FINAL REPORT EXECUTIVE SUMMARY. ENERGETICALLY EFFICIENT ENVELOPES IN RESIDENTIAL, PUBLIC AND COMMERCIAL BUILDINGS

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1. Background

The project "Mechanisms and networks of technology transfer related to climate change in Latin America and the Caribbean", prepared by the Inter-American Development Bank (IDB), was approved by the Council of the Global Environment Facility (GEF, - GEF, for its acronym in English-) on September 11, 2014 and by the IDB Board of Directors on December 17 of the same year.

The objective of the project is to promote the development and transfer of environmentally sustainable technologies (ESTs) in countries of Latin America and the Caribbean (LAC), in order to contribute to the final goal of reducing gas emissions. of greenhouse effect and vulnerability to the effects of climate change in specific sectors of the region.

1.1. Objective of the consultancy

The objective of the consultancy is the preparation of a roadmap for the adoption of energy-efficient technologies in housing envelopes of residential, commercial and public buildings in the Dominican Republic.

1.2. Brief introduction on the current situation of energy efficiency in residential, commercial and public buildings in the Dominican Republic

Residential construction in the Dominican Republic does not respond to energy criteria. There are different types of construction levels attending socio-economic levels. In the particular case of residential buildings the design and as a consequence thereof, the energy consumption depends on the construction area and the available spaces. The buildings of greater height are called towers and usually their design is more aesthetic than functional in terms of efficient use of energy. The towers have a basic structure of beams and columns but contain more presence of crystals in their structure than the other buildings.

Most commercial buildings lack ventilation and natural lighting. The type of construction of these requires a continuous energy expenditure in air conditioning and lighting regardless of the time of day. Another significant consumption is generated by the pumping of water in most of the large shopping centers. Trade as an individual user is a high consumer of electricity but its impact on the country's energy consumption matrix is lower than other consumption sectors such as transport and the residential sector. Similar conditions are found in public buildings.

In general, in the design and construction of buildings, energy consumption during its operation is not considered. In general, the country does not apply designs that take into account the environmental conditions for better use of available natural resources (sun, winds) within it. The orientations respond to the layout of the streets and not to the solar route (when there are urban plans.) There is a high thermal transfer from outside to inside and not in the opposite direction due to the type of materials used, among other reasons. in public buildings.

In summary, the country has not yet given the necessary conditions for the introduction of criteria and energy efficient technologies and that take advantage of the natural conditions of an island in the Caribbean, so it is considered timely the implementation of the proposed project among other reasons found in public buildings..

2. Table of Acronyms

Next, the following table of acronyms is established:

Table 1 Acronyms

TABLE OF ACRONYMS	
DHW	Domestic heated water
AIRD	Industrial Association of the Dominican Republic
ASHRAE	American Society of Refrigeration Air Conditioning Engineers
IDB	Interamerican Development Bank
BIEE	Base of energy efficiency indicators. CEPAL
CADOCO	Dominican Chamber of Construction
CEPAL	Economic Commission for Latin America
CNCCMDL	National Conucil for Climate Change and the Clean Development Mechanism
CNE	National Energy Commission
CODIA	Dominican College of Architects, Engineers and Surveyors
CURB	Climate Action for Urban Sustainability
DOE	United States Department of Energy
EDES	Electric power distribution companies
EE	Energy efficiency
HVAC	Heating, Ventilation and Air Conditioning
FMAM	Fund for the Global Envirnoment
GBM	World Bank Group
GEI	Greenhouse gases
LPG	Liquefied petroleum gases
LNG	Liquefied natural gas
INDOCAL	Dominican Institute for Quality
LED	Light emmiting diode
LEED	Leadership in Energy and Environmental Desing
MIMARENA	Minstry of Environment and Natural Resources
MOPC,	Ministry of Public Works and Communications
MUSD	Millions of US dollars
NZEB	Near zero enerby buildings
OISOE	Office of Engineers Supervisors oj Works of the State
OLADE	Latin American Electric Power Organization
ONE	National Statistical Office of the Dominican Republic
PIB/GDP	Gross domestic product
PRSI	Simple return period of an investment = Value of the Investment/Annual avoided cost
PUCMM	Pontificia Universidad Católica Madre y Maestra
PVC	Polyvinylchloride
DR	Dominican Republic
SARD	Society of Architects of the Dominican Republic
SEER	Seasonal Energy Efficiency Ratio
SIEN	Natinal Energy Information System

tep	Oil equivalent ton= 11,63 MWh
ktep	1,000 tep
tCO_{2e}	CO_2 equivalent tons to calculate GEI
USGBC	United States Green Building Council.

3. Energetic matrix of the Dominican Republic

From the energy point of view, the total consumptions in the DR and in the different sectors and by energy vectors (electric power, fuels, biomass, etc.) have been analyzed in the 1998-2015 period. **The methodology for estimating the consumption of each source must be taken into account, due to differences between the supply and intermediate consumption of the electricity generation of the Interconnected National Electric System, Isolated Systems and Self-Producers or Backup Systems (Power Plants), in this sense , if the intermediate consumption were equal to the supply, there would be no final consumption.**

Likewise, estimated projections of energy consumption have been prepared up to 2030, ending the scope of the Roadmap.

In the first place, from the study of the graphs of evolution in time, from 1998 to 2015, the following conclusions have been drawn:

- **In the rural area**, energy consumption tends to remain constant and electric energy has a low weight in its composition.
- However, **in the urban residential environment**, the growth is very sustained and in terms of the components, the most relevant are electricity, 47% of the total and LPG, 41%
- **In the commercial, service and public sectors**, the total energy and its electrical component are very similar, in fact the latter accounts for 80% of the total (LPG only 14.6%). There is also a very sustained growth
- Consumption **in construction activities** shows a moderate increase, but it does not seem to be related to the growing contribution of this sector to GDP, due to the fact that this increase is not sufficiently powerful. The reason is that the increases of the contributions of the GDP to the construction sector are given by the increases in the activities of the residential real estate sector and the construction of schools at the national level; the latter, as a result of the increase in the education sector budget. However, construction activities in the Dominican Republic are not energy-intensive, so the pending value added and energy consumption need not be similar.
- There is also no great evolution in the consumption of energy **in the industry**, which may indicate some stagnation in this activity. The most relevant component is electricity and one would think that the demands for fuel type are determined by the evolution of prices in foreign markets. It is appreciated, as indicated next to the graph, a strong increase in the demand for natural gas.
- The consumption of the **industrial sector** has experienced a growth rate of 3.82% and 3.15% between 1998 - 2015 and 2011 - 2015, respectively, of 775.61 ktoe and 1,296.69 ktep to 1,468.11 ktep.
- For comparative purposes, industrial consumption can be compared with the added value of the sector, calculating the industrial energy intensity more specifically.

For all the above, we can say that the economic engine of R.D. it is the Services Activity, especially Tourism; in fact, the weighting of the industrial sector has dropped from 31% in 2000 to 27% in 2015 and the Services Sector has gone from 56% to 58%, respectively.

Regarding the projections obtained through trend lines for the year 2030, without taking into account the application of energy efficiency measures, we have:

- **Total Consumption**: values close to **6,240 ktep / year** are foreseen.
- **Electric Power**: values close to **1,700 ktep** / year are foreseen.

- **LPG**: values close to **1,280 ktep / year** are foreseen.
- **Natural gas**: values close to **375 ktep / year** are foreseen

4. Analysis of the regulatory, institutional and financial framework related to envelopes in the DR

4.1. Regulatory Framework.

Next, we will review the main laws that in the Dominican Republic are related to efficient envelopes or their purpose, which is to ensure comfort in buildings, by reducing internal thermal loads and by irradiation, thus ensuring a reduction in the consumption of energy for air conditioning and lighting; and having a positive impact on the environment. We review the following:

- Dominican Constitution 2010. This establishes that the State will define policies to promote and encourage the preservation of the environment and that it will promote clean technologies and these principles are aligned with the objectives of the envelopes, so we can say that the constitution Dominican Republic, supports the use of efficient envelopes.
- Law 1-12 that establishes the National Development Strategy 2030, with the following points being relevant for the development of this Road Map:
    - 3.2. General objective. Reliable, efficient and environmentally sustainable energy.
    - 3.2.1 Ensure a reliable supply of electricity, at competitive prices and in conditions of financial and environmental sustainability.
    - 3.2.1.5 Develop a citizen culture to promote energy saving and efficient use of the electrical system.
    - 3.2.1.6 Promote a citizen and business culture of energy efficiency, through the induction to practices of rational use of electricity and the promotion of the use of equipment and processes that allow less use or better use of energy.
- Law No. 687. Creates a system of elaboration of technical regulations. In relation to efficient envelopes, we can say that this is one of the most important documents, because it creates the procedures so that Dominicans can elaborate technical regulations, and this is a great opportunity for the introduction of regulations that contemplate the use of efficient envelopes or as a measure of energy efficiency in buildings.
- Law No. 675. On urbanization and public decoration in the construction, Law No. 6232 of Urban Planning and Law No. 176-07 of the National District and Municipalities, 2007. When examining these laws we can verify that they do not refer to efficient envelopes, however, we understand that these laws can be updated to introduce energy efficiency measures, such as the use of efficient envelopes.
- Law No. 64-00. General Law on Environment and Natural Resources. We can see that this Law seeks to protect the environment from the actions of humans and protect their habitat, and is related to efficient envelopes, in which they seek to provide comfort with the minimum use of energy resources, therefore, also preserve the environment.
- Law No 57-07 of Incentive for Renewable Energies and Special Regimes. This law, although not focused on constructive aspects, is relevant in that it defines in Chapter III "Incentives for the production and use of renewable energy", Article 9, Paragraph II the list of equipment, part and systems to receive initial customs exemption. Among them: photovoltaic panels and solar cells, inverters and converters, fuel cells, solar heaters, etc. that can be commonly used in the efficient air conditioning of buildings. On the other hand, Article 11 provides exemptions from Income Tax for up to 10 years from the start of operations, income derived from the sale of electric power, hot water, steam, ... generated from renewable energy sources. Also, Article 11 proposes the reduction of taxes on external financing for projects developed under this Law. Articles 13 (Incentives to community projects) and 14 Certificates or bonds for reduction of polluting emissions are also relevant.

- Regulations of the Ministry of Public Works. The Ministry of Public Works, through the General Directorate of Standards and Systems, has several regulations whose application are mandatory, the most important related to efficient envelopes are the following: provisional recommendations for natural ventilation (Bulletin No. 16 / 86 of the DGRS - General Directorate of Regulations and Systems), wind analysis, minimum spaces of urban housing (M-016 of the DGRS), regulations for design and construction of buildings in masonry (R-027 of the DGRS), steel structures (R-028 of the DGRS), wood (R-029 of the DGRS) and reinforced concrete (R-033 of the DGRS), among others.Renta up to 10 years from the start of operations the income derived from sale of electric power, hot water, steam, ... generated from renewable energy sources. Also, Article 11 proposes the reduction of taxes on external financing for projects developed under this Law. Articles 13 (Incentives to community projects) and 14 Certificates or bonds for reduction of polluting emissions, are also relevant.

The Public Works Regulations, in a general sense, we can say that they are obsolete; these regulations do not refer practically in any of their aspects to energy efficiency.

