Deloitte.

APREN Associação de Energias Renováveis

Decisions that matter

Impact of electricity from renewable energy sources

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0. Executive Summary

STUDY PRESENTATION

Goal of the analysis

This study aims to assess the impact of electricity from renewable sources in the electric system and national economy between 2014 and 2018, as well as project these impacts in the context of energy policy and objectives set by the country until 2030

Scope and methodology considerations

This study presents the impacts that electricity production from renewable sources have on the daily electricity market, as well as the economic, social and environmental impact for the country.

Information was gathered from the main national and international organizations responsible for the definition of energy sector policies and regulation - in particular, of electricity and renewable energy, as well as filled-in questionnaires from companies operating in the renewable energy sector in Portugal.

Historical data referring to the 2014-2018 time horizon were analyzed and projections were made until 2030.

The 2030 projections apply two scenarios: one, the 2030 National Energy and Climate Plan (NECP), which drifts mainly from the "Peloton" scenario of the 2050 Carbon Neutrality Roadmap (CNR); another, from continuity of the currently implemented, that drifts from the scenario "Off Track", also of the CNR.

Renewable Energy Framework in Portugal

Leveraged by the established commitment in the Paris Agreement to move to a carbon neutral economy, the renewable energy sector in Portugal continues its growing trend, with an estimated contribution of over 80% to the country's electricity generation mix by 2030.

Considering the Portuguese socioeconomic context, this study assesses the contribution of Renewable Energy Sources (RES) over the 2014-2018 period, and its evolution was estimated until 2030 ensuring the achievement of the targets for decarbonization of the economy and energy transition foreseen in NECP 2030.

The results of this study reflect on the relevance achieved by the sector, analyzing the impact on the price of the daily electricity market, its relation with the renewable energy growth in the country, as well as the verified and expected impact of RES for the following dimensions:

- Economic and Social (Gross Domestic Product (GDP), employment, tax contribution, trade balance, social security contribution)
- Environment (CO_2 emissions reduction)
- Energy dependency

STRUCTURE AND MAIN RESULTS OF THE ANALYSIS

Main impacts

The analysis carried out allowed the identification of impacts in four aspects: Impact on the electricity market; Economic/social impact of the sector; Environmental impact of the sector; Impact of the sector on energy dependence

Impact on the electricity market

The existence of electricity produced from renewable sources has an impact on different portions of electricity tariffs, highlighting in this context (i) the effect that these technologies have on the price of the daily wholesale electricity market, due to their zero or almost zero marginal cost; and (ii) the cost differentials associated with existing feed-in tariffs for some of these producers when compared to market values.

From the analysis carried out it resulted the following main conclusions:

Regarding the market price, the main findings were:

a. The renewable Special Regime Production (SRP) generally has a zero marginal cost (or very close to it);

b. If there was no SRP from a renewable source, the selling price per MWh of electricity in the Iberian daily market would have been € 24,2 higher (on average).

Economic/social impact of the sector

Included in this analysis is the assessment of the direct contribution of the renewable electricity sector to Portugal's GDP, the indirect effect on other sectors of the economy and the employment generated directly and indirectly.

Regarding the impact on the GDP, the analysis reveals that over the 2014-2018 period the contribution from RES amounted to ~3 billion euros per year (on average), about 1,7% of the GDP. It is estimated that by 2030 this will amount to ~11 billion euros (~4,6% of the GDP).

Based on the gathered information, in 2018, the renewable production sector had ~46 thousand employees, generating a GDP per worker of ~70,7 thousand euros. Between 2018 and 2030, the RES should reach an additional 114 thousand employees, generating around 160 thousand jobs.

In line with these results, it is estimated that, on average, between 2018 and 2030, the annual contribution to the Social Security will be over 73 million euros, with an estimated 116 million euros for 2030.

Given the growth, it is expected that in the 2019-30 period, the sector will generate a cumulative total of about 6 billion euros with Corporate Income Tax and Municipal Surtax.

STRUCTURE AND MAIN RESULTS OF THE ANALYSIS

Main impacts

Environmental impact of the sector

In this aspect, the contribution to the environment of electricity production through renewable energy sources was analyzed, expressed in the reduction of CO_2 emissions that would have been verified if this production had been assured through conventional sources (coal and natural gas).

The performed analysis proves that renewable energy production, between 2014 and 2018, allowed to:

i. Avoid more than 55 million tons of CO_2 emissions;

ii. Save more than 427 million euros with CO_2 licenses.

Between 2018 and 2030, avoided CO_2 emissions are estimated to continue to increase at a rate of 6,7% per year.

Impact of the sector on energy dependence

The impact of energy dependence was analyzed based on the quantification of the substitution effect of electricity and fossil fuels imports for electricity production, namely coal and natural gas, as well as the determination of the impact of this substitution on the energy dependency ratio.

Based on the analysis carried out, it appears that in 2018 ~1,2 billion euros in imports of fossil fuels for electricity generation were avoided, 243 million less than in 2014.

From 2018 to 2030, these savings are estimated to exceed 27 billion euros for avoided imports of fossil fuels.

In response to the weak sector developments in recent years, external energy dependence has reached almost 77% in 2018. Even though, by 2030, dependence on imported fossil fuels is expected to be lower, reaching 65,8% (- 25,6 pp compared to a scenario without RES).

STRUCTURE AND MAIN RESULTS OF THE ANALYSIS

Main impacts

Off Track Scenario

In order to obtain an alternative that could be compared with the scenario recommended in NECP 2030, the "Off Track" Scenario defined in CNR 2050 was used, which assumes the maintenance of the shared indicators in the roadmap regarding the average rate of annual change in GDP and degree of external openness. Additionally, for the purpose of this analysis, the country installed capacity remains unchanged.

From the conducted analysis, for this scenario, comparatively to the NECP 2030 scenario, the RES installed capacity in Portugal, in 2030, is approximately half of the estimated value in that scenario, the same for the production, which is 35.159 GWh lower.

In this scenario, the installed capacity remains constant, while it is estimated that the GDP contribution of RES follows that trend and stabilizes in an average annual value of 3.4 billion euros, between 2018 and 2030, which is about 30% of the GDP contribution in 2030, resulting from the NECP scenario.

In terms of the employment generated by RES, the creation of jobs in 2030 is estimated to be 113 thousand lower, when compared to the NECP scenario.

According to these data, it is estimated, for 2030, that: (i) RES power plants contribute with over 280 million euros in CIT and 13 million euros in Municipal Surtax (less than half when compared to the NECP scenario); (ii) the contribution to the Social Security rises to 34 million euros in 2030 (~1/3 of the estimated value in the NECP scenario).

As to energy dependency, according to this scenario, it is estimated that, in 2030, the dependency in fossil fuels accounts for 77%, compared to a value of 65,8% in the NECP scenario.

According to this scenario, it is estimated that renewable electricity will result in savings of about 2 billion euros in 2030, related to avoided imports of fossil fuels, a figure that is 40% lower than the one verified in the NECP scenario.

Additionally, as a consequence of the inaction inherent to RES growth, CO_2 avoided emissions, according to this scenario, tend to stagnate at 11,6 million tons in 2030, more than half of the avoided value according to the NECP scenario.

STRUCTURE AND MAIN RESULTS OF THE ANALYSIS

Main impacts summary

	2018	2020	2025	2030	Off Track 2030
Contribution to GDP	3.306 M€	3.860 M€	8.015 M€	10.959 M€	3.396 M€
Job creation	46.790	55.008	116.796	160.974	47.129
CO_2 emissions avoided	11,3 Mt	12,9 Mt	19,5 Mt	24,6 Mt	11,6 Mt
Imports avoided	1.262 M€	1.243 M€	2.389 M€	3.460 M€	2.087 M€
Energy dependence rate	77,0%	75,7%	71,1%	65,8%	77,0%

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1. Renewable energy in the electricity sector

CURRENT SITUATION

Installed capacity in Portugal

The installed capacity of renewable electricity power plants increased 2.549 MW, between 2014 and 2018, corresponding to an annual average growth rate higher than that observed between 2010 and 2013

In the period under review (2014-2018), the total installed capacity for electricity production in Portugal increased 12%, due to investments in new renewable power plants. There was also a decrease in the capacity associated with non-renewable sources, although residual (-147 MW in the period under review).

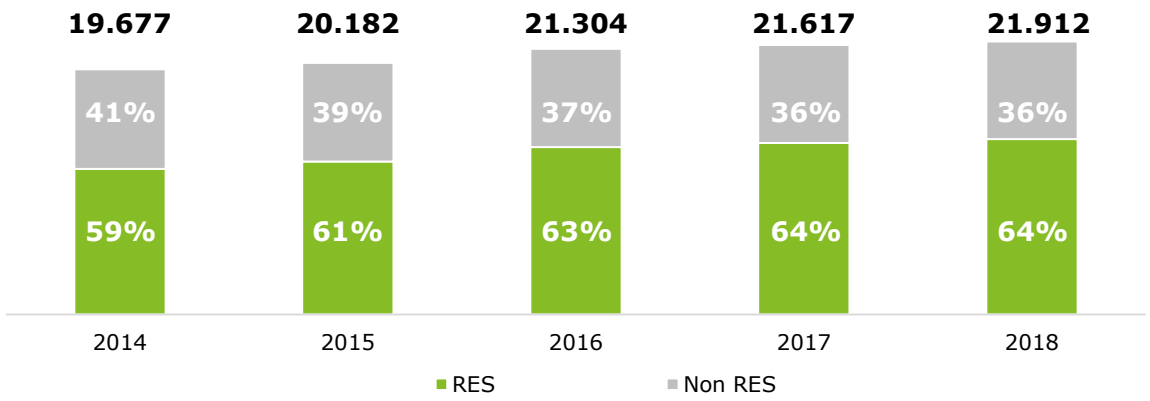

Figure 1. Evolution of installed capacity in Portugal (MW)

Source: DGEG, Deloitte analysis

In 2018, the installed capacity in Portugal of renewable electricity producing centres reached 14.059 MW, which represents more 2.549 MW compared to 2014.

This increase corresponds to an **average annual growth of 5.1%** between 2014 and 2018, which is higher than that observed between 2010 and 2013 (4,2%)[1].

Contributions for the growth of installed capacity arise from different sources, but with a strong emphasis (about 60% of the total increase) on the observed increased of the large hydro.

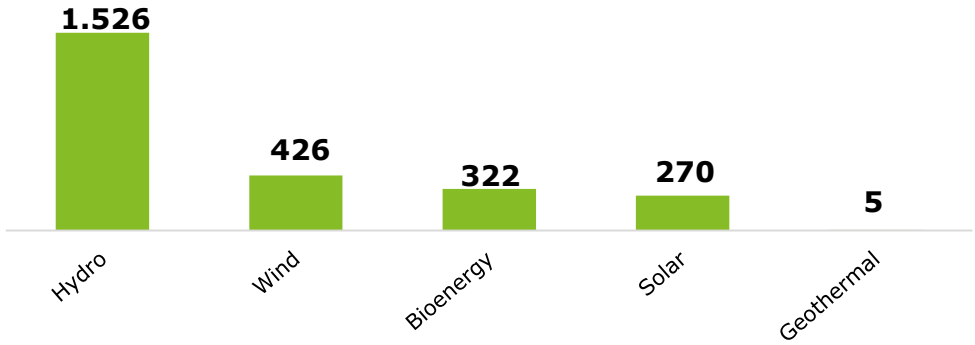

Figure 2. Increase in RES installed capacity in Portugal, between 2014 and 2018 (MW)

Source: DGEG, Deloitte analysis

Hydro capacity has increased since 2014, due, among others, to the reinforcement of power in hydroelectric plants of Venda Nova III, Salamonde II and the construction of the hydroelectric exploitations of Foz Tua, Baixo Sabor and Ribeiradio – Ermida. Regarding wind energy, the evolution of capacity has stagnated in the period under review, while solar energy, despite its growth, remains low, considering the 2030 targets.

[1] APREN (2014), Macroeconomic impact of the renewable electricity sector in Portugal

CURRENT SITUATION

Installed capacity in Portugal

The electricity generation capacity from renewable sources focuses mainly on hydro and wind RES, which represents over 90% of installed capacity in Portugal in all the years under analysis

Even with the widespread growth of RES (Renewable Energy Sources) in Portugal, hydro and wind sources remained the main sources of the power mix in 2018, representing **more than 12.000 MW of installed capacity of renewable power plants**, which represents over 90% of total RES capacity.

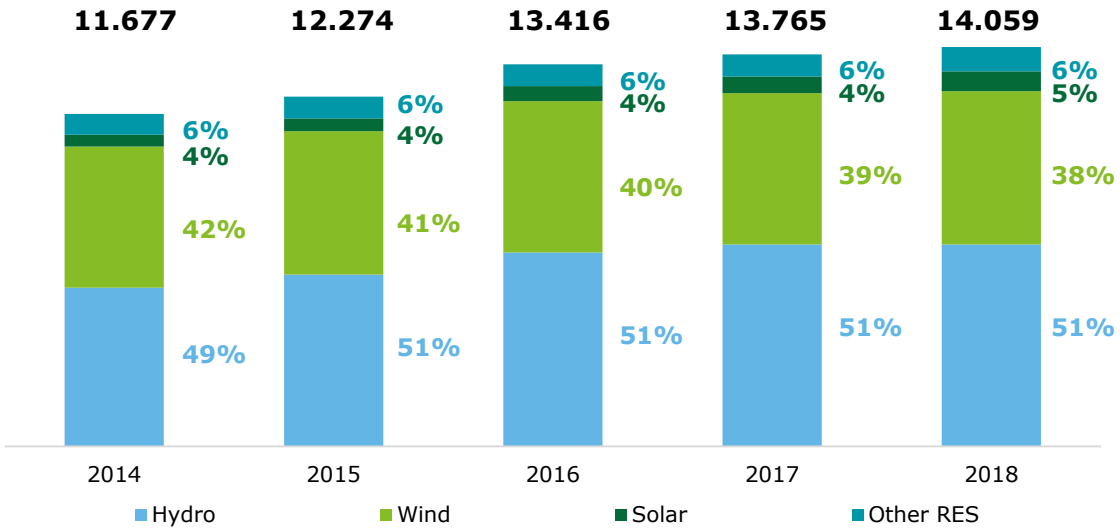

Figure 3. Share of installed capacity in Portugal by RES

Source: DGEG, Deloitte analysis

CURRENT SITUATION

Production in Portugal

In the period under review, the share of RES in electricity production ranged between 40% and 60% of total production, due, mainly, to the large variability of hydroelectric production between wet and dry years

Following the significant investments in RES in the 2000s, Portugal is positioned in the group of countries with the largest share of renewables in the electricity produced in national territory, exhibiting, however, some stagnation in recent years.

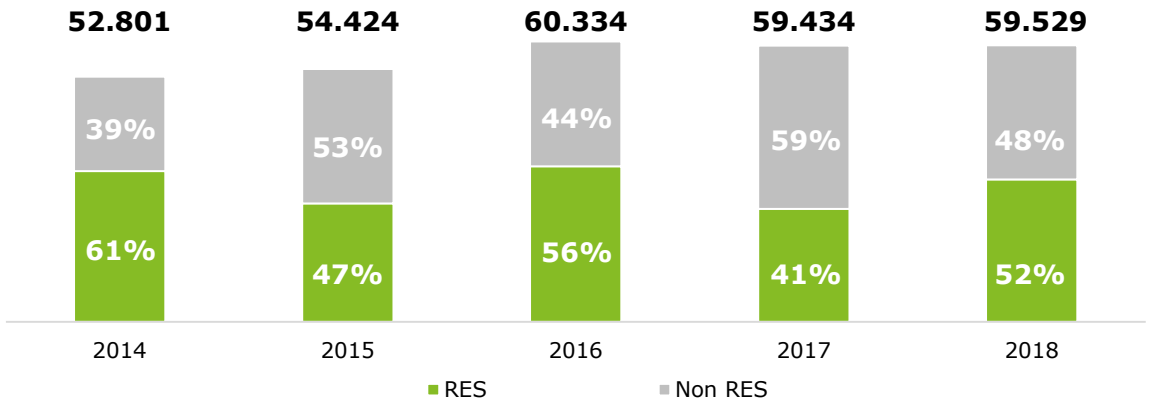

Figure 4. Evolution of gross production of electricity in Portugal (GWh)

Source: DGEG, Deloitte analysis

In the period under review, total gross electricity production in Portugal increased 13%, while there was a decrease in the weight of RES in 2017, due to weather conditions, which negatively influenced production.

