The Democratic and Popular Republic of Algeria
Ministry of higher education and scientific research
National Polytechnic School

A dissertation submitted to the chemical engineering department
For Degree of engineer
In chemical engineering

A sustainable energy model for Algeria in 2030: the study of Electro-mobility in the transport sector

Mounia Tidjani, Nihal Mansouri

Under the guidance of Mr C.E Chitour Professor

Publicly presented in (06/07/2020)

Committee members:

President	Mr T.AHMED-ZAID,	Professor,	ENP
Promoter	Mr C.E CHITOUR	Professor,	ENP
Examiners	Pr A.MEKHALDI	Professor,	ENP
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Guests	Mr A.GUEND	Chief excutive,	Ministry of Industry And mines
	Mr K.BENFRIHA	CEO	Naftal
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ملخص

مع إرتفاع الطلب المتزايد على الطاقة في وبالأخص مجالات متعددة وخاصة النقل، ومع تحديات القرن الواحد و العشرون والمتعلقة بنفاذ إحتياطي الطاقات الأحفورية خلال بضع سنوات القادمة من جهة، ومن جهة أخرى، مشكلة تغير المناخ و مايترتب عليه من كوارث طبيعية كارتفاع درجة حرارة الأرض. وجب التفكير في بدائل تهدف إلى تحقيق الإنتقال الطاقوي والذي يهدف إلى استغلال ثروات البلاد من الطاقات المتجددة لإنتاج الطاقة كالكهرباء وتحقيق التنمية المستدامة للأجيال الصاعدة.

تتضمن مذكرة البحث دراسة لمجال النقل في الجزائر و التي من هدفها إقتراح إستراتيجية 2030 نحو التنمية المستدامة و الذي يهدف إلى ترشيد إستهلاك الوقود و استبداله بأنواع أقل ضررا على البيئة مع فتح آفاق جديدة لستقبل المركبات الكهربائية و التي تعتبر من أهم المواضيع المتداولة عالميا لما لها من آثار إيجابية على الوطن و الفرد.

كلمات مفتاحية: الطاقات المتجددة، الإنتقال الطاقوي، المركبات الكهربائية، تغير المناخ

Résumé

La demande énergétique ne cesse d'augmenter dans plusieurs domaines, particulièrement dans le domaine des transports, l'épuisement des réserves des énergies fossiles au cours des prochaines années est le défi pour 21ème siècle, d'une part, et d'autre part, le problème du changement climatique et les catastrophes naturelles qui en découlent telles que l'augmentation de température de la terre. Des solutions alternatives visant la transition énergétique devraient se faire, en exploitant les richesses du pays en énergies renouvelables pour la production de l'électricité par exemple ainsi que la stratégie énergétique vers le développement durable pour les générations futures.

Notre travail consiste à réaliser une étude détaillée sur le domaine des transports en Algérie, et qui vise à proposer un modèle énergétique 2030, pour réduire le gaspillage des énergies fossiles et les laisser pour des usages nobles et à les remplacer par des sources d'énergies alternatives plus écologiques tout en ouvrant de nouveaux horizons pour la locomotion électrique, qui est l'un des sujets les plus discutés à travers le monde en raison de son impact économique et environnemental.

Mots-clés :

Energie renouvelable, transition énergétique, locomotion électrique, changement climatique.

Abstract:

Energy demand keeps increasing in several sectors, in particular in the field of transport, Energy demand has seen a rapid increase, a reason for the depletion of fossil energy reserves over the next decades, in addition to the problem of climate change with the increase of earth temperature. The call for energy transition is essential and the decision must be taken to invest in country's wealth on renewables to produce energy such as electricity will be a major challenge for the country to achieve sustainability and energy efficiency within the next few years.

This work includes a detailed study on the transport sector in Algeria, which aims to set up a sustainable model for Algeria by 2030, which focuses on the use of ecofriendly fuels and to open the new horizon for electro-mobility, the most discussed technology around the world.

Keywords: Energy transition, Electro-mobility, Climate change, Renewable energy.

Acknowledgment

At the end of this work, we would like to thank God the Almighty for having given us courage, willingness and patience throughout our engineering curriculum.

We warmly thank the national polytechnic school family and specifically, the Chemical Engineering department for the enormous work they have done to create the most favorable conditions for the conduct of our studies. For their patience, their meaningful advice and for the follow-up and interest they have brought to our work.

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We also extend our thanks to Professor Toudert Ahmed-Zaid, for agreeing to chair the jury, as well as to the Professor A.Mekhaldi, and the professor M.Haddadi, for agreeing to review our work as members of the Jury.

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Finally, we must express our gratitude, and our sincere thanks to all the people who contributed to the good progress and in the help to the development our final work.

Mounia TIDJANI

Nihal MANSOURI

july 2017

dedication

I dedicate this modest work to the dearest and closest people who have enlightened me on the path to the future and to success.

In memory of my father.

To my dear mom

If God has put paradise under the feet of mothers, it is not for nothing.

Affable, honorable, kind; you represent for me the symbol of kindness par excellence. The source of tenderness and the example of dedication that has not ceased to encourage me and pray for me. Your prayer and your blessing have been of great help to me in carrying out my studies.

No dedication would be eloquent enough to express what you deserve for all the sacrifices that you have constantly given me since my birth, during my childhood and even in adulthood. You've done more than a mother can do to keep her children on the right path in their lives and studies. I dedicate this work to you as a testimony of my deep love.

May God, the almighty, preserve you and grant your health, long life and happiness.

Also I dedicate to my two dear sisters "Ines, Nadjet, Naçira".

Thank you for all their moral support, their love and their affection.

I carry you in my mind, in my soul and in my heart.

And to all my friends "my second love family".

I love you from the bottom of my heart

MOUNIA

dedicated

To my family, and specifically my mother. For the past five years, you were encouraging me to follow my ambitions despite the circumstances that appeared within that period.

To my lovely three years' teammate Mounia, thanks for supporting me and being a nice sister, friend and teammate.

To my DZeng Family, I have enjoyed learning English with you, the work could not be done without your daily motivation.

My friends, from different parts of the world, the distance was not an obstacle to show me your care and support to achieve this work

Khaled, Yahia,Hichem, Moncef, Ghania, Redouane, Ramzi, Moh

My roommate Marwa

To our Professor Chemss Eddine Chitour, thank you for being a father to us. Despite the heavy responsibility that you have taken, you were always ready to guide us in making this thesis.

To my eternal love, my niece Celine

To the new baby my lovely fruit Kiraz

To my little ice cream Kacem

You were the vibes of achieving this work

To all people, who were part of my success

Nihal, Queen Bee

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list of acronyms and abbreviations

AC	Alternating current
APS	Algérie presse service
BEV	Battery electric vehicle
BP	British Petroleum
CIS	Commonwealth of independent states
COP	Conférence de Paris
CO_2	Carbon dioxide
CNG	Compressed Naturel Gas
CSD	Commission for Sustainable Development
DC	Direct current
DNR	direct normal radiation
EV	Electric vehicle, i.e. BEV,
EVI	Electric Vehicles Initiative
EVSE	Electric vehicle splay equipment
FCEV	Fuel Cell Electric Vehicle
GDP	Growth domestic product
GECF	Forum of the Gas Exporting Countries
GHG	Greenhouse gas
HEV	Hybrid vehicle
ICE	Internal combustion engine
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
LDV	Light-duty vehicle
LCV	Light commercial vehicles
LPG	Liquefied Petroleum Gas
NPS	New Policy Scenario
NGV	Naturel Gas vehicle
OPEC	Organization of the Petroleum Exporting Countries
PHEV	Plug-in Hybrid Electric Vehicle
PLDV	Passenger light-duty vehicle
PV	Photovoltaic
RES	renewable energy sources
RPR	Reserves Production Ratio
RP	Reserves Production
SDS	Sustainable development scenario
U	Uranium
UN	United Nation
UNFCCC	United Nation Framework Convention on Climate Change
US	United State
WEO	World Energy Outlook
WTW	Well-to-wheel
ZEV	Zero-emissions vehicle

General introduction

Global energy demand is increasing rapidly. This fact has existed for a long time ago, since human existence to our present day. The concept of energy appears in different forms depending on its uses for human needs: light, heat and safety. As its availability, abundance or scarcity affect human lifestyle, the rising demand accompanied with population growth creates new challenges among of which may have a negative impact on the environment such as climate change dilemma.

The environmental challenges require diligence from governments and international organizations to limit carbon dioxide (CO_2) emissions. Despite these efforts, the problem is still present. The rise of energy production specifically from fossil energy creates a major problem that, somehow has encouraged positively to think about alternatives sources for power generation.

Despite the current abundance of non-renewables resources, the need for future vision for next generation is primordial and it requires new thinking and new wise decisions for energy transition policies, in the way we produce energy, deliver energy and consume energy.

The goal of the human will be always seeking for high life standards, more modern access to energy utilities and cleaner environment. The key for these opportunities is the green energy.

The transport sector is considered as the leader energy consumer where it accounts for more than half of the total share of energy demand. The previous mentioned impact appears also in this sector, where energy mix relies mainly again, on fossils.

Our case study is the evaluation of global and national transport sector with deep analysis of energy consumption followed by the proposal of sustainable model in 2030 that will ensure a new vision of the Algerian energy mix. The sustainable energy model 2030 will not only help to follow the progress of the energy consumption in this sector, but also to make a decision about the future energy mix in the country and accelerate the transition into green resources.

Finally, the study should be supplied by the opportunities available and the upcoming challenges in order to meet the required perspectives.

Part 1

World energy situation

1 Chapter 1: Energy and history

1.1 Introduction

The history of energy represents the chronological life-style of the mankind from early ages (million years BCE) until the recent decades of the 21th century. However, it is important to define the energy according to the economical viewpoint in order to understand the long term historical perspective of the world energy consumption.

The anthropogenic energy system - which means the use of earth's resources for chances of survival and a better quality of life- has considered three components of natural energy resources: Food, firewood and fodder, where their conversion give variety of specific uses for the available energy. In addition, the evolution of energy has rapidly increased in the last centuries since the discovery of fossil fuels despite the fact that environmental issues such as climate change obliged countries to look for alternatives which are known later by the green energy.

As previously mentioned, many countries are making efforts to switch to other energy resources which can eliminate or at least reduce the amount of greenhouse emissions resulted from the use of fossil fuels and hence according to 21th century experts, this shift must lead to sustainability and energy efficiency.

Understanding these terms require to look for energy use by ancient civilizations, when human major concern was survival, safety and warmth.

1.2 Energy in economy

When dealing with energy in the economic and environmental vision, the concept may change a bit. *Professor* ***Paolo Malanima***[1] defined energy as "*the capacity of performing work, useful for human beings, thanks to changes introduced with some cost or effort in the structure of the matter or its location in space*". For instance, solar heat can be both considered as an energy for heating via its radiation or as a source of energy that must be converted into another form in order to fulfill the economic definition.

1.3 Primary energy

The historical evolution of energy has shown the strong relation between the growth in energy consumption and the type of its resources hence, we can mention the most apparent types of sources that have changed the trajectory of the history of energy:

- **Organic sources** known as: biomass, coal, oil and natural gas which extend since million years ago until our present day.
- **Renewables** that have been used in the recent centuries for the environmental matter.

According to IEA, about 81% of the world primary energy consumption was represented by organic fossil sources; coal, oil and natural gas. Nuclear energy has accounted for only 5% while hydroelectricity represents only 3%, this 8% was the non-organic contribution to the energy balance. Bioenergy share represents only 9% while the 2% remained is saved for other renewables. The following pie chart shows world consumption of energy by fuel:

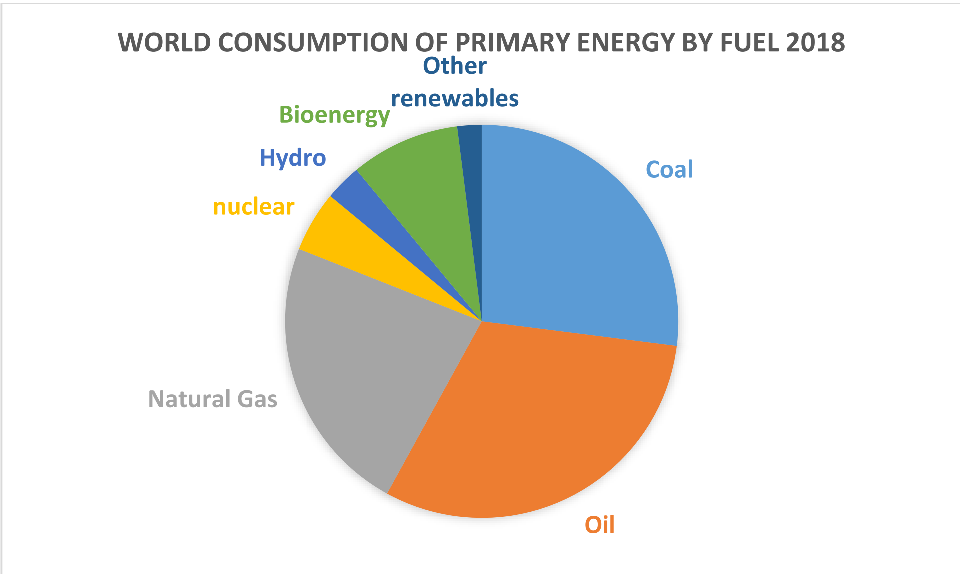


Figure 1.1 World consumption of primary energy by fuel 2018 (15)

As shown in the previous results, we will track the history of how early human consumed the available energy starting with organic vegetable sources then to the intermediate modern ages with the discovery of the fossil sources, and subsequently to the use of non-organic sources which will be considered as the future clean kind of energy.

As a consequence, human civilization can be divided into two main epochs: (24)

[1] Is an Italian economic historian and director of the Institute of Studies on Mediterranean Societies in Naples. *Source: Wikipédia.com*

In the first long epoch [Human existence – 15th century], energy sources included three different types: Food for humans, fodder for animals and firewood was the significant discovery in early times. Although, wind and water energy appeared to fill few limited uses (e.g. grinding grain, sail boats, pumping water…)

The second epoch [last 5 centuries] was known by the discovery and use of fossils in mid-centuries where this latter divided again the era into pre-modern and modern periods that extends to 21th century.

The last five hundred years were and still known by the fast growth in the use of fossil energy for its economic value, availability and low cost investments when comparing to other sources. However, its influence on the environment is considerable and requires fast action to protect the planet.

A synthetic view characterizing the two main epochs is shown in Table 1.1:

Table 1.1 Energy sources for each epoch

First epoch	Second epoch
Food	Coal
Firewood	Oil
Fodder(for working animals)	Primary electricity
Water power	Natural gas
Wind power	Nuclear power

Given the definition of fossil fuel as composition of organic compounds in which they are oxidized in order to fill an organized mechanical work, heat or light for today's energy demand. Consequently, in economy the mechanical converts that oxidize the organics are known by: **fossil organic economies**[2]. On the other hand, the ancient organic sources (with similar chemical definition) are called **organic vegetable economies** applied into biological conversion by animals or humans.

1.3.1 Pre-modern organic vegetable economies:

The first epoch has three fundamental organic vegetable energy sources which represent the biomass including: firewood, food and fodder for animals.

1.3.1.1 Food

In the past years BCE, food was the main source to engender movement or heat that is consumed in the form of organic material which is produced by plants or as meat by animals for human needs.

1.3.1.2 Firewood:

The consumption of the firewood is not uniform in all the regions. It varies from warm to cold places and consequently the estimation of the real human consumption is not plausible. However, the studies show that firewood demand had varied from 1 kg per head per day in warm climates to 10 in cold ones. In other words, the consumption is about 3,000–4,000 and 30,000–40,000 Cal. (24)(19)

[2] "Organic economies" is the expression used by Wrigley (1988). With reference to the history of energy, the same term of "organic" had been used before by Cottrell (2009).

1.3.1.3 Agriculture

Agriculture started with the development of vegetables cultivation and especially cereals (24) which was covering the human need for food. Despite being one of the main human activities, it progressed slowly along Europe in 3000 years where it reached the northern region later. China was also independently developed at the same time or later than Europe.

A followed period which extends to 3000 BCE. In addition, the innovation of tools (e.g. wheels) used for the conversion energy offered an important progress in human agriculture.

1.3.2 Modern organic fossil economies

According to historical records and archeological finds, organic fossils existed for millions of years ago and resulted from dead organisms that accumulated and submerged below the surface of the earth along the time. Consequently, the history of petroleum, coal and natural gas are as old as the history of the human civilization.

Nowadays, those three major forms of fossils combined account for almost two-third of energy demand since industrial revolution and the petroleum discovery has given the chance for many countries to invest in this field.

Ancient civilizations (e.g. Egyptian, Roman) started to use the liquid submerged on the surface known as **petroleum** in different applications: dried asphalt in medicine, waterproofing, construction etc. Despite the lack of technological tools for oil extraction and refining.

Back in the 15th and 16th century, coal, for its part has been widespread in Europe and China where it has replaced the firewood for its abundance and low cost price. In addition, the invention of chimneys made of firebrick has encouraged the use of coal for homes heating.

Despite the old discovery of these resources, the old utilization was limited due to the lack of knowledge in technology where later, it has been recognized during the industrial revolution.

1.3.2.1 The industrial revolution

Refers to the dramatic change during the 18th to the 19th century starting from England, where coal was the main core to this upheaval.

At the same period, coal has emerged Europe and replaced firewood in multiple applications because of its lower cost of production and transportation and also due to the abundant quantity in nature during that era.

Meanwhile, the industrial revolution has marked the history by improving the mechanical converts that replace human and animals as labors and to increase the production rate. Subsequently, in the 18th century James Watt and Thomas Newcomer have contributed into the invention of the steam engine and coal as its fuel; later ‘’age of machine’’ had really begun. This invention has enabled human to overcome the old obstacle that limited the capacity of the economic growth. However, the question of efficiency was again present, the steam engine capacity was around only 3% which means, only small quantity of coal was converted into work despite the huge quantities that have been used for that.

In the early 1800s, a French engineer and physicist named Sadi Carnot introduced what he called – “*machines à feu*”, thermal machines based on thermodynamics notions that later helped to understand the phenomenon of energy transition.

1.3.2.2 Oil industry

Fossils remains the key element to the growth of country's economy, this latter, encouraged oil companies to think about a way to improve their methods of extracting and oil refining.

In the mid-18th century, an American businessman named Drake was the first to adopt a new method for oil drilling using drill-pipe to reach the oil deposit. However, he failed to patent his drilling method.

Figure 1.2 Oil gushing from the Spindle top well near Beaumont, Texas, in January 1901 (37)

The discovered hydrocarbon fields contained both crude oil and associated natural gas, but gas was rarely used during the early decades of the hydrocarbon industry because without compressors and steel pipes it could not be moved over long distances. (37) Oil demand was basically kerosene as a fuel for lightening lamps. Meanwhile, another invention that has changed the world oil demand is the first car with Internal combustion engine invented by the German Benz in 1885 running on an oil refined product – gasoline (petrol).

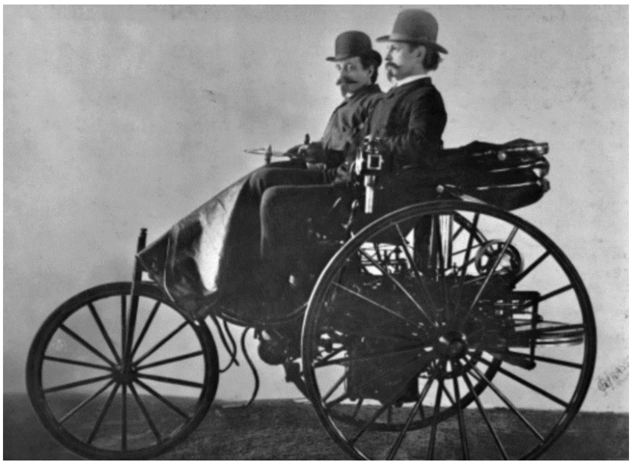


Figure 1.3 Patented in 1886 by Karl Benz, the Motorwagen was the first vehicle designed to be powered by an internal combustion engine. ***Source: History center website*** **(37)**

Years later, in the united states, New type of automobiles called Ford Model T (related to its owner Henry Ford) has opened a new automobile market which increased gasoline demand and hence oil demand.

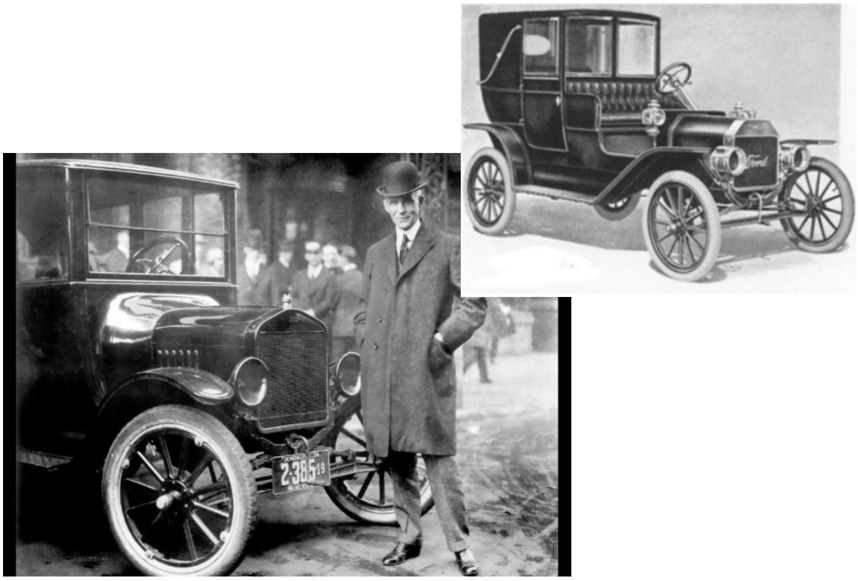


Figure 1.4 Ford model T Car 1908 (37)

By the end of the 19th century, the world's switched into fossil energy with its three forms: oil, natural gas and coal and they are still considered as today's main contributors in world energy demand.

The following chart shows the rapid growth of the world energy consumption within the last two centuries where coal dominated since the early 18th century until the industrial revolution that enabled to switch to other use of fossils (Oil and Natural gas).

2 Chapter 2: World energy situation and future scenarios

2.1 Introduction

The previous chapter has described the timeline of energy use in human civilization and how energy mix changes according to human needs for food, light and mobility. Nowadays, energy demand is dramatically increasing due to the rise of world population with more energy access and technology in many countries. However, the increasing consumption is followed by environmental issues and consequently, governments and concerned organizations are working together on future policies to achieve energy efficiency and sustainability.

2.2 Primary energy

World energy can be divided into two main categories: **Fossils** {mainly: coal, oil, natural gas} with nuclear used in recent decades and **Renewables** {in which we mention: Solar, Wind, hydraulic, geothermal etc.}

2.2.1 Fossil energy

- **Reserves:**

In the late 20s, the consumption of coal, oil and natural gas increased to reach high records however those sources are threatened to run out by the end of 21st century. The table below illustrates the estimated RPR for non-renewable resources for some countries.

Table 2.1 Reserves-production ratio of the world and some countries (per year) (7)

Country/region	Coal RPR (year)	Natural gas RPR (year)	Oil RPR (year)
World	132	50.9	50.0
China	38	37.6	18.7
Us	365	14.3	11.0
India	132	46.9	14.1
Saudi arabia	\	52.6	66.4
Norway	\	13.3	12.8
Germany	214	4.8	\
Brazil	>500	15.1	13.7

Given world's RPR, fossil fuels will run out by the end of the 21st century for oil and natural gas, while coal may remain for another century due to its abundance in nature.

Despite the fact that countries like China is among the largest countries in coal reserves, with 138 Billion tons, it has only 38 years remaining for its coal reserves to run out and hence its supply sustainability is insufficient (7).

The RPR indicates the importance of balancing between proven reserves and their uses, as a result, other means of energy production is always required for a long term sustainability.

Oil

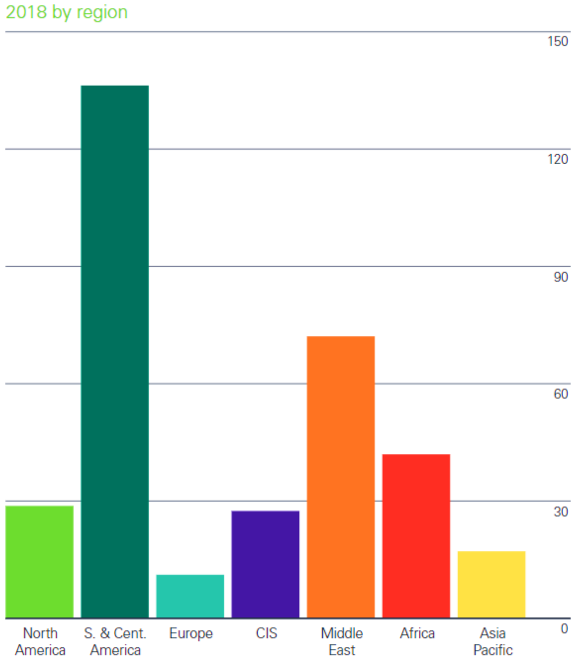


Figure 2.1 Oil RPR per year and per region (7)

The previous chart (Figure 2.1) shows the oil reserves around the world, Where 1730 billion barrels are marked for the total world oil reserves (up to 2 billion barrels with respect to 2017). (7) The total RPR in 2018 accounts for 50 years of current production. Regionally, South and central America accounts for 18.8% of global oil reserves which represents the highest share of Global RPR -equals to 136 years, followed by the middle east with 72, however it has the largest share of oil reserves with 48.3% of global share. Finally, the lowest record is held by Europe with remaining 11 years.

The countries with highest records in terms of oil reserves are: Venezuela (17.5% of global reserves), Saudi Arabia (17.2%), then Canada (9.7%), Iran (9.0%)and Iraq (8.5%). (7)

Natural Gas

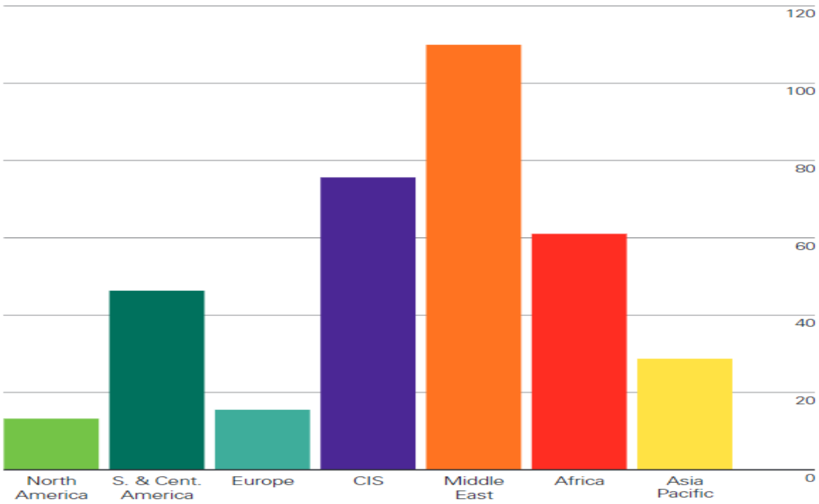


Figure 2.2 World Natural Gas RPR per region - 2018 (7)

The chart indicates the partition of natural gas reserves around the world according to their remaining-time (RPR). The current global RP Ratio shows that gas reserves in 2018 accounted for 50.9 years of current production, where Middle East and CIS holds the highest RPR with 110 and 76 years respectively (7)

Coal

Considered as the most abundant non-renewables source on earth with the highest CO_2 emitted.