The lack of updating of the Dominican regulations creates a huge opportunity to introduce energy efficiency measures at the moment in which these regulations are updated

4.2. Financial Framework.

It is noted that currently there are no financing lines for energy efficiency projects and at the date of presentation of the final version of this Study, it is highlighted that there are no laws or regulations in the Dominican Republic that incentivize construction companies and / or owners of buildings. the fact of having built evolventes of energetically efficient buildings. The absence of fiscal incentives includes both the possible construction systems and the materials used.

Next, the tax incentives related to the building construction sector are listed, but as will be detailed in the brief explanation of each one, they refer to the building as a whole and in no case to the particularities of the energy efficiency of the building.envelope.

- General Standard of DGII No. 07-2007. It governs the application process for the exemption of the assets of the Income Tax and Itbis for the construction sector. It establishes the steps so that the assets are not included during the construction process of the building in the ISR declaration.
- Law No. 195-13 of the National Congress. It governs the tax exemptions tending to foment the Tourist Development for the Poles of Little Development, New Poles in provinces and localities of great potentiality. Extends to 15 years the tax exemption period granted to companies dedicated to tourism activities in certain areas of the country, among other incentives.
- Law 189-11, for the Development of the Mortgage Market and Trust. Fundamentally, only in the case of low-cost housing, can compensate the amounts in concept of ITBIS (VAT outside of RD) that is paid during the process of construction of the house and that will benefit the buyer of the house.

4.3. List of Institutions and Associations related to energy efficiency projects in the Dominican Republic.

Tabla 2. List of Institutions and Associations related to energy efficiency projects in the Dominican Republic.

Institution	Name	Position	Telephone/cell phone	e-mail
Government public institutions				
Instituto Dominicano de Calidad (INDOCAL)	Ing. Manuel Guerrero	Director General	809-626-2205	indocal@indocal.gob.do
Comisión Nacional de Energía (CNE)	Francisco Cruz Castillo	Director Planificación y Des.	829-471-1165	Fcruz@cne.gov.do
Ministerio de Energía y Minas (MEM)	Lic. Petruska Muñoz	Viceministra de Ahorro Gubernamnetal	809-696--2788	pmunoz@mem.gob.do
Ministerio de Industria y Comercio (MIC)	Salvador Rivas	Director Energ No Convencional	(809) 373.1800	salvador.rivas@mic.gob.do
Ministerio de Ambiente y Recursos Naturales (MIMARENA)	Nathalie Flores	Enc. Mitigación al cambio climático	809-5674300 ext.7244	nathalie.flores@ambiente.gob.do
Ministerio de Industria y Comercio (MIC)	Luis Rodríguez	Enc. De Eficiencia Energética	809-722-9366	Luis.rodriguez@mic.gob.do
Ministerio de Obras Públicas y Comunicaciones (MOPC)	Ing. Freddy Veras	Encargado de Normas y Sistemas	809-284-9151	henryd28@hotmail.com
Ministerio de Hacienda	Lic. Martín Zapata	Viceministro Politicas Tributarias	809-687-5131	mzapata@hacienda.gov.do
Dirección General de Impuestos Internos (DGII)	Marvin Cardoza	Gte Estudios Economicos y Tributarios	809-689-2181	mcardoza@dgii.gov.do
Superintendencia de electricidad (SIE)	Ing. Ramón Acosta	Depto de Regulación	809-683-2500	jacosta@sie.gov.do
Ministerio de Industria y Comercio (MIC)	Nelson Toca Simo	Ministro	809) 685-5171	info@mic.gob.do
Consejo Nacional para el Cambio Climático y Mecanismo de	Moisés Álvarez	Director General		m.alvarez@cambioclimatico.gob.do

Desarrollo Limpio				
Ministerio de Educación Superior, Ciencia y Tecnología (MESCyT)	Placido Gomez Ramirez	Director	809-543-0179	morenosanjuan@gmail.com
Dirección General de Contrataciones Públicas	Lic. Eduardo Montes de Oca Peña	Analista de Políticas	809-682-7407, ext3142	emontesdeoca@dgcp.gob.do
Instituto Nacional de transito y transporte terrestre (INTRANT)	Ing. Milciades Perez Polanco	Director de transporte de carga	809-565-2811 ext 7037	fmilciades@gmail.com
Ministerio de Turismo	VM FAUSTO FERNANDEZ	VM de Cooperacion internacional	809-221-4660	-
Federación Dominicana de Municipios (FEDOMU)	Beatriz Alcántara	Enc. Gestión Ambiental	809-669-8888	balcantara@fedomu.org
Interntional cooperation agencies				
Agencia Internacional de Cooperación Japonesa **(JICA)**	Sr. Huáscar Peña	Oficial de Programa	809-381-0005	HuascarPena.DN@jica.go.jp
Agencia de Cooperación Internacional Alemana **(GIZ)**	PhD. Günter Eberz	Apoyo plan DECC	809-669-1221	guenter.eberz@giz.de
Banco Interamericano de Desarrollo (BID)	Jorge Mercado	Responsable Dptp Energía en RD	(809) 784-6436	JORGEM@iadb.org
World Bank Group	Maritza Rodríguez	Gestión Financiera	809-872-7300	marodriguez@worldbank.org
Asociación Francesa para el Desarrollo (AFD)	Sr. Valéry Vicini,	Director de Operaciones y Representante en RD y Haití de PROPARCO		https://do.ambafrance.org
Associations of energy efficiency and construction related.				
Chapter en RD de Association of Energy Engineers (AEE-RD)	Sr. Ángel Salas	Presidente	809-621-8598	asalas@energia.com.do
Sociedad de Arquitectos de RD (SARD)	Carlos Baez	Seg. Gral	809-423-1130	Cbaezb@gmail.com

Cámara Dominicana de Construcción (CADOCO)	David Sotelo			-
Habitat para la Humanidada RD	Yanelba Abréu	Programas	829-761-6646	yabreu@habitatdominican.org
Sur Futuro	Eduardo Julia	Coordinado Cambio Climático	809-472-0611	ejulia@surfuturo.org
Asociación Dominicana de Constructores y Promotores de la Vivienda (ACOPROVI)	Susy Gatón	Presidenta	809.616.0614	contacto@acoprovi.org
Sur Futuro	Ana Sofía Ovalle	Oficina Cambio Climático	809-472-0611	aovalle@surfututo.org
Constructora Bisonó SA	Guillermo Santoni	Gte. Dto. Eléctrico/Gte. General	809-722-4752	gtsantoni@gmail.com
Colegio Dominicano de Ingenieros, Arquitectos y Agrimensores (CODIA)	Ing. Alfonso Orbe	Representante	(829) 378-0038	selecor@gmail.com
Asosciación Industriales de Repúclica Dominicana (AIRD)	Carlos Rodriguez	Director de Desarrollo Institucional	(809) 472-0000	crodriguez@aird.org.do
ASSEFEER	Pedro Lopez	Presidente	809-530-0450	lopezbelego@hotmail.com
ASOFER	Suanyr Jimenez	Miembro	829-341-6320	Suanyr.jimenez@gmail.com
Universities and Houses of Study				
Universidad Tecnológica de Santo Domingo (INTEC)	Ing. Arturo Del Villar	Decano del Área de Ingenierías	829-707-8684	arturo.delvillar@intec.edu.do
Univ. Pontificia Católica Madre Maestra (PUCMM)	Dra. Virginia Flores Sasso	Directora de Arquitectura	809-3905933	vfloressasso@gmail.com
Univ, Autónoma Santo Domingo (UASD)	Ing. Amparo Cespedes	Decano Electromecánica	(809) 532-4745	info@uasd.edu.do
Universidad Apec (UNAPEC)	Frank Núñez R.	Decano Ingeniería Eléctrica	809-924-2826	Fnunez@adm.unapec.edu.do

Consulting firms related to energy efficiency issues				
IEC	Francisco Ortega	Consultor	809-350-6052	kicoortega@gmail.com
T&S Energía SRL	Mariano Chabert	Gerente	809-333-4019	mariano@tysenergia.com.do
Atrato Energy	Federico Valera	Director Ejecutivo	809-669-2821	federico@atratoenergy.com
RAVEZA	Rafael Velazco	Gerente General	809-350-7001	rvelazco@raveza.com
Consultoría Industrial SRL	Ing. Julián Despradel	Gerente	(809) 756-0399	
ESC group, SRL	Roque Ureña	Gerente. General	849-207-4999	roque.ureña@esc-group.srl

5. Analysis and evaluation of the social, economic and institutional context to promote energy efficiency in new and constructed buildings in the DR

5.1. Economic and social context

During the last two decades, the Dominican Republic has established itself as one of the continent's fastest growing economies. Between 1992 and the year 2000, the economy of the Dominican Republic grew at an average annual rate of 6.7%. During the period 2001-2013, growth remained high at an average rate of 5.1%, improving recently when economic growth rates averaged 7% in 2014-2015.

This growth has led to notable reductions, according to official sources of the Central Bank, of the number of Dominicans living in moderate poverty (less than 152 Dominican pesos per day), which has dropped considerably from 36.4% in 2014 to 30.5% in 2016. The decline in the moderate poverty index is highlighted considering that during the banking macroeconomic crisis 2003 this index averaged 50%

