Provision of Audit Services in compliance with the Ministerial Order no. 4694/2014

Final Second Report

(Report D2)

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I. Executive Summary and Conclusions

Redes Energéticas Nacionais, REN, has retained *The Brattle Group* to conduct a study of the Portuguese electricity secondary reserve market as set out in the *Despacho* 4694/2014 of the Portuguese Secretary of State for Energy. This report is the second deliverable of the study and is intended *"to assess the effectiveness of the Despacho no. 4694/2014 in the correction of the distortions of the competition identified in the system services market."*

The *Despacho* 4694/2014 was intended to address concerns about the level of competition in the market for secondary reserve and the effect on the participation of generating units in this market of the regulations ruling the *Custos para a Manutenção do Equilíbrio Contractual*, CMEC.

Analysis of the measures

We have first assessed the effectiveness of the *Despacho* 4694/2014 by analysing the measures from a theoretical point of view. The *Despacho* 4694/2014 has two main provisions that affect the market for secondary reserve in Portugal. First, it amends the procedure for adjusting the CMEC to take account of revenues obtained in the secondary regulation reserve market. It provides that, below a certain threshold, the amount deducted from the CMEC for a unit shall be independent of its actual level of participation in that market.

According to this provision, the units with CMEC keep the marginal profits from their participation in the market and bear the marginal costs of their lack of participation. This provides the units with the incentive to optimize their provision of reserve, in relation to their costs.

The new incentive operates only below a given threshold: when the actual revenues obtained by a company's units in the secondary reserve market are lower than the proportion of the total secondary reserve payments that their share of energy production would imply they should have received.[1] This does not rule out completely the possibility that the adjustment to the CMEC interferes with the secondary reserve market. In order to minimize the potential

[1] In other words, the total secondary reserve costs multiplied by the output of the company's units that provide reserve divided by the total output of all units providing reserve.

distortions, while minimizing the CMEC compensation, it is important that the threshold reflects the efficient level of reserve provision by the units with CMEC.

A threshold based on revenues obtained assumes that a unit's electricity generation is a good measure of how much secondary reserve it should provide. However, a unit's ability to provide reserve depends as well on other known factors, such as its flexibility or minimum load. The level of secondary reserve provided by a unit in an efficient market depends also on the relative costs of the different units, which are only weakly related to their generation levels. An electricity market simulation tool would provide better estimates of the efficient level of provision of secondary reserve by the units with CMEC than their generation levels. Although it would be difficult to adapt VALORAGUA for this function and the adjustments to the CMEC will end in less than two years, a market simulation model could be used to monitor the market after the end of CMEC.

The second main provision of the *Despacho* 4694/2014 introduces a cap on the quarterly average price earned by generators in the secondary reserve market. In principle, a price cap can ensure that the market price does not exceed the efficient price level i.e. the marginal cost of providing reserve, when there is insufficient competition for the efficient price to emerge automatically from the market.

However, a cap on the quarterly average price cannot reflect the varying marginal cost of provision of secondary reserve and may interfere with the bidding process.[2] One potential effect is to incentivise the units to bid above their marginal costs so as to ensure that they still recover their costs when the cap is applied. Also a price cap on the average price does not avoid the potential for "strategic behaviour" in the market, since this has a separate price for every hour.

The price cap applied in Portugal is based on two indirect measures of the efficient price in Portugal: 1) the secondary reserve price in Spain and 2) the energy cost of a combined cycle gas turbine (CCGT); rather than on a detailed estimation of the marginal cost of provision of reserve in Portugal. Although both measures can be related to the cost of providing reserve in Portugal, there are reasons to think that they will not track appropriately the evolution over time of this cost.

[2] We understand that the cap is applied adjusting downward the hourly prices until the average price coincides with the cap.

In particular, (a) the market design in both countries is still not identical, (b) reserve in Spain is provided by Spanish plants whose cost structure may be different to that of the plants in Portugal, (c) there is no cross-border provision of reserve, and the cost to a CCGT of providing reserve is more volatile than its marginal energy cost. An alternative would be to estimate the efficient secondary reserve market price using electricity market simulation tools, and use those estimates as price caps, instead of relying on indirect measures.

Assessment of the effectiveness of the Despacho 4694/2014

We have also assessed the effectiveness of the *Despacho* 4694/2014 by looking at the quantitative evolution of the secondary reserve market before and after the measures were approved, during 2014 and 2015. We look at the units' bids to the secondary reserve market and the reserve market outcomes in terms of prices and the amount of reserve allocated, and assess whether this evolution is consistent with an efficient and well-functioning market. Our assessment is based on a comparison of (a) the data on bids and outcomes for this period, (b) the estimates of cost-reflective bids and markets outcomes that we created in the first phase of this study, (c) the data for preceding years and (d) information from the Spanish market.

We find that the evolution of the bid prices and market outcomes suggests that the market has become more efficient. The bids and average reserve prices have fallen and converged with the secondary reserve prices in Spain. Moreover, the CMEC units have increased their provision of reserve and our estimate that the margins these units were making is roughly consistent with the margins from cost-reflective bids. However, we also find evidence that this evolution does not necessarily mean that the market has become more competitive. The capacity bid into the reserve market has decreased and the secondary reserve prices resulting from the market are anomalously similar to those in Spain. This might suggest that EDP is setting its bids in order to match Spanish prices, as these have been deemed "efficient" market outcomes, rather than to reflect the true costs of providing the service.

In addition, the market started gradually evolving before the approval of the *Despacho* 4694/2014, from around mid-2013. This is approximately the period when ERSE and AdC published their studies drawing attention to the significant rise in the costs of the secondary reserve market and the low levels of provision of secondary regulation by generation units covered by the CMEC. Therefore, we think it is possible that these investigations had an impact on the behaviour of EDP that precedes the entry in force of the *Despacho* 4694/2014.

Overall assessment and recommendations

We think that *Despacho* 4694/2014 has successfully incentivized EDP to provide secondary reserve at a lower cost, removing the distortions created by the CMEC adjustment procedure. It has also limited the impact that the exercise of market power can have by capping the price paid for the secondary reserve. However, we think that it might be possible obtain the same results more efficiently and that the second reserve market is still not a fully competitive market.

In particular, a fine tuning of the measures introduced by the *Despacho* 4694/2014 would:

- minimize the cost of CMEC born by the electricity customers (maximizing the share of secondary reserve revenues that is settled in the annual adjustment to the CMEC) and
- avoid jeopardizing the long term development of the market; in particular, the entry of new providers.

We think it is possible to achieve a more efficient and competitive market by means of the following measures:

- Considering replacing electricity production with another proxy of a unit's ability to provide secondary reserve that takes into account other relevant factors. This could, for example, be done via market simulations similar to those used for the CMEC adjustment. Such simulations could be used to monitor both the regulation and the energy market. However, the benefits of this approach should be assessed against the cost and complexity of specifying and calibrating a new simulation model.
- Implement an ex-ante control of bids to the market, based on guidelines on both the quantity and price that agents are expected to bid, rather than an ex-post control of the average price.
- Limit the control of bids and prices to those agents regarded as dominant in the market, rather than to all the agents. This will avoid discouraging the entry of new providers of secondary reserve.
- If a price cap is retained, adjust its linkage to the secondary reserve market price in Spain to take into account the difference in the market design in both countries. Again, this could be achieved using market simulations.

II. Introduction and Scope of Work

Redes Energéticas Nacionais, REN, the Portuguese electricity Transmission System Operator, has retained *The Brattle Group* to conduct a study of the Portuguese electricity secondary reserve market between 2010 and March 2014, as set out in the *Despacho* 4694/2014, of 1 April 2014, from the Office of the Portuguese Secretary of State for Energy. This report is the second deliverable of the study and is intended *"to assess the effectiveness of the Despacho no. 4694/2014 in the correction of the distortions of the competition identified in the system services market.*" The analyses of this report build on the analytical framework developed in the first deliverable of this engagement.[3]

The Portuguese Secretary of State for Energy approved the *Despacho* 4694/2014 due to concerns about the significant rise in the prices of the electricity secondary reserve market and the low levels of provision of secondary reserve by generation units covered by the CMEC.

The *Despacho* 4694/2014 has two main provisions. First, it amends the CMEC adjustment procedure in order to incentivize the participation of the units with CMEC in the secondary reserve market.[4] Second, it modifies the price mechanism for the secondary reserve market, introducing an ex-post price cap.[5]

This report is structured as follows:

- section III analyses the measures in the *Despacho* 4694/2014 using the analytical framework we have already developed to study the provision of secondary regulation reserve and the costs associated with it;
- section IV examines the operation of the secondary reserve market after the measures were approved. It looks at the secondary reserve market bids and

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3 In our first report we developed an analytical framework to assess the secondary reserve capacity that should have been available in Portugal and the competitive costs of providing that capacity. The analytical framework for the cost of providing secondary reserve identified four elements that would be reflected in competitive bids to the secondary reserve market: capacity costs, service costs, opportunity costs and energy margin.

4 *Despacho* 4694/2014, preamble: *"criar mecanismos que incentivem uma participação mais ativa das centrais com CMEC no mercado da banda de regulação secundária".*

5 Ruled by the Decree-Law no. 240/2004, of 27 December, modified by Decree-Laws no.s 199/2007, of 18 May, no. 264/2007, of 24 July, and no. 32/2013) of 26 February.

outcomes both in terms of prices and the amount of reserve allocated and assesses whether this evolution is consistent with an efficient and well-functioning market;

- section V quantifies the impact of the *Despacho* 4694/2014 on the margins of the CMEC units. It compares our estimates of the units' current margins with the margin the units would have obtained under a cost-reflective scenario;
- Finally, section VI provides some recommendations on potential adjustments to the measures approved in the *Despacho* 4694/2014.

III. Assessment of the *Despacho* 4694/2014

III.A. PARTICIPATION ON THE SECONDARY RESERVE MARKET

We have first assessed the effectiveness of the *Despacho* 4694/2014 by analysing the measures from a theoretical point of view. The *Despacho* 4694/2014 has two main provisions that affect the market for secondary reserve in Portugal. Article 2 of *Despacho* 4694/2014 amends the calculation of the annual adjustments to the CMEC with regard to the revenues that the units covered by the CMEC obtain in the secondary reserve market. This adjustment to the initial compensation granted by the CMEC is intended to ensure that CMEC units would achieve the same remuneration than with the original Power Purchase Agreements had not been terminated. In a simple manner, revenues obtained in the secondary reserve market reduce, other things equal, the compensation granted to the units.

Units are affected by this adjustment because their total profits they earn are determined from the revenues they obtain in all the electricity markets, *minus* all the costs they incur, *plus* the compensation they receive from the CMEC mechanism. If higher revenues in the secondary reserve market lead to an equivalent reduction in the CMEC compensation, then the profits of the units will not change and the units will be indifferent between participating or not in the market. However, to the extent that participating in the secondary reserve market may lead to costs that are not recovered, then the units would be better off if they do not participate.

The original adjustment considered that all the actual revenues obtained by the units should be taken into account in the adjustment, and "deducted" from the estimated compensation. The *Despacho* 4694/2014 instead provides that the revenues that should be considered for the CMEC adjustment shall be the maximum of the actual revenues obtained a company's CMEC units in this market and the proportion of the total secondary reserve payments that their

share of energy produced by units providing reserve would imply they should have received. In other words, the *Despacho* assumes that the electricity produced by a unit is a good proxy for its ability to provide reserve.[6]

The following sub-sections assess the efficiency of the measure, the quality of the production as a proxy for the ability to provide reserve, and the impact of assuming a different proxy.

III.A.1. Incentive to participate in the market

The modification introduced by the *Despacho* 4694/2014 decouples the adjustment to the CMEC from the behaviour of the units in the secondary reserve market, as long as their share of the secondary reserve revenues is lower than their share of energy production. As a consequence, a unit's marginal profit from participating in the secondary reserve market will depend only on its revenues and costs related to that participation in that market, rather than the impact on the CMEC compensation.

This has two effects. First, it ensures that units choosing to provide less reserve than they could face an opportunity cost: the loss of the profits they could have made. Second, it allows units to make a profit when participating in the reserve market: the margin between the secondary reserve price and the cost of providing the reserve. Both effects should incentivize CMEC units to provide reserve efficiently.

Units may also take into account the impact of their participation in the secondary reserve market on the rest of the market. This is particularly relevant in view of the dominant position enjoyed by EDP, given that its CMEC units may now be able to retain the revenues they obtain in this market. However, since the market price is capped by the second main provision in the *Despacho* 4694/2014, EDP would not profit from increasing the market price above the cap. Additionally, since now units both with and without CMEC can retain the margin that they make in the secondary reserve market, it is reasonable for EDP to provide reserve using the lowest costs units.

Nevertheless, the new provisions have an effect only when the actual share of revenues obtained by the units in the secondary reserve market are lower than their share of the energy produced. Otherwise, the CMEC adjustment related to secondary reserve will not

[6] We understand that the objective of this provision is to break the link between revenues in the secondary reserve market and CMEC annual adjustment, while still including as much revenue as possible in this adjustment. This implies that the measure assumes that the electricity production is a good proxy for the efficient provision of electricity.

change from what it was previously. Therefore, the new provisions do not completely rule out the possibility that the CMEC adjustment interferes with the secondary reserve market. How likely it is that *Despacho* will interfere with the bidding behaviour of CMEC units depends on how close the share of a unit's production is to it efficient reserve production level, and the price received by the unit when providing that reserve. Section III.A.2 analyses how good a proxy the production of electricity is to a unit's capacity to provide secondary reserve.

III.A.2. Electricity generation as a proxy for the capacity to provide secondary reserve

The new provision applied to the revenues from the secondary reserve market seems to assume implicitly that:

- the electricity generation is a proxy for a unit´s capacity to provide secondary reserve; and
- the expected participation of a unit in the market only depends on its capacity, not on its costs.

To some extent, a unit's electricity production is a proxy for its capacity to provide secondary reserve because a unit needs to be generating in order to provide reserve. This is particularly relevant for units with "fuel" constraints, including hydro units, which set limits on the total electricity they can provide over a particular time period. Such restrictions also set a limit on the amount of reserve that a unit can provide. For example, the secondary reserve provided by hydro units covered by the CMEC, which are fuel constrained, has evolved over time in line with their generation.

Nonetheless, a unit's ability to provide secondary reserve also depends on other factors such as its ramping constraints and/or its minimum load. While the reserve capacity a hydro unit can provide is equal to the difference between its maximum and its minimum capacity (the apparent regulation capacity), for a plant with low ramping rates such as *Pego* (coal), its capacity to provide secondary reserve will be only 21% of that difference. Likewise, while *Alqueva* II (hydro) can provide secondary reserve equivalent to 76% of its maximum production capacity, Pego can only provide 13%. Table 1 shows that the ratio of actual to apparent regulation capacity and the ratio of minimum to maximum capacity are different for each unit.

Table 1: Secondary regulation capacity of units December 2014

Physical unit	Maximum capacity MW	Minimum load MW	Actual regulation capacity MW	Apparent regulation capacity MW	Ratio of actual to apparent regulation capacity %	Ratio of regulation to maximum capacity
Hydro units						
Aguieira	336.0	180.0	156.0	156.0	1.00	0.46
Alto Lindoso	630.0	300.0	330.0	330.0	1.00	0.52
Alqueva	254.0	100.0	154.0	154.0	1.00	0.61
Alqueva II	250.0	60.0	190.0	190.0	1.00	0.76
Bemposta	240.0	150.0	90.0	90.0	1.00	0.38
Bemposta II	191.0	75.0	116.0	116.0	1.00	0.61
Cabril	108.0	50.0	58.0	58.0	1.00	0.54
Castelo de Bode	159.0	75.0	84.0	84.0	1.00	0.53
Frades	191.0	100.0	91.0	91.0	1.00	0.48
Miranda	180.0	150.0	30.0	30.0	1.00	0.17
Miranda II	180.0	120.0	60.0	60.0	1.00	0.33
Picote	195.0	105.0	90.0	90.0	1.00	0.46
Picote II	245.0	100.0	145.0	145.0	1.00	0.59
Pocinho	186.0	75.0	111.0	111.0	1.00	0.60
Régua	180.0	75.0	105.0	105.0	1.00	0.58
Torrão	140.0	80.0	60.0	60.0	1.00	0.43
Valeira	240.0	90.0	150.0	150.0	1.00	0.63
Thermal units						
Lares - Group 1	425.0	160.0	165.0	265.0	0.62	0.39
Lares - Group 2	425.0	160.0	165.0	265.0	0.62	0.39
Pego C.C.- Group 3	395.0	220.0	97.5	175.0	0.56	0.25
Pego C.C.- Group 4	385.0	220.0	97.5	165.0	0.59	0.25
Ribatejo - Group 1	380.0	235.0	120.0	145.0	0.83	0.32
Ribatejo - Group 2	380.0	235.0	120.0	145.0	0.83	0.32
Ribatejo - Group 3	392.0	215.0	82.5	177.0	0.47	0.21
Pego - Group 1	288.0	110.0	37.5	178.0	0.21	0.13
Pego - Group 2	288.0	110.0	37.5	178.0	0.21	0.13

Source: REN.
Note: The apparent regulation capacity is calculated as the difference between the units' maximum capacity and the minimin load when providing secondary reserve.

Additionally, the efficient level of participation of a unit in the provision of secondary reserve depends also on 1) the capacity of the unit, and 2) the relative cost of that unit compared with other units. There is no straightforward relationship between the costs to a unit of providing reserve and its electricity generation costs.

It is, however, possible to estimate efficient secondary reserve provision levels using generation models, rather than relying on indirect measures. It is likely that VALORAGUA cannot be adapted to perform this function. Nonetheless, VALORAGUA can still be used to estimate the margins that the units make in the market. A new model could be used to

estimate the efficient level of system services that CMEC units should provide. This estimation would be used for the purpose of the CMEC adjustment procedure. Moreover, even though the CMEC adjustment ends in less than two years, a market simulation model could be used to monitor the market after the end of CMEC.

III.B. SECONDARY RESERVE PRICE FORMATION PRINCIPLES

Article 2 of *Despacho* 4694/2014 modifies the pricing mechanism for the secondary reserve market, introducing an ex-post price cap.[7] It prevents the quarterly average price earned by electricity generators in Portugal from being higher than the average price in Spain for the same service.[8] It also states that the calculation of the average price in Spain shall exclude those hours with prices above 20% of the energy marginal cost of a combined cycle gas turbine ("CCGT"). The difference between a unit's actual revenues and its allowed revenues taking the price cap into account are settled after the end of each quarter, once the reserve prices in Spain are made public.

Potential excessive prices in the secondary reserve market have been a concern in Portugal and a price cap can contribute to preventing market prices from exceeding the efficient price levels that would be seen in a fully competitive market. This efficient price corresponds to the hourly marginal cost of providing reserve. Therefore, for a price cap to be efficient, it should be set equal to the efficient marginal cost of providing reserve.

Before the price cap was introduced, all units whose reserve bids were accepted received a price set by the bid of the marginal unit called on to provide reserve —although the revenues obtained by units with CMECs were subsequently deducted from their CMEC compensation.

Whilst there have clearly been benefits to consumers from introducing a price cap, an important question is whether this is the most efficient way of regulating the market. Given that secondary reserve is a critical service for the electricity system, it is likely that EdP would continue to provide the service even if it suffers a loss from time to time due to the cap. However, such an outcome would not be efficient because it might deter new entry into the secondary reserve market or increase the cost of other services (or both).

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7 Ruled by the Decree-Law no. 240/2004, of 27 December, modified by Decree-Laws no.s 199/2007, of 18 May, no. 264/2007, of 24 July, and no. 32/2013) of 26 February.

8 We understand that this implies capping the average cost of the services, estimated as the quantity weighted average price of secondary reserve provided by all the units, rather than the average price earned by different units.

The following sub-sections assess the efficiency of the provision and the convenience of using electricity generation as a proxy for the units' capacity to provide reserve.

III.B.1. Incentive to bid efficiently

The price cap introduced by the *Despacho* 4694/2014 does not explicitly limit the ability of the units to offer bids that reflect the true costs they face in providing reserve. However, it alters the revenues that the units will finally obtain and therefore the margin they can make. Since a unit will seek to avoid making a negative margin whenever possible, this might distort its incentives to bid efficiently. There may be several ways in which a price cap can distort agents' bids.[9]

First, it incentivises units to bid above their true marginal costs in order to avoid making a negative margin. Units will wish to ensure that their bids are only accepted when the final price they are paid i.e. after the price cap has been applied, will cover their costs. Thus, if they anticipate the price cap will reduce prices by 10%, they will only wish to have their bids accepted when the initial price is 11% (=1/(1-10%)) higher than their costs. To achieve this, they will increase their bid above their costs by 11% and the net result will be that they at least cover their costs when the cap is applied (assuming they have correctly anticipated what the cap will be).[10] Although agents with market power may, nevertheless, have incentives to bid above their true marginal costs for different reasons, the price cap affects all agents.

Second, it seems likely that units will base their bids on what they expect the price cap will be rather than considering only their costs. This may result in inefficient outcomes.

Third, it may induce "strategic" behaviour. The marginal cost of providing secondary reserve varies hour to hour, and the price cap cannot reflect these variations. This discrepancy may allow units to bid strategically in order to modify the profile of reserve prices. Table 2 shows an example of how an agent with market power could find it profitable, under certain assumptions,[11] to modify the prices in different periods to maximize their margins.

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9 These analyses assumed that the price cap is applied as a correction factor to the price in all the hours in a given quarter.

10 A unit with costs A, will increase its bid to A/0.9, and be selected only if the price is higher than A/0.9. Then, because of the price cap, it is paid the price adjusted downward. The new price will be, at least A/0.9x0.9 = A, its original cost.

11 Table 2 assumes that the quantity allocated in period 1 and period 2 is the same, that the strategic agents has the ability to modifies the prices without changes in its market shares.

Table 2: Example of potential strategic bids

	Average cost of provision €/MW [A] Assumed	Quantitiy procured MW [B] Assumed	Marginal bid/price €/MW [C] Assumed	Market share % [D] Assumed	Margin € [E] [A])x[D]
Non-strategic bid					
Efficient bids					
Period 1	50	1	100	70%	35.0
Period 2	30	1	50	80%	16.0
Total		2	75		51.0
Price cap adjusted					
Period 1	50	1	80	70%	21.0
Period 2	30	1	40	80%	8.0
Total		2	60		29.0
Strategic bid					
Modified bid					
Period 1	50	1	75	70%	17.5
Period 2	30	1	75	80%	36.0
Total		2	75		53.5
Price cap adjusted					
Period 1	50	1	60	70%	7.0
Period 2	30	1	60	80%	24.0
Total		2	60		31.0

Source: The Brattle Group.

Finally, the impact of the price cap on the bids of the units will depend on how well the cap reflects the marginal cost of providing secondary reserve. Section III.B.2 analyses whether the price cap is cost-reflective.

III.B.2. Costs reflectiveness of the new price cap

As pointed out above, a price cap is only efficient if it reflects the marginal cost of providing the service. The price cap for the secondary reserve market in Portugal is not based on a detailed estimation of the marginal cost of providing secondary reserve in Portugal every hour; rather, it uses proxies to this cost. In particular, the provisions in *Despacho* 4694/2014 assume that:

- the price of secondary reserve in Spain is a good proxy for the price of secondary reserve in Portugal; and that

- the cost of secondary reserve is related to 20% of the energy marginal cost of a CCGT.[12]

It is reasonable to think that the price of secondary reserve in Spain could be a proxy for the marginal cost in Portugal. The design of the two markets has been largely harmonized and some segments of both electricity markets are now integrated. For instance, the electricity day-ahead hourly price is the same in both countries in most hours. However, there are still some reasons why the secondary reserve price can be different in Portugal and Spain or follow a divergent pattern.

- The secondary reserve market design in both countries is not fully harmonized. There are some differences that point towards a more economic provision in Spain:
  - Secondary reserve in Spain is provided by portfolios of units ("*zonas de regulación*"), not by individual physical units.[13]
  - Secondary reserve capacity bids in Spain can be symmetric, while in Portugal units are require to provide twice as much upward reserve as downward reserve.[14]
- The secondary reserve markets in Portugal and Spain are not integrated. The price in each country is set exclusively by units located in the respective country.
  - Although the mix of units providing reserve in both countries is now more similar than before, there are still considerable structural differences between the two markets. Therefore, there is no guarantee that costs of reserve in the two markets will be the same. In Appendix A, we include two charts showing the breakdown of secondary reserve per technology in both countries.[15]

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12 We do not know how this 20% was derived.

13 Portfolio provision can reduce the cost of provision because they can combine the upward regulation capacity of some units (e.g. hydro units that are not running) with the downward regulation capacity of other units (e.g. coal units at full output), instead of incurring in the cost of having a single unit providing both types of reserves.

14 This imply that the regulation set point is lower, increasing the units' opportunity cost and the fuel cost due to the decrease of the unit's efficiency.

15 In 2014 in Portugal thermal units provided 30.3% of all the secondary reserve, of which less than a 1% with coal units. REE does not provide an exact figure for Spain, although we judge that it is around 40% for thermal units, a significant part with coal units.

See the figures for Spain in REE, *El Sistema Eléctrico Español* in 2014, p.63, "*Total mensual de banda de regulación secundaria asignada. Desglose por tecnologías*".

– The prices in each country can be affected by asymmetric shocks in the short term, such as the failure of a power plant in one market and, in any event, may develop differently over time if the generation mix in the two countries evolves differently.

It is also possible that the cost of providing reserve may be related to the energy marginal cost of a CCGT since CCGTs participate in the secondary reserve market and sometimes set its marginal price. As there is spare CCGT capacity, the secondary reserve supplied by CCGTs could increase as the reserve price increase. The cost to a CCGT of providing reserve should act, therefore, as a limit on the reserve price.

However, establishing a cap on the secondary reserve price that is based on a fixed proportion of a CCGT's energy market costs does not seem consistent with the opportunity cost to a CGGT of providing reserve. Its opportunity cost depends on:

- the price of the day-ahead market, as well as on the energy marginal cost of the unit. To the extent that the CCGTs are not price setters in the day-ahead market, the opportunity cost can evolve differently than the energy marginal cost of these units.
- whether it is economic for the unit to be despatched in the day-ahead market i.e. whether its variable costs are below the energy price. Therefore, it is likely that the 20% threshold may not be a stable assumption, since the competitiveness of CCGTs may change.

In addition, as explained above, the secondary reserve price in the Spanish market should already be limited by the reserve costs of CCGT. Therefore, it seems unnecessary to filter the hourly prices in the Spanish market in order to obtain a benchmark for the cost of providing reserve in Portugal.

We think it is would be preferable to estimate the efficient secondary reserve market price using electricity markets simulation tools, and use those estimates as price caps, instead of relying on indirect measures.

IV. Assessment of the Effectiveness of the *Despacho* 4694/2014

We have also assessed the effectiveness of the *Despacho* 4694/2014 by looking quantitatively at the evolution of the secondary reserve market before and after the measures were approved. We look at the capacities bid into the secondary reserve market, the price of those bids, and the market outcomes, both in terms of prices and the amount of reserve allocated to

units. We compare the actual behaviour of the CMEC and non-CMEC units in the market to our estimates of what their efficient (competitive) behaviour would have been, based on the same series of assumptions on the technical and economic characteristics of the units that we made in our First Report. We assess whether the observed behaviour is consistent with an efficient and well-functioning market.[16]

Our results suggest that after the *Despacho* 4694/2014 the bids submitted to the market have been better aligned with our estimated costs. There has also been a change in the types of plants providing reserve so that it is more consistent with our estimates of the least cost reserve allocation. These changes are consistent with the incentives provided by the *Despacho* 4694/2014, which have been analysed in section III.

However, we also observe that there has been a reduction in the percentage of the available reserve capacity that is offered to the market and anomalies in the profile of hourly prices. We think, therefore, that while the evolution of the market suggests that the market has become more efficient, this evolution does not necessarily mean that the market has become more competitive.

In addition, this evolution in market outcomes began in mid-2013, well before the approval of the *Despacho* 4694/2014. This would be consistent with EDP changing its bidding strategy at the time when ERSE and AdC were investigating the secondary reserve market.

IV.A. ASSESSMENT OF THE QUANTITY OFFERED TO THE MARKET

We have estimated (on an hourly basis) the maximum secondary reserve capacity that every unit could provide. These estimates rely on the analytical framework laid out in our First Report. We have calculated the aggregate monthly reserve capacity available for different types of units[17] and compare the actual and simulated data on this aggregated basis.

We find that units have reduced the percentage of their available capacity that they offer to the market. This is has led to an overall reduction in the amount of supply to the market, as shown in Figure 1. Although a low total supply to demand ratio does not necessarily signal that the market is not competitive or working properly, the change in this ratio is intriguing.

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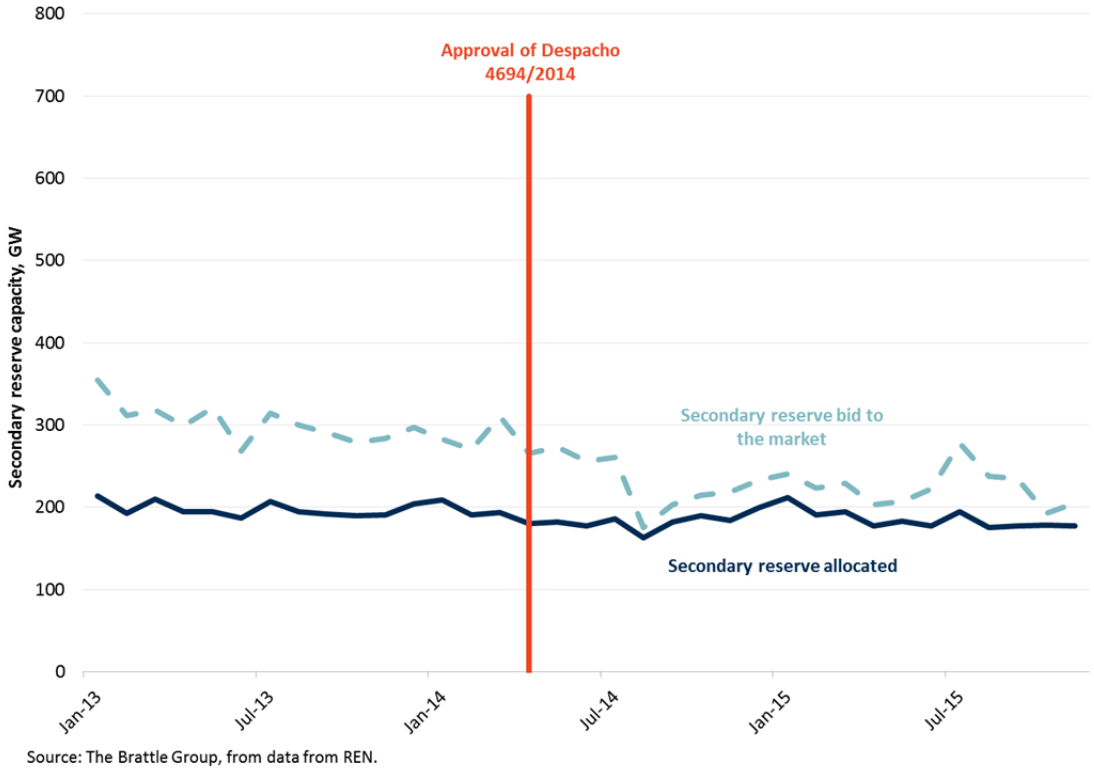
16 We have developed cost-reflective bids for all the units based on the methodology developed in our first report.

