



UNIVERSIDAD PONTIFICIA COMILLAS

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)



OFFICIAL MASTER'S DEGREE IN THE ELECTRIC POWER
INDUSTRY

MASTER'S THESIS

ENERGY TRANSITION IN SPAIN

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Supervisor: Jorge Angulo Fernández

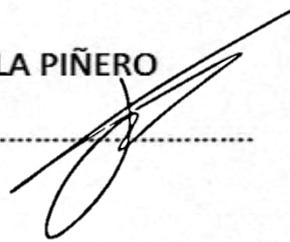
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TABLE OF CONTENTS

EXECUTIVE SUMMARY	XI
1 INTRODUCTION AND FRAMEWORK	12
2 ENERGY TRANSITION	14
3 SHARES TOOL	17
3.1 ELECTRIC POWER INDUSTRY. RES-E	17
3.1.1 DEFINITION. THE ELECTRIC SECTOR	17
3.1.2 SHARES COMPUTATION OF RES-E.....	18
3.1.3 RES-E MODEL	20
3.2 TRANSPORT SECTOR. RES-T	25
3.2.1 DEFINITION. THE TRANSPORT SECTOR.....	25
3.2.2 SHARES COMPUTATION OF RES-T.....	26
3.2.3 RES-T MODEL	29
3.3 HEATING AND COOLING SECTOR. RES-H&C.....	32
3.3.1 DEFINITION. THE HEATING AND COOLING SECTOR.....	32
3.3.2 SHARES COMPUTATION OF RES-H&C	33
3.3.3 RES-H&C MODEL.....	34
4 MODEL SCENARIOS	36
4.1.1 H&C	36
4.1.2 TRANSPORT	38
4.1.3 ELECTRIC POWER INDUSTRY	40
4.1.4 ASSUMPTIONS	42
5 RESULTS.....	44
6 CONCLUSIONS.....	49
7 REFERENCES	52
8 ANNEX.....	53
MEDIUM SCENARIO	57
LOW SCENARIO	73
HIGH SCENARIO	88



TABLE OF FIGURES

FIGURE 1. PRIMARY ENERGY SOURCES IN THE US [1].....	15
FIGURE 2. SANKEY DIAGRAM OF THE SPANISH ENERGY STRUCTURE (KTOE)	15
FIGURE 3. RES-E COMPARISON BETWEEN REE AND EUROSTAT	23
FIGURE 4. TYPICAL AND DEFAULT VALUES FOR BIOFUELS IF PRODUCED WITH NO NET CARBON EMISSIONS FROM LAND-USE CHANGE	27
FIGURE 5. PERCENTAGE OF BIOFUEL CONTAINED IN CONVENTIONAL FUELS IN SPAIN (CNMC)	28
FIGURE 6. ENERGY TRANSITION’S DASHBOARD	44
FIGURE 7. FINAL ENERGY CONSUMPTION FOR THE MEDIUM SCENARIO	45
FIGURE 8. BAU, MEDIUM AND HIGH RES TENDENCY	46
FIGURE 9. POWER INSTALLED CAPACITY IN THE ELECTRIC POWER INDUSTRY	47
FIGURE 10. NATIONAL DEMAND BY TYPE OF TECHNOLOGY.....	48



LIST OF TABLES

TABLE 1. RES-E SHARE FOR YEAR 2016 IN KTOE	20
TABLE 2. SELF-CONSUMPTION BY TYPE OF RENEWABLE TECHNOLOGY	22
TABLE 3. RENEWABLE ENERGY SHARE CALCULATION FOR THE POWER SECTOR.....	23
TABLE 4. GROSS PRODUCTION OF THE ELECTRIC POWER SECTOR	24
TABLE 5. GROSS FINAL ENERGY GENERATION OF THE ELECTRIC POWER SECTOR	25
TABLE 6. BREAKDOWN OF TRANSPORT BRANCHES BY TYPE OF FUEL	31
TABLE 7. COMPARISON AMONG DIFFERENT SOURCES (2017). TRANSPORT SECTOR.....	31
TABLE 8. RES-T FOR YEAR 2017	32
TABLE 9. COMPARISON ON THE GROSS FINAL ENERGY IN THE HEATING AND COOLING SECTOR (2017).....	34
TABLE 10. RES-H&C IN 2017	35
TABLE 11. CONFIGURATION OF THE I TERM IN THE TRANSPORT EQUATIONS	38
TABLE 12. OUTPUT COMPARISON.....	45
TABLE 13. INDIVIDUAL CALCULATION OF THE RENEWABLE ENERGY SHARE.....	46
TABLE 14. COMPARISON OF GFCoE ON THE PERIOD 2017-2030	47



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EXECUTIVE SUMMARY

For many years, climate change has always been in the background. But, since developed countries are seeing the causes and the damages that can cause, not to act in time has done to the western governments to put a step forward in an imminent and fast form.

This master's thesis aims to provide a clear evolution on how the Spanish energy sector may end up by 2030, with a time scope fixed by the European Commission. The energy sector is broken down into three branches: the electricity sector, the transport sector and, finally, the heating and cooling sector.

Spain must struggle to attain the requirements the EU have imposed by changing current regulation and policies on the energy field. As a summary, each Member State should reach out a noticeable change on four main issues. Those remarkable issues are:

- i. 40% reduction of GHG emissions with respect to 1990.
- ii. 32% of renewable energy gross final consumption, over the whole European Union (EU).
- iii. 32,5% of efficiency gain.
- iv. 15% of interconnection for each of the Member States with their neighboring countries.

A model will be developed to quantify the measures needed to attain, in order to comply with the European directives and regulations. This analysis comes along with a discussion on results and the different assumptions taken during the analysis. The design of this model tries to cover as much likely realities as possible, but also tries to be manageable and simply to understand the given results. Hence, three scenarios were thought to be the optimal.

The average scenario of this analysis contemplates the compliance with 32% of renewable energy sources for the year 2030. Much of the demand is electrified to the detriment of the transport sector and the heating sector. Such reduction is largely due to the implementation of heat pumps and the use of the electric vehicle.

The tool has been developed at ACCIONA's facilities as a trainee. The tool presented in this document is one-half of a bigger tool that is currently being developed. The energy transition's tool analyzes how renewable energy sources impact on the overall energy mix, whereas the other part of the tool analyzes the economic impact of the results given by the former. Putting both together, it is possible to quantify and decided whether an investment decision is worth moving forward or not.

Focusing the discussion, the European Commission has gone over the years modifying the directives and regulations so that countries, little by little, adapt to these changes. However, little has been done in these years. As a consequence of the passivity of the Member States, the Commission has decided to tighten its policies, even to penalize economically those countries that do not comply with the directives, in an attempt trying to reach the limits that are believed to be adequate for 2030 in energy matters.

1 INTRODUCTION AND FRAMEWORK

It was 1996 when the European Union, EU, started to care about the GHG and climate change, and tried to reverse the situation of CO₂ emissions exponential increase year by year. The economy was growing very fast, but in exchange of harming the environment. That year EU issued the so-called *First Energy Package*, which mainly settled down the basic principles and desired to establish an internal market for gas and electricity. The idea behind this internal market pretended to protect consumers from market abuse, and enhance the reliability of the system and security of supply throughout the investment in interconnection capacity.

In 2003, the EU issued the ‘Second Energy Package’. Through the pass of time, the Community evolved along with the technologies, thus, modifications on the actual directives and regulations were needed. In addition, new articles and objectives were added.

The ‘Third Energy Package’ came into play in 2009, six years after the issuance of the second package. This package is very close to what is intended to carry out for the sustainable future in the Union and to what the MSs are obliged to comply.

The energy and climate policy framework of Spain is determined by the European Union, which, at the same time, is conditioned by a global context in which the Paris Agreement surges as the most international ambitious up to date initiative against the climate change. The Agreement was ratified October 2016; Spain, in turn, started settling down the foundations and the starting point to draw the energy policies and the strategy to comply with the Paris Agreement for the 2030 horizon.

Likewise, in 2016, the European Commission presented the so-called ‘Winter package’, clean energy for all the Europeans¹. It was drafted throughout several regulations and directives. This package focuses on the review and legislative proposals related to, for instance, the energy efficiency, the renewable energy sources, electricity market design, and security of supply, all of them aiming to reduce the GHG (Green House Gases) emissions, increase the share of renewable energies in the system and enhance the overall energy efficiency in Europe by 2030.

This initiative by the EC has opened up new opportunities for business, incentives to invest in green technologies, and, finally yet importantly, this package empowers the consumer side to participate actively in the transformation process: The European Energy Transition. As a result, the EU has set four binding objectives that every Member State must comply with by 2030:

- i. 40% reduction of GHG emissions with respect to 1990.
- ii. 32% of renewable energy gross final consumption, over the whole European Union (EU).
- iii. 32.5% of efficiency gain.
- iv. 15% of interconnection for each of the Member States with their neighboring countries.

Moreover, the EU has reportedly announced its roadmap presenting the guidelines countries should follow to achieve a European Union fully decarbonized by 2050².

Lately in 2019, the Spanish Government has released the Energy and Climate Integrated National Plan (PNIEC stands for ‘*Plan Nacional Integrado de Energía y Clima*’). This plan reveals the strategy of Spain on how to turn to a green country, by means of the reduction of CO₂

¹ COM2016 860 final

² COM/2018/773 final

emissions, the gain in efficiency and the penetration of renewable sources within the three main economic sectors that have largest impact on emissions: the electric power industry, the transport and the residential sector.

For the time being, this document is a draft. As a public document, everyone is entitled to suggest and make comments on it, thus, PNIEC might be subject to some changes in the upcoming months. Points ii), iii) and iv) could be reviewed, just upwards, by 2023.

The ‘Winter package’ settles the accomplishments after the 2030 period, but in any case, it obliges any country to follow a straight and firm strategy to achieve the goals. Indeed, it is Members’ responsibility to develop and draw a specific energy plan, which may fit best them, according to their degree of mature of the different technologies implemented and developed in the country, their culture, among others. Fiscal policies play a very important role in this aspect, as the difficulties private investors may have to struggle with the measures available in the market to. That is the main reason EU gives totally independence and flexibility to implement the plan, but it is demanded every Member State drafts a national plan on energy and climate 2021-2030, as well as a long-term strategy sketch by 2050 on low emissions.

The PNIEC identifies the challenges and opportunities presented in this ambitious project. Those challenges are classified according to five major pillars:

- 1) Decarbonization. Renewable energy sources included.
- 2) Energy efficiency.
- 3) Security of supply.
- 4) Internal energy markets.
- 5) Innovation, research and competitiveness.

The plan, itself, aims to send the appropriate signals to all the agents involved in the process, giving them stability and certainty through it.

2 ENERGY TRANSITION

Amid lots of reports warning about the climate, change and its irreversible catastrophically effects throughout the years, the increasingly number of associations created to convince governments and societies that the sustainable development about climate change, finally, it has been reached a break-even point in which the world realizes this trend cannot be kept any longer. This change emerges from the old Continent. The European Union has issued several directives and regulations that mainly oblige the European countries to achieve an important and real compromise concerning this very relevant topic.

It is expected that by 2030, EU drop their CO₂ emissions by 40% with respect to 1990. To do so, measures on electric power industry, transportation and household consumption will be tackled. However, EU's plans seem to be very optimistic, as some State Member clearly will not be able con comply with the goals. The good news is that is happening right now, and sooner or later, this plan will produce a major change in the core of the European economies; more employees, less emissions, R+D+I investments, competitiveness across the more and more globalized market...

There is an existing opportunity to create value and gain presence in the global market regarding sustainability and eco-friendly business. Focusing on Spain, the PNIEC aims to set the guidelines to achieve and comply with the European project. Spain has a lot of work to do in this concern, settling down a firm base to develop and deploy a CO₂-neutral economy. As a reminder, three out of four tons of GHG emissions come from the energy sector. For that reason, the decarbonization is a key element in the energy transition.

The plan conceives this transition will be carried out by private investors, mostly local ones, which in consequence will increase the Spanish GDP, and most importantly, it will result in a noticeable decrease on the energy dependence from fossil fuel, making Spain become self-sufficient, and fully independent from energy imports (oil and gas specially). Time will speak itself.

The sustainable energy transition takes decades, it is not a matter of one or two years. Due to this time dependency, it is needed to develop a strategy that withholds the actual CO₂ levels and buy time to think of new ways of supply but on a sustainable and low-carbon, if not zero, framework. The second part of the strategy lies in the development of long-term solutions that finally attain the reduction and decline the actual conditions of emissions and pollutants to the environment.

As an example, in the US fossil fuels each took several decades to achieve their peak use [1]. Hence, renewable energy may take several decades to overcome the use of fossil fuels, but, it is right to say that technology has evolved very fast and the penetration of them in the societies and economies moves forward exponentially; the time of implementation and adoption could decline very rapidly.

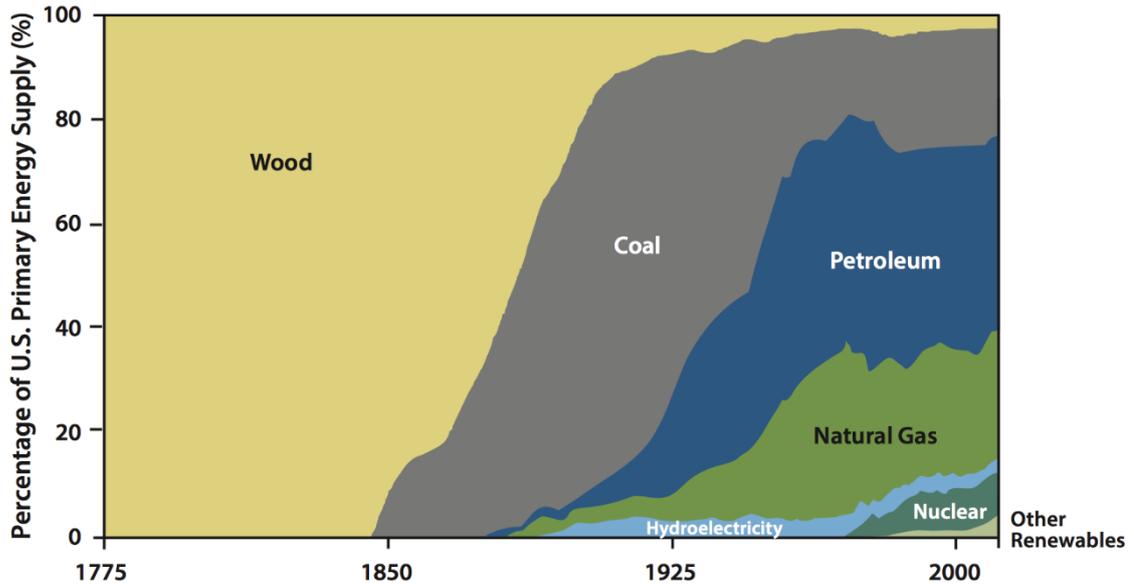


Figure 1. Primary energy sources in the US [1]

There are three types of levels when talking about energy. On the one hand, there is the so-called primary energy, which encompasses all sort of energy sources available in the nature before being transformed or converted into other type of energy. This level is composed by energetic raw materials such as wood, coal, oil, natural gas, the sun, the rain, wind...

While on the other hand, there is the final energy. It is defined as the energy employed in specific uses, in the form of electricity or heat. Likewise, the final energy is differentiated in gross final energy and net final energy; gross final energy does not take into account the potential energy losses in carrying the energy to final consumers, whereas net final energy considers the losses derived from the energy transportation. The energy losses are related to the transmission and distribution activities in the electric power industry, losses in the transportation of natural gas through piping systems, and so forth.

The energy flow is usually represented by means of a Sankey diagram, which disaggregate the energy in branches according to the utilization of the energy.

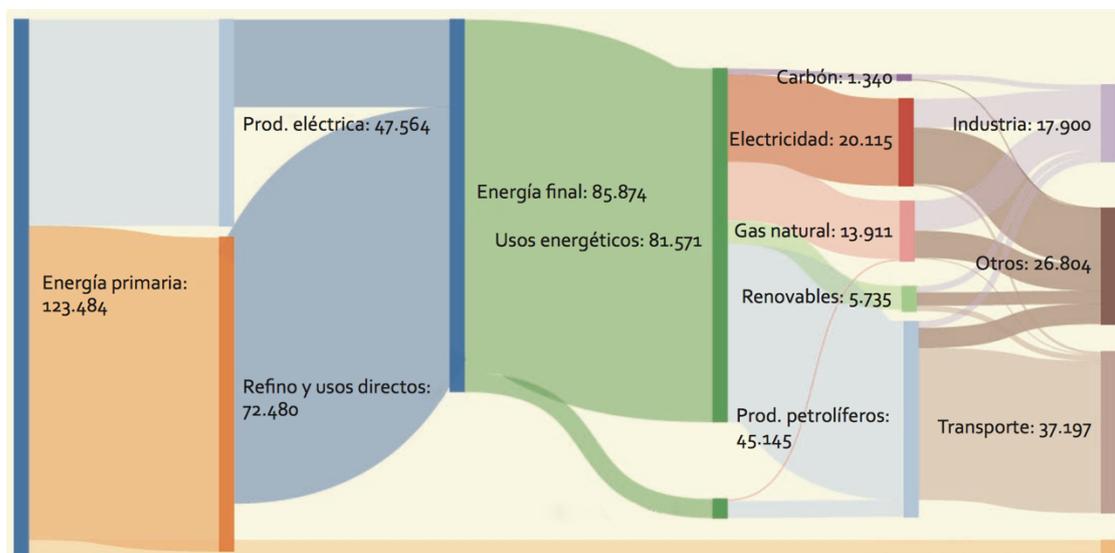


Figure 2. Sankey diagram of the Spanish energy structure (ktoe) [2]



The assessment of the share coming from renewable energy sources imposed by the Europe focuses on the gross final energy consumption. The energy losses are also part of the energy mixed used in the country's energy context. Giving a more illustrative explanation of this concept, the electricity sectors seems to be the easiest way to see it. If there are losses in the grid, the generators shall produce the electricity demand, plus the losses incurred during the electricity transmission to final consumers. Therefore, the losses count in the renewable energy assessment when calculating how green a country is in its energy activities.

3 SHARES TOOL

The SHARES tool is the given name the European Commission designated to report the calculation of the renewable energy share of all the EU Member States. SHARES stands for Short Assessment of Renewable Energy [1]. The tool supports reporting activity on Directive 2009/28/EC.

This tool is in charge of collecting and present the energy data from all the members. By means of documentation, it updates the energy data for what is considered the economic sectors deemed as the most relevant ones in energy terms, including within them other blurred and diffused activities: electricity, transport, and heat and cooling. Somehow, the reporting tracks the compliance of what the European directives state, but also, it paces the path each member has to follow. This way, it harmonizes the calculation of the energy share, making possible absolute comparisons among countries and easing the settlement for further objectives.

The methodology SHARES uses to compute and present the results is based on the information submitted by the ministries of each Member State through annual statistics and energy questionnaires³. Five annual energy questionnaires are required for the use of the SHARES tool [1]:

- Coal. Covers solid fossil fuels.
- Oil. Considers crude oil and derived oil products.
- Natural gas.
- Electricity and heat.
- Renewables. Includes renewable and non-renewable wastes.

Each of them is broken down into different parts according to the energy source, nature and application. Thus, each questionnaire composes a detached panel with the different sources used in each of the three sectors, differentiating the type of fuel used.

As previously mentioned, three energy vectors gather all the final energy consumption in the Spanish territory. A detailed explanation of each sector is carried out next.

3.1 Electric Power Industry. RES-E

The power industry sector deals with the generation of electricity in the country. Therefore, this sector comprises everything related to the production of electric energy from primary energy sources, such as fossil fuels and natural energy resources (wind, sun radiation, water...) and raw materials that have recently made room in the market (biomass and biogas mostly).

This chapter will define, analyze and discuss the process followed during the modelling of the electric sector, emphasizing those aspects that might be relevant and important to understand or further studies and objectives stated in the European Directive 2009/28/EC.

3.1.1 Definition. The electric sector

The generation power plants producing electricity to supply the national demand compose the electricity sector. This sector is extremely relevant when talking about reaching a decarbonized economy, because the power industry nowadays accounts for the largest CO₂ emission share across Spain. By contrast, this sector has a potential of efficiency gain higher than any other

³ Detailed information available on the European Commission website.

sector, and, therefore, implementing measures will favor the reduction of GHG emissions, and will increase in a great manner the overall renewable energy share in the country.

According to the European Commission, by 2030 Each Member State must reduce its CO₂ emissions by 40% with respect to 1990. As mentioned, the electric power industry is positioned in a strong a favorable position to carry out this task. Renewable energy sources will be the pillar in this transition to a green economy.

Many factors induce investors to decarbonize the electricity sector. First, renewable technologies (wind and solar PV, mainly) have experienced in the past few years a drastic cost-reduction; technologies are becoming mature and there is a lot of expertise permitting cheapen the capital investment and O&M expenditures. This fact has become the renewable technologies a very attractive investment with high rates of return. Second, renewable technologies have a very low, not say null, variable cost, which means, their production is effective, matches in the electric spot market, every time is available (cloudless days and wind blowing). Since the clearance of the spot price is usually in hands of CCGTs and coal plants, they have much higher bids than RES. Therefore, the renewables see in the market a very attractive capture price, pushing capital for new investments. As a result, the penetration of renewables in the power industry has two sided-effects: the decarbonization of the sector, reducing GHG emissions and meet with the European Directive, and the reduction in the spot market price, benefiting demand by reducing the electricity bill.

3.1.2 SHARES computation of RES-E

The chapter focuses on describing the procedure the European Commission follows to calculate the total amount of renewable energy that stems from the electricity generation activity. In other words, it serves as a key performance indicator to track how much energy from green sources derived from the total electricity produced.

The SHARES takes hydro, wind, solar and solid biofuels as the four major renewable sources to drive the energy transition. Also, there is a fifth group which encompasses the less accountable technologies that, for the time being do not contribute too much in the green production, but they are expected to grow in the coming years. All other renewable electricity plants were not mentioned above forms this group. Those are:

- Gaseous biofuels;
- Liquid biofuels;
- Renewable municipal waste;
- Geothermal and;
- Tide and wave technologies.

In addition, solar includes not only solar photovoltaic but also thermal generation that, in the case of Spain, has 2,300MW of installed capacity.

For this calculation, it is necessary to make some adjustments regarding the hydro and the wind power. Since wind and hydro resources are not very predictable, especially in the case of hydrology (due to the software development wind forecast have better off throughout the years). A normalization⁴ of the production coming from these two sources is done.

The normalization rules for hydro and wind are as follows:

⁴ Directive 2009/28/EC of the European Parliament and of the Council.

$$Q_{N,wind} = \frac{C_N - C_{N-1}}{2} \cdot \frac{\sum_{i=N-4}^N Q_i}{\frac{C_{N-5} + C_{N-4} + C_{N-3} + C_{N-2} + C_{N-1} + C_N}{2}} \quad [3.1]$$

where:

N = Reference year;

$Q_{N,wind}$ = Normalized electricity generated by all wind power plants of the Member State in year N ;

Q_i = The quantity of electricity actually generated in year i by all wind power plants of the Member State measured in GWh;

C_i = The total installed capacity of all wind power plants of the Member State at the end of year i , measured in MW.

$n = 4$ or the number of years preceding year N for which capacity and production data are available for the Member State in question, whichever is lower.

$$Q_{N,hydro} = C_N \cdot \left[\sum_{i=N-14}^N \frac{Q_i}{C_i} \right] / 15 \quad [3.2]$$

where:

N = Reference year;

$Q_{N,hydro}$ = Normalized electricity generated by all hydropower plants of the Member State in year N ;

Q_i = The quantity of electricity actually generated in year i by all hydropower plants of the Member State measured in GWh, excluding production from pumped storage units using water that has previously been pumped uphill;

C_i = The total installed capacity, net of pumped storage, of all hydropower plants of the Member State at the end of year i , measured in MW.

For the wind case, [1] an average is done taking into the calculations the sum of energy produced in the last five years with respect to the reference year N , and the installed capacity for the same period. This number is multiplied by an average of installed capacity of year N and $N-1$.

Hydropower generation normalization lies in a simpler formula. The SHARES manual employs a 15-year-average considering the electricity generated by hydropower plants and their nominal capacity, excluding all related to pumped storage hydro plants.

Moving onto the methodology, the renewable share coming out from the electric power industry is simply the coefficient resulted from dividing the total renewable energy produced by the total energy generated (this includes RES, coal, nuclear, CCGTs and any other technology producing electricity in the market).

Data collection for the SHARES calculation stemmed from the energy questionnaires submitted by each Member State, in all five questionnaires. These questionnaires add up to the SHARES Tool file issued by the European Statistics Bureau⁵.

The data Eurostat uses to compute the RES share stemmed from the official institutions in charge of reporting and analyze the status of the sector. In this particular case is the Institute for Development and Energy Savings⁶ the one responsible to submit the data to Europe. Other official and governmental institutions such as the CNMC⁷ and the MITECO⁸ complement these data.

Providing an example, the calculation for the RES-E in SHARES for the Spanish panorama would look like this:

Table 1. RES-E share for year 2016 in ktoe

Hydro	2,691.1
Wind	4,428.4
Solar	1,173.1
Solid Biofuels	348.1
All Other Renewables	141.2
RES-E Numerator	8,781.8
RES-E Denominator	23,987.6
RES-E Share [%]	36.61%

3.1.3 RES-E model

Having set the procedure and steps needed to compute and calculate the accountability for renewables according to the European Union, it is now going to be explained the values and steps considered to assess the renewable share in the electricity sector. Such values may differ from the ones taken by the EC, proving that the tendency and results are very similar.

The sources employed in this computation will be the data coming from the Spanish transmission system operator, Spanish TSO⁹, and the Institute for Developing and Energy Savings, previously introduced with its acronym as IDAE.

Beginning with hydro, installed capacity and power generation are retrieved from REE and ranked in descending order. Applying the normalization formula for hydro taking into account fifteen years prior to the year under study, it is needed to look back on 1990. Thus, it can be deemed as right calculations any year ahead of 2004.

⁵ Visit Eurostat website for SHARES consulting.

⁶ *Instituto para el Desarrollo y el Ahorro Energético.*

⁷ *Comisión Nacional para los Mercados y la Competencia.*

⁸ *Ministerio para la Transición Ecológica.*

⁹ *'Red Eléctrica de España', REE.*

$$Q_{N,hydro} = C_N \cdot \left[\sum_{i=N-14}^N \frac{Q_i}{C_i} \right] / 15$$

Equation 1. Formula for hydropower normalization

For wind energy values, data are obtained from REE and using the formula for wind generation results are stored in the database.

$$Q_{N,wind} = \frac{C_N - C_{N-1}}{2} \cdot \frac{\sum_{i=N-4}^N Q_i}{\frac{C_{N-5}}{2} + C_{N-4} + C_{N-3} + C_{N-2} + C_{N-1} + \frac{C_N}{2}}$$

Equation 2. Formula for wind power normalization

Solar power, solid biofuels and all other types of energy deemed as renewable do not encompass any type of formula for generation normalization. Data derived from solar, biofuels and others are straight imported and stored in the database. Solar energy encompasses both photovoltaic cells and thermal solar power generation, whereas solid biofuels just includes the biomass. Urban solid waste, tide and wave technologies, geothermal and biogas are labelled as other RES.

The calculation of RES within the electricity sector is quite straightforward; mainly thanks to the transparent information, REE disposes publicly. Therefore, up to now, the renewable accountability has been already recorded in the database, but to reach the percentage that the Eurostat has published, it is necessary to calculate the total production of the electricity sector, the gross electricity production of the system.

For the computation of the final gross electricity production two sources have been consulted. First, REE was used to import final electricity demand, imports, exports, and pumping consumption, which accounts for the energy consumed by pumping uphill water that will be driven to the turbine to produce electricity during peak-load hours (higher prices). The second source is IDAE; this one was useful to collect data concerning the auto-production and the power plants' self-consumption. The Spanish TSO makes public the final demand at the power plants' busbars; in other words, the energy that will be carried to the final points of consumption. This demand does not take into account the possibility that there are some heavy industries that demands such big amount of energy that they have their own power plant for their own and private use. Usually, the plant is next to the industry; hence, the network connecting generation point and consumption point does not affect the rest of the grid and cause any problem to REE. For this reason, REE does not consider that generation, or demand, in their publications.

The other issue, which does not appear in REE's publications, is the power plants' self-consumption or auxiliary consumption. The own consumption represents the properly energy consumed within the plants necessary to make them work. Thermal plants are mostly the ones that more consumed – accounting for about 8-10% of the total production of the plants –, because they have water pumps in the condenser, fans, heaters, feeders, trays, etc. Hydropower plants consumed energy when they open and close the floodgates to produce electricity; wind turbines occupy part of their production in the yaw mechanism (it allows the blade to keep the blade perpendicular to the wind in order to extract the maximum energy), the blade pitch control, controllers and so forth [3].

When talking about solar power, a split between PV and thermal solar power must be done. In the case of solar PV panels, the self-consumption mainly accounts for the rotation of the panel tracking and orienting itself to the sun; if the panel is fixed there is no consumption at all. The thermal solar power plant consumes much more than the PV panels, as they need to pump water up to the top tower, where the sunrays are concentrated due the heliostats. In addition, if the heliostats are not fixed, but they move jointly along with the sun track, the self-consumption increases.

As the self-consumption is published as an aggregate value, there is no likelihood to disaggregate the number by technologies. Since it is needed to break into technologies the own consumption, the best option has been to give, in terms of percentage, a reasonable value to each technology. As the technology matures, this consumption may lower, but for the time being the percentages attributed to each technology are the followings:

Table 2. Self-consumption by type of renewable technology

Hydro	Wind	Solar ¹⁰	Solid Biofuels	Other RES
2%	1.15%	4.5%	3%	1%

The leftover corresponds to the non-renewable energy sources, e.g., CCGTs and coal plants mostly. Drawing an example, in 2017, 10,422 GWh were consumed due to self-consumption. Out of it, 2,118 GWh accounts for RES, and the rest for non-RES, resulting around 20% of declared self-consumption is renewable. This fact brings out a good indicative of the benefits of the renewable energies: they are less intensive in terms of equipment consumption.

Table 3 makes a comparison between the renewable share in the electricity sector from two different data sources, REE and the data published by the European Energy Commission. To support this comparison, Figure 3 depicts the traceability for both sources, thus it can be concluded the method Eurostat makes use has been replicated with the Spanish system operator's database, the one will count from 2017 to develop the model in the electricity sector branch.

¹⁰ Solar includes thermal and PV.

Table 3. Renewable energy share calculation for the power sector

Year	Total RES-E			RES-E REE Share
	REE (ktoe)	Eurostat (ktoe)	Difference	
2017	8,780.0	8830.3	0.57%	36.4%
2016	8,760.8	8800.5	0.45%	36.7%
2015	8,845.3	8802.2	-0.49%	37.9%
2014	8,873.1	8817.2	-0.63%	38.0%
2013	8,714.0	8674.5	-0.46%	38.2%
2012	8,324.4	8136.0	-2.31%	36.1%
2011	7,855.7	7745.3	-1.43%	32.1%
2010	7,495.0	7425.0	-0.94%	31.4%
2009	6,629.3	6,792.0	2.40%	26.8%
2008	5,843.6	6,124.4	4.59%	24.5%
2007	5,222.0	5,520.3	5.41%	20.4%
2006	4,787.0	5,024.1	4.72%	19.1%
2005	4,505.9	4,738.8	4.92%	19.6%
2004	4,174.0	4,464.5	6.51%	18.8%

The comparison represents the renewable share of the electric sector in milliards of tons of oil equivalent and the difference between both calculations. Last data corresponds to 2017 and downs to 2004 in a top-down order. As noticed, the further from 2017, the error tends to increase. Therefore, 2004 counts with the highest error of all the years in consideration; this has to do probably that in the previous years the IT lacked some features that they do have nowadays.

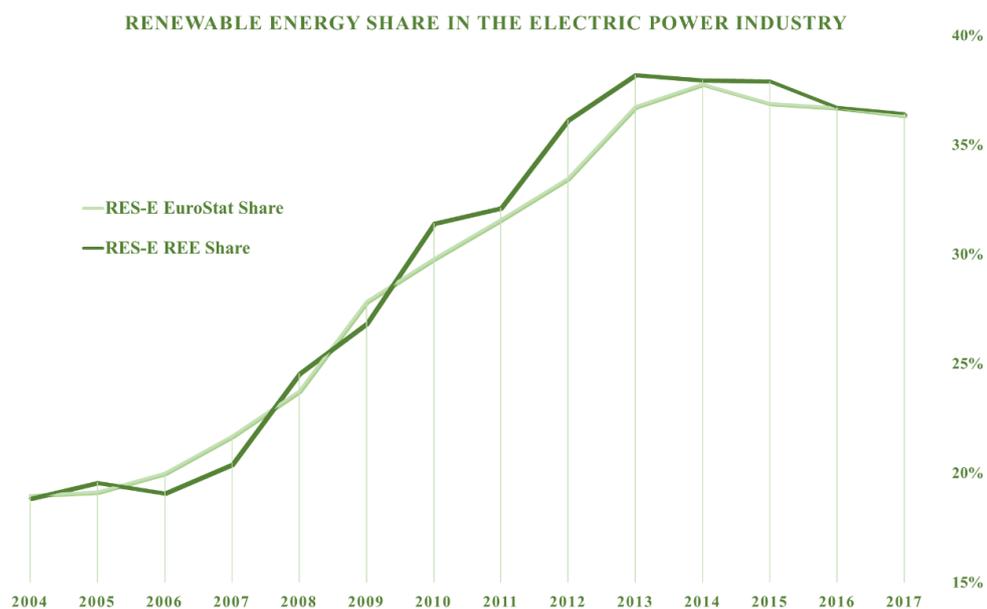


Figure 3. RES-E comparison between REE and Eurostat

Until now, the main discussion focuses on the calculation and description of the numerator, the total renewable electricity produced by generating units in the electric power sector. However, for the RES-E calculation is necessary a number to divide the renewable resources by. This number, the denominator, includes all the RES plus the non-RES, which are conventional thermal plants, cogeneration, urban solid waste, etc. For this purpose, the gross energy production has been computed by aggregating different concepts in relation to the energy generation and consumption.