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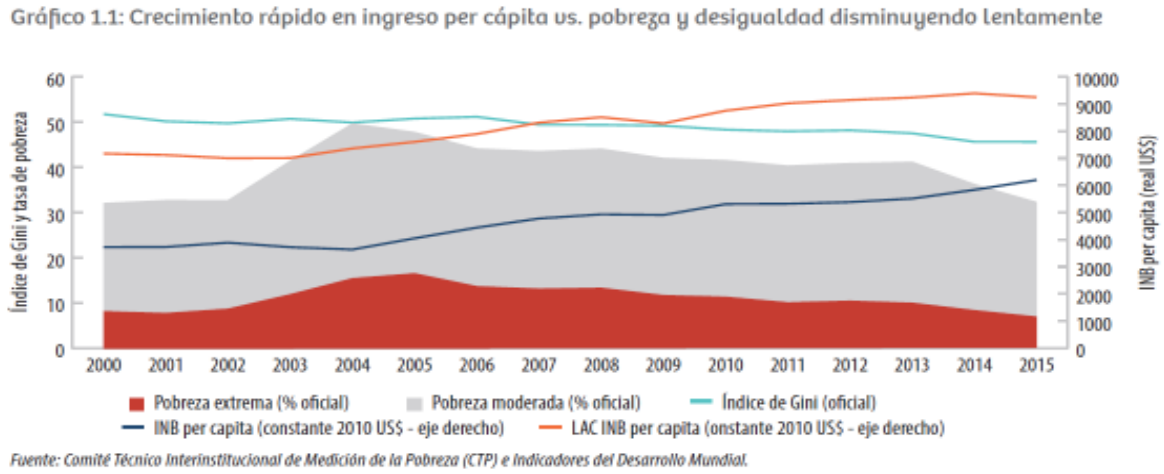
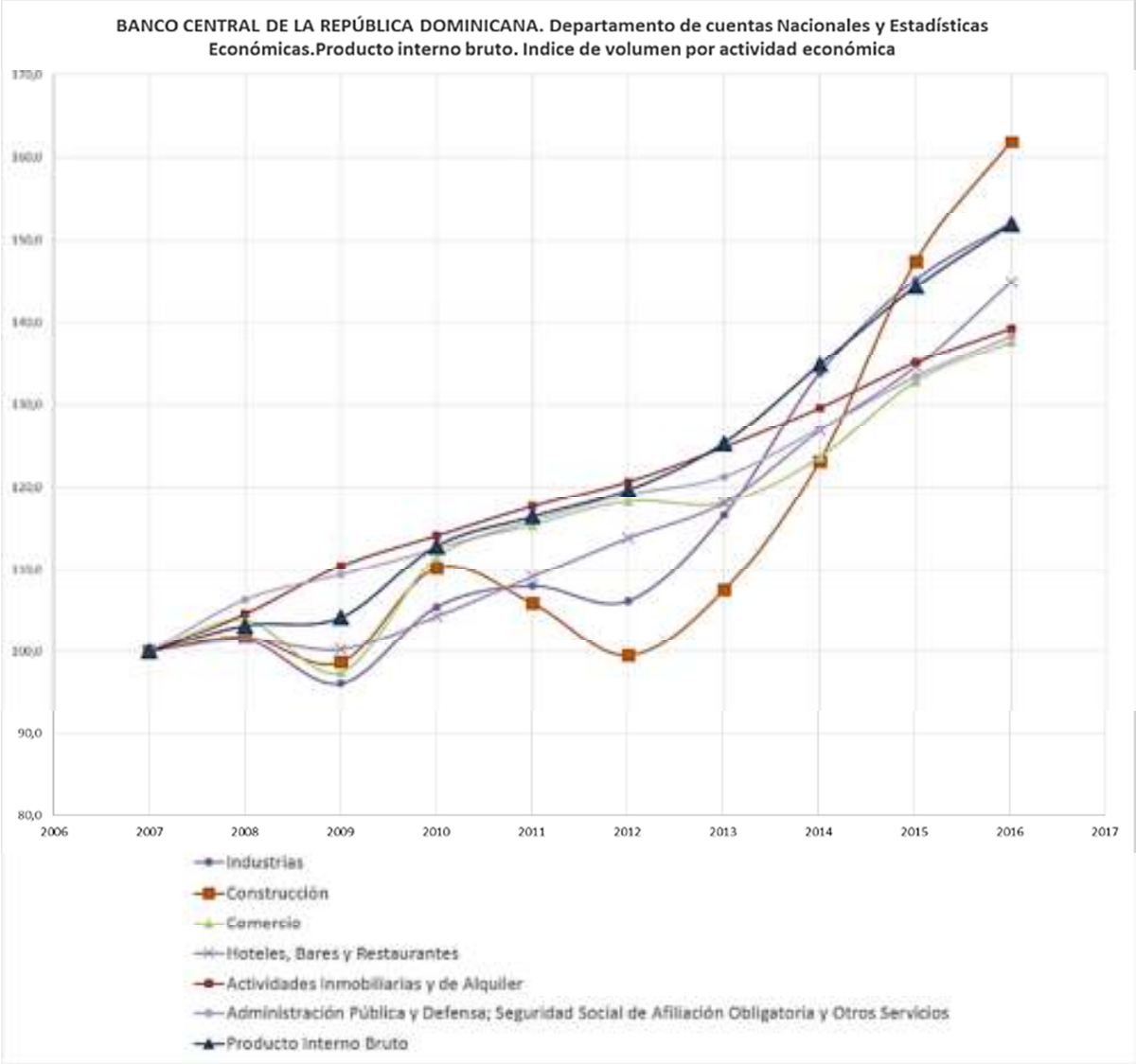
Graphic 1 . Evolution of GDP and indices of moderate and extreme poverty in the DR.



Regarding the economic context in the construction sector, the official figures published by the Department of National Accounts and Economic Statistics of the Central Bank of DR are taken. Where it is highlighted that the index of economic activity of the construction sector, since its inflection point in 2012, has the highest slope of growth compared to the other economic activities, with an average rate of increase of 15%

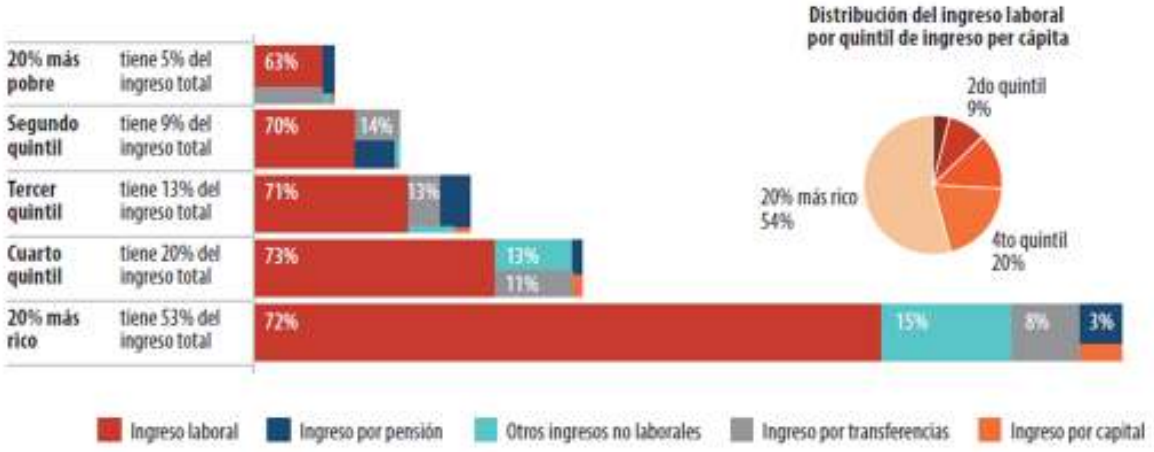
Graphic 2. Distribution of economic activity index of productive sectors in the DR.



Finally, it should be noted that in spite of the sustained macroeconomic growth, important challenges still exist to translate into inclusive improvements in society. In this regard, the recent World Bank report "Policy Notes for DR to build a better future together" highlights three priorities for the achievement of greater and more continuous prosperity for all citizens.:

- Greater productive inclusion, through a labor market with better human capital and greater participation of women, links between foreign investment and the local economy, and increased competitiveness.
- A public expenditure that is sufficient and effective in the context of a limited fiscal space.
- Increased resilience to climate change and natural disasters, and improved management of natural resources to sustain high levels of growth.

Graph 3. Distribution of income by quintile in the Dominican Republic in 2013



Fuente: Plataforma LAC Equity Lab usando datos de SEDLAC (CEDLAS y Banco Mundial).

5.2. Institutional Context

The most relevant institutional sector in the process of implementing the recommendations of the roadmap to improve the energy efficiency of building envelopes would be in particular the electric power sector. This sector has undergone major changes since the process of capitalization in the late 90s and since then it does not seem to have settled efficiently, constituting a serious drawback. Although, in general, the regulatory framework clearly defines the functions of each institution, in practice there are confusions in the roles of the institutions of the sector generating overlaps in their functions and confusion in the coordination of the different projects. Recently, since 2013, with the creation of the Ministry of Energy and Mines (MEM), there have been increasing confusions in the sector since at times this ministry has maintained a strong power struggle with the Superintendence of Electricity (SIE) and above all with the Dominican Corporation of State Electric Companies (CDEEE). Another noteworthy case is the National Energy Commission (CNE), which, although it should depend on the MEM, is practically dissociated from the Ministry.

The institutional issues of the sector have been debated since the beginning of 2015 within the framework of the so-called Electric Pact, which is managed by the Economic Social Council (CES), institutional and economic council composed of members of a representative sample of society, responsible for guide the discussions among all the sectors involved in order to agree on a proposal for a long-term solution .. Finally, a document has been reached that contains a consensus among all the parties in 95% of the points dealt with and leaving a few points open. On November 1, 2017, the CES delivered the President of the Republic, Danilo Medina, for review and observations. From now on, after the revision of the State of said pact, it would be signed, which is estimated to happen before the end of 2017. The application of the agreement established in said Pact would institutionally organize the sector and bring about the execution of numerous projects with the objective of cleaning up the electricity sector and, in the case of the study in question, promoting energy efficiency projects.

5.3. Analysis of the built park.

The quantitative information on the construction and park sector built in the Dominican Republic has been obtained, mainly, through the statistical data of the National Statistical Office (ONE) available in the web http://www.one.gob.do/.

From the population and housing census, information is collected on the characteristics of the dwellings, including the composition of their walls, ceilings and walls.

It is observed that, in the most urbanized provinces, with the largest number of dwellings, the concrete block predominates as material in the exterior walls. These provinces have a greater number of houses in

block or apartments and this constructive system is the only one of the habitual ones in the country that allows the construction in height. Therefore, the phenomenon of urban growth that has experienced the main cities of the country has driven this constructive system to the detriment of other traditional systems made from natural materials available in rural areas such as wood, palm table or yagua.

These data are in the line defined by Gedeon, 2013[1] in which he points out that the use of materials with natural elements for enclosures has been reduced in the Dominican Republic in recent decades while the use of the block or concrete has had a very significant increase since that in the census of 1981, this was the predominant material in 31.2% of the private homes; in the year 2002 its use doubled to 66.4% and in the 2010 census it reaches a percentage of 74.69%.

According to the Housing Census of 2010, the main materials used in the roofs of Dominican housing are the following:

- Concrete roofs: they are those that are configured by a structure direction of beams and joists with a subsequent concreting on the corresponding assembly. Due to its cost, this type of roof is common in tall buildings.
- Zinc: It is a light cover made of zinc sheet or corrugated galvanized steel on a supporting structure that is usually made of wood. This type of coverage began to be used in the country in the late nineteenth century and quickly spread by "the lightness of the material and its resistance to earthquakes and strong hurricane winds, in addition to being fireproof and presenting a good appearance visual "(Díaz, 2012).
- Asbestos cement: Like zinc, this material is placed on a lightweight structure. Its use was extended in many countries in the 1980s, but the subsequent evidence on its carcinogenic effect has led to it being banned in the construction of buildings.
- Caña and yagua: As in the walls, caña and yagua are traditional materials that were used to cover homes, especially in rural areas 31.2% of private homes; in the year 2002 its use doubled to 66.4% and in the 2010 census it reaches a percentage of 74.69%.

The evolution of the materials used to cover the buildings in the last two decades shows, as in the walls of the enclosure, that more traditional techniques such as cane and yagua have been abandoned for zinc and for concrete. In the case of concrete, its use is increasingly widespread, possibly due to the increase in the construction of high-rise housing in the most urbanized areas.

The floors most commonly used in Dominican housing according to the last housing census are ceramic and stone materials, such as marble and granite, cement, wood and earth. There is no data on the structural element that supports them. It is reasonable to assume that in single-family homes the flooring is placed directly on the floor or left untreated and in concrete buildings used concrete slabs

No statistical data were found on the characteristics of the commercial buildings, but from the data on the evolution of the residential buildings, it can be deduced that the urban growth and the concentration of the population in the large cities of the Dominican Republic (Santo Domingo and Santiago) has led to the appearance of large shopping centers easily accessible by private car. For the construction of these shopping centers large containers are executed, whose design does not follow the guidelines of an architecture contextualized in the climate and the conditions of the place in which they are located. The envelope of these buildings is made with large glass surfaces or opaque panels, on metal structures and lght sheet covers, relying on the interior comfort of the air conditioning systems

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1 [1] Gedeón, L (2013) Confort y comportamiento térmico en cerramientos con materiales naturales, técnica de construcción tejamanil en República Dominicana. Tesina Universidad Politécnica de Catalunya/Comfort and thermal behavior in enclosures with natural materials, tejamanil construction technique in DR. Thesis in Politechnic University of Catalonia.