17 These types are: thermal units, hydro with and without CMEC.

Not only has it decreased from the values in previous years, it is also lower than the corresponding ratio in Spain.

Figure 1: Capacity offered to and allocated in the secondary reserve market

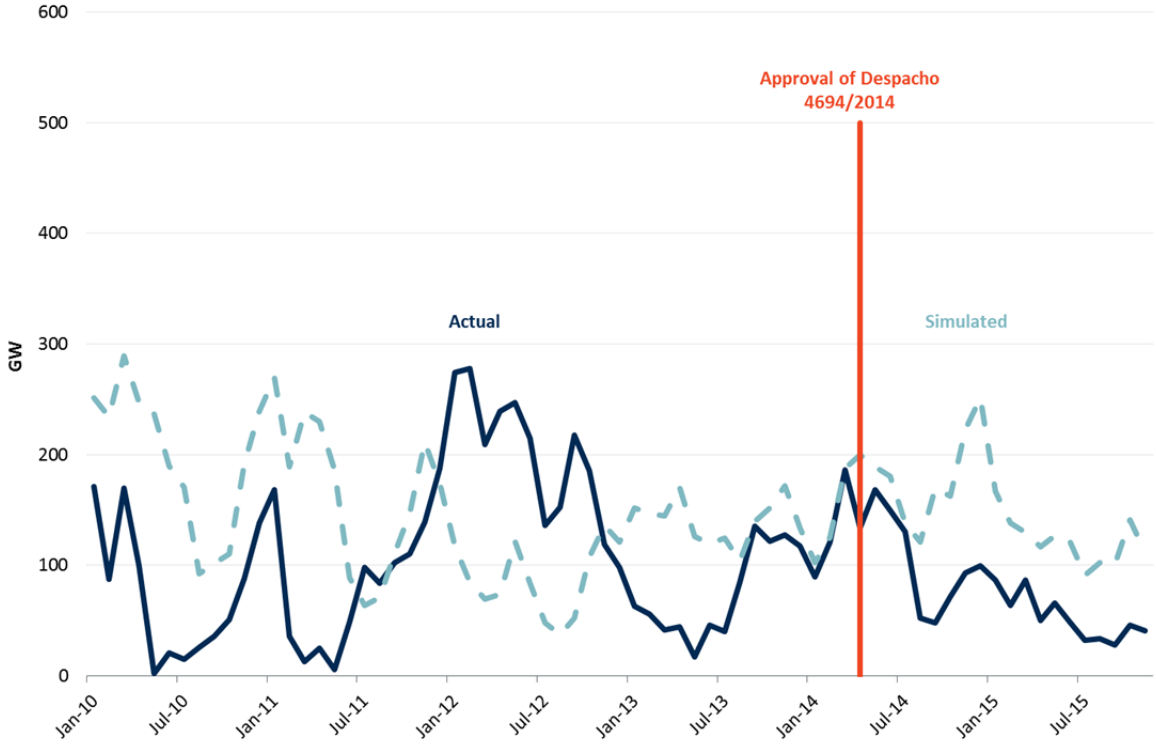


Source: The Brattle Group, from data from REN.

We also find that all types of units, and not only the units with CMEC, seem to bid into the secondary reserve market capacities that are lower than the capacity we estimate they have available to bid.[18] Figure 2 compares the estimated and actual quantities bid by hydro units with CMEC and show the divergent evolution of both series. Figure 3 and Figure 4 show the same comparison for thermal units and hydro units without CMEC.

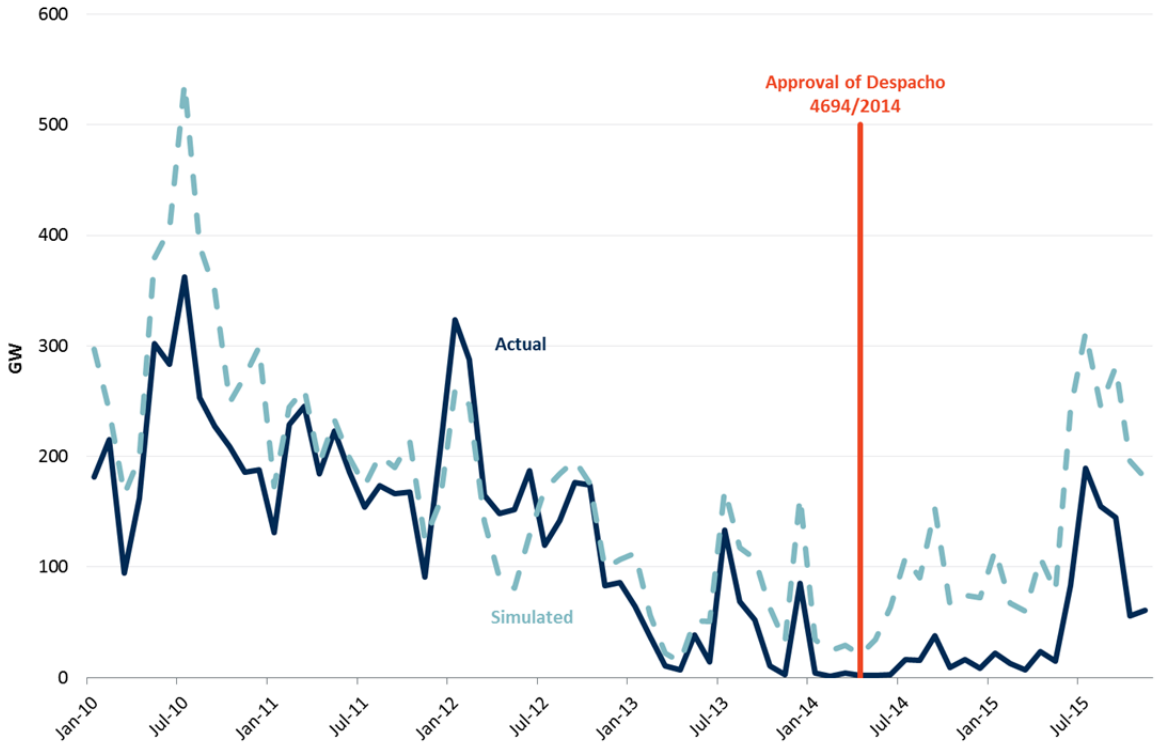
[18] This is not the case for the units of the Pego CCGT, but these units participation in the market is very low during entire period.

Figure 2: Secondary regulation reserve offered to the market by hydro units with CMEC



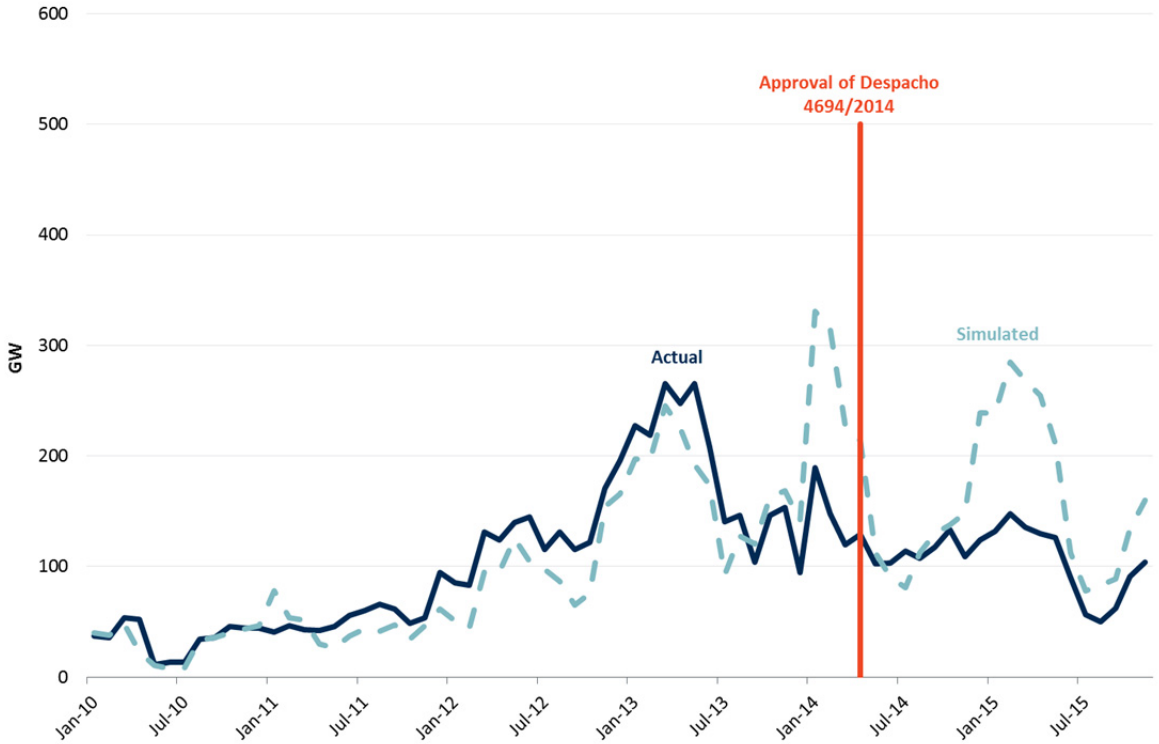
Source: The Brattle Group, using data from REN and own elaboration.

Figure 3: Secondary regulation reserve offered to the market by thermal units



Source: The Brattle Group, using data from REN and own elaboration.

Figure 4: Secondary regulation reserve offered to the market by hydro units without CMEC



Source: The Brattle Group, using data from REN and own elaboration.

IV.B. ASSESSMENT OF THE BID PRICES

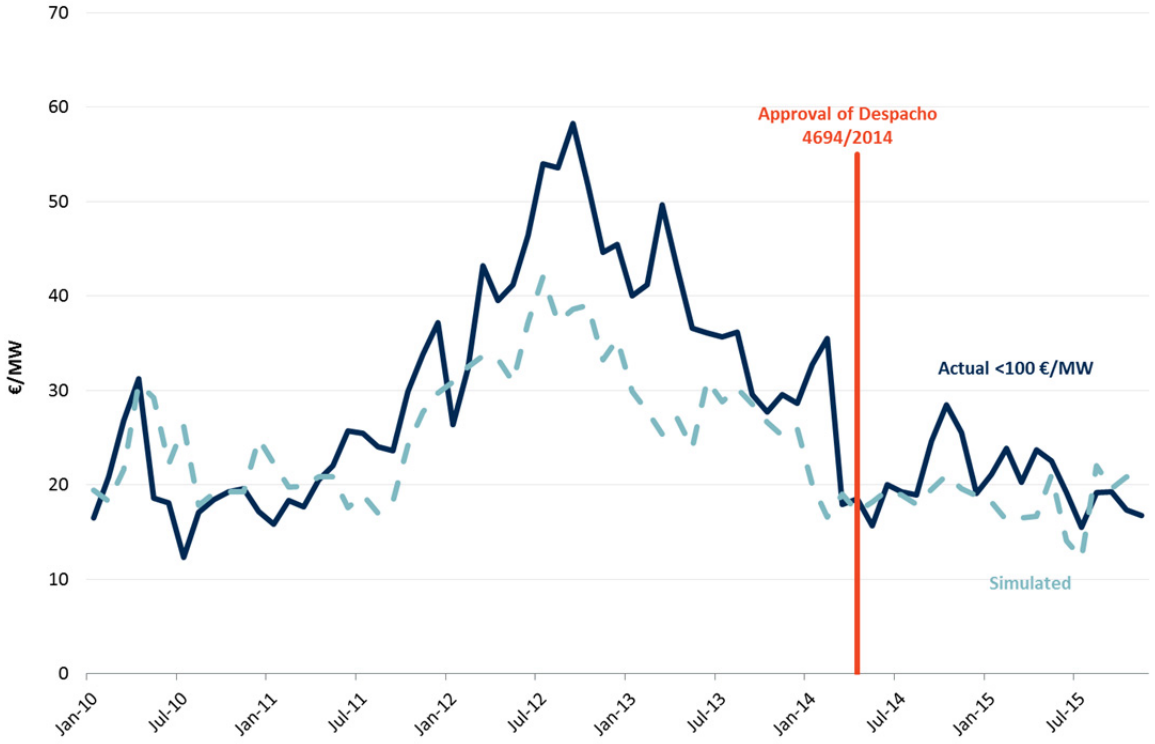
We have also estimated (again on an hourly basis and using the analytical framework from our First Report) what price every unit should have bid for the secondary reserve capacity they had available. We use these prices as a benchmark to assess the evolution of the units' actual bidding behaviour, rather than to identify precisely what they should have bid. We have calculated aggregate average monthly bids for different types of units,[19] excluding those bids over 100 €/MW[20] and compare the actual and simulated data on this aggregated basis.

We find that after the *Despacho* 4694/2014 the actual bids are more aligned to our estimates of cost-reflective bids for all type of units. In our First Report we had identify that units' bids had deviated significantly from our benchmarks, so the current convergence can be interpreted as a correction of previous distortions. The following figures compare the monthly averages of the actual bids and our simulated bids for and hydro units with CMEC (Figure 5), thermal units (Figure 6) and hydro units without CMEC (Figure 7).

[19] These types are: thermal units, hydro with and without CMEC.

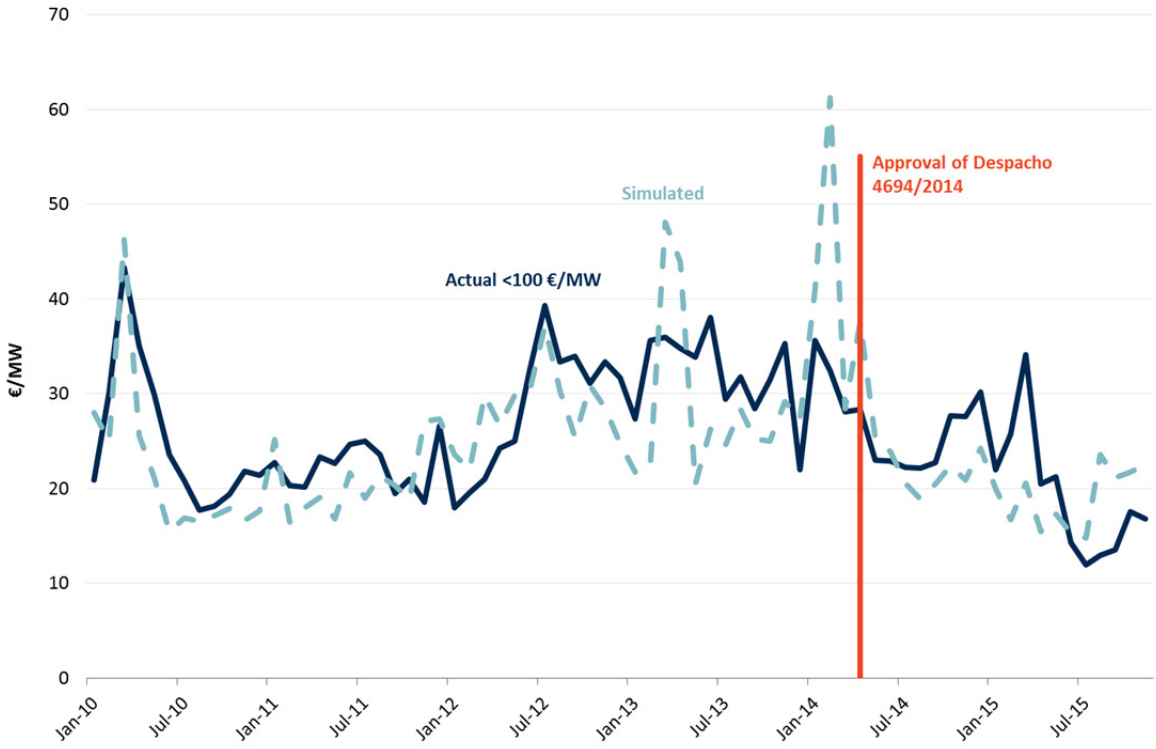
[20] In our First Report we filtered the bids over 100 €/MW. We have kept this filter for consistency.

