

Strategies to Fulfill Medium-Term Objectives through Short-Term Operation in Competitive Power Markets

J. Reneses, A. Baíllo, E. Centeno, M. Ventosa, M. Rivier, A. Ramos

Abstract—This paper presents two different approaches in order to guarantee that short-term decisions made by a generation company taking part in a wholesale electricity market are consistent with its operation objectives formulated from a medium-term perspective. In particular, it shows how certain economic signals must be used so as to orient short-term decisions toward medium-term objectives. The paper focuses in the case of a generation company that establishes a minimum-market-share objective for the medium term, and shows the implications of the different guidelines that can be used in the short-term operation in order to achieve that objective.

Keywords—Generation scheduling, medium-term planning, short-term operation, medium- and short-term coordination, power market.

I. INTRODUCTION

THE operation of power generation systems has traditionally been organized following a hierarchical structure. Planning decisions belong to a long-, medium- or short-term level according to their horizon of influence [1]. Typically, the long-term decision level considers about five years of operation, the medium-term level sees from a few months up to two years, and the short-term level includes at most the following week. The detail with which the power system and the time intervals are represented diminishes as the time horizon of interest increases.

Longer-term decision levels yield resource allocation requirements that must be incorporated into shorter-term decision levels. This coordination between different decision levels is particularly important in order to guarantee that certain aspects of the operation that arise in the medium-term level (e.g. annual or monthly take-or-pay contracts with minimum-fuel-consumption requirements, annual emission allowances, monthly allocation of hydro resources, etc.) are explicitly taken into account. Several works [2], [3], [4] have considered the problem of coordinating different time scopes in a traditional framework, where a system operator tries to minimize the total cost. In [5], the coordination between annual resource allocations and short-term operation is discussed, but not implemented. This paper presents two

different approaches to deal with the coordination between medium-term planning and the short-term operation. In addition, a practical implementation of the proposed approaches is carried out, considering a medium-term market equilibrium, and a short-term detailed operation.

In the new competitive framework, generation companies are not only worried about minimizing the cost of allocating their resources, but also bear in mind the revenues they obtain when selling their production in the wholesale electricity market. This situation complicates the decision process, given that the price at which companies sell their energy typically increases as the amount of energy they wish to sell diminishes. If a company sells too much energy, the price may be too low to permit cost recovery. In contrast, if incumbent companies reduce their sales in order to obtain high prices, this may attract new entrants and lead to the loss of their market position. Hence, a generation company should decide the medium-term market position it wishes to maintain according to its current assets and those of its rivals. The company would then pursue that objective through its short-term operation.

Thus, this paper focuses on the case of a generation company that establishes a minimum-market-share objective for the medium term, and shows the implications of the different guidelines that can be used in the short-term operation in order to achieve that objective.

Section II provides a description of the medium-term decision stage and expresses it as the computation of market equilibrium between the existing generation companies. Section III corresponds to the short-term decision stage, which is formulated as a profit maximization problem including a detailed representation of the spot market and the company's generation portfolio. Section IV suggests two alternative methods in order to coordinate both stages and guarantee that the company's market-share objectives are fulfilled. Finally, section V includes a case study, in which all the methodology is implemented, and section VI summarizes the main conclusions of the paper.

II. MEDIUM-TERM MODEL

This section describes the medium-term decision stage as a market equilibrium problem. The single-period case is addressed first and then it is extended to the multiperiod case.

A. Single-period Case

The market equilibrium model used in this paper is

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proposed in [6]. It is a conjectured-variation model that represents the strategic behavior of a number of firms ($e=1,2,\dots,E$) competing in an oligopolistic market.

The conjectured variation of the clearing price λ with respect to each firm production θ_e is assumed to be known:

$$\theta_e = -\frac{\partial \lambda}{\partial P_e} \quad (1)$$

Each firm e is the owner of a number of generating units, $g \in e$, so its output in MW is given by $P_e = \sum_{g \in e} P_g$. In addition,

demand D is considered to be inelastic (the extension to a linear decreasing demand is developed in [6]).