In 2018, approximately 59.529 GWh were produced, of which **52% were from renewable sources** (9 pp less than in 2014) and during the 2014-2018 period the average production from RES was 29.289 GWh.

In 2018, the RES production mix was dominated by **hydro (44%)**, followed by wind (41%). **Hydro generation in years with low rainfall is the most affected,** with a decrease of 13 pp between 2014 and 2015 and 19 pp between 2016 and 2017.

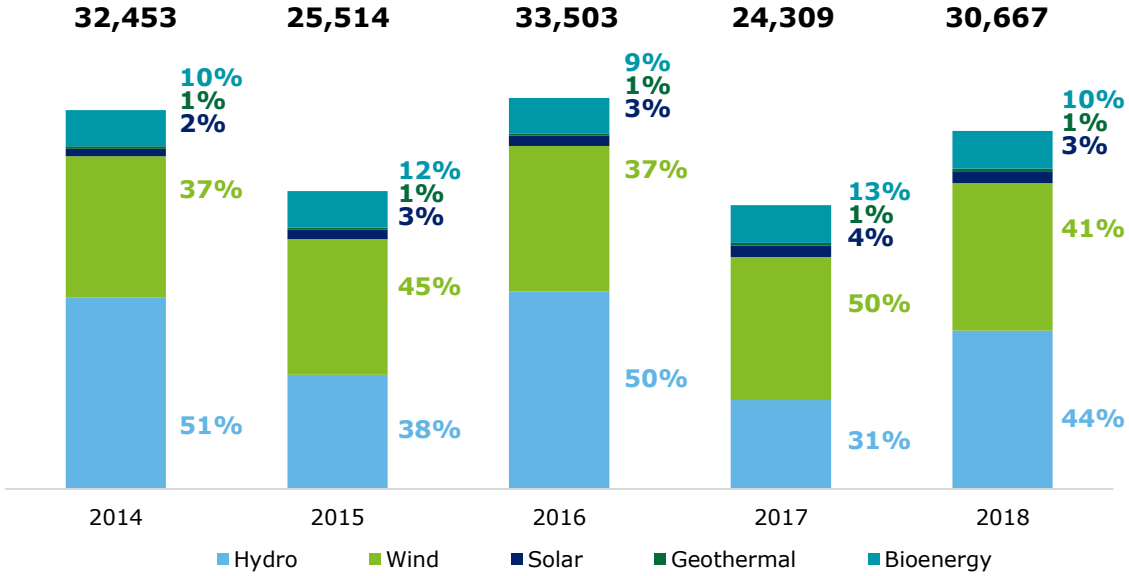

Figure 5. Evolution of electricity production in Portugal by RES (GWh)

Source: DGEG, Deloitte analysis

EVOLUTION OF ENERGY POLICIES

Goal setting

The prioritization of topics such as decarbonization have been on the Energy sector's political agenda since the Paris Agreement. The trend has been to set increasingly demanding and binding targets for different EU countries, and their fulfillment is only possible with the development of renewable energy

	Paris Agreement	Long term Strategy – "A Clean Planet for All"	"Clean energy for all Europeans" package	Carbon Neutrality Roadmap	**National Energy and Climate Plan**
MEASURES	• Greenhouse gas reduction (GHG) • Creation of a voluntary commitment review mechanism • Limit the rise in global average temperature below 2ºC, and ideally below 1,5ºC	• Maximize the benefits of energy efficiency • Maximize the deployment of renewable energy • Adhere to clean, safe and connected mobility	• Priority to energy efficiency • RES world leadership • A level playing field for consumers • Decarbonization of the economy	• Priority to limit global average temperature rise • Identify and analyze alternative paths to achieve the national carbon neutrality target by 2050	• Decarbonization • Energy Efficiency • Security of Supply • Internal Market • Research, Innovation and Competitiveness
	-40%	**-80%**	**-40%**	**-45% to -55%**	**-45% to -55%**
	GHG Emission for the EU (compared to 1990) To be reached by 2030	GHG Emission for the EU (compared to 1990) To be reached by 2050	GHG Emission for the EU (compared to 1990) To be reached by 2030	GHG Emission for Portugal (compared to 2005) To be reached by 2030	GHG Emission for Portugal (compared to 2005) To be reached by 2030

ENERGY POLICIES EVOLUTION

National Energy and Climate Plan

The NECP, in line with the European regulation, aims to promote the decarbonization of the economy and the energy transition, pointing to the next decade as essential to achieve these goals.

The goals set for Portugal in this policy document are **ambitious** and their achievement will depend on the **investment capacity collected by the sector.**

The European Community's awareness of the use of RES is reflected in the "Clean energy for all Europeans" package, closed in 2019, which sets, among other aspects, favorable targets for decarbonization and energy efficiency.

Among the areas of activity that make it possible to meet these goals are the **reinforcement and diversification of endogenous energy sources of renewable origin**, as well as the revision of the regulatory model, framework and market mechanisms.

The National Energy and Climate Plan (NECP) answers to the European policy framework by setting targets for GHG emissions, primary energy consumption, incorporation of renewables into final gross energy consumption and transport, and electricity interconnections, considering that the growth of **country installed capacity in renewable power plants more than doubles from 2018 to 2030.**

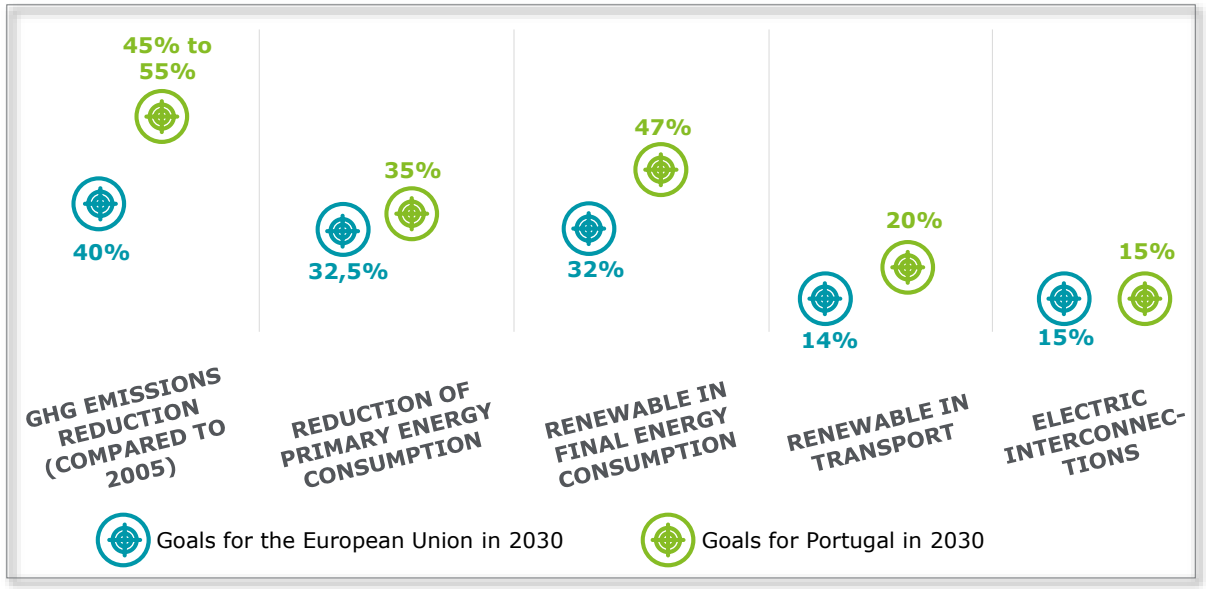

Figure 6. Targets for the European Union and Portugal for 2030

Source: NECP, Deloitte analysis

2030 GOALS

Installed capacity

In line with the proposed goals in the NECP for 2030, the renewable sector is expected to see growth in renewable power plants to more than double the 2015 figure

According to the goals presented in the NECP, Portugal will have, in 2030, an installed capacity mix, in which renewable electricity sources will represent 86% of the total. It should also be noted that the total installed capacity in the country is expected to grow around 63% between 2015 and 2030.

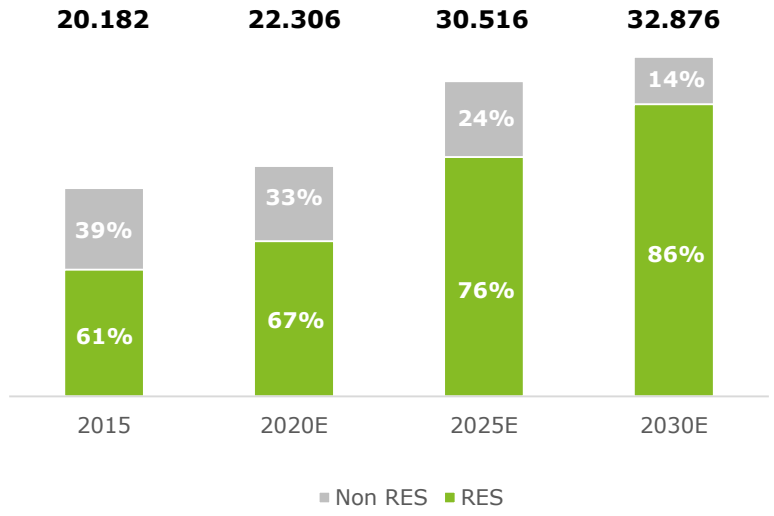

Figure 7. Estimate of evolution of installed capacity in Portugal (MW)

Source: NECP, Deloitte analysis

By 2030, it is estimated that **RES will be responsible for over 28.000 MW installed capacity**. For this value, it is estimated that solar has the largest contribution (9.600 MW, considering centralized, decentralized and concentrated thermal solar energy), followed by wind (9.200 MW) and hydro (8.700 MW).

The installed capacity in the country will thus tend towards a tripartite distribution among these renewable energy sources.

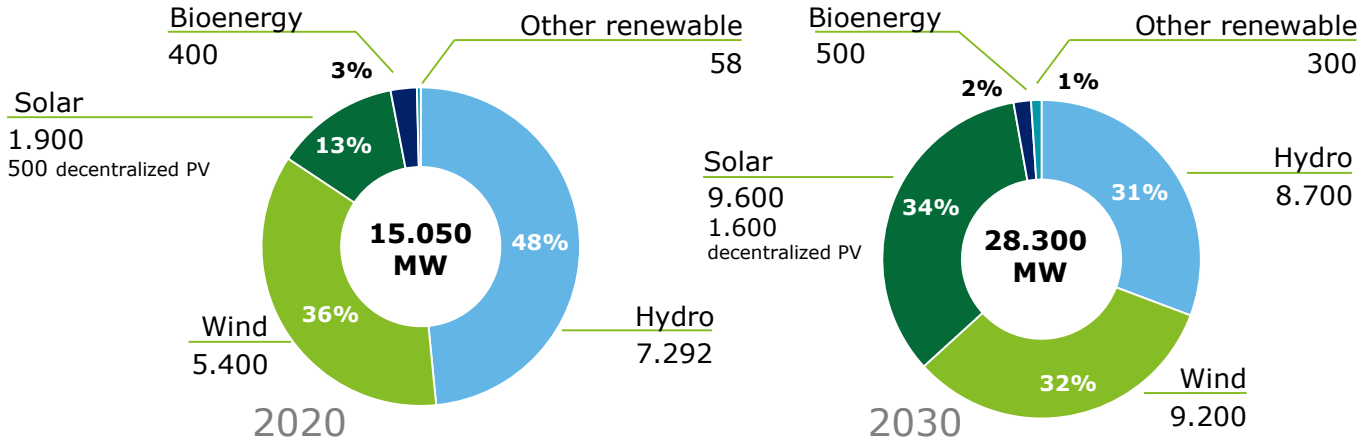

Figure 8. Distribution of the installed capacity by RES in 2020 and 2030 (MW)

Source: NECP, Deloitte analysis

2030 GOALS

Production

Along with the development of the country's installed capacity, NECP also predicts a growth in electricity production, which is to grow more than 40% between 2015 and 2030

The evolution of renewable installed capacity in Portugal will allow for a growth in the production of renewable electricity in the country from 25.514 GWh in 2015 to **66.528 GWh in 2030**. On the other hand, it is expected that the non-renewable production will decrease by 61%, from 28.910 GWh in 2015 to 11.191 GWh in 2030.

In terms of the weight of each RES in the renewable production mix, in **2030 the wind sector will generate 23.000 GWh**, followed by the solar (21.870 GWh) and hydro sectors (17.475 GWh).

In 2030 the distributed production will have an expressive market quota within the solar technology sector (3.520 GWh), being, however, expected that most of its development will happen after 2030.

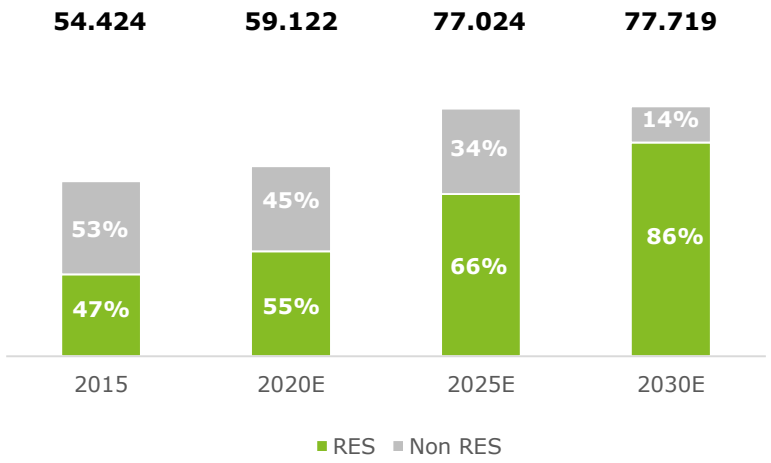

Figure 9. Estimate of evolution of electricity production in Portugal (GWh)

Source: DGEG, NECP, Deloitte analysis

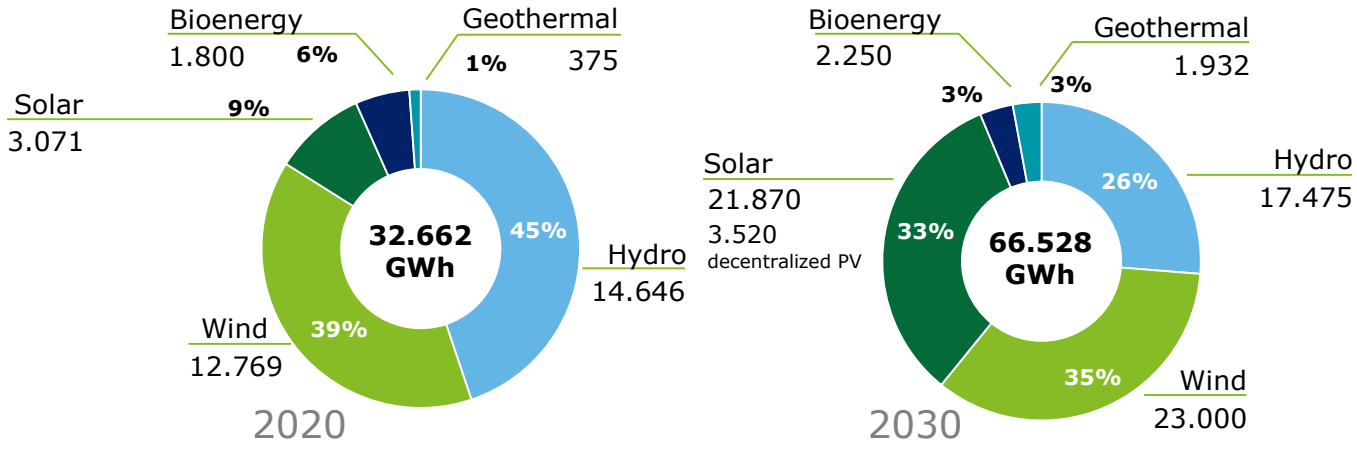

Figure 10. Distribution of electricity production by RES in 2020 and 2030 (GWh)

Source: NECP, Deloitte analysis

2030 GOALS

Investment

In order to achieve NECP's proposed goals, it will be necessary to undertake a significant investment in the renewable sector with the ability to support the ambitious growth of the installed capacity

The average growth between 2014 and 2018 (4,7%) **is close to the required growth rate for achieving the values proposed by NECP in 2030** (5,3%).

The estimates for installed capacity until 2030 require a coordination of the governmental entities with the sector players. In this context, the National Investment Plan (NIP) was established, as an integrating part on the national strategy by 2030, which acts on part of NECP's necessities. For the energy sector the NIP considers an investment of 4.930 M€.