Figure 5: Average bids to the secondary reserve market by hydro units without CMEC below 100 €/MW



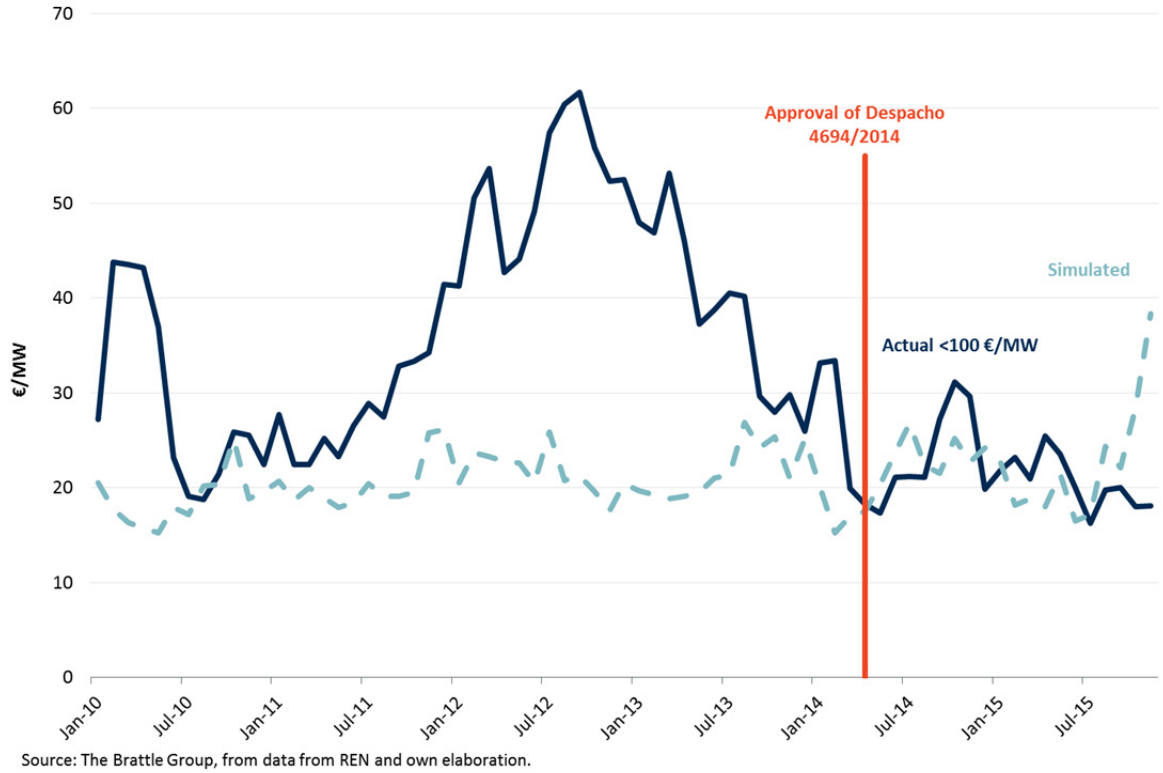
Source: The Brattle Group, from data from REN and own elaboration.

Figure 6: Average bids to the secondary reserve market by thermal units below 100 €/MW



Source: The Brattle Group, from data from REN and own elaboration.

Figure 7: Average bids to the secondary reserve market by hydro units with CMEC below 100 €/MW



Source: The Brattle Group, from data from REN and own elaboration.

IV.C. ASSESSMENT OF THE MARKET RESULTS

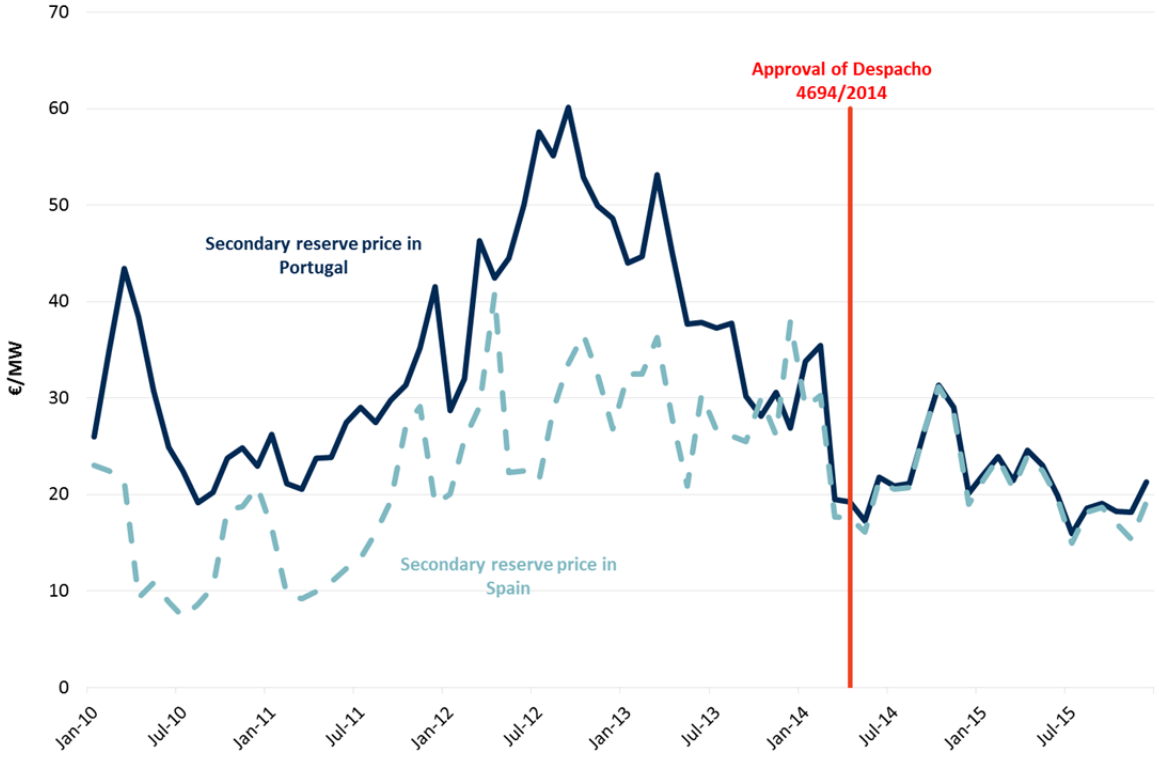
We have also assessed the effectiveness of the *Despacho* 4694/2014 by looking quantitatively at the evolution of the secondary reserve market outcomes before and after the measures were approved. We look at the secondary reserve market outcomes both in terms of prices and the amount of reserve allocated and assess whether this evolution is consistent with an efficient and well-functioning market.

IV.C.1. Evolution of the price

We have first looked at the evolution of the secondary reserve price in Portugal, especially compared to the price in Spain. One of the concerns we raised in our First Report was that the prices in the two countries had diverged. The *Despacho* 4694/2014 also assumes that there should be a close relationship between the two prices since it sets the price cap for Portugal based on the price in Spain.

It is unsurprising that after the passing of the *Despacho*, the reserve prices in both markets are almost identical. However, it is notable that this convergence was achieved before the *Despacho* was passed. This can be seen in Figure 8 which shows the evolution of both prices from 2010.

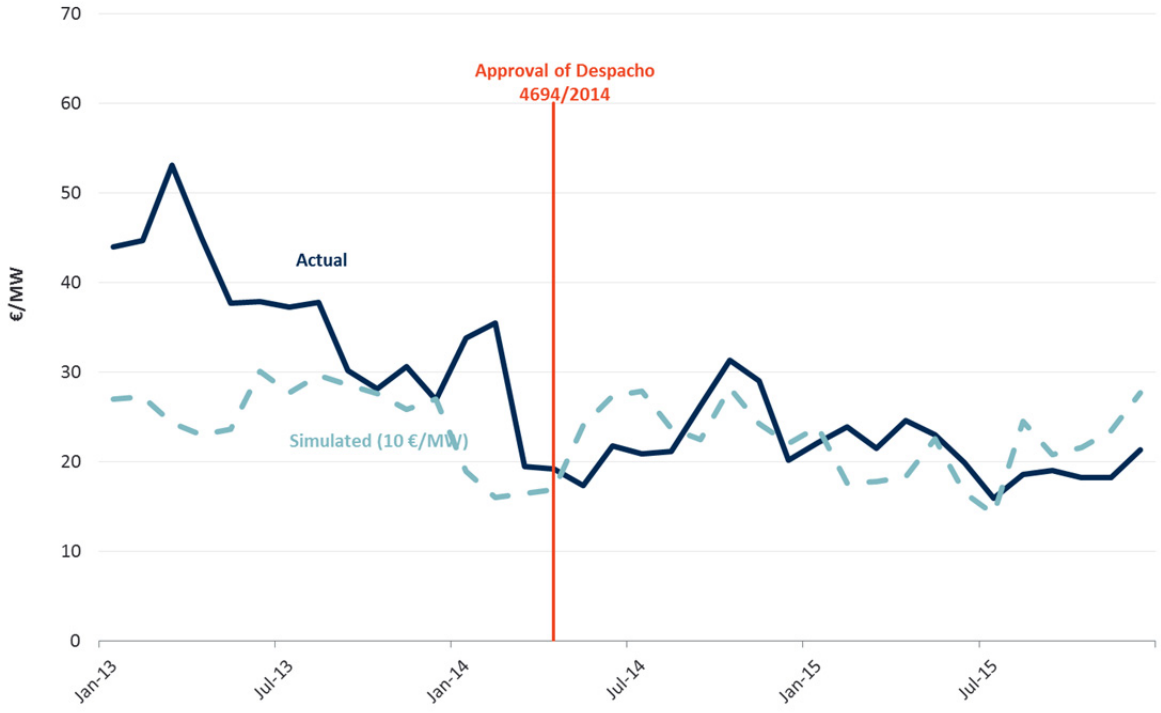
Figure 8: Secondary reserve prices in Portugal and Spain



Source: The Brattle Group, from data from REN and REE.

The actual secondary reserve price also converges to our base case estimates of the cost-reflective market price. Figure 9 compares the actual price with our estimation and how the difference between both has narrowed.

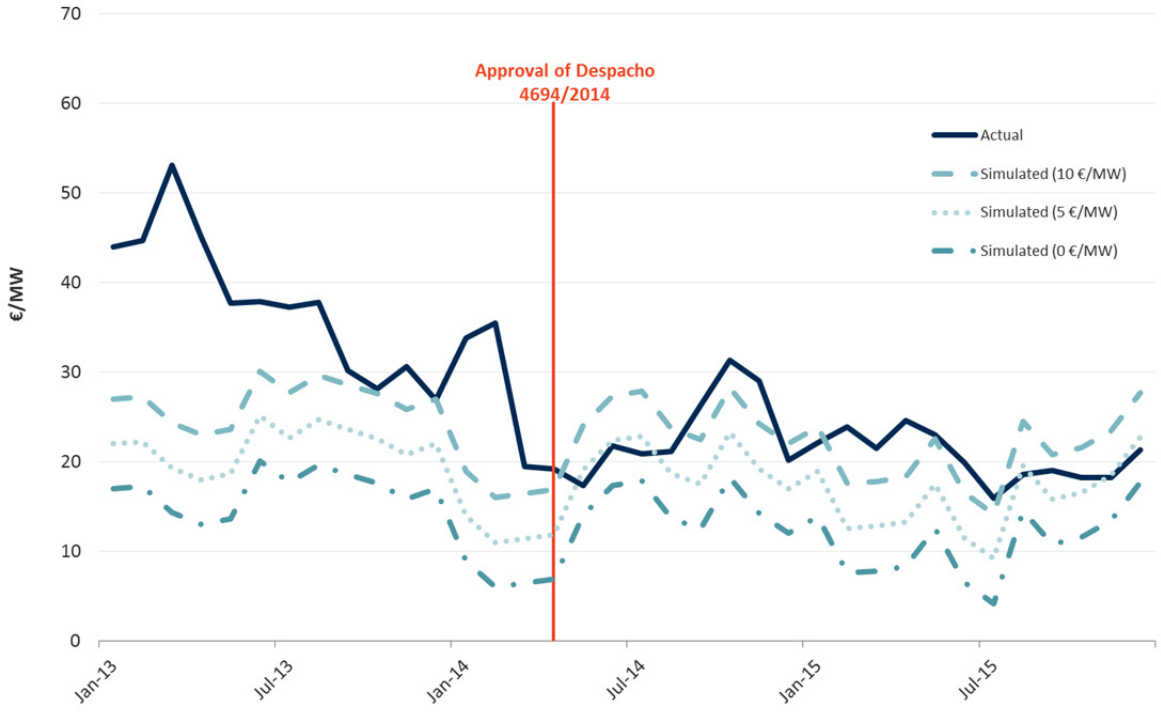
Figure 9: Simulated and actual monthly average price of secondary reserve



Source: The Brattle Group from data from REN and own elaboration.

Our estimates depend to some extent on the value assumed for different costs parameters, particularly the risk premium. Our base case included a risk premium of 10 €/MW, and it is these price estimates that are in line with the actual prices in both Portugal and Spain. If the Spanish price is a good proxy of the cost of providing reserve, then this suggests that our base case assumptions are in line with the true costs of providing reserve in Portugal. Figure 10 shows our estimation of the price for different values of the risk premium.

Figure 10: Simulated secondary reserve price, sensitivity to risk premium assumption



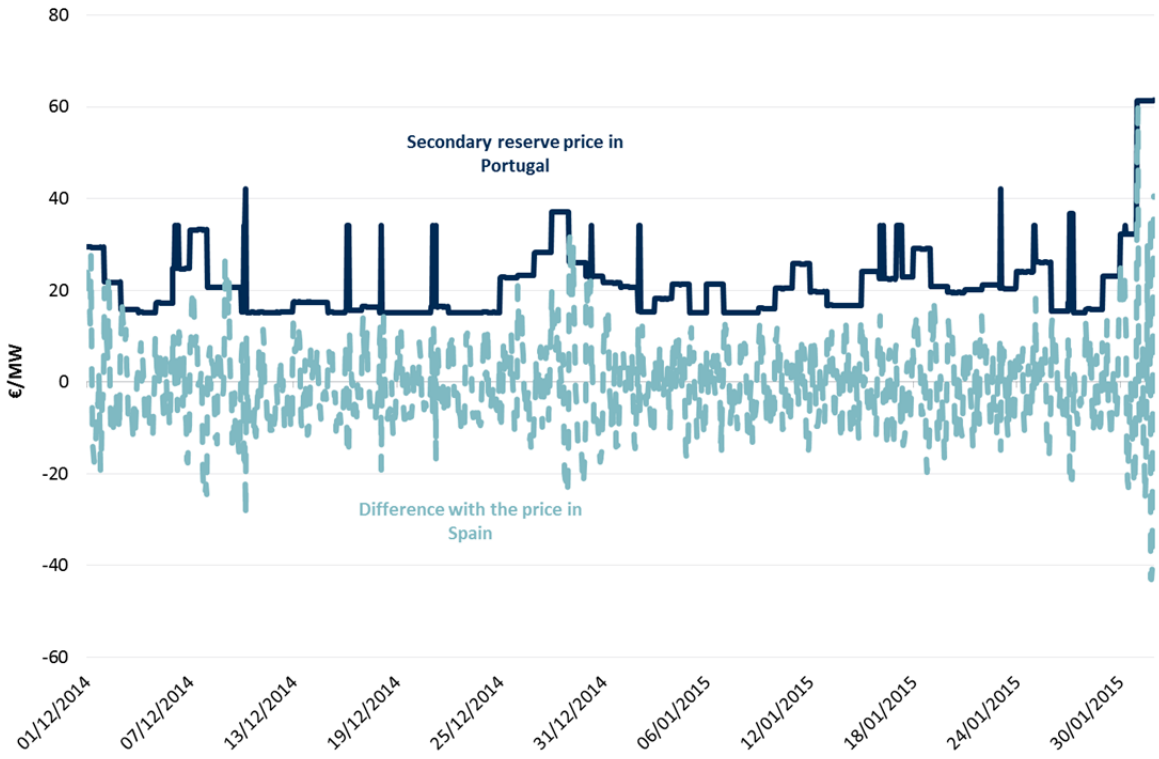
Source: The Brattle Group from data from REN and own elaboration.