5.4. List of recently approved or ongoing measures

The following are the projects carried out in the Dominican Republic related to the energy efficiency of building evolutions, grouped by the institution to which they belong:

5.4.1. Formulation of the draft Law on Energy Efficiency and Rational Use of Energy.

Project in progress since 2012. Since the National Energy Commission (CNE), a draft of the Law has been drafted that has not been approved to date. Since 2015, the Japanese International Collaboration Agency (JICA) has collaborated with whom a large part of the bill has been redrafted, and during the year 2016 participation workshops of the related sectors have been held to reach a consensus the criteria and the wording of it. Towards the end of 2017, this bill seems to be stagnating, in the sector it is estimated that the signing of the "Electric Pact" (see section 5.2 of the Institutional Framework of this report) should generate the necessary agreements to have the final agreement of the draft Law and move on its approval. The points of section 8.10 of the Electricity Pact refer to the topics of Energy Efficiency.

5.4.2. Ecochoice Consulting (Energy Management System, Building Certification).

This project is the most relevant in relation to improving the efficiency of the building envelope, it has the minimum objectives of:

- Collect elements and local climatic data and integrate them into the structure of the energy certification system of buildings.
- Create bases for the methodology of the system, considering new and functioning buildings.
- Develop an energy efficiency manual for buildings, where improvements in energy efficiency and rational use of energy are identified.
- Define training mechanisms for trainers of qualified system consultants and develop training in these trainers.
- Regulatory framework for the building energy certification system.
- Analysis and comparison of existing regulatory frameworks in 5 countries (including Europe and outside Europe).
- Proposal of methodology for the regulations of said system for the Dominican Republic.
- Regulations implementation plan.
- Support in the implementation of these regulations in 3 new buildings and 3 in operation.
- Management of the Building Certification System and regulatory framework.
- Identify the structure of the working group that will manage this system in the country.
- Create the bases for the constitution of a supervisory and supervisory entity

The result of the Ecochoice project is specified in the following reports, both reviewed but yet available to the public at the date of this document:

- Energy certification of buildings. Dated June 24, 2016
- Energy labeling system for buildings in the Dominican Republic. Dated December 2016.

5.4.3. Energy audits in public institutions.

From 2012 to 2015, the Energy Efficiency Department and U.R.E of CNE has carried out nearly thirty energy audits of public institutions. Their analysis regarding the improvement of efficiency in evolvents have dealt with the elimination of the loss of refrigeration both in enclosure and in openings, via their determination with thermographic images and cold load calculations through the use of applicable software. From these final data, technologies and systems have been proposed for optimal insulation.

The following are the audits with their main financial indicators:

Table 3. Energy Audits conducted by CNE from 2012 to2015

No.	Institución	Ahorro Energético (Energía)	Ahorro Económico		Inversión	Retorno Simple (año)
1	A	16,360 kWh	RD$	127,774.88	RD$ 1,894,894.00	14.83
2	B	1,061,152 kWh	RD$	6,908,106.00	RD$ 9,077,345.00	1.31
3	C	427,253 kWh	RD$	3,089,034.00	RD$ 3,135,263.00	1.01
4	D	591,879 kWh	RD$	3,853,132.29	RD$ 897,841.00	0.23
5	E	618,261 kWh	RD$	4,470,029.00	RD$ 24,237,097.00	5.42
6	F	591,880 kWh	RD$	2,406,511.00	RD$ 1,987,421.00	0.83
7	G	220,720 kWh	RD$	1,723,823.20	RD$ 4,216,522.00	2.45
8	H	293,647 kWh	RD$	4,761,162.30	RD$ 14,773,453.00	3.10
9	I	100,611 kWh	RD$	730,435.86	RD$ 9,131,918.00	12.50
10	J	298,372 kWh	RD$	2,330,285.32	RD$ 845,247.00	0.36
11	K	588,003 kWh	RD$	4,592,303.43	RD$ 22,128,233.86	4.82
12	L	265,441 kWh	RD$	2,073,094.21	RD$ 3,820,755.98	1.84
13	LL	32,230 kWh	RD$	371,611.90	RD$ 1,188,253.00	3.20
14	M	581,673 kWh	RD$	5,363,053.00	RD$ 6,574,344.00	1.23
15	N	70,756 kWh	RD$	1,207,448.00	RD$ 3,057,665.00	2.53
16	Ñ	241,329 kWh	RD$	1,884,779.49	RD$ 4,657,507.41	2.47
17	O	56,892 kWh	RD$	444,328.00	RD$ 727,565.00	1.64
18	P	699,019 kWh	RD$	5,459,336.91	RD$ 12,937,657.00	2.37
19	Q	275,966 kWh	RD$	2,003,512.00	RD$ 9,283,077.00	4.63
20	R	174,660 kWh	RD$	1,364,094.60	RD$ 7,566,678.00	5.00
21	S	218,369 kWh	RD$	1,705,459.00	RD$ 10,334,593.00	6.06
22	T	994,958 kWh	RD$	7,770,628.00	RD$ 53,838,137.00	6.93
23	U	170,289 kWh	RD$	1,329,958.34	RD$ 193,710.00	0.15
24	V	55,877 kWh	RD$	593,860.01	RD$ 1,217,982.00	2.10
25	W	118,355 kWh	RD$	1,271,986.02	RD$ 1,316,196.00	1.03
26	X	44,979 kWh	RD$	1,846,370.44	RD$ 2,533,034.60	1.37
	TOTAL GUBERNAMENTALE	**8,808,932 kWh**	**RD$**	**69,682,117.20**	**RD$ 211,572,389.85**	**3.04**

5.4.4. Broadcast lectures on Energy Efficiency and Rational Use of Energy.

Through its program of "Dissemination of Energy Efficiency", created with the purpose of disseminating the rational use of energy in the student population and state employees, CNE has trained thousands of people, distributed among government institutions and educational centers. The main contribution is related to the improvement of the efficiency of the evolvents, the ventilation of the environments and the avoidance of cold losses in the air-conditioned environments. Below, the quantities of people benefited by CNE EE dissemination talks are detailed:

Tabla 4. Benefited people by program “Dissemination of Energy Effciency” 2011 to 2016

YEAR	NUMBER OF PEOPLE
2011	37,912
2012	17,058
2013	296,118
2014	280,077
2015	436,816
2016	225,452

5.4.5. Bank of capacitors for aqueducts

.With the use of institutional budget, the National Energy Commission promotes energy efficiency in institutions related to the water sector.

The project consists in the installation of a capacitor banks to reduce the power factor and in this way the billing of these institutions is substantially reduced, representing important economic savings for the sector that consumes the most in the government sector.

Table 5. Capacitor banks for aqueducts. Project details

Execution date	Dic-2011 to Jul-2016	October 2016	June 2017	**TOTAL**
Benefited Institutions	8 *	12 **	3 ***	**20**
NIC’s Ammount	262	17	27	**306**
Capatitor banks installed	428	40	33	**501**
Invevestment RD$	434,126,310.92	54,510,401.90	40,059,227.37	**528,695,940.19**
Projected avoided costs accumulated (RD$)	542,298,783.08	13,554,312.82	N/A	**555,853,095.90**
Projected energy savings accumulated (kWh)	67,787,347.88	1,694,289.10	N/A	**69,481,636.99**

Source: Comisión Nacional de Energía, julio 2017

* CORAAVEGA, CORAAMOCA, CORAASAN, INAPA, CAASD, CORAAPLATA, MISPAS, BNAC.

** COAAROM, ITLA, CERTV, INAPA, FFAA, Ministerio de Agricultura, Consejo del Poder Judicial, Ministerio de Deporte (Arena de Cibao), JCE, Hospital Central de las Fuerzas Armadas, Centro de Desarrollo y Competitividad Industrial, Ministerio de Cultura (Bellas Artes).

*** CAASD, INDRHI, INAPA.

5.4.6. “Sun bulb ” project

The National Energy Commission has replicated international experiences in the field of energy efficiency, such as the combination of the replacement of incandescent bulbs with fluorescent bulbs and the inclusion of a "sun bulb". This improvement consists of a plastic bottle inserted in a piece of zinc sheet to be placed on the roof of the house and which contains water and other elements that prevent the creation of slats and the formation of bacteria and worms to reflect the effect of prism sunbeams inside the room.

Between 2014 and 2016 more than 4,000 units have been installed and more than 9,000 incandescent bulbs have been replaced. The above with an investment of more than 4 million RD$ from CNE budget..

Table 6. Sun bulb project conducted by CNE. Details

Year	Number of Communities	Number of installed sun bulbs	Number of incandescent bulbs replaced	Invesment (MM RD$)
2014	7	1,111	2,768	1.2
2015	17	2,439	5,161	2.3
2016	3	496	1,392	0.5
TOTAL	**27**	**4,046**	**9,321**	**> 4.0**

Source: Comisión Nacional de Energía, may 2016

5.4.7. Base of Energy Efficiency Indicators (BIEE)

Launched in 2011, this project has been executed by the Planning Department of the CNE and consists of collecting statistical information on national energy behavior to establish Energy Efficiency indicators. He has counted on the contribution of the German Cooperation GIZ and the technical support of the French Agency ADEME, within the framework of the IPEEC (International Partnership for Energy Efficiency Cooperation).

5.4.8. En.Lighten – Efficient lighting for developing countries

Project coordinated locally by the Energy Efficiency Department of CNE, aims to evaluate the transition to efficient lighting technologies in all sectors of the DR. Developed by 10 countries of Central America and the Caribbean, with the initiative En.Ligthen of the United Nations Program for the Environment (UNEP)

5.4.9. Project to improve Government Energy Efficiency.

From the CNE is very advanced in an ambitious project to improve the energy efficiency of all government institutions, replacing lighting equipment, air conditioning and pumping. The project estimates a financing of US $ 100 MM by the JICA institutions and the IDB.

5.4.10. Analysis of envelopes in social housing in RD .

Dr. Virginia Flores and Dr. Letzai Ruiz lead a work team of the Pontificia Universidad Catolica Madre y Maestra (PUCMM) who, since 2014, have been investigating the evolution of parameters related to human comfort in low-income housing, specifically studying the thermal effect produced by the optical and insulation properties of the enclosure materials. National Council for Climate Change and the Clean Development Mechanism.

5.4.11. Study of Energy Efficiency in hotel buildings

During 2015 and until mid-2016, it was carried out with the support of the Inter-American Development Bank (IDB). It is unknown if the report covers issues related to the envelope of the buildings because, until

mid-October, it has not been possible to have this report or a draft of it. According to what the CNCCMDL informed us, this report should be made public in the remainder of 2016, so only then will we analyze it and include its conclusions in this report.

5.5. Opportunities for energy rehabilitation in the building sector

Rehabilitation in the Dominican Republic is a strategic and essential opportunity. In addition to the statistical data, other elements show the opportunities of all kinds that accompany it. The current state of the buildings and the associated energy consumption show that there is an intersante margin of improvement in the energy efficiency of the envelope in residential, commercial and public buildings.

5.6. Potential of trasnformation of the envelope towards energy efficiency

Energy efficiency measures on buildings are designed to reduce the demand for energy by ensuring that the interior conditions of habitability are adequate. On the other hand, energy efficiency is the most appropriate strategy to reduce CO2 emissions, although to achieve this goal, some measures have been shown to be less expensive than others..

The report on the Use of Sustainable Energy Resources of the Dominican Republic (WorldWacth Institute, 2015) (http://www.worldwatch.org/system/files/DR_report_Spanish_hi-res.pdf) points out that, in the buildings sector, the change of incandescent light bulbs to LEDs in commercial and residential buildings and the replacement of inefficient air conditioning equipment are two of the least costly measures to mitigate greenhouse gas emissions. However, it also notes that the use of climatic conditions, the improvement of the behavior of the envelope and the use of efficient equipment are an opportunity to reduce the energy consumption of buildings, since cooling accounts for more than half of the energy They use residential and government buildings. To this is added that inefficient buildings pose a high economic burden for households, causing energy poverty situations in 43.8% of households in the Dominican Republic (Cruz, 2014).