Generation and demand are linked through the power balance equation:

$$D = \sum_{e=1}^E P_e \quad (2)$$

The profit B_e that firm e obtains when being remunerated at the marginal price is:

$$B_e = I_e(\lambda, P_e) - C_e(P_e) = \lambda \cdot P_e - C_e(P_e) \quad (3)$$

where $I_e(\lambda, P_e)$ is the revenue function for firm e .

The equilibrium is obtained by expressing the first-order profit-maximization condition for every firm:

$$\frac{\partial B_e}{\partial P_e} = 0 = \lambda + P_e \cdot \frac{\partial \lambda}{\partial P_e} - \frac{\partial C_e(P_e)}{\partial P_e} \quad (4)$$

The conjectured variation of the clearing price with respect to each firm production leads to:

$$\lambda = \frac{\partial C_e(P_e)}{\partial P_e} + P_e \cdot \theta_e \quad (5)$$

Under these assumptions, the market equilibrium can be computed by solving an equivalent quadratic optimization problem.

$$\begin{aligned} \min_{P_e} \quad & \sum_{e=1}^E \bar{C}_e(P_e) \\ \text{s.t.} \quad & D = \sum_{e=1}^E P_e \quad : \quad \lambda \end{aligned} \quad (6)$$

Technical Constraints

Where $\bar{C}_e(\bullet)$ denotes a term called *effective cost function*.

$$\bar{C}_e(P_e) = C_e(P_e) + \frac{P_e^2 \cdot \theta_e}{2} \quad (7)$$

Under the hypothesis of continuous and convex cost functions, it can be proved (see [6]) that this optimization problem is equivalent to the market equilibrium problem defined by (2), and (5). The first and second order optimality conditions are the same for both approaches. Note that the dual variable of the demand constraint is the system's marginal price.

B. Multiperiod Case

The extension of previous results to the multiperiod case is immediate. The generation planning in the medium term considers $p=1, \dots, P$ time periods (typically, weeks), each one of then comprising $l=1, \dots, L$ load levels.

A demand D_{pl} and firm's output P_{epl} is considered for every period and load level.

The market equilibrium is computed through the following optimization problem:

$$\begin{aligned} \min_{P_{epl}} \quad & \sum_{e=1}^E \sum_{p=1}^P \sum_{l=1}^L \bar{C}_{epl}(P_{epl}) \\ \text{s.t.} \quad & D_{pl} = \sum_{e=1}^E P_{epl} \quad : \quad \lambda_{pl} \end{aligned} \quad (8)$$

Technical Constraints

C. Market-share objective

Let us consider that firm e is willing to reach a minimum market-share objective s_e in the medium-term horizon. In order to comply with this requirement a minimum-market-share constraint can be included in the medium-term model:

$$\sum_{p=1}^P \sum_{l=1}^L P_{epl} \geq s_e \cdot \sum_{p=1}^P \sum_{l=1}^L D_{pl} \quad : \quad \pi_e \quad (9)$$

Being π_e the dual variable of the constraint. As seen in [7], this dual variable represents the valuation of the market share for the firm.

Note that the medium-term model allows computing the valuation of the market share, which is not usual in market equilibrium models proposed in the literature.

III. SHORT-TERM MODEL

A model oriented to the optimization of the short-term operation of a certain company e , must provide two different types of result:

1. An expected generation schedule that observes the units' operating constraints.
2. Hourly offers complying with the rules of the spot market in which company e is operating.

The short-term model considered in this paper represents in detail both the company's decisions in the spot market and the operation of the company's generating units [8]. In order to fulfill the abovementioned requirements this model does not represent each of the company's rivals, but rather handles them in an aggregate manner.

In this paper we assume that the company of interest makes its short-term decisions with a time scope that ranges from one day to one week. In other words, the short-term horizon comprises only a part of the first time period, $p=1$, considered from the medium-term perspective.