Including the NIP, according to NECP, it is estimated that the required investment will be from **22.000 million euros to 23.600 million euros by 2030.**

NIP 2030
4.930 M€

NECP 2030
17.000 to 18.700 M€

Source: NECP

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2. Impact on the electricity market

THE ELECTRICITY MARKET IN PORTUGAL

Price structure for the consumer

The price of electricity borne by companies and private consumers results from the costs related to production and sale of electric energy, transmission and distribution networks, and the commercialization of electricity.

The regulated activities for electricity supply are the following:

- Global network management;
- Electric energy transmission;
- Electric energy distribution;
- Logistics Operation of Retailer Change;
- Purchase and Sale of electric energy;
- Commercialization of electric energy.

Only for the last resort supplier

Typically, **the electricity supply price payed by the end consumer can be divided into three components:**

- Networks;
- Power;
- Fees and taxes.

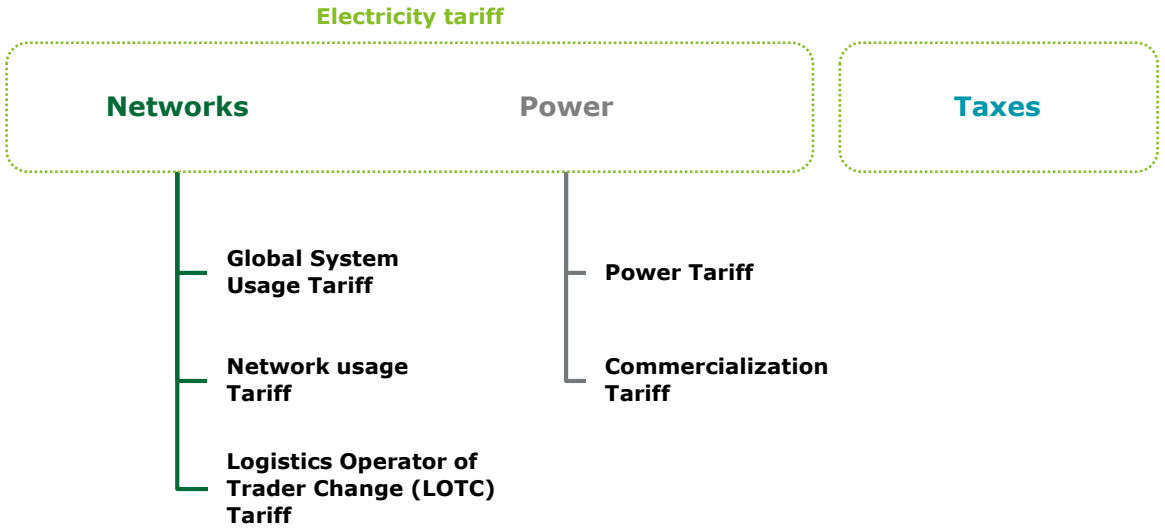

Figure 11. Electricity charges in Portugal
Source: ERSE, Deloitte analysis

The **value of the networks** represents an amount related to the infrastructures that transport electric energy from its production to its consumption point. The **value of power** is related with the cost of electric energy produced and its commercialization. Lastly, the **fees and taxes** include the several types of taxation, namely VAT (Value-Added Tax), IECE (*Imposto Especial de Consumo de Eletricidade*) and CAV (Audiovisual Contribution).

The sum of the regulated tariffs for the networks and power is the **End-User Sale Tariff**.

SPECIAL REGIME PRODUCTION

Impact of the SRP on the tariff

The main impacts, resulting from the usage of RES, on the electricity tariff are reflected on the global system usage tariff through the CIEG and through the purchase and commercialization of electricity in the Iberian Market.

In order to promote and attract investment to the renewable energy sector, Portugal has created a remuneration regulatory framework based on feed-in-tariffs (FIT) as a stability mechanism to promote the transition into endogenous energies from an early stage. The incorporation of the cost differential of these tariffs against the market price is incorporated in the End-User Sale Tariff.

Therefore, the main impacts on the tariff for the promotion and usage consumer of RES are two:

1) On the **Global System Usage Tariff are considered the costs arising from energetic, environmental and General Economic Interest policy measures (CIEG),** among which is included the SRP cost differential.

2) On the other hand, the usage of RES has an influence in the reduction of the marginal cost of electricity in the market, since the **marginal cost of electricity production from RES tends to be lesser than those from other sources.**

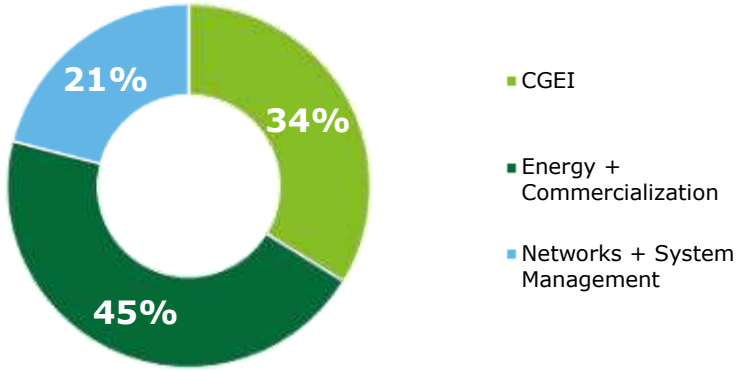

Figure 12. Electricity price composition in 2018

Source: ERSE, Deloitte analysis

There are other still other impacts, namely investments **associated with the adjustment of the transmission and distribution networks to the growing amount of electricity from RES**, that were not analyzed in the present study.

SPECIAL REGIME PRODUCTION

Differential cost with the renewable SRP

The differential cost of the renewable SRP is a significant component of the CIEG and it is reflected in the end consumer sale tariff

In order to promote the Special Regime Production (SRP) from a renewable source, the tariff includes a component related to the cost differential of the SRP against the market value, which then impacts the End Consumer Sale Tariff.

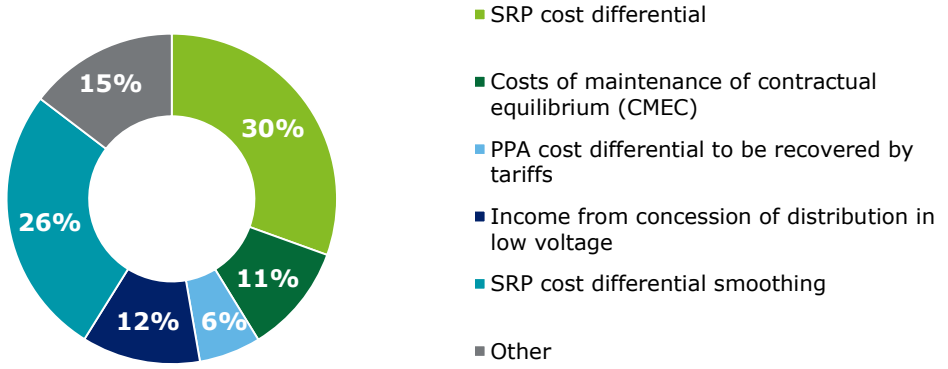

Figure 13. CIEG recovered in the 2018 tariffs

Source: ERSE, Deloitte analysis

This cost differential when compared with the market values (renewable and non-renewable SRP) corresponded to approximately 30% of the total amount charged in tariff related to the CIEG in 2018.

Between 2010 and 2018, **the costs related with the renewable SRP were approximately 7,5 billion euros** in Portugal. Nonetheless, it is necessary to take into consideration that the amount incoming from the renewable SRP cost differential has contributed to the fulfillment of the goals established for 2030, by incentivizing the investment in the sector.

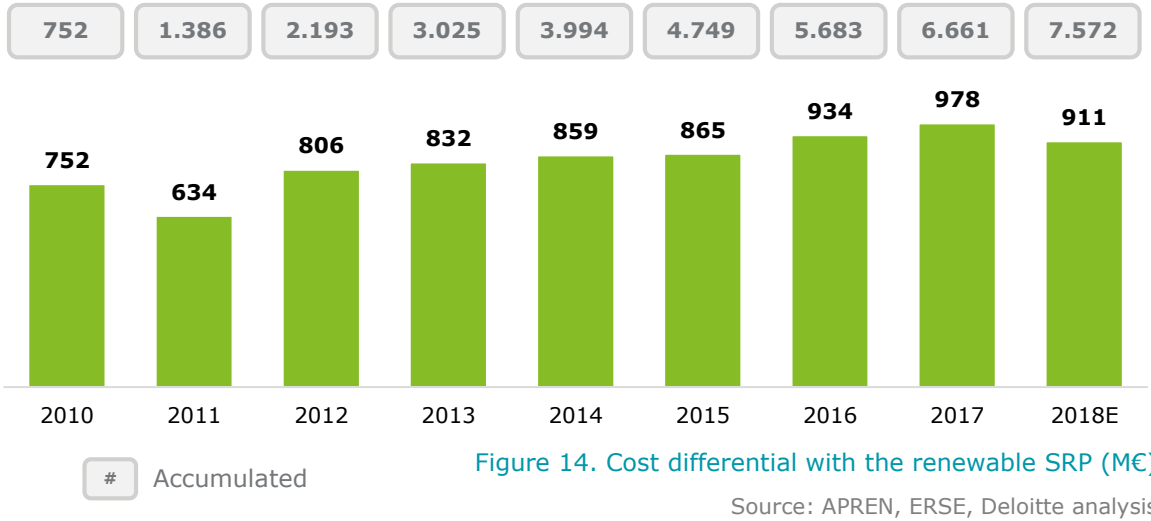

Figure 14. Cost differential with the renewable SRP (M€)

Source: APREN, ERSE, Deloitte analysis

THE ELECTRICITY MARKET IN PORTUGAL

Impact on the Iberian Market

The impact of the renewable sources positively affects the market price of the electricity commercialized in the Iberian Market due to its low marginal cost

At the Electricity Iberian Market the offerings of purchase and sale of electric energy are aggregated by the suppliers and producers, allowing for the development of supply and demand curves. The intersection of these curves defines the market equilibrium point – the daily market price for electricity for the respective hour.

The renewable SRP typically has a zero marginal cost (or close to it), which contributes for the introduction of electricity offerings lower than the market cost, thus reducing the daily market price for electricity for a certain hour.

It was also observed that **the electricity sale price without renewable SRP would be on average 24,2 €/MWh higher than the sale price with the renewable SRP.**

It is estimated that the accumulated savings obtained since 2010 are, approximately, **10 billion euros.**

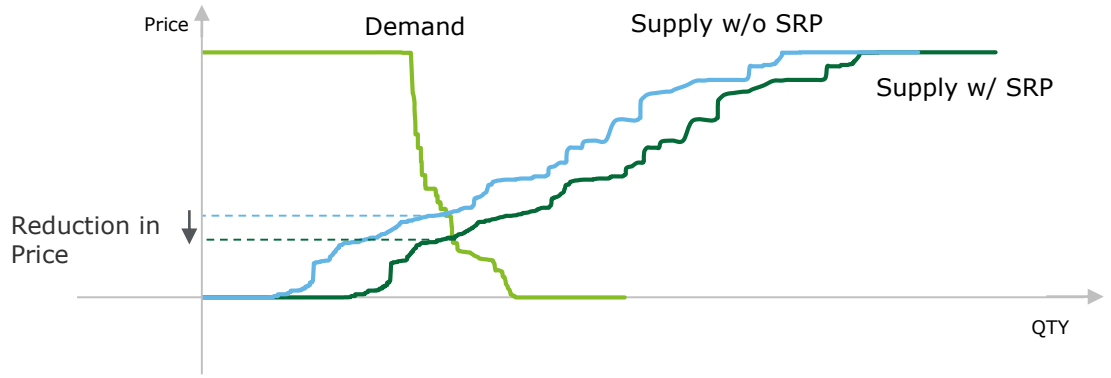

Figure 15. Impact of the RES production on the daily market electricity price
Source: Deloitte analysis

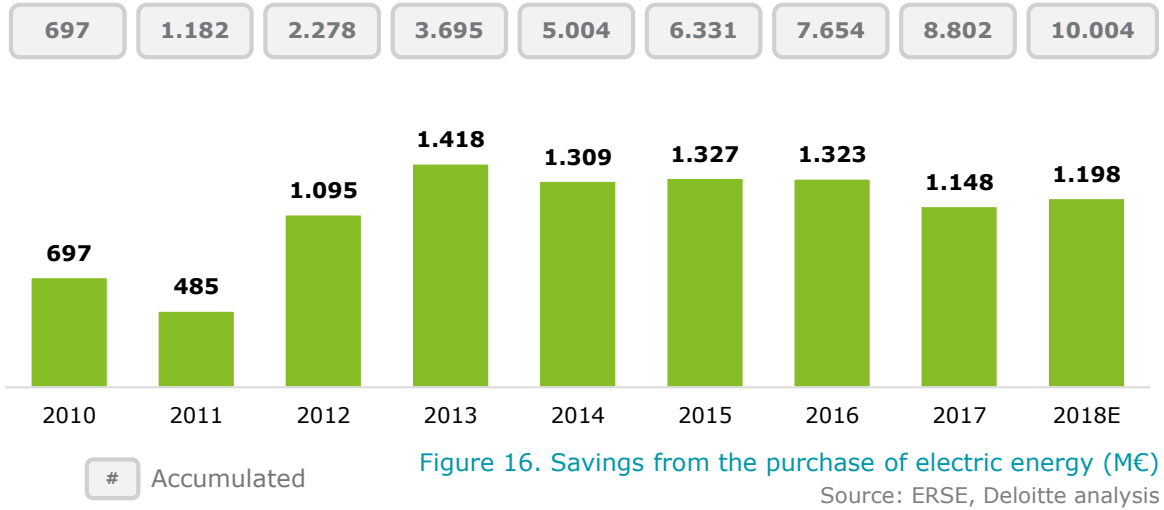

Figure 16. Savings from the purchase of electric energy (M€)
Source: ERSE, Deloitte analysis

ECONOMIC IMPACT OF THE RENEWABLE SRP

Balance of the SRP Cost differential versus the Iberian Market Savings

Considering the cost differential of the renewable SRP and its impact on the daily market electricity price, there is a positive net effect for the system, with an accumulated value of around 2,4 billion euros in the last 9 years

Without SRP the daily market electricity price would increase

Without SRP the cost differential with the SRP would not exist

It is important to analyze the impact of the introduction of electricity produced from RES on the daily market of electricity against its cost differential, evaluated as the difference between the FIT and the daily market electricity price.

In order to simplify, it was assumed that there were no variations in the other components of the tariff (e.g. costs associated with the transmission and distribution networks).

When evaluating the values of the cost differential with the renewable SRP included in the CIEG, it is possible to conclude that this amount had an annual growth of 21% in the period from 2010 to 2018. In terms of savings, it is possible to conclude that it surpassed the value of the cost differential, with the exception of 2010.

For this time period, a positive cumulative balance was achieved, amounting to **2.428 million euros**.

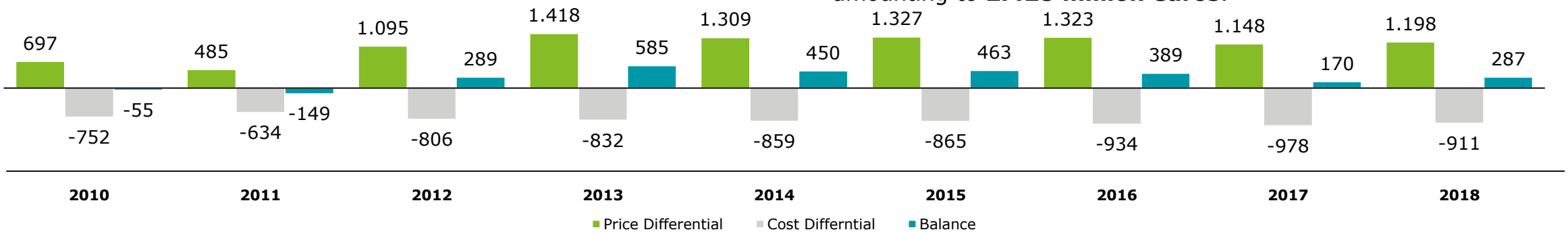

Figure 17. Differential between the obtained savings with the renewable SRP and the cost differential of the renewable SRP (M€) Source: ERSE, Deloitte analysis

ECONOMIC IMPACT OF THE RENEWABLE SRP

Future expectations

With the rise of the contribution of renewable energy sources for the Iberian electricity market, it is expected that savings passed on to the consumer increase.

The expected increase in electricity production from renewable sources and the continuing decrease of the associated costs will tend to contribute to the reduction of electricity costs in the Iberian market.

