sustainable Development Report, 2023).

Diving into further specifically progress in different timelines on some SDGs related with energy efficiency such as SDG7 which main goal and SDG9, SDG12, SDG13 which are indirect linkages. In 2023 UN published a special edition report focusing on progress on SDGs.

2.5 National Review of Türkiye Towards Sustainable Development Goals

Türkiye adopts a comprehensive approach to implementing SDGs by integrating them into sectoral strategies. Therefore, Türkiye prioritises action for faster progress and allocates appropriate resources while considering the interlinkages between the SDGs. To ensure the implementation of the SDGs, Türkiye has integrated them into its national development strategies and prepared the 11th Development Plan (2019-2023) with consideration for the SDGs. Necessary precautions were taken to ensure maximum participation in the project. The national priorities should be taken into consideration when preparing and integrating the SDGs into the Development Plan.

The 11th Development Plan features a dedicated section for the SDGs. It outlines the necessary steps to implement the SDGs during the Development Plan and ensure coordination throughout the process. The policies and precautions regarding the thematic areas take into account the relevant SDGs.

The 12th Development Plan (2024-2028) also includes dedicated targets related with SDGs. The main objective is to ensure the implementation of the SDGs with an involved approach and to increase the effectiveness of coordination, monitoring and review processes. Under this purpose a number of targets are identificated;

- The SDGs will be effectively and routinely monitored and evaluated, and the degree of progress made toward their implementation will be tracked.
- The Third National Voluntary Review Report will be prepared to assess our nation’s progress toward the SDGs in the context of the policies and programs that have been put into place.

- The National Sustainable Development Board will periodically assess the SDGs’ implementation process and offer recommendations.
- An interactive SDG map will be developed to assess the SDGs’ progress level and will be considered in decision-making processes.
- Indicators not included in the national SDG indicator set will be generated, the data breakdown level will be increased, and the quality will be improved.
- Local governments and other stakeholders shall work together to implement, monitor, and evaluate the SDGs in order to assist their local level implementation.
- More voluntary review reports will be generated by local governments.

In terms of SDGs with an environmental dimension, Türkiye’s principal actions are concentrated on the preservation of genetic resources and biodiversity (SDG 2 and SDG 15), as well as the implementation of sustainable and climate-resilient agricultural production methods and technologies (SDG 2), and ensuring water resources and a harmonious balance between the conservation of nature and the development of resources (SDG6).

Energy efficiency in buildings, industries, and transportation (SDG 7); ensuring "zero waste" at the industrial scale; and advancing eco-labelling and bioplastics (SDG 12). To ensure GHG emission management through new technologies (SDG9, SDG13); to increase consumer and producer understanding of sustainable consumption and production (SDG12).

Reaching the goals of SDG13, SDG14, and SDG15. Preventing and decreasing marine litter, to increase the utilisation of aquaculture resources in marine and inland waters, to enhance the protection of aquaculture stocks and to facilitate the development of aquaculture. The overarching objective is to devise and implement a comprehensive plan for the management of land-based ecosystems, with a particular focus on promoting the development of high-value forest ecosystems. Creating comprehensive policies on genes, species, habitat, and ecosystems (EEA Briefing, 2020).

2.5.1 Ownership of SDGs

Political ownership and commitment are considered prerequisites for achieving successful results in implementing SDGs in Türkiye. Commitment to integrating SDGs into its national policies and improving practices is emphasized at the ministerial level and were highlighted by the Parliament. Responsibilities related with SDGs are distributed to the different authorities and ministries that shown in Figure 8.

Figure 8. Distribution of institutional responsibility by SDGs

(Source: http://www.surdurulebilirkalkinma.gov.tr)

Türkiye has elected not to prepare a distinct action plan or policy document for the Sustainable Development Goals (SDGs). Instead, a holistic approach has been adopted, whereby SDGs and their indicators are integrated into NDPs, such as the 11th and 12th, and sectoral strategies, thus providing a policy approach. In 2017, Türkiye carried out a stocktaking analysis project for the SDGs with the engagement of all relevant stakeholders to build a baseline and identify gaps in the integration of the 2030 Agenda into the country’s strategies.

Policies, strategies, applicable legislation, institutional framework procedures, and projects that touched on the objectives were assessed during the inventory analysis to identify any gaps and potential improvement areas.

2.5.2 SDG Indicators

In terms of monitoring the progress, generating indicators that reflects the countries own culture and development status have critical importance. The Turkish Statistical Institute (TURKSTAT) has conducted a number of activities to promote awareness of SDG indicators among institutions included in the Official Statistical Programme (OSP), as part of its responsibility to boost the generation of non-available SDG indicators. Distribution of Indicators by SDGs are shown in Figure 9.

Figure 9. Indicators and current status of availability
(Source: TUIK, reporting status, 2023)

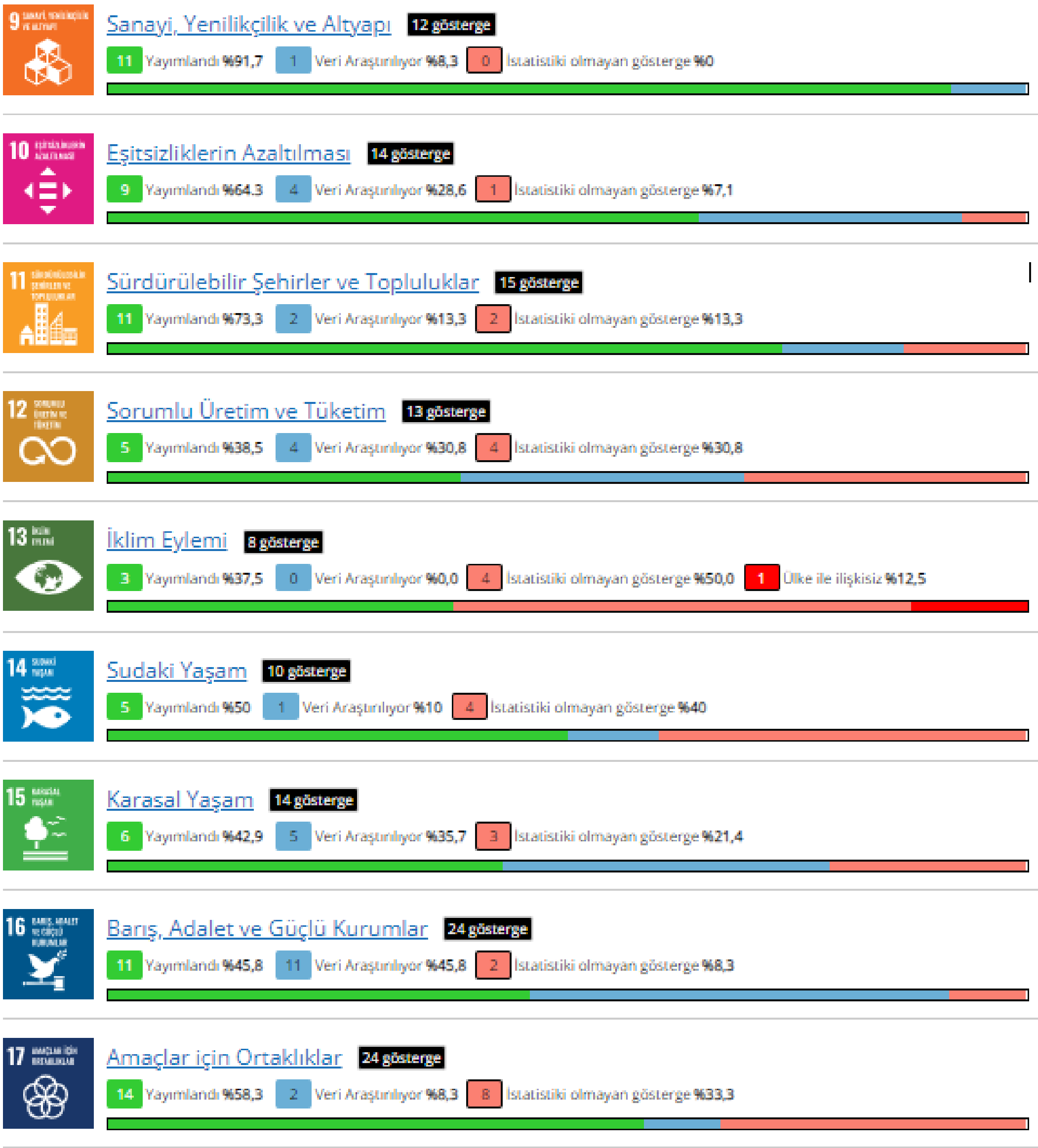


Figure 9. (Continued) Indicators and current status of availability

(Source: TUIK, reporting status, 2023)

2.5.3 Progress of SDGs

Execution of the SDGs has different variables that need to be encompass for all level of private sector toward country. As shown in Figure 10, developing SDG heat map defines the current situation and gaps for each SDG with regard to project inventory, policy approach, legislation, institutional framework, and implementation in order to demonstrate the degree of consistency (VNR Türkiye, 2019).

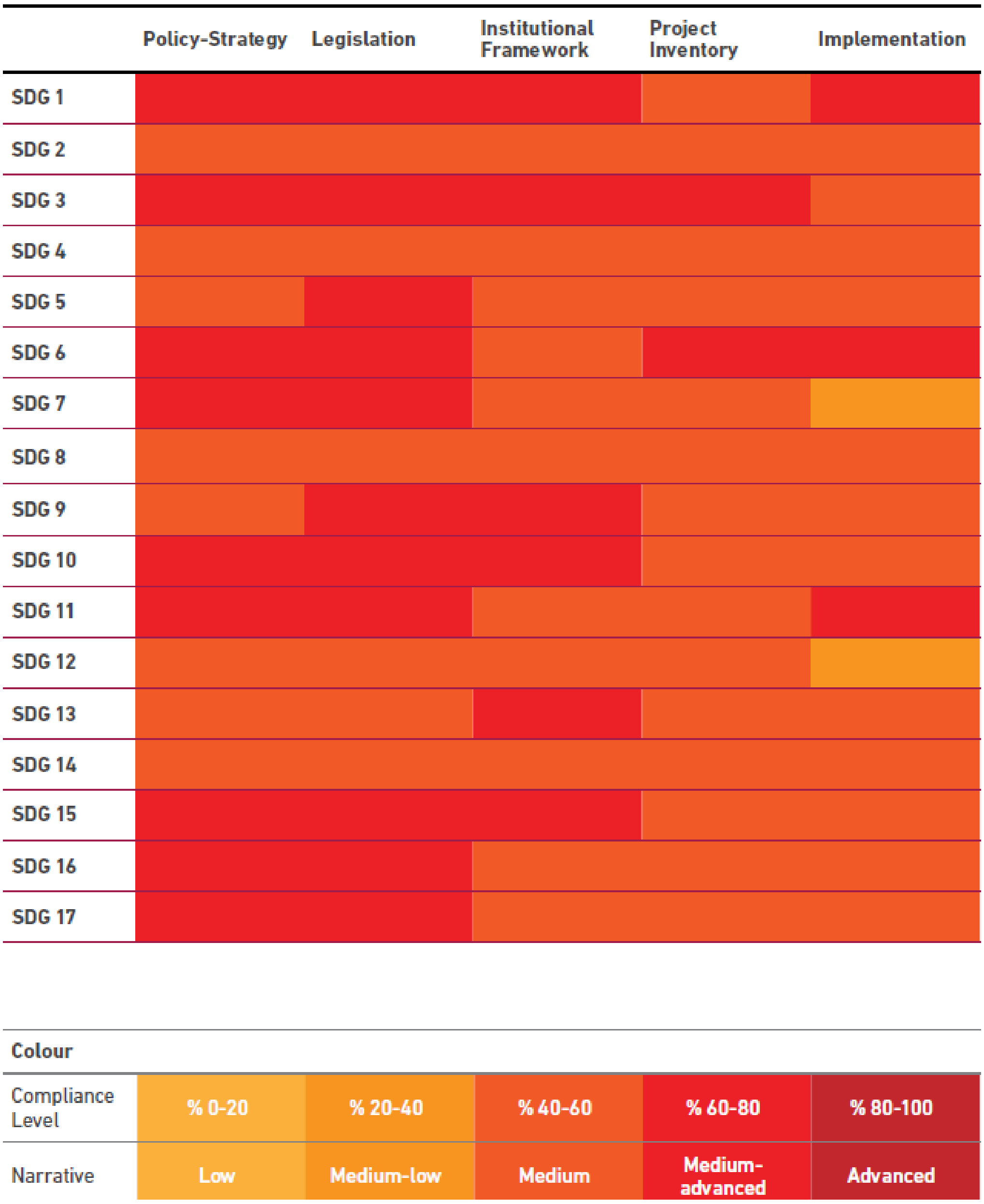


Figure 10. SDG heat map

(Source: VNR Türkiye, 2019).

Upon reviewing Türkiye’s SDG heat map, as shown in Figure 10, it is evident that over half of the SDGs have reached a medium-advanced level in terms of policy-strategy, while the remaining are at a medium level. The legislation has a more optimistic projection, with the number of SDGs at the medium level reaching. While the responsibilities of public institutions are relatively clear, there is currently no institutional structure in place that is specifically associated with the Sustainable Development Goals (SDGs) and managed on a regular basis. This lack of structure and regular management has a negative impact on the outlook of the institutional framework, which is more challenging to navigate than policy and strategy.

2.6 Ecodesign And Energy Labeling for Energy Efficiency

The growing need for energy poses a crucial challenge for humanity, requiring us to balance our requirements with environmental responsibility. Two key instruments, ecodesign and energy labeling, work together to create a powerful composition for energy efficiency.

Ecodesign, determines the fundamental nature of a product, carefully constructing its energy-saving potential throughout its entire lifecycle. Ecodesign integrates features and functionalities that minimize energy consumption from resource extraction to disposal.

Energy labeling empowers consumers to make informed choices by translating complex energy performance data into a readily understandable format. The labels, displayed prominently on products, use a familiar A to G scale in Europe or the Energy Star [3] rating in the US as a visual cue, guiding consumers towards the most energy-efficient options. This collaboration between ecodesign and energy labeling

[3] The Energy Star is a government-promoted mark of energy efficiency, at the same time label delivers straightforward, trustworthy, and reliable information that consumers and businesses can trust to make informed choices.

has yielded significant results, empowering individuals to become active participants in the energy efficiency by harmonizing their purchasing decisions with broader sustainability goals.

2.6.1 Definition of Ecodesign

Reflecting the fact that there is still no single concrete definition, there are many definitions of ecodesign in the literature reasons are differ from point of views, affected groups, areas or handling issues. Over the last two decades, as environmental issues have become more apparent, the terminology of product design that considers environmental concerns has changed, with a shift in focus between ecology and design. The variation of terminology demonstrates the development of the subject. The phrase “green design” was first used in the 1980s. Currently, the concept is also known as ecological design, ecologically sound design, environmentally sensitive design, and ecodesign (Gurakar, 2008).

Ecodesign, also known as Green Design in Europe and Design for Environment in the United States, is a comprehensive approach that aims to impose limitation on a product’s environmental effect throughout the process of design. Sustainable Design, Environmentally Conscious Design, Life Cycle Design or Life Cycle Engineering, and Clean Design are all synonyms (Bereketli, 2013).

Ecodesign is a cross-functional and horizontal strategy that integrates several areas of design and environmental concerns, as well as the systematic inclusion of environmental aspects into product design and development to enhance product environmental characteristics.

Rethinking every component is necessary for this transformative strategy, from the lifespan of the product and end-of-life management to the choice of materials and manufacturing techniques. Eco-design is emerging as a critical paradigm shift in product development at a time when resource depletion, climate change, and rising waste are pressing issues. It becomes a philosophy embedded in creating things that reduce their environmental impact throughout their existence, going beyond simple aesthetics.

Eco-design encompasses more than just using eco-friendly materials; it also includes creating things that use less energy. This includes parts that use less energy by nature, such as water-efficient appliances or LED lighting. It also takes into account how energy-efficient production is, employing renewable energy sources and process optimization.

Reliability and durability are essential components of eco-design. Waste production and resource consumption are decreased by long-lasting products made of high quality materials and modular designs (EPRS, 2024). Consider smartphones with simple battery replacement mechanisms or lighting products with an easily accessible repair parts. This includes designing with disassembly in mind to facilitate effective dismantling and material recovery at the end of a product’s useful life.

The goal of eco-design is constant progress rather than a fixed point in time. If businesses want to reduce their environmental impact, they must continue to be innovative, investigating new materials, technologies, and business strategies. They may contribute to a sustainable future where products fulfill their needs without endangering the environment by adopting this all-encompassing strategy.

Implementing the soul of ecodesign in products could be possible with technical regulations by setting limitations and constraints from higher authorities to ensure competition between companies and manufacturers.

Aside from the general definition, in terms of the product design perspective, Karagoz B. (2022) highlighted that the European Commission provides the most comprehensive and all-encompassing definition of ecodesign is as follows: The term “ecodesign” is employed to delineate the process of incorporating environmental considerations into the design of a product, with the objective of optimising the product's ecological impact across its entire life cycle.

Ecodesign involves considering a product’s environmental effect from its early stages of design. This, in particular, eliminates disorganized product planning for instance, removing a harmful chemical should not result in increased energy usage, which might have a negative environmental impact (European Commission, 2024).

2.6.2 Definition of Energy Label

Energy label purposes to educate consumers about the energy performance of different products, the provision of this information allows consumers to make informed choices that benefit both their financial resources and the environment.

Lack of information and attention causes environmentally conscious people to underestimate the energy efficiency and performance of products, contributing to escalating environmental issues and climate change. Energy labels, provide efficiency classifications to encourage people to use less energy.

The labels, that is shown in Figure 11, provide easily understandable information about a product's energy consumption compared to similar models, with the aim of informing consumers. This feature enables consumers to prioritize energy efficiency when making purchasing decisions.

Labels incentivize manufacturers to invest in developing and offering more efficient products, benefits consumers by driving down prices and expanding choices, while reducing energy consumption.

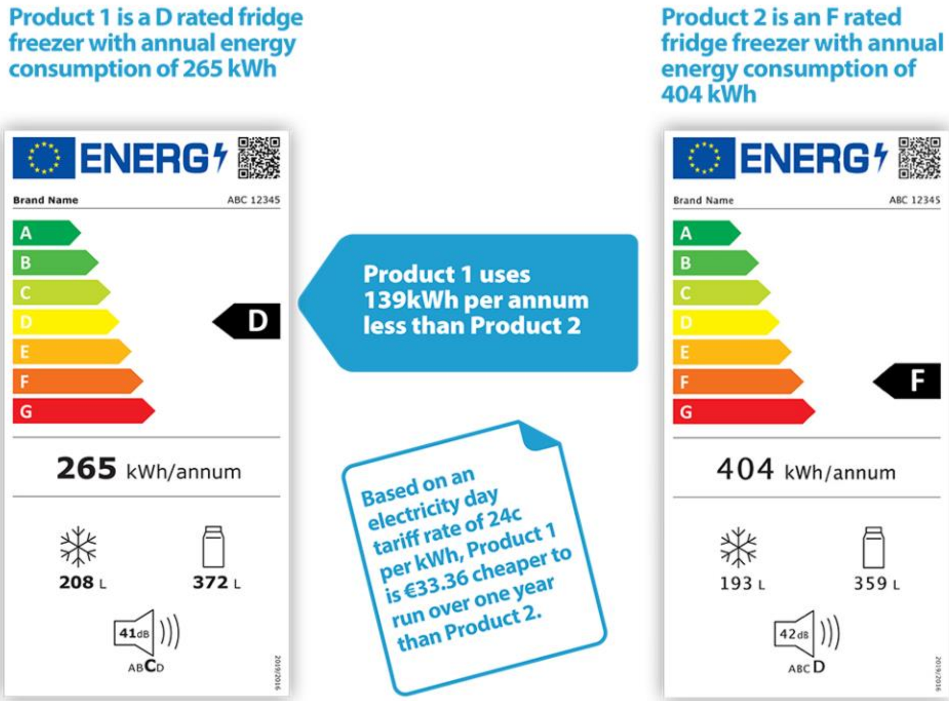


Figure 11. How to read energy labels

(Source: Sustainable Energy Authority of Ireland-SEAI)

The widespread adoption of energy-efficient products results in significant reductions in overall energy demand, contributing to resource conservation and environmental protection.

From the perspective of the product lifecycle, it is evident that the Ecodesign and Energy Labelling (ED & EL) legislative framework represents the most significant policy instrument for the regulation of product design from the standpoint of the circular economy. (Dalhammar, 2014; Polverini, 2021).

2.7 Energy Efficiency as a Pillar of Sustainable Development

Energy efficiency and sustainable development are closely linked, as the prudent and optimised use of energy is fundamental to achieving long-term sustainability. Within the spectrum of sustainable development, energy efficiency offers a way to reduce environmental degradation by reducing the demand for energy resources, especially non-renewable ones such as fossil fuels.

By maximising the output from the energy consumed, it slows down the rate at which resources are consumed and helps to keep ecosystems intact. In addition, reducing greenhouse gas and pollutant emissions using energy efficiently contributes to both improving air quality and reducing climate change.Since 1973, industrialized countries have been using energy more efficiently. Policies were implemented to increase energy efficiency across all sectors of their economies as a result of the oil shocks of the 1970s. These policies have been a factor in the decline in energy intensity. In addition, as part of their strategies in order to reduce greenhouse gas emissions, a number of industrialised countries have implemented a range of measures. have stepped up their energy efficiency efforts (Türkoğlu, 2018).

From an economic perspective, improving energy efficiency catalyzes sustainable development by promoting cost efficiency and productivity. Reduced energy consumption lowers operating costs, allocating resources more effectively across economic sectors. This energy optimization leads to economic resilience, as businesses become less vulnerable to volatile energy prices and supply disruptions.

The high energy intensity of the economy has an adverse effect on the security of the country's energy supply as well as the environment because of the excessive use of fuel and energy resources. In this regard, enhancing energy efficiency by consuming less energy through the broad use of energy-efficient technologies is considered to be one of the critical issues of economic growth (Soltangazinov, 2019).

In addition, investment in energy-efficient technologies often creates employment opportunities, stimulates innovation and builds competitive markets, all of which are essential components of a thriving, sustainable economy.

At the social level, energy efficiency has significant implications for sustainable development, as it is crucial for ensuring equitable access to energy. Low-income households can experience less energy strain thanks to efficient energy use, increase energy security and improve living standards.

It helps bridge the energy divide, enabling wider social prosperity as savings from reduced energy bills are reallocated to health, education and other critical areas of human development.

On a larger scale, energy efficiency is also about reducing inequalities between nations by enabling developing countries to advance to cleaner, more efficient systems, thereby contributing to global efforts towards sustainable development.

When considering the complex patterns of sustainable development, some of the varying components are social justice, economic prosperity, and environmental health. Energy efficiency is a vital component of this pillars, its effect flowing into and through the other sustainability goals to form a strong, cohesive whole.

Energy efficiency has a profound impact on sustainable development with a transformative role. Not all, but some of the SDGs contain energy efficiency issues with a variable sphere of influence.

SDG7: Affordable And Clean Energy

Energy efficiency is a straight target in this goal which encompasses a number of SDGs. Target under SDG7 points out for global progress on energy efficiency by doubling, information about doubling published by IEA shown in Figure 12 and Figure 13, the projected degree of improvement in global energy efficiency by the year 2030.

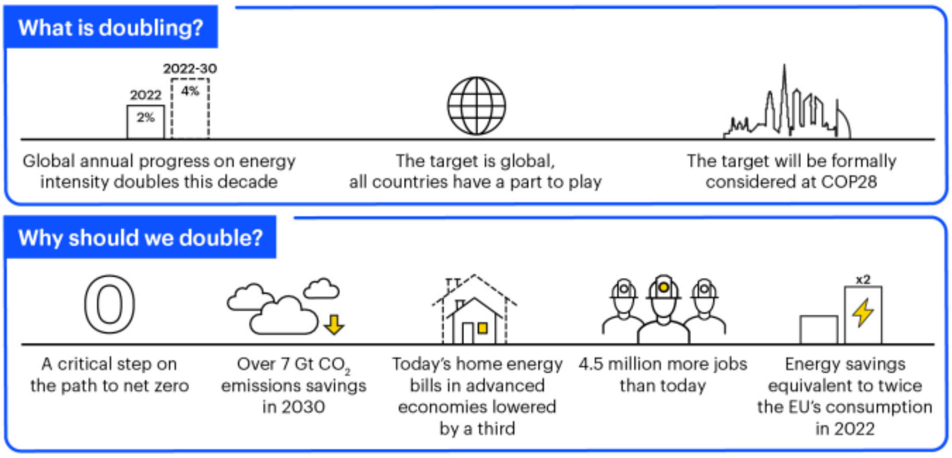


Figure 12. Doubling progress on energy efficiency

(Source: IEA, Energy Efficiency 2023)

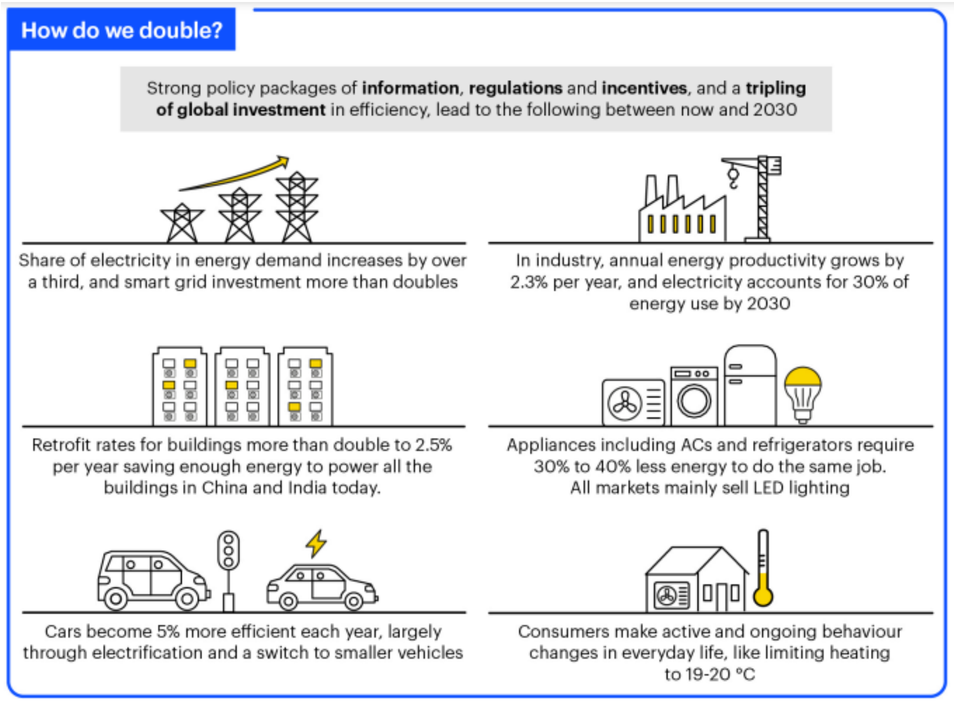


Figure 13. Doubling progress on energy efficiency

(Source: IEA, Energy Efficiency 2023)

Figure 14 illustrates that, Türkiye shown in red circle, while there are differences amongst nations in terms of their progress toward increasing energy efficiency, there is a general trend (yellow line) indicating that it can be observed that there is a correlation between countries with higher rates of economic growth and those which experience a reduction in energy intensity.

The yellow line is the trendline for all nations from 2013 to 2018, showing the correlation between energy intensity development and GDP growth. This line does not reflect what is required to meet the SDG 7.3 objective, but it does demonstrate that plenty of nations must improve their energy intensity as assessed by primary energy and GDP.