The analysis of the Dominican Republic climate shows that it is possible to improve the energy efficiency of buildings through the implementation of passive measures that do not suppose an energy consumption to the inhabitants. The energy audits carried out in public buildings indicate that there is an important margin for improvement through the implementation of measures in the envelope. The study of the constructive characteristics of the residential and commercial park in relation to the climate allows to deduce concrete measures on the envelope that would suppose a reduction of the energetic consumption maintaining the conditions of comfort. The "ROAD MAP FOR A SUSTAINABLE ENERGY SYSTEM. Taking advantage of the Sustainable Energy Resources of the Dominican Republic "is committed to solutions such as thermal insulation, the installation of cold roofs or the reduction of infiltrations to reduce energy consumption in buildings with cooling systems. He also points out that "the control over the installations in the government buildings has meant an important energy saving". Homes in the Dominican Republic (Cruz, 2014).

As noted, it is possible to implement numerous measures in the envelope of buildings in the Dominican Republic, but it is necessary to identify different situations to apply the most appropriate measures in each case.

In this sense, the houses have very particular conditions of use. As indicated in the Worldwatch Institute document (2015), energy consumption in homes is determined by the level of income. Households with higher incomes spend more electricity, especially in lighting and cooling of the environment, that is, the air conditioning of these homes. Urban households consume more electricity than rural households

Therefore, it would be reasonable to propose measures based on the type of housing and the presence of refrigeration facilities, which is the highest percentage of energy consumption in homes, as opposed to passive measures that would apply to all dwellings, regardless of the facilities . In this sense, it seems essential the existence of an energy labeling of electrical appliances, which allows to raise awareness and guide consumers towards energy efficiency. A study that is being developed in parallel to this Roadmap shows that the Dominican Republic has a significant relative backwardness in the region in terms of the implementation of energy efficiency standards and labels in residential, commercial and public buildings. . The work is called "Comparative study of energy efficiency standards in buildings of the residential,

commercial and public sector in selected countries of LAC". It refers to ten countries under study and one of them is the Dominican Republic

On the other hand, there is a park in the Dominican Republic of some 3,000,000 homes that need action. Thus it would be necessary to propose measures not only for new buildings, but also for existing ones.

In the case of the commercial and governmental sector, more than 75% of the energy consumed in the commercial sector is electrical, especially for lighting, air conditioning and electrical appliances. In this case it is essential the existence of cooling and ventilation facilities to maintain the interior comfort conditions.

5.7. State of the art in technologies and construction systems.

Given that the main objective of the route of the Roadmap refers, among others, to the individual technologies related to the building envelope, then we indicate and comment on the state of the art in the Dominican Republic, work that will be fundamental to define the current situation of the country.

5.7.1. Preliminary considerations on energy efficiency and sustainable architecture

In this section a brief introduction is made about the whole process that accompanies the construction, construction, use and maintenance, since, in order to discover the complex and extensive relations between architecture and the environment at present, the process must be analyzed. complete that encompasses.

Architecture should conform to the basic objectives of "sustainable development", understanding it as "allowing us to meet our current needs without compromising the ability of future generations to meet theirs" (Brundtland Report, 1988)

To fulfill these objectives, in each context, the entire process that accompanies the building and its maintenance should be reviewed and changed since, in order to discover the impact of architecture on the environment today, the process that encompasses the building.

Habitually when talking about building, the energy adequacy of buildings is valued based solely on consumption, expenditure or energy savings in air conditioning and lighting during use, as well as the pollution that occurs in their immediate environment.

However, the relationships between the building and the environment are much more extensive and complex; if the entire activity involved in a construction is analyzed, its environmental impact will have to be assessed throughout the entire process

- Extraction of rocks, minerals and materials of all kinds;
- Eenergy costs and procedures for the construction of construction elements;
- Energy costs and procedures for the manufacture of systems and equipment of facilities;
- Transport of materials, elements and equipment;
- Commissioning, means and machinery;
- Energy costs in air conditioning and lighting and derived pollution;
- Maintenance and use, water, waste and discharges;
- Reuse and procedures for changes in use; and
- Demolition and derivations of the abandonment of the buildings.

To discover the incidence of architecture in the environment today, we must analyze the whole process that encompasses the building.

The correction of many of the environmental impacts derived from construction is linked to the review of processes in the fields of mining, industry, etc., others are inextricably linked to urban and social rethinking, but they should not be forgotten when doing.

The future must take into account the minimization of consumption in materials and energy and the use of reusable elements, taking advantage of the continuous interactions in the recycling processes that are taking place, both of construction materials and of other usable for the building and that come from waste from other industrial processes or manufacturing, and that somehow serve to alleviate the problems arising

from erosion and environmental impact caused by obtaining rocks and minerals on one side, and the decrease in those caused for spills.

The energy-efficient architecture seeks the minimum energy consumption and the minimum contamination derived from that consumption. Decrease in those caused by the spills.

It has several ways forward:

- The review of manufacturing processes and industrialization of materials and systems of facilities.
- The constructive solutions that, taking advantage of the natural energies, on the control of the environmental conditions (solar radiation, temperatures, etc.) facilitate a saving in the habitual consumption during the use of the buildings in air conditioning, heating of the sanitary water, lighting, etc.
- The choice of systems of facilities, which are necessary to complement the passive solutions, and that are efficient, adjusted, and that take into account the different environmental behavior of the different types of energy.

5.7.2. The envelope as a fundamental element of energy efficiency and comfort

The definition of the design strategies must take into account the climatic zone where the building is located, the characteristics of its thermal envelope, the building typology, the form factor, the conditions of insertion in the urban plot, orientations and use of systems liabilities, among other factors. The quantification of this reduction will depend fundamentally on the characteristics of the thermal envelope and the capacity to take advantage of the favorable climatic conditions through the design of the building.

Habitually, when talking about energy efficiency and sustainability in the building, parameters referring to consumption, energy and economic savings are used, referring to the amortization of the actions being obviated, in numerous occasions, a fundamental factor, directly related to the welfare and the quality of life of the inhabitants, as is the comfort.

A good design of the building systems that characterize the envelope of a building reduces, and even, in some climatic zones, eliminates the energy consumption and, with it, the corresponding expense to the energy consumed in air conditioning throughout the year. To this is added the fact that a good design of the envelope has an impact on long-term energy efficiency, compared to other types of strategies aimed at optimizing facilities, whose useful life is shorter and require, therefore, , a greater renovation than the elements of the envelope.

If we analyze the energy consumption throughout the life of a building, most of it derives from its use and is especially important when an intensive use of the facilities is combined with an inefficient thermal envelope from the energy point of view. . This means that any strategy adopted in the buildings aimed at reducing consumption during its use (firstly, by taking advantage of climatic conditions, limiting energy losses by the envelope and secondly, improving the energy efficiency of the facilities), will lead to a significant reduction in the use of resources associated with achieving comfort.

5.7.3. Technically approved construction systems

The objective of the roadmap is the technology transfer of energy efficient envelopes in residential, commercial and public buildings. To this end, the benefits of existing construction systems have been analyzed and, therefore, commonly used in the country, in relation to energy efficiency, so that it is possible to establish a diagnosis and define the objectives and strategies to improve the dynamics of the sector in the Dominican Republic.

Some of the most common construction systems are included in the proposed Regulation for the design and installation of ventilation and air conditioning systems.

The systems and materials of the most common enclosures in the Dominican Republic allow easily the addition of insulations on the inside faces of the enclosures, as well as on the exterior ones with the SATE type (Exterior Thermal Insulation Systems), perfectly compatible with the most existing construction.

A table has been made in which the transmittances are indicated according to the thicknesses of thermal insulation for the walls that are most commonly used in buildings in the Dominican Republic and that are currently in their market.

In the calculations, expanded polystyrene with a density of 15 kg / m3 has been taken as thermal insulation since it is a material whose use is valid both in horizontal and vertical position and in the interior and in the SATE, as well as in cases of inverted roofs, their equivalences for other isolations are found in the corresponding table.

On the other hand, the thicknesses that have been considered for the calculations are those commonly commercialized, from 2 cm to 8 cm.

These values could serve as a reference for the establishment of limitations through technical regulations based on the use of the building and the climatic zone in which it is located.

It might be advisable to introduce thermo-clay ceramic blocks in the construction materials market in the Dominican Republic, especially in the high areas such as Constanza. The termoarcilla blocks are ceramic blocks of low density that, by their characteristics, are configured walls of a layer that behave as if they had several layers, improving, therefore, its thermal and acoustic behavior. Next, a table is included with the transmittance values of different thermo-clay ceramic block walls in which EPS insulation of 15 kg / m2 of different thicknesses has been incorporated.

5.7.4. Thermal insulation, materials and proposals for the Dominican Republic

There is no regulation for the use of insulation in the enclosures of the Dominican Republic; the lack of this regulation means that they are not commonly used in many of the buildings.

No information has been obtained on the manufacture of insulating materials, so this is an open field in the future to the implementation of new industries for its manufacture if you do not want to depend only on the import of them.

The energetic behavior of the envelope of the buildings in relation to the climatic conditions is fundamental for the energetic efficiency. In that sense, the insulating capacity can be decisive in reducing energy consumption.

Although in cold climates the use of materials with great insulating capacity is essential to avoid energy losses, in warm climates, as is the case of the Dominican Republic, the inclusion of insulating materials is also important, to avoid energy loss linked to refrigerated rooms and overheating by incident solar radiation, especially in certain types of buildings.

In the case of the roof, since the greatest amount of radiation throughout the year affects the horizontal elements, it is essential to have a high insulating capacity. In this case, it is reasonable to place the insulating element on the outermost face, to prevent the solar radiation from hitting the structural elements and accumulate, producing heating in the interior space. The combination of an insulated roof with a reflective finish that reduces the heating of this element (this is called cold roof) is an adequate strategy and widely tested in hot climates energy loss linked to refrigerated rooms and. overheating by incident solar radiation , especially in certain types of buildings

In the case of the other elements (walls, floors and windows) of the buildings in the Dominican Republic, it is also interesting to define constructive solutions with insulating capacity. In this climate, it would be a matter of avoiding the warming of the interior spaces both by the external temperature and by the incidence of solar radiation on the walls. In the previous section we describe the values that would be achieved with the incorporation of insulation to the most common wall, roof and floor systems in the DR.

The position of the insulating material will depend on the operating regime and the use of the building. The position of the insulator on the outside face allows the inertia of the building to work in favor of the interior well-being since it prevents the heating of the thermal mass of the building that remains inside.

If the insulator is located on the inside, energy losses from inside to outside are avoided. In the case of warm climates, it would be to reduce the consumption in the cooling of the building.

Next, the most common insulating materials in construction are described, in decreasing order regarding sustainability in their manufacture and installation.:

- Cork.
- Cellulose.
- Mineral Wool.
- Glass wool.

- Expanded polystyrene EPS.
- Extruded polystyrene XPS without CFC.
- XPS extruded polystyrene.
- PUR Polyurethane

The market analysis of construction products in the Dominican Republic indicates the habitual use of some of these materials such as fiberglass or EPS. There would be an opportunity to implement other types of materials with better performance such as XPS, but all associated impacts should be taken into account for their assessment, from the extraction of materials for their manufacture, through transport from the point of manufacture until the start-up and the end of its useful life.