Recently, on July 27th, the Portuguese State auctioned permits for the installation of 1.300 MW of solar power, of which 950 MW had associated a fixed average tariff of nearly 20€/MWh. These figures are inferior to the ones currently being traded on the Iberian market, which signals likely future saving for consumers.

A simplified analysis considering a stable 40 €/MWh electricity price until 2030, and factoring in the expected growth in utility scale solar to 8 GW until 2030, indicates that 1.928 million euro savings could be achieved in that time period.

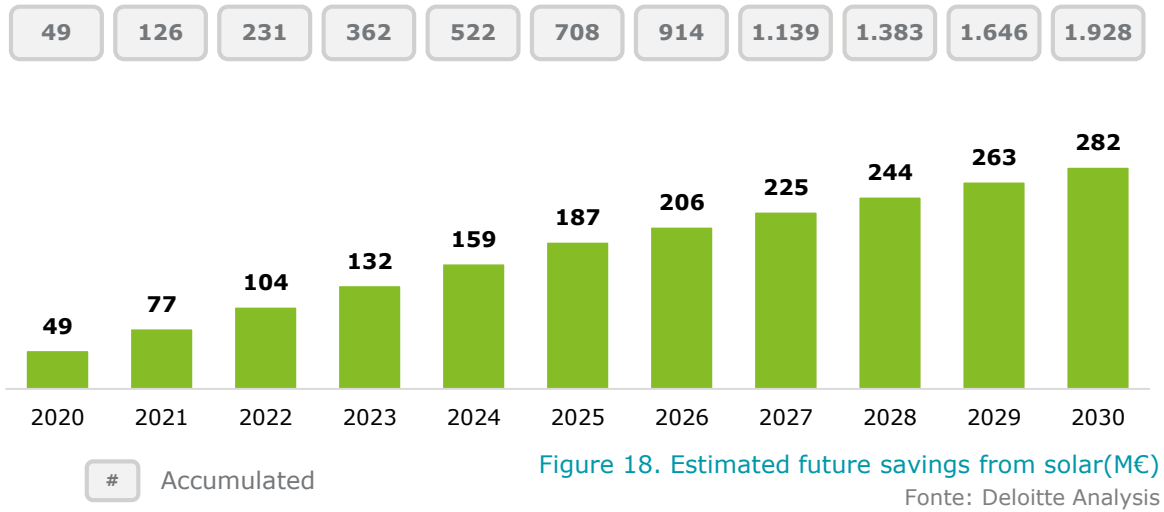

Figure 18. Estimated future savings from solar(M€)

Fonte: Deloitte Analysis

IMPACT ON THE ELECTRICITY MARKET

Findings

- The price of electricity borne by companies and private consumers results from the costs related to production and sale of electric energy, transportation and distribution networks, and the commercialization of electricity.

- The main impacts, resulting from the usage of RES, on the electricity tariff are reflected on the global system usage tariff through the CGEI and through the purchase and commercialization of electricity in the Iberian Market.

- The differential cost of the renewable SRP is a significant component of the CGEI and it is reflected in the end consumer sale tariff

- The impact of the renewable sources positively affects the market price of the electricity commercialized in the Iberian Market due to its low marginal cost

- Considering the cost differential of the renewable SRP and its impact on the daily market electricity price, there is a positive net effect for the system, with an accumulated value of around 2,4 billion euros in the last 9 years

- With the rise of the contribution of renewable energy sources for the Iberian electricity market, it is expected that savings passed on to the consumer increase

3. Economic/social impact

IMPACT ON GDP

RES' GDP contribution between 2014 and 2018

The cumulative RES contribution towards the GDP surpassed the 15 billion euros between 2014 and 2018, corresponding to an average annual value of ~3 billion euros

The weight of wealth creation in the electricity production sector from RES on the Gross Domestic Product (GDP) was stable between 2014 and 2018. The year of 2017 was, however, an exception, since it was affected by adverse conditions ("dry year").

Although there is a stabilized growth trend of the installed capacity, this trend does not happen for the production from RES for the analyzed time period.

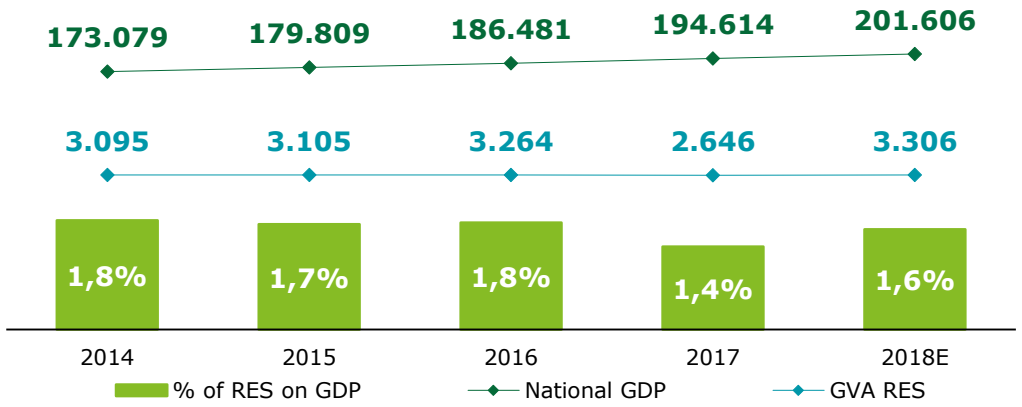

Figure 19. GDP and renewable GVA evolution in Portugal (M€)
Source: RES sector players, SABI, Deloitte analysis

Nevertheless, the investment in the production of energy from renewable sources has result in the significant contribution of the sector towards the country's wealth creation.

Although less favorable conditions were verified in the year of 2017, **the estimate for 2018 indicates that the contribution of RES towards the GDP surpassed 3 billion euros.**

The source of the contribution comes mainly from the direct impact resulting from the contribution of the electricity producers (55% estimated for 2018).

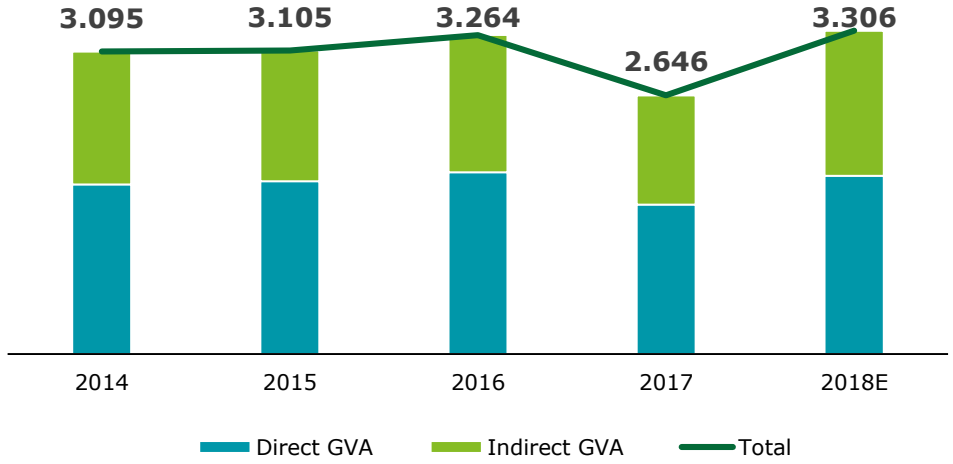

Figure 20. Evolution of the total contribution of the RES electricity sector towards the GDP (M€)
Source: RES sector players, SABI, Deloitte analysis

IMPACT ON GDP

Detail of the contribution towards the GDP by RES between 2014 and 2018

Within the RES context, the wind sector was the one which impacted the GDP the most between 2014 and 2018. In terms of the contribution by MW, solar stands out with an average annual contribution of 661k €/MW

Wind was the energy source the registered the highest contribution towards the GDP (58%), followed by hydro (24%). In total, it is estimated that they generated more than 2,5 billion euros in GVA in 2018.

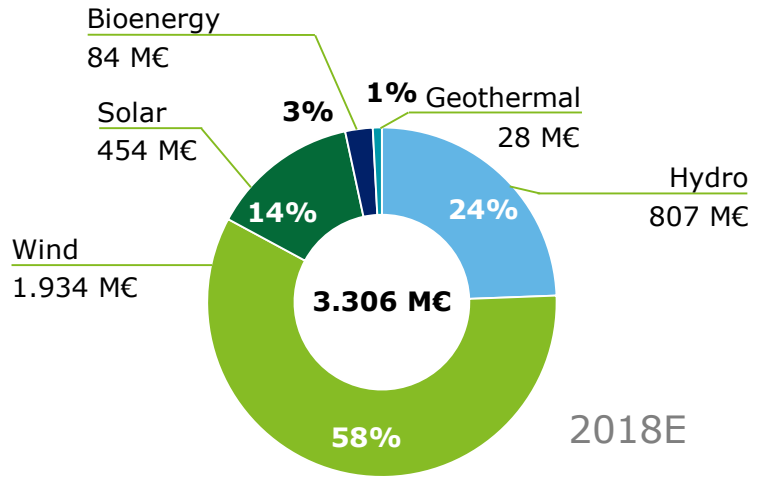

Figure 21. Distribution of the total contribution towards the GDP by RES in 2018E (M€)

Source: RES sector players, SABI, Deloitte analysis

The source that contributed the most towards the GDP by installed MW was solar, with an average annual contribution of 661k €/MW, followed by wind with 360k €/MW.

In the study conducted in 2014, however, it was possibly to verify that solar was the source the had the highest unit contribution towards the GDP (549k €/MW in 2013). Hydro energy has been on a downward trajectory since 2010, when it represented 176k €/MW.

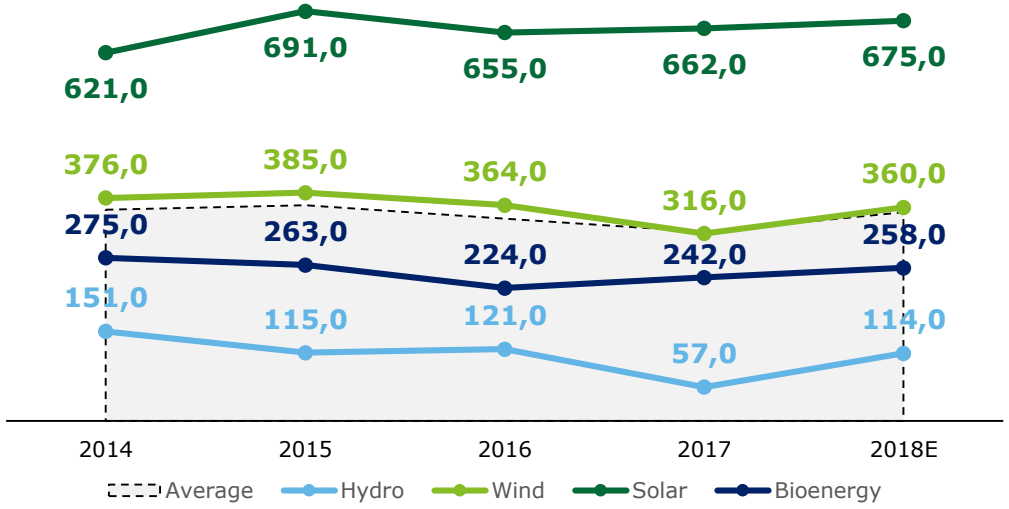

Figure 22. Evolution of the k€ ratio generated for the GDP by installed MW

Source: RES sector players, SABI, Deloitte analysis

IMPACT ON GDP

Evolution of the RES contribution towards the GDP until 2030

According to the established goals for the 2030 horizon, it is estimated that the GVA derived from RES will grow at a rate of 9% per year, reaching ~11 billion euros in 2030, representing more than 4,5% of the GDP

Through the growing trend verified for the period of analysis, it is expected that the GVA of the renewable energy sector will continue to increase, **reaching approximately 4,6% of the GDP in 2030.**

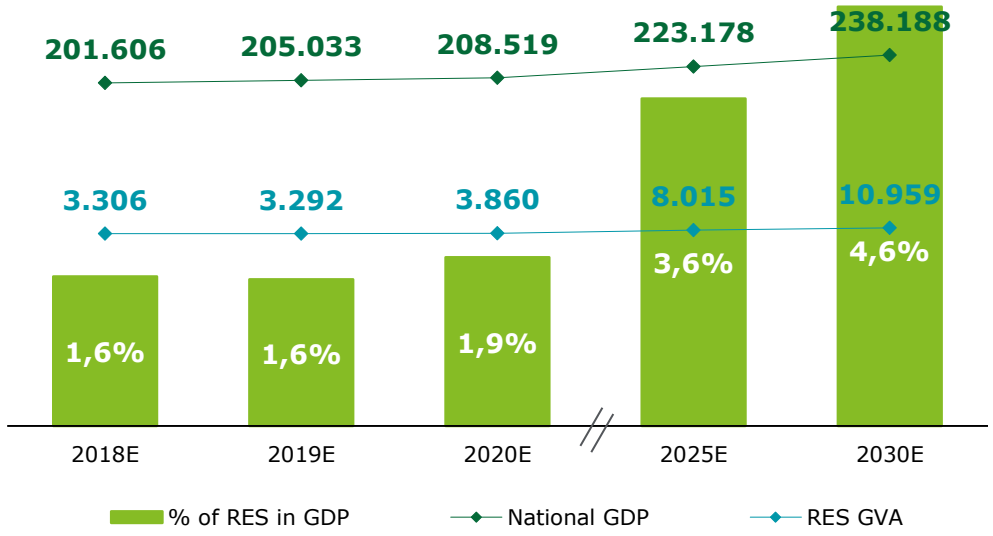

Figure 23. Estimate on the evolution of the GDP and GVA of RES in Portugal (M€)

Source: RES sector players, SABI, Deloitte analysis

This progression represents **an average annual growth rate of 10,5%**, which is related with the increase in installed capacity and, consequentially, increase in production.

Thus, in 2030, it is estimated that the contribution of RES towards the GDP will represent ~11 billion euros, with a direct contribution of ~5,6 billion euros and indirect contribution of ~5,4 billion euros.

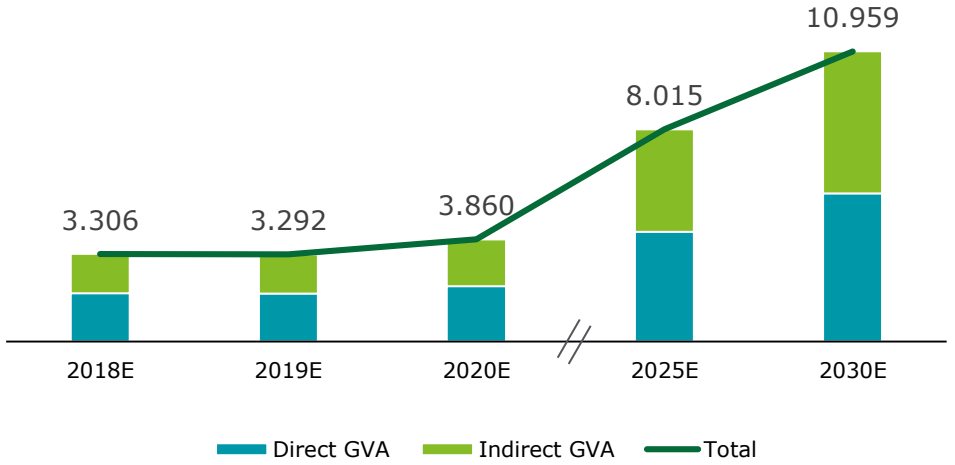

Figure 24. Estimate on the total contribution of the RES electricity sector towards the GDP (M€)

Source: RES sector players, SABI, Deloitte analysis

IMPACT ON GDP

Evolution of the RES contribution towards the GDP until 2030

In 2030, solar will be the main contributor of the RES towards the GDP, representing approximately 59% of the total, followed by wind with approximately 30%

In terms of the contribution mix towards the GDP, it is expected that **solar source will surpass wind energy** as the main contributor towards the GDP (59%). The sources of wind (29%) and hydro (8%), will remain having relevant values for contribution towards the GDP.

When comparing the estimated data between 2020 and 2030, it is possible to verify that the total contribution value will more than double, thus requiring an adequate territory planning, the achievement of the defined policies and the involvement of the different sectors of the Portuguese society, in order to guarantee a transition that is able to deliver on the defined goals.