Thus, the convergence of the reserve prices in Portugal with our benchmark and with the price in Spain support the idea that the price in Portugal is now reflecting the underlying costs of providing reserve and suggests that the *Despacho* has been successful in moderating reserve prices.

However, we find it intriguing that the Spanish and Portuguese prices converged before the imposition of the price cap. When we analyse hourly prices, we find an important difference in the volatility of the prices in the two markets. While the prices in Spain vary from hour to hour, hourly prices in Portugal are quite stable across each day and approximate to the average price in Spain. This suggests that prices in Portugal are not reflecting appropriately the hourly cost of the secondary reserve. Our conclusion is that the evolution of the market outcomes suggests that the market has become more efficient, but that this evolution does not necessarily mean that the market has become more competitive.

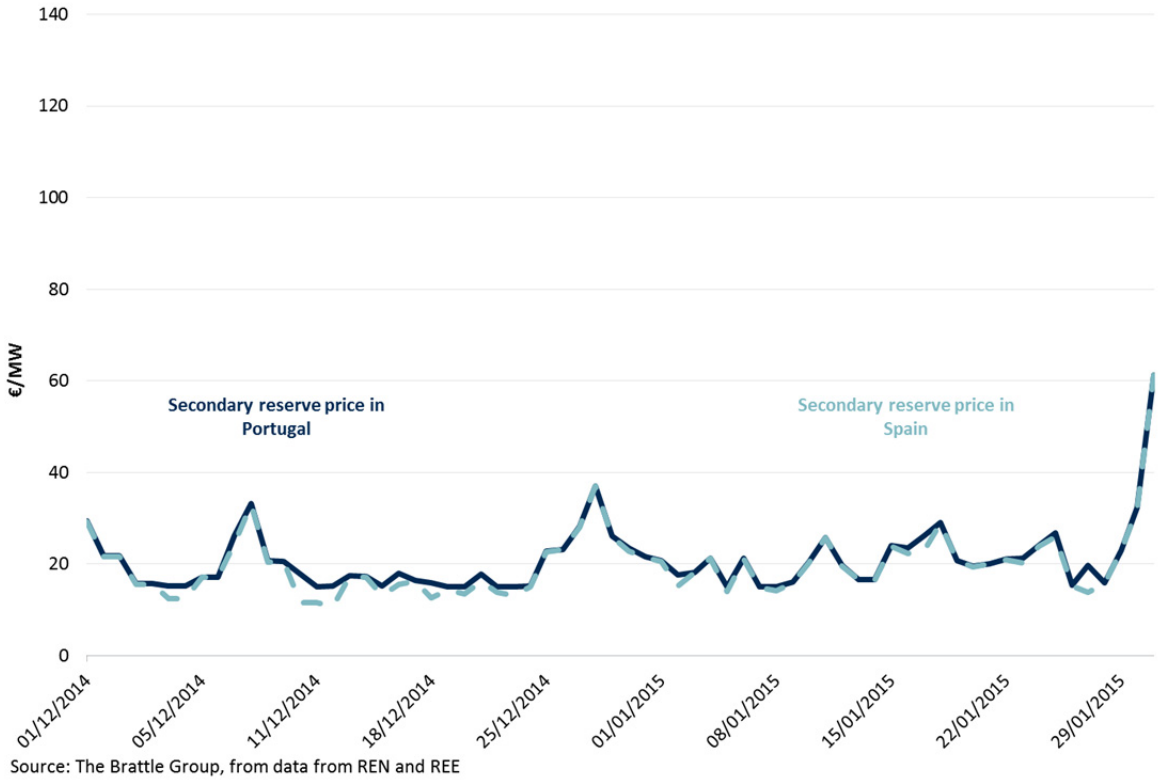
Figure 11 shows the discrepancies between both the hourly prices in Spain and Portugal during two months after the approval of *Despacho* 4694/2014 whilst Figure 12 shows compares the daily average prices in the two countries over the same period.

Figure 11: Sample of hourly prices in Portugal and Spain



Source: The Brattle Group, from data from REN and REE

Figure 12: Sample of average daily prices in Portugal and Spain



Source: The Brattle Group, from data from REN and REE

One possible explanation for the convergence of Spanish and Portuguese daily average prices from mid-2013 relates to the publication of the results investigations into the reserve market that occurred in 2013. ERSE published its *Analysis of the costs of the market for system services* in March 2013 and the AdC released its *Recommendations to the Government regarding the CMEC* in November 2013.[21,22] It is at least possible that the prices in the two markets converged as market agents responded to the findings of the study and the possibility that the market would be amended, as it subsequently was via the *Despacho* 4694/2014.

IV.C.1. Evolution of the quantities

We have also looked at the evolution of the amount of reserve allocated. The low participation of CMEC units in this market in the past was again a source of concern, and one explicit purpose of the *Despacho* 4694/2014 was to promote the participation of CMEC units in this market.[23]

During 2014 and 2015, there was a significant increase in the participation of CMEC units in the secondary reserve market. This increase does not reflect an increase in the nominal reserve capacity of CMEC units, since this increased only slightly in 2014.[24] Nor does it seem to reflect changes in the reserve capacity that was really available or its average cost, at least when we compare the changes to our estimates of the available reserve capacity per unit and the cost of this capacity. Therefore, the increase in the provision of reserve by CMEC units seems to be only related to how these units have been bid to the market. Figure 13 shows the allocation of secondary reserve between January 2010 and November 2015.

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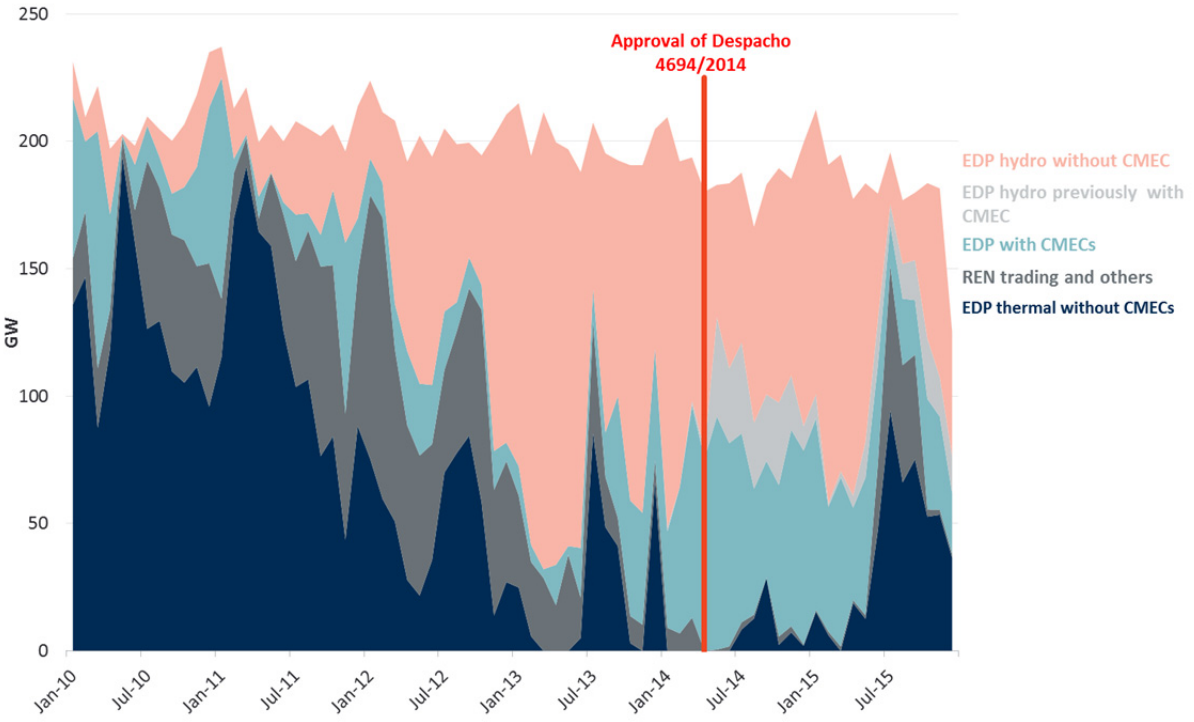
21 ERSE, "Análise de custos do Mercado de Serviços de Sistema 2010-2012", March 2013.

22 AdC, "Recomendação ao Governo, relativa ao regime de Auxílios de Estado denominado por Custos para a manutenção do Equilíbrio Contratual (CMEC)", November 2013.

23 *Despacho* 4694/2014, preamble: "criar mecanismos que incentivem uma participação mais ativa das centrais com CMEC no mercado da banda de regulação secundária"

24 In 2014 the CMEC for *Picote*, which had 90 MW came to an end. However, the *Aguieira* could again be considered a unit with the same incentive as other CMEC units, after the end of the contract between EDP and Iberdrola. The evolution of the reserve capacity of the different types of units can be consulted in **Error! Reference source not found.** in section **Error! Reference source not found.** in **Error! Reference source not found.**.

Figure 13: Monthly allocation of secondary reserve

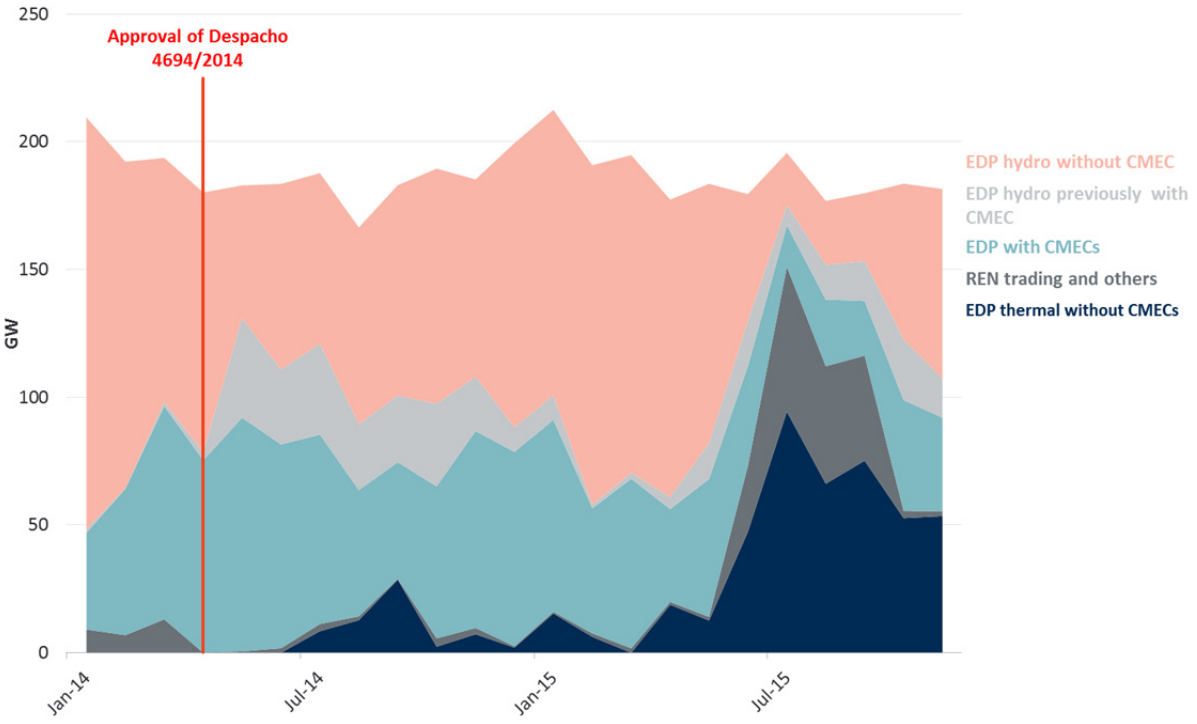


Source: The Brattle Group, using data from REN.

The actual allocation of secondary reserve per types of units is similar to our estimates of the allocation that would result from cost-reflective bids. Although there are some differences between the actual and the simulated allocations, these seem to derive from differences in the relative competitiveness of thermal units. .

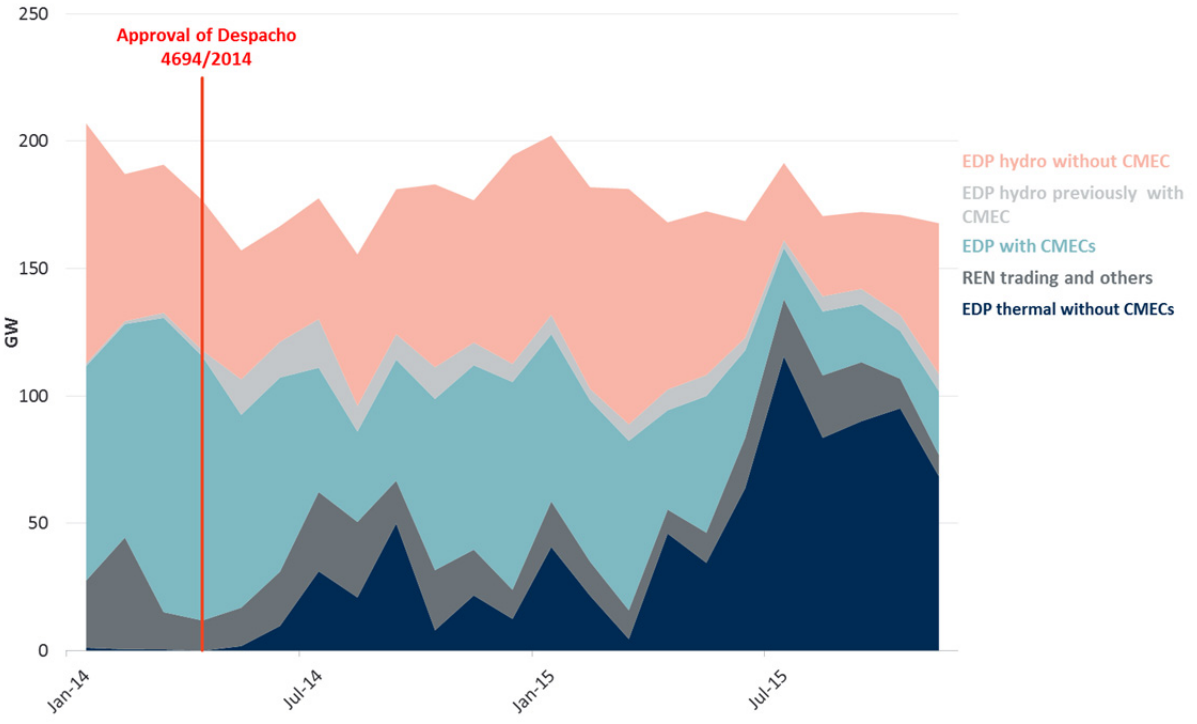
Figure 14 shows the actual allocation in 2014 and 2015, while Figure 15 shows the allocation according to our simulation.

Figure 14: Actual monthly allocation of secondary reserve



Source: The Brattle Group, using data from REN.

