

JUST ENERGY TRANSITION

Scenarios Dominican Republic





Just Energy Transition / Scenarios Dominican Republic

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Just Energy Transition

Scenarios Dominican Republic

CONTENTS



List of abbreviations	19
Foreword	21-27
1. General objective	22
2. Specific objectives	23
3. Organization of the Just Energy Transition series	24
4. Organizational aspects	25
5. Scenarios: Dominican Republic	26

Chapter 1

Diagnosis and base line

28-88

1. General characterization	29	Socio-economic aspects	29
		Socio-economic and energy indicators	34
		Energy intensity of the economy	34
		Consumption per capita	35
		Local prices	36
		Energy aspects	37
		Reserves and total fuel supply (production, imports and exports)	37
		Final consumption by source and sector	40
		Climate profile	44
		Climate change scenarios and risks to the energy sector	44
		GHG contribution, base year	45
		National commitments (NDC and Paris Agreement)	48
2. Institutional, regulatory and public policy aspects	50	Sectoral government	50
		Main regulatory concepts	51
		Public policy aspects	52
		Energy efficiency policies	52
		Pricing, subsidy and incentive policies	53

3. Energy balance 2019 and 2022	56		
4. Evolution of energy demand by sector and source	59	Residential sector	60
		Commercial, services, and public sector	62
		Industrial sector	66
		Transportation sector	69
		Demand by source	69
		Vehicle fleet and consumption by type	71
		Agriculture, fishing, mining, and construction sector	74
5. International energy trade	76		
6. Power sector	78	Power demand	78
		Installed capacity	80
		Power generation	82
7. Existing power grids and gas pipelines	85		
8. Conclusions	86		

Chapter 2
Energy projection
methodology

89-105

1. Base year and
planning horizon 90

2. Projection
modeling 91

General description	91
Demand by sector	93
Residential sector	93
Commercial, services, and public sector	94
Industrial sector	94
Transportation sector	95
Air, maritime/river, and railway sector	97
Agriculture, fishing, mining and construction sector	98
Power sector	98

3. Scenarios and
global framework 101

Definition of the scenarios	101
Projections of the socio-economic variables	103
GDP per capita and GDP	103
Population	103

4. Main assumptions
in the energy sector 104

Chapter 3
Transition
scenarios

106-166

1. Global results 107

Emissions by sector	107
Energy demand by sector	110
Energy demand by source	113
Environmental and energy intensity	116

2. Results and
assumptions
by sector 118

Residential sector	118
Commercial, services, and public sector	122
Industrial sector	125
Projections by subsector	125
Results	130
Transportation sector	134
Road passenger transportation	134
Road freight transportation	136
Air, maritime and railway transportation	138
Results	138
Agriculture, fishing, mining, and construction sector	145
Power sector	148

3. Energy transition
financing 154

Total investment	155
Power sector	157
End uses	161

4. Main transition indicators 166

Chapter 4
Roadmap of a just energy transition
Recommendations

167-182

1. The environment for the transition	168	Projections	168
		Implications for public policies	171
		Stage I - Preparation	171
		Stage II - Implementation	174
		Stage III - Development	177

2. Roadmap 179

Works cited 183

TABLES AND GRAPHICS

Table 1.	Socio-economic indicators	29
Table 2.	Prices of the main energy products in the Dominican Republic, cut-off year 2019	36
Table 3.	Fuel reserves, hydroelectric potential, and infrastructure, 2019, Dominican Republic	39
Table 4.	Wind and solar resources, Dominican Republic	39
Table 5.	Mapping of institutions in the energy sector	50
Table 6.	Main regulatory concepts by sector and segment	51
Table 7.	Energy efficiency in the Dominican Republic	52
Table 8.	Total number of road vehicles and by type, 2019, Dominican Republic	71
Table 9.	Consumption by transportation type and by fuel, 10 ³ TJ and %, 2019, Dominican Republic	72
Table 10.	Socio-economic indicators and CAGR 2019-2060 (%)	103

Table 11.

Final and own consumption by scenario, thousands of TJ and CAGR (%) 113

Table 12.

Indicators by time horizon and scenario 166

Table 13.

Roadmap to be promoted by CAF 180

Graphic 1.

GDP and annual growth rate, MUSD constant of 2010 and % 30

Graphic 2.

GDP by sector, 2021, % 31

Graphic 3.

GDP per capita, constant USD of 2010 per capita 32

Graphic 4.

Impact of total and extreme poverty by year, % 33

Graphic 5.

Total final consumption versus final energy intensity, 10³ TJ and GJ/MUSD constant of 2010 34

Graphic 6.

Total final consumption versus final consumption per capita, 10³ TJ and GJ per capita 35

Graphic 7.

Potential solar resource (kWh/kWp) and mean wind speed at 100 m (m/s) 38

Graphic 8.

Production, imports and exports by main sources, 2019, 10³ TJ 40

Graphic 9.

Final consumption by sector, 10³ TJ and % 41

Graphic 10.

Final consumption by source, 10³ TJ and % 42

Graphic 11.

Net total emissions, 2020, MtCO₂e 46

Graphic 12.

Emissions from the energy sector estimated by sector and by source, MtCO₂e, 2019 47

Graphic 13.

Energy balance, 2019 57

Graphic 14.

Energy balance, 2022 58

Graphic 15.

Residential sector: evolution of final consumption by source (10³ TJ) and final residential consumption per capita (GJ per capita) 60

Graphic 16.

Residential sector: energy consumption by end use, 2018, % 62

Graphic 17.

Commercial and public sector: evolution of final consumption by source (10³ TJ and %) 63

Graphic 18.

Commercial and public sector: energy consumption for end use, 2018 64

Graphic 19.

Industrial sector: evolution of final consumption by source (10³ TJ) and industrial energy intensity (GJ/thousands of constant 2010 USD) 67

Graphic 20.

Industrial sector: energy consumption by end use, 2018 68

Graphic 21.

Transportation sector: evolution of final consumption by source and year 2019, 10³ TJ 70

Graphic 22.

Vehicle fleet versus GDP per capita, 2010-2019 72

Graphic 23.

Transportation sector: final consumption by type and by fuel, 10³ TJ 73

Graphic 24.

Other sectors: evolution of final consumption by source, 10³ TJ 74

Graphic 25.

Dominican Republic, energy imports 77

Graphic 26.

Final electricity consumption by sector, 2000-2019, and year 2019, GWh 78

Graphic 27.

Installed capacity, 2000-2020, MW 80

Graphic 28.

Installed capacity by source, 2019-2022, % 81

Graphic 29.

Power generation by source, 2006-2020, GWh and 10³ TJ 83

Graphic 30.

Power generation by source, 2006-2020, %, and CO₂ emission index in the power sector, g/kwh 84

Graphic 31.

National Interconnected System 2018, Dominican Republic 85

Graphic 32.

Sectors, activity levels, and explanatory variables 92

Graphic 33.

Direct emissions (final consumption and generation) by sector, MtCO₂e 108

Graphic 34.

Final and own consumption, by sector and scenario (thousands of TJ) 111

Graphic 35.

Final consumption and own consumption, by source and scenario (thousands of TJ) 114

Graphic 36.

Unitary energy intensity (2019=1), thousands of TJ/MUSD PPP 2017 (left) and thousands of TJ per capita (right) 116

Graphic 37.

Unitary environmental intensity (2019=1), tCO₂e/thousands of USD at PPP 2017 (left) and tCO₂e per capita (right) 117

Graphic 38.

Residential sector: results by fuel and by scenario (10³ TJ) 119

Graphic 39.

Residential sector: direct emissions by scenario (MtCO₂e) 121

Graphic 40.

CSP sector: results by fuel and by scenario (10³ TJ) 122

Graphic 41.

CSP sector: direct emissions by scenario (MtCO₂e) 124

Graphic 42.

Industrial sector: energy consumption by industrial subsector, 2019 (%) 126

Graphic 43.

Industrial sector: Distribution by end use for the main industry subsectors (%) 127

Graphic 44.

Industrial sector: evolution by scenario for the main uses in the most relevant industrial subsectors (%) 129

Graphic 45.

Industrial sector: final consumption by fuel and by scenario (10³ TJ) 130

Graphic 46.

Industrial sector: direct emissions by scenario (MtCO₂e) 131

Graphic 47.

Number of private vehicles per 1,000 inhabitants and share of motorcycles (%) 135

Graphic 48.

Total number of freight vehicles 137

Graphic 49.

Transportation: final consumption by type/fuel and by scenario (10³ TJ) 139

Graphic 50.

Final consumption of road passenger and freight transportation, by fuel and by scenario, 10³ TJ 142

Graphic 51.

Transportation sector: direct emissions by scenario, MtCO₂e 144

Graphic 52.

Results of the agriculture, fishing, mining, and construction sector, by scenario, 10³ TJ 145

Graphic 53.

Agriculture, fishing, mining, and construction sector: direct emissions by scenario, MtCO₂e 147

Graphic 54.

Projection of installed capacity by source and by scenario (GW) 149

Graphic 55.

Projection of power generation by source and by scenario (TWh) 152

Graphic 56.

Estimated total annual investment, MUSD 155

Graphic 57.

Estimated total annual investment in GDP (%) 156

Graphic 58.

Power sector: cumulative investment in the transition period (billions of USD) 158

Graphic 59.

Power sector: annual investment by type (millions of USD-year) 159

Graphic 60.

Power sector: annual investment by period (millions of USD-year) 160

Graphic 61.

End uses: cumulative investment in the transition period (billions of USD) 162

Graphic 62.

Road transportation: annual investment by period (millions of USD-year) 163

Graphic 63.

End uses: annual investment by type (millions of USD-year) 164

Graphic 64.

Roadmap: stages 168

List of abbreviations

AFOLU	Agriculture, forestry, and other land use
AMI	advanced metering infrastructure
BAU	Business as usual
CAGR	compound annual growth rate
CAPEX	capital expenditure
CCUS	carbon capture, use, and storage
CDEEE	<i>Corporación Dominicana de Empresas Eléctricas Estatales</i>
CEPAL	<i>Comisión Económica para América Latina y el Caribe</i> (Economic Commission for Latin America and the Caribbean)
CNE	<i>Comisión Nacional de Energía</i> (National Energy Commission)
CNG	compressed natural gas
EE	energy efficiency
EV	electric vehicles
GCRI	global climate risk index
GDP	gross domestic product
GDPpc	gross domestic product per capita
GHG	greenhouse gases
HDI	human development index
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
JET	just energy transition
LEAP	SEI’s low emissions analysis platform
LNG	liquefied natural gas

LPG	liquefied petroleum gas
MEM	Ministry of Energy and Mines
MICM	Ministry of Industry, Trade and Small Businesses
MUSD	Millions of dollars
NCRE	non-conventional renewable energy
NDC	nationally determined contributions
NZ	net zero
OC	<i>Organismo Coordinador del Sistema Eléctrico</i> (Power System Coordinator)
OLADE	Latin American Energy Organization
PPP	purchasing power parity
REFIDOMSA	<i>Refinería Dominicana de Petróleo</i>
SEI	Stockholm Environment Institute
SIE	<i>Superintendencia de Electricidad</i> (Superintendency of Electricity)
sieLAC	Energy Information System for Latin America and the Caribbean
SHW	sanitary hot water
SIC	International Standard Industrial Classification
TJ	terajoules
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change



1. General objective

The general objective of the project was to develop a methodological approach to define the concept of just energy transition (JET) in a national context, with potential application in the CAF – development bank for Latin America and the Caribbean – member countries and to evaluate the proposed approach in Brazil, Colombia, Mexico, Peru, and the Dominican Republic.



2. Specific objectives

The specific objectives of this report are the following:

1. to define a methodological approach to address the just energy transition in the region in a comprehensive way;
2. to diagnose the national energy systems and – in particular, the power systems – (target countries) in the context of the energy transition process;
3. to define national scenarios for the low-carbon development model of the energy transition in the target countries, including those elements to be electrified in energy sectors that are currently not being served by the power sector, within the prospective requirements;
4. to model the viable energy transition alternatives in the previously defined context.

3. Organization of the Just Energy Transition series

The study to meet the objectives indicated above was conducted between October 2022 and October 2023. The series was organized into seven reports.

1. Just Energy Transition / Conceptual framework for the region. Analysis in the national context
2. Just Energy Transition / Projection assumptions
3. Just Energy Transition / Scenarios for Brazil
4. Just Energy Transition / Scenarios for Colombia
5. Just Energy Transition / Scenarios for Mexico
6. Just Energy Transition / Scenarios for Peru
7. Just Energy Transition / Scenarios for the Dominican Republic

The reports were organized following the alphabetical order of their names.

4. Organizational aspects

This report has been financed by CAF and is published to communicate the results and conclusions obtained to the community interested in Latin American development. Therefore, the document has not been prepared following the procedures of an official document. Some of the sources cited in this report could be informal documents that are difficult to obtain.

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Edgar Salinas, Juan Ríos, and Walter Cont from CAF formed a working team that established the terms of reference and supervised the development of the abovementioned reports by GME consultants.

The GME team – in alphabetical order – was composed of Agustín Ghazarian, Coline Champetier, Darío Quiroga, Francisco Baqueriza, Nicolás Barros, Laura Souilla, Ramón Sanz, and Roberto Gomelsky.

5. Scenarios: Dominican Republic

This report contains the analysis of the energy transition for the Dominican Republic and is organized into four chapters.

- **Diagnose and base line.** This chapter establishes the diagnosis of the base line in terms of sources and energy uses, characteristics of the power sector, environmental aspects (greenhouse gas (GHG) inventories, commitments), and institutional, regulatory, and public policy aspects, among others. It allows us to present the starting point of the energy projections and to identify the main characteristics that may condition the just energy transition strategy.
- **Energy projection methodology.** This chapter summarizes the low-emissions analysis platform (LEAP) model and its use to model emissions in the energy sector¹. Energy demand projection methodologies are presented by sector, subsector, use, and source, as well as the power generation modeling. It also describes the three projection scenarios contemplated and the main assumptions considered.
- **Transition scenarios.** This chapter presents the projections in terms of emissions and energy demand for the three scenarios previously defined (Business as Usual (BAU), Net Zero 2050 (NZ 2050), and Net Zero 2060 (NZ 2060)). It details the results by sector and the main explanatory assumptions, and presents the needs in terms of energy transition

¹ More specifically, the LEAP (Low Emissions Analysis Platform) model was used to model the emissions related to burning fuel.

investment related to the power sector and its end uses. It concludes with the starting point and the end point of the main transition indicators by scenario.

- **Proposal for the roadmap for a just energy transition.** The roadmap describes the public policies to be developed and the segments that require concessional finance or support to accompany the just energy transition scenarios previously presented.





1. General characterization



Socio-economic aspects

The Dominican Republic has a population of over 10 million people and a population density of 226 inhabitants per km²; 83 % of the population lives in urban areas.

Table 1

► Socio-economic indicators

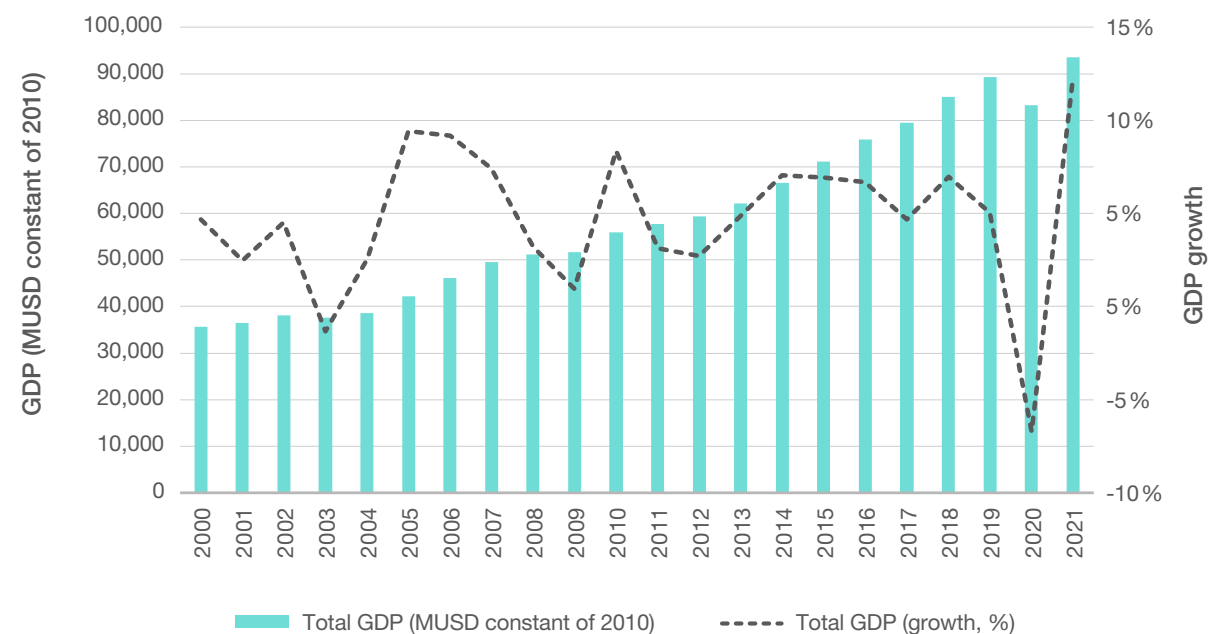
Indicator/Country	Dominican Republic
Total population (2021, million)	10.95
Population density (inhab./km ²)	226
Urban (%)	83%
GDP per capita 2021 (USD at constant prices of 2010)	8,537
Extreme poverty index, 2020	5.6 %

Source: Own preparation based on data from the World Bank and CEPALSTAT.

In the last two decades, the Dominican Republic has experienced sound economic expansion with an average annual growth of about 4 % (2000-2021). In 2020, the impact of the COVID-19 pandemic on the Dominican Republic's economy was significant, like in many other countries in the region.

Graphic 1

► GDP and annual growth rate, MUSD constant of 2010 and %



Source: Own preparation, based on data from the World Bank.

The Dominican Republic has a diverse economic matrix, in which the Public Administration accounts for 20.3% of the GDP, followed by the commercial sector (17%), manufacturing industries (15.9%), construction (13.8%) and financial intermediation (13%).

Graphic 2

► GDP by sector, 2021, %

Dominican Republic

Electricity, gas and water supply

1.8%

Financial intermediation, real estate, business and rental activities

13%

Manufacturing industries

15.9%

Mining and quarry exploitation

1.6%

Mail and telecommunications

1.1%

Transportation, storage and communications

9.9%

Public administration, defense, teaching, social and health services

20.3%

Agriculture, cattle raising, hunting, forestry and fishing

5.6%

Trade, goods repair, and hotels and restaurants

17%

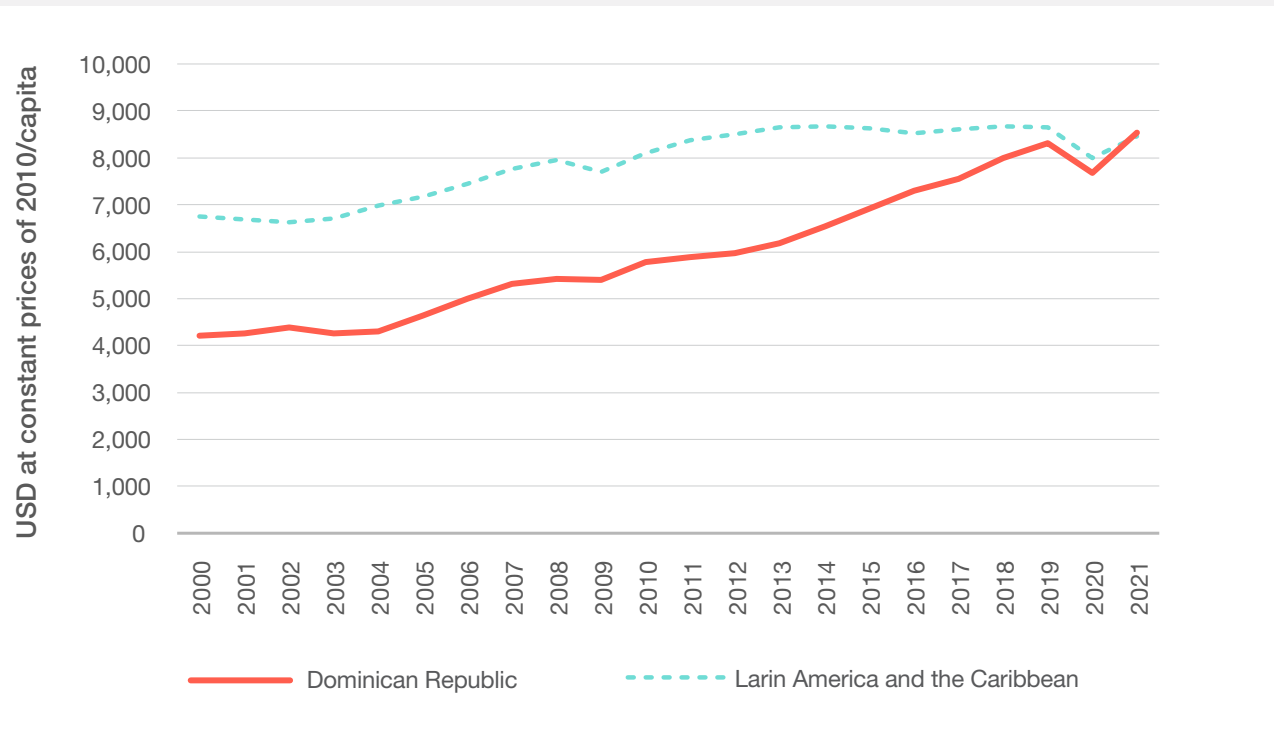
Construction

13.8%

Source: Own preparation based on data from CEPAL.

Except for certain particular years, the GDP per capita has shown an upward trend in the last 20 years. In 2021, it was 8,537 constant US dollars (USD) of 2010 per capita, in line with the regional average.

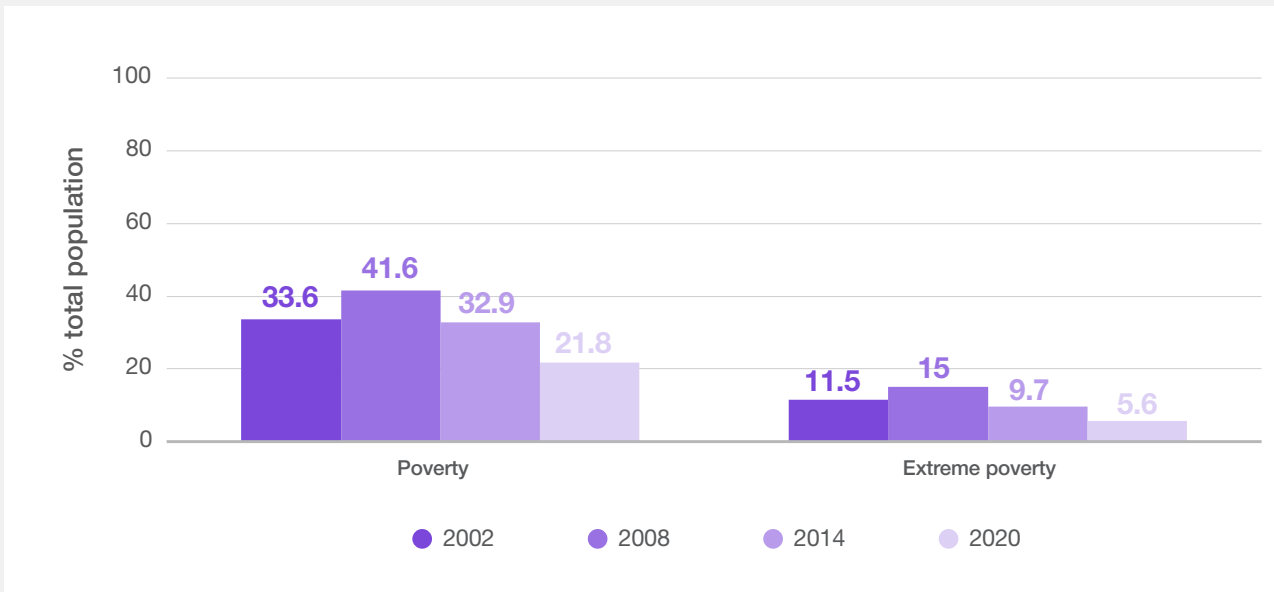
Graphic 3 ► GDP per capita, constant USD of 2010 per capita



Source: Own preparation based on data from the World Bank.

At present, poverty levels in the Dominican Republic are around 20% for poverty and 5.6% for extreme poverty. Thus, significant improvements have been identified in both indicators based on the last 20 years.

Graphic 4 ► Impact of total and extreme poverty by year, %



Source: Own preparation based on data from CEPALSTAT



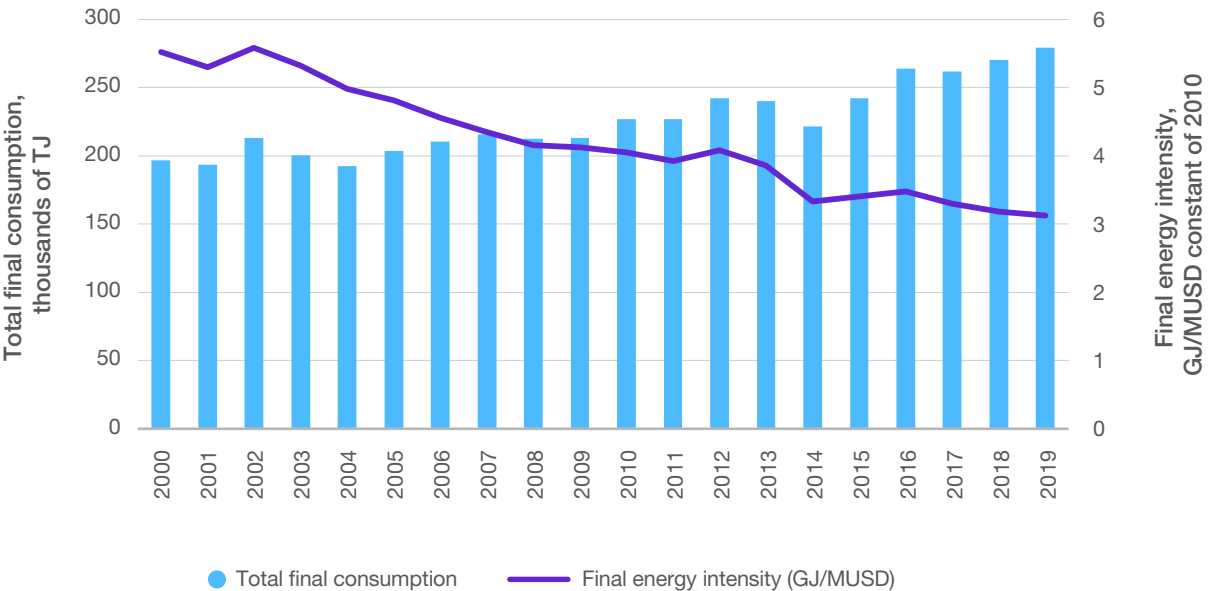
Socio-economic and energy indicators

Energy intensity of the economy

Final energy intensity² was significantly reduced in the period between 2000 and 2019 (cumulative -43 %, average annual -2.17 %) while total final consumption grew at an average annual 2.09 %.

Graphic 5

► Total final consumption versus final energy intensity, 10³ TJ and GJ/MUSD constant of 2010



Source: Own preparation based on data from sieLAC, OLADE³.

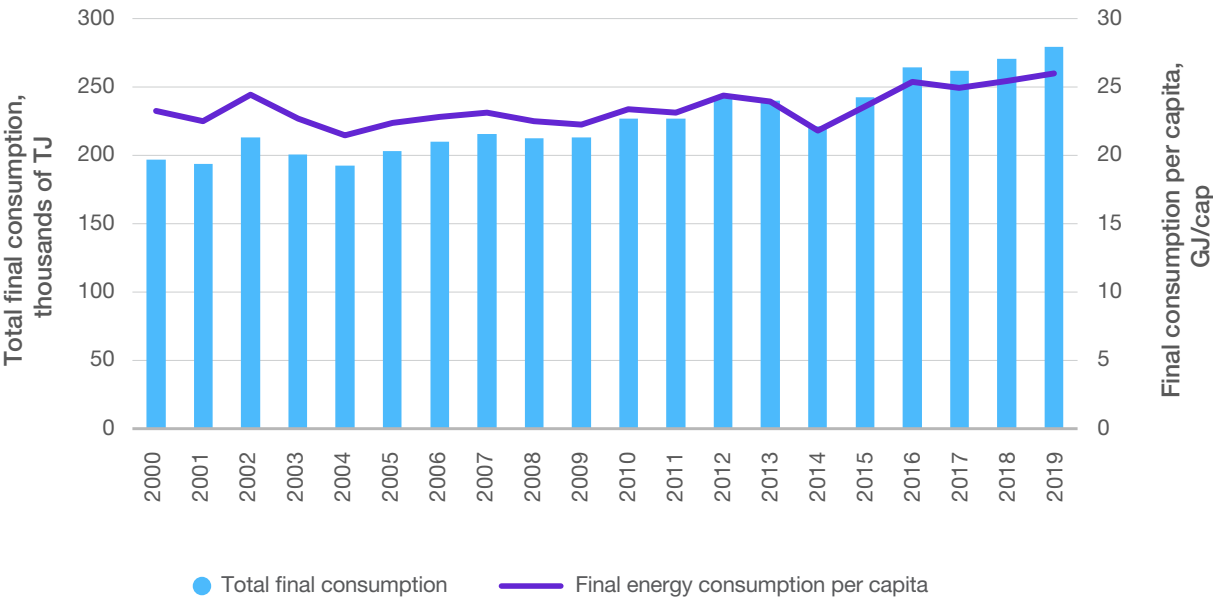
² Defined as the relation between final energy consumption and GDP at constant USD of 2010.
³ Data on energy intensities internally calculated in the system with GDP data from the World Bank and energy consumption from national energy balances.

Consumption per capita

The increase in final energy consumption per capita was lower than total final consumption in the period 2000-2019 (0.59 % vs. 2.06 %).

Graphic 6

► Total final consumption versus final consumption per capita, 10³ TJ and GJ per capita



Source: Own preparation based on data from sieLAC, OLADE.



Local prices

The following consumer prices refer to the Dominican Republic. Compared to the region, the Dominican Republic’s prices are generally in line with the rest, except for liquefied petroleum gas (LPG) for the residential sector, which shows low prices like in Barbados and Chile. As to the prices of premium gasoline, the highest prices are those of Paraguay, the Dominican Republic, Costa Rica and Belize.

Table 2

► Prices of the main energy products in the Dominican Republic, cut-off year 2019

Energy product	VAT%	Special taxes	Price
Electricity (residential)	-	-	131.61 USD/MWh
Electricity (commercial)	-	-	196.01 USD/MWh
Electricity (industrial)	-	-	166.46 USD/MWh
Natural gas (residential)	16%	Yes	15.46 USD/MBtu
Natural gas (commercial)	16%	Yes	15.46 USD/MBtu
Natural gas (industrial)	16%	Yes	15.46 USD/MBtu
Natural gas (transportation)	16%	Yes	15.46 USD/MBtu
Natural gas (generation)	-	-	2.24 USD/MBtu
LPG (residential)	16%	-	3.42 USD/kg
LPG (transportation)	16%	-	3.42 USD/kg
Residential kerosene	16%	Yes	0.89 USD/l
Regular gasoline	16%	Yes	1.12 USD/l
Premium gasoline	16%	Yes	1.20 USD/l
Diesel (transportation)	16%	Yes	0.93 USD/l
Diesel (generation)	-	-	0.34 USD/l

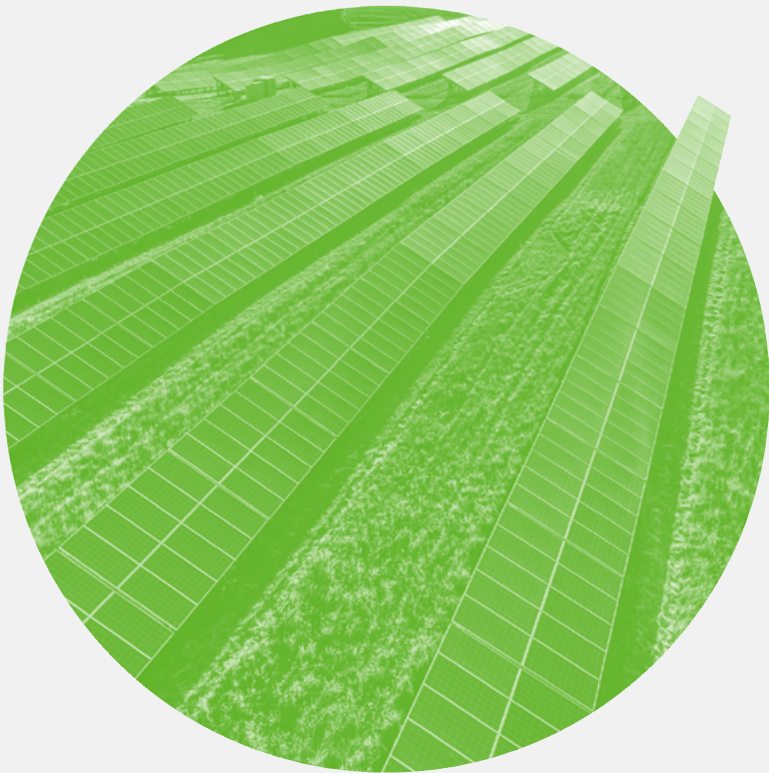
Source: OLADE - <https://www.olade.org/publicaciones/precios-de-la-energia-en-america-latina-y-el-caribe-informe-anual-abril-2021/>



Energy aspects

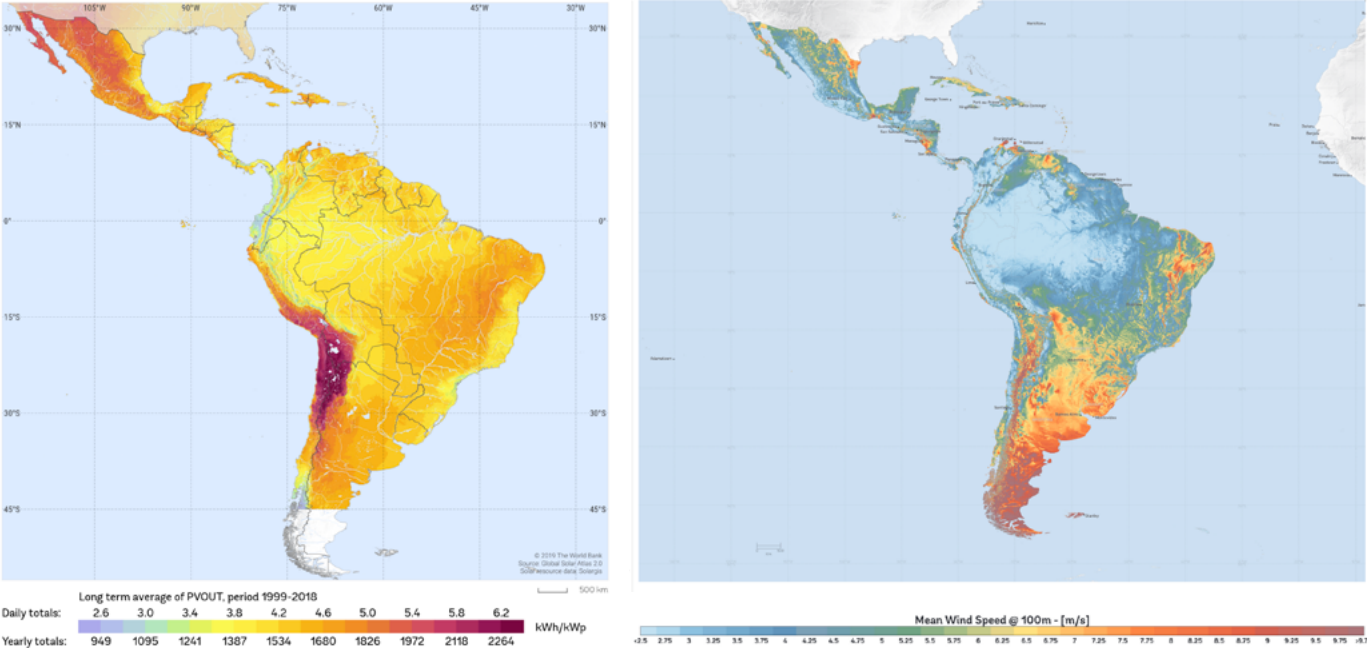
Reserves and total fuel supply (production, imports and exports)

The Dominican Republic has no fossil fuels and a limited hydroelectric potential. As to its solar resource, according to the Global Solar Atlas, the Dominican Republic shows a value of 1,781 kWh/kWp for 10 % of the areas with the largest photovoltaic production and an average 1,668 kWh/kWp. As a reference, the world resource for 10 % of the areas with the largest irradiation is 1,736 kWh/kWp and the average world resource is 1,576 kWh/kWp. On the other hand, its wind resource for 10% of the areas with more wind is equal to or higher than 367 W/m², and the mean wind speed at 100 meters is equal to or higher than 7.4 m/s.



Graphic 7

► Potential solar resource (kWh/kWp) and mean wind speed at 100 m (m/s)



Source: Global Solar Atlas (World Bank)⁴ and Global Wind Atlas (World Bank)⁵.

The Dominican Republic imports oil, natural gas, coal and petroleum products to cover its domestic consumption. Its refining capacity allows it to supply part of its domestic consumption and exports. It is a net energy importer⁶.

⁴ Global Solar Atlas, World Bank Group, <https://globalsolaratlas.info/download/latin-america-and-caribbean>

⁵ [ws_LAC.pdf](#)

⁶ Its external energy dependence index (relation between total energy imports less total exports divided by total energy supply) is close to 85 %.

Table 3

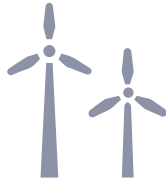
► Fuel reserves, hydroelectric potential, and infrastructure, 2019, Dominican Republic

Reserves				Potential	Installed capacity	
Oil	Natural gas	Coal	Uranium	Hydro energy	Refining	Power generation
						
0	0	0	0	2.1	50	4.9
Mbbl	Gm ³	Mt	10 ⁶ bep	GW	kbbbl/day	GW

Source: sieLAC, OLADE.

Table 4

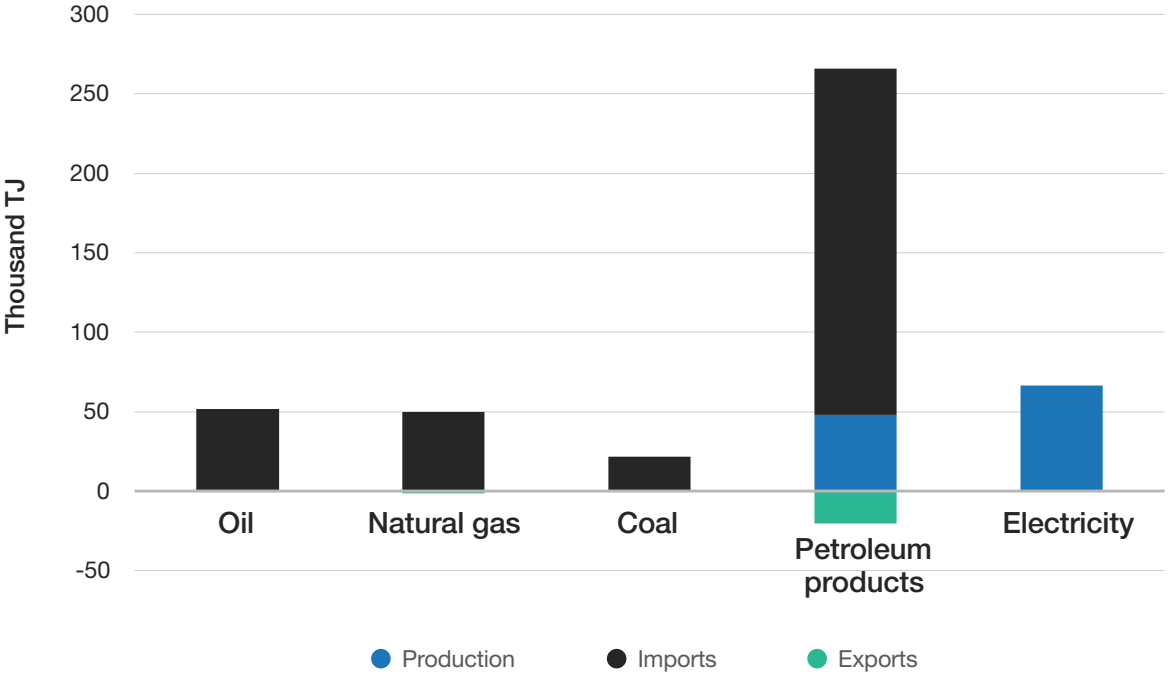
► Wind and solar resources, Dominican Republic

Resources		
Wind (10 % of the areas with more wind)	Solar (average)	Solar (10 % largest production)
		
7.37	1,668	1,781
m/s	kWh/kWp	kWh/kWp

Source: Own preparation based on the Global Solar Atlas and the Global Wind Atlas.

Graphic 8

► Production, imports and exports by main sources, 2019, 10³ TJ



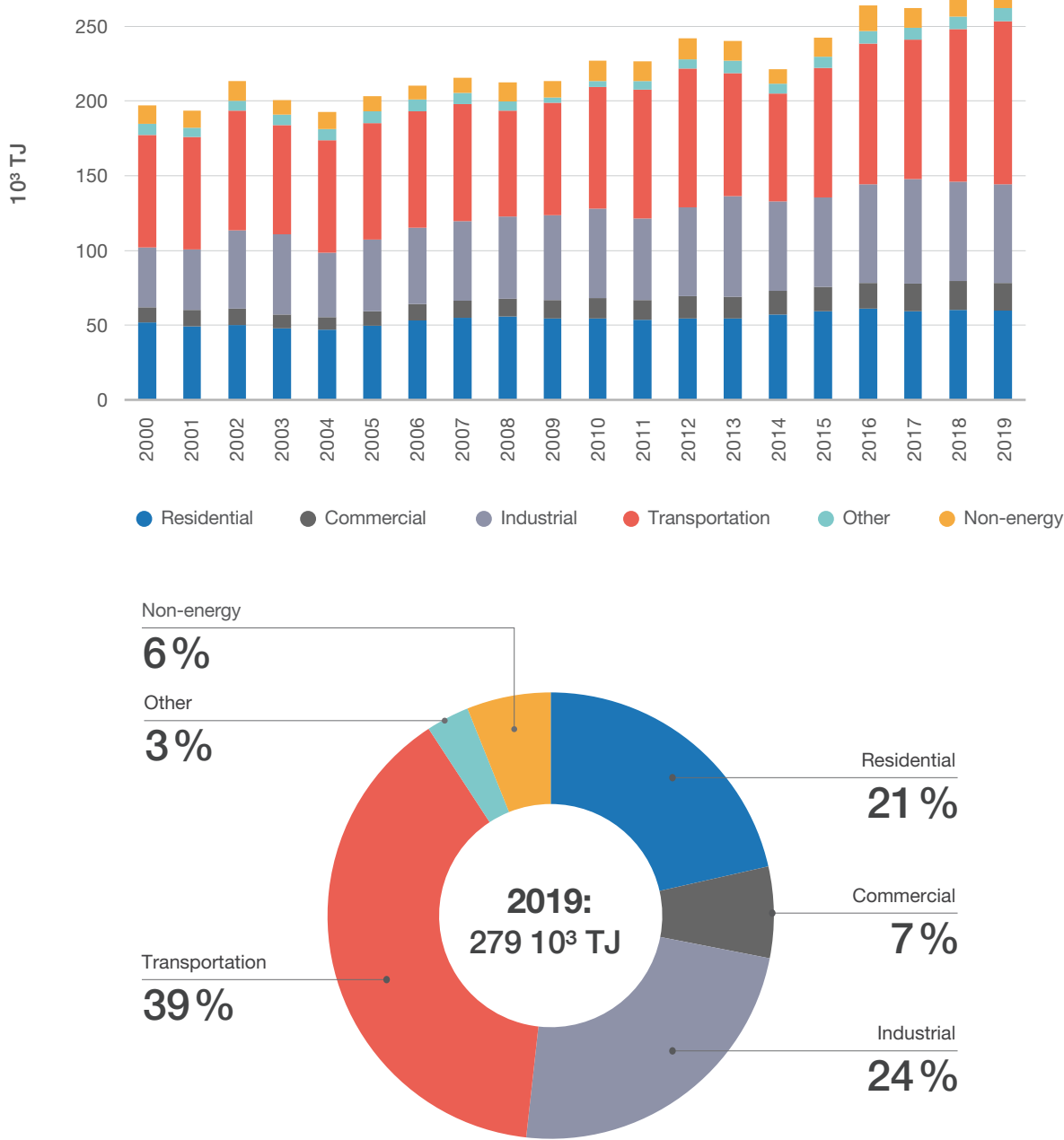
Source: Own preparation based on data from sieLAC, OLADE.

Final consumption by source and sector

The share of final consumption by sector has remained quite stable in the last 20 years. Transportation was the sector with the largest consumption in 2019 (39%), followed by the industrial sector (24%) and the residential sector (21%). Final energy consumption grew at an average rate of 1.9% in the period, with certain irregularities in some years.

Graphic 9

► Final consumption by sector, 10³ TJ and %

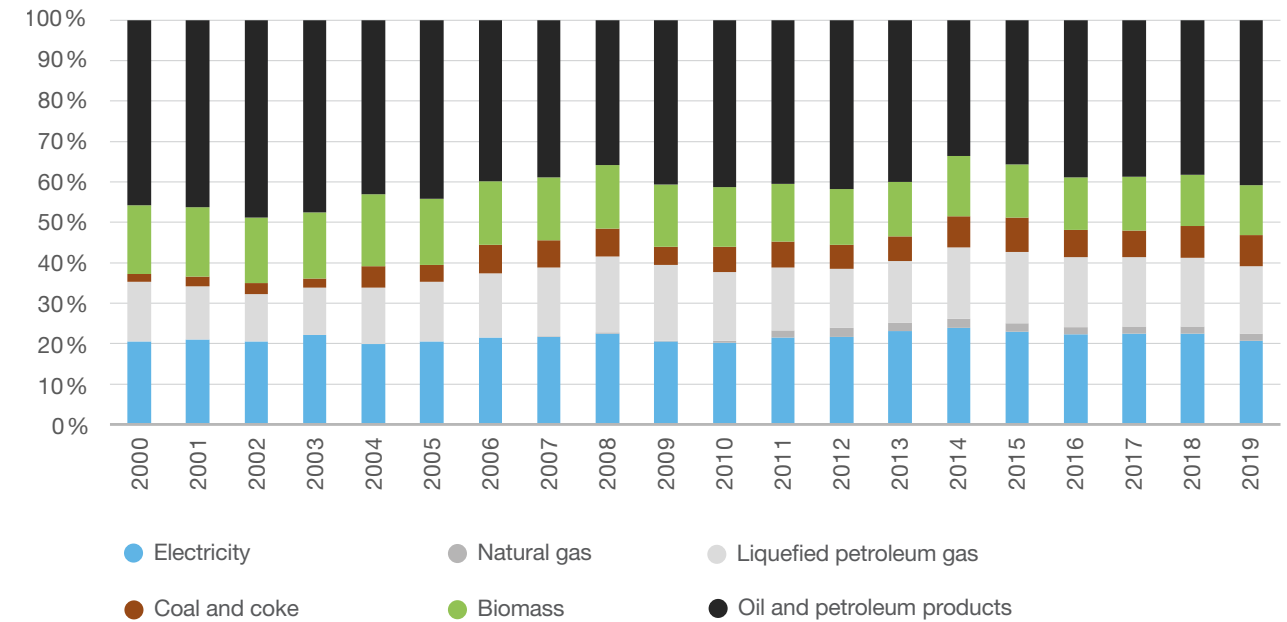


Source: Own preparation based on data from the sieLAC, OLADE.

The share of final consumption by source has remained quite stable in the last 20 years. By source, no major changes are observed in the period although the penetration of each source may be uneven from one year to the next. Oil and petroleum products account for 39% of total consumption, electricity for 20%, and natural gas and coal are starting to play a very small role in the matrix.

Graphic 10 A

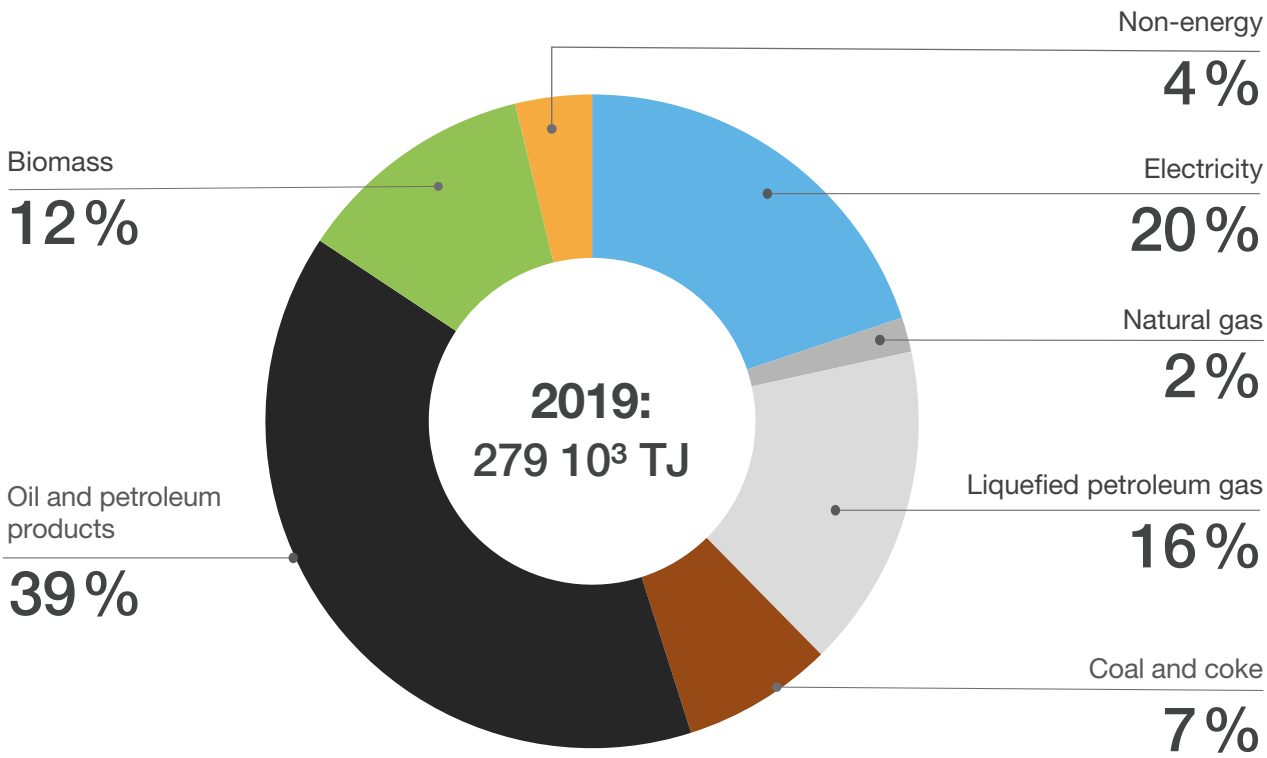
► Final consumption by source, 10³ TJ and %



Source: Own preparation based on data from sieLAC, OLADE, data as of November, 2022.

Graphic 10 B

► Final consumption by source, 10³ TJ and %



Source: Own preparation based on data from sieLAC, OLADE, data as of November, 2022.

Note: data downloaded from sieLAC in November 2022, two years after the publication of *El Panorama Energético de América Latina y el Caribe 2020* in November 2020 (Graphic 12 below), which may cause certain differences, as the sieLAC is updated with final data. Category “Non-energy” is not included in the historical evolution.



Climate profile

Climate change scenarios and risks to the energy sector

The Dominican Republic is a country in the Caribbean, where the climate is influenced by the proximity of the Atlantic Ocean and the presence of mountains. During the rainy season, which may last from May to November, the country experiences intense rainfall and tropical storms that may cause floods and landslides.

According to the United States Agency for International Development (USAID⁷):

[...] The Dominican Republic is one of the most vulnerable countries to climate change, and has a long history of natural catastrophes⁸ that have seriously affected the country in the past. A hurricane or an earthquake can hit the country at any time and any climate emergency can destroy the systems that this Caribbean nation has taken years to build.

In addition, with reference to the power system, it adds: “small and isolated, it is a perfect breeding ground for any unexpected catastrophe to place national security in the hands of fate”.

Even though climate change may affect hydrology and have an impact on the generated hydroelectricity, at the moment, the energy matrix of the Dominican Republic is strongly thermal (over 73 % of installed capacity, OLADE⁹). Another

⁷ <https://www.usaid.gov/dominican-republic/news/investigando-sobre-resiliencia-energetica>

⁸ In addition, the Dominican Republic shows seismic activity, as it is located within the interaction between the Caribbean and the North American plates, especially in the north, where the Septentrional Fault and the Camu Fault, which are major seismographic sources, are located.

⁹ <https://www.olade.org/wp-content/uploads/2023/01/Panorama-ALC-13-12-2022.pdf>

expected result is the variation in demand as a result of the changes in climate patterns. Climate change may affect energy demand and consumption in the commercial, services and public sector; for example, with an increase in the need for climate control.

The Global Climate Risk Index (GCRI)¹⁰ indicates the level of exposure and vulnerability to extreme climate events. In the period 2000-2019, the Dominican Republic was in the 50th position among 180 countries (1 is the position with the greatest exposure and vulnerability).

In general, it is believed that climate change may have a significant impact on the energy sector in the Dominican Republic and on all the Caribbean region (for example, on coastal areas) due to eventual changes in ocean levels or changes in climate patterns that may increase the frequency and size of hurricanes and tropical storms. Mitigation and adaptation to climate change are important to reduce its negative impact on the economy and the people’s quality of life.

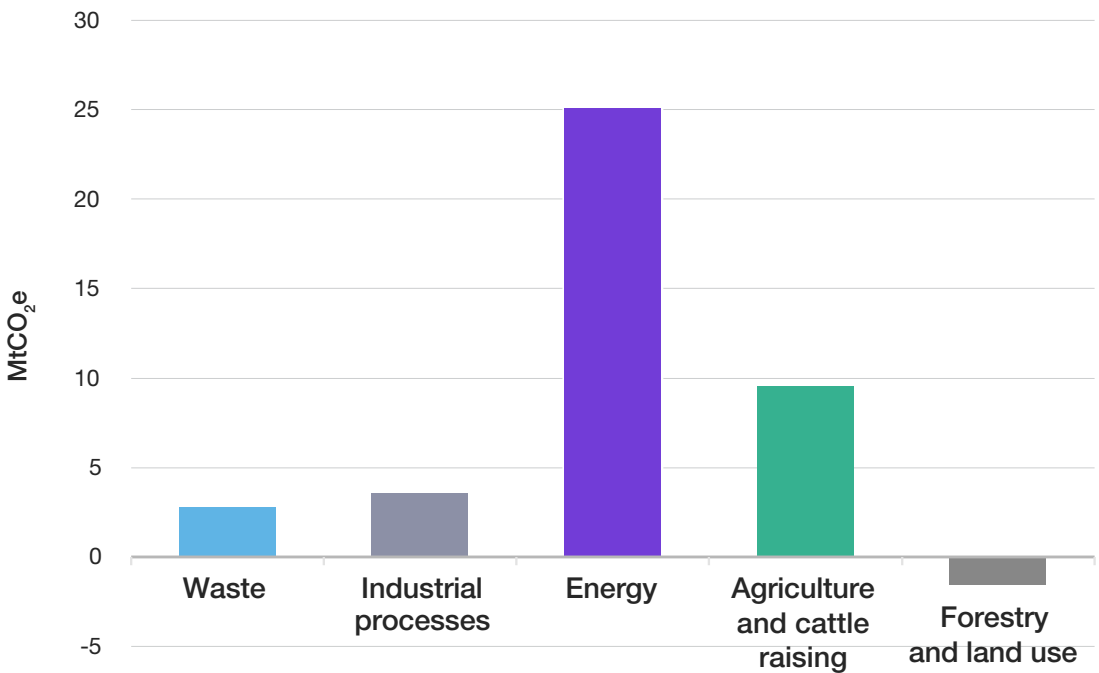
GHG contribution, base year

According to data from the Climate Watch platform of the World Resource Institute (WRI), net total emissions were 35.5 MtCO₂e in 2020, 56 % of which related to the energy sector (that is, emissions from burning fuels or fugitive emissions) and 24 % to the agriculture and cattle-raising sector, whereas the forestry and land use sector absorbed 4 % of the emissions.

¹⁰ The GCRI is composed of four indicators: number of deaths; number of deaths per 100,000 inhabitants; sum of losses in USD purchasing power parity (PPP); and losses by gross domestic product (GDP) unit. The final ranking considers these indicators with different weights and in a 20-year period. <https://www.germanwatch.org/en/19777>

Graphic 11

► Net total emissions, 2020, MtCO₂e

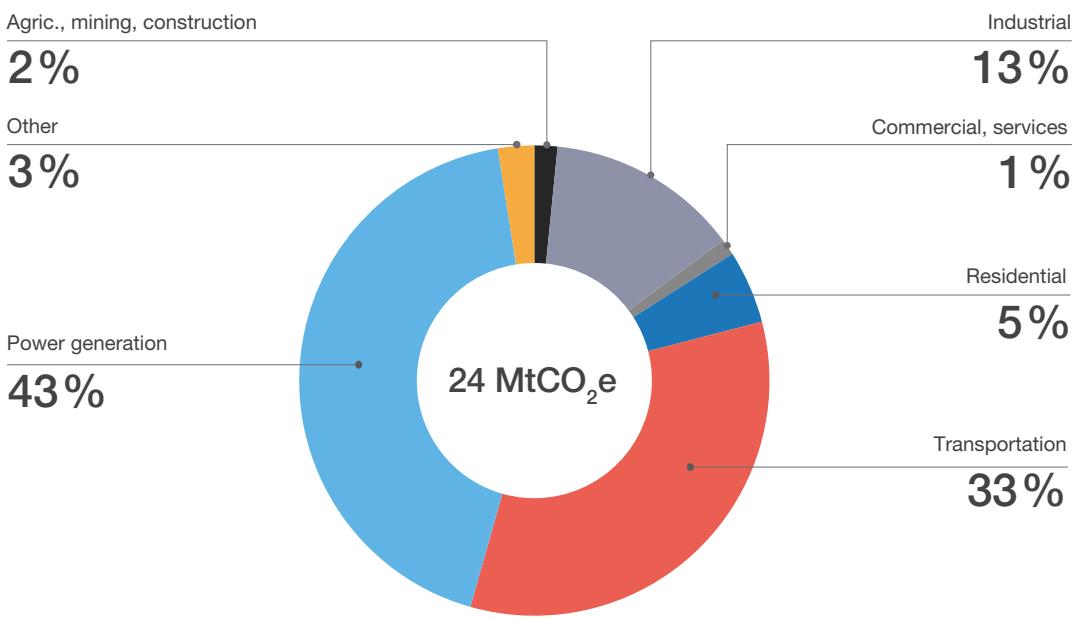


Source: Own preparation based on Climate Watch, CAIT database, WRI.

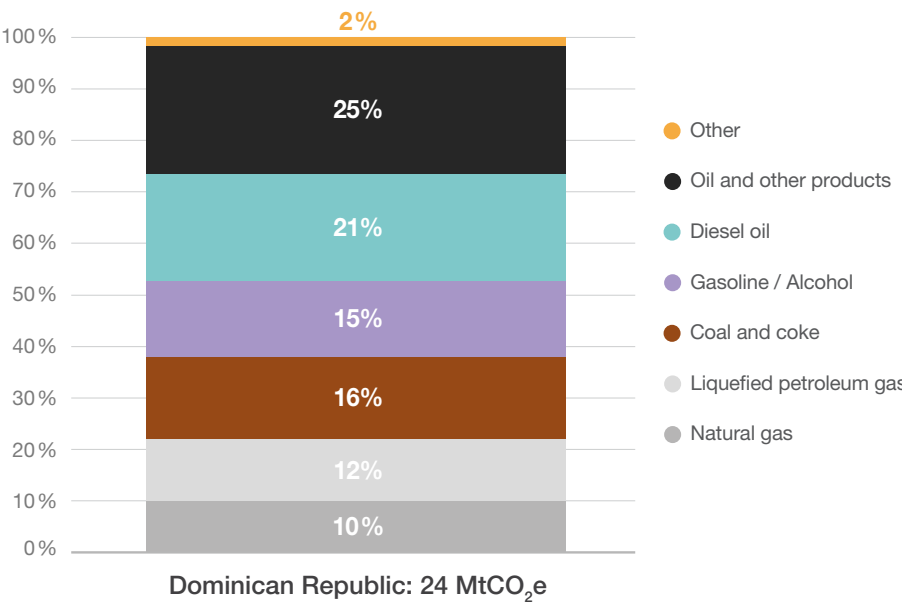
When specifically considering the energy sector (emissions from fuel burning and fugitive emissions), it is possible to analyze the emissions by sector and by source. The data presented below is from an estimation of CO₂ emissions made by the OLADE (sieLAC).

Graphic 12

► Emissions from the energy sector estimated by sector and by source, MtCO₂e, 2019



Emissions by source



Source: Own preparation based on data from sieLAC, OLADE.

In 2019, the power generation sector accounted for 43 % of the emissions from energy. The main fuels that the sector uses are oil and petroleum products, natural gas, and coal. In the second position, transportation explains 33 % of the emissions in the sector, mainly from burning gasoline and diesel.

National commitments (NDC and Paris Agreement)

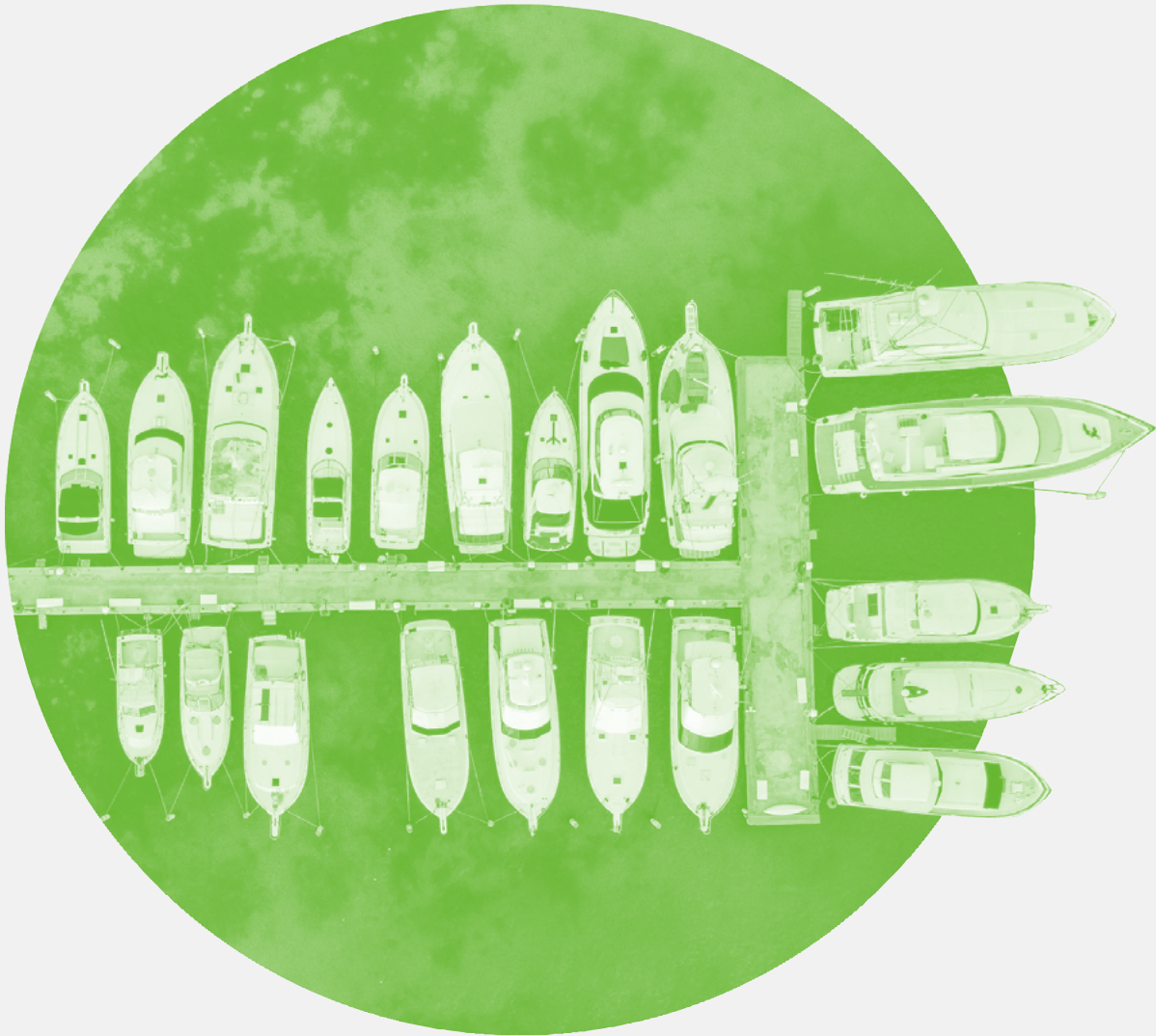
Regarding commitments to reduce CO₂ emissions, we can mention three elements:

- In its NDC 2020¹¹, the Dominican Republic increased its climate ambition and committed to reducing GHG emissions by 27 % in the Business as usual (BAU) scenario by 2030. This scenario has a goal of 20 % conditioned to external financing and 7 % unconditioned to domestic financing, with a distribution of 5 % for the private sector and 2 % for the public sector.
- There are 46 mitigation options distributed into 27 identified and assessed options for the energy sector (focusing on power generation, energy efficiency, and road transportation); 4 identified and assessed options for the industrial processes and product use (IPPU) sector; 10 identified options for the agriculture, forestry and other land use (AFOLU) sector; and 5 options for the waste sector.
- The Dominican Republic signed the Paris Agreement; therefore, it has committed to “substantially reducing the greenhouse gas emissions to limit

¹¹ NDC by country (<https://unfccc.int/NDCREG>).

the increase in global temperature in this century to 2 °C and make efforts to limit this increase to even more, only 1.5 °C”.

In 2022, the Dominican Republic worked in the preparation of a long-term strategy to reach carbon neutrality by 2050 and on a preliminary bill on climate change.



2. Institutional, regulatory and public policy aspects



Sectoral government

Table 5 lists the main institutions in the energy sector.

Table 5

► Mapping of institutions in the energy sector

Institution	Function
Ministry of Energy and Mines (MEM)	- Defines policies for the oil, gas and electricity sectors - Governs the national energy system and the electric energy, renewables, nuclear, natural gas and mining subsectors
Ministry of Industry, Trade and Small Businesses (MICM, in Spanish)	- Grants transportation licenses and licenses to sell liquid fuels, LPG, gas transportation licenses, classification of power generation companies as private generation or isolated systems
National Energy Commission (CNE, in Spanish)	- Planning of the electricity sector
Superintendency of Electricity (SIE, in Spanish)	- Regulation of the electricity market
Power System Coordinator (OC, in Spanish)	- Administrator of the electricity market
Corporación Dominicana de Empresas Eléctricas Estatales (CDEEE), federal company. It is currently part of the Ministry of Energy.	- Administrator of all the companies in the energy sector in which the Dominican State is the owner or a majority partner
REFIDOMSA	- Petroleum product refining and imports

Source: Own preparation.



Main regulatory concepts

Table 6 indicates whether there is price regulation and a competitive market and open access to each energy sector and each segment.

Table 6

► Main regulatory concepts by sector and segment

Sector	Segments	Price regulation	Market
Electricity	- Generation - Distribution - Transmission	- Transmission - Distribution	- Competitive in generation - Open access in all segments of the chain
Natural gas	- Regasification - Transportation - Commercialization	- Free, except for vehicle natural gas (VNG), which is regulated by the Ministry of Energy and Mines	- Competitive in exploitation and exploration - Open access in all the segments of the chain
Oil	- Refining - Distribution and commercialization	- Regulation by the Ministry of Energy and Mines at import parity Price (IPP)	- Competitive
Coal	- Comercialization		- Free pricing

Source: Own preparation.



Public policy aspects

Energy efficiency policies

In 2018, the Dominican Republic worked on a preliminary bill on energy efficiency and rational energy use.

The main energy efficiency policies, measures and programs are briefly described below in Table 7.

Table 7

► Energy efficiency in the Dominican Republic

Aspect	Item	Country progress
Labeling regulation	Sector	- Commercial, industrial and transportation
	Program	- The bill provides that the Dominican Quality Institute (INDOCAL) will prepare the labeling rules for energy equipment. In addition, and in connection with the transportation sector, it stipulates that vehicle importers and sellers will show performance related to fuel consumption and CO ₂ emissions through a label.
	Minimum energy performance standards (MEPS)	- The bill provides that the CNE will present the minimum energy efficiency criteria and parameters and these will be approved by the National Technical Energy Efficiency Committee (CTNEE).
Sectoral policies	Public sector	✓
	Transportation	✓
	Residential	
	Commercial and Industrial	
Energy efficiency fund	Type	
	Name	
	Other	- Promotion of credit facilities

Cont'd.

Cont'd.

Aspect	Item	Country progress
Promotion and cultural change	Labeling	
	Training programs and workshops for the public and private sectors	
	Promotion of dissemination and demonstration programs and campaigns	✓
	Social participation, consultations and access to information by the public	✓
	Inclusion of energy efficiency in education syllabuses	✓
	Prizes, honors and/or recognition to energy efficiency	✓

Source: Document *Leyes de Eficiencia Energética en Latinoamérica y el Caribe*, OLADE.

Pricing, subsidy and incentive policies

Subsidies and taxes on fuel prices

Subsidies

There are no general explicit subsidies. The Dominican Republic has a program of direct subsidy to demand called BonoLuz for power consumption and BonoGas for LPG consumption. These subsidies are applied by transferring resources to the users. It is important to mention that tariffs do not cover costs; therefore, there is an implicit subsidy to consumers in the electricity tariffs.

Taxes

Fuel prices in the Dominican Republic are taxed with three different types of taxes: an *ad-valorem* tax with a fixed percentage on its import cost (Law No.557-5), a specific tax that is added to the final price (Law No.112-00), and an additional item of 2.00 Dominican pesos (DOP) for each premium and regular gasoline and gas oil gallon that is sold (Law No. 253-12).

Incentives to renewable energy

Main laws

In 2007, Law No. 57 created a regulatory framework to promote and develop investment in renewable sources in order to diversify the energy matrix and reduce dependence on fossil fuels. The incentives to promote renewable energy are tax exemptions. The law also set non-mandatory coverage goals for generation based on renewables (10 % in 2015 and 25 % in 2025).

In 2020, a new goal was set for renewable energy for 2030 (25 % of total generation).

Long-term auctions.

In early 2021, the Dominican Government stated its intention to conduct a tender to install renewables in the following four years (as well as a thermal tender to install a combined cycle thermal plant (CCGT)). Later, both tenders were suspended due to the economic impact of COVID-19 in 2021 and the elections in the country.

In October 2021, the Government announced the direct grant of contracts to eight renewable developers as a result of its negotiations with new non-conventional

renewable energy (NCRE) developers for both existing and new projects. This direct grant is likely to replace – in the short term – the envisaged renewable tender and to postpone such tender to the medium term.

Distributed generation

The regulation is in the process of being approved.

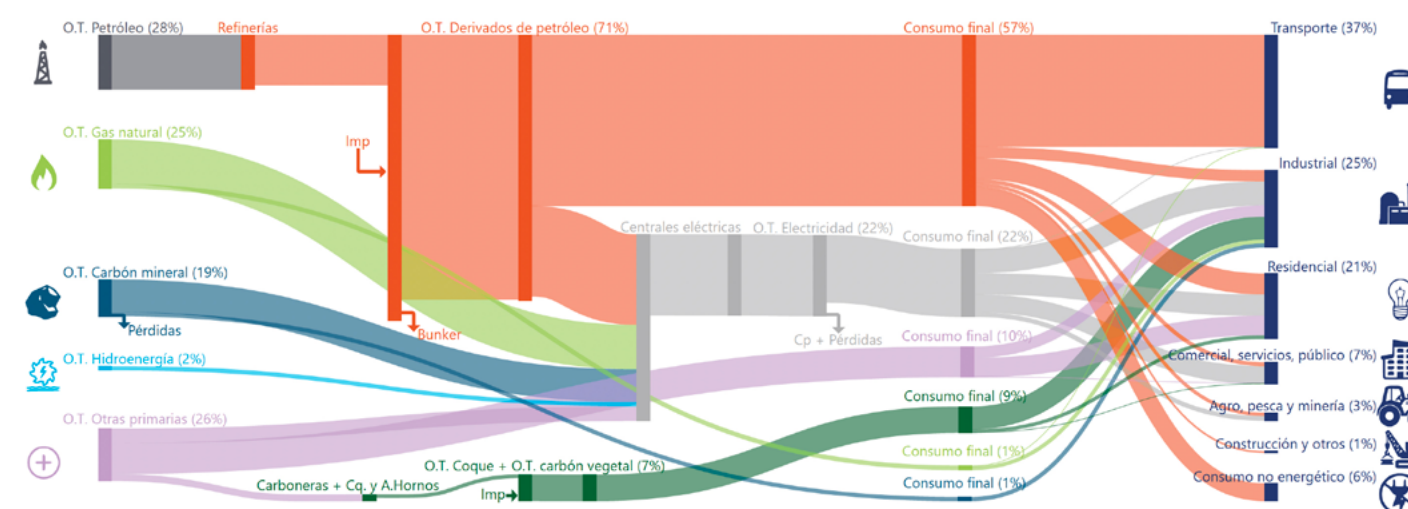


3. Energy balance 2019 and 2022

The energy balance records the energy flows from energy production, exports and imports, and transformation to final consumption in the different socio-economic sectors for a certain period (one year). In this case, 2019 is considered the base year for this study. As a reference, a graphic summary (Sankey diagram) of the energy balance in the Dominican Republic is shown below for the year 2019.

Graphic 13

► Energy balance, 2019



Source: Panorama energético de América Latina y el Caribe 2020, OLADE, November 2020.

Note: The *Panorama Energético de América Latina y el Caribe* is published in November every year, is prepared some months before, and includes information on the energy sector in the previous year; therefore, the data may be preliminary in certain cases.

The energy balance allows us to see some of the main characteristics of the energy sector in the Dominican Republic in a summarized manner:

- the massive use of petroleum products (71 %), both for electricity production and for end uses, in particular, in the transportation sector;
- the large volume of petroleum product imports;
- the use of natural gas and coal, mainly limited to producing electricity, unlike other countries in the region;

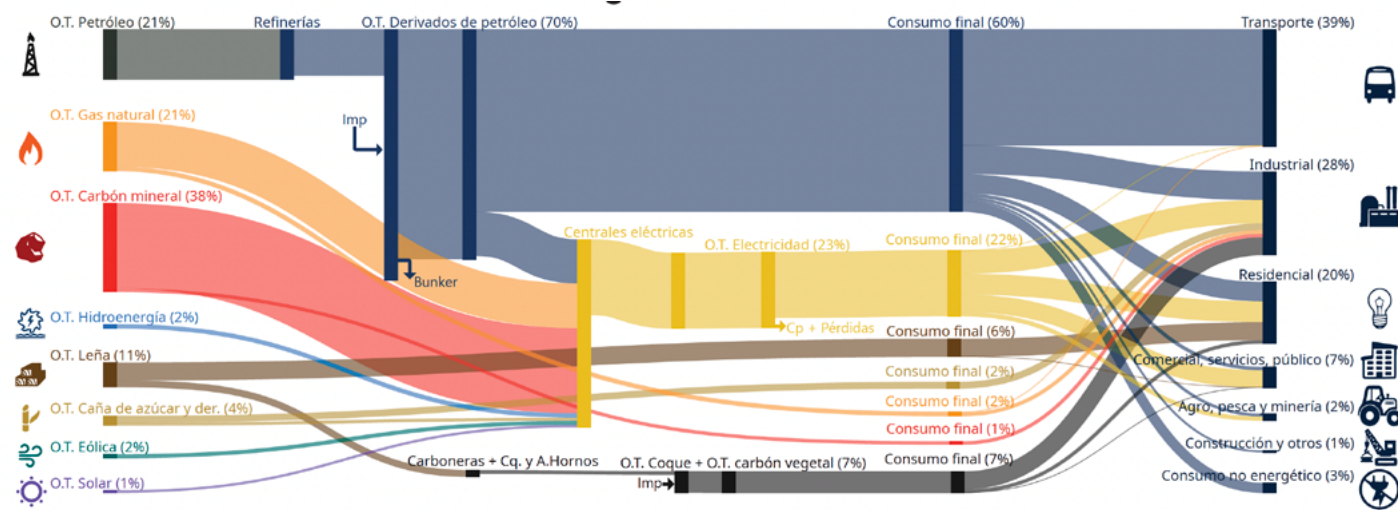
- the use of other primary sources (firewood in the residential sector, sugar cane and byproducts in the industrial sector);
- the role of electricity in final consumption is still limited (22%).

Moreover, the latest available energy balance (2022) includes some differences with the energy balance of 2019:

- a greater weight of coal (38% vs. 19%) and a smaller weight of the other sources in terms of primary energy supply;
- a greater weight of the transportation sector (39%) and the industrial sector (28%) in terms of final consumption.

Graphic 14

► Energy balance, 2022



Source: Panorama energético de América Latina y el Caribe 2020, OLADE, December 2023.

4. Evolution of energy demand by sector and source

The national energy balance allows us to visualize the dynamics of the energy sector over time through the analysis of time series of the main variables that form the country's energy matrix and the comparison of the structures and indicators in different years in a historic period.

The following paragraphs include, together with the energy demand by source, additional data, necessary to characterize this demand, such as the share of demand by use (useful energy balance), the description of the vehicle fleet, the sectoral energy intensity, etc.

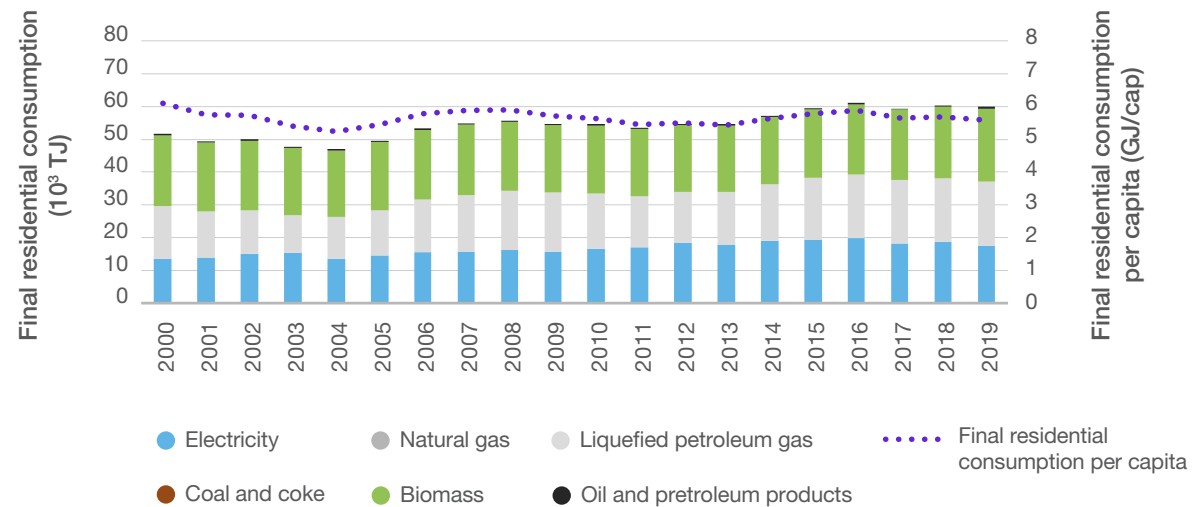


Residential sector

Final residential consumption has increased slightly in the last 20 years (annual average of 0.8 %). There is a certain decrease (1.2 % annual average) per capita. By source, the share of biomass, LPG, and electricity is similar, with 37 %, 33 % and 29 %, respectively.

Graphic 15 A

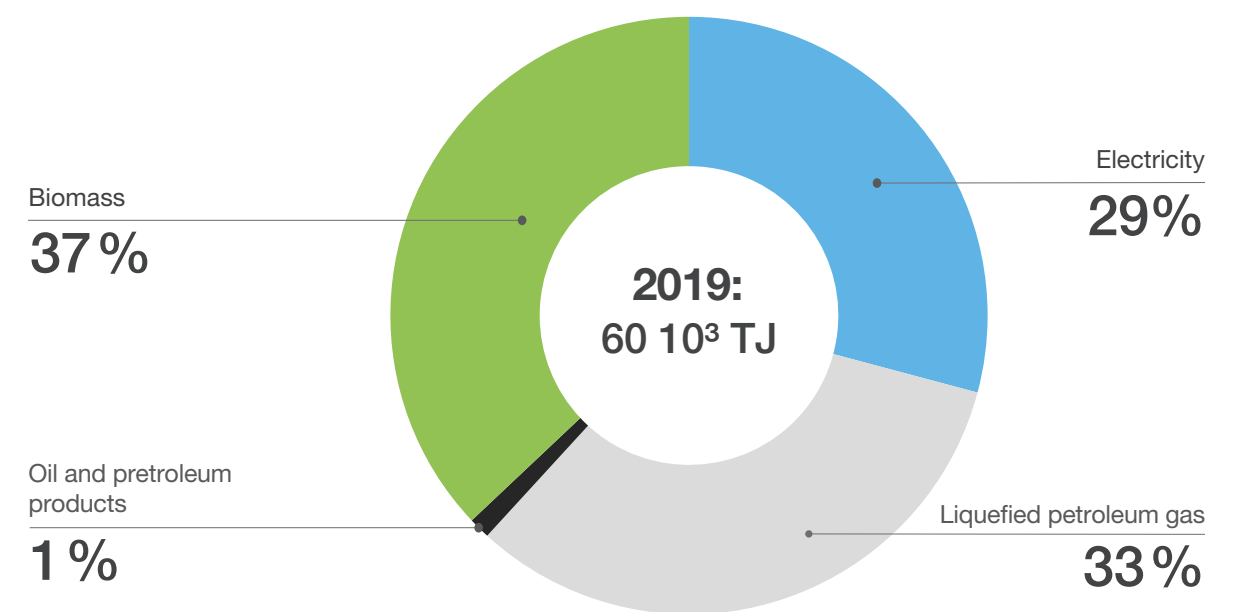
► Residential sector: evolution of final consumption by source (10^3 TJ) and final residential consumption per capita (GJ per capita)



Source: Own preparation based on data from sieLAC, OLADE.

Graphic 15 B

► Residential sector: evolution of final consumption by source (10^3 TJ) and final residential consumption per capita (GJ per capita)

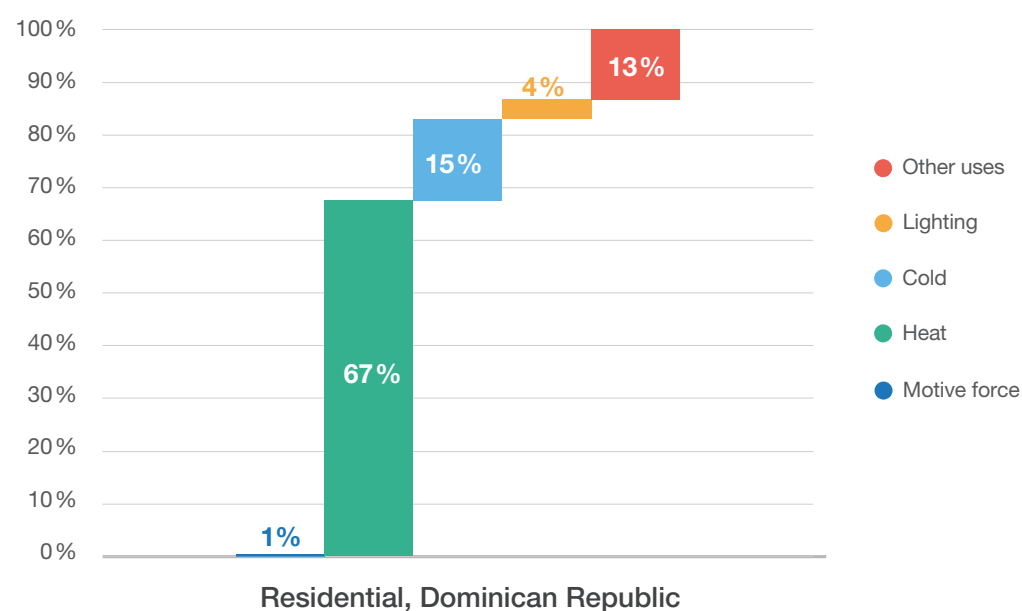


Source: Own preparation based on data from sieLAC, OLADE.

In terms of energy for end use, 67% of the total is heat (cooking or space heating, mainly). Uses reserved to electricity are limited (lighting, cold, and other uses).

Graphic 16

► Residential sector: energy consumption by end use, 2018, %



Source: Own preparation based on data from *Encuesta Nacional a Sectores de Consumo Final de Energía de República Dominicana (2018)*, Tomo I, *Balance Nacional de Energía Útil (2018)*. IDEE/Ministry of Energy and Mines, July 2020.

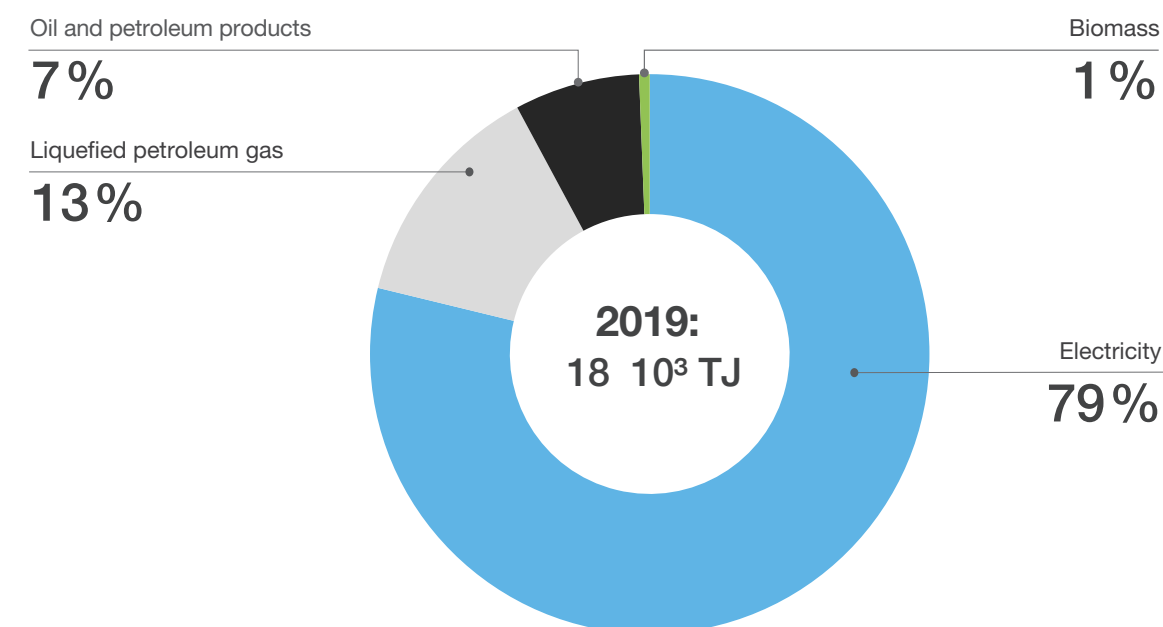
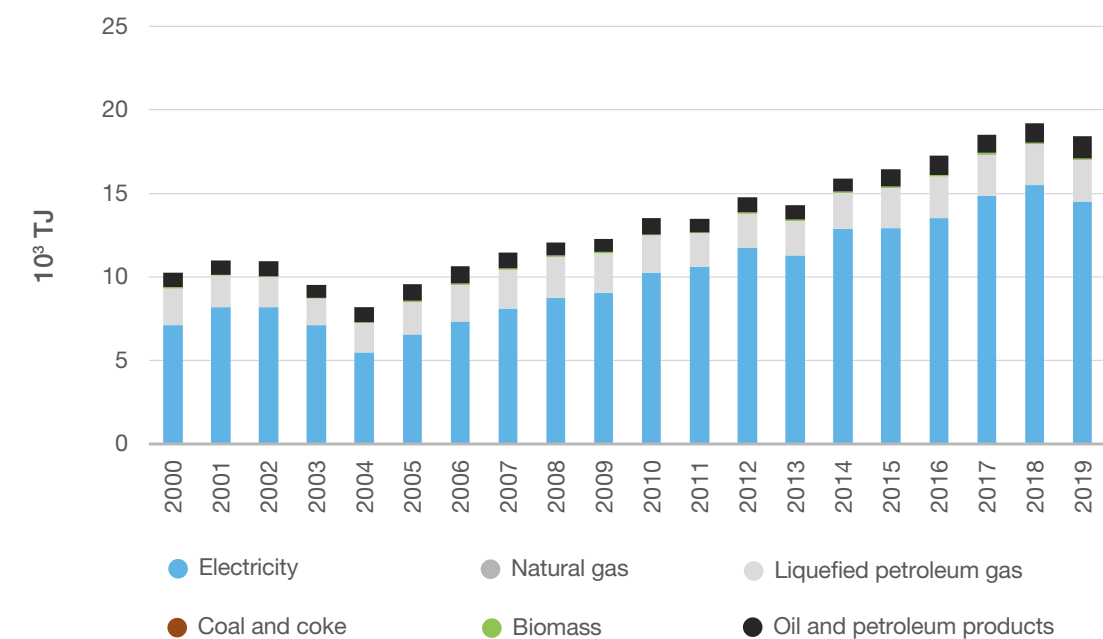


Commercial, services, and public sector

The final consumption of the commercial, services, and public sector has increased in the last 20 years (21 % annual average). By source, the following characteristics can be pointed out:

- high share of electricity in total consumption (79 % in 2019);
- the supply of LPG, oil, and petroleum products mainly covers the rest of the demand.

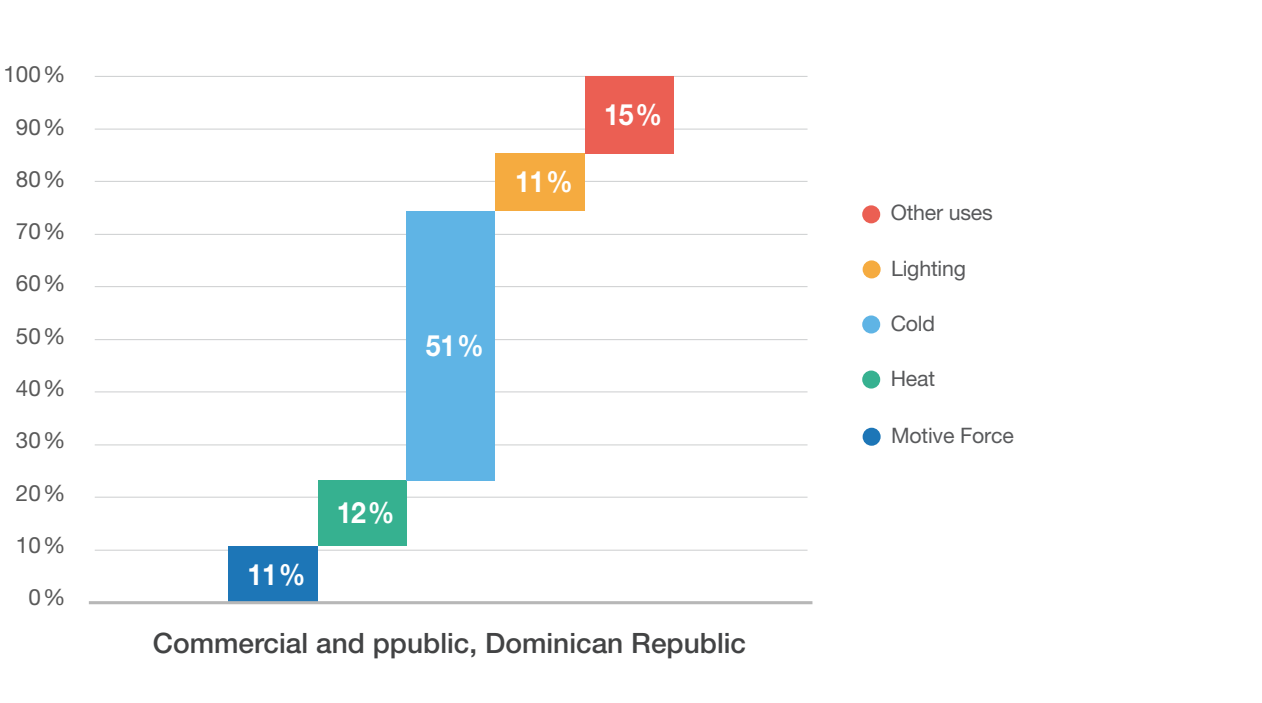
Graphic 17

► Commercial and public sector: evolution of final consumption by source (10³ TJ and %)

Source: Own preparation based on data from sieLAC, OLADE.

In terms of energy consumption for end use, cold covers almost half of consumption, followed by heat, motive force, and lighting, with very similar shares. Participation by end use is very different to that of the residential sector.

Graphic 18 ▶ Commercial and public sector: energy consumption for end use, 2018



Source: Own preparation based on data from Fundación Bariloche, 2018.

“The energy balance of the Dominican Republic reflects the use of petroleum products, electricity, firewood, sugarcane, mineral coal, and limited use of natural gas.”



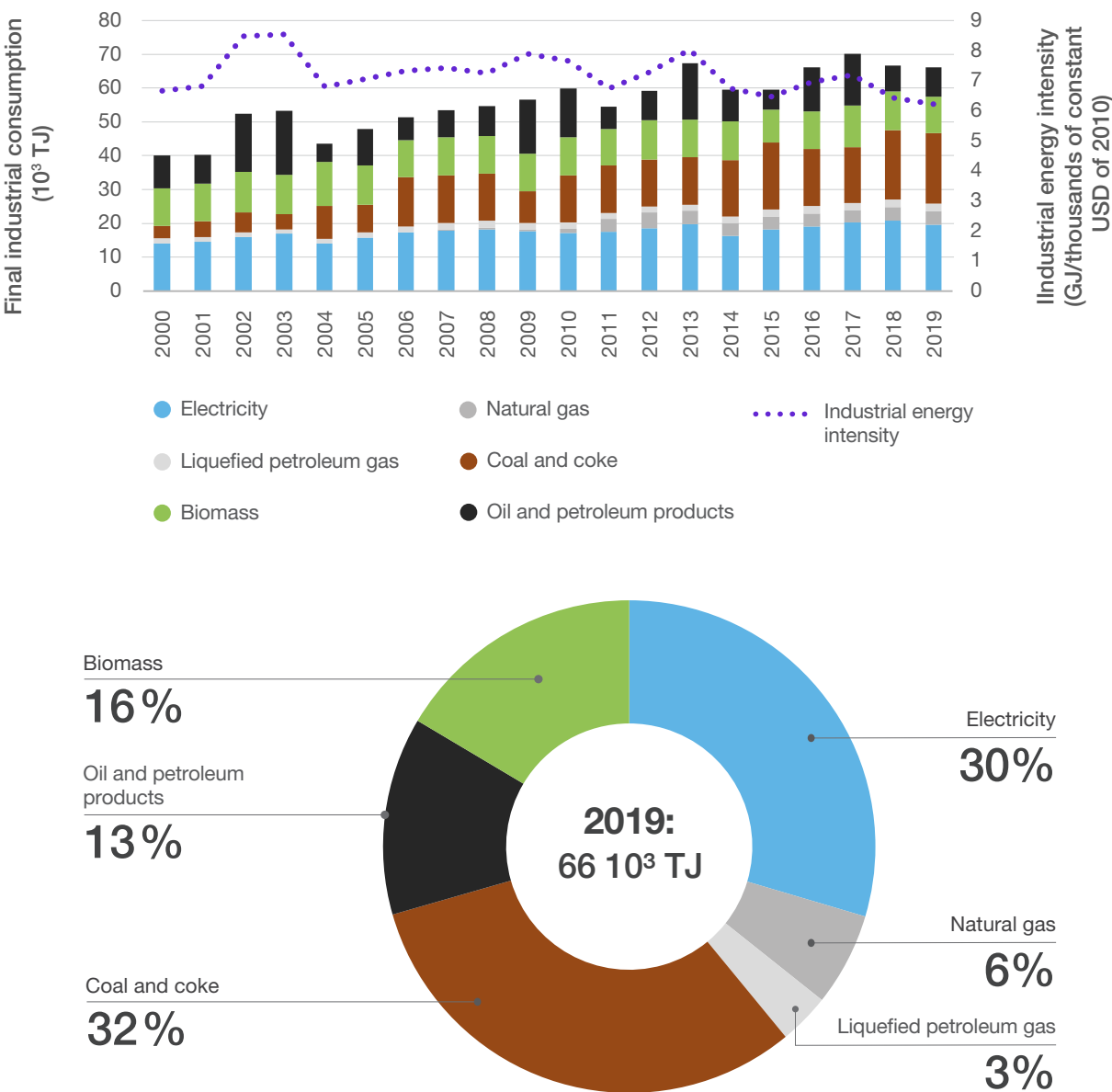
Industrial sector

Final industrial consumption has increased in the last 20 years (2.7 % annual average); however, this growth has been very irregular and has had significant ups and downs between one year and the next. By GDP unit, the energy intensity of the industrial sector has decreased slightly, but with a very irregular evolution in the period. By source, the following characteristics can be pointed out:

- great share of coal and coke with an increase in volume and in participation in the period;
- increase in electricity consumption at an average rate of around 1.8%.



Graphic 19 ► Industrial sector: evolution of final consumption by source (10³ TJ) and industrial energy intensity (GJ/thousands of constant 2010 USD)

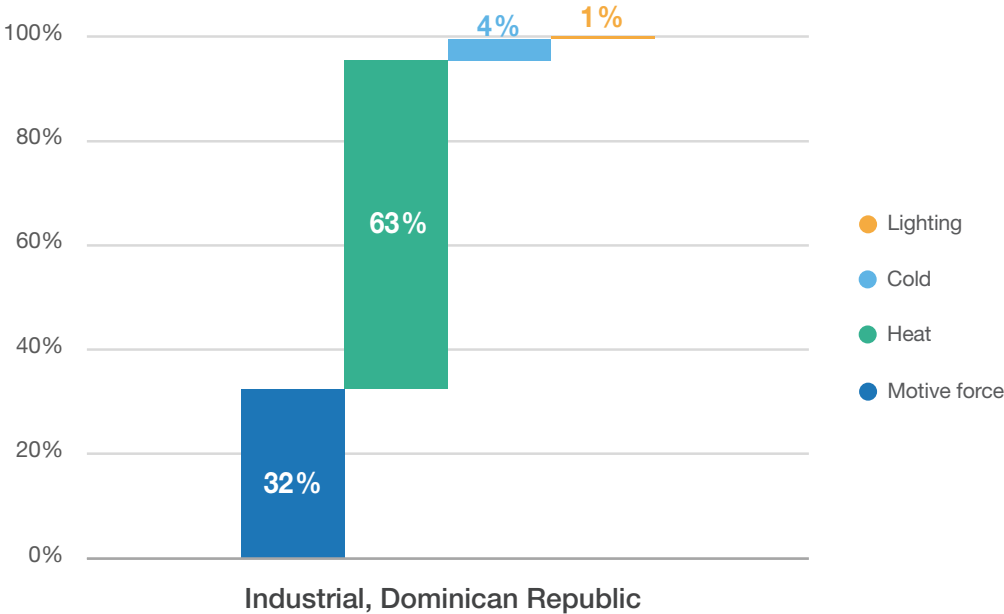


Source: Own preparation based on data from sieLAC, OLADE.

In terms of energy consumption by end use, heat and motive force uses amount to 95 % (63 % and 32 %, respectively).

Graphic 20

► Industrial sector: energy consumption by end use, 2018



Source: Own preparation based on data from Fundación Bariloche, 2018.



Transportation sector

Demand by source

Final consumption in the transportation sector has increased in the last 20 years (2.0 % annual average). By GDP unit, the energy intensity of the transportation sector¹² fell significantly in the period. By source, the following characteristics can be mentioned:

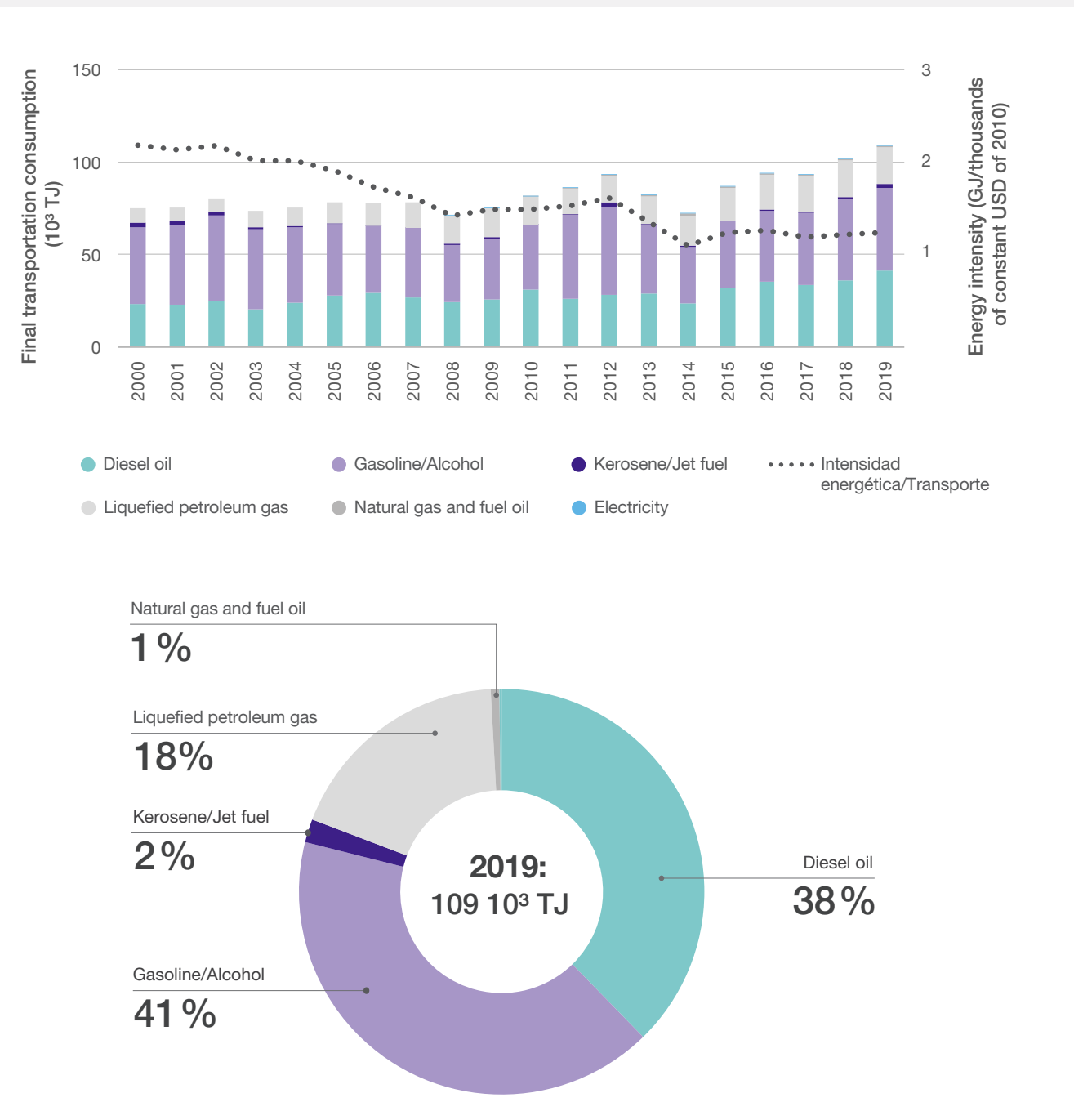
- high gasoline/alcohol and diesel consumption; both fuels are the most chosen by road transportation, followed by LPG;
- at present, a very small role of electricity in the sector.



¹² The energy intensity of the transportation sector is calculated as energy consumption transportation/ total GDP. The GDP of the sector alone is not considered. Consumption in transportation involves all the economy.

Graphic 21

► Transportation sector: evolution of final consumption by source and year 2019, 10³ TJ



Source: wn preparation based on data from sieLAC, OLADE.

Vehicle fleet and consumption by type

Table 8 shows the total road vehicles and their share by type. The Dominican Republic (and also Colombia) differs from other countries because of the large number of motorcycles, which account for 56 % of the total fleet against 21 % for cars and 11 % for light trucks.

Table 8

► Total number of road vehicles and by type, 2019, Dominican Republic

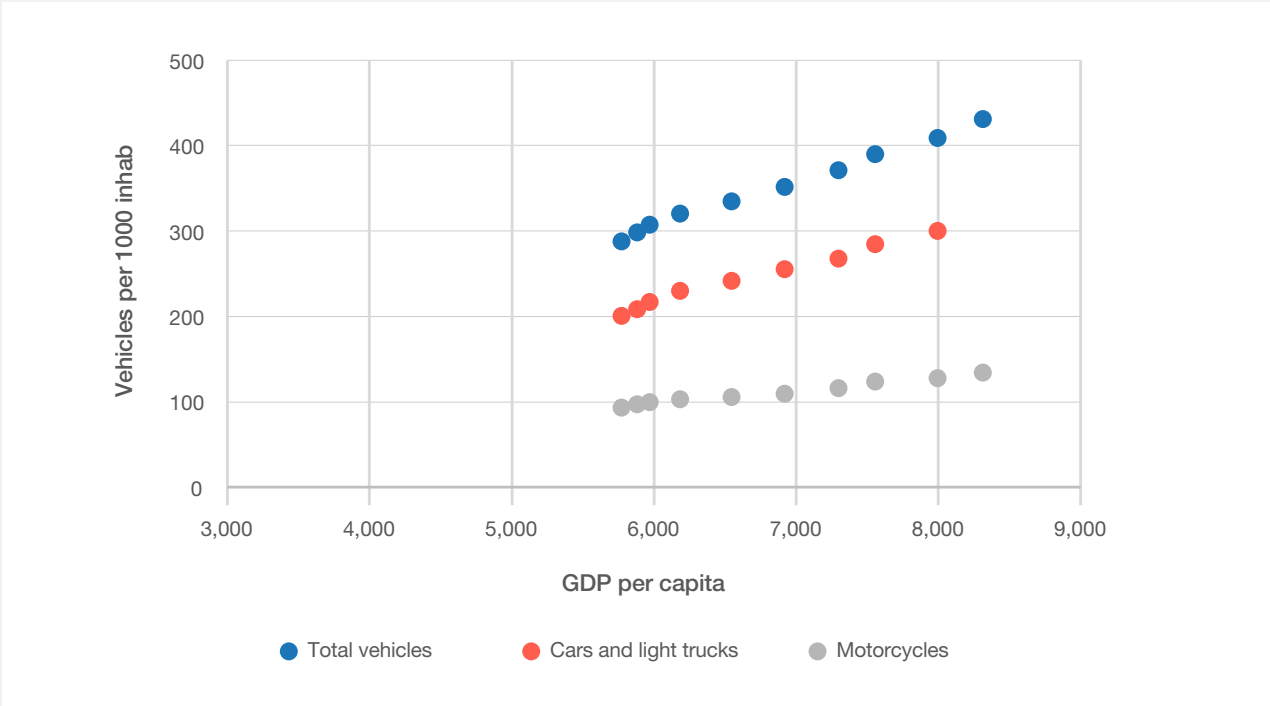
2019	
Cars	21 %
Light trucks	11 %
Motorcycles	56 %
Buses	2 %
Freight	10 %
Heavy machines + dump	1 %
Other	0 %
Total	4,634,876

Source: Own preparation based on data from the National Office of Statistics, Dominican Republic.

As the GDP per capita rises, the Dominican Republic slowly develops its vehicle fleet.

Graphic 22

► Vehicle fleet versus GDP per capita, 2010-2019



Source: Own preparation based on data from the National Office of Statistics, Dominican Republic.

Table 9 shows fuel consumption by transportation type and by fuel.

Table 9

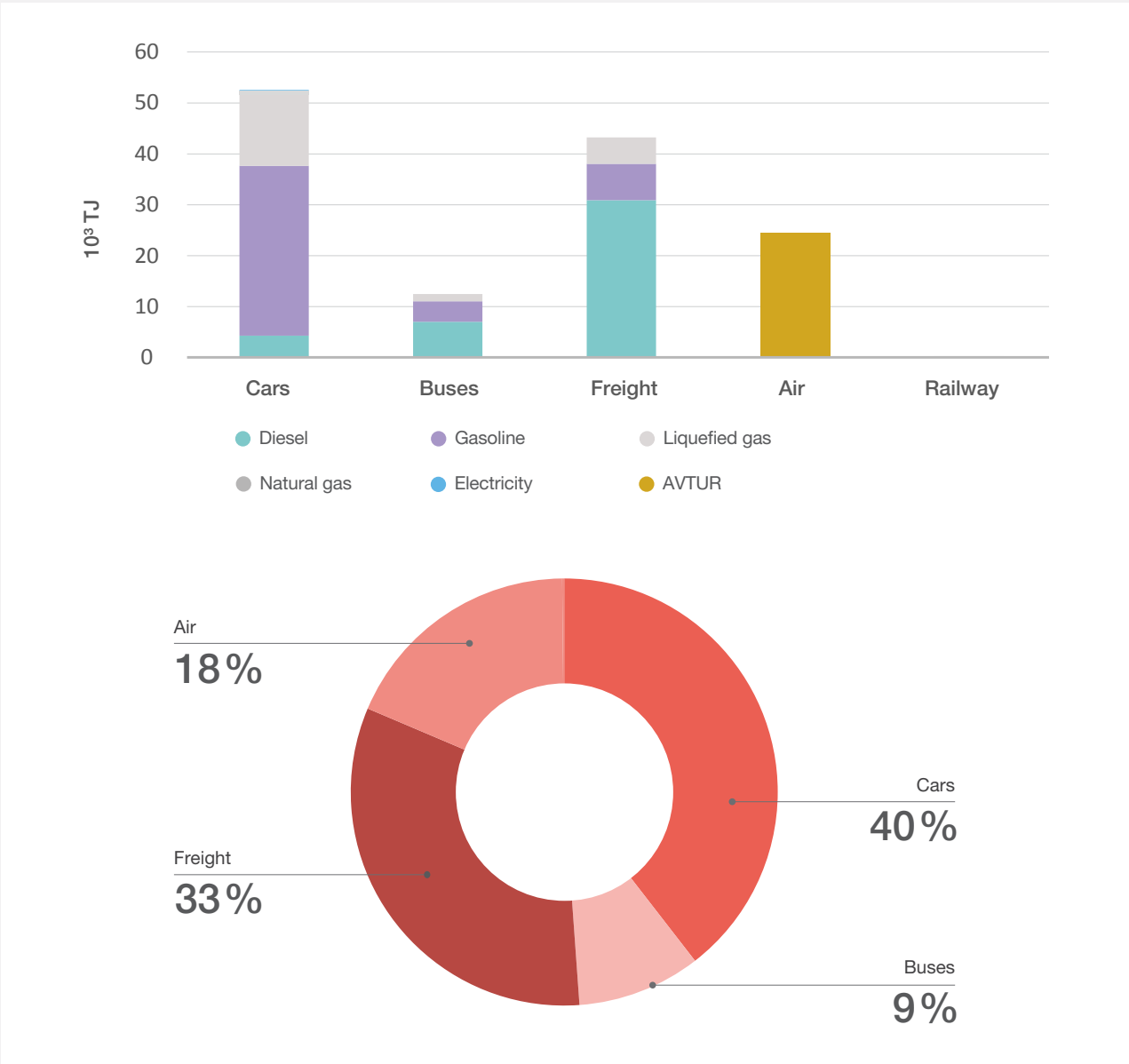
► Consumption by transportation type and by fuel, 10³ TJ and %, 2019, Dominican Republic

	Total consumption (10 ³ TJ)	Diesel	Gasoline	Liquified gas	Natural gas	Electricity	AVTUR
Cars	52.4	8%	64%	27%	1%	0%	-
Buses	12.4	57%	32%	11%	-	-	-
Freight	43.2	72%	17%	12%	-	-	-
Air	24.5	-	-	-	-	-	100%
Railway	0.2	-	-	-	-	100%	-

Source: Own preparation based on data from Fundación Bariloche, 2018.

Graphic 23

► Transportation sector: final consumption by type and by fuel, 10³ TJ



Source: Own preparation based on data from Fundación Bariloche, 2018.



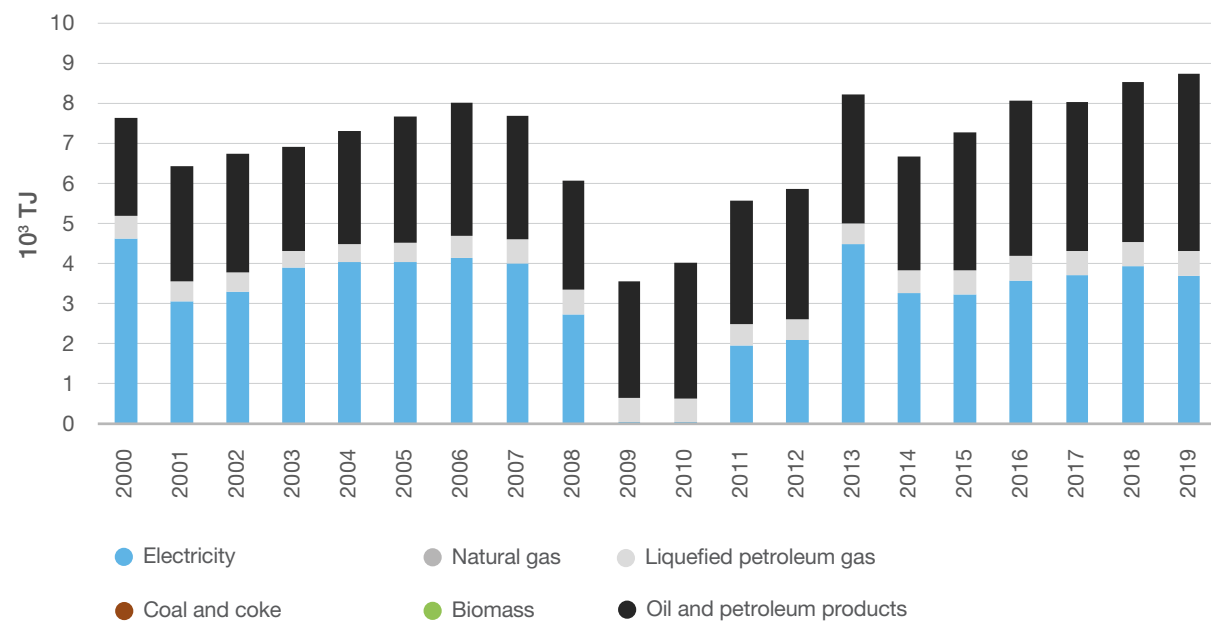
Agriculture, fishing, mining, and construction sector

Final consumption of the sector has increased irregularly in the last 20 years (0.7 % annual average). By source, we can mention the following characteristics:

- share of oil and petroleum products close to half the total consumption in 2019 (51 %);
- electricity supply (42 %) and LPG (7 %) in the rest of the demand.

Graphic 24 A

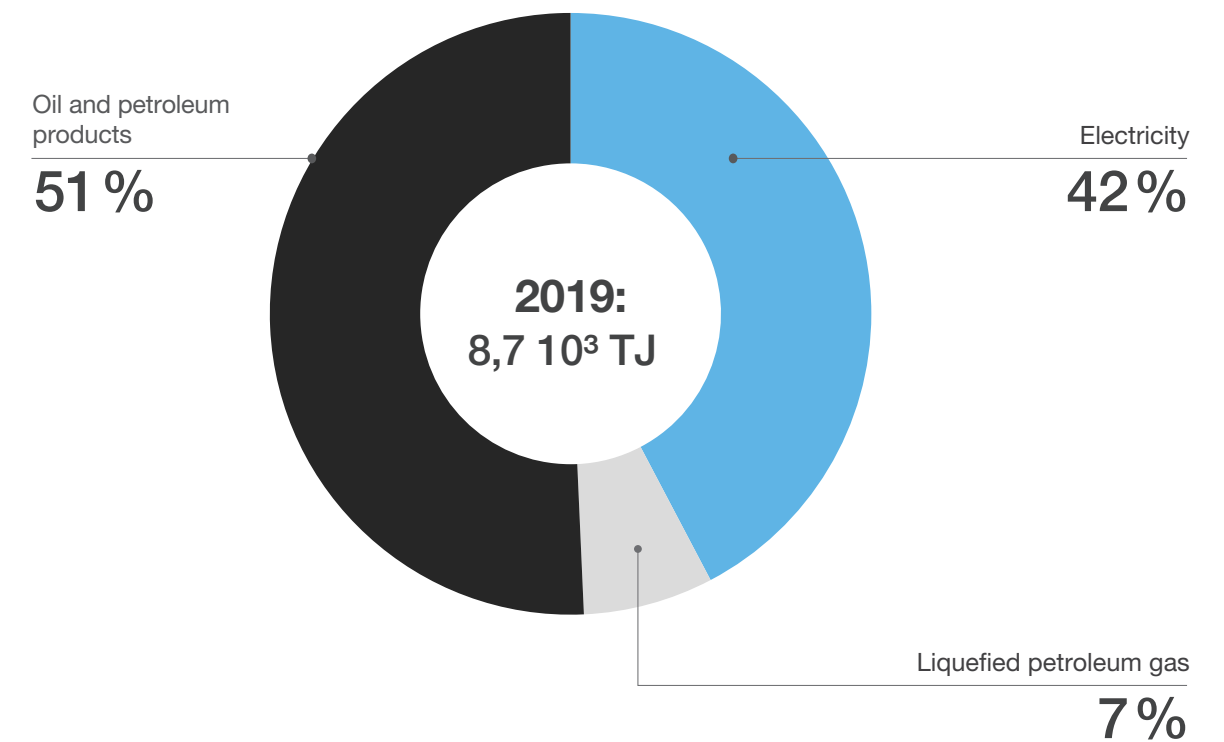
► Other sectors: evolution of final consumption by source, 10³ TJ



Source: Own preparation based on data from sieLAC, OLADE.

Graphic 24 B

► Other sectors: evolution of final consumption by source, 10³ TJ



Source: Own preparation based on data from sieLAC, OLADE.

By subsector, we can mention that the agriculture sector has the largest consumption (81 %) whereas construction accounts for 19 % of the demand.

5. International energy trade

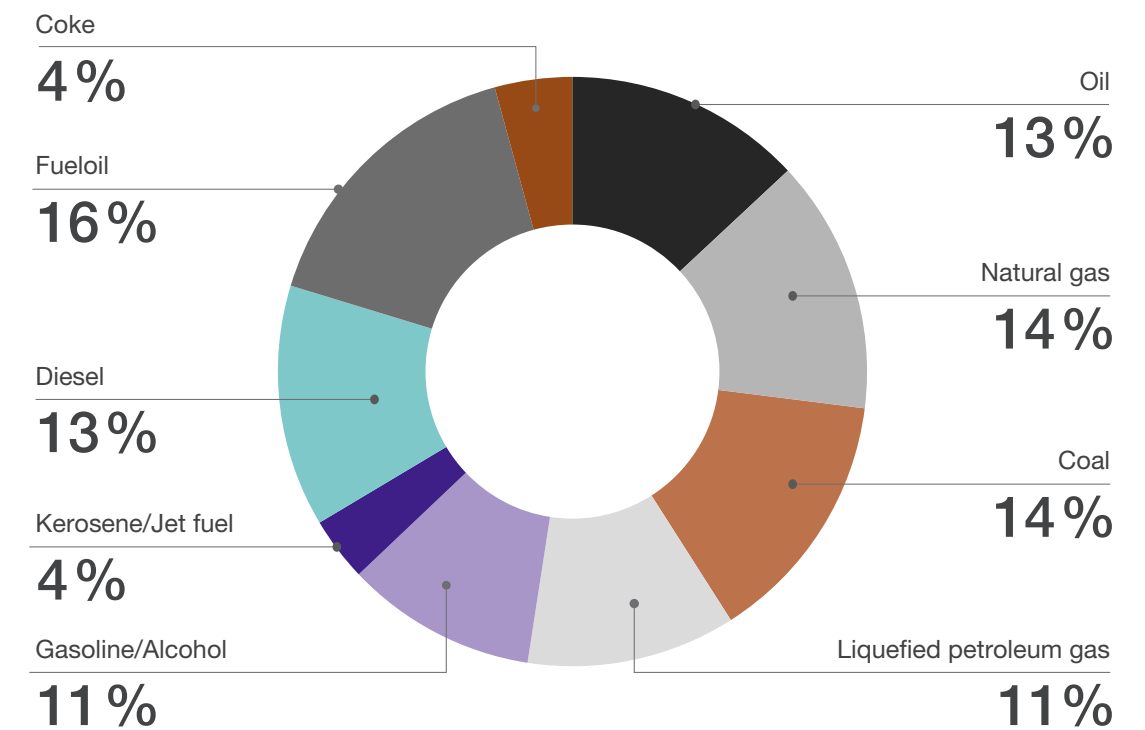
The Dominican Republic is a net energy importer; imports covered 92.5% of its total energy supply in 2019 whereas kerosene/jet fuel exports accounted for only 5.5% of the supply.

The country imports primary energy (oil, natural gas, and coal), which represent 41 % of the total energy imports; the rest is secondary energy (petroleum products).



Graphic 25

► Dominican Republic, energy imports



Source: Own preparation based on data from sieLAC, OLADE.

Oil and petroleum product imports grew to USD 3,700 million in 2019 (8 % of total imports in 2019) according to the Central Bank of the Dominican Republic¹³.

¹³ There is no differentiated item showing the value of natural gas imports.