The model must decide the amount of energy that the company should sell in each of the hourly uniform-price multiunit double auctions that typically constitute the daily sessions of the spot market. The amount sold by the company in the auction for hour h , P_{eh} , exerts an influence on that auction's clearing price, λ_h . We represent this influence by means of the company's residual demand curve, $\lambda_h(P_{eh})$.

The objective function that guides the search for the company's best offering strategy in each auction can be formulated as follows:

$$B_e = \sum_h (\lambda_h(P_{eh}) \cdot P_{eh} - C_{eh}(P_{eh})) \quad (10)$$

where $C_e(\bullet)$ is the cost function of the company's generating portfolio.

The short-term model must include constraints to guarantee that the offers submitted by the company to the spot market are consistent with the spot market rules. Additionally, the energy sold by the company in the spot market must lead to a generation schedule that complies with the operating constraints of each of its units, such as maximum and minimum power output, ramp-rate limits, available hydro resources, etc. A description of all these constraints can be found in [8]. With the aim of simplifying the formulation we use the following expression to indicate that company e 's short-term decisions must belong to the set of company e 's feasible decisions, $\mathcal{P}_{eh}$.

$$P_{eh} \in \mathcal{P}_{eh} \quad (11)$$

Hence, we suggest this compact formulation for the problem faced by the generation company in the short term:

$$\begin{aligned} \max B_e &= \sum_h (\lambda_h(P_{eh}) \cdot P_{eh} - C_{eh}(P_{eh})) \\ \text{s.t.: } P_{eh} &\in \mathcal{P}_{eh} \end{aligned} \quad (12)$$

IV. SIGNALS BETWEEN MEDIUM- AND SHORT-TERM MODELS

A. Decisions Hierarchy

The operation planning for a firm competing in a power market is traditionally divided into different time scopes. In order to maximize its present and future profit, different constraints have to be considered, such as resource constraints (e.g. minimum or maximum fuel consumption limits), or hydro management. When a constraint is defined over the short-term scope, it can be directly included in the short-term model. Nevertheless, when a constraint is defined over a long- or medium-term scope, it is necessary to apply a methodology to consider it in the short-term operation-planning.

Traditional short-term operation-planning tools such as *unit-commitment* or *economic-dispatch* models include guidelines in order to direct their results toward the objectives previously identified by medium-term models. For example, a volume of available hydro resources can be specified for the short-term decision stage according to the results of a medium-term *hydrothermal-coordination* model. Alternatively, instead of specifying a fixed amount of available water for the short-term, a cost curve can be defined for this water, namely the *water-value curve*. These guidelines prevent short-term models from making use of all available hydro resources.

B. Market share objective

Similarly, when the short-term model is used to decide the amount of energy that should be sold in a certain auction, the results obtained typically suggest reducing the company's output in order to increase the clearing price well above marginal costs. Indeed, considering the objective function formulated for the short-term model (10), and assuming that there are no binding constraints, we can formulate the company's first order optimality conditions for every hour, obtaining:

$$\frac{\partial B_e}{\partial P_{eh}} = \lambda_h(P_{eh}) + \frac{\partial \lambda_h}{\partial P_{eh}} \cdot P_{eh} - \frac{\partial C_{eh}}{\partial P_{eh}} = 0 \quad (13)$$

where $\partial \lambda_h / \partial P_{eh}$ is the slope of the company's residual demand curve (negative) and $\partial C_{eh} / \partial P_{eh}$ is the company's marginal cost. This leads to the following expression for the company's optimal clearing price:

$$\lambda_h(P_{eh}) = \frac{\partial C_{eh}}{\partial P_{eh}} + \left| \frac{\partial \lambda_h}{\partial P_{eh}} \right| \cdot P_{eh} \quad (14)$$

As can be seen, if the amount of energy sold by the company is high and the residual demand curve is steep (a typical situation in on-peak hours), the company's incentive to reduce its sales so as to increase the auction clearing price, is strong. This strategy leads to the loss of the company's market position in the long-term, as it encourages its rivals to increase their market shares.