Figure 15: Simulated monthly allocation of secondary reserve



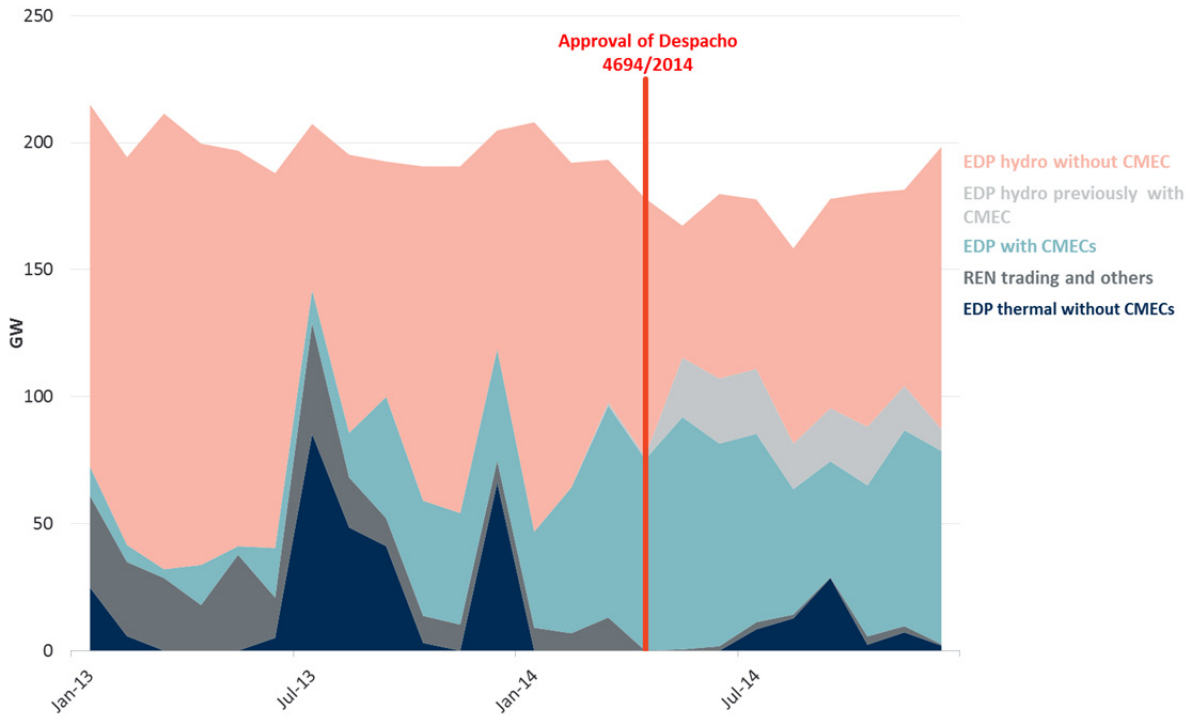
Source: The Brattle Group.

The increase in the provision of secondary reserve by CMEC units and the similarities between the actual allocations and our simulations suggest that the *Despacho* 4694/2014 has

been successful in increasing the participation of the CMEC units in the secondary reserve market.

Finally, as for the convergence of Spanish and Portuguese reserve prices, we observe that the increase in the provision of reserve by CMEC units started before approval of the *Despacho* 4694/2014. This would be also consistent with the hypothesis that the studies by ERSE and AdC had an impact on the behaviour of the market agents that precedes the *Despacho* 4694/2014. Figure 16 provides a close look of the evolution of the allocation of reserve around the approval of the *Despacho* 4694/2014.

Figure 16: Monthly allocation of secondary reserve in 2013 and 2014



Source: The Brattle Group, using data from REN.

V. Quantification of the Impact of *Despacho* 4694/2014

We have used our estimates of cost-reflective bids and hourly market outcomes to quantify the impact that the provisions of the *Despacho* 4694/2014 have had on the margins of the units providing secondary reserve. This quantification provides us also with an additional indicator of the effectiveness of the measures in the *Despacho* 4694/2014.

Consistent with our findings in previous sections, we estimate that the measures in *Despacho* 4694/2014 have removed any excess margin that the units may have made with respect to our

estimation of cost-reflective market outcomes. As we have already noted, our estimates depend to on the value assumed for different costs parameters, such as the risk premium. However, we think our base case assumptions are consistent with the approached followed by the *Despacho* 4694/2014 because our base case estimation of the cost-reflective price is in line with the price in Spain.

Following the methodology we proposed in our First Report, we calculate the potential over-compensation for secondary reserve by determining the difference between the actual margin a unit appears to have earned in the secondary reserve market and its margin under our cost-reflective scenario. Consequently, a positive impact implies that the units made a larger margin in the actual world than we estimate they would have made with cost-reflective bids. The margin is given by the difference between the revenue and the cost of a unit.

The margin that a unit makes can vary because of:

- Changes in the extent to which its reserve bids are accepted. We refer to this impact as "the quantity effect".
- Changes in the market clearing price. We refer to this impact as "the price effect".

The following subsections show our estimations of the potential over-compensation if we consider only the quantity effect on units' margins or the total effect. The total effect is the combination of the quantity and the price effect.

V.A. QUANTITY EFFECT

The quantity effect includes only the changes in the units' margins due to changes in the amount of secondary reserve provided. Both the margin in the actual world and the margin in our alternative scenario are calculated using the actual market price for the secondary reserve.

If we consider only the quantity effect, we estimate that the margin made by both EDP's CMEC and non-CMEC units would have been slightly higher, with cost-reflective bidding than what they actually were, both in 2014 and 2015. This result is independent from the value of risk premium assumed, because of the small changes in secondary reserve allocation in our simulation with respect to the reality.

Table 3 below summarizes the results for the quantity effect under three different values for the risk premium, whilst Appendix B presents a detailed set of results. A positive figure indicates that the margin would have been lower with cost-reflective bidding.

Table 3: Decrease in margins from cost-reflective bidding considering only the quantity effect, € million

Unit	2014	2015	Total
Risk premium 10 €/MW			
EDP with CMEC	-0.4	-0.5	-1.0
EDP without CMEC	0.1	-0.7	-0.6
Risk premium 5 €/MW			
EDP with CMEC	-0.4	-0.4	-0.8
EDP without CMEC	1.1	-1.3	-0.2
Risk premium 0 €/MW			
EDP with CMEC	-0.3	-0.3	-0.6
EDP without CMEC	2.0	-2.0	0.0

Source: The Brattle Group
Note: positive values indicate that the margins are higher with the actual bids than with cost-reflective bids.

V.B. Total Effect

The total effect includes the changes in the units' margins due to both changes in the amount and price of the secondary reserve provided, both the quantity and price effect. In this case, therefore, the margins in the actual world are calculated using the actual market price and the margins for our "cost-reflective" case are calculated using our estimation of the market price for the secondary reserve.

If we consider price effects as well as quantity effects, and under our base case assumptions, we estimate that the margins earned by EDP's non-CMEC units would have been around €1 million higher than with cost reflective bids, while it would have been around €1 million lower for EDP's units with CMEC. This small differences are justified because we estimate that the cost-reflective secondary reserve price and allocation would have been roughly the same than in the actual world, so the impact of the actual bids on units' margins have been very small.

The impacts considering the total effect are, however, more sensitive to the risk premium assumption. The reason is that, while the margin in the actual world changes with this assumption on costs, the margin in the cost-reflective scenario is always the same because the price moves with the costs. If we do not include a risk premium, we estimated that EDP's non-CMEC would have had a margin a €26 million higher, while the figure for EDP's CMEC units is €10 million.

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Table 4 below summarizes the results for the quantity effect under three different values for the margin/risk premium, whilst Appendix B presents a detailed set of results.

Table 4: Decrease in margins from cost-reflective bidding considering both the price and quantity effects, € million

Unit	2014	2015	Total
Risk premium 10 €/MW			
EDP with CMEC	-1.0	-0.1	-1.1
EDP without CMEC	1.0	-0.1	0.9
Risk premium 5 €/MW			
EDP with CMEC	2.1	2.4	4.5
EDP without CMEC	6.0	7.6	13.6
Risk premium 0 €/MW			
EDP with CMEC	5.2	4.8	10.1
EDP without CMEC	11.1	15.3	26.3

Source: The Brattle Group
Note: positive values indicate that the margins are higher with the actual bids than with cost-reflective bids.

VI. Recommendations regarding the Measures of the *Despacho* 4694/2014

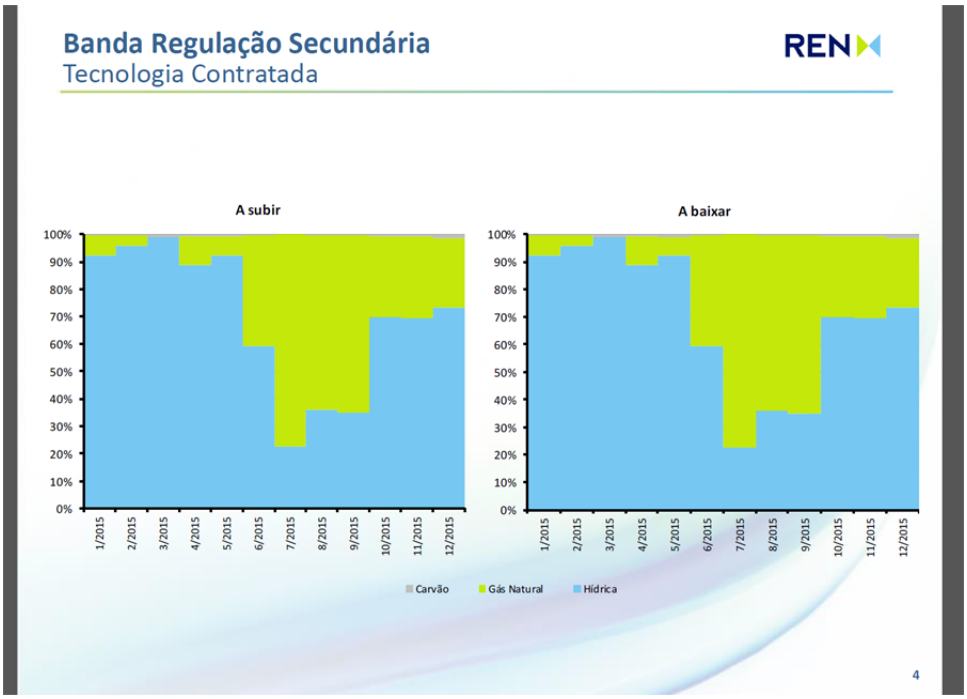
We have identified potential adjustments to the control measures introduced by the *Despacho* 4694/2014 that should improve the efficiency of these provisions. We recommend:

- Considering replacing electricity production with another proxy of a unit's ability to provide secondary reserve that takes into account other relevant factors. This could, for example, be done via market simulations similar to those used for the CMEC adjustment which could continue to be used to monitor the market after the end of the CMEC. However, specifying and calibrating a model with the relevant capabilities (be it VALORAGUA or some new model) would be a complex task.

- Implement an ex-ante control of bids to the market, based on guidelines on both the quantity and price that agents are expected to bid, rather than an ex-post control of the average price.
- Limit the control of bids and prices to those agents regarded as dominant in the market, rather than to all the agents. This will avoid discouraging the entry of new providers of secondary reserve.
- If a price cap is retained, adjust its linkage to the secondary reserve market price in Spain to take into account the difference in the market design in both countries. Again, this could be achieved using market simulations.

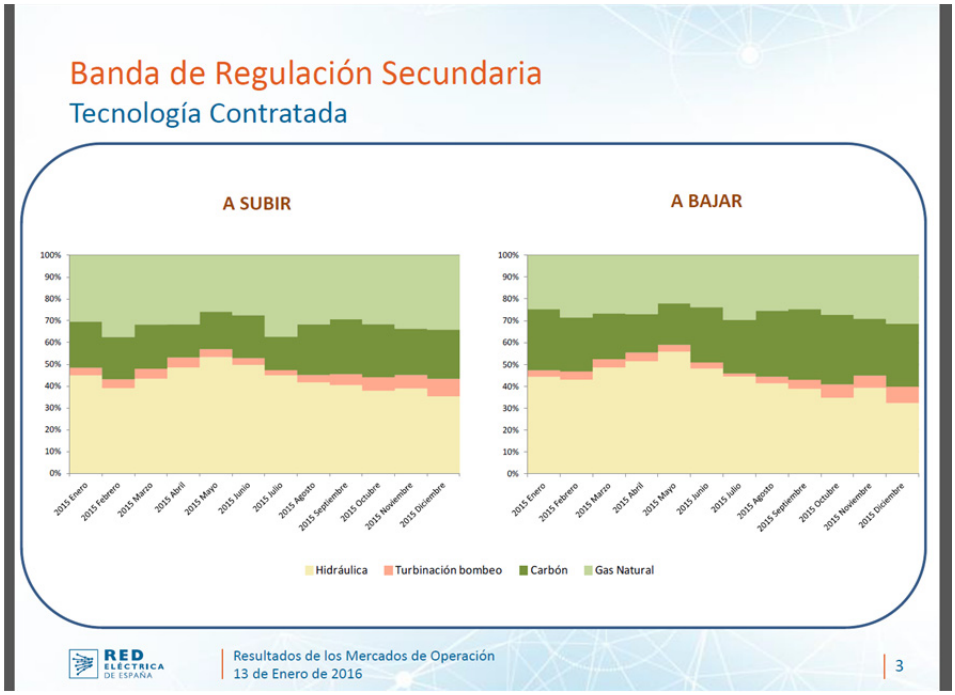
Appendix A. Contracted Regulation Reserve by Technology in Portugal and Spain

Figure 17: Contracted Regulation Reserve by Technology in Portugal



Source: Provided by the Monitoring Committee, original sources REN, TSOSEI

Figure 18: Contracted Regulation Reserve by Technology in Spain



Source: Provided by the Monitoring Committee, original sources REE, TSOSEI

Appendix B. Estimated margins and impacts

This section provides an overview of the detailed results that justify our estimation of the quantification of the potential over-compensation presented in section VI. The Excel files accompanying this report provide additional results, such as the cost structure of regulation service by unit that, due to their extension, cannot be presented in the report.

B.I. ESTIMATED OVER-COMPENSATION

Table 5: Estimated impact on units' margins. Quantitity effect.

	Total margin		Margin on capacity		Margin on energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	-0.1	-0.1	-0.1	-0.1	0.0	0.0
Alto Lindoso	0.0	0.1	0.1	-0.1	-0.1	0.2
Cabril	-0.1	-0.1	-0.1	-0.1	0.0	0.0
Castelo Bode	0.0	-0.1	-0.1	-0.1	0.1	0.0
Pocinho	0.1	0.2	0.0	0.1	0.1	0.1
Regua	0.0	0.0	-0.1	-0.1	0.2	0.2
Torrao	-0.1	-0.1	-0.1	0.0	0.0	0.0
V.Nova II(Frades)	0.1	-0.1	0.0	-0.2	0.1	0.1
Valeira	-0.3	-0.3	-0.5	-0.5	0.1	0.2
EDP with CMEC	**-0.4**	**-0.5**	**-1.0**	**-1.1**	**0.6**	**0.6**
Bemposta	0.0	-0.2	0.0	-0.1	0.0	-0.1
Miranda	0.1	-0.2	0.0	-0.1	0.1	0.0
Miranda II	0.0	0.0	0.0	0.0	0.0	0.0
Picote	0.3	-0.1	-0.1	-0.3	0.4	0.2
Alqueva	0.0	-0.2	-0.2	-0.2	0.1	0.0
Alqueva II	0.3	0.1	0.0	-0.2	0.3	0.2
Bemposta II	0.1	-0.1	-0.5	-0.9	0.6	0.9
Picote II	-0.5	-0.4	-0.7	-0.9	0.2	0.5
CC. Ribatejo 1	0.0	0.0	0.0	-0.1	0.0	0.2
CC. Ribatejo 2	-0.1	0.0	-0.1	0.0	0.0	0.0
CC. Ribatejo 3	0.0	0.0	0.0	0.0	0.0	0.0
CC. Lares 1	0.0	0.0	0.0	-0.3	0.0	0.3
CC. Lares 2	-0.1	0.2	-0.1	-0.1	0.1	0.4
EDP without CMEC	**0.1**	**-0.7**	**-1.7**	**-3.3**	**1.8**	**2.5**
Pego coal 1	-0.4	-0.3	0.0	0.0	-0.4	-0.3
Pego coal 2	-0.4	-0.3	0.1	0.0	-0.5	-0.4
REN Trading	**-0.8**	**-0.7**	**0.1**	**0.1**	**-0.9**	**-0.7**
CC. Pego. G3	0.0	-0.4	0.0	-1.0	0.0	0.7
CC. Pego. G4	0.0	0.0	0.0	-0.1	0.0	0.1
Others	**0.0**	**-0.4**	**0.0**	**-1.2**	**0.0**	**0.8**
Total	**-1.1**	**-2.3**	**-2.6**	**-5.5**	**1.5**	**3.2**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

Table 6: Estimated impact on units' margins. Total effect.