6. Power sector

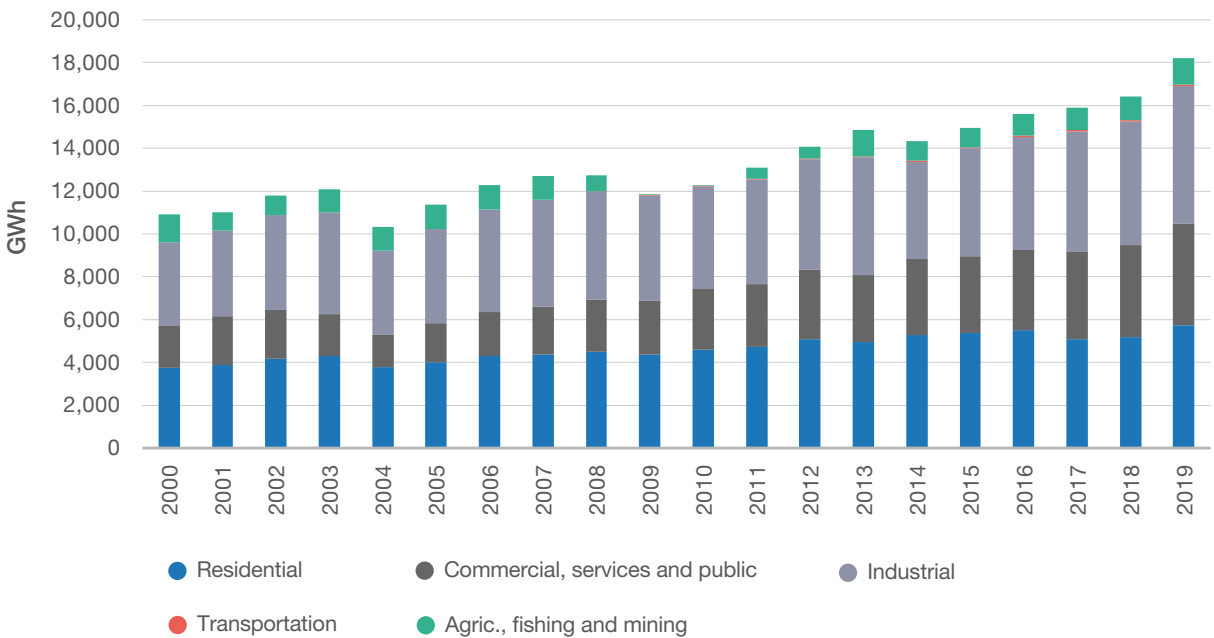


Power demand

Graphic 26 shows final electricity consumption in the different sectors of the economy.

Graphic 26 A

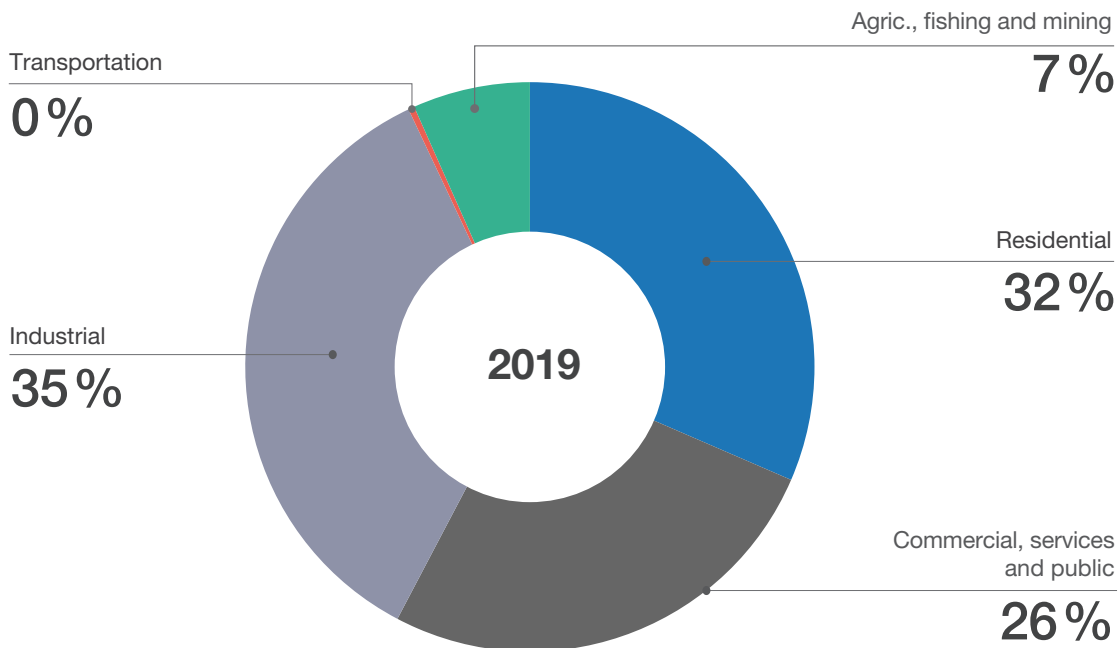
► Final electricity consumption by sector, 2000-2019, and year 2019, GWh



Source: Own preparation based on data from sieLAC, OLADE.

Graphic 26 B

► Final electricity consumption by sector, 2000-2019, and year 2019, GWh



Source: Own preparation based on data from sieLAC, OLADE.

The evolution of the annual growth rate of power demand has had great variations, with positive and negative inter-annual values. This is due to structural problems in the Dominican power sector, which has historically suffered from rotating outages (Demand Management Program, PGD) due to scarcity of supply and an unstable payment chain.

The PGD consists in regular load outages imposed on the regulated demand. It has reached historical peaks of around 20%. Some years ago, the Government established a plan to eliminate it in 2024. So far, it managed to reduce it to around 1.2% in 2021, with a strong reduction in the period 2019-2021. It is expected that the managed demand will continue being reduced in the next few years, ahead of the official plan (total elimination in 2022), especially with the incorporation of new power plants.

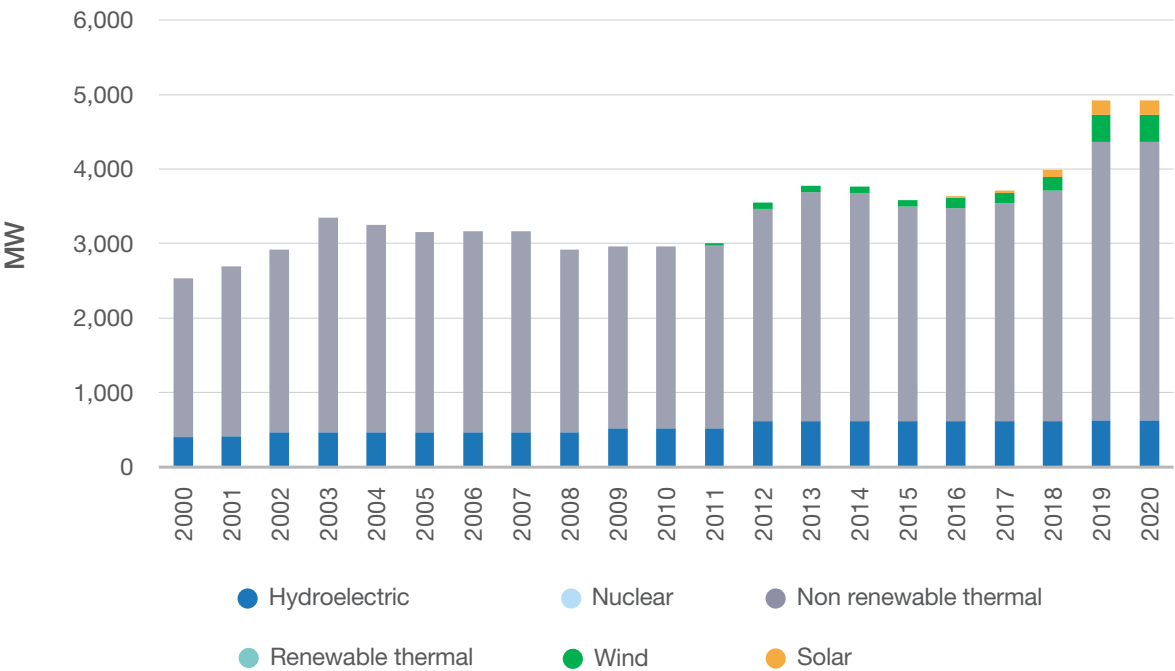
In 2019, the average composition of electricity consumption in the Dominican Republic was represented by the industrial sector (35%) in the first place, followed by the residential sector (32 %) and the commercial, services, and public sector (26%). In the last 20 years, the share of the commercial, services, and public sector has grown.



Installed capacity

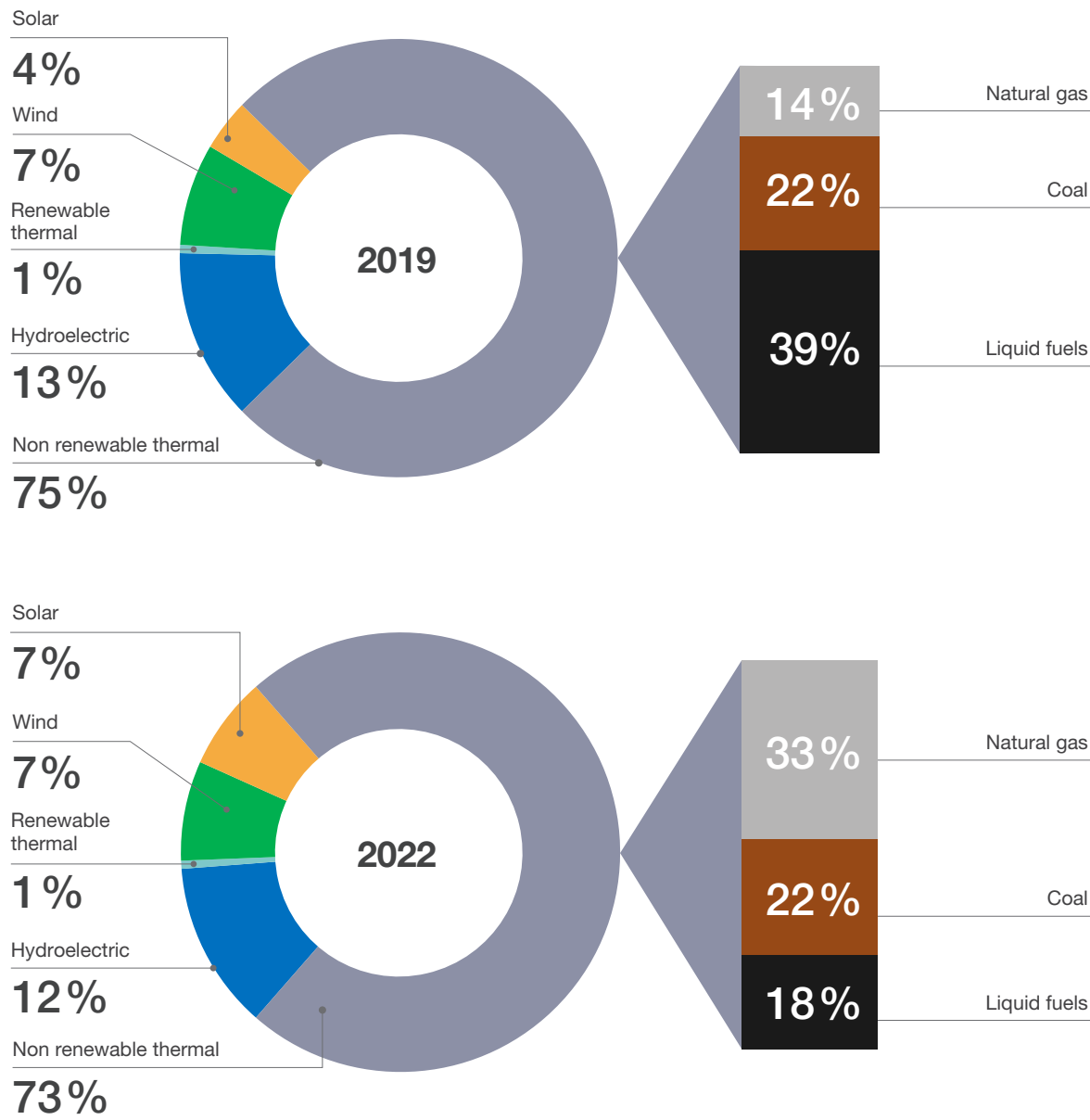
Net installed capacity was 4.9 GW in 2019 and mainly thermal. Thermal plants employ coal, gas, or liquids as fuel.

Graphic 27 ▶ Installed capacity, 2000-2020, MW



Source: Own preparation based on data from sieLAC, OLADE.

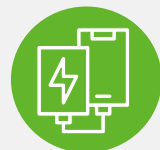
Graphic 28 ▶ Installed capacity by source, 2019-2022, %



Source: Own preparation based on data from the Coordinator's (OC, in Spanish) annual report.

The generation fleet's available capacity has been historically low (for example, 61 % in 2022), mainly due to fuel shortage, which limits the thermal fleet¹⁴ availability.

In recent years, wind and solar projects were initiated to diversify the generation matrix. On the other hand, some of the thermal plants burning liquid fuels were reconverted to gas. In 2019 and 2020, the two modules of Punta Catalina coal-fired plant went into service. With its 750 MW of installed capacity, it is the largest power plant in the country.



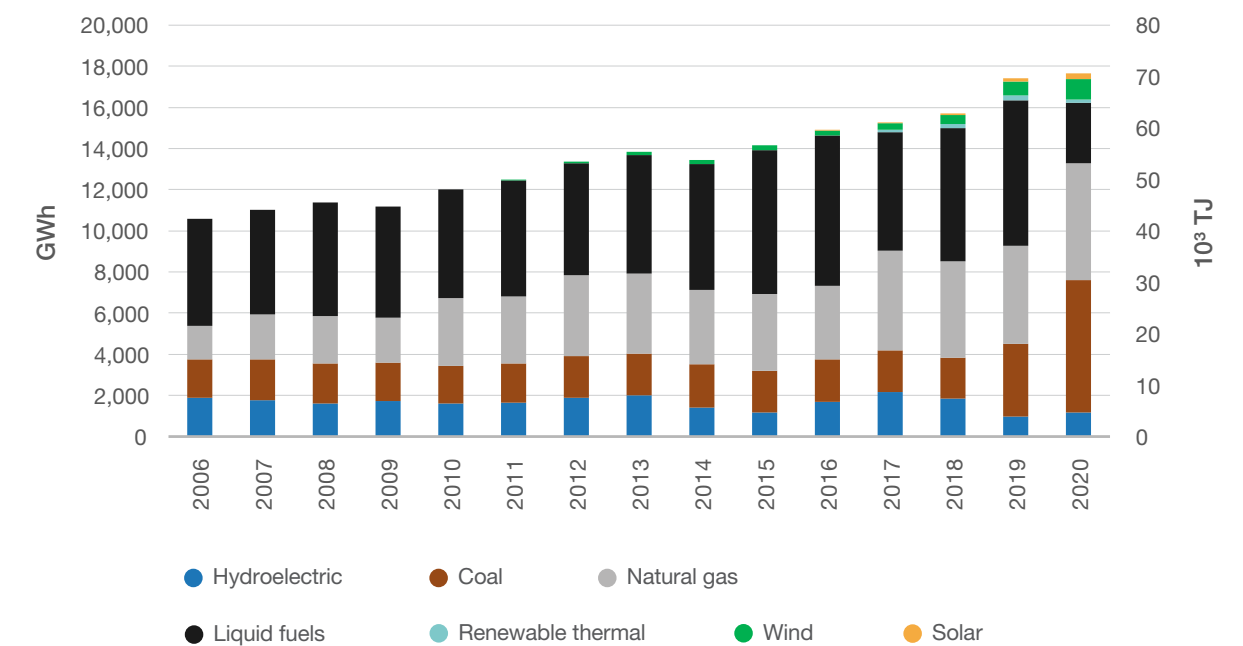
Power generation

As shown in Graphics 29 and 30, most of the generation mix is thermal. Hydroelectric generation is limited to less than 20% and its share reached minimums close to 6% in dry years. Moreover, until 2012, NCRE had no impact on the generation mix, and the share of solar and wind was around 7% in 2020.

¹⁴ Historically, high unavailability was mainly due to the lack of fuel availability. At present, several power plants have been reconverted to natural gas and this problem has been reduced, whereas the rest are mostly obsolete (they still appear in the system but their unavailability is close to 100%).

Graphic 29

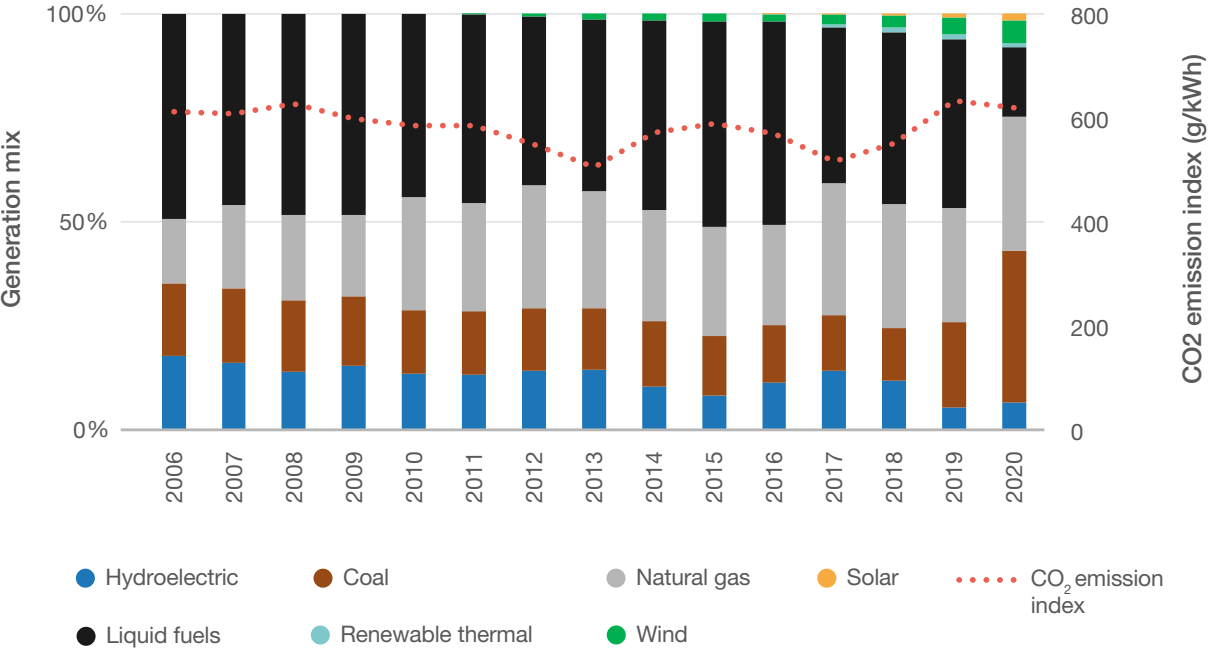
► Power generation by source, 2006-2020, GWh and 10³ TJ



Source: Own preparation based on data from the OC, system operator.

Graphic 30

► Power generation by source, 2006-2020, %, and CO₂ emission index in the power sector, g/kwh



Source: Own preparation based on data from the OC and sieLAC-OLADE.

The CO₂ emission index is high due to the large share of thermal generation (particularly with liquid fuels and coal).

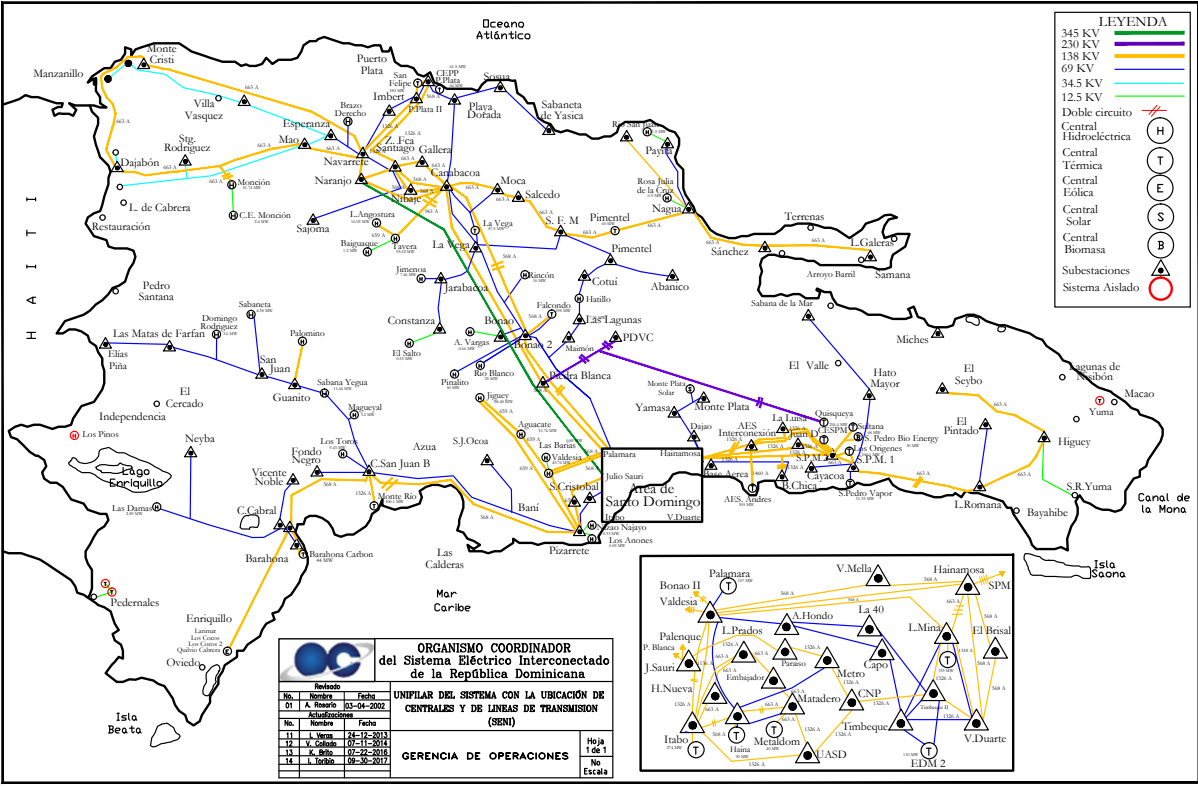
Historically, electricity prices have been high and have been directly related to the price of liquid fuels.

7. Existing power grids and gas pipelines

At present, the Dominican Republic has 5,362 km of power transmission lines (2018, OC) and a 50km-long gas transportation network, the Gasoducto de Andrés, from Boca Chía to San Pedro de Macorís (2019, CNE). The electrification rate is around 98 %.

Graphic 31

► National Interconnected System 2018, Dominican Republic



Source: OC, Coordinator of the National Interconnected System (SENI).

8. Conclusions

The Dominican Republic shows a current reality that presents certain relevant characteristics as a base line to face the energy transition towards carbon neutrality.

- The country's economy has shown sustained historical growth. There was an important fall in 2020 as a result of the COVID-19 pandemic and a significant recovery in 2021. This behavior is a favorable condition to sustain an energy transition process in the future.
- The impact of poverty has continued its declining trend, with levels that are still significant but are lower than many other countries in the region. The reduction of poverty, which will necessarily occur as part of a just energy transition, will entail energy demand growth. This growth will increase investment requirements but – at the same time – will allow the markets to expand, which may enhance competitiveness to introduce new low-emission technologies.
- The country has no fossil fuel reserves and imports practically all its energy. This may reduce possible constraints to carry out an energy transition process.

- On the other hand, the country has recently invested in power generation with liquefied natural gas (LNG) and coal, which may slow down the transition process in the medium term (stranded assets).
- The country's energy potential is limited due to its geographical conditions (an island with limited land availability).
 - Offshore wind generation may be an option to increase the share of renewable energy generation.
- Electricity tariffs do not cover the costs of the service. The Government owns the distribution companies and provides funds for their operation.

Energy demand

- Historical energy intensity was significantly reduced in the period 2000-2019.
- There is replacement potential for the residential use of firewood with cleaner fuels.
- The population is mainly urban and distances are short; this may facilitate the development of more efficient and cleaner public passenger transportation and the electrification of the private vehicle and freight fleet.

Power sector

- The generation mix is very fossil.
- Recently, some wind and solar projects have started being developed to diversify the generation matrix.
- In 2019 and 2020, the two modules of coal-fired Punta Catalina power plant went into service. With its 750 MW of installed capacity, it is the largest power plant in the country.

“The Dominican Republic initiated onshore wind and solar projects to diversify its energy matrix. In the long term, offshore wind generation may be an option to increase renewable electricity sources in the country.”



2

Energy projection
methodology



1. Base year and planning horizon

The base year considered for the projection is 2019, previously described in the chapter “Diagnosis and base line”. The planning horizon starts in 2019 and ends in 2060.



2. Projection modeling



General description

In order to conduct the study, a low-emissions analysis platform (LEAP) model, developed by the Stockholm Environment Institute (SEI), was used. The LEAP model is a (software) tool used to analyze energy policies and assess climate change mitigation. In this case, it was used to model the emissions from the energy sector relating to burning fuel in the Dominican Republic.

In terms of modeling methodologies, the LEAP model is particularly versatile.

- It starts from the information from the energy balances, which guarantee the integrity of the data used.
- Energy demand can be projected by using methodologies:
 - bottom-up, from specific detailed data to a total projection, or
 - top-down.

In this study, bottom-up modeling was selected and the demand was divided into sectors (residential, industrial, transportation, etc.) which, in turn, were subdivided into subsectors and uses.

- Energy supply offers a wide range of simulation methodologies that allow us to estimate an annual power generation dispatch or incorporate the results of other more specialized optimization models.

The modeled demand sectors are projected according to an activity level and an explanatory variable, summarized in Graphic 32 in a simplified manner.

Graphic 32

► Sectors, activity levels, and explanatory variables

Sector	Activity level	Explanatory variable
Residential	Population	Consumption per capita
Road transportation	Target variable, vehicle fleet	Average consumption per vehicle
Non-road transportation	Total GDP	Energy intensity
Industrial	Sectoral GDP	Energy intensity by subsector and use
Commercial, services, and public sector	Sectoral GDP	Energy intensity
Agricultural, fishing, mining, and construction	Sectoral GDP	Energy intensity

Source: Own elaboration

The sectoral GDP is one of the main drivers of energy demand growth, particularly for production sectors, while the evolution of the population plays an important role in the energy demand growth of the residential sector. The road transportation sector depends on the evolution of the number of vehicles which, in turn, is related to the GDP per capita in the case of passenger transportation and the GDP in the case of freight transportation. Non-road transportation is projected on the basis of the global GDP.



Demand by sector

Residential sector

In order to analyze and project energy consumption in the residential sector, the **projection of the population and of unitary consumption** are estimated by use and by source per capita.

Residential consumption has two kinds of energy uses: heat uses (mostly cooking, sanitary hot water (SHW), space heating), which use different fuels with substitution potential, and electrical uses (lighting, refrigeration, etc.). The following analysis apply to each group.

- **Heat uses**
 - **Cooking.** The historical consumption trends used for future projections are analyzed in terms of useful energy¹⁵ per 1,000 inhabitants. Fuel substitution assumptions are presented by scenario (replacement of firewood with electric appliances or others running on natural gas).

¹⁵ According to OLADE, IADB, 2017, final energy is “the amount of energy source consumed in each economic and social sector in the country”. On the other hand, useful energy is “the amount of energy actually used to perform the productive task of the consuming equipment or device, for example, the necessary heat that food must absorb to be cooked”.

- **SHW and space heating.** For SHW, the increase in consumption for water heating was considered in proportion to the GDP increase, as it is considered that greater wealth entails more comfort; however, this use will not be developed to very significant levels due to the hot climate. The space heating use is not considered because of the hot climate.
- **Other electrical uses.** Electrical uses (lighting, refrigeration, air conditioning, water pumping, electronics, etc.) are projected based on a historical regression against the GDP per capita, which shows the increase in electrical uses as the standard of living increases. In addition, energy efficiency enhancements are considered.

Commercial, services, and public sector

In order to estimate the energy consumption of the commercial sector, we started from its consumption in 2019 and projected it **based on the GDP growth and energy intensity obtained for the base year**, by source, without discriminating by end use. Different assumptions are presented in terms of energy efficiency and fuel substitution.

Industrial sector

Industry was projected with information on energy consumption from 2019, broken down with an International Standard Industrial Classification (ISIC) digit, additional to that of the sector's GDP **by activity subsector**. Seven subsectors were modeled, of which non-metallic products; food, beverages and tobacco;

and sugar mills were the most relevant in terms of energy consumption. In turn, for each industrial subsector, consumption was broken down by end use (direct heat, steam, motive force, etc.) and by source.

Expected GDP growth, together with energy intensity by subsector and use obtained for 2019 are used for the energy consumption **projection**, mainly based on the final and useful energy balances available. The assumption was that the industrial sectors will maintain their share of the total industrial GDP during the planning horizon¹⁶. Energy efficiency is modeled through a reduction in energy intensity while fuel substitutions are performed in terms of useful energy, with annual rates of participation.

Transportation sector

The transportation sector is projected pursuant to the following structure to reflect the main drivers that vary in each segment:

- road passenger transportation (cars, motorcycles, buses, etc.);
- road freight transportation (trucks, truck tractors);
- other (air, maritime/river, railway).

Road passenger transportation

To estimate the energy consumption level or the activity level of road passenger transportation, the following were estimated:

- **evolution of the vehicle fleet** (number of motorcycles, cars, light trucks, buses, etc.); and

¹⁶ This assumption implies that no structural changes are modeled within the industrial sector and the same GDP growth rate is applied to all the subsectors.

- **average consumption by vehicle** calculated as the average annual distance traveled, divided by performance in km by energy unit.

Projection of the passenger vehicle fleet

- Private transportation (motorcycles, cars, light trucks)

In the first place, countries with high development levels were identified and the average number of cars and motorcycles per 1,000 inhabitants in these countries was estimated. Such average was used as a long-term **saturation point** (2060), and projections were made using a logit function¹⁷ to estimate the number of future private transportation vehicles.

In addition, to calculate the number of vehicles by type (motorcycles/cars), Law’s conclusions (Law, 2015) on the relation between the **number of motorcycles per 1,000 inhabitants and GDP per capita**, shaped like an **inverted “U”**¹⁸ , were used. This implies that, at first, the number of motorcycles per 1,000 inhabitants has a positive relation to GDP per capita until it peaks; from there on, as the development level of the countries increases, the number of motorcycles starts to fall and the number of cars increases.

- Public transportation (bus)

Like in the case of private transportation, the average number of passenger vehicles per 1,000 inhabitants in developed countries was considered as an expected saturation point for developing countries in the long term. A logistic function was also used.

¹⁷ The logit function or logistic curve or S-shaped curve is a mathematical function used in population growth models, product introductions, etc. Such function is a refinement of the exponential model for magnitude growth. In product introduction, growth is initially exponential; after some time, the growth rate decreases; finally, at maturity, growth stops.

¹⁸ Law, Hamid & Goh (2015), *The motorcycle to passenger car ownership ratio and economic growth: A cross-country analysis*.

Road freight transportation

To estimate the energy consumption level or the activity level of the freight transportation sector, the following were estimated:

- **evolution of the vehicle fleet** (number of trucks + truck tractors), and
- **average consumption per vehicle** calculated as the annual average distance traveled divided by performance in km per energy unit.

Projection of the freight vehicle fleet

In order to estimate the future evolution of the freight vehicle fleet, the freight transportation fleets were projected with the linear regression method, using the total GDP (measured at purchasing power parity, PPP, of 2017) as an independent variable.

Freight transportation is segmented into two types of trucks: trucks and truck tractors; the latter are heavy-duty trucks with trailers. The shares of each type of truck were projected as constant.

Air, maritime/river, and railway sector

Energy consumption for the sector was projected based on the **global GDP growth and the energy intensity** obtained for 2019, for each type of transportation, by source and without discriminating by end use.

Agriculture, fishing, mining and construction sector

Energy consumption for this sector was **projected based on the GDP growth and energy intensity** obtained for 2019, by source and without discriminating by end use. The transition measures considered were enhancements in terms of energy efficiency and fuel substitution.



Power sector

The starting point was the current composition of installed capacity and generation. To cover the growth of the sector in the short and medium terms, the development of the power sector considers the projects under construction or tender winners with a high degree of certainty and progress.

In the future, the expansion of the generation fleet will depend on:

- the relative competitiveness of the expansion options (renewable projects, particularly solar and wind, are believed to become more and more competitive due to the projected reduction in construction and development costs);
- the maximum project development potential by technology, as published at national level. This potential is considered a maximum limit;
- energy policy decisions included in the generation expansion plan;
- the local context regarding the development of projects by type.

The expansion of the generation fleet considers aspects such as:

- the average production factor, by technology and by country, for renewable projects;
- the firm energy or capacity that each technology can provide;
- the minimum production factor from which new thermal projects are developed;
- the estimation of power demand¹⁹, including losses and own consumption.

The analysis is carried out on an annual basis (that is, it is not a detailed hourly simulation exercise but a ‘high-level’ estimation, as a first estimation in the context of a long-term energy transition analysis).

Even though most countries will need flexibility means (storage, demand management) to accompany the development of non-conventional renewable energy (NCRE), a high-level estimation was carried out in the chapter on financing²⁰.

¹⁹ The projections presented in this report do not include the power demand associated with the electrolysis process to produce green hydrogen for local consumption and/or export, nor the related electrical capacity.

²⁰ Current technologies are not competitive and productivity enhancements are expected, which prevents us from establishing with certainty the degree of penetration they could reach.

“Sectoral GDP is one of the main drivers of energy demand growth, particularly for productive sectors. Population growth plays a key role in the increase of energy demand in the residential sector.”

3. Scenarios and global framework



Definition of the scenarios

Three scenarios were studied to characterize different pathways towards a just energy transition. See the detailed description in the chapter “Methodological section and assumptions”, *Just Energy Transition / Projection Assumptions report*.

The Business as Usual (BAU) scenario represents the expected evolution following national public policy guidelines and the current trends. The assumptions are based on the analysis of recent historical trends in terms of energy transition in each analyzed country, as well as the paths traveled by more developed countries, to identify mitigation measures that can be rapidly implemented. Even though no disruptive changes are expected and it is not possible to meet the net zero emissions target during the planning horizon in this scenario, investment is required to continue the energy transition policies that are being carried out in the Dominican Republic. The pathway that was started with the 2030 goals committed under the NDC should be taken into consideration even though some of those goals may not be attained.

On the other hand, the **Net Zero 2050 (NZ 2050) and Net Zero 2060 (NZ 2060) scenarios** are based on the terms established in Article 4 of the Paris Agreement²¹. Both scenarios focus on reducing GHG emissions from the energy sector²² to a permissible minimum²³, so that the country can manage the absorption of CO₂ in the general balance of the national GHG inventory²⁴.

These scenarios require major investment and addressing different topics to **transform the current energy sector deeply**. Such topics include, for example, strengthening the technological bases, training human resources, energy planning, regulatory commissioning, infrastructure expansion, and instruments to develop the market for the new energy resources, as well as **changes** – in some cases disruptive – in the energy matrix, among others.

21

Paris Agreement, paragraph 4.1: “achieve a balance between anthropogenic emissions by sources and removals by sinks of GHG in the second half of the century”.

22

The analysis performed focuses on the emissions related to burning fuels, both in energy demand processes by sector and in power generation. GHG emissions from other sectors (e.g., industrial processes, waste, fugitive emissions, etc.) are not detailed in this study, but are broadly estimated and are subtracted to estimate the national reduction potential.

23

It is assumed that emission reduction must be achieved through an effective combination of regulatory measures, promotion of market efficiency, technology transfer, and investment.

24

It is assumed that CO₂ absorptions will result from measures implemented in the agriculture, cattle-raising, forestry, and other land uses (AFOLU) sectors or via the adoption of CO₂ capture, use, and storage technologies (CCUS).



Projections of the socio-economic variables

GDP per capita and GDP

In line with the grounds for a **just energy transition (JET)**, the scenarios presented are accompanied by similar socio-economic development in the region, **reaching sufficient GDP per capita levels to be considered high-income countries**. In the case of the Dominican Republic, the GDP per capita stands at approximately USD 42,500 per capita at PPP in 2060, with a 2.1 % annual growth rate in the period.

Table 10

► Socio-economic indicators and CAGR 2019-2060 (%)

		2019	2030	2040	2050	2060	CAGR of period
GDP per capita	USD per capita	18,171	24,314	29,887	35,743	42,474	2.1 %
Total GDP	MUSD	197,736	291,340	379,659	471,112	571,919	2.6 %
Population	1,000 inhabitants	10,882	11,983	12,703	13,181	13,379	0.5%

Source: Own preparation.

The GDP by sector is projected assuming that the share of each sector is maintained pursuant to 2021 values. This results in a GDP growth rate by sector equal to the total GDP growth rate.

Population

As to the projection of the population, information from CEPALSTAT²⁵ was used. A deceleration in population growth is expected in the Dominican Republic in the future.

25 <https://statistics.cepal.org/portal/cepalstat/dashboard.html?theme=1&lang=es>

4. Main assumptions in the energy sector

The general framework of the study covers the definition of assumptions for **five target countries**. Even though each country has its own characteristics, the study **standardizes, whenever possible, the assumptions used** and assumes that the countries will undergo similar processes for the just energy transition. The particularities inherent in each country were considered, such as the coal industry in Colombia, biofuels in Brazil, natural gas at very competitive prices in Mexico, gas in Peru, and fossil natural resources shortage in the Dominican Republic, among others.

In order to meet the decarbonization targets set in each scenario, the assumptions considered were more ambitious in the case of the net zero (NZ) scenarios. The main assumptions are based on the measures described below.

- **Energy efficiency enhancements.** This is applied in all sectors, with equipment replacements, more thermal efficiency in homes, optimization of the use of energy in industrial processes, and technological replacements to more efficient appliances and facilities, more efficiency in transportation vehicles, etc.
- **Behavior changes.** This refers, in particular, to the reduction in average distances traveled by vehicle (km/vehicle) as a result of digitalization in society (remote work, etc.), the development of public transportation, logistics enhancements, and the shift from freight transportation by truck to the railway system.

- **Fuel substitution.** In most of the sectors, there is a trend towards further electrification of energy uses, except for industrial uses or subsectors where there are low electrification possibilities. In these cases, the replacement of fuels with more CO₂ emissions by natural gas or the use of CO₂ capture and storage technologies are the projected options. Hydrogen and its low-emission derivatives may also contribute to the decarbonization of the industrial sector (fertilizers, refining) and of heavy road, maritime, and air transportation (synthetic fuels).
- **Power generation matrix with non-fossil technologies.** A very significant development of renewable energy and, in some cases, nuclear energy, is incentivized, as well as the phase-out of coal-fired plants and plants running on liquid fuel. It is important to remember that power generation composition is a key element in scenarios where strong electrification of the consumption matrix is proposed to guarantee that this substitution will have the expected effect in terms of GHG reduction. This integration of renewable energy must be accompanied by the development of grid infrastructure, smart grids, and batteries to facilitate the integration of variable power generation.

The assumptions detailed by sector are presented in the chapter “Results and assumptions by sector”. It is important to point out that the sectors with the most emission reduction potential in absolute values are the transportation and industrial sectors, which nowadays are responsible for around two thirds of the emissions from the energy sector.

1. Global results

The global results presented below show the sum of the assumptions adopted by each sector.

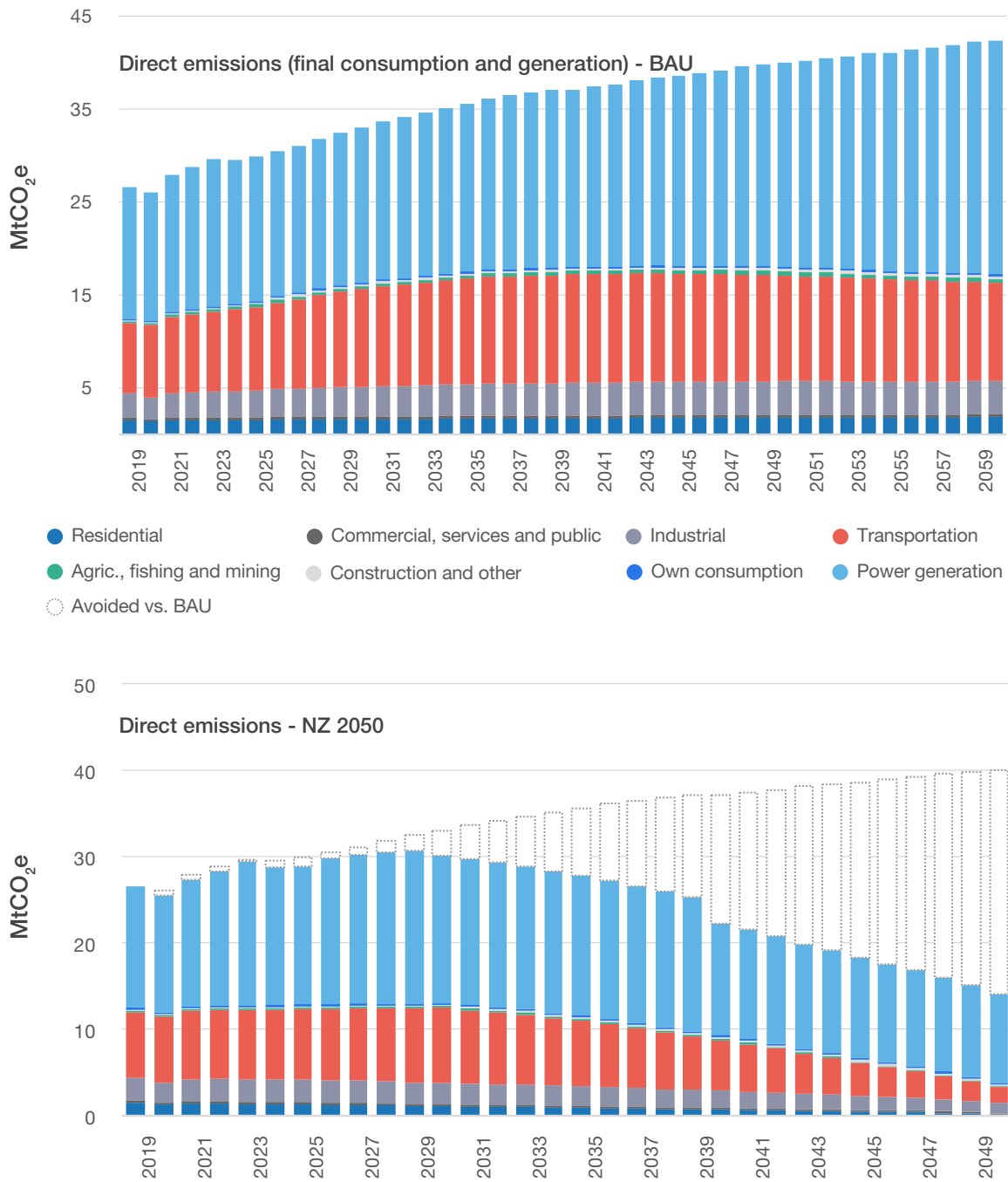


Emissions by sector

In the **BAU scenario**, the emissions related to burning fuels grow at an average annual rate of 1.1%, from 27 MtCO₂e in 2019 to 42 MtCO₂e in 2060. Even though this increase is sustained, it is **lower than the expected GDP growth**, which shows certain environmental improvement in the economy. Power generation continues being the sector with the most emissions in the Dominican Republic, followed by the transportation segment and, further behind, industry. Compliance with the NDC for 2030 implies decarbonization efforts with respect to the BAU scenario²⁶.