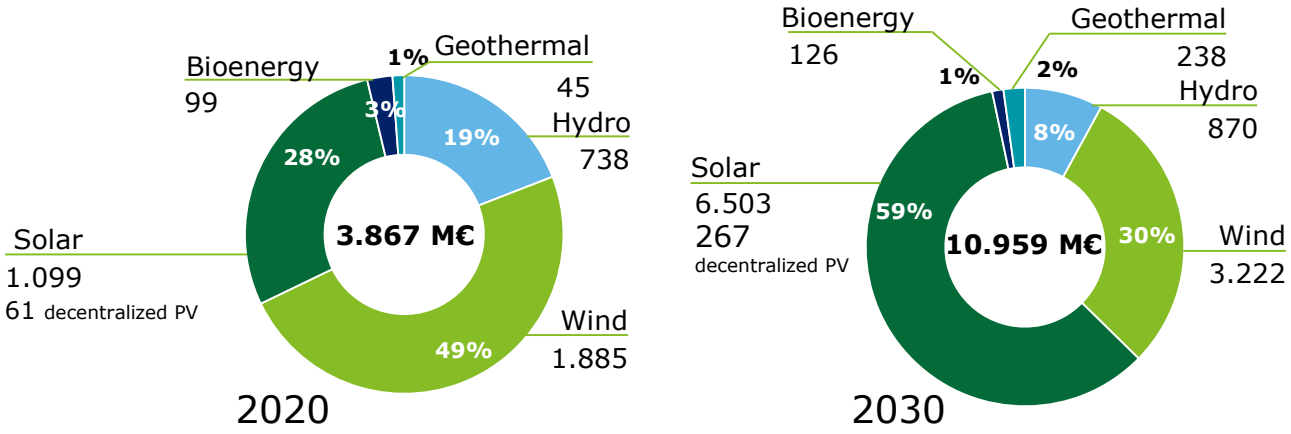

Figure 25. Distribution of the total contribution towards the GDP by RES in 2020 and 2030

Source: RES sector players, SABI, Deloitte analysis

IMPACT ON EMPLOYMENT

Employment at RES between 2014 and 2018

Between 2014 and 2018, the RES have generated more than 41 thousand jobs (average per year), with a value added per employee far superior to the national average

For the period of analysis**, the employment generated by RES has been kept stable at values close to 41 thousand jobs**, being estimated an increase in 2019 of 9% when compared with 2014.

The values of 2017 were affected by the less favorable conditions registered, which translated into less direct and indirect employment.

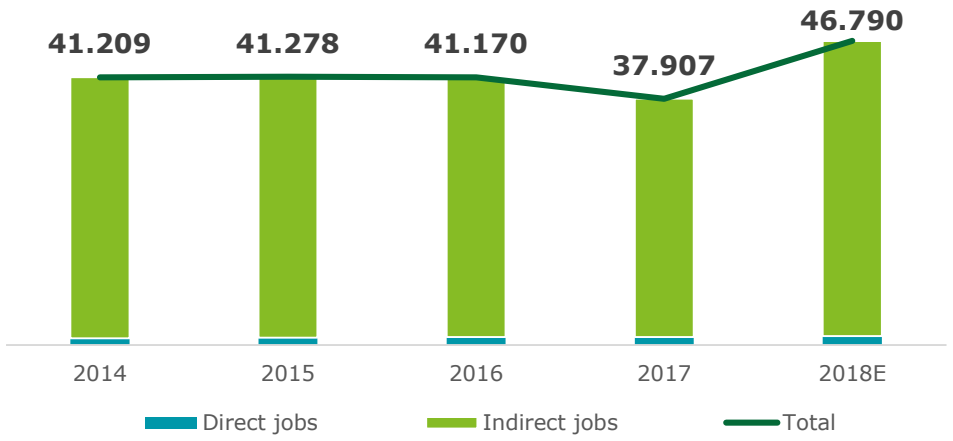

Figure 26. Evolution of the employment generated directly and indirectly by the RES sector

Source: RES sector players, SABI, Deloitte analysis

Between 2014 and 2018, it is estimated that the contribution towards the GDP by each worker in the RES sector has registered a annual average of ~73 thousand euros, a value which is two times larger than the national average, which represented ~36 thousand euros for this period.

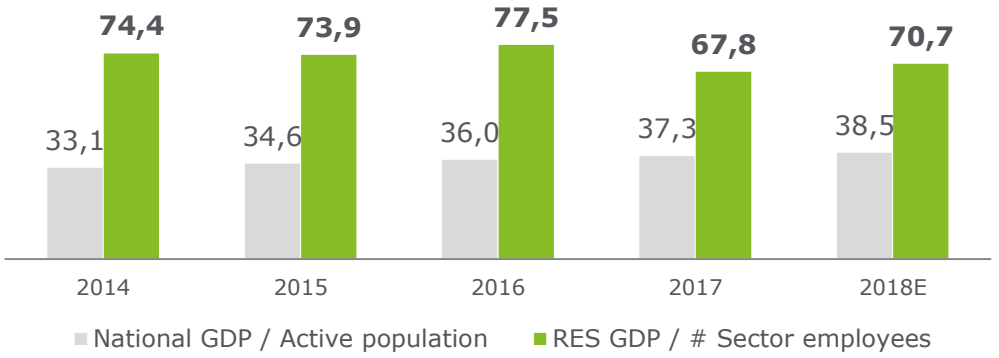

Figure 27. Evolution of the GDP per worker ratio (k€)

Source: RES sector players, SABI, Pordata, Deloitte analysis

IMPACT ON EMPLOYMENT

Detail of the employment at RES between 2014 and 2018

The wind and hydro sources are the ones which generated a larger volume of employment (82%, on average, of the RES total) between 2014 and 2018, it is solar, however, that generates more employment per installed MW

The wind and hydro sources registered the highest number of workers in the sector, contributing altogether with approximately 82% of the total value (38.315).

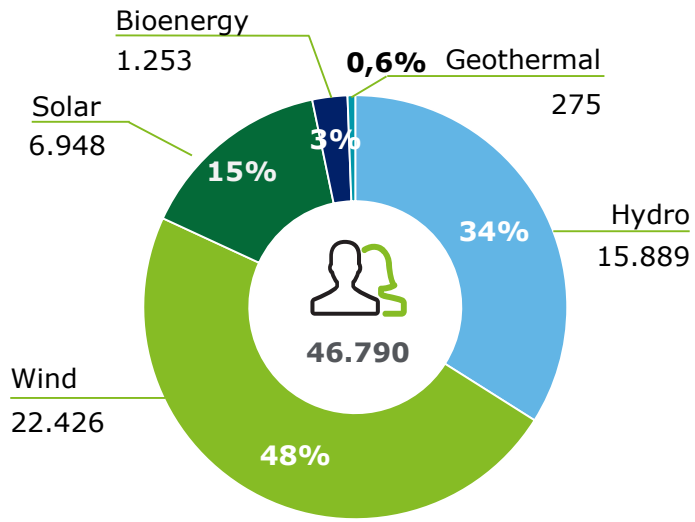

Figure 28. Distribution of the total contribution towards job creation by RES in 2018 (estimate)

Source: RES sector players, SABI, Deloitte analysis

The solar source was the one which generated more jobs per installed capacity, registering on average 10 workers per installed MW, a value which is 5 times superior to that of the wind source.

The hydro source has been registering a decrease in workers per installed MW (2,4 in 2014 and 2,2 in 2018E), a result of a stabilization of employment with an increase of the installed capacity.

The wind and bioenergy sources registered an employment per installed MW ratio similar to each other, close to 4 workers.

In the previous study, solar was also identified as the source with the largest number of workers per installed MW (10,7 in 2013), with hydro maintaining a decreasing trend that has been verified since 2010 (3,8 in 2010; 2,7 in 2013).

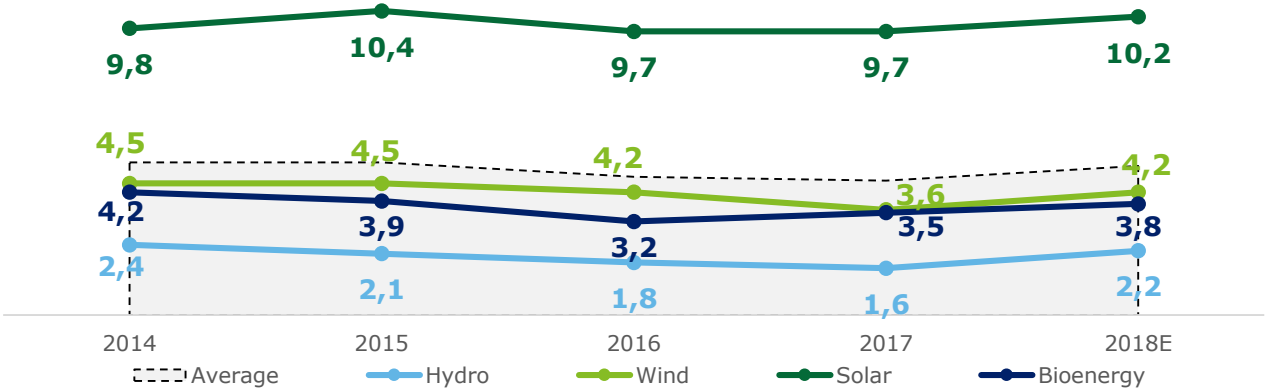

Figure 29. Evolution of the employment ratio (direct and indirect) by installed MW

Source: RES sector players, SABI, Deloitte analysis

IMPACT ON EMPLOYMENT

Evolution of the employment at RES until 2030

With the expected growth of the installed capacity and electricity generated from renewable sources in the upcoming years, the impact of the RES sector on employment will continue to intensify, particularly due to the growth of solar

Between 2018 and 2030, the impact of RES on employment will more than triple, generating an **additional of approximately 114 thousand workers** in the sector.

These values are due to the sector's growth, in particular to that of the solar source. It is estimated that the later will be responsible for about 63% of the associated workers, directly and indirectly, to the sector in 2030.

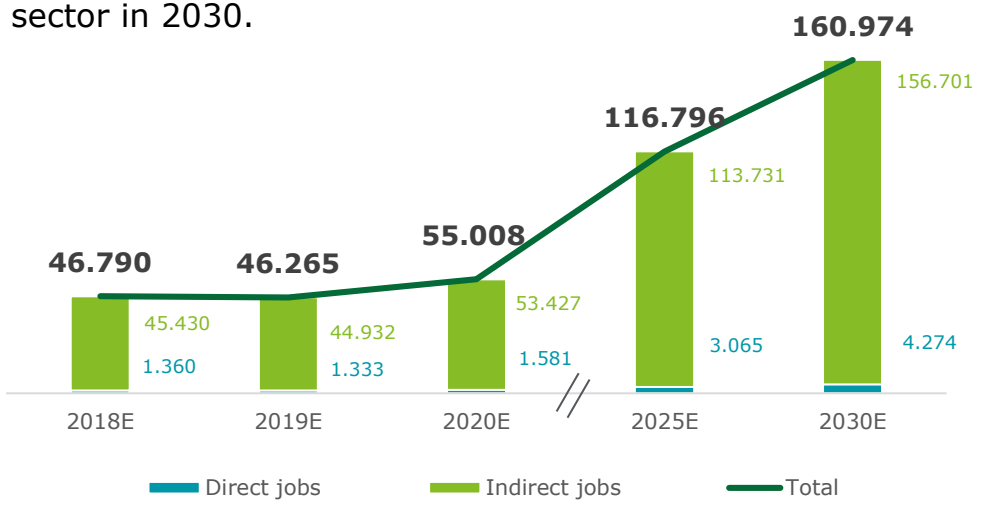

Figure 30. Estimate of job creation in the RES electricity sector

Source: RES sector players, SABI, Deloitte analysis

Employment will grow on all energy sources, although at different paces.

Due to the high growth of solar (5 times, between 2020 and 2030), the weight of hydro and wind will be reduced to 23% and 11% respectively in 2030. Nonetheless, both hydro and wind will increase the number of workers between 2020 and 2030 (2,7 thousand and 15,5 thousand, respectively).

The steep increase of workers in the sector until 2030 should be accompanied by a reinforcement of the professional training for the sector of energy efficiency, given also the need to deepen the knowledge on the climate change mitigation, promote good practices and stimulate low carbon behaviors in society, as stated by NECP.

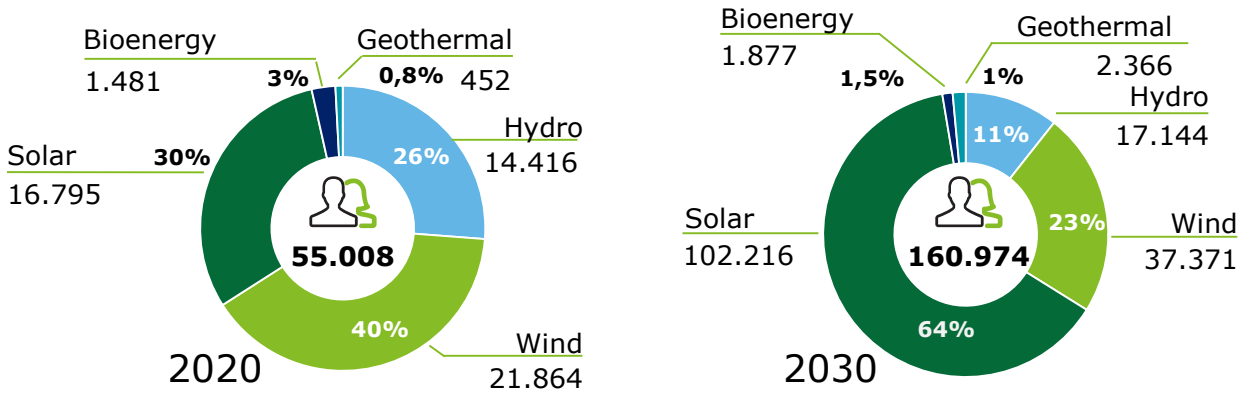

Figure 31. Distribution of job creation by RES in 2020 and 2030

Source: RES sector players, SABI, Deloitte analysis

IMPACT ON EMPLOYMENT

Evolution of the RES contribution towards Social Security Social

In 2030 the contributions for Social Security from RES will reach more than 100 million euros, of which 2,7% will come from the sector's direct employability

Considering the estimated growth for employment for the period of analysis, it is estimated that the total contribution of the RES sector towards Social Security will maintain a similar trend.

Assuming an average monthly base salary for employees in the sector of electricity, gas and water (2.070 €, in 2017), it is estimated that, **between 2018 and 2030, the sector will represent a cumulative total of more than 952 million euros of contributions**, among beneficiary and company contributions.

The average annual value of contributions estimated between 2018 and 2030 is greater than 73 million euros, which would be enough to guarantee more than 22 thousand minimum pensions of pensioners[2].

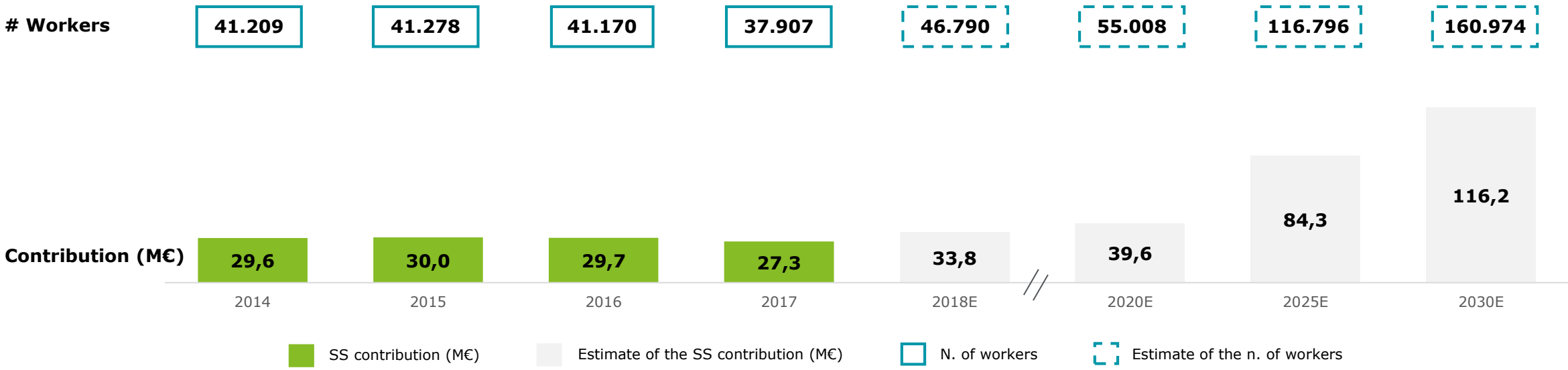

Figure 32. Impact of RES on Social Security

Source: RES sector players, SABI, Pordata, Deloitte analysis

[2] Assuming a minimum monthly value for old-age and disability pensions, in 2019, of 273,4€

IMPACT ON TAXES

Evolution of the Corporate Income Tax and Municipal Surtax in the Renewable sector

Between 2014 and 2018, the Portuguese State collected each year on average about 213 million euros of Corporate Income Tax and about 12 million euros of Municipal Surtax from the RES sector. It is estimated that in 2030 this value will rise to more than 650 million euros

In 2018, the RES power plants contributed with more than 280 million euros towards the Corporate Income Tax, with the hydro and wind sectors contributing with approximately 47% and 44%, respectively, of that value. In terms of the Municipal Surtax, it is estimated that, for the same time period, the State collected 12 million euros.