In this paper, a minimum medium-term market share is considered for a firm e , in order to avoid the described effect. Nevertheless, the proposed methodologies can be easily extended to other medium-term objectives or constraints (such as minimum or maximum fuel consumption limits, or emission allowances).

Two different approaches to coordinate medium- and short-term models are explored in the following two subsections. On the one hand, the primal information approach, which hardly imposes to the short-term model the production levels obtained in the medium-term model. On the other hand, the dual information approach makes use of the market-share valuation obtained from the medium-term model, to explicitly value the market share in the short-term model.

C. Primal Information Approach

This is the approach that has been traditionally used to send signals from medium-term generation planning to short-term operation models.

Once the market equilibrium is computed with the medium-term model, a market-share level s_{ep} will result for each time period p considered in the medium-term scope. The strategy followed by the primal information approach is to hardly impose these market-share levels as constraints in the short-term operation of the company. From our perspective, this implies introducing new constraints to the short-term model:

$$\sum_h P_{eh} \geq s_{el} \cdot \sum_h D_h \quad (15)$$

Being s_{el} the market share level for $p=l$ obtained from the medium-term planning.

The main advantage of the primal coordination is that it is very easy to implement in the short-term models. Furthermore, the signals provides with this approach are very easy to understand, since they are just minimum short-term-scope market shares.

However, this methodology has important drawbacks. The main one is the limitation of the flexibility of the decisions that the company can take in the short term, mainly due to two reasons: 1) the time aggregation in the model; 2) the presence of uncertainty. The results obtained with the medium-term model are based on a forecast of the future market conditions that may not finally occur. Furthermore, the medium term model deals with aggregated load levels that may distort short-term results.

Hence, when facing the short-term operation, the company may find a market situation slightly different from the one forecasted and the market-share objective s_{el} may not be consistent or economically efficient.

D. Dual Information Approach

The dual information approach is based on valuing the company's market share in the medium-term horizon. This value is given by the dual variable of the minimum-market-share constraint, π_e (see [7]). Once the medium-term planning provides this value, it can be incorporated into the short-term operation. The short-term model used in this paper incorporates the explicit valuation of the company's market share into its objective function:

$$B_e = \sum_h (\lambda_h(P_{eh}) \cdot P_{eh} - C_{eh}(P_{eh}) + \pi_e \cdot P_{eh}) \quad (16)$$

As can be seen, the dual approach is more flexible than the primal one, given that it allows choosing different market-share levels according to the current market conditions or the current situation of the company's generating portfolio.

The main disadvantage of the dual coordination is the lack of robustness. A small change in the medium-term valuation can lead to important changes in the short-term operation. Another problem of the dual approach arises when the actual market conditions are further different from the forecasts used in the medium-term planning. In this situation, the valuation provided by the medium term may be incorrect.

A solution to avoid this effect is combine primal and dual approach: the valuation of the market share is included, but the production levels are limited according the medium-term results.

A relevant observation is that medium-term models generally represent in less detail the operation of the generating units (e. g. ramp-rate constraints are usually not represented) and consider larger time steps. Due to this, the valuation provided by a medium-term model may not correspond exactly with the perspective adopted for the short-term model. This effect should be examined and corrected.

E. Comparison of primal and dual information

This paper proposes a methodology to compare the results obtained with the two abovementioned approaches. The methodology is developed in four steps:

1. Execute the medium-term planning model, including a minimum-market-share constraint for firm e . Two results are obtained:
 - Market-share levels for each time period p , s_{ep} .
 - The dual variable π_e of the market-share constraint.
2. Execute the short-term operation model for the first time period, $p=1$, using both the primal-information and the dual-information approach. Check the results obtained for different market conditions and different situations of the company's generating portfolio.
3. Execute again the medium-term planning model, beginning in the second time period. These executions take into account the actual conditions that the firm has faced in the short-term operation. In order to widely compare both approaches, different conditions have to be considered in the short-term operation

4. Compare the results obtained for the two proposed approaches. The comparison will be performed through the total profit obtained in the whole time horizon: the actual short-term operation, and the forecasted medium-term planning beginning in period $p=2$. These comparisons will permit the identification of the advantages and disadvantages of the primal-information and the dual-information approach.

