The Greek Capacity Adequacy Mechanism: Design, Incentives, Strategic Behavior and Regulatory Remedies

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***Abstract*—This paper describes and analyzes the Greek Capacity Market or, as named, the "Capacity Adequacy Mechanism". A detailed description of the recently established mechanism is given, whose design is a hybrid model combining elements from three different designs: the US Capacity Markets, the Capacity Payment Mechanisms and the Centralized Auctions for Capacity Contracts. Next, the goals of this design are explained. In the case of Greece the goals are not restricted just to the so-called "missing money" problem, therefore an analysis follows examining the incentives given to the market participants. The analysis shows the dependence of the mechanism on mainly two factors: the over/under-capacity of the market and the strategic behavior of the market participants, especially of the incumbent. In general, the Capacity Adequacy Mechanism is expected to operate quite satisfactory, giving the "right" incentives to the market participants. Some minor amendments to the rules are proposed, aiming to further increase its efficiency.**

***Keywords*—Capacity Mechanisms, Electricity Markets, Mechanism Design, Strategic Behavior.**

I. Introduction

Greece has been going through a phase of lack of investments in electricity generation capacity for almost a decade. The continuously growing demand in electricity and the disproportionally smaller number of investments in new generation plants has significantly reduced the generation capacity reserve margin. The need for an electricity market design that would give incentives to new independent power producers to enter the market was always one of the top priorities of the Regulatory Authority for Energy (RAE). It became one of the main topics of the reforms discussed from 2003 to 2005, during the process of redesigning the initial electricity market framework of 2001.

The new Grid and Market Operation Code [1] provides for the development of a centrally organized daily wholesale market and the introduction of a capacity mechanism. More details regarding the Greek electricity market and its design can be found in [1]-[5].

Capacity mechanisms are an important supplement to the wholesale electricity markets, as they provide incentives to new generators to come on-line by guaranteeing them an additional income, ideally enough to cover the so-called "missing money problem". The capacity mechanisms are mainly of two types, capacity payments and capacity markets, although lately there is a rising support for the centralized auctions for forward capacity/reliability contracts [6-7].

Moreover, capacity mechanisms tend to differ among each other, as they are appropriately customized to address the problem of investments in the specific context of each market, characterized by its design, structure and particularities. It should come then as no surprise that the Greek *Capacity Adequacy Mechanism (CAM)*, although belonging to the capacity market type, combines elements from all mechanism types, bringing forth a new capacity mechanism design.

This paper has two parts. The first part (corresponding to Section II) presents in detail the novel design of the Greek Capacity Market. The second part (Sections III and IV) proceeds a step further, shedding light on the expected strategic behavior of the market participants and showing its dependence on the generation adequacy level of the market. Finally, based on the analysis of both parts, the main weaknesses of the mechanism are identified and some proposals are offered to counter them.

II. Description of the Capacity Adequacy Mechanism

A. *The Capacity Adequacy Mechanism Design*

The Capacity Adequacy Mechanism aims to ensure long-term capacity availability and is based on the obligation of the suppliers to present sufficient guarantees in this direction. Its design is similar to the one of the Northeast US capacity markets (PJM, NYISO, ISO-NE), adapted appropriately to the structure and characteristics of the Greek electricity market.

Each supplier, self-supplying customer and exporter (hereon "*load representatives*") is assigned a *Capacity Adequacy Obligation*, which is measured in units of MW-Available Capacity and is calculated for every Reliability Year (October 1^{st} – September 30^{th}) according to the energy consumed[1] by each load representative during the periods of increased probability of loss of load, as calculated by the System Operator (SO)[2]. The calculation of the Obligations takes into consideration the required capacity reserve margin, determined

[1] CAM includes both an ex-ante and an ex-post calculation of the Obligations. The final settlement is based on the ex-post Obligations. As this complexity exceeds the scope of this paper, details regarding the settlement process of the CAM were deliberately left out.

[2] These periods are determined according to a formula described in [1] and correspond to the hours with the lowest reserve availability.

yearly by the Minister of Development, based on RAE's opinion following a recommendation by the SO.

Furthermore, each producer issues, for each of his units and for the next five Reliability Years, *Capacity Availability Tickets*, each Ticket being valid for one Reliability Year. The total number of Tickets issued for each unit equals its net capacity. Every Reliability Year the SO estimates the available capacity (*UCAP*) of each unit, based on the Demand Equivalent Forced Outage Rate of the unit (*EFORd*), and allocates it equivalently among its Tickets. Thus, every Ticket has an available capacity value equal to $\left(1-EFORd\right)$.

The Tickets constitute a call to load representatives for the conclusion of *Capacity Availability Contracts*. Each Contract has an available capacity value equal to the one of its underlying Ticket. The conclusion of a Contract implies the existence of a price for available capacity, set privately between the two counterparties. Moreover the two counterparties are encouraged to sign, independently of the CAM, bilateral financial agreements in the form of Contracts for Differences (CfDs) or Call Options.

The Code provides that Obligations can only be covered through the conclusion of Contracts between the load representatives and the producers. The load representatives must submit to the SO Contracts with a total available capacity value equal to their Obligations.

The above description of the CAM is presented in Fig. 1.

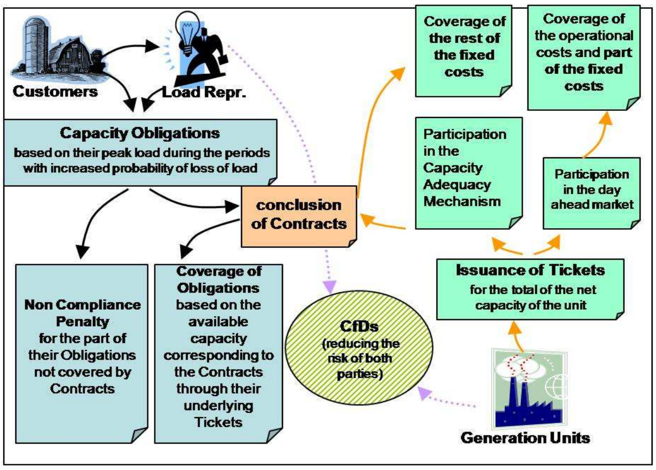

Fig. 1. The Capacity Adequacy Mechanism Design

In case a load representative does not cover all of its Obligations, he is charged with the *Non Compliance Penalty* for the part of his Obligations not covered by Contracts. Thus the Penalty defines in some sense the price cap for available capacity. The Penalty value is set by RAE for each Reliability Year (currently equal to 35,000 €/MW-Available Capacity), considering amongst other factors the capacity reserve margin and the cost of adding new generation capacity to the Greek electricity system.

The Penalty value calculation methodology is currently under review, in order to promote a more transparent one, directly linking the Penalty value to the generation adequacy level, thus giving better economic signals to the market. The concept of the new methodology, first presented by Caramanis [8], is based on the construction of a kinked curve, matching each (system-wide) available capacity level to a specific value. The Penalty value for each Reliability Year is then determined by the value of the kinked curve at the total available capacity valid for that Reliability Year. An example of this curve is presented in Fig. 2.

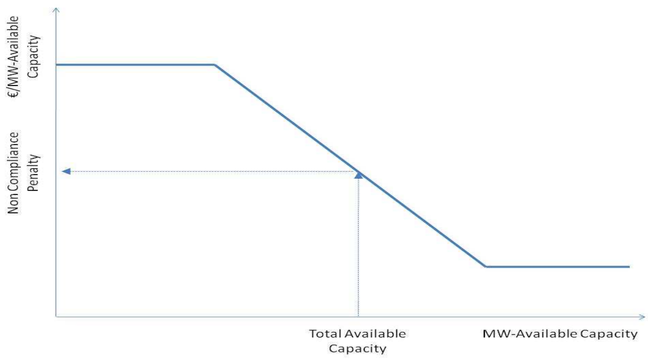

Fig. 2. The Non Compliance Penalty Curve

Finally, as a safeguard measure, the SO can conduct tenders for the pre-purchase of Contracts, corresponding to new units, when a danger for capacity shortage is foreseen. The pre-purchase provides the minimum required security for the income of the new units, thus facilitating their financing, and takes the form of a "Financial Contract of Guaranteed Revenues" (similar to a call option on the generator's revenues). This pre-purchase assumes that the investor takes the full business risk regarding the equity and commits to the prompt construction of the unit, its smooth operation and maintaining it to its full capacity availability. The SO recovers every cost resulting from the contract, with these costs being distributed to the load representatives.

B. *The Transitional Mechanism*

During the Transitional period and due to the difficulty in the conclusion of Contracts between load representatives and producers, as currently the only load representative - apart from some small exporters - is the incumbent, a *Regulated Mechanism (RM)* is also offered to the market participants. The producers and the load representatives are given the alternative choice to participate in the CAM by concluding Contracts with the SO. In this case the producers receive a regulated price equal to the Penalty value for the available capacity with which they participate in the RM[3]. This amount,

[3] This is a simplification of the actual rules, but adequate for the overview of the RM. There is also an ex-post adjustment to these payments, so that the producers will receive them only for the hourly periods that their units were declared available in the day ahead market. This adjustment could be interpreted as a second derating of the units' capacity, only now it is just considered for the purposes of the SO payments.

The "double-counting" of the capacity derating in the SO payments may seem strange to the reader but there is a justification behind it. If the regulated payment was made for all hours of the year, independently of the availability of the unit, then no unit would have an incentive to conclude a Contract with a load representative, as this would always cost more. This would, in effect, cancel the described CAM design. Under the current design, a unit participating in the RM will receive the regulated payment, but this will most likely be less than the amount received by concluding a Contract with a load representative, as shown in Section IV. Moreover this rule gives to the units participating in the RM a stronger incentive to be available in the day ahead market.

equal to the total available capacity participating in the RM multiplied by the Penalty value, is covered by the participating load representatives in the RM, proportionally to their Obligations[4]. Note that the producers may conclude Contracts with the SO for only a part of their Tickets. At the same time, the load representatives, if they choose to conclude Contracts with the SO, they must do it for all of their Obligations.

It is also worth noting that, so far, all market participants have participated in the CAM only through the RM. Moreover the SO has conducted tender for the pre-purchase of Contracts, awarding the relative contract to a 440 MW CCGT unit to be constructed by 2010.

C. Goals of the Capacity Adequacy Market Design

The addition of the RM to the CAM leads to a design where:

- The main design (hereon "*Capacity Market*") is based on the capacity market design, introduced to draw sufficient investments, solve the "missing money" problem and set the base for the conclusion of (long term) financial contracts between load representatives and producers.
- The tenders held by the SO aim to induce investments for periods in which a capacity deficit is forecasted. The awarded contracts guarantee the minimum revenues of the new generator(s) for 12 years and at the same time they set a cap to the bids of the generator, reducing the volatility of prices in the market. Thus, many of the benefits of the Centralized Auction design are gained, creating a more secure and less risky environment for investments and entry of new players, both in generation as in retail.
- In order to face the current immaturity of the market, where no load representatives apart from the incumbent exist, the RM is introduced, having a lot of similarities with various capacity payment schemes. The RM offers a significantly less complex mechanism for new entrants to participate into and a certain income for the producers.
- Finally, the planned introduction of the Non Compliance Penalty Curve will link the otherwise independently calculated Penalty value to the total available capacity of each Reliability Year, creating also an indicative demand curve for available capacity in a transparent way.

The main concerns with the above design have to do with the interactions between the Capacity Market and the RM, as well as the incentives given to and the anticipated strategic behavior by the market participants as explained next.

III. Incentives Given To Market Participants

A. Nomenclature and Assumptions

In this section the profit functions of each market participant are analyzed and their best responses are identified. For this analysis the following symbols are used:

j: index of unit

i: index of load representative

$\mathrm{P}^{\mathrm{CAC}}$: the price of available capacity (in €/MW-Available Capacity)

$\mathrm{P}^{\mathrm{NCP}}$: the Penalty value (in €/MW-Available Capacity)

$UCAP^{j}$: the available capacity of unit j

$UCAP^{j}_{RM}$: the available capacity of unit j with which it participates in the RM

$UCAP^{j}_{CAC}$: the available capacity of unit j with which it participates in the Capacity Market

CAO^{i}: number of Obligations of load representative i

CAO_{RM}: total number of Obligations covered through RM

CAO_{CAC}: total number of Obligations covered through the Capacity Market

When the indices i or j are omitted then the symbol refers to all units.

It is assumed that a price of available capacity $\mathrm{P}^{\mathrm{CAC}}$ exists and can be observed by all participants. This assumption seems reasonable, considering the Greek market structure with its small number of players. In reality, Contract prices are not observable as they are the result of (private) bargaining between producers and load representatives.

Moreover, it is assumed, without loss of generality, that it always holds $\mathrm{P}^{\mathrm{CAC}} < \mathrm{P}^{\mathrm{NCP}}$.

B. Producer Profits and Participation to CAM

Each producer has two choices for his Tickets. One choice is to conclude a Contract with a load representative, receiving an amount equal to the available capacity of the Ticket, $(1-\mathrm{EFORd})^{j}$, multiplied by the price of available capacity $\mathrm{P}^{\mathrm{CAC}}$, i.e. $\mathrