Carbon dioxide mitigation through energy efficiency labeling

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ABSTRACT:

The purpose of the research was to determine to what extent the use of energy efficiency labeling (EEE) favors the mitigation of carbon dioxide (C02), an influential gas in the greenhouse effect that affects the increase in temperatures and climate change. This research is descriptive - analytical; anthropogenic actions and the use of EEE as an action to reduce CO_2 are related. The sources of information were the NOAA satellite atmospheric monitoring center and the Ministries of Energy of Peru and Chile. It is evident that the EEE, applied to electrical appliances in the Peruvian case, will prevent between 2015 and 2030 a total of 6,345 GgC02eq; while in the Chilean case there is evidence of the application of the vehicle EEE in which they accurately report the differences between combustion and electric vehicles in terms of performance and emission and it is highlighted that electric vehicles do not emit C02 into the environment. We can conclude that these labels enable informed purchases for consumers and based on the experience of the European Union, state that efficient vehicle driving can reduce emissions by approximately 15%. Finally, public policies in favor of non-polluting vehicles contribute to the mitigation of the main greenhouse gas.

Keywords: Energy efficiency labeling, CO2 mitigation, electric vehicles, vehicle driving
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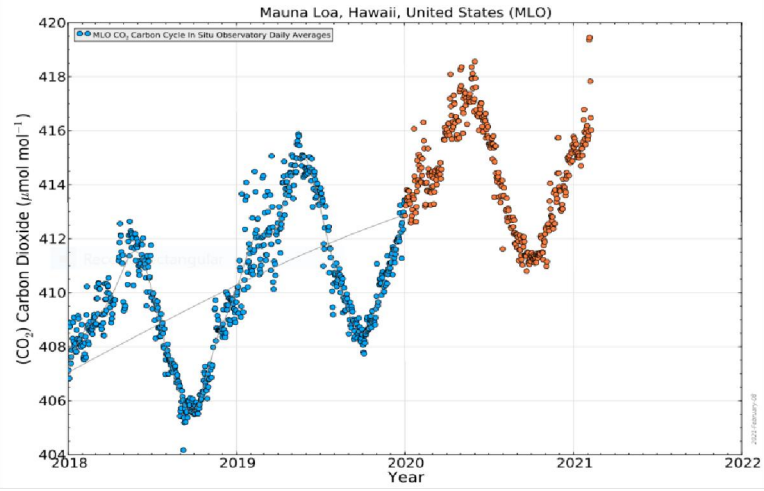
INTRODUCTION

Climate change continues, the year 2020 integrates one of the three warmest years since records began [1]. That year, the global average temperature was 1.2°C above the estimated pre-industrial averages, which puts compliance with the Paris Agreement at risk, whose objective is to prevent the increase in the average global temperature of the planet from exceeding 2°C compared to pre-industrial levels. The Secretary General of the World Meteorological Organization, Professor Taalas, stated that the concentrations of greenhouse gases (GHG) also continue to increase [2]; in particular carbon dioxide (CO_2), the main greenhouse gas (56%) responsible for climate

change, especially due to anthropogenic actions and the combustion of fossil materials [3,4]. (Figure 1) shows the global emission of CO_2 from 2018 to the beginning of 2021. It is seen that even in the time of the COVID-19 pandemic, when industries and transport were paralyzed in 2020, the levels of CO_2 did not decrease in global terms [5].

Figure 1.
CO_2 emission in the atmosphere from 2018 to February 2021



The greenhouse effect occurs when certain gases in the atmosphere such as water vapor, carbon dioxide, methane, nitrous oxide and chlorofluorocarbons, among others, retain part of the heat energy emitted by the earth (invisible long-wave infrared radiation) after from being heated by radiation from the sun (visible light and short wavelengths); that is, greenhouse gases maintain high temperatures in the lower atmosphere allowing less heat to escape into space [6]. What is worrying is that greenhouse gas emissions are cumulative, what settles in the atmosphere stays there for hundreds of years [7,8,9]. Consequently, excess heat produces a rise in temperature, called global warming, and this generates climate change with serious consequences, such as floods, rising sea levels, droughts in other areas and collateral effects on socioeconomic development, human health, migration, food security and the impacts on terrestrial and marine ecosystems, etc. [10,11].