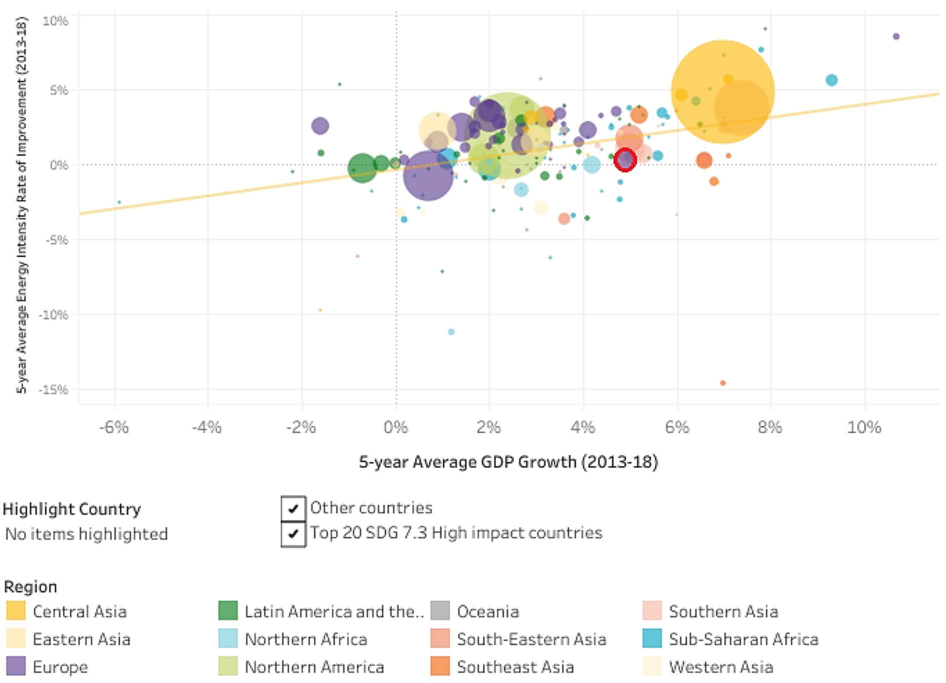


Figure 14. Economic growth and the rate of energy efficiency development are correlated.

(Source: SEforALL, SDG 7.3 - Energy efficiency)

If the country’s GDP grows at a positive pace, a negative rate of improvement shows that primary energy consumption increased faster than GDP growth. If the country's GDP growth is negative, an unfavorable rate of improvement means that the primary energy consumption decreased at a slower rate than the GDP. In both circumstances, energy efficiency improvement is regressing. (SEforALL, 2024).

SDG8: Good Jobs and Economic Growth

The additional efficiency-related jobs created by increasing energy consumption improvements, reaching the doubling goal, to around 4% every year this decade might result in around 4.5 million additional employment opportunities in 2030 than in 2022. Stepping in front to 2030, the growing demand for better-performing products and services, supported by increased investment, indicates that the energy efficiency job market will continue to grow as the transition to clean energy (IEA Energy Efficiency, 2023).

These jobs will be focused on specific activities such as:

- Effective building retrofitting and weatherization.
- The manufacture and installation of pumps, electric motors and other heating and cooling systems.
- The creation and application of systems for energy management.
- Designing and manufacturing energy-efficient products and building materials.
- Managing energy efficiency programs at the community, utility, and regional level.
- Energy service companies (ESCOs) and other energy-related activities in buildings and industries.
- Improving energy efficiency in manufacturing.

SDG9: Industry, Innovation and Infrastructure

Implementing energy efficiency measures saves firms money, allowing them to invest in innovation, technological advancement, and modernization. Energy efficiency is a fundamental decarbonization technique that represents the greatest cost-effective solution for reducing GHG emissions. When used on a variety of motorized devices, a systems-based approach may save a lot more energy than individual initiatives. Improvements to motor systems could save between 27% and 50% of electricity. In order to achieve energy reductions, energy management system standards like ISO 50001 can be implemented. (UN HLPF, 2021).

Also research and development in energy-efficient technologies, efficient appliances, smart grids, energy storage, and advanced materials are crucial for accelerating progress towards SDG 9.

SDG12: Responsible Consumption and Production

Energy efficiency helps to preserve precious natural resources including fossil fuels, water, and forests. By maximizing energy consumption and decreasing waste, energy efficiency techniques alleviate strain on finite resources and minimize the negative environmental and social impacts associated with their extraction, processing and use.

Circular economy presents numerous opportunities to alter the production and consumption patterns, while promoting everyone has access to modern, affordable, dependable, and ecological energy.

İmproved energy and resource efficiency, eco-design, waste management, and techniques for recycling, reusing, and reducing in addition to reliable consumer habits, contribute to climate change mitigation and environmental integrity in a complementary way to SDGs.

SDG13 Climate Action

IEA (IEA, 2021) highlights that; The "first fuel" for accomplishing ambitious climate goals, raising living standards, and generating employment and new job opportunities is “energy efficiency”.

Tackling climate change must be a top priority, particularly in light of the mounting indications of more intense and extreme weather patterns that are putting people’s lives and livelihoods at risk around the world. More efficienct products less contribute effectively carbon emission targets. Energy efficiency is emerging as a critical component of sustainable development in the fight against climate change. It directly lowers greenhouse gas emissions by consuming less energy, hence reducing global warming and its disastrous effects. It is projected that upwards of 40% of the emissions reductions necessary for implementing suitable energy saving programs could help achieve the goals outlined in the Paris Agreement.

2.8 Ecodesign and energy labelling regulations and links to the SDGs

In order to provide a comparative analysis of the relationship between Ecodesign and Energy Labeling Regulations and relevant SDGs, a comprehensive literature review was conducted to examine the current state of academic research. To guarantee the absence of bias in the literature search, the following search/key terms were employed, no chronological limits or other restrictions were imposed.

Commands for our search were as shown: {(“Ecodesign” OR “Eco-design”) AND (“Sustainable Development Goal” OR “SDG”)}. A search of the Scopus database for documents containing relevant keywords returned 2.039 results. From a broader perspective, an analysis of this result was conducted using the bibliometric tool. Figure 15 and 16 illustrate findings of a VOSviewer co-occurrence analysis, which identifies connections between key terms. The VOSviewer displays the relationships between the different terms, with lines indicating connections between them and the thickness of the lines representing the strength of the links. A thicker line indicates a stronger link between the terms. VOSviewer identifies items as being closely related when the software calculates the strength of associations between items that are similar. The relative importance of an article is determined by the size of the circle surrounding it; a larger circle indicates a greater level of significance. As seen in Figure 15 and 16, bibliometric outputs do not show intense and strong connection regarding ecodesign and sustainable development.

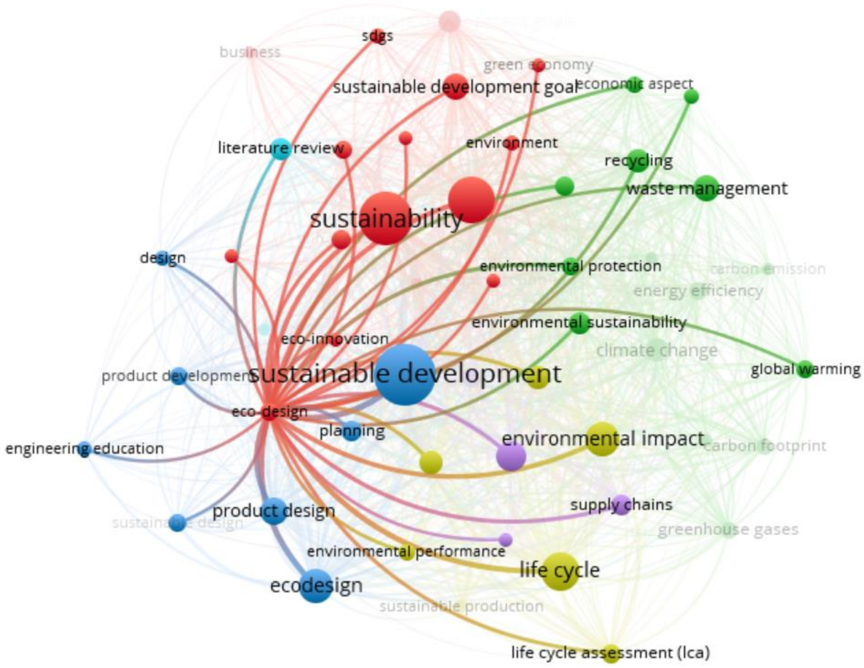


Figure 15. VOSviewer output of keyword “eco-design” co-occurrences.

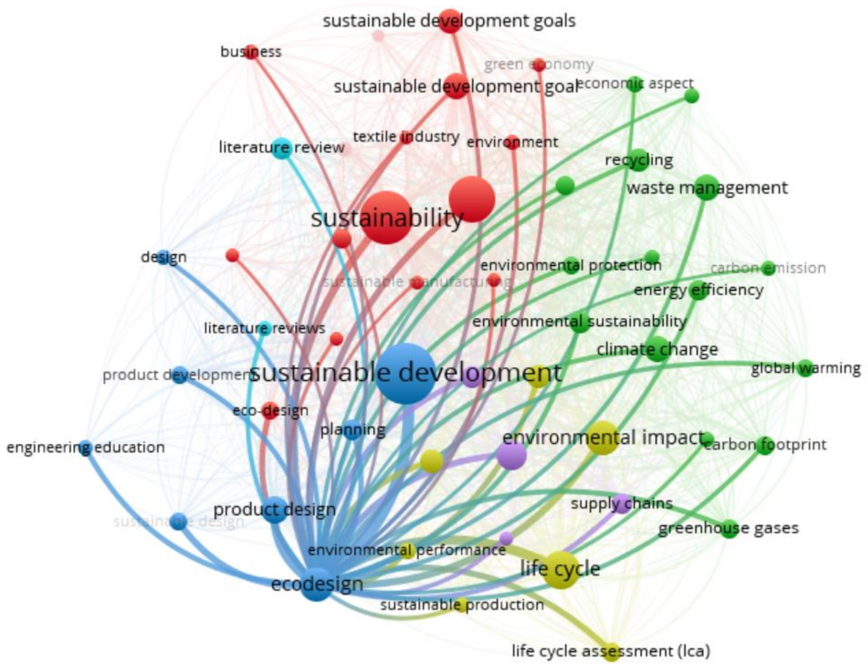


Figure 16. VOSviewer output of keyword "ecodesign" co-occurrences

In order to conduct more result-orientated research, the keywords were modified such as; ("Ecodesign Regulation" OR "Eco-design Regulation") AND ("Sustainable Development Goal" OR "SDG"). 22 documents were found on Scopus by using these key words. It should be noted, however, not all studies, from these 22 documents, are related to product regulations. Some are focused on the automotive industry, while others indicate that the "sharing economy" is related to the circular economy. Additionally, some studies are related to wastewater remediation, while others focus on human rights and the global plastics treaty, which aims to protect human health, ocean ecosystems and the climate. The majority of research in this field is concerned with the relationship between the Circular Economy (CE) and the Sustainable Development Goals (SDGs).

Table 2. presents an overview of studies that have been conducted to examine the relationship between product regulations and the linkage with SDGs.

Table 2. Some studies about product regulations and SDGs

No	Title	Author	Year	Summary	Ecodesign	Energy Label	SDG
1	The Relevance of Circular EconomyPractices to the Sustainable DevelopmentGoals	Schroeder, P., et al	2018	According to study by Schroeder et al., circular economy practices such as eco-design, reuse, refurbishment, remanufacturing, repair, product sharing, industrial symbiosis and energy efficiency have linkage with SDGs. **However, the impact of the Ecodesign and Energy Labelling Regulations and its relationship with the SDGs were not directly addressed in this study.**	✓	x	x
2	Circular economy for climate neutrality: Setting the priorities for the EU	Rizos V., et al.	2019	Authors indicates that the implementation of ecodesign requirements, encompassing aspects such as reparability, durability, upgradability and recyclability, is widely regarded as a pivotal policy instrument for the advancement of a circular economy.	✓	x	SDG12
3	One step back, two steps forward - Resource efficiency requirements within ecodesign	Schlegel, M.-C., et al.	2019	This study draws attention to the incorporation of resource efficiency considerations, including the availability of spare parts and dismantling capabilities, within the framework of Ecodesign regulations also discuss concepts related to resource efficiency, environmental impact, and sustainability. **However, the impact of the Ecodesign and Energy Labelling Regulations and its relationship with the SDGs were not directly addressed in this study.**	✓	x	x
4	Analysing European Union circular economy policies: words versus actions	Friant, M.C., et al.	2020	The article **does not explicitly mention a direct linkage between ecodesign and the SDGs.** However, it discusses the Ecodesign Directive and its updates, which aim to improve the repairability and recyclability of products. The increased availability of spare parts and the ease of disassembly of these products will facilitate their maintenance and repair.	✓	x	x
5	Advances towards circular economy policies in the EU: The new Ecodesign regulation of enterprise servers	Peiro, L.t., et al.	2020	The article discusses the integration of circular economy (CE) principles into EU product policies, focusing on the Ecodesign Directive for enterprise servers. It highlights the development of material efficiency requirements such as design for disassembly, firmware availability, data deletion, and the presence of critical raw materials. **However, the impact of the Ecodesign and Energy Labelling Regulations and its relationship with the SDGs were not directly addressed in this study.**	✓	x	x
6	Potential impacts of the European Union's circular economy policy on Japanese manufacturers	Yasushi, U., et al	2020	This study highlights the Ecodesign regulation as an example of circular economy implementation and highlighting the importance of proactive action, intensive communication, and integrating sustainability into core business activities. Essential technologies for realizing a circular economy include ecodesign, process technologies, business strategy and planning, and digital technology. **However, the impact of the Ecodesign and Energy Labelling Regulations and its relationship with the SDGs were not directly addressed in this study.**	✓	x	x
7	Regulating the circular economy within the ecodesign directive: Progress so far, methodological challenges and outlook	Davide, P.	2021	Polverini highlightes that it would be false to claim that the Ecodesign Directive, with its associated legal framework, is a universal remedy for all environmental problems. Rather, the promotion of CE could be achieved through the combined action of a number of different legal instruments. **However, the impact of the Ecodesign and Energy Labelling Regulations and its relationship with the SDGs were not directly addressed in this study.**	✓	x	x

Table 2. (Continued) Some studies about product regulations and SDGs

No	Title	Author	Year	Summary	Ecodesign	Energy Label	SDG
8	Review and Analysis of Ecodesign Directive Implementing Measures: Product Regulations Shifting from Energy Efficiency towards a Circular Economy	Barkhausen, R., et al	2022	According to the Barkhausen, Ecodesign regulation is going shift from energy efficiency to resource efficiency with ESPR and the growing incorporation of circular economy criteria into the field of ecodesign may be regarded as a favourable indication. **However, the impact of the Ecodesign and Energy Labelling Regulations and its relationship with the SDGs were not directly addressed in this study.**	✓	x	x
9	Consumer Preference for Energy Label in the Purchase Decision of Refrigerator: A Discrete Choice Experiment Approach in the East Coast, Malaysia	Razali, M. A. S., et al.	2022	Author explicitly indicates that the implementation of an energy label serves to promote the use of energy-efficient appliances, which is in accordance with the objectives set out in SDG Goal 7, namely ensuring access to affordable, reliable, sustainable, and modern energy for all.	x	✓	SDG7
10	From the circular economy to the sustainable development goals in the European Union: an empirical comparison	Rodríguez-Antón, J. M., et al.	2022	Rodriguez-Anton's study examines the European regulatory and advisory frameworks pertaining to the CE, with a particular focus on investigating the existing interconnections between the CE and each SDG. **However, the impact of the Ecodesign and Energy Labelling Regulations and its relationship with the SDGs were not directly addressed in this study.**	✓	x	x
11	Analysing regulatory instruments in sustainability transitions: A combined 'intervention points' and 'roles of law' approach to the European Union's Ecodesign framework	Entsalo, H., et al	2023	Entsalo et al, indicates that Ecodesign has a potential as a regulatory instruments for transition to sustainability by putting of SDG12 at the core of article. Author indicates that ecodesign framework represents a component of a broader political trend, as identified in SDG12.	✓	x	SDG12
12	Review of EU product energy efficiency policies: What have we achieved in 40 years?	Gonzalez-Torres, M., et al.	2023	The article discusses major policies like the Ecodesign Directive, Energy Labelling, and Minimum Energy Performance Standards (MEPS), and their impact on energy savings also identifies barriers to efficient technology adoption and provides policy recommendations to further enhance energy efficiency. **However, the impact of the Ecodesign and Energy Labelling Regulations and its relationship with the SDGs were not directly addressed in this study.**	✓	✓	x
13	Creating national strategy for circular design: an Australian perspective on cross sector levers for change	Lockrey, S., et al.	2023	This study highlights a specific linkage between Eco-Design and SDG. SDG 12 focuses on sustainable consumption and production patterns. This paper explains that design, particularly when focused on material circularity, can significantly aid in the transition to these sustainable patterns.	✓	x	SDG12
14	Climate Law and Litigation: Planetary, Regional, and Societal Perspectives	Research Center for Climate Law-Faculty of Law of the University of Graz	2023	According to this study in order to promote more sustainable production, the European Commission has introduced labelling for the energy consumption of household appliances and established regulations for the necessary eco-design of a number of products. These two directives represent the primary foundations of the European policy on sustainable production.	✓	✓	SDG12
15	A systematic literature review exploring and linking circular economy and sustainable development goals in the past three decades (1991–2022)	Yarosona, E. V., et al.	2024	This study shows connections between CE research themes, drivers, and barriers and the SDGs. Authors enable the identification of potential synergies, inconsistencies related this linkages also highlighting performance measurements and indicators. **However, the impact of the Ecodesign and Energy Labelling Regulations and its relationship with the SDGs were not directly addressed in this study.**	x	x	x

CHAPTER 3

ENERGY EFFICIENCY

This chapter aims to examine energy efficiency policy also strategies in this regard. However energy efficiency affecting number of sectors and areas, therefore from the general to the specific approach method will be followed. Energy efficiency related with products are more exclusive area. Therefore focus will be on energy efficiency legislation related with products (ecodesign and energy labeling). In previous chapter only definition and historical background of ecodesign and energy label is mentioned, but in this chapter legislative role will be addressed.

To boost domestic energy resource usage, encourage energy efficiency, and construct sustainable energy infrastructure in order to further enhance energy security, create an increasingly affordable energy market with price-sensitive energy costs, and promote every effort for establishing a sustainable energy system, Türkiye has implemented challenging energy policies. Increasing energy efficiency, using more renewable energy, and conducting more research and development on energy technologies are essential themes.

After a prolonged period of intense volatility beginning in 2020, some of the tensions in the energy markets have decreased in 2023 by the reason of war. Still, there are a lot of threats, and this relative calmness might not endure. As a result, Türkiye must diversify, secure its energy needs, and use resources wisely. There are compelling indications that the clean energy transition is accelerating rapidly, despite the presence of obstacles. The overall balance of investment is changing towards solar PV, clean energy, energy efficiency, and the deployment tendencies for electric vehicles,EVs, heat pumps and batteries are optimistic for the coming years.

IEA World Energy Outlook 2023 published that, in Figure 15;

> “The ratio of expenditure on fossil fuels to expenditure on clean energy technologies and related infrastructure is now for each $1 spent $1.8, representing a significant shift from the ratio of 1:1 observed five years ago”.

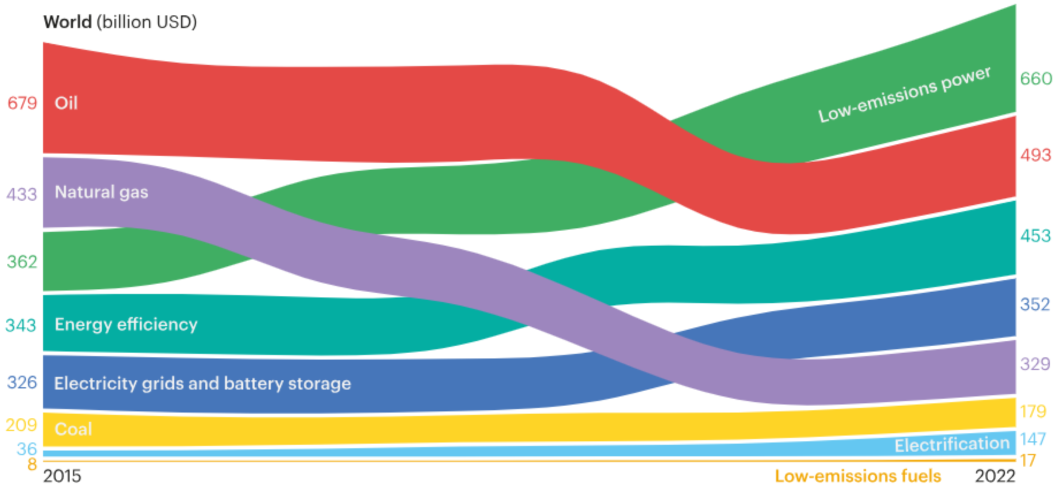


Figure 17. Investment flow

Taking into account all the progress made, securing the energy transition, and achieving the targets for global surface temperature rise and CO_2 emissions, Figure 17 , will require a concerted effort with responsible consumption.

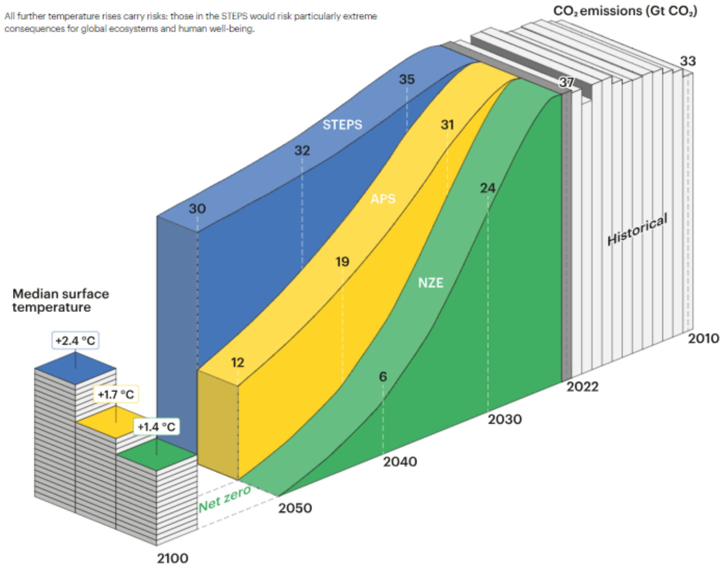


Figure 18. CO_2 emissions and temperature rise

When considering the consumption, energy efficiency have to be enable in different sectors and product groups. Energy efficiency gains can be attained by focusing on the extraction, transformation, and distribution phases of the "energy supply side," as well as the "demand side," which involves enhancing end-user appliances.

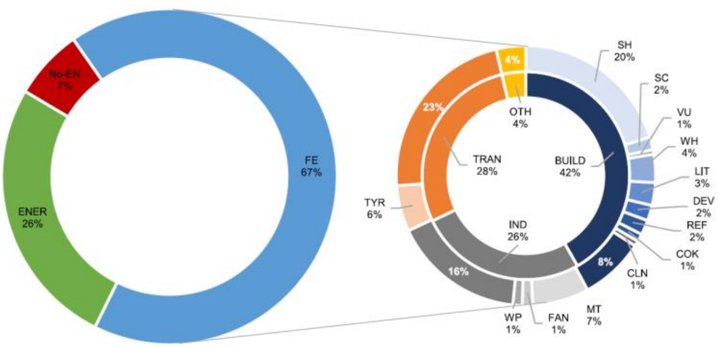


Figure 19. Energy consumption, both primary and final, in 2020

(Source: Gonzalez-Torres, 2023)

Given that end-use technologies accounted for 67% of primary energy consumption, as shown in Figure 19. Policies for products that target their energy efficiency therefore have a lot of potential and enable the introduction of cross-cutting strategies that address the majority of energy use (Gonzalez-Torres, 2023).

3.1 Overview of Energy Policy of Türkiye

“Security of Supply” is one the core point energy policy of Türkiye, as a country heavily reliant on energy import, ensuring a stable and diverse energy supply remains a top priority. The government pursues this through various strategies, including diversifying fuel sources, investing in domestic exploration and production, and fostering regional energy cooperation.

Establishing robust infrastructure for energy transition to secure energy supply needs a number of steps, shown in Figure 20, Bayraktar A.[4] highlights the transition periods and energy policy navigates a complex landscape shaped by

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[4] ESS 710 Energy Regulation and Policy, 2022, Lecturer Dr. Alparslan Bayraktar, Minister of Energy and Natural Resources.

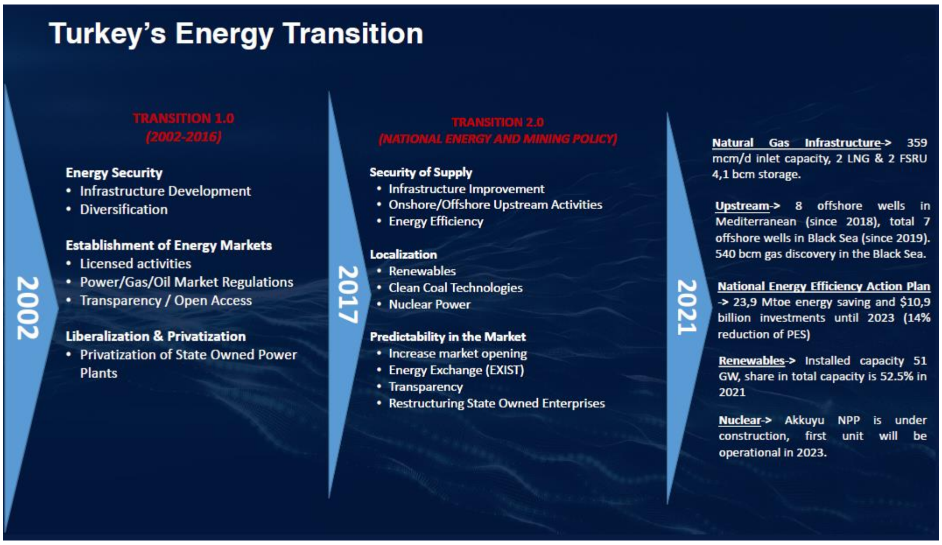

Figure 20. Energy Transition Periods

diverse factors. Also economic competitiveness should be provided with affordable and reliable energy underpins economic growth. Policies target both cost reduction and market liberalization, aiming to enhance energy efficiency and attract investments in renewable energy infrastructure.

According to Türkiye National Energy Plan[5], in 2022, following improvements are expected in the 2020–2035 period;

- increasing of primary energy consumption to 205.3 Mtoe;
- growth in electricity consumption to 510.5 TWh;
- increasing the proportion of electricity in total energy used to 24.9%;
- a 35.3% decrease in energy intensity;
- escalations in the installed capacity to: 189.7 GW in total

[5] Published by Ministry of Energy and Natural Resources, National Energy Plan.

3.2 Energy Efficiency Policy of Türkiye

Türkiye's energy efficiency program seeks to lower energy use, improve supply security, and promote sustainability across various sectors. Implementation product regulation as Eco-design and Energy labeling is strategic component for reducing consumption, also carbon emission and meeting the target under Paris Agreement. In each policies and action plans that examined, it appears that product regulations has nonignorable effect.

3.2.1 National Energy Efficiency Action Plan[6] - NEEAP II (2024-2030)

Action plan outlines sector-specific strategies for industry, buildings, transportation, and agriculture. In industry, minimum energy performance standards for equipment and technology advancements are crucial. Buildings will see stricter energy standards for new and existing structures, along with green building technologies encouraged. Transport aims for increased public transport and electric vehicle use, while agriculture focuses on energy-efficient irrigation and sustainable practices.

With the NEEAP II, encompasses a total of 61 actions across seven sectors, with an investment of $20.2 billion earmarked for energy efficiency initiatives between 2024 and 2030. The overarching objective is to achieve a cumulative primary energy savings of 37.1 Mtoe.