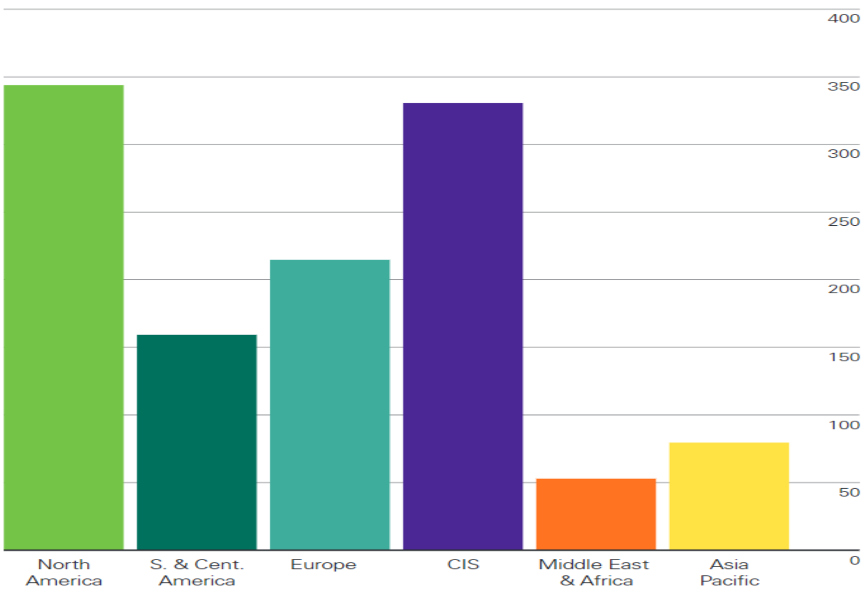


Figure 2.3 World Coal reserves by region- 2018 (7)

World coal reserves in 2018 stood at 1055 billion tons and are heavily concentrated in north America (342 years) and CIS (329 years) regions. Countries among US (24%), Russia (15%), Australia (14%) and China (13%) hold the highest share of production with 24%,15%,14% and 13% of coal production respectively.

According to BP review, most of the reserves are anthracite and bituminous (with 70% of total coal available).

- **Production**

The non-renewable resources are depleted so fast that by the end of this century, oil and gas will run out. This is explained by the increased use of energy for electricity generation where 64.7% of electricity worldwide was generated by fossils. In addition, the carbon dioxide emissions given off by industrial sector and transport.

Oil

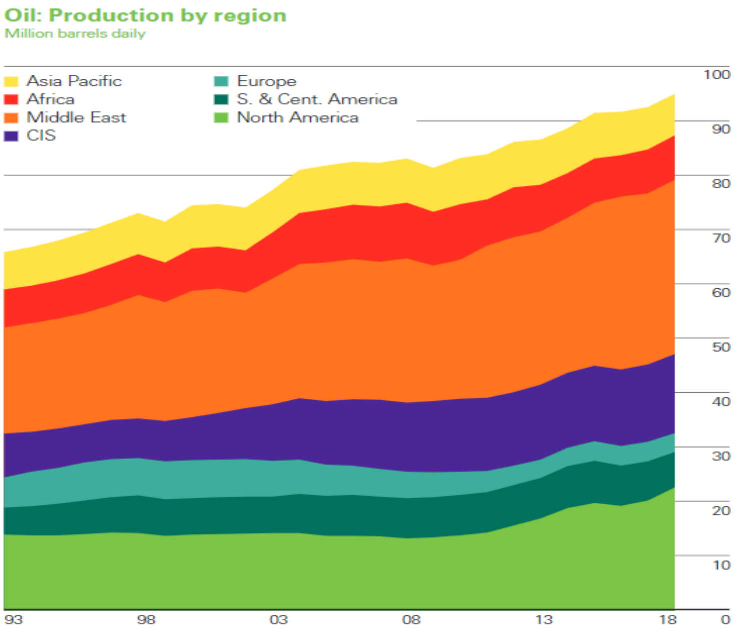


Figure 2.4 Oil production by region - 2018 (7)

Figure 2.4 indicates the drastic increase of oil production between 1993 and 2018, as BP review indicates, the rise of global production by 2.2 million b/d in 2018. Growth was heavily concentrated in the US (2.2 million b/d), Canada (410,000 b/d) and Saudi Arabia (390,000 b/d) while oil production declined sharply in Venezuela (-580,000 b/d) and Iran (-310,000 b/d). OPEC production declined by 330,000 b/d while non-OPEC production increased by 2.6 million b/d.

Natural gas

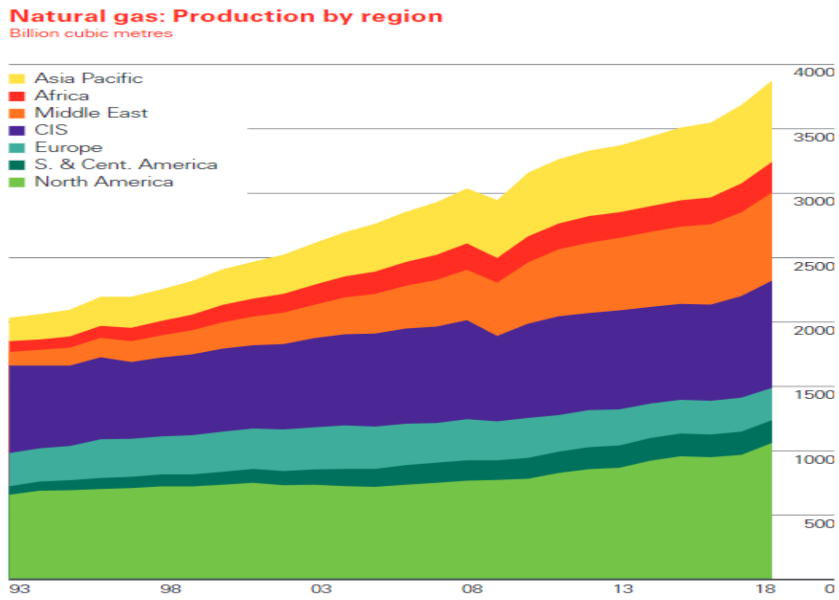


Figure 2.5 Natural Gas production by region (7)

Gas production registered record-high volumetric increases in 2018. Given the production rise of 5.2%, the highest rate since 2010.US (86 bcm) and Russia (34 bcm) accounted for almost two thirds of global growth.

Coal

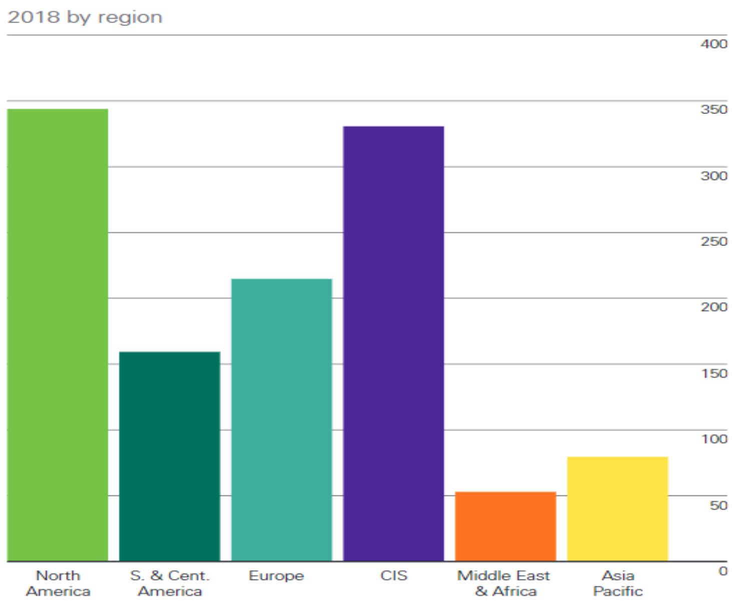


Figure 2.6 Coal Production by region (7)

Global coal production increased by 4.3% in 2018. (3) The largest consumption is governed by Asia Pacific with 163 Mtoe, China alone accounts for half of global growth followed by Indonesian production up by 51 Mtoe.

- **Consumption**

Oil

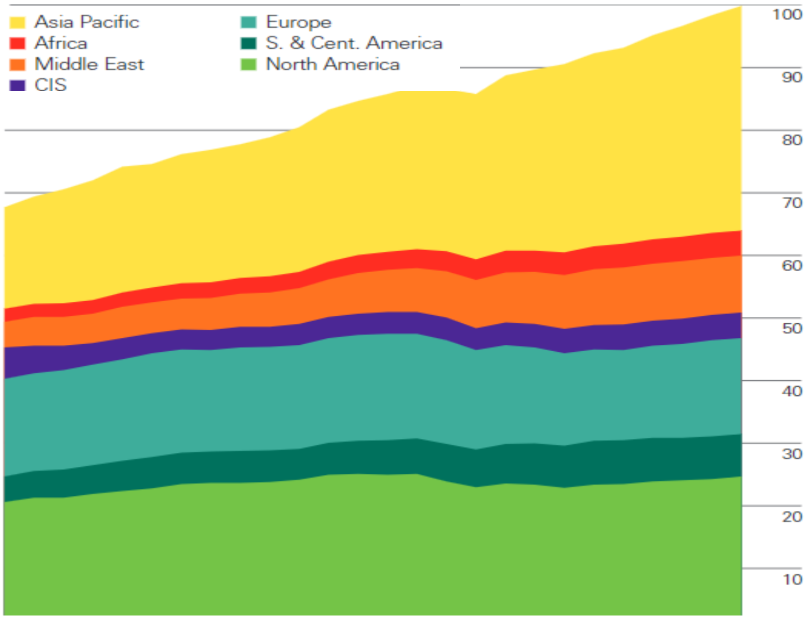


Figure 2.7 Oil consumption by region (7)

Alike oil production, the consumption increased as well, by 1.4 million b/d. Where China (680,000 b/d) and the US (500,000 b/d) accounted for the majority of the year's growth.

Natural gas

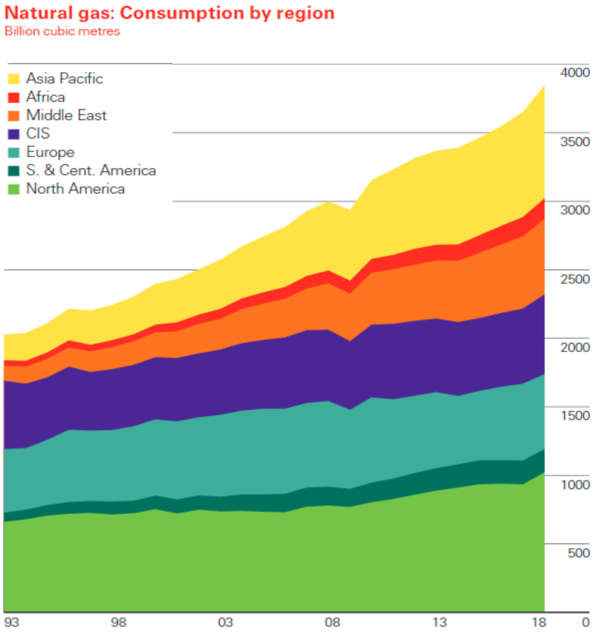


Figure 2.8 Natural gas consumption by region (7)

Similarly, to production, the increase is marked for gas consumption, with the US (78 bcm) held the biggest growth on record. China also saw a growth of 17.7% (43 bcm). (7)

Coal

Coal consumption increased by 1.4% in 2018. According to BP experts, this was the fastest growth since 2013, where it is mainly driven by the strongest consumption in Asia pacific with 71 Mtoe; India accounts 36 Mtoe of global coal consumption.

With countries like China and India, this region shares now over three quarters of global consumption, while 10 years ago it represented two thirds.

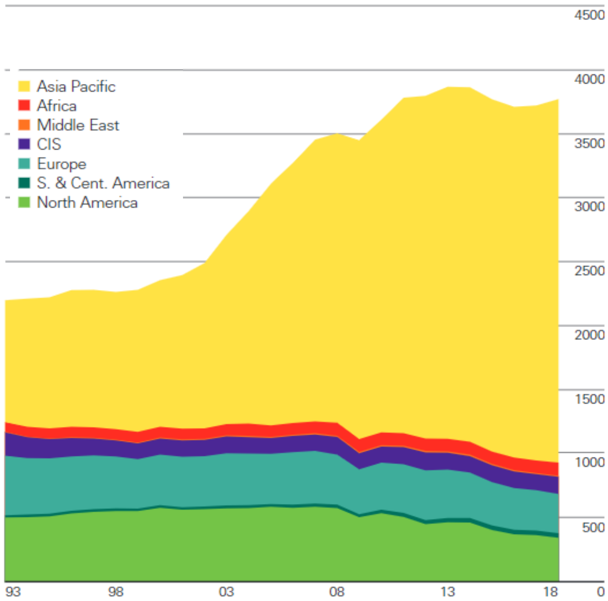


Figure 2.9 Coal consumption by region (7)

The table below presents a fast review of overall world's reserves, production and consumption of the three common fossil fuels, previously explained with some countries illustrations.

Table 2.2 Review of fossil energy reserves, production and consumption by country and by region 2018 (7)

by Country/region	Oil			Natural Gas			Coal		
	Reserves thousand million barrels	Production million tonnes	Consumption MTOE	Reserves trillion cubic meters	Production billion cubic meters	Consumption billion cubic meters	Reserves million tonnes	Production MTOE	Consumption MTOE
World	244.1	4474.3	4662.1	196.9	3887.9	3848.9	1054782	3916.8	3772.1
algeria	1.5	65.3	19.6	4.3	92.3	42.7			0.2
brazil	2.0	140.3	135.9	0.4	25.2	35.9	6596	1.2	15.9
China	3.5	189.1	641.2	6.1	161.5	283.0	138819	1828.8	1906.7
Germany			113.2	<	5.5	88.3		37.6	66.4
India	0.6	39.5	239.1	1.3	27.5	58.1	101363	308.0	452.2
nigeria	5.1	98.4		5.3	49.2				
norway	1.1	83.1	10.4	1.6	120.6	4.5			0.8
qatar	2.6	78.5	12.2	24.7	175.5	41.9			_
saudi arabia	40.9	578.3	162.6	5.9	112.1	112.1			0.1
us	7.3	669.4	919.7	11.9	831.8	817.1	250219	364.5	317.0
iraq	19.9	226.1	38.4	3.6	13.0	17.0			_
iran	21.4	220.4	86.2	31.9	239.5	225.6			1.5
OECD	37.6	1198.6	2204.8	19.4	1422.5	1750.6	499718	839.5	861.3
non-OECD	206.6	3275.8	2457.3	177.4	2445.5	2098.3	555064	3077.2	2910.8
European Union	0.4	72.7	646.8	1.1	109.2	458.5	75968	125.8	222.4

Nuclear energy

Nuclear energy represents the energy released from the splitting of atoms inside a nuclear reactor. Technology in the 21st century enabled a strong investment in electricity generated by nuclear power. Based on data reported to the IEA, currently, 450 nuclear reactors are in operation around the world. The United states, France and China hold the highest number of reactors, 97, 58 and 45 respectively.(41)

The nuclear power is the second largest source of global low carbon electricity as shown in the figure below.

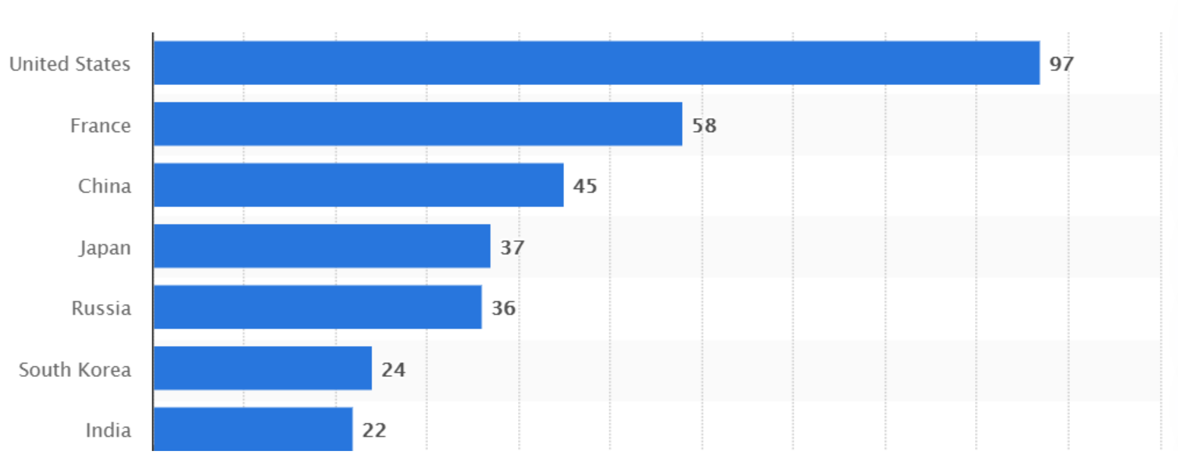


Figure 2.10 Number of operable nuclear reactors in the world (39)

2.2.2 Renewables

Renewable energy often referred to clean or green energy, is the energy produced by natural resources such as sunlight, wind, water etc. These resources are considered as interesting alternatives to fossil because of their positive impact on the environment.

Renewables have many uses such as for electricity generation, water heating (or cooling) and transportation. Simultaneously, renewables including solar, wind and others account for one-third of current global world capacity according to IRENA.

Figure 2.11 below demonstrates the share of electricity generation over time since 2001 within the use of renewable and non-renewable energy. The red line indicates the average share of renewables in the total growth per year. (64% in 2018).

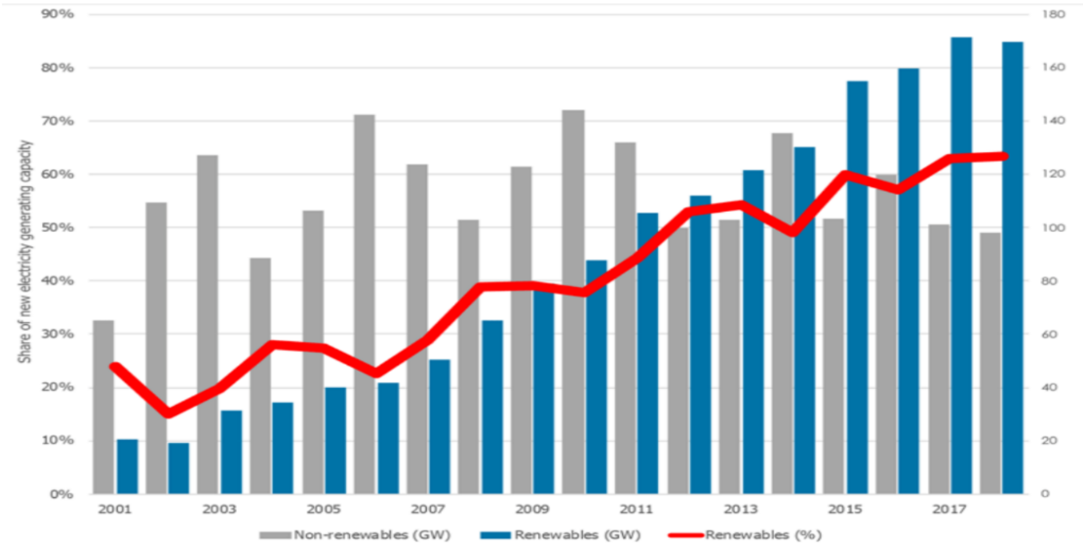


Figure 2.11 Share of new generation capacity installed each year 2001 - 2018 (17)

2.2.2.1 Hydroelectricity

Hydroelectricity marked the strongest contribution in renewable energy worldwide. Electricity generation from hydropower projects achieved a record 4,200 terawatt hours (TWh) in 2018, where new installed capacity around the world has increased to reach 1,292 GW. Together, China and Brazil have the highest share of the new capacity and the following bar chart represent the 10 countries with the highest contribution (Figure 2.12)(31)

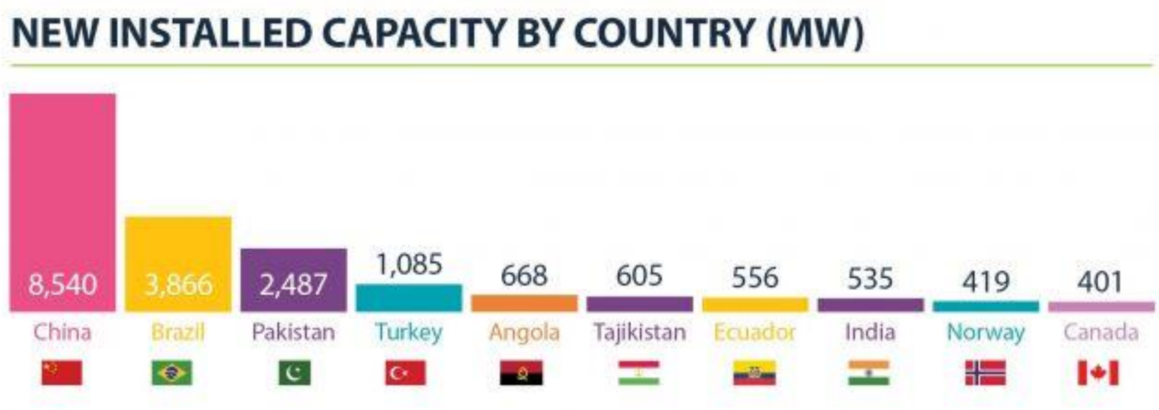


Figure 2.12 New installed capacity by country (16)

2.2.2.2 Solar energy

The sun is considered as the unlimited source of energy that gives off far more energy than we need. Electricity generated is clean, with low operating costs and available in wide areas around the world. The map shows the estimated average of direct normal radiation (DNR) available for power generation.

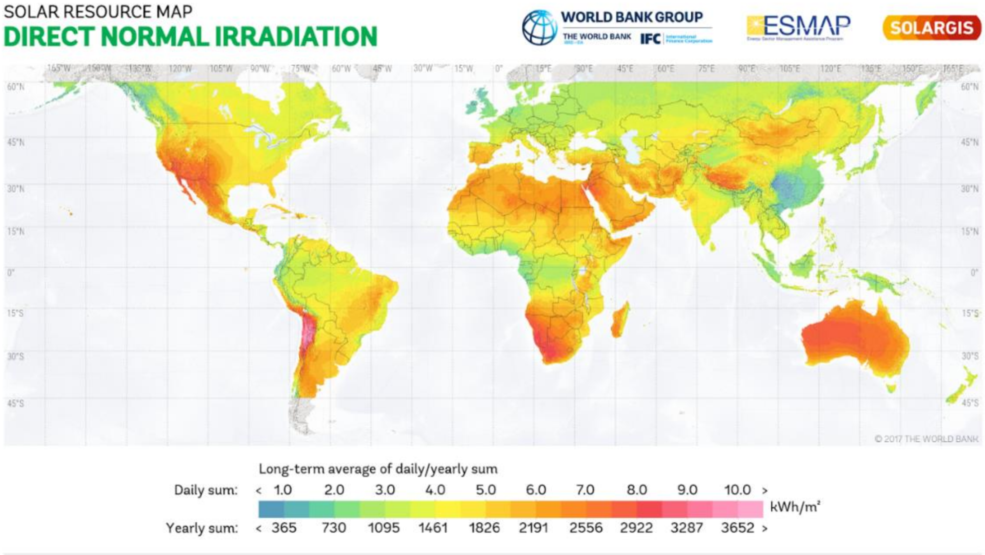


Figure 2.13 Direct normal irradiation in the world (9)

2.2.2.3 Wind power

Similarly, to the sun, wind power is one of the fastest-growing renewable energy technologies. Using the kinetic energy created by motion of air, one turbine can generate around 6 MWh in a year according to IRENA status. The Figure 2.14 provides the total installed capacity of wind power for the last 10 years.

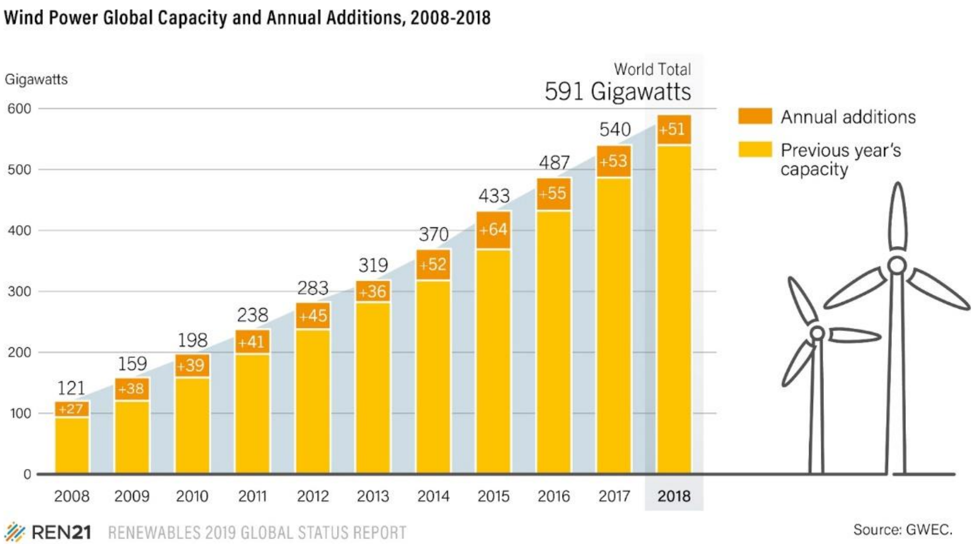


Figure 2.14 Total installed capacity of wind power 2008 – 2018 (17)

2.3 Sustainability 2030 – 2040

2.3.1 Energy mix

In Dictionary of Energy (Second Edition), 2015, energy transition is "*the change of the primary form of energy consumption of a given society; e.g., the historic transition from wood to coal and then to oil and gas in industrial Europe*".

Climate change commitment and the switch to electrification have encouraged many countries to go beyond renewables with low-carbon strategies. Figure 2.15 shows the evolution of energy consumption for the last two decades.

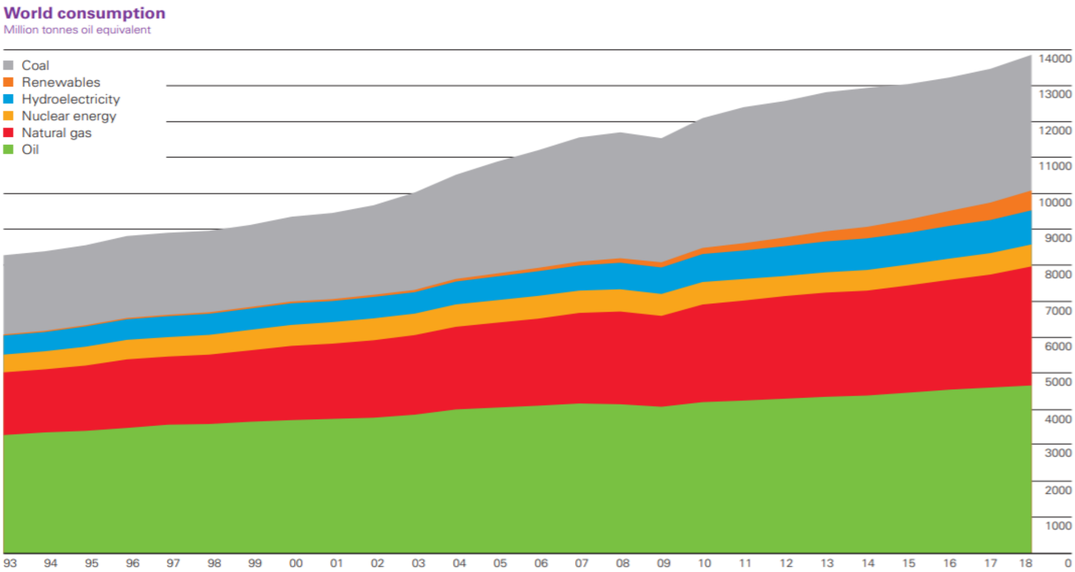


Figure 2.15 World energy consumption by fuel 1993-2018 (7)

Generating power from renewables is part of the energy transition. Energy demand for all fuels increased. According to BP statistical review, growth was particularly strong in the case of gas (168 Mtoe, accounting for 43% of the global increase) and renewables (71 Mtoe, 18% of the global increase).

Actually, the share of renewables in global electricity generation is almost one-third of overall share in the first quarter of 2020 compared to 2019 (26% of total share) where on the other hand, coal and gas, still represent the rest of global electricity supply.

The shift to renewable energy in the energy supply mix, will not only preserve natural sources but to engage in a sustainable development and help solving climate change problem. Consequently, regulation and commitment to zero-carbon emissions have been established by many countries in order to improve sustainability and energy efficiency in the next decades.

2.3.2 Environmental commitment related to climate change

2.3.2.1 Earth summit RIO

The first large international conference that focused on the environment and climate change was held in Rio de Janeiro during June 1992, by the UN, where this latter adopted the framework convention on climate change (UNFCCC).

The conference adopted principles to face the problem of global warming and the necessity to consider them as governmental actions within the next decades, and to ensure the successful flow of the agreement, the UN Commission for Sustainable Development (CSD) was founded.

2.3.2.2 KYOTO protocol

Rio conference in 1992, in turn, has paved the way for Kyoto protocol to be prepared and introduced in 1997. In Kyoto protocol, members have been legally working together on global challenges: greenhouse emissions challenges. In addition, penalties will be set for any violation regarding the emission-trading program. Later, the world started to see results within the integration of new technology that helped reduction of CO2 and adapt new alternatives ways to invest in renewables. (10)

2.3.2.3 RIO +20

In 2012, members met again in Brazil. Two major topics were discussed: 'The Green Economy' and 'Environmental Governance' (22). It has focused on political outcomes and creating a valuable political forum in the aim of a future sustainable development. New policies have been adopted such as green economy, followed by launching an international process to provide funding options for 'sustainable development' including all what is related to energy, food security and oceans.

Rio+20, which has attracted more than hundreds of the United Nations representatives, has been found to be successful on a broad-scale due to the fact that it resulted in around 8 hundred voluntary commitments, in addition to the beginning of new corporations to advance sustainable development (10)

2.3.2.4 COP conferences

The COP is an international climate conference that brings together each year the world leading countries that are signatories to the United Nations Framework Convention on Climate Change (UNFCCC). The first edition (21^{st} conference of the parties COP21) was held in 2015, organized by France. The meeting involved international agreement (Paris agreement) to limit greenhouse gas emissions. Countries have committed to reduce their greenhouse gas emissions

Table 2.3 Top 10 CO2 Emitters 2018 (12)

Country	2018 CO2 Emissions in Billion Metric Tons	Global Share	Change Since Kyoto Protocol
China	9.43	27.8%	54.6%
U.S.	5.15	15.2%	-12.1%
India	2.48	7.3%	105.8%
Russia	1.55	4.6%	5.7%
Japan	1.15	3.4%	-10.1%
Germany	0.73	2.1%	-11.7%
South Korea	0.70	2.1%	34.1%
Iran	0.66	1.9%	57.7%
Saudi Arabia	0.57	1.7%	59.9%
Canada	0.55	1.6%	1.6%

and hold planetary warming below 2°C (3.6°F) of preindustrial levels 2°C by 2100.

Three top emitters are China, India and US despite the fact that this latter has reduced its emissions since Kyoto protocol (edition of 2006) such as Germany and Japan (Table 2.3)

This change was due to coal consumption, where according to BP statistical review, coal is main contributor in energy mix of China and India. On the other hand, within the last decade, US switched its energy sources from coal to shale gas and renewables. Since that, CO_2 emissions declined to reach the actual emissions.

2.3.3 World scenario 2030

The future energy analysis is based on the understanding of the actual situation of world energy and to look in-depth of what policies, technology and investment choices may effect on it.(27)

The scenario analysis explored by many outlook reports describes the possible pathways of energy sector that may be taken within the next decades and its different implications for climate change, energy security and the economy. (15)

In WEO2019, three important pillars for sustainability development scenario: **ensure universal energy access for all by 2030; to go toward zero-net emission in the atmosphere; and to meet global climate goals in line with the Paris Agreement.**

The approach to what will world energy look like in 2030s is based on two distinct ways: the Stated policies scenario and current policies scenario is the first type that is based on starting conditions that leads towards future results. In contrast, Sustainable Development Scenario set future outcomes and work on how they can be achieved.

The importance of SDS is that it can orient stated scenario policies by setting out the major changes that are required to meet the United Sustainable Development Agenda, in which we mention:

- Working on Paris agreement in matter of limitations of emission
- Easy energy access for all, by 2030

- **Primary energy demand**

Primary energy demand grows by a quarter to 2014, where energy growth is estimated of 1% each year. This growth is based on announced goals and technology in the stated policies scenario. All fuels except coal contribute in the growth, where renewables and natural gas account respectively for 50% and 35% of global demand growth.

Despite promises for reduction in emission and air pollution, the peak in global energy-related CO_2 emissions does not appear in next two decades. In order to reach the zero-net emissions in 2070, governments shall take more measures related to energy demand and use.

Similarly, to primary energy, electricity demand grows by 60% in 2040 in the stated scenario policies. The rise is governed by advanced low-carbon technology. Solar PV and wind remains the best energy supply techniques for electricity generation. In addition, low cost battery storage plays an essential role in electricity generated from renewables, notably in India.

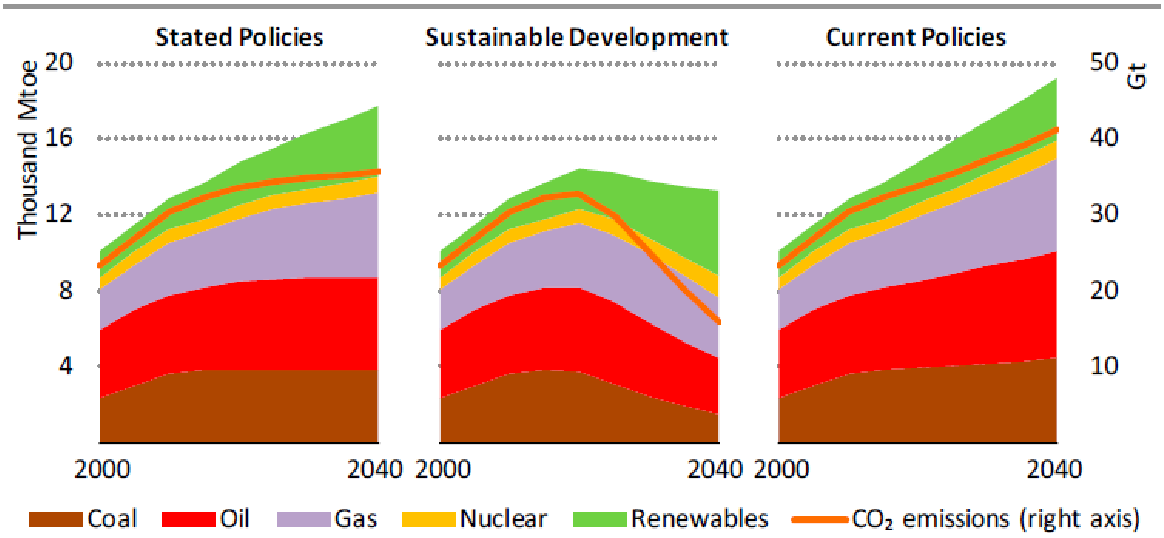
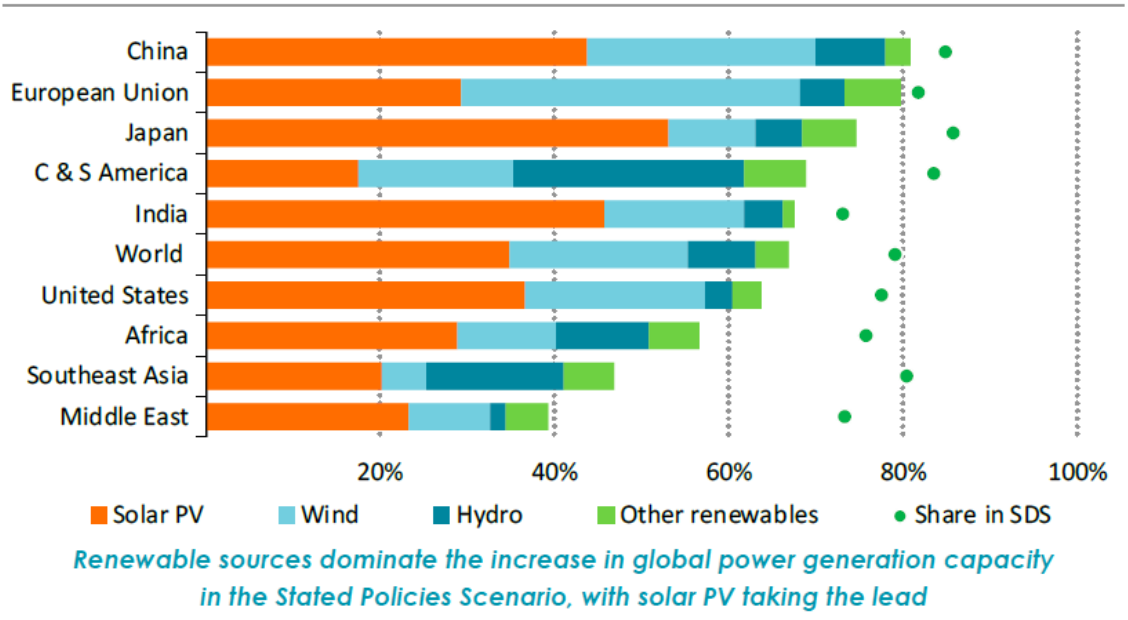


Figure 2.16 World Primary energy demand by fuel and related CO2 emissions by scenario (15)

Energy generated from fossils (except coal) still contribute in future energy mix. Developed countries demand for energy is still increasing, the case for natural gas and nuclear which still hold the strongest share.

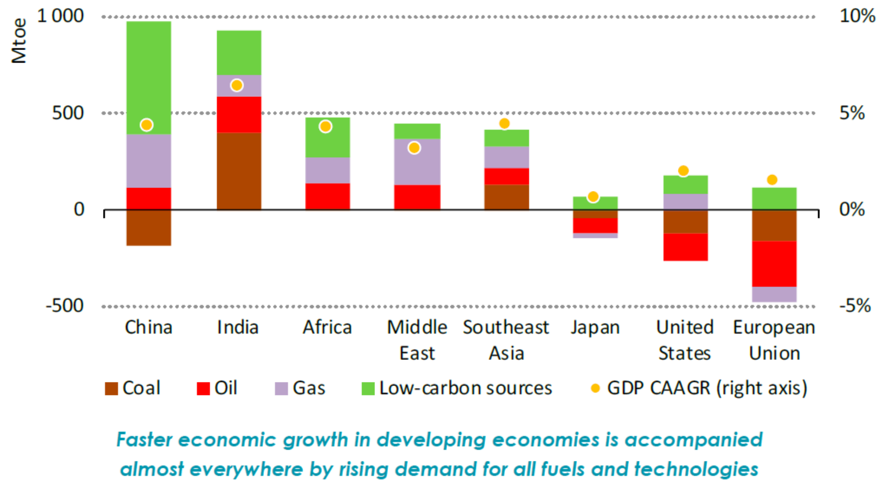


Notes: C&S America = Central and South America; SDS = Sustainable Development Scenario. Other renewables includes geothermal, concentrating solar power, bioenergy and marine.

Figure 2.17 Share of renewables in total capacity addition by region and scenario, 2019-2040 (15)

Energy growth in scenarios is mainly covered by developing countries, in particular, Asia region. where energy demand doubles, is the single largest source of demand growth to 2040 in the Stated Policies Scenario. Meanwhile, China remains the largest energy consumer but it has maintained an important share of its energy from renewables, particularly, solar PV and wind energy.

Rising incomes and population growth underpin strong growth in Africa and the Middle East. With the improvement of lifestyle and growth in population. Figure 2.18 below illustrates the changes in energy demand and average GDP per region, in the period 2018-2040.



Notes: GDP CAAGR = gross domestic product, compound average annual growth rate. Low-carbon sources includes nuclear and renewables.

Figure 2.18 Change in energy demand and average annual GDP growth (15)

- **Energy consumption**

Electricity, overtakes oil around 2040 to become the largest component of final Consumption. Oil consumption falls by around 1.5% per year on average, and coal use by 3%. Gas demand in final consumption rises slightly through to the early 2030s, largely because of increased industrial demand, but then declines under pressure from efficiency improvements, low-carbon gases such as hydrogen and bio methane, and **electrification**.

3 Chapter 3: Electro mobility, case of study: vehicles fleet

3.1 Introduction

Electro mobility is one of the mega topics in the automotive industry. It represents the new road system in which it propelled by vehicles working with electricity, from bicycles to high speed trains. Technology and digitalization have enabled the development of transport sector, where electric vehicles can now produce its own electricity (e.g. hybrid electric vehicles) or use an outside supply - electric grid.

The history of automotive has shown that electric vehicle was born in the early 19th century. Since the invention of battery and the development of its uses, electric vehicle has passed through several breakthroughs but until the late 19th century, EV saw the early rise. However, at the same period of time, ICE vehicles has dominated the US market, with its low cost and wide range comparing to Electric vehicle; this latter saw its first fall.

A century later, “Modern" electro mobility was launched in 90s and followed by different types of vehicles that depend generally on the capacity of battery storage.

The integration of electro-mobility in the transport sector meets challenges within its conventional competitors (e.g. fuels), environmental and economic impact.

3.2 Fuels features

3.2.1 Gasoline (or petrol)

A refined product from petroleum resulted from mixture of hydrocarbons, additives and blending agents. It is used as a fuel for internal combustion engine.

$$C_8\,H_{18(g)} + \frac{25}{2}\,O_{2(g)} \rightarrow 8\,CO_{2(g)} +\ 9\,H_2O_{(g)}$$

According to combustion reaction, 1 liter of gasoline can produce approximately 2.3 kg of CO_2!!

3.2.2 Diesel Fuel

Describes the liquid fuel that is used for diesel engines. It is the result of distillation of crude oil and hence a mixture of hydrocarbons. However, it contains more hydrocarbons than gasoline and consequently more CO_2 emissions (2.68 kg). In addition, it is harmful product for human health.

3.2.3 Liquefied petroleum gas LPG

Flammable of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and vehicles that runs on combustion engine of the piston engine type. It is essentially composed of propane and butane. Nevertheless, as any fossil product, it generates carbon dioxide with an estimated amount of CO_2 1.51 Kg for one liter on LPG burned.

3.2.4 Natural gas for vehicles NGV

The GNV represents the natural gas liquefied LNG and compressed natural gas CNG. It is mainly composed of methane, the cleanest hydrocarbon that may release CO_2 from its combustion.

Compressed natural gas, or CNG, remains clear when stored under pressure (around 200 bar) and can be used as a cheaper, greener, and more efficient alternative than traditional fuels. The compression enables the engine to use the fuel to extend driving range, much like the gasoline tank in vehicles.

3.3 Evolution of the world automobile fleet

The global vehicle fleet has been growing at a near-constant rate, since 2008, the number of vehicles in 2018 is expected to be around 1.4 billion vehicles. While the number of vehicle sales ranges between 60 and 90 million per year, with the increase rate is around 2% as shown in Figure 3.1 .

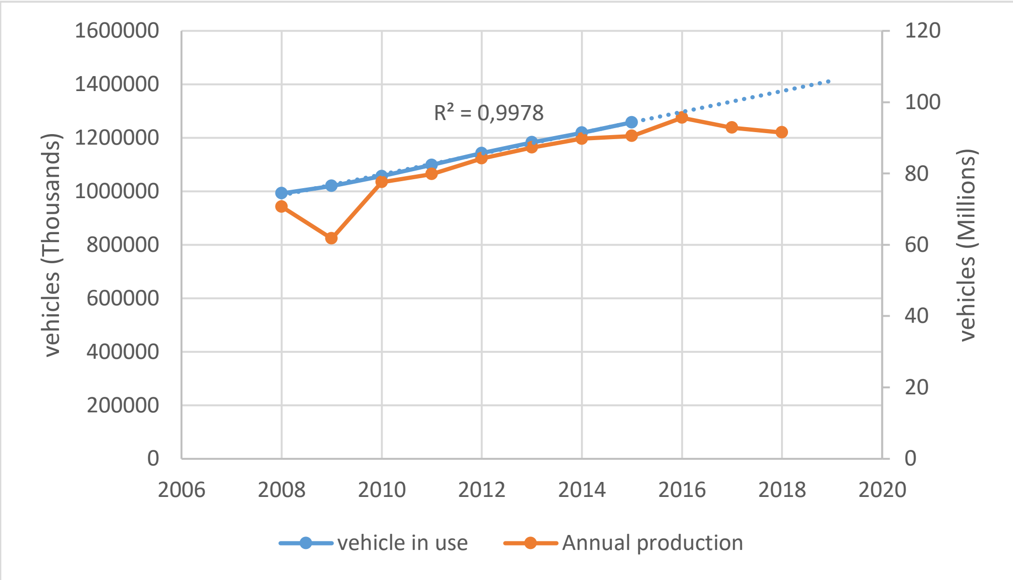


Figure 3.1 Evolution of vehicle fleet and sales 2006 – 2020 (29)

3.4 Energy consumption

Global energy consumption for is almost 2.1 Gtoe/year as shown in Figure 3.2 where in 2017, alternatives to oil-based gasoline and diesel fuels represented 7.7% of total fuel consumption. Although their quantity increased from 158.6 Mtoe to reach 161.1 Mtoe between 2016 and 2017, their penetration rate remained stable at 7.7%**.** Among these alternatives (LPG, NGV, electricity), biofuels represented 79.6 Mtoe. Their consumption increased by around 3% between 2016 and 2017. Besides, the demand for fuel increased by 1.5%, similar to the rise seen between 2015 and 2016 (+1.8%).

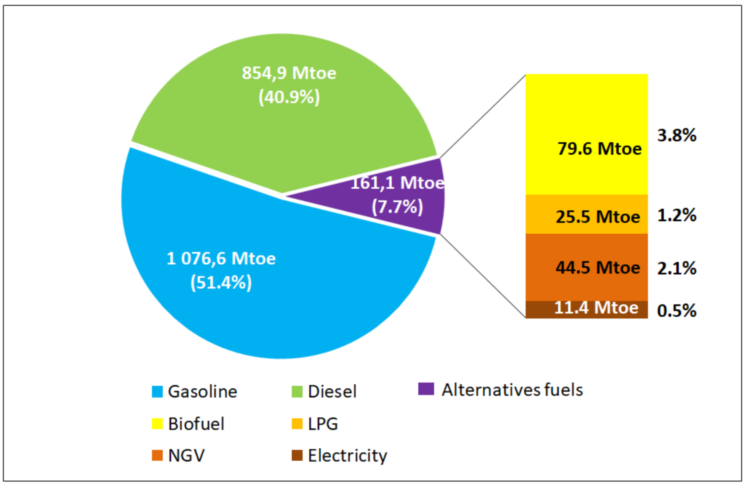


Figure 3.2 : Global energy consumption in the road transport sector in 2017 (23)

3.5 Electric vehicles

3.5.1 Types of EV

Electric vehicles can be classified into three categories according to their energy source and propulsion (mechanical/electrical) as explained in the scheme below (Figure 3.3):

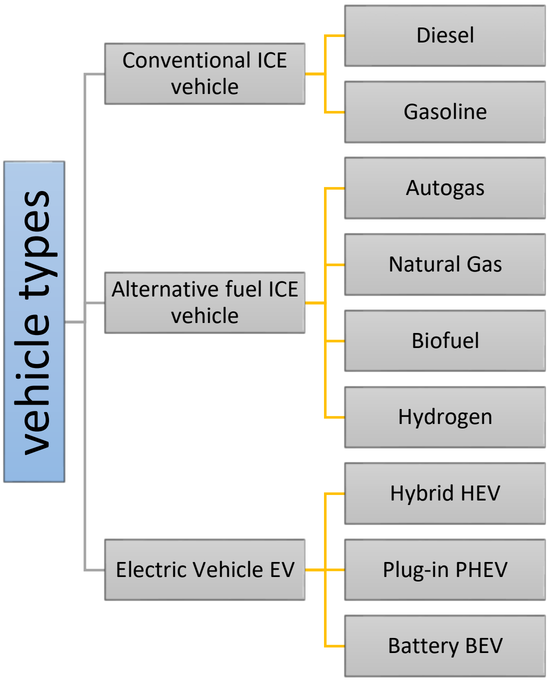


Figure 3.3 Vehicle type
Source: online course, Electric cars, Edx.com

As mentioned in Table 3.1, the classification of EV according to energy source (fuel type) and propulsion system (drive-train) is as follows:

Table 3.1 EVs classification Source: Electric cars, Edx.com

EV type	Energy Source	Propulsion
HEV	Diesel Gasoline	Engine Electric motor
PHEV	Diesel Gasoline Electricity to charge the battery (Charging Port)	Engine Electric motor
BEV	Electricity to charge the battery (Charging Port)	Electric motor

The technology of battery of the next decades will focus on the development of new types of EV alike Fuel cell vehicle and Solar electric vehicle.

3.5.2 EV Vs Gasoline vehicle and Environmental impact

The EV looks the same as gasoline car from the outside, except the absence of tail pipe as for fuel vehicle. However, the internal parts are widely different, the moving part inside the EV is the motor, while for gasoline cars many moving parts, from frequent oil changes, filter replacements, periodic tune ups, and exhaust system repairs, to the less frequent component replacement, such as the water pump, fuel pump, alternator, etc. This leads to say that gasoline cars have a wide range of maintenance.(8)

The main differences between EV and Gasoline vehicles are summarized below:

Table 3.2 Main differences between EVs and Gasoline parts (13)

Fuel Vehicle Parts	Electric Vehicle Parts	Functions
Fuel tank	Battery	Stores energy to make the vehicle run
Fuel Pump	Charger	Puts energy/fuel into the vehicle to make it run
Fuel Engine	Electric Motor	Makes the vehicle move
Carburetor	Controller	Controls starts, stops, speed, acceleration
Alternator	DC / DC Converter	Provides power to accessories such as radio, lights, air conditioner
	DC / AC Converter	Converts DC to AC Power to make the motor run

However, the main disadvantage of EV is the cost comparing to regular competitor (gasoline vehicle).

3.5.2.1 Environmental impact (11)

From the environmental aspect, the electric vehicle is the best choice when compared to gasoline-powered vehicle. Among the advantages offered for the environment when using an EV:

- Better for the Environment
- Electricity is Less Expensive than Gasoline
- Electric Cars Tend to Be Quiet

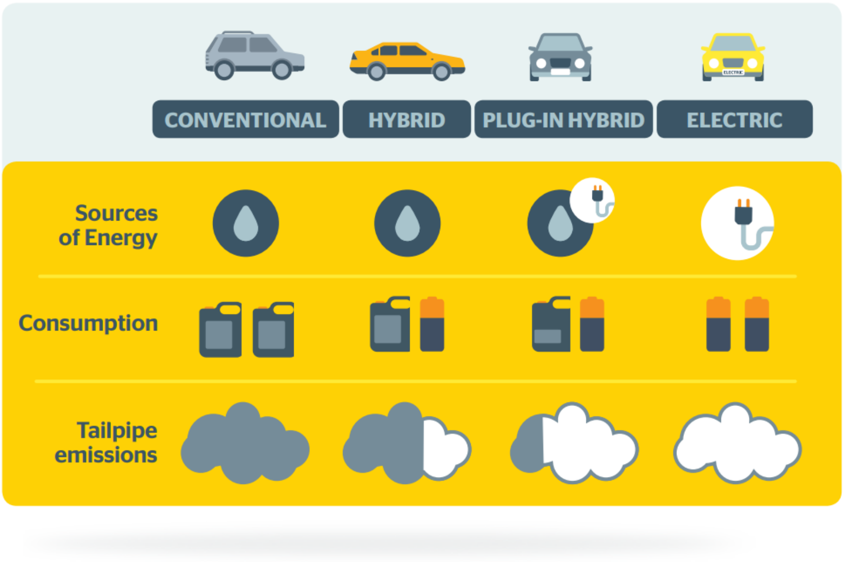


Figure 3.4 qualitative comparison of Energy consumption and environmental impact of 4 types of Vehicles (11)

3.6 Current status of electric vehicles:

3.6.1 Stocks, sales, charging infrastructure

3.6.1.1 Stock

The global stock of electric passenger cars reached 5.1 million units in 2018, an increase of 63% from the previous year. Battery electric vehicles (BEVs) account for 64% of the world's electric car fleet. Around 45% of the world's electric car fleet was located in China in 2018.

The stock of electric cars in China almost doubled between 2017 and 2018 to reach 2.3 million. In 2018, Europe accounted for 24% of the global stock of electric cars at 1.2 million (of which 0.96 million were in European Union countries) and the United States accounted for 22% with 1.1 million.

3.6.1.2 Sales

Global electric car sales were close to 2 million in 2018, after having reached the 1 million peak in 2017. This represents a year-on-year growth in electric car sales of 68% between 2017 and 2018, a strong rate compared to 2015 (68%), after two years of weaker growth.

3.7 Global EV stock and sales by scenario (2018-2030)

3.7.1 New Policies scenario

The New Policies Scenario (NPS) is the central scenario of the WEO. The scenario describes the policies and measures that governments around the world have already put in place, as well as the likely effects of announced policies that are expressed in official targets or plans. It aims to illustrate the consequences of existing and announced policy measures and ambitions to encourage the use of EVs and the deployment of charging infrastructure.

3.7.2 EV30@30 scenario

The scenario accounts for relevant measures such as the progressive reduction of the carbon intensity of electricity generation by:

- Decrease average trip distances and fewer trips by car
- Enable a larger share of movements on public transportation and non-motorized modes of transport.

3.7.3 Global results

In the New Policies Scenario, the global EV stock (excluding two/three-wheelers) exceeds 55 million vehicles in 2025 and reaches about 135 million vehicles in 2030 (Figure 3.5), with an average year-on-year compound annual growth rate of 30% over the projection period.

The EV30@30 Scenario projects global EV stock and sales that in 2030 are nearly double the projections in the New Policies Scenario. In the EV30@30 Scenario, the global EV stock surpasses 250 million vehicles in 2030 (Figure 3.5Figure 3.5), when sales reach 43 million. In this scenario, it is assumed that all countries rapidly implement policy measures that promote the adoption of EVs such that by 2030.

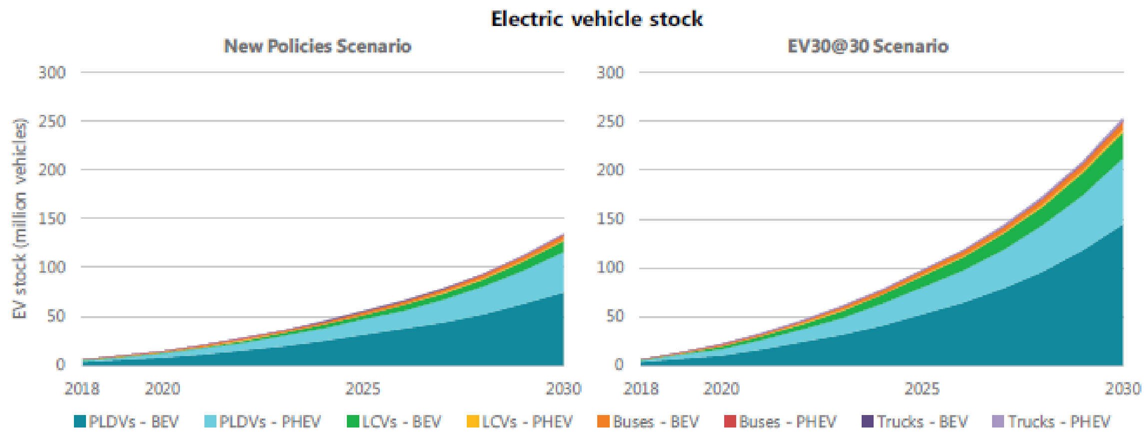


Figure 3.5 Global EV stock by scenario, 2018-2030 (14)

3.7.4 Charging infrastructure

Private chargers for vehicle expand to 128 million in the New Policies Scenario and 245 million in the EV30@30 Scenario in 2030. In the New Policies Scenario, total power capacity reaches nearly 1 TW and the electricity consumption is about 480 TWh

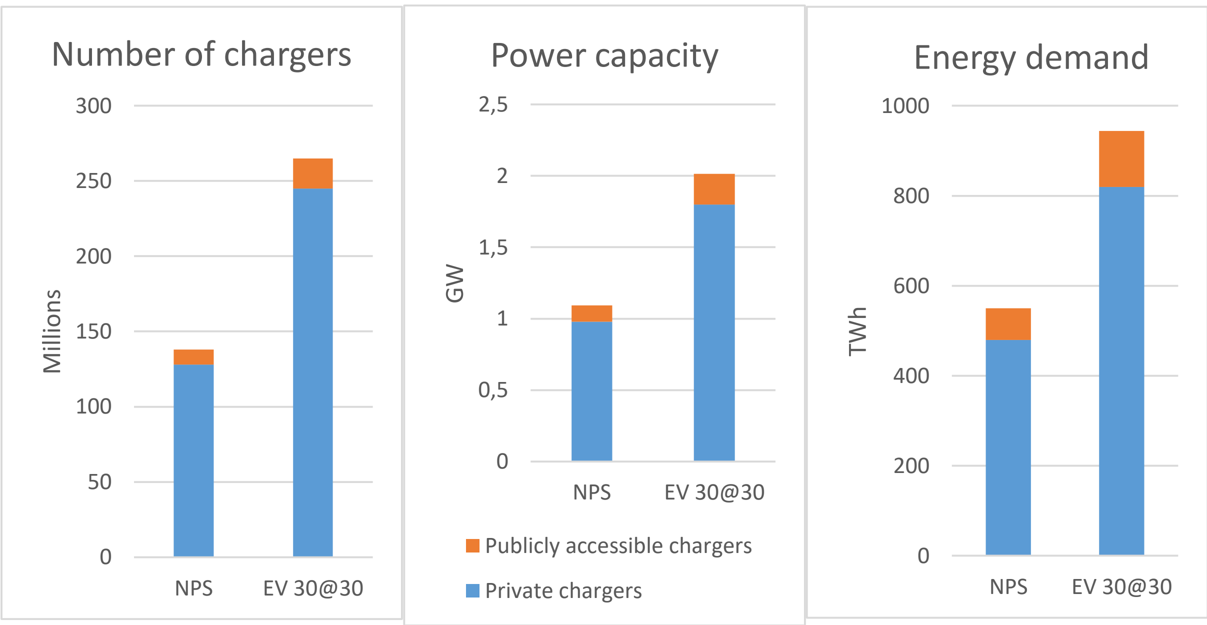


Figure 3.6 Number of private chargers & publicly accessible chargers for vehicles, relative power capacity and energy demand by scenario. (14)

The number of public chargers reaches 10 million in the New Policies Scenario and almost 20 million in the EV30@30 Scenario in 2030.

3.7.5 Impacts of electric mobility on energy demand and GHG emissions

Global electricity demand from EVs is close to 640 TWh in 2030, concentrated in China and Europe in the New Policies Scenario and more widespread in the EV30@30 Scenario. Slow charging accounts for the largest share of electricity consumed by EVs.

Electric vehicles reduce GHG emissions by half from an equivalent ICE fleet in 2030, offsetting 220 Mt CO2-eq in the New Policies Scenario and 540 Mt CO2-eq in the EV30@30 Scenario as shown in Table 3.3 Impacts of electric mobility on energy demand and GHG emissions by scenario, 2018-2030

Table 3.3 Impacts of electric mobility on energy demand and GHG emissions by scenario, 2018-2030 (14)

	2018	New Policies Scenario	EV30@30 Scenario
Global electricity demand (TWh)	58	640	1100
GHG emissions (Mt CO2-eq)	38	230	340
GHG emissions with ICE (Mt CO2-eq)	78	450	770
net savings (Mt CO2-eq)	40	220	430

4 Chapter 4: Algeria – Energy situation

4.1 Presentation of the country

Algeria is the largest country in Africa and tenth in the world. It is situated in the Mediterranean coast with a surface of 2 381 741 square kilometers. Its capital Algiers, located in the north has the highest population.

The Sahara accounts for almost 80% of total surface and is considered one of the best irradiated zones in the world.

Algeria is known by its reserves in oil and natural gas. It has the 16th largest oil reserves in the world and the third largest in Africa, while it has the 11th largest reserves of natural gas. [12]

Figure 4.1 location of Algeria (42)

4.2 Energy situation

4.2.1 Primary energy

The economic sector of energy in Algeria includes the local production and import of primary energy, their possible transformation into secondary energy use, their transportation into the final consumption, as well as the import export market. Hydrocarbons and natural gas are by far the main source of income for the country.(40)

4.2.1.1 Primary energy production

According to the latest statistics of SONATRACH[3], Commercial primary energy production recorded near-stability (-0.2% in 2017) compared to 2016 achievements, reaching 165.9 mtoe. The production structure shown in Figure 4.2.

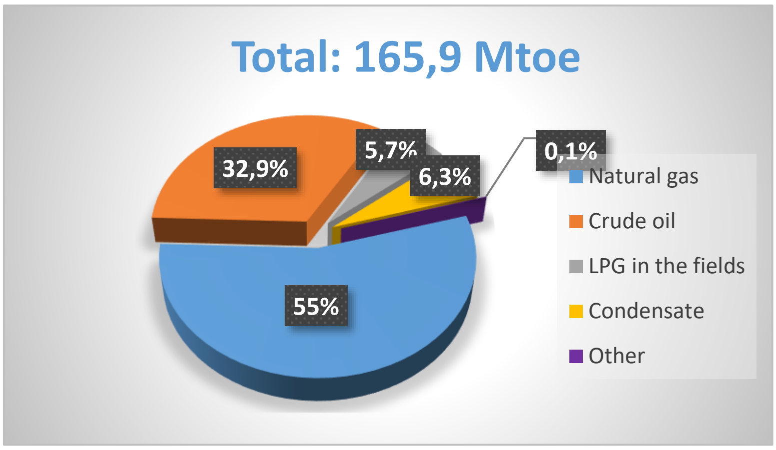


Figure 4.2 Structure of primary energy production (37)

[3] is the national state-owned oil company of Algeria. Founded in 1963. *Source: Wikipédia*.

▪ Derived energy production

Derived energy production reached 64.2 Mtoe (2017), up 1.8% compared to 2016 achievements, following the increase (+ 6.0%) in the production of liquefied natural gas (LNG), thermal electricity (5.2%) and LPG (5.3%), as detailed in Figure 4.3 This increase more than offset the drop in production of petroleum products (-2.7 %).

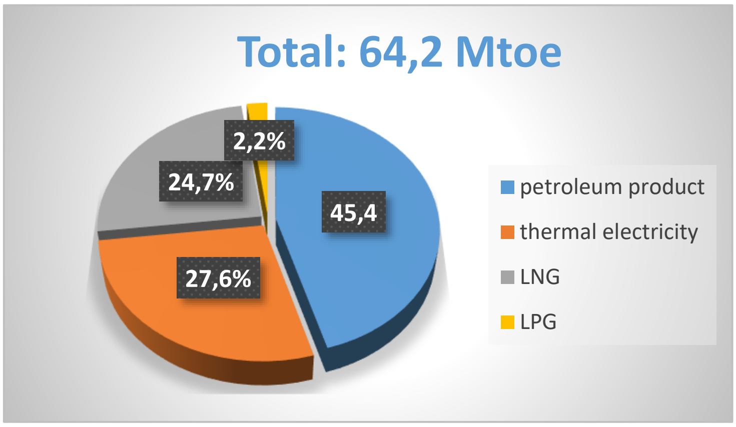


Figure 4.3 Structure of derived energy production (37)

4.2.1.2 Oil

Algeria is a member of the Organization of the Petroleum Exporting Countries (OPEC) and the Forum of the Gas Exporting Countries (GECF). It is the 3rd oil producer in Africa behind Nigeria and Angola and the 11th exporter worldwide.

- Reserves and exploitation

Algeria has proven BP estimated oil reserves at 1.5 billion tones at the end of 2017 (12.2 billion barrels).

- Oil production

In 2018, Algeria produced 65.3 Mt (million tons) of oil, or 1.51 mb/d (million barrels per day), down 2% in 2018.

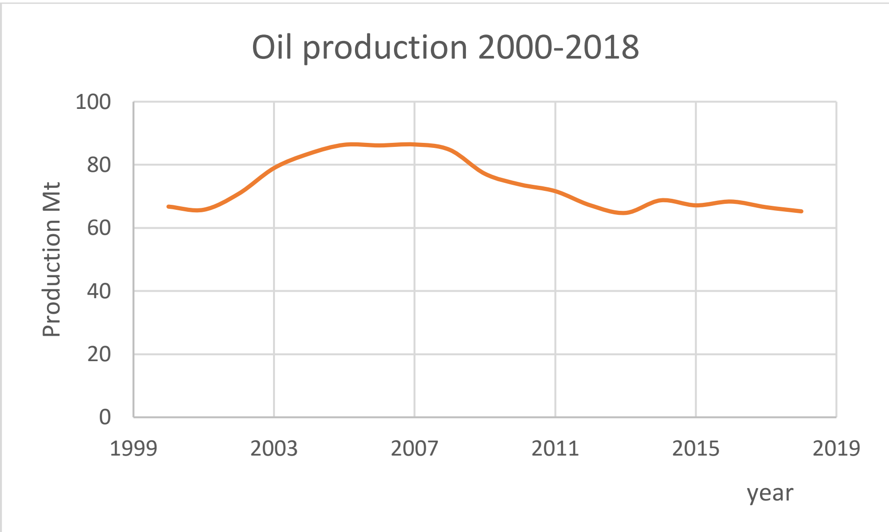


Figure 4.4 Evolution of crude oil production in Algeria (7)

- Oil consumption

In 2018, Algeria consumed 19.6 Mt (million tons) of oil, or 414 kb/d (thousands of barrels per day), up 1.2% in 2018.

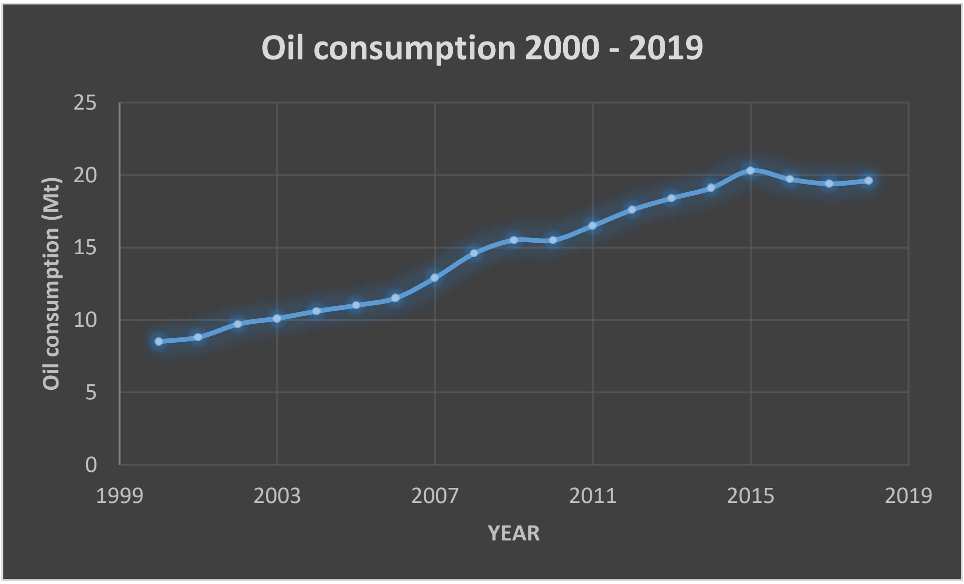


Figure 4.5 Evolution of oil consumption in Algeria (7)

Oil and natural gas are found in the south eastern region as shown in the figure below:

4.2.1.3 Natural gas

The International Energy Agency ranked Algeria 10th in the world for natural gas producers in 2018 with 2.4% of world production and 9th for natural gas exporters with 5.3% of the world total.

- Natural gas reserves

Algeria has proven BP estimated natural gas reserves at 4,300 bcm at the end of 2018. These reserves ranked Algeria 10th in the world with 2.4% of the world total, and 2nd in Africa behind Nigeria.

- Natural gas production

In 2018, Algeria produced 92.3 bcm of natural gas, or 79.4 Mtoe, down 0.7% in 2018. It ranks 10th in the world with 2.4% of world production and 1st in Africa.

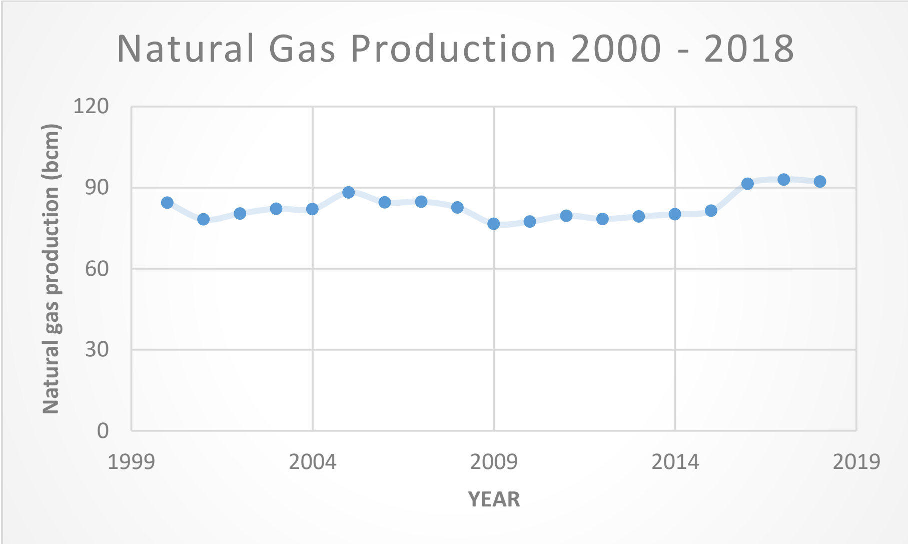


Figure 4.6 evolution of natural gas production in Algeria (7)

- Natural gas consumption

In 2018, Algeria consumed 42.7 billion cubic meter of natural gas, or 36.8 Mtoe up 9.9% in 2018. It ranks 19th in the world with 1.1% of world consumption. Its consumption takes 46% of its production.

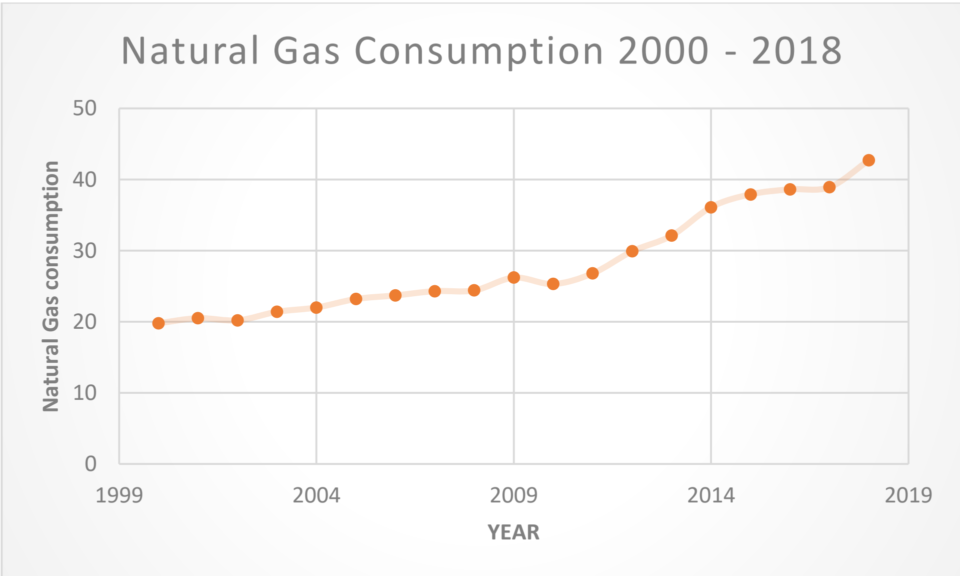


Figure 4.7 evolution of natural gas consumption in Algeria (7)

Table 4.1 summarizes the total share of fossil energy for Algeria:

Table 4.1 reserves, production and consumption of fossil fuels in Algeria 2018 (7)

	Reserves R	Production P	Consumption C	RPR (Years)
Coal	65 million short tons	_	_	_
Oil	1.5 Billion tons	65.3 million tons	19,6 million tons oil equivalent	22
Natural gas	4,300 Billion cubic metres	92.3 billion cubic metres	42.7 Billion cubic metres	47

4.2.2 secondary energy: Electricity

4.2.2.1 Electricity generation

In 2018, electricity net generation for Algeria was 76.4 billion kilowatt-hours. Between 2008 and 2018, electricity net generation of Algeria grew substantially from 40.20 to 76.4 billion kilowatt-hours rising at an increasing annual rate that reached a maximum of 16.19% in 2011 and then decreased to 7.04 in 2017 and to 0.52% in 2018. (21)

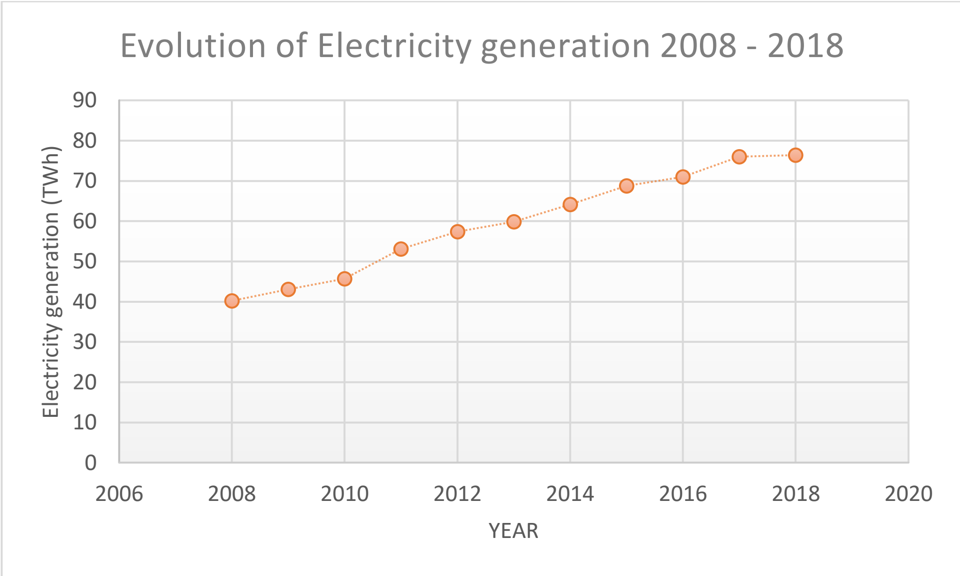


Figure 4.8 Evolution of electrical production in Algeria (20)

4.2.2.2 Renewable energy

- Solar potential

Seen from its geographical location, Algeria has one of the highest solar deposits in the world. The duration of sunshine on almost the entire national territory exceeds 3000 hours annually and can reach 3900 hours (highlands and Sahara). (25)

The energy received annually on a horizontal surface of $1m^2$ is nearly range of $7kWh/m^2$ as shown in figure 4.9:

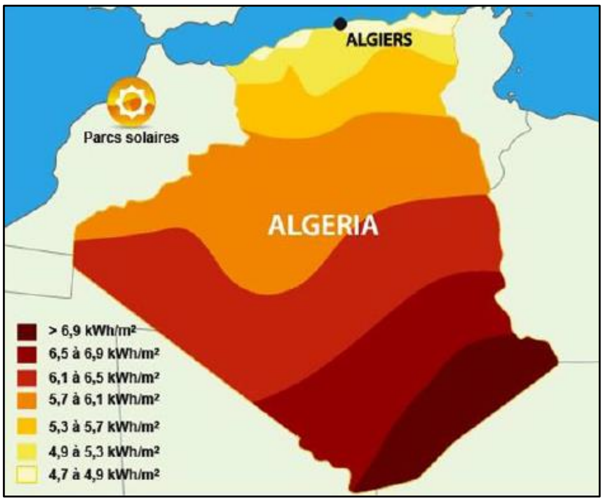


Figure 4.9 Variation of irradiation in Algeria (35)

4.2.2.3 Wind potential

The wind resource in Algeria varies greatly from one place to another. This is mainly due to a very diverse topography and climate. Indeed, the country is subdivided into two large distinct geographical areas. The North Mediterranean which is characterized by a coastline of 1200km

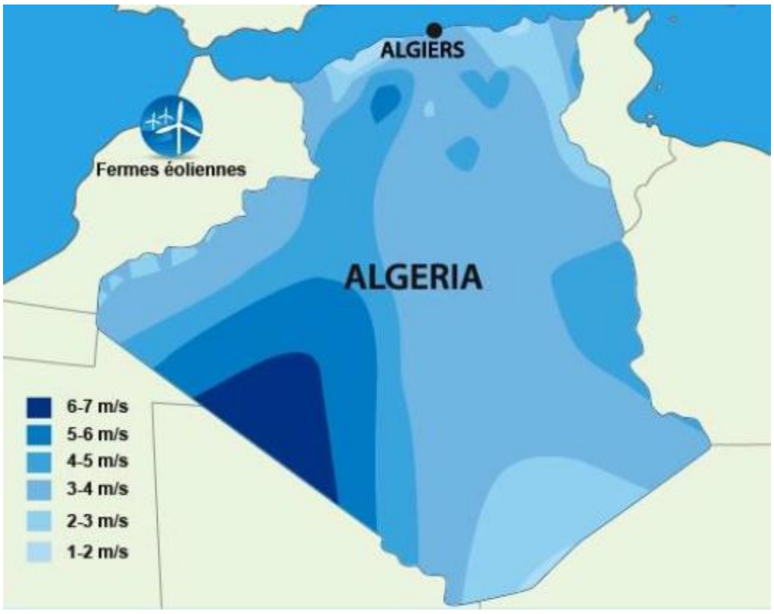


Figure 4.10 Map of wind power in Algeria (35)

and a mountainous relief, represented by the two chains of the Tell Atlas and the Saharan Atlas.

Between them, there are plains and the highlands of continental climate. The South, meanwhile, is characterized by a Saharan climate.

Figure 4.12 shows wind speed partition where southern region has higher speeds than the North, more particularly in the Southeast, with speeds higher than 7 m/s and which exceed the value of 8 m / s in the Tamanrasset region (In Amguel).

Concerning the North, the average speed is generally low. However, the existence of microclimates on the coastal sites of Oran, Bejaïa and Annaba, on the highlands of Tébessa, Biskra, M'sila and El bayadh (6 to 7 m/s), and the Great South (> 8m/s). (25)

4.2.2.4 Geothermal Energy Potential

The compilation of geological, geochemical and geophysical data has made it possible to identify more than two hundred (200) hot springs, which have been inventoried in the northern part of the country. About a third (33%) of them have temperatures above 45 °C. There are high temperature sources up to 118 °C in Biskra.

Studies on the thermal gradient have made it possible to identify three zones whose gradient exceeds 5 °C / 100m. (25)

- Relizane and Mascara area
- Aïne Boucif and Sidi Aïssa area
- Guelma and Djebel El Onk area

4.2.2.5 Hydraulic potential

The overall quantities falling on Algerian territory are estimated at 65 billion m^3, but countries benefit are limited: reduced number of precipitation days, concentration in limited spaces, high evaporation, and rapid evacuation to the sea.

4.3 Total population

In 2019, population for Algeria was 43.1 million persons. Population of Algeria increased from 34.6 million persons in 2008 to 43.1 million persons in 2019 growing at an average annual rate of 2.1 %. (
Figure 4.11)

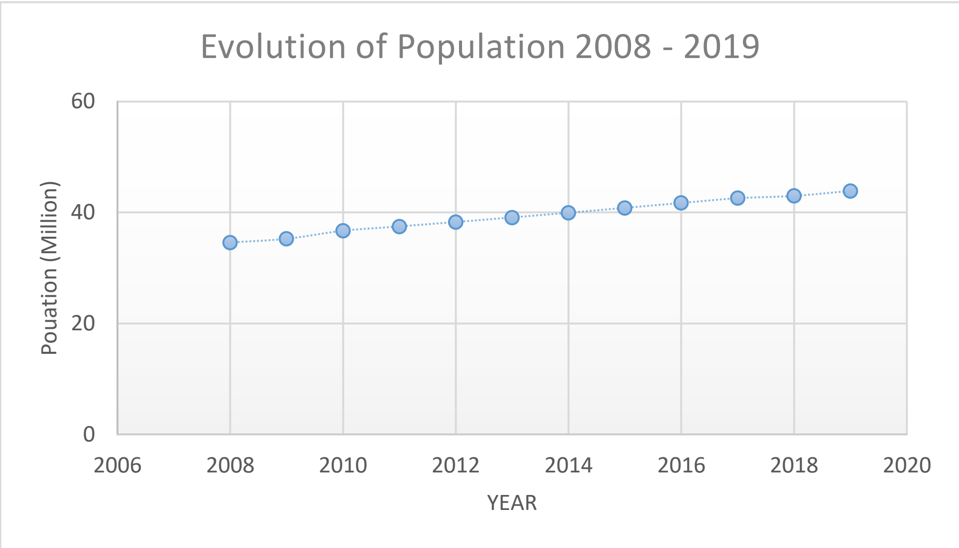


Figure 4.11 evolution of the Algerian population (20)

4.4 Carbon dioxide emission

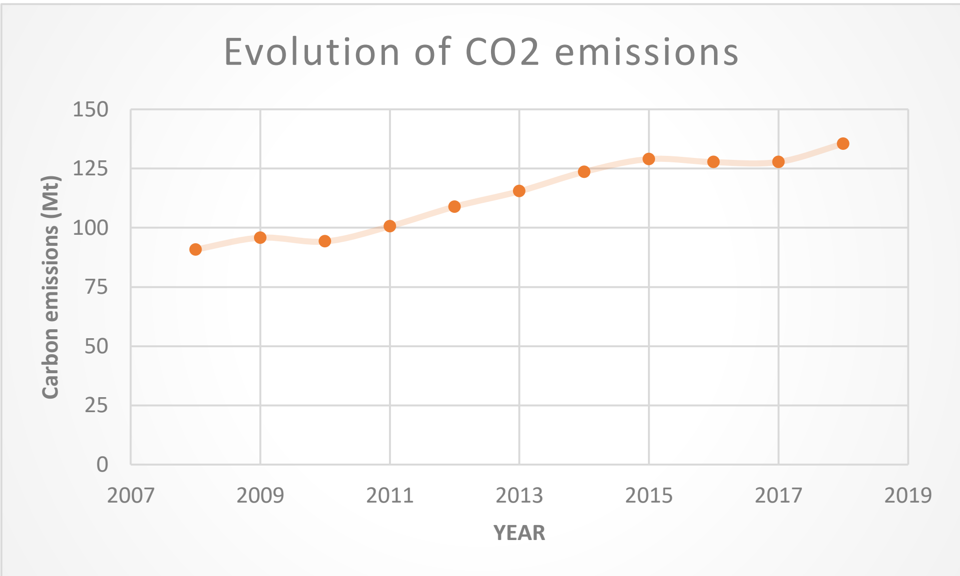


Table 4.2 Evolution of carbon dioxide (20)

In 2018, CO_2 emissions for Algeria was 135.5 million tons. Between 1999 and 2018, CO_2 emissions of Algeria grew substantially from 81.7 to 135.5 million tons rising at an increasing annual rate that reached a maximum of 8.25% in 2014 and then decreased to 6.02% in 2018.The chart above shows the evaluation of emissions though the past 10 years.

Part 2

Towards energy transition
A sustainable model 20|30

5 Chapter 5: Algerian vehicles fleet situation

5.1 Introduction

Fuel consumption in the transport sector keeps increasing every year. The study of the national automobile fleet is essential due to the important position in the global Algerian share of energy, with a contribution of more than one-third of final energy consumption, the policy still depending on fossil energy that may run out in the future few decades. The analysis of the current situation helps to simulate the next policies related to energy use in this sector with the integration of energy efficiency. (1)

5.2 Assessment of national Fuels Market

5.2.1 Evolution of fuel consumption in the national market 2008 – 2019

Fuel consumption has been experiencing a high rate of growth. It increased from 0.6 million tons in 1964 to 5.9 million tons in 1999 and 11,11 million tons in 2010 to reach 14,53 million tons in 2019. This increase is due to:

- High energy demand particularly in the industrial and transport sectors.
- The relatively low cost of fuels
- The relative improvement of economic incomes which helped the growth of national vehicle fleet.

Table 5.1 Evolution of fuel consumption 2008 – 2019 (Appendix 3)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	AAGR 08-19	Evolution 18-19
Gas oil (Mt)	5.91	6.50	8.17	8.89	9.68	10.04	10.25	10.70	10.13	9.76	9.73	9.89	5.09	1.63
Gasoline (Mt)	1.80	1.96	2.63	3.07	3.55	4.00	4.30	4.56	4.30	4.17	3.89	3.91	7.89	0.65
LPG (Mt)	0.31	0.31	0.31	0.32	0.29	0.29	0.27	0.25	0.31	0.41	0.56	0.72	9.31	29.91
Total (Mt)	8.02	8.77	11.11	12.28	13.52	14.33	14.82	15.51	14.74	14.34	14.18	14.53	5.85	2.47

Over the period 2008-2019, the average annual growth rate of fuel consumption reached 5,85%, with gas oil recording an average annual growth rate of 5.09%, gasoline 7.89% and important growth in LPG with 9.31%.

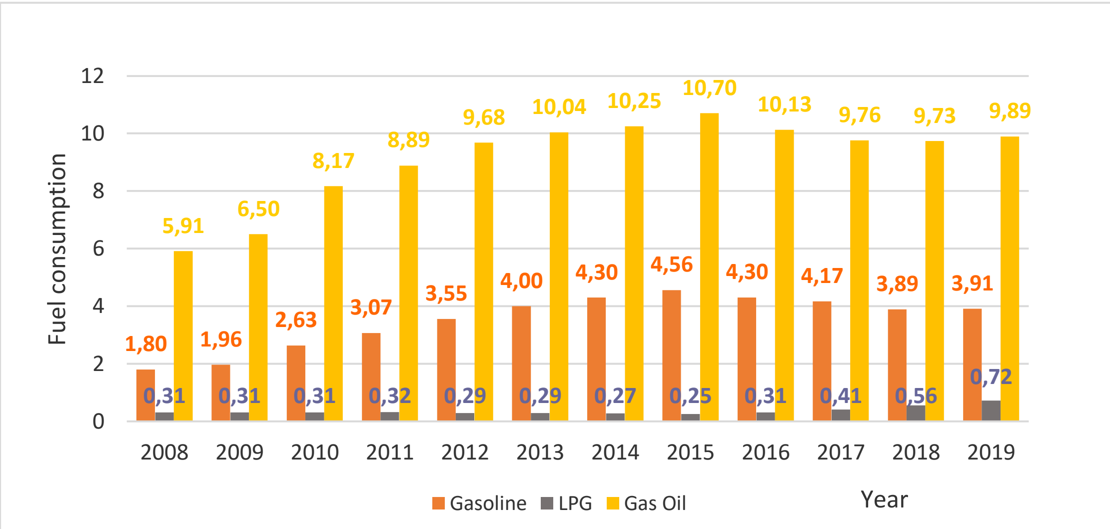


Figure 5.1 Fuel consumption by Wilaya 2008 – 2019 (Appendix 3)

The consumption of fuels (gas oil and gasoline) reached 13.80 million tons (2019), an increase of 1.35 % compared to 2018 (13.62 million tons).

Benefiting from a very competitive price and subsidies, LPG consumption reached 720,000 tons, an increase of 29.91%.

The increases in fuel prices recorded in 2016, 2017 and 2018 induced, in part a decrease in average annual fuel consumption of 1% over the period 2015-2019. Maintaining the price of LPG at 9 DA/L has encouraged its use, which recorded an average. Annual decline of 1.58% over the period 2015-2019 compared to an average annual increase of 30.34% for LPG.

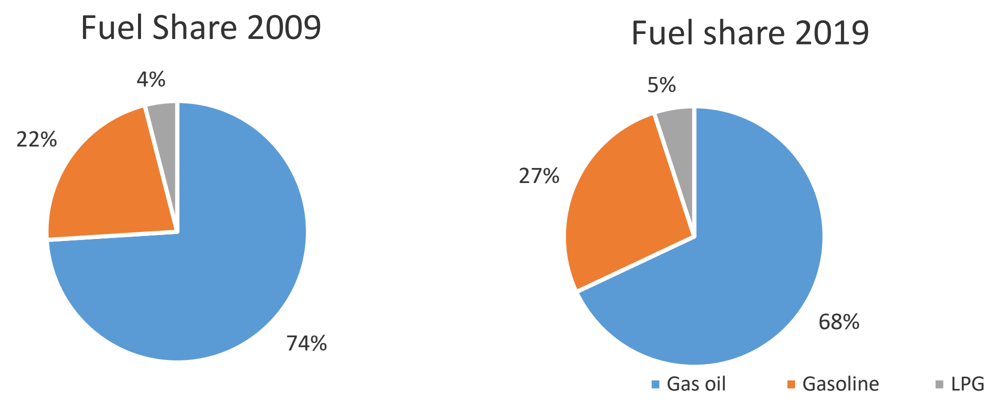


Figure 5.2 Comparison between Fuel share in 2009 and current share (appendix 3)

5.2.2 Configuration of the supply of fuels in the national market

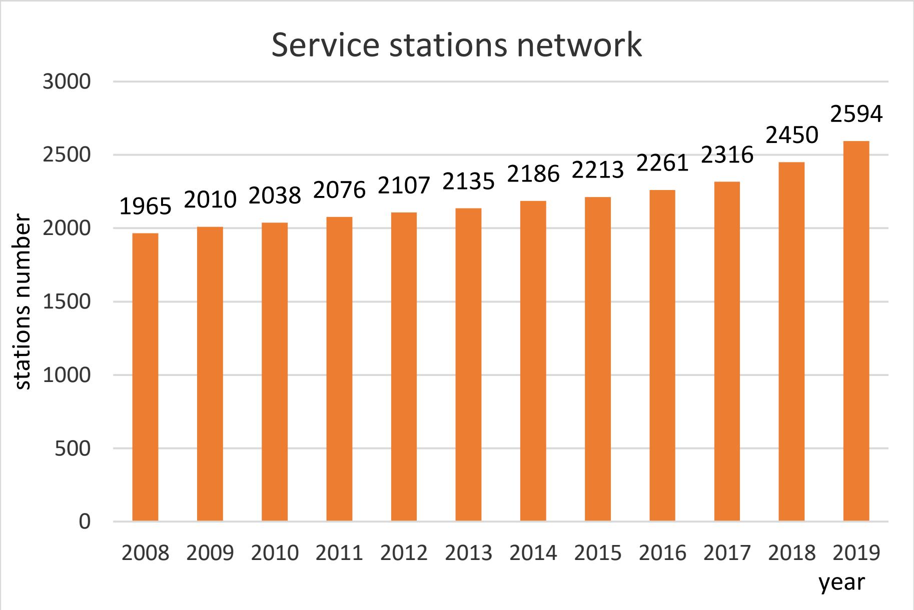
5.2.2.1 National service stations network

As of December 31, 2016, ten (10) distributors are engaged in the business of fuel distribution on the national market. They are: NAFTAL, PETROSER, GBS BELHOCINE, GALAOIL, PROPAL, ALPETRO, HAMDI, STPP, PETROBARAKA and PETROGEL (18). NAFTAL however, contribute more than 93% of the total national supply of fuels. The following chart shows the number of NAFTAL service stations across the country.

Table 5.2 NAFTAL Service Stations network 2020 (Appendix3)

Year	Service stations network
2008	1965
2009	2010
2010	2038
2011	2076
2012	2107
2013	2135
2014	2186
2015	2213
2016	2261
2017	2316
2018	2450
2019	2594

Table 5.3 Evolution of NAFTAL service stations network 2008 – 2019 (Appendix 3)



- **LPG Sales**

Naftal LPG sales out of 2594 service stations, the number of sales outlets distributing LPG in Algeria reached 803 against 426 in 2008.

Table 5.4 LPG Sales Evolution in period between 2008 – 2019 (Appendix 3)

Year	2008	2019	Evolution 2008 - 2019 (%)
LPG network	426	803	88,50

5.3 Vehicle fleet situation

5.3.1 Evolution of the Algerian vehicle fleet

Between 2008 and 2018, the average annual growth reached 4.8%, or an average of 300,000 new vehicles each year, to reach 6,418,212 vehicles of all types in 2018. In 10 years, the vehicle

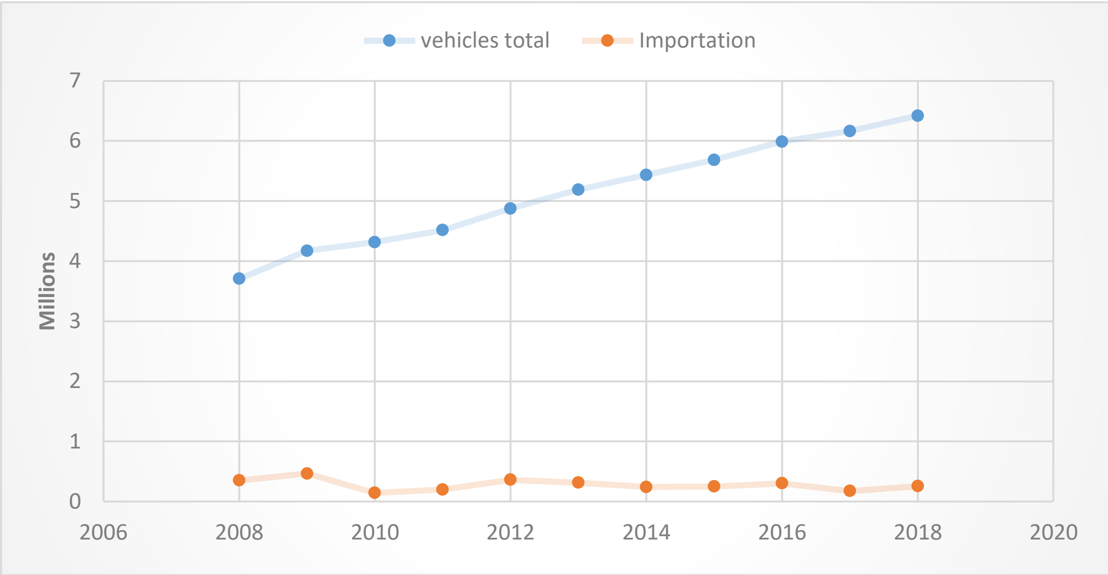


Figure 5.3 comparison of global vehicles share (22)

fleet has increased by a factor of 1.7. The chart describes the evolution of vehicles fleet and number of imported vehicles in the past 10 years.(2)

5.3.2 Distribution of the car fleet for the year 2018

5.3.2.1 Distribution of the vehicle fleet by type of vehicles:

Passenger cars account for the majority of the national vehicle fleet at 65%, followed by trucks with 19%.

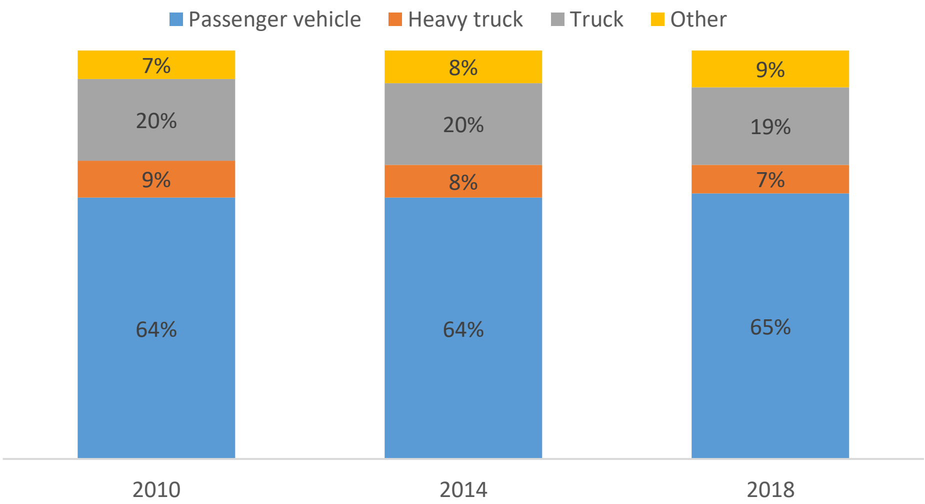


Figure 5.4 Evolution of the Algerian vehicle fleet 2008-2018 (22)

Passenger cars account for 66% of all new vehicles, while road tractors, agricultural tractors and special vehicles account for no more than 2% of all new vehicles and 8% of the total national vehicle fleet.

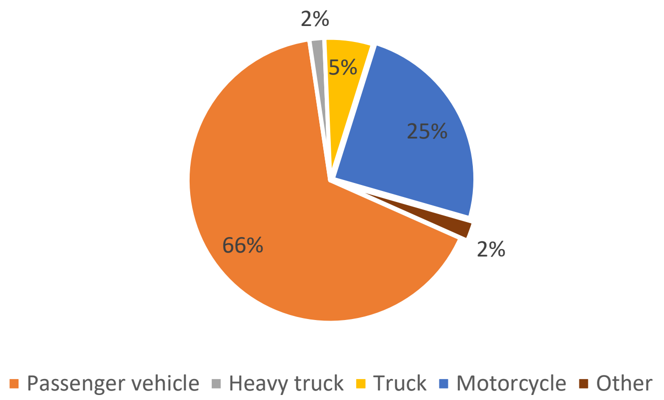


Figure 5.5 Distribution of the vehicle fleet by type of vehicles in 2018 (28)

5.3.2.2 Fleet distribution by fuel type used:

Gasoline is the largest fuel source at 65%, compared to diesel at 35%, which accounts for about one-third of the national vehicle fleet.

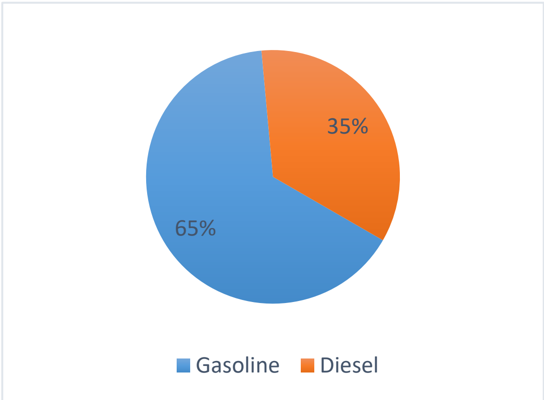


Figure 5.6 Share of fleet vehicles by type of fuel 2019 (22)

The following figure shows the distribution of certain Wilayas, according to the energy source used.

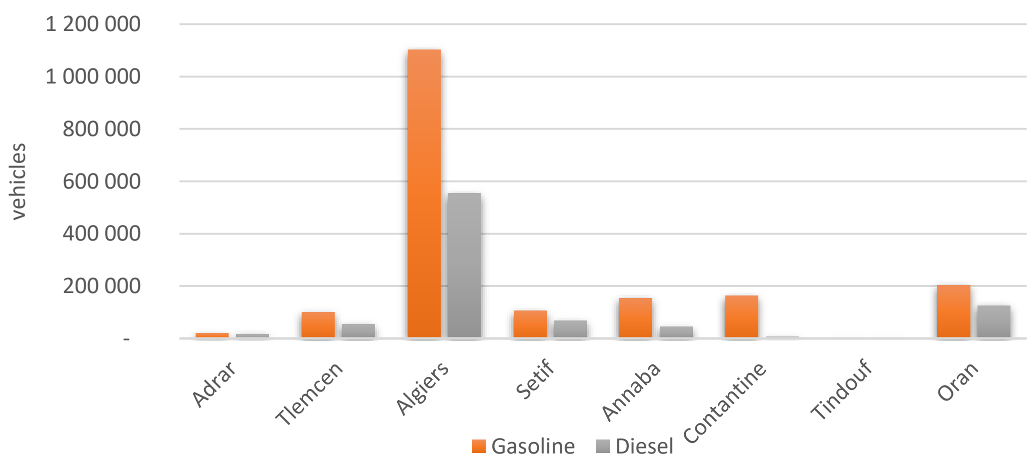


Figure 5.7 Distribution of certain Wilayas by fuel type used in 2018 (22)

Algiers situation alone has more than 1,000,000 vehicles, which consume about 18.8% of the total gasoline and 9% of the total diesel. Algiers holds the highest share of vehicles in the national fleet.

5.3.2.3 Distribution of the vehicle fleet by vehicle age group

The vehicle fleet by age group is broken down as follows:

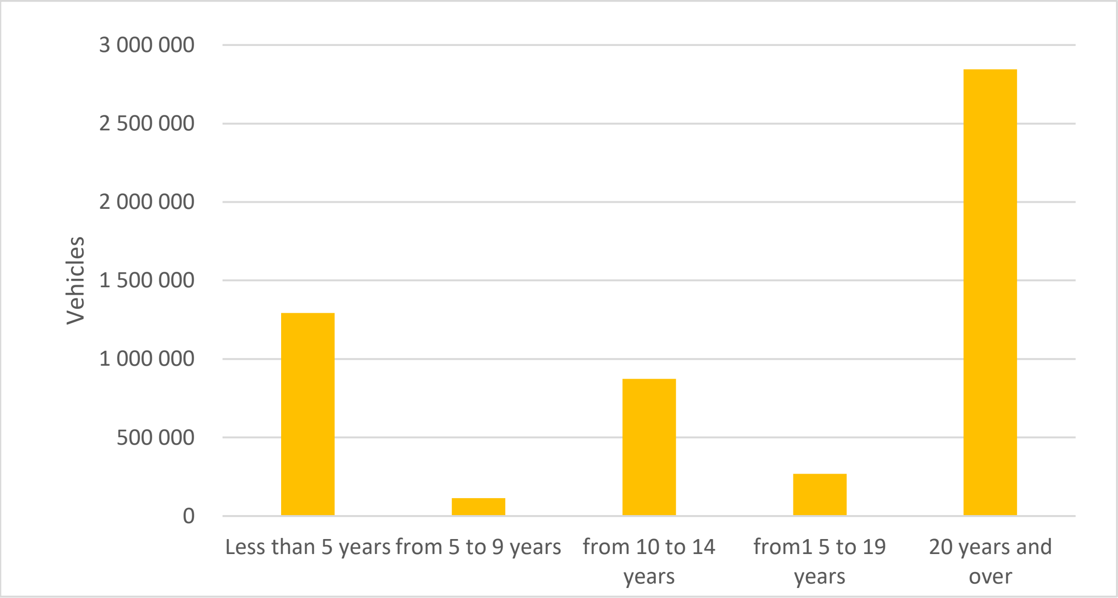


Figure 5.8 age of available vehicles (22)

More than 44% of vehicles in the fleet are 20 years old and older!!

6 Chapter 6: Perspectives Algeria 2030 – case of energy use in transport sector

6.1 Current Scenario

6.1.1 Fuel consumption

6.1.1.1 Gasoline and Diesel Fuel

Fuel consumption along the past decade has been increasing with an average annual rate of 5,8%. If we assume that vehicles consumption takes a constant annual rate along the next decade, the total fuel consumption will be around 25,7 Million tons, where diesel represents two-third of the total consumption and the remaining represents gasoline contribution. The table below indicates the fuel consumption evolution.

Table 6.1 Gasoline and Diesel fuel consumption perspectives for 2030 (5)

	2008	2010	2015	2019	2025	2030
Gasoline (Mt)	1.800	2.633	4.560	3.912	5.770	7.274
Diesel Fuel (Mt)	5.910	8.172	10.701	9.894	13.594	18.395
Total (Mt)	7.710	10.805	15.261	13. 806	19.363	25.669

The following Figure 6.1 represents the evolution of the consumption within the last years. The significant rise was noticed in 2017.

The growth in consumption is related to energy demand of the transport sector with more than 6 million vehicles running on gasoline and diesel.