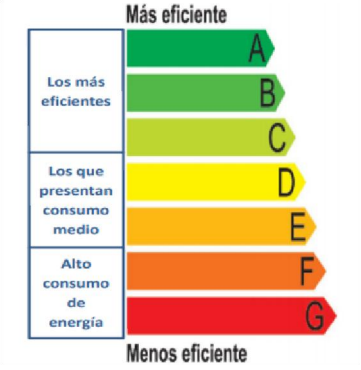
The activities of the human being that add more CO_2 to the atmosphere by burning fossil fuels are altering the carbon cycle, as well as the activities of deforestation of forests and the destruction of marine ecosystems, which are natural sinks, which absorb and capture carbon dioxide. reducing its concentration in the atmosphere. In order to mitigate such actions, human intervention is necessary to reduce the sources or increase the sinks of GHG as indicated by the United Nations Framework Convention on Climate Change [11]. On the other hand, the planet needs to have soils covered with vegetation, to enable photosynthesis and sequester CO_2, absorb and retain water, maintain habitats and regulate temperatures [12]. In this context, it has also been proposed to improve energy efficiency (EE) and rationalize the use of energy [13].

Energy efficiency is defined as a set of actions that allows reducing energy consumption while maintaining service quality [14]. It is required to identify and avoid unnecessary energy

consumption [15]. Considering the EE and its necessary identification, the energy efficiency labeling (EEE) arises.

In general, the labels can be used in electrical devices, buildings, machinery and in vehicular units. In them, it is reported regarding the saving of electricity and fuel; likewise, on the CO_2 emissions that contribute to the informed decision of consumers. This information sensitizes consumers to be friendlier to the environment and stimulates companies to produce equipment with greater efficiency in energy consumption, which generates economic, environmental and social benefits. Figure 2 shows the label that is placed on electrical appliances in Peru.

Figure 2.
EE label for electrical appliances-Peru



Source: Ministry of Energy and Mines - Inacal (Peru)

This research, in the face of global warming due to the increase in GHG caused by anthropogenic activities that put humanity at risk due to climatic catastrophes that could arise, considers it necessary to show prevention actions, before it is too late. Consequently, it is proposed: to determine to what extent energy efficiency labeling contributes to the mitigation of carbon dioxide, the main greenhouse gas.

MATERIALS AND METHOD

The research is of a descriptive-analytical level and ex post facto design due to anthropogenic interventions and the combustion of fossil materials such as gasoline, diesel and gas. The evolution of global warming as a consequence of the greenhouse effect influenced mainly by carbon dioxide was reviewed. Their behavior was analyzed from the NOAA (National Oceanic and Atmospheric Administration) satellite atmospheric monitoring center and figures were prepared for academic purposes.

Then, information was collected from the Ministries of Energy and Mines of the Peruvian government and the Ministry of Energy of the Chilean government, regarding the energy efficiency labeling of electrical appliances and vehicles, respectively. Public policies and experiences from other countries on efficient vehicle driving were also examined.

Similarly, the greenhouse-gas-equivalences-calculator of the United States Environmental Protection Agency (EPA) was used for conversions and comparisons of energy consumption and carbon dioxide emissions. of carbon.

RESULTS

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In the Latin American region there are industrialized countries such as Brazil, Mexico and Argentina, in which cases the level of contamination is high and consequently they have advanced in the regulation to minimize it; Other countries in the region have recently begun to implement government measures to reduce pollution, especially carbon dioxide. This study presents two cases, the first corresponds to Peru based on the legislation on energy efficiency, mainly for electrical appliances and the second case refers to the energy efficiency labeling for vehicles in Chile. Also, based on experiences from other countries, it incorporates what refers to efficient driving and the link with public policies and incentives.