The goal of this approach is to lower primary energy usage by 16% by 2030, and also 100 million tonnes of CO_2 equivalent greenhouse gas reduction targeted to be achieved.

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[6] Published by (MENR) Ministry of Energy and Natural Resources, NEEAP Progress Report 2019.

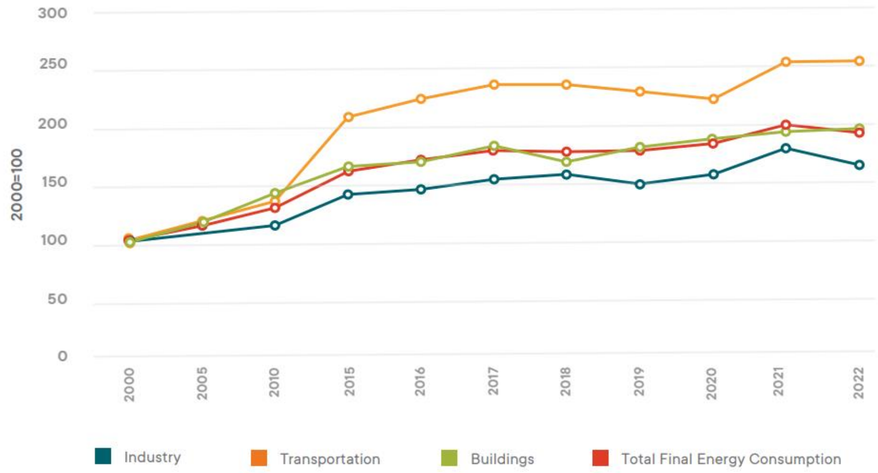

Figure 21. Sector-specific Final Energy Consumption Index

With 32.6 percent of the total energy used at the end, the buildings and services sector was the highest contributor, 31.6% the amount of energy used in the industrial sector, while 25.5% was consumed in the transportation sector.

Final energy consumption increased by 2.3% yearly on average in the industry sector between 2000 and 2022, 3.2% in the buildings and services sector, and 4.4% in the transportation sector. The whole final energy consumption grew at an average yearly rate of 3.1%. (NEEAP II, 2024).

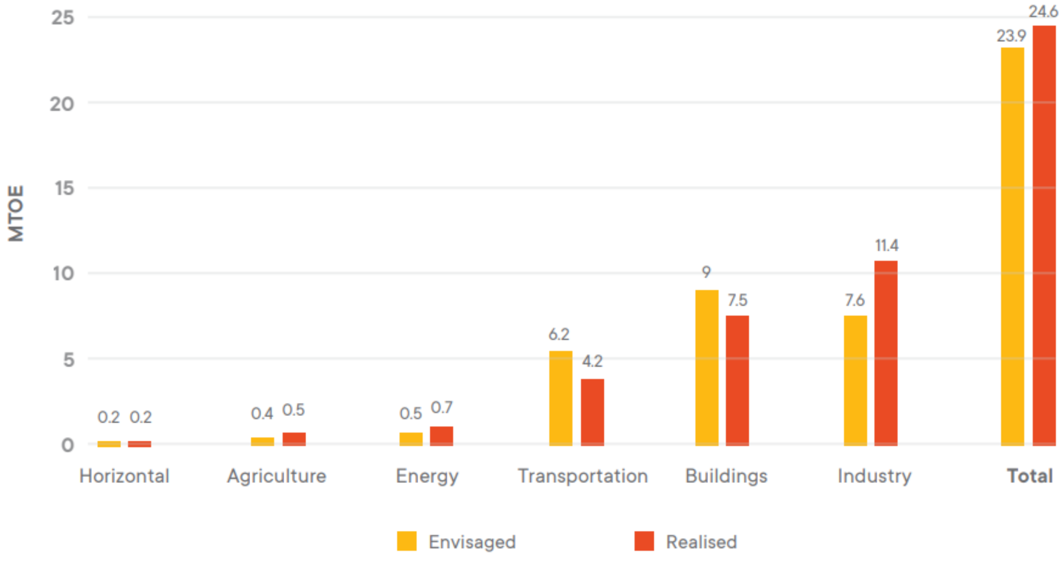

Figure 22. Cumulative Energy Savings envisaged and realised (2017-2023)

Overall energy savings in the industry sector were 11.4 MTOE, with buildings accounting for 7.5 MTOE, agriculture contributing 0.5 MTOE, energy accounting for 0.7 MTOE, horizontal themes contributing 0.2 MTOE, and transportation accounting for 4.2 MTOE. (NEEAP II, 2024). Figure 21 and 22 shows the energy consumption index and savings.

The NEEAP II includes horizontal and vertical goals. The strategic goal that encompass industry and building are closely connected to ecodesign and energy labeling. Strategic goal and actions are shown below;

- To guarantee the market's transition to products that are energy-efficient, circular in nature, and ecologically beneficial.(Strategic Goal 9)
- Enhance the adoption of environmentally friendly, energy-efficient products, devices, equipment and machinery, and to make the necessary arrangements in line with ecodesign norms.

In order to accomplish actions related Eco-design and Energy Label;

- Implementation of regulations andvstandards (S4)

- Industry-Wide distribution of energy-efficient products (S9)
- Increasing awareness activities (Y6)

3.2.2 Medium Term Programme[7] (2024-2026)

Under the “Macroeconomic Objectives and Policies” goal, Türkiye’s green transformation process will be accelerated in accordance with the priorities for national development and the 2053 net zero emission objective. To achieve this, supporting the mitigation of CO_2, increasing the capacity for adaptation to climate change, prioritization of efficiency and competitiveness are explicitly highlighted.

- To focus on improving resource efficiency, process optimization, and digitalization also awareness activities in this regard.

3.2.3 12th Development Plan of Türkiye[8] (2024-2028)

Energy efficiency is recognized as a critical driver for achieving sustainable development, reducing energy dependence, and enhancing competitiveness. As is seen in the other strategic and action plans. The development plan highlights the necessity to curtail the utilization of primary energy resources and to mitigate the impact of greenhouse gases through the implementation of enhanced efficiency measures.

In this plan one of the main objectives; increasing localization by producing high value-added products in the electrical equipment sector, ensuring sustainability, creating an international brand and creating international brands have a say in the

[7] Published by PSB, Orta Vadeli Program (2024-2026).
[8] Published by PSB, On İkinci Kalkınma Planı (2024-2028).

preparation of product standards. Under this aim following measurements highlighted;

- Implementation of eco-design requirements for electrical and electronic goods and components will be ensured.
- Lighting equipment industry to become a regional production and logistics center and the sector will be encouraged to meet the supply of light sources and separate control equipment from domestic production.

3.2.4 11th Development Plan (2019-2023) and NEEAP I (2017-2023)

Previous development plan (DP) and action plan also includes product related energy efficiency targets and goals. The steps Türkiye will take between 2017 and 2023 to meet its energy efficiency targets have been outlined in the NEEAP. Development plans are consistently mention about energy efficiency not just 11th Development Plan, but in 10th Development Plan (2014-2018) also highlights the importance of the energy efficiency.

NEEAP I (2017-2023)

In this action plan was aimed at lowering Türkiye's primary energy usage by 14% by 2023. A total of 23.9 Mtoe in savings are anticipated by 2023, necessitating $10.9 billion in investments. The total savings of $30.2 billion at 2017 prices must be reached by 2033, with particular savings having an impact that extends until 2040 (NEEAP Progress Report, 2019).

55 acts were categorized into six groups by the actions: energy, transportation, buildings and services, industry and technology, agriculture, and horizontal sectors. Energy labelling and ecodesign are strongly related to the three activities categorized as industry-technology and energy (Karagoz, 2022);

- The implementation of minimum energy performance standards for products; electric motors, transformer and household appliances (action E5 and S4)

11th Development Plan (2019-2023)

In terms of ecodesign and energy labeling, the two distinct policy objectives were reaching completion of the EU's rescaled energy label law in the white appliances sector and increasing manufacturing industry knowledge of the energy efficiency of electric motors (Karagoz, 2022):

- Providing financial investment to ensure compliance with the latest product regulations. Incentives and awareness-raising activities are necessary to promote the use of efficient motors.motors.

3.3 Ecodesign and Energy Labeling Framework Regulations

In this section energy efficiency of products will be discussed from regulative perspective. In previous chapters only definition and history of "eco-design" and "energy labeling" terms are explained.

3.3.1 Harmonizing Ecodesign and Energy Labeling Framework: Türkiye's Journey towards EU

A pivotal moment arrived in 1963 with the signing of the Ankara Agreement, formally creating a relationship between Türkiye and the European Union (EEC).

On December 31, 1995, the Customs Union came into effect. The EU and a non-EU country established the first meaningful customs union. All industrial items are covered, but services, public procurement, and agriculture (apart from processed agricultural products) are left out. Concessions on bilateral trade pertain to steel, coal, and agricultural items. For the products covered, a standard external tariff is provided by the Customs Union. The removal of trade barriers in sectors related to the Customs Union, such as customs legislation, it is also anticipated that Türkiye will align with EU law, or the acquis communautaire (European Commission Trade, 2024).

This included regulations on product safety, technical standards, and consumer protection. Early efforts focused on harmonization with these regulations, laying the groundwork for future developments in areas like ecodesign and energy labeling, sustainable product initiatives, more envronmental-based regulation.

As Türkiye aspires toward EU membership, aligning its environmental policies with the regulations becomes crucial. This includes harmonization with the Ecodesign and Energy Labeling Framework Regulations, a key driver of resource efficiency and circularity within the EU. This process holds both opportunities and challenges for Türkiye's economy and environment.

On the one hand, harmonization with the Ecodesign and Energy Labeling Framework Regulations can open doors for Turkish manufacturers to access the vast EU market. By adhering to the same standards, their products become automatically compliant, eliminating technical barriers and opening avenues for growth and competitiveness. Additionally, implementing the regulation's principles can lead to domestic advancements in design, technology, and manufacturing, fostering innovation and resource efficiency within the Turkish economy.

However, challenges also come with this harmonization process. Upgrading infrastructure, production processes, and product designs to meet EU standards might require significant investments from Turkish manufacturers. Ensuring effective enforcement and compliance across sectors could pose logistical and administrative hurdles. Moreover, potential short-term cost increases for both businesses and consumers might require careful management to ensure a smooth transition without jeopardizing economic stability.

In conclusion, harmonizing Ecodesign and Energy Labeling Framework Regulations presents a complex but valuable opportunity for Türkiye. By carefully navigating the challenges and leveraging the potential benefits, this alignment can pave the way for a more sustainable, resource-efficient, and competitive Turkish economy, ultimately contributing to a greener future for both Türkiye and the EU.

3.3.2 Eco Design Regulation

The Ecodesign Regulation (2009/125/EC) provides a framework for manufacturers to meet performance criteria required to legally bring their products to market. It does not prescribe specific measures or standards, nor does it set overall energy-saving targets.

The Regulation covers all energy-using products sold in the professional and non-professional areas, except for means of transport, which are covered by other legislation. The revised Regulation[9], extends the scope of the existing 2009/125/EC to encompass all goods having to do with energy.

In response to the increasing quantities, varieties, and complexities of products, eco-design principle introduced the concept of Integrated Product Policy (IPP). The focus of the policy was placed on products and their effects on the environment during their whole life span. This approach allows for the assessment and addressing of cumulative environmental impacts. The particular aim is to prevent burden shifting, which occurs when an environmental improvement at one stage of the life cycle results in increased environmental impacts at another stage (Dalhammar, C., 2014).

In order to advance sustainable development, it is essential to pursue unceasing enhancements to the collective environmental impact of products. This entails the identification of primary sources of detrimental environmental impacts and the

[9] The European Parliament and Council Regulation 2005/32/EC, enacted on 6 July 2005, constituted a framework for defining eco-design criteria for energy-consuming products, subsequently amended. The only additional amendments that are required are those that extend the scope of application of the Regulation to include all energy-related products.

mitigation of pollution transfer, provided that the associated costs remain within reasonable limits.

Since the legislation is a framework rule, products are not subject to its legally obligatory requirements. Instead, it sets out a framework for implementing measures (IMs), which lay down binding eco-design requirements for a number of product groups.

According to the ecodesign regulation, each product group's ecodesign specifications are developed through a procedure managed by the European Commission. This product groups, shown in the Table 3, have their own limitation and constraint for each products about their specifications. The regulation's influence extends beyond product features. It mandates producers to provide clear and accurate information about energy consumption, noise emissions, water consumption and other environmental aspects throughout the product's lifecycle. This transparency not only empowers consumers but also facilitates waste management and recycling efforts.

Table 3. List of Implementing Measures

(Source: European Comission, 2024)

Product group	Type(s)	of measure		Relevant acts/legislation
	ED	EL	VA	
Horizontal: framework legislation	X			Directive 2009/125/EC
Horizontal: framework legislation		X		Regulation (EU) 2017/1369
Horizontal: Guidelines on self-regulation/VAs			X	Recommendation (EU) 2016/2125
Horizontal: Standby / off mode consumption	X			Regulation (EC) 1275 /2008
				Regulation (EU) 2023/826
Welding equipment	X			Regulation (EU) 2019/1784
Power transformers	X			Regulation (EU) 548/2014
Electric motors + variable speed drives (VSDs)	X			Regulation (EU) 2019/1781
Water pumps	X			Regulation (EU) 547/2012
Circulators	X			Regulation (EC) 641/2009
Industrial fans	X			Regulation (EU) 327/2011
Professional refrigeration equipment	X			Regulation (EU) 2015/1095
		X		Regulation (EU) 2015/1095
Air heating/cooling products	X			Regulation (EU) 2016/2281
External power supplies	X			Regulation (EU) 2019/1782
Computers	X			Regulation (EU) 617/2013
Servers and data storage products	X			Regulation (EU) 2019/424
Simple set-top boxes - REPEALED	X			Regulation (EU) 107/2009
Vacuum cleaners	X			Regulation (EU) 666/2013
Mobile phones and tablets	X			Regulation (EU) 2023/1670
		X		Regulation (EU) 2023/1669
TVs/Electronic displays	X			Regulation (EU) 2019/2021
		X		Regulation (EU) 2019/2013
Light sources and control gears	X			Regulation (EU) 2019/2020
		X		Regulation (EU) 2019/2015

Table 3. (Continued) List of Implementing Measures

(Source: European Comission, 2024)

Dishwashers	x			Regulation (EU) 2019/2022
		X		Regulation (EU) 2019/2017
Washing machines + washer-dryers	x			Regulation (EU) 2019/2023
		X		Regulation (EU) 2019/2014
Tumble driers	x			Regulation (EU) 932/2012
		X		Regulation (EU) 392/2012
Domestic cooking appliances: ovens, range hoods, hobs	x			Regulation (EU) 66/2014
(NB: no label for hobs)		X		Regulation (EU) 65/2014
Household fridges and freezers	x			Regulation (EU) 2019/2019
		X		Regulation (EU) 2019/2016
Refrigerating appliances with a sales function	x			Regulation (EU) 2019/2024
		X		Regulation (EU) 2019/2018
Ventilation units	x			Regulation (EU) 1253/2014
(labelling for residential only)		X		Regulation (EU) 1254/2014
Space and combination heaters	x			Regulation (EU) 813/2013 Council Directive 92/42/EEC
		X		Regulation (EU) 811/2013
Water heaters/storage tanks + solar devices	x			Regulation (EU) 814/2013
		X		Regulation (EU) 812/2013
Local Space Heaters	x			Regulation (EU) 2015/1188
(labelling in same regulation)		X		Regulation (EU) 2015/1186
Solid fuel space heaters	x			Regulation (EU) 2015/1185
Solid fuel boilers	x			Regulation (EU) 2015/1189
		X		Regulation (EU) 2015/1187
Air conditioners (incl. air-to-air heat pumps)	x			Regulation (EU) 206/2012
		X		Regulation (EU) 626/2011
Tyres		X		Regulation (EU) 2020/740
Imaging equipment			X	COM (2013) 23
Game consoles			X	COM(2015) 178
Total: 31 specific product groups, excl. standby.	**30**	**17**	**2**	**51**

The majority of these obligations relate to compulsory requirements for the energy consumption of products. Minimum environmental performance standards (MEPS) is a common term used to describe. These standards, continuously reviewed and tightened, pushes manufacturers to innovate and develop products that consume less energy throughout their use phase. This translates to benefits for both consumers and the environment. Consumers experience lower energy bills and reduced carbon footprints, while the environment appreciates lowered greenhouse gas emissions and reduced pressure on energy resources.

The Regulation outlines the qualification criteria for product groups that require specific requirements to be met. To be considered for regulatory action, it is recommended that the selected products should represent a meaningful volume of sales and trade, with a minimum of 200,000 units per year in the EU. Furthermore, they should demonstrate a notable ecological impact and present a substantial potential for improvement (European Comission, 2024).

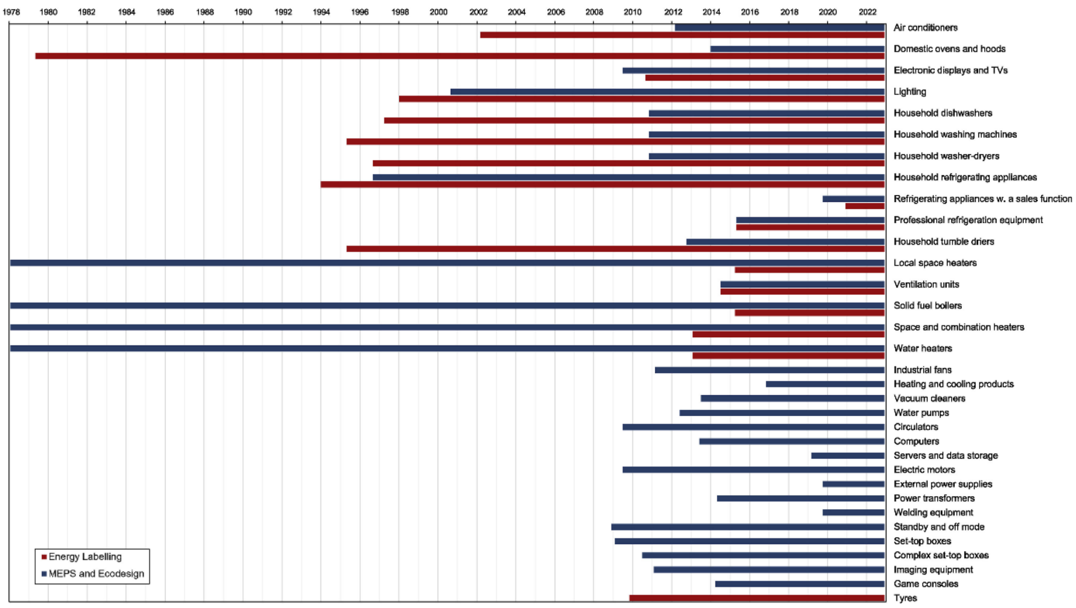

Figure 23. Ecodesign and Energy Labeling for products in timeline

Although the EU had implemented product rules starting in the late 1970s, until the 1990s, when the first energy labels became widely used, there were almost no mandatory specific implementations shown in Figure 23.

Standard European thresholds were not implemented until 1992 since Member States were still in charge of determining the minimum standards, even though the MEPS rule on heat generators had previously been in effect since 1978 (Gonzalez-Torres, 2023).

The Ecodesign Regulation, plays a crucial role in shaping resource-efficient products and reducing environmental impact. Considering this more clearly, in this section, some information related to products under the regulation, such as consumption and emission reduction, will be shared from the impact assessment published by the Commission. From the ecodesign impact assessment report, 6 products selected four of them end-user products such as lighting product, TV, refrigerator&freezer and washing machine; rest of is professional products such as electric motor and water pump.

3.3.2.1 Energy Consumptions of the Products

- **Televisions**

The amount of power used per unit display area when in on mode has been steadily decreasing over the last few decades. TVs and monitors used 9.2 W per dm^2 of display area in 1990. This decreased to 1.6 W/dm^2 in 2020. It is predicted that particular power usage for both types of displays will drop to 0.4 W/dm^2 by 2030 and beyond. As power usage in on mode drops, standby power consumption becomes relatively more applicable. 10% of the energy used by screens overall in 2020 was used in standby mode; however, by 2030, this percentage is predicted to rise to 18%. Smart TV standby power usage is predicted to drop from 6.4 W in 2015 to 4 W in 2030 as a result of the rules, shown in Figure 24 (VHK, 2022).

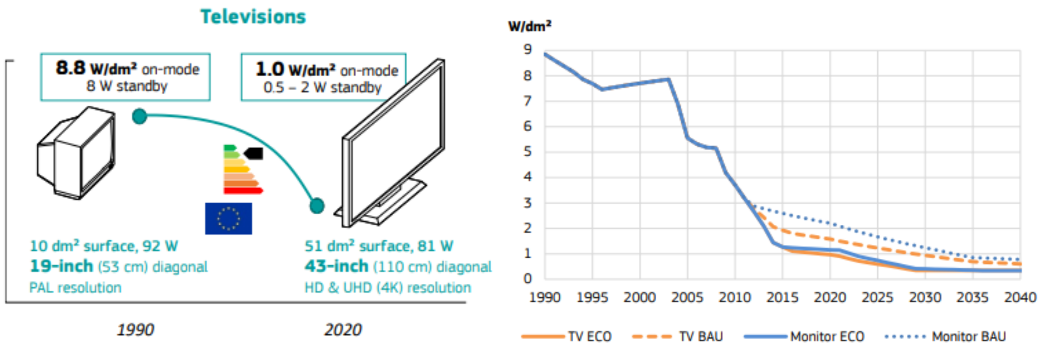

Figure 24. Energy consumptions in on-mode and standby

- **Refrigerator-Freezer**

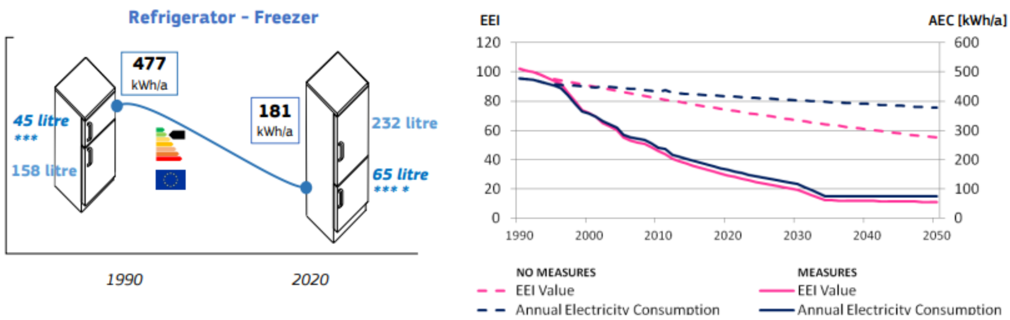

Figure 25. Energy consumptions and EEI value

The Energy Efficiency Index (EEI) is a metric used to express the energy efficiency of refrigerator equipment. Lower EEI values for refrigeration units have been encouraged by both the Ecodesign regulation and Energy Labeling programs. According to projections, the 2030 EEI value will be 19, which is 37% less than 2020 and corresponds to an A+++ label (old scale) of 114 kWh/a. It is projected that the EU27 will consume 42 TWh/a of electricity overall in 2030. This represents a 19 TWh/a reduction from 2020 and a 75 TWh/a reduction from the consumption in 2030 in the absence of any actions, shown in Figure 25 (VHK, 2022).

- **Lighting Products**

In the EU27 residential sector, 6.4 billion lamps (32 lamps per hour) are anticipated to be installed by 2030, using 27 TWh of electricity annually (132 kWh/a/hh). As the quantity of installed lightbulbs in each household increased by 62%, this is 75% less than in 2005. It is projected that over 96% of these lighting will be LED. In the absence of interventions, the amount of electricity consumed in 2030 would have been approximately 51 TWh/a, shown in Figure 26 (VHK, 2022).

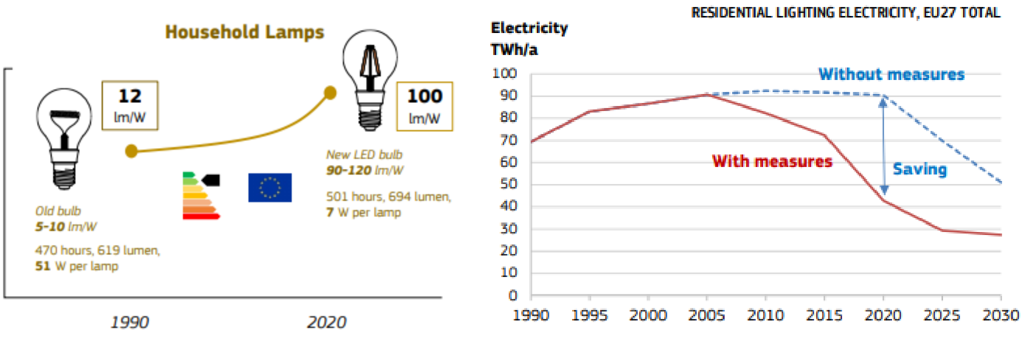

Figure 26. Energy consumptions

- **Washing Machine**

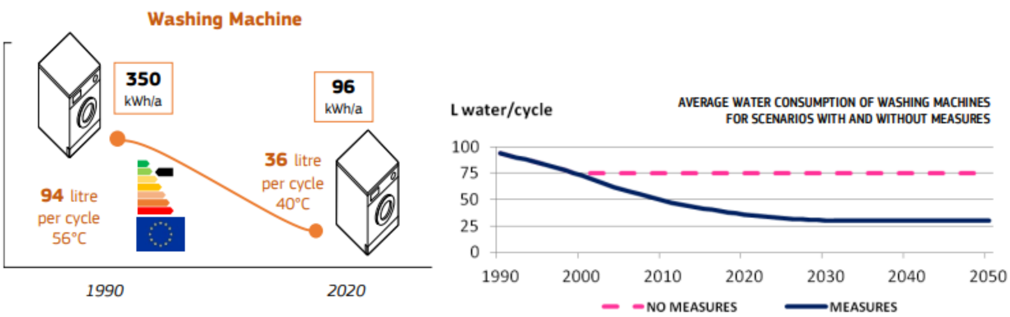

Figure 27. Energy and water consumptions

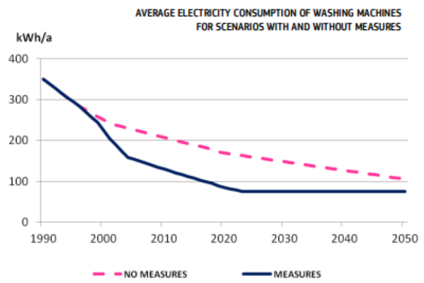

Figure 28. Energy consumptions

The Ecodesign standards also impose restrictions on how much water WMs can use. The typical WM used 84 liters per cycle in 1995. In the absence of action, this was predicted to decrease to 75 l/cycle by 2000. This can be decreased to 36 l/cycle in 2020 and is predicted to drop to 30 l/cycle by 2030 as a result of the initiatives, shown in Figure 27 and 28(VHK, 2022).