First, the generation at the busbars, i.e., the electricity accountability just right before the high-voltage substation. The annual net balance from the interconnection, positive means imports and negative exports, is added up to the generation, and also the self-production¹¹. This last term has to do with the production that is not poured into the grid but directly consumed by a consumer who is proprietary of the power plant. These consumers are often heavy industries where the power plant and the consumption point is near. This way the industry may control and optimized in a better manner its demand profile and can save up transmission and distribution costs, as well as reduce the losses.

On the other hand, there are some values to be subtracted. Those are the self-consumption and the pumping storage. Self-consumption accounts to the electricity power plants self-demand. This consumption includes, in the case of a wind farm, the pitch control, blade rotation, controllers and meters that constantly send information in real time of the wind turbine operation. Hydroelectric power plants require a huge amount of electricity when starting operation opening the floodgates, thermal plants with the water pumps and fans, the feeder tray that carries the fuel to the combustion chamber... Last, but not least, the pumping amounts to a significant portion of the total energy. This concept lies in the electricity used to pump water uphill, usually at nighttime when electricity is cheaper; to afterwards turbine the water during peak loads, capturing high prices in the spot market.

Summing all the terms previously mentioned the results are drawn in Table 4. Comparing the gross final energy generation published on Eurostat reports, the methodology has been successfully proved to be right and consistent. Next, a table shows the difference derived from accessing two different sources.

Table 4. Gross production of the electric power sector

Year	Gross Production							Eurostat	Difference
	REE (ktoe)	Generation GWh	Imp. & Exp. GWh	Autoprod. GWh	Gen. Con. GWh	Pumping GWh			
2017	24,107.61	262,305.76	9,168.99	2,082.00	10,422.33	3,607.58	24,299.83	0.79%	
2016	23,871.93	262,305.76	7,658.04	2,175.31	10,319.00	4,827.59	23,987.65	0.48%	
2015	23,323.84	261,835.69	-133.16	2,795.95	11,270.00	4,512.25	23,865.00	2.27%	
2014	23,372.91	267,453.85	-3,406.12	2,795.95	10,369.00	5,385.77	23,348.47	-0.10%	
2013	22,803.90	266,460.98	-6,732.13	2,345.26	9,091.00	5,955.78	23,619.41	3.45%	

¹¹ Red Eléctrica de España does not provide this term. Therefore, the Institute for the Development and Energy Savings (IDAE) was consulted through the energy bulletin published by the Ministry for the Ecological Transition.

Table 5. Gross final energy generation of the electric power sector

Year	Gross Production		
	REE (ktoe)	Eurostat	Difference
2017	24,107.61	24,299.83	0.79%
2016	23,871.93	23,987.65	0.48%
2015	23,323.84	23,865.00	2.27%
2014	23,372.91	23,348.47	-0.10%
2013	22,803.90	23,619.41	3.45%

The actual tendency is the massive installation of renewables in the coming years. Wind and solar energy are the big contenders to carry forward and make feasible the energy transition worldwide, especially in Spain, where the wind and solar resource is very attractive and the technologies are already matured. Wind energy takes the first place when talking about renewable generation in Spain. In 2017, wind energy covered more than 20% of the national demand, lowering the operation of coal plants and reducing the CO₂ emissions.

3.2 Transport Sector. RES-T

Defined as one of the takeaways in the European context to mitigate the GHG emissions and become a green continent, it is indispensable to make a deep analysis on how to tackle the CO₂ emissions produced in this sector. For that purpose, this chapter will try to explain and go in deep detailing through the study of the different modes of transport, how much they consume on average, current fleet in Spain, future developments and cutting-edge ways of transport making noise from behind and threatening the viability of the conventional transport (EVs and NGVs).

The computation of the total consumption is extremely sensitive to slight changes in the method, mainly because of the number of vehicles across the country, which nearly amounts to 33 million up to date.

3.2.1 Definition. The transport sector

The transportation encompasses all way of transport available in the market that are used to carry persons or freight either by any sort of transport, e.g. aviation, railway, road or maritime transport. This sector plays a key role in the decarbonization of the economy. The reason, it is the most pollutant branch due to the great number of individual users it has, but also it is the energy branch where most effective would be to implement efficient measures based on a cost-benefit analysis. Measures on power plants are very intensive in capital, and the investment can afford such disbursement. However, the transport sector, specifically the car industry, disposes a wide variety of car models and services affordable to almost every customer; sufficient reasonably to state this is the fact that there are more than 1.2 trillion vehicles worldwide.

The broad sector allows tackling the emissions and energy efficiency issues in a more Ramsey-like basis. In other words, due to the number of vehicles, a slight enhancement in the technology will propitiate a major impact in the sector, and the investment is not tackled by a handful of investors/customers, but for millions of them.

As a result, the transport sector is apparently the cornerstone for every government on the energy transition in order to minimize the CO₂ emissions by 2030. In the United States, LDV (Light Duty Vehicle) alone accounts for 43% of the total petroleum consumption and 23% of the CO₂ emissions [4]. Hence, the current situation offers potential for a substantial reduction on greenhouse gas emissions.

Measures to mitigate and follow the European directive pass through the electrification of the transportation, at least in the medium-term, until a new technology breaks the market, for instance, the hydrogen. Another measure is the use of gas and biogas in LDV and trailers; these fuels and biofuels pollute less than the actual ones, but in exchange of a higher consumption. The good point is that their tax-imposition is very low compared with diesel and gasoline, but still, this higher consumption may worsen the national economy, as drivers shall spend more money. A cost-benefit analysis will be needed to provide evidences that this measure would be not only beneficial for the environment, but also economically effective. To develop the two measures mentioned big lumps of money are needed. The electrification will bring along reinforcements in the actual distribution networks, investments in charging points, tariff design by the regulator and so forth. On the same line, the gas, Spain lacks refineries used to treating gaseous fuel (biogas), not the case in liquid fuels, where Spain is the European's leader in biofuel refinery. The cost of gas plants is huge and, therefore, investors do not take the next step amid political instability and changing regulatory policies every four years after government switching.

3.2.2 SHARES computation of RES-T

Leaning on the documents publicly published by the European Commission, the SHARES Tool Manual [1] states the steps to coming up with the transport consumption. Consulting this document, in addition of the Excel file ¹² habilitated by the Eurostat for this purpose, it can be deducted the accountability for the different technologies in the sector, as they will be explained further in this chapter.

The RES-T share, the numerator, encompasses the following fuels to be included in [1]:

- Compliant biofuels in all modes of transport;
- Renewable electricity stemmed from the electric power industry;
- Hydrogen from renewable origin;
- Renewable synthetic fuels and,
- Any other sort of renewable energy considered in the energy questionnaires, i.e., geothermal, solar, solid biofuels, etc.

Compliant biofuels refer to those gasolines that have a small proportion of biomass in their composition. Mostly, gasoline 95, gasoline 98 and diesel are the fuels containing this label of biofuel. The accountability is carried out by applying the percentage the fuel has to the overall fuel consumption on the three former fuels mentioned.

Gasolines are labelled with the E, normally is E5, which means 5% of the total content and composition of the gasoline is ethanol. The same applies to diesel. Instead, diesel labels with B7; 7% is biodiesel. The origin of the biofuels is diverse; there is no one-off raw material to produce bioethanol and biodiesel, but there are many, each with their properties, calorific values, processing and costs.

¹² The SHARES Tool. Available at the Eurostat website.

There are many more, with different origins and processing. Next, an indicative table on how these fuels could help achieve an important reduction in CO₂ emissions.

Biofuel production pathway	Typical greenhouse gas emission saving	Default greenhouse gas emission saving
sugar beet ethanol	61 %	52 %
wheat ethanol (process fuel not specified)	32 %	16 %
wheat ethanol (lignite as process fuel in CHP plant)	32 %	16 %
wheat ethanol (natural gas as process fuel in conventional boiler)	45 %	34 %
wheat ethanol (natural gas as process fuel in CHP plant)	53 %	47 %
wheat ethanol (straw as process fuel in CHP plant)	69 %	69 %
corn (maize) ethanol, Community produced (natural gas as process fuel in CHP plant)	56 %	49 %
sugar cane ethanol	71 %	71 %

Figure 4. Typical and default values for biofuels if produced with no net carbon emissions from land-use change [5]

As a result, it is remarkable the substantial reduction on GHG emissions by consuming biofuels instead of conventional gasolines. Nevertheless, these ones have some drawbacks that may cause a big impact and damage in other parts of the economy. The raw material to produce biodiesel and ethanol comes from the harvest in the agriculture sector. In addition, the calorific value per liter of ethanol is lower – say half of it – than the liter of oil. This fact would trigger massive harvesting to produce the sufficient biofuel to feed the national territory.

Roughly speaking, the annual consumption in transport is near 30 Mtoe, which is around one third of the gross final energy consumption in Spain. Therefore, the amount of agriculture products needed to harvest to cope the oil demand would be that immense that there will be food supply issues as the most part of the soil is derived to fuel production. Currently on breaking news, it is the issue concerning the palm oil – mainly used to produce pastry – which is inducing the massive cut of trees in the Brazilian region of Amazonas. Figure 4 shows palm oil could be employed to produce biodiesel, aggravating the problem even more than today.

After these events, the EU has reportedly announced in a review on the Directive 2009/EC to let each MS to set the biofuel percentage at their will, but always below the actual 7%. Spain, on their side, have published through the national regulator – the CNMC – the annual bio-percentage fuels consumed in Spain contain.

Certificación mensual provisional a cuenta				
Fuente: Dirección de Energía CNMC				
Año	Mes	Cumplimiento provisional GASOLINA	Cumplimiento provisional DIÉSEL	Cumplimiento provisional GLOBAL
Acumulado anual 2009		1,8%	3,0%	2,8%
Acumulado anual 2010		4,2%	5,1%	4,9%
Acumulado anual 2011		4,3%	6,6%	6,2%
Acumulado anual 2012		4,1%	9,5%	8,5%
Acumulado anual 2013		3,4%	3,4%	3,4%
Acumulado anual 2014		3,7%	3,7%	3,7%
Acumulado anual 2015		3,8%	3,6%	3,6%
Acumulado anual 2016*		-	-	4,1%
2017*	enero	-	-	5,6%
2017*	febrero	-	-	5,3%
2017*	marzo	-	-	5,3%
2017*	abril	-	-	4,9%
2017*	mayo	-	-	4,2%
2017*	junio	-	-	3,9%
2017*	julio	-	-	3,9%
2017*	agosto	-	-	3,8%
2017*	septiembre	-	-	4,4%
2017*	octubre	-	-	4,5%
2017*	noviembre	-	-	5,6%
2017*	diciembre	-	-	4,8%
Acumulado anual 2017*		-	-	4,7%
2018*	enero	-	-	6,7%
2018*	febrero	-	-	5,7%
2018*	marzo	-	-	5,9%
2018*	abril	-	-	5,4%
2018*	mayo	-	-	5,4%
2018*	junio	-	-	6,5%
2018*	julio	-	-	5,7%
2018*	agosto	-	-	6,3%
2018*	septiembre	-	-	5,9%
2018*	octubre	-	-	5,6%
2018*	noviembre	-	-	6,2%
2018*	diciembre	-	-	4,9%
Acumulado anual 2018*		-	-	5,9%

Figure 5. Percentage of biofuel contained in conventional fuels in Spain (CNMC)

As already stated, the calculation of the numerator comprises the amount of biofuels, renewable electricity, hydrogen, synthetic fuels and other types of energies with renewable origin. Starting with biofuels, the numbers are presented in the Eurostat's SHARES Tool based on three questionnaires: oil, natural gas and renewables. Each is breaking into different fuel types, i.e., oil questionnaire is divided into bio-gasoline, bio-kerosene and biodiesel. As an example of the Spanish case, bio-gasoline and biodiesel are the non-zero consumption fuels collected throughout the oil questionnaire. The oil questionnaire also collects data consumption on conventional fuel. Summing up all these terms it is calculated the total compliant biofuels amount.

Moving forward, the renewable electricity. To calculate the amount of renewable electricity used in transport, this is multiplied with the renewable energy mix percentage of the electric sector (RES-E share) of year n-2 [1]. In this regard, MSs can freely make their own choice of what RES-t to select. There are three possibilities:

- Use the EU average renewable energy share;
- Use the national average renewable energy share or;
- Use the higher value of the two above.

The three-branch renewable electricity transportation consists of electricity in road transport, railway and other sort of transportation means. Although road transport is nowadays less

significant, it is rapidly growing with the EV penetration and is expected to become, with wind and solar power generation permission, the most disruptive actor in the climate change aiming to reduce GHG emissions and foster the low-carbon transport. Moreover, the Spanish Government intends to move the road freight to train cargos in a European project designated as Project of Common Interest (PCI). Specifically, in transport, there is a PCI called TEN-T (Trans-European Transport Network) [6] which its goal is to facilitate the transportation, either persons and freight, across the European countries, at the expense of reducing CO₂ emissions and of gaining in efficiency in the sector itself.

An important issue to bear in mind when studying the transport sector; the EU's Directive forbids the consumption gasolines with high-content of biofuels in the European countries due to the reasons explained before. In order to manage this issue, the European Commission has set a cap on the total biofuel consumption, which amounts to 7% out of the total energy consumption in the transport sector. If count of biofuel consumption overcomes the fuel cap, then, the cap is set as the new value.

It has been said the transportation join any way of transport, but aviation is not taken into account for the transport calculation. Instead, it is considered at the end of the calculation as an add-up item to the gross energy final consumption and serves as an adjusting term. According to the Directive 2009/EC Article 5, the aviation will be used to adjust the final energy consumption. To do so, a cap has been set to 6.18% of the total GFCoE (Gross Final Consumption of Energy), if the aviation consumption therefore exceeded 6.18% of the GFCoE, the total energy consumption will diminish in the same proportion to the difference between the real aviation consumption and the default cap.

3.2.3 RES-T model

Next step is coming up with the transport model. Sources and methodology is quite more complex than in the electric power industry; much more available technologies, less control over the millions of vehicles and, etcetera. In addition, there is a fact that cannot be ignored when giving results. When a vehicle is not used any longer, most of the drivers do not go to the administration to unsubscribe such vehicle. This issue may influence the results, since the calculation of renewable share in the transport sector deals with the fleet of the country, thus, the more vehicles in the ledger, the lesser renewable share for the same (real) consumption. Furthermore, an aside effect is also the fleet growth over the years, being despaired from real numbers due to the accountability of those decommissioned but not unsubscribed vehicles.

Starting up with the modelling of the transport sector, it is needed the current number of the Spanish vehicle fleet. Consulting the DGT¹³ database for 2017 [7] the total fleet amounts to more than 32 million vehicles. This number serves as a baseline to project the future growth of the fleet, dependent on the type of vehicle. To be consistent and accurate to the reality the growth of trucks and vans should be lower than that of the private cars and motorcycles, for instance. Six types of vehicles have been identified, but grouped all of them into four main groups, attending their similarities and characteristics. The four groups are defined as follows:

- Trucks, trailers and buses. Heavy vehicles for freight transportation, and in the case of buses, for people transportation. Trucks takes the big chunk of this group, 2.5 million against 400,000 and 65,000 trailers and buses, respectively. These three types of vehicles according to its weight, purpose and consumption form this group.

¹³ Stands for 'Dirección General de Tráfico' (Traffic General Administration).

- Private cars. In 2017, the number of cars was 23.5 million.
- Vans. Also known as Light Duty Vehicles (LDV), this type of transport mean is considered apart from other transportation vehicles mainly because its wide range of use, mobility and consumption. In 2017, DGT estimates there were 2.3 million LDVs.
- Motorcycles. 3.3 million in 2017.

Adding up all means of transport in Spain amounts to a total fleet of 32,275,226 vehicles. Growth rates for each specific mean of transport is set, but this growth rate is deemed as an overall rate; it has to be broken down into parameters that are more specific.

When increasing the number of vehicles, the causes for it may be miscellaneous, but in principle, there are due to two main reasons: purchasing of a completely new vehicle or the replacement of an existing one, putting aside the old one and acquiring a new model. This latter is defined as the renovation rate, which is likewise divided into other subsections, as it will now be explained. The renovation rate unveils the replacing of an existing unit by another unit with same functioning principle but newer version, e.g., a driver acquires a new gasoline car model in turn of stop using his elder gasoline car. However, as new emerging technologies are making room into the mobility market, there are currently other technologies available at the market. Those are the natural gas engines and the electric vehicle. Hence, the renovation rate is divided into the new vehicles that belong to the conventional combustion engines, and the electricity and gas newcomers.

Calculation of energy consumption requires some add-up data such as the marginal consumption, average mileage and percentage of each technology within the fleet. Some data have been withdrawn from the DGT database and statistics, and some other are based on own market-knowledge assumptions.

Marginal consumption depends very much on the type of fuel and the type of vehicle as well. Giving out an example, the marginal consumption expressed in liters/100km of a gasoline car is 6.5, on average, for year 2017, whereas diesel cars consumed 6 liters for the same year. Another sample could be the comparison between cars and trucks; diesel trucks are around 20-25 liters each 100 kilometers. One may think 20 liters for a truck is not very high consumption, but instead, the consumption is an average consumption among trucks, trailers and buses. A truck could be consuming less than 20 l/100km depending on its size and speed; a trailer could reach up to 35 liters every 100 kilometers, but as the number of trailers is quite low compared with the number of trucks, the average consumption results so. Regarding the mileage, this parameter is highly dependent on the type of vehicle, being the trailers the outstanding actor.

After the collection of all the inputs necessary to continue the modelling, it comes the transport-energy consumption calculation. In total, the consumption stemmed from the four branches of transport that will add up to calculating the final energy consumption in the transport sector. Each transport branch splits in old and new conventional engines, apart from the new technologies such as gas and electricity. Showing next, the categorization for the branches:

Table 6. Breakdown of transport branches by type of fuel

Branch	Type of fuel
Truck, Trailer and Bus	Gasoline, Diesel, EV and NG (biogas included)
Van	Gasoline, Diesel, EV and NG (biogas included)
Private Car	Gasoline, Diesel, EV and NG (biogas included)
Motorcycle	Gasoline and EV

Having computed the values and consumptions for the road transport, railway transport, maritime transport and aviation transport are the inputs left to be made. They were consulted through IDEA website. Closing up the transport modelling, it is necessary to compare the actual values the model has risen with the final energy consumption on the transport sector of Eurostat and IDAE.

Table 7. Comparison among different sources (2017). Transport sector

Model	Eurostat	IDAE
29,246 ktoe	28,909 ktoe	29,022 ktoe

Table 7 shows, in total, the energy accounted within the transport sector in 2017. There is a slight difference among the sources derived from the different approaches and assumptions that have been made. Due to this fact, the number vary approximately 2% with respect to IDAE's value and less than 1% when comparing with Eurostat's database. In spite of it, the model is robust and valid to forecast. As it will be shown later on, as approaching to 2030, the model tends to converge to the expectations PNIEC draws.

According to [1], the denominator just takes into account all modes of road and railway transport, but nothing related with aviation and shipping. Aviation is used as an adjusting factor on the overall GFCoE, as other consumptions such as the 7% limit in the biofuel consumption. Currently, this cap called aviation adjustment is 6.18% over the total energy consumption in the country. International shipping is not considered in the calculation of the RES-T, neither in the computation of the total energy consumption (denominator).

The numerator, which is the renewable energy utilized in the sector. There are two existing methods to calculate the numerator; one with multipliers and the other without them. Trying to be accurate and explicit, it has been decided to compute the numerator without using any sort of multiplier that may affect the overall renewable energy share. Hence, biofuels, EV and railway transportation are the three inputs needed to calculate the RES-T.

Having said the biofuel consumption stems from multiplying the fuel consumption by the share of biofuel they contain themselves (gasoline and diesel mostly), it is merely the multiplication by this ratio. Figure 5 depicts the ratios in the past years, and as the ratio cannot surpass the 7% limit specified by the European Union, a flat 6% ratio, both for gasoline and diesel has been imposed for the rest of the coming years. Electric vehicles are computed by means of the number of EVs, their consumption that was initially set as 15 kWh/100 km and the annual average mileage. Last yet importantly, the railway mode computes with the ktoe per annum

consumed. The RES-T share comes up when summing all these terms and divided them by the total transport energy.

Table 8. RES-T for year 2017

Model	Eurostat	Difference
6.08 %	5.92 %	2.7 %

This sector is especially very sensitive to small modifications and changes, as the number of machines or facilities involved in it is enormous. Another key issue is the double counting¹⁴ which must be mitigated to avoid incurring in errors when modelling. EVs and railway transport are those two inputs that must be removed from one sector to not count them twice. The reason is the way they are powered: electricity. The model includes the EV consumption in the electricity demand, and remove it from the transport sector when computing the total transport energy. Likewise, the rail transportation is very similar, with the difference that not all the railway is powered with electricity, but some trains still use fuel to work. Thus, the electricity part is removed from the transport sector and implicitly included in the electricity demand, whereas the non-renewable part accounts for the total energy accountability within the transport sector.

3.3 Heating and Cooling Sector. RES-H&C

The heating and cooling sector is extremely relevant to tackle the global warming, since it accounts for more than 50% of the total energy used across the EU, and it is expected to remain so.

The electricity sector is deemed as the driver to reduce the GHG emissions and take advantage of the synergies with the transport sector to decarbonize the economy. A step passes through the electrification of the transport by means of EV and NGV (Natural Gas Vehicles). Another solution focusing on the transport sector is the launch of better and more efficient engines at the same time the mobility undergoes the electricity and natural gas wave. The heating and cooling sector is the key to reduce the total energy consumption thanks to the development and installation of new technologies, e.g., heat pumps, or the substitution of conventional boilers burning coal and oil to natural gas boilers that are more efficient and low-carbon technologies.

Heat pumps result to be the medium-term solution to mitigate the GHG emissions and reduce the energy consumption in the heating sector.

3.3.1 Definition. The heating and cooling sector

The heating sector encompasses all modes of heating and cooling utilized by consumers to heat up and cool down the buildings they live or work in. Roughly speaking, there are three core businesses or areas and a fourth one that constitutes the rest of consumptions that cannot be classified within the other three.

The areas or businesses considered are:

- Residential
- Services
- Industry

¹⁴ Double counting is an error whereby, and in this specific case, the energy is counted more than once.

- Blurred sectors. Agriculture and cattle raising belong to this one.

Residential mainly implies households and some small commercial businesses such as local stores and small offices, which consumptions are similar to houses and apartments. In Spain [8], around 17.2 million houses are permanently occupied, out of which 12 million are apartments and familiar houses makes the leftover sum. On average, the consumption amounts to 0.85 ktoe and 3,500 kWh of electricity per year. Since electricity consumption in households comes from the grid, and, in order to avoid the double counting, the electricity consumption must be removed from the H&C calculations. This part in the residential sector is near 40% of the total consumption, on average.

Services sector gathers large facilities in the commercial sector, malls for instance, as well as big office buildings with great consumption and with heaters and chillers with more capacity than 6 kW. Education buildings, hospitals, restaurants and hotels are included here as well. Concerning the industry sector, Spain lacks industrial activities but, despite this fact, the consumption in this sector is very intensive, being higher than the residential sector. Thus, the implementation of RES within the industries could carry a great decrease in the total consumption, although it will require very big investments. However, the residential sector seems to be easier to board it, since the number of users is larger and, therefore, coordinated tiny enhancements have a big impact in the total number, at the same time the cost is widely spread among million users.

Last, the blurred sector includes business areas that are not specified, but they contribute to the renewable shared willed to achieve by 2030.

3.3.2 SHARES computation of RES-H&C

Eurostat addresses the calculation of the heating and cooling to the consumption of charcoal, biogases, municipal waste (biomass), geothermal and solar energy. All this information is gathered under the renewable questionnaire submitted by each MS to the European Commission on a yearly basis. A different tap is exclusively used for the heat pump values; the breakdown is very detailed, differentiating aerothermal heat pumps from hydrothermal ones, reversible and non-reversible, by type of coolant (air-air, water-air, etc.).

SHARES computes the renewable sources used in heating summing the renewable energy used in industrial activities and the other three remain sectors (residential, services and blurred sector) plus the energy heat pumps provide. A key issue here is to be discussed. Heat pumps are electrically driven and, therefore, the electricity from the grid powers them. It is right to say that the consumption of energy is the heat they produce, but this heat, likewise, has been produced by the conversion of electricity into heat. As a result, the energy that should be accounted must be the electricity consumed to produce that heat, which it is in this case. Now, since the energy comes from the grid, say, there are generators supplying that heat pumps' demand, the consumption is already included within the electricity sector. Adding the consumption of them also within the H&C energy vector, we are incurring in the so-called double counting. The double counting is an error derived from including twice, or more, a value in a calculation but in separate calculus that will end up put together.

Then, the SHARES model developed in this project takes only once the energy consumed. In this case, and as it will be explained in the next section, heat pumps' consumption is calculated in the H&C sector, but eliminated when computing the final gross energy and the overall energy share, as it is implicitly included in the RES-E.

3.3.3 RES-H&C model

Once determined and located the inputs needed to complete the heating and cooling sector, the process to create the H&C sector is detailed.

The H&C model is divided likewise into four sections, in accordance to the previous classification. Hence, the consumption is calculated for each subsector separately and put together at the end. Each subsector is formed by the aggregation of different sort of energy sources:

- Oil products
- Gas
- Solid fuels. Mostly coal
- RES, e.g., biomass, biofuel, geothermal, solar and biogas

An annual growth rate establishes the increase in heating demand throughout the forecasting. Fuel oil, gas demand and heat pumps are related on each other. The larger the operating hours of heat pumps, along with the COP and the substitution ratio, the gas and oil products change in time. The substitution ratio has to do with the number of oil boilers – mostly diesel boilers – that are subbed by heat pumps, hence, the higher the replacement ratio, the sharper the decrease in oil demand. The same ratio works right the opposite with the gas; the higher the substitution ratio, the smoother the gas demand will be, and more heat pumps will be destined to replace diesel boilers.

In addition, the gas demand has another parameter associated, which is the proportion between gas boilers and heat pumps currently being acquiring in the market. In accordance with it, a ratio of seven out of ten new boilers are gas boilers and three are heat pumps. By contrast, diesel boilers are deemed to reduce its utilization and slightly shifting to heat pumps instead. Solid fuels, coal and derives, are expected to disappear in this sector by 2030, while renewable sources grow correlatively to the overall heating growth defined as an input.

Regarding the heat pump issue, settling down the baseline in 2017, only heat pumps used in the residential sector are considered, but from 2018 upfront all heat pumps from any sector is included in the accountability of renewable heat. HPs have their own and separate growth rate, since this technology is deemed as the main driver to achieve the European goals in the heating sector by 2030. In the industrial sector the penetration of renewable sources by means of heat pumps is quite different. Firstly, the average power capacity for heating and cooling is, by large, greater than for commercial and households. An estimated average power capacity of 15 kW has been considered, although it can be change at will. Furthermore, the capital investment for this type of heavy equipment is very high so that it is expected than an extra 5% over the total new heat pumps installed in commercial buildings and households is going to replace the current situation. Criterion for gas and oil products remain the same as done with services and residential sector.

Computing all the values and adding them up into one, in total, the energy consumption within the heating and cooling sector amounts to 28,049 ktoe. Comparing the consumption with the Eurostat value is:

Table 9. Comparison on the gross final energy in the heating and cooling sector (2017)

Model	Eurostat	IDAE
28,049 ktoe	28,905 ktoe	28,277 ktoe

Noticing the error is small when calculating the final energy through different sources and methods, it is proved the model is robust in this aspect and can be concluded it is ready to be used to forecast future demand.

Moving to the renewable share calculus, summing all the RES terms¹⁵ in the residential, industry, services and blurred sectors, and make a comparison among Eurostat, IDAE and the model, the results are as follows:

Table 10. RES-H&C in 2017

Model	Eurostat	Error
17.48%	17.52%	0.04%

¹⁵ Heat pump contribution is included here to determine the individual RES-H&C, but in the overall calculation it does not

4 MODEL SCENARIOS

This chapter is devoted to deeply explain the inner parts of the model, how it works and the assumptions made to develop it. The idea is to set three scenarios, in order to cover a low, medium and high expectation on renewable energy sources penetration. Additionally, although this is not compulsory, but desirable, the low and high voltage shall be kept with no modifications, since they were created to set the limits of the model, but as already said, they are fully changeable like the medium scenario. The high scenario lies in the PNIEC report published by the Spanish Ministry for the Ecological Transition; a 42% of renewable share by 2030 is expected to be reached, whereas in the low scenario a 25% is expected to become.

Having said this, an explanation on how each quantity has been calculated and forecasted is next presented.

4.1.1 H&C

Formulas and calculations in the heating and cooling sector are very similar along the subsectors (residential, services, industry and blurred sector). Starting with the conventional fuels, there are three sort of fuels deemed as non-renewable, which are solid fuels, oil and gas. 2016 has been set as the baseline starting-time point. Therefore, data in 2016 were collected through the database IDAE provides in its website that can be publicly consulted. Solid fuels, coal mostly, are expected to be fully decommissioned by 2030. This assumption is based on the aggressive and energy policies Spain have recently issued in the BOE (Official Bulletin). A linear flat relation between past consumption and future consumption reflects this behavior.

$$Q_n = Q_{n-1} \cdot \frac{(Q_{2016} - Q_{2030})}{14} \quad [4.1]$$

Q_n . The energy amount, expressed in ktoe, consumed in the year n

n . It ranges from 2016 to 2030.

Gas behaves according to the growth in the sector, but it is also affected by the new heat pumps being installed, the substitution rate, the operating hours, the average consumption of the heat pump, COP and relation between the new heat pumps and new gas heating installed each year. Summing up, it results in the equation below:

$$Q_n = Q_{n-1} \cdot (1 + g_{n,i} - e_{n,i}) - (N_{n,Equipment} \cdot r_{n,s} \cdot r_{n,HP} \cdot (COP - 1) \cdot t \cdot C_n \cdot (1 - r_{n,sub})) / (11630 \cdot 1000) \quad [4.2]$$

Q_n . The energy amount, expressed in ktoe, consumed in the year n.

Annual growth (g_i). The expected demand increase, as a percentage, in the heating sector

Annual efficiency (e_i). Gain in efficiency expressed in percentage.

New equipment ($N_{Equipment}$). It comes from the subtraction of the new heat pumps equipment between two consecutive years.

Heat pump ratio (r_{HP}). Percentage of heat pumps out of the total new equipment (gas and HP).

Average consumption (C). Average consumption of the heating and cooling equipment of the residential and services sector.

Sector rate (r_s). Percentage each sector, residential or service, makes more use of heat pumps.

COP. Coefficient of performance usually is 3 for HPs. Gas and oil boilers have a coefficient of performance of 1.

Operating hours (t). Hours the heating is turned on during the year.

Substitution rate (r_{sub}). It is relation between the gas and oil boilers. As this parameter increases, the number of oil boilers will descend in exchange of a greater number of heat pumps replacing oil machines. If the substitution rate reaches a value of 1, then, it means all new equipment were utilized in the replacement of oil boilers.

Oil products' consumption diminishes in accordance to overall expected growth and the entry of heat pumps. Therefore:

$$Q_n = Q_{n-1} \cdot (1 - g_{n,i}) \cdot (COP - 1) \cdot t \cdot C \cdot r_{sn,ub} / (11630 \cdot 1000) \quad [4.3]$$

Renewable energy sources grow at the same level the expected overall growth in the sector:

$$Q_n = Q_{n-1} \cdot (1 + g_{n,i}) \quad [4.4]$$

The demand forecast in the industry sector changes a bit compared to the other ones. The reason has to do with the average consumption heaters and chillers, since they are bigger and more energy intensive devices.

$$Q_n = Q_{n-1} - (N_{Equipment} \cdot r_{sub} \cdot C_{Industry} \cdot (COP - 1) \cdot t \cdot r_{Industry}) / (11630 \cdot 1000) \quad [4.5]$$

Industry average consumption ($C_{Industry}$). The average consumption of industrial chillers and heaters, which are higher than that of residential and services sectors

Industrial rate ($r_{Industry}$). Since the investment in new equipment is much higher in this sector, this rate weighs the percentage of new equipment that is going to be installed in the industry based on the new equipment in the other sectors.

The total H&C energy consumption is the result of summing the total energy of each of the four subsectors¹⁶.

$$Q_{n,H\&C} = Q_{Residential} + Q_{Services} + Q_{Industry} + Q_{Blurred} \quad [4.6]$$

Finally, the RES-H&C share is calculated including the renewable energy of the heat pumps.

$$RES_{H\&C} = \frac{Q_{RES,Residential} + Q_{RES,Services} + Q_{RES,Industry} + Q_{RES,Blurred}}{Q_{n,Total} + Q_{n,HPs}} * 100 \quad [4.7]$$

The renewable energy provided by heat pumps is through the application of the formula stated in the Article 5 of the European Directive 2009/28/EC [9]. It says:

¹⁶ Excluding the heat pumps because they are included in the electricity sector consumption

$$E_{RES,HP} = Q_{Usable} \cdot \left(1 - \frac{1}{SPF}\right) \quad [4.8]$$

$$Q_{Usable} = H_{HP} \cdot P_{Rated} \quad [4.9]$$

Seasonal Performance Factor (SPF). Also known as the seasonal coefficient of performance (SCOP).

Equivalent full load hours of operation (H_{HP}). Time the heat equipment is operating. Depending on the region, HHP shall be higher or lower.

Rated power capacity (P_{rated}). The average power capacity installed of heat pumps.

4.1.2 Transport

The fleet is expected to increase throughout the years, thus, growth rates have been applied to each type of way of transport. In total, four annual growth rates until 2030. The rates are based on reports and historical data. The fleet's growth equation ends up like the one below.

$$T_{n,i} = T_{n-1,i} \cdot (1 + g_{n,i}) \quad [4.10]$$

n. Year under study.

i. From 1 to 4, the type of mean of transport.

*Table 11. Configuration of the *i* term in the transport equations*

Truck and trailer	LDV	Private car	Motorcycle
1	2	3	4

Annual growth ($g_{n,i}$). Expected yearly growth for each type of transport mode. The renovation ratio is included.