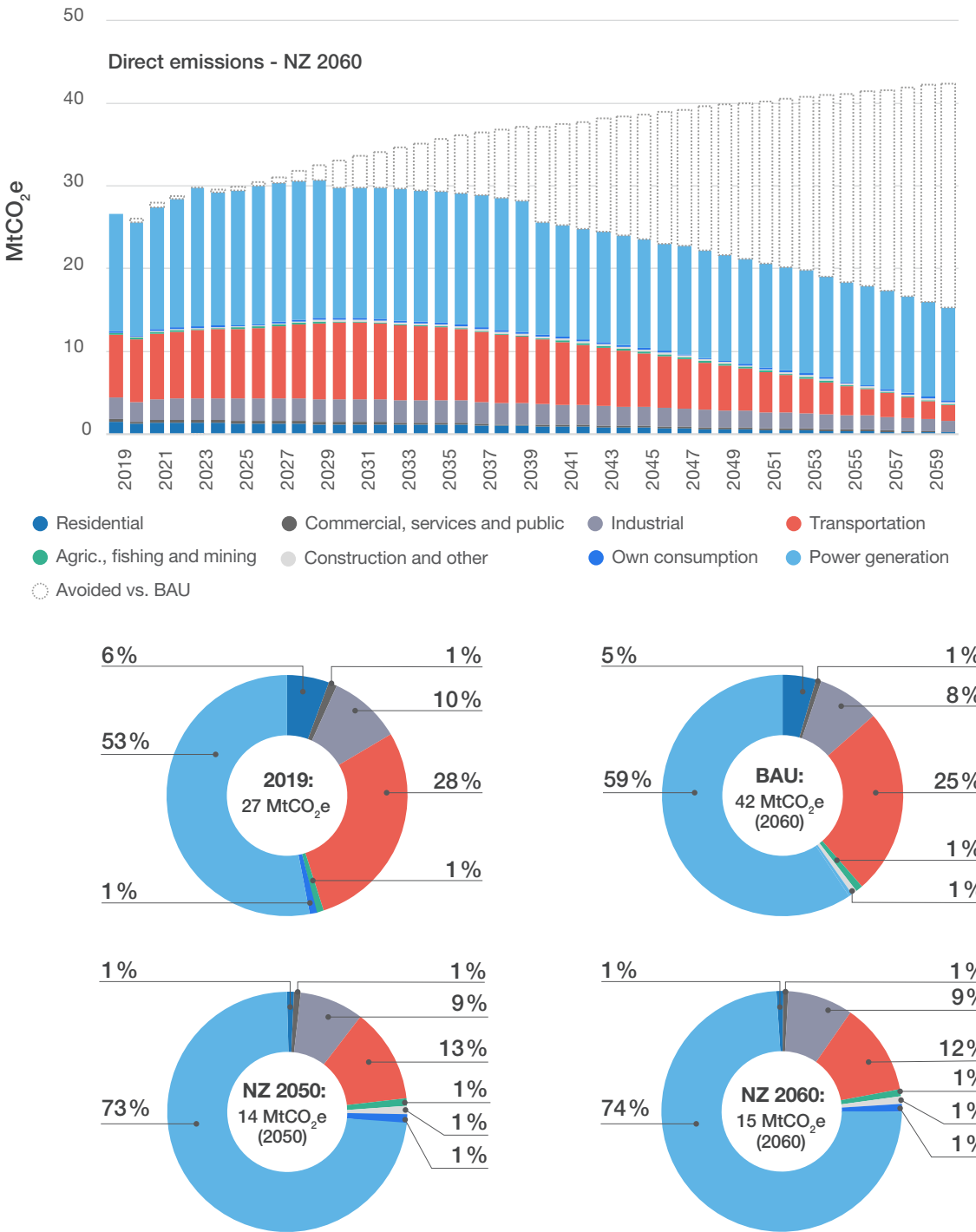
²⁶ <https://unfccc.int/sites/default/files/NDC/2022-06/Dominican%20Republic%20First%20NDC%20%28Updated%20Submission%29.pdf> (around 37 MtCO₂e in the 2030 horizon for all the sectors, including the IPPU sector, waste, etc.).

Graphic 33 A ▶ Direct emissions (final consumption and generation) by sector, MtCO₂e



Source: Own preparation.

Graphic 33 B ▶ Direct emissions (final consumption and generation) by sector, MtCO₂e



Source: Own preparation.

In the **NZ scenarios**, the need to reduce the emissions from the energy sector by 45% to 50% compared to the current value was proposed, since there are no international studies that mention the country's CO₂ absorption capacity. With this assumption, the projected emissions amount to 14 MtCO₂e in 2050 in the NZ 2050 scenario and 15 MtCO₂e in the NZ 2060 scenario. The average annual emission reduction pace is -2.0% in the NZ 2050 scenario and -1.3% in the NZ 2060 scenario. Power generation continues being the greatest source of CO₂ emissions.

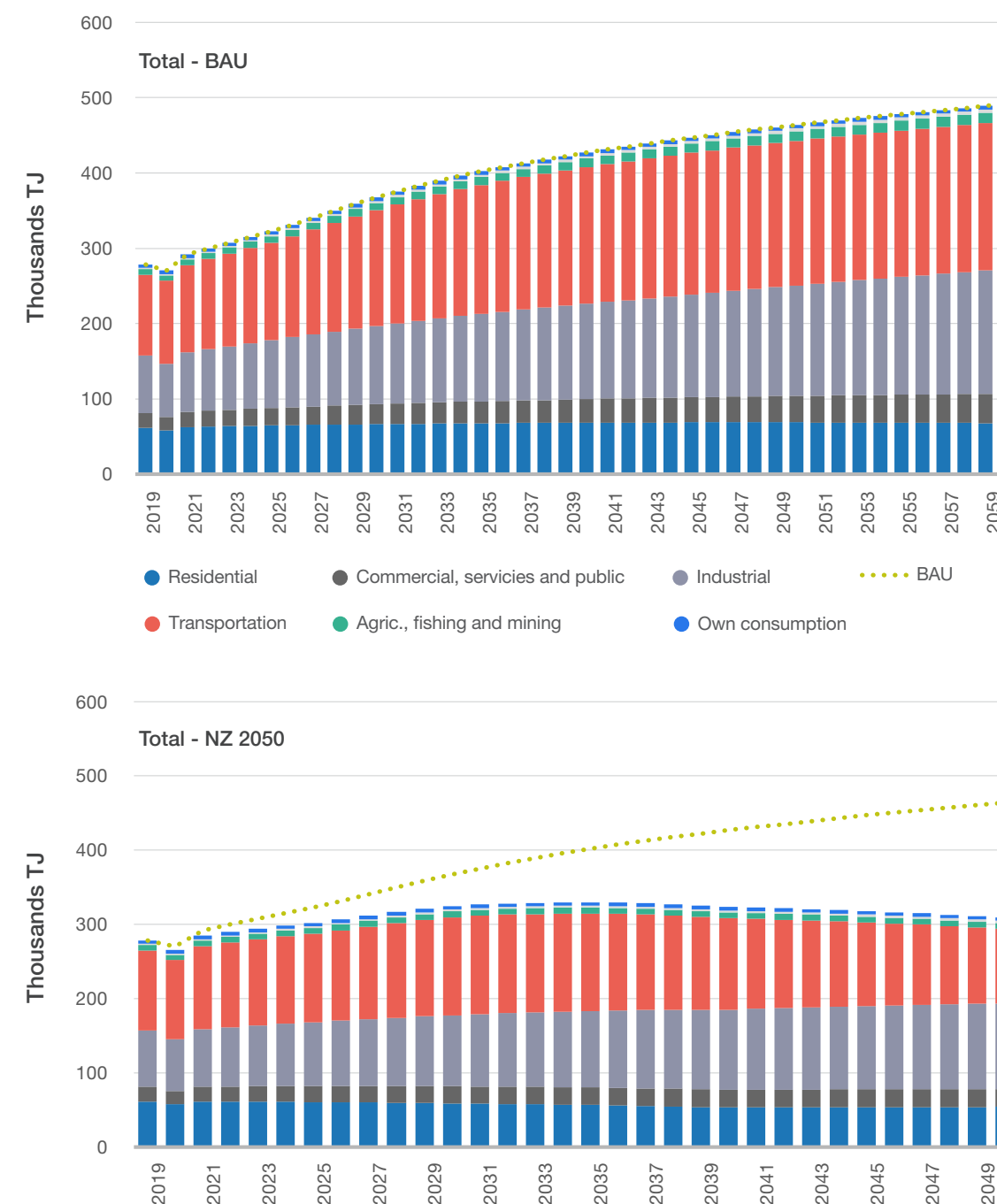


Energy demand by sector

In the BAU scenario, the demand grows by 76% during the analyzed period and reaches around 491 thousand TJ in 2060. In the NZ scenarios, the demand remains relatively constant due to the stronger effects of efficiency and fuel substitution. In all the scenarios, **the demand growth is greater than the increase in GHG emissions**.

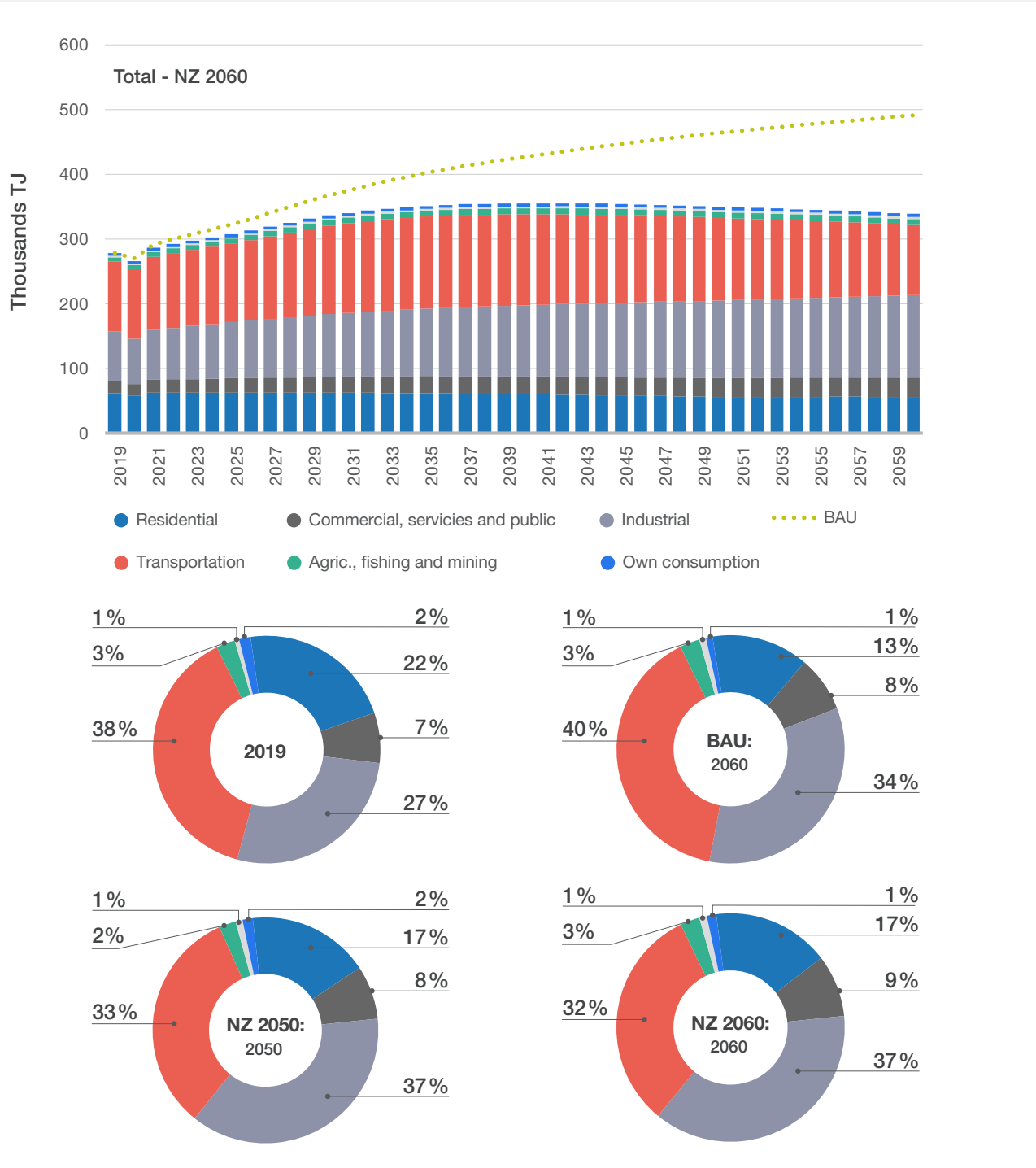
Graphic 34 A

► Final and own consumption, by sector and scenario (thousands of TJ)



Source: Own preparation. Excludes non-energy consumption.

Graphic 34 B ► Final and own consumption, by sector and scenario (thousands of TJ)



Source: Own preparation. Excludes non-energy consumption.

Table 11 ► Final and own consumption by scenario, thousands of TJ and CAGR (%)

Demand (thousands of TJ)	2019	2030	2040	2050	2060	CAGR (%)
BAU	278	367	427	464	491	1.4%
NZ 2050	278	324	323	309		0.3%
NZ 2060	278	336	355	350	339	0.4%

Source: Own preparation. Excludes non-energy consumption.

In all the scenarios, the relative participation of the demand by sector varies slightly in the long term, but the transportation, industry, and residential sectors continue adding up to over 80 % of the demand. Most of the sectors have similar growth rates, which evidences that **all the sectors participate in the transition efforts**.

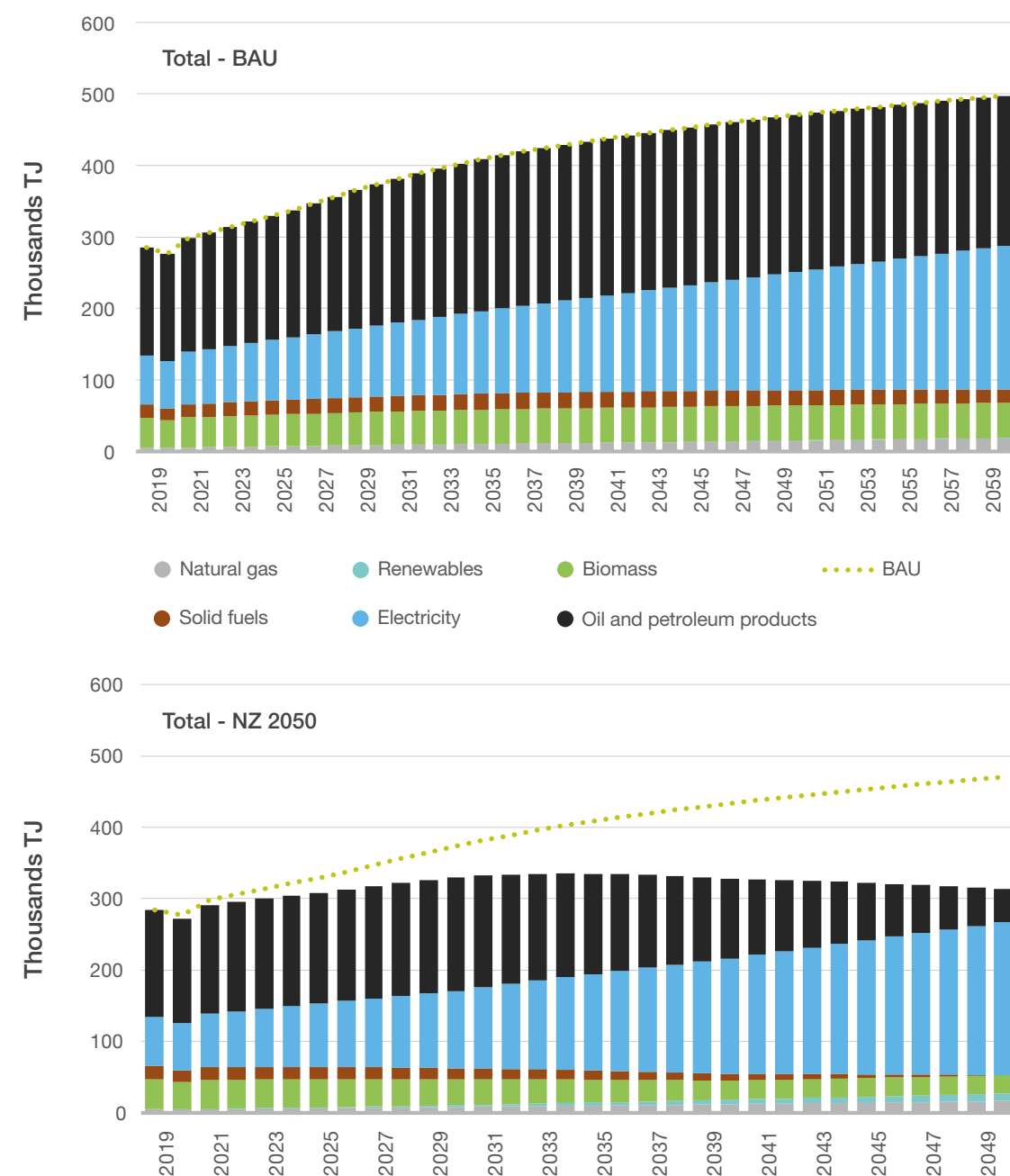


Energy demand by source

By fuel, a **strong trend towards electrification** of the demand is observed in all the scenarios. The BAU scenario reflects stability in coal, biomass, and fossil fuel consumption while the increase in demand is covered by electricity and natural gas. The NZ scenarios present stronger electrification hypotheses (around 70 % of final and own energy consumption) and partial substitution of biomass and liquid fuels. Hydrogen derivatives and solar thermal energy are developing in the long term near the end of the planning horizon.

Graphic 35 A

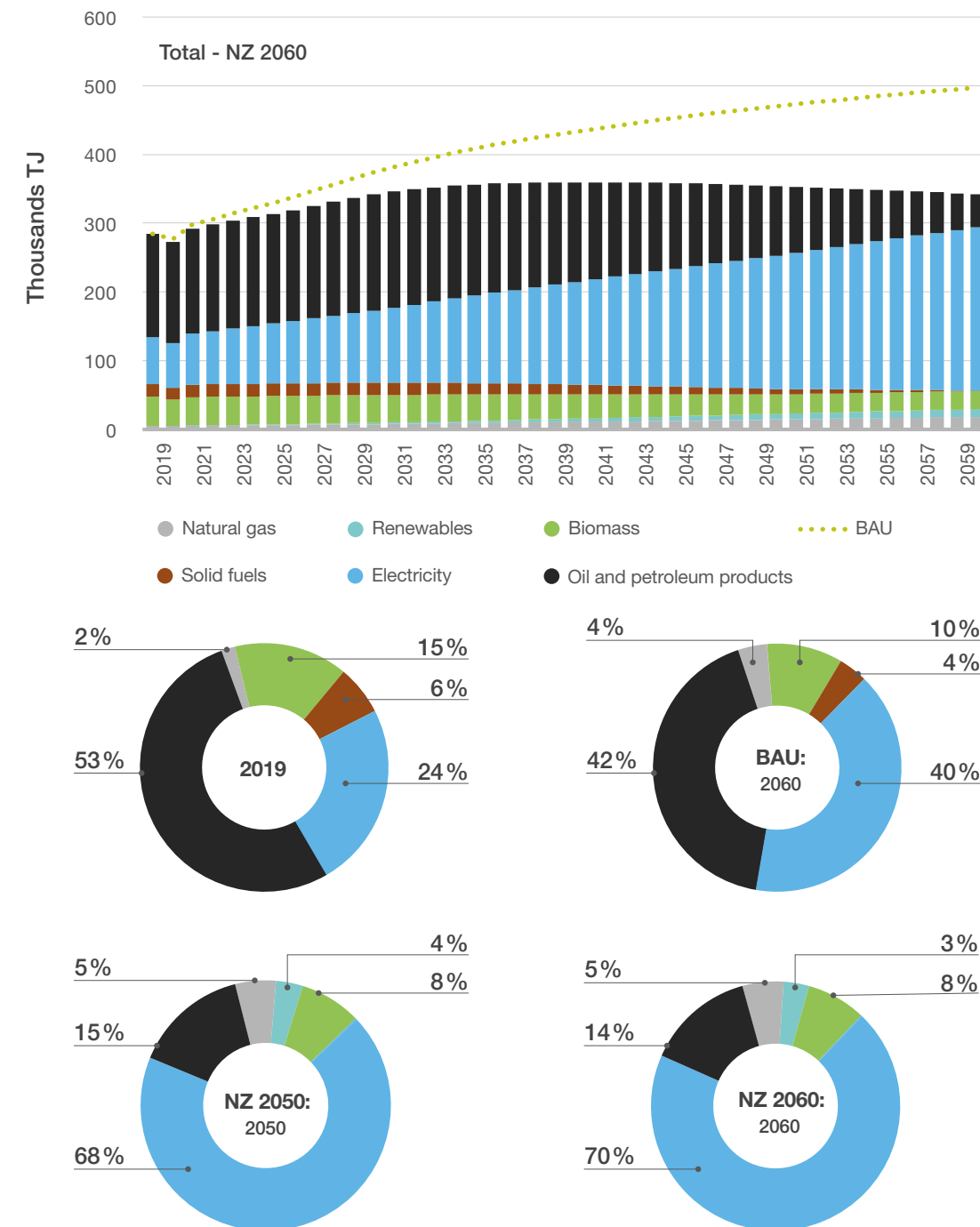
► Final consumption and own consumption, by source and scenario (thousands of TJ)



Source: Own preparation. Note: The renewables category refers to solar thermal or hydrogen derivatives. The oil and petroleum products category includes LPG. The non-energy source is not included.

Graphic 35 B

► Final consumption and own consumption, by source and scenario (thousands of TJ)



Source: Own preparation. Note: The renewables category refers to solar thermal or hydrogen derivatives. The oil and petroleum products category includes LPG. The non-energy source is not included.



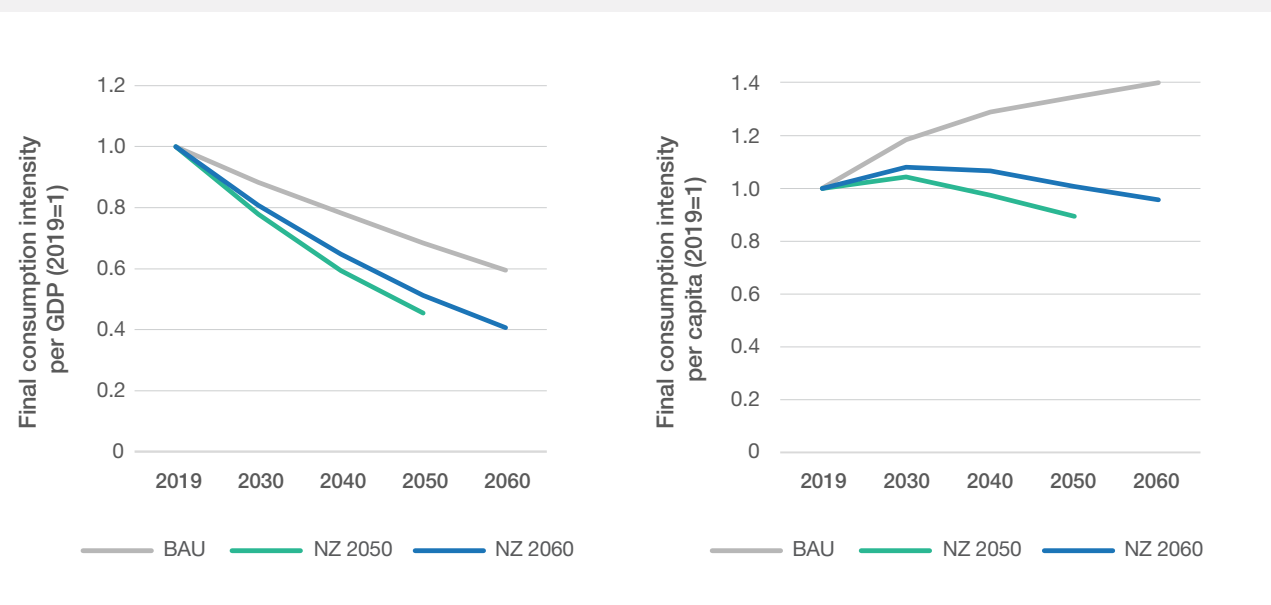
Environmental and energy intensity

In the BAU scenario, energy intensity, measured in economic terms, (final consumption/total GDP) is reduced by about 40% in the period, whereas in the NZ 2050 and NZ 2060 scenarios, it is reduced by around 60%.

Measured in terms of population (final consumption per capita), total unitary consumption grows by around 40% whereas in the NZ scenarios it falls by around 10%. These figures evidence the necessary evolution of final consumption to fulfill the country's economic development and cover the current consumption gaps.

Graphic 36

► Unitary energy intensity (2019=1), thousands of TJ/MUSD PPP 2017 (left) and thousands of TJ per capita (right)

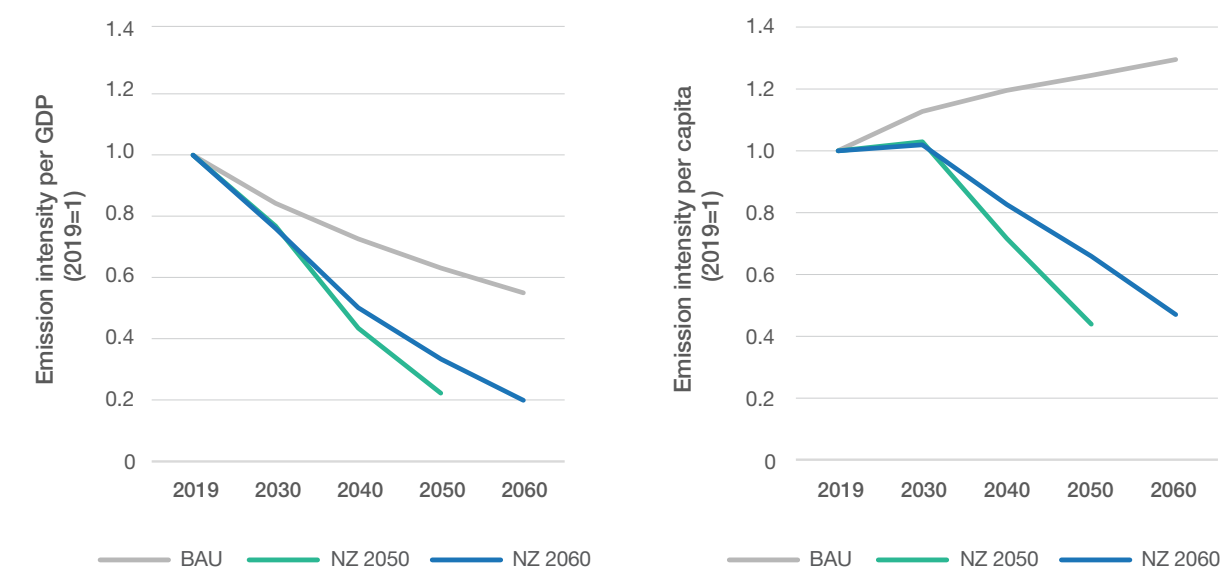


Source: Own preparation.

A significant reduction in energy intensity is required to meet the Paris Agreement targets. This reduction reflects the **decoupling between economic growth and energy consumption**. The assumptions adopted to implement the proposed solutions (see *Just Energy Transition / Projection Assumptions report*) for energy transition in the Dominican Republic allow the country to reach a high future decarbonization level and **promote a more developed and efficient economy**.

Graphic 37

► Unitary environmental intensity (2019=1), tCO₂e/thousands of USD at PPP 2017 (left) and tCO₂e per capita (right)



Source: Own preparation.

Unitary environmental intensity, measured in terms of economy (GHG emissions/total GDP), and population (GHG emissions/capita) is more significantly reduced than energy intensity for all the scenarios and shows the emission reduction by energy unit consumed. To achieve net zero emissions, the current emissions by GDP unit should be reduced by 75% to 80%.

2. Results and assumptions by sector



Residential sector

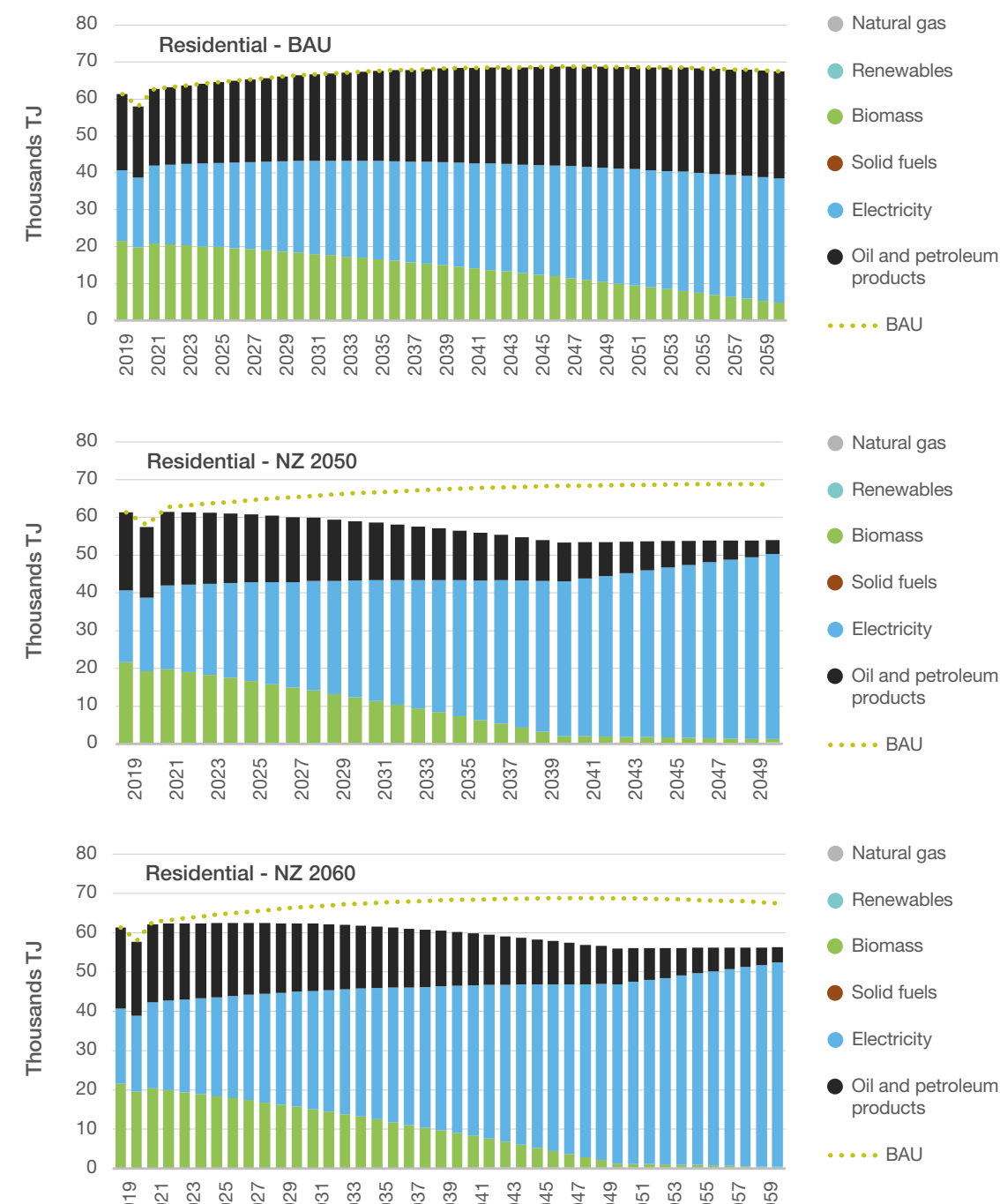
The residential sector is the third sector in terms of energy demand (22 % in 2019). It is responsible for a limited volume of GHG emissions (1.5 MtCO₂e), but there is potential to reduce them even further with energy transition measures. This sector is characterized by:

- high biomass consumption related to the cooking use, with great electrification potential (and, in turn, large efficiency gains²⁷). This firewood consumption for cooking (37 % of the sector's final consumption) relates to the most vulnerable sectors of the population; therefore, its replacement is possible in a context of higher standards of living and support programs for the sector. The cooking use accounts for 67 % of the sector's final consumption, one of the highest rates in the region;
- other uses (SHW, home appliances, air conditioning, etc.) with growth potential as the standard of living improves and in line with what was observed in developed countries.

²⁷ It is estimated that the use of electricity or natural gas instead of firewood for cooking allows for very significant final energy savings.

Graphic 38

► Residential sector: results by fuel and by scenario (10³ TJ)



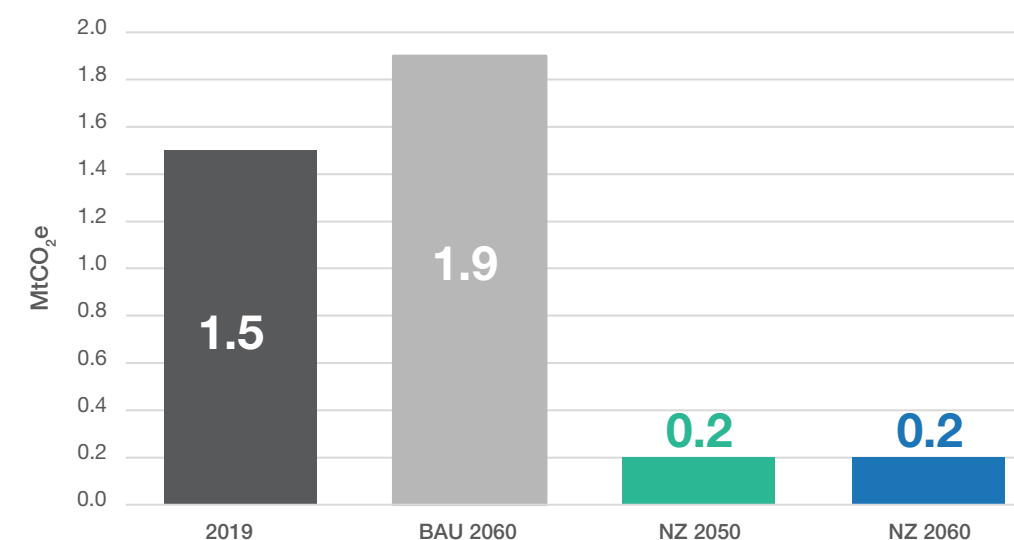
Source: Own preparation. NB: The oil and petroleum products category includes LPG.

In the BAU scenario (graphic on the left), we can see a 10% increase in residential energy demand in the period (annual 0.2 %). This growth is lower than that of the population (23 % in the period). Firewood is replaced almost completely towards the end of the period, following historical trends. Natural gas consumption grows considerably whereas LPG remains relatively constant. The fuel share of oil and petroleum products remains relatively constant whereas electric consumption grows.

In the NZ 2050 and NZ 2060 scenarios, power consumption covers a large part of final consumption (over 90 %); there is a surplus of oil and petroleum products. In turn, the replacement of biomass takes place faster. More energy efficiency efforts²⁸, both for appliances and buildings, allow compensating for the new uses that accompany the increase in GDP per capita and reducing the energy intensity of the sector measured as demand per capita.

²⁸ There are only two lines of action to increase energy efficiency in all sectors: technological change and good energy use practices. For example, the replacement of incandescent bulb lighting with discharge units (bulbs to save energy) and later with LED bulbs, which took place in most countries, produces, by itself, a reduction in installed lighting capacity of up to 80 %. However, this would result in a similar reduction in terms of energy consumption only if the same patterns of use previous to replacement were maintained. Otherwise, it may be higher if there is more care in the use of lights (with motion sensors, for instance); instead, it may be lower if all the lights are left on more time when switching to LED. Changing the technology is not enough; what is known as “good practices in the use of energy and operation and maintenance of facilities and equipment” should be applied.

Graphic 39

► Residential sector: direct emissions by scenario (MtCO₂e)

Source: Own preparation

CO₂e emissions grow slightly in the BAU scenario and fall by around 85 % in the NZ scenarios in the long term, as a result of the energy efficiency and electrification measures from clean generation sources.

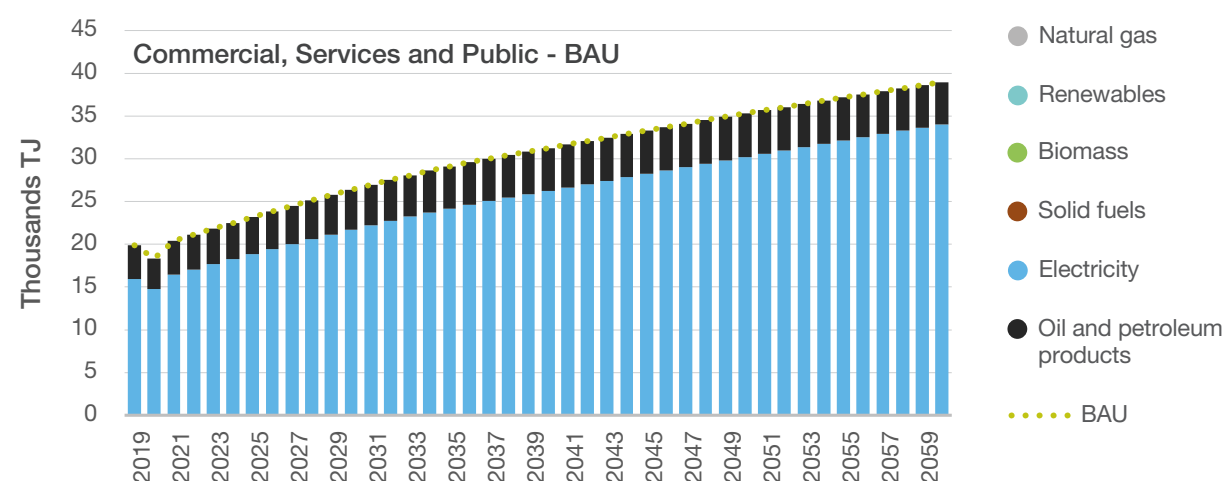
In practice, the energy transition measures required to limit GHG emissions in the residential sector relate to mature technologies (electric ovens, more efficient electrical appliances). However, their implementation entails a massive effort from all households and covering consumption gaps for lower-income households, thus ensuring a just transition.