5.7.5. Solutions for sun protection and shading of the envelope

Sun protection, according to the Givoni diagram for the Dominican climate, is necessary after 20ºC, and must be combined with the other strategies that correspond according to the months of the year. The main mission of these systems is to avoid the incidence of direct solar radiation on the skin of the building, either in glazed or lighting or ventilation holes, or in any type of enclosure.

These systems of solar protection are of great utility throughout the year being essential in many occasions the adoption of some of the measures that are exposed below.

- Interception of energy occurs in the right place, that is, before its impact on the building. Thus the obstructed radiation is reflected, or absorbed, and can dissipate in the outside air.
- The efficiency of these means is indisputable, with a good design you can guarantee its benefits in warm times, allowing the capture of radiation in the places or times when they are necessary.

The parameter with which the degree of effectiveness is indicated is **the shadow factor**, which is the fraction of radiation incident in the hole not blocked by any element. The higher this value, the lower the efficiency of the system, since the amount of radiation in the interior will be greater. A shadow factor equal to 1 indicates that all radiation affects the hole. A shadow factor equal to 0 indicates that the sun protection is complete and no solar radiation hits the hole. The shadow factor acts in combination with the solar factor of the glass, which is the fraction of solar radiation incident on the glass that crosses it.

An effective system is subordinated to multiple factors: the sun, the amount of radiation, or its angle of incidence; these factors are in accordance with the orientation, latitude and geographical position in which the building is located, which implies the impossibility of standardization, having to design the solar protection specifically for the place of application.

There are some basic types, which adapting and combining them will give the ideal protection for each place; The choice of the system and its possible combinations are attributions of the designer.

The protection can occur in the holes, limiting the amount of radiation that passes through them or can also be mounted protecting the enclosures, decreasing the sun-air temperature of the same.

In the case of the Dominican Republic, the months for which there are solar protections in each of the defined climatic zones are described in the corresponding section on the relationship between climate and building. At the time of establishing regulatory requirements it is worth remembering the forecast of an increase in temperatures and heat waves throughout the year, which increases the periods throughout the day and year in which solar protections are necessary in buildings to achieve inner well-being.

A wide variety of systems for solar protection has not been found in the construction products market of the Dominican Republic, so it is a field with a wide range of improvement. There are very diverse systems and materials such as awnings, textiles with different characteristics, slats, umbrellas, mechanical solar control systems that expand the design and quality of buildings and contribute to the energy efficiency of the enclosures that could be implemented in the Dominican Republic.

5.7.6. Colors and surfaces appropiate

The decrease in the temperature of the outer surface of the enclosure has a great influence on the interior temperature distribution. This effect of decreasing temperatures can be achieved either by increasing the reflection qualities of the wall by means of light colors, reflective coatings, etc., or by means of some of the

already seen systems for the openings, which intercept the solar radiation before striking. on the wall (parasols, umbras, vegetation, etc.)

Given the climatic conditions of the Dominican Republic, especially in coastal areas, the recommendations will lead us to clear colors and surfaces with cold materials. In that sense, in the area there are some experiences of cold roofs that have obtained good results and that could lead to the local development of specific products for this type of solutions

5.7.7. Infiltrations of air and air exchange systems

The zone denominated as refrigeration by natural and mechanical ventilation, fundamental strategy for buildings in the Dominican Republic, occupies an area of the Givoni diagram included between the lines of 75% and 20% relative humidity, by the comfort zone and by a line broken, which in its lower vertical section corresponds to 31.5ºC, and which reaches up to 50% humidity, where the line breaks to the point determined by 29ºC and 75% humidity

Through the use of ventilation a renewal of indoor air is achieved by eliminating stale air, or with excess water vapor, influencing the best quality of the interior environment while improving the thermal sensation. From the normative point of view, in the Dominican Republic there is a document of provisional recommendations for natural ventilation (Bulletin No. 16/86 of the DGRS - General Directorate of Regulations and Systems) that generally explains the most common strategies for ventilation.

5.7.8. Technologies for production and control of air conditioning

Based on local experience and also considering these audits, the conclusions that are shown in the following points have been obtained.

5.7.8.1. Usual air conditioning systems

In general in the Dominican Republic, the following air conditioning systems are massively installed:

- Individual equipment for direct expansion, conventional technology (SEER up to 10) and Inverter technology (SEER 14 to 26)
- Central air conditioning equipment (chillers), whose regular configuration is with chillers condensed by water or air, an ice water circuit and a fan coil (or Air Treatment Unit, UTA) at each point to be heated. The technologies of chillers that are found are Centrifugal, Screw, Reciprocating (the oldest), Screws, Absorption and to a much lesser extent the centrifuges with magnetic bearings (for example, the Iberostar chain has them in their hotels).

Additionally, in centralized equipment (but for low power) the following two very common types can be considered:

- Package" air conditioners, which are direct expansion and directly injected with air conditioned by ducts and distributed in different exits, this is very common in offices and large houses, but in cooling powers 10.5 to 123 kWf
- There are also "multi-split" airs that, instead of reaching the air conditioning, bring to each room or office the coolant where an evaporator is placed in each room to be cooled.

It should be noted that only households with medium and high socio-economic levels have air conditioning equipment, especially in the bedrooms. The rest of the houses do not usually have air conditioning systems.

On the other hand, there is no regulation in this regard, which obliges the installation or sets the conditions for energy efficiency of the equipment. Each case is subject to the recommendations of the manufacturer, designer or installer.

5.7.8.2. Air quality, emissions and humidity controls

Nor are there regulations on air quality, or CO2 controls, or regulations that determine the temperature and humidity levels for indoor comfort. Locally, large businesses, offices and hotels are based on international

standards in this regard, for example, the 2013.ASHRAE 90.1, 2014.ASHRAE-USGBC 189.1, and Spanish chain hotels in European and Spanish regulations on the subject.

With regard to the control of indoor humidity, only its installation in ducts of large spaces heated by chillers, installed in the final part of the outlet grid, after the Air Treatment Unit (UTA) has been verified.

It does not seem in any case habitual to realize a local control of the humidity, that should not sue 60% in relative value. Therefore, air conditioning equipment will normally work at lower temperatures than would be required with a more reasonable humidity level, which affects an unnecessary increase in energy consumption.

5.7.8.3. Production of domestic hot water (DHW)

Regarding hot water (DHW) for showers, washing, cleaning, etc., it must be taken into account that in the Dominican Republic there is no natural gas network. All supplies (residential, commercial, industrial, etc.) that require gas have storage tanks in their facilities and are periodically filled by "gas" trucks.

At the residential level, the most common way to obtain the DHW is via electric thermo-tanks, which are directly connected to 120 V ac. The vast majority of residences, which have DHW systems, have it electrically powered. Also for residential level there are systems of thermo-tanks and gas heaters, but their use is minimal.

In the residential area, given the high water temperatures of the network in each month, which are shown in the following table, it is common for low-income households to have no minimum DHW systems..

Table 7. Climatological data in the residential area.

	Temperatura mínima	Temperatura Máxima	Temperatura del agua	Horas de sol	Probabilidad de Lluvia	Humedad
Enero	21°C 70°F	29°C 84°F	27°C 81°F	8	35%	83%
Febrero	21°C 70°F	30°C 86°F	26°C 79°F	8	32%	82%
Marzo	22°C 72°F	30°C 86°F	25°C 77°F	8	23%	81%
Abril	23°C 73°F	31°C 88°F	26°C 79°F	8	31%	79%
Mayo	24°C 75°F	31°C 88°F	27°C 81°F	8	36%	82%
Junio	24°C 75°F	32°C 90°F	27°C 81°F	9	38%	83%
Julio	25°C 77°F	32°C 90°F	27°C 81°F	7	39%	82%
Agosto	25°C 77°F	32°C 90°F	28°C 82°F	8	37%	83%
Septiembre	25°C 77°F	32°C 90°F	28°C 82°F	6	47%	84%
Octubre	24°C 75°F	32°C 90°F	29°C 84°F	7	43%	85%
Noviembre	23°C 73°F	31°C 88°F	28°C 82°F	8	31%	83%
Diciembre	22°C 72°F	30°C 86°F	27°C 81°F	7	42%	84%

Fuente: ONAMET (Oficina nacional de Meteorología)

In large establishments and especially hotels, the DHW is usually obtained via fire tube boilers systems powered by LPG (in the decade of 2000-2010 they changed from diesel to LPG in most of the country, although there must be some diesel); In some minority cases the DHW is obtained from the heat recovery of the chillers.

There are no regulations that require the installation of solar thermal panels for hot water heating and we do not know if they are manufactured in the Dominican Republic. However, since the last decade, but especially in recent years, we have begun to see many residential solar thermal installations, given the good radiation conditions in the Dominican Republic. In the sector of "cabins" (transient hotels) and small hotels, this type of technology for the DHW is the most widespread.

5.7.8.4. Recommendations for the improvement of air conditioning

It is recommended to adopt the following measures for indoor climate control, in addition to those already described for the building as a whole.

- Provide centralized ventilation systems, with dehumidification, to maintain the relative value in occupied areas, less than 55-60%.

- By reducing the humidity, indoor comfort temperatures of 24-.25 ° C could be maintained, which, due to their similarity with the average outdoor temperature, will cause a very sensible reduction of thermal losses.
- Dedicate the local air conditioning units, normally without humidity control, only to compensate internal loads: equipment, lighting and thermal losses.
- In those facilities with DHW demand or other heat needs, foresee the elements of ice water production, with heat recovery systems.
- n the establishments mentioned in the previous script, foresee the use of heating systems using solar thermal energy.
- As a general criterion, the use of electric power for air conditioning, to be obtained through transformation from other primary energies, leads to a higher consumption of these than if these energies were used directly once the losses due to transport and distribution were deducted. . That is why the use of such electric power should be limited. As a reference in the European Union, for each kWh of electric power, 2.5 kWh of primary energy is required, which represents a 40% yield in the process: electric generation plus losses in transport and distribution.

5.7.8.5. Description of the document in Public Survey: regulation for design and installation of ventilation and air conditioning systems in buildings

The document has been obtained and a description of its contents follows.:

- The comfort conditions are set in temperature and relative humidity of the air, very similar to those mentioned in the previous point.
- The different equipment and components that should be part of the air conditioning system
- The different air distribution systems.
- Air quality requirements.
- Psychrometric diagrams and ventilation systems with energy recovery and air extraction.
- Methods, procedures and formulations for the calculation of thermal loads.
- Thermal transmittance values (W / m2 K) are proposed according to the types of enclosures, floors, ceilings, etc.
- Symbology and description are provided, which will undoubtedly facilitate the interpretation of plans
- Specific requirements are given for health facilities.

However, some questions are missing:

- The treatment of domestic hot water (DHW) both in its preparation and in its distribution, as well as a relationship of water temperatures in the network for the different climatic zones. The necessary measures for protection against legionellosis should be considered in this section.
- The lack of coefficients of passage of the different types of energy to primary energy and also the factors that allow to quantify the polluting emissions associated with each type of energy.

For what has been described here, we believe that this improved regulation will be an excellent starting point for this roadmap in terms of internal air conditioning.

5.7.9. Windows: types and analysis of existing standards

The Population and Housing Census does not collect data on the characteristics of the holes in the houses. In the vernacular architecture of the country, the most commonly used material is wood. Due to the ventilation needs, these houses had different mechanisms that allowed the circulation of air currents inside the house as lattices and drafts at the same time that they acted as solar protections (Núñez Zorrilla, 2011).