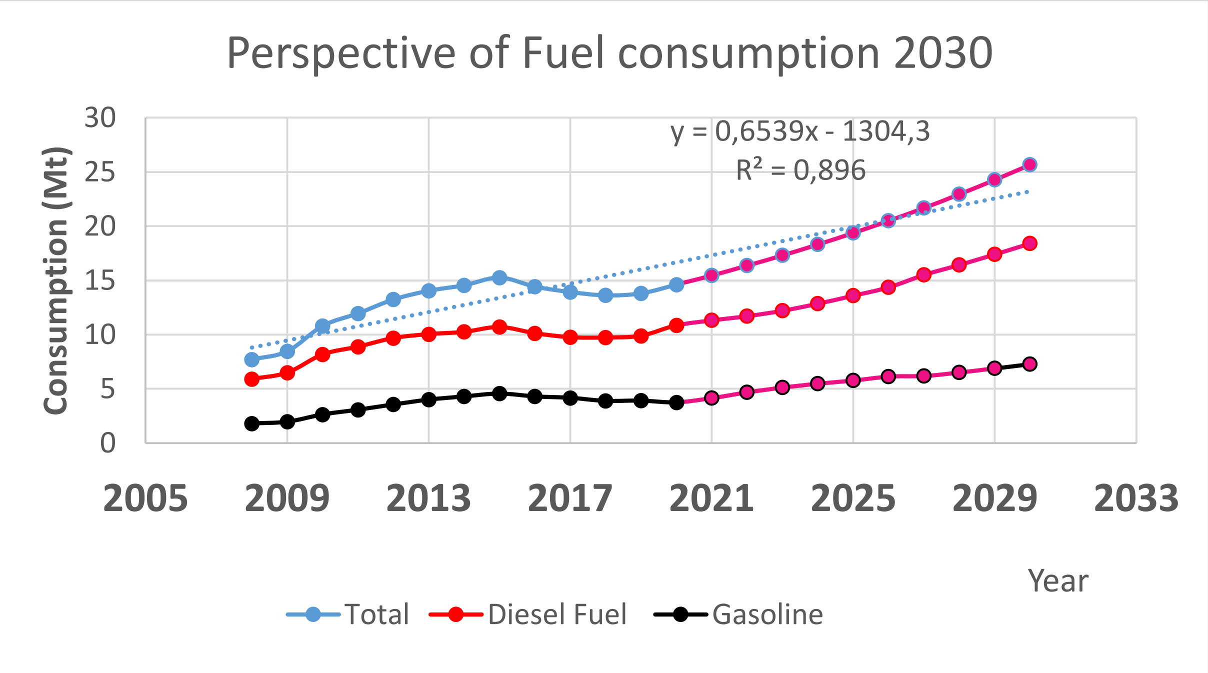


Figure 6.1 Perspective of Fuel consumption in 2030

6.1.1.2 LPG

Despite the low price of LPG (9DZD/Liter), the consumption within the past 10 years was not important when comparing to other fuels (Gasoline and diesel). According to APS ("Algérie presse service") the number of converted gasoline vehicles is around 300 000 units with a cost for conversion ranging between 70000 – 80000 DZD/Unit.

6.1.2 Vehicle fleet

the increased consumption of fuels gives an idea about the increase of vehicles number. Indeed, the number passed from 3,7 million units in 2008 to reach its doubled value in 2019 with almost 8,9 million units.

If we suppose that all vehicles are assimilated to passenger cars, and the annual growth remains the same (4,7%) hence in 2030, the fleet will attain more than 11 million units. The results are summarized in the table below

Table 6.2 Perspectives of the Algerian vehicle fleet in 2030

	2008	2010	2015	2019	2025	2030
Number of vehicles (Million units)	3.71	4.31	5.68	6.72	8.85	11.14

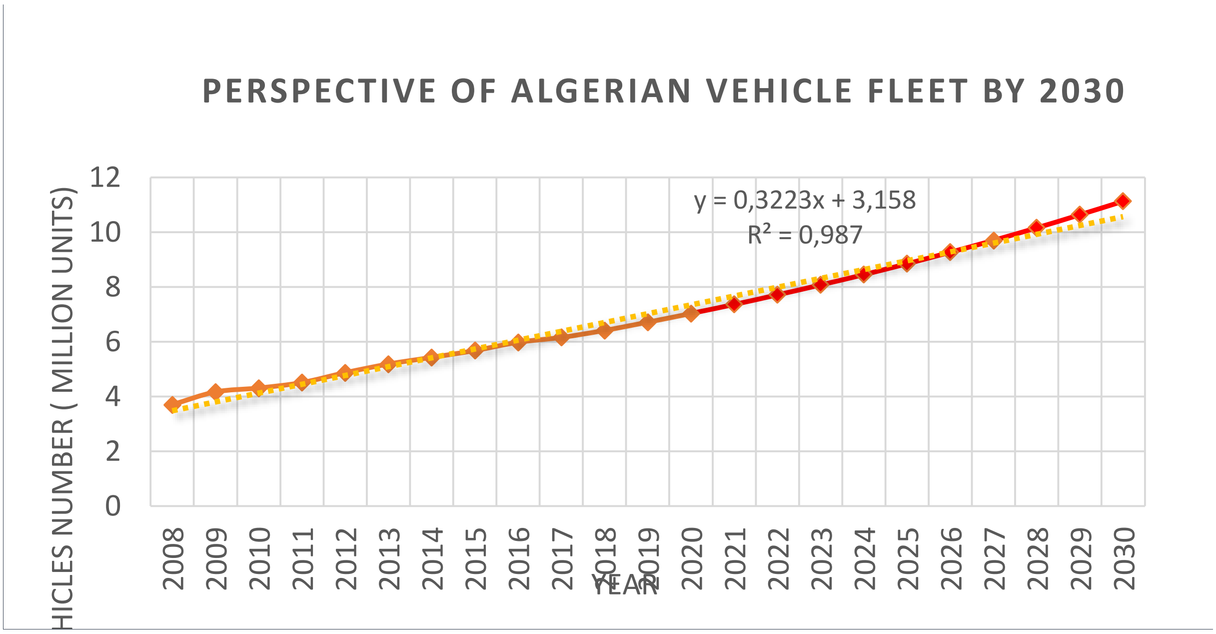


Figure 6.2 Perspective of Algerian Vehicle fleet situation in 2030

- <u>Comments:</u>
  - The previous charts Figure 6.1 and Figure 6.2, illustrates the strong contribution of fossils in the transport sector. Consequently, the increasing demand from this sector and the limited reserves will cause a serious issue in the next few years.
  - The results shown in 2030 are essential to reconsider the energy mix in the transport sector; meanwhile, alternatives types of fuels should contribute for their economic and environmental impact. For instance, GNV.

6.2 Sustainable Energy Model 20|30

6.2.1 Presentation of the model

The model 20|30 describes the vision of energy transition in 2030. A new suggested energy mix with shared low-emissions fuels contribution such as GNV, LPG and most importantly the new concept in the Algerian energy use in transport sector: E-mobility. (43)(44)

The present work suggests a model of 30% contribution of GNV, LPG and EV in the new vehicles added in the sector between 2020 and 2030. In addition, the conversion of some existing gasoline vehicles into LPG will hold a 20% contribution of: GNV, LPG and EV in the total fleet.

The new contribution not only will encourage the switch to ecofriendly vehicles but also to save fossils for other applications.

The pie chart below describes the contribution of LPG, CNG and EV in the added vehicles with an assumption that no more import of diesel automobiles.

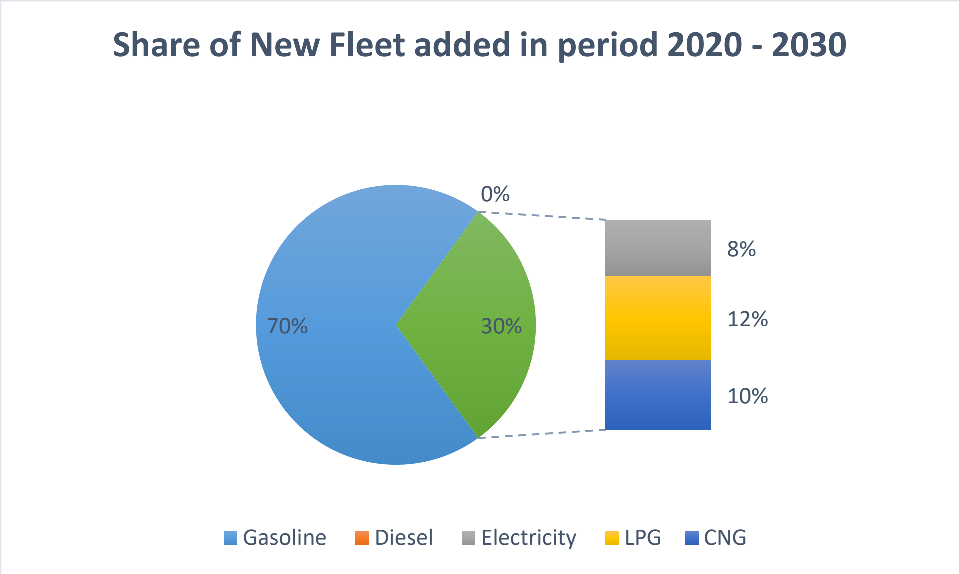


Figure 6.3 The energy mix of the added vehicles in period between 2020 – 2030

6.2.2 Calculations and results (18)

The calculations are based on the added vehicle between 2020 – 2030, nevertheless simple calculations are required for the current fleet of 2019 (7 million units).

6.2.2.1 Added Fleet 2020 – 2030

The number of new vehicles added in the next decade is around 4 100 000 vehicles. The model suggests that 30% of the total number represents vehicles running on LPG, CNG, and EV with a contribution respectively equals 12%,10% and 8%.

- Calculations method:

We consider in what follows:

- Average travel of the car is around 20 000 km/year.
- Average fuel consumption along 100km for one vehicle is 7L,8L, 6Nm^3 for Gasoline, LPG and CNG respectively while for Electric vehicles consumption is around 10kWh for same traveled distance.

a- The quantity of gasoline saved in each case is calculated according to the equation:

$$Gasoline\ saved\ \left(\frac{ML}{year}\right) = vehicles\ (unit) * 20\ 000\ \left(\frac{km}{year}\right) * \frac{7}{100}\ \left(\frac{L}{Km.Unit}\right) * 10^{-6}$$

- The amount of fuel used by vehicles for:

LPG

$$LPGc\ consumption\ \left(\frac{ML}{year}\right) = vehicles\ (unit) * 20\ 000\ \left(\frac{Km}{year}\right) * \frac{8}{100}\left(\frac{L}{Km.Unit}\right) * 10^{-6}$$

CNG

$$CNG\ consumption\ \left(\frac{MNm^3}{year}\right) = vehicles\ (unit) * 20\ 000\ \left(\frac{Km}{year}\right) * \frac{6}{100}\left(\frac{Nm^3}{Km.Unit}\right) * 10^{-6}$$

- Similarly, for electricity consumption:

$$Electricity\ consumption\ \left(\frac{GWh}{year}\right) = vehicles\ (unit) * 20\ 000\ \left(\frac{Km}{year}\right) * \frac{10}{100}\left(\frac{kWh}{Km.Unit}\right) * 10^{-3}$$

b- The gain obtained when working with new vehicles share:

Simply, we multiply the amount of fuel (or Electricity) with unit price for each case. However, we expect that the unit price of diesel fuel, gasoline and electricity will increment 6DZD, 3DZD and 0,6 DZD respectively every year along the next 10 years.

The current unit price of energy in Algeria is summarized in the table below:

Table 6.3 Current Energy price 2020
Source: Minister of Energy

Energy type	Diesel fuel (+6DZD)	Gasoline (+3DZD /Year)	LPG-c	CNG (Assumption)	Electricity (+0.6 DZD /Year)
Price (DZD/unit)	29.01	45.97	9.00	15.00	5.34

- <u>Results:</u>

a- The quantity of gasoline saved:

- <u>Liquefied Petroleum Gas LPG</u>

Table 6.4 Amount of Gasoline saved from LPG share

LPG share 12%	Number of vehicles (million units)	Added LPG vehicles (unit)	Quantity of Gasoline saved (ML)	Required amount of LPG (ML)
2020	7,036	0,000	0,000	0,000
2021	7,366	49217	68,904	78,748
2022	7,713	98434	137,809	157,496
2023	8,075	147652	206,713	236,244
2024	8,455	196869	275,618	314,992
2025	8,852	246087	344,522	393,739
2026	9,268	295304	413,426	472,487
2027	9,704	344522	482,331	551,235
2028	10,160	393739	551,235	629,983
2029	10,637	442956	620,140	708,731
2030	11,137	492174	689,044	787,479
Total			**3789,74**	**4331,13**

Comment:

The additional LPG vehicles in the fleet (around 492 000) will save almost 3 million tons of gasoline (0,75kg/L) equivalent to 9% of total fuel consumption in 2030.

- <u>Compressed Natural Gas CNG</u>

Table 6.5 Amount of Gasoline saved from CNG share

CNG share 10%	Number of vehicles (million units)	Added CNG vehicles (unit)	Quantity of Gasoline saved (ML)	Required amount of CNG (MNm3)
2020	7,036	0	0,00	0,00

2021	7,366	41015	57,42	49,22
2022	7,713	82029	114,84	98,43
2023	8,075	123044	172,26	147,65
2024	8,455	164058	229,68	196,87
2025	8,852	205073	287,10	246,09
2026	9,268	246087	344,52	295,30
2027	9,704	287102	401,94	344,52
2028	10,160	328116	459,36	393,74
2029	10,637	369131	516,78	442,96
2030	11,137	410145	574,20	492,17
Total			**3158,12**	**2706,96**

Comment:

Alike LPG, CNG cars added into the new fleet seems to have approximatively the same amount of gasoline saved. With more than 410 000 units running on CNG fuel (0,72kg/Nm^3), 2,2 million tons of gasoline are replaced with alternative fuel.

- Electric Vehicles

The most interesting part of the work was the impressive result of the integration of electric vehicles among the 4 million cars added in period between 2020 – 2030, the next table represents the result obtained with only 8% of EV (equivalent to 328 000 units)

Table 6.6 Amount of Gasoline saved from EV share

EV share 8%	Number of vehicles (million units)	Added EV (Units)	Quantity of Gasoline saved (ML)	Amount of Electricity generated (GWh)
2020	7,036	0	0,00	0,00
2021	7,366	32812	45,94	65,62
2022	7,713	65623	91,87	131,25
2023	8,075	98435	137,81	196,87
2024	8,455	131246	183,75	262,49
2025	8,852	164058	229,68	328,12
2026	9,268	196870	275,62	393,74
2027	9,704	229681	321,55	459,36
2028	10,160	262493	367,49	524,99
2029	10,637	295305	413,43	590,61
2030	11,137	328116	459,36	656,23
Total			**2526,49**	**3609,28**

Comment:

The energy required for the added electric vehicles is expected to be around 3,6 TWh. While 1,9 million tons of gasoline will not be used for this type of vehicles.

The energy required for the EV fleet represents only 5% of the total electricity produced (71,4 TWh in 2017 according to the minister of Energy)!!

b- The gain obtained when working with new vehicles share:

- <u>Liquefied Petroleum Gas LPG</u>

Table 6.7 Gain from LPG share

LPG share 12%	Total LPG vehicles	Price of Gasoline (Billion Da)	Price of LPG (Billion DZD)	Gain (Billion DZD)
2021	49217	3,37	0,71	2,67
2022	98435	7,16	1,42	5,74
2023	147652	11,36	2,13	9,24
2024	196870	15,98	2,83	13,14
2025	246087	21,01	3,54	17,46
2026	295305	26,45	4,25	22,19
2027	344522	32,30	4,96	27,34
2028	393739	38,57	5,67	32,90
2029	442957	45,25	6,38	38,87
2030	492174	52,35	7,09	45,26
			Total	**214,82**

Comment:

The gain obtained from the new share of LPG vehicles will not only save the previous amount of gasoline calculated, but also save more than 2 hundred billion DZD; equivalent to around $1.6 Billion!!

Table 6.8 Gain from NCG share

NCG share 10%	Total CNG vehicles	Price of Gasoline (Billion Da)	Price of NCG (Billion Da)	Gain (Billion Dinars)
2021	41015	2,81	0,74	2,07
2022	82029	5,97	1,48	4,49
2023	123044	9,47	2,21	7,25
2024	164058	13,31	2,95	10,36
2025	205073	17,50	3,69	13,81
2026	246087	22,04	4,43	17,61
2027	287102	26,92	5,17	21,75
2028	328116	32,14	5,91	26,24
2029	369131	37,71	6,64	31,07
2030	410145	43,62	7,38	36,24
			Total	170,89

Comment:

Alike LPG, the gain from NCG vehicles is important, with 170 Billion Da, equivalent to $1,3 billion!!

- Electric Vehicles

Table 6.9 Gain from EV share

EV share 8%	Total electric vehicles	Price of Gasoline (Da)	Price of Electricity (Da)	Gain (Billion Dinars)
2021	32812	2,249	0,390	1,860
2022	65623	4,775	0,858	3,916
2023	98435	7,575	1,406	6,170
2024	131246	10,652	2,032	8,620
2025	164058	14,004	2,736	11,267
2026	196870	17,631	3,520	14,111
2027	229681	21,534	4,382	17,152
2028	262493	25,713	5,323	20,390
2029	295305	30,168	6,343	23,825
2030	328116	34,898	7,442	27,456
			Total	**134,77**

Comment:

The implementation of electric vehicles network in the Algerian fleet will help to save 134 Billion dinars $1 Billion.

The amount of electricity generated for the electric vehicle fleet will have a relative low cost for its implementation if the sources of generating electricity is renewable. In other words, the necessity for investing in the solar and wind resources will not only reduce the amount of fossils used for transport sector, but also to limit the CO_2 emissions.

6.2.2.2 Current fleet 2019

The current transport sector gathers around 7 million vehicles. Despite the fact that diesel vehicles hold almost one-third of the total current fleet, the required fuel contribute in two-third of the total fuel consumption.

The danger of diesel fuel appears in the type of ICE vehicles in Algeria, where automobiles release both greenhouse gases and most importantly the particles that enters the human respiratory system. In what follows, we will detail the impact of improving the ICE vehicles and how it can help to reduce the amount of toxic gases.

Meanwhile, the fleet hold around 300 000 converted units into LPG ones. It is expected that around 1 million units will be converted into LPG by 2030.

- The amount of Gasoline saved from the conversion operation and the gain obtained from the conversion are detailed in table 6.10 below:

Table 6.10 Calculation in amount and gain for LPG converted vehicles

Year	Number of converted vehicles	Quantity of Gasoline saved (ML)	Quantity of LPG necessary (ML)	Price of Gasoline (Billion Da)	Price of LPG (Billion Da)	Gain (Billion Dinars)
2021	91464	128,050	146,343	6,271	1,317	4,954
2022	182928	256,100	292,685	13,309	2,634	10,675
2023	274392	384,149	439,028	21,117	3,951	17,165
2024	365856	512,199	585,370	29,692	5,268	24,424
2025	457321	640,249	731,713	39,036	6,585	32,451
2026	548785	768,299	878,056	49,148	7,903	41,246
2027	640249	896,348	1024,398	60,028	9,220	50,809
2028	731713	1024,398	1170,741	71,677	10,537	61,140
2029	823177	1152,448	1317,083	84,094	11,854	72,240
2030	914641	1280,498	1463,426	97,279	13,171	84,109
Total		7042,74	8048,84			399,213

Comment:

The impressive results from the conversion of 1 million car confirm the important gasoline fuel saved along the ten next year with more than 5 million tons saved with 400 Billion dinars.

The cost of the conversion is around 70 000 to 80 000 DZD which leads to have a total cost of around 70 to 80 Billion dinars; 20% of total gain.

6.3 Environmental impact

The famous information about fossil energy is the amount of toxic gases released from their combustion. Indeed, these gases depends on the type of fuel, however, cars like BEV have zero-emissions in which will be our assumption for the next calculation of the reduced CO_2 emissions.(32)

6.3.1 Calculation of reduced CO2 emissions for model 20|30

a- Calculation method (26)

- **Gasoline**

The gasoline has approximate relation with octane C_8H_{18} when talking about the combustion products quantity. As a result, we consider the following reaction of octane as our reference for CO_2 emissions calculation:

$$C_8\,H_{18(g)} + \frac{25}{2}\,O_{2(g)} \rightarrow 8\,CO_{2(g)} + \,9\,H_2O_{(g)}$$

According to the reaction, 1 mole (114g) burned produces 8 moles of CO_2 (352g)

For 1L weights 0,75 Kg.

In order to find the amount of CO_2 emitted from the quantity of gasoline in our data, we apply the equation below, where 1L of gasoline produces 2.3 Kg.

$$Emitted\ CO_2\ (Mt) = 2.3 * 10^{-3} *\ quantity\ saved\ of\ Gasoline\ (ML)$$

- **Liquefied Petroleum Gas LPG**

The same procedure for LPG, with combustion equation is assimilated to propane and butane:

$$C_4\,H_{10(g)} + \frac{13}{2}\,O_{2(g)} \rightarrow 4\,CO_{2(g)} + \,5\,H_2O_{(g)}$$

$$C_3\,H_{8(g)} + 5\,O_{2(g)} \rightarrow 3\,CO_{2(g)} + \,4\,H_2O_{(g)}$$

- One mole of propane (44g) gives 3 moles of CO_2 (132g)
- 1L of propane weights 502g
- One mole of butane (58g) gives 4 moles of CO_2 (176g)
- 1L of butane weights 560g

We suppose that LPG composition is 80% propane and 20% butane hence we find that 1L of LPG produces 1.53 Kg of CO_2

$$Emitted\ CO_2\ (Mt) = 1.53 * 10^{-3}\ quantity\ saved\ of\ LPG\ (ML)$$

- **Compressed Natural Gas CNG**

The CNG is assimilated to methane, where the combustion reaction produces 3 moles of CO_2 as shown below:

$$CH_{4(g)} + 2O_{2(g)} \rightarrow \ CO_{2(g)} + \,2\,H_2O_{(g)}$$

The same method applied in the previous fuels, we find that

- One mole (16g) produces 44g of CO_2
- We consider that $1Nm^3 = 0.948\ m^3$ and CNG has a density of 0.79 Kg/Nm^3 hence:

$$Emitted\ CO_2\ (Mt) = 2.29 * 10^{-3}\ Amount\ of\ CNG\ (MNm^3)$$

b- Results and comments

- **Liquefied Petroleum Gas LPG**

Table 6.11 Reduction in emissions in LPG share

Year	total LPG vehicles	Gasoline Emissions (Mt)	LPG emissions (Mt)
2021	140682	0,456	0,344
2022	281363	0,912	0,688
2023	422045	1,368	1,032
2024	562726	1,824	1,376
2025	703408	2,281	1,720
2026	844089	2,737	2,064
2027	984771	3,193	2,408
2028	1125452	3,649	2,752
2029	1266134	4,105	3,095
2030	1406816	4,561	3,439
Total		25,086	18,917

Reduction	33%

- **Compressed Natural Gas CNG**

Table 6.12 Reduction in emissions in CNG share

Year	Total CNG vehicles	Gasoline Emissions (Mt)	NCG emissions (Mt)
2021	41015	0,133	0,113
2022	82029	0,266	0,226
2023	123044	0,399	0,338
2024	164058	0,532	0,451
2025	205073	0,665	0,564
2026	246087	0,798	0,677
2027	287102	0,931	0,790
2028	328116	1,064	0,902
2029	369131	1,197	1,015
2030	410145	1,330	1,128
Total		7,314	6,203
		Reduction	**18%**

6.3.2 Interpretation of results

6.4 Overview of the energy model

The results obtained from the suggested model confirms the important impact of switching into more ecofriendly energy resources for transportation in matter of consumption costs or CO_2 emissions. Therefore, the results for each case is summarized in the table below.

Table 6.13 Energy model 20|30 overview

Summary of 2020 - 2030 energy mix	LPG	Converted LPG	CNG	Electricity
Number of vehicles (units)	492174	914641	410145	328116
New fleet share %	12		10	8
Total fleet share %	13		4	3
Amount of petrol saved (ML)	3789,74	7042,74	3158,12	2526,49
Gain (billion DZD)	214,82	399,21	170,89	134,77
Reduction of CO2 emissions (%)	33		18	100

7 Chapter 7: Implementation overview

7.1 Electricity from renewables

The use of electricity in the future energy mix of 2030 model requires the implementation of power systems for electricity generation from renewables. In other words, RES will be part of the solution in balancing electricity supply with demand for transport sector in the next decade. The methodology used involves the construction of renewable power plants. (4)

In the previous calculation, we have found that the electricity consumed by the electric vehicles fleet is estimated around 3 TWh. Therefore, the following calculation explain the necessary installed capacity to meet the required energy demand.

In order to confirm the necessity to invest in renewables, specifically solar energy, we suppose that the needed electricity will be produced from solar energy using solar plants,(34) the calculated installed capacity and number of power plants are explained in the following calculation:

If we assume that:

- One solar panel with a surface of 2 m² with capacity of 300 Wp
- Average sunshine is: 3000h/Year
- Average annual electricity production for EV (Energy Model 2030): 0,3 TWh/year

$$Annual\ installed\ capacity\ (MW) = \frac{0.3}{3000} = 100\ MW$$

In addition,

$$1\ Solar\ Panel\ \rightarrow 300\ Wp$$

$$x\ Solar\ Panels\ \rightarrow 100\ MWp$$

$$Number\ of\ Solar\ panels = 330\ 000\ panels$$

Which leads to a total surface of: $S = 2 * number\ of\ panels = 66\ ha$

As a consequence, the 3 TWh requires:

- 10 solar power plants with capacity of 100 MW
- Total surface of 660 ha (0.001 % of total surface of Tamanrasset Wilaya!!)
- Similar 100MW power plant is Kazakhstan costs around $71 M. As a result, the $710M cost for 10 power plants represents around 3% of total gain from EV fleet.

Cost:

For one cubic meter burned of natural gas, we have 10kWh of electricity produced

Hence, for the 3 TWh, we have 0.3 bcm of natural gas that will be saved if we implement the solar power plants instead of burning natural gas.

7.2 Model implementation

7.2.1 Vehicles conversion

7.2.1.1 Petrol to LPG

The conversion of gasoline-to-LPG vehicles has already existed in Algeria. the estimated converted vehicles for 2030 should pass 1 million units which means that more service-stations and sales point for LPG would necessarily increase specifically in the southern. The LPG conversion system below is among the existed systems that offers rapid operation, in less than one hour.

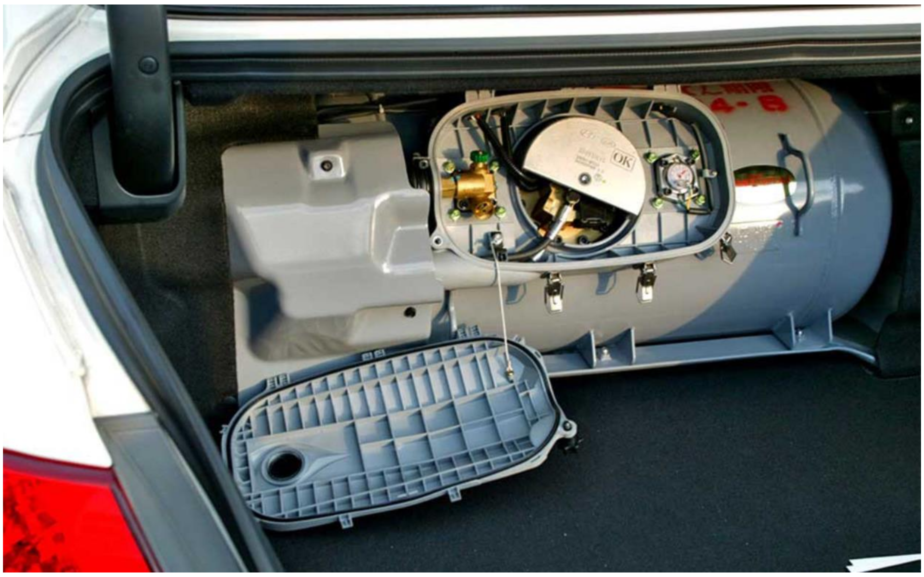


Figure 7.1 LPG conversion systems – Ecoge workshopl, Batna Wilaya, Algeria

7.2.1.2 CNG

The appropriate use of CNG will be in hybrid vehicles equipped with important tank storage capacity, the case heavy trucks such as tractors in agriculture, where plant waste can be a good source for biogas production which can be injected in the fuel vehicle.