In Fig. 1 a scheme of the comparison methodology is showed.

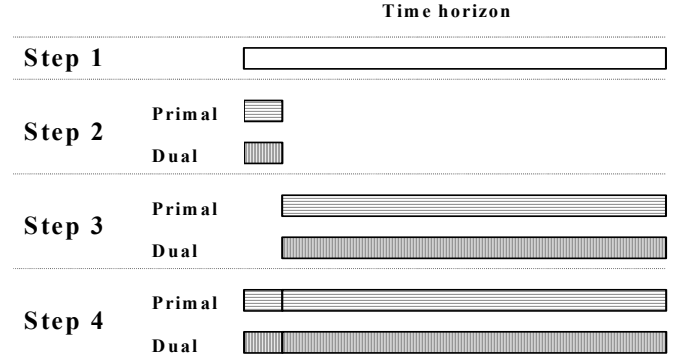


Fig. 1. Scheme of comparison of primal and dual approaches

If the conditions faced in the short term are similar to those forecasted in the medium-term planning, the results obtained with the two approaches should be almost the same. The main differences will arise in the cases in which market conditions are far from the forecasted in the medium-term planning.

F. Marginal Resource-valuation functions

This section provides an overview of an alternative approach to coordinate the medium-term planning and the short-term operation. It consists on the calculation of a *marginal resource-valuation function* in the medium term and its use in the short term. A marginal resource-valuation function is a continuous valuation of the resource (in the case of the paper, the market share), for all the different operation points that the firm can face. This is to say, for an operation point, the function provides the marginal valuation of the resource.

The valuation function is an extension of the dual-information approach, which only provides a point of the function. The independent variable of the function is E_{el} , the total energy produced by the company in $p=1$.

$$E_{el} = \sum_h P_{eh} \quad (17)$$

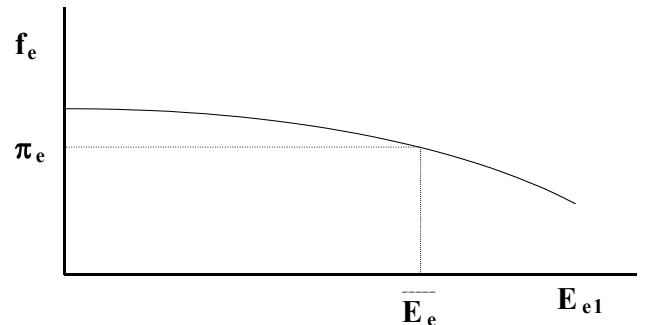


Fig. 2. Example of a marginal resource-valuation function

An example of a marginal valuation function f_e for the market share is shown in Fig. 2.

$\bar{E}_e$ is the total energy for $p=1$ provided for the medium-term model, and π_e the valuation for the market share used in the dual-information approach.

The coordination based on resource-valuation functions improves the dual coordination, because it eliminates its two main disadvantages. On the one hand, the valuation function provides robustness, since significant changes in short-term operation are eliminated. On the other hand, the function provides information for all the values of the independent variable, even for those far from the medium-term forecast.

The main drawback of this method is its practical implementation. On the one hand, the computation of the function may be hard with the medium-term model. On the other hand, its implementation in the short-term model requires including the integral of the valuation function, which may not be easy.

V. CASE STUDY

The case study represents an application of the described methodology, according to the proposed scheme in four steps. The first step is the medium-term planning, and includes a minimum market-share objective for a firm. The second step is the short-term operation for different market conditions. The third step is the updating of the medium-term planning with the actual short-term market conditions. Finally, a comparison of the primal- and dual-information approach is performed.