Since there is no regulation that requires the use of windows (carpentry and glass) with defined thermal characteristics, the materials used are diverse. For the field work done, modern buildings use metal or PVC joinery as well as single and double glazing, but without any type of solar protection

n the buildings with a higher quality, double glass with an air chamber is used, available in the country's materials market. In addition to this type of glazing, there are solutions of low emissivity glass, reflective or solar controlled whose use would be appropriate in the Dominican Republic as they contribute to reduce solar gains and, therefore, improve the energy efficiency of the surrounding thermal characteristics defined, The materials used are diverse. For the field work done, modern buildings use metal or PVC joinery as well as single and double glazing, but without any type of solar protection

In addition to the characteristics of the carpentry, in the energy efficiency of the envelopes the characteristics of the glass are fundamental. The following table shows the main characteristics of different types of glass. It should be remembered that, in the directions most exposed to solar radiation in summer, and that do not need solar input in the cold months, a low-emissivity glass has a lower solar factor and therefore avoids a higher percentage of incident solar radiation.

5.7.10. Envelope control systems

At present, there are no control systems required on the energy efficiency requirements of the enclosures, nor on the whole building, nor on the maximum transmittances that would be required for each plane of the enclosure.

The control systems, which can be theoretical or practical, should be required from the information of the construction elements that the manufacturer must indicate, to the evaluation of its detail for the implementation or, finally, in the direct measurement on the work carried out.

5.7.11. Incorporation of solutions using renewable energy

There are no factories of integrated elements in the Dominican Republic for the use of renewable energies, so that solutions of these types should currently be acquired outside the country.

With the solar radiation conditions existing in the Dominican Republic, there is the possibility of implementing solutions with integrated photovoltaic systems that would be very efficient, especially in roofing. Also solar thermal energy as indicated in previous sections.

t would also be possible to incorporate systems such as solar chimneys with natural cooling, which could be applied in buildings of sufficient complexity and size.

Finally, there are refrigeration absorption machines on the market that can provide ice water from hot water at about 90 ° C, which can be obtained perfectly by means of biomass combustion boilers. The COP of these absorption machines is of the order of 0.7, but in certain cases can lead to lower generation costs of the refrigeration kWh than that obtained by electric power in a chiller, especially if this is of low power.

5.7.12. Shadow projection analysis

After the bioclimatic analysis of several representative areas of the country, it can be affirmed that the need for shading in buildings and public spaces in the Dominican Republic is necessary throughout the year, mainly in the hottest months. As exceptional cases, there are some areas located towards the interior of the island, and higher than 1,000 m altitude, where the need for shading decreases, as is the case of Constanza or to a lesser extent in Santiago (although it remains a fundamental strategy). for comfort).

The projections of climate change for the region worsen the situation regarding the current state, being the strategy of shading essential to achieve comfort inside the buildings and in the outdoor space and, in many cases, it will have to be supported with active methods.

It is recommended that the use of protections in the building, whenever possible, be located outside, to prevent solar radiation from directly affecting the envelope, especially in the glazed recesses of facades and roofs (main capturing elements in building). In this way they will be much more effective. In addition, it is essential to take into account the different orientations of the façades for a good passive design of the solar protections.

Another strategy to combat excess solar radiation is the implementation of solar-controlled glass, as mentioned in previous points, although they are less effective than external protections can be a support strategy.

5.7.13. Evaluation of facades, roofs and storage tanks of water

There are no regulations or statistics that indicate the situation or the state of the matter at present.

The possibility of making rain-collecting facades or with storage on roofs, in principle does not directly affect the transmittance of said elements, unless integrated solutions are proposed in their solutions in which the water forms part of the insulating layers of the enclosure.

The possibilities of enclosure systems that take advantage of evaporative cooling should be evaluated, although a priori they do not seem very effective in climates such as the coastal Dominican Republic, given the high relative humidity that would hamper said evaporation in a saturated atmosphere.

Otra cosa será el ahorro energético derivado de minimizar el utilizado para el suministro de agua a las edificaciones, pero para ello los sistemas de recogida, almacenamiento y uso, tienen que tener unas condiciones higiénicas aceptables.

5.8. Analysis of the technological maturity of the market

Regarding the technological maturity of the market related to energy-efficient envelopes, to date the Ministry of Public Works and Communications (MOPC), the Dominican Chamber of Construction (CADOCO) and the Society of Architects of the Dominican Republic (SARD) have been consulted . This consultation has focused from the point of view of the construction materials, of the companies providing the services and the design studies related to the envelopes.

In general, all the interviewees, from the different points of view of each institution or association coincide that at present the projects that are being addressed in the Dominican Republic in the building envelopes with the aim of improving their energy efficiency are practically null and It attributes as its main cause the lack of regulations that force new construction in this sense.

Given the absence of regulations that condition the envelopes from the point of view of their energy efficiency, the vast majority of construction companies and customers only build and demand what is known by the market. Only a few companies, in general of international chains (such as banks, hotels and large shopping centers (malls) have taken concrete measures, for which they have had to rely on foreign regulations.

Specifically, it is common in the world of electromechanical design of air conditioning equipment that the designers are based mainly on the ASHRAE (American Society of Refrigeration Air Conditioning Engineers) regulations, which in 2016 was shaping its local chapter in the DR, in the absence of local requirements as it will begin to be the Regulation for HVAC driven by the MOPC. And regarding the envelopes, the most concrete thing at present is the certification under the LEED (Leadership in Energy and Environmental Design) standard of a well-known mega shopping center inaugurated in 2013 in Santo Domingo and the current search for the same certification in the construction of the branch of this mega center in the city of La Romana

In the interview with the architect Neiquel Filpo, architecture manager of the commercial real estate company Landmark Realty Corp., member of the USGBC (United States Green Building Council) since 2008 and whose architecture staff is accredited to it, he has informed that the Ágora Mall has certified the LEED standard at the "silver" level, which positions this position as the first of its kind to achieve this certification in the country. They are currently working on the construction and certification of a new plaza in the city of La Romana.

Given that there is already a lot of experience working under standards such as ASHRAE and a growing experience with LEED, the heads of each institution interviewed agree that the market could quickly adapt to new regulations that regulate the construction of envelopes. As an example that supports this thought, what happened in R.D. in the constructions with the expanded polystyrene mezzanines, "lightweight slabs or foam panels" as they are locally called.

These panels, which are used in buildings to lighten the mezzanines and accelerate the construction process, began to be seen in sporadic constructions starting in 2005, of imported origin. Currently these panels have become a common material in most commercial and residential tower constructions and there are a large number of local manufacturers with different ranges of qualities, which has allowed the cheapening of them and their massive use in relatively little time. These panels are not required by a particular regulation, but show a rapid adaptation of the systems of design, construction, local manufacturing and commercial response of suppliers, which highlights the adaptability of the sector to technological changes.

One more example of the adaptability of the sector, the architect Filpo himself highlights, when he reveals that, at the origins of the LEED certification project, when they contacted the contractors they realized that most of them had no experience in buildings. environmentally sustainable, so the project became a learning and a new and enriching experience where the entire chain responded favorably.

Broadly speaking, it can be inferred that the construction sector in the Dominican Republic could adapt to regulations that require new conditions for building envelopes, enabling professionals to adapt their designs, encouraging local companies to improve their materials. and construction systems and construction companies in the proper management and installation of the same.

Finally, the results of interviews with 14 institutions related to the energy efficiency sector in the DR are highlighted, in this respect, among other issues, of the estimates of market adaptability to possible new conditions. This round of interviews was conducted within the framework of the Proposal of the Institutional Framework of Energy Efficiency carried out by the Ministry of Energy Mines (MEM) with the collaboration of Olade executed from July to November 2017. The 14 institutions interviewed were the MEM , CNE, MOPC, DGII, Treasury, MINARENA, SIE, INDOCAL, CNCCMDL, UASD, PCMM, ITEC, AIRD and AEE-RD. Regarding the perception of the interviewees about the technological maturity of the market, the tenth question asked textually "How do you think the market of suppliers and installers of materials and equipment would react to the demands of the new regulations, regarding the improvement of the energy efficiency? To which, in general, all interviewees agreed that the market would adapt to the new demands of the sector. For this, it would be essential that the regulations are clear, mandatory and enforceable for all actors. While there could be initial resistance, in the long run, new opportunities would be created for these suppliers, which would be adapted.

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6. Roadmap

6.1. General considerations

he final step is the definition of the strategic plan for the development of the Roadmap. It establishes goals and milestones, describes gaps and barriers, the elements of action to overcome and impulse and finally the priorities and deadlines required for implementation.

6.2. Goals

The proposed period includes from this year 2018 to 2030 and objectives are set according to the attached table:

Tabls 8 Roadmap goals

Sector	Yearly goals				Goals to 2030				
	Energy savings (ktep/año)	Energy savings (%/año)	CO2e Reduction (kt/año)	Estimated Investment (MUSD/año)	Energy savings (ktep_2030)	CO2e Reduction (kt_2030)	Estimated investment (MUSD_2030)	PRSI (years)	Comments
Residential	6.86	5 %	33	82.3	625	3,009	1,070	7	Less favourable investment ratio (12.000 USD/tep)
Commercial and public services	2	17 %	9.62	24	182	876.3	312	7	Less favourable investment ratio (12.000 USD/tep)
Others	31.54	78 %	151.85	189.23	2,871	13,823	2,460	7	Less favourable investment ratio (12.000 USD/tep)
Total	40.4	100 %	194.5	295.5	3,678	17,708	3,842	7	Less favourable investment ratio (12.000 USD/tep)

All of them have been quantified in annual and global values in the period of validity of this Road Map. For each objective, the equivalent in investment required and its quantification in reduction of CO2 emissions are formulated. All this is however conditioned to an evolution similar to the one presented here, in the economic and population growth.