Commercial, services, and public sector

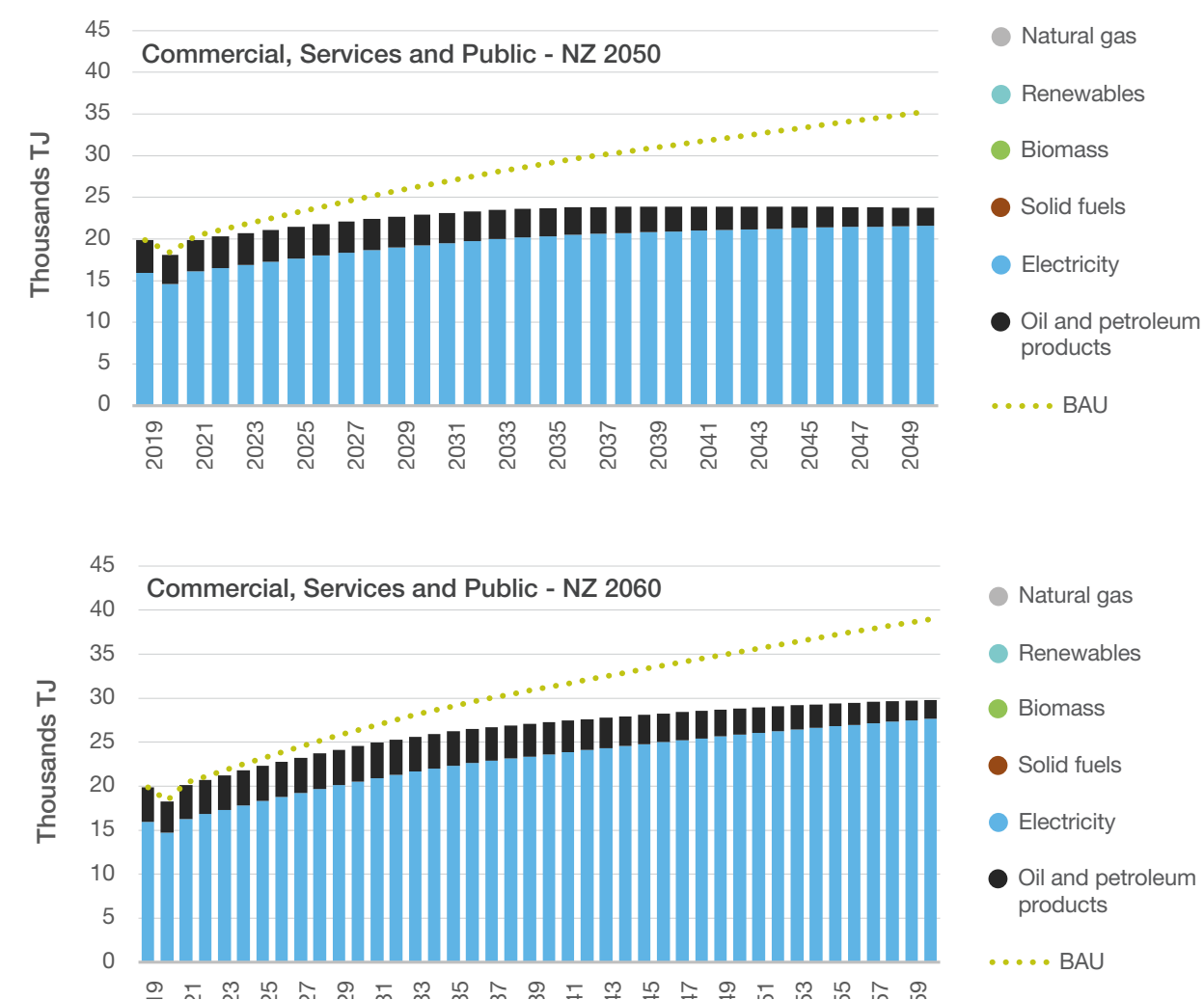
The commercial, services, and public sector (CSP) is composed of the public administration, hospitals, hotels, and stores, etc. It is usually a sector with little weight in terms of energy consumption (7 % of the total, in 2019) compared to the transportation, industrial, and residential sectors. It starts with a high electrification rate (around 80 % in 2019) and energy uses with electrification potential (motive force, cooking, etc.), as in the case of the residential sector. There is also potential for more energy efficiency, both in equipment and in the buildings themselves (thermal renovation of existing buildings, application of strict thermal regulations for new buildings).

Graphic 40 A

► CSP sector: results by fuel and by scenario (10³ TJ)

Source: Own preparation. Note: The oil and petroleum products category includes LPG.

Graphic 40 B

► CSP sector: results by fuel and by scenario (10³ TJ)

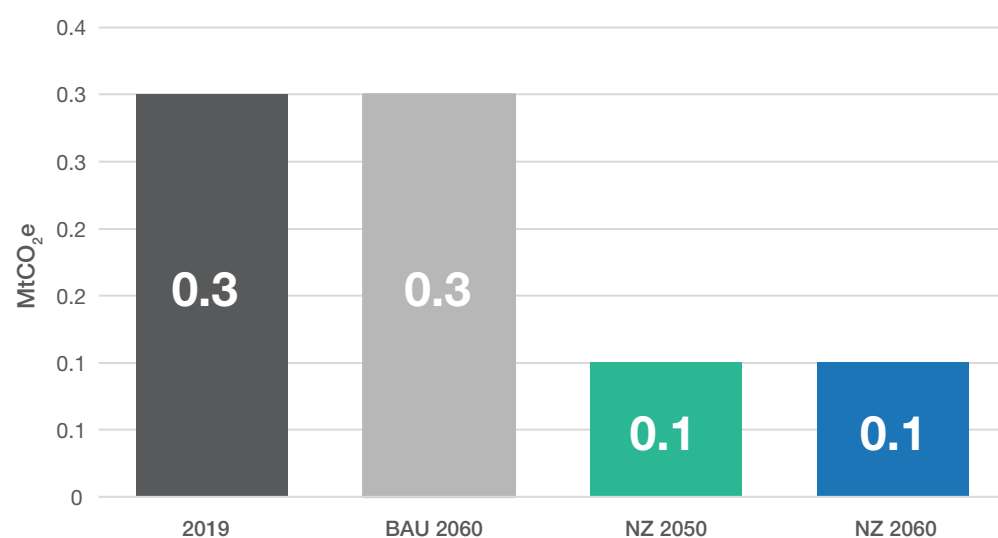
Source: Own preparation. Note: The oil and petroleum products category includes LPG.

In the BAU scenario, the fuel share remains constant. In addition, even though the sector's GDP almost trebles, the energy demand grows by around 96 % due to the energy efficiency measures.

For the NZ scenarios, there is almost total electrification of the sector (≥ 90 %) and there is an oil and petroleum products surplus in the last year. A 23% demand reduction is achieved for 2060 (NZ 2060 scenario) and 33 % for 2050 (NZ 2050 scenario) compared to the BAU scenario. Energy efficiency enhancements account for a large part of this phenomenon.

Graphic 41

► CSP sector: direct emissions by scenario (MtCO₂e)



Source: Own preparation.

CO₂e emissions are maintained in the BAU scenario, and they are reduced to one third in the NZ scenarios.

The energy transition measures required to limit GHG emissions in the commercial, services, and public sector include mature technologies related to refrigeration, lighting, and direct or indirect heat uses; therefore, electrification must be prioritized and the efficiency of the appliances should be enhanced. Although it has little weight at energy level, the sector itself is heterogeneous, with consumption related to cooking and refrigeration uses in restaurants, IT equipment and lighting in offices, mixed uses in hospitals or schools, etc.



Industrial sector

The industrial sector is composed of several industrial subsectors and is the second with the largest energy demand (27 % in 2019) after the transportation sector. Its starts with low penetration of electricity (36 %²⁹), conditioned by several sectors that are difficult to electrify, such as non-metallic industries.

It is important to remember that fuel substitution possibilities may vary considerably from one industrial subsector to another, given the variety of existing industrial processes. To make the projections, the industrial subsectors were grouped together into a limited number of subsectors. The analysis focused more in detail on the subsectors with the greatest consumption and their associated uses.

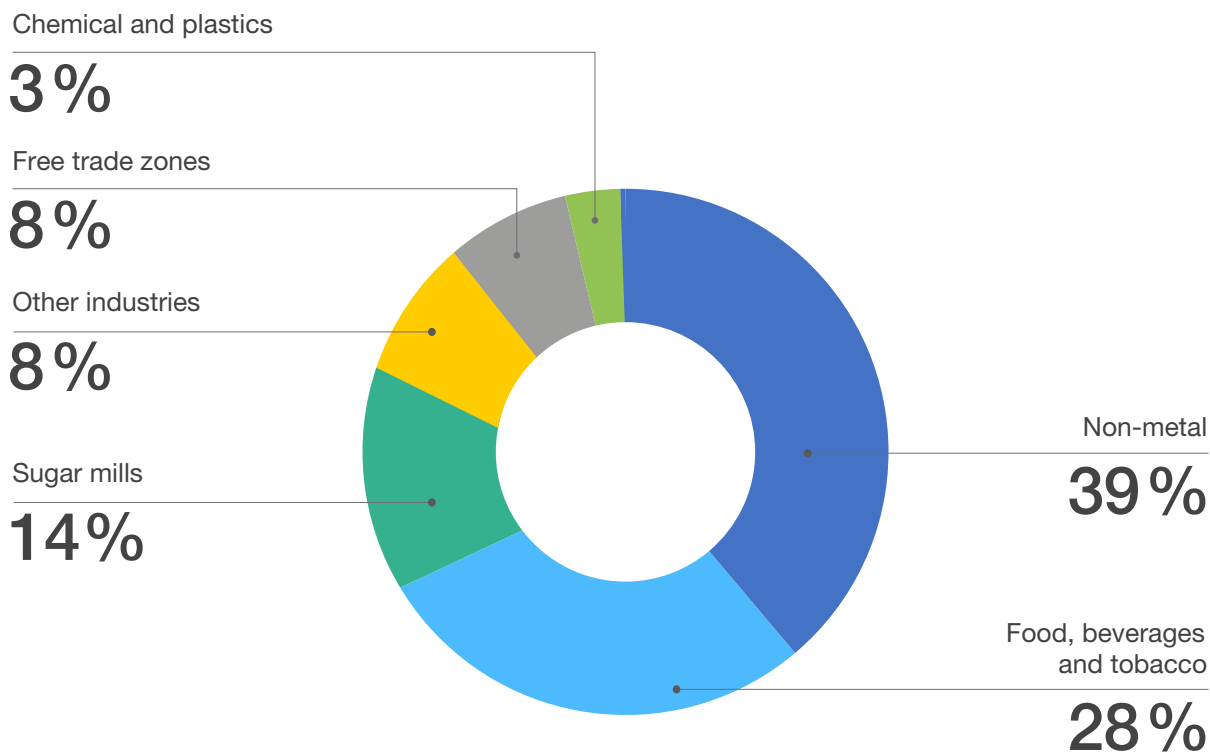
Projections by subsector

The Useful Energy Balance of the Dominican Republic presents the information on the industrial sector for the following subsectors:

²⁹ This value was obtained from the Useful Energy Balance of the Dominican Republic and differs slightly from the one presented in the sieLAC by OLADE.

Graphic 42

► Industrial sector: energy consumption by industrial subsector, 2019 (%)

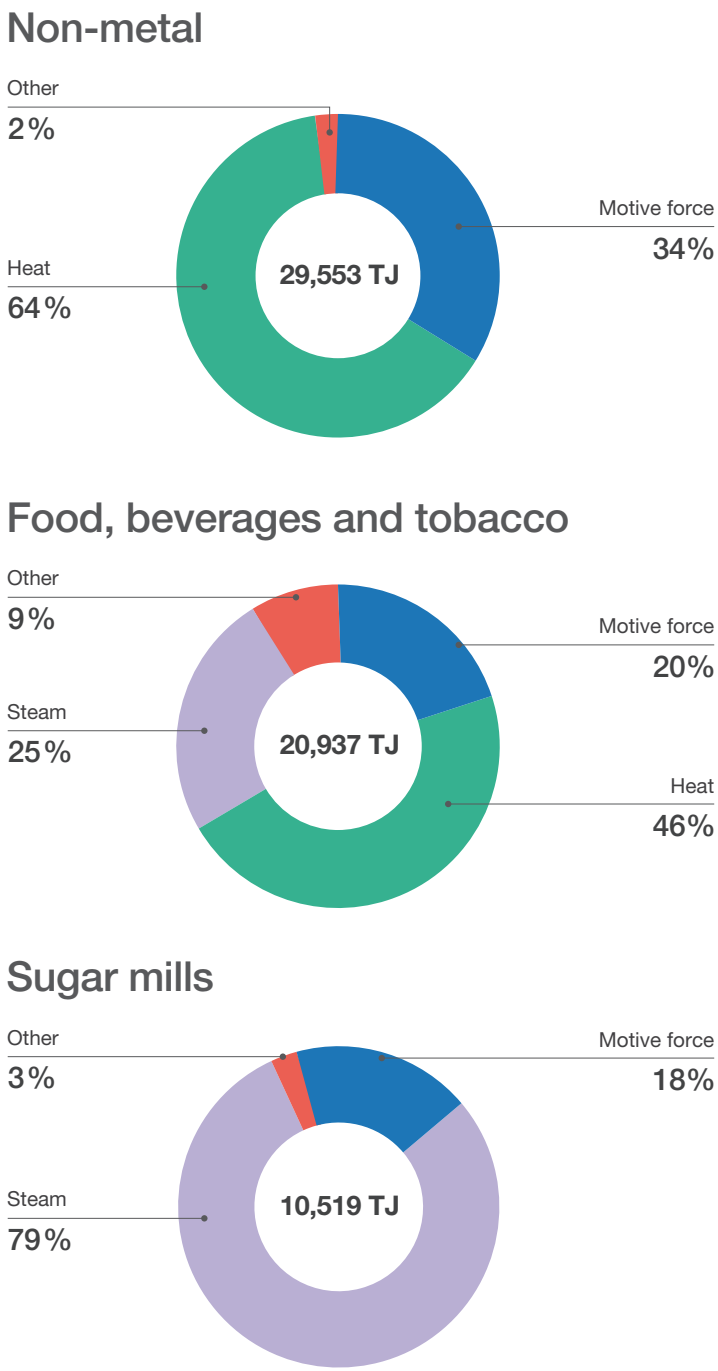


Source: Own preparation based on data from the Useful Energy Balance of the Dominican Republic.

Non-metallic subsectors; food, beverages and tobacco; and sugar mills account for 81 % of the energy consumption in the sector. The steam use is predominant in the sugar mills category (79%). In the non-metallic and other food, beverages and tobacco subsectors, the predominant use is direct heat, with 64 % and 46 %, respectively.

Graphic 43

► Industrial sector: Distribution by end use for the main industry subsectors (%)



Source: Own preparation based on data from the Useful Energy Balance of the Dominican Republic.

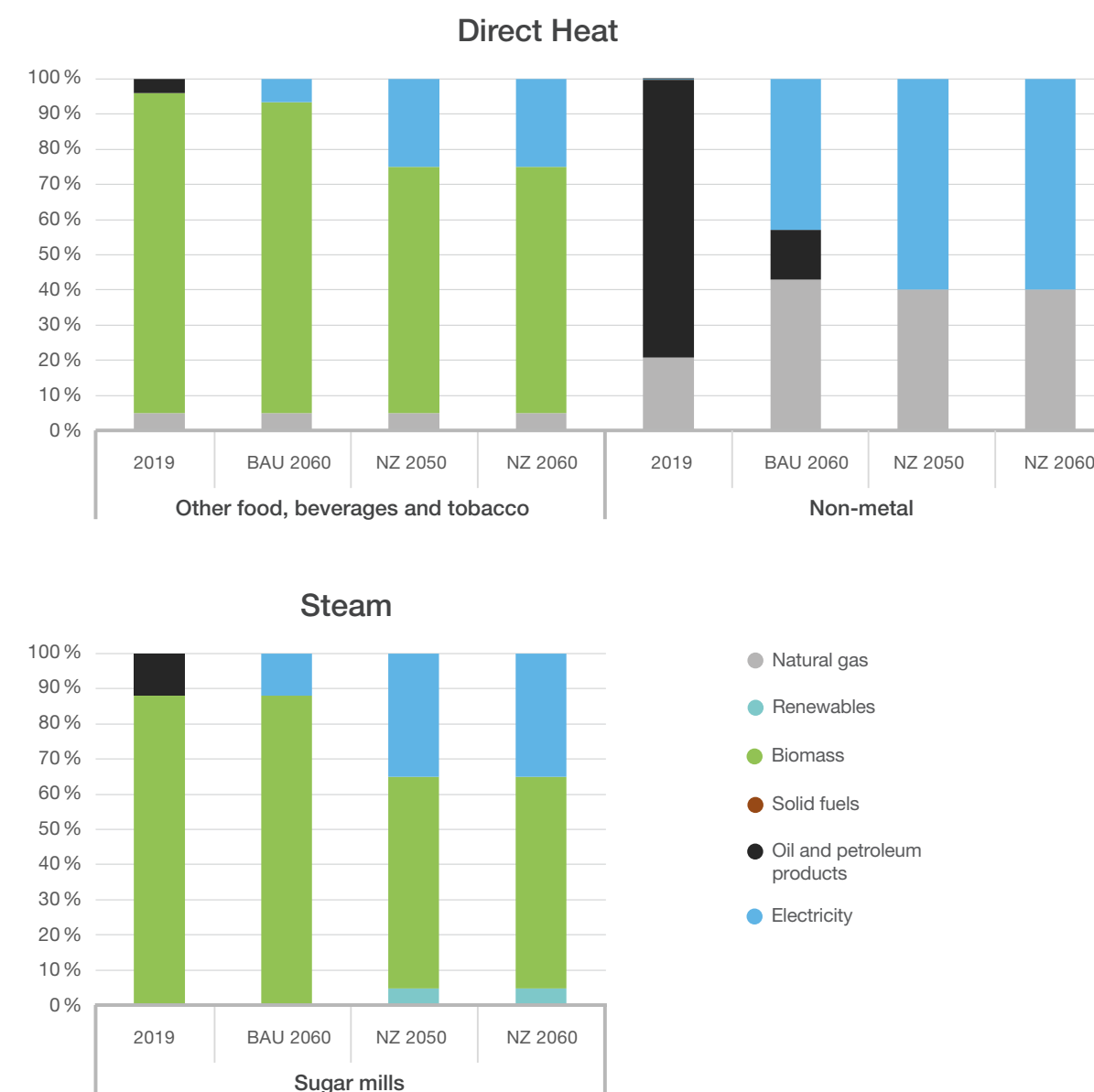
Transition measures focus on **enhancements in terms of efficiency and fuel substitution**. Energy efficiency is achieved thanks to the optimization of energy use in industrial processes and technological replacement to more recent and efficient appliances and facilities. The substitution assumptions considered for the Dominican Republic are detailed below.

- A strong reduction in consumption (deeper for the NZ scenarios) was considered for the industrial subsectors with high penetration of fossil fuels and substitution potential. Natural gas partially replaces coal.
- Natural gas and LPG fully replace fuel oil and diesel in the next decade and a progressive penetration of solar thermal energy is assumed in some sectors for indirect heat.
- The use of sustainable biomass is considered in the subsectors with available biomass for their processes (for example, cane-related products) and the replacement of the use of firewood with other sources (electricity, solar thermal) is also considered.

Graphic 44 shows the evolution of final consumption by fuel for the main uses in the different scenarios.

Graphic 44

► Industrial sector: evolution by scenario for the main uses in the most relevant industrial subsectors (%)



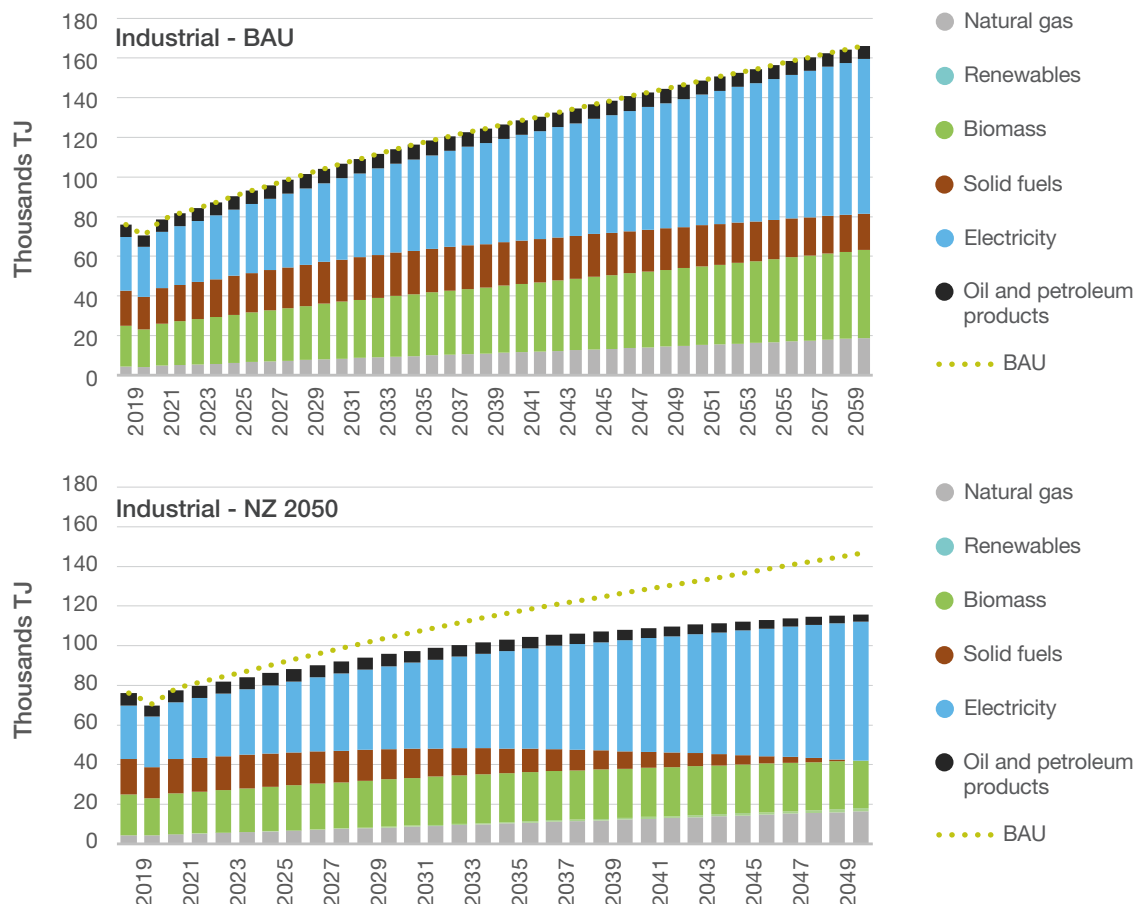
Source: Own preparation.

Results

Even though a 189% increase in the GDP of the sector is projected, the demand for final energy in the BAU scenario will grow by 119% due to fuel substitution and energy efficiency measures. The electrification of the final demand goes from 36% to 47%.

Graphic 45 A

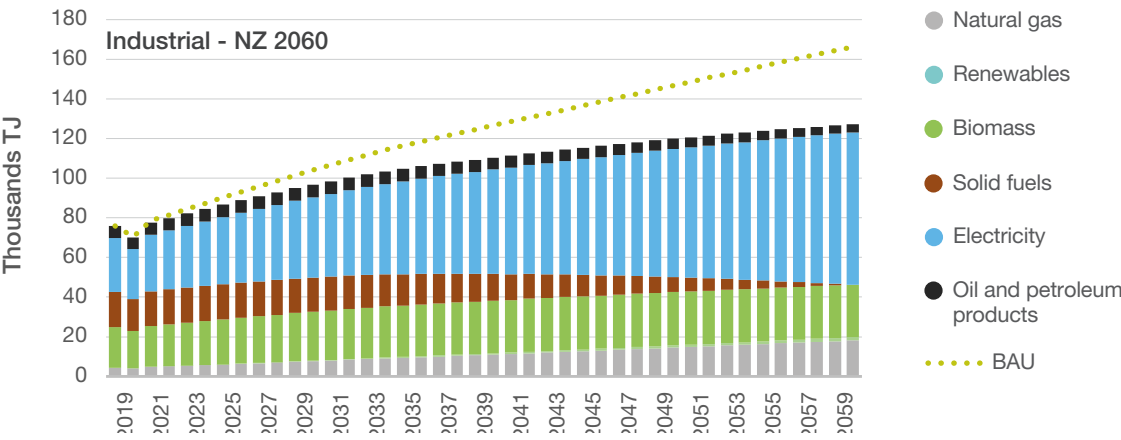
► Industrial sector: final consumption by fuel and by scenario (10³ TJ)



Source: Own preparation.

Graphic 45 B

► Industrial sector: final consumption by fuel and by scenario (10³ TJ)

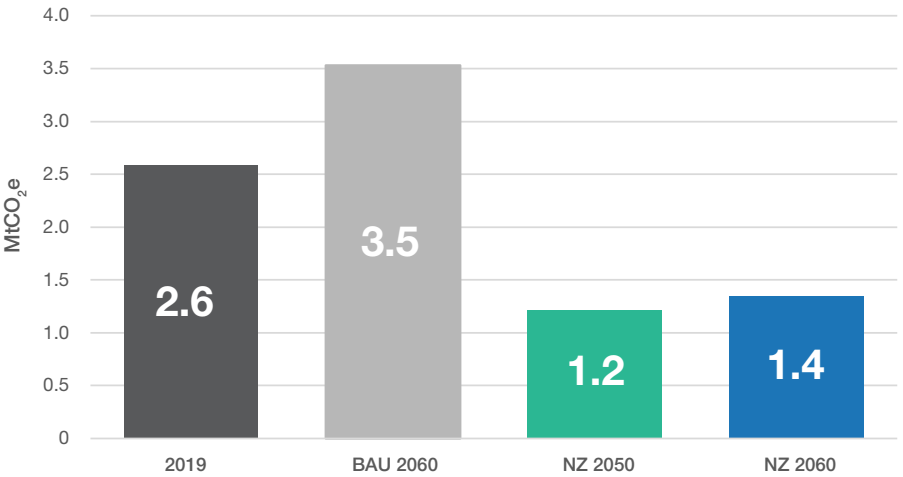


Source: Own preparation.

For the NZ scenarios, coal consumption is completely substituted. Electrification grows in the period (from 36% to 60%).

Graphic 46

► Industrial sector: direct emissions by scenario (MtCO₂e)



Source: Own preparation.

CO₂e emissions grow in the BAU scenario (+36 %), but at a much slower pace than that of the GDP. On the other hand, emissions are reduced to one half in the NZ scenarios in the long term, as a result of the energy efficiency measures, fuel substitution, and carbon capture. The energy transition measures required to limit GHG emissions in the industrial sector relate to existing technologies worldwide that are not always very mature. As years go by, it will be necessary to adapt the industrial processes gradually with the best technological option available and, in turn, rethink the processes in a comprehensive manner.



“Transition measures focus on improvements in terms of efficiency, fuel substitution, behavior changes, and an electricity generation matrix with non-fossil technologies.”





Transportation sector

In the Dominican Republic, the transportation sector is the maximum energy consumer (38 % in 2019) and the second greenhouse gas emitter after power generation. It mainly consumes liquid fuels (diesel, gasoline, etc.). Even though electric vehicle sales have increased worldwide in recent years, these vehicles account for a very small portion in the Dominican Republic.

In the case of the Dominican Republic, there is not enough information to discriminate diesel consumption of maritime and railway transportation from road consumption; therefore, all the diesel consumption was allocated to the latter. Railway electricity consumption and aviation fuel consumption are discriminated but they are low percentages³⁰.

Road passenger transportation

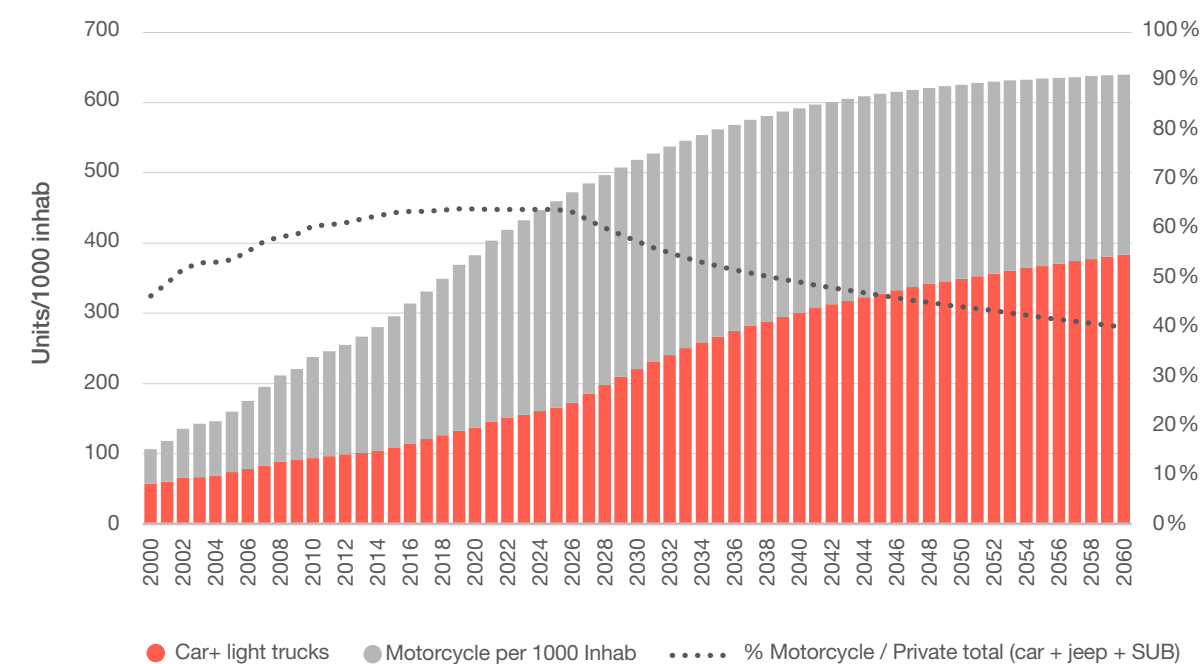
Energy consumption by road transportation mainly depends on the evolution of the number of vehicles. A **significant increase in motorization** is expected in all the scenarios, in line with the growth in the standard of living and the recent national trend. This increase starts with a slightly stronger increase in the number of motorcycles per 1,000 inhabitants. From a certain level in GDP per capita on, the increase in motorization starts focusing on cars³¹. 640 vehicles per 1,000 inhabitants are projected in 2060, 40 % of which are motorcycles and 60 % cars.

³⁰ “In the case of the railway, there was no information available on diesel oil consumption so as to distinguish it from the diesel oil used in road transportation; the same happened with maritime transportation. Therefore, the total diesel oil consumption indicated in the Energy Balance was allocated to the different types of vehicles that comprise road transportation”. (*Useful Energy Balance, Dominican Republic*).

³¹ Law, Hamid & Goh (2015), *The motorcycle to passenger car ownership ratio and economic growth: A cross-country analysis*.

Graphic 47

► Number of private vehicles per 1,000 inhabitants and share of motorcycles (%)



Source: Own preparation.

In this motorization context, measures will be required to promote the energy transition in order to limit the increase in GHG emissions. One of the main measures to contemplate is the **electrification** of the vehicle fleet, which reduces emissions and total consumption (a reduction of 75 % to 80 % in consumption per km compared to a standard vehicle). The use of hybrid vehicles also allows for a significant reduction in unitary energy consumption. In the case of cars, it is estimated that their share will be 30 % electric and 20 % hybrid in the BAU scenario by 2060. Instead, in the NZ scenarios, a 65 % share of electric, 20 %

of hybrid and 5 % of vehicles running on biofuels is projected at the end of the period. In addition, the electrification of the motorcycle and public bus fleet is envisaged until 100 % of the fleet is reached in both scenarios within the planning horizon (see *Just Energy Transition / Projection Assumptions report*).

In line with historical observations, the average efficiency of the vehicle fleet is expected to improve due to technological enhancements and/or the reduction in vehicle weight.

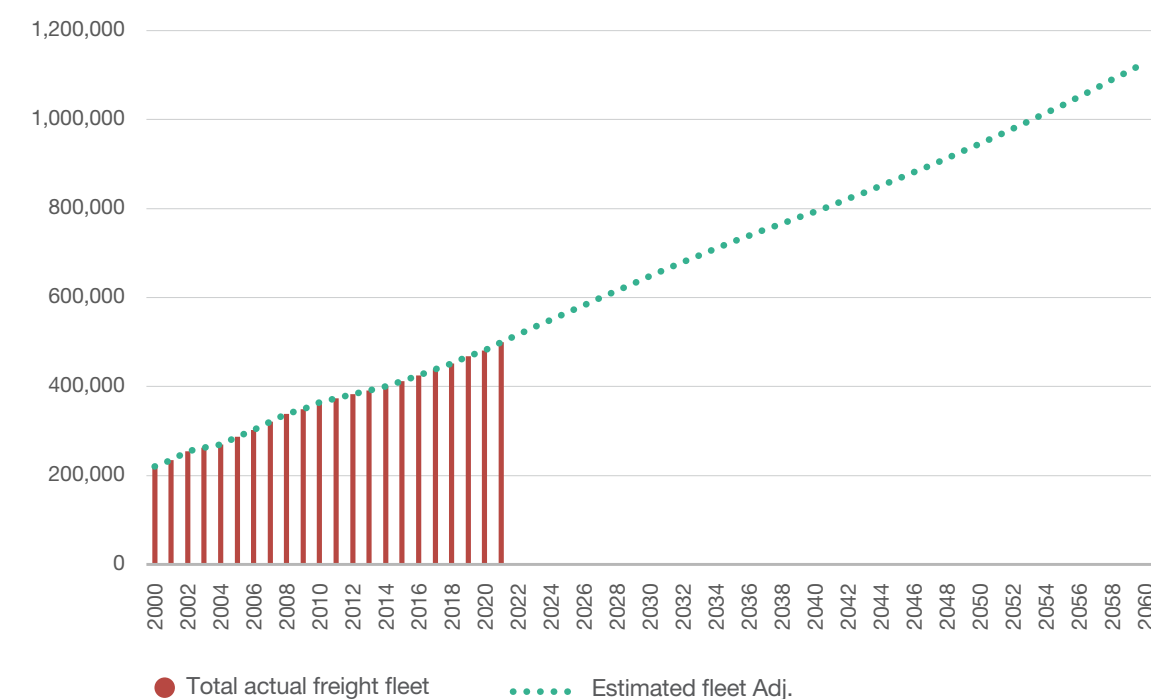
Finally, a decrease in the average distances traveled by vehicle (km/vehicle) is envisaged as a result of the **digitalization** of society (remote work, etc.) and greater penetration of **public transportation** systems.

Road freight transportation

Road freight transportation grows with economic activity (GDP), taking into account the historical elasticity of income. In this context, sustained growth in the number of freight vehicles is expected in the period (2.1 % annual average), both for trucks (over 95 % of the total) and for truck tractors.

Graphic 48

► Total number of freight vehicles



Source: Own preparation.

In order to limit the GHG emissions increase, it will be necessary to promote energy transition fuels depending on the time horizon considered: electricity appears as the main alternative to reduce GHG emissions in the Dominican Republic, where distances are not long and there are no fossil fuel reserves. Moreover, the energy transition must be accompanied by an **enhancement in vehicle performance, logistics enhancements, and a shift to railway transportation**.

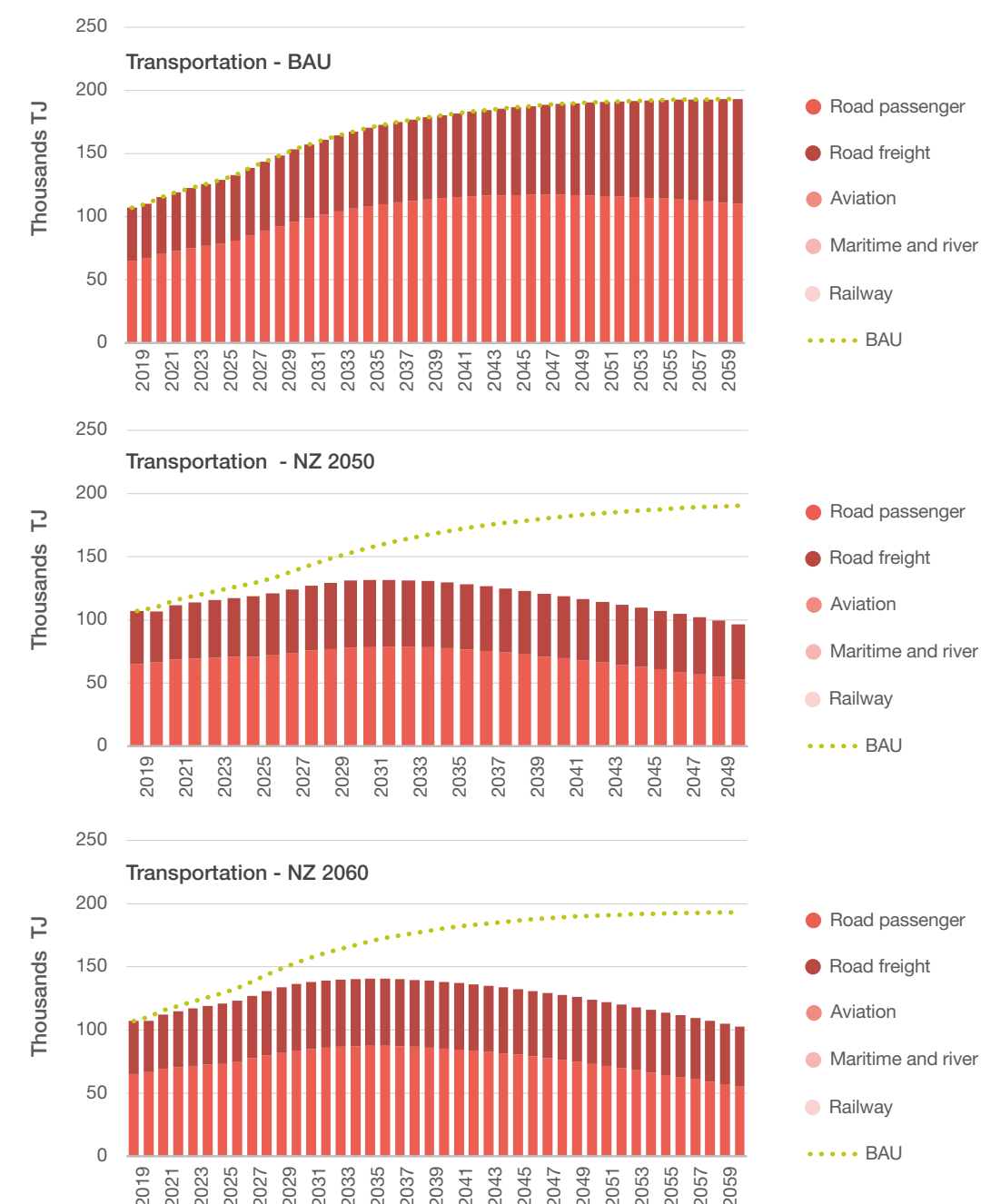
It has been assumed that, in the BAU scenario and for 2060, 30 % of the truck fleet will be electric and the rest will continue on diesel. As to truck tractors, 10 % of the fleet is expected to use electricity and the rest continues running on diesel. In the NZ scenarios, more transition efforts are required, with 90 % electric trucks and 70 % electric truck tractors in the long term. In addition, 20 % of truck tractors are expected to use synthetic fuels. Electrification appears as the main alternative for trucks and truck tractors, but a smaller electrical penetration is expected for truck tractors, as technological solutions to transport very heavy loads are still being developed and electrification is not always a solution. Hydrogen cells may also play an important role in this segment in the long term. Natural gas allows the transition to start in both segments.

Air, maritime and railway transportation

There is no information available for this sector.

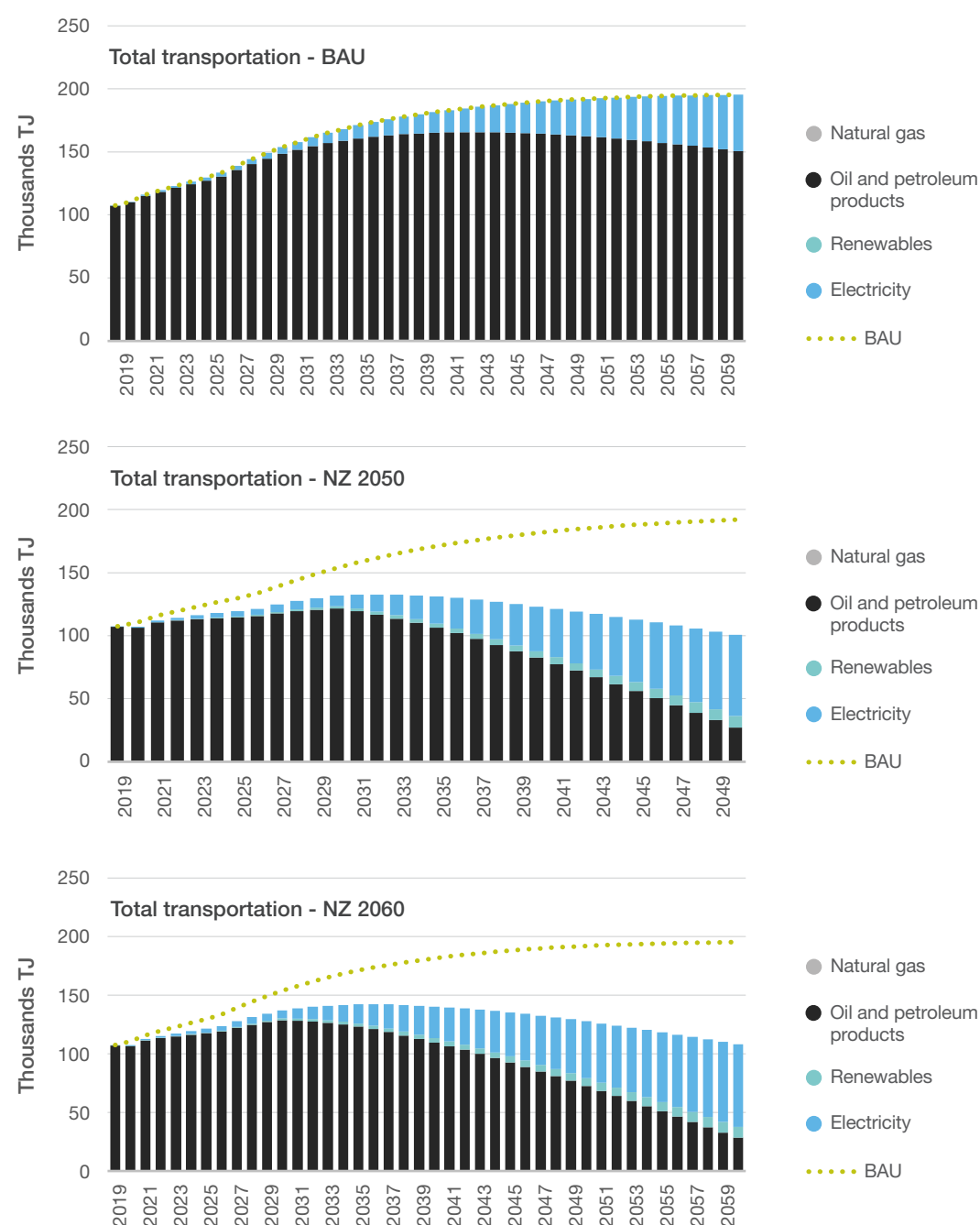
Results

In the BAU scenario, energy consumption in the transportation sector grows by 82 %, driven by the freight sector. The consumption of oil and petroleum products grows by 41 %, and electricity grows considerably in the private and public passenger sector.