	Total margin		Margin on capacity		Margin on energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.0	0.0	0.0	0.0	0.0	0.0
Alto Lindoso	0.3	0.2	0.3	0.0	-0.1	0.2
Cabril	-0.4	0.0	-0.4	0.0	0.0	0.0
Castelo Bode	-0.2	-0.1	-0.4	0.0	0.1	0.0
Pocinho	0.0	0.3	-0.1	0.2	0.1	0.1
Regua	-0.2	-0.1	-0.3	-0.2	0.2	0.2
Torrao	-0.1	0.0	-0.1	0.0	0.0	0.0
V.Nova II(Frades)	0.1	0.0	0.0	-0.1	0.1	0.1
Valeira	-0.5	-0.3	-0.7	-0.5	0.1	0.2
EDP with CMEC	**-1.0**	**-0.1**	**-1.6**	**-0.7**	**0.6**	**0.6**
Bemposta	-0.1	-0.1	-0.1	0.0	0.0	-0.1
Miranda	0.1	-0.2	0.0	-0.1	0.1	0.0
Miranda II	0.0	0.0	0.0	0.0	0.0	0.0
Picote	0.1	-0.2	-0.3	-0.4	0.4	0.2
Alqueva	0.2	0.1	0.0	0.1	0.1	0.0
Alqueva II	0.7	0.6	0.4	0.4	0.3	0.2
Bemposta II	0.1	-0.1	-0.5	-1.0	0.6	0.9
Picote II	-0.1	0.2	-0.4	-0.3	0.2	0.5
CC. Ribatejo 1	0.0	-0.3	0.0	-0.5	0.0	0.2
CC. Ribatejo 2	0.0	0.0	0.0	0.0	0.0	0.0
CC. Ribatejo 3	0.0	0.0	0.0	-0.1	0.0	0.0
CC. Lares 1	0.0	0.2	0.0	-0.1	0.0	0.3
CC. Lares 2	0.1	-0.3	0.0	-0.7	0.1	0.4
EDP without CMEC	**1.0**	**-0.1**	**-0.9**	**-2.6**	**1.8**	**2.5**
Pego coal 1	-1.0	-0.7	-0.6	-0.4	-0.4	-0.3
Pego coal 2	-1.0	-0.8	-0.6	-0.4	-0.5	-0.4
REN Trading	**-2.1**	**-1.5**	**-1.2**	**-0.8**	**-0.9**	**-0.7**
CC. Pego. G3	0.0	-0.4	0.0	-1.1	0.0	0.7
CC. Pego. G4	0.0	0.0	0.0	-0.1	0.0	0.1
Others	**0.0**	**-0.4**	**0.0**	**-1.2**	**0.0**	**0.8**
Total	**-2.1**	**-2.0**	**-3.6**	**-5.3**	**1.5**	**3.2**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

B.II. ESTIMATION OF ACTUAL RESULTS

Table 7: Estimated units' margins with actual market results (from 1st April 2014)

	Total margin		Margin on capacity		Margin on energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.0	0.0	0.0	0.0	0.0	0.0
Alto Lindoso	0.3	0.0	0.1	-0.1	0.1	0.0
Cabril	0.0	0.0	-0.1	0.0	0.1	0.0
Castelo Bode	0.0	0.0	-0.2	0.0	0.2	0.0
Pocinho	0.1	0.3	0.0	0.1	0.1	0.2
Regua	0.1	0.1	-0.1	-0.2	0.2	0.2
Torrao	0.0	0.0	0.0	0.0	0.0	0.0
V.Nova II(Frades)	0.3	0.0	0.1	-0.1	0.2	0.1
Valeira	-0.4	-0.2	-0.6	-0.5	0.2	0.3
EDP with CMEC	**0.4**	**0.2**	**-0.8**	**-0.7**	**1.2**	**0.9**
Bemposta	0.0	0.0	-0.1	0.0	0.0	0.0
Miranda	0.1	-0.1	0.0	-0.2	0.1	0.0
Miranda II	0.0	0.0	0.0	0.0	0.0	0.0
Picote	0.8	0.2	0.1	-0.2	0.6	0.4
Alqueva	0.5	0.3	0.2	0.1	0.3	0.1
Alqueva II	1.1	0.8	0.7	0.5	0.3	0.3
Bemposta II	0.7	0.3	-0.1	-0.8	0.7	1.0
Picote II	0.2	0.3	-0.2	-0.5	0.4	0.7
CC. Ribatejo 1	0.0	0.1	0.0	-0.2	0.0	0.3
CC. Ribatejo 2	0.1	0.0	0.0	0.0	0.1	0.0
CC. Ribatejo 3	0.0	0.0	0.0	-0.1	0.0	0.1
CC. Lares 1	0.0	0.3	0.0	-0.2	0.0	0.6
CC. Lares 2	0.3	0.2	0.1	-0.5	0.1	0.7
EDP without CMEC	**3.6**	**2.3**	**0.8**	**-2.0**	**2.8**	**4.3**
Pego coal 1	0.1	0.1	0.1	0.0	0.0	0.0
Pego coal 2	0.1	0.2	0.1	0.1	0.0	0.0
REN Trading	**0.2**	**0.2**	**0.2**	**0.2**	**0.1**	**0.1**
CC. Pego. G3	0.0	-0.3	0.0	-1.1	0.0	0.8
CC. Pego. G4	0.0	0.0	0.0	-0.1	0.0	0.1
Others	**0.0**	**-0.3**	**0.0**	**-1.2**	**0.0**	**0.9**
Total	**4.2**	**2.4**	**0.2**	**-3.7**	**4.1**	**6.1**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

Table 8: Estimated units' revenues with actual market results (from 1st April 2014)

	Total revenue		Revenue on capacity		Revenue on energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.4	0.1	0.2	0.1	0.1	0.0
Alto Lindoso	1.1	0.5	0.7	0.3	0.4	0.2
Cabril	1.3	0.0	0.7	0.0	0.6	0.0
Castelo Bode	2.4	0.3	1.7	0.2	0.7	0.1
Pocinho	3.4	3.7	2.4	2.5	1.0	1.2
Regua	4.6	3.8	3.1	2.5	1.4	1.3
Torrao	0.0	0.0	0.0	0.0	0.0	0.0
V.Nova II(Frades)	2.3	1.4	1.5	0.9	0.8	0.5
Valeira	5.5	6.4	3.8	4.3	1.7	2.1
EDP with CMEC	**21.0**	**16.2**	**14.3**	**10.8**	**6.8**	**5.5**
Bemposta	0.5	0.2	0.3	0.1	0.2	0.1
Miranda	1.5	0.4	1.0	0.3	0.5	0.1
Miranda II	0.0	0.0	0.0	0.0	0.0	0.0
Picote	5.7	4.2	3.8	2.7	1.8	1.5
Alqueva	3.5	1.6	2.4	1.1	1.1	0.5
Alqueva II	6.1	4.8	4.1	3.3	2.0	1.5
Bemposta II	11.1	14.7	7.5	9.7	3.7	5.1
Picote II	3.7	8.0	2.5	5.2	1.2	2.8
CC. Ribatejo 1	0.0	2.0	0.0	1.2	0.0	0.8
CC. Ribatejo 2	0.4	0.2	0.3	0.1	0.2	0.1
CC. Ribatejo 3	0.1	0.4	0.0	0.3	0.0	0.2
CC. Lares 1	0.1	4.8	0.0	3.0	0.0	1.8
CC. Lares 2	1.3	6.0	0.9	3.6	0.4	2.4
EDP without CMEC	**34.0**	**47.3**	**22.9**	**30.7**	**11.1**	**16.6**
Pego coal 1	0.3	0.2	0.2	0.1	0.1	0.0
Pego coal 2	0.3	0.4	0.2	0.3	0.1	0.1
REN Trading	**0.5**	**0.5**	**0.4**	**0.4**	**0.1**	**0.1**
CC. Pego. G3	0.0	4.4	0.0	2.3	0.0	2.1
CC. Pego. G4	0.0	0.9	0.0	0.5	0.0	0.4
Others	**0.0**	**5.3**	**0.0**	**2.8**	**0.0**	**2.5**
Total	**55.6**	**69.4**	**37.5**	**44.6**	**18.0**	**24.7**

Source: The Brattle Group.

Table 9: Estimated units' costs with actual market results (from 1st April 2014)

	Total costs		Costs of capacity		Costs of energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.3	0.1	0.2	0.1	0.1	0.0
Alto Lindoso	0.9	0.5	0.6	0.4	0.3	0.2
Cabril	1.3	0.0	0.9	0.0	0.5	0.0
Castelo Bode	2.4	0.3	1.9	0.2	0.6	0.1
Pocinho	3.3	3.4	2.4	2.3	0.9	1.0
Regua	4.4	3.7	3.2	2.7	1.2	1.1
Torrao	0.0	0.0	0.0	0.0	0.0	0.0
V.Nova II(Frades)	2.0	1.5	1.4	1.0	0.6	0.4
Valeira	5.9	6.6	4.4	4.8	1.5	1.8
EDP with CMEC	**20.7**	**16.1**	**15.1**	**11.5**	**5.6**	**4.6**
Bemposta	0.5	0.2	0.4	0.1	0.1	0.1
Miranda	1.4	0.5	1.0	0.4	0.4	0.1
Miranda II	0.0	0.0	0.0	0.0	0.0	0.0
Picote	4.9	4.0	3.7	2.9	1.2	1.1
Alqueva	3.0	1.3	2.2	1.0	0.8	0.3
Alqueva II	5.0	4.0	3.4	2.8	1.6	1.2
Bemposta II	10.5	14.5	7.5	10.4	2.9	4.0
Picote II	3.5	7.7	2.7	5.7	0.8	2.0
CC. Ribatejo 1	0.0	1.9	0.0	1.4	0.0	0.5
CC. Ribatejo 2	0.4	0.2	0.3	0.1	0.1	0.0
CC. Ribatejo 3	0.1	0.4	0.0	0.3	0.0	0.1
CC. Lares 1	0.1	4.5	0.0	3.2	0.0	1.3
CC. Lares 2	1.1	5.8	0.8	4.1	0.2	1.6
EDP without CMEC	**30.4**	**45.0**	**22.0**	**32.6**	**8.4**	**12.4**
Pego coal 1	0.2	0.1	0.1	0.1	0.0	0.0
Pego coal 2	0.2	0.2	0.1	0.2	0.0	0.0
REN Trading	**0.3**	**0.3**	**0.2**	**0.2**	**0.1**	**0.1**
CC. Pego. G3	0.0	4.7	0.0	3.4	0.0	1.3
CC. Pego. G4	0.0	0.9	0.0	0.6	0.0	0.3
Others	**0.0**	**5.6**	**0.0**	**4.0**	**0.0**	**1.6**
Total	**51.4**	**66.9**	**37.1**	**48.1**	**13.9**	**18.5**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

Table 10: Actual capacity allocated and estimated energy allocation (from 1st April 2014)

	Secondary reserve capacity		Net secondary reserve energy	
Unit	2014 GW	2015 GW	2014 GWh	2015 GWh
Aguieira	13	3	2	0
Alto Lindoso	35	16	6	3
Cabril	38	0	9	0
Castelo Bode	76	8	12	1
Pocinho	102	115	15	19
Regua	128	110	22	21
Torrao	1	0	0	0
V.Nova II(Frades)	69	43	12	8
Valeira	161	195	26	35
EDP with CMEC	**622**	**490**	**105**	**87**
Bemposta	16	5	3	1
Miranda	42	11	7	2
Miranda II	0	0	0	0
Picote	162	131	26	22
Alqueva	105	49	15	6
Alqueva II	166	149	25	21
Bemposta II	331	456	53	77
Picote II	126	248	18	43
CC. Ribatejo 1	0	72	0	8
CC. Ribatejo 2	13	6	2	1
CC. Ribatejo 3	2	14	0	2
CC. Lares 1	2	173	1	22
CC. Lares 2	43	222	4	29
EDP without CMEC	**1,010**	**1,535**	**154**	**232**
Pego coal 1	6	3	1	0
Pego coal 2	7	8	1	1
REN Trading	**13**	**11**	**2**	**2**
CC. Pego. G3	0	141	0	27
CC. Pego. G4	0	28	0	5
Others	**0**	**169**	**0**	**32**
Total	**1,645**	**2,194**	**261**	**353**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

B.III. ESTIMATION OF ALTERNATIVE RESULTS (QUANTITY EFFECT)

Table 11: Estimated units' margins (quantity effect, from 1st April 2014)

	Total margin		Margin on capacity		Margin on energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.1	0.1	0.1	0.1	0.0	0.0
Alto Lindoso	0.3	-0.1	0.1	0.1	0.2	-0.2
Cabril	0.1	0.1	0.0	0.1	0.1	0.0
Castelo Bode	0.0	0.1	-0.1	0.0	0.1	0.0
Pocinho	0.1	0.1	0.0	0.0	0.0	0.1
Regua	0.1	0.0	0.0	0.0	0.1	0.1
Torrao	0.1	0.1	0.1	0.0	0.0	0.0
V.Nova II(Frades)	0.2	0.1	0.1	0.1	0.1	0.0
Valeira	-0.1	0.1	-0.1	0.0	0.1	0.1
EDP with CMEC	**0.8**	**0.7**	**0.2**	**0.4**	**0.7**	**0.3**
Bemposta	0.0	0.2	0.0	0.1	0.0	0.1
Miranda	0.0	0.0	0.0	0.0	0.0	0.0
Miranda II	0.0	0.0	0.0	0.0	0.0	0.0
Picote	0.4	0.3	0.2	0.1	0.2	0.2
Alqueva	0.5	0.4	0.4	0.3	0.1	0.1
Alqueva II	0.8	0.7	0.7	0.7	0.1	0.1
Bemposta II	0.5	0.3	0.4	0.2	0.1	0.2
Picote II	0.6	0.7	0.4	0.4	0.2	0.3
CC. Ribatejo 1	0.0	0.1	0.0	-0.1	0.0	0.1
CC. Ribatejo 2	0.2	0.0	0.1	0.0	0.1	0.0
CC. Ribatejo 3	0.0	0.0	0.0	0.0	0.0	0.0
CC. Lares 1	0.0	0.3	0.0	0.1	0.0	0.3
CC. Lares 2	0.4	0.0	0.3	-0.4	0.1	0.4
EDP without CMEC	**3.5**	**3.0**	**2.5**	**1.3**	**1.0**	**1.7**
Pego coal 1	0.5	0.4	0.1	0.0	0.5	0.4
Pego coal 2	0.5	0.5	0.0	0.1	0.5	0.4
REN Trading	**1.0**	**0.9**	**0.0**	**0.1**	**1.0**	**0.8**
CC. Pego. G3	0.0	0.1	0.0	0.0	0.0	0.1
CC. Pego. G4	0.0	0.0	0.0	0.0	0.0	0.0
Others	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.1**
Total	**5.3**	**4.7**	**2.8**	**1.8**	**2.6**	**2.9**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

Table 12: Estimated units' revenues (quantity effect, from 1st April 2014)

	Total revenue		Revenue on capacity		Revenue on energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.8	0.8	0.5	0.5	0.3	0.3
Alto Lindoso	2.9	1.3	1.7	0.7	1.2	0.6
Cabril	2.1	1.2	1.3	0.7	0.8	0.4
Castelo Bode	2.9	1.2	1.9	0.7	1.0	0.5
Pocinho	1.6	2.3	1.1	1.5	0.5	0.9
Regua	3.4	1.8	2.3	1.1	1.1	0.7
Torrao	0.8	0.9	0.5	0.6	0.3	0.4
V.Nova II(Frades)	2.1	1.6	1.4	1.0	0.7	0.6
Valeira	4.5	4.9	3.0	3.2	1.5	1.7
EDP with CMEC	**21.2**	**16.0**	**13.8**	**9.9**	**7.5**	**6.1**
Bemposta	0.5	1.5	0.3	0.9	0.2	0.5
Miranda	0.8	0.9	0.5	0.6	0.3	0.3
Miranda II	0.0	0.1	0.0	0.1	0.0	0.0
Picote	3.6	2.7	2.4	1.8	1.2	1.0
Alqueva	3.6	2.9	2.3	1.8	1.3	1.1
Alqueva II	4.7	5.2	3.0	3.2	1.7	1.9
Bemposta II	7.1	8.8	4.6	5.6	2.5	3.2
Picote II	3.5	5.1	2.2	3.2	1.3	1.9
CC. Ribatejo 1	0.2	3.4	0.1	1.9	0.1	1.5
CC. Ribatejo 2	1.4	0.8	0.8	0.4	0.6	0.3
CC. Ribatejo 3	0.2	0.8	0.1	0.4	0.1	0.3
CC. Lares 1	0.7	8.1	0.4	4.5	0.2	3.6
CC. Lares 2	2.9	10.1	1.7	5.4	1.1	4.7
EDP without CMEC	**29.2**	**50.3**	**18.6**	**29.8**	**10.6**	**20.6**
Pego coal 1	3.2	2.3	2.1	1.5	1.1	0.9
Pego coal 2	3.4	2.8	2.2	1.8	1.2	1.0
REN Trading	**6.6**	**5.1**	**4.3**	**3.2**	**2.3**	**1.9**
CC. Pego. G3	0.0	1.3	0.0	0.7	0.0	0.6
CC. Pego. G4	0.0	0.3	0.0	0.1	0.0	0.1
Others	**0.1**	**1.6**	**0.0**	**0.8**	**0.0**	**0.8**
Total	**57.0**	**73.0**	**36.6**	**43.8**	**20.4**	**29.3**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

Table 13: Estimated units' costs (quantity effect, from 1st April 2014)

	Total costs		Costs of capacity		Costs of energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.7	0.7	0.4	0.4	0.3	0.3
Alto Lindoso	2.7	1.4	1.6	0.6	1.0	0.8
Cabril	2.1	1.1	1.3	0.7	0.7	0.4
Castelo Bode	2.9	1.1	1.9	0.7	1.0	0.4
Pocinho	1.6	2.2	1.1	1.5	0.5	0.8
Regua	3.3	1.7	2.3	1.1	1.0	0.6
Torrao	0.7	0.8	0.5	0.5	0.3	0.3
V.Nova II(Frades)	1.9	1.5	1.3	0.9	0.6	0.6
Valeira	4.5	4.8	3.1	3.1	1.4	1.6
EDP with CMEC	**20.4**	**15.3**	**13.6**	**9.5**	**6.8**	**5.8**
Bemposta	0.5	1.3	0.3	0.8	0.1	0.5
Miranda	0.8	0.9	0.6	0.6	0.2	0.3
Miranda II	0.0	0.1	0.0	0.1	0.0	0.0
Picote	3.1	2.4	2.2	1.6	1.0	0.8
Alqueva	3.1	2.5	1.9	1.5	1.2	1.0
Alqueva II	3.9	4.4	2.3	2.6	1.7	1.9
Bemposta II	6.6	8.4	4.2	5.4	2.4	3.0
Picote II	2.9	4.4	1.8	2.8	1.1	1.6
CC. Ribatejo 1	0.2	3.4	0.1	1.9	0.1	1.4
CC. Ribatejo 2	1.3	0.8	0.7	0.5	0.5	0.3
CC. Ribatejo 3	0.2	0.8	0.1	0.5	0.1	0.3
CC. Lares 1	0.6	7.7	0.4	4.4	0.2	3.3
CC. Lares 2	2.5	10.1	1.5	5.8	1.0	4.4
EDP without CMEC	**25.7**	**47.3**	**16.0**	**28.4**	**9.6**	**18.8**
Pego coal 1	2.7	1.9	2.1	1.4	0.6	0.5
Pego coal 2	2.9	2.3	2.2	1.7	0.7	0.6
REN Trading	**5.6**	**4.2**	**4.3**	**3.1**	**1.4**	**1.1**
CC. Pego. G3	0.0	1.3	0.0	0.8	0.0	0.5
CC. Pego. G4	0.0	0.2	0.0	0.1	0.0	0.1
Others	**0.0**	**1.5**	**0.0**	**0.9**	**0.0**	**0.6**
Total	**51.7**	**68.3**	**33.9**	**42.0**	**17.8**	**26.3**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

Table 14: Estimated capacity and energy allocation (quantity effect, from 1st April 2014)

	Secondary reserve capacity		Net secondary reserve energy	
Unit	2014 GW	2015 GW	2014 GWh	2015 GWh
Aguieira	22	23	5	5
Alto Lindoso	83	38	19	9
Cabril	62	34	15	7
Castelo Bode	86	34	19	8
Pocinho	52	70	10	15
Regua	92	50	21	12
Torrao	24	28	5	6
V.Nova II(Frades)	59	46	13	10
Valeira	127	143	26	31
EDP with CMEC	**608**	**465**	**133**	**103**
Bemposta	14	43	3	9
Miranda	23	25	5	6
Miranda II	1	3	0	1
Picote	98	76	21	17
Alqueva	102	84	22	18
Alqueva II	126	149	27	32
Bemposta II	200	259	43	56
Picote II	99	151	22	33
CC. Ribatejo 1	6	111	1	24
CC. Ribatejo 2	41	26	8	5
CC. Ribatejo 3	5	23	1	5
CC. Lares 1	22	249	4	56
CC. Lares 2	81	322	16	74
EDP without CMEC	**820**	**1,521**	**174**	**337**
Pego coal 1	86	63	19	16
Pego coal 2	92	75	22	19
REN Trading	**178**	**138**	**41**	**35**
CC. Pego. G3	0	41	0	10
CC. Pego. G4	1	8	0	2
Others	**1**	**49**	**0**	**12**
Total	**1,607**	**2,172**	**349**	**486**

Source: The Brattle Group.

Note: assuming a risk-premium of 10 €/MW. The total amounts may not coincide with the actual totals because of differences in the hourly market clearance.

B.IV. ESTIMATION OF ALTERNATIVE RESULTS (TOTAL EFFECT)

Table 15: Estimated units' margins (total effect, from 1st April 2014)

	Total margin		Margin on capacity		Margin on energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.0	0.0	0.0	0.0	0.0	0.0
Alto Lindoso	0.0	-0.2	-0.2	0.0	0.2	-0.2
Cabril	0.4	0.0	0.3	0.0	0.1	0.0
Castelo Bode	0.2	0.1	0.2	0.0	0.1	0.0
Pocinho	0.1	0.0	0.0	-0.1	0.0	0.1
Regua	0.3	0.1	0.2	0.1	0.1	0.1
Torrao	0.1	0.0	0.0	0.0	0.0	0.0
V.Nova II(Frades)	0.2	0.0	0.1	0.0	0.1	0.0
Valeira	0.2	0.2	0.1	0.0	0.1	0.1
EDP with CMEC	**1.4**	**0.2**	**0.7**	**0.0**	**0.7**	**0.3**
Bemposta	0.1	0.1	0.0	0.0	0.0	0.1
Miranda	0.1	0.0	0.0	0.0	0.0	0.0
Miranda II	0.0	0.0	0.0	0.0	0.0	0.0
Picote	0.6	0.4	0.4	0.2	0.2	0.2
Alqueva	0.3	0.2	0.2	0.1	0.1	0.1
Alqueva II	0.4	0.2	0.3	0.1	0.1	0.1
Bemposta II	0.6	0.4	0.5	0.2	0.1	0.2
Picote II	0.3	0.1	0.1	-0.2	0.2	0.3
CC. Ribatejo 1	0.0	0.4	0.0	0.3	0.0	0.1
CC. Ribatejo 2	0.1	0.0	0.0	0.0	0.1	0.0
CC. Ribatejo 3	0.0	0.0	0.0	0.0	0.0	0.0
CC. Lares 1	0.0	0.1	0.0	-0.1	0.0	0.3
CC. Lares 2	0.2	0.6	0.1	0.2	0.1	0.4
EDP without CMEC	**2.7**	**2.4**	**1.7**	**0.7**	**1.0**	**1.7**
Pego coal 1	1.1	0.8	0.7	0.4	0.5	0.4
Pego coal 2	1.1	0.9	0.7	0.5	0.5	0.4
REN Trading	**2.3**	**1.7**	**1.3**	**0.9**	**1.0**	**0.8**
CC. Pego. G3	0.0	0.1	0.0	0.0	0.0	0.1
CC. Pego. G4	0.0	0.0	0.0	0.0	0.0	0.0
Others	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.1**
Total	**6.3**	**4.5**	**3.8**	**1.5**	**2.6**	**2.9**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

Table 16: Estimated units' revenues (total effect, from 1st April 2014)

	Total revenue		Revenue on capacity		Revenue on energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.7	0.7	0.4	0.4	0.3	0.3
Alto Lindoso	2.6	1.2	1.4	0.6	1.2	0.6
Cabril	2.4	1.1	1.6	0.7	0.8	0.4
Castelo Bode	3.1	1.1	2.1	0.7	1.0	0.5
Pocinho	1.6	2.3	1.1	1.4	0.5	0.9
Regua	3.6	1.9	2.5	1.2	1.1	0.7
Torrao	0.8	0.9	0.5	0.5	0.3	0.4
V.Nova II(Frades)	2.1	1.5	1.4	0.9	0.7	0.6
Valeira	4.7	4.9	3.2	3.2	1.5	1.7
EDP with CMEC	**21.8**	**15.5**	**14.3**	**9.5**	**7.5**	**6.1**
Bemposta	0.5	1.3	0.4	0.8	0.2	0.5
Miranda	0.9	0.9	0.6	0.6	0.3	0.3
Miranda II	0.0	0.1	0.0	0.1	0.0	0.0
Picote	3.8	2.8	2.6	1.8	1.2	1.0
Alqueva	3.4	2.6	2.1	1.5	1.3	1.1
Alqueva II	4.3	4.6	2.5	2.7	1.7	1.9
Bemposta II	7.2	8.8	4.7	5.6	2.5	3.2
Picote II	3.2	4.5	1.9	2.6	1.3	1.9
CC. Ribatejo 1	0.2	3.8	0.1	2.2	0.1	1.5
CC. Ribatejo 2	1.3	0.8	0.8	0.4	0.6	0.3
CC. Ribatejo 3	0.2	0.8	0.1	0.5	0.1	0.3
CC. Lares 1	0.7	7.9	0.4	4.3	0.2	3.6
CC. Lares 2	2.7	10.7	1.6	5.9	1.1	4.7
EDP without CMEC	**28.3**	**49.7**	**17.7**	**29.1**	**10.6**	**20.6**
Pego coal 1	3.8	2.7	2.7	1.9	1.1	0.9
Pego coal 2	4.0	3.2	2.8	2.2	1.2	1.0
REN Trading	**7.9**	**5.9**	**5.6**	**4.1**	**2.3**	**1.9**
CC. Pego. G3	0.0	1.4	0.0	0.7	0.0	0.6
CC. Pego. G4	0.0	0.2	0.0	0.1	0.0	0.1
Others	**0.0**	**1.6**	**0.0**	**0.9**	**0.0**	**0.8**
Total	**58.0**	**72.8**	**37.6**	**43.5**	**20.4**	**29.3**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

Table 17: Estimated units' costs (total effect, from 1st April 2014)

	Total costs		Costs of capacity		Costs of energy	
Unit	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €	2014 mill. €	2015 mill. €
Aguieira	0.7	0.7	0.4	0.4	0.3	0.3
Alto Lindoso	2.7	1.4	1.6	0.6	1.0	0.8
Cabril	2.1	1.1	1.3	0.7	0.7	0.4
Castelo Bode	2.9	1.1	1.9	0.7	1.0	0.4
Pocinho	1.6	2.2	1.1	1.5	0.5	0.8
Regua	3.3	1.7	2.3	1.1	1.0	0.6
Torrao	0.7	0.8	0.5	0.5	0.3	0.3
V.Nova II(Frades)	1.9	1.5	1.3	0.9	0.6	0.6
Valeira	4.5	4.8	3.1	3.1	1.4	1.6
EDP with CMEC	**20.4**	**15.3**	**13.6**	**9.5**	**6.8**	**5.8**
Bemposta	0.5	1.3	0.3	0.8	0.1	0.5
Miranda	0.8	0.9	0.6	0.6	0.2	0.3
Miranda II	0.0	0.1	0.0	0.1	0.0	0.0
Picote	3.1	2.4	2.2	1.6	1.0	0.8
Alqueva	3.1	2.5	1.9	1.5	1.2	1.0
Alqueva II	3.9	4.4	2.3	2.6	1.7	1.9
Bemposta II	6.6	8.4	4.2	5.4	2.4	3.0
Picote II	2.9	4.4	1.8	2.8	1.1	1.6
CC. Ribatejo 1	0.2	3.4	0.1	1.9	0.1	1.4
CC. Ribatejo 2	1.3	0.8	0.7	0.5	0.5	0.3
CC. Ribatejo 3	0.2	0.8	0.1	0.5	0.1	0.3
CC. Lares 1	0.6	7.7	0.4	4.4	0.2	3.3
CC. Lares 2	2.5	10.1	1.5	5.8	1.0	4.4
EDP without CMEC	**25.7**	**47.3**	**16.0**	**28.4**	**9.6**	**18.8**
Pego coal 1	2.7	1.9	2.1	1.4	0.6	0.5
Pego coal 2	2.9	2.3	2.2	1.7	0.7	0.6
REN Trading	**5.6**	**4.2**	**4.3**	**3.1**	**1.4**	**1.1**
CC. Pego. G3	0.0	1.3	0.0	0.8	0.0	0.5
CC. Pego. G4	0.0	0.2	0.0	0.1	0.0	0.1
Others	**0.0**	**1.5**	**0.0**	**0.9**	**0.0**	**0.6**
Total	**51.7**	**68.3**	**33.9**	**42.0**	**17.8**	**26.3**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

Table 18: Estimated capacity and energy allocation (total effect, from 1st April 2014)

	Secondary reserve capacity		Net secondary reserve energy	
Unit	2014 GW	2015 GW	2014 GWh	2015 GWh
Aguieira	22	23	5	5
Alto Lindoso	83	38	19	9
Cabril	62	34	15	7
Castelo Bode	86	34	19	8
Pocinho	52	70	10	15
Regua	92	50	21	12
Torrao	24	28	5	6
V.Nova II(Frades)	59	46	13	10
Valeira	127	143	26	31
EDP with CMEC	**608**	**465**	**133**	**103**
Bemposta	14	43	3	9
Miranda	23	25	5	6
Miranda II	1	3	0	1
Picote	98	76	21	17
Alqueva	102	84	22	18
Alqueva II	126	149	27	32
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Picote II	99	151	22	33
CC. Ribatejo 1	6	111	1	24
CC. Ribatejo 2	41	26	8	5
CC. Ribatejo 3	5	23	1	5
CC. Lares 1	22	249	4	56
CC. Lares 2	81	322	16	74
EDP without CMEC	**820**	**1,521**	**174**	**337**
Pego coal 1	86	63	19	16
Pego coal 2	92	75	22	19
REN Trading	**178**	**138**	**41**	**35**
CC. Pego. G3	0	41	0	10
CC. Pego. G4	1	8	0	2
Others	**1**	**49**	**0**	**12**
Total	**1,607**	**2,172**	**349**	**486**

Source: The Brattle Group.
Note: assuming a risk-premium of 10 €/MW.

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