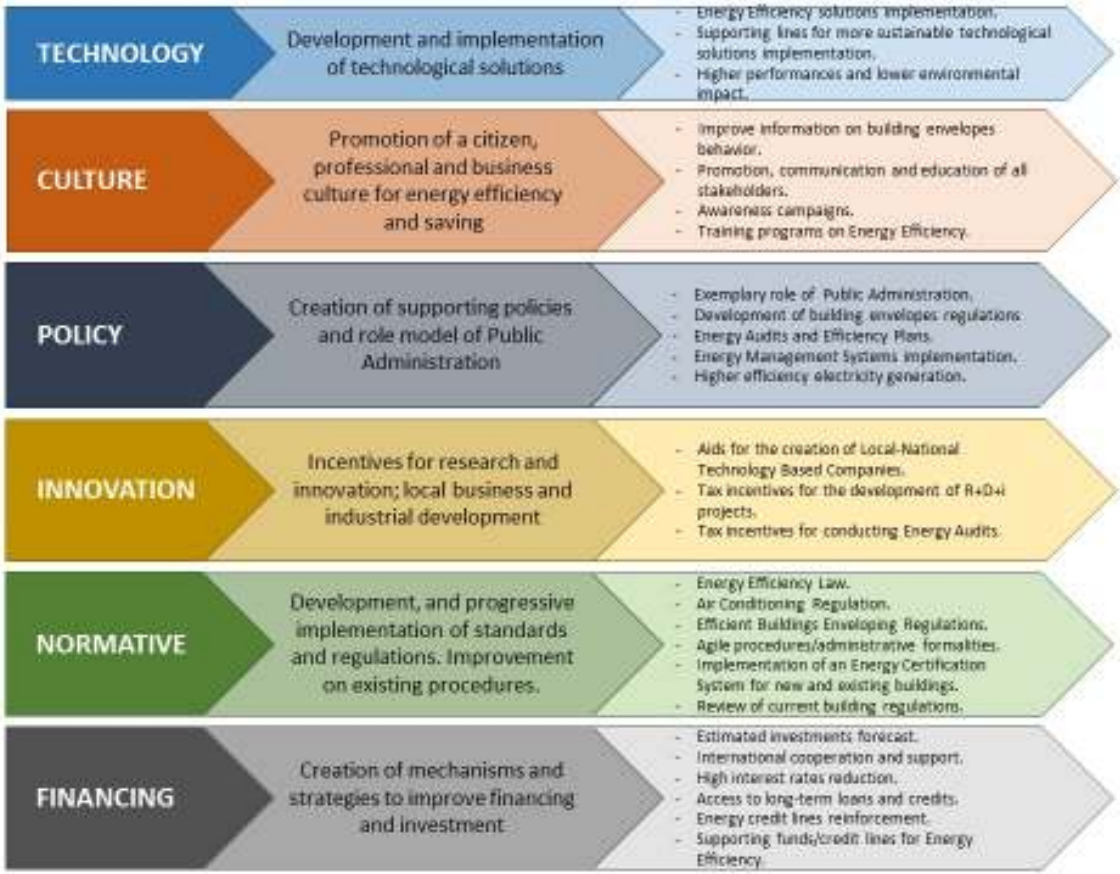
6.3. Elements of action

Action elements are proposed in the following areas:

- Technology.
- Culture
- Politics
- Innovation
- Normative.
- Financing

The following is broken down in the attached table

Table 9 Elements of action



6.4. Deadlines and responsible

6.4.1. Energy Efficiency Law.

Promulgated before the end of 2017.

6.4.2. Regulation of energy efficient building envelopes

Promulgated before the end of 2018: Ministry of public works.MOPC

6.4.3. Regulation of air conditioning of buildings

Promulgated before the end of 2018: Ministry of public works.MOPC. The existing draft of the actual regulation for air conditioning shall be used

6.4.4. Inventory of public buildings

Made before the end of 2018

6.4.5. Direct measures on the building (Included in the Regulation)

Table 10 Direct measures on the building

Characteristics of the building					Performance on buildings				
					Recommendations	Technical regulations			
USE	GEOGRAPHICAL SCOPE	TYPOLOGY	TYPE OF PERFORMANCE	CONDITIONING SYSTEMS	Passive conditioning strategies	Limitation of energy demand	Limitation of energy consumption	Incorporation of renewable energies	Energy performance certificate
RESIDENTIAL	Urban (76%)	Housing block	New	WITH conditioning systems					
				WITHOUT conditioning systems					
			Renovation	WITH conditioning systems					
				WITHOUT conditioning systems					
		Single family housing	New	WITH conditioning systems					
				WITHOUT conditioning systems					
			Renovation	WITH conditioning systems					
				WITHOUT conditioning systems					
	Rural (24%)	Housing block	New	WITH conditioning systems					
				WITHOUT conditioning systems					
			Renovation	WITH conditioning systems					
				WITHOUT conditioning systems					
		Single family housing	New	WITH conditioning systems					
				WITHOUT conditioning systems					
			Renovation	WITH conditioning systems					
				WITHOUT conditioning systems					
COMMERCIAL	Urban	Shopping Centre	New	WITH conditioning systems					
			Renovation	WITHOUT conditioning systems					
		Traditional shopping	New	WITH conditioning systems					
				WITHOUT conditioning systems					
			Renovation	WITH conditioning systems					
				WITHOUT conditioning systems					
PUBLIC	Urbano	Block	New	WITH conditioning systems					
			Renovation	WITHOUT conditioning systems					
				WITH conditioning systems					

Short-term measures (Until 2020)
Medium-term measures (Until 2025)
Long-term measures (Until 2030)

6.5. Gaps and barriers for the implementation of the Roadmap

Regarding the most notable barriers, it is worth highlighting the lack of legislation, regulations and regulations and the slowness of the review and comment processes required until their approval; institutional weakness; customs fees; insufficient training of human resources in architectural and construction companies, as well as, in the academic field; the deficient system of information and awareness, the lack of culture in energy efficiency and the lack of quality control plans and revision of buildings and the lack of fiscal incentives, financing or subsidies for this activity.

6.5.1. ¿ How to overcome these barriers?

- First, by creating a Regulatory Framework: first a General Law and then developing new specific regulations that include parameters for measuring energy efficiency, reporting systems and quality verification in this field in existing and new buildings and their follow-up and fulfillment.
- Establishing both reimbursable and non-reimbursable public financing lines that make private investment attractive in this sector.
- Channeling funds from external banks through local financial institutions for the development of these projects, also in a reimbursable and non-reimbursable form.
- Incorporating energy efficiency in all educational levels of the national system and encouraging the development of research and development in this field.
- Training architects, engineers and construction and air conditioning professionals.
- Developing public awareness campaigns in social networks, radio, television and press.
- •Reducing or eliminating tariffs and tax rates for construction materials and efficient air conditioning equipment aimed at energy efficiency. The elements susceptible to this reduction must be regulated.

6.6. Mechanisms for monitoring and supervising

6.6.1. ¿ What monitoring and control mechanisms will be applied?

- **Progress reviews are proposed in 2020, 2025 and 2030** of:
    - The energy efficiency objectives set out in the previous section
    - The investments made, global and specific
    - he primary energy conversion factors and CO2 emissions, according to the types of energy. The last values appear in the Excel table available on the web: https://cambioclimatico.gob.do/emisiones-co2,
- Obligatory nature of EDES and trading companies and distributors (those companies that buy and sell these energy products) of fuels, natural gas and petroleum products to inform CNE of the energy supplied monthly and annually.
- Preparation of annual comparative energy generation report, energy consumption distributed by energy sources and sectors. It should also include the evolution of energy intensity in these sectors and the basic macroeconomic parameters: GDP, population, USD / RD $ exchange rate, in addition to the increase in commercial, residential and public construction, all separately
- Annual review of GHG emissions and emission factors for each type of energy.
- Constitution of a Commission to supervise the execution of the Plan. This commission will meet at least five years and previously each of its members will have received and analyzed the different annual reports. In said meeting actions for the following 5 years will be determined. This Commission would be composed of representatives of:
    - CNE (General Coordinator)
    - Ministry of Finance
    - Ministry of Public Works (MOPC)

    - CODIA
    - AIRDY d
- Should have external advisors to assist in the preparation of regulations
- Compilation of Financial Institutions of the number of reimbursable and non-reimbursable resources devoted to support energy efficiency projects.
- Establishment of indicators: They are related in the tables by different types. Also, a column is included to designate the Institution Responsible for obtaining or calculating the value and another column in which it would be filled in, that is, if the information is new or existing.

7. Conclusions

The work carried out aims to give the guidelines to achieve an evolution of the new construction and the rehabilitation of residential, commercial and public buildings in the DR towards methodologies, materials and systems of greater energy efficiency. It should be noted that no significant limitations have been detected due to the unavailability of these materials or equipment, nor due to technical qualification in the construction and installation aspects, nor due to the technological maturity of the market. Yes in relation to

- Legislation, Regulations and Regulations.
- Awareness of the value of energy efficiency.
- Technical training in energy efficiency.
- Adaptation of the buildings to the climatic conditions of the country
- Definition of internal comfort conditions and energy-efficient design of indoor hot water, air conditioning, ventilation and lighting installations.
- Sources of financing for energy efficiency projects.
- Tax exemptions for this type of projects.

Focusing on the first script, there is currently no law or basic regulation that allows this evolution, so the first step is to develop them and with this purpose recommendations are given in this document.

Other steps that must be activated simultaneously are both awareness and training in energy efficiency at all levels, including the application of good practices for energy use.

With regard to financing channels, lines of public support (recoverable loans and subsidies) included in the State Budgets should be enabled, while at the same time favoring private ones.

This financing must be completed with tax incentives for the purchase and installation of high energy efficiency equipment: household appliances, computer equipment, air conditioning and ventilation equipment and systems, solar thermal panels, energy control and monitoring systems for buildings, regulatory elements for both lighting, as for air conditioning, etc.

8. Recommendations for a successful implementation of the Roadmap

For the successful implementation of the roadmap and as already described in section 6.6, it is considered necessary to create a Supervisory Commission, but with clear leadership that acts as an inspirer and driver. This leadership role seems more appropriate to be reserved to the CNE, but undoubtedly backed by the Ministry of Energy and Mines. The first objective of this Commission is the preparation and advice until its enactment, Regulations and subsequently monitoring the implementation of sectoral energy efficiency plans, in particular the one discussed in this document for the building sector, but also other relative to transport, industry, more efficient generation, application of renewable energies, etc.

The Energy Efficiency Law, still not promulgated, must undoubtedly include energy saving objectives. The guidelines presented here can serve. Setting these objectives and ensuring their compliance will also greatly contribute to achieving the expected goal of reducing greenhouse gas emissions until 2030.

The Energy Efficiency Law should establish the obligation to conduct energy audits at least in public buildings, for which it would be necessary to carry out a prior inventory of them. These audits should incorporate energy saving measures with real savings guaranteed and that should be measured and corroborated according to international protocols (for example, IPMVP). This corresponds to an exemplary role of the Public Administration.

In the private sphere, the performance of energy audits should be favored, through some subsidy percentage. These audits should have the same scope as that described in the previous point

To raise awareness of energy efficiency, a national campaign should be carried out, involving both the Central and Local Administrations, the educational centers (primary, middle and higher), the Official Colleges, Shopping Centers, Industry, Construction Companies, Rehabilitation and air conditioning, building promoters, construction professionals, etc. As a first result, one would expect better use of energy and also of water.

On the other hand**, Table 10 provides recommendations and deadlines for the application of Direct Measures on construction** in the short, medium and long term. These would be ordered from highest to lowest priority

- Application of bioclimatic strategies. Adapted to each of the climatic zones defined in this report.
- Limitation of energy demand, through the improvement of building insulation and its interrelation with the environment.
- Limitation of energy consumption. Equipment and more efficient systems to meet the demand.
- Incorporation of renewable energies: solar thermal and photovoltaic, biomass, etc.
- Energetic certification. As of the date of this report, the proposal made in this regard by the Ecochoice Consultancy is available.

It is also essential to create financing or subsidy lines. As already indicated, we are talking about investments that are at least recoverable. There is a methodology in the European Union through which a program of collaboration between local companies in the beneficiary country and others at European level is applied to draw up proposals for specific projects and define their subsequent financing. These programs require the participation of external consultants hired by the European Union. Currently, programs of this type are already underway in Mexico and Brazil and could be replicated in the DR. Likewise, recourse should be had to Institutions that channel funds from Development Banks and, of course, to the qualification of items in the State Budgets.

Undoubtedly, the rehabilitation of buildings would contribute enormously to the achievement of energy saving objectives, but it requires heavy investments. However, the high energy costs in the DR favor the reduction of investment recovery times, so a decided state support for this activity, enabling specific funds, would be very beneficial. And, of course, the qualification of items in the State Budgets.

Regarding tax exemptions, the role of the Ministry of Finance is essential in order to establish new ones and quickly apply existing ones for energy efficiency projects. depending on the MEM, in practice it is practically dissociated from said ministry.