A. Medium-term Planning

The case study represents a system with two generation companies. GenCo x owns 10 generation groups: $G1$ - $G10$, while GenCo y owns 8 groups: $G11$ - $G18$. Table I shows the installed generation capacity and the cost for every generation group.

TABLE I
INSTALLED GENERATION CAPACITY (MW) AND
GENERATION COSTS (€/MWh)

	G1	G2	G3	G4	G5
Installed Capacity	1000	1000	800	800	600
Generation Cost	5	7	25	22	48
	G6	G7	G8	G9	G10
Installed Capacity	500	500	300	300	200
Generation Cost	46	41	15	12	18
	G11	G12	G13	G14	G15
Installed Capacity	1000	900	800	600	600
Generation Cost	6	4	22	43	41
	G16	G17	G18		
Installed Capacity	600	300	300		
Generation Cost	38	18	16		

TABLE II
LOAD LEVEL DURATION (HOURS)

I1	I2	I3	I4	I5
14	28	56	42	28

The time horizon for the medium-term planning is considered to be 10 weeks, corresponding to time periods

$p=1 \dots p10$. Each period is supposed to be split into 5 load levels ($l=1 \dots 15$). Table II shows the duration of the load levels in every week.

Finally, inelastic demand for every time period and load level, and conjectured variation of the price with respect to each firm production are shown in Tables III and IV.

TABLE III
INELASTIC DEMAND (MW)

	I1	I2	I3	I4	I5
p1	8900	8200	7500	6500	5800
p2	9300	8400	7700	6800	6000
p3	9600	8700	8100	7000	6200
p4	10100	9000	8400	7200	6400
p5	9500	8700	8000	6900	6200
p6	9200	8400	7800	6700	6100
p7	8600	7800	7200	6200	5600
p8	8200	7500	6900	6000	5300
p9	8100	7300	6900	5900	5100
p10	8500	7800	7300	6200	5400

TABLE IV
CONJECTURED VARIATION OF THE PRICE WITH RESPECT
TO THE FIRM'S PRODUCTION ((€/MWh)/GW)

	I1	I2	I3	I4	I5
GenCo X	5	5	6	8	10
GenCo Y	6	4	8	6	6

The computation of the market equilibrium with this data yields a market share of 54.63% for GenCo X in the medium-term horizon. Nevertheless, it has been supposed that GenCo X wants to assure its market position with a 60% market share. This constraint has been included into the market-equilibrium model.

Table V shows the production for all groups belonging to GenCo X in the first week ($p=1$).

TABLE V
PRODUCTION OF GROUPS IN THE FIRST WEEK (GWh)

G1	G2	G3	G4	G5
168.0	168.0	105.0	134.4	0.0
G6	G7	G8	G9	G10
1.4	21.0	50.4	50.4	33.6

In order to fulfill the market-share objective in the short-term operation, primal and dual information are required. As said before, the primal information is the market-share objective for the first week. In the case study, the value obtained is 60.53%. On the other hand, the dual information needed is the global valuation of the market share for GenCo X. In the case study, this valuation is 15.48 €/MWh.

With these results, the next step is the short-term operation under different situations.

B. Short-term Operation

Two cases have been considered in the short-term operation. The first one (case *a*) corresponds to a market situation similar to that forecasted in the medium-term. The second one (case *b*) corresponds to a situation significantly different from the forecast used in the medium-term planning.

In the case *a*, the only deviation considered from the medium-term forecast is the hourly demand shape. A maximum deviation of 5% has been implemented, considering a total weekly demand equal to the medium-term forecast. Table VI shows how primal and dual approaches lead to similar results for the weekly generation of groups.