- **Electric Motor**

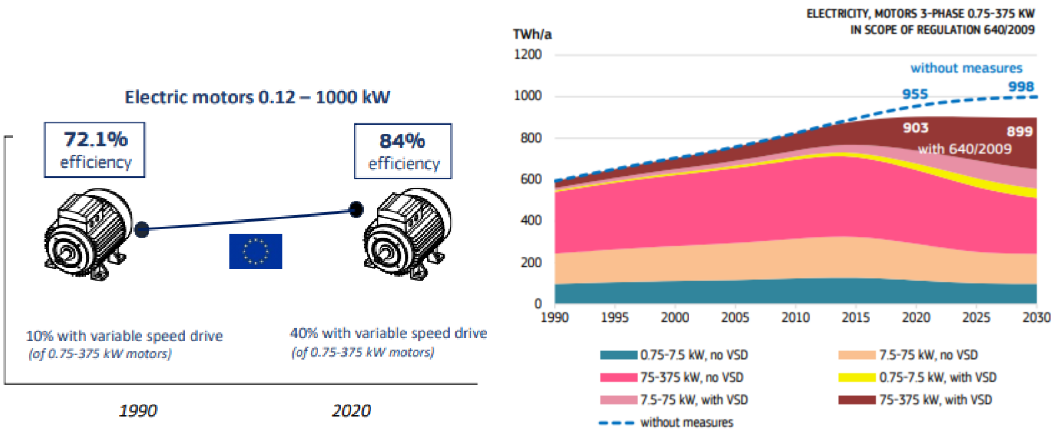

Figure 29. Efficiency of Motors

The scope will be expanded as per the 2019 regulation (see Electric Motors Regulation). In this enlarged context, the consumption of electricity by electric motors would have climbed from 1192 TWh in 2010 to 1378 TWh in 2020 and 1449 TWh in 2030 if no action had been taken in 2009, shown in Figure 29 (VHK, 2022).

- **Circulator**

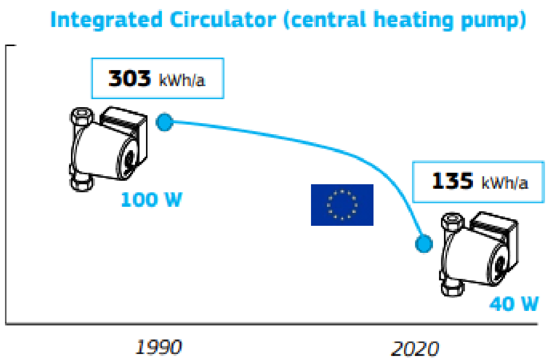

Figure 30. Energy consumption

The potential for energy savings was considerable, largely due to the tendency within the sector to oversize the pump and utilise only basic control mechanisms. The Ecodesign regulation's new metrics, which reduced electricity use to 33 TWh/a in 2015, 24 TWh/a in 2020, and predicted 21 TWh/a in 2030, were crucial in turning the market around. This is a 40% reduction in CO_2 emissions and electricity use, and the device also helped to achieve more consistent and comfortable heating, shown in Figure 30 (VHK, 2022).

3.3.3 Energy Labeling Regulation

In 1994, the EU energy label was first implemented for several household appliances and later expanded in 2004. It uses a comparative scale from A (higher effciecny) to G (lower efficiency) to help end-users selection of more efficient products. The label also incentivizes manufacturers to innovate by using more energy-efficient technologies. According to the Special Euro barometer 492, in 2019, 93% of end-users recognized the energy label, and 79% considered it when purchasing energy-efficient products. Manufacturers strive to have their energy-labeled products in the most favorable category compared to their competitors. For instance, in 2006, approximately two-thirds of refrigerators and washing machines put into market were labeled as class A, while in 2017, over 90% of them were labeled “A+”, “A++” or “A+++”. The labels not only give details regarding the amount of energy that the product uses but also about other relevant features of usage, such as noise emissions or water consumption (European Commission, 2024).

In response to increasing concerns about energy security and environmental sustainability, Türkiye initiated a programme of action to promote energy efficiency in the early 2000s. A pivotal step in this process was the introduction of an energy labelling scheme in 2010, aimed to empower consumers with clear and readily understandable information regarding the energy consumption of various household appliances.

The classification system for energy performance of products was initially established with seven distinct energy classes, ranging from "A" to "G". Additionally, the label incorporated fundamental parameters and product specifications that differed according to the product category. In 2010, the Regulation 2010/30/EC introduced the second version of the label, which included additional classes of “A+”, “A++”, and “A+++”.

In compliance with the “Sustainable Industrial Policy Action Plan” and “Sustainable Consumption and Production”, the definition was broadened to encompass all energy-related products (ErP) with a significant direct or indirect impact on energy utilisation during their operational phase.This will result in the generation of additional energy savings and environmental benefits.

The expansion of the scope reinforces the coherence between the EU Energy Labeling scheme and the Ecodesign Regulation, this facilitates a more optimal exploitation of the complementarity between the two policy instruments. The third generation rescaled to the original “A” to “G” scale again for some products group and entried into force in 2021 (Karagoz, 2022). Evaluation of the energy label shown in Figure 31.

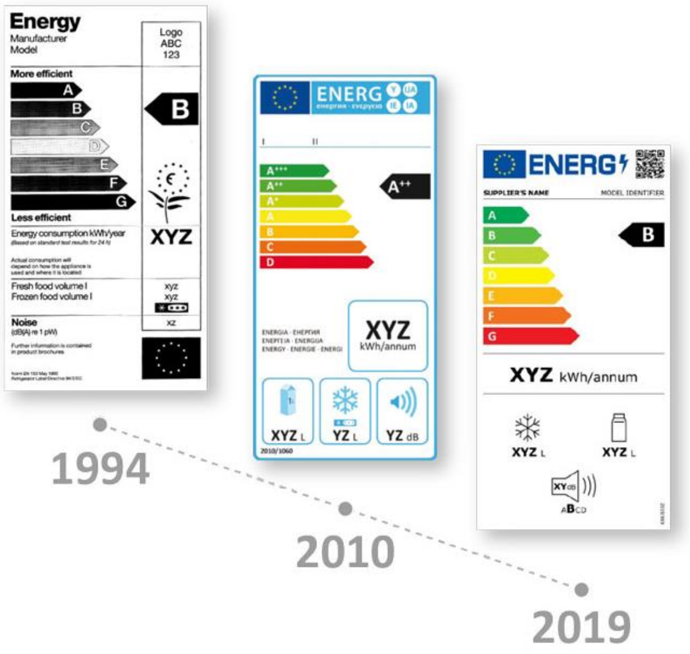

Figure 31. Varying of Energy Label

By providing correct information about a product's energy consumption, energy labels enhance market performance and help businesses and consumers make informed decisions when buying equipment or appliances. End users may only estimate the ongoing energy costs for equipment and appliances once they are purchased with the use of this information. Nowadays, the majority of Organization for Economic Co-operation and Development (OECD) nations as well as a growing number of other nations and developed non-EU countries have energy labeling regimes in place for appliances and equipment, shown in Figure 32.

Figure 32. [10]Different labels

(Source: Gonzalez-Torres, 2023)

According to a 2014 assessment that examined many nations' MEPS and energy labeling initiatives, 59 non-EU nations had previously embraced energy labeling for equipment that uses energy, shown in Figure 33. At the same time, the Australian Department of Industry carried out a review of a similar nature, emphasizing the remarkable quantity of other nations that replicate the EU label. Beyond the borders of the EU and the appliance industry from whence it originated, the EU energy label has gained international recognition as a symbol of energy efficiency (European Commission-Fact Sheet, 2019).

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[10] The labels for Canada, the EU, Australia, and China are among the comparable labels that can be found in the upper line. The three reference labels-the German Blue Angel, the EU ecolabel, and the US Energy Star-are located in the lower line.

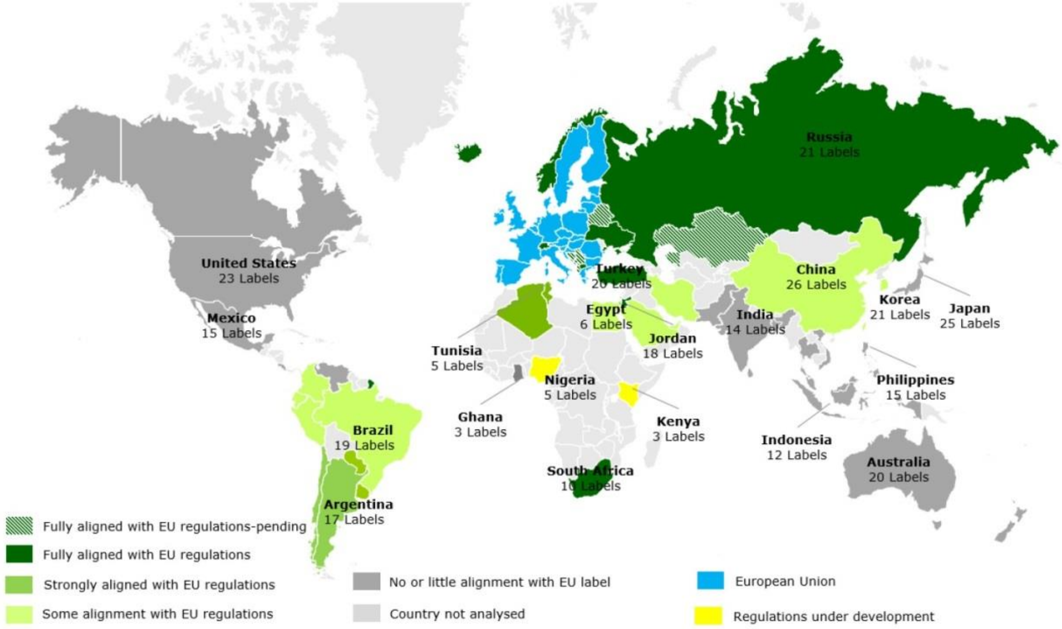

Figure 33. Adopted energy label by non-EU countries

(Sources: European Commission, Fact sheet, 2019)

3.3.4 Regulatory Framework in Türkiye

The implementation of policies is contingent upon the provision of a legal framework, standards, and support that are conducive to the promotion of energy efficiency, the protection of consumers, and a contribution to a more sustainable future. In this regard there are two law that that underpin these policies and play a leading role in helping to implement them.

3.3.4.1 Energy Efficiency Law in Türkiye

The Energy Efficiency Law (Law No. 5627)[11] was enacted in 2007 with the primary objective of promoting the efficient use of energy, reducing energy consumption and protecting the environment.

The purpose of this Law is to increase the efficiency in the use of energy sources and energy in order to make effective use of energy, avoid waste, reduce the burden of energy costs on the economy and protect the environment.

It covers the principles and procedures for increasing and promoting energy efficiency in the phases of energy production, transmission, distribution and consumption in industrial plants, buildings, energy production plants, transmission and distribution networks and transport, for raising energy awareness among the general public and for using renewable energy sources.

The procedures and principles about product effciency's regarding the determination of minimum yields shall be determined by the Ministry of Industry and Trade and the sale of those that do not meet the minimum limits shall not be permitted (Law 5627, Article 7). With this article in the law, regulations, sanctions and prohibitions on products will be evaluated under a different law.

3.3.4.2 Product Safety and Technical Regulations Law in Türkiye

Product Safety and Technical Regulations Law[12] (Law No. 7223) establishes standards and regulations that manufacturers, importers, and distributors are obliged to adhere to, thereby protecting consumers from potential hazards, considering

[11] Official Journal, Energy Efficiency Law,https://www.mevzuat.gov.tr/MevzuatMetin/1.5.5627.pdf
[12] Official Journal, Product Safety and Technical Regulations Law, https://www.resmigazete.gov.tr/eskiler/2020/03/20200312-1.htm

environmental impacts and promoting fair market practices. This law aims (Law 7223, Article 4);

- Consumer Protection: One of the principal aims of the legislation is to protect consumers from the potential risks associated with the use of unsafe products and to safeguard consumers and the environment from the adverse effects of inefficient products. By establishing safety and performance standards and requiring compliance, it helps to prevent accidents, injuries, and property damage.
- Market Integrity: Law 7223 contributes to the integrity of the market by ensuring that products sold are safe and meet quality standards. This prevents the sale of substandard or dangerous goods, which can harm consumers and erode trust in the market.
- Fair Competition: The law promotes fair competition among businesses by ensuring that all products are subject to the same safety and efficiency requirements.
- Public Health and Safety: Law 7223 is essential for public health and safety. By preventing the sale of unsafe products, it helps to protect the health and well-being of Turkish citizens.

Sanctions, measures and prohibitions for products under the responsibility of Ecodesign and Energy Labelling Regulations are carried out under this Law.

3.3.5 The Complementary Relationship Between Energy Labeling and Ecodesign

Energy Labelling "sister" regulations, which target consumers and influence their purchase decisions, accompany the majority of Ecodesign regulations. Furthermore, they promote the ongoing enhancement of product design among manufacturers in an effort to place them in the highest classes and with the best ratings on all label parameters (European Commission- Ecodesign and Energy Label, 2024).

The research conducted in 2019 by the Department for Business, Energy and Industrial Strategy (BEIS), UK, found that, based on the most conservative assessment, the existing ecodesign regulations and energy labelling requirements for appliances and other energy-consuming products have the potential to reduce the average UK household's energy expenditure by approximately £100 per year.s and avert the release of eight million tonnes of CO_2 equivalent ($MtCO_2e$) in the country in 2020. (Green-alliance, 2020).

In addition to the troubling rate at which electronics goods are being overlooked, in 2019, the global production of e-waste reached 53.6 million tons. Over the course of a mere five years, there has been a 21% increase. The data presented here is based on the findings of the UN's Global e-Waste Monitor for the year 2020., Figure 34 indicates that the UK produces the second-highest amount of electronic waste globally per person, after Norway.

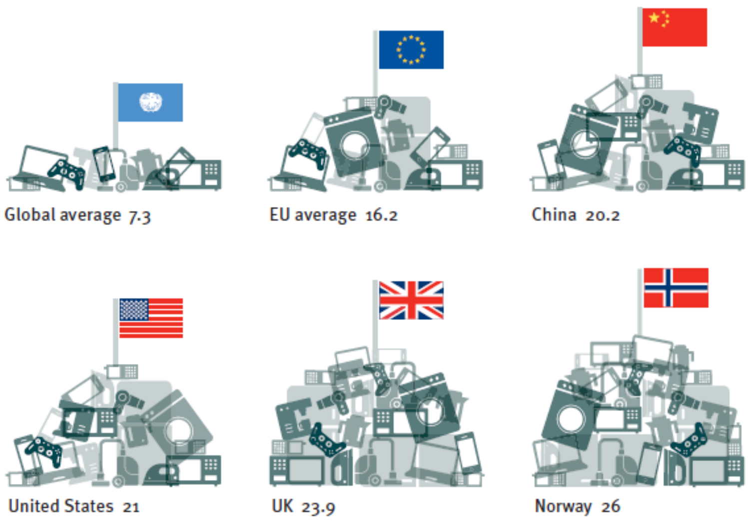

Figure 34. Generated e-waste in 2019 (kg per person)

An effective legislative tool that works in tandem with ecodesign principles is the Energy label. The goal of the Ecodesign legal framework is to establish minimum standards, primarily for energy performance during the product's usage phase, but also increasingly, during the regulation reviews of individual items, for the energy and material use across the course of the product's lifetime. Product placement on the market is based upon meeting required ecodesign requirements. They go after producers who have to ensure that their goods are designed with all constraints and needs taken into account like carbon emissions, water and energy consumption.

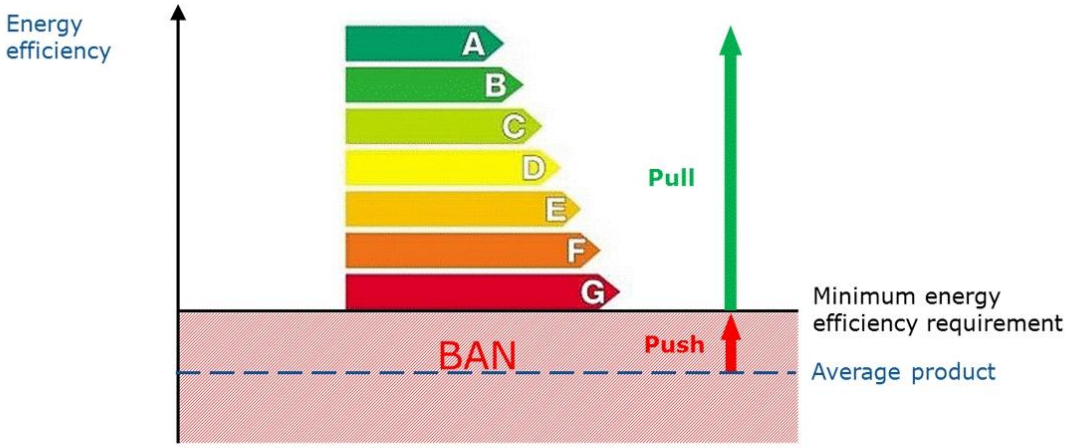

Figure 35.The Push & Pull Effect

(Source: Karagoz, 2022)

Excessive consumptions triggers environmental concerns and promotes sustainable practices across all sectors. The “Push & Pull” approach, shown in Figure 35, a synergistic effect between ecodesign regulations and energy labelling, offers a powerful solution to reduce unneccesarry usage of resources (European Commission, 2019). Ecodesign acts as trigger effect of “push” and mandating minimum environmental performance standards for products. This pushes manufacturers to innovate and design products that minimize environmental impact throughout their life cycle. Energy labelling, on the other hand, functions as the “pull,” empowering consumers with clear information about a product’s energy consumption. By providing this transparency, energy labelling “pulls” consumers towards more eco-friendly choices. This combined force creates a win-win situation, driving market transformation towards sustainable products and empowering consumers to make informed purchasing decisions for a greener future.

3.4 The New Game Changer: ESPR (Ecodesign for Sustainable Products Regulation)

The ESPR, published by the European Commission (EC), is envisioned to be a cornerstone initiative within the framework of both the Circular Economy Action Plan (CEAP) and the European Green Deal. This new regulation is the successor of ecodesign regulation and aims expanding its scope and strengthen its provisions, reflecting the EU's commitment to a more resource-efficient and sustainable future.

The EC unveiled the European Green Deal at the end of 2019. It is a comprehensive set of legislative measures intended to decouple resource consumption from economic growth and make the EU carbon neutral by 2050. Energy-consuming and energy-related items have a substantial detrimental impact on the environment, especially when it comes to the impact category of the use of mineral and metal resources, by way of the EU's consumption footprint calculations demonstrate (European Comission- Indicators and Assessment of the Environmental Impact of EU Consumption, 2019).

The production of raw materials is mentioned explicitly as a factor influencing how home items affect the environment. Early on, the EU implemented energy-efficient product regulations aimed at enhancing the environmental performance of appliances.

10% of the primary energy consumption of the EU27 was predicted to be saved in 2020 by EU ecodesign and labeling regulations, with a total estimated savings in consumer expenditure of 60 billion euros. The Ecodesign Regulation adopts a highly comprehensive strategy that goes well beyond energy efficiency. ESPR can be extremely important in encouraging industry actors to overcome the cultural and market hurdles that stand in the way of their transition to the circular economy, as these are the leading causes of the aforementioned difficulties rather than only technological ones (Barkhausen, 2022).

Under the key goals to foster the growth of markets for climate-neutral and sustainable products, to achieve this, outlines a framework for sustainable product policy has substantial importance. This framework encompasses three main pillars:

1- Fostering the development of sustainable products through design,
2- Empowering consumers and government entities to make informed decisions
3- Promoting the circularity of production processes.

Although the three constituent parts of the sustainable product policy framework are complementary and reinforcing. This regulatory measure chiefly addresses the measures delineated under the initial area (sustainable product design), which are designed to guarantee that products are suitable for a climate-neutral, resource-efficient, and circular economy, and to minimise waste, and facilitate the progressive adoption of sustainability standards by industry (European Comission- Explanatory Memorandum, 2022).

By enacting laws and non-laws with the goals of standardizing sustainable products, empowering public purchasers and consumers, and preventing waste by extending the life of resources in the economy, ESPR under the CEAP is an essential element and an important contribution to achieving the goals in the Green Deal. ESPR focuses in especially on sectors including electronics and ICT, packaging, batteries, cars, plastics, textiles, construction, food, water, and nutrients—all of which have a strong potential for improved circularity. Achieving climate neutrality requires a synergy between circularity and a reduction in greenhouse gas emissions, and money must be directed toward more sustainable patterns of production and consumption.

It is widely acknowledged that the design phase has the potential to influence a product's environmental impact to a significant extent, with estimates suggesting that it can account for up to 80% of the overall effect., the take-make-use-dispose pattern does not provide companies enough incentive to create more circular products. A number of things degrade too quickly, are difficult to recycle, repair, or reuse, and are designed to be used just once. In addition, the single market gives the EU the critical mass it needs to influence global value chain management, product design, and environmental norms.

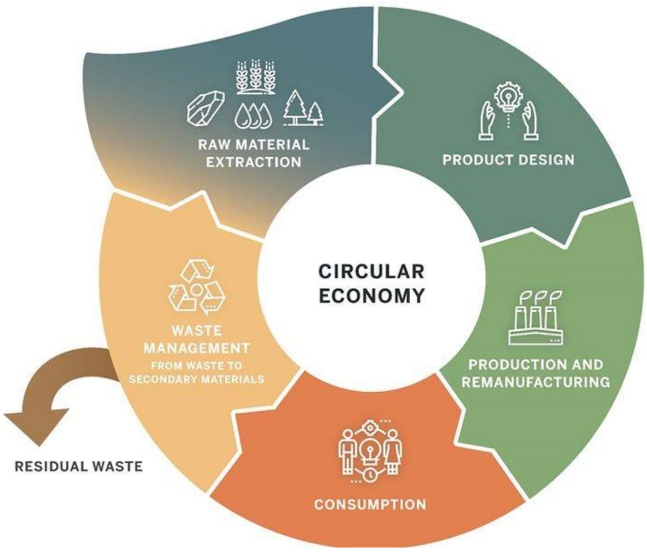

Figure 36. Circular Economy

(Source: www.cencenelec.eu)

The upcoming ESPR marks a significant shift, moving beyond a focus solely on energy efficiency. Instead, it aims to propel the circular economy by addressing a more comprehensive range of product characteristics:

Durability, Reusability, Upgradability, and **Repairability:** Products must be designed to last longer, be easily reused and repaired, and allow for upgrades to extend their lifespan.

Reduced Reliance on Harmful Substances: The presence of chemicals that hinder material reuse and recycling will be restricted, promoting cleaner and more sustainable product lifecycles.

Resource Efficiency: Both energy and resource consumption during the whole life cycle of a product will be under scrutiny, encouraging manufacturers to optimize resource use.

Recycled Content: Utilizing materials that have been recycled will be actively encouraged, minimizing dependence on virgin resources and fostering a closed-loop system.

Carbon and Environmental Footprints: The environmental impact of products, including their carbon footprint, will be assessed, promoting eco-conscious design choices.

Digital Product Passports: Products will require readily available information, potentially through a "Digital Product Passport," allowing for informed decision-making during the whole life cycle.

3.5 Life Cycle Assessment (LCA)

LCA is thought to be a crucial idea and instrument for encouraging sustainable changes. LCA is important in decision support because it aims to provide comprehensive coverage of environmental variables and identifies hotspots, environmental precision, possible trade-offs and the distribution of the load among effect categories or life cycle phases. When assistance with decision-making is needed in the policy domain, these results are also beneficial.

LCA can be used to evaluate the efficacy of current environmental policies and regulations. Policymakers can assess whether rules have achieved the expected environmental improvements by performing LCA assessments on products prior to and following policy interventions. This data-driven approach enables continual development and refining of environmental policies to guarantee they produce the desired effects (Guinée, 2011).

LCA and ESPR are two critical tools working hand-in-hand to promote the development and marketing of environmentally responsible products. While they serve distinct functions, their synergy plays a crucial role in achieving sustainability goals, in Figure 37 shown technical regulations and tools that are used.

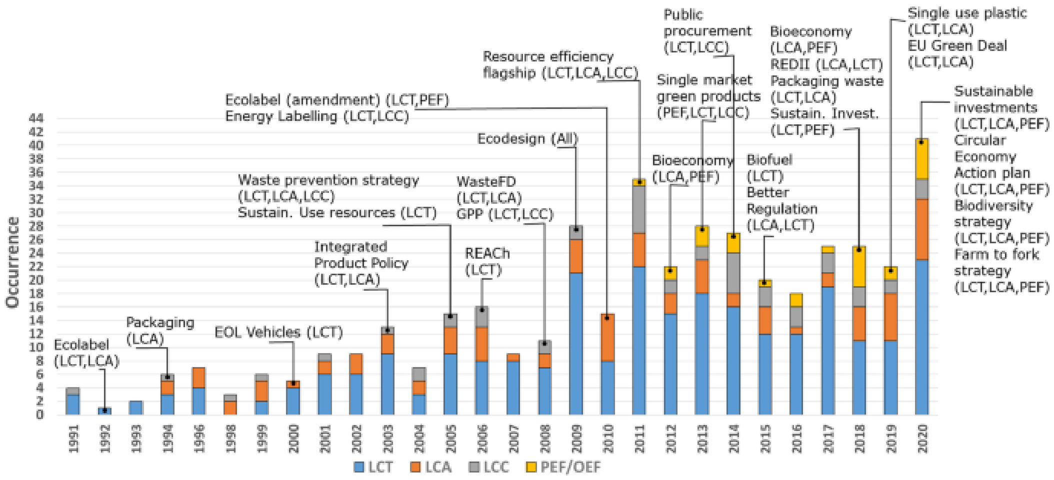

Figure 37. The progression of the incorporation of LCT, LCA, LCC, and PEF/OEF into policy and communication strategies.

(Source: Sala, 2021)

The concept of life cycle thinking is a fundamental idea in the field of sustainability. It refers to the necessity of examining the burden and benefits of products, sectors, and projects using a life-cycle perspective, which encompasses the entire life cycle of a product, from raw material extraction to end of life. It is possible to assess the environmental, economic, and social pillars using life cycle thinking. The LCA technique provides primary support for the environmental pillar of life cycle thinking. The ISO 14040 defines LCA as the synthesis and assessment of inputs, outputs and potential ecological impacts associated with a product system throughout its life cycle.

In comparison to alternative techniques with a more limited scope of consideration, the LCA approach, illustrated in Figure 38, offers the benefit of incorporating the potential for burden shifts across the life cycle stages and the associated environmental impacts, thereby facilitating a more comprehensive and systematic evaluation (Sala, 2023).

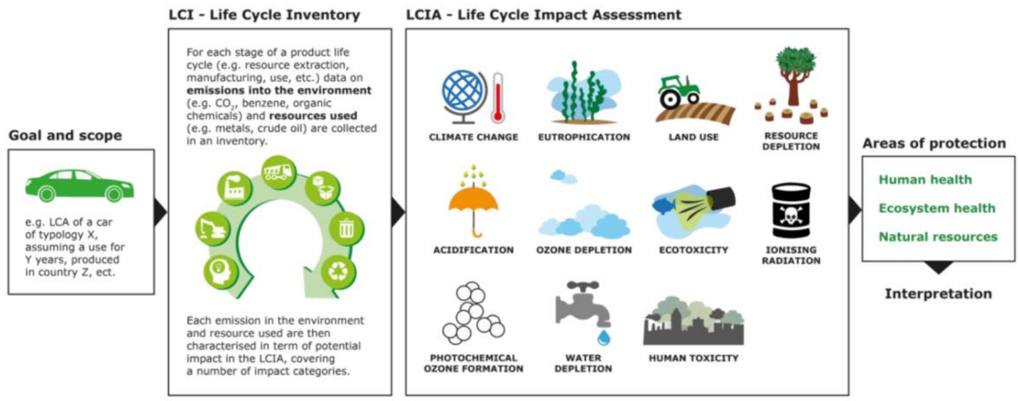

Figure 38. LCA steps

(Source: Sala, 2021)

3.6 Circular Economy

The preservation of resources and product value is the core tenet of the circular economy (CE) at the highest possible level for the most prolonged possible duration, as shown in Figure 39. This methodology serves to reduce the necessity for the input of new materials and energy, consequently diminishing the environmental impact correlated with the life cycle of products, from the extraction of raw materials through production and utilisation to the conclusion of their useful lifespan. (EEA, 2017)

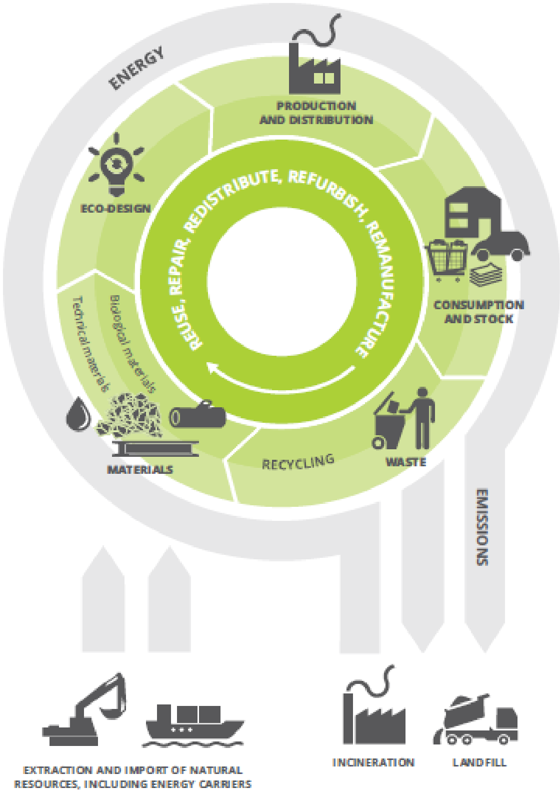

Figure 39. A simplified model of the CE for materials and energy

(Source: EEA, 2017)

The CE and the ESPR represent a powerful combination for achieving a future with greater sustainability. By promoting responsible product design, resource efficiency, and closed-loop systems, these frameworks can significantly reduce the environmental impact of products while fostering innovation and resource security. As CE principles become increasingly embedded within the ESPR framework, it is possible to see a transformative shift in the direction of a more circular economy, where waste is turned into a resource and sustainability becomes the norm.