Graphic 49 A**► Transportation: final consumption by type/fuel and by scenario (10³ TJ)**

Source: Own preparation. Diesel consumptions in the maritime, river, and railway sectors are included in the road sector. In the aviation sector, only domestic travel is considered (very low value).

Graphic 49 B

► Transportation: final consumption by type/fuel and by scenario (10³ TJ)

Source: Own preparation. Diesel consumptions in the maritime, river, and railway sectors are included in the road sector. In the aviation sector, only domestic travel is considered (very low value).

In the analyzed period, energy demand in the transportation sector falls in the NZ 2050 scenario due to the measures to promote electric transportation. In the passenger sector, electric penetration increases strongly, whereas the rest use gasoline in hybrid motors.

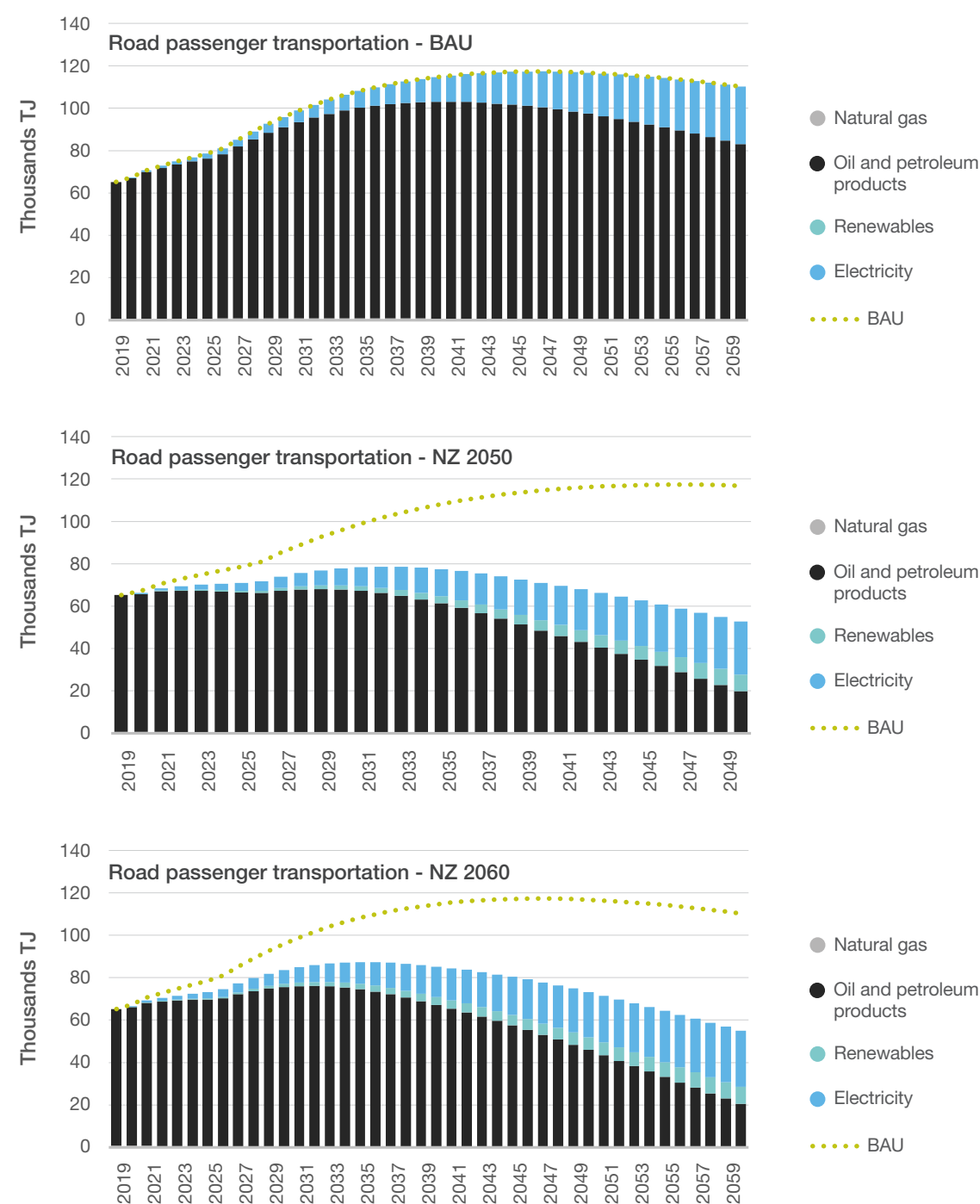
As to freight transportation, electrification appears as the main alternative for trucks and truck tractors due to the short distances in the country. Bearing in mind these considerations, the passenger sector reduces its energy consumption considerably whereas the freight transportation sector grows slightly.

The NZ 2060 scenario is very similar to the one mentioned above.



Graphic 50 A

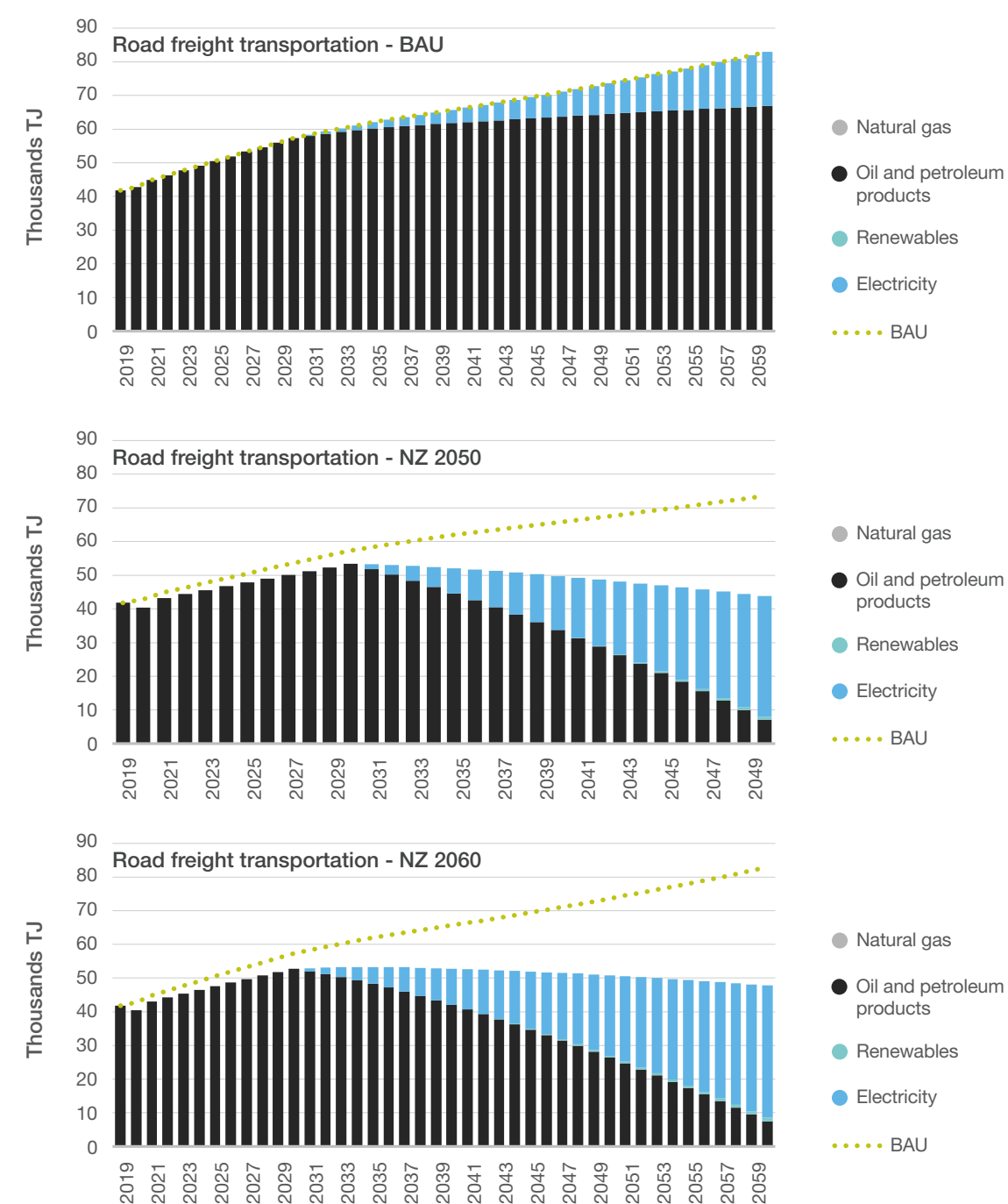
► Final consumption of road passenger and freight transportation, by fuel and by scenario, 10³ TJ



Source: Own preparation.

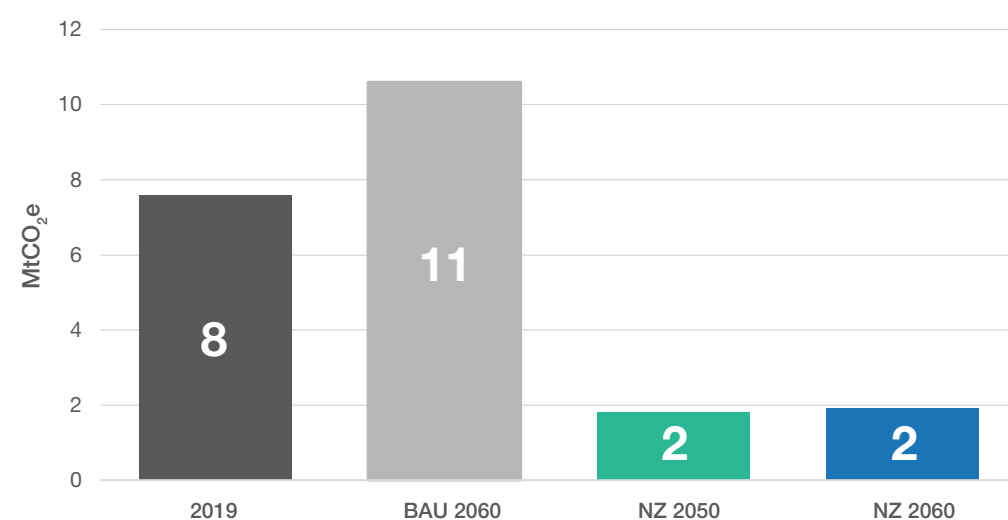
Graphic 50 B

► Final consumption of road passenger and freight transportation, by fuel and by scenario, 10³ TJ



Source: Own preparation.

Graphic 51

► Transportation sector: direct emissions by scenario, MtCO₂e

Source: Own preparation.

CO₂e emissions grow in the BAU scenario (+39 %) but at a slower pace than that of the vehicle fleet. On the other hand, emissions fall to one quarter in the NZ scenarios in the long term, as a result of fuel substitution (mainly electrification), energy efficiency, and behavior changes.

The energy transition measures required to limit GHG emissions in the transportation sector relate to mature technologies for the light vehicle segment and developing ones for the other segments. Substantial changes are expected in all scenarios, given the strong motorization associated with economic growth.

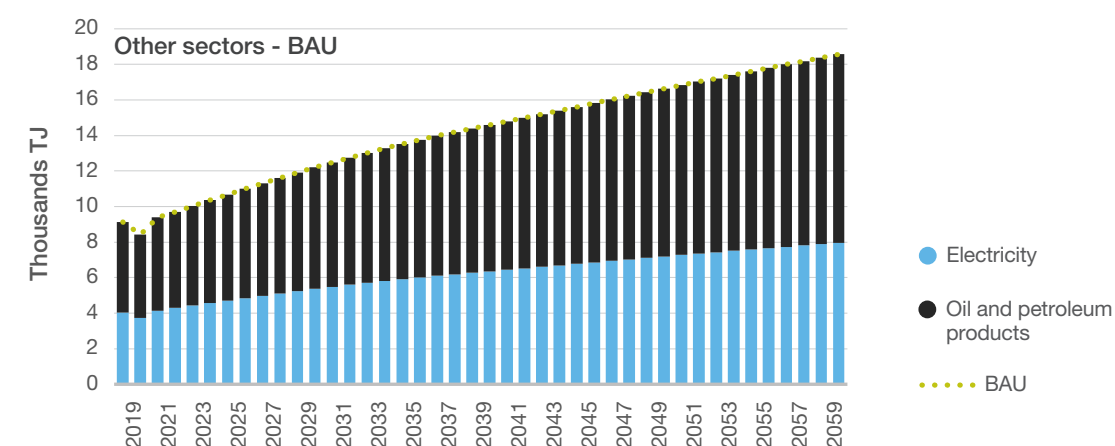


Agriculture, fishing, mining, and construction sector

The agriculture, fishing, mining, and construction sector, along with the commercial, services, and public sector, are the sectors with the lowest energy consumption. The electrification of the sector was 44 % in 2019.

In the BAU scenario, the demand in this sector grows by around 1.7 % annually (cumulative 104 % in the period) and maintains the current fuel share. An improvement in the energy intensity of the sector is observed (GDP growth is higher than that of demand, annual 2.6 % against annual 1.7 %).

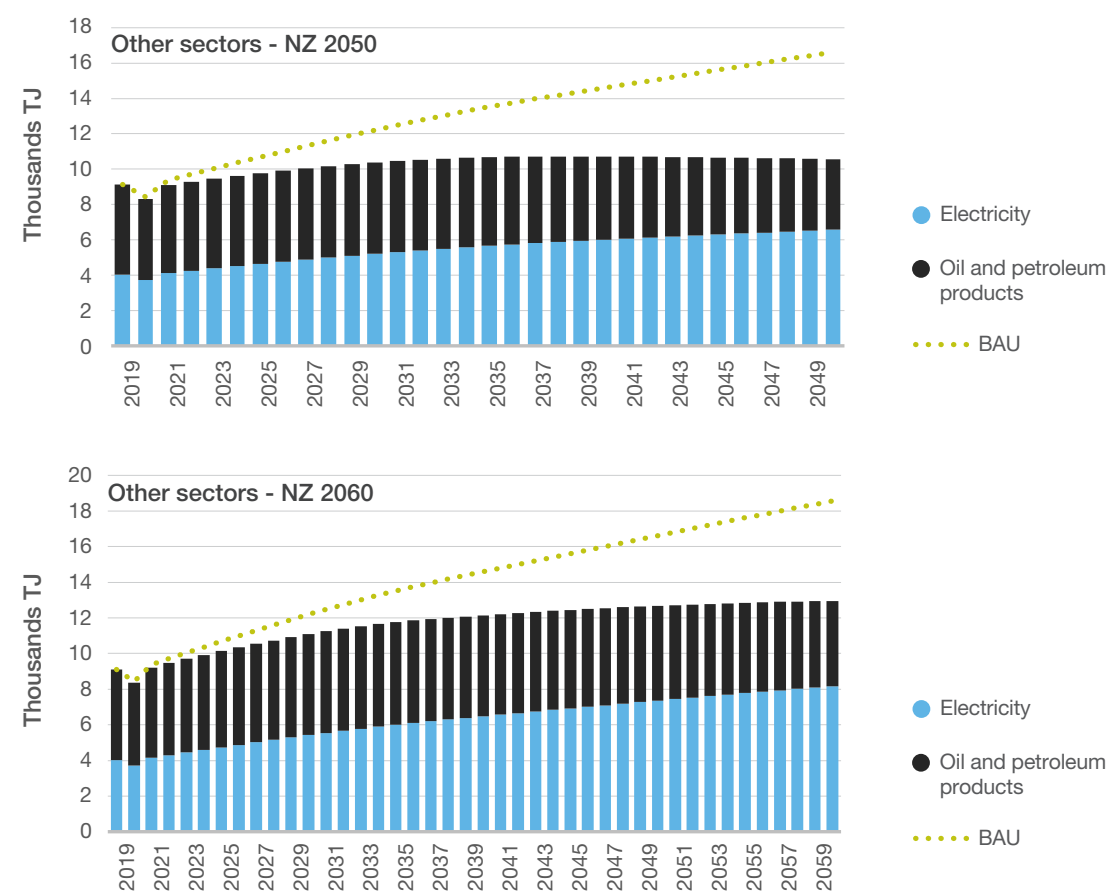
Graphic 52 A

► Results of the agriculture, fishing, mining, and construction sector, by scenario, 10³ TJ

Source: Own preparation.

Graphic 52 B

► Results of the agriculture, fishing, mining, and construction sector, by scenario, 10³ TJ

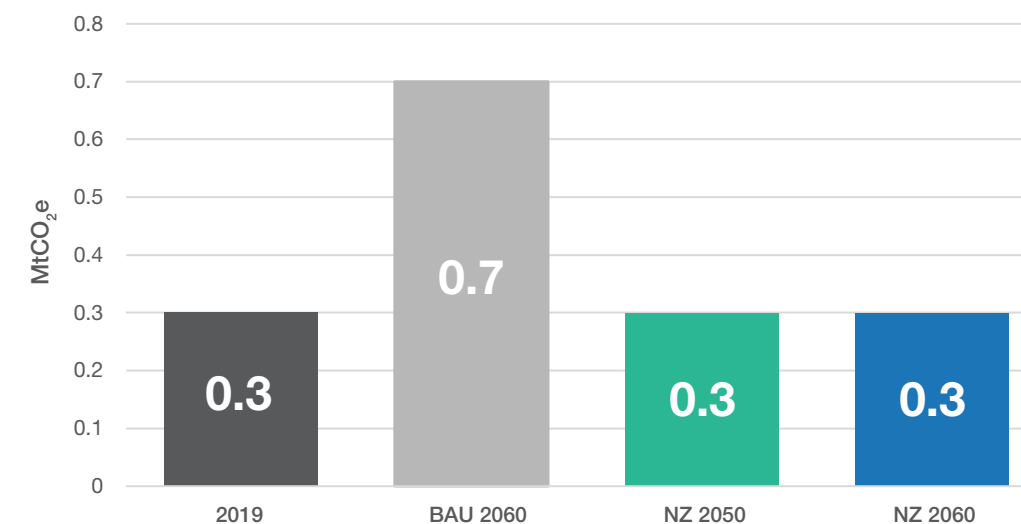


Source: Own preparation.

The largest electrification of the sector is achieved in the NZ scenarios; the rest is for oil and petroleum products. Consumption grows slightly in the analyzed period due to the combined effect of greater energy efficiency and the savings from the electrification of certain uses.

Graphic 53

► Agriculture, fishing, mining, and construction sector: direct emissions by scenario, MtCO₂e



Source: Own preparation.

CO₂e emissions grow more than twice in the BAU scenario. On the other hand, emissions remain constant in the NZ scenarios in the long term as a result of the electrification of the sector and energy efficiency efforts.

The energy transition measures required to limit GHG emissions in the sector relate to technologies that are expected to have matured worldwide in the next few years, such as the use of electric agricultural machinery and electric mining trucks.



Power sector

The Dominican Republic starts from a mostly fossil mix (78% in terms of installed capacity), where we can mention the introduction of a coal-fired power plant in 2019, with 2 generation units of 360 MW each.

Its energy potential is limited due to its geographical conditions (an island with limited land availability). Offshore wind generation can be an option to increase the share of renewable generation. Its offshore wind potential is estimated at 63 GW³². It also has solar potential, favorable to develop a low-emission power generation fleet. In recent years, wind and solar projects have started being developed to diversify the generation matrix.

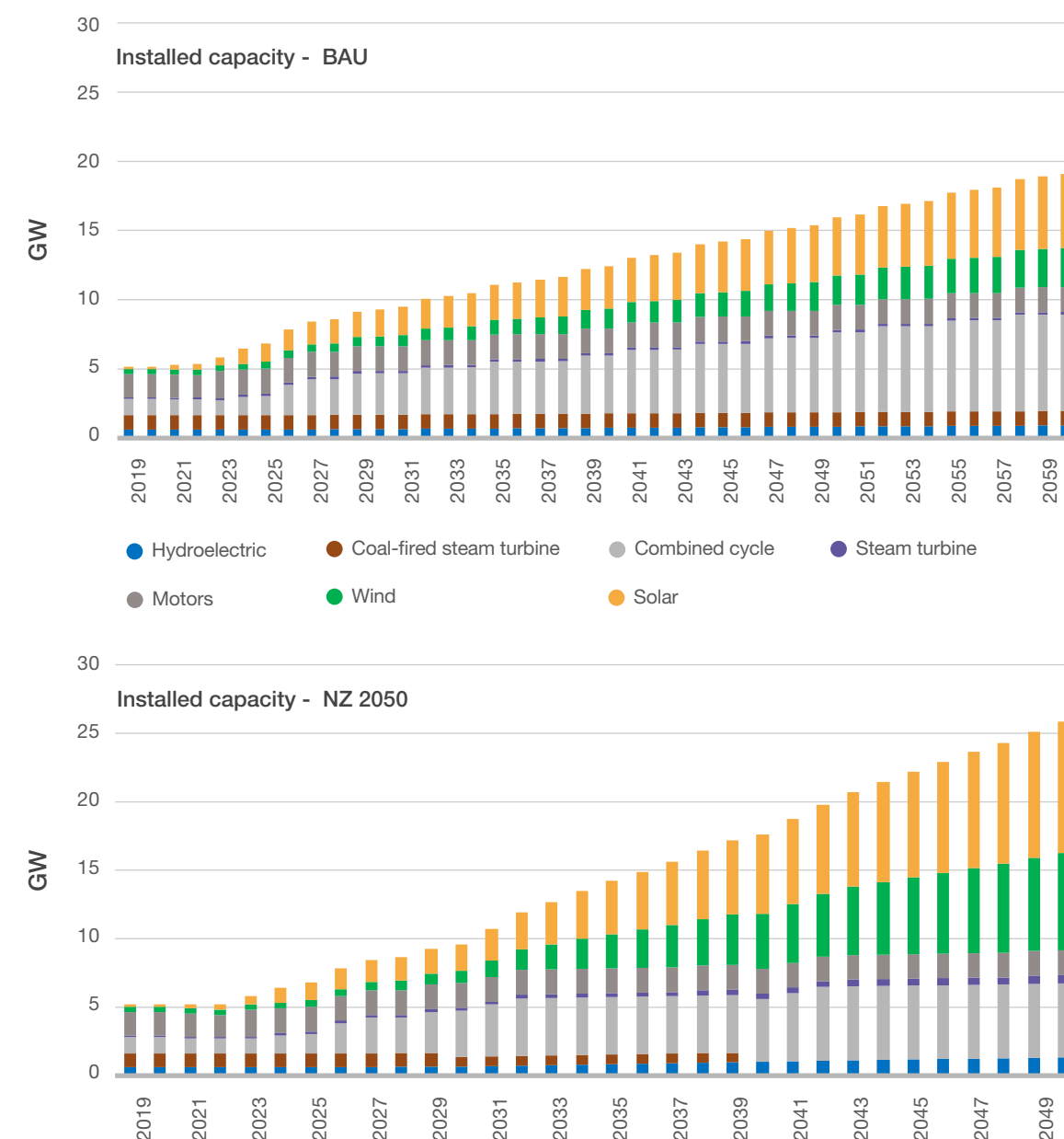
In all the scenarios presented, an increase in solar and wind capacity is expected and, to a lesser degree, in hydroelectric capacity. Instead, in the NZ scenarios, the phase-out of the coal-fired thermal plants is envisaged in the long term, as they are characterized by a very high emission factor by energy unit. In the BAU scenario, the additional renewable capacity to be installed is 8.1 GW, 5.3 GW of which is solar, 2.5 GW wind, and 0.3 GW hydro. In the NZ scenarios, even more renewable capacity needs to be installed to cover the greater power demand and ensure a significant reduction in GHG emissions. In the NZ 2050 scenario, the addition of 16.9 GW of renewable energy is expected, 9.5 GW of which will be solar; 6.7 GW, wind and 0.7 GW, hydro. In the NZ 2060 scenario, the installation of 18.9 additional GW of renewable energy is required, 10.5 GW of which is solar; 7.5 GW, wind; and the rest, hydro.

In all the scenarios, the installation of new thermal plants, particularly CCGT, is also required, as they play a backup role, as well as batteries and smart grids, which participate for a better integration of renewable energy in the grid.

³² <https://www.energiaestrategica.com/republica-dominicana-afina-licitacion-de-1200-mw-eolicos-y-solares/>

Graphic 54 A

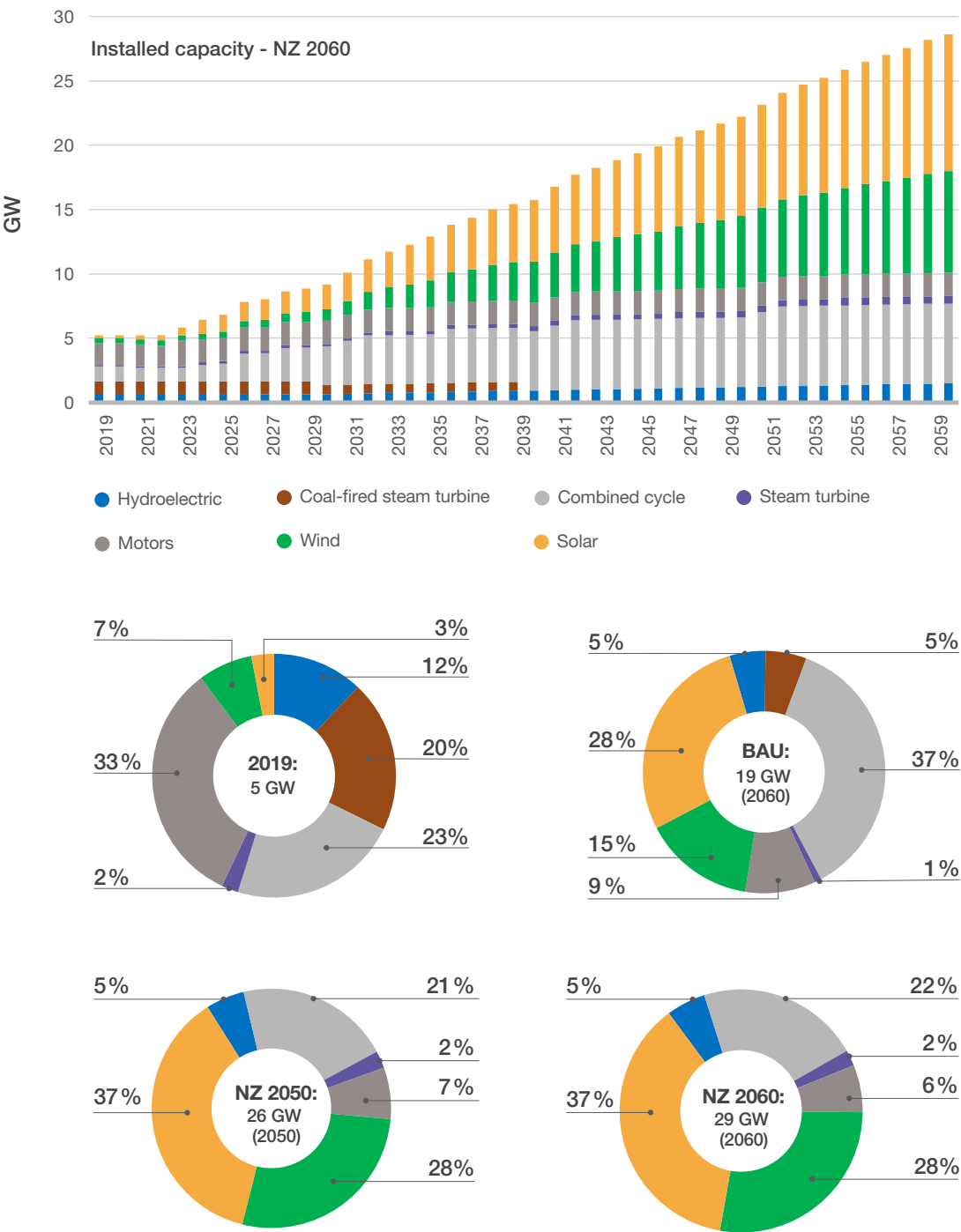
► Projection of installed capacity by source and by scenario (GW)



Source: Own preparation.

Graphic 54 B

► Projection of installed capacity by source and by scenario (GW)



Source: Own preparation.

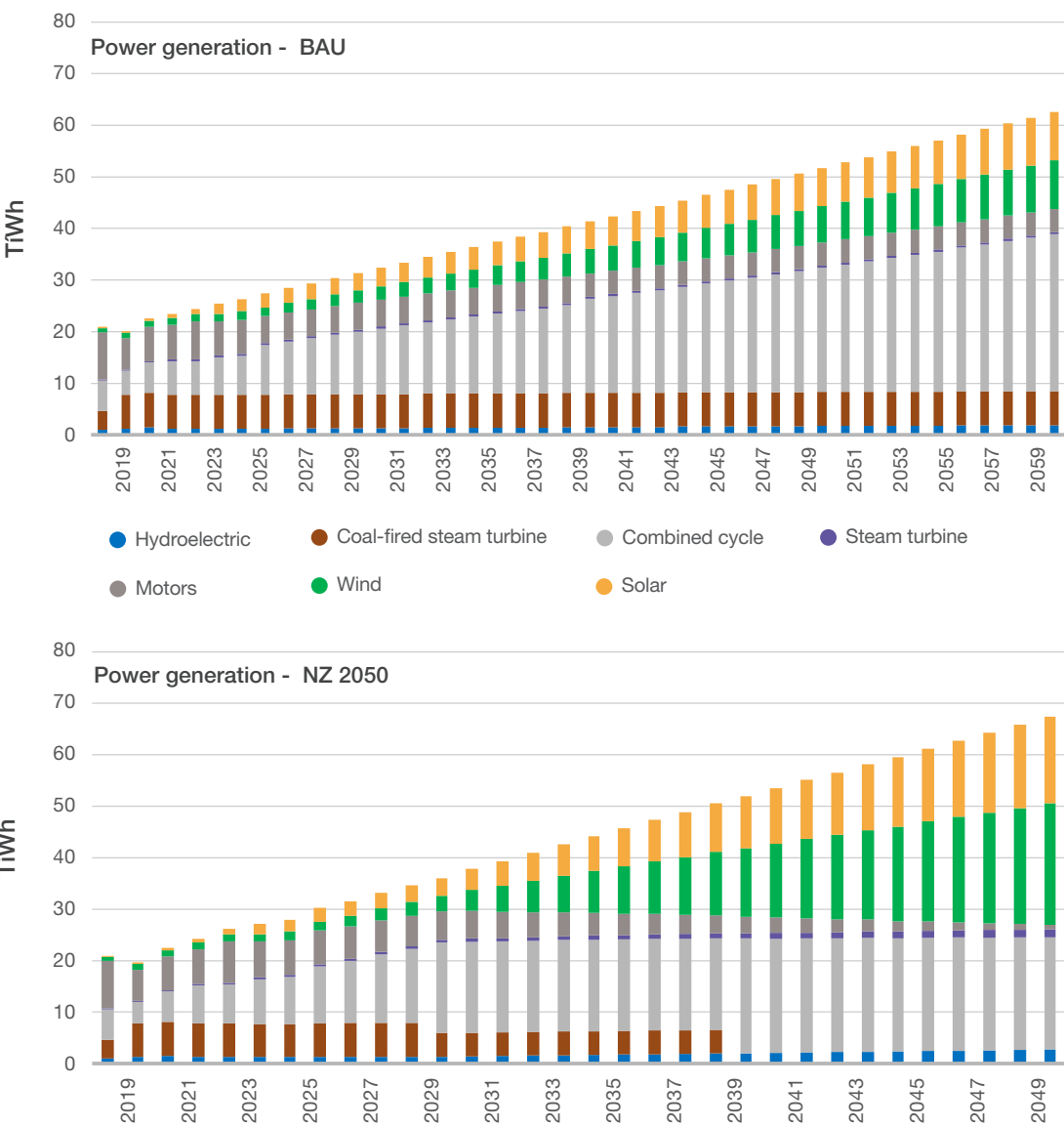
In all the scenarios, a much greater increase in the generation fleet than the one observed in the last 20 years is required, as well as greater growth in the fleet than the increase in power demand, measured in growth %.

In addition, the electric generation matrix becomes more renewable: 33% of the emission-free generation in the BAU scenario and 65% in the NZ scenario.



Graphic 55 A

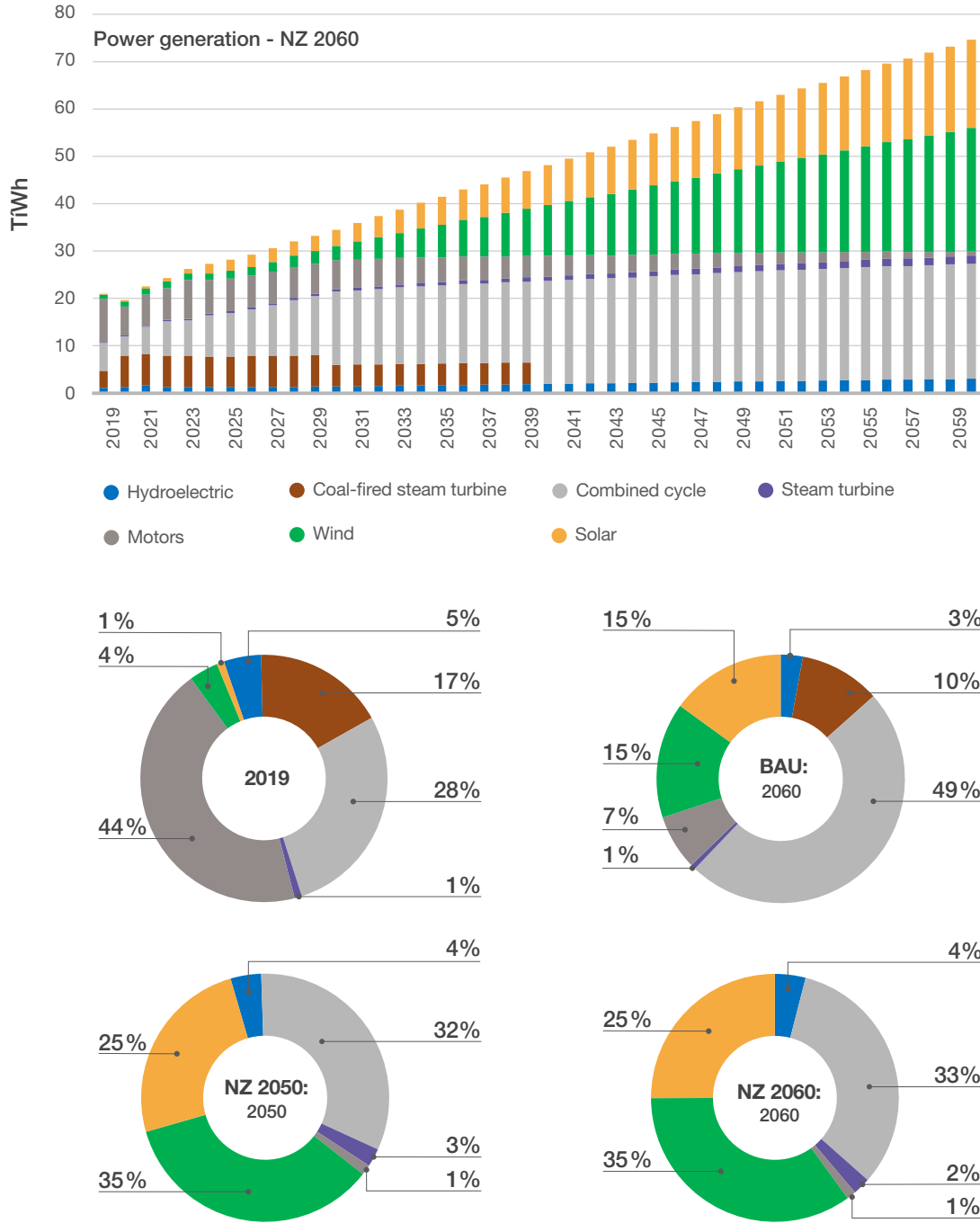
► Projection of power generation by source and by scenario (TWh)



Source: Own preparation.

Graphic 55 B

► Projection of power generation by source and by scenario (TWh)



Source: Own preparation.

3. Energy transition financing

In this section, total investment in each scenario is presented as a result of all the just energy transition measures previously described.

The main subsectors requiring investment are indicated, including a brief description of the assumptions used to obtain the amounts included in the following sections:

1. power generation (and the need for additional power grids as well as flexibility measures);
2. electrification of the road transportation sector (investment in electric vehicles and charging stations);
3. energy efficiency measures and electrification of subsectors and end uses for the other sectors.



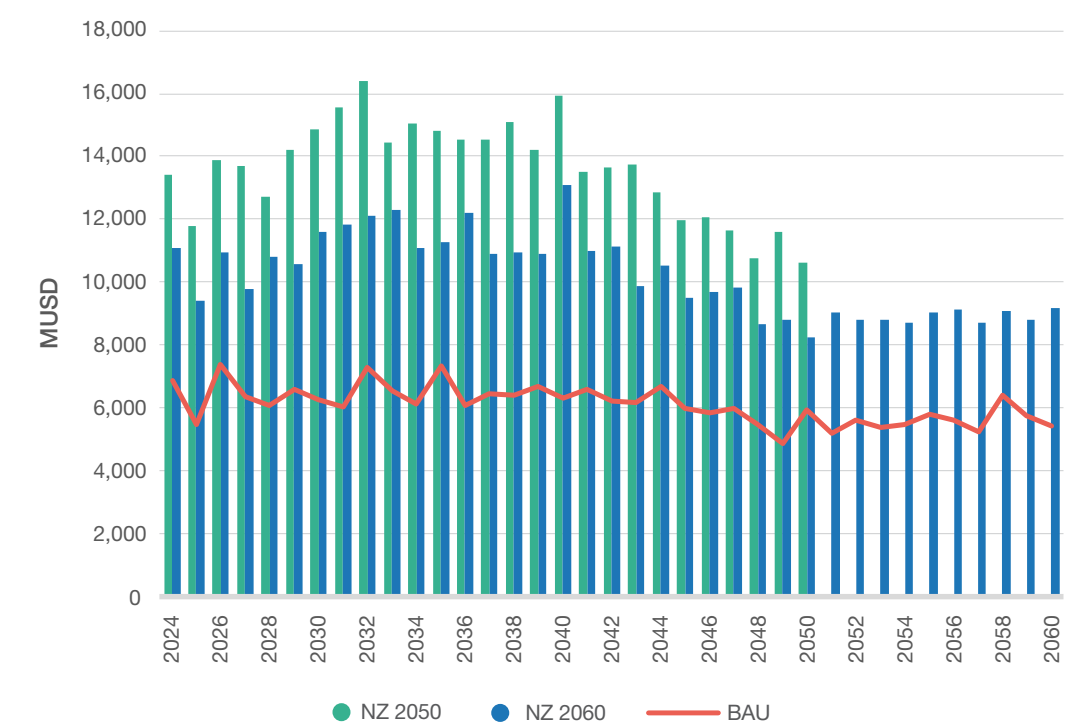
Total investment

Investment is calculated on an annual basis and the total investment amount is applied as of the first year in which it is possible to reduce CO₂ emissions. This is a simplification of the model, as large investment must take place in advance, from one to five years before, depending on construction times or the implementation of the investment considered (hydro plants, for example, are characterized by a construction period of several years).

Graphics 56 and 57 show the estimated total annual investment by scenario, in millions of USD and as a percentage of the GDP, according to the guidelines and assumptions described in the section “Investment”, chapter “Methodological section and assumptions” in the *Just Energy Transition / Projection assumptions report*.

Graphic 56

► Estimated total annual investment, MUSD



Source: Own preparation.

The cumulative investment in the period 2024-2060 was USD 226,000 million in the BAU scenario, USD 401,000 million in the NZ 2050 scenario and USD 377,000 million in the NZ 2060 scenario.