TABLE VI
PRODUCTION OF GROUPS IN THE FIRST WEEK WITH A SIMILAR
SITUATION TO THE FORECAST– CASE A (GWh)

	G1	G2	G3	G4	G5
Primal	168.0	168.0	106.3	134.4	0.0
Dual	168.0	168.0	104.0	134.4	0.0
	G6	G7	G8	G9	G10
Primal	2.2	18.9	50.4	50.4	33.6
Dual	2.0	18.4	50.4	50.4	33.6

In case *b*, the situation is considerably different from the forecasted. On the one hand, the hourly demand has been considered 5% higher than in case *a*. On the other hand, the group *G7* has been considered as unavailable due to a failure.

Table VII shows how in this case, the results obtained using both approaches are considerably different.

TABLE VII
PRODUCTION OF GROUPS IN THE FIRST WEEK WITH A SIMILAR
SITUATION TO THE FORECAST– CASE B (GWh)

	G1	G2	G3	G4	G5
Primal	168.0	168.0	133.4	134.4	10.0
Dual	168.0	168.0	124.3	134.4	4.3
	G6	G7	G8	G9	G10
Primal	20.6	0.0	50.4	50.4	33.6
Dual	14.5	0.0	50.4	50.4	33.6

C. Medium-term Planning Updating

Once the short-term operation has faced the two proposed situations, the medium-term model has to be executed beginning in the second period ($p=2$). In these executions, the results obtained in the short-term operation have to be taken into account in order to fulfill the medium-term market-share objective. Due to the similarity of the results obtained in case *a* with both approaches, this step will only be performed with the case *b*.

D. Comparison of Primal- and Dual-Information Approaches

Table VIII shows the total production for every group belonging to GenCo X in the medium term, considering the short-term operation and the updated medium-term planning. Finally, Table IX shows the obtained profit for GenCo X in the medium-term scope.

TABLE VIII
TOTAL PRODUCTION OF GROUPS CONSIDERING SHORT-TERM OPERATION
AND UPDATED MEDIUM-TERM PLANNING (GWh)

	G1	G2	G3	G4	G5
Primal	1680.0	1680.0	1050.2	1324.4	17.8
Dual	1680.0	1680.0	1055.5	1324.4	14.2
	G6	G7	G8	G9	G10
Primal	98.9	142.3	504.0	504.0	336.0
Dual	95.3	144.2	504.0	504.0	336.0

TABLE IX
TOTAL BENEFIT OF GENCO X CONSIDERING SHORT-TERM OPERATION
AND UPDATED MEDIUM-TERM PLANNING (M€)

Primal	227.85
Dual	229.03

It can be seen as, with the primal approach the total generation of groups *G5* and *G6* has increased, decreasing the generation of *G3* and *G7*. Thus, the total cost for GenCo X has increased, since the total generation is the same for both approaches, and *G5* and *G6* are the most expensive groups owned by X.

The cost reduction, joined to an increment in the obtained revenues, lead to a higher profit with the dual-information approach. In conclusion, the dual-information approach provides a significant advantage with respect to the traditional primal information.

VI. CONCLUSIONS

The operation of power generation systems has traditionally been organized following a hierarchical structure. Longer-term decision levels yield resource allocation requirements that must be incorporated into shorter-term decision levels. This coordination between different decision levels is particularly important in order to guarantee that certain objectives of the operation that arise in the medium-term level are explicitly taken into account in the short-term operation.

This paper focuses on the market-share objective of a Generation Company competing in an electricity market. Two different strategies to fulfill the medium-term objective through short-term operation are described, as well as their implementation and comparison. The first one is the primal-information approach, in which the objective market-share for the short-term operation is the signal between the medium-term planning and the short-term operation. In the dual-information approach, the market share is valued in the medium-term planning, and this valuation is included into the short-term operation.

The dual approach is more flexible than the primal, allowing to the short-term operation to better adapt to actual conditions faced by the generation company.

An extensive case study has confirmed the validity of the methodologies, and the better adequacy of the dual-information approach, especially in cases where the actual short-term operation is considerable different than the forecasted in the medium-term planning.

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