Following an accountability of new and old vehicles of the fleet for further calculations, a breakdown among old, new and replaced vehicles is carried out. The replaced vehicles lean on a replacement rate. Within the replacement rate, it is differentiated the renovation of a vehicle for another of the same kind (conventional car by conventional car, for example) against electric vehicles and vehicles powered by natural gas. Likewise, a breakdown between EV and NGV is made as well. This classification is necessary to envisage the number of EV that will be rolling on the Spanish roads in the future, and to incorporate the enhancements in the new vehicles purchased later than 2020.

Starting with the calculation of the new vehicles, this is calculated by means of the fleet from the previous year multiplied by the yearly growth rate (equation [4.8]). New vehicles which have been replaced are obtained through the following equation:

$$N_{n,i} = T_{n-1,i} \cdot (1 + g_{n,i}) \cdot r_{n,r} = T_{n,i} \cdot r_{n,r}$$

[4.11]

Renovation ratio (r_r). Percentage out of the total fleet that is renewed every year.

Moving to the calculus, in ktoe, of the energy consumption in the transport sector, and attending to Table 6 to know what technologies to include in the calculations; trucks can be either gasoline or diesel, motorcycles just gasoline and electric, etc. Depending on the sort of vehicle, it can be distinguished two modalities when computing the conventional engines: old and new gasoline and diesel engines. EV and NG are considered as new acquisitions always in this model.

For old gasoline and diesel engines, the formula to be applied is:

$$Q_{i,old} = (T_{n,i} \cdot (1 - r_{n,r}) \cdot r_j \cdot m_i \cdot C_i \cdot cf_i) / (100 \cdot 1000 \cdot 11630) \quad [4.12]$$

Specific fuel-technology type (r_j). Share of each type of fuel in the different branches. The term j refers to the type of fuel, 1 accounts for gasoline and 2 for diesel.

Mileage (m_i). Average mileage for each branch. There is a disaggregation in branch one, trucks and trailers, where the mileage is different between these two, being the trailer mileage larger.

Average consumption (C_i). Consumption of each branch.

Conversion factor (cf_i). Factor used to convert the consumption expressed in L/100 km into kWh/100 km.

New gasoline and diesel vehicles is calculated just by adding an extra term in the equation [4.10] and changing the total fleet just by the new vehicles incorporated in the fleet, the renovation ratio minus the rate out of which the renewed vehicles are powered either by electricity or by gas. Therefore:

$$Q_{i,New} = (N_{n,i} \cdot (1 - r_{n,r}) \cdot (1 - r_{nt}) \cdot r_j \cdot m_i \cdot C_i \cdot cf_i) / (100 \cdot 1000 \cdot 11630) \quad [4.13]$$

Ratio of new technologies (r_{nt}). This ratio measures the percentage of new cars that are EV or NGV.

Electric vehicles and natural gas vehicles are computed as follows:

$$Q_{i,NGV} = (N_{n,i} \cdot r_{nt} \cdot r_{NGV} \cdot m_i \cdot C_i \cdot cf_i) / (100 * 1000 * 11630) \quad [4.14]$$

Natural gas vehicle ratio (r_{NGV}). It measures the percentage of NGV

$$Q_{i,EV} = (N_{n,i} \cdot r_{nt} \cdot (1 - r_{NGV}) \cdot m_i \cdot C_i \cdot cf_i) / (100 * 1000 * 11630) \quad [4.15]$$

The RES-T is calculated in the same way as the total energy just right explained, but with slight differences. First, NGVs do not account for the renewable energy share, EVs does. Second, the renewable energy contained in the conventional fuels is determined by the content of biofuels of them. The CNMC¹⁷ publish the biofuel percentage conventional fuels contain (see Figure 5). And third, although it has been considered nil due to its low development in

¹⁷ The National Commission of Markets and Competition.

Spain, there is room for the biogas as a fuel if in the coming years biogas becomes a driver in the energy transition.

$$Q_{n,RES,T} = (Q_{i,Old} + Q_{i,New}) \cdot r_{Bio,k} + Q_{i,EV} + Q_{i,Rail} \cdot r_{n-2,Mix} \cdot 0.8 \quad [4.16]$$

Content of biofuel ($r_{Bio,k}$). It goes from 1 to 2, being 1 bioethanol and 2 biodiesel.

Energy consumption in railway transport ($Q_{i,Rail}$). Energy consumed by trains both electric and non-electric energy.

Energy mix of the electric power industry ($r_{n-2,Mix}$). Just to include in the RES-T the share of electricity (renewable electricity) the railway energy is multiplied by the renewable energy mix two years before the year being calculated and by a coefficient estimated based on historical data that indicates the share of electricity railway mode utilizes. The leftover correspond to fossil fuels. In this case, the percentage has been estimated with an 80% share.

In addition, it is needed to come up with aviation, railway and ship consumption. These data are extracted from IDAE database. Since these consumptions are blurred and difficult to estimate, a flat coefficient has been applied to each of them. Railway transport is expected to grow 5% annually, aviation 1% and shipping mode 3%. However, the railway electric energy consumption is included in the calculation of the RES-T share, but as it happens with the heat pumps in the heating and cooling sector, this amount is removed when computing the overall RES share in order to avoid the double counting.

$$Q_{n,T} = Q_{i,Old} + Q_{i,New} + Q_{i,NGV} + Q_{i,EV} + Q_{i,Rail} + Q_{i,Ship} \quad [4.17]$$

As a reminder, aviation is utilized as an adjusting energy, and is included when in the GFCoE calculus.

Finally, the RES-T share is calculated as follows:

$$RES_T = \frac{Q_{n,RES,T}}{Q_{n,T}} \cdot 100 \quad [4.18]$$

4.1.3 Electric power industry

Three parameters are used to determine the energy within the electricity sector. Those are:

- Installed power capacity
- Generation (annual generation and normalized generation)
- Operating hours

Combining the three of them, it is possible to completely define this sector. Heat pumps and electric vehicles are included in this sector too. The power capacity baseline is set with REE database, which can be consulted at its website. There are available data for 2017 and 2018, thus, 2019 until 2030 will be forecasted.

Inputs in this regard can be both manually or by means of formulas written. This is the case for hydroelectric, nuclear, pumping storage. fuel, CCGTs, thermal solar and renewable thermal power plants. The capacity of the mentioned technologies have been set manually due to its certainty about how they will evolve through the time. The hydraulic potential in Spain is almost

exploited and there are no further expectations on it to expand; pumping storage power plants follows up the trend. In the nuclear sector, there is certainty about the evolution of them. For the medium scenario, as an example, the installed capacity changes in 2028 and 2029 since the CSN¹⁸ has ordered the progressive decommissioning of the current nuclear reactor. By 2030, Almaráz I and Almaráz II will be decommissioned, Almaráz I in 2028 and Almaráz II in 2029.

As the transition is going along the way, the natural gas places as a main driver for this energy transition. There are no further intentions on investing in more CCGTs, because currently the Spanish power sector is oversized and there is enough capacity to cope the current demand. Fuel oil, thermal solar and renewable thermal are deemed to remain constant throughout these coming years.

The left technologies to be talked about are coal, cogeneration, wind and solar. As the future is unpredictable, it has been chosen a flat increase – or decrease – in the evolution of the capacity of these four technologies. Coal and cogeneration power plants are expected to lower their power generation, so will their power capacity, whereas wind and solar plants are considered to be the core of the electricity generation in Spain, with a huge increase by 2030.

The growth, decrease, is effectively made through the formula showing next. Since the cockpit only allows modifying every five years the inputs, i.e., 2020, 2025 and 2030, the capacity values change accordingly to this rule. For instance, the capacity one period for wind and solar energy would be expressed with the formula:

$$P_{n,i} = \frac{P_{UL} - P_{LL}}{5} + P_{n-1} \quad [4.19]$$

n. year considered.

i. Type of technology.

Power capacity upper limit (P_{UL}). The upper limit's period (2025 or 2030).

Power capacity lower limit (P_{LL}). The lower limit's period (2020 or 2025).

Coal and fuel oil forecasted capacity is obtained inverting the upper and lower limit.

$$P_{n,i} = \frac{P_{LL} - P_{UL}}{5} + P_{n-1} \quad [4.20]$$

Concerning the operating hours, these have been assumed on historical data. There is a bifurcation in the wind power due to the better exploitation thanks to the enhancements on the foils, that can be produced even with low wind velocities. The only technology in which the operating hours are not defined manually is the coal power plants. Instead, the generation is fixed and the working hours come up from the generation divided by the installed power capacity. Having said that, new wind turbines will have a better utilization of the wind, and therefore, the operating hours will be higher than those in the current generation mix, which have 2,500 hours.

Last branch of the electricity sector is the generation. There are two generation calculus, one with the forecasted generation and the other one take into account the normalization of hydro and wind power¹⁹. The one it is calculated is simply the multiplication of installed power capacity by the

¹⁸ Nuclear Security Council ('*Consejo de Seguridad Nuclear*')

¹⁹ European Directive 2009/28/EC.

annual operating hours of each technology. There are some exceptions, such as the CCGT's generation, the wind power, coal, hydro-wind and others.

Coal has been already stated that the production is manually set, so do hydro-wind and others; wind power is split into two parts according to the old and new parks put in operation. The formula to express the wind power production on a yearly basis is:

$$E_{n,Wind} = P_{2018,wind} \cdot t_{n,wind} + (P_{n,New\ wind} - P_{2018,wind}) \cdot t_{n,New\ wind} \quad [4.21]$$

n. Year

Installed capacity of current wind facilities ($P_{2018,wind}$). 2018 has been established as the limit to which set the operating hours for the current wind farms deployed across the territory.

Installed capacity of future wind installations ($P_{n,New\ wind}$). From 2018, new facilities will be considered as better turbines with high performance even at low wind conditions. Therefore, the operating hours will increase.

Combined cycle gas turbines close the generation loop to cope with the demand that is set as a parameters based on the last available data (demand in 2018).

$$E_{n,CCGT} = Demand - \sum E_{n,i} \quad [4.22]$$

Being $E_{n,i}$ the annual production for each type of technology (technology is defined by the I coefficient).

The normalization is used to compute the overall renewable energy share in the electricity sector. Having said so, it only applies to wind and hydroelectric production. The formulas to normalize such productions have been explained previously.

Moving forward in the explanation of more parameters, it comes the interconnection, pumping consumption, electricity demand, self-consumption in generation activities and losses in transport, distribution and energy transformation.

Interconnection in Spain has nowadays an import balance, but it is expected to become an exporter country as the penetration of RES comes to reality. According to this assumption, the net balance is starting from an import balance and ending up in an export balance.

National electricity demand is the parameter that closes the model. Departing from 2018, an annual increase of 0.9% is justified as the expected annual growth of electricity demand until 2030.

Self-consumption in generation accounts for 4.5% of the total generation until 2025, year where it diminishes to 4% due to the high renewable energy sources. Transport, distribution and transformers' losses amounts to 12% of the demand. Pumping storage consumption is 4 GWh flat consumption.

4.1.4 Assumptions

Prior going to the outputs explanation and discussion, this section is devoted to make understand the reader why to decide to change one input in detriment of any other.

The model enables the user to change any input, thus, many possible combinations to reach out the RES target are plausible and totally valid. This project has been thought to assess the



feasibility of new renewable projects in the electricity sector. Hence, the priority to compute the inputs is the wind and solar power, followed up by the EVs and finally the HPs. Solar and wind power plants are well-known and there is a lot of interest on investors' behalf to promote and develop wind projects.

Solar energy is the same thing, although is not as developed as wind is, the incipient decrease in production costs has stirred the willingness to promote this sort of technology, not just carried forward by utilities at large scale, but also at small scale. Consumers are becoming aware of the economic benefits the solar self-consumption brings along and the enhancements and support they will provide to the network.

By contrast, heat pumps are making room in the heating and cooling sector, but not as much as gas boilers do. Currently now, the gas is the driver to a low-carbon heating sector; gas technologies are cheaper. In addition, the shrink of gas prices in the international markets has propitiated this behavior.

5 RESULTS

All that has been already presented is, to some extent, the inwards of the model. As any other model, it needs an interface that enables the user to interact throughout an accessible and visual cockpit. The idea is to make visual and easy the presentation of results.

INPUTS	Low RES Penetration Scenario (BAU)					Medium RES Penetration Scenario					High RES Penetration Scenario				
	2017	2018	2020	2025	2030	2017	2018	2020	2025	2030	2017	2018	2020	2025	2030
Heating and Cooling Sector															
Growth	1,00%	1,00%	1,50%	2,00%	2,00%	1,00%	1,00%	3,00%	3,50%	3,50%	1,00%	1,00%	3,50%	5,00%	5,00%
Heat pump replacement ratio	-	-	20,00%	20,00%	20,00%	-	-	50,00%	50,00%	50,00%	-	-	70,00%	70,00%	70,00%
Heat pump growth ratio	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	3,00%	3,00%	3,00%	1,00%	1,00%	5,00%	5,00%	5,00%
Transport Sector															
Truck growth ratio	0,30%	0,75%	1,00%	1,00%	1,00%	0,30%	0,75%	1,00%	1,50%	2,00%	0,30%	0,75%	1,50%	1,50%	1,50%
Van growth ratio	1,40%	1,60%	1,50%	1,50%	1,50%	1,40%	1,60%	1,50%	2,00%	2,50%	1,40%	1,60%	3,50%	3,50%	3,50%
Car growth ratio	2,70%	0,75%	2,00%	2,00%	2,00%	2,70%	0,75%	1,50%	3,00%	3,50%	2,70%	0,75%	3,00%	3,00%	3,00%
Motorcycle growth ratio	3,60%	3,00%	3,00%	3,00%	3,00%	3,60%	3,00%	3,00%	3,00%	3,00%	3,60%	3,00%	4,00%	4,00%	5,00%
Trailer growth ratio	0,50%	0,50%	1,00%	1,00%	1,00%	0,50%	0,50%	1,00%	1,50%	1,50%	0,50%	0,50%	1,00%	1,00%	1,00%
Fleet renovation ratio	-	4,00%	0,50%	0,50%	0,50%	-	2,00%	2,00%	2,50%	3,00%	-	2,00%	3,50%	4,00%	4,00%
% EV&NG from renovation	-	10,00%	20,00%	30,00%	40,00%	-	10,00%	30,00%	50,00%	50,00%	-	10,00%	50,00%	70,00%	90,00%
%EV	-	30,00%	30,00%	30,00%	30,00%	-	30,00%	50,00%	60,00%	70,00%	-	30,00%	40,00%	50,00%	60,00%
Electricity Sector															
Wind [MW]	22.600	22.995	24.000	27.000	31.000	22.600	23.507	26.000	34.000	39.000	22.600	22.995	26.000	38.000	51.000
Solar PV [MW]	4.688	4.707	6.000	8.000	11.000	4.688	4.707	8.000	16.000	32.000	4.688	4.707	10.000	25.000	40.000
OUTPUTS															
Aggregate of HPs	1.935.321	1.954.674	1.993.963	2.095.675	2.202.575	1.935.321	1.954.674	2.033.447	2.311.549	2.679.719	1.935.321	1.954.674	2.072.932	2.645.644	3.376.587
New HPs	-	19.353	39.289	101.712	106.900	-	19.353	78.773	278.102	368.170	-	19.353	118.258	572.713	730.943
Aggregate of EVs	30.000	15.355	46.584	141.734	303.177	30.000	10.090	76.256	485.233	1.503.222	30.000	10.090	146.918	1.032.416	3.013.744
Aggregate of NGV	8.500	35.827	108.696	330.712	707.413	8.500	23.542	104.036	464.020	1.109.499	8.500	23.542	237.989	1.431.578	3.304.604
Total national demand [TWh]	268.829	269.766	279.593	292.832	306.819	268.829	269.766	272.194	284.665	297.708	268.829	265.353	270.410	291.309	313.822
Gross Final Energy [ktoe]	86.453	84.358	85.793	88.281	89.486	85.221	83.527	82.385	80.966	80.673	82.701	81.251	80.159	80.937	76.940
RES H&C	4.416	4.460	4.573	4.950	5.465	4.416	4.460	4.640	5.405	6.420	4.416	4.460	4.663	5.618	7.170
RES Transport	1.898	1.808	1.870	1.876	1.886	1.798	1.679	1.651	1.513	1.321	1.898	1.808	1.821	1.677	1.510
RES Electric	8.397	8.144	9.117	10.674	12.471	8.397	8.144	9.331	13.074	16.898	8.397	8.144	9.654	15.497	21.211
Overall RES Share	17%	18%	18%	22%	25%	17%	18%	20%	25%	32%	18%	19%	20%	30%	42%

Figure 6. Energy transition's dashboard²⁰

The panel is divided into three big columns, one for each scenario. Leftwards to rightwards: low scenario (BAU), medium scenario and high scenario. The inputs selected as the most relevant ones were:

- **Heating and cooling sector (H&C).** Expected growth in H&C, heat pump replacement ratio and heat pump growth ratio.
- **Transport sector (T).** Truck, LDV, Car, Motorcycle and trailer growth ratio, fleet renovation ratio, ratio of new technologies (NGV and EV) and EV percentage out of the ratio of new technologies entering.
- **Electric sector (E).** Wind and solar power capacity installed.

The inputs are labelled every five years, starting from 2020. Years 2017 and 2018 have been set as the baseline due to the data is known and official. This is just to check the evolution from historical data to forecasting.

The dashboard gives as outputs the number of HPs EVs and NGVs by the end of 2030, showing the amount of them every five years. Highlighted in blue the gross final energy consumption – in ktoe after summing up the total energy used in each of the three sectors – and the overall renewable energy sources share (RES). A breakdown of ktoe of renewable energy in each sector is showed as well.

The user can interact and change any input highlighted in green of his choice. The outputs²¹ will be automatically updated.

²⁰ See annex for better quality and clarity.

²¹ Any other output, input or data is available for consultation at any time.



Figure 7. Final energy consumption for the medium scenario²²

Focusing more in detail on some outputs, there is a big impact EVs have on the final energy consumption, at the same time they contribute to the overall RES. Next, it is shown a comparison among the three scenarios; GFCoE, RES, EVs, solar and wind power are collected through the following table:

Table 12. Output comparison

	EV	Wind	Solar	GFCoE	RES
Low	303,177	31,000 MW	11,000 MW	89,486 ktoe	25%
Medium	1,493,139	39,000 MW	32,000 MW	82,022 ktoe	32%
High	3,013,744	51,000 MW	40,000 MW	76,940 ktoe	42%

At a glimpse, it can be noticed some differences. The business as usual scenario contemplates a low penetration of both solar and wind power; electric vehicles do not have the impact and the increase is steadily, hitting the amount of three thousand hundred. The energy increases up to 89.5 Mtoe, which seemingly could be translated into an increase in the CO₂ emissions, failing the EU's directives. The overall RES would end up in 25%, resulting in a 0.6% gain per year.

The high RES penetration scenario is to be unlikely to happen, since it would require a massive deployment of renewable energy sources, alongside huge investments. First, the wind capacity would be more than twice the actual, regarding solar energy more around 32 GW would be installed, and this scenario contemplates that by 2030 more than three million EV will be rolling out on Spanish roads. Likewise, the final energy consumption will trespass the barrier of 80 Mtoe and achieving a renewable share of 42% with 65% of renewable energy in the energy mix within the electric power industry.

The focus shall lie in the medium scenario, the one that is more likely to come by 2030. According to many reports, the cypher of electric vehicles ranges from 1.5 to 2.5 million in 2030. The price of electric cars and the autonomy batteries provide in the market are not very attractive, by now, to switch a gasoline or conventional engine at low prices and with more than 700 km in the fuel tank. Hence, based on this reasoning, the number of electric vehicles does not exceed the

²² See annex for better quality and clarity.

million and a half vehicles. Renewable installed capacity for solar and wind energy reaches attainable levels if companies and consumers bids to this energy transition. The gross final consumption of energy will slightly decrease to 82 Mtoe. It is justified because from the one side the demand increases, but on the other side enhancements in the sectors, efficiency gain and more renewables diminish the overall consumption. Eventually, the energy share from renewable sources reaches out 32%.

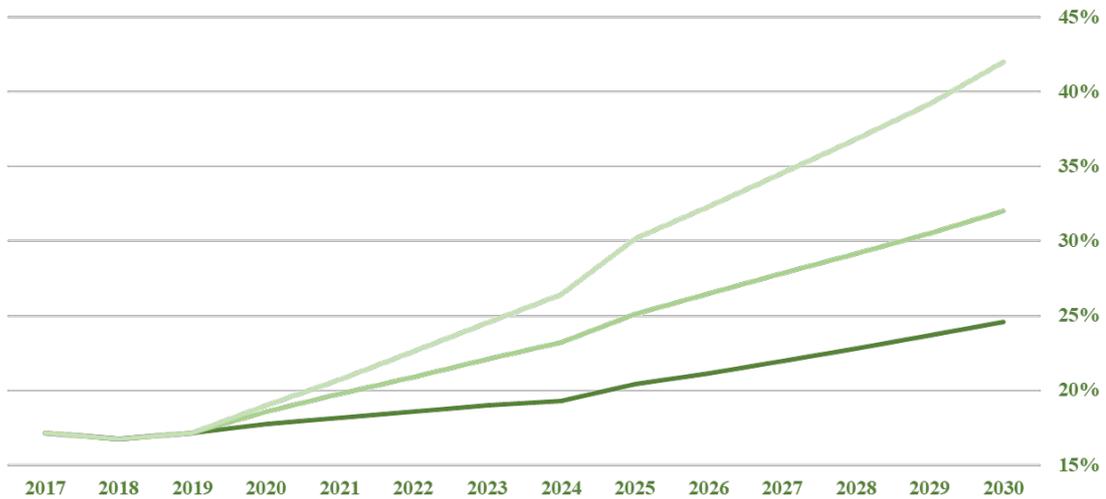


Figure 8. BAU, medium and high RES tendency

After the energy auctions in 2019, it is estimated the deployment of large PV and wind installations projects in the coming years. Regarding the EVs, 1.5 million are expected to come due to the governmental subsidies and the rapid development the automotive sector is undergoing. Battery systems are the cornerstone of the EV price that is nowadays higher than the conventional combustion engines. Heat pump systems are not expected to soar very much, instead, a steadily increase will come throughout the coming years. The reasons for this smooth increase are: high investments in replacing the conventional heaters, especially in big cities, where the heating is centralized; and the tendency small and medium consumers are adopting in installing solar panel in their rooftops. Self-consumption is in the spotlight more than ever due to the recently amendment the Spanish government has approved. It has to do with the new mechanism that allows self-consumers to inject surplus of energy into the grid and be remunerated for it. This fact may shift the ‘boom’ of heat pumps in exchange of more PV installations at small scale.

Considering each of the three sectors separately, the computation of the energy from renewable sources is depicted below.

Table 13. Individual calculation of the renewable energy share

RES-H&C	RES-T	RES-E	Overall RES
27.90%	7.66%	65.32%	32.02%

It is remarkable the contribution of the electric power industry, which doubles the overall share thanks to the penetration of solar and wind energy, as well as the contribution of EVs and HPs that increase the demand, and therefore, the need of installing more renewable energy generators.

Talking about the gross final energy, by sectors too, the results are:

Table 14. Comparison of GFCoE on the period 2017-2030

Year	H&C	Transport	Electricity	Total ²³
2017	28,063.85 ktoe	29,303.85 ktoe	24,299.83 ktoe	85,836 ktoe
2030	28,264.08 ktoe	22,125.53 ktoe	25,328.66 ktoe	81,908 ktoe

The transport shrinks such in a great way, mostly because of the introduction of new enhancements that decrease the engines' consumption and pollutants, in order to comply with the EU's regulations on CO₂ emissions. NG in trucks will play an important role in this regard, and electric vehicles too, moving the demand of 'fuel' to the electricity sector.

The next two charts depict the evolution of the electricity generation sector by power capacity and electricity demand in Spain. Wind and solar are the technologies that experiment a huge increase. Gas turbines remain still in terms of capacity, but due the decrease of coal production due to environmental reasons, and alongside the decommissioning of coal power plants, the CCGT plants becomes the perfect substitute to cope with the lack of firm capacity and inertia to the system. NPPs are still the baseload in the Spanish sector, and will be producing a large share of the total demand, even-though the decommissioning of the two-reactor power plant Almaráz will be made effective as of 2029.

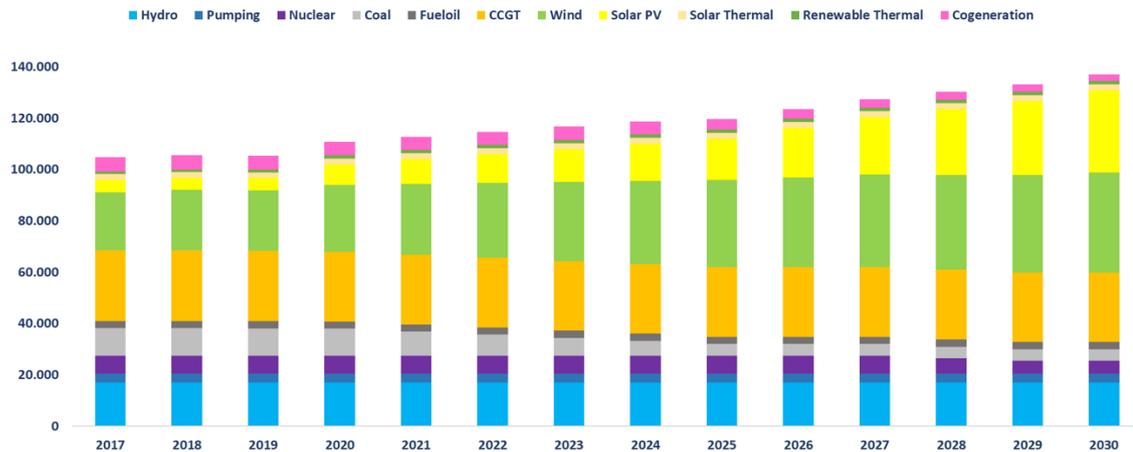


Figure 9. Power installed capacity in the electric power industry

²³ Includes aviation consumption and renewable gas that is distributed across the sectors.

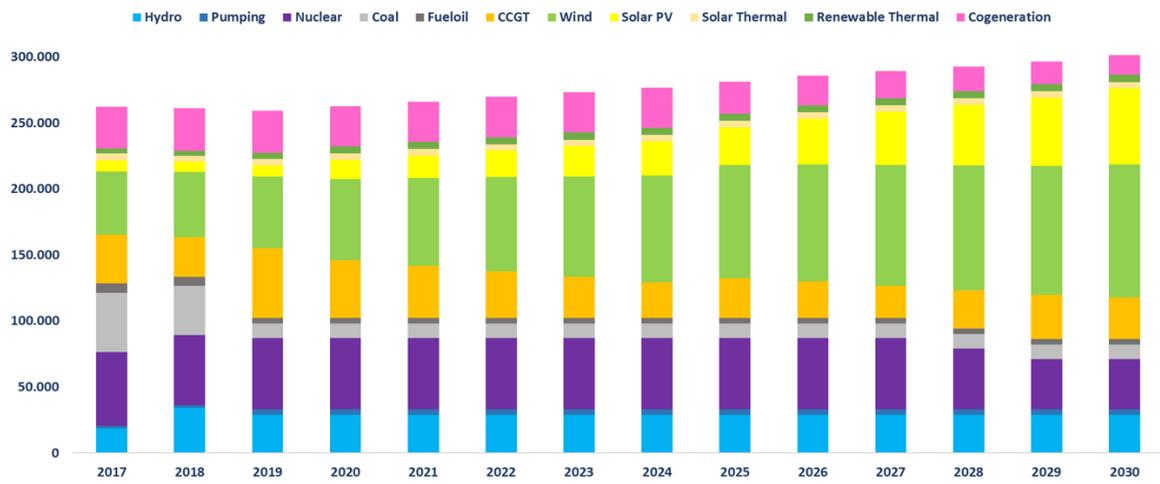


Figure 10. National demand by type of technology

6 CONCLUSIONS

Once analyzed the final outputs and putting them into context, some conclusions can be drawn out of the model and its implications. The results have been discussed and commented in Chapter 5. Here lies a brief reflection on the implications the results given by the model might cause.

An economic and technical assessment is required for each scenario to perform a good investment decision. Also, the benefits of the investments must overcome the cost of installing RES facilities, purchase electric vehicles or change the heating systems by heat pumps, if not, everything will be void of sense and useless.

By 2030, according to the model's outputs, the gross final energy consumption will decline up to 82 Mtoe, according to the medium scenario, which is likely the most plausible case. By contrast, a high penetration of renewable energies means reaching 42% of renewable energy share, a share very high if compared with the current, which amounts to 17.5%. For this goal, more than three million electric vehicles are expected to be rolled out in the next twelve years, and the energy will shrink to 77 Mtoe. Finally, the business as usual scenario follows up the current policies and dedication governments have, with low expectations on new investments in sustainable energy. In fact, the energy consumption increases and almost hit the barrier of 90 Mtoe.

This model enables to modify several inputs according to own expectations, and gives too much freedom on selecting the inputs that must be changed to predict the future of the energy sector. The electricity sector is the cornerstone, as the majority of renewable penetration comes, directly or indirectly, upon the electricity generation. It is the sector that will grow the most, almost doubling the current contribution to the total, from 36% to 65% in year 2030.

Concerning the transport sector, the use of biofuels will diminish as the natural gas and electricity will cope and overcome the use of conventional gasoline and diesel. Biogas is an alternative, but still needs to be developed. Heating and cooling sector grows thanks to the use of natural gas, as it pollutes less than oil and coal. Oil decreases its utilization and coal is expected to disappear by 2030. It, which is the highest consumption of all, will experience a continuous but slow energy transition in which heat pumps will gradually become hollow in homes, small businesses and industries. In turn, self-consumption (solar panels on rooftops) has recently been pushing the use of renewable energy for the consumption of hot water and electricity.

In addition, the given results are based on today's perception and knowledge, which means that, efficiency, consumption per unit and so forth are calculated based on the current characteristics of the sector, with a prognosis on how much they will evolve throughout the time. For instance, the actual performance of wind turbines is close to 2,500 hours of operation on a yearly basis. If new enhancements are introduced in the old facilities by means of the so-called re-powering process, the operating hours will increase and very likely this will be translated in the need of less renewable installed capacity in the coming years. The model has estimated a total wind capacity of 39 GW and 32 GW of solar PV. Furthermore, it seems quite difficult that Spain attain such large amount of 32 GW installed in twelve years if looking to the current power installed that is near 8 GW.

Some incentives regarding the RES deployment might be needed. The penetration of renewable energies in the past was possible thanks to the subsidies the governments gave to the owners of those facilities, but now, those are sufficiently competitive to invest without any sort of economic certainty. It is time to procure with some investments to the emerging technologies

that are expected to be by 2030. The electric vehicle (EV) is one of those technologies that needs a slightly push to become a reality. Consumers and drivers are not very sure to face a major change in moving from fossil fuels to electricity. The reason lies mostly in the purchase price, which is a bit higher for the time being. Thanks to the subsidies and discounts municipalities are giving to those drivers willing to bet for the electric mobility is making this sector grow steeply.

The cutting-edge technologies arising in the market have not been considered in the model. The storage systems, both large and small scale could be a break-even point in the future of the energy sector. If they prove their good performance and scalability alongside a competitive price, the interruptibility issues and lack of generation will decline to extreme levels, as the supply will be guaranteed whenever a line trips, since consumers could be able to have a household-battery to cope with small blackouts. The reason to not include this technology in the analysis is their low maturity and the lack of enough data and experience with them in real conditions. Nevertheless, this technology will make some noise sooner than later, as well as other emerging energy processes such as the H₂ in the transport sector.

The technical feasibility is an important issue to take into account. Even-though it is worth investing in such technologies, this willingness shall be rejected due to technical problems. The massive rollout of electric vehicles requires the deployments of charging points across the territory, and this fact is not always possible, at least in the short-term. In the electricity sector, when talking about large scale facilities that directly inject the electricity into the grid at high voltage, it is REE the responsible to assess and give green light to the projects. Moving to medium and low voltage structures, the EV carries the electrification of the mobility, so that distribution companies have to assess and evaluate if the actual network would be capable of withholding the future demand derived from the charging points users will install at their households, or in the streets, offices, etcetera. A priori, taking a look at the results, the EV will not make distribution companies to incur in further investments on reinforcing the low voltage network, since the demand increase is low compared with the total demand (3.5 TWh in the medium scenario with 1.5 million electric vehicles).

An issue that is not very much discussed and put on the table is the interconnection capacity. In the case of Spain, a country neighboring with Portugal and France, and to some extent to Morocco; to some extent because Morocco do not belong to the European Union and the rules and policies do not apply to them, if these three European countries caught up with the EU's goals there will be most of the time, for sure, excess of renewable energy production. As this energy cannot be evacuated, there will be poured as spillage, thus, a spillage of energy which is very inefficient. The idea of the interconnection tries to solve the lack of supply among the neighbor countries; therefore, the power capacity needed to install by the MSs may be reduced if the interconnection capacity reaches the 15% imposed by the European Commission.

Linking to the interconnection capacity, the solution to avoid the energy spillages could be the oversizing of the lines. This way it would make sense to install, in the case of Spain, the large amount of solar and wind power, to supply a demand in the northern Europe where is cloudy and due to some climate event the wind is not blowing.

All of the current discussion must be done amid the uncertainty of political issues and changes in the current regulations. This topic might be deemed as the most important one when envisaging a decision-making. Therefore, parties, no matter what wing, must find a common path that gives uncertainty to the investors since these sort of decisions takes long periods of time to be profitable and paid back the initial investment.



In any case, the challenge that Spain faces in order to comply with Directive 2009/28 / EC requires a great coordination between government, companies and consumers in order to create incentives for investments in all sectors and at any scale. Only this way will be ended up in success, and synergies can be exploited to the fullest, although a thorough analysis of the impact that will involve investments is more than necessary to avoid making the mistakes of the past²⁴.

²⁴ Address to the solar PV owners feed-in tariff's case.