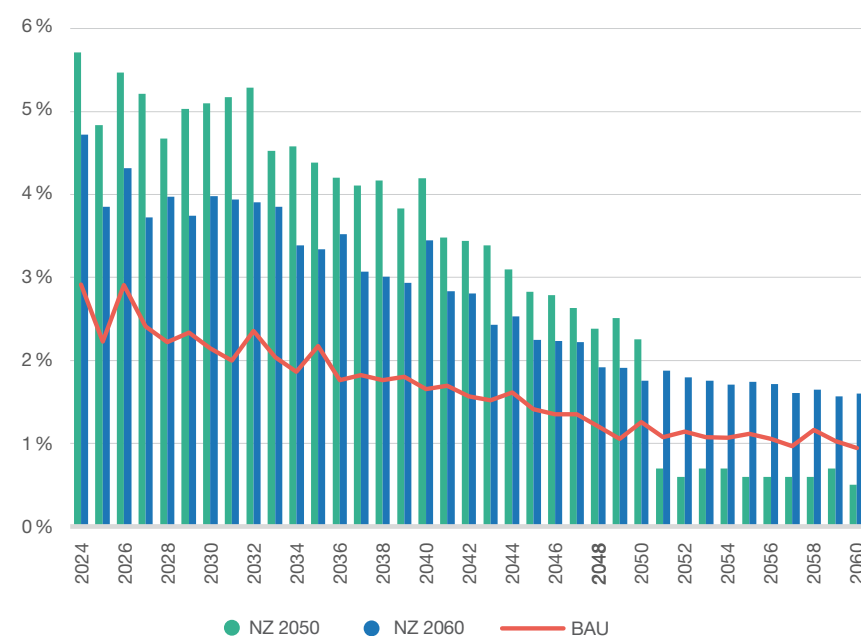
By year, investment shows a slightly growing trend until the period 2030 to 2040 in the NZ scenarios. From then on, slightly decreasing investment is observed, which reflects the fall in the unitary cost of some of the transition technologies in the long term, particularly, electric vehicles. In the BAU scenario, annual investment is quite stable.

The maximum annual investment in the BAU scenario is approximately USD 7,000 million, around USD 16,000 million in the NZ 2050 scenario, and around USD 13,000 million in the NZ 2060 scenario. This implies almost doubling the annual investment in the NZ scenarios.

As from 2051, investment in the NZ 2050 scenario is lower, as the net zero goal has been reached and the effort to maintain this level is small.

Graphic 57

► Estimated total annual investment in GDP (%)



Source: Own preparation.

The investment effort, measured in GDP percentage, amounts to 2.9% in the short term in the BAU scenario; 5.5% in the NZ 2050 scenario; and 4.5% in the NZ 2060 scenario.

Investment by type is presented in the following sections.



Power sector

Investment in the power sector includes:

- investment in new power generation plants, in line with the generation expansion presented in the “Power sector” subsection, “Results and assumptions by sector” section, pursuant to the CAPEX prices projected by the National Renewable Energy Laboratory (NREL) to start up new facilities³³;
- investment in infrastructure and flexibility, including the concepts of smart grids, batteries, and revamping of old hydro plants, estimated at an additional 15%³⁴ to investment in power generation. This investment is key to facilitate the integration of intermittent power generation in the electric dispatch;
- investment in transmission and distribution grids, which accompanies the very significant growth in power demand as a result of the projected economic growth and the electrification of end uses, based on a 16% share of transmission and 44% of distribution³⁵.

³³ Table 9, *Just Energy Transition / Projection assumptions*.

³⁴ This generic amount is in line with the global investment amounts estimated by the International Renewable Energy Agency (IRENA) in its report *World energy transitions outlook 2023: 1.5 °C pathway*.

³⁵ See again the *Just Energy Transition / Projection Assumptions report*.

- The investment required to phase out coal-fired power plants before the end of their useful lives (stranded assets) was calculated based on 50% of the CAPEX of a new coal-fired thermal plant published by the NREL³⁶.

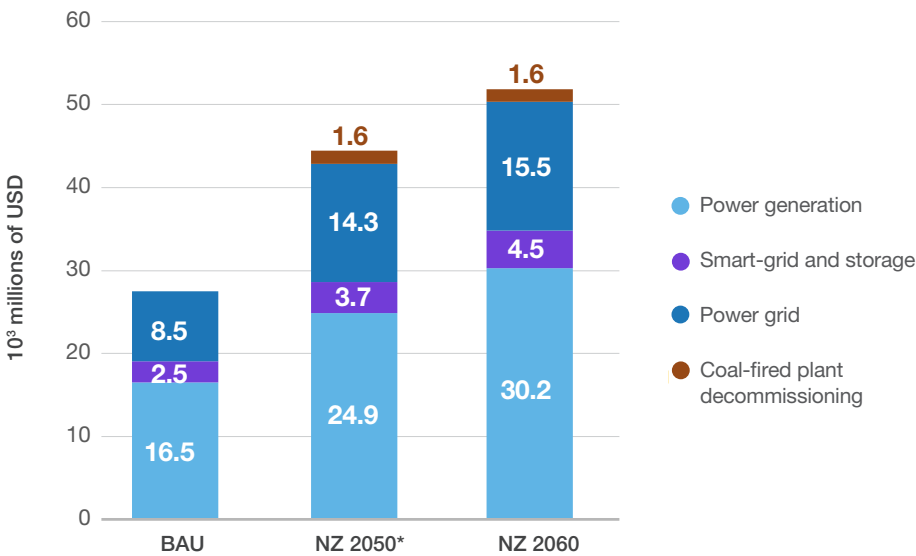
It is important to point out that, even though the addition of new power generation capacity grows in the long term, the unitary costs of the renewable technologies are expected to fall gradually over time as a result of the technological enhancements and the development of the sector that allows for returns to scale.

On the other hand, in the long term, there is also the need for reinvestment in solar and wind power plants (replacement at the end of useful life).

Cumulative investment in the transition period is presented below for each scenario.

Graphic 58

► Power sector: cumulative investment in the transition period (billions of USD)



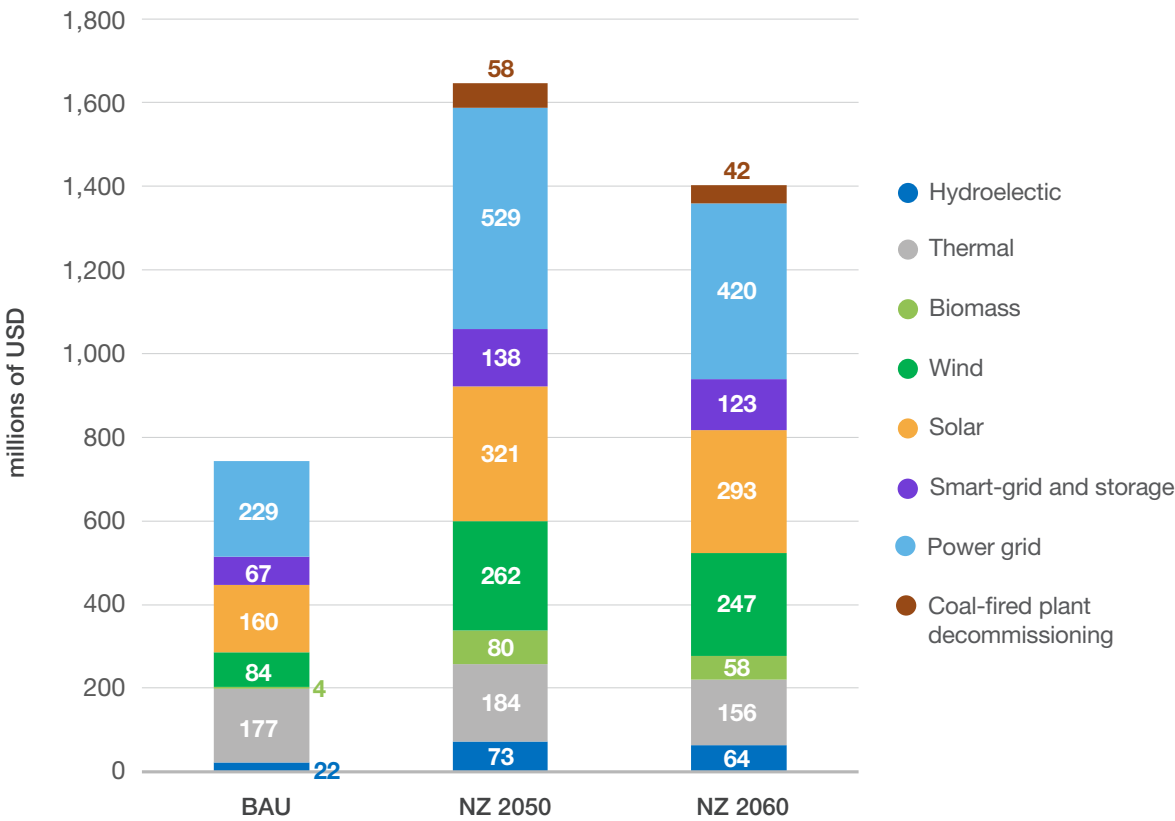
Source: Own preparation. *Investment in the NZ 2050 scenario refers to the period 2024-2050, whereas it refers to the period 2024-2060 in the other scenarios.

36 Table 10, Just Energy Transition / Projection assumptions.

Cumulative investment related to the power sector is approximately USD 28,000 million in the period 2024-2060 for the BAU scenario; USD 44,000 million in the period 2024-2050 for the NZ 2050 scenario; and USD 52,000 million in the period 2024-2060 for the NZ 2060 scenario. Investment related to power generation, smart grids, and storage adds up to around two thirds of this, whereas investment in the power grid is about one third.

Graphic 59

► Power sector: annual investment by type (millions of USD-year)

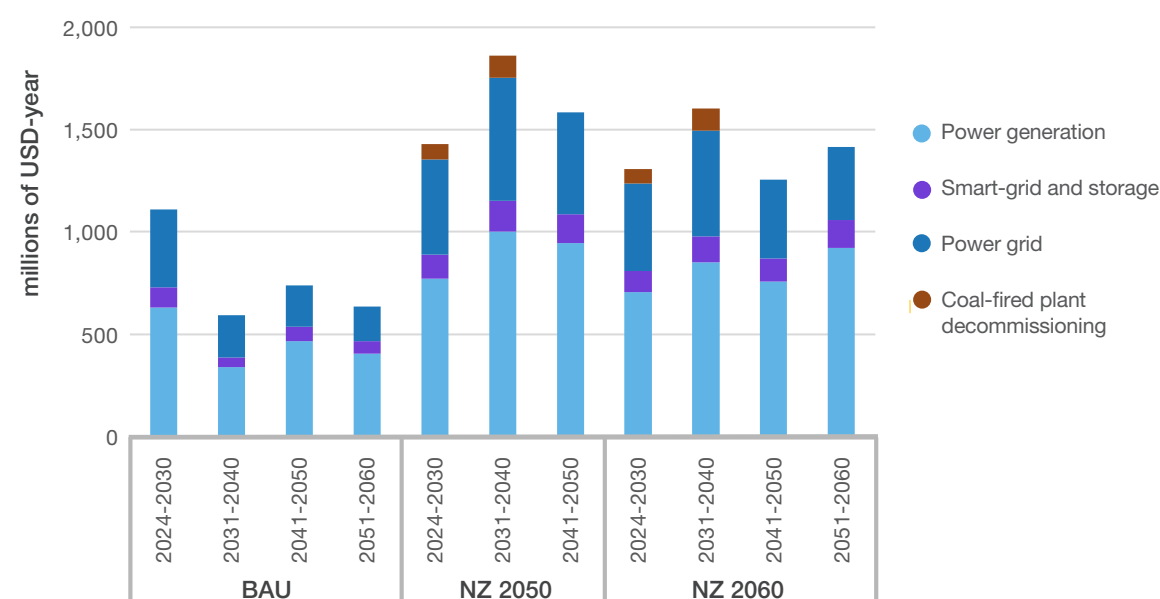


Source: Own preparation.

By year (average value), the required investment is higher in the NZ 2050 scenario with USD 1,646 million. The NZ 2060 scenario follows with USD 1,402 million and, finally, the BAU scenario with USD 743 million. By technology, the investment in power generation with the largest participation is in solar and wind.

Graphic 60

► Power sector: annual investment by period (millions of USD-year)



Source: Own preparation.

By time interval, the need for investment is variable over time, depending on the project development chronology, the projected evolution of the CAPEX of each technology, and also the need for reinvestment in power plants at the end of their useful lives in the long term.



End uses

From the point of view of investment related to energy end uses, we can mention the following:

- the road transportation sector, in which the total investment³⁷ in electric vehicles (EV) and hybrid vehicles (VH) is estimated on the basis of the unitary CAPEX projected by IRENA and the number of new vehicles, as well as the charging stations, based on a calculation of the number of stations required and a unitary cost;
- energy efficiency measures, electrification, use of alternative fuels (hydrogen and its derivatives, among others), and behavior changes with an impact on the end use sectors, except for road transportation and the carbon capture, use, and storage technology (CCUS). A proxy³⁸ was considered by final consumer sector, equivalent to a unitary CAPEX expressed in USD/ton of avoided emissions, multiplied by the savings in emissions in each sector.

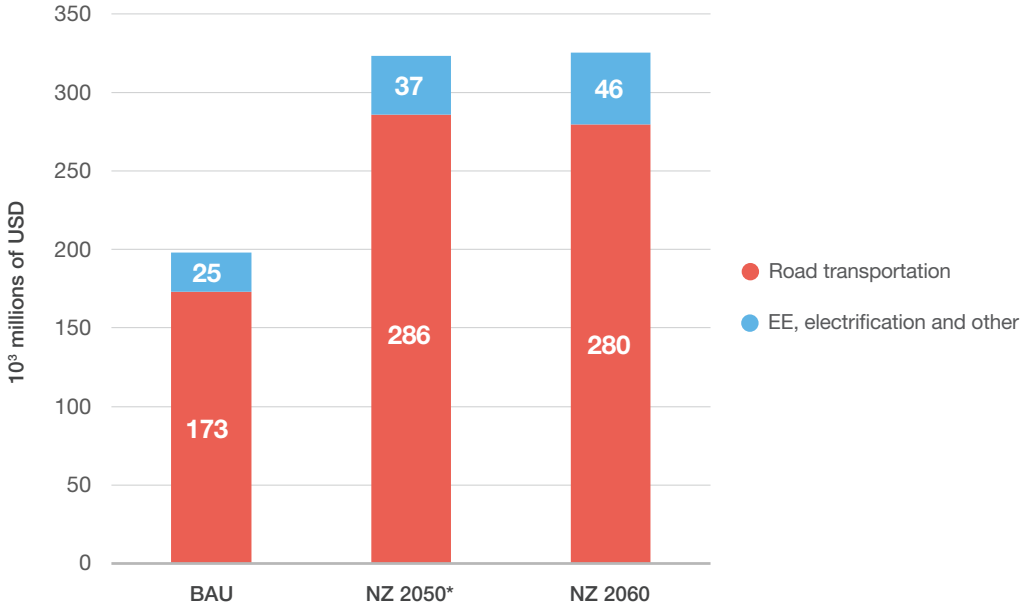
Graphic 61 presents cumulative investment in the transition period for each scenario.

³⁷ This investment does not consider the necessary replacement of EVs at the end of their useful life or the anticipated replacement of batteries.

³⁸ This equivalent CAPEX by sector was estimated based on a study conducted by the Climate Change Committee (CCC).

Graphic 61

► End uses: cumulative investment in the transition period (billions of USD)

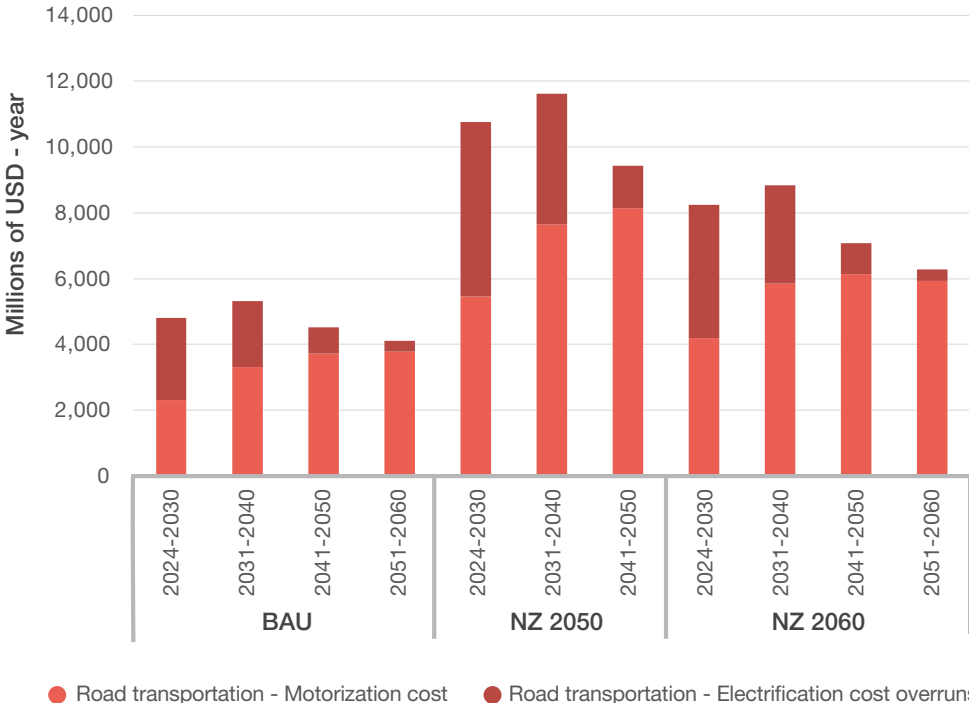


Source: Own preparation. *Investment in the NZ 2050 scenario refers to the period 2024-2050, whereas it refers to the period 2024-2060 in the other scenarios.

Cumulative investment related to end uses is approximately USD 198,000 million in the period 2024-2060 for the BAU scenario; USD 323,000 million in the period 2024-2050 for the NZ 2050 scenario; and USD 326,000 million for the period 2024-2060 in the NZ 2060 scenario. Investment related to road transportation amounts to approximately 85 % to 90 % of this investment if total investment related to EVs and HVs required for this segment is considered. If only the cost overruns related to this investment (calculated in a simplified way as the difference in cost between buying EV, HV and investing in charging stations, and buying a vehicle that runs on fossil fuel) are considered, road transportation amounts to less, but it is still around two thirds of the investment related to end uses (see Graphics 62 and 63, dark red segment referring to electrification cost overruns). Graphic 62 illustrates the difference between both concepts in road transportation.

Graphic 62

► Road transportation: annual investment by period (millions of USD-year)



Source: Own preparation.

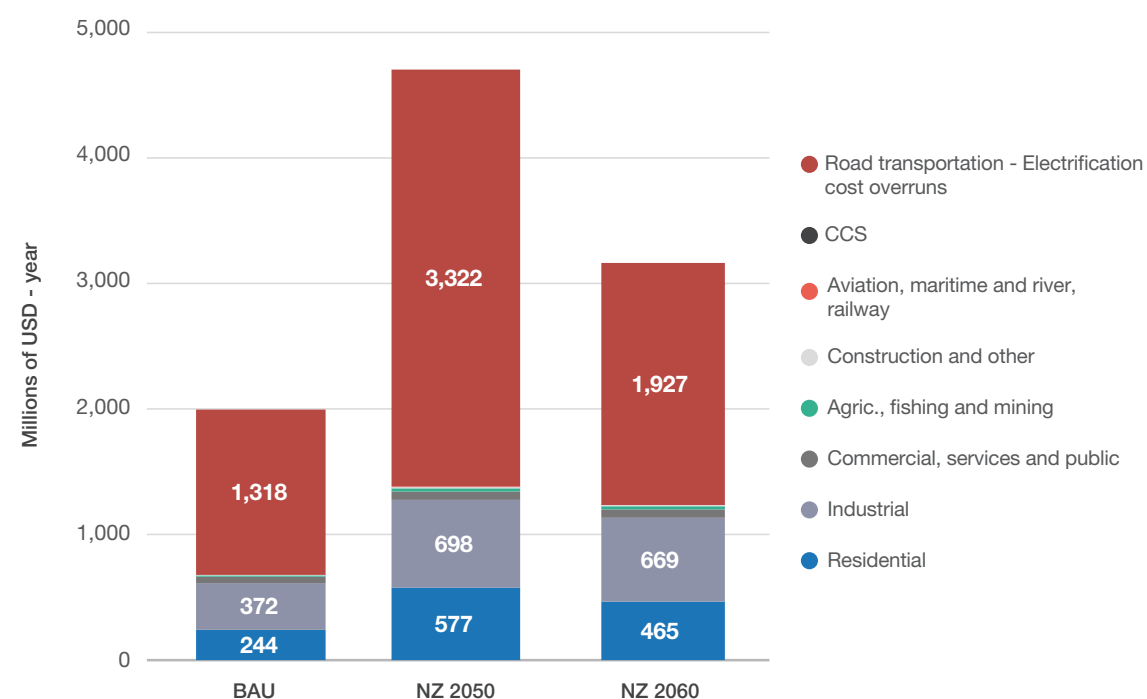
It should be mentioned that all the analyzed scenarios present a future reduction in the cost of electric vehicles of about 60 % in the period. In addition, the scenarios contemplate an increase in motorization, evidenced through the possession of vehicles per 1,000 inhabitants, as indicated in the assumptions by sector. The need for investment includes two major effects: greater access to mobility and mobility electrification. The latter represents lower cost overruns in the long term due to the competitiveness of EVs against vehicles running on fossil fuels in almost all the vehicle segments.

It is important to remember that an increase in the possession of cars and a reduction in their annual unitary use were estimated for private passenger transportation. Other schemes may also exist, such as shared autonomous vehicles, which could partially reduce the total number of vehicles and their associated investment.

Graphic 63 presents investment by type, without considering the cost of motorization.

Graphic 63

► End uses: annual investment by type (millions of USD-year)



Source: Own preparation. This Graphic does not consider the cost of motorization.

By year (average value), the investment required is higher in the NZ 2050 scenario, since the transformation of the sector must be achieved fast. By technology, the investment with the largest share is that of the road transportation sector, followed by the industrial and residential sectors.

“The main areas requiring investment are electricity generation; electric vehicles and charging stations; energy efficiency measures; and the electrification of branches and end uses for other sectors.”

4. Main transition indicators

Table 12 presents some of the just energy transition indicators.

These indicators illustrate the increase in the penetration of renewable energy in final consumption and power generation, the energy intensity enhancements in the sector, the use of energy per capita, and the penetration of electric mobility, among other aspects related to the just energy transition.

Table 12

► Indicators by time horizon and scenario

Number	Potential indicators	Unit	2019	BAU 2060	NZ 2050	NZ 2060
E-2.1	Share of renewable energy in total final energy consumption	%	15%	23%	54%	55%
	Share of renewable energy in power generation	%	12%	33%	64%	64%
E-2.1bis	Renewable energy installed generation capacity	GW	1.2	9.1	18.0	20.0
E-2.2	Energy intensity measured based on primary energy and GDP	TJ/ MUSD PPP 2017	2	0.9	0.6	0.6
E-2.3	Efficiency of energy conversion	%	37%	50%	50%	50%
	Efficiency of energy distribution	%	85%	85%	85%	85%
E-2.4	Energy intensity by sector (Industrial)	TJ/ MUSD PPP 2017	2.6	2.0	1.7	1.5
	(Agriculture, fishing, and mining)		0.5	0.3	0.2	0.2
	(Services and commercial)		0.2	0.1	0.1	0.1
	(Transportation)		0.5	0.3	0.2	0.2
E-2.5	Energy intensity in the residential sector	TJ/1,000 inhabitants	5.6	5.0	4.1	4.2
E-2.6	Penetration of electricity in the transportation sector	%	%	23%	64%	65%
E-2.7	Penetration of natural gas in the transportation sector	%	1%	0%	0%	0%
	Penetration of hydrogen in the transportation sector	%	0%	0%	9%	9%
S-1.4	Use of energy per capita	TJ/1,000 inhabitants	24.1	38.0	24.3	25.9
A-1.1	GHG emissions per year, energy*	MtCO ₂ e	27	42	14	15

Source: Own preparation. *Fugitive emissions are not included.



1. The environment for the transition

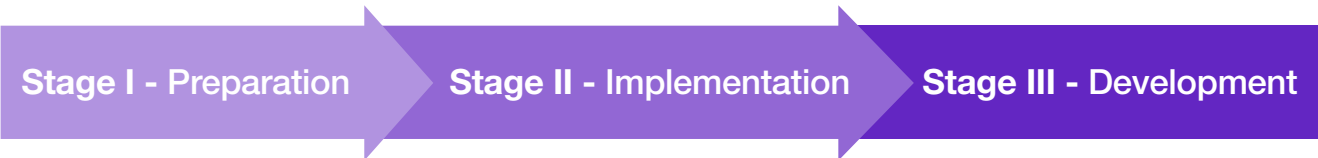


Projections

When analyzing the results of the projections of the energy matrix in the Dominican Republic in the long-term NZ scenarios, we observe more consumption electrification, a reduction in the demand for liquid fuels (refined hydrocarbons), and a very slight increase in natural gas consumption.

The transition in the Dominican Republic can be divided into three stages: the preparation stage between 2020 and 2030, the implementation stage with strong investment between 2030 and 2040, and the development stage as from 2040.

Graphic 64 ► Roadmap: stages



STAGE I – Preparation (between 2020 and 2030). It is characterized by growing investment in the energy transition:

- the electricity sector in the Dominican Republic has a large share of thermal energy; therefore, the growing introduction of renewable generation was assumed together with gas-fired plants already contracted as from this decade;

- tenders were carried out to introduce renewable energy as from 2021; these tenders started increasing the installed capacity in solar and wind generation;
- it is expected that electric vehicles and batteries for power generation will not be as massive and competitive as in the following decades.

It is worth pointing out that thermal generation projects have mainly supplied the strong economic growth experienced by the Dominican Republic in the last 20 years (around 4 %) and the increase in energy demand (1.9 %). More recently, Punta Catalina coal-fired thermal plant started operations (2019) and LNG-fired plants were tendered for, will be built in Manzanillo and will start operating between 2024 and 2025. These assets will be operative during the whole 2030 decade and, in the case of the gas-fired plants, beyond 2050.

The development of gas-fired power plants (including import capacity expansions and the recently tendered plants) will allow the Dominican Republic to increase the penetration of intermittent energy; for example, wind and solar energy and natural gas-fired plants can play a back-up role.

In the second half of this period, we can mention investment in energy efficiency, renewable generation (particularly, solar and wind), and the need to increase investment in the associated transmission grid, investment in renewable energy, and the introduction of distributed generation.

Fuel oil is starting to be eliminated as fuel in this decade. The appearance of LNG allows it to be eliminated from the electricity matrix even though it is still operational in the market in maritime transportation.

STAGE II - Implementation (between 2030 and 2040). It is assumed that energy transition technologies are massive, available, and have high demand. The CAPEX of electric vehicles, power generation from renewable sources, and batteries continue their downward trend, which allows for the massive development of these technologies.

In this decade, the introduction of clean technologies and the enhancement of energy efficiency in the energy sector’s value chains gain speed even though

investment in natural gas is maintained to back up the introduction of renewables. Coal phase-out starts at the end of the decade.

Public policies to revamp and expand transmission and distribution grids gain speed so that they can efficiently incorporate and transport clean energy to the consumer centers (minimizing technical losses) and give way to a smart grid by incorporating the electrification of new uses (electric vehicles, solar roofs, etc.).

Energy efficiency policies are promoted in all the segments.

The introduction of electric vehicles in the Dominican Republic concurrently with the increase in renewable energy will allow the country to slowly reduce its exposure to the international prices of raw materials. As it is a fuel importer, electric vehicles are more competitive than in those countries that produce fuels; therefore, greater and faster penetration is expected. Moreover, its vastness allows for less extensive supply networks.

STAGE III - Development (as from 2040). Clean technologies are already mature, massive, and competitive; therefore, the cost of the transition is more related to accelerating the phase-out of the technologies with higher emissions. In the case of the Dominican Republic, this process will only start after 2040.

Investment in the sectors responsible for CO₂e emissions stops. In the case of natural gas, investment is maintained to operate the plants that are still operational without additional expansions, and this gives way to the technologies that replace it, such as hydrogen (marginally).

These actions will bring about a debate on stranded assets, particularly in the case of the regasification terminals and their associated thermal generation plants that have not been depreciated in the business cycle.



Implications for public policies

The Human Development Index (HDI) of the Dominican Republic was 0.767 in 2021, which places the country in the high human development category and in the 80th position among 189 countries and territories³⁹. Moreover, it is not a country in Annex I to the Paris Agreement. Therefore, its policies must focus on allowing it to meet its emission reduction commitments and the need for its economy to grow in order to reach the maximum emission reductions in the shortest possible time; it is likely to meet the net zero emissions target after 2050.

Stage I - Preparation

In preparation stage I, the Dominican Republic's policies should focus on the following points.

- 1. Public policies.** A National Energy Plan for 2050 and 2060 must be developed so that it shows a pathway to decarbonization. The Dominican Republic has a National Energy Plan 2022 to 2036 (CNE, 2022) and two reports, a report on the Nationally Determined Contribution 2020 and a report on the Economic Assessment of the Power Sector Decarbonization for 2050 (IADB). These studies should include the concept of just energy transition and clearly explain the terms within which the Dominican Republic can reach a NZ economy and ensure compatible decent standards of living.

³⁹ The UNDP indicator establishes four categories: low (less than 0.55), medium (between 0.55 and 0.70), high (between 0.70 and 0.80), and very high (over 0.80).

2. Access. The Dominican Republic has a high coverage and access level, but it must improve the quality-of-service aspects. Thus, programs to enhance power distribution are a key element to provide access with quality and should be slowly developed in this preparation stage.

3. Energy efficiency. The labeling of energy equipment⁴⁰ should be implemented and promotion and replacement programs should be developed. During this stage, energy efficiency policies should be promoted for the residential, industrial and transportation sectors.

In the Dominican Republic, electricity tariffs require to be aligned to cover all the costs incurred. This effect focuses on distribution tariffs.

4. Renewables. The Dominican Republic has solar and wind resources. It has launched programs to develop renewable energy since 2007. In 2021, it carried out a tender for renewable energy and has continued this policy through an increase in the penetration of renewable energy.

No regulation on distributed generation and microgeneration with panels has been approved.

The promotion of the penetration of renewable energy, distributed generation, and microgeneration must continue in this period, and the coordination aspects of the administration of off-grid generation mentioned in the automation aspects should be addressed.

5. Subsidies and prices. Energy efficiency policies require well-focused price schemes that reflect costs and subsidies to be effective. Tariffs do not reflect costs in the Dominican Republic. It is necessary to improve subsidy policies so that tariffs can recover all the costs invested⁴¹.

⁴⁰ The Dominican Republic can create its own system or adhere to an external labeling system, but it must have a single labeling system so that consumers can make an intelligent decision. This process will help to phase out inefficient equipment in the medium term.

⁴¹ As to tariffs, efficient costs must be recognized; that is, the costs of an efficient company.

6. Regulations. Eventually, fiscal and financial incentives that promote investment in renewable energy must be maintained and they should be extensive to investment in energy efficiency.

Promote regulations that allow the entry of electric freight vehicles.

Banking regulations should be promoted to incentivize loans associated with the energy transition (renewable sources and transition fuels) and penalize investment in the oil and petroleum product chain.

Detailed policies and regulations should be developed to promote hydrogen-related policies in order to reduce the uncertainty in the business and allow its development in the long term.

7. Transition fuels. The Dominican Republic has consolidated its gas supply in the first part of this decade; in this case, with LNG.

45 % of the fuel in the industrial sector comes from sources with high emissions; therefore, the country should try to introduce gas in the sectors using liquid fuels or coal in order to reduce the emission levels.

8. Reconversions. Even though there is no official plan to phase out coal and fuel oil-fired plants, in recent years, the Dominican Republic has promoted the substitution of these power plants with natural gas-fired power plants.

In this decade, we believe that the Government should not promote additional reconversions.

9. Smart grids. During this decade, the Dominican Republic should focus on strengthening transportation and distribution companies in order that, by the end of the decade, new regulations can be introduced to promote this type of grids.

10. Transportation. In this decade, the introduction of hybrid vehicles and the development of electric charging networks should be fostered.

As it is a hydrocarbon importer, the transition to renewable energy should be accompanied by the creation of the electric networks required for the penetration of electric vehicles.

11. Education. Promote education policies on the energy transition to develop habits regarding energy consumption in the population. During this stage, the energy transition should be included at all education levels and in awareness campaigns addressed to society.

Stage II - Implementation

In the second stage there will be more investment.

1. Public policies. Develop the transition plans to NZ detailed in the planning horizon that is finally defined.

2. Energy efficiency. Continue promoting energy efficiency in all segments of the economy (residential, industrial, commercial, transportation, agriculture, public sector, etc.) in order to reduce energy consumption.

Promote equipment and vehicle replacement and scrappage plans focusing on vehicles (cars and trucks), given the expected progress in electric vehicle development and prices.

These programs should focus on replacements with electric vehicles and on reducing dependence on fossil fuels.

3. Subsidies and prices. Prices must be defined in the energy markets and subsidies for people with unfulfilled energy needs should be maintained.

4. Regulations. Foster tariff schemes that envisage investment in mitigation and adaptation to climate change.

Promote restrictive regulations for the vehicle fleet in order to incentivize the replacement and retirement of units with high CO₂ emissions and the design of cities that allow the use of alternative transportation (electric public transportation, bicycles for short distances, etc.).

Within the fiscal incentives, it should be established that taxes on carbon should relate to the international prices of carbon certificates so that they adequately reflect the mitigation cost⁴². This mechanism should be gradually applied to slowly incentivize the replacement of coal dispatch for that of natural gas.

5. Transition fuels. The hydrocarbon and natural gas sectors should be normally financed and financing of new hydrocarbon system expansion projects should be suspended.

6. Reconversions. Given that the Dominican Republic has made large investment in gas-fired thermal generation plants in the last 10 years, these assets will remain operational during the whole third decade of the century.

Considering that one of the assets to reconvert is a coal-fired asset located in a region with few possibilities of implementing CCUS mechanisms, the compensation mechanisms required to phase out this asset must be analyzed. Since the asset belongs to the State, the mechanisms required to phase it out in advance should be analyzed.

⁴² It is important to mention that price signals must be constant over time in order to be effective; therefore, another alternative could be the development of levelized mitigation costs.

In the projections carried out herein it was assumed that the asset will continue operational until 2039; however, as it is owned by the State, its anticipated phase-out requires no compensations to private investment; therefore, it is assumed that this option will be analyzed during this period.

- 7. Smart grids.** Revamp the energy infrastructure by promoting investment in smart grids and energy storage systems to facilitate the integration of renewable energy and enhance supply reliability.

The Government must analyze and cover the costs of introducing smart grids in low consumptions as part of the agenda to facilitate energy efficiency.

In addition, data transmission schemes should be envisaged to be able to create a safe data administration scheme of the centralized transmission and distribution grid (including cybersecurity aspects) without neglecting distributed generation.

- 8. Transportation.** Foster hybrid and electric freight vehicles and their associated cargo infrastructure. In the Dominican Republic, distances are short, which facilitates the introduction of electric cargo trucks and truck tractors.

Improve public passenger transportation and enhance the efficiency of the system.

- 9. Markets.** Develop secondary markets in the power sector, focusing on electricity trading and its financial derivatives (futures, swaps, options, etc.) to allow the residential and commercial segments to select the energy sources they want to acquire and allow the industrial sectors to calculate their prices in the very long term.

⁴³ Several pilot projects are being proposed to finance hydrogen and CCUS; however, these mechanisms seek to allow an increase in the amount of funds through the development of these technologies. Here, what is proposed is financing technologies that have already been developed.

This implies developing reforms in the power sector to adopt Consumer Choice-type schemes, by which regulated end users can choose the power service provider that suits them best.

- 10. New technologies.** Develop concessional financial instruments to implement hydrogen and CCUS technology projects⁴³.

Stage III - Development

In the third stage, efforts will focus on few objectives.

- 1. Energy efficiency.** Promote energy efficiency in all the segments of the economy (residential, industrial, commercial, transportation, agriculture, public sector, etc.) in order to reduce energy consumption. The alignment of prices, subsidies, financial regulations that promote energy transition, and carbon prices (taxes on carbon or emission trading systems) should foster this investment.

Promote replacement and scrappage programs for equipment and cars, focusing on all the equipment using liquid fuels.

- 2. Subsidies and prices.** Prices should be defined in the energy markets and subsidies for people with unfulfilled energy needs should be maintained.

- 3. Regulations.** Within the fiscal incentives, carbon price mechanisms should reflect social costs so that they incentivize the scrappage and replacement of such equipment.

- 4. Reconversions.** In this stage, investment should focus on introducing CCUS in the regasification plants and the associated generation assets if the technologies exist.

Moreover, the local refinery is not expected to be dismantled, as all the scenarios include some kind of transportation running on liquid fuels in 2060.

- 5. **Transportation.** Continue fostering electric transportation both for passengers and cargo.
- 6. **New technologies.** Promote the massive adoption of the new technologies with proven emission reductions, such as new energy efficiency practices.

2. Roadmap

In order to develop the roadmap, three stages were proposed. In the first stage, two phases were established, one for debate and another for development, where the public policies to be implemented and the segments that require concessional financing or support are defined. Table 13 shows the policies by topic and the expected action.

The debate phase is focused on conceptualizing, together with the countries, the implications of the just energy transition between 2024 and 2025. This transition presents the need to combine economic plans that allow high growth rates and an enhancement of the population’s quality of life through public policies that focus on reducing energy needs.

Moreover, the just energy transition must also discuss the financing of the transition measures, in line with the content of Article 7 of the Paris Agreement.

Table 13

► Roadmap to be promoted by CAF

Policy	Between 2024 and 2025	Between 2026 and 2030	Between 2031 and 2040	As from 2040
Public policies	- Integrate the concepts of JET in the energy transition plans and the policies developed by the Ministry of Energy and Mines.	- Issue the first plans for the JET.	- Adjust JET plans to the deadlines to meet decent standard of living goals	
Energy efficiency	- Establish its own labeling rules for home appliances and vehicles.	- Design, finance and implement replacement and scrappage policies for home appliances (refrigerators, air conditioning, etc.). - Establish policies to promote the introduction of hybrid vehicles and start introducing electric vehicles. - Analyze scrappage and replacement programs for trucks and vehicles over 20 years old.	- Continue the replacement policies, including all types of home appliances and insulation equipment for homes. - Promote plans to replace private vehicles with low efficiency with hybrid and electric vehicles. - Promote freight vehicles, both electric trucks and electric truck tractors.	- Continue the replacement policies, including all types of home appliances and insulation equipment for homes.
Energy subsidies	- Promote universal BonoLuz.	- Reinforce subsidy mechanisms as tariffs align.	- Focus subsidies on inhabitants with unfulfilled energy needs.	
Fuel prices			- Increasingly internalize remediation costs in fuel prices, either through taxes on emissions or emission trading systems.	
Utility tariffs	- Strengthen transmission and distribution companies so that they can operate with efficient tariffs.	- Gradually implement efficient subsidy and tariff schemes that recover the costs invested.	- Internalize investment in mitigation and adaptation in the tariffs. - Establish decoupled distribution tariffs, that is, tariffs that cover costs separately from generation.	

Cont'd.

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Policy	Between 2024 and 2025	Between 2026 and 2030	Between 2031 and 2040	As from 2040
Regulations	- Promote stronger policies related to fiscal and financial incentives to foster investment in renewable energy and energy efficiency. - Promote financial regulations that incentivize loans associated with energy transition (renewable sources and transition fuels). - Promote regulations that favor hybrid and electric vehicles both for the private and the commercial fleets. - Promote strict regulations for the freight vehicle fleet to incentivize the replacement of units with high emission factor. - Promote the participation of the private sector in the expansion of transmission assets.		- Within the fiscal incentives, it should be established that carbon taxes should be related to the costs of remediation and adaptation. - Develop detailed regulations to promote policies related to CCUS, to allow longer useful lives of regasification plants and their associated generation assets.	
Transition fuels	- Allow the financing and regulation of the oil and gas sector with banking regulations.	- Promote investment in the natural gas assets required to favor the development of renewable fuels.		- Maintain investment in the gas sector, focusing on financing operation and not on its expansion.
Reconversions				- Introduce CCUS technologies in the regasification terminals and in power generation as much as possible.
Phase-out of coal-fired and fuel oil-fired plants		- Conduct studies to analyze the potential of accelerating the phase-out of coal-fired plants. - Establish regulations to phase out the fuel oil-fired plants that remain operational.	- Establish regulations to phase out coal-fired plants.	
Development of smart grids (AMI)		- Analyze the integrated mechanisms of smart grids in transmission and distribution, and international financing for better management of the system as a whole.	- Introduce smart metering.	

Cont'd..

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Policy	Between 2024 and 2025	Between 2026 and 2030	Between 2031 and 2040	As from 2040
Integration of renewable energy and storage systems	- Develop detailed certification, operation, and remuneration rules for storage services (in progress).	- Include storage systems in the planning of generation, transmission and distribution expansion in the sector to integrate large amounts of renewable energy.		
Coordinated operation of distribution networks and transmission grids			- Develop integrated operation mechanisms between distributors and transporters.	
Development of secondary electricity markets			- Deregulate commercial and residential commercialization to introduce consumer decisions based not only on prices but also on the type of energy produced. - Introduce derivative markets for all energy segments. - Progress with competition schemes in terms of final supply to regulated consumers.	

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