EEE in electrical appliances in Peru

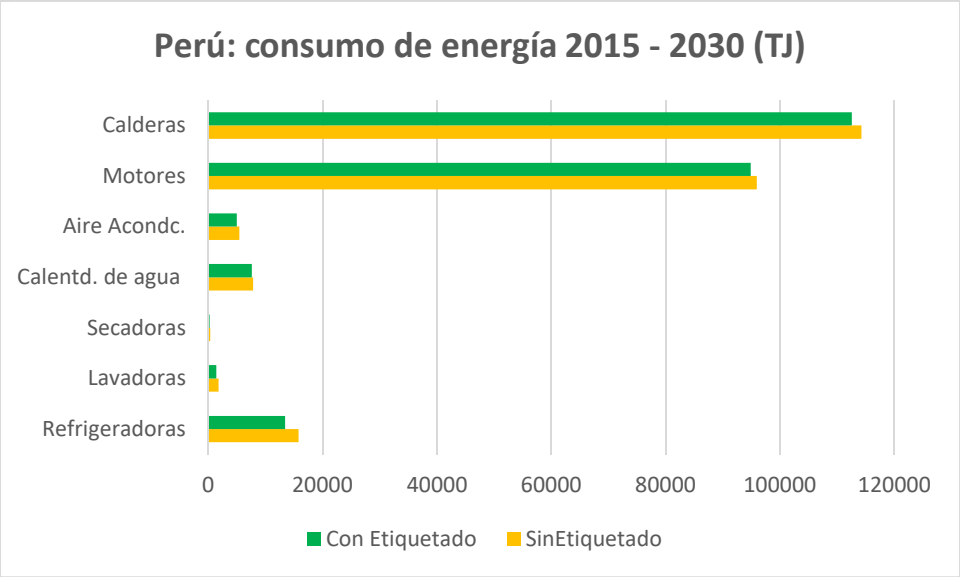
Peruvian Law No. 27345 establishes that "it is of national interest to promote the Efficient Use of Energy, to ensure the supply of energy, protect the consumer, promote the competitiveness of the economy and reduce the negative environmental impact of use and consumption of the energetic" [16]. In this sense, the energy efficiency labeling implies that the equipment that requires energy supplies contain said label on their labels, containers, packaging and advertising so that the consumer can be informed of the energy consumption and the energy efficiency of the product.

The appliances or equipment included in the mandatory nature according to the Technical Regulation (DS Nº 009-2017-EM) are: Lamps for domestic use, ballasts for fluorescent lamps for domestic use, refrigeration appliances for domestic use, boilers, three-phase electric motors, household washing machines, household tumble dryers, household air conditioners and water heaters.

The energy efficiency labeling (EEE) in Peru is informative and also normative; that is, it is mandatory, which reinforces its application and benefits environmental care.

Below, we present the projections of the impact of the energy efficiency labeling program (EEE) of the Ministry of Energy and Mines of Peru, based on the studies of minimum energy efficiency standards (MEPS, for its acronym in English). The reduction in energy consumption is shown (Figure 3) during the period 2015 - 2030 for boilers, motors, air conditioning, water heater, dryers, washing machines and refrigerators or freezers and it is in this last appliance that a lower consumption is observed. projected energy.