7 REFERENCES

- [1] Energy Information Administration, «On the Road toward 2050,» 2015.
- [2] Ministry for the Ecological Transition, «La Energía en España 2016,» 2016.
- [3] European Commission, "SHARES Tool Manual," 2017.
- [4] S. A Kallen, What Energy Sources Should Be Pursued?, San Diego: Greenhaven Press, 2005.
- [5] Sloan Automotive Laboratory, MIT, "Potential for Substantial Reductions in Light-Duty Vehicle Energy Use and Greenhouse Gas Emissions," 2015.
- [6] European Commission, «Directive 2009/28/EC of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources,» 2009.
- [7] European Commission, «The Trans-European Transport Network. An EU that Delivers Investments in Smart, Sustainable and Safe Mobility for Jobs and Growth,» Ljubljana, 2018.
- [8] DGT, "Historical Series Vehicle Fleet," 2017.
- [9] Ministry of Industry, Energy and Tourism, "'Consumos del Sector Residencial en España'," 2015.
- [10] European Commission, "Establishing the Guidelines for Member States on Calculating Renewable Energy from Heat Pumps from Different Heat Pump Technologies Pursuant to Article 5 of Directive 2009/28/EC of the European Parliament and of the Council," 2013.
- [11] European Commission, «An EU strategy on heating and cooling,» Brussels, 2016.
- [12] Ministry for the Ecological Transition, «Energy and Climate Integrated National Plan (PNIEC),» 2019.

8 ANNEX

This chapter is exclusively dedicated to the collection of any data that might be relevant for the good understanding of the results the model gives. The inner parts of the model are shown here, as well as the inputs that are not shown on the energy transition's dashboard.

The order tables and figures are presented is:

- 1) General calculations and outputs. This includes the dashboard and the Eurostat's calculations for the electricity sector.
- 2) Medium scenario. Outputs and tables related to the medium scenario, the one which has been discussed and presented throughout this document.
- 3) Low scenario data.
- 4) High scenario data.



Low RES Penetration Scenario (BAU)

Medium RES Penetration Scenario

High RES Penetration Scenario

INPUTS	2017	2018	2020	2025	2030
Heating and Cooling Sector					
Growth	1,00%	1,00%	1,50%	2,50%	3,50%
Heat pump replacement ratio	-	-	40,00%	40,00%	40,00%
Heat pump growth ratio	1,00%	1,00%	1,00%	2,00%	3,00%
Transport Sector					
Truck growth ratio	0,30%	0,75%	1,00%	1,00%	1,00%
Van growth ratio	1,40%	1,60%	1,50%	1,50%	1,50%
Car growth ratio	2,70%	0,75%	2,00%	2,50%	3,00%
Motorcycle growth ratio	3,60%	3,00%	3,00%	3,00%	3,00%
Trailer growth ratio	0,50%	0,50%	1,00%	1,00%	1,00%
Fleet renovation ratio	-	2,00%	0,50%	0,50%	0,50%
% EV&NG from renovation	-	10,00%	20,00%	30,00%	40,00%
%EV	-	30,00%	30,00%	30,00%	30,00%
Electricity Sector					
Wind [MW]	22.600	23.507	24.000	27.000	35.000
Solar PV [MW]	4.688	4.707	6.000	8.000	13.000
OUTPUTS					
Aggregate of HPs	1.935.321	1.954.674	1.993.963	2.116.424	2.359.612
New HPs	-	19.353	39.289	122.461	243.188
Aggregate of EVs	30.000	10.090	35.683	131.317	305.451
Aggregate of NGV	8.500	23.542	83.260	306.405	712.720
Total national demand [TWh]	268.829	0	272.194	284.665	297.708
Gross Final Energy [ktoe]	85.836	86.057	85.305	86.690	87.958
RES H&C	4.416	4.460	4.573	4.975	5.683
RES Transport	1.898	1.790	1.803	1.822	1.869
RES Electric	8.397	8.144	8.765	10.096	12.872
Overall RES Share	17%	18%	19%	20%	25%

INPUTS	2017	2018	2020	2025	2030
Heating and Cooling Sector					
Growth	1,00%	1,00%	3,00%	3,50%	3,50%
Heat pump replacement ratio	-	-	50,00%	50,00%	50,00%
Heat pump growth ratio	1,00%	1,00%	2,50%	3,00%	3,50%
Transport Sector					
Truck growth ratio	0,30%	0,75%	1,00%	1,50%	2,00%
Van growth ratio	1,40%	1,60%	1,50%	2,00%	2,50%
Car growth ratio	2,70%	0,75%	1,50%	3,00%	3,00%
Motorcycle growth ratio	3,60%	3,00%	3,00%	3,00%	3,00%
Trailer growth ratio	0,50%	0,50%	1,00%	1,50%	1,50%
Fleet renovation ratio	-	2,00%	2,00%	2,50%	3,00%
% EV&NG from renovation	-	10,00%	30,00%	50,00%	50,00%
%EV	-	30,00%	50,00%	60,00%	70,00%
Electricity Sector					
Wind [MW]	22.600	23.507	26.000	34.000	39.000
Solar PV [MW]	4.688	4.707	8.000	16.000	32.000
OUTPUTS					
Aggregate of HPs	1.935.321	1.954.674	2.023.576	2.300.659	2.680.041
New HPs	-	19.353	68.902	277.083	379.382
Aggregate of EVs	30.000	10.090	76.256	485.233	1.493.139
Aggregate of NGV	8.500	23.542	104.036	464.020	1.103.391
Total national demand [TWh]	268.829	269.766	272.194	284.665	297.708
Gross Final Energy [ktoe]	85.867	86.078	84.974	83.959	81.908
RES H&C	4.416	4.460	4.640	5.405	6.420
RES Transport	1.898	1.790	1.798	1.762	1.695
RES Electric	8.397	8.144	9.331	13.074	16.898
Overall RES Share	17%	18%	20%	25%	32%

INPUTS	2017	2018	2020	2025	2030
Heating and Cooling Sector					
Growth	1,00%	1,00%	3,50%	5,00%	5,00%
Heat pump replacement ratio	-	-	70,00%	70,00%	70,00%
Heat pump growth ratio	1,00%	1,00%	5,00%	5,00%	5,00%
Transport Sector					
Truck growth ratio	0,30%	0,75%	1,50%	2,50%	3,50%
Van growth ratio	1,40%	1,60%	3,50%	3,50%	3,50%
Car growth ratio	2,70%	0,75%	3,00%	3,00%	3,00%
Motorcycle growth ratio	3,60%	3,00%	4,00%	4,00%	5,00%
Trailer growth ratio	0,50%	0,50%	1,00%	1,00%	1,00%
Fleet renovation ratio	-	2,00%	3,50%	4,00%	4,00%
% EV&NG from renovation	-	10,00%	50,00%	70,00%	90,00%
%EV	-	30,00%	40,00%	50,00%	60,00%
Electricity Sector					
Wind [MW]	22.600	23.507	26.000	38.000	51.000
Solar PV [MW]	4.688	4.707	10.000	25.000	40.000
OUTPUTS					
Aggregate of HPs	1.935.321	1.954.674	2.072.932	2.645.644	3.376.587
New HPs	-	19.353	118.258	572.713	730.943
Aggregate of EVs	30.000	10.090	146.918	1.032.416	3.027.799
Aggregate of NGV	8.500	23.542	237.989	1.431.578	3.316.865
Total national demand [TWh]	268.829	269.766	272.194	284.665	297.708
Gross Final Energy [ktoe]	85.883	86.088	84.677	81.444	76.526
RES H&C	4.416	4.460	4.663	5.618	7.170
RES Transport	1.898	1.790	1.794	1.655	1.528
RES Electric	8.397	8.144	9.641	15.462	21.176
Overall RES Share	17%	18%	20%	30%	42%



Year	Hydro						Wind						Solar (PV + Solar Thermal)			Solid Biofuels			All other RES				
	Installed Capacity (MW)	Generation (GWh)	Equivalent Hours of Operation	Q _N (GWh)	Q _N (ktoe)	Cons. Ppiois 1,5%	Installed Capacity (MW)	Generation (GWh)	Equivalent Hours of Operation	a	b	c	Q _N (GWh)	Q _N (ktoe)	Installed Capacity (MW)	Generation (GWh)	Q (ktoe)	Cons. Ppiois 0,5%	Installed Capacity (MW)	Generation (GWh)	Q (ktoe)	Installed Capacity (MW)	Generation (GWh)
2017	16742,0000	18782,0000	1121,8492	30696,3009	2639,4068	23100,0000	49127,0000	2126,7100	23045,0000	255015,6840	114760,5000	51209,5751	4403,2309	7029,0000	14397,0000	1237,9192	677,0000	4365,0000	375,322442	1713,0000	147,2915		
2016	16743,0000	36395,0000	2173,7443	30959,6789	2662,0532	22990,0000	48905,0170	2127,2300	22966,5000	255360,7290	113874,5000	51501,8040	4428,3580	7020,0000	13642,7300	1173,0636	677,0000	4048,3500	348,0954	1641,5800	141,1505		
2015	16773,0000	28140,0000	1677,6963	31512,6744	2709,6023	22943,0000	49324,9380	2149,8905	22934,0000	249374,1160	112019,0000	51055,1422	4389,9520	7008,0000	13859,9450	1191,7408	677,0000	4013,8330	345,1275	1750,0120	150,4739		
2014	16768,0000	39169,0000	2335,9375	31660,1677	2722,2844	22925,0000	52012,6530	2268,8180	22941,5000	244320,3500	109019,5000	51413,5114	4420,7662	7001,0000	13672,5560	1175,6282	677,0000	3820,3150	328,4880	1593,4390	137,0111		
2013	16730,0000	36865,0000	2203,5266	30772,1654	2645,9300	22958,0000	55646,0760	2423,8207	22873,5000	230424,7420	103943,5000	50706,5890	4359,9819	6994,0000	13096,5270	1126,0986	657,0000	4143,7810	356,3010	1655,0080	142,3051		
2012	16085,0000	20545,0000	1277,2770	29829,2501	2564,8538	22789,0000	49472,0450	2170,8739	22159,0000	207725,1090	96757,5000	47572,3400	4090,4850	6569,0000	11967,7020	1029,0371	640,0000	3396,0000	292,0034	1581,0000	135,9415		
2011	16075,0000	30596,0000	1903,3281	31090,0437	2673,2626	21529,0000	42918,4040	1993,5159	21111,0000	185821,5000	87869,5000	44644,3611	3838,7241	5432,0000	9399,6080	808,2208	563,0000	3011,0000	258,8994	1598,0000	137,4033		
2010	16086,0000	42304,0000	2629,8645	32076,7784	2758,1065	20693,0000	44271,1720	2139,4274	19934,5000	166200,4070	77578,5000	42706,7037	3672,1155	4605,0000	7185,7510	617,8634	545,0000	2508,0000	215,6492	1507,0000	129,5787		
2009	16056,0000	26411,0000	1644,9302	30955,6817	2661,7095	19176,0000	38117,0450	1987,7474	17865,5000	143104,5260	66761,5000	38295,0340	3292,7802	3705,0000	6064,0880	521,4177	502,0000	2197,0000	188,907997	1291,0000	111,0060		
2008	16027,0000	23364,0000	1457,7900	31374,9898	2697,7635	16555,0000	32946,4430	1990,1204	15687,5000	120687,0290	56027,0000	33792,2389	2905,6095	3445,0000	2577,8350	221,6539	396,0000	1888,0000	162,338779	1366,4660	117,4949		
2007	15948,0000	27309,0000	1712,3777	31611,3089	2718,0833	14820,0000	27568,4360	1860,2184	13271,0000	99815,5860	45757,5000	28949,4103	2489,2012	505,0000	508,6150	43,7330	388,0000	1553,0000	133,533964	1345,0000	115,6492		
2006	15894,0000	25959,0000	1633,2578	31188,1848	2681,7012	11722,0000	23297,3110	1987,4860	10820,0000	81589,1500	36630,5000	24099,9878	2072,2259	141,0000	118,9280	10,2260	374,0000	1573,0000	135,253654	1201,0000	103,2674		
2005	15796,0000	18393,0000	1164,4087	31429,5945	2702,4587	9918,0000	21175,2910	2135,0364	9117,5000	65050,8390	28612,0000	20729,1005	1782,3818	52,0000	41,1230	3,5359	354,0000	1578,2360	135,703869	1074,6050	92,3994		
2004	15743,0000	31084,0000	1974,4648	32121,2102	2761,9269	8317,0000	15699,5480	1887,6455	7131,0000	48602,5480	21404,0000	16192,5234	1392,3064	33,0000	56,0280	4,8175	344,0000	2213,5390	190,330095	1116,0600	95,9639		
2003	15619,0000	40483,0000	2591,9073			5945,0000	12075,0000	2031,1186	5418,0000	35647,0000	15503,5000			22,0000	41,0000	3,5254	329,0000	2096,0000	180,137575				
2002	15650,0000	21224,0000	1356,1661			4891,0000	9342,0000	1910,0388	4144,0000	24924,0000	10719,5000			17,0000	30,0000	2,5795	285,0000	1831,0000	157,437661				
2001	15614,0000	40888,0000	2618,6755			3397,0000	6759,0000	1989,6968	2801,5000	16324,0000	6899,0000			13,0000	24,0000	2,0636	183,0000	969,0000	83,3190026				
2000	15542,0000	28256,0000	1818,0414			2206,0000	4727,0000	2142,7924	1909,5000	9929,0000	4260,0000			10,0000	18,0000	1,5477	167,0000	841,0000	72,3129837				
1999	14228,0000	22823,0000	1604,0905			1613,0000	2744,0000	1701,1779	1230,5000	5472,0000	2420,0000			8,0000	17,0000	1,4617	150,0000	1074,0000	92,3473775				
1998	13984,0000	33989,0000	2430,5635			848,0000	1352,0000	1594,3396	634,0000	2903,0000	1227,0000			7,0000	15,0000	1,2898	138,0000	996,0000	85,6405847				
1997	14064,0000	34753,0000	2471,0609			420,0000	742,0000	1766,6667	323,5000	1667,0000	626,5000			6,0000	13,0000	1,1178	128,0000	946,0000	81,3413586				
1996	14191,0000	39786,0000	2803,6079			227,0000	364,0000	1603,5242	162,5000	1028,0000	321,0000			5,0000	12,0000	1,0318	127,0000	672,0000	57,7815993				
1995	14087,0000	23080,0000	1638,3900			98,0000	270,0000	2755,1020	69,5000	679,0000	161,0000			5,0000	15,0000	1,2898	127,0000	668,0000	57,4376612				
1994	13512,0000	28236,0000	2089,6980			41,0000	175,0000	4268,2927	37,5000	423,0000				4,0000	10,0000	0,8598	126,0000	490,0000	42,1324162				
1993	13377,0000	24420,0000	1825,5214			34,0000	116,0000	3411,7647	33,5000					4,0000	9,0000	0,7739	115,0000	482,0000	41,44454				
1992	13377,0000	18916,0000	1414,0689			33,0000	103,0000	3121,2121	18,0000					4,0000	8,0000	0,6879	115,0000	478,0000	41,1006019				
1991	13322,0000	27245,0000	2045,1133			3,0000	15,0000	5000,0000	2,5000					3,0000	7,0000	0,6019	115,0000	462,0000	39,7248495				
1990	13239,0000	25470,0000	1923,8613			2,0000	14,0000	7000,0000						3,0000	6,0000	0,5159	114,0000	462,0000	39,7248495				

Data Source: SHARES Tool

Data Source: SHARES Tool

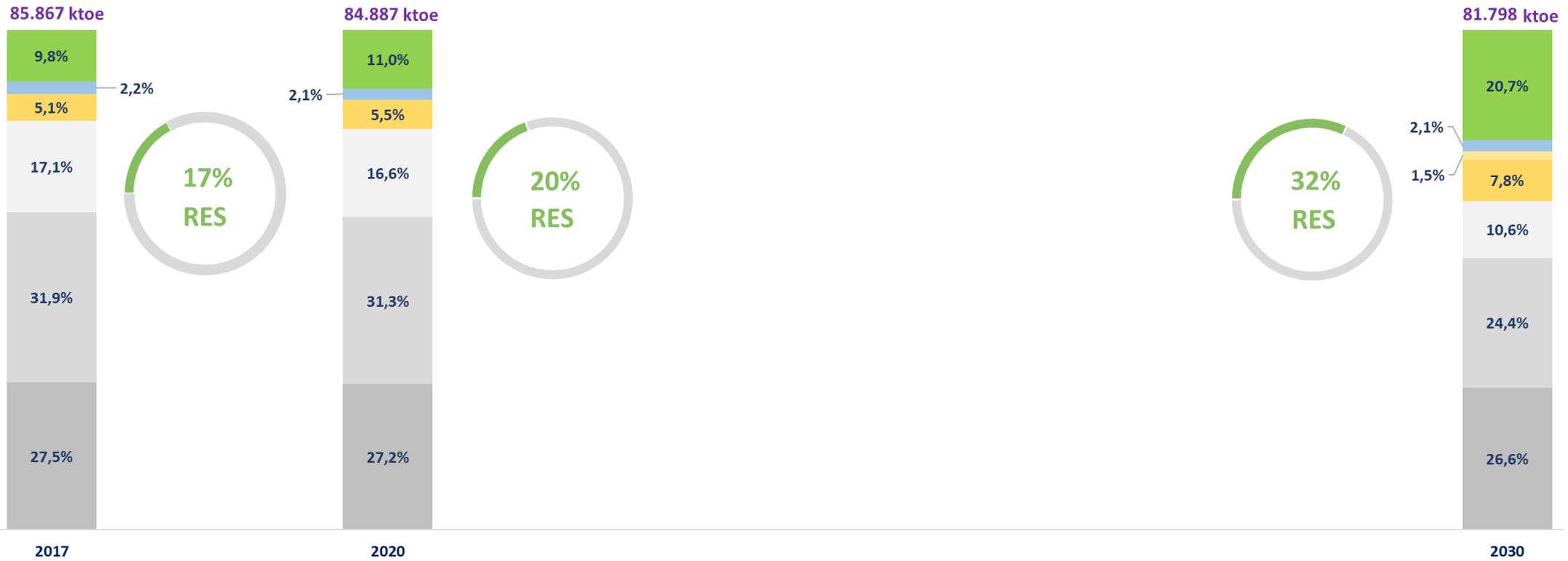


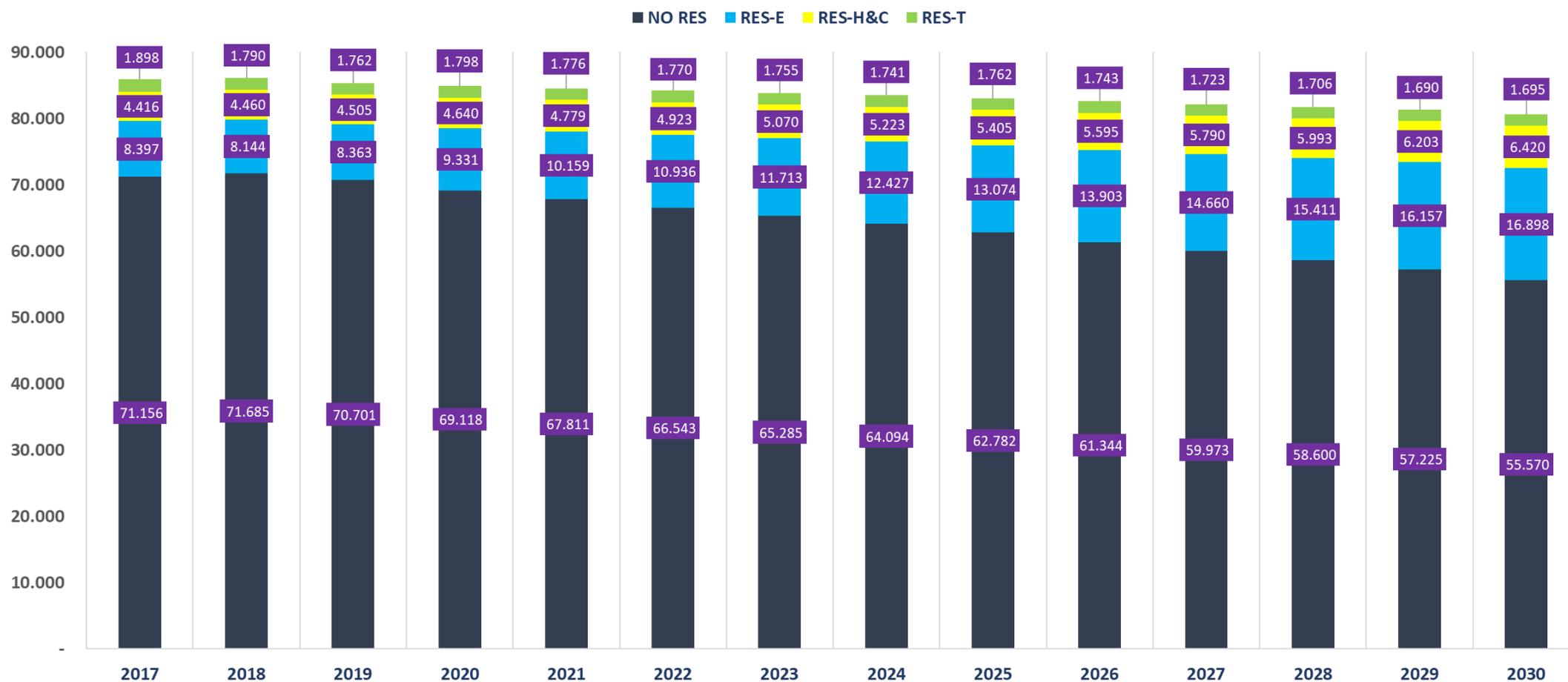
Year	Hydro			Wind			Solar			Solid Biofuels			All other RES			Gross Production			Total RES-E			RES-E EuroStat Share
	Acciona (ktoe)	Eurostat (ktoe)	Error	Acciona (ktoe)	Eurostat (ktoe)	Error	Acciona (ktoe)	Eurostat (ktoe)	Error	Acciona (ktoe)	Eurostat (ktoe)	Error	Acciona (ktoe)	Eurostat (ktoe)	Error	Acciona (ktoe)	Eurostat (ktoe)	Error	Acciona (ktoe)	Eurostat (ktoe)	Error	
2017	2639,4068	2665,0946	0,9639%	4403,2309	4403,2536	0,0005%	1237,9192	1237,9192	0,0000%	375,3224	375,3224	0,0000%	147,291488	148,738076	0,9726%	23932,4675	24299,8280	1,5118%	8803,1708	8830,3279	0,3075%	36,3391%
2016	2662,0532	2691,1113	1,0798%	4428,3580	4428,3801	0,0005%	1173,0636	1191,7408	1,5672%	348,0954	348,0954	0,0000%	141,150473	141,150473	0,0000%	23199,4841	23987,6457	3,2857%	8752,7208	8800,4781	0,5427%	36,6875%
2015	2709,6023	2740,9969	1,1454%	4389,9520	4389,9500	0,0000%	1191,7408	1175,6282	-1,3705%	345,1275	345,1275	0,0000%	150,473947	150,473947	0,0000%	23774,6346	23865,0043	0,3787%	8786,8965	8802,1765	0,1736%	36,8832%
2014	2722,2844	2757,8773	1,2906%	4420,7662	4420,7599	-0,0001%	1175,6282	1173,0636	-0,2186%	328,4880	328,4880	0,0000%	137,011092	137,011092	0,0000%	23520,8942	23348,4650	-0,7385%	8784,1779	8817,1999	0,3745%	37,7635%
2013	2645,9300	2689,7828	1,6303%	4359,9819	4359,9678	-0,0003%	1126,0986	1126,0986	0,0000%	356,3010	356,3010	0,0000%	142,305073	142,305073	0,0000%	23869,6475	23619,4102	-1,0595%	8630,6165	8674,4553	0,5054%	36,7260%
2012	2564,8538	2588,5814	0,9166%	4090,4850	4090,4631	-0,0005%	1029,0371	1029,0371	0,0000%	292,0034	292,0034	0,0000%	135,941531	135,941531	0,0000%	25153,3964	24311,5219	-3,4629%	8112,3209	8136,0267	0,2914%	33,4657%
2011	2673,2626	2702,0682	1,0661%	3838,7241	3838,6931	-0,0008%	808,2208	808,2208	0,0000%	258,8994	258,8994	0,0000%	137,403267	137,403267	0,0000%	24992,0894	24543,5942	-1,8273%	7716,5101	7745,2847	0,3715%	31,5573%
2010	2758,1065	2789,8021	1,1361%	3672,1155	3672,0845	-0,0008%	617,8634	617,8634	0,0000%	215,6492	215,6492	0,0000%	129,578676	129,578676	0,0000%	25677,816	24934,3938	-2,9815%	7393,3133	7424,9777	0,4265%	29,7781%
2009	2661,7095	2677,9234	0,6055%	3292,7802	3292,7681	-0,0004%	521,4177	521,4177	0,0000%	188,9080	188,9080	0,0000%	111,006019	111,006019	0,0000%	25151,2468	24399,3981	-3,0814%	6775,8215	6792,0233	0,2385%	27,8368%
2008	2697,7635	2717,3508	0,7208%	2905,6095	2905,6088	0,0000%	221,6539	221,6539	0,0000%	162,3388	162,3388	0,0000%	117,494927	117,494927	0,0000%	27010,5761	25790,1118	-4,7323%	6104,8607	6124,4472	0,3198%	23,7473%
2007	2718,0833	2738,2123	0,7351%	2489,2012	2489,2116	0,0004%	43,7330	43,7330	0,0000%	133,5340	133,5340	0,0000%	115,649183	115,649183	0,0000%	26470,9372	25458,9854	-3,9748%	5500,2007	5520,3400	0,3648%	21,6833%
2006	2681,7012	2703,0847	0,7911%	2072,2259	2072,2475	0,0010%	10,2260	10,2260	0,0000%	135,2537	135,2537	0,0000%	103,267412	103,267412	0,0000%	25597,7644	25133,4480	-1,8474%	5002,6742	5024,0793	0,4261%	19,9896%
2005	2702,4587	2723,4706	0,7715%	1782,3818	1782,4136	0,0018%	3,5359	4,8175	26,6028%	135,7039	135,7039	0,0000%	92,3993981	92,3993981	0,0000%	24751,8487	24772,3130	0,0826%	4716,4797	4738,8051	0,4711%	19,1294%
2004	2761,9269	2782,3421	0,7337%	1392,3064	1392,3193	0,0009%	4,8175	3,5359	-36,2449%	190,3301	190,3301	0,0000%	95,9638865	95,9638865	0,0000%	23766,81	23527,4291	-1,0175%	4445,3448	4464,4913	0,4289%	18,9757%

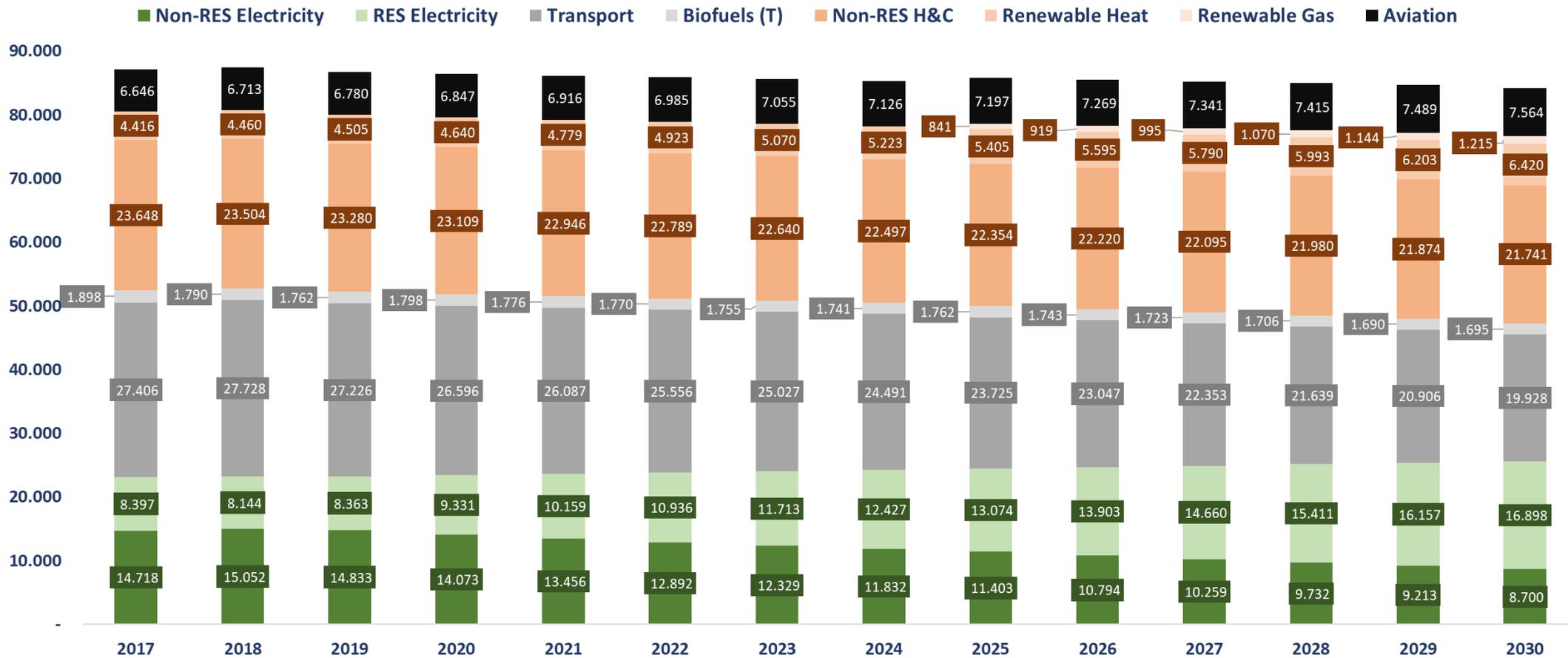


Medium scenario

■ Non-RES H&C ■ Transport ■ Non-RES Electricity ■ Renewable Heat ■ Renewable Gas ■ Biofuels (T) ■ RES Electricity