In 2030, it is estimated that the sector will contribute with 648 million euros of Corporate Income Tax, with a tripartite contribution structure where the wind source will contribute with 35%, solar with 33% and hydro with 26%.

When it comes to the Municipal Surtax, it is estimated that the sector will contribute with 27,5 million euros.

Between 2018 and 2030, it is predicted that the sector will generate a cumulative total of approximately 6 billion euros of Corporate Income Tax and Municipal Surtax.

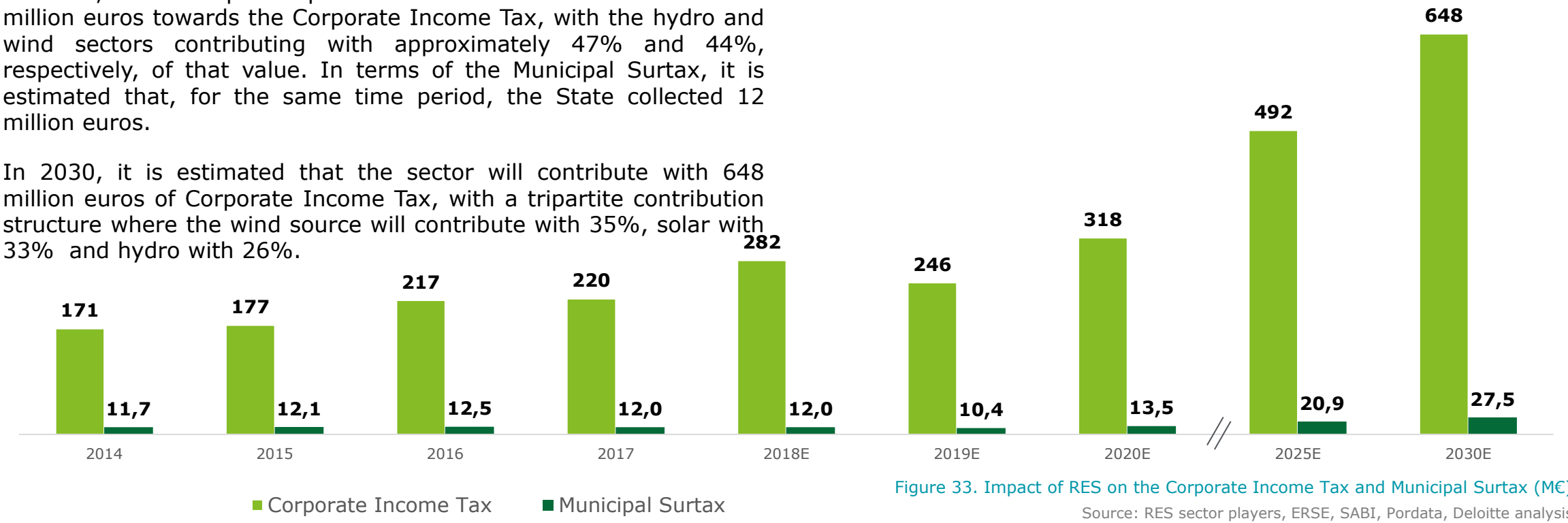

Figure 33. Impact of RES on the Corporate Income Tax and Municipal Surtax (M€)

Source: RES sector players, ERSE, SABI, Pordata, Deloitte analysis

ECONOMIC/SOCIAL IMPACT OF THE SECTOR

Conclusions

- The cumulative RES contribution towards the GDP surpassed the 15 billion euros between 2014 and 2018, corresponding to an average annual value of ~3 billion euros
- Within the RES context, the wind sector was the one which impacted the GDP the most between 2014 and 2018. In terms of the contribution by MW, solar stands out with an average annual contribution of 661k €/MW
- According to the established goals for the 2030 horizon, it is estimated that the GVA derived from RES will grow at a rate of 9% per year, reaching ~11 billion euros in 2030, representing more than 4,5% of the GDP
- In 2030, solar will be the main contributor of the RES towards the GDP, representing approximately 59% of the total, followed by wind with approximately 30%
- Between 2014 and 2018, the RES have generated more than 41 thousand jobs (average per year), with a value added per employee far superior to the national average

ECONOMIC/SOCIAL IMPACT OF THE SECTOR

Conclusions

- The wind and hydro sources are the ones which generated a larger volume of employment (82%, on average, of the RES total) between 2014 and 2018, it is solar, however, that generates more employment per installed MW
- With the expected growth of the installed capacity and electricity generated from renewable sources in the upcoming years, the impact of the RES sector on employment will continue to intensify, particularly due to the growth of solar
- In 2030 the contributions for Social Security from RES will reach more than 100 million euros, of which 2,7% will come from the sector's direct employability
- Between 2014 and 2018, the Portuguese State collected each year on average about 213 million euros of Corporate Income Tax and about 12 million euros of Municipal Surtax from the RES sector. It is estimated that in 2030 this value will rise to more than 650 million euros

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4. Environmental impact

AVOIDED EMISSIONS

Avoided CO_2 emissions and license costs between 2014 and 2018

Renewable electricity prevented the emission of 11.3 million tons of CO_2 in 2018, by replacing more polluting sources

The increase in renewable energy production allowed, between 2014 and 2018, to avoid the emission of more than 55 million tons of CO_2.

In 2018 there was an increase of 2.8 million tons of avoided CO_2 emissions compared to 2017, due to the increase in production from renewable sources.

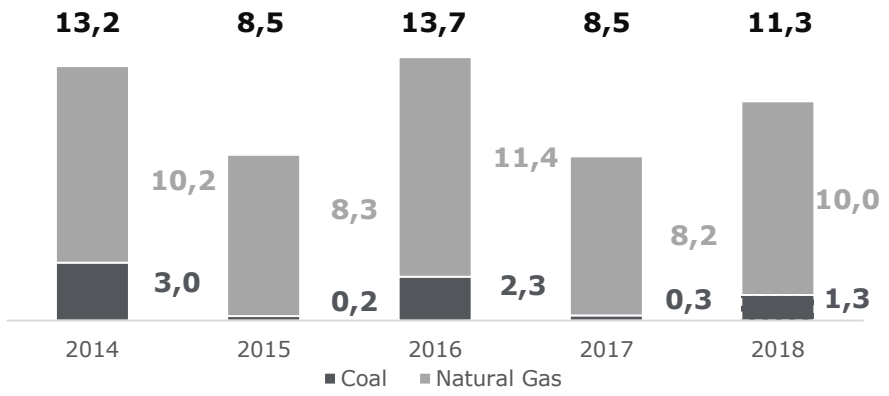

Figure 34. Avoided CO_2 Emissions (Mt)

Source: DGEG, ERSE, RMSA, Sendeco2, Deloitte analysis

Electricity generation from RES allowed **savings of over 427 million euros** between 2014 and 2018. This figure is directly influenced by the price of CO_2 emissions allowances (5,83€/t in 2017 and 15,88€/t in 2018).

Emission allowances

5,96 €/t **7,68 €/t** **5,35 €/t** **5,83 €/t** **15,88 €/t**

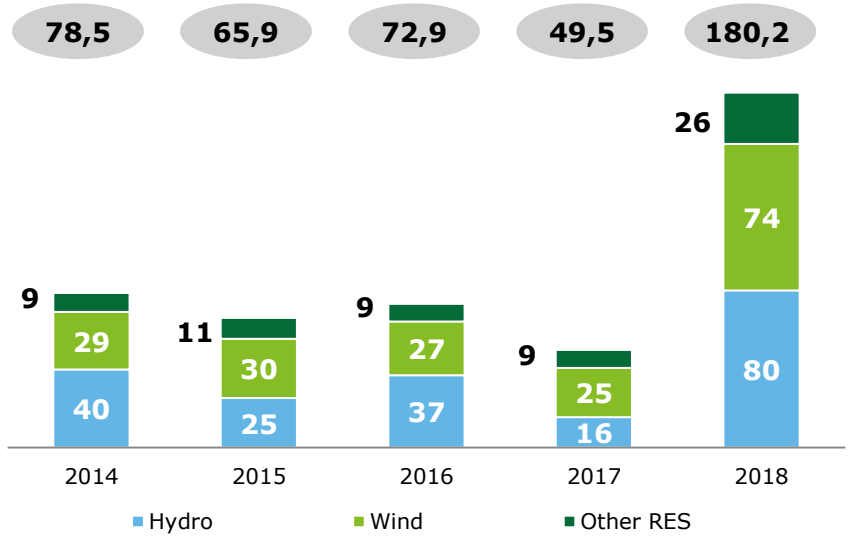

Figure 35. Total costs avoided with CO_2 licenses due to RES production (M€)

Source: DGEG, ERSE, IEA, Sendeco2, Deloitte analysis

AVOIDED EMISSIONS

Avoided CO_2 emissions and license costs by 2030

By 2030, total savings of around 784 million euros are expected from CO_2 permits due to CO_2 emissions that are expected to be avoided that year

Between 2018 and 2030, avoided CO_2 emissions are estimated to increase at an average annual rate of 6,7%.

According to the NECP, in 2030 there will be no capacity to produce from coal and it is expected that Sines and Pego plants will be closed by that year.

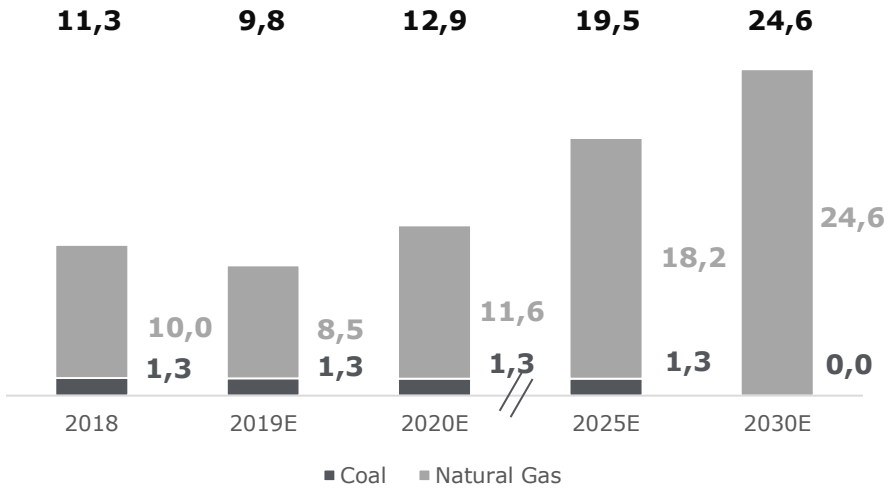

Figure 36. Estimate of Avoided CO_2 Emissions (Mt)

Source: DGEG, ERSE, RMSA, Sendeco2, Deloitte analysis

Comparing the estimates for 2020 and 2030, the contribution of RES will be more than 2x higher in 2030.

The savings mix will now be represented in its entirely by 3 renewable sources (wind, hydro and solar).

In 2030, the RES that will most contribute to the savings in CO_2 allowances will be wind and solar, with and estimated savings of 252 million and 250 million respectively.

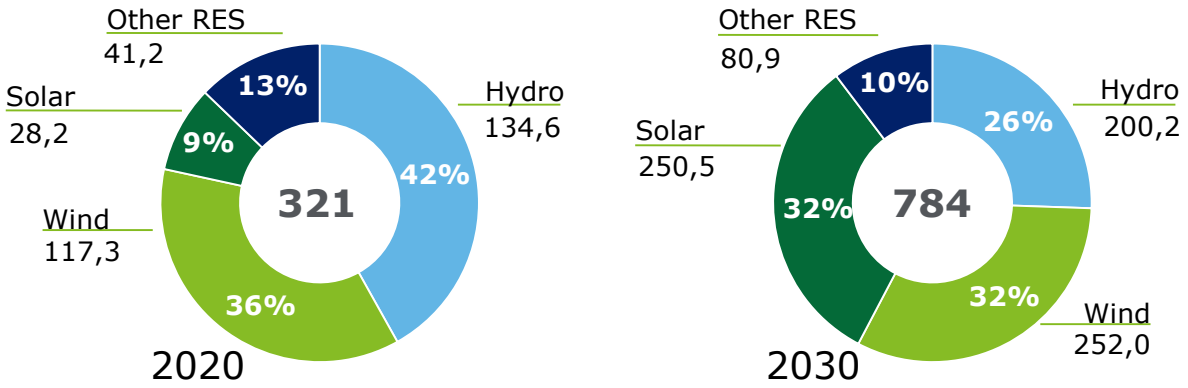

Figure 37. Estimated costs of CO_2 licenses avoided due to RES production in 2020 and 2030 (M €)

Source: DGEG, ERSE, RMSA, Sendeco2, Deloitte analysis

ENVIRONMENTAL IMPACT OF THE SECTOR

Findings

- In 2018, renewable electricity prevented the emission of 11,3 million tons of CO_2, by replacing more polluting sources
- By 2030, total savings of around 784 million euros are expected from CO_2 permits due to CO_2 emissions that are expected to be avoided that year

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5. Impact on energy dependency

IMPACT ON AVOIDED IMPORTS

Avoided fossil fuel imports between 2014 and 2018

Between 2014 and 2018, the production of renewable electricity saved about 5 billion euros in imports of coal and natural gas

Avoided imports of fossil fuels averaged 27,528 GWh between 2014 and 2018, and more than 137,000 GWh of imported fossil fuels were avoided during that period.

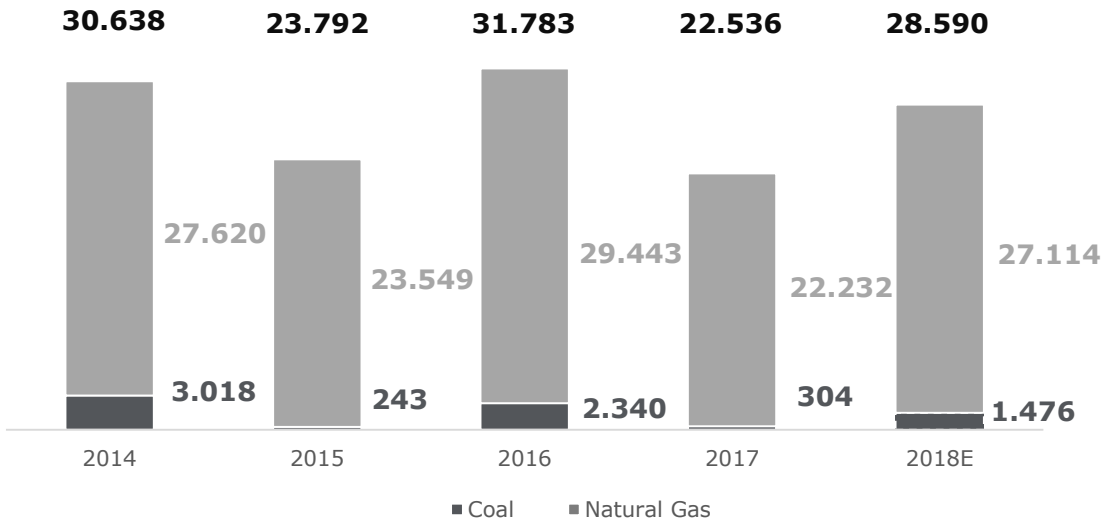

Figure 38. Evolution of avoided imports (GWh)

Source: DGEG, Deloitte analysis

In 2018, it is estimated that ~1,2 billion euros were avoided in imports of fossil fuels for electricity production, 243 million less than in 2014.

Between 2014 and 2018, about 5 billion euros were saved in fossil fuels imports, due to the capacity to produce electricity from renewable sources.