Figure 3:
Projected energy consumption with and without EEE – Peru

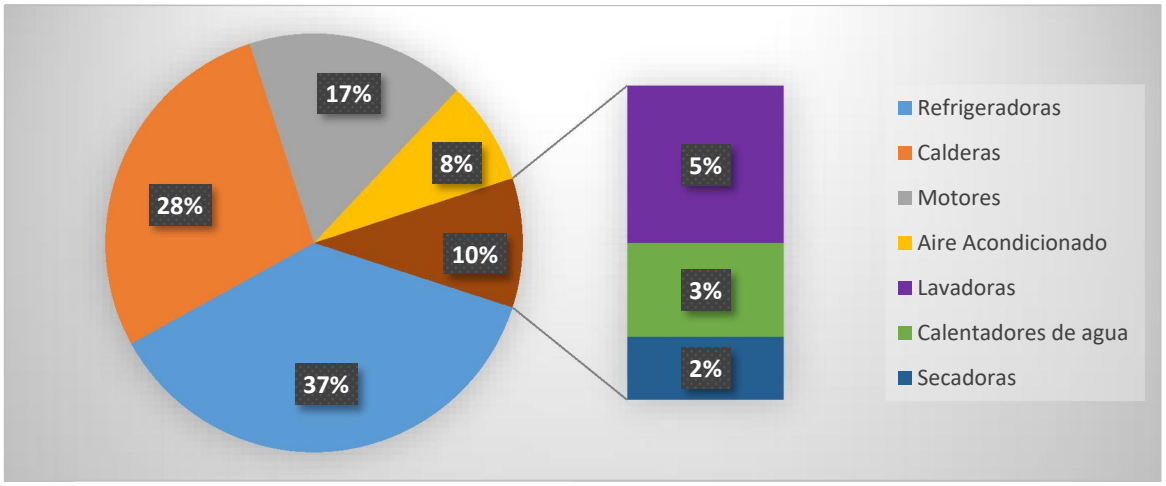


Source: Prepared with data from the Ministry of Energy and Mines - Peru (2021)

According to data from the Ministry of Energy and Mines of Peru, a decrease between the scenarios with and without a label of 6,345 GgC02eq is projected for the period 2015-2030, which corresponds to 702,712 gallons of gasoline consumed.

Regarding the percentage decrease in greenhouse gases, projected to the year 2030, these are related to the decrease in electricity consumption and it can be seen in (Figure 4) that in household appliances, the decrease corresponds, mainly, to to refrigerators, washing machines and water heaters, which are renewed frequently in millions of homes in the country.

Figure4.
Mitigation (%) of GHG with EEE by 2030



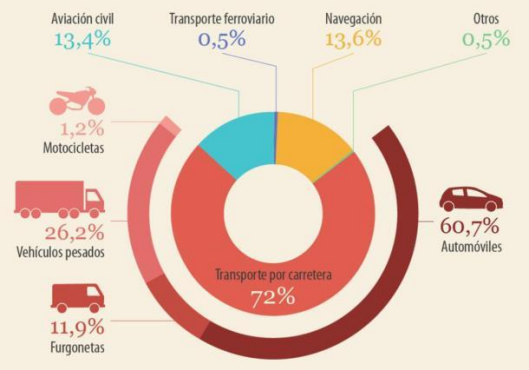
Adapted from the Ministry of Energy and Mines – Peru (2021)

EEE Vehicles from Chile and the European Union

One of the sectors that pollutes the most in the world is transport, because they make use of fossil sources such as oil, coal and natural gas. In a study by the European Environment Agency [17] it was found that, of the different modes of transport, the one that pollutes the most is road transport (72%), motorcycles (1.2%), vans (11, 9%), heavy vehicles (26.2%) and cars (60.7%) (Figure 5). For this reason, it is necessary to search for actions that minimize vehicular pollution.

Figure5.

CO_2 emissions caused by transport in the EU.



Source: European Environment Agency

There are two actions that are already applied in Latin America as public policies: one is the energy efficiency labeling (EEE) whose nature is informative and the other is the energy efficiency standards, in this case, of a regulatory nature [18].

It is necessary to encourage the increased use of electric vehicles. For this purpose, information and awareness to buyers through energy efficiency labeling already shows its benefits as in the case of the European and Chilean standard. The vehicle energy efficiency label provides information to consumers to assist in their purchasing decisions for vehicles with lower fuel consumption, minimum CO_2 emissions and higher mileage. With this, it aspires to a rational use of energy based on the penetration of efficient technology in the market.

The vehicle label is used in 13 countries around the world [18]. In Latin America, Chile was the first country to implement mandatory vehicle energy efficiency labeling since February 2013. Buyers of light vehicles, with diesel or gasoline engines, could already compare the energy performance of new vehicles and opt for those that provide more mileage per liter of fuel. The labeling was very useful for buyers of light vehicles and by virtue of this, as of June 26, 2017, a new label was implemented, and its use was expanded [19] for medium-sized vehicles such as trucks and vans; as well as for hybrid and pure electric vehicles weighing less than 3,860 kg.

It is important to note that the vehicle label does not contain the same data for all cases. The energy performance and CO_2 emissions correspond to the laboratory tests of the Ministry of Transport and Telecommunications based on the test cycle of the European Economic Community as indicated on the label. In addition, it points out that driving habits, maintenance frequency and environmental and geographical conditions have an influence, which could show differences between the values calculated in the laboratory and real experience.

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The energy efficiency labels in Chile, displayed on the windshield of vehicles for sale (Figure 6), show that cars whose fuel consumption is gasoline or diesel emit 97 and 91 grams of CO_2 for each kilometer traveled, respectively, which when year represents 1.9 and 1.8 tons, while the electric vehicle emits zero grams per kilometer; that is, it does not pollute.

Figure 6.
Labels with energy performance - CO_2 emission in vehicles

Adapted from the Portal of indicators of energy consumption and vehicle emissions (2021)

The Indicators Portal of the Ministry of Energy of the Government of Chile shows the mixed performance of vehicles according to the energy source and the annual expenditure generated expressed in Chilean pesos (Table 1). It is observed that the electric vehicle has a lower cost per year than diesel and much lower than gasoline.

Table 1.
Expenditure indicators according to source.

Source	Cost per year ($)
Gasoline	683.761
Diesel	419.58
Electric	281.69

The European Federation for Transport and Environment (T&E) has analyzed the amount of carbon dioxide released into the atmosphere by combustion vehicles. Then, he did the same with electric vehicles. For the latter, they have considered the amount of CO_2 that is generated when producing electricity; as well as the environmental impact created by the extraction of resources for batteries or the implementation of an electric power plant. After these considerations, it is concluded that electric vehicles emit approximately 30% less than conventional motors [20].

Efficient driving and the link with incentive policies

One factor that influences the reduction of GHG emissions is efficient driving or ecological driving. It is proposed that the mitigation measures should consider it as a potential fuel saving and emission reduction [21]. In this regard, the objective is to change the driver's behavior through recommendations such as maintaining a constant speed, accelerating moderately, anticipating the flow of traffic, and taking advantage of the vehicle's inertia [22]. With efficient driving, average fuel savings of around 15% and a reduction in CO_2 emissions are obtained in the same proportion [23]. It is recommended that the EEE be linked to other efficiency instruments such as tax incentives or

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regulations to achieve a more effective change in the energy efficiency of the vehicle fleet that is marketed in the country [24]. These instruments, together, enable a renewal of the vehicle units that are marketed, oriented towards vehicles with lower GHG emissions, such as electric vehicles that, compared to fossil fuel vehicles, offer lower spending on fuel, maintenance, and taxes (Table 2).

Although it is true that the price is higher than that of the traditional vehicle, over the years such monetary difference can be recovered, but in that time, it stops polluting. The case of France is a clear example: the so-called "Bonus-Malus" whereby buyers of vehicles that emit less than 100 g CO_2/km would receive a bonus of 1,000 euros, while buyers of vehicles with more than 260 g CO_2 /km would be taxed at 2,600 euros. This initiative allowed the reduction of carbon dioxide emissions by 6% [18].

Table 2.
Comparison of expenses: electric and combustion vehicles

Cost (€)	**Electric Vehicle**	**Fossil Fuel Vehicle**
Price (withchargingpoint)	28 000	16 000
Fuel expense	2 600	18 200
Maintenance expense	8 000	10 000
Taxes	165	660

CONCLUSIONS

The rule that requires the energy efficiency label to be displayed on electrical appliances for sale so that the buyer makes an informed purchase, came into effect in 2019 in Peru. Its objective was for the buyer to make an informed purchase and as an effect of the EEA on household appliances, a decrease of 6,345 GgC02eq is projected, which corresponds to 702,712 gallons of gasoline consumed.

Regarding mandatory vehicle labeling in Chile, it can be stated that although it is true that there are no evidence of studies on the results of its application, it is noteworthy that the label shows very clear information on the emission of gasoline and diesel vehicles for each kilometer traveled. of 97 and 91 grams of CO_2, respectively. This amount represents 1.9 and 1.8 tons per year; while the electric vehicle emits zero grams per kilometer; that is, it does not pollute.

To be effective in mitigating CO_2, it is necessary to complement the EEE with efficient driving, which enables a 15% reduction in emissions, and if added to this, public policies for reducing taxes or giving out bonuses that favor less efficient vehicles. pollutants, such as electricity, the achievement of the objective is made feasible.

It is desirable that more countries include public policies and regulations on the EEA and enable compliance with the Paris Agreement to avoid global warming and the collateral effects that impact socioeconomic development, human health, migration and food security.

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