7.2.2 Electric vehicles (3)

7.2.2.1 The cost

The essential factor limiting the consumer to by an electric car is its price. In fact, the total price for having an electric car is higher than for a conventional car. In most cases, this price difference outweighs the appreciably lower fuel and maintenance costs for an electric car.

Many countries around the world have made a series of actions to surpass the barriers in front the electric vehicle market development and to accelerate the transition to electric mobility.

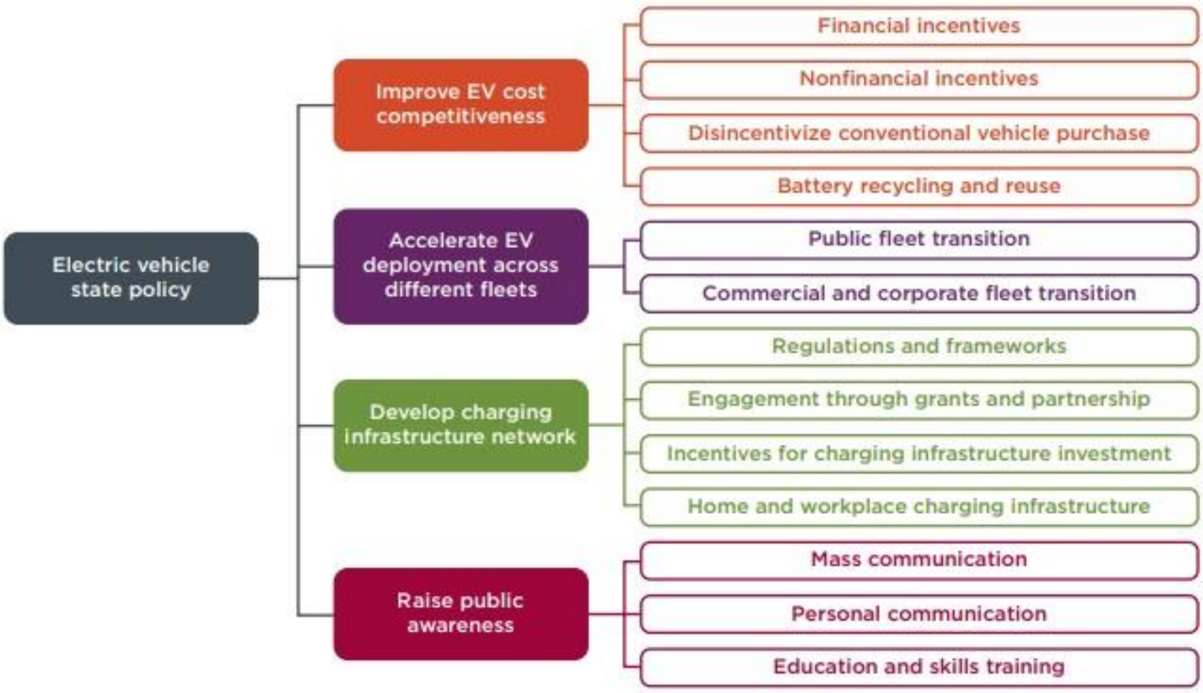


Figure 7.2 Strategies to address electric vehicle market barrier

7.2.2.2 Improve EV cost competitiveness

Governments have taken measures to make them more cost-competitive and suitable to consumers. These measures include providing financial and nonfinancial incentives, dis-incentivizing conventional vehicles (Table 7.1).

Table 7.1 Summary of strategies to improve EV cost competitiveness

Strategies	Policy Actions
Financial incentives	Provide purchase subsidies for electric vehicles
	Provide discounts on road tax, registration fees.
	Exempt parking fees.
	Subsidize and regulate fees for electric vehicle charging.
Nonfinancial incentives	Provide designated parking
Disincentivize conventional vehicle purchase	Introduce fossil fuel tax
	Increase road tax and registration fee for conventional vehicles
Battery recycling and reuse	Incentivize end-of-life recycling

7.2.2.3 Accelerate EV deployment across different fleets

Facilities for electric vehicle procurement by fleets through mandatory transition requirements or by taking market-driven approaches to encourage fleet transition (Table 7.2).

Table 7.2 Summary of strategies to accelerate EV development across different fleets

Strategies	Policy Actions
Public fleet transition	
	Develop government procurement guidelines
	Create detailed public fleet operation plans
Commercial and corporate fleet transition	
	Provide financing schemes targeting commercial vehicle/fleet owners
	Coordinate financing of operations

7.2.2.4 Develop charging infrastructure network

The improvement of the charging infrastructure network will encourage more charging options, and consequently enable electric vehicle drivers to take longer trips. The promotion of public charging stations is a mandatory act that should be taken by governments and also facilitate the availability of means for charging vehicles at home. (Table 7.3).

Table 7.3 Summary of strategies to develop charging infrastructure network

Strategies	Policy Actions
Regulations and frameworks	Unify charger standards
	Streamline the permitting and inspection process
Engagement through grants and partnerships	Install fast-charging stations along highways
	Install charging stations in public transit hubs, airports, and train stations
	Install charging infrastructure for electric buses, and taxis
Home and workplace charging infrastructure	Provide a home charger subsidy
	Construct charging stations in government offices
	Support curbside charging infrastructure

7.2.2.5 Raise public awareness

Electric vehicles users should get the essential information related to EV uses and charging methods. The awareness strategy made by governments should stand on three categories: mass communication, personal communication, and education (Table 7.4).

Table 7.4 Summary of strategies to raise public awareness

Strategies	Policy Actions
Mass communication	Create an outreach campaign
	Display convenient EV-related guide
	Display information on social media and create websites dedicated for EV users.
Personal communication	
	Showcase ride-and-drive events
Education and skill training	Develop an electric mobility vocational training program
	Introduce electric mobility for children and youth

7.2.3 Electric Vehicle Charging (38)

The connections to electric vehicle charging equipment, is known by to as Electric Vehicle Supply Equipment (EVSE). This system communicates with the vehicle and monitors electrical activity to ensure safe charging. While the actual “charger” is contained in the vehicle, the appliance referred to as a charging station or EVSE is the conduit, control, and monitoring device which connect the vehicle to the electric grid (33)

The charging power of EVSE is based on 3 levels: Level 1, Level 2 and DC Fast Charging. The amount of range provided for each of these is shown in Figure 1.3 below with additional details in the next table.

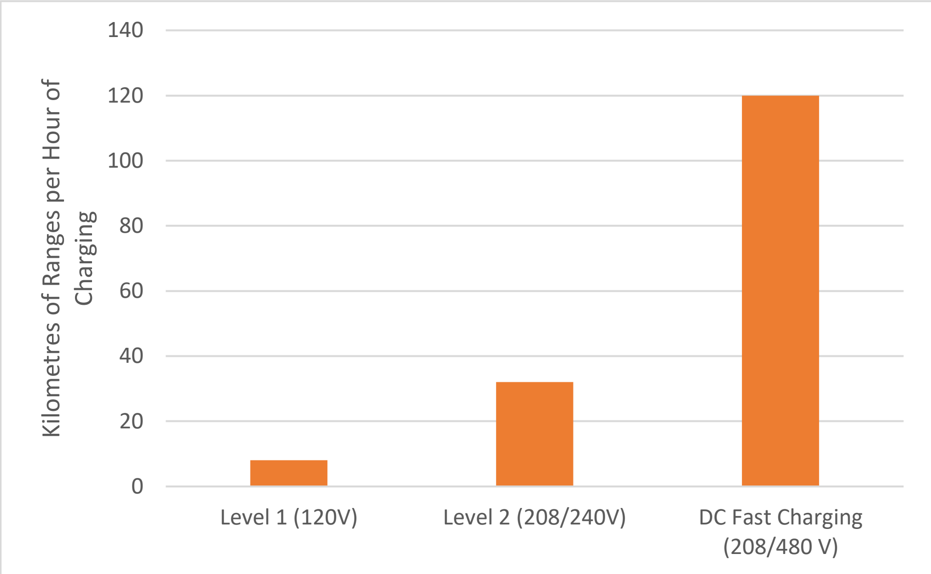


Figure 7.3 Charging Range Added per Hour of Charging

Information described in the electric vehicles charging stations guidebook are summarized in the Table 7.5.

Table 7.5 Charging Range Added per Hour of Charging (20)

	Level 1 (120V)	Level 2 (208/240V)	DC Fast Charging
Typical Duration of Charge Event	6-10 hours	1-3 hours	30 minutes
Range per hour of charging	8 km	16-32 km	120+ miles
Desirable Characteristics	▪ Workplaces ▪ Lit, safe area	▪ Shopping, dining, restrooms etc. ▪ Transit service ▪ Pedestrian facilities ▪ Lit, safe area	▪ Amenities at the charging site (food, coffee, Wi-Fi) Lit, safe area

Priority Locations	▪ Employee parking areas ▪ Long term customer/visitor parking ▪ Park and ride lots	▪ Municipal or private parking lots in downtowns, village centers, growth centers or shopping centers.	▪ Near high volume roadway access points

7.2.4 EVSE Installation Costs (38)

Costs of EVSE installation depend on site features and the quantity and type of EVSE being installed. The cost is also influenced by the competition of vehicles.

The installation can include the following items:

- Power connection to the electric grid, including any electric circuit components and conduit runs necessary to reach the equipment;
- Protective devices, such as bollards or wheel stops
- Wayfinding signage, parking lot lines and stripes
- Lightning

Table 7.6 provides estimates of per unit costs for charging equipment.

Table 7.6 EVSE Infrastructure Costs

	Level 1 AC – 1.4 kW	Level 2 AC – 3.3-6.6 kW	DC Fast Charging +250 kW
Equipment Price	$30-900	$600 - 9,000	$15,000 – 60,000
Installation	$200-450	$2,000-12,000	$10,000 - 25,000
TOTAL	$230-1,350	$2,600-21,000	$25,000 – 85,000

7.3 Building support towards energy efficiency

7.3.1.1 Reform Fossil fuels subsidies

The policy of fossil fuels subsidies represents the benefits given to producers or consumers of fossils fuels in order to maintain a suitable price for different society classes. However, among the disadvantages of this policy:

- Encouraging the investment in the oil industry, therefore, more production and consumption of fossils.
- The climate change dilemma still present with more emissions of GHG resulted from fossils combustion in all sectors.
- The subsidy also causes misuse of subsidized fuels and their excessive consumption, will absorb the efforts made to achieve energy efficiency.
- Other remarkable effect of this policy is the proven benefits for both rich and poor class. For instance, the price of energy is available to those who can afford it at low prices so they will not make attention to the amount of energy wasted in their energy consumption. The case appears in owners of large factories as they enjoy, of spending support funds other than the purposes intended for it.

7.4 Electro-mobility solutions to Improve transport sector network

The world will switch in couple of decades into electrification or known as green energy. The fourth industrial revolution with the encouragement of investment will stimulate the desire to create smart grids, green cities that should for sure limit or to be more optimistic, cut the CO_2 emissions.

The previous suggestions for different types of vehicles, their services stations and conversion workshops implementation will be mainly installed in the big cities according to data (appendix 2).

General Conclusion – towards sustainability

In the presented work we propose a framework aiming at improving the situation of energy in the transport sector by applying a new policy in the form of a sustainable model for Algeria by 2030. Initially, we have dealt with the global energy situation in the world in which we have shown the increased energy demand that went along with climate change crisis over the past years. Furthermore, our main interest has focused on the policy of energy consumption applied in the case of transport sector and the main available sources to fulfill the energy need.

In the same procedure, we have stated the potential that our country holds, not only in fossils energy but also in renewables and the challenges that comes within the use of non-renewables sources. Such as the depletion of Oil and Natural Gas by 2050 and the consequential problems that will come later. To illustrate this problem, we have made our study on the Algerian transport sector and point out the challenges and available opportunities to rearrange the policy of transport in Algeria.

Our suggested energy model will allow us to gradually quit the use of fossil fuels in the transport sector in Algeria as far as green energy takes its place in the energy mix by 2030. In reality, green energy in our sustainable model encourages the use of eco-fuels such as GNV, LPG that have lower carbon dioxide emissions in comparison to petrol and diesel fuel. This latter remains as the most dangerous fuel for human health.

The main intention goes to electro-mobility. In our opinions, the future belongs to the use of electric vehicles with the fact that electricity required for their use will be basically from renewables such as solar and wind power.

We have focused in our model on creating a new energy mix that consists on having a contribution of three different energy sources: CNG, LPG, and electricity for our vehicle fleet. In addition, we are encouraging the cut off importation of diesel vehicles for their environmental impact.

The evaluation of the model has shown the important amount of gasoline that might be saved if we replace it with previous sources mentioned above. As a result, fossils fuels such as oil will remain for other noble uses, for instance: petrochemicals industry. Moreover, the availability of LPG and CNG with their relative low price comparing to gasoline will encourage their use and hence the implementation of service stations and conversion workshops on the Algerian territory is primordial to allow Algerian to use these fuels.

With the exception from conventional power plant, electricity can be produced from clean, free and renewable source: the sun. Our suggestion in this framework is to adopt an implementation project of 10 solar plants in the Algerian Sahara, to cover the need of EV fleet.

The switch to electricity is an important step that has been made by many countries around the world such as China, Germany and Norway etc. over the past recent decades. This step has improved the positive impact on the environment where:

- More quiet, efficient and no polluting vehicles are in road

- The notion of smart cities has really emerged in the past decade, with improvement of energy efficiency in their daily life.
- The invasion of technology has accelerated the pace of electro-mobility development in the transport sector.

Nowadays, many countries around the world are encouraging the use of public transports such as eco-buses, high speed trains and bicycles in order to reduce the use of cars for short-distance travels.

To sum up, we can say that our sustainable model may take place if government and citizens worked together. The change may seem hard at the beginning, but public awareness should take the lead to convince the citizens of the importance to switch to renewables and electrification. In addition, government should take an important step to encourage the use of green energy, by making subsidies conventions for LPG and CNG fuels use, and maintain a higher price for diesel fuel. Within the next five years, we estimate that diesel fuel should surpass gasoline price while CNG and LPG maintain their current price.

Our sustainable energy model is the fruit of efforts made by our ancient colleagues of the chemical engineer department with different suggested energy model in 2030.

The last but not the least, we encourage the development of the Algerian desert, with improving means of transportation that links northern region with southern region. The solution proposed is to implement a railway system that links Medea state to Timimoun city in Adrar, passing by two other Wilayass: Laghouat, Djelfa and Ghardaia. In addition to the existing railways, the infrastructure will guarantee the linkage between southern and northern cities and hence the development of the Sahara can be achieved in the near future.

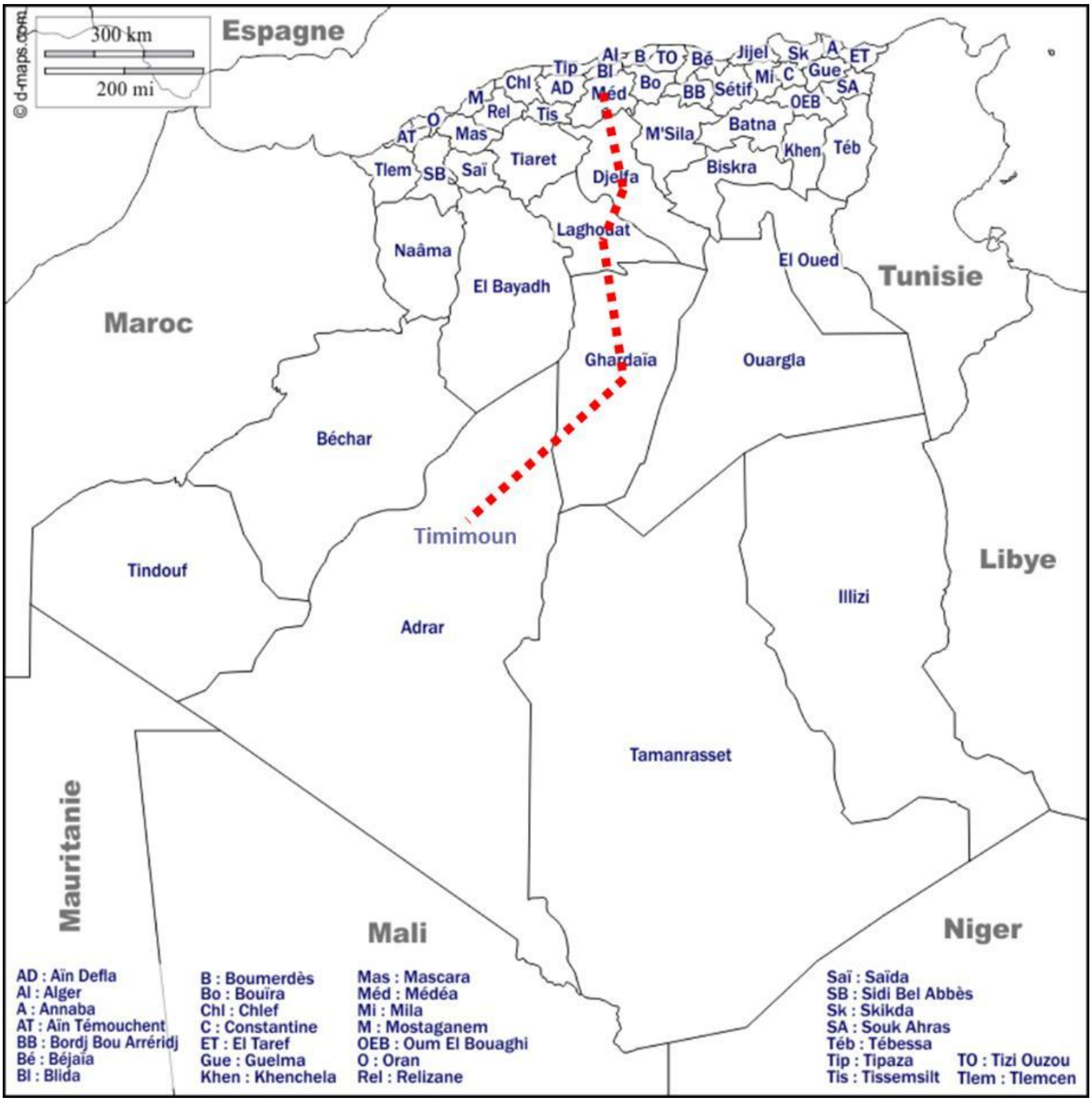


Figure 7.4 Railway suggested that links Medea to Ghardaia

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Appendix 1
Units

Unites

Power symbol	
cal	calories
toe	tons oil equivalent
TWh	TeraWatt hour
GWh	GigaWatt hour
TW	TeraWatt
Wp	Watt-peak

Mass symbol	
g	gramme
T	tons
b/d	barrel per day

Volume symbol	
bcm	Billion cubic meter
L	Liter
Nm^3	Normal cubic meter

Surface symbol	
m^2	Square meter
ha	Hectare

Length symbol	
m	meter

Temperature symbol	
°C	Celsius
°F	Fahrenheit

Conversion	
k	Thousand
m	Million
b	Billions

Appendix 2

Key government policy measures and targets to advance deployment of electric light duty vehicles

(inspired from EV outlook 2019)

Country/ region	Key policy measures and targets*	Announced (year)	Source
Asia			
China (EV30@30 signatory)[a]	Target of 5 million EVs by 2020 (including 4.6 million PLDVs).	2012	Government of China (2012)
	New electric vehicle (NEV)[b] mandate: 12% NEV credit sales in passenger cars by 2020.[c]	2016	Government of China (2018)
	Roadmap for NEV sales share: 7-10% by 2020, 15-20% by 2025 and 40-50% by 2030.	2017	Marklines (2017)
	***Proposal for tightened fuel economy standard (4 L/100 km** [NEDC] **by 2025)**.* (Current fuel economy standard until 2020).	2019	Government of China (2019)
India	Target of 30% EV sales by 2030 across all modes.	2018	Government of India (2018)
	Public procurement from EESL (target 500 000 vehicles, implementation delayed).	2018	
	CO_2 emissions standard of 113 g CO_2/km in 2022.	2015	Ministry of Power of India (2015)
Indonesia	***2 200 EVs in PLDVs by 2025.***	2019	Market Research Indonesia (2019)
Japan (EV30@30 signatory)	Target of 20-30% BEV and PHEV sales in PLDVs by 2030 (in addition to 40% HEVs and 3% FCEVs).	2014	Government of Japan (2014) and Government of Japan (2018)
	Long-term goal ("by the end of 2050") of a reduction of 80% of GHG emissions per vehicle produced by Japanese automakers.	2018	Government of Japan (2018)
	Fuel economy target of 19.7% reduction in specific fuel consumption by 2020 compared to 2009 and an additonal 23.8% between 2020 and 2030.	2011 and 2019	ECCJ (2011) and Government of Japan (2019a)
Korea	***Targets of 430 000 BEVs and 67 000 FCEVs on the road by 2022.***	2019	Government of Korea (2019)
	Subsides and rebates on national and local vehicle acquisition taxes, reduced highway toll fees and public parking fees.	2018	Korean Environment Corporation (2019)

Country/ region	Key policy measures and targets*	Announced (year)	Source
Thailand	***Target of 1.2 million EVs by 2036.***	2016	Harman (2018)
Malaysia	***Target of 100 000 passenger LDV stock in 2030.***	2017	Government of Malaysia (2017)
Europe[d]			
European Union	***Emission standards for g CO_2/km of LDVs, requiring 15% reduction between 2021 and 2025 and 37.5% (30% for vans) by 2030, including incentives attached to 15% and 35% zero- and low-emissions vehicle shares.***	2019	European Council (2019a)
	Revision of the Clean Vehicles Directive on public procurement, including minimum requirements of 17.6% in 2025 and 38.5% in 2030.	2018	European Parliament (2019a)
Denmark	***Target of 1 million electrified vehicles stock in PLDVs by 2030.***	2018	Government of Denmark (2018)
Finland (EV30@30 signatory)	Target of 250 000 EV stock in PLDVs by 2030.	2016	Government of Finland (2017)
France (EV30@30 signatory)	Ban on the sales of new cars emitting GHG in 2040.	2017	Government of France (2017)
	Multiply by five the sales of BEVs in 2022 compared to 2017.	2018	Government of France (2018)
	Reach a fleet of 1 million BEVs and PHEVs in 2022.	2018	
Ireland	Target of 500 000 EVs in passenger LDVs by 2030.	2018	Government of Ireland (2018)
Netherlands (EV30@30 signatory)	Target of 100% ZEV sales in PLDVs by 2030.	2017	Kabinetsformatie (2017)
Norway	100% EV sales in PLDVs and LCVs by 2025.	2016	Government of Norway (2016)
Poland	***1 million EVs in PLDVs by 2025.***	2016	Government of Poland (2016)
Slovenia	Targets of: - 100% EV sales in PLDVs by 2030 - 17% EV stock in PLDV by 2030.	2017	Novak (2017)
Spain	***Targets of:*** ***-5 million EVs in LDVs, buses and two/ three-wheelers.*** ***-100% ZEVs sales in PLDVs by 2040.***	2019	Government of Spain (2019)
Sweden (EV30@30 signatory)	Targets of: -Reduction of CO_2 emissions from transport by 70% in 2030 compared to 2010. -Net zero GHG emissions by 2045.	2017	Government of Sweden (2017)
United Kingdom	Target of 50-70% EV sales in PLDVs by 2030.	2018	Government of the UK (2018)

Country/ region	Key policy measures and targets*	Announced (year)	Source
(EV30@30 signatory)	Ban sales of new ICE cars from 2040.	2018	Government of the UK (2017)
Other European Union[e]	Targets of: - 370 000 to 680 000 electric cars by 2020. - 4.4 million to 5.24 million electric cars by 2030.	2017	EC (2017a)
North America			
Canada (EV30@30 signatory)	***Targets of:*** ***- 10% ZEV sales in PLDVs from 2025***. ***- 30% ZEV sales in PLDVs from 2030***. ***- 100% ZEV sales in PLDVs from 2040.***	2019	Government of Canada (2019)
	Annual reduction of CO_2 emissions per kilometre of 5% from 2017 to 2025 for PLDVs and 3.5% from 2017 to 2021 and 5% from 2022 to 2025 for light trucks.	2012	Government of Canada (2012)
United States (selected states)	Targets of: - 3.3 million EVs in eight states combined by 2025.[f]	2014	ZEV Program Implementation Task Force (PITF) (2014)
	- ZEV[g] mandate in ten states[h]: 22% ZEV credit sales in passenger cars and light-duty trucks by 2025.[i]	2016	ZEV PITF (2014)
	- California: 1.5 million ZEVs and 15% of effective sales by 2025, and 5 million ZEVs by 2030.	2016	State of California (2018; 2016) CARB (2016)
Other countries			
Costa Rica	***Target of 37 000 EVs stock in PLDVs by 2023.***	2017	Government of Costa Rica (2017)
Chile	***40% EVs in PLDVs by 2050.***	2018	Government of Chile (2018)
Israel[3]	***Targets of:*** ***- 177 000 EV stock in PLDVs by 2025.*** ***- 1.5 million EV stock in PLDVs by 2030.***	2018	Government of Israel (2018)
New Zealand	Target of 64 000 EVs stock in PLDV by 2021.	2016	Government of New Zealand (2016)

OEM announcements related to electric cars

Original equipment manufacturer	Announcement
BMW	15-25% of the BMW Group's sales in 2025 and 25 new EV models by 2025.
BJEV-BAIC	0.5 million electric car sales in 2020 and ***1.3 million electric car sales in 2025***.
BYD	0.6 million electric car sales in 2020.
Chonquing Changan	***21 new BEV models and 12 new PHEV models by 2025, 1.7 million sales by 2025 (100% of group's sales)***.
Dongfeng Motor CO	6 new EV models by 2020 and 30% electric sales share in 2022.
FCA	***28 new EV models by 2022.***
Ford	40 new EV models by 2022.
Geely	1 million sales and 90% of sales in 2020.
GM	20 new EV models by 2023.
Honda	15% electric vehicle sale share in 2030 (part of two-thirds of electrified vehicles by 2030, globally and by 2025 in Europe).
Hyundai-Kia	12 new EV models by 2020.
Mahindra & Mahindra	0.036 million electric car sales in 2020.
Mazda	One new EV model in 2020 and 5% of Mazda sales to be fully electric by 2030.
Mercedes-Benz	0.1 million sales in 2020, ***10 new EV models by 2022 and 25% of the group's sales in 2025.***
Other Chinese OEMs	7 million sales in 2020.
PSA	0.9 million sales in 2022.
Renault-Nissan-Mitsubishi	12 new EV models by 2022. Renault plans 20% of the group's sales in 2022 to be fully electric. Infiniti plans to have all models electric by 2021.
Maruti Suzuki	A new EV models in 2020, ***35 000 electric car sales in 2021*** up to ***1.5 million in 2030.***
Tesla	Around 0.5 million sales in 2019 and a new EV model in 2030.