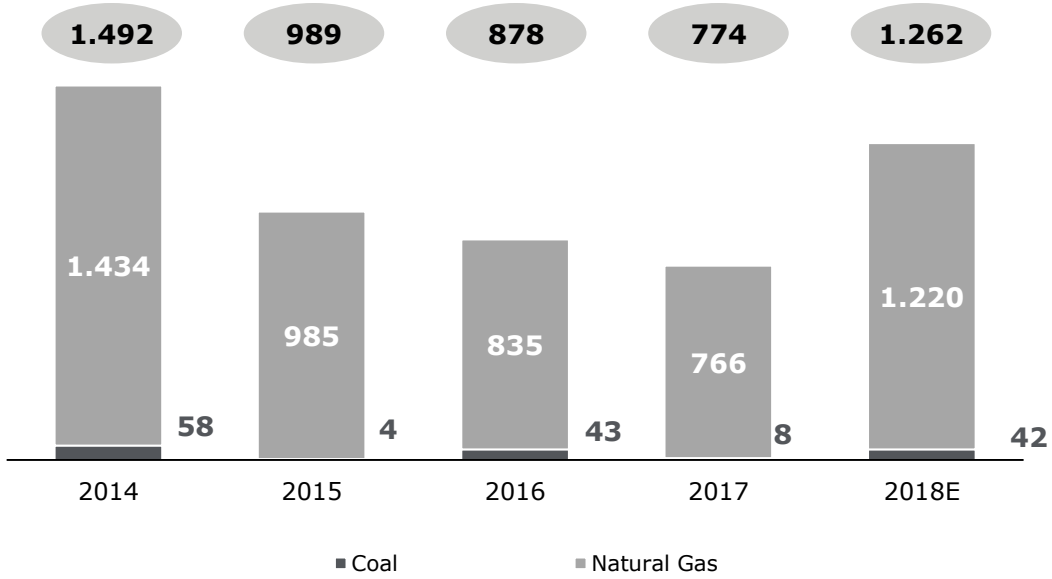

Figure 39. Total imports costs avoided by type of fossil fuel imported (M €)

Source: DGEG, Deloitte analysis

IMPACT ON AVOIDED IMPORTS

Avoided fossil fuel imports by 2030

Energy dependency tends to decrease considerably by 2030, highlighting the case of coal, which is expected to end its imports

Renewable electricity production has a positive impact on the trade balance and on the reduction in the energy dependency rate.

As a result of the expected increase in RES production, it is estimated that in 2030 avoided imports would reach 66,528 GWh, more than 2x higher than 2018.

Renewable electricity production will result in cumulative savings of more than 27 billion euros between 2018 and 2030 for avoided fossil fuel imports.

By 2030, according to the NECP, electricity production from coal will cease and the role of natural gas in the energy production mix will decrease.

Thus, in 2030, avoided imports should reach ~3.460 million euros, about 2,7x higher than the 2018 figure.

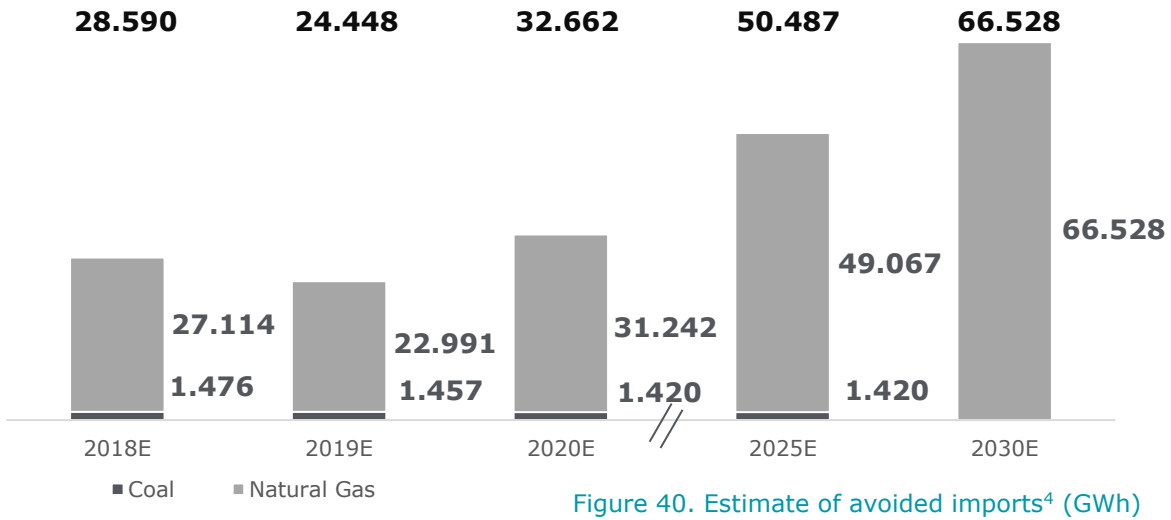

Figure 40. Estimate of avoided imports[4] (GWh)

Source: DGEG, Deloitte analysis

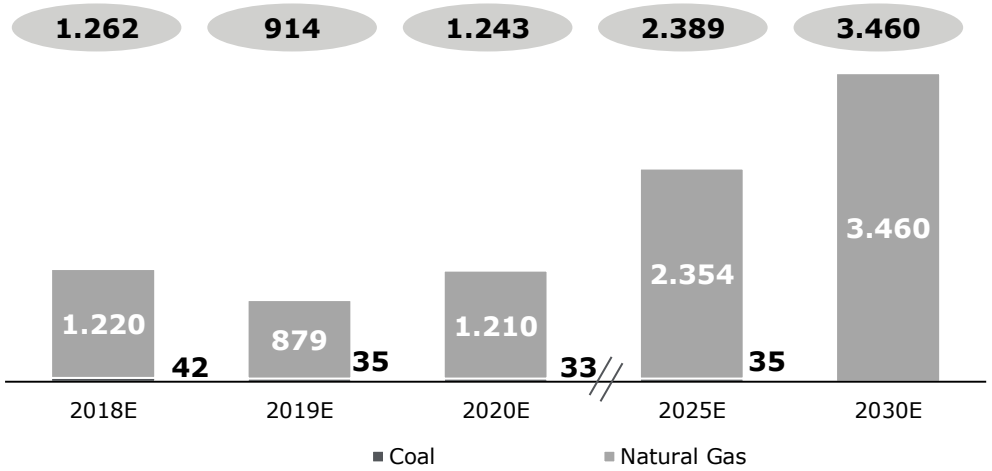

Figure 41. Estimated total import costs avoided by type of fossil fuel imported (M €)

Source: DGEG, Deloitte analysis

[4] Assuming a maximum utilization coefficient of 8.000 hours

IMPACT ON THE ENERGY DEPENDENCE

Evolution of the impact of RES on energy dependence

The incentive on electricity production from endogenous and renewable sources will tend to reduce external energy dependency by more than 25 pp by 2030

In 2018, energy dependence reached more than 76% – although lower than 2017, still one of the highest values of recent times – and the expected trend for the following years indicates a decrease of this value.

By 2030 it is estimated that RES production levels will reduce the energy dependency value to 65,8%. This value is representative of the weight that renewable energies have in reducing energy dependency: the higher the RES production, the lower the external energy dependency.

If there were no renewables in 2030, the energy dependency rate would be expected to reach 91.3%, 25.6 pp higher than the estimated value with RES.

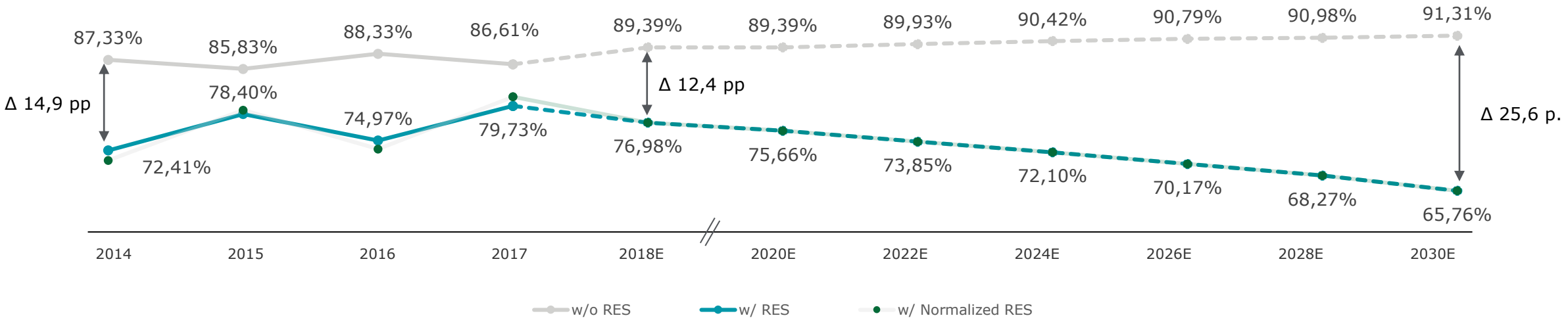

Figure 42. Impact on the evolution of the energy dependence rate (real rate vs. estimated rate w/o renewables)

Source: DGEG, Deloitte analysis

IMPACT OF THE SECTOR ON ENERGY DEPENDENCE

Findings

- Between 2014 and 2018, the production of renewable electricity saved about 5 billion euros in imports of coal and natural gas
- Energy dependency tends to decrease considerably by 2030, highlighting the case of coal, which is expected to end its imports
- The incentive on electricity production from endogenous and renewable sources will tend to reduce external energy dependency by more than 25 pp by 2030

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6. Estimations for the future

OFF TRACK SCENARIO

Estimated installed capacity and production

In a scenario of preservation of what has been implemented to date, Portugal is out of the track that leads to the fulfillment of the established objectives, having, in 2030, a weight of 64% of RES in the installed capacity mix, which is below the 86% projected in NECP

Under the Carbon Neutrality Roadmap 2050 (CNR 2050), three scenarios were identified: a reference one (Off Track) and two that represent an evolution: Peloton ("Pelotão") and Yellow Jersey ("Camisola Amarela"), which reach carbon neutrality.

If, in the case of the Peloton scenario, a progressive evolution of sectors is represented, similar to that observed in the NECP 2030, in the Off Track scenario the effects of climate change and policy change are not considered, with the objective of being compared with the other scenarios.

Estimated of the impact of RES in the CNR 2050 Off Track scenario are supported by the indicators and estimates presented in the report, namely average annual rate of change in GDP and degree of openness to the outside. Additionally, the preservation of the installed capacity was considered.

From the analysis performed, it is estimated that the RES will have an installed capacity of 13.726 MW in 2030, corresponding to a RES production of 31.369 GWh. Compared to the NECP 2030, the installed capacity in Portugal in 2030 is approximately half of the estimated value in this scenario, with generation being 35.159 GWh lower.

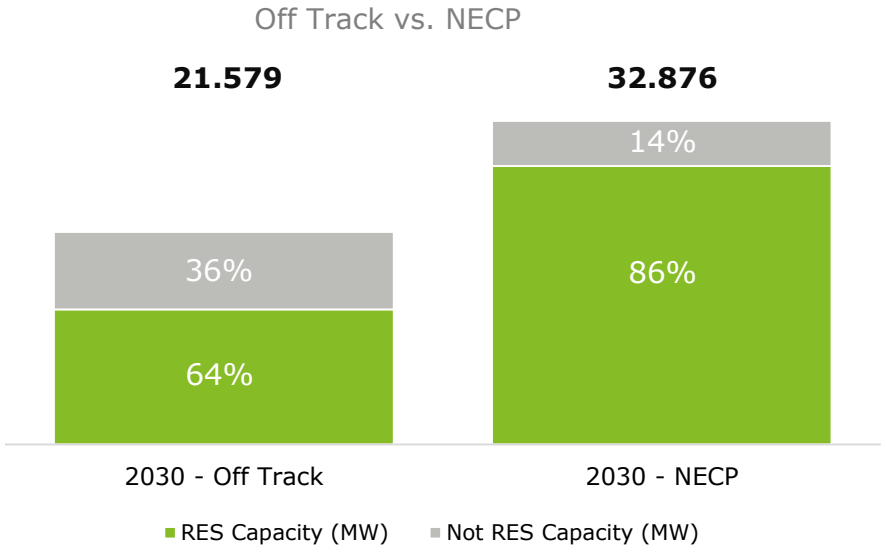


Figure 43. Estimate of installed capacity in Portugal (MW)

Source: DGEG, CNR 2050, Deloitte analysis

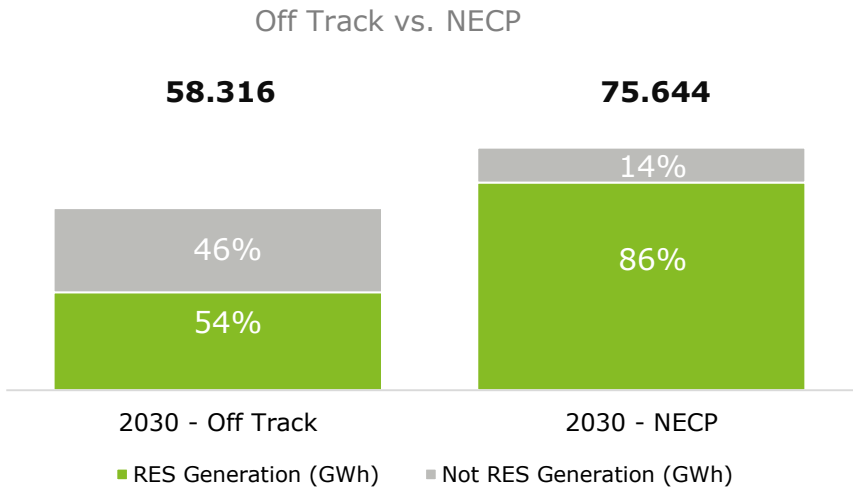


Figure 44. Estimate of electricity generation in Portugal (GWh)

Source: DGEG, CNR 2050, Deloitte analysis

OFF TRACK SCENARIO

Estimated contribution to GDP and employment

In the Off Track scenario, there is a stabilization of the contribution of RES to GDP and, consequently, the stagnation in the number of employees directly and indirectly employed by the sector

In the Off Track scenario, the installed capacity remains constant, and it is estimated that the RES contribution to GDP will follow this trend and stabilize at an average annual value of 3.4 billion euros, around 30% of the total impact predicted in 2030 with the NECP scenario.

In this scenario, the direct contribution to GDP remains at around 44%.

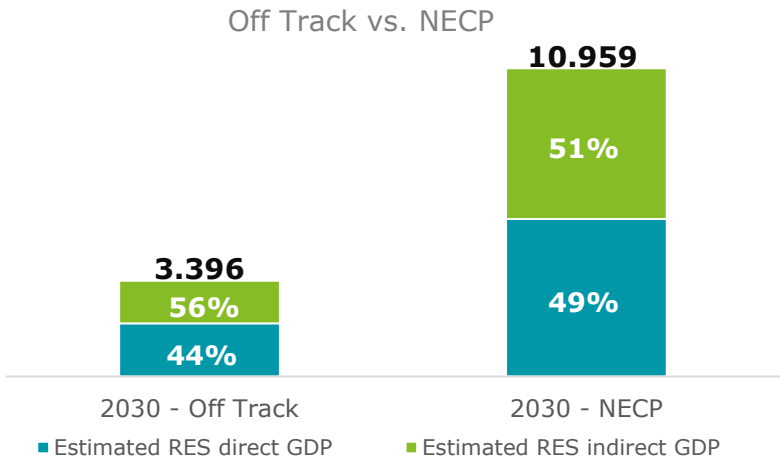


Figure 45. Estimated contribution of RES to GDP (M€)

Source: DGEG, CNR 2050, RES sector players, Deloitte analysis

In this scenario, in 2030, the employment generated by RES is of 47.129 employees, a figure that is essentially related to indirect employment (97%).

In the Off Track scenario, it is estimated 113.000 fewer jobs will be created in 2030 compared to the NECP scenario.