By achieving the aims of a circular economy as a reducing material consumption, renewing the Earth and/or averting material losses, is possible done through four key strategies shown in Figure 40 (Circularity Gap Report, 2023).

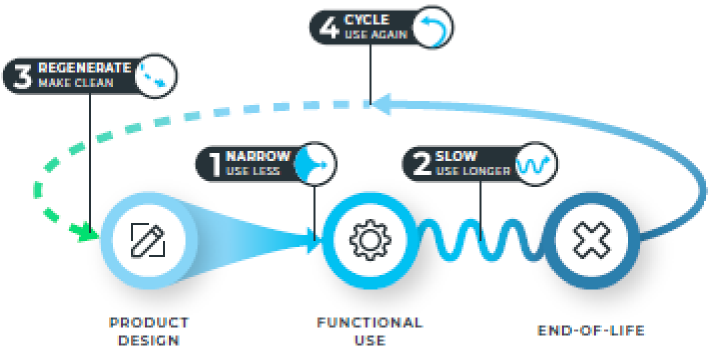

Figure 40. Flows of circularity

1. Narrow: Lessening Consumption

Narrow tactics require less energy and materials. The way materials are currently used is very wasteful and useless; by utilizing far less and eventually eliminating fossil fuels, for example, we can achieve comparable social goals. This does not imply living in poverty; instead, it means emphasizing the effective use of resources. Consider alternatives like biking instead of driving a car, consuming less meat, and living in a home that meets your needs.

2. Slow: Use Longer

The goal of slow methods is to prolong the useful life of materials, for instance by designing them to be durable and repairable. Because the products, parts, and resources we lock in stock—including buildings and infrastructure—are long-lasting, a more circular economy also happens more slowly. Over time, this will reduce the need for materials, therefore narrowing resource flows as well.

3. Regenerate: Make Clean

Regenerate techniques replace toxic or hazardous materials and processes with regenerative biomass resources over time. A circular economy seeks to maximize the amount of circular biomass that enters the system while simultaneously imitating natural cycles, such as by switching to more regenerative farming methods. Regeneration can occur at the product level as well as at the systems level, for example, by converting synthetic fertilizers to organic ones and establishing regenerative processes.

4. Cycle: Use Again

Cycle techniques maximize the amount of secondary materials that reenter the economy, hence reducing the requirement for virgin material inputs and, consequently, limiting flows. The goal is to cycle and reuse materials at their maximum value. Naturally, there will always be a need for virgin materials to some extent because all materials consume energy, deteriorate over time, and must be blended with virgin elements to retain strength and functioning.

At the end of this part, making conclusion of a synergistic approach to sustainable development. The endeavor to achieve sustainable development necessitates a multifaceted approach, and the interplay between the circular economy, sustainable products and environmental considerations offers a compelling framework for achieving this goal.

LCA serves as the cornerstone of this framework, providing a scientific and thorough evaluation of a product's effects on the environment over its whole life cycle. This meticulous analysis, akin to an environmental audit, helps identify areas for improvement across resource utilization, emissions decreasing, and waste production. With this data-driven understanding, stakeholders can make informed decisions that minimize environmental burdens and contribute to a more sustainable product development narrative.

ESPR acts as the bridge between LCA findings and practical implementation. By establishing minimum environmental performance standards for specific product categories, the ESPR translates LCA requirements into a characterized set of principles. These regulations, establish fair competition for manufacturers, incentivizing them to embrace eco-design practices and also fosters innovation in product design, leading to the creation of products that are not only aesthetically pleasing but also demonstrably sustainable, minimizing their environmental footprint throughout their lifespan.

The success of this framework hinges on collaborative efforts across various stakeholders. Policymakers play a crucial role in crafting robust regulations that promote CE principles and incentivize businesses to adopt eco-design practices. Businesses must actively participate in this narrative by investing in innovative technologies that facilitate resource recovery, product reuse, and efficient recycling processes. Consumers, empowered by clear information and transparent labels, become discerning drivers of market demand for sustainable products. Research institutions act as facilitators, continuously refining LCA methodologies, developing innovative recycling technologies, and fostering knowledge exchange across all stakeholders.

3.7 Challenging Issues

3.7.1 Rebound Effect

Most of the energy savings resulting from technology advancements are attributable to increases in energy efficiency. On the other hand, increased use of the specific energy service as well as other energy services, would result from a decrease in the cost of that particular energy service brought about by an increase in efficiency.

In the literature, these phenomena is referred to as the "rebound effect," which is the phenomenon of using more energy as a result of cost savings from energy-efficient upgrades. Numerous energy services, including transportation, home appliances, lighting, heating, and cooling, are susceptible to the rebound effect. The idea originated with the mid-1800s “Jevon's Paradox,” which states that when energy improves, resource demand increases unpredictably (Yüksel , 2019).

The rebound effect must be considered while establishing energy strategies and targets for energy efficiency. In addition to technological advancement, consumer behavior is a critical component in the formulation of energy efficiency policies, making it possible to achieve energy efficiency targets.

According to Ouyang et al. (2010), rebound effects are contingent upon the income levels of energy consumers. Also, the magnitudes of rebound effects are likely to be considerably larger in low-income countries or among low-income consumers in wealthy countries.

Rebound effects need to be addressed by combining various policies that were developed without considering the rebound effect with the already-existing policies. Activities and policy development are required to mitigate the rebound effect. As suggested by Cil (2019), the adaptation of consumer behavior to facilitate more sustainable consumption, in conjunction with the promotion of awareness-raising activities and by Vivanco et al. (2016), educational initiatives within specific sectors, represent strategies in the context of the mitigation rebound effect.

3.7.2 Photovoltaic (PV) products

As mentioned in previous chapters, ecodesign regulation is a forceful instrument for pushing products/technologies toward increased sustainability and energy efficiency. Energy-saving inventions have been greatly aided by ecodesign regulation, which encourages manufacturers to create innovative technology that maximizes energy efficiency while minimizing waste.

One of the product groups is PV products, which will be set with limitations by ecodesign regulation in the coming years. Currently, work is being done on a technical rule that would define sustainable product regulation requirements for solar PV modules and inverters by the Commission. A number of studies have been done in the last years to discuss the technical details of defining the carbon footprint during the PV module manufacturing process, which is a novel approach from a policy standpoint. The energy yield, which is calculated taking into account the pace at which the performance of the PV modules deteriorates, will be used to normalize the carbon footprint.

The EC initiated a feasibility study to use such policy instruments for PV products in 2017. In the following months, the EC website will publish the final draft materials for the Ecodesign and Energy Labeling regulations pertaining to PV products.

The importance of this product group is expected to decarbonize the energy systems. So, in Türkiye, this sector is growing at an unprecedented rate, and manufacturers, research centers, the Center for Solar Energy Research and Applications (GUNAM), and testing bodies should be aware of the new limitations and technologies. Setting limits of eco-design is seen chiefly for products that use energy, but PV’s are products that generate electricity not use when compared with other product groups, so this is a solid message to understand the importance of material efficiency regardless of the aim of the products that use or generate electricity.

CHAPTER 4

RESULTS AND DISCUSSION

The survey's methodology is described in “1.2 Research Methods” section. This chapter will look at the semi-structured interview information and display the statistical interpretation of the processed data.

4.1 Participant Background Information

This interview is structured to reflect the opinions of all economic actors in the private sector, including manufacturers, importers, and OEMs. The number of people who expressed their opinion was 21, but statistical outputs were acquired from 17 participants because the interviews were made on a specific date, one to one meeting, and got permission to record the interview (except one of the participants’ opinion, P9, delivered by e-mail). Nevertheless, all participants’ opinions were reflected somehow in the discussion and results section, so were benefited from all the valuable participants’ remarks.

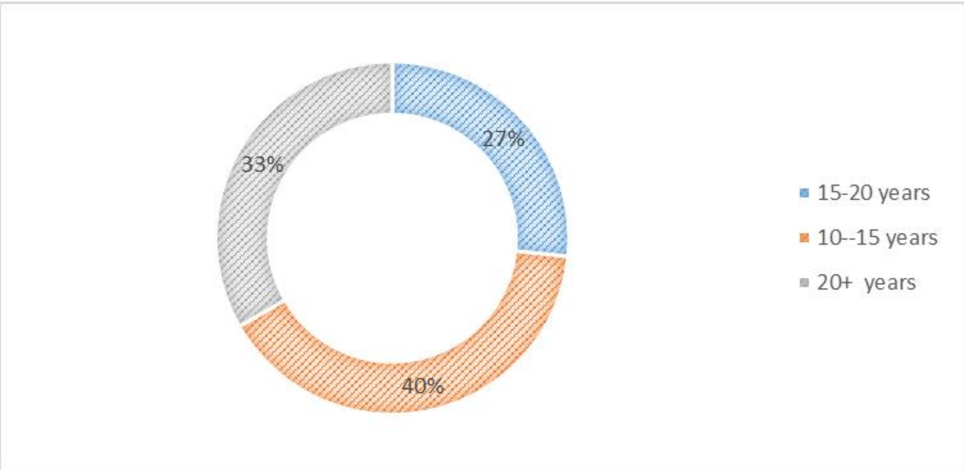

Figure 41. Experience of participants

As shown in Figure 41, participants from industry, public authority, and experts from NGOs have experience in ecodesign and energy labeling regulation for at least ten years and are also familiar with SDGs.

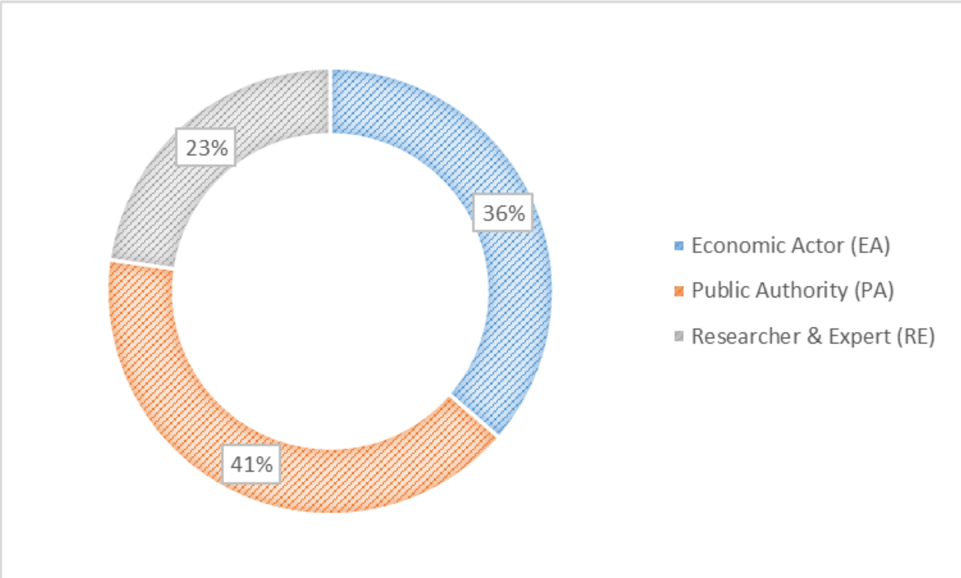

Figure 42. Category of participants

Figure 42. demonstrates the participants' category; some participants have experience in both industry and public authority, so this is reflected accordingly. Product regulations are not the responsibility of many authorities, so the experts who deal with these regulations are limited. Participants have different backgrounds and working areas, which strengthens the accuracy of the answer because of the reflection of past and current experience.

The participants are experts from a variety of organisations, including non-governmental organisations (NGOs), the European Commission, the Member States' inspection authorities, and independent experts. With regard to the sectoral separation, private sector participants have experience in home appliances, white appliances, lighting, and electric motors in the electronics, electrical machines, and machinery industries, which correspond to the majority of the ecodesign and energy labelling regulations.

Table 4. Product categories of participants

Participants	Private Sector (PS)		Public Authority (PA)		Researcher & Expert		Duration
	B2C Products	B2B Products	B2C Products	B2B Products	B2C Products	B2B Products	
P1			x	x	x	x	75 min.
P2					x	x	69 min.
P3	x						85 min.
P4			x	x			40 min.
P5			x	x			50 min.
P6			x	x	x	x	58 min.
P7	x						67 min.
P8	x						60 min.
P9		x					0
P10		x					55 min.
P11	x						55 min.
P12		x		x			78 min.
P13					x		30 min.
P14					x		25 min.
P15			x	x	x	x	62 min.
P16			x	x			50 min.
P17	x						55 min.

Participants have experience in different product groups, and these products are listed according to the European Commission[13] categorization.

The B2B product range encompasses circulators, electric motors, industrial fans, power transformers, water pumps and welding equipment. B2C products are directly used by consumers who are the end users. White appliances, lighting products, cleaning and drying products, etc. Table 4 also shows the interview duration for two months; the mean value of the interview duration is approximately 57 min. (except participant P9) Interviews with consumers last a short time compared with other

[13] Product List - European Commission (europa.eu) The present Regulation 2009/125/EC and Regulation (EU) 2017/1369 encompass all products falling within its purview. Information on the savings in energy, the labelling of energy-consuming products and the requirements of the Ecodesign Directive can be found on each product page. The products are classified into distinct categories.

private sector, but it is highly expected because deep regulation knowledge is not supposed to. Almost all the associations' opinions were gathered from an industrial perspective, excluding the HVAC. ESPR and circular economy requirements will also affect this sector, but assessment will be done only by published reports or documents. However, for the statistical outputs, these publicly available documents were not taken into consideration.

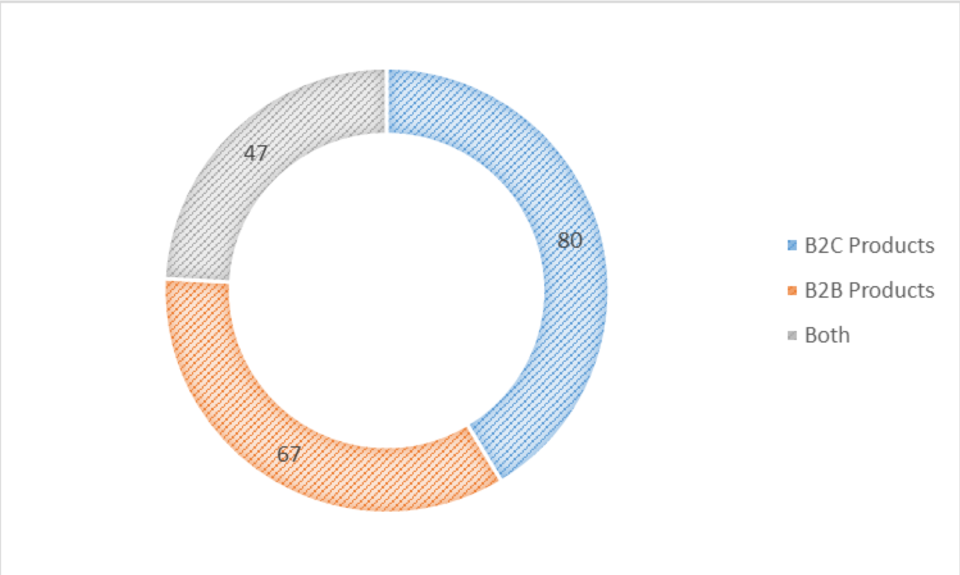

Figure 43. Product groups of participants

As shown in Figure 43, the distribution of the participants' experience on products group have different proportion, major part of the participants, 80%, have an experience on consumer products, B2C, and this ratio for B2B product is 67%. Participants who are dealing with both product groups B2B and B2C, have lower percentage, 47%, when compare with individual groups.

A great majority of participants of private sector are head of their departments that deals/dealt with sustainability, legislation, quality, and product management of manufacturers.

Most of the participants are also members of related industry associations. As such, their contributions included general views on their particular areas, complaints about market abuse, distortion activities of players in their industry, and as well as the opinions of their company.

They are competent in discussing topics related to their industries, including consumer electronics, machinery, home appliances, lighting, and “electrical machines and power electronics.”

4.2 Analysis of Semi-Conducted Interview Questions

Understanding the behavioral approach of the companies to the energy efficiency regulations, we asked the participants, ***“What are the primary motivators for the companies to adopt eco-design and energy label principles?”*** with the choices of *“Regulatory obligations”, “Competition-related issues”, “Company policy”, “Other”*.

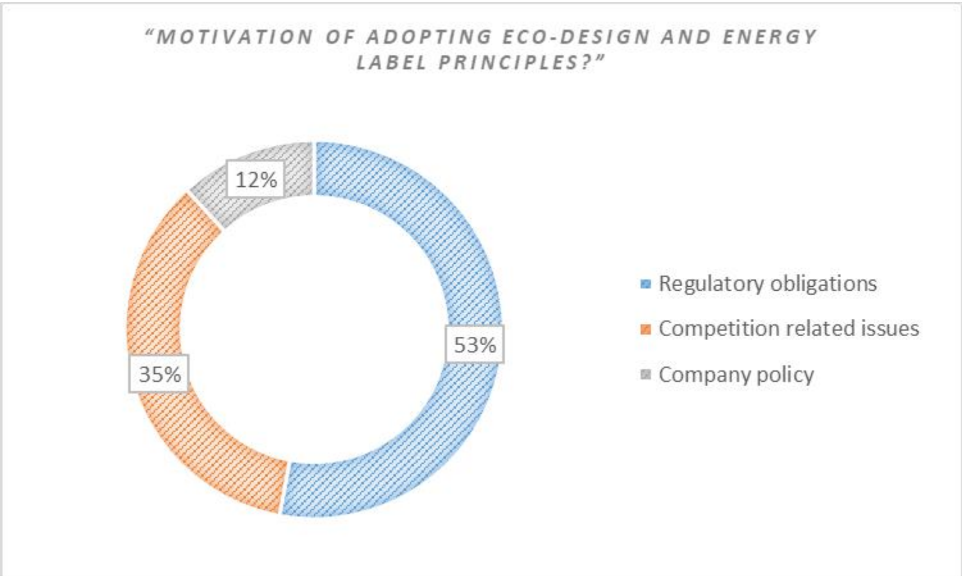

Figure 44. Approach to the Energy Efficiency Regulations

“Regulatory obligations” emerged as the primary motivator for adopting eco-design and energy label principles, accounting for 53% of responses. This suggests a strong influence of environmental regulations on business practices.

With 35% of responses, “competition-related issues” follow, indicating that market competition and consumer demand for sustainable products are significant factors in adoption decisions.

“Company policy” is the least influential factor, with only 12% of responses suggesting a relatively minor impact of internal commitments than external pressures.

During the interviews, most participants answered that all the choices are primary motivators, but this table arose when claimed for making a priority between choices. Getting a high percentage answer of regulatory obligations is natural, but the point is that regulatory requirements are set as the minimum requirement. To elucidate this point further, an illustrative example can be drawn from the electric motor sector. The IE3 motor represents the lowest efficiency class due to the technical norm that has been requested, and as a result, the majority of companies are primarily engaged in the production of this particular range, even at the threshold of the aforementioned limit. The cost of more efficient products, competitive market conditions, and consumer purchasing power influence end-users to select products that offer the best price-performance ratio.

From the answer, we concluded that market conditions have a supportive effect. Correspondingly, based on the strict market conditions, just aiming for the most efficient product regarding highly environmental issues will not be realistic behavior from the company side.

Manufacturing more efficient products entails using different materials for high efficiency, seeking suppliers of raw materials, employing people for extraordinary design, and allocating a budget for R&D, testing, and also marketing to highlight the differences with their competitors.

Then, we asked participants to gather their points of view regarding the meaning of energy efficiency regulations for them, as shown in Figure 45.

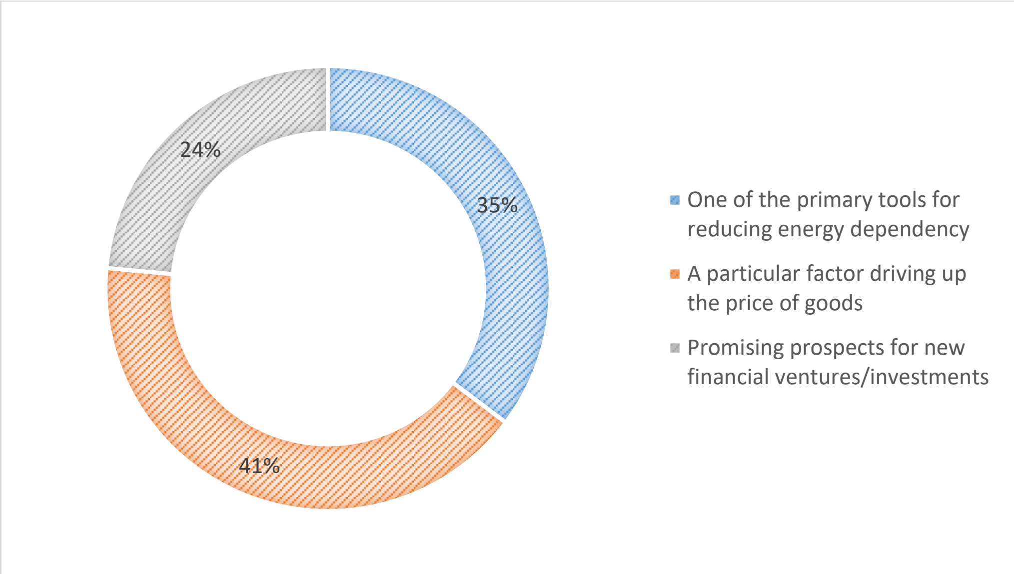

Figure 45. Meaning of energy efficiency regulations

The diversity in the group of participants explains why there is no common ground on this question.

- The objective of reducing energy dependency is to achieve a reduction in the reliance on external energy sources. Approximately one-third of participants (35%) emphasize the instrumental role of these regulations in ensuring energy security and reducing reliance on external energy sources. The results suggest a positive outlook on the contribution of the regulations to national interests. For Türkiye, energy dependency is of critical importance. Looking for the last two year energy import bill, it was $96.5 billion in 2022[14] and $70 billion in 2023, so using more efficient products, and implementing and focusing energy efficiency policies has a reducing effect on imported energy.

[14] Statement from Minister of Energy and Natural Resources Alparslan Bayraktar, in march 2024

- Increased Product Prices: 41% of participants believe that energy efficiency requirements adversely affect the product price. This perception underscores a common concern about the economic implications of regulatory measures, with participants associating energy efficiency with higher costs. This might stem from a lack of awareness about long-term cost savings or the perceived added burdens on businesses.
- Financial Opportunities: 24% of the participants believe that green investments are an opportunity for expanding their marketing options and infrastructure. This perspective reveals an entrepreneurial mindset, with some participants recognizing potential business avenues arising from the increased demand for energy-efficient products and technologies.

After understanding embracing energy efficiency policies, we also need to understand which area the industry could/will be facing difficulty. So, the open-ended question, ***"What are the main challenges/barriers for companies in adopting energy efficiency and sustainability principles?"*** was addressed to the participants. In addition, participants were requested to answer this question in view of the ESPR.

Based on the provided answers, compelling circumstances will be faced by companies in adopting environmentally friendly product regulations can be listed under three categories as follows;

1- Supply Chain Related Problems

Understanding a product's total environmental impact needs to be analyzed from raw material to the end product. The complying requirements during the life cycle is one of the hesitations of companies for the production phase.

- Identifying sustainable materials: Sourcing materials with low environmental impact can be complex due to limited availability and high costs.
- Material consistency: Due to market fluctuations, maintaining a consistent supply of sustainable materials can be challenging.

- Ensuring material traceability: Tracking the origin of materials to verify their sustainability claims is often complicated and needs technical infrastructure.
- Monitoring supplier compliance: Ensuring suppliers adhere to environmental standards and regulations is difficult, so frontrunner companies plan to educate their suppliers to enable them to work under valid certification.

2- Technical Based Problems

- Product complexity: Increasing product complexity, especially in electronics and home appliances, makes eco-design integration difficult.
- Material selection: Identifying suitable sustainable materials with desired performance characteristics is challenging.
- Design for disassembly: Creating products that need to be easily disassembled and repaired by consumers for recycling and reuse is complex.
- Digital product passports: Developing and implementing systems for digital product passports requires technical expertise.
- Data management: Collecting and managing accurate environmental data throughout the supply chain is complex.
- Waste reduction: Minimizing waste generation, implementing efficient recycling systems, and using recycled material in specific percentages in designed products.

3- Regulatory and Policy-Related Problems

- Standardization: Developing harmonized standards and methodologies for eco-design assessment is complex, long-lasting and inefficient.
- Monitoring and enforcement: To develop effective systems for monitoring compliance and enforcement of regulations, authorities must do a due diligence inspection of suppliers, which is why staff recruitment, especially those qualified in the environmental technical side, is crucial.
- Public awareness and engagement: Limited public understanding of eco-design principles can hinder market demand for sustainable products.

Regarding the supportive question related to the previous answer, we tried to examine the difficulty level of ESPR in implementing its product group in the given scaling from 1-5. Scale “1” corresponds to *ESPR can be implemented with ease* and scale “5” corresponds to *implementation needs hard work*. The answer, shown in Figure 46, is not a surprise; the lowest value given by the participants is “4” with 53%, and the remaining are the opinions on giving the highest value of “5”. The mean value of the difficulty level is approximately “4,5”.

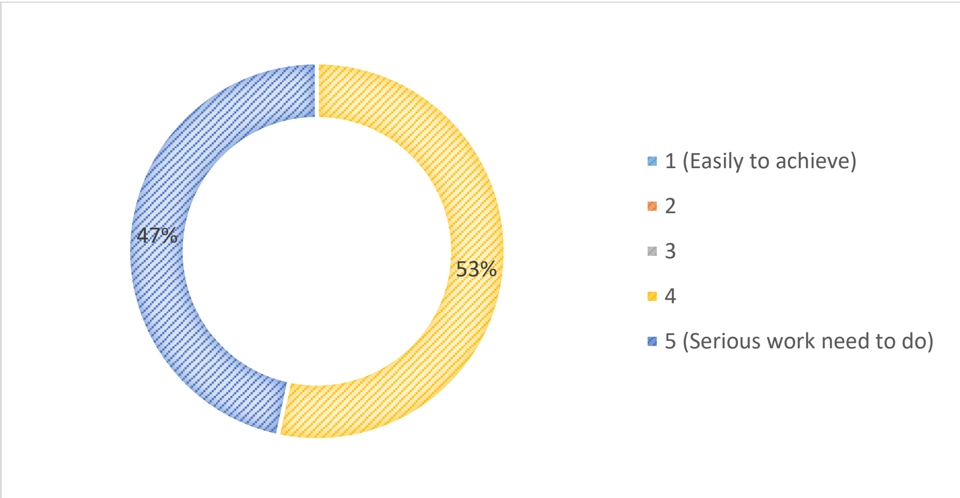

Figure 46. Difficulty level of ESPR

In order to find out the industrys’ projection towards sustainability and SDG, we asked participants, especially associations, “Do they have any publicly disclosed SDG targets or reports?”