Year	Hydro					Wind					Solar			Solid Biofuels			All other RES						
	Installed Capacity (MW)	Generation (GWh)	Equivalent Hours of Operation	Qn (GWh)	Qn (ktoe) Cons. Ppios 2%	Installed Capacity (MW)	Generation (GWh)	Equivalent Hours of Operation	a	b	c	Qn (GWh)	Qn (ktoe) Cons. Ppios 1,15%	Installed Capacity (MW)	Generation (GWh)	Q (ktoe) Cons. Ppios 4,5%	Installed Capacity (MW)	Generation (GWh)	Q (ktoe) Cons. Ppios 3%	Installed Capacity (MW)	Generation (GWh)	Q (ktoe) Cons. Ppios 1%	
2030						39000,0000	100544,8176	2578,0722	38500,0000	472724,0878	182500,0000	99725,3555	8703,4597										
2029						38000,0000	97544,8176	2566,9689	37500,0000	457724,0878	177200,0000	96865,9892	8453,9105										
2028						37000,0000	94544,8176	2555,2653	36500,0000	440924,0878	171300,0000	93950,5499	8199,4676										
2027						36000,0000	91544,8176	2542,9116	35500,0000	422324,0878	164800,0000	90973,9388	7939,6860										
2026						35000,0000	88544,8176	2529,8519	34500,0000	401924,0878	157700,0000	87928,8588	7673,9288										
2025						34000,0000	85544,8176	2516,0240	33200,0000	379724,0878	150000,0000	84045,5981	7335,0200										
2024						32400,0000	80744,8176	2492,1240	31600,0000	355724,0878	141577,8893	79397,1519	6929,3301										
2023						30800,0000	75944,8176	2465,7408	30000,0000	329191,4233	133489,0053	73981,6937	6456,6998										
2022						29200,0000	71144,8176	2436,4664	28400,0000	302772,6616	126787,4471	67820,1493	5918,9554										
2021						27600,0000	66344,8176	2403,7977	26800,0000	279534,7996	121478,6336	61669,5497	5382,1662										
2020						26000,0000	61544,8176	2367,1084	24777,8893	260886,6424	117707,5587	54917,6315	4792,8973										
2019						23555,7785	54212,1531	2301,4375	23511,1160	247459,7124	115946,4787	50178,7900	4379,3183										
2018	17050,9286	34100,0727	1999,8953	29686,7894	2603,6565	23466,4535	49526,0559	2110,5045	23298,4419	244279,5902	115453,8383	49295,3194	4302,2140	7010,8575	12171,0125	1093,6120							
2017	17031,8196	18450,6188	1083,3029	30223,0313	2650,6872	23130,4303	47906,9556	2071,1658	23091,1865	249466,9280	115038,9433	50074,2373	4370,1935	6992,2016	13745,7052	1235,1042	4235,5192	375,1147712		1714,6763	148,9100		
2016	17034,5816	36114,8883	2120,0925	30521,6397	2676,8764	23051,9427	47696,6603	2069,0950	23028,9252	250084,5024	113910,1329	50558,9550	4412,4969	6989,7817	13048,6689	1172,4728	4038,0000	357,6216681		1627,0000	141,2958		
2015	17030,9066	28382,5800	1666,5337	31030,4926	2721,5049	23005,9077	48117,8875	2091,5448	23016,8093	244865,0928	111318,3145	50629,7024	4418,6714	6985,2679	13328,7964	1197,6434	4014,0000	355,4961307		1750,0000	151,9776		
2014	16992,1048	39181,9852	2305,8936	31085,8541	2726,3604	23027,7109	51032,0308	2216,1139	23018,4756	240292,5353	107585,5141	51411,8272	4486,9307	6945,1271	13166,8411	1183,0910	3821,0000	338,4032674		1593,0000	138,3431		
2013	16985,8748	37385,4368	2200,9721	30277,1185	2655,4309	23009,2404	54713,3937	2377,8879	22883,5469	227513,3315	102064,1340	51010,2009	4451,8791	6482,2308	12768,8021	1147,3257	3789,0000	335,5692175		1426,0000	123,8401		
2012	16927,8418	20653,5666	1220,0945	30282,6878	2655,9193	22757,8534	48524,5300	2132,2103	21962,3761	204959,7597	94079,5417	47846,7820	4175,7940	6482,2308	11649,7528	1046,7749	3396,0000	300,7635426		1671,0000	145,1169		
2011	16704,8938	30437,3182	1822,0600	31067,9859	2724,7933	21166,8988	42477,2508	2006,7772	20437,1068	184046,8808	84592,2310	44464,9078	3880,6433	5231,8097	9302,3939	835,8557	3011,0000	266,6663801		1701,0000	147,7223		
2010	16687,5320	41833,7742	2506,8880	31902,0971	2797,9483	19707,3148	43545,3300	2209,6024	19284,0089	164450,4861	74624,9903	42496,0140	3708,8095	4361,3032	7114,3920	639,2553	2459,0000	217,7790198		1511,0000	131,2218		
2009	16657,0797	26186,3737	1572,0867	30699,7733	2692,4995	18860,7030	38252,8270	2028,1761	17497,0955	141762,8220	64056,5560	38722,6194	3379,4891	3623,7767	6202,2130	557,2926							
2008	16614,0487	22935,4546	1380,4856	30913,9078	2711,2800	16133,4880	32159,8220	1993,3583	14898,9545	119264,1128	53356,0520	33302,8874	2906,4859	3411,4694	2513,3340	225,8327							
2007	16450,2837	27105,4791	1647,7211	30873,9474	2707,7753	13664,4210	27611,6510	2020,6967	12475,0654	98824,5369	43560,6180	28301,7692	2470,0168	628,9992	491,5290	44,1658							
2006	16362,7751	25374,9488	1550,7729	30307,1273	2658,0628	11285,7097	22880,8561	2027,4185	10469,8661	80472,1826	34689,5109	24287,8310	2119,7032	129,8711	102,3750	9,1988							
2005	16228,9786	18248,1970	1124,4206	30362,0468	2662,8794	9654,0225	20857,6660	2160,5156	8715,5745	64185,4747	26542,5718	21076,0770	1839,3997	42,9462	40,0883	3,6021							
2004	16122,0756	30870,0375	1914,7682	30785,5971	2700,0266	7777,1265	15754,1178	2025,6991	6796,5915	47790,3048	19252,4293	16871,1789	1472,4202	20,9255	17,7940	1,5989							
2003	16029,3966	40097,0072	2501,4670			5816,0565	11720,2461	2015,1534	5103,5205	34510,2203	13283,6963			11,3756	8,9301	0,8024							
2002	15817,0114	21225,3249	1341,9302			4390,9845	9259,2967	2108,7063	3603,9583	24026,6309	8684,7858			4,8429	4,5615	0,4099							
2001	15691,9505	40392,0998	2574,0650			2816,9320	6594,1481	2340,8972	2322,9270	15387,2192	5341,7300			2,1768	1,6396	0,1473							
2000	15690,0205	27893,9347	1777,8138			1828,9220	4462,4961	2439,9597	1425,4320	9097,2001	3140,2630			1,7157	1,2698	0,1141							
1999	15631,2260	25037,7046	1601,7749			1021,9420	2474,0333	2420,9136	827,8585	4794,5610	1782,5660			1,2202	1,3412	0,1205							
1998	15422,3880	35434,0091	2297,5696			633,7750	1236,6567	1951,2551	504,6100	2393,3877	990,9775			1,1590	1,1703	0,1052							
1997	15376,4540	35110,2577	2283,3781			375,4450	619,8850	1651,0674	260,9025	1241,4990	518,4025			1,1370	1,1270	0,1013							
1996	15329,0918	39868,6044	2600,8458			146,3600	304,1290	2077,9516	121,4600	638,9750	272,9900			1,1000	0,8910	0,0801							
1995	15211,9578	22461,9618	1476,5990			96,5600	159,8570	1655,5199	67,7350	337,7110	152,0700			1,1000	1,0620	0,0954							
1994	14961,1390	27483,9337	1837,0215			38,9100	72,8600	1872,5263	36,2700	180,0410	84,6050			1,1000	15,2959	1,3744							
1993	14642,5050	23748,7177	1621,9027			33,6300	84,7680	2520,6066	32,0350	107,1810				0,1000	12,0000	1,0782							
1992	14576,6220	18638,6405	1278,6667			30,4400	17,3610	570,3351	15,4900					0,1000	12,0560	1,0833							
1991	14439,4930	26432,7149	1830,5847			0,5400	2,8650	5305,5556	0,5400					0,1000	0,0000	0,0000							
1990	14386,8290	24523,3926	1704,5725			0,5400	2,1870	4050,0000						0,1000	0,0000	0,0000							



H&C

Average Growth Ratio	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Efficiency	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	
			17,59											6,53	
														24,12	
ktoe	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Heat Pump	494,18	588,34	1512,65	1527,77	1565,97	1605,12	1645,24	1686,37	1728,53	1780,39	1833,80	1888,82	1945,48	2003,84	2073,98
Heat Pump Subbed			5,99	6,05	15,28	15,66	16,05	16,45	16,86	20,74	21,36	22,01	22,67	23,35	28,05
Units	1916159	1935321	1954674	1974221	2023576	2074165	2126020	2179170	2233649	2300659	2369679	2440769	2513992	2589412	2680041
Growth	-	1,0%	1,0%	1,0%	2,5%	2,5%	2,5%	2,5%	2,5%	3,0%	3,0%	3,0%	3,0%	3,0%	3,5%
kWhe/h	2,00	2,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
HP Growth			8,99	9,08	22,92	23,49	24,08	24,68	25,30	31,11	32,05	33,01	34,00	35,02	42,08
HPs			40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%
New Equip.			19353	19547	49356	50589	51854	53150	54479	67009	69020	71090	73223	75420	90629
Commercial			1935	1955	4936	5059	5185	5315	5448	6701	6902	7109	7322	7542	9063
Residential			17418	17592	44420	45530	46669	47835	49031	60309	62118	63981	65901	67878	81566



Residential	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gas	<u>3472,03</u>	<u>3499,64</u>	<u>3530,32</u>	<u>3554,73</u>	<u>3650,21</u>	<u>3748,27</u>	<u>3848,99</u>	<u>3952,44</u>	<u>4058,69</u>	<u>4185,59</u>	<u>4316,47</u>	<u>4451,47</u>	<u>4590,71</u>	<u>4734,33</u>	<u>4879,53</u>	
Solid Fuel	<u>79,05</u>	<u>73,40</u>	<u>67,76</u>	<u>62,11</u>	<u>56,46</u>	<u>50,82</u>	<u>45,17</u>	<u>39,52</u>	<u>33,88</u>	<u>28,23</u>	<u>22,59</u>	<u>16,94</u>	<u>11,29</u>	<u>5,65</u>	<u>0,00</u>	
Oil Products	<u>2939,10</u>	<u>2909,71</u>	<u>2864,44</u>	<u>2794,95</u>	<u>2669,24</u>	<u>2546,26</u>	<u>2425,89</u>	<u>2308,03</u>	<u>2192,58</u>	<u>2059,00</u>	<u>1928,40</u>	<u>1800,61</u>	<u>1675,48</u>	<u>1552,87</u>	<u>1421,65</u>	
GLP																
Gasoil																
RES	<u>2738,61</u>	<u>2765,99</u>	<u>2793,65</u>	<u>2821,59</u>	<u>2906,24</u>	<u>2993,42</u>	<u>3083,23</u>	<u>3175,72</u>	<u>3270,99</u>	<u>3385,48</u>	<u>3503,97</u>	<u>3626,61</u>	<u>3753,54</u>	<u>3884,92</u>	<u>4020,89</u>	
Solar Thermal	<u>233,47</u>	235,81	238,17	240,55	247,77	255,20	262,85	270,74	278,86	288,62	298,72	309,18	320,00	331,20	342,79	
Biomass	<u>2494,48</u>	2519,43	2544,62	2570,07	2647,17	2726,58	2808,38	2892,63	2979,41	3083,69	3191,62	3303,33	3418,94	3538,61	3662,46	
Geothermal	<u>10,65</u>	10,76	10,86	10,97	11,30	11,64	11,99	12,35	12,72	13,17	13,63	14,10	14,60	15,11	15,64	
TOTAL	9228,79	9248,74	9256,17	9233,38	9282,15	9338,77	9403,28	9475,72	9556,14	9658,30	9771,43	9895,63	10031,02	10177,76	10322,06	

Services	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil Products	<u>1265,40</u>	<u>1252,75</u>	<u>1238,42</u>	<u>1221,50</u>	<u>1180,20</u>	<u>1140,03</u>	<u>1100,94</u>	<u>1062,91</u>	<u>1025,88</u>	<u>983,66</u>	<u>942,73</u>	<u>903,03</u>	<u>864,53</u>	<u>827,16</u>	<u>789,67</u>	
Gas	<u>3006,17</u>	<u>3029,12</u>	<u>3058,93</u>	<u>3088,31</u>	<u>3179,72</u>	<u>3273,84</u>	<u>3370,75</u>	<u>3470,53</u>	<u>3573,28</u>	<u>3696,66</u>	<u>3824,31</u>	<u>3956,38</u>	<u>4093,01</u>	<u>4234,37</u>	<u>4380,29</u>	
RES	<u>166,73</u>	<u>168,40</u>	<u>170,08</u>	<u>171,78</u>	<u>176,94</u>	<u>182,24</u>	<u>187,71</u>	<u>193,34</u>	<u>199,14</u>	<u>206,11</u>	<u>213,33</u>	<u>220,79</u>	<u>228,52</u>	<u>236,52</u>	<u>244,80</u>	
Solar Thermal	<u>55,35</u>	55,91	56,47	57,03	58,74	60,50	62,32	64,19	66,11	68,43	70,82	73,30	75,87	78,52	81,27	
Geothermal	<u>3,75</u>	3,79	3,82	3,86	3,98	4,10	4,22	4,35	4,48	4,63	4,80	4,96	5,14	5,32	5,50	
Biomass	<u>92,51</u>	93,44	94,37	95,31	98,17	101,12	104,15	107,28	110,50	114,36	118,37	122,51	126,80	131,23	135,83	
Biogas	<u>10,89</u>	11,00	11,11	11,22	11,56	11,90	12,26	12,63	13,01	13,46	13,93	14,42	14,92	15,45	15,99	
Biofuel	<u>4,23</u>	4,27	4,31	4,36	4,49	4,62	4,76	4,90	5,05	5,23	5,41	5,60	5,79	6,00	6,21	
TOTAL	4438,30	4450,26	4467,43	4481,59	4536,86	4596,11	4659,40	4726,78	4798,31	4886,44	4980,37	5080,20	5186,06	5298,05	5414,76	



Industry	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil Products	2828,00	2825,33	2822,64	2815,83	2808,85	2801,70	2794,37	2786,86	2779,15	2769,68	2759,92	2749,88	2739,52	2728,86	2716,05	
Gas	6530,00	6541,92	6541,20	6539,38	6537,52	6535,62	6533,66	6531,66	6529,60	6527,08	6524,48	6521,80	6519,04	6516,19	6512,78	
RES	1387,00	1401,07	1415,08	1429,23	1472,11	1516,27	1561,76	1608,61	1656,87	1714,86	1774,88	1837,00	1901,30	1967,84	2036,72	
Solar Thermal	3,00	3,03	3,06	3,09	3,18	3,28	3,38	3,48	3,58	3,71	3,84	3,97	4,11	4,26	4,40	
Geothermal	0,00	0,20	0,20	0,20	0,21	0,22	0,22	0,23	0,24	0,24	0,25	0,26	0,27	0,28	0,29	
Biofuel	1384,00	1397,84	1411,82	1425,94	1468,71	1512,78	1558,16	1604,90	1653,05	1710,91	1770,79	1832,77	1896,91	1963,31	2032,02	
Coal	1501,00	1393,79	1286,57	1179,36	1072,14	964,93	857,71	750,50	643,29	536,07	428,86	321,64	214,43	107,21	0,00	
TOTAL	12246,00	12162,10	12065,49	11963,80	11890,63	11818,52	11747,50	11677,63	11608,92	11547,69	11488,14	11430,32	11374,29	11320,11	11265,54	

Blurred Sectors	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil Products	2011,00	2000,32	1973,37	1905,30	1835,53	1764,01	1690,71	1615,57	1538,56	1443,83	1346,26	1245,77	1142,26	1035,64	907,52	
Gas	91,00	91,91	92,83	93,76	96,57	99,47	102,45	105,52	108,69	112,49	116,43	120,51	124,72	129,09	133,61	
RES	80,00	80,80	81,61	82,42	84,90	87,44	90,07	92,77	95,55	98,90	102,36	105,94	109,65	113,49	117,46	
Solar Thermal	2,00	2,02	2,04	2,06	2,12	2,19	2,25	2,32	2,39	2,47	2,56	2,65	2,74	2,84	2,94	
Geothermal	4,00	4,04	4,08	4,12	4,24	4,37	4,50	4,64	4,78	4,94	5,12	5,30	5,48	5,67	5,87	
Biofuel	74,00	74,74	75,49	76,24	78,53	80,89	83,31	85,81	88,39	91,48	94,68	97,99	101,42	104,97	108,65	
Coal	32,00	29,71	27,43	25,14	22,86	20,57	18,29	16,00	13,71	11,43	9,14	6,86	4,57	2,29	0,00	
TOTAL	2214,00	2202,75	2175,23	2106,62	2039,85	1971,49	1901,51	1829,87	1756,52	1666,65	1574,20	1479,07	1381,20	1280,50	1158,59	

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TOTAL H&C	28127,09	28063,85	27964,31	27785,39	27749,48	27724,89	27711,69	27709,99	27719,88	27759,09	27814,13	27885,22	27972,57	28076,42	28160,96
RES-H&C	17,00%	17,47%	18,86%	#iDIV/0!	#iVALOR!	#iDIV/0!	20,14%	20,71%	22,70%	23,39%	24,11%	24,83%	25,55%	26,29%	27,07%



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Growth Rate		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
<i>Bus</i>		2,80%	3,00%	3,00%	2,00%	2,00%	2,00%	2,00%	2,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,50%
<i>Van</i>		1,40%	1,60%	1,60%	1,50%	1,50%	1,50%	1,50%	1,50%	2,00%	2,00%	2,00%	2,00%	2,00%	2,50%
<i>Motorcycle</i>		3,60%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%
<i>Truck</i>		0,30%	0,75%	0,75%	1,00%	1,00%	1,00%	1,00%	1,00%	1,50%	1,50%	1,50%	1,50%	1,50%	2,00%
<i>Trailer</i>		0,50%	0,50%	0,50%	1,00%	1,00%	1,00%	1,00%	1,00%	1,50%	1,50%	1,50%	1,50%	1,50%	1,50%
<i>Car</i>		2,70%	0,75%	0,75%	1,50%	1,50%	1,50%	1,50%	1,50%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%
1	<i>Truck Old</i>	2.586.443	2.534.714	2.482.597	2.430.090	2.377.057	2.323.494	2.269.395	2.214.755	2.145.773	2.075.755	2.004.688	1.932.554	1.859.338	1.770.162
	<i>Truck Repl.</i>	0	51.729	52.117	52.508	53.033	53.563	54.099	54.640	68.983	70.017	71.068	72.134	73.216	89.177
	<i>Truck New</i>	0	71.127	142.788	234.676	327.484	421.219	515.892	611.511	763.273	917.312	1.073.660	1.232.354	1.393.429	1.571.782
	NEW	0	71.127	71.661	91.888	92.807	93.735	94.673	95.620	151.762	154.038	156.349	158.694	161.074	178.353
3	<i>Van Old</i>	2.338.033	2.291.272	2.243.764	2.195.495	2.146.502	2.096.774	2.046.300	1.995.069	1.930.070	1.863.770	1.796.145	1.727.167	1.656.810	1.570.693
	<i>Van Repl.</i>	0	46.761	47.509	48.269	48.993	49.728	50.474	51.231	64.999	66.299	67.625	68.978	70.357	86.117
	<i>Van New</i>	0	84.169	169.685	254.156	339.894	426.917	515.247	604.901	721.899	841.238	962.963	1.087.123	1.213.766	1.371.648
	NEW	0	84.169	85.516	84.471	85.738	87.024	88.329	89.654	116.999	119.339	121.725	124.160	126.643	157.882
	<i>Bus Old</i>	63.589	62.317	61.007	59.658	58.282	56.878	55.446	53.986	52.124	50.206	48.230	46.196	44.100	41.509
	<i>Bus Repl.</i>	0	1.272	1.310	1.349	1.376	1.404	1.432	1.460	1.862	1.918	1.975	2.035	2.096	2.590
	<i>Bus New</i>	0	3.179	6.454	9.153	11.905	14.713	17.576	20.497	24.594	28.813	33.159	37.636	42.246	47.859
	NEW	0	3.179	3.275	2.698	2.752	2.807	2.864	2.921	4.097	4.219	4.346	4.476	4.611	5.613
2	<i>Car Old</i>	23.500.401	23.030.393	22.556.860	22.079.775	21.595.534	21.104.030	20.605.153	20.098.793	19.456.348	18.794.631	18.113.061	17.411.045	16.687.968	15.794.245
	<i>Car Repl.</i>	0	470.008	473.533	477.085	484.241	491.504	498.877	506.360	642.444	661.718	681.569	702.016	723.077	893.723
	<i>Car New</i>	0	646.261	1.297.369	2.132.267	2.979.689	3.839.821	4.712.856	5.598.986	7.012.364	8.468.143	9.967.596	11.512.032	13.102.801	14.890.248
	NEW	0	646.261	651.108	834.898	847.421	860.133	873.035	886.130	1.413.378	1.455.779	1.499.453	1.544.436	1.590.769	1.787.446
4	<i>Motorcle Old</i>	3.327.048	3.260.507	3.191.970	3.121.377	3.048.665	2.973.773	2.896.634	2.817.180	2.714.884	2.609.519	2.500.993	2.389.211	2.274.076	2.131.769
	<i>Motorcle Repl.</i>	0	66.541	68.537	70.593	72.711	74.892	77.139	79.453	102.296	105.365	108.526	111.782	115.135	142.307
	<i>Motorcle New</i>	0	166.352	337.695	514.179	695.956	883.187	1.076.036	1.274.669	1.499.721	1.731.524	1.970.281	2.216.201	2.469.499	2.754.114
	NEW	0	166.352	171.343	176.483	181.778	187.231	192.848	198.633	225.052	231.803	238.757	245.920	253.298	284.614
1	<i>Trailer Old</i>	459.712	450.518	441.278	431.991	422.612	413.139	403.571	393.908	381.707	369.324	356.755	343.998	331.049	315.278
	<i>Trailer Repl.</i>	0	9.194	9.240	9.286	9.379	9.473	9.568	9.663	12.200	12.383	12.569	12.757	12.949	15.772
	<i>Trailer New</i>	0	11.493	23.043	36.973	51.042	65.251	79.603	94.098	113.618	133.431	153.542	173.953	194.672	218.329
	NEW	0	11.493	11.550	13.930	14.069	14.210	14.352	14.495	19.520	19.813	20.110	20.412	20.718	23.657
	TOTAL	32.275.226	32.612.304	32.954.510	33.499.788	34.054.621	34.619.196	35.193.708	35.778.354	36.816.376	37.883.667	38.981.074	40.109.471	41.269.755	42.477.634



Fleet	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Truck	2.586.443	2.605.841	2.625.385	2.651.639	2.678.155	2.704.937	2.731.986	2.759.306	2.800.696	2.842.706	2.885.347	2.928.627	2.972.556	3.032.008
Van	2.338.033	2.375.442	2.413.449	2.449.650	2.486.395	2.523.691	2.561.546	2.599.970	2.651.969	2.705.008	2.759.108	2.814.291	2.870.576	2.942.341
Bus	63.589	65.497	67.462	68.811	70.187	71.591	73.023	74.483	76.718	79.019	81.390	83.831	86.346	89.368
Car	23.500.401	23.676.654	23.854.229	24.212.042	24.575.223	24.943.851	25.318.009	25.697.779	26.468.713	27.262.774	28.080.657	28.923.077	29.790.769	30.684.492
Motorcycle	3.327.048	3.426.859	3.529.665	3.635.555	3.744.622	3.856.960	3.972.669	4.091.849	4.214.605	4.341.043	4.471.274	4.605.413	4.743.575	4.885.882
Trailer	459.712	462.011	464.321	468.964	473.653	478.390	483.174	488.006	495.326	502.756	510.297	517.951	525.721	533.606

Tasa	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Renovation	0%	2%	2%	2%	2%	2%	2%	2%	3%	3%	3%	3%	3%	3%
EV & NG	0%	10%	10%	30%	30%	30%	30%	30%	50%	50%	50%	50%	50%	50%
EV	0%	30%	30%	50%	50%	50%	50%	50%	60%	60%	60%	60%	60%	70%
NG	0%	70%	70%	50%	50%	50%	50%	50%	40%	40%	40%	40%	40%	30%

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
EV	0,09%	0,03%	0,06%	0,23%	0,39%	0,56%	0,73%	0,90%	1,32%	1,74%	2,15%	2,57%	2,98%	3,52%
NG	0,03%	0,07%	0,15%	0,31%	0,48%	0,64%	0,81%	0,98%	1,26%	1,54%	1,82%	2,09%	2,37%	2,60%

	Truck, Trailer & Bus (1)				Car (2)			Van (3)			Motorcycle (4)	
	Gasoline	Diesel	Trailer [km]	Truck [km]	Gasoline	Diesel	km	Gasoline	Diesel	km	Gasoline	km
2017	5,00%	95,00%	35000	14000	44,85%	55,15%	14000	7,00%	93,00%	14000	100,00%	5000
2018	4,00%	95,77%	35000	14000	47,00%	52,73%	14000	6,00%	93,65%	14000	99,51%	5000
2020	2,00%	97,12%	35000	14000	50,00%	48,97%	14000	5,00%	93,97%	14000	98,54%	5000
2025	1,00%	96,70%	35000	14000	49,00%	48,33%	14000	4,00%	93,79%	14000	97,33%	5000
2030	0,50%	97,00%	35000	14000	44,00%	53,09%	14000	3,00%	94,32%	14000	97,09%	5000

Biofuels	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ethanol	4,70%	5,90%	5,90%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%
Biodiesel	7,00%	5,90%	5,90%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%



ktoe	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Road	28288,06	28466,15	27903,84	27275,24	26709,48	26136,07	25554,89	24965,83	24180,81	23442,50	22686,26	21911,60	21118,06	20097,47
Truck	9081,18	9149,03	8967,83	8805,52	8622,71	8438,08	8251,60	8063,25	7833,48	7597,25	7357,46	7114,09	6867,06	6552,51
Gasol. Old	345,94	271,22	265,64	130,01	127,17	124,31	121,41	118,49	57,40	55,53	53,63	51,70	49,74	23,68
Gasol. New	0,00	6,85	6,90	3,30	3,34	3,37	3,40	3,44	1,95	1,98	2,01	2,04	2,07	1,15
Diesel Old	8735,24	8629,75	8452,45	8390,46	8207,64	8022,99	7836,49	7648,13	7378,37	7138,04	6894,11	6646,51	6395,21	6108,08
Diesel New	0,00	211,85	213,29	201,93	203,95	205,99	208,05	210,13	227,31	230,72	234,18	237,70	241,26	270,01
NG	0,00	29,35	29,55	79,82	80,62	81,42	82,24	83,06	168,45	170,98	173,54	176,14	178,79	149,60
EV	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Van	2486,32	2514,69	2465,83	2387,46	2337,24	2286,28	2234,54	2182,03	2097,98	2031,21	1963,11	1893,64	1822,78	1743,50
Gasol. Old	192,63	161,81	158,46	129,21	126,32	123,40	120,43	117,41	90,87	87,75	84,56	81,32	78,00	0,00
Gasol. New	0,00	5,35	5,44	3,48	3,53	3,59	3,64	3,69	2,75	2,81	2,87	2,92	2,98	2,79
Diesel Old	2293,68	2263,41	2216,48	2176,21	2127,65	2078,36	2028,32	1977,54	1909,63	1844,03	1777,12	1708,87	1639,26	1562,72
Diesel New	0,00	74,83	76,03	58,61	59,49	60,38	61,29	62,21	57,88	59,04	60,22	61,42	62,65	78,54
NG	0,00	9,28	9,43	19,95	20,25	20,56	20,86	21,18	36,85	37,59	38,34	39,10	39,89	99,45
EV	0,00	0,00	0,00	3,81	3,87	3,93	3,99	4,05	10,56	10,77	10,99	11,21	11,43	16,63
Car	16445,08	16521,44	16194,46	15817,50	15490,39	15158,38	14821,39	14479,34	14021,38	13594,29	13154,40	12701,30	12234,61	11618,65
Gasol. Old	7330,66	7528,43	7373,64	7678,39	7509,99	7339,06	7165,58	6989,49	6630,75	6405,24	6172,96	5933,71	5687,28	4833,45
Gasol. New	0,00	190,13	191,56	203,24	206,29	209,38	212,52	215,71	240,84	248,07	255,51	263,17	271,07	273,50
Diesel Old	9114,43	8539,71	8364,13	7603,15	7436,40	7267,15	7095,36	6921,00	6612,83	6387,93	6156,28	5917,67	5671,91	5896,56
Diesel New	0,00	215,67	217,29	201,25	204,27	207,33	210,44	213,60	240,19	247,40	254,82	262,46	270,34	333,66
NG	0,00	47,49	47,85	131,48	133,45	135,45	137,48	139,55	296,77	305,67	314,84	324,29	334,01	281,48
EV	5,42	3,50	3,53	22,61	22,95	23,30	23,65	24,00	76,56	78,86	81,23	83,66	86,17	112,96
Motorcle	275,48	280,99	275,72	264,76	259,13	253,33	247,36	241,21	227,97	219,75	211,29	202,58	193,60	182,81
Gasol. Old	275,48	268,66	263,01	254,68	248,75	242,64	236,35	229,86	218,79	210,30	201,55	192,54	183,26	171,37
Gasol. New	0,00	12,34	12,71	10,08	10,38	10,69	11,01	11,35	9,18	9,46	9,74	10,03	10,33	11,44
EV	0,00	0,72	0,74	2,28	2,34	2,41	2,49	2,56	4,84	4,98	5,13	5,29	5,44	6,12
Rail	313,93	350,00	367,50	385,88	405,17	425,43	446,70	469,03	492,49	517,11	542,96	570,11	598,62	628,55
Aviation	6646,11	6712,57	6779,70	6847,49	6915,97	6985,13	7054,98	7125,53	7196,78	7268,75	7341,44	7414,85	7489,00	7563,89
Ships	953,00	981,59	1011,04	1041,37	1072,61	1104,79	1137,93	1172,07	1207,23	1243,45	1280,75	1319,17	1358,75	1399,51
TOTAL	29303,85	29517,74	28988,38	28393,78	27863,13	27325,94	26782,16	26231,71	25486,54	24789,38	24075,60	23344,80	22596,53	21622,70
TOTAL	29554,99	29797,74	29282,38	28702,48	28187,26	27666,28	27139,52	26606,93	25880,53	25203,06	24509,98	23800,89	23075,42	22125,53



Gasoline

	Car						Motorcycle						Truck						Van					
	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]
2017	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	25,00	222,22	0,74	42998,81	3600,00	8,89	11,00	97,78
2018	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	25,00	222,22	0,74	42998,81	3600,00	8,89	11,00	97,78
2020	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	24,00	213,33	0,74	42998,81	3600,00	8,89	11,00	97,78
2025	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	24,00	213,33	0,74	42998,81	3600,00	8,89	11,00	97,78
2030	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	24,00	213,33	0,74	42998,81	3600,00	8,89	11,00	97,78

Diesel

	Car						Truck						Van					
	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]
2017	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	21,00	204,47	0,86	40767,49	3600,00	9,74	9,00	87,63
2018	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	21,00	204,47	0,86	40767,49	3600,00	9,74	9,00	87,63
2020	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	20,00	194,73	0,86	40767,49	3600,00	9,74	9,00	87,63
2025	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	20,00	194,73	0,86	40767,49	3600,00	9,74	9,00	87,63
2030	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	20,00	194,73	0,86	40767,49	3600,00	9,74	9,00	87,63

NG

	Car						Van						Truck					
	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]
2017	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2018	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2020	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2025	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2030	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85

EV

	Truck	Car	Van	Moto
	[kWh/100km]	[kWh/100km]	[kWh/100km]	[kWh/100km]
2017		15,00		10,00
2018		15,00		10,00
2020		15,00	25,00	10,00
2025		15,00	25,00	10,00
2030		15,00	25,00	10,00



RES-T	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Road	1798,25	1678,64	1645,47	1651,34	1617,68	1583,56	1548,98	1513,93	1512,69	1470,31	1426,92	1382,48	1336,97	1309,73
Truck	627,73	538,06	527,36	523,54	512,53	501,40	490,16	478,81	459,90	445,58	431,04	416,28	401,30	384,17
Bioethanol	16,26	16,41	16,08	8,00	7,83	7,66	7,49	7,32	3,56	3,45	3,34	3,22	3,11	1,49
Biodiesel	611,47	521,65	511,28	515,54	504,70	493,74	482,67	471,50	456,34	442,13	427,70	413,05	398,19	382,69
Biogas														
EV	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Van	169,61	147,82	144,93	145,86	142,89	139,87	136,81	133,70	134,23	130,39	126,48	122,48	118,41	115,27
Bioethanol	9,05	9,86	9,67	7,96	7,79	7,62	7,44	7,27	5,62	5,43	5,25	5,05	4,86	0,17
Biodiesel	160,56	137,96	135,26	134,09	131,23	128,32	125,38	122,39	118,05	114,18	110,24	106,22	102,11	98,48
Biogas														
EV	0,00	0,00	0,00	3,81	3,87	3,93	3,99	4,05	10,56	10,77	10,99	11,21	11,43	16,63
Car	987,97	975,46	956,18	963,77	944,37	924,67	904,68	884,39	900,04	876,18	851,60	826,28	800,21	793,19
Bioethanol	344,54	455,40	446,35	472,90	462,98	452,91	442,69	432,31	412,30	399,20	385,71	371,81	357,50	306,42
Biodiesel	638,01	516,57	506,30	468,26	458,44	448,47	438,35	428,08	411,18	398,12	384,67	370,81	356,53	373,81
Biogas														
EV	5,42	3,50	3,53	22,61	22,95	23,30	23,65	24,00	76,56	78,86	81,23	83,66	86,17	112,96
Motorcle	12,95	17,29	17,00	18,16	17,89	17,61	17,33	17,03	18,52	18,17	17,81	17,44	17,06	17,09
Bioethanol	12,95	16,58	16,27	15,89	15,55	15,20	14,84	14,47	13,68	13,19	12,68	12,15	11,62	10,97
EV	0,00	0,72	0,74	2,28	2,34	2,41	2,49	2,56	4,84	4,98	5,13	5,29	5,44	6,12
% RES-E	32%	38%	39%	44%	46%	48%	51%	53%	55%	57%	59%	61%	64%	65%
Rail	99,82	111,29	116,86	146,40	158,05	186,20	205,85	226,70	248,83	272,29	296,10	323,40	353,47	385,35
TOTAL	1898,08	1789,93	1762,32	1797,75	1775,73	1769,76	1754,83	1740,63	1761,51	1742,60	1723,02	1705,89	1690,45	1695,08
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RES-T	6,42%	6,01%	6,02%	6,26%	6,30%	6,40%	6,47%	6,54%	6,81%	6,91%	7,03%	7,17%	7,33%	7,66%



E

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Power Capacity (MW)														
Hydro	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049
Pumping	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329
Nuclear	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	6.068	5.023	5.023
Coal	10.720	10.720	10.622	10.524	9.326	8.127	6.929	5.730	4.532	4.532	4.532	4.532	4.532	4.532
Fueloil	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790
CCGT	27.531	27.531	27.339	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146
Hydro-wind	200	200		0					0					0
Wind	22.600	23.507	23.556	26.000	27.600	29.200	30.800	32.400	34.000	35.000	36.000	37.000	38.000	39.000
Solar PV	4.688	4.707	4.780	8.000	9.600	11.200	12.800	14.400	16.000	19.200	22.400	25.600	28.800	32.000
Solar Thermal	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303
Renewable Thermal	970	982	1.164	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346
Cogeneration	5.700	5.483	5.276	5.069	5.069	5.069	5.069	5.069	4.022	3.716	3.410	3.104	2.798	2.492
Renewable Capacity	47.810	48.748	48.851	54.698	57.898	61.098	64.298	67.498	70.698	74.898	79.098	83.298	87.498	91.698
Total Capacity	104.997	105.718	105.324	110.673	112.674	114.676	116.678	118.679	119.634	123.528	127.422	130.266	133.116	137.010