D

Appendix 3
Naftal Consumption fuels Database

SOCIETE NATIONALE DE COMMERCIALISATION ET DE DISTRIBUTION DE PRODUITS PETROLIERS

NAFTAL spa au capital social de 40 000 000 000 DA, filiale SONATRACH



Consommation Carburants du Réseau Stations-Service NAFTAL

Par Wilaya

2007 – 2019




RECAP : EVOLUTION CONSOMMATION CBR / GPLC et NOMBRE DE STATIONS-SERVICE TOUT PRODUITS /GPL-C

2007 - 2019

UM : - CBR (M3)
- GPLC (TM)
- NBR S/S (UNITE)

WILAYA	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019	2019 / 2007
CBR	6 915 531	7 710 303	8 458 125	10 805 404	11 958 258	13 235 894	14 046 103	14 548 901	15 260 912	14 430 768	13 932 620	13 622 049	13 805 797	5,9%
GPL-C	304 502	307 892	307 639	309 201	320 354	286 496	286 530	270 913	252 154	306 033	410 494	558 022	724 951	7,5%
NBR S/S GPLC	396	426	442	462	481	500	525	549	604	633	676	755	803	6,1%
NBR S/S T-PROD	1 933	1 965	2 010	2 038	2 076	2 107	2 135	2 186	2 213	2 261	2 316	2 450	2 594	2,5%

EVOLUTION DE LA CONSOMMATION CARBURANTS TERRE DU RESEAU STATIONS-SERVICE

2007 - 2019

UM : M3

ORI	WILAYA	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019	2019/2007	2019/2015
1	ADRAR	40 768	56 552	80 532	121 312	140 290	160 111	137 123,74	162 168	173 531	176 276	187 637	232 098	269 779	17,1%	12%
2	CHLEF	175 134	182 446	206 528	251 969	285 487	298 749	322 283,07	347 221	368 885	377 740	361 512	346 792	349 193	5,9%	-1%
3	LAGHOUAT	63 959	73 689	93 280	115 838	130 546	146 556	170 319,94	185 188	192 962	186 407	178 454	172 983	169 109	8,4%	-3%
4	O.E.BOUAG	149 748	171 866	216 108	257 031	337 275	373 882	379 510,54	353 963	368 459	347 918	306 069	292 356	276 360	5,2%	-7%
5	BATNA	198 966	217 033	245 254	351 140	394 965	438 606	475 707,37	492 581	529 645	491 244	460 607	443 744	417 943	6,4%	-6%
6	BEJAIA	219 533	244 453	276 708	355 679	379 660	419 561	451 942,17	479 023	514 451	497 663	481 259	460 404	450 959	6,2%	-3%
7	BISKRA	193 391	203 181	225 120	295 050	333 672	361 609	419 665,47	450 983	396 996	348 384	315 961	309 559	290 902	3,5%	-7%
8	BECHAR	48 892	51 625	54 531	78 891	91 428	102 098	115 707,48	125 666	139 674	125 103	120 862	114 390	111 456	7,1%	-5%
9	BLIDA	326 334	351 489	383 009	447 669	482 979	521 547	562 560,07	586 384	546 228	506 311	514 752	509 192	554 452	4,5%	0%
10	BOUIRA	127 156	138 389	161 447	204 081	231 246	257 699	293 976,48	338 726	372 667	403 279	413 712	393 650	366 005	9,2%	0%
11	TAMANRAS	35 638	41 702	44 092	115 560	141 690	152 645	160 076,70	170 576	162 583	152 261	172 456	191 574	213 169	16,1%	7%
12	TEBESSA	171 679	240 603	281 568	335 011	291 270	291 241	272 004,42	299 975	326 695	339 496	439 112	456 368	478 346	8,9%	10%
13	TLEMCEN	429 153	476 265	469 441	611 108	636 378	648 942	467 186,49	464 884	500 969	323 496	304 982	293 079	302 825	-2,9%	-12%
14	TIARET	107 373	115 606	136 603	165 530	183 627	207 024	241 198,20	267 194	278 262	262 556	240 483	248 739	243 972	7,1%	-3%
15	TIZI-OUZOU	254 051	270 720	296 869	346 263	372 155	398 173	425 984,40	457 112	495 364	479 602	466 961	450 073	449 317	4,9%	-2%
16	ALGER	627 461	660 855	637 217	890 628	965 714	1 032 652	1 070 632,61	1 100 449	1 254 668	1 228 025	1 148 043	1 159 856	1 163 124	5,3%	-2%
17	DJELFA	125 211	132 139	133 740	164 211	183 705	217 977	245 901,94	277 006	292 371	276 273	260 691	259 796	261 365	6,3%	-3%
18	JIJEL	73 852	82 444	82 593	147 392	158 535	172 922	185 106,08	201 180	207 251	209 011	210 886	213 258	215 334	9,3%	1%
19	SETIF	377 622	408 360	458 781	571 255	611 646	704 637	740 549,05	766 314	791 245	765 587	676 506	627 866	649 962	4,6%	-5%
20	SAIDA	44 848	43 206	55 354	88 673	98 214	112 864	122 234,54	129 901	138 335	132 267	117 092	103 288	103 319	7,2%	-7%
21	SKIKDA	113 425	124 221	137 279	181 743	202 701	226 481	246 681,54	258 574	277 420	275 001	252 600	243 332	241 453	6,5%	-3%
22	S.B.ABBES	80 002	103 593	120 687	140 977	174 524	209 721	262 675,09	225 905	244 212	203 828	193 162	188 309	191 231	7,5%	-6%
23	ANNABA	147 622	163 278	171 421	199 807	220 754	249 724	274 996,39	283 180	296 719	283 848	273 089	265 073	243 893	4,3%	-5%
24	GUELMA	82 829	93 637	110 000	142 960	176 484	200 636	211 407,53	200 040	208 239	202 918	181 931	173 399	165 219	5,9%	-6%
25	CONSTANT	173 331	189 490	203 208	305 214	331 854	362 592	373 670,60	381 552	399 021	373 996	354 763	326 443	324 367	5,4%	-5%

EVOLUTION DE LA CONSOMMATION CARBURANTS TERRE DU RESEAU STATIONS-SERVICE
2007 - 2019

UM : M3

ORI	WILAYA	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019	2019/2007	2019/2015
26	MEDEA	154 635	169 628	168 086	197 471	225 324	240 748	268 838,47	278 024	299 496	285 860	262 435	243 860	245 411	3,9%	-5%
27	MOSTAGHA	104 441	120 537	147 149	185 683	197 318	181 594	237 117,32	217 266	231 007	204 874	222 940	226 975	233 859	6,9%	0%
28	M'SILA	199 853	244 409	293 253	308 121	341 682	376 100	404 732,04	436 029	434 921	413 997	392 571	396 718	408 429	6,1%	-2%
29	MASCARA	58 195	66 674	79 558	117 042	135 338	150 365	161 984,23	158 096	198 556	182 172	170 853	165 796	173 115	9,5%	-3%
30	OUARGLA	117 182	123 754	141 883	231 313	253 963	276 526	289 950,87	299 795	275 551	261 556	252 690	249 175	264 680	7,0%	-1%
31	ORAN	216 840	230 370	245 581	298 735	335 530	376 304	388 738,16	388 771	436 542	405 753	396 997	369 150	391 366	5,0%	-3%
32	EL BAYADH	38 155	33 123	39 674	56 634	63 288	71 856	82 181,32	85 804	95 106	96 371	92 647	91 540	96 899	8,1%	0%
33	ILLIZI	6 313	358	3 321	40 316	45 604	47 733	51 039,04	56 652	56 161	51 537	53 146	62 487	71 014	22,3%	6%
34	B.B.ARRERI	172 881	206 868	240 935	227 771	256 234	269 532	352 165,05	397 180	421 725	415 589	401 000	382 758	390 287	7,0%	-2%
35	BOUMERDE	290 705	318 573	336 201	343 645	389 652	414 496	434 725,26	430 355	461 254	474 305	470 101	471 587	477 879	4,2%	1%
36	EL TAREF	81 632	101 271	107 849	136 139	176 160	211 556	213 743,03	231 689	230 095	218 392	212 725	232 218	241 166	9,4%	1%
37	TINDOUF	12 213	13 000	19 035	42 117	46 494	58 014	60 810,76	49 071	54 144	57 542	52 091	65 465	67 810	15,4%	6%
38	TISSEMSSI	19 622	22 678	41 465	47 122	48 245	54 433	62 442,36	65 028	75 224	70 524	60 977	63 845	63 364	10,3%	-4%
39	EL OUED	135 516	157 963	176 038	219 082	222 732	290 926	270 963,18	282 345	252 352	236 229	250 599	262 214	277 136	6,1%	2%
40	KHENCHEL	60 622	88 096	112 074	146 426	178 394	215 524	245 182,43	196 792	183 511	163 654	137 304	117 982	119 240	5,8%	-10%
41	SOUK AHRI	74 684	93 961	110 166	139 720	147 818	162 837	179 702,69	177 349	184 494	168 148	148 708	160 586	180 013	7,6%	-1%
42	TIPAZA	117 442	124 661	127 661	236 916	257 124	281 434	295 493,86	323 500	299 881	290 825	343 123	327 197	322 803	8,8%	2%
43	MILA	180 767	193 012	218 657	231 055	258 748	281 309	323 776,80	359 249	396 530	398 805	361 083	309 659	295 192	4,2%	-7%
44	AIN DEFLA	129 606	151 067	119 624	190 039	219 277	236 701	295 455,12	321 378	341 196	338 851	341 742	307 196	318 512	7,8%	-2%
45	NAAMA	32 255	34 786	34 693	60 867	67 630	75 766	85 075,90	99 757	99 825	90 801	85 249	83 962	85 261	8,4%	-4%
46	A/TEMOUCI	117 167	137 638	152 097	141 555	188 150	262 813	247 455,90	204 530	230 749	141 715	123 191	110 648	114 458	-0,2%	-16%
47	GHARDAIA	91 682	108 318	131 504	155 542	162 209	173 665	181 567,60	179 551	197 993	197 149	183 244	167 493	188 886	6,2%	-1%
48	RELIZANE	115 146	132 715	130 250	167 098	184 542	257 015	283 859,90	304 945	327 749	297 631	283 620	277 915	275 963	7,6%	-4%
NATIONAL		6 915 531	7 710 303	8 458 125	10 805 404	11 958 258	13 235 894	14 046 103	14 548 901	15 260 912	14 430 768	13 932 620	13 622 049	13 805 797	5,9%	-2%

EVOLUTION DE LA CONSOMMATION GPL-C DU RESEAU STATIONS-SERVICE

2007 - 2019

UM : TM

ORI	WILAYA	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019	2019/2007	2019/2015
1	ADRAR	897	408	251	306	369	320	161,12	214	198	686	1 387	2 478	3 304	11%	102%
2	CHLEF	4 868	4 379	4 724	4 595	4 230	4 345	4 249,01	3 899	3 936	5 224	7 012	9 667	12 305	8%	33%
3	LAGHOUAT	2 474	2 264	2 549	2 330	2 374	2 489	2 026,72	2 697	2 520	3 410	6 266	9 384	11 972	14%	48%
4	O.E.BOUAG	11 491	6 111	7 751	6 816	8 706	8 816	7 622,46	6 663	6 112	8 109	10 861	14 633	16 656	3%	28%
5	BATNA	11 919	11 551	10 952	10 755	10 782	10 536	10 418,74	10 318	10 612	13 770	17 596	25 250	30 344	8%	30%
6	BEJAIA	4 117	4 154	4 042	3 778	3 424	3 244	2 652,65	2 283	1 884	2 545	2 945	3 924	7 057	5%	39%
7	BISKRA	6 530	6 568	7 003	6 428	6 899	6 290	6 615,46	6 345	5 849	7 405	9 459	12 915	15 799	8%	28%
8	BECHAR	4 524	4 090	3 048	2 940	2 439	2 120	2 185,09	1 709	1 304	1 877	3 058	5 027	7 161	4%	53%
9	BLIDA	7 825	10 577	10 464	10 743	12 873	9 935	9 716,97	7 445	6 409	7 416	11 259	13 548	19 015	8%	31%
10	BOUIRA	7 547	7 933	7 912	8 139	8 402	8 264	8 060,97	7 996	7 675	10 466	15 343	21 915	25 883	11%	36%
11	TAMANRAS	-	-	-	-	-	-	-	-	-	-	-	-	-		
12	TEBESSA	3 381	3 530	4 402	5 609	5 465	4 944	5 822,05	7 338	6 795	8 067	9 846	12 819	18 206	15%	28%
13	TLEMCEN	24 458	25 299	24 403	28 706	29 730	13 873	24 665,14	25 630	26 890	22 210	28 070	34 628	37 538	4%	9%
14	TIARET	9 565	10 444	9 726	9 279	9 683	10 443	10 062,58	9 086	9 311	12 286	15 123	21 759	30 955	10%	35%
15	TIZI-OUZOU	8 495	7 695	7 827	7 502	7 413	6 152	6 498,86	5 888	5 604	5 981	7 861	11 114	14 274	4%	26%
16	ALGER	25 373	27 770	26 333	25 756	25 297	25 200	22 680,18	18 734	15 676	18 942	26 209	18 805	40 916	4%	27%
17	DJELFA	11 116	11 477	11 662	12 302	12 578	13 484	12 101,49	11 017	8 365	10 240	16 258	26 416	36 156	10%	44%
18	JIJEL	1 883	1 901	2 266	1 748	1 796	1 512	1 454,32	1 137	1 020	1 353	1 806	2 625	4 017	7%	41%
19	SETIF	14 258	14 487	14 500	15 374	16 362	16 726	15 866,61	13 121	13 268	17 256	20 333	29 082	35 454	8%	28%
20	SAIDA	8 111	7 567	7 659	7 608	7 548	7 277	7 383,96	6 673	6 500	8 834	11 795	14 077	15 550	6%	24%
21	SKIKDA	4 070	4 138	3 584	2 312	2 516	2 816	2 653,20	2 406	1 908	2 556	3 851	6 218	8 913	7%	47%
22	S.B.ABBES	9 914	9 894	8 817	7 296	7 876	7 325	7 169,84	5 238	4 954	6 409	8 537	11 583	15 332	4%	33%
23	ANNABA	5 003	6 257	6 559	6 243	5 984	4 926	4 849,50	4 341	3 996	5 568	9 889	12 818	16 079	10%	42%
24	GUELMA	4 543	5 825	5 861	5 431	5 397	4 478	3 816,53	3 544	3 072	3 418	3 899	5 448	6 955	4%	23%
25	CONSTANT	11 757	12 458	10 654	10 410	10 817	10 043	9 194,97	8 018	7 761	10 134	15 140	20 478	26 758	7%	36%

EVOLUTION DE LA CONSOMMATION GPL-C DU RESEAU STATIONS-SERVICE

2007 - 2019

UM : TM

ORI	WILAYA	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019	2019/2007	2019/2015
26	MEDEA	7 146	8 155	7 144	7 820	8 970	8 420	8 249,98	8 987	7 545	9 403	12 582	16 873	23 040	10%	32%
27	MOSTAGHA	5 465	6 136	5 500	5 661	4 519	3 287	2 603,36	2 009	1 872	2 563	4 019	7 544	8 176	3%	45%
28	M'SILA	9 838	10 562	10 730	11 520	11 777	11 735	11 923,41	11 367	11 311	13 408	16 730	24 615	27 601	9%	25%
29	MASCARA	7 382	6 869	6 524	6 426	6 129	5 974	5 490,57	5 004	4 424	4 955	6 558	8 638	11 115	3%	26%
30	OUARGLA	1 447	1 582	1 716	1 796	1 389	1 252	1 193,56	1 018	992	1 922	3 616	6 931	9 350	17%	75%
31	ORAN	15 392	11 738	12 263	11 295	11 454	9 671	8 154,69	7 053	6 364	8 166	8 694	11 969	11 267	-3%	15%
32	EL BAYADH	2 800	2 978	3 273	2 840	2 931	3 060	3 199,61	3 273	3 018	4 403	6 095	8 576	10 985	12%	38%
33	ILLIZI	-	-	-	-	-	-	-	-	-	-	-	1	82		
34	B.B.ARRERI	6 568	6 599	8 503	7 146	7 929	7 367	7 952,12	8 119	7 896	10 342	13 911	21 042	26 212	12%	35%
35	BOUMERDE	2 385	2 769	2 842	2 881	2 872	2 712	2 717,38	3 253	2 513	4 777	6 801	8 771	12 174	15%	48%
36	EL TAREF	2 770	2 848	3 302	2 936	3 217	2 679	2 953,69	2 629	2 189	2 317	4 158	5 386	7 507	9%	36%
37	TINDOUF	-	-	-	-	-	-	-	78	38	149	711	1 559	2 034		170%
38	TISSEMSSI	3 389	3 367	3 960	5 283	5 317	5 236	4 976,78	3 956	4 213	4 703	5 519	7 958	10 447	10%	25%
39	EL OUED	2 298	2 684	2 377	2 608	3 135	3 147	2 794,16	3 072	2 378	4 649	6 651	8 407	12 768	15%	52%
40	KHENCHEL	3 879	4 436	5 416	5 675	5 778	5 105	4 970,87	4 571	4 012	4 651	5 620	6 926	8 857	7%	22%
41	SOUK AHRI	3 798	4 502	5 236	6 014	6 443	4 841	4 583,97	4 258	4 049	3 986	3 901	8 301	11 529	10%	30%
42	TIPAZA	2 867	995	3 364	3 501	3 937	3 406	2 828,61	2 576	2 202	2 563	4 289	5 494	6 804	7%	33%
43	MILA	5 083	5 885	4 925	4 663	4 704	3 784	4 352,36	6 598	6 250	5 465	7 391	9 599	11 533	7%	17%
44	AIN DEFLA	7 355	6 352	5 805	5 751	5 550	4 856	6 110,37	7 498	6 964	8 538	10 983	15 008	19 303	8%	29%
45	NAAMA	3 765	4 120	3 821	3 706	3 906	3 638	3 447,65	3 675	3 808	4 822	6 793	9 292	11 503	10%	32%
46	A/TEMOUCI	861	2 554	2 068	3 252	5 454	3 551	3 003,00	3 711	2 428	3 174	3 827	4 600	6 542	18%	28%
47	GHARDAIA	1 046	1 061	941	978	1 125	972	920,61	735	707	914	1 738	2 812	3 623	11%	50%
48	RELIZANE	4 849	4 927	4 979	5 046	4 857	6 245	6 175,03	5 732	5 360	6 002	6 108	11 106	15 898	10%	31%
NATIONAL		304 502	307 892	307 639	309 201	320 354	286 496	286 530	270 913	252 154	306 033	410 494	558 022	724 951	7%	30%

EVOLUTION DU NOMBRE DE STATIONS-SERVICE TOUS PRODUITS

2007 - 2019

UM : U

ORI	WILAYA	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019	2019 / 2007
26	MEDEA	43	46	47	47	47	47	46	46	45	43	44	50	51	1,4%
27	MOSTAGHA	45	41	42	43	44	44	48	49	49	51	54	56	60	2,4%
28	M'SILA	56	59	60	61	60	62	62	64	64	66	69	89	98	4,8%
29	MASCARA	42	40	42	42	40	39	40	40	42	42	42	43	46	0,8%
30	OUARGLA	27	27	28	29	33	33	35	36	40	43	43	58	67	7,9%
31	ORAN	82	83	83	80	81	84	85	87	86	85	87	90	92	1,0%
32	EL BAYADH	14	14	14	14	15	15	15	15	16	18	19	20	23	4,2%
33	ILLIZI	9	10	11	11	9	9	9	10	10	11	11	11	12	2,4%
34	B.B.ARRERI	38	40	41	45	45	48	48	52	53	54	55	59	64	4,4%
35	BOUMERDE	46	50	51	52	52	52	52	52	52	55	55	57	57	1,8%
36	EL TAREF	30	30	30	30	30	32	32	34	34	35	35	37	37	1,8%
37	TINDOUF	4	4	5	5	7	8	8	8	8	8	8	8	10	7,9%
38	TISSEMSSII	16	17	19	19	19	19	19	19	18	18	18	18	18	1,0%
39	EL OUED	33	34	36	36	37	37	37	37	38	39	40	43	46	2,8%
40	KHENCHEL	29	29	30	31	32	33	33	36	37	39	42	46	47	4,1%
41	SOUK AHRI	27	27	28	28	28	28	28	28	28	30	30	31	34	1,9%
42	TIPAZA	30	33	32	32	32	32	33	34	35	35	36	36	38	2,0%
43	MILA	42	43	42	43	48	49	50	52	52	53	54	55	56	2,4%
44	AIN DEFLA	32	32	33	33	34	37	37	37	40	41	42	43	42	2,3%
45	NAAMA	13	13	13	13	13	13	15	15	15	17	18	20	25	5,6%
46	A/TEMOUCI	42	39	41	42	42	41	41	41	43	43	45	46	48	1,1%
47	GHARDAIA	22	23	24	24	25	25	25	25	25	25	27	27	34	3,7%
48	RELIZANE	41	42	42	42	43	43	44	47	49	51	52	56	57	2,8%
NATIONAL		1 933	1 965	2 010	2 038	2 076	2 107	2 135	2 186	2 213	2 261	2 316	2 450	2 594	2,5%

EVOLUTION DU NOMBRE DE STATIONS-SERVICE DOTEES DE MODULE GPL-C

2007 - 2019

UM : U

ORI	WILAYA	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019	2019/2007
1	ADRAR	3	3	3	3	4	4	4	3	4	4	4	7	7	7%
2	CHLEF	6	6	6	6	6	6	7	7	9	10	10	8	7	1%
3	LAGHOUAT	6	5	5	5	5	5	5	8	8	8	9	13	15	8%
4	O.E.BOUAG	14	14	16	16	16	16	16	16	17	20	27	28	30	7%
5	BATNA	17	18	18	19	20	22	24	25	29	29	29	31	30	5%
6	BEJAIA	9	9	9	9	10	10	10	10	10	10	10	10	10	1%
7	BISKRA	13	15	16	17	19	21	21	21	26	26	22	22	21	4%
8	BECHAR	5	6	6	8	8	8	8	7	8	9	9	12	14	9%
9	BLIDA	11	12	10	10	12	10	11	11	11	12	12	12	14	2%
10	BOUIRA	9	9	8	9	10	11	12	14	15	17	17	18	19	6%
11	TAMANRAS	-	-	-	-	-	-	-	-	-	-	-	-	-	
12	TEBESSA	11	13	14	15	15	16	18	22	24	24	29	30	30	9%
13	TLEMCEN	20	25	26	27	28	28	29	31	31	32	33	35	38	5%
14	TIARET	12	13	13	13	13	17	16	14	18	21	20	24	26	7%
15	TIZI-OUZOU	14	14	13	13	13	13	15	14	14	14	14	16	16	1%
16	ALGER	20	20	19	19	20	22	22	19	18	18	17	17	17	-1%
17	DJELFA	15	17	16	16	17	17	19	19	20	22	23	29	32	7%
18	JIJEL	3	3	5	4	4	4	4	4	4	4	4	6	7	7%
19	SETIF	19	20	22	22	22	25	28	24	28	30	29	33	40	6%
20	SAIDA	10	11	11	11	12	12	12	13	13	13	15	17	17	5%
21	SKIKDA	6	6	6	6	6	5	5	5	5	8	9	9	10	4%
22	S.B.ABBES	9	9	9	10	9	10	12	12	14	14	14	20	20	7%
23	ANNABA	6	7	7	9	10	10	11	11	15	14	14	13	14	7%
24	GUELMA	6	5	7	7	8	8	8	8	8	8	9	11	11	5%
25	CONSTANT	13	13	10	12	11	11	11	11	13	14	14	14	14	1%
26	MEDEA	12	13	13	14	17	17	17	18	18	17	20	21	19	4%

EVOLUTION DU NOMBRE DE STATIONS-SERVICE DOTEES DE MODULE GPL-C

2007 - 2019

UM : U

ORI	WILAYA	2 007	2 008	2 009	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019	2019/2007
27	MOSTAGHA	9	9	9	9	10	12	14	14	15	15	17	19	19	6%
28	M'SILA	12	13	13	16	17	18	18	18	20	20	28	31	36	10%
29	MASCARA	15	15	15	16	13	13	13	15	17	16	16	16	19	2%
30	OUARGLA	4	4	4	4	4	4	4	4	4	4	4	12	16	12%
31	ORAN	14	14	14	14	13	13	14	14	15	16	17	17	17	2%
32	EL BAYADH	7	8	7	7	8	8	8	9	9	9	11	12	12	5%
33	ILLIZI	-	-	-	-	-	-	-	-	-	-	-	-	-	
34	B.B.ARRERI	10	11	12	13	14	14	16	16	21	23	29	29	29	9%
35	BOUMERDE	2	2	4	4	3	2	2	8	8	11	11	12	13	17%
36	EL TAREF	6	7	7	8	8	8	8	9	9	9	10	11	11	5%
37	TINDOUF	-	-	-	-	-	-	-	1	1	2	2	3	4	
38	TISSEMSSI	5	5	6	6	6	6	6	6	6	6	7	7	7	3%
39	EL OUED	4	4	5	5	5	5	5	7	8	8	8	13	14	11%
40	KHENCHEL	7	8	9	11	11	13	13	12	14	15	15	18	20	9%
41	SOUK AHRI	4	5	7	7	7	7	7	7	7	7	8	12	12	10%
42	TIPAZA	2	3	5	5	4	5	5	5	5	5	7	8	9	13%
43	MILA	5	6	8	8	10	9	10	15	19	19	21	22	23	14%
44	AIN DEFLA	5	5	6	6	7	8	8	10	12	15	16	17	17	11%
45	NAAMA	4	4	5	5	5	6	7	8	8	8	10	11	12	10%
46	A/TEMOUCI	2	7	8	8	8	8	8	8	9	10	10	12	13	17%
47	GHARDAIA	4	4	4	4	4	4	4	4	5	5	5	6	9	7%
48	RELIZANE	6	6	6	6	9	9	10	12	12	12	11	11	13	7%
NATIONAL		396	426	442	462	481	500	525	549	604	633	676	755	803	6%