As can be seen in Figure 47, half of the associations set a plan related to SDG. These reports are published in their web pages and make links with related SDGs.

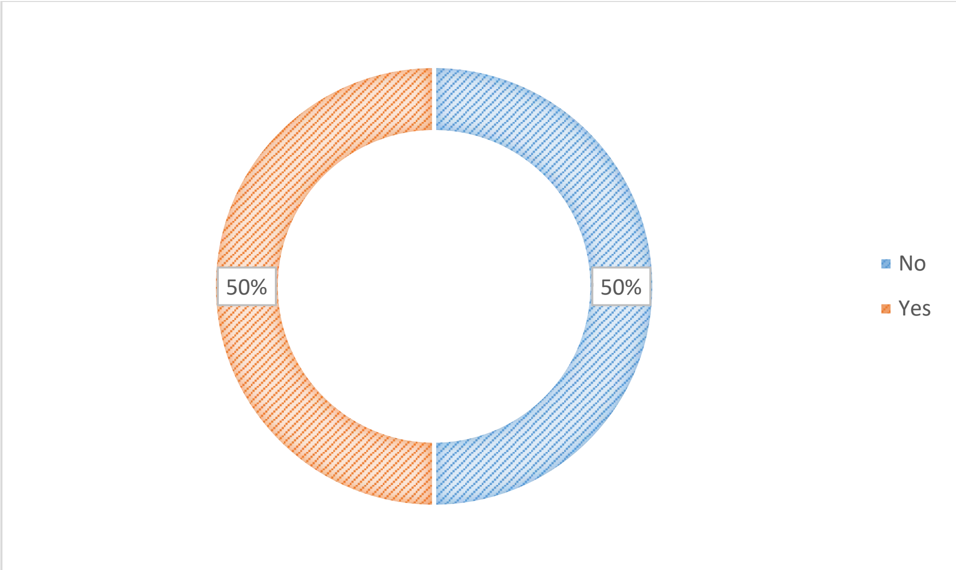

Figure 47. Publicly disclosed SDG targets or reports

Moreover, the same question is addressed to public authorities, and the result can be seen in Figure 48. These public authorities are involved, and some are responsible for the circular economy, green deal, carbon emission reduction, and environmental issues. Even if publishing any report related to sustainability and SDG is not mandatory, being a pioneer creates synergy with industry and public authority.

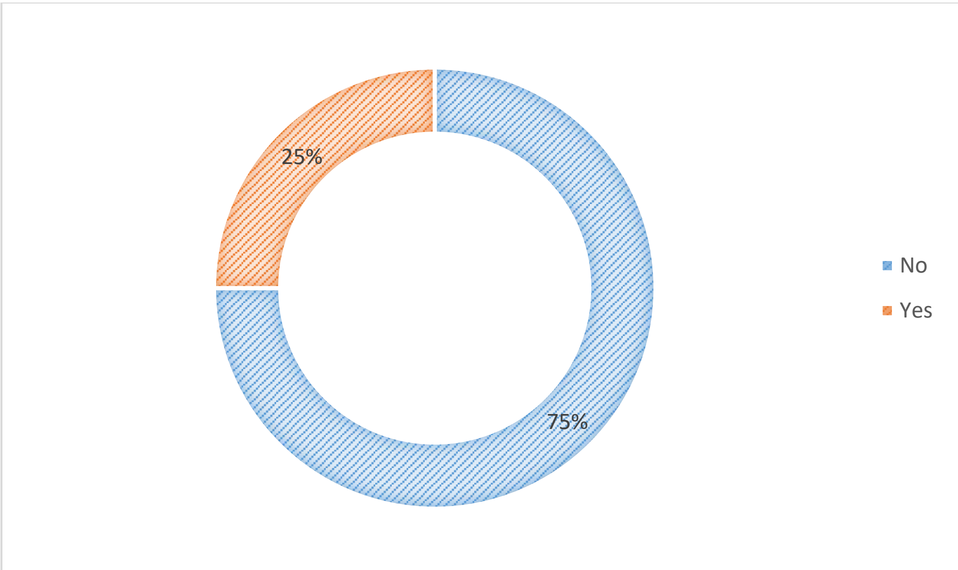

Figure 48. Publicly disclosed SDG targets or reports

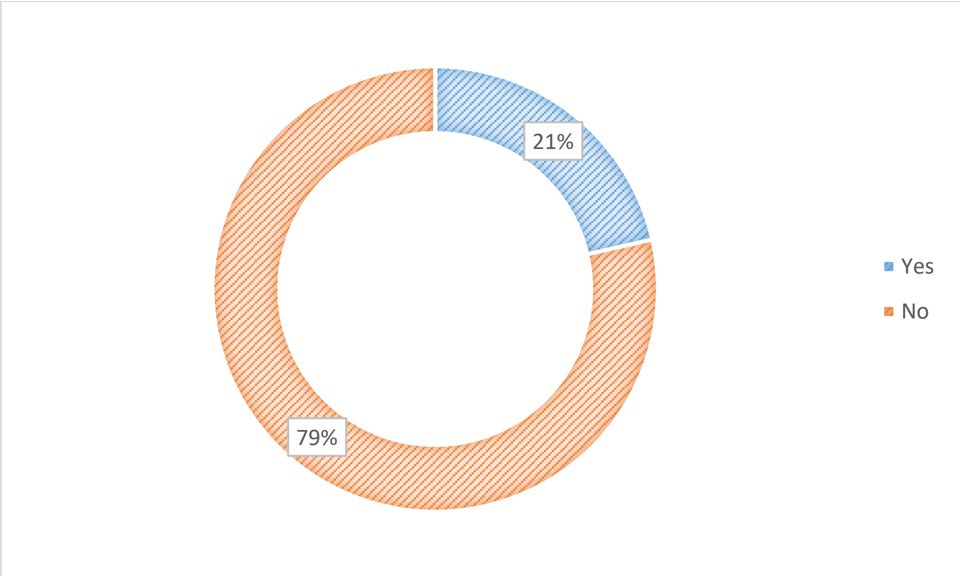

Figure 49. The responsible authority of SDGs

Figure 49 shows the participants' answers to the question, *"Do you know which institution is in charge of the SDGs and the distribution of the tasks among the responsible institutions?"* This output gives us opinions about the low awareness level of SDGs from both the industry and the public. Moreover, communication strategies to disseminate SDG governance information might be ineffective or insufficient.

Another question for the participant will express the effect of energy efficiency regulation on sustainability in Figure 50. We addressed the question, *"How do you assess the impact of energy efficiency regulations on sustainability? Could we characterize it as a successful mechanism?"*

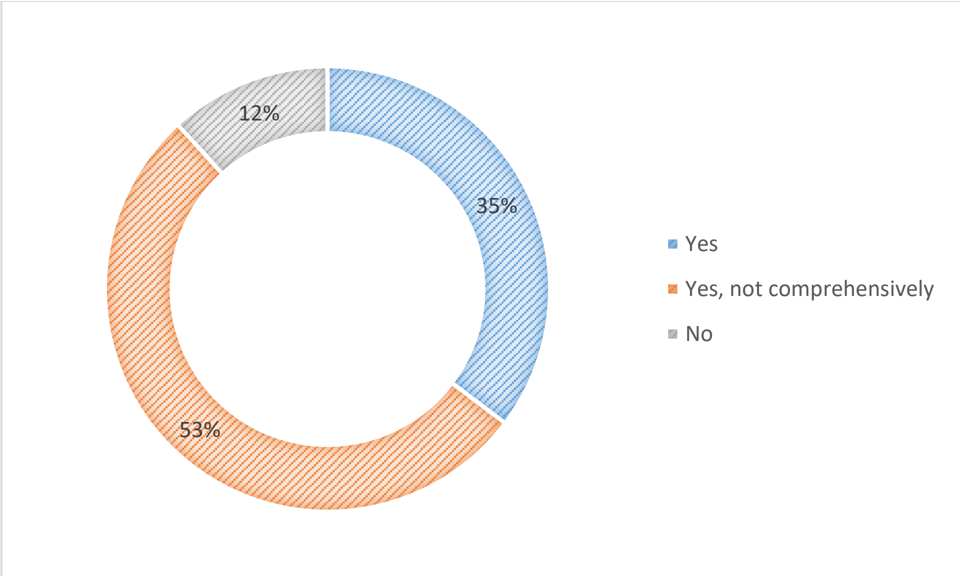

Figure 50. Is the Ecodesign and Energy Labeling a successful mechanism for sustainability

More than half of the participants stated that energy efficiency regulations have partially impacted sustainability. Energy efficiency regulations, such as eco-design and energy labeling, are integral components of a broader sustainability strategy. By focusing on reducing energy consumption and resource utilization, these regulations contribute to several key sustainability goals.

- Climate change mitigation: Reducing energy consumption directly contributes to lowering greenhouse gas emissions and mitigating climate change.
- Resource conservation: These regulations help conserve natural resources like fossil fuels by improving product efficiency.
- Waste reduction: Longer product lifespans and improved durability associated with energy-efficient products can reduce waste generation.

It is crucial to acknowledge the interconnectivity of the three pillars of sustainability: environmental, economic, and social. To illustrate, the reduction of greenhouse gas emissions (an environmental measure) may result in cost savings for consumers (an economic benefit) and an improvement in public health (a social benefit).

By promoting energy efficiency, regulations contribute to a more sustainable future by addressing environmental challenges, enhancing economic well-being, and improving social conditions.

Nevertheless, these do not cover all sustainability, consider the product's life cycle and meet the requirements such as; durability, reusability, upgradability, and repairability parameters.

Related to this question, we claim participants' opinions on the following: "Do you have any projects that align with the SDG targets?" projects conducted under energy efficiency align with SDGs.

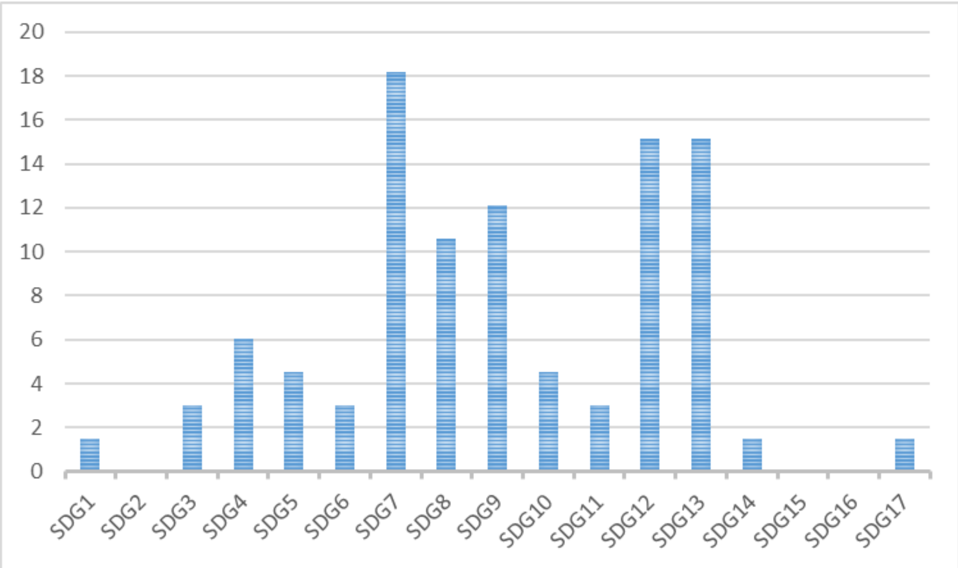

Figure 51. SDGs that are relevant to Ecodesign and Energy Labeling

We tried to examine the linkage between energy efficiency regulations and SDGs. As can be explicitly seen in Figure 51, **18%** of respondents and the highest rated target is **SDG7 (Affordable Clean Energy)**, then the two goals share the same percentage with **15%**, these are the **SDG12 (Responsible Consumption and Reproduction), and SDG13 (Climate Action). SDG9 (Industry, Innovation, and Infrastructure)** gets the third highest rate from participants with **12%** and the last target is **SDG8 (Good Jobs and Economic Growth)** with **10,6%**. Remain parts are below 10% and have low interactions. Also, participants stated that these technical norms directly affect their target, supporting the project linked with related goals.

A direct contribution of ecodesign and energy labeling has been seen to **SDG7** by promoting energy efficiency. By mandating higher energy performance standards, these regulations promote the creation and uptake of energy-efficient technology. This, in turn, reduces energy consumption, lowers energy bills for consumers, and increases access to clean energy sources. Additionally, by extending product lifespans, ecodesign can contribute to the durability and reliability of energy-using products, enhancing energy security.

Ecodesign and energy labeling can **indirectly** contribute to **SDG8** by encouraging economic growth and job creation. Developing and producing energy-efficient products can lead to new industries and employment opportunities. Moreover, by extending product lifespans, these regulations can support repair and maintenance services, creating jobs in the circular economy. However, it is essential to manage the transition to a more energy-efficient economy effectively to prevent job losses in certain sectors.

SDG9 can stimulate innovation and industrial growth through ecodesign and energy labeling. By setting ambitious efficiency targets, these regulations encourage businesses to develop new technologies and processes to meet regulatory requirements, new industry and career possibilities may result from this. Furthermore, energy-efficient products often require advanced manufacturing techniques, contributing to technological progress and infrastructure development.

Ecodesign and energy labeling are fundamental to achieving **SDG12**. By promoting the efficient use of resources and reducing waste, these regulations contribute to sustainable consumption patterns. Energy-efficient products often have longer lifespans, reducing the need for frequent replacements and minimizing environmental impacts. Additionally, eco-design principles can encourage the use of recycled materials and promote circular economy practices. ESPR considers fundamental changes in product design, bearing into mind the life cycle of products.

Energy efficiency is a cornerstone of climate action under the target **SDG13**. By reducing energy consumption, eco-design and energy labeling contribute to mitigating greenhouse gas emissions. These regulations also promote the development of low-carbon technologies and contribute to a more sustainable energy mix. Moreover, by extending product lifespans, energy efficiency helps to reduce the carbon footprint associated with product manufacturing and disposal.

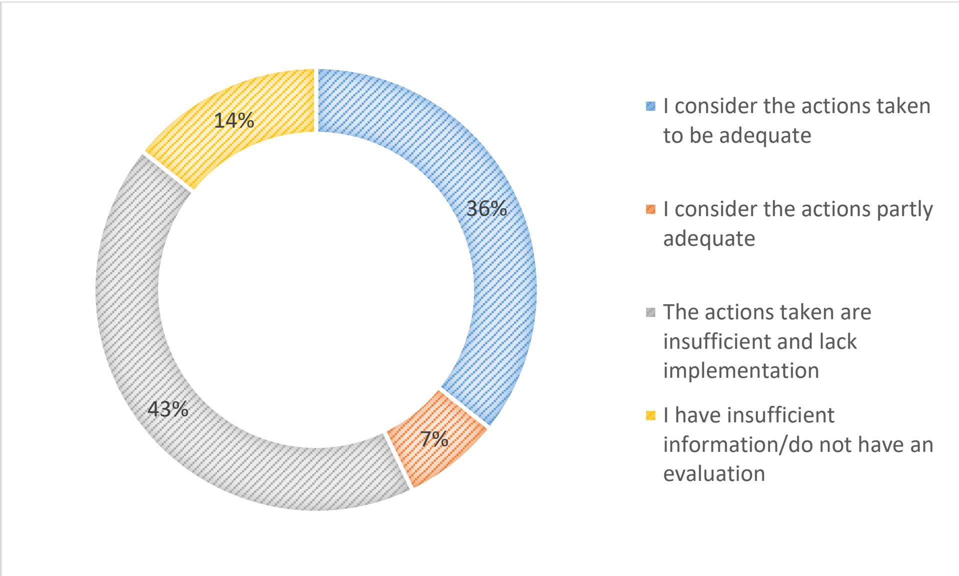

Figure 52. Awareness level of SDGs

To examine SDGs' awareness level, we ask, "How do you evaluate the awareness activities or studies on SDGs?"

The data provided reveals a significant gap in the perceived effectiveness of SDG awareness activities, as shown in Figure 52. While a proportion of participants expressed satisfaction, the majority indicated a lack of adequate implementation or insufficient information. Participants who responded to the question as considered partly, 7%, specified that awareness of energy efficiency is adequate, but awareness activities related to SDGs are insufficient. Nevertheless, the participants were unable to identify the absence of awareness regarding the specific SDG, given that each SDG is under the responsibility of a different authority or ministry.

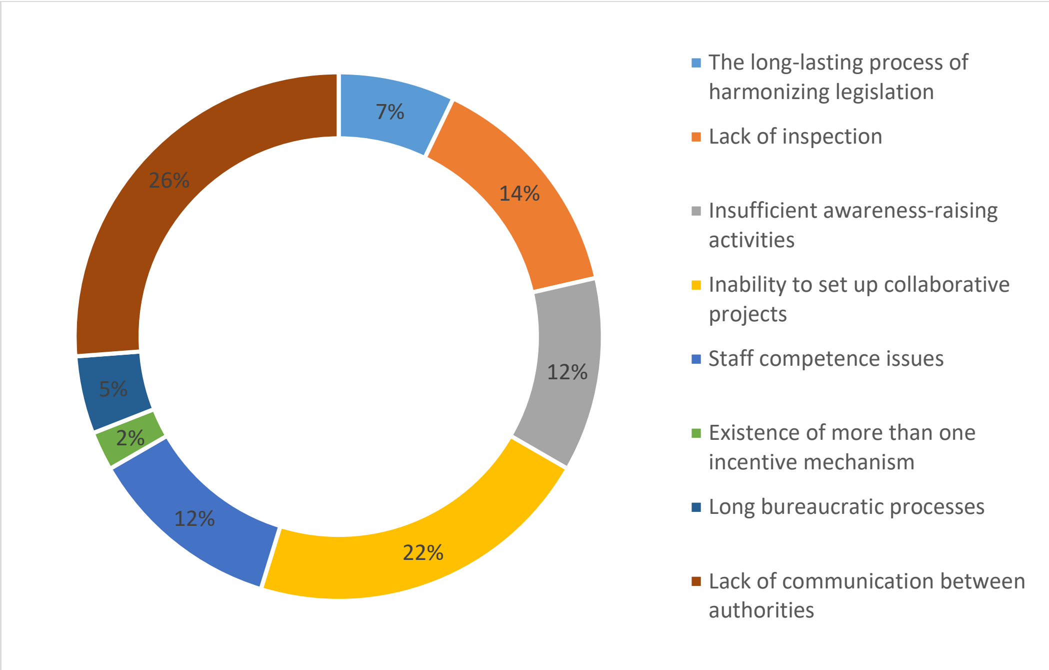

Figure 53. Areas in need of improvement for public authority

In order to strengthen the weaknesses in public areas, we conveyed the question of, "*Which areas require improvement in the governmental authority operating in this field? (Max. 3 answers)*"

As can be seen in Figure 53, **26%** of participants emphasize that ineffective communication and information sharing among public authorities are major barriers to coordinated environmental governance. This can lead to inconsistencies, delays, and inefficiencies. Establishing clear communication channels, developing shared platforms for information exchange, and fostering a culture of collaboration are crucial to addressing this challenge. The new sustainability and circular economy requirements are horizontal subjects, which means that they interact with other regulations, policies, and strategies and also embody common targets. That is why they include issues that are the responsibility of more than one authority/organization. Therefore, strong communication and collaborative working principles between authorities also need to be built up, understood, and moreover reflected in this principle in the implementation.

Also, the second highest rate is **22%**. Participants highlight the practical cooperation and partnership in addressing environmental challenges. A conservative working approach to environmental governance can hinder the development of comprehensive and effective solutions. Collaborative projects between public authorities, businesses, and civil society can lead to more innovative and sustainable outcomes. However, establishing such partnerships requires solid political support, effective communication, and a shared environmental vision.

Insufficient monitoring and enforcement of regulations, the **14%**, indicate a gap in the regulatory area. This can lead to non-compliance, create unfair competition, and undermine the effectiveness of environmental policies. Strengthening inspection activities, utilizing technology for monitoring, verification and enforcement (MV&E) and implementing robust penalty systems can mitigate this issue.

A lack of public awareness, **12%**, about environmental issues and regulations can hinder public support and participation in environmental initiatives. Effective communication strategies, targeted awareness campaigns, and educational programs are essential to address this challenge. Most public authorities do not allocate a budget for awareness. Instead, these activities are carried out under projects funded by different partnership programs, not from an internal budget; however, these projects are achieved within a particular time after the conclusion of the project awareness activities also terminated. Awareness activities need to be long-term because of the learning behavior of the consumer, end user, or people who have environmental considerations.

Human resources, **12%**, are a critical factor in the successful implementation of environmental policies. A shortage of qualified personnel can impede the development and implementation of effective regulations. Investing in staff training, development, and recruitment is crucial to build a competent workforce. Up to now, environmental implementation does not have such an extensive sphere of influence with dedicated targets; accordingly, there is a significant necessity for the attainment of specific competencies or qualifications pertaining to this subject area.

A long-lasting process of harmonizing legislation, **7%**, can hinder efficient implementation and create uncertainty for businesses. Harmonizing the regulations and adopting a more coordinated approach can address this challenge. As this option has a low rate, Türkiye is implementing the EU acquis as part of its customs union responsibilities. If we consider trade war across the globe, The targets of Türkiye regarding the aim of lessening the foreign trade balance deficit, shortened harmonizing processes in recent years and implemented without any delay or implemented it with an acceptable delay.

Long bureaucratic processes, **5%**, are a persistent challenge for public authorities, hindering efficiency, public satisfaction, and overall service delivery. Inefficient administrative procedures can delay decision-making and frustrate stakeholders. Streamlining processes and utilizing digital technologies can contribute to more efficient and effective governance.

Beyond streamlining processes, digitalization can enhance transparency and accountability. Additionally, data analytics can be employed to identify bottlenecks and inefficiencies within bureaucratic processes, enabling targeted improvements. By embracing digital transformation, public authorities can significantly reduce the burden of long bureaucratic processes, improve service delivery, and enhance public satisfaction.

While this challenge appears less prevalent, the existence of more than one incentive mechanism, **2%**, still highlights the potential for conflicting policy instruments. Aligning incentive mechanisms and avoiding overlaps can improve policy effectiveness and prevent unintended consequences. However, this is also important because institutions that provide financial solutions and allocate resources prioritize projects under shared goals, such as environmental issues, green transition, and digitalization. So, public authorities pretend to benefit from these resources even if they overlap with the same goal or strategy with different authorities.

These outputs indicate a clear need for improvement in several areas of public authority performance. Strengthening collaboration, enhancing enforcement, improving public awareness, and developing the necessary human resources are essential steps towards effective environmental governance. Additionally, simplifying regulatory processes and aligning incentive mechanisms can contribute to a more efficient regulatory environment.

Analyzing human resources competency, we convey to participants the question, "Have you had enough training to be able to establish or implement a sustainable development or energy-efficiency policy?"

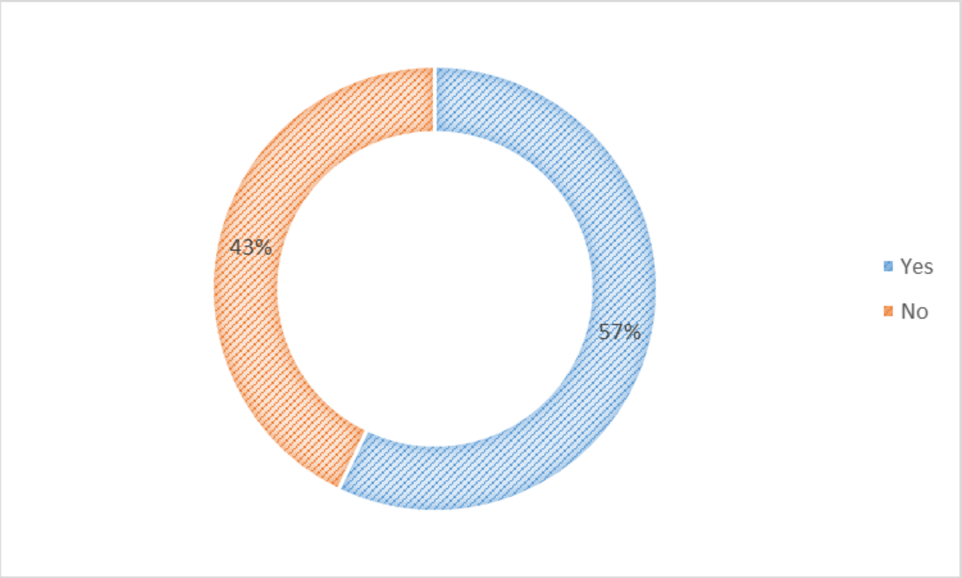

Figure 54. Qualification of public authorities

As can be seen in Figure 54, The results indicate a disparity in perceived training adequacy. **57%** of participants expressed confidence in their ability to establish or implement sustainable development or energy-efficiency policies. **43%** of participants indicated a lack of sufficient training, highlighting a potential capacity-building need.

Table 5. Supports/Incentives for effective implementation

Industry-based Incentives		**Consumer-Focused Incentives**
Financial Incentives	**Technical Assistance and Support**	**Tax Refund**
• Financial incentives emerged as a critical factor in encouraging companies to adopt sustainability and efficiency practices. • Direct financial support, such as grants and subsidies, can help offset the initial costs associated with these initiatives. • Tax exemption and cost reduction measures can also incentivize companies to invest in energy efficiency and sustainable product development.	• Participants highlighted the need for expert guidance and support in implementing eco-design and energy labeling practices. • Access to technical expertise can help companies overcome challenges, improve product design, and comply with regulatory requirements. • Simplified regulatory processes and clear guidelines can also facilitate adoption. • Best practice sharing will be a supportive activity.	• Creating a favorable market environment for energy-efficient products is essential for widespread adoption. Tax refunds for consumers can stimulate demand and encourage purchasing decisions. Implementing tax reduction from the most efficient product to the least efficient one can encourage consumers' decision-making mechanism. • Establishing markets for used and efficient products promotes the circular economy and reduces waste.
Collaborative Approach		
• Participants emphasized the importance of public and private sector collaboration in driving sustainable and green initiatives. • Knowledge sharing, best practice exchange, and joint research projects can accelerate progress. • Public-private partnerships can leverage the strengths of both sectors to develop innovative solutions and overcome common challenges. Building trust and fostering long-term relationships are essential for successful collaboration. • Public awareness campaigns can play a vital role in educating consumers about the benefits of energy-efficient products and fostering a sustainable consumption mindset.		

In Table 5, we sorted the answers from participants to the question of, *“What kind of support or incentives would be most helpful for companies to embrace sustainable and green initiatives?”*.

According to the responses from participants, firstly, classification is done by who will directly benefit from these incentives: industry or end-user. Then, the second phase is sorting incentives used by the industry, sorted into two categories; one is direct *“financial support”*, and the other one is *“technical support”*. Direct financial support is demanded chiefly from companies, which is not surprising, and complementary to the financial support, technical support from the governmental bodies and public authorities must be.

Participants expressed their opinion about incentives directly given to companies to compensate for the costs that emerged from human resources, new suppliers and their supply chain adaptation, R&D expenses related to material efficiency issues, and fostering competitive capacities. Offering tax credits for purchasing sustainable technologies or implementing energy efficiency measures can stimulate investment. These incentives can be particularly effective in encouraging businesses to adopt new technologies and practices.

Moreover, technical support is needed for the regulatory side and assistance to SMEs for competition and conformity. Offering expert advice, training, and support can help companies implement sustainability practices effectively. This could include guidance on eco-design, energy efficiency, and supply chain management. Facilitating knowledge exchange among companies can accelerate the adoption of sustainable practices. Industry associations and networks can play a crucial role in this process.

Creating a favorable market environment for energy-efficient products is essential for widespread adoption. Tax refunds for consumers can stimulate demand and encourage purchasing decisions. Implementing tax reduction from the most efficient product to the least efficient one can encourage consumers’ decision-making mechanism.

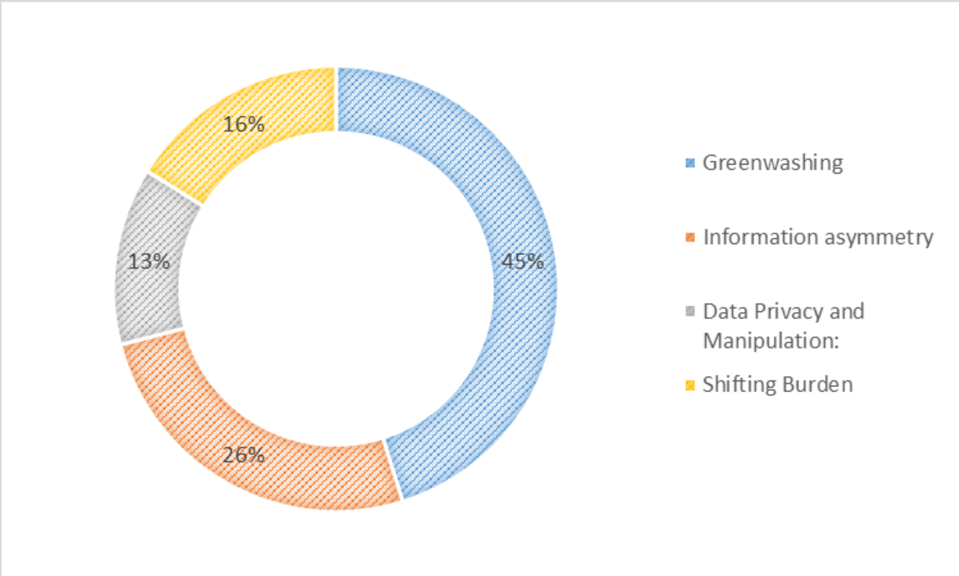

Figure 55. Ethical consideration

The last question asked the participants was about understanding their opinion about ethical considerations that cause hesitation about environmental considerations. In Figure 55, the majority of the participants, **45%**, express that the greenwashing issue needs to be taken into consideration. Exaggerated claims or misleading information about a product's environmental impact can undermine consumer trust and hinder genuine progress. It contains massive potential for greenwashing or misleading claims about a product or service's environmental performance and resistance from some consumers, producers, or regulators to adopt ecodesign practices.

Energy efficiency overclaims, exaggerating energy savings to attract consumers' attention.

One way to define the idea of planned obsolescence is, the deliberate design of products with a shorter lifespan, with the intention of encouraging consumers to replace them more frequently and to increase resource consumption. Mobile phone manufacturers employ planned obsolescence strategies, deliberately slowing down older models through software updates.

The second highest rate, **26%**, is that the unequal distribution of information between manufacturers, regulators, and consumers creates a significant ethical challenge in sustainability. Manufacturers often possess detailed product information, while consumers rely on limited labeling and marketing claims. This information asymmetry can lead to consumer confusion, unfair competition, and suboptimal product choices.

Participants also expressed their opinion about shifting burdens, with **16%** saying that eco-design might address one environmental issue (e.g., energy consumption) but create another (e.g., increased material use or toxic components). Ecodesign regulation focusing solely on energy efficiency might encourage the use of materials with higher effects on the environment at different phases of the whole product life.

Increased costs for consumers, stricter energy efficiency standards can lead to higher product prices, disproportionately affecting low-income consumers. Making air conditioners more energy-efficient is good for the planet. However, if we use unique materials to make them lighter and smaller, they might not be as strong or last as long. This means we might need to replace them more often, which is not great for the environment either.

Data privacy has the lowest rate, with **13%**, which can be sensible because now there are strict regulations about data use and privacy protection. Collection and use of consumer data by tracking purchasing habits or energy consumption through intelligent appliances raises concerns about privacy and potential misuse of data. Transparency and trust in life cycle assessments (LCAs) is also pointed out. Ensuring fair and reliable data and methodologies when conducting LCAs is crucial to avoid greenwashing and misleading claims.

4.3 Interlinkages with SDGs

It is of the utmost importance to situate sustainable development at the core of product regulations and to comprehend the interconnections between these target synergies. A review of the literature reveals a clear leveraging effect between SDG7 and SDG8, SDG9, SDG12 and SDG13.

This finding is also supported by our participants' answers, which are shown in this chapter, Figure 49. Most of the participants developed projects that aligned with SDGs, which we detected probable effects on, and this shows that there is a similar tendency with our findings and research, so they support each other.

The concept of energy efficiency norms is associated with three distinct dimensions of the SDGs. The implementation of these technical regulations has an impact on economic growth, social inclusion and environmental protection.

SDG8, SDG9 and SDG12 pertain to the *economic aspects* of the goals. With regard to the *societal aspects*, SDG7, which is the primary goal for energy transition, energy security and energy efficiency, will be of particular relevance. The final goal, SDG13, pertains to the *environmental aspects*.

The dimension of the SDGs and the dimension in which we can assess these energy efficiency regulations are shown in Figure 56.

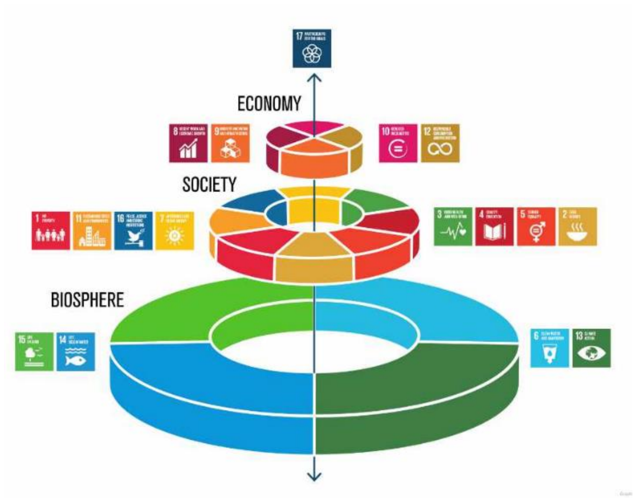

Figure 56. Effect of energy efficiency regulation at different dimensions

(Source: Stockholm Resilience Centre)

4.3.1 Effect of Energy Efficiency on SDG8

Goal 7 and Goal 8 are basically interlinked. The pursuit of SDG7, which concerns universal access to sustainable energy, and SDG8, which addresses decent work and economic growth, will, inextricably, lead to the generation of numerous job opportunities and a substantial expansion of the economy, not only in the energy sector itself but across a multitude of other economic activities. ESPR, which led to the setting of requirements, stems from the environmental challenges and limitations of excessive use of materials; therefore, this demand creates more R&D investments, redesign, and remanufacturing.

- Green Jobs: The transition towards energy efficiency requires a skilled workforce in areas such as energy audits, installation of energy-efficient equipment, maintenance, monitoring of life cycle, verification of material and inspection of the supply chain. This results in the creation of new employment and contributes to employment growth.
- Innovation and Technology: Developing and implementing energy-efficient technologies necessitate research and development, leading to job creation, as can be seen in Figure 57, in the innovation sector. When the scope of sustainability gets wider, new products will be considered. Photovoltaics, PVs, are now the most popular products, so new innovative products will be on the market when higher limitations and criteria enter into force.

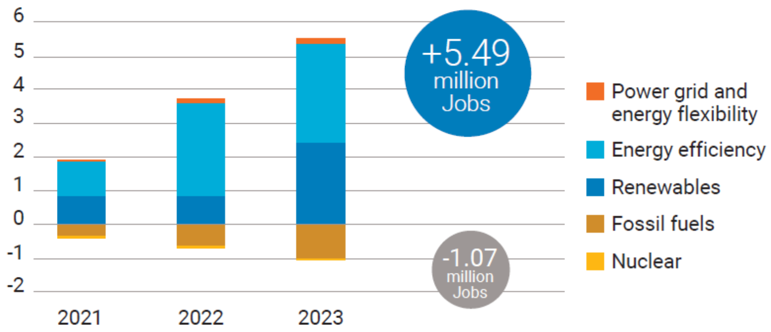

Figure 57. Job opportunities

(Source: United Nations, 2021)

4.3.2 Effect of Energy Efficiency on SDG9

The objective of SDG9, which pertains to industry, innovation, and infrastructure, is to effect a redirection of economic forces in a manner that will yield beneficial development outcomes. While the industrial sector currently contributes significantly to greenhouse gas emissions, it can play an influential part in the transition towards a carbon-neutral economy. This can be achieved if the objectives of SDG9 are aligned with those of related initiatives aimed at promoting sustainable or carbon-neutral development, including energy efficiency.

It is also the case that the industry sector is responsible for emissions. Furthermore, energy use across all economic sectors represents the primary source of all anthropogenic greenhouse gas (GHG) emissions. It can be seen, therefore, that the generation of clean, sustainable energy through renewable sources, the decrease in energy-related greenhouse gas emissions and energy usage, and the interlinkages between energy efficiency and SDG 9 are directly related to the goals of SDG13, which is to combat climate change.

- Driving Innovation: The pursuit of energy efficiency stimulates innovation in various sectors. For instance, the desire to lower energy usage has fueled the development of sophisticated insulating materials, silicon steel for electric motors, better energy-efficient appliances, and renewable energy technology.
- Creating New Markets: Energy efficiency measures can create new markets for energy-efficient products and services, new supplier chains, and stimulating economic growth.
- Resource Efficiency: By optimizing energy use, industries can reduce their environmental footprint, endeavor for material efficiency, and assist in promoting sustainable patterns of consumption and production.

In Türkiye, small and medium-sized enterprises (SMEs) constitute the overwhelming majority (99.8%)[15] of all enterprises. Despite the relatively low energy consumption per company, SMEs collectively account for a substantial proportion of the country's total energy consumption.

There is a high need for research and development (R&D) to provide the necessary support for designing and implementing energy policies and energy efficiency programs for small and medium-sized enterprises (SMEs).

By enabling the exchange of best practice on energy efficiency between SMEs and providing guidance on how to attain energy efficiency targets, will contribute to ensuring that SMEs play a significant role in the development of the clean energy sector and its supply chain.

4.3.3 Effect of Energy Efficiency on SDG12

The relationship between energy efficiency and SDG 12 is demonstrated through improved energy and resource efficiency, waste management, eco-design, ESPR, circularity and "reduce, reuse and recycle" 3R practices, as well as responsible consumption patterns.

SDG12 and energy efficiency can complement one another in promoting environmental sustainability and reducing climate change. When combined, renewable energy sources and energy efficiency can significantly reduce CO_2 emissions and air pollution. SDG7 and SDG12 both encourage technological advancements in manufacturing that increase energy efficiency. Promote energy efficiency in production and throughout the value chain through sustainable consumption and production practices.

[15] EBRD, Türk KOBİ Sektörünün Değerlendirmesi Veri Bazlı Yöntem Tavsiyesi, 2022

Encouraging Circular Economy Principles: Energy-efficient products are often designed with recyclability and reparability in mind, aligning with the principles of the circular economy.

- Reducing Waste: Energy-efficient products often have longer lifespans, leading to less waste generation. Additionally, the production of energy-efficient products can be designed to minimize waste throughout the supply chain.
- Consumer Empowerment: Energy labeling and other consumer information tools enable informed decision-making, empowering consumers to choose products with lower environmental impacts.
- Sustainable Supply Chains: Energy-efficient supply chains can be developed by incorporating energy-efficient practices throughout the value chain. The process encompasses the entire supply chain, starting with the first raw material obtaining and ending with the final distribution of the finished product. This could lessen the overall effect of production and consumption on the environment.

4.3.4 Effect of Energy Efficiency on SDG13

The priority of SDG 13 is the urgent adoption of measures to combat climate change and its effects. Energy efficiency plays a crucial role in cutting back on greenhouse gas emissions in order to mitigate climate change.

As energy consumption is a major contributor to global anthropogenic emissions, decarbonisation of industry is at the heart of the climate change agenda. Energy transitions are mostly driven by the need to lower CO_2 emissions associated with energy use. It should be highlighted that many kinds of energy transitions can occur based on local conditions, resources, and beginning locations. Energy efficiency contributes to the accomplishment of several SDGs and provides a means of addressing climate change.

- Direct Emissions Reduction: By improving the energy efficiency of infrastructure, transportation, and business operations, we can immediately cut back on greenhouse gas emissions, especially those of CO_2.
- Decoupling Economic Growth and Emissions: Energy efficiency allows economies to grow without a corresponding increase in emissions, a process known as "decoupling."
- Informed Decision Making: Energy efficiency labeling empowers consumers to choose energy-efficient appliances with knowledge and enables them to reduce their carbon footprint.
- Behavior Change: Energy efficiency campaigns can promote behavioral changes, such as reducing energy consumption through basic measures like shutting off appliances and lights when not in use.

4.4 Contributions From Participants

As shown in Table 6, participants made highly valuable contribution from their different perspectives regarding with their sectors and experiences. These contributions include a wide range of different opinion, from building new structure to the widening content of energy management, also from tax incentive to calculating social cost.

Table 6. Contribution from participants

Participant	Contribution
Public Authority (PA)	At the corner of the new production era, Türkiye should establish a strict policy regarding the transition to sustainable production and enable companies to adopt the concept of sustainability. Also, we need to focus on the circularity index of products, as Türkiye, our circularity index was 4,5% in 2022; however, in the EU, this rate is 11,7%. Producing economic value-added products and evaluating policies in this regard is critical.
Researcher & Expert (RE)	Awareness activities are carried out under EU-funded projects, not from public authoritys' own budget, that is why these activities, lasting within a specific period, using traditional communication tools, such as leaflets and public service announcements, so lose their effect. If do not maintain continuity in awareness activities, the learning process interrupts. At the same time, different communication instruments should be utilized, and a budget should be allocated just to focus on this.
Private Sector (PS)	Türkiye should improve its standardization infrastructure with particular attention to energy efficiency. Encouraging industry by embracing the green taxonomy, producers can position themselves as leaders in sustainability and contribute to a more sustainable economy.
Public Authority (PA)	The content of energy management should be enriched and technical know-how on carbon emissions and water consumption should be increased. It is essential that resource efficiency and energy efficiency are handled holistically, and the relevant institutions should adopt a proactive approach. It is not possible to reduce carbon emissions by a single authority; therefore, inter-institutional cooperation should be ensured.
Public Authority (PA)	It is essential to evaluate the relationship between twin transition and sustainability. It is, therefore, essential to establish an effective policy in accordance with the aforementioned considerations.
Public Authority (PA)	Increasing market surveillance activities and adopting policies will increase companies' innovation, thus increasing the contribution of energy efficiency regulations to sustainability.

Table 7. (Continiued) Contribution from participants

Participant	Contribution
Private Sector (PS)	The blue deal for water consumption should be encouraged by authorities, and sustainability in water resources needs to be accompanied by product regulation. Taxes under the green transition should be used for green financing and incentives.
Private Sector (PS)	Public authorities are uncertain about taking responsibility; hence, hardly taking action is seen in legislation concerning issues. At this point, the public authority should be proactive.
Private Sector (PS)	Mandate transparent reporting requirements for companies regarding their sustainability practices and eco-design compliance. This can help build consumer trust and hold companies accountable for their environmental impact.
Private Sector (PS)	Energy efficiency regulation has limited scope and focuses on energy efficiency, but water consumption, CO_2 emission, and material usage need to be considered for the transition to sustainability. ESPR will have a broad effect when compared. Especially in Türkiye, in specific sectors, the market is price-based. Even if more efficient products are available, the cost is nearly 10-15% higher, and their ROI is not more than two years. Unfortunately, end-users do not tend to buy more efficient ones.
Private Sector (PS)	Associations need to be more active and develop projects, raise awareness for their members, especially small-sized ones that have lack of technical regulation knowledge, and also using a scientific approach when conducting awareness activities with communication instruments focusing on children by using different techniques.

Table 8. (Continiued) Contribution from participants

Participant	**Contribution**
Private Sector (PS)	Improvement must be made in the processes, not just in the products. We should focus on cascaded systems for total efficiency and also consider sustainability. We must introduce different buying methods, such as rental models specifically for electric motor products in heavy-duty work areas. Furthermore, for the transition to sustainability, the ESPR Committee should be established, led, and supported by the higher political administrator because the fundamental changes will shape the future of production and implicitly affect our exports and trade balances.
Researcher & Expert (RE)	The performance of the products does not reflect the actual usage. Also, the quality of the materials goes from bad to worse, and consumer complaints need to be taken into consideration.
Researcher & Expert (RE)	There is hesitation about the performance of the “eco mode” and the electricity consumption of products lessening, but this triggers product performance and also increases the run time of products.
Public Authority (PA)/ Researcher & Expert (RE)	The social cost of all noncompliances under ecodesign, the negative impact of climate changes, waste, and soil contamination and the cost of clean-up could be calculated and implemented by authorities.
Public Authority (PA)	The administrative level needs to pioneer sustainability and set targets on this issue. Otherwise, achieving goals and complying with requirements would not be possible.
Private Sector (PS)	These regulations have driven significant technological advancements, leading to more energy-efficient and environmentally friendly products. However, challenges such as increased production costs and consumer education remain. By collaborating with policymakers and industry stakeholders, we can effectively address these issues and accelerate the transition to a sustainable future.

CHAPTER 5

RECOMMENDATIONS

A summary of the results is provided in this chapter from the participants, along with recommendations regarding the accomplishment of SDGs, the optimization of energy efficiency regulations, and sustainability. It also offers concluding remarks on the research limitations and suggestions for future studies.

Energy efficiency regulations, in particular those pertaining to ecodesign and energy labeling, these have become instrumental in the progression of sustainable development. By requiring enhanced product efficiency, these regulations have directly contributed to environmental sustainability through the reduction of resource consumption, the minimization of greenhouse gas emissions, and the reduction of waste. Furthermore, these policies have stimulated innovation, resulting in the creation of new technologies and business models that are focused on energy efficiency.

This study aimed to make an assessment of the industry's approach to the nexus of energy efficiency and sustainability. By conducting semi-structured interviews with private sector, we targeted to identify the deficiencies, difficulties, and challenges encountered besides potential improvable areas. The core of the recommendations intends to enable an effective transition for sustainability, better implementation of energy efficiency, and dissemination of SDGs for broader. These recommendations are new structural suggestions, strategical and policy-based. As shown in Table 7, recommendations directly linked to the results from semi-structured interview.

Table 9. Correlation table for recommendations

<table>
<tr><th colspan="2">Findings</th><th colspan="2">Recommendations</th></tr>
<tr><td rowspan="3">Lack of activities for sustainable development</td><td>Supply Chain Related Challenges</td><td>Overcome from supply problem;
1- Incentives and supports companies in the establishment of public-private-partnerships under the ESPR Committee. (Recommendation 5.3)
2- Development of project and implement educational and awareness-raising activities for suppliers. (Recommendation 5.3 and 5.4.3)</td><td rowspan="3">Dissemination of SDGs Broader (Recommendation 5.2)</td></tr>
<tr><td>Technical Challenges</td><td>Provide solution for technical part;
1- The objective is to share knowledge and experience related to design. (Recommendation 5.1)
2- Provide incentives and developed joint/collaborative projects. (Recommendation 5.3)
3- In particular, with regard to DPP and data management, to collaborate closely with regulatory authorities in other countries with a view to sharing information, coordinating inspections and addressing cross-border compliance challenges.(Recommendation 5.3)
4- Best practices sharing and technical guidance by Market Surveillance Authority. (Recommendation 5.3 and 5.4.3)</td></tr>
<tr><td>Regulatory and Policy Challenges</td><td>Improvement of implementations;
1- Monitoring and enforcement regarding inspection. (Recommendation 5.4.1 and 5.4.2)
2- Identifying the needs and developing strategies for new employment opportunities to increase sectoral capacity. (Recommendation 5.1, 5.3)
3- Enhance public awareness (Recommendation 5.4.3)</td></tr>
</table>

When conveying the question for challenging issues in sustainability, ESPR, and energy efficiency regulation, the conclusion raised by participants was;

1- Technical Based Problems
2- Supply-Chain Related Problems
3- Regulatory and Policy-Related Problems

In addition to this question, we address the question for understanding the difficulty level of the transition to sustainability, and grade of private sector was for this transition as “4.5”. It is clear that, private sector seen this sustainability transition challenging, so companies need technical support, including design assistance, testing, and laboratory support.

A structural proposal that can meet more than one need will provide a permanent solution to sustainability, which will become widespread in all sectors in the following period.

To ensure the promotion and better achievement of energy efficiency and sustainable development, four structural and policy recommendations, shown in Figure 58 and 59, with nine sub-actions are offered in relation to the findings of the interviews for the successful implementation of the SDGs, energy efficiency and the transition to sustainability.

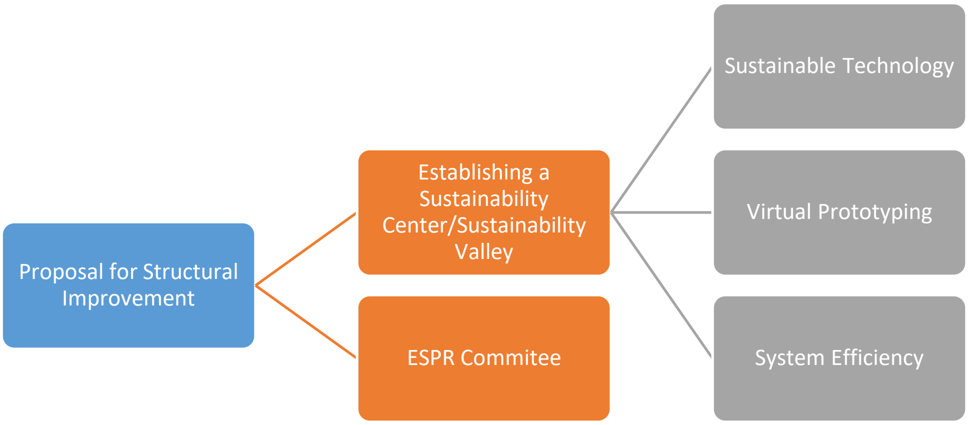

Figure 58. Structural-Based Recommendations

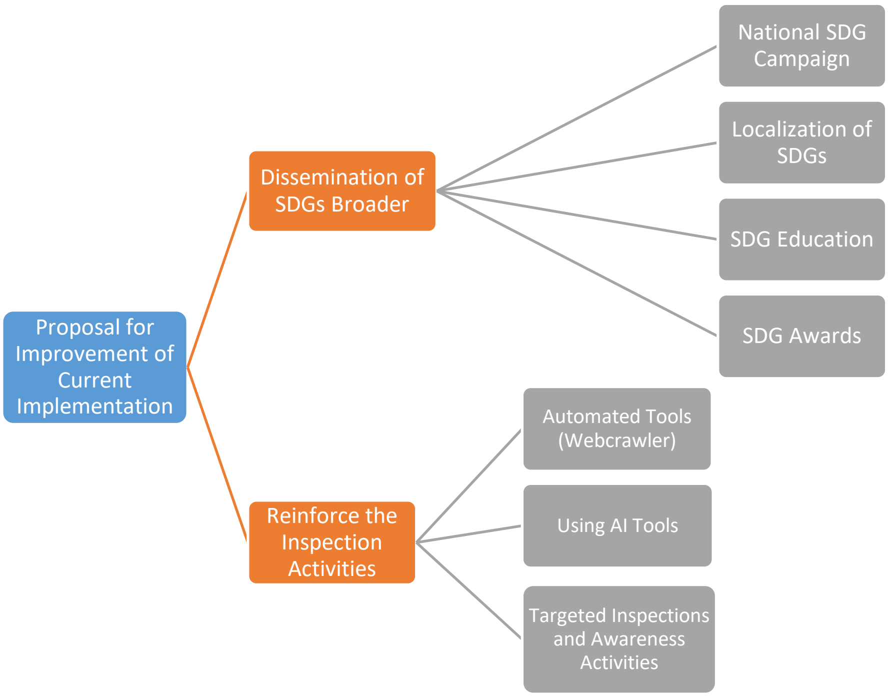

Figure 59. Policy and Technical Based Recommendations

5.1 Establishing Sustainability Valley

The Sustainability Valley (SV) will provide knowledge and expertise in sustainable innovation and product sustainability. This institution researches, develops, and expands knowledge of the effects that innovation has on sustainability both now and in the future. The SV seeks to give SMEs the abilities and information they need to be more eco-innovative.

This valley will promote the ‘sustainable design’ method as a means to transition to sustainability under the circular economy. It will address the role of government authorities, particularly in providing physical spaces and guidance to companies. Since sustainability under the circular processes requires cross-sector collaboration, SV provides physical working spaces with innovation and design laboratories, as well as proven circular tools and methods, and access to capital. The aforementioned centre comprises the following parts;

5.1.1 Sustainable Technologies

Sustainable Technologies aim to develop more ecologically friendly and state-of-the-art products, appliances, and services, encompassing numerous advancements with an emphasis on economic viability, the environment, and social justice. These technological advancements seek to enhance societal benefits while reducing their detrimental effects on the environment. Besides, it should maximize resource and energy efficiency while producing minimal waste and emissions.

Sustainable Technology is a new term that is arising in many industries. The importance is that whatever the product, it needs to be designed with consideration of sustainability.

Comparing the high-tech product export value of Türkiye, the proportion of high-tech goods exported by the manufacturing sector to EU is 3.5%[16] in January 2024. Also, in Figure 60, the value of high-tech product exports can be compared with that of frontrunner countries[17].

Sustainable technology is the new production and design approach; therefore, competency with the rest of the world is relatively easy since not all countries are familiar with this new approach. For that matter, focusing on innovative areas and utilizing these opportunities is crucial for Türkiye.

Sustainability valley ensures that sustainable technology is incorporated into business operations. As a result, third-party involvement in the adoption process becomes necessary, and the government may play a significant role in adopting sustainable technology since it has the authority and means to do so.

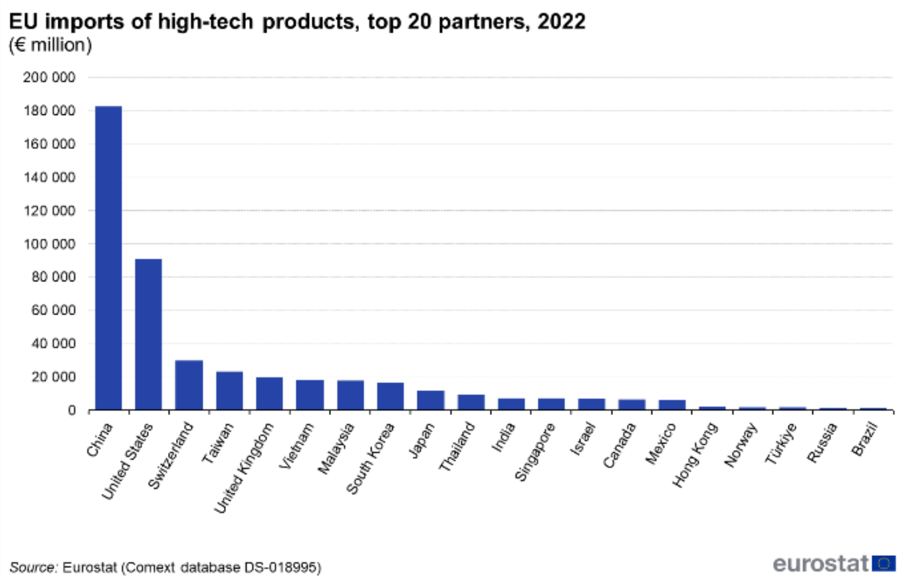

Figure 60. EU imports of high-tech products

16 Data gathered from TUİK, Dış Ticaret İstatistikleri, 2024
17 Data gathered from Eurostat, International trade and production of high-tech products, 2024

5.1.2 Virtual Prototyping

Virtual prototyping involves creating digital representations of products before physical production. By leveraging computer-aided design (CAD), simulation, and other digital technologies, designers and engineers can test, analyze, and improve product concepts in a virtual environment. This approach accelerates development cycles, reduces costs, and minimizes physical prototypes, increasing efficiency and innovation.

Adopting virtual prototyping to derive engineering eco-knowledge is possible, reducing the need for physical prototypes and the cost of tests and laboratories for compatibility under Ecodesign and Energy Labeling regulations.

The study done by Landi et al. (2017) shows the use of virtual prototyping and without building a physical prototype of an appliance, understanding its performance, and if it requires reproduction again.

Figure 61. Modeling of appliances

(Source: Landi, 2017)

The modeling of an oven, the creation of a virtual prototype of it, in Figure 60, and the subsequent testing of this prototype under the specified requirements set by ecodesign and energy labeling, in Figure 61, are then carried out. Following this, the test results are analyzed, and the energy label is obtained.

The utilization of data derived from the aforementioned test conditions facilitates enhancements to the product design and optimization of the product. In this instance, the implementation of modified fan covers resulted in the attainment of superior internal airflows, as illustrated in Figure 62. Consequently, the energy class of the product exhibited an improvement from A to A+.

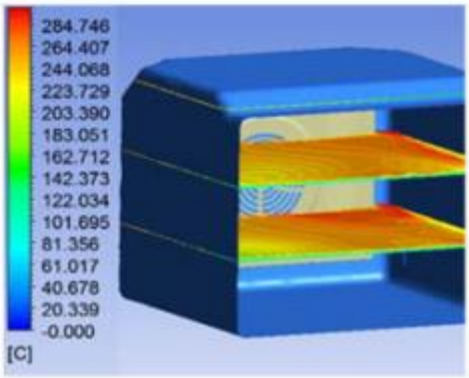

Figure 62. Virtual heat distribution

(Source: Landi, 2017)

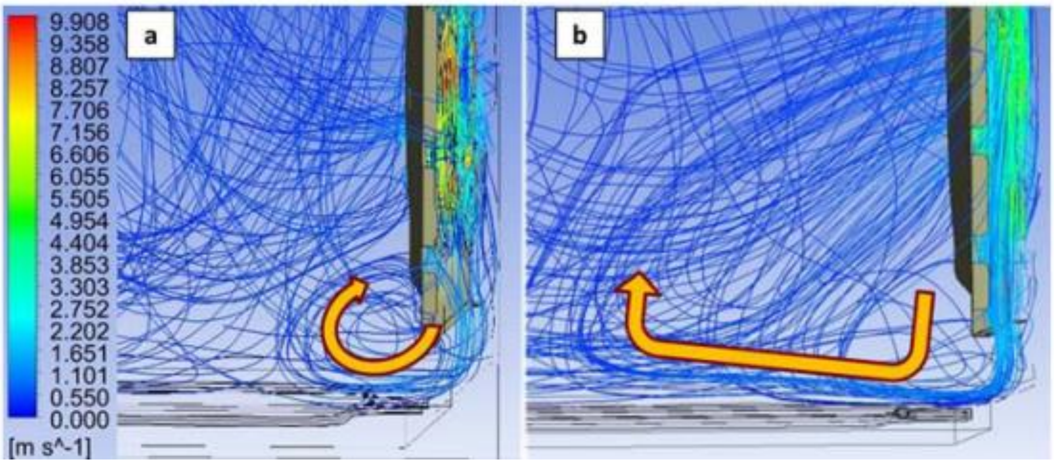

Figure 63. Airflows before (a) and after (b)

(Source: Landi, 2017)

In conclusion, the effect of using virtual prototyping will reduce testing costs, it is also possible to increase efficiency, provide low-cost operations and simplify redesign and optimization processes.

5.1.3 System Efficiency

System efficiency becomes particularly critical when considering cascaded systems like electric motors, fans, and pumps. These components often work in tandem, and optimizing their performance can lead to significant energy savings and reduced environmental impact. In the context of ecodesign and, sustainability refers to the holistic optimization of processes, materials, and energy flows within a product's lifecycle. It encompasses a broader perspective than simply focusing on individual components or isolated stages.

Using the most efficient electric motor, fan, and also compressor without understanding the system and analysis processes does not mean acquiring ideal efficiency and consuming less.

While system efficiency offers significant potential benefits, challenges such as component compatibility, system complexity, and initial investment costs need to be addressed. However, technological advancements, such as digital prototyping and sensor-based optimization, are creating new opportunities for improving system efficiency in cascaded systems.

Businesses and industries can achieve substantial energy savings and environmental benefits by focusing on system-level optimization rather than individual component efficiency.

5.2 Dissemination of SDGs Broader

The obtained results from participants indicate that the general public is not very aware of the dissemination of SDGs. Even could not get a certain answer of which authority is in charge SDGs.

Türkiye emphasizes its commitment to contribute for the adaptation of SDGs, transition to a sustainable world, and also demonstrates great ownership toward development policy and leadership for effective and timely implementation.

In Türkiye, each SDG is the responsibility of more than one institution. As part of the PSB’s overall coordination, this system demonstrates that Türkiye’s institutional infrastructure is suitable for implementing SDGs. Although SDGs are highly embraced by our country and, navigating the comprehensive side of SDG implementation in Türkiye presents several challenges.

Firstly, the institutional framework for SDG coordination is fragmented. While various ministries and agencies are involved in SDG-related activities, a clear overarching structure and accountability mechanisms are lacking. Ministries are not focusing exactly on because of these targets are based on voluntariness. This often leads to resource constraints and inconsistent implementation efforts.

Secondly, Türkiye faces significant regional disparities in terms of socio-economic development and environmental conditions. This necessitates tailored SDG strategies for different regions, which can be challenging to implement due to limited resources and capacities at the local level.

5.2.1 National SDG Campaign

A successful national SDG campaign requires a multi-faceted approach that engages a wide range of stakeholders, collaborating with government agencies, NGOs, businesses, and influencers to amplify the campaign’s reach and impact. Tracking campaign performance, measuring public awareness, and making necessary adjustments.

The contribution of ministries could be provided with the monitoring activities by PSB, ensuring the alignment of SDGs in their national or international projects done by authorities.

5.2.2 SDG Education

Integrating SDG education into formal and informal learning environments is crucial for building a sustainable future. Incorporating SDG concepts into school curricula at all levels, from primary to higher education. Creating platforms for young people to learn about and engage with the SDGs, such as youth summits, competitions, and volunteer opportunities and offering SDG-related training and education programs for adults and professionals.

5.2.3 SDG Awards

Recognizing and rewarding excellence in SDG implementation is essential for inspiring and motivating action. Establishing categories that align with sustainable development's different dimensions, environmental, social, and economic. The awarding mechanism could be implemented by first starting with the companies that compulsively report their sustainability activities, ESG, and manage a number of projects in this regard.

5.2.4 Localization of SDGs

SDG Localization is the process of translating the global SDGs into actionable plans and initiatives at the local level. It involves adapting the global goals to specific regions or cities, prioritizing needs and challenges, and mobilizing resources for implementation. This, enables authority to understand a specific region's distinct environmental, social, and economic circumstances. Besides, it strengthens communities’ and local governments’ ability to organize, carry out, and monitor SDG initiatives.

5.3 Removing Institutional Gap (ESPR Committee)

The transition to sustainability with the nexus of circular economy is long-lasting since the publishing regulations, implementations, and standardization will take quite a while. Besides, the prevalent scope of sustainability affects varying sectors, industries, and economic actors. Sustainability will be the main subject of each public authority. It is essential to understand sustainability as a horizontal issue with a broad scope.

Participants express the opinion of ineffective communication and information sharing among public authorities as a major barrier to coordinated environmental governance. “Lack of communication” received the highest value from the participants with 26%, and the second highest value is 22% with “lack of collaborative projects” between public authorities and businesses.

Moreover, participants expressed the view that public authorities are uncertain about taking the responsibility, and also emphasised the necessity for incentives and assistance to facilitate this transition.

To overcome this institutional gap problem, establish the “ESPR Committee, " which solves the regulatory landscape’s difficulty with multiple agencies/ministries responsible for varying aspects of product regulation. This can lead to inconsistencies, delays, and inefficiencies. It also builds strong communication and collaboration among relevant authorities and industries. Developing joint projects and benefiting from the outputs by sharing best practices.

The establishment of a unified incentive mechanism and the implementation of a centralized decision-making process are essential for addressing cross-ministerial and cross-jurisdictional concerns, such as those pertaining to sustainability.

It is imperative to establish a committee where the actions related to sustainability transformation are discussed with all stakeholders at regular intervals. This will foster incentive mechanisms, monitor progress regarding the transition, and facilitate the production and dissemination of progress reports to the private sector.

In the absence of such a committee, it will be challenging to establish an inter-institutional dialogue and collaboration, as each ministry/authority will have its own priorities, incentive budget, and strategies. This will impede the capacity to allocate sufficient time for effective decision-making at an opportune moment.

5.4 Reinforce the Inspection Activities

Market surveillance, a cornerstone of consumer protection, fair competition, and public safety, relies heavily on effective inspection practices. Inspections serve as the frontline defense against selling unsafe or non-compliant products.

Market surveillance authorities can identify potential risks of noncompliance in less efficient products by accurately examining products and enforce regulations.

In today's globalized marketplace, where products pass through vast supply chains, the importance of robust inspection activities cannot be overstated. Inspections act as a critical checkpoint, ensuring that products meet the mandatory safety, performance, and environmental standards.

Through diligent examination, market surveillance authorities can detect and address potential risks before they escalate into widespread harm, protecting consumers and maintaining public trust in the marketplace.

The Interview result shows that 14% of the participants point out the "lack of inspection". Using digital tools could be a solution to improve inspection efficiency and capacity. Digital technologies have revolutionized countless industries, and market surveillance is no exception. Inspection authorities can significantly enhance their efficiency, effectiveness, and reach by harnessing the power of digital tools and platforms.

5.4.1 Web crawlers

These bots employ data mining techniques to identify products that are not in compliance with the relevant standards and regulations at online market place, save for the market surveillance authorities (MSA) to make an assessment about results the objective is to ascertain whether the products in question are, in fact, non-compliant. Without any extra effort products that sold online market place could be inspected.

5.4.2 Digitization

Digitization also plays an essential role in inspection. Documents provided by the manufacturer, such as test reports and product information sheets, assist MSA inspectors in analyzing compliance and in making decisions regarding the acceptability of the product in question. These declared documents can be screened using AI tools, enabling market surveillance authorities to compare them. The assessment of outputs shows counterfeit test reports and conflicting values, which will prove noncompliance or be a reason for further and detailed investigation.

5.4.3 Targeted Inspections and Awareness Activities

Provide resources for capacity building to provide inspectors with the necessary training and skills to carry out effective inspections, including technical expertise, knowledge of ecodesign requirements and enforcement procedures. Also focus on products and manufacturers that pose the greatest risk to compliance, such as new and challenging regulations, ESPR.

At the same, focusing to educate suppliers about the new requirements and to provide consultancy services to manufacturers. Furthermore, activities are being conducted to raise consumer awareness about the significance of ESPR and sustainable product design.

CHAPTER 6

CONCLUSION

Beyond environmental gains, energy efficiency regulations have also yielded economic benefits. Increased product efficiency has translated to cost savings for consumers, stimulating demand and economic growth. Additionally, the regulations have fostered a competitive landscape, the objective is to encourage to improve product performance and minimize environmental effect, businesses should allocate resources to research and development. However, challenges such as ensuring equitable access to energy-efficient products and addressing potential rebound effects require ongoing attention.

The purpose of this study is to evaluate the Turkish industry with the nexus of energy efficiency and sustainability by conducting semi-structured interviews with economic actors of private sector, experts and public authorities. From the policy side, energy efficiency policies and targets, national development plans and sustainability targets are examined. Regarding from these policy papers indicate that Türkiye paid particular attention to the energy efficiency, energy transition, state in other words security of supply and focused on decreasing consumption with determinedly. Public authorities have an effective implementation on this issue, also encourages industry with a number of incentive tools.

However, with regard to the sustainability landscape, it is evident that both industry and public authority are confronted with significant challenges on this issue, not only in Türkiye but also in the wider global context. This is because sustainability is a comprehensive concept with a broad scope that directly affects all private sector, between the final consumers and the raw material providers.

While noticeable progress made in renewable energy and energy efficiency areas, the transition towards a truly circular economy requires concerted efforts from both the public and private sector. Public authorities play a pivotal role in creating an enabling environment through effective policymaking, regulatory frameworks, and infrastructure development.

With a growing number of policies, it is important to coordinate between policies and authorities. However, challenges such as institutional fragmentation, limited financial resources, and public awareness gaps hinder progress. Addressing these issues necessitates a holistic approach that combines policy innovation, technological advancements, and behavioral change. By fostering collaboration among government, industry, academia, and civil society, Türkiye can overcome these obstacles and accelerate its journey toward a sustainable future.

We determined the effect of existing energy efficiency legislations and ESPR on sustainability and for which SDGs they are in interaction and linkage. Our findings show that these legislations interact with similar purposes (SDG7, SDG8, SDG9, SDG12, and SDG13) both in literature reviews and semi-conducted interviews. Although SDG8 may not have a direct impact, it is crucial to emphasize its possible effect to SDG8 and include it because transition will facilitate the creation of new business areas and markets and should not be overlooked.

The transition to sustainability under the umbrella of the circular economy is a multifaceted and lengthy process, characterised by a multitude of interrelated factors and variables. It is thus imperative that industry and public authorities evince a high level of preparation and commitment to this transition if it is to be accomplished.

The present study proposes a series of robust recommendations aimed at eliminating institutional deficiencies and fostering enhanced inter-agency collaboration. The analysis of the performance of public authorities in the implementation of environmental regulations reveals the necessity for a more coordinated and effective approach. While individual efforts to address challenges such as coordination, capacity, and implementation gaps are undoubtedly valuable, a more structural solution is required.

Establishing a dedicated, independent structural body could significantly enhance the coordination of authorities. This committee is responsible for implementing comprehensive strategies and resolving institutional gaps. This committee will streamline processes, improve efficiency, and enhance public trust by centralizing these functions.

And for securing transition to circular economy requirements, a center, the Sustainability Valley (SV), is suggested for driving eco-innovation and fostering a circular economy. By providing SMEs with the requisite knowledge, tools, and resources, the SV empowers businesses to adopt sustainable practices and contribute meaningfully to environmental preservation. Through the strategic focus on sustainable technologies, innovative design, and system efficiency, the SV is poised to become a leading force in shaping a more sustainable future for both businesses and society at large.

Furthermore, the proposed body could serve as a knowledge hub, facilitating information sharing and capacity building among public authorities. It could also play a crucial role in engaging with stakeholders, including businesses, NGOs, and the public, to foster collaboration and support for environmental initiatives.

Establishing a novel design hub, with a mandate for environmental regulation represents a pivotal strategic step towards achieving more effective and sustainable environmental governance. By addressing the systemic challenges identified in this analysis, this organization has the potential to be a major force behind beneficial environmental change.

In conclusion, energy efficiency regulations have proven to be a cornerstone of sustainable development. By combining social progress and economic prosperity with environmental protection, these regulations have demonstrated their effectiveness in driving a transition toward a more sustainable future. To maximize their impact, it is essential to continuously evaluate and refine these policies, considering emerging technologies and evolving consumer preferences.

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APPENDICES

A. Semi-Structured Interview Questions For Policy Makers & Authorities

Q1: Type of Authority

Q2: Which sector does your authority operate in? Please explain in brief.

Q3: What are the main challenges/barriers to adopting Eco-design and energy label principles?

Q4: Does your authority have any publicly disclosed SDG targets or reports? Which one(s)?

Q5: Does your authority have any distribution of tasks under the responsible SDG?

Q6: Does your authority have any projects that align with the SDG targets?

Q7: How do you assess the impact of Eco-design and energy label on sustainability? Could we characterize it as a successful mechanism?

Q8: To what extent do you think that products should adhere to energy efficiency principles?

□ One of the main tools for reducing energy dependency

□ A particular factor driving up the price of goods

□ Promising prospects for new financial ventures/investments

□ I am hesitant about this

□ I have no idea

Q9: Do you currently work on ESPR (Ecodesign for Sustainable Products Regulation)? To what extent is this regulation being followed? What kind of work is being done?

Could you please specify the ESPR (1–5) difficulty level?

□ Serious work is required for compliance with the new legislation (5)

□ Compliance with new legislation can be easily achieved (1)

□ I have no idea

Q10: What is the most challenging aspect of sustainability and ESPR?

Q11: How do you evaluate the awareness activities or studies on SDGs and Energy Efficiency?

□ I consider the actions taken to be adequate

□ The actions taken are insufficient

□ I have no idea what is being done in this regard

Q12: Which Turkish industrial sectors/product groups are better suited for achieving compliance with the Eco-design and energy label?

Q13: Which areas require improvement in the sectors?

□ Inadequate staffing for technical legislation

□ Failure to develop joint projects

□ Failure to consider the capability of consultancy firms when outsourcing

□ Other

Q14: Have you had enough training to create a sustainable and energy-efficient policy?

Q15: What ethical considerations do you see in developing and implementing Ecodesign & Energy labeling regulations?

1. Trade-offs and unintended consequences:

<u>Greenwashing:</u> *Exaggerated claims or misleading information about a product's environmental impact can undermine consumer trust and hinder genuine progress.*

<u>Shifting burdens:</u> *Ecodesign might address one environmental issue (e.g., energy consumption) but create another (e.g., increased material use or toxic components).*

<u>Accessibility and affordability:</u> *Sustainable products can be more expensive initially, potentially excluding low-income communities from participating in the transition to a greener economy.*

2. Data privacy and manipulation:

Collection and use of consumer data: *Tracking purchasing habits or energy consumption through smart appliances raises concerns about privacy and potential misuse of data.* Transparency and trust in life cycle assessments (LCAs): Ensuring fair and reliable data and methodologies when conducting LCAs is crucial to avoid greenwashing and misleading claims.

3. Global equity and fairness:
Developed vs. developing countries: *Imposing strict ecodesign standards on developing countries without adequate support can hinder their economic growth and access to basic needs.* Fair labor practices and supply chains: *Ecodesign shouldn't come at the cost of unfair labor conditions or exploitation of workers in manufacturing countries.*

4. Access to information and empowerment:
Information asymmetry: *Ensuring consumers have clear, accessible, and accurate information about the environmental impact of products is crucial for informed choices.* Vulnerable communities: *Special attention should be paid to ensure information and educational resources reach marginalized groups who might be disproportionately affected by environmental issues.*

5. Balancing individual vs. collective good:
Incentivizing individual consumer choices: *While individual actions are essential, systemic change requires addressing broader issues like production systems and societal infrastructure.* Addressing free-rider problems: *How can participation be encouraged when some individuals might benefit from others' environmentally responsible choices without contributing themselves?*

Q16: Are there any specific policies or initiatives you would like to see implemented to strengthen the impact of Eco-design and energy label on sustainability?

B. Semi-Structured Interview Questions For Economic Actors

Q1: Type of Economic Actor (Manufacturer, OEM, Importer, Other)

Q2: Which sector does your business operate in? Please explain in brief.

Q3: What are the primary motivators for your company to adopt Eco-design and energy label principles?

□ Regulatory obligations □ Competition related issues □ Company policy □ Other

Q4: What are your company's main challenges/barriers in adopting eco-design principles?

Q5: How do you integrate Eco-design and energy label considerations during operations?

□ Just by legal department □ By technical deprtment □ By outsourcing

Q6: What are the main sustainability concerns within your company?

Q7: When developing sustainability and energy efficiency strategies, what kind of approach do you consider?

□ Short term (1-3 years)

□ Mid-term (3-5 years)

□ Long-term (5-10 years)

Q8: Does your organization have any publicly disclosed SDG targets or reports? Which one(s)?

Q9: What are the criteria your company considers during the design of the products?

□ Sustainability of products □ Efficiency of products

□ A competitive price policy □ Other

Q10: Do you know which institution is in charge of the SDGs and the distribution of the tasks among the responsible institutions?

Q11: Do you have any projects that align with the SDG targets?

Q12: How do you assess the impact of Eco-design and energy label on sustainability? Could we characterize it as a successful mechanism?

Q13: To what extent do you think that products should adhere to energy efficiency principles?

□ One of the main tools for reducing energy dependency

□ A particular factor driving up the price of goods

□ Promising prospects for new financial ventures/investments

□ I am hesitant about this

□ I have no idea

Q14: Do you currently work on ESPR (Ecodesign for Sustainable Products Regulation)? To what extent is this regulation being followed? What kind of work is being done?

Could you please specify the ESPR (1–5) difficulty level?

□ Serious work is required for compliance with the new legislation (5)

□ Compliance with new legislation can be easily achieved (1)

□ I have no idea

Q15: What is the most challenging aspect of sustainability and ESPR for you?

Q16: What kind of support or incentives would be most helpful for companies to embrace Eco-design and energy label more widely?

Q17: How do you evaluate the awareness activities or studies on SDGs and Energy Efficiency?

□ I consider the actions taken to be adequate

□ The actions taken are insufficient

□ I have no idea what is being done in this regard

Q18: Which areas require improvement in the governmental authority operating in this field?(Max. Three answers)

□ The long-lasting process of harmonizing legislation

□ Inadequacies in the application of harmonized legislation (lack of inspection)

□ Insufficient awareness-raising activities

□ Inability to set up collaborative projects

□ Staff competence issues

□ Existence of more than one incentive mechanism

□ Long bureaucratic processes

□ Lack of communication between authorities

Q19: What ethical considerations do you see in the development and implementation of Eco-design and energy label regulations?

1. Trade-offs and unintended consequences:

Greenwashing: Exaggerated claims or misleading information about a product's environmental impact can undermine consumer trust and hinder genuine progress. Shifting burdens: Ecodesign might address one environmental issue (e.g., energy consumption) but create another (e.g., increased material use or toxic components). Accessibility and affordability: Sustainable products can be more expensive initially, potentially excluding low-income communities from participating in the transition to a greener economy.

2. Data privacy and manipulation:

Collection and use of consumer data: Tracking purchasing habits or energy consumption through smart appliances raises concerns about privacy and potential misuse of data. Transparency and trust in life cycle assessments (LCAs): Ensuring fair and reliable data and methodologies when conducting LCAs is crucial to avoid greenwashing and misleading claims.

3. Global equity and fairness:

Developed vs. developing countries: Imposing strict eco-design standards on developing countries without adequate support can hinder their economic growth and access to basic needs. Fair labor practices and supply chains: Ecodesign shouldn't come at the cost of unfair labor conditions or exploitation of workers in manufacturing countries.

4. Access to information and empowerment:

Information asymmetry: Ensuring consumers have clear, accessible, and accurate information about the environmental impact of products is crucial for informed choices. Vulnerable communities: Special attention should be paid to ensure information and educational resources reach marginalized groups who might be disproportionately affected by environmental issues.

5. Balancing individual vs. collective good:

Incentivizing individual consumer choices: While individual actions are essential, systemic change requires addressing broader issues like production systems and societal infrastructure. Addressing free-rider problems: How can participation be encouraged when some individuals might benefit from others' environmentally responsible choices without contributing themselves?

Q20: Are there any specific policies or initiatives you would like to see implemented to strengthen the impact of Eco-design and energy label on sustainability?

C. Semi-Structured Interview Questions For NGO And Experts

Q1: Type of Participant's Working Area (NGO, Experts, Researchers)

Q2: Which areas do you operate in? Please explain in brief.

Q3: What are the primary motivators for companies to adopt eco-design and energy label principles?

□ Regulatory obligations □ Competition related issues

□ Company policy □ Other

Q4: What are companies' main challenges/barriers in adopting Eco-design principles?

Q5: What are the main sustainability concerns?

Q6: Do you have any publicly disclosed SDG targets or reports? Which one(s)?

Q7: Do you know which institution is in charge of the SDGs and the distribution of the tasks among the responsible institutions?

Q8: Do you have any projects that align with the SDG targets?

Q9: How do you assess the impact of Eco-design and energy label on sustainability? Could we characterize it as a successful mechanism?

Q10: To what extent do you think that products should obey energy efficiency principles?

□ One of the primary tools for reducing energy dependency

□ A particular factor driving up the price of goods

□ Promising prospects for new financial ventures/investments

□ I am hesitant about this

□ I have no idea

Q11: Will your sector be affected by ESPR (Ecodesign for Sustainable Products Regulation)? To what extent is this regulation being followed? What kind of work is being done? Could you please specify the ESPR (1–5) difficulty level?

□ Serious work is required for compliance with the new legislation (5)

□ Compliance with new legislation can be easily achieved (1)

□ I have no idea

Q12: What is the most challenging aspect of sustainability and ESPR?

Q13: What kind of support or incentives would be most helpful for companies to embrace the Eco-design and energy label more widely?

Q14: How do you evaluate the awareness activities or studies on SDGs and Energy Efficiency?

□ I consider the actions taken to be adequate

□ The actions taken are insufficient

□ I have no idea what is being done in this regard

Q15: Which areas require improvement in the governmental authority operating in this field?(Max. 3 answers)

□ The long-lasting process of harmonizing legislation

□ Inadequacies in the application of harmonized legislation (lack of inspection)

□ Insufficient awareness-raising activities

□ Inability to set up collaborative projects

□ Staff competence issues

□ Existence of more than one incentive mechanism

□ Long bureaucratic processes

□ Lack of communication between authorities

Q16: Have you had enough training to create a sustainable and energy-efficient policy?

Q17: How can the industry and legislators better encourage consumers to make sustainable purchasing decisions?

Q18: What ethical considerations do you see in developing and implementing Eco-design and energy label regulations?

1. Trade-offs and unintended consequences:

Greenwashing: Exaggerated claims or misleading information about a product's environmental impact can undermine consumer trust and hinder genuine progress. Shifting burdens: Ecodesign might address one environmental issue (e.g., energy consumption) but create another (e.g., increased material use or toxic components). Accessibility and affordability: Sustainable products can be more expensive initially, potentially excluding low-income communities from participating in the transition to a greener economy.

2. Data privacy and manipulation:

Collection and use of consumer data: Tracking purchasing habits or energy consumption through smart appliances raises concerns about privacy and potential misuse of data. Transparency and trust in life cycle assessments (LCAs): Ensuring fair and reliable data and methodologies when conducting LCAs is crucial to avoid greenwashing and misleading claims.

3. Global equity and fairness:

Developed vs. developing countries: Imposing strict ecodesign standards on developing countries without adequate support can hinder their economic growth and access to basic needs. Fair labor practices and supply chains: Ecodesign shouldn't come at the cost of unfair labor conditions or exploitation of workers in manufacturing countries.

4. Access to information and empowerment:

Information asymmetry: Ensuring consumers have clear, accessible, and accurate information about the environmental impact of products is crucial for informed choices. Vulnerable communities: Special attention should be paid to ensure that information and educational resources reach marginalized groups who might be disproportionately affected by environmental issues.

5. Balancing individual vs. collective good:

Incentivizing individual consumer choices: While individual actions are important, systemic change requires addressing broader issues like production systems and societal infrastructure. Addressing free-rider problems: How can participation be encouraged when some individuals might benefit from others' environmentally responsible choices without contributing themselves?

Q19: Are there any specific policies or initiatives you would like to see implemented to strengthen the impact of Eco-design and energy label on sustainability?