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Power Production (GWh)														
Hydro	18.450,6	34.100,1	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7
Pumping	2.249,0	2.009,4	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7
Nuclear	55.539,4	53.197,6	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	46.116,0	38.177,8	38.177,8
Coal	45.019,4	37.273,6	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0
Fueloil	7.001,6	6.683,2	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0
CCGT	37.065,8	30.044,6	52.731,1	43.811,8	39.574,5	35.359,3	31.166,4	26.995,9	30.130,0	27.685,0	24.263,0	28.839,8	33.402,8	31.551,2
Hydro-wind	982,0	982,0	714,5	447,0	454,0	461,0	468,0	475,0	482,0	565,0	648,0	731,0	814,0	897,0
Wind	47.907,0	49.526,1	54.212,2	61.544,8	66.344,8	71.144,8	75.944,8	80.744,8	85.544,8	88.544,8	91.544,8	94.544,8	97.544,8	100.544,8
Solar PV	8.397,8	7.746,7	8.604,0	14.400,0	17.280,0	20.160,0	23.040,0	25.920,0	28.800,0	34.560,0	40.320,0	46.080,0	51.840,0	57.600,0
Solar Thermal	5.348,0	4.424,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3
Renewable Thermal	3.610,3	3.556,4	4.656,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0
Cogeneration	31.696,8	32.320,6	31.656,0	30.414,0	30.414,0	30.414,0	30.414,0	30.414,0	24.132,0	22.296,0	20.460,0	18.624,0	16.788,0	14.952,0
Interconnection	9.169,0	11.102,3	10.102,3	9.102,3	8.102,3	7.102,3	6.102,3	5.102,3	3.102,3	1.102,3	102,3	-897,7	-1.897,7	-4.397,7
Renewable Generation	83.713,6	99.353,5	101.291,2	115.147,9	122.827,9	130.507,9	138.187,9	145.867,9	153.548	162.307,9	171.067,9	179.827,9	188.587,9	197.348
Self-generation	10.530,7	10.474,6	10.386,6	10.523,7	10.661,7	10.800,5	10.940,3	11.081,0	9.854,7	10.014,4	10.139,8	10.266,1	10.393,3	10.573,7
Losses	32.259,5	32.371,9	32.371,9	32.663,3	32.957,3	33.253,9	33.553,2	33.855,1	34.159,8	34.467,3	34.777,5	35.090,5	35.406,3	35.724,9
Pumping	-3.607,6	-3.200,7	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0
Total Generation	263.268	261.865	259.663,8	263.091,7	266.541,5	270.013,3	273.507,3	277.023,8	281.563	286.124,9	289.710,0	293.318,3	296.950,1	302.106
Demand Increase	-	-	0,00%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%
Electricity Demand	261.923,5	258.086,6	257.877,8	259.892,5	261.917,2	263.951,9	265.996,5	268.050,8	269.882,1	271.668,2	273.446,9	275.217,3	276.978,5	278.584,3
EV	63,00	21,19	43,04	160,14	281,59	407,53	538,11	673,47	1.018,99	1.381,93	1.762,98	2.162,82	2.582,18	3.135,59
HP	6.842,42	11.658,37	11.845,32	12.141,46	12.444,99	12.756,12	13.075,02	13.401,90	13.764,15	14.177,07	14.602,38	15.040,45	15.491,67	15.987,95
Total Increase	-	-	0,00%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%
Total Demand	268.828,9	269.766,2	269.766,2	272.194,1	274.643,8	277.115,6	279.609,6	282.126,1	284.665,3	287.227,2	289.812,3	292.420,6	295.052,4	297.707,9
Increase by EV and HP	-	-	4,41%	4,52%	4,63%	4,75%	4,87%	4,99%	5,19%	5,42%	5,65%	5,88%	6,13%	6,42%



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Normalized Generation (GWh)														
Hydro	30.223,0	29.686,8	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7
Pumping	2.249,0	2.009,4	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7
Nuclear	55.539,4	53.197,6	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	46.116,0	38.177,8	38.177,8
Coal	45.019,4	37.273,6	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0
Fueloil	7.001,6	6.683,2	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0
CCGT	37.065,8	30.044,6	56.764,4	50.439,0	44.249,8	38.684,0	33.129,5	28.343,5	31.629,2	28.301,0	24.833,9	29.434,1	34.081,6	32.370,7
Hydro-wind	982,0	982,0	714,5	447,0	454,0	461,0	468,0	475,0	482,0	565,0	648,0	731,0	814,0	897,0
Wind	50.074,2	49.295,3	50.178,8	54.917,6	61.669,5	67.820,1	73.981,7	79.397,2	84.045,6	87.928,9	90.973,9	93.950,5	96.866,0	99.725,4
Solar PV	8.397,8	7.746,7	8.604,0	14.400,0	17.280,0	20.160,0	23.040,0	25.920,0	28.800,0	34.560,0	40.320,0	46.080,0	51.840,0	57.600,0
Solar Thermal	5.348,0	4.424,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3
Renewable Thermal	3.610,3	3.556,4	4.656,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0
Cogeneration	31.696,8	32.320,6	31.656,0	30.414,0	30.414,0	30.414,0	30.414,0	30.414,0	24.132,0	22.296,0	20.460,0	18.624,0	16.788,0	14.952,0
Interconnection	9.169,0	11.102,3	10.102,3	9.102,3	8.102,3	7.102,3	6.102,3	5.102,3	3.102,3	1.102,3	102,3	-897,7	-1.897,7	-4.397,7
Renewable Generation	97.653,3	94.709,5	97.257,8	108.520,7	118.152,6	127.183,2	136.224,7	144.520,2	152.049	161.691,9	170.497,0	179.233,6	187.909,0	196.528
Self-generation	12.474,3	11.574,9	11.684,9	11.839,1	11.994,4	12.150,6	12.307,8	12.466,1	11.262,5	11.445,0	11.588,4	11.732,7	11.878,0	12.084,2
Losses	33.264,9	30.866,5	31.159,7	31.571,0	31.985,0	32.401,6	32.820,9	33.242,9	33.787,6	34.335,0	34.765,2	35.198,2	35.634,0	36.252,7
Pumping	-3.607,6	-3.200,7	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0
Total Generation	277.207	257.221	259.663,8	263.091,7	266.541,5	270.013,3	273.507,3	277.023,8	281.563	286.124,9	289.710,0	293.318,3	296.950,1	302.106
Demand Increase	-	-	0,00%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%
Electricity Demand	261.923,5	258.086,6	257.877,8	259.892,5	261.917,2	263.951,9	265.996,5	268.050,8	269.882,1	271.668,2	273.446,9	275.217,3	276.978,5	278.584,3
EV	63,00	21,19	43,04	160,14	281,59	407,53	538,11	673,47	1.018,99	1.381,93	1.762,98	2.162,82	2.582,18	3.135,59
HP	6.842,42	11.658,37	11.845,32	12.141,46	12.444,99	12.756,12	13.075,02	13.401,90	13.764,15	14.177,07	14.602,38	15.040,45	15.491,67	15.987,95
Total Increase	-	-	0,00%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%
Total Demand	268.828,9	269.766,2	269.766,2	272.194,1	274.643,8	277.115,6	279.609,6	282.126,1	284.665,3	287.227,2	289.812,3	292.420,6	295.052,4	297.707,9
Increase by EV and HP	-	-	4,41%	4,52%	4,63%	4,75%	4,87%	4,99%	5,19%	5,42%	5,65%	5,88%	6,13%	6,42%

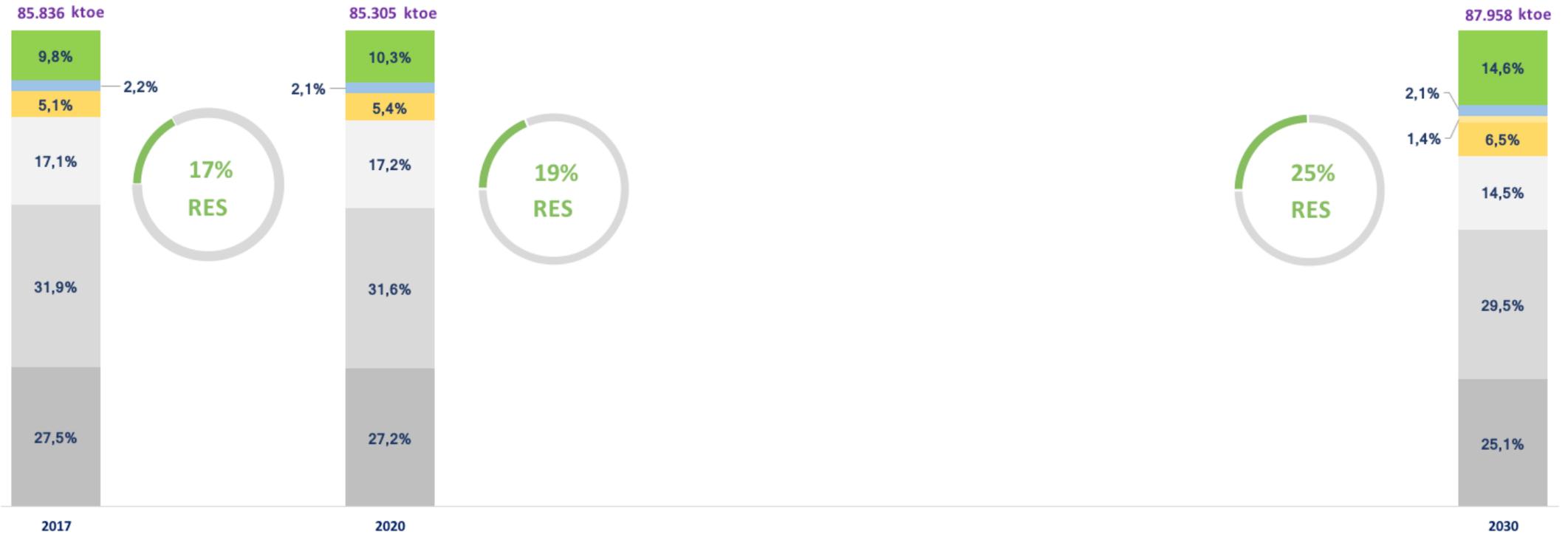


	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Operating Hours														
Hydro	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700
Pumping	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200
Nuclear	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600
Coal	4.200	3.477	1.036	1.045	1.180	1.353	1.588	1.920	2.427	2.427	2.427	2.427	2.427	2.427
Fueloil	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
CCGT	1.150	1.200	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300
Hydro-wind														
Wind	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300
New Wind	-	-	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
Solar PV	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800
Solar Thermal	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100
Renewable Thermal	3.722	3.622	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
Cogeneration	5.561	5.895	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Inputs														
EV	30.000	10.090	20.496	76.256	134.090	194.064	256.245	320.700	485.233	658.063	839.512	1.029.913	1.229.609	1.493.139
Av. Consump. EV kWh/100km	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00
Av. Mileage EV km	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000
Marginal Demand EV MWh	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
HP	1.935.321	1.954.674	2.003.541	2.053.629	2.104.970	2.157.594	2.211.534	2.266.822	2.334.827	2.404.872	2.477.018	2.551.329	2.627.868	2.719.844
Growth Ratio	-	1,00%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	3,00%	3,00%	3,00%	3,00%	3,00%	3,50%
Av. Consump. [kWh/h]	2,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Incremento de eficiencia	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%

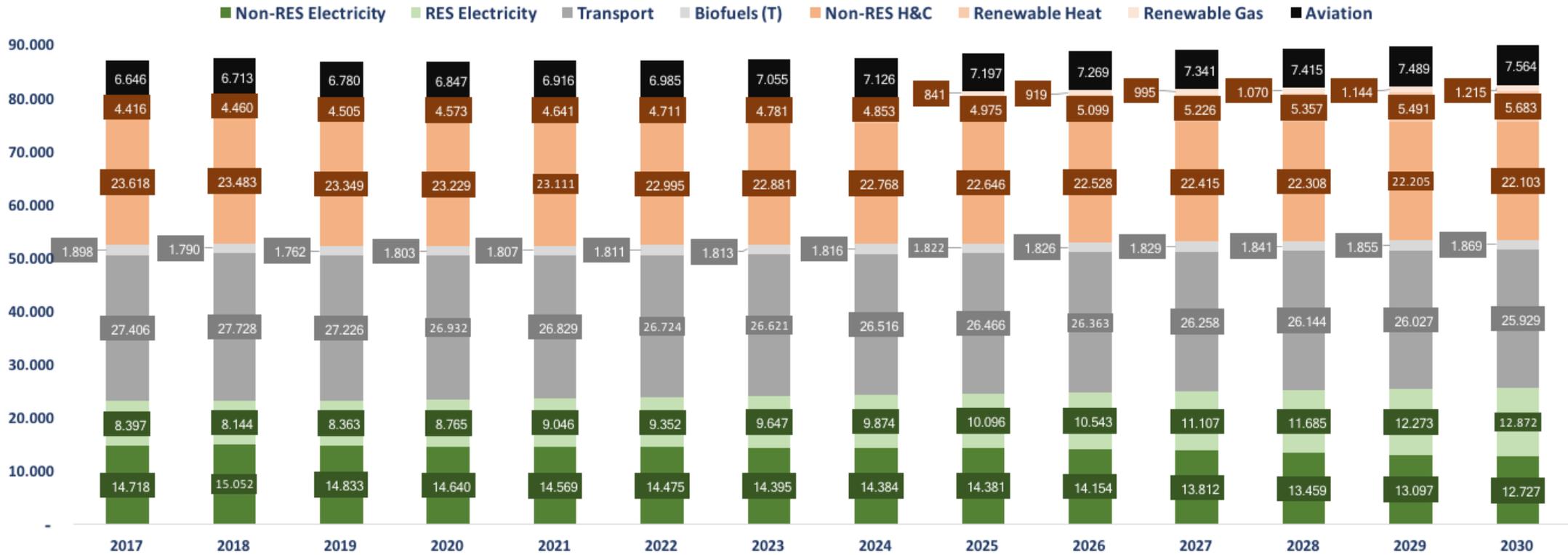


Low scenario

■ Non-RES H&C ■ Transport ■ Non-RES Electricity ■ Renewable Heat ■ Renewable Gas ■ Biofuels (T) ■ RES Electricity









Year	Hydro					Wind					Solar			Solid Biofuels			All other RES								
	Installed Capacity (MW)	Generation (GWh)	Equivalent Hours of Operation	Qv(GWh)	Qv (ktoe) Cons. Ppios 2%	Installed Capacity (MW)	Generation (GWh)	Equivalent Hours of Operation	a	b	c	Qv(GWh)	Qv (ktoe) Cons. Ppios 1,15%	Installed Capacity (MW)	Generation (GWh)	Q (ktoe) Cons. Ppios 4,5%	Installed Capacity (MW)	Generation (GWh)	Q (ktoe) Cons. Ppios 3%	Installed Capacity (MW)	Generation (GWh)	Q (ktoe) Cons. Ppios 1%			
	2030						35000,0000	88544,8176	2529,8519	34200,0000	394724,0878	155000,0000	87093,9600	7601,0636											
2029						33400,0000	83744,8176	2507,3299	32600,0000	370724,0878	147500,0000	81936,3069	7150,9331												
2028						31800,0000	78944,8176	2482,5414	31000,0000	349724,0878	141000,0000	76889,6931	6710,4934												
2027						30200,0000	74144,8176	2455,1264	29400,0000	331724,0878	135500,0000	71975,5585	6281,6158												
2026						28600,0000	69344,8176	2424,6440	27800,0000	316724,0878	131000,0000	67213,2034	5865,9846												
2025						27000,0000	64544,8176	2390,5488	26700,0000	304724,0878	127500,0000	63812,8090	5569,2176												
2024						26400,0000	62744,8176	2376,6976	26100,0000	295724,0878	124577,8893	61956,4093	5407,2017												
2023						25800,0000	60944,8176	2362,2022	25500,0000	287191,4233	121989,0053	60033,1258	5239,3485												
2022						25200,0000	59144,8176	2347,0166	24900,0000	275772,6616	119787,4471	57324,3644	5002,9432												
2021						24600,0000	57344,8176	2331,0901	24300,0000	264534,7996	117978,6336	54486,1000	4755,2357												
2020						24000,0000	55544,8176	2314,3674	23777,8893	254886,6424	116707,5587	51930,3670	4532,1859												
2019						23555,7785	54212,1531	2301,4375	23511,1160	247459,7124	115946,4787	50178,7900	4379,3183												
2018	17050,9286	34100,0727	1999,8953	29686,7894	2603,6565	23466,4535	49526,0559	2110,5045	23298,4419	244279,5902	115453,8383	49295,3194	4302,2140	7010,8575	12171,0125	1093,6120									
2017	17031,8196	18450,6188	1083,3029	30223,0313	2650,6872	23130,4303	47906,9556	2071,1658	23091,1865	249466,9280	115038,9433	50074,2373	4370,1935	6992,2016	13745,7052	1235,1042	4235,5192	375,1147712			1714,6763	148,9100			
2016	17034,5816	36114,8883	2120,0925	30521,6397	2676,8764	23051,9427	47696,6603	2069,0950	23028,9252	250084,5024	113910,1329	50558,9550	4412,4969	6989,7817	13048,6689	1172,4728	4038,0000	357,6216681			1627,0000	141,2958			
2015	17030,9066	28382,5800	1666,5337	31030,4926	2721,5049	23005,9077	48117,8875	2091,5448	23016,8093	244865,0928	111318,3145	50629,7024	4418,6714	6985,2679	13328,7964	1197,6434	4014,0000	355,4961307			1750,0000	151,9776			
2014	16992,1048	39181,9852	2305,8936	31085,8541	2726,3604	23027,7109	51032,0308	2216,1139	23018,4756	240292,5353	107585,5141	51411,8272	4486,9307	6945,1271	13166,8411	1183,0910	3821,0000	338,4032674			1593,0000	138,3431			
2013	16985,8748	37385,4368	2200,9721	30277,1185	2655,4309	23009,2404	54713,3937	2377,8879	22883,5469	227513,3315	102064,1340	51010,2009	4451,8791	6482,2308	12768,8021	1147,3257	3789,0000	335,5692175			1426,0000	123,8401			
2012	16927,8418	20653,5666	1220,0945	30282,6878	2655,9193	22757,8534	48524,5300	2132,2103	21962,3761	204959,7597	94079,5417	47846,7820	4175,7940	6482,2308	11649,7528	1046,7749	3396,0000	300,7635426			1671,0000	145,1169			
2011	16704,8938	30437,3182	1822,0600	31067,9859	2724,7933	21166,8988	42477,2508	2006,7772	20437,1068	184046,8808	84592,2310	44464,9078	3880,6433	5231,8097	9302,3939	835,8557	3011,0000	266,6663801			1701,0000	147,7223			
2010	16687,5320	41833,7742	2506,8880	31902,0971	2797,9483	19707,3148	43545,3300	2209,6024	19284,0089	164450,4861	74624,9903	42496,0140	3708,8095	4361,3032	7114,3920	639,2553	2459,0000	217,7790198			1511,0000	131,2218			
2009	16657,0797	26186,3737	1572,0867	30699,7733	2692,4995	18860,7030	38252,8270	2028,1761	17497,0955	141762,8220	64056,5560	38722,6194	3379,4891	3623,7767	6202,2130	557,2926									
2008	16614,0487	22935,4546	1380,4856	30913,9078	2711,2800	16133,4880	32159,8220	1993,3583	14898,9545	119264,1128	53356,0520	33302,8874	2906,4859	3411,4694	2513,3340	225,8327									
2007	16450,2837	27105,4791	1647,7211	30873,9474	2707,7753	13664,4210	27611,6510	2020,6967	12475,0654	98824,5369	43560,6180	28301,7692	2470,0168	628,9992	491,5290	44,1658									
2006	16362,7751	25374,9488	1550,7729	30307,1273	2658,0628	11285,7097	22880,8561	2027,4185	10469,8661	80472,1826	34689,5109	24287,8310	2119,7032	129,8711	102,3750	9,1988									
2005	16228,9786	18248,1970	1124,4206	30362,0468	2662,8794	9654,0225	20857,6660	2160,5156	8715,5745	64185,4747	26542,5718	21076,0770	1839,3997	42,9462	40,0883	3,6021									
2004	16122,0756	30870,0375	1914,7682	30785,5971	2700,0266	7777,1265	15754,1178	2025,6991	6796,5915	47790,3048	19252,4293	16871,1789	1472,4202	20,9255	17,7940	1,5989									
2003	16029,3966	40097,0072	2501,4670			5816,0565	11720,2461	2015,1534	5103,5205	34510,2203	13283,6963		11,3756	8,9301	0,8024										
2002	15817,0114	21225,3249	1341,9302			4390,9845	9259,2967	2108,7063	3603,9583	24026,6309	8684,7858		4,8429	4,5615	0,4099										
2001	15691,9505	40392,0998	2574,0650			2816,9320	6594,1481	2340,8972	2322,9270	15387,2192	5341,7300		2,1768	1,6396	0,1473										
2000	15690,0205	27893,9347	1777,8138			1828,9220	4462,4961	2439,9597	1425,4320	9097,2001	3140,2630		1,7157	1,2698	0,1141										
1999	15631,2260	25037,7046	1601,7749			1021,9420	2474,0333	2420,9136	827,8585	4794,5610	1782,5660		1,2202	1,3412	0,1205										
1998	15422,3880	35434,0091	2297,5696			633,7750	1236,6567	1951,2551	504,6100	2393,3877	990,9775		1,1590	1,1703	0,1052										
1997	15376,4540	35110,2577	2283,3781			375,4450	619,8850	1651,0674	260,9025	1241,4990	518,4025		1,1370	1,1270	0,1013										
1996	15329,0918	39868,6044	2600,8458			146,3600	304,1290	2077,9516	121,4600	638,9750	272,9900		1,1000	0,8910	0,0801										
1995	15211,9578	22461,9618	1476,5990			96,5600	159,8570	1655,5199	67,7350	337,7110	152,0700		1,1000	1,0620	0,0954										
1994	14961,1390	27483,9337	1837,0215			38,9100	72,8600	1872,5263	36,2700	180,0410	84,6050		1,1000	15,2959	1,3744										
1993	14642,5050	23748,7177	1621,9027			33,6300	84,7680	2520,6066	32,0350	107,1810			0,1000	12,0000	1,0782										
1992	14576,6220	18638,6405	1278,6667			30,4400	17,3610	570,3351	15,4900				0,1000	12,0560	1,0833										
1991	14439,4930	26432,7149	1830,5847			0,5400	2,8650	5305,5556	0,5400				0,1000	0,0000	0,0000										
1990	14386,8290	24523,3926	1704,5725			0,5400	2,1870	4050,0000					0,1000	0,0000	0,0000										



H&C

Average Growth Ratio	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Efficiency	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	
			17,59											3,64	
														21,24	
ktoe	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Heat Pump	494,18	588,34	1512,65	1527,77	1543,05	1558,48	1574,06	1589,81	1605,70	1637,82	1670,57	1703,99	1738,07	1772,83	1826,01
Heat Pump Subbed			8,99	9,08	9,17	9,26	9,35	9,44	9,54	19,27	19,65	20,05	20,45	20,86	31,91
Units	1916159	1935321	1954674	1974221	1993963	2013902	2034041	2054382	2074926	2116424	2158753	2201928	2245966	2290886	2359612
Growth	-	1,0%	1,0%	1,0%	1,0%	1,0%	1,0%	1,0%	1,0%	2,0%	2,0%	2,0%	2,0%	2,0%	3,0%
kWhe/h	2,00	2,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
HP Growth			1.008,43	1.018,51	1.028,70	1.038,99	1.049,38	1.059,87	1.070,47	1.091,88	1.113,72	1.135,99	1.158,71	1.181,88	1.217,34
			495,23	500,18	505,18	510,24	515,34	520,49	525,70	526,67	537,20	547,95	558,91	570,09	576,76
		HPs	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
		New Equip.	19353	19547	19742	19940	20139	20340	20544	19949	42328	43175	44039	44919	68727
		Commercial	1935	1955	1974	1994	2014	2034	2054	4150	4233	4318	4404	4492	6873
		Residential	17418	17592	17768	17946	18125	18306	18489	37349	38096	38858	39635	40427	61854

Residential	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gas	3472,03	3496,08	3521,33	3546,74	3590,04	3633,90	3678,31	3723,28	3768,83	3842,24	3917,07	3993,34	4071,09	4150,35	4261,15	
Solid Fuel	79,05	73,40	67,76	62,11	56,46	50,82	45,17	39,52	33,88	28,23	22,59	16,94	11,29	5,65	0,00	
Oil Products	2939,10	2909,71	2869,83	2830,24	2776,79	2724,03	2671,95	2620,53	2569,78	2482,41	2396,77	2312,79	2230,43	2149,65	2036,11	
GLP																
Gasoil																
RES	2738,61	2765,99	2793,65	2821,59	2863,91	2906,87	2950,47	2994,73	3039,65	3115,64	3193,53	3273,37	3355,21	3439,09	3559,46	
Solar Thermal	233,47	235,81	238,17	240,55	244,16	247,82	251,54	255,31	259,14	265,62	272,26	279,07	286,04	293,19	303,45	
Biomass	2494,48	2519,43	2544,62	2570,07	2608,62	2647,75	2687,46	2727,77	2768,69	2837,91	2908,86	2981,58	3056,12	3132,52	3242,16	
Geothermal	10,65	10,76	10,86	10,97	11,14	11,30	11,47	11,65	11,82	12,12	12,42	12,73	13,05	13,37	13,84	
TOTAL	9228,79	9245,18	9252,57	9260,68	9287,21	9315,61	9345,90	9378,07	9412,14	9468,53	9529,96	9596,45	9668,03	9744,73	9856,72	

Services	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil Products	1265,40	1252,75	1239,02	1225,42	1205,82	1186,50	1167,45	1148,68	1130,18	1099,36	1069,25	1039,85	1011,12	983,06	944,40	
Gas	3006,17	3025,56	3054,73	3084,19	3129,36	3175,18	3221,69	3268,88	3316,77	3397,38	3479,95	3564,55	3651,21	3739,98	3867,06	
RES	166,73	168,40	170,08	171,78	174,36	176,97	179,63	182,32	185,06	189,69	194,43	199,29	204,27	209,38	216,70	
Solar Thermal	55,35	55,91	56,47	57,03	57,89	58,75	59,64	60,53	61,44	62,97	64,55	66,16	67,82	69,51	71,95	
Geothermal	3,75	3,79	3,82	3,86	3,92	3,98	4,04	4,10	4,16	4,27	4,37	4,48	4,59	4,71	4,87	
Biomass	92,51	93,44	94,37	95,31	96,74	98,20	99,67	101,16	102,68	105,25	107,88	110,58	113,34	116,17	120,24	
Biogas	10,89	11,00	11,11	11,22	11,39	11,56	11,73	11,91	12,09	12,39	12,70	13,02	13,34	13,67	14,15	
Biofuel	4,23	4,27	4,31	4,36	4,42	4,49	4,55	4,62	4,69	4,81	4,93	5,05	5,18	5,31	5,49	
TOTAL	4438,30	4446,70	4463,84	4481,40	4509,53	4538,66	4568,77	4599,89	4632,01	4686,42	4743,63	4803,68	4866,60	4932,43	5028,16	



Industry	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil Products	2828,00	2826,22	2824,42	2822,61	2820,77	2818,92	2817,05	2815,16	2813,26	2809,40	2805,47	2801,46	2797,37	2793,20	2786,82	
Gas	6530,00	6515,23	6513,61	6511,98	6510,33	6508,66	6506,98	6505,28	6503,56	6500,09	6496,55	6492,94	6489,26	6485,51	6479,77	
RES	1387,00	1401,07	1415,08	1429,23	1450,67	1472,43	1494,52	1516,93	1539,69	1578,18	1617,63	1658,08	1699,53	1742,02	1802,99	
Solar Thermal	3,00	3,03	3,06	3,09	3,14	3,18	3,23	3,28	3,33	3,41	3,50	3,59	3,68	3,77	3,90	
Geothermal	0,00	0,20	0,20	0,20	0,21	0,21	0,21	0,22	0,22	0,23	0,23	0,24	0,24	0,25	0,26	
Biofuel	1384,00	1397,84	1411,82	1425,94	1447,33	1469,04	1491,07	1513,44	1536,14	1574,54	1613,91	1654,25	1695,61	1738,00	1798,83	
Coal	1501,00	1393,79	1286,57	1179,36	1072,14	964,93	857,71	750,50	643,29	536,07	428,86	321,64	214,43	107,21	0,00	
TOTAL	12246,00	12136,30	12039,68	11943,17	11853,91	11764,94	11676,26	11587,87	11499,79	11423,75	11348,52	11274,13	11200,59	11127,94	11069,57	

Blurred Sectors	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil Products	2011,00	2003,88	1985,91	1967,76	1949,43	1930,91	1912,21	1893,32	1874,24	1835,70	1796,40	1756,30	1715,41	1673,69	1609,87	
Gas	91,00	91,91	92,83	93,76	95,16	96,59	98,04	99,51	101,00	103,53	106,12	108,77	111,49	114,28	118,28	
RES	80,00	80,80	81,61	82,42	83,66	84,92	86,19	87,48	88,79	91,01	93,29	95,62	98,01	100,46	103,98	
Solar Thermal	2,00	2,02	2,04	2,06	2,09	2,12	2,15	2,19	2,22	2,28	2,33	2,39	2,45	2,51	2,60	
Geothermal	4,00	4,04	4,08	4,12	4,18	4,25	4,31	4,37	4,44	4,55	4,66	4,78	4,90	5,02	5,20	
Biofuel	74,00	74,74	75,49	76,24	77,39	78,55	79,72	80,92	82,13	84,19	86,29	88,45	90,66	92,93	96,18	
Coal	32,00	29,71	27,43	25,14	22,86	20,57	18,29	16,00	13,71	11,43	9,14	6,86	4,57	2,29	0,00	
TOTAL	2214,00	2206,31	2187,78	2169,08	2151,11	2132,99	2114,72	2096,31	2077,75	2041,67	2004,94	1967,55	1929,48	1890,72	1832,13	

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TOTAL H&C		28127,09	28034,49	27943,87	27854,33	27801,76	27752,19	27705,65	27662,14	27621,69	27620,36	27627,05	27641,81	27664,70	27695,81	27786,58
RES-H&C		17,00%	17,48%	20,28%	20,53%	20,84%	21,15%	21,46%	21,78%	22,10%	22,60%	23,11%	23,62%	24,13%	24,65%	25,36%



T															
Growth Rate		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Bus	2,80%	3,00%	3,00%	2,00%	2,00%	2,00%	2,00%	2,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,50%
	Van	1,40%	1,60%	1,60%	1,50%	1,50%	1,50%	1,50%	1,50%	1,50%	1,50%	1,50%	1,50%	1,50%	1,50%
	Motorcycle	3,60%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%
	Truck	0,30%	0,75%	0,75%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%
	Trailer	0,50%	0,50%	0,50%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%
	Car	2,70%	0,75%	0,75%	2,00%	2,00%	2,00%	2,00%	2,00%	2,50%	2,50%	2,50%	2,50%	2,50%	3,00%
1	Truck Old	2.586.443	2.534.714	2.482.597	2.469.470	2.456.212	2.442.821	2.429.297	2.415.637	2.401.840	2.387.906	2.373.832	2.359.617	2.345.261	2.330.760
	Truck Repl.	0	51.729	52.117	13.127	13.258	13.391	13.525	13.660	13.797	13.934	14.074	14.215	14.357	14.500
	Truck New	0	71.127	142.788	208.422	274.713	341.667	409.291	477.590	560.370	643.977	728.420	813.707	899.847	1.001.349
	NEW	0	71.127	71.661	65.635	66.291	66.954	67.623	68.300	82.779	83.607	84.443	85.287	86.140	101.502
3	Van Old	2.338.033	2.291.272	2.243.764	2.231.696	2.219.448	2.207.016	2.194.398	2.181.590	2.168.590	2.155.395	2.142.002	2.128.409	2.114.611	2.100.607
	Van Repl.	0	46.761	47.509	12.067	12.248	12.432	12.618	12.808	13.000	13.195	13.393	13.594	13.798	14.005
	Van New	0	84.169	169.685	217.954	266.947	316.675	367.149	418.380	470.379	523.158	576.730	631.104	686.294	742.313
	NEW	0	84.169	85.516	48.269	48.993	49.728	50.474	51.231	51.999	52.779	53.571	54.375	55.190	56.018
	Bus Old	63.589	62.317	61.007	60.670	60.326	59.975	59.617	59.252	58.880	58.496	58.101	57.694	57.275	56.843
	Bus Repl.	0	1.272	1.310	337	344	351	358	365	372	384	395	407	419	432
	Bus New	0	3.179	6.454	8.141	9.861	11.616	13.406	15.231	17.838	20.523	23.289	26.137	29.072	32.525
	NEW	0	3.179	3.275	1.687	1.720	1.755	1.790	1.826	2.607	2.685	2.766	2.849	2.934	3.454
2	Car Old	23.500.401	23.030.393	22.556.860	22.437.589	22.315.932	22.191.842	22.065.271	21.936.168	21.804.483	21.669.506	21.531.154	21.389.344	21.243.989	21.094.999
	Car Repl.	0	470.008	473.533	119.271	121.657	124.090	126.571	129.103	131.685	134.977	138.352	141.810	145.356	148.989
	Car New	0	646.261	1.297.369	1.893.725	2.502.008	3.122.456	3.755.314	4.400.828	5.190.938	6.000.801	6.830.910	7.681.772	8.553.905	9.596.832
	NEW	0	646.261	651.108	596.356	608.283	620.448	632.857	645.515	790.110	809.863	830.109	850.862	872.133	1.042.926
4	Motorcle Old	3.327.048	3.260.507	3.191.970	3.174.322	3.156.144	3.137.421	3.118.136	3.098.272	3.077.813	3.056.740	3.035.035	3.012.679	2.989.652	2.965.934
	Motorcle Repl.	0	66.541	68.537	17.648	18.178	18.723	19.285	19.863	20.459	21.073	21.705	22.356	23.027	23.718
	Motorcle New	0	166.352	337.695	461.234	588.478	719.540	854.533	993.577	1.136.792	1.284.303	1.436.239	1.592.734	1.753.923	1.919.948
	NEW	0	166.352	171.343	123.538	127.244	131.062	134.994	139.043	143.215	147.511	151.937	156.495	161.189	166.025
1	Trailer Old	459.712	450.518	441.278	438.956	436.611	434.243	431.851	429.435	426.995	424.531	422.042	419.528	416.988	414.424
	Trailer Repl.	0	9.194	9.240	2.322	2.345	2.368	2.392	2.416	2.440	2.464	2.489	2.514	2.539	2.564
	Trailer New	0	11.493	23.043	30.008	37.042	44.147	51.323	58.571	65.891	73.284	80.751	88.293	95.910	103.604
	NEW	0	11.493	11.550	6.965	7.034	7.105	7.176	7.248	7.320	7.393	7.467	7.542	7.617	7.693
	TOTAL	32.275.226	32.612.304	32.954.510	33.632.186	34.323.723	35.029.420	35.749.584	36.484.531	37.380.808	38.298.619	39.238.504	40.201.018	41.186.727	42.360.138