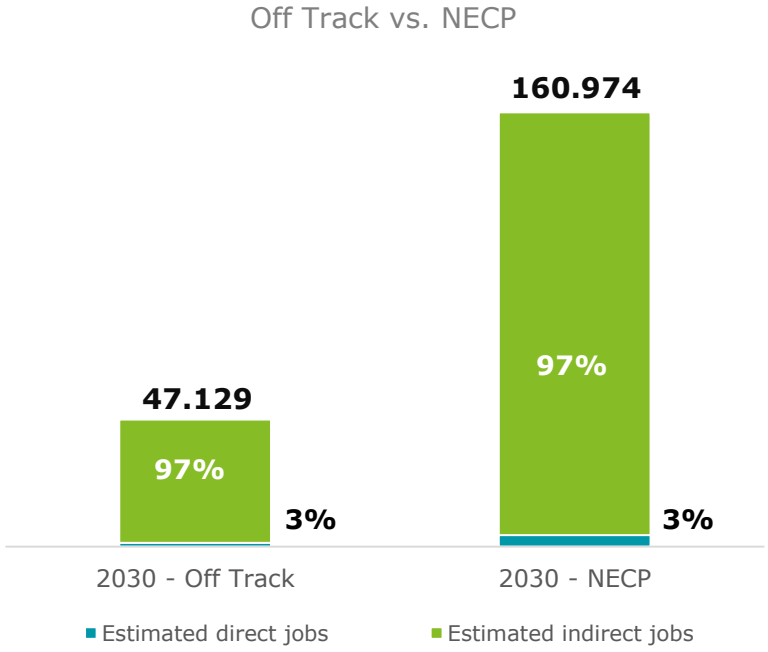


Figure 46. Estimated contribution of RES to national employment

Source: DGEG, CNR 2050, Deloitte analysis

OFF TRACK SCENARIO

Estimated contribution to CIT and Social Security

Based on the Off Track scenario, it is estimated that in 2030 the State will raise about 280 million euros in corporate income tax and 13 million euros in Municipal Surtax, less than half of the predicted in the NECP scenario

In 2030, RES power generation centers are estimated to contribute with more than 280 million euros in CIT, less than half of the NECP scenario, as well as 13 million with Municipal Surtax (compared to 27,5 million euros in NECP scenario).

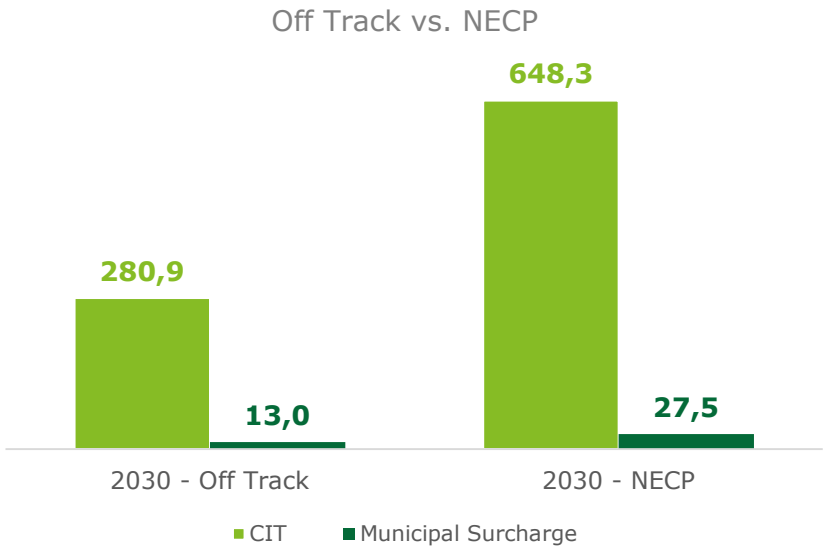


Figure 47. RES impact on CIT (M€)

Source: DGEG, CNR 2050, RES sector players, Deloitte analysis

Considering the estimated evolution of RES employment, in this scenario it is expected that Social Security contributions will amount to 34 million euros in 2030.

In 2030 this represents around 30% of the estimated value in the NECP scenario, in line with employment estimates.

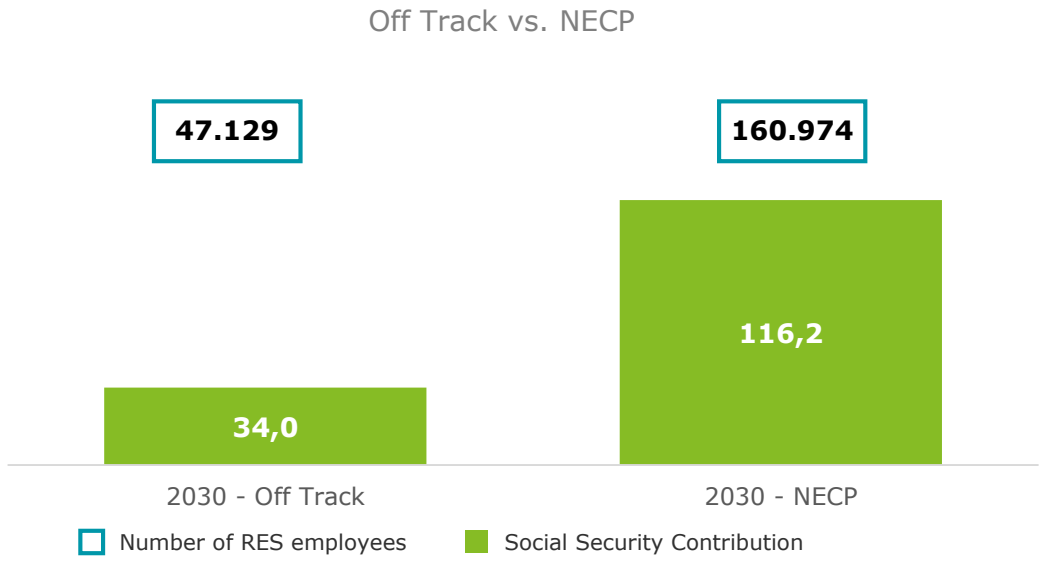


Figure 48. RES impact on social security (M€)

Source: DGEG, CNR 2050, RES sector players, Deloitte analysis

OFF TRACK SCENARIO

Evolution of energy dependency rate and avoided import costs

In the Off Track scenario, energy dependency would tend to be around 11 pp above the NECP scenario, with RES

Due to the lack of fossil energy sources in the national territory (such as goal and natural gas), the Portuguese energy dependency is very conditioned by the development of RES. **With the evolution of their installed capacity, according to this scenario, the energy dependence with RES would be 76,98%.**

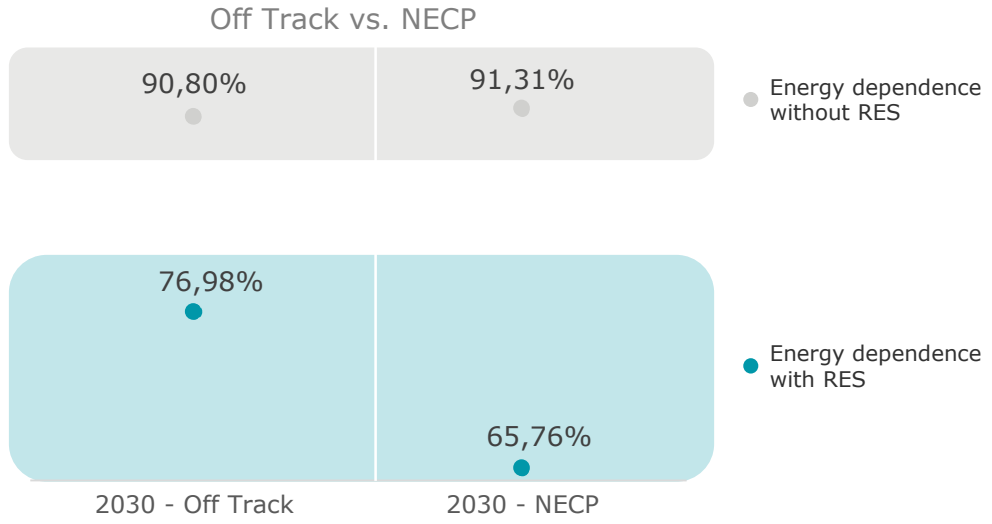


Figure 49. Evolution of the energy dependency rate (real rate vs estimated rate w/o RES)

Source: DGEG, CNR 2050, RES sector players, Deloitte analysis

Contrary to the scenario previously analyzed (in line with the NECP targets), in this case it is not foreseen to cease electricity generation from coal by 2030.

Under this scenario, it is estimated that renewable electricity production will result in savings of over 2 billion euros in 2030 from avoided imports of raw materials, 40% less than under NECP scenario.

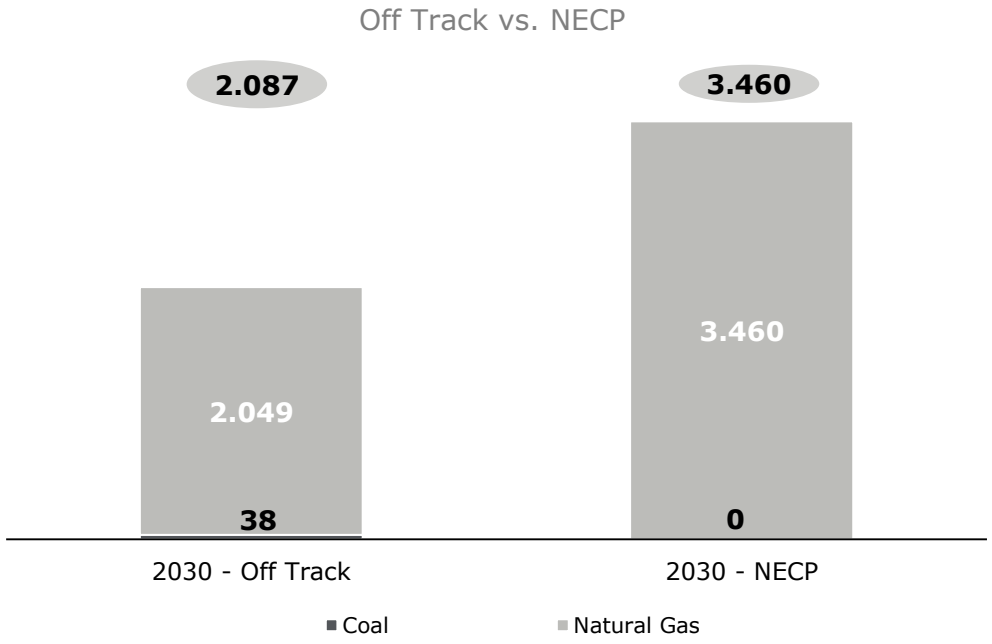


Figure 50. Total import costs avoided by type of fossil fuel imported (M €)

Source: DGEG, CNR 2050, RES sector players, Deloitte analysis

OFF TRACK SCENARIO

Estimated avoided CO_2 emissions

Under this scenario, an estimated 11,6 million tonnes of CO_2 emissions are avoided in 2030, which is below expectations give the targets set

As a consequence of the inaction inherent in RES growth, the avoided CO_2 emissions tend to stagnate at 11,6 million tonnes in 2030, and non-renewable production is assumed to be high in order to achieve NECP 2030 targets.

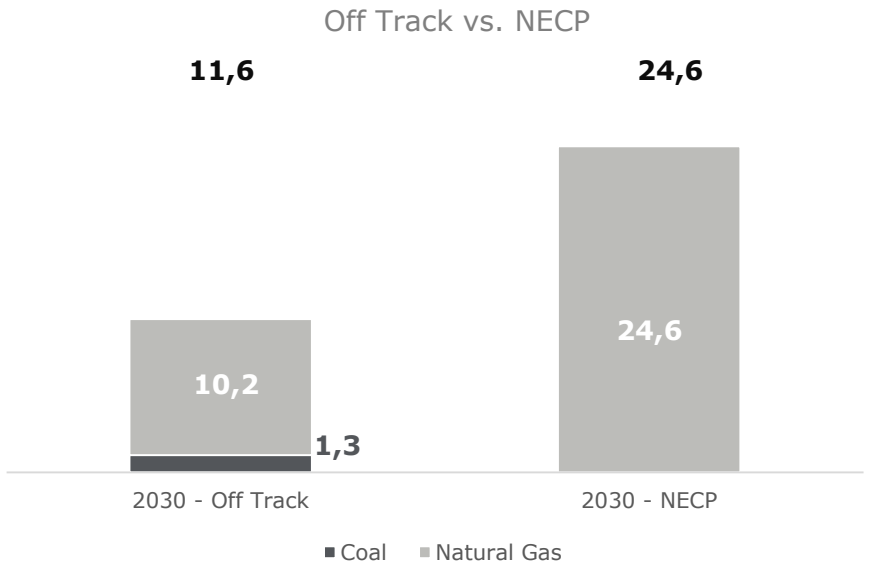


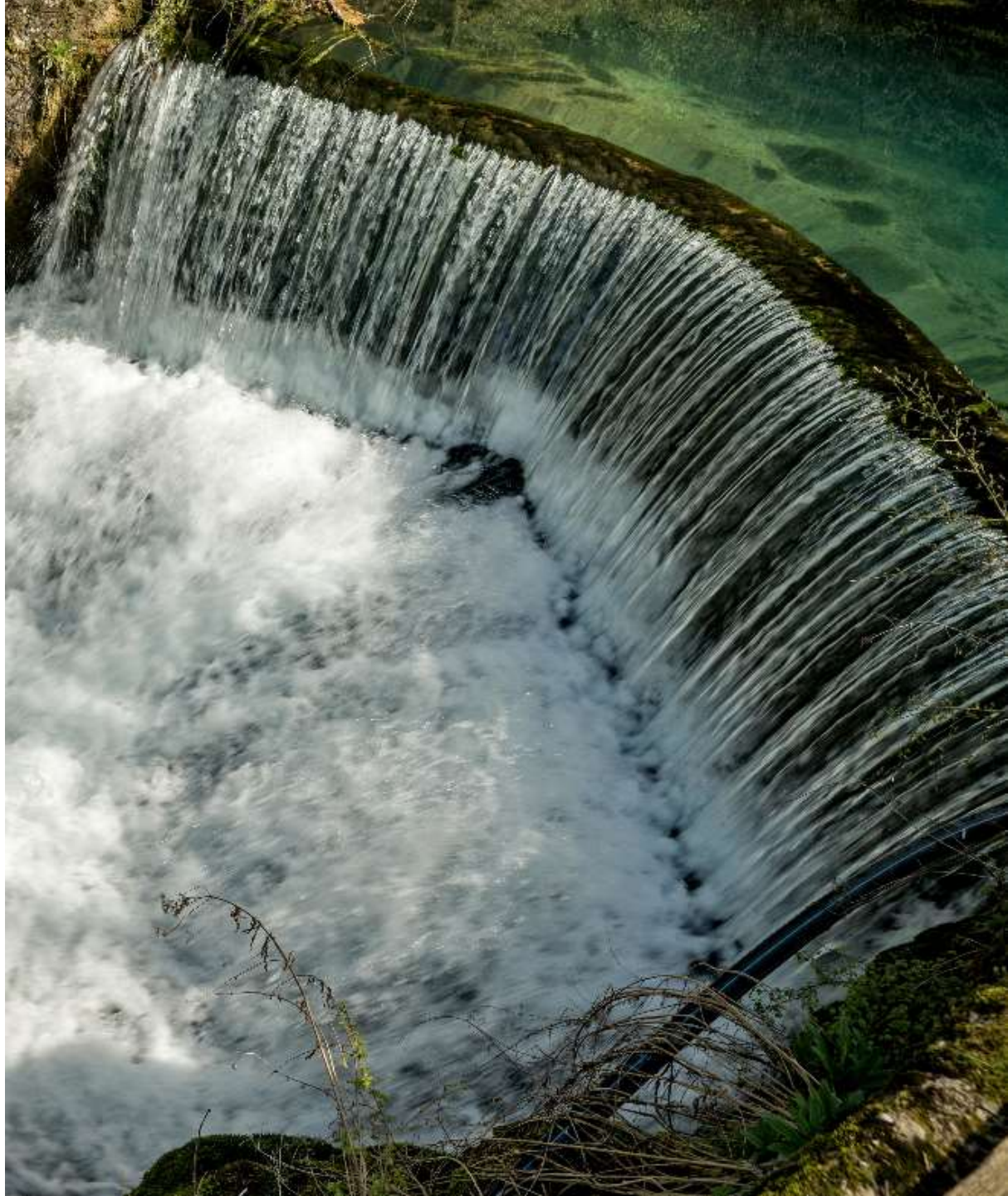
Figure 51. Avoided CO_2 Emissions (Mt)

Source: DGEG, CNR 2050, RES sector players, Deloitte analysis

OFF TRACK SCENARIO

Findings

- In a scenario of preservation of what has been implemented to date, Portugal is out of the track that leads to the fulfillment of the established objectives, having, in 2030, a weight of 64% of RES in the installed capacity mix, which is below the 86% projected in NECP
- In the Off Track scenario, there is a stabilization of the contribution of RES to GDP and, consequently, the stagnation in the number of employees directly and indirectly employed by the sector
- Based on the Off Track scenario, it is estimated that in 2030 the State will raise about 280 million euros in corporate income tax and 13 million euros in municipal surtax, less than half of the predicted in the NECP scenario
- In the Off Track scenario, energy dependency would tend to be around 11 pp above the NECP scenario, with RES
- Under this scenario, an estimated 11,6 million tonnes of CO2 emissions are avoided in 2030, which is below expectations give the targets set



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