Fleet	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Truck	2.586.443	2.605.841	2.625.385	2.651.639	2.678.155	2.704.937	2.731.986	2.759.306	2.786.899	2.814.768	2.842.916	2.871.345	2.900.059	2.929.059
Van	2.338.033	2.375.442	2.413.449	2.449.650	2.486.395	2.523.691	2.561.546	2.599.970	2.638.969	2.678.554	2.718.732	2.759.513	2.800.906	2.842.919
Bus	63.589	65.497	67.462	68.811	70.187	71.591	73.023	74.483	76.718	79.019	81.390	83.831	86.346	89.368
Car	23.500.401	23.676.654	23.854.229	24.331.313	24.817.940	25.314.299	25.820.585	26.336.996	26.995.421	27.670.307	28.362.064	29.071.116	29.797.894	30.691.831
Motorcycle	3.327.048	3.426.859	3.529.665	3.635.555	3.744.622	3.856.960	3.972.669	4.091.849	4.214.605	4.341.043	4.471.274	4.605.413	4.743.575	4.885.882
Trailer	459.712	462.011	464.321	468.964	473.653	478.390	483.174	488.006	492.886	497.815	502.793	507.821	512.899	518.028

Tasa	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Renovación	0%	2%	2%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
EV & NG	0%	10%	10%	20%	20%	20%	20%	20%	30%	30%	30%	30%	30%	40%
EV	0%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
NG	0%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
EV	0,09%	0,03%	0,06%	0,11%	0,15%	0,19%	0,24%	0,28%	0,35%	0,42%	0,49%	0,56%	0,63%	0,72%
NG	0,03%	0,07%	0,15%	0,25%	0,35%	0,45%	0,56%	0,66%	0,82%	0,98%	1,14%	1,30%	1,46%	1,68%

	Truck, Trailer & Bus (1)				Car (2)			Van (3)			Motorcycle (4)	
	Gasoline	Diesel	Trailer [km]	Truck [km]	Gasoline	Diesel	km	Gasoline	Diesel	km	Gasoline	km
2017	5,00%	95,00%	35000	14000	44,85%	55,15%	14000	7,00%	93,00%	14000	100,00%	5000
2018	4,00%	95,77%	35000	14000	47,00%	52,73%	14000	6,00%	93,65%	14000	99,51%	5000
2020	2,00%	97,58%	35000	14000	50,00%	49,51%	14000	5,00%	94,61%	14000	99,32%	5000
2025	1,00%	98,24%	35000	14000	49,00%	50,12%	14000	4,00%	95,41%	14000	98,98%	5000
2030	0,50%	98,32%	35000	14000	44,00%	54,64%	14000	3,00%	96,21%	14000	98,64%	5000

Biofuels	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ethanol	4,70%	5,90%	5,90%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%
Biodiesel	7,00%	5,90%	5,90%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%



ktoe	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Road	28288,06	28466,15	27903,84	27616,31	27482,02	27345,54	27206,82	27065,84	26982,07	26841,45	26698,14	26552,08	26403,20	26272,41
Truck	9081,18	9149,03	8967,83	8902,45	8857,85	8812,81	8767,31	8721,37	8707,07	8660,64	8613,74	8566,38	8518,54	8488,83
Gasol. Old	345,94	271,22	265,64	132,12	131,41	130,69	129,97	129,24	64,25	63,88	63,50	63,12	62,74	31,17
Gasol. New	0,00	6,85	6,90	2,70	2,72	2,75	2,78	2,81	1,49	1,50	1,52	1,53	1,55	0,78
Diesel Old	8735,24	8629,75	8452,45	8566,84	8520,92	8474,53	8427,69	8380,37	8389,24	8340,65	8291,57	8242,00	8191,93	8147,94
Diesel New	0,00	211,85	213,29	151,97	153,49	155,02	156,57	158,14	162,95	164,58	166,22	167,89	169,56	166,97
NG	0,00	29,35	29,55	48,82	49,31	49,81	50,30	50,81	89,14	90,03	90,93	91,84	92,76	141,97
EV	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Van	2486,32	2514,69	2465,83	2409,96	2397,79	2385,43	2372,89	2360,16	2340,20	2327,13	2313,87	2300,41	2286,74	2233,10
Gasol. Old	192,63	161,81	158,46	131,34	130,62	129,89	129,14	128,39	102,10	101,48	100,85	100,21	99,56	0,01
Gasol. New	0,00	5,35	5,44	2,27	2,31	2,34	2,38	2,41	1,71	1,74	1,77	1,79	1,82	1,19
Diesel Old	2293,68	2263,41	2216,48	2227,17	2214,95	2202,54	2189,95	2177,16	2182,56	2169,28	2155,80	2142,12	2128,23	2131,93
Diesel New	0,00	74,83	76,03	38,54	39,11	39,70	40,30	40,90	36,63	37,18	37,74	38,31	38,88	34,11
NG	0,00	9,28	9,43	10,64	10,80	10,96	11,13	11,29	17,20	17,45	17,72	17,98	18,25	65,87
EV	0,00	0,00	0,00	0,87	0,88	0,90	0,91	0,93	1,41	1,43	1,45	1,47	1,49	2,02
Car	16445,08	16521,44	16194,46	16034,73	15958,46	15880,67	15801,31	15720,37	15674,31	15594,67	15513,05	15429,38	15343,62	15300,11
Gasol. Old	7330,66	7528,43	7373,64	7802,82	7760,51	7717,36	7673,34	7628,45	7431,00	7385,00	7337,85	7289,52	7239,98	6455,61
Gasol. New	0,00	190,13	191,56	165,91	169,23	172,61	176,06	179,59	188,49	193,20	198,03	202,98	208,06	191,50
Diesel Old	9114,43	8539,71	8364,13	7812,25	7769,89	7726,68	7682,61	7637,66	7685,68	7638,10	7589,34	7539,35	7488,12	8105,97
Diesel New	0,00	215,67	217,29	166,11	169,43	172,82	176,28	179,80	194,95	199,82	204,82	209,94	215,19	240,45
NG	0,00	47,49	47,85	87,65	89,40	91,19	93,02	94,88	174,19	178,55	183,01	187,59	192,28	306,58
EV	5,42	3,50	3,53	6,46	6,59	6,72	6,86	6,99	12,84	13,16	13,49	13,83	14,17	22,60
Motorcycle	275,48	280,99	275,72	269,17	267,92	266,63	265,31	263,94	260,49	259,01	257,48	255,91	254,30	250,37
Gasol. Old	275,48	268,66	263,01	261,04	259,55	258,01	256,42	254,79	252,24	250,52	248,74	246,90	245,02	242,24
Gasol. New	0,00	12,34	12,71	8,13	8,37	8,62	8,88	9,15	8,24	8,49	8,75	9,01	9,28	8,14
EV	0,00	0,72	0,74	1,06	1,09	1,13	1,16	1,20	1,85	1,90	1,96	2,02	2,08	2,86
Rail	313,93	350,00	367,50	385,88	405,17	425,43	446,70	469,03	492,49	517,11	542,96	570,11	598,62	628,55
Aviation	6646,11	6712,57	6778,70	6847,49	6915,97	6985,13	7054,98	7125,53	7196,78	7268,75	7341,44	7414,85	7489,00	7563,89
Ships	953,00	981,59	1011,04	1041,37	1072,61	1104,79	1137,93	1172,07	1207,23	1243,45	1280,75	1319,17	1358,75	1399,51
TOTAL	29303,85	29517,74	28988,38	28734,86	28635,66	28535,41	28434,09	28331,72	28287,80	28188,32	28087,49	27985,28	27881,67	27797,64
TOTAL	29554,99	29797,74	29282,38	29043,56	28959,80	28875,75	28791,45	28706,94	28681,78	28602,01	28521,86	28441,37	28360,57	28300,48



Gasoline

	Car						Motorcycle						Truck						Van					
	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]
2017	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	25,00	222,22	0,74	42998,81	3600,00	8,89	11,00	97,78
2018	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	25,00	222,22	0,74	42998,81	3600,00	8,89	11,00	97,78
2020	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	24,00	213,33	0,74	42998,81	3600,00	8,89	11,00	97,78
2025	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	24,00	213,33	0,74	42998,81	3600,00	8,89	11,00	97,78
2030	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	24,00	213,33	0,74	42998,81	3600,00	8,89	11,00	97,78

Diesel

	Car						Truck						Van					
	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]
2017	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	21,00	204,47	0,86	40767,49	3600,00	9,74	9,00	87,63
2018	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	21,00	204,47	0,86	40767,49	3600,00	9,74	9,00	87,63
2020	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	20,00	194,73	0,86	40767,49	3600,00	9,74	9,00	87,63
2025	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	20,00	194,73	0,86	40767,49	3600,00	9,74	9,00	87,63
2030	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	20,00	194,73	0,86	40767,49	3600,00	9,74	9,00	87,63

NG

	Car						Van						Truck					
	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]
2017	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2018	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2020	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2025	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2030	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85

EV

	Truck	Car	Van	Moto
	[kWh/100km]	[kWh/100km]	[kWh/100km]	[kWh/100km]
2017		15,00		10,00
2018		15,00		10,00
2020		15,00	25,00	10,00
2025		15,00	25,00	10,00
2030		15,00	25,00	10,00



RES-T	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Road	1798,25	1678,64	1645,47	1656,55	1648,52	1640,36	1632,07	1623,65	1618,19	1609,82	1601,29	1592,60	1583,74	1572,96
Truck	627,73	538,06	527,36	531,22	528,51	525,78	523,02	520,23	517,08	514,24	511,37	508,47	505,55	500,81
Bioethanol	16,26	16,41	16,08	8,09	8,05	8,01	7,96	7,92	3,94	3,92	3,90	3,88	3,86	1,92
Biodiesel	611,47	521,65	511,28	523,13	520,46	517,77	515,06	512,31	513,13	510,31	507,47	504,59	501,69	498,89
Biogas														
EV	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Van	169,61	147,82	144,93	144,83	144,10	143,37	142,62	141,86	140,79	140,01	139,22	138,42	137,60	132,06
Bioethanol	9,05	9,86	9,67	8,02	7,98	7,93	7,89	7,85	6,23	6,19	6,16	6,12	6,08	0,07
Biodiesel	160,56	137,96	135,26	135,94	135,24	134,53	133,81	133,08	133,15	132,39	131,61	130,83	130,03	129,96
Biogas														
EV	0,00	0,00	0,00	0,87	0,88	0,90	0,91	0,93	1,41	1,43	1,45	1,47	1,49	2,02
Car	987,97	975,46	956,18	963,29	958,73	954,09	949,35	944,52	942,85	938,13	933,29	928,33	923,25	922,21
Bioethanol	344,54	455,40	446,35	478,12	475,78	473,40	470,96	468,48	457,17	454,69	452,15	449,55	446,88	398,83
Biodiesel	638,01	516,57	506,30	478,70	476,36	473,97	471,53	469,05	472,84	470,28	467,65	464,96	462,20	500,79
Biogas														
EV	5,42	3,50	3,53	6,46	6,59	6,72	6,86	6,99	12,84	13,16	13,49	13,83	14,17	22,60
Motorcycle	12,95	17,29	17,00	17,21	17,17	17,12	17,08	17,03	17,48	17,44	17,41	17,37	17,34	17,88
Bioethanol	12,95	16,58	16,27	16,15	16,08	16,00	15,92	15,84	15,63	15,54	15,45	15,35	15,26	15,02
EV	0,00	0,72	0,74	1,06	1,09	1,13	1,16	1,20	1,85	1,90	1,96	2,02	2,08	2,86
% RES-E	32%	38%	39%	40%	41%	41%	41%	42%	42%	44%	45%	47%	49%	50%
Rail	99,82	111,29	116,86	146,40	158,05	170,67	181,11	192,10	203,67	215,84	227,84	248,56	271,40	295,61
TOTAL	1898,08	1789,93	1762,32	1802,95	1806,57	1811,04	1813,18	1815,75	1821,85	1825,66	1829,13	1841,16	1855,14	1868,56
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RES-T	6,42%	6,01%	6,02%	6,21%	6,24%	6,27%	6,30%	6,33%	6,35%	6,38%	6,41%	6,47%	6,54%	6,60%



E

Power Capacity (MW)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Hydro	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049
Pumping	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329
Nuclear	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	6.068	5.023	5.023
Coal	10.720	10.720	10.622	10.524	9.326	8.127	6.929	5.730	4.532	4.532	4.532	4.532	4.532	4.532
Fuel	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790
CCGT	27.531	27.531	27.339	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146
Hydro-wind	200	200		0					0					0
Wind	22.600	23.507	23.556	24.000	24.600	25.200	25.800	26.400	27.000	28.600	30.200	31.800	33.400	35.000
Solar PV	4.688	4.707	4.780	6.000	6.400	6.800	7.200	7.600	8.000	9.000	10.000	11.000	12.000	13.000
Solar Thermal	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303
Renewable Thermal	970	982	1.164	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346
Cogeneration	5.700	5.483	5.276	5.069	5.069	5.069	5.069	5.069	4.022	3.716	3.410	3.104	2.798	2.492
Renewable Capacity	47.810	48.748	48.851	50.698	51.698	52.698	53.698	54.698	55.698	58.298	60.898	63.498	66.098	68.698
Total Capacity	104.997	105.718	105.324	106.673	106.474	106.276	106.078	105.879	104.634	106.928	109.222	110.466	111.716	114.010



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Power Generation (GWh)														
Hydro	18.450,6	34.100,1	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7
Pumping	2.249,0	2.009,4	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7
Nuclear	55.539,4	53.197,6	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	46.116,0	38.177,8	38.177,8
Coal	45.019,4	37.273,6	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0
Fuel	7.001,6	6.683,2	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0
CCGT	37.065,8	30.044,6	52.731,1	53.411,8	54.334,5	55.279,3	56.246,4	57.235,9	65.530,0	65.245,0	63.983,0	70.719,8	77.442,8	77.751,2
Hydro-wind	982,0	982,0	714,5	447,0	454,0	461,0	468,0	475,0	482,0	565,0	648,0	731,0	814,0	897,0
Wind	47.907,0	49.526,1	54.212,2	55.544,8	57.344,8	59.144,8	60.944,8	62.744,8	64.544,8	69.344,8	74.144,8	78.944,8	83.744,8	88.544,8
Solar PV	8.397,8	7.746,7	8.604,0	10.800,0	11.520,0	12.240,0	12.960,0	13.680,0	14.400,0	16.200,0	18.000,0	19.800,0	21.600,0	23.400,0
Solar Thermal	5.348,0	4.424,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3
Renewable Thermal	3.610,3	3.556,4	4.656,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0
Cogeneration	31.696,8	32.320,6	31.656,0	30.414,0	30.414,0	30.414,0	30.414,0	30.414,0	24.132,0	22.296,0	20.460,0	18.624,0	16.788,0	14.952,0
Interconnection	9.169,0	11.102,3	10.102,3	9.102,3	8.102,3	7.102,3	6.102,3	5.102,3	3.102,3	1.102,3	102,3	-897,7	-1.897,7	-4.397,7
Renewable Generation	83.713,6	99.353,5	101.291,2	105.547,9	108.067,9	110.587,9	113.107,9	115.627,9	118.148	124.747,9	131.347,9	137.947,9	144.547,9	151.148
Sell-Generation	10.530,7	10.474,6	10.386,6	10.523,7	10.661,7	10.800,5	10.940,3	11.081,0	9.854,7	10.014,4	10.139,8	10.266,1	10.393,3	10.573,7
Losses	32.259,5	32.371,9	32.371,9	32.663,3	32.957,3	33.253,9	33.553,2	33.855,1	34.159,8	34.467,3	34.777,5	35.090,5	35.406,3	35.724,9
Pumping	-3.607,6	-3.200,7	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0
Total Generation	263.268	261.865	259.663,8	263.091,7	266.541,5	270.013,3	273.507,3	277.023,8	281.563	286.124,9	289.710,0	293.318,3	296.950,1	302.106
Demand Increase	-	-	0,00%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%
Electricity Demand	261.923,5	252.152,9	251.955,1	254.173,5	256.410,5	258.666,5	260.941,6	263.235,7	265.341,7	267.460,4	269.591,8	271.735,9	273.892,7	275.829,9
EV	63,00	21,19	43,04	74,93	108,14	142,69	178,64	216,04	275,76	338,10	403,13	470,96	541,67	641,45
HP	6.842,42	17.592,06	17.767,98	17.945,66	18.125,12	18.306,37	18.489,44	18.674,33	19.047,82	19.428,77	19.817,35	20.213,70	20.617,97	21.236,51
Total Increase	-	-	0,00%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%
Total Demand	268.828,9	269.766,2	269.766,2	272.194,1	274.643,8	277.115,6	279.609,6	282.126,1	284.665,3	287.227,2	289.812,3	292.420,6	295.052,4	297.707,9
Increase by EV and HP	-	-	6,60%	6,62%	6,64%	6,66%	6,68%	6,70%	6,79%	6,88%	6,98%	7,07%	7,17%	7,35%



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Normalized Power Generation														
Hydro	30.223,0	29.686,8	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7
Pumping	2.249,0	2.009,4	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7
Nuclear	55.539,4	53.197,6	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	46.116,0	38.177,8	38.177,8
Coal	45.019,4	37.273,6	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0
Fuel	7.001,6	6.683,2	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0
CCGT	37.065,8	30.044,6	56.764,4	57.026,3	57.193,3	57.099,8	57.158,1	58.024,3	66.262,0	67.376,6	66.152,3	72.774,9	79.251,3	79.202,1
Hydro-wind	982,0	982,0	714,5	447,0	454,0	461,0	468,0	475,0	482,0	565,0	648,0	731,0	814,0	897,0
Wind	50.074,2	49.295,3	50.178,8	51.930,4	54.486,1	57.324,4	60.033,1	61.956,4	63.812,8	67.213,2	71.975,6	76.889,7	81.936,3	87.094,0
Solar PV	8.397,8	7.746,7	8.604,0	10.800,0	11.520,0	12.240,0	12.960,0	13.680,0	14.400,0	16.200,0	18.000,0	19.800,0	21.600,0	23.400,0
Solar Thermal	5.348,0	4.424,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3
Renewable Thermal	3.610,3	3.556,4	4.656,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0
Cogeneration	31.696,8	32.320,6	31.656,0	30.414,0	30.414,0	30.414,0	30.414,0	30.414,0	24.132,0	22.296,0	20.460,0	18.624,0	16.788,0	14.952,0
Interconnection	9.169,0	11.102,3	10.102,3	9.102,3	8.102,3	7.102,3	6.102,3	5.102,3	3.102,3	1.102,3	102,3	-897,7	-1.897,7	-4.397,7
Renewable Generation	97.653,3	94.709,5	97.257,8	101.933,4	105.209,1	108.767,4	112.196,2	114.839,5	117.416	122.616,3	129.178,6	135.892,7	142.739,4	149.697
Sell-Genration	12.474,3	11.574,9	11.684,9	11.839,1	11.994,4	12.150,6	12.307,8	12.466,1	11.262,5	11.445,0	11.588,4	11.732,7	11.878,0	12.084,2
Losses	33.264,9	30.866,5	31.159,7	31.571,0	31.985,0	32.401,6	32.820,9	33.242,9	33.787,6	34.335,0	34.765,2	35.198,2	35.634,0	36.252,7
Pumping	-3.607,6	-3.200,7	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0
Total Genration	277.207	257.221	259.663,8	263.091,7	266.541,5	270.013,3	273.507,3	277.023,8	281.563	286.124,9	289.710,0	293.318,3	296.950,1	302.106
Demand Increase	-	-	0,00%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%
Electricity Demand	261.923,5	252.152,9	251.955,1	254.173,5	256.410,5	258.666,5	260.941,6	263.235,7	265.341,7	267.460,4	269.591,8	271.735,9	273.892,7	275.829,9
EV	63,00	21,19	43,04	74,93	108,14	142,69	178,64	216,04	275,76	338,10	403,13	470,96	541,67	641,45
HP	6.842,42	17.592,06	17.767,98	17.945,66	18.125,12	18.306,37	18.489,44	18.674,33	19.047,82	19.428,77	19.817,35	20.213,70	20.617,97	21.236,51
Total Increase	-	-	0,00%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%
Total Demand	268.828,9	269.766,2	269.766,2	272.194,1	274.643,8	277.115,6	279.609,6	282.126,1	284.665,3	287.227,2	289.812,3	292.420,6	295.052,4	297.707,9
Increase by EV and HP	-	-	6,60%	6,62%	6,64%	6,66%	6,68%	6,70%	6,79%	6,88%	6,98%	7,07%	7,17%	7,35%

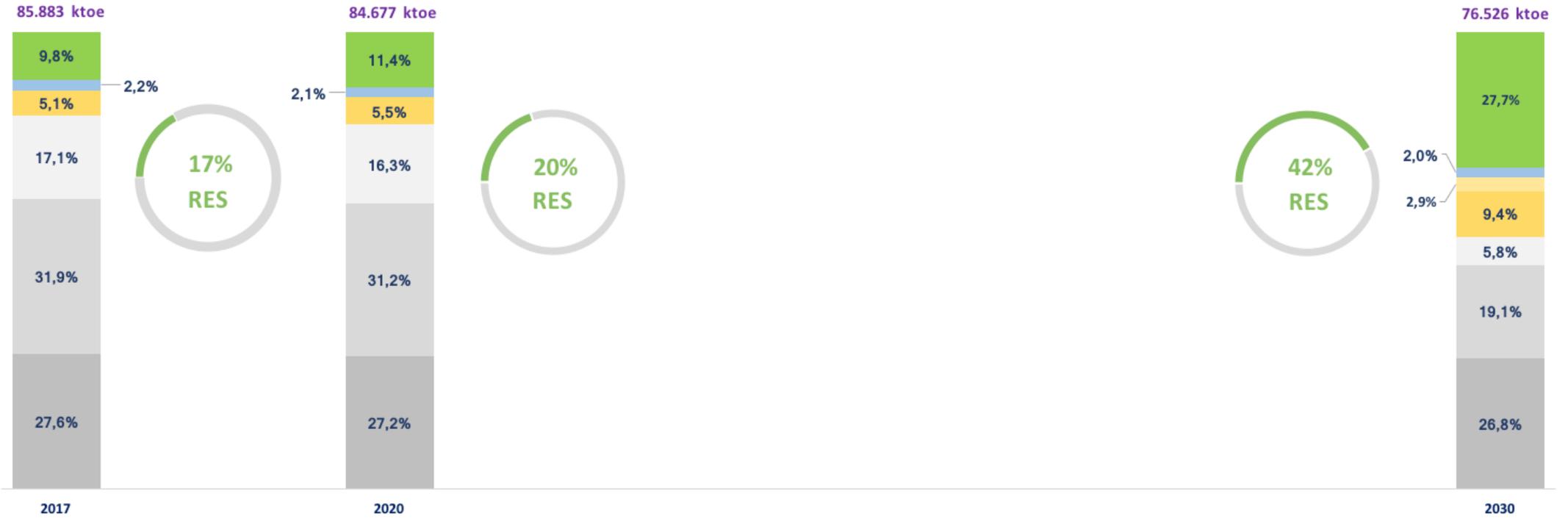


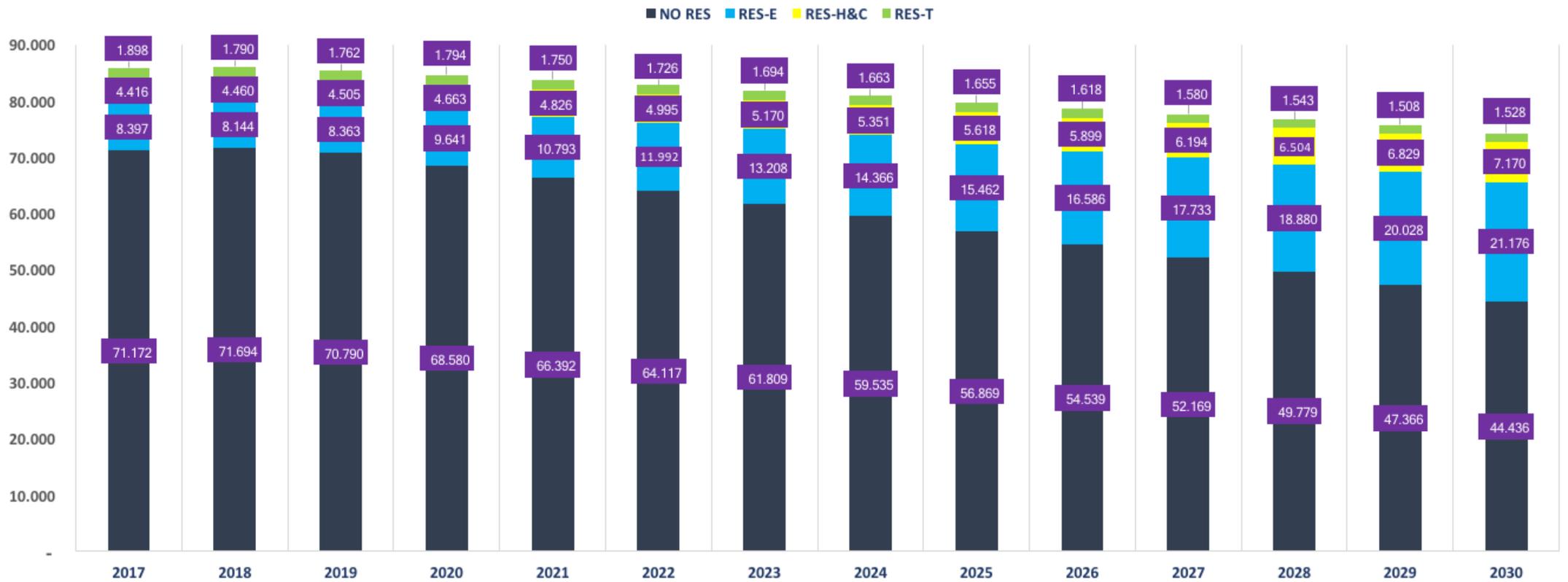
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Operating Hours														
Hydro	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700
Pumping	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200
Nuclear	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600
Coal	4.200	3.477	1.036	1.045	1.180	1.353	1.588	1.920	2.427	2.427	2.427	2.427	2.427	2.427
Fuel	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
CCGT	1.150	1.200	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300
Hydro-wind														
Wind	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300
New Wind	-	-	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
Solar PV	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800
Solar Thermal	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100
Renewable Thermal	3.722	3.622	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
Cogeneration	5.561	5.895	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Inputs														
EV	30.000	10.090	20.496	35.683	51.494	67.948	85.069	102.877	131.317	160.999	191.966	224.264	257.940	305.451
Av. Consump. EV kWh/100km	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00
Av. Mileage EV km	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000
Marginal Demand EV MWh	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
HP	1.935.321	1.954.674	1.974.221	1.993.963	2.013.902	2.034.041	2.054.382	2.074.926	2.116.424	2.158.753	2.201.928	2.245.966	2.290.886	2.359.612
Growth Ratio	-	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	2,00%	2,00%	2,00%	2,00%	2,00%	3,00%
Av. Consump. [kWh/h]	2,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Incremento de eficiencia	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%

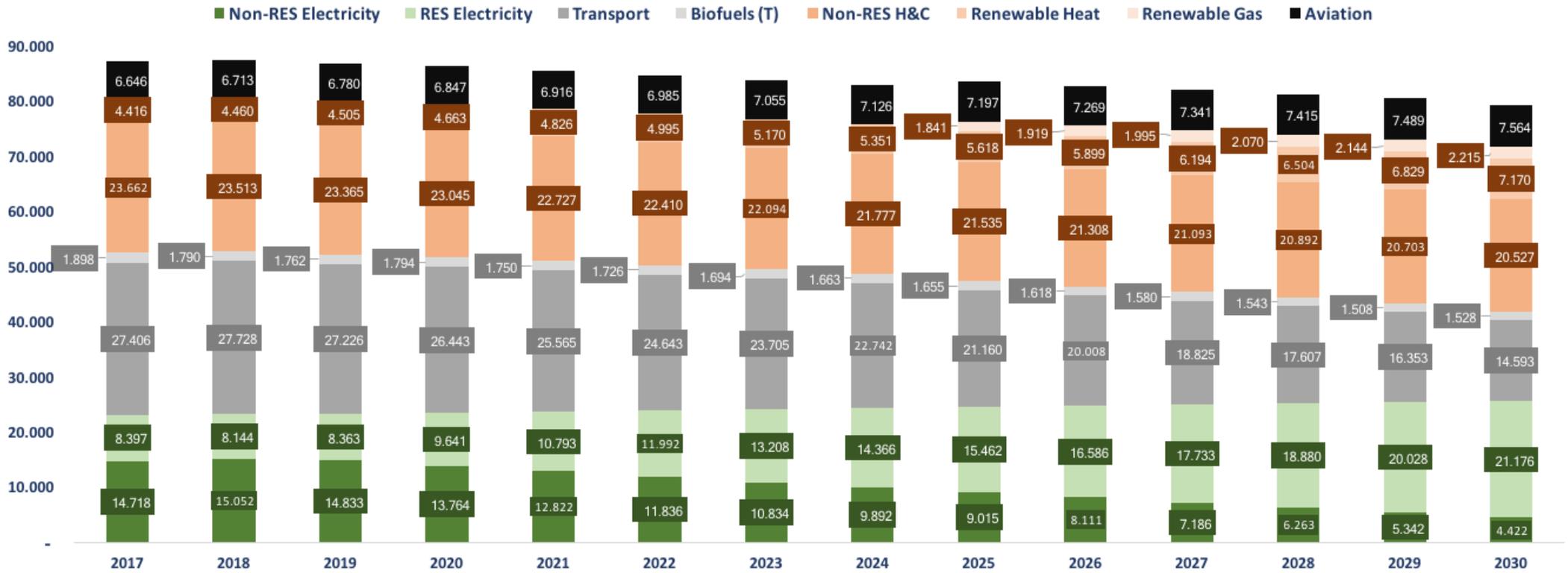


High scenario

■ Non-RES H&C ■ Transport ■ Non-RES Electricity ■ Renewable Heat ■ Renewable Gas ■ Biofuels (T) ■ RES Electricity









H&C

Average Growth Ratio	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
	1,00%	1,00%	1,00%	3,50%	3,50%	3,50%	3,50%	3,50%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	
Efficiency	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	
			17,59											12,80	
														30,39	
ktoe	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Heat Pump	494,18	588,34	1512,65	1527,77	1604,16	1684,37	1768,59	1857,02	1949,87	2047,36	2149,73	2257,21	2370,08	2488,58	2613,01
Heat Pump Subbed			4,49	4,54	22,92	24,06	25,27	26,53	27,86	29,25	30,71	32,25	33,86	35,55	37,33
Units	1916159	1935321	1954674	1974221	2072932	2176578	2285407	2399677	2519661	2645644	2777927	2916823	3062664	3215797	3376587
Growth	-	1,0%	1,0%	1,0%	5,0%	5,0%	5,0%	5,0%	5,0%	5,0%	5,0%	5,0%	5,0%	5,0%	5,0%
kWhe/h	2,00	2,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
			1.008,43	1.018,51	1.069,44	1.122,91	1.179,06	1.238,01	1.299,91	1.364,91	1.433,15	1.504,81	1.580,05	1.659,05	1.742,01
HP Growth			499,72	504,72	511,80	537,39	564,26	592,48	622,10	653,21	685,87	720,16	756,17	793,98	833,67
		HPs	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
		New Equip.	19353	19547	98711	103647	108829	114270	119984	125983	132282	138896	145841	153133	160790
		Commercial	1935	1955	9871	10365	10883	11427	11998	12598	13228	13890	14584	15313	16079
		Residential	17418	17592	88840	93282	97946	102843	107985	113385	119054	125007	131257	137820	144711

Residential	ktoe														
Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gas	3472,03	3501,41	3534,00	3566,89	3679,36	3795,14	3914,33	4037,00	4163,26	4355,63	4556,82	4767,25	4987,33	5217,50	5458,22
Solid Fuel	79,05	73,40	67,76	62,11	56,46	50,82	45,17	39,52	33,88	28,23	22,59	16,94	11,29	5,65	0,00
Oil Products	2939,10	2909,71	2861,74	2814,07	2619,33	2426,59	2235,54	2045,88	1857,28	1641,57	1430,51	1223,55	1020,17	819,85	622,07
GLP															
Gasoil															
RES	2738,61	2765,99	2793,65	2821,59	2920,34	3022,56	3128,35	3237,84	3351,16	3518,72	3694,66	3879,39	4073,36	4277,03	4490,88
Solar Thermal	233,47	235,81	238,17	240,55	248,97	257,68	266,70	276,04	285,70	299,98	314,98	330,73	347,27	364,63	382,86
Biomass	2494,48	2519,43	2544,62	2570,07	2660,02	2753,12	2849,48	2949,21	3052,43	3205,05	3365,31	3533,57	3710,25	3895,76	4090,55
Geothermal	10,65	10,76	10,86	10,97	11,36	11,75	12,17	12,59	13,03	13,68	14,37	15,09	15,84	16,63	17,47
TOTAL	9228,79	9250,52	9257,15	9264,66	9275,49	9295,10	9323,39	9360,24	9405,58	9544,15	9704,58	9887,13	10092,15	10320,02	10571,17

Services	ktoe														
Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil Products	1265,40	1252,75	1238,12	1223,62	1170,10	1117,92	1067,00	1017,28	968,67	906,59	846,93	789,53	734,26	680,95	629,49
Gas	3006,17	3030,90	3060,93	3091,27	3198,09	3308,58	3422,87	3541,07	3663,34	3844,75	4035,15	4234,97	4444,69	4664,79	4895,79
RES	166,73	168,40	170,08	171,78	177,79	184,02	190,46	197,12	204,02	214,22	224,94	236,18	247,99	260,39	273,41
Solar Thermal	55,35	55,91	56,47	57,03	59,03	61,09	63,23	65,44	67,74	71,12	74,68	78,41	82,33	86,45	90,77
Geothermal	3,75	3,79	3,82	3,86	4,00	4,14	4,28	4,43	4,59	4,82	5,06	5,31	5,58	5,86	6,15
Biomass	92,51	93,44	94,37	95,31	98,65	102,10	105,68	109,38	113,20	118,86	124,81	131,05	137,60	144,48	151,70
Biogas	10,89	11,00	11,11	11,22	11,61	12,02	12,44	12,87	13,32	13,99	14,69	15,43	16,20	17,01	17,86
Biofuel	4,23	4,27	4,31	4,36	4,51	4,67	4,83	5,00	5,17	5,43	5,70	5,99	6,29	6,60	6,93
TOTAL	4438,30	4452,04	4469,14	4486,68	4545,99	4610,52	4680,33	4755,48	4836,04	4965,57	5107,01	5260,69	5426,94	5606,13	5798,69



Industry	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil Products	<u>2828,00</u>	<u>2824,89</u>	<u>2821,74</u>	<u>2818,56</u>	<u>2802,52</u>	<u>2785,68</u>	<u>2767,99</u>	<u>2749,42</u>	<u>2729,92</u>	<u>2709,45</u>	<u>2687,95</u>	<u>2665,38</u>	<u>2641,68</u>	<u>2616,79</u>	<u>2590,66</u>	
Gas	<u>6530,00</u>	<u>6555,26</u>	<u>6554,86</u>	<u>6554,45</u>	<u>6552,39</u>	<u>6550,22</u>	<u>6547,95</u>	<u>6545,56</u>	<u>6543,05</u>	<u>6540,42</u>	<u>6537,66</u>	<u>6534,76</u>	<u>6531,71</u>	<u>6528,51</u>	<u>6525,15</u>	
RES	<u>1387,00</u>	<u>1401,07</u>	<u>1415,08</u>	<u>1429,23</u>	<u>1479,25</u>	<u>1531,03</u>	<u>1584,61</u>	<u>1640,08</u>	<u>1697,48</u>	<u>1782,35</u>	<u>1871,47</u>	<u>1965,04</u>	<u>2063,30</u>	<u>2166,46</u>	<u>2274,78</u>	
Solar Thermal	3,00	3,03	3,06	3,09	3,20	3,31	3,43	3,55	3,67	3,85	4,05	4,25	4,46	4,69	4,92	
Geothermal	0,00	0,20	0,20	0,20	0,21	0,22	0,23	0,23	0,24	0,25	0,27	0,28	0,29	0,31	0,32	
Biofuel	1384,00	1397,84	1411,82	1425,94	1475,84	1527,50	1580,96	1636,30	1693,57	1778,24	1867,16	1960,51	2058,54	2161,47	2269,54	
Coal	<u>1501,00</u>	<u>1393,79</u>	<u>1286,57</u>	<u>1179,36</u>	<u>1072,14</u>	<u>964,93</u>	<u>857,71</u>	<u>750,50</u>	<u>643,29</u>	<u>536,07</u>	<u>428,86</u>	<u>321,64</u>	<u>214,43</u>	<u>107,21</u>	<u>0,00</u>	
TOTAL	<u>12246,00</u>	<u>12175,01</u>	<u>12078,25</u>	<u>11981,60</u>	<u>11906,31</u>	<u>11831,86</u>	<u>11758,27</u>	<u>11685,56</u>	<u>11613,74</u>	<u>11568,30</u>	<u>11525,94</u>	<u>11486,82</u>	<u>11451,11</u>	<u>11418,98</u>	<u>11390,60</u>	

Blurred Sectors	ktoe															
	Energy Resource	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Oil Products	<u>2011,00</u>	<u>1998,54</u>	<u>1967,09</u>	<u>1935,33</u>	<u>1774,91</u>	<u>1606,47</u>	<u>1429,62</u>	<u>1243,91</u>	<u>1048,93</u>	<u>844,19</u>	<u>629,22</u>	<u>403,50</u>	<u>166,49</u>	<u>-82,37</u>	<u>-343,67</u>	
Gas	<u>91,00</u>	<u>91,91</u>	<u>92,83</u>	<u>93,76</u>	<u>97,04</u>	<u>100,44</u>	<u>103,95</u>	<u>107,59</u>	<u>111,35</u>	<u>116,92</u>	<u>122,77</u>	<u>128,91</u>	<u>135,35</u>	<u>142,12</u>	<u>149,23</u>	
RES	<u>80,00</u>	<u>80,80</u>	<u>81,61</u>	<u>82,42</u>	<u>85,31</u>	<u>88,29</u>	<u>91,39</u>	<u>94,58</u>	<u>97,89</u>	<u>102,79</u>	<u>107,93</u>	<u>113,32</u>	<u>118,99</u>	<u>124,94</u>	<u>131,19</u>	
Solar Thermal	2,00	2,02	2,04	2,06	2,13	2,21	2,28	2,36	2,45	2,57	2,70	2,83	2,97	3,12	3,28	
Geothermal	4,00	4,04	4,08	4,12	4,27	4,41	4,57	4,73	4,89	5,14	5,40	5,67	5,95	6,25	6,56	
Biofuel	74,00	74,74	75,49	76,24	78,91	81,67	84,53	87,49	90,55	95,08	99,83	104,83	110,07	115,57	121,35	
Coal	<u>32,00</u>	<u>29,71</u>	<u>27,43</u>	<u>25,14</u>	<u>22,86</u>	<u>20,57</u>	<u>18,29</u>	<u>16,00</u>	<u>13,71</u>	<u>11,43</u>	<u>9,14</u>	<u>6,86</u>	<u>4,57</u>	<u>2,29</u>	<u>0,00</u>	
TOTAL	<u>2214,00</u>	<u>2200,97</u>	<u>2168,96</u>	<u>2136,65</u>	<u>1980,12</u>	<u>1815,78</u>	<u>1643,24</u>	<u>1462,09</u>	<u>1271,89</u>	<u>1075,33</u>	<u>869,06</u>	<u>652,59</u>	<u>425,40</u>	<u>186,98</u>	<u>-63,26</u>	

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
TOTAL H&C	<u>28127,09</u>	<u>28078,53</u>	<u>27973,50</u>	<u>27869,59</u>	<u>27707,90</u>	<u>27553,26</u>	<u>27405,22</u>	<u>27263,36</u>	<u>27127,25</u>	<u>27153,35</u>	<u>27206,59</u>	<u>27287,23</u>	<u>27395,61</u>	<u>27532,11</u>	<u>27697,20</u>

RES-H&C	<u>17,00%</u>	<u>17,46%</u>	<u>20,26%</u>	<u>20,52%</u>	<u>21,38%</u>	<u>22,27%</u>	<u>23,18%</u>	<u>24,13%</u>	<u>25,11%</u>	<u>26,25%</u>	<u>27,42%</u>	<u>28,60%</u>	<u>29,81%</u>	<u>31,04%</u>	<u>32,28%</u>
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T																
Growth Rate		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
	Bus	2,80%	3,00%	3,00%	2,00%	2,00%	2,00%	2,00%	2,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,50%	
	Van	1,40%	1,60%	1,60%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	
	Motorcycle	3,60%	3,00%	3,00%	4,00%	4,00%	4,00%	4,00%	4,00%	4,00%	4,00%	4,00%	4,00%	4,00%	5,00%	
	Truck	0,30%	0,75%	0,75%	1,50%	1,50%	1,50%	1,50%	1,50%	2,50%	2,50%	2,50%	2,50%	2,50%	3,50%	
	Trailer	0,50%	0,50%	0,50%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	1,00%	
	Car	2,70%	0,75%	0,75%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	3,00%	
1	Truck Old	2.586.443	2.534.714	2.482.597	2.390.709	2.297.442	2.202.776	2.106.690	2.009.163	1.896.032	1.780.072	1.661.214	1.539.383	1.414.507	1.286.510	
	Truck Repl.	0	51.729	52.117	91.888	93.267	94.666	96.086	97.527	113.131	115.960	118.859	121.830	124.876	127.998	
	Truck New	0	71.127	142.788	313.438	486.648	662.456	840.901	1.022.022	1.220.002	1.422.932	1.630.935	1.844.137	2.062.670	2.286.666	
	NEW	0	71.127	71.661	170.650	173.210	175.808	178.445	181.122	197.980	202.929	208.003	213.203	218.533	223.996	
3	Van Old	2.338.033	2.291.272	2.243.764	2.159.293	2.071.866	1.981.379	1.887.724	1.790.792	1.676.135	1.557.466	1.434.642	1.307.520	1.175.949	1.039.773	
	Van Repl.	0	46.761	47.509	84.471	87.427	90.487	93.654	96.932	114.657	118.670	122.823	127.122	131.571	136.176	
	Van New	0	84.169	169.685	338.626	513.481	694.455	881.763	1.075.628	1.290.609	1.513.115	1.743.408	1.981.762	2.228.458	2.483.789	
	NEW	0	84.169	85.516	168.941	174.854	180.974	187.308	193.864	214.981	222.506	230.294	238.354	246.696	255.331	
	Bus Old	63.589	62.317	61.007	58.646	56.238	53.781	51.276	48.720	45.740	42.672	39.511	36.255	32.902	29.448	
	Bus Repl.	0	1.272	1.310	2.361	2.408	2.457	2.506	2.556	2.979	3.069	3.161	3.256	3.353	3.454	
	Bus New	0	3.179	6.454	10.165	13.949	17.810	21.747	25.763	30.977	36.347	41.879	47.576	53.444	59.920	
	NEW	0	3.179	3.275	3.710	3.785	3.860	3.937	4.016	5.214	5.370	5.531	5.697	5.868	6.476	
2	Car Old	23.500.401	23.030.393	22.556.860	21.721.962	20.862.017	19.976.274	19.063.958	18.124.273	17.018.129	15.878.802	14.705.294	13.496.581	12.251.607	10.969.283	
	Car Repl.	0	470.008	473.533	834.898	859.945	885.743	912.316	939.685	1.106.144	1.139.328	1.173.508	1.208.713	1.244.974	1.282.324	
	Car New	0	646.261	1.297.369	2.847.894	4.444.935	6.089.886	7.784.187	9.529.316	11.465.067	13.458.891	15.512.530	17.627.777	19.806.482	22.050.549	
	NEW	0	646.261	651.108	1.550.525	1.597.041	1.644.952	1.694.300	1.745.129	1.935.751	1.993.824	2.053.638	2.115.248	2.178.705	2.244.066	
4	Motorcle Old	3.327.048	3.260.507	3.191.970	3.068.432	2.939.952	2.806.333	2.667.369	2.522.847	2.351.072	2.172.425	1.986.634	1.793.410	1.592.457	1.383.467	
	Motorcle Repl.	0	66.541	68.537	123.538	128.480	133.619	138.964	144.522	171.775	178.646	185.792	193.224	200.953	208.991	
	Motorcle New	0	166.352	337.695	602.420	877.734	1.164.061	1.461.840	1.771.531	2.115.081	2.472.373	2.843.957	3.230.404	3.632.309	4.102.538	
	NEW	0	166.352	171.343	264.725	275.314	286.326	297.780	309.691	343.550	357.292	371.584	386.447	401.905	470.229	
1	Trailer Old	459.712	450.518	441.278	425.026	408.613	392.035	375.291	358.380	338.860	319.144	299.232	279.120	258.807	238.291	
	Trailer Repl.	0	9.194	9.240	16.251	16.414	16.578	16.744	16.911	19.520	19.715	19.913	20.112	20.313	20.516	
	Trailer New	0	11.493	23.043	43.937	65.041	86.355	107.883	129.626	154.026	178.670	203.561	228.701	254.092	279.737	
	NEW	0	11.493	11.550	20.894	21.103	21.314	21.528	21.743	24.400	24.644	24.891	25.140	25.391	25.645	
	TOTAL	32.275.226	32.612.304	32.954.510	33.980.548	35.037.914	36.127.599	37.250.629	38.408.061	39.601.731	40.832.910	42.102.795	43.412.628	44.763.686	46.209.971	



Fleet	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Truck	2.586.443	2.605.841	2.625.385	2.664.766	2.704.737	2.745.308	2.786.488	2.828.285	2.898.993	2.971.467	3.045.754	3.121.898	3.199.945	3.311.943
Van	2.338.033	2.375.442	2.413.449	2.497.919	2.585.346	2.675.834	2.769.488	2.866.420	2.966.745	3.070.581	3.178.051	3.289.283	3.404.408	3.523.562
Bus	63.589	65.497	67.462	68.811	70.187	71.591	73.023	74.483	76.718	79.019	81.390	83.831	86.346	89.368
Car	23.500.401	23.676.654	23.854.229	24.569.856	25.306.951	26.066.160	26.848.145	27.653.589	28.483.197	29.337.693	30.217.824	31.124.358	32.058.089	33.019.832
Motorcycle	3.327.048	3.426.859	3.529.665	3.670.852	3.817.686	3.970.393	4.129.209	4.294.377	4.466.153	4.644.799	4.830.591	5.023.814	5.224.767	5.486.005
Trailer	459.712	462.011	464.321	468.964	473.653	478.390	483.174	488.006	492.886	497.815	502.793	507.821	512.899	518.028

Tasa	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Renovación	0%	2%	2%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
EV & NG	0%	10%	10%	50%	50%	50%	50%	50%	70%	70%	70%	70%	70%	90%
EV	0%	30%	30%	40%	40%	40%	40%	40%	50%	50%	50%	50%	50%	60%
NG	0%	70%	70%	60%	60%	60%	60%	60%	50%	50%	50%	50%	50%	40%

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
EV	0,09%	0,03%	0,06%	0,43%	0,80%	1,17%	1,54%	1,91%	2,61%	3,30%	4,00%	4,70%	5,41%	6,55%
NG	0,03%	0,07%	0,15%	0,70%	1,26%	1,81%	2,37%	2,92%	3,61%	4,31%	5,01%	5,71%	6,41%	7,18%

	Truck, Trailer & Bus (1)				Car (2)			Van (3)			Motorcycle (4)	
	Gasoline	Diesel	Trailer [km]	Truck [km]	Gasoline	Diesel	km	Gasoline	Diesel	km	Gasoline	km
2017	5,00%	95,00%	35000	14000	44,85%	55,15%	14000	7,00%	93,00%	14000	100,00%	5000
2018	4,00%	95,77%	35000	14000	47,00%	52,73%	14000	6,00%	93,65%	14000	99,51%	5000
2020	2,00%	95,28%	35000	14000	50,00%	46,84%	14000	5,00%	91,62%	14000	96,39%	5000
2025	1,00%	94,91%	35000	14000	49,00%	46,24%	14000	4,00%	90,93%	14000	94,62%	5000
2030	0,50%	94,24%	35000	14000	44,00%	49,88%	14000	3,00%	90,48%	14000	92,29%	5000

Biofuels	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Ethanol	4,70%	5,90%	5,90%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%
Biodiesel	7,00%	5,90%	5,90%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%	6,00%



ktoe	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Road	28288,06	28466,15	27903,84	27119,42	26161,28	25179,03	24172,02	23139,54	21508,92	20279,18	19015,43	17716,70	16381,95	14596,02
Truck	9081,18	9149,03	8967,83	8760,34	8447,79	8131,02	7809,99	7484,62	7014,34	6637,11	6252,15	5859,30	5458,37	4882,55
Gasol. Old	345,94	271,22	265,64	127,91	122,92	117,85	112,71	107,49	50,72	47,62	44,44	41,18	37,84	17,21
Gasol. New	0,00	6,85	6,90	4,38	4,45	4,51	4,58	4,65	1,53	1,56	1,60	1,64	1,68	0,29
Diesel Old	8735,24	8629,75	8452,45	8098,35	7783,40	7464,20	7140,71	6812,85	6408,59	6022,53	5628,56	5226,48	4816,11	4365,86
Diesel New	0,00	211,85	213,29	248,90	252,34	255,83	259,37	262,97	172,86	176,58	180,37	184,26	188,24	63,64
NG	0,00	29,35	29,55	280,80	284,68	288,62	292,61	296,66	380,65	388,82	397,18	405,74	414,50	435,56
EV	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Van	2486,32	2514,69	2465,83	2380,36	2296,55	2209,80	2120,01	2027,09	1870,00	1757,01	1640,06	1519,02	1393,74	1403,67
Gasol. Old	192,63	161,81	158,46	127,08	121,93	116,61	111,09	105,39	78,91	73,33	67,54	61,56	55,36	0,00
Gasol. New	0,00	5,35	5,44	4,97	5,15	5,33	5,51	5,70	3,04	3,14	3,25	3,37	3,48	0,90
Diesel Old	2293,68	2263,41	2216,48	2086,86	2002,37	1914,92	1824,40	1730,72	1607,70	1493,87	1376,06	1254,13	1127,93	992,39
Diesel New	0,00	74,83	76,03	81,64	84,49	87,45	90,51	93,68	61,86	64,03	66,27	68,59	70,99	24,37
NG	0,00	9,28	9,43	79,81	82,61	85,50	88,49	91,59	118,49	122,64	126,93	131,37	135,97	386,01
EV	0,00	0,00	0,00	10,17	10,52	10,89	11,27	11,67	22,64	23,44	24,26	25,11	25,98	41,49
Car	16445,08	16521,44	16194,46	15723,26	15171,31	14602,81	14017,25	13414,12	12432,17	11706,31	10958,68	10188,63	9395,47	8200,49
Gasol. Old	7330,66	7528,43	7373,64	7553,95	7254,90	6946,88	6629,62	6302,83	5799,80	5411,52	5011,58	4599,65	4175,36	3356,88
Gasol. New	0,00	190,13	191,56	269,60	277,69	286,02	294,60	303,44	197,91	203,85	209,96	216,26	222,75	68,67
Diesel Old	9114,43	8539,71	8364,13	7155,96	6872,66	6580,87	6280,32	5970,75	5534,31	5163,80	4782,18	4389,10	3984,23	3848,08
Diesel New	0,00	215,67	217,29	255,40	263,06	270,95	279,08	287,45	188,85	194,52	200,35	206,36	212,56	78,72
NG	0,00	47,49	47,85	488,35	503,00	518,09	533,63	549,64	711,29	732,63	754,61	777,24	800,56	848,14
EV	5,42	3,50	3,53	55,99	57,67	59,40	61,19	63,02	122,34	126,01	129,79	133,68	137,69	218,81
Motorcycle	275,48	280,99	275,72	255,47	245,64	235,41	224,78	213,72	192,41	178,74	164,53	149,75	134,38	109,31
Gasol. Old	275,48	268,66	263,01	244,90	234,65	223,98	212,89	201,36	184,18	170,19	155,63	140,50	124,75	105,71
Gasol. New	0,00	12,34	12,71	10,56	10,99	11,43	11,88	12,36	8,23	8,56	8,90	9,25	9,62	3,59
EV	0,00	0,72	0,74	5,69	5,92	6,15	6,40	6,66	10,34	10,75	11,18	11,63	12,10	18,19
Rail	313,93	350,00	367,50	385,88	405,17	425,43	446,70	469,03	492,49	517,11	542,96	570,11	598,62	628,55
Aviation	6646,11	6712,57	6778,70	6847,49	6915,97	6985,13	7054,98	7125,53	7196,78	7268,75	7341,44	7414,85	7489,00	7563,89
Ships	953,00	981,59	1011,04	1041,37	1072,61	1104,79	1137,93	1172,07	1207,23	1243,45	1280,75	1319,17	1358,75	1399,51
TOTAL	29303,85	29517,74	28988,38	28237,97	27314,92	26368,91	25399,29	24405,41	22814,65	21626,05	20404,78	19149,89	17860,43	16121,25
TOTAL	29554,99	29797,74	29282,38	28546,67	27639,06	26709,25	25756,65	24780,64	23208,64	22039,73	20839,15	19605,98	18339,32	16624,09



Gasoline

	Car						Motorcycle						Truck						Van					
	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]
2017	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	25,00	222,22	0,74	42998,81	3600,00	8,89	11,00	97,78
2018	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	25,00	222,22	0,74	42998,81	3600,00	8,89	11,00	97,78
2020	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	24,00	213,33	0,74	42998,81	3600,00	8,89	11,00	97,78
2025	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	24,00	213,33	0,74	42998,81	3600,00	8,89	11,00	97,78
2030	0,74	42998,81	3600,00	8,89	6,50	57,78	0,74	42998,81	3600,00	8,89	2,17	19,26	0,74	42998,81	3600,00	8,89	24,00	213,33	0,74	42998,81	3600,00	8,89	11,00	97,78

Diesel

	Car						Truck						Van					
	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]
2017	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	21,00	204,47	0,86	40767,49	3600,00	9,74	9,00	87,63
2018	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	21,00	204,47	0,86	40767,49	3600,00	9,74	9,00	87,63
2020	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	20,00	194,73	0,86	40767,49	3600,00	9,74	9,00	87,63
2025	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	20,00	194,73	0,86	40767,49	3600,00	9,74	9,00	87,63
2030	0,86	40767,49	3600,00	9,74	6,00	58,42	0,86	40767,49	3600,00	9,74	20,00	194,73	0,86	40767,49	3600,00	9,74	9,00	87,63

NG

	Car						Van						Truck					
	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]	Density [kg/L]	LHV [kJ/kg]	Conversion [kJ/kWh]	Equivalence [kWh/L]	Avg. Cons. [L/100km]	[kWh/100km]
2017	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2018	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2020	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2025	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85
2030	0,63	50234,50	3600,00	8,72	10,00	87,21	0,63	50234,50	3600,00	8,72	15,00	130,82	0,63	50234,50	3600,00	8,72	40,00	348,85

EV

	Truck	Car	Van	Moto
	[kWh/100km]	[kWh/100km]	[kWh/100km]	[kWh/100km]
2017		15,00		10,00
2018		15,00		10,00
2020		15,00	25,00	10,00
2025		15,00	25,00	10,00
2030		15,00	25,00	10,00



RES-T	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Road	1798,25	1678,64	1645,47	1648,08	1591,58	1533,66	1474,30	1413,45	1373,23	1302,30	1229,43	1154,56	1077,63	1054,08
Truck	627,73	538,06	527,36	508,77	489,79	470,54	451,04	431,28	398,02	374,90	351,30	327,21	302,63	266,82
Bioethanol	16,26	16,41	16,08	7,94	7,64	7,34	7,04	6,73	3,13	2,95	2,76	2,57	2,37	1,05
Biodiesel	611,47	521,65	511,28	500,84	482,14	463,20	444,00	424,55	394,89	371,95	348,54	324,64	300,26	265,77
Biogas														
EV	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Van	169,61	147,82	144,93	148,20	143,36	138,35	133,17	127,80	127,73	121,50	115,04	108,36	101,45	102,55
Bioethanol	9,05	9,86	9,67	7,92	7,62	7,32	7,00	6,67	4,92	4,59	4,25	3,90	3,53	0,05
Biodiesel	160,56	137,96	135,26	130,11	125,21	120,14	114,89	109,46	100,17	93,47	86,54	79,36	71,94	61,01
Biogas														
EV	0,00	0,00	0,00	10,17	10,52	10,89	11,27	11,67	22,64	23,44	24,26	25,11	25,98	41,49
Car	987,97	975,46	956,18	970,09	937,77	904,49	870,20	834,89	825,59	784,43	742,03	698,36	653,39	659,95
Bioethanol	344,54	455,40	446,35	469,41	451,96	433,97	415,45	396,38	359,86	336,92	313,29	288,96	263,89	205,53
Biodiesel	638,01	516,57	506,30	444,68	428,14	411,11	393,56	375,49	343,39	321,50	298,95	275,73	251,81	235,61
Biogas														
EV	5,42	3,50	3,53	55,99	57,67	59,40	61,19	63,02	122,34	126,01	129,79	133,68	137,69	218,81
Motorcle	12,95	17,29	17,00	21,02	20,66	20,28	19,89	19,48	21,88	21,48	21,05	20,61	20,16	24,75
Bioethanol	12,95	16,58	16,27	15,33	14,74	14,12	13,49	12,82	11,54	10,72	9,87	8,99	8,06	6,56
EV	0,00	0,72	0,74	5,69	5,92	6,15	6,40	6,66	10,34	10,75	11,18	11,63	12,10	18,19
% RES-E	32%	38%	39%	45%	49%	53%	57%	61%	65%	68%	72%	75%	79%	82%
Rail	99,82	111,29	116,86	146,40	158,05	192,02	220,13	250,05	281,88	315,74	350,48	388,44	430,09	474,32
TOTAL	1898,08	1789,93	1762,32	1794,49	1749,63	1725,68	1694,43	1663,50	1655,11	1618,04	1579,91	1543,00	1507,72	1528,40
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
RES-T	6,42%	6,01%	6,02%	6,29%	6,33%	6,46%	6,58%	6,71%	7,13%	7,34%	7,58%	7,87%	8,22%	9,19%



E

Power Capacity (MW)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Hydro	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049	17.049
Pumping	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329	3.329
Nuclear	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	7.117	6.068	5.023	5.023
Coal	10.720	10.720	10.622	10.524	9.326	8.127	6.929	5.730	4.532	4.532	4.532	4.532	4.532	4.532
Fuel	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790	2.790
CCGT	27.531	27.531	27.339	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146	27.146
Hydro-wind	200	200												
Wind	22.600	23.507	23.556	26.000	28.400	30.800	33.200	35.600	38.000	40.600	43.200	45.800	48.400	51.000
Solar PV	4.688	4.707	4.780	10.000	13.000	16.000	19.000	22.000	25.000	28.000	31.000	34.000	37.000	40.000
Solar Thermal	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303	2.303
Renewable Thermal	970	982	1.164	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346
Cogeneration	5.700	5.483	5.276	5.069	5.069	5.069	5.069	5.069	4.022	3.716	3.410	3.104	2.798	2.492
Renewable Capacity	47.810	48.748	48.851	56.698	62.098	67.498	72.898	78.298	83.698	89.298	94.898	100.498	106.098	111.698
Total Capacity	104.997	105.718	105.324	112.673	116.874	121.076	125.278	129.479	132.634	137.928	143.222	147.466	151.716	157.010



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Power Generation (GWh)														
Hydro	18.450,6	34.100,1	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7
Pumping	2.249,0	2.009,4	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7
Nuclear	55.539,4	53.197,6	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	46.116,0	38.177,8	38.177,8
Coal	45.019,4	37.273,6	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0
Fuel	7.001,6	6.683,2	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0
CCGT	37.065,8	30.044,6	52.731,1	40.211,8	31.054,5	21.919,3	12.806,4	3.715,9	1.930,0	-4.955,0	-12.817,0	-12.680,2	-12.557,2	-18.848,8
Hydro-wind	982,0	982,0	714,5	447,0	454,0	461,0	468,0	475,0	482,0	565,0	648,0	731,0	814,0	897,0
Wind	47.907,0	49.526,1	54.212,2	61.544,8	68.744,8	75.944,8	83.144,8	90.344,8	97.544,8	105.344,8	113.144,8	120.944,8	128.744,8	136.544,8
Solar PV	8.397,8	7.746,7	8.604,0	18.000,0	23.400,0	28.800,0	34.200,0	39.600,0	45.000,0	50.400,0	55.800,0	61.200,0	66.600,0	72.000,0
Solar Thermal	5.348,0	4.424,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3
Renewable Thermal	3.610,3	3.556,4	4.656,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0
Cogeneration	31.696,8	32.320,6	31.656,0	30.414,0	30.414,0	30.414,0	30.414,0	30.414,0	24.132,0	22.296,0	20.460,0	18.624,0	16.788,0	14.952,0
Interconnection	9.169,0	11.102,3	10.102,3	9.102,3	8.102,3	7.102,3	6.102,3	5.102,3	3.102,3	1.102,3	102,3	-897,7	-1.897,7	-4.397,7
Renewable Generation	83.713,6	99.353,5	101.291,2	118.747,9	131.347,9	143.947,9	156.547,9	169.147,9	181.748	194.947,9	208.147,9	221.347,9	234.547,9	247.748
Sell-Generation	10.530,7	10.474,6	10.386,6	10.523,7	10.661,7	10.800,5	10.940,3	11.081,0	9.854,7	10.014,4	10.139,8	10.266,1	10.393,3	10.573,7
Losses	32.259,5	32.371,9	32.371,9	32.663,3	32.957,3	33.253,9	33.553,2	33.855,1	34.159,8	34.467,3	34.777,5	35.090,5	35.406,3	35.724,9
Pumping	-3.607,6	-3.200,7	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0
Total Generation	263.268	261.865	259.663,8	263.091,7	266.541,5	270.013,3	273.507,3	277.023,8	281.563	286.124,9	289.710,0	293.318,3	296.950,1	302.106
Demand Increase	-	-	0,00%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%
Electricity Demand	261.923,5	252.152,9	251.955,1	253.229,1	254.464,2	255.657,5	256.806,1	257.906,8	258.686,4	259.393,1	260.022,3	260.569,4	261.029,2	260.960,2
EV	63,00	21,19	43,04	308,53	590,40	889,44	1.206,47	1.542,34	2.168,07	2.832,84	3.538,57	4.287,25	5.080,99	6.358,38
HP	6.842,42	17.592,06	17.767,98	18.656,38	19.589,20	20.568,66	21.597,10	22.676,95	23.810,80	25.001,34	26.251,41	27.563,98	28.942,17	30.389,28
Total Increase	-	-	0,00%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%
Total Demand	268.828,9	269.766,2	269.766,2	272.194,1	274.643,8	277.115,6	279.609,6	282.126,1	284.665,3	287.227,2	289.812,3	292.420,6	295.052,4	297.707,9
Increase by EV and HP	-	-	6,60%	6,97%	7,35%	7,74%	8,16%	8,58%	9,13%	9,69%	10,28%	10,89%	11,53%	12,34%



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Normalized Power Generation														
Hydro	30.223,0	29.686,8	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7	28.982,7
Pumping	2.249,0	2.009,4	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7	3.994,7
Nuclear	55.539,4	53.197,6	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	54.091,4	46.116,0	38.177,8	38.177,8
Coal	45.019,4	37.273,6	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0	11.000,0
Fuel	7.001,6	6.683,2	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0	4.185,0
CCGT	37.065,8	30.044,6	56.764,4	46.839,0	36.879,2	26.399,3	15.748,4	5.787,3	3.858,3	-2.900,9	-10.903,5	-10.912,2	-10.938,4	-17.381,6
Hydro-wind	982,0	982,0	714,5	447,0	454,0	461,0	468,0	475,0	482,0	565,0	648,0	731,0	814,0	897,0
Wind	50.074,2	49.295,3	50.178,8	54.917,6	62.920,2	71.464,9	80.202,8	88.273,4	95.616,5	103.290,7	111.231,3	119.176,9	127.126,0	135.077,7
Solar PV	8.397,8	7.746,7	8.604,0	18.000,0	23.400,0	28.800,0	34.200,0	39.600,0	45.000,0	50.400,0	55.800,0	61.200,0	66.600,0	72.000,0
Solar Thermal	5.348,0	4.424,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3	4.836,3
Renewable Thermal	3.610,3	3.556,4	4.656,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0	5.384,0
Cogeneration	31.696,8	32.320,6	31.656,0	30.414,0	30.414,0	30.414,0	30.414,0	30.414,0	24.132,0	22.296,0	20.460,0	18.624,0	16.788,0	14.952,0
Interconnection	9.169,0	11.102,3	10.102,3	9.102,3	8.102,3	7.102,3	6.102,3	5.102,3	3.102,3	1.102,3	102,3	-897,7	-1.897,7	-4.397,7
Renewable Generation	97.653,3	94.709,5	97.257,8	112.120,7	125.523,2	139.467,9	153.605,9	167.076,4	179.820	192.893,8	206.234,4	219.579,9	232.929,0	246.281
Sell-Genration	12.474,3	11.574,9	11.684,9	11.839,1	11.994,4	12.150,6	12.307,8	12.466,1	11.262,5	11.445,0	11.588,4	11.732,7	11.878,0	12.084,2
Losses	33.264,9	30.866,5	31.159,7	31.571,0	31.985,0	32.401,6	32.820,9	33.242,9	33.787,6	34.335,0	34.765,2	35.198,2	35.634,0	36.252,7
Pumping	-3.607,6	-3.200,7	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0	-4.000,0
Total Genration	277.207	257.221	259.663,8	263.091,7	266.541,5	270.013,3	273.507,3	277.023,8	281.563	286.124,9	289.710,0	293.318,3	296.950,1	302.106
Demand Increase	-	-	0,00%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%	0,90%
Electricity Demand	261.923,5	252.152,9	251.955,1	253.229,1	254.464,2	255.657,5	256.806,1	257.906,8	258.686,4	259.393,1	260.022,3	260.569,4	261.029,2	260.960,2
EV	63,00	21,19	43,04	308,53	590,40	889,44	1.206,47	1.542,34	2.168,07	2.832,84	3.538,57	4.287,25	5.080,99	6.358,38
HP	6.842,42	17.592,06	17.767,98	18.656,38	19.589,20	20.568,66	21.597,10	22.676,95	23.810,80	25.001,34	26.251,41	27.563,98	28.942,17	30.389,28
Total Increase	-	-	0,00%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%	0,89%
Total Demand	268.828,9	269.766,2	269.766,2	272.194,1	274.643,8	277.115,6	279.609,6	282.126,1	284.665,3	287.227,2	289.812,3	292.420,6	295.052,4	297.707,9
Increase by EV and HP	-	-	6,60%	6,97%	7,35%	7,74%	8,16%	8,58%	9,13%	9,69%	10,28%	10,89%	11,53%	12,34%



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Operating Hours														
Hydro	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700
Pumping	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200
Nuclear	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600	7.600
Coal	4.200	3.477	1.036	1.045	1.180	1.353	1.588	1.920	2.427	2.427	2.427	2.427	2.427	2.427
Fuel	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
CCGT	1.150	1.200	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300
Hydro-wind														
Wind	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300	2.300
New Wind	-	-	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000	3.000
Solar PV	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800
Solar Thermal	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100	2.100
Renewable Thermal	3.722	3.622	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
Cogeneration	5.561	5.895	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
Inputs														
EV	30.000	10.090	20.496	146.918	281.143	423.543	574.509	734.447	1.032.416	1.348.973	1.685.031	2.041.547	2.419.521	3.027.799
Av. Consump. EV kWh/100km	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00	15,00
Av. Mileage EV km	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000
Marginal Demand EV MWh	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10	2,10
HP	1.935.321	1.954.674	1.974.221	2.072.932	2.176.578	2.285.407	2.399.677	2.519.661	2.645.644	2.777.927	2.916.823	3.062.664	3.215.797	3.376.587
Growth Ratio	-	1,00%	1,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%
Av. Consump. [kWh/h]	2,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Incremento de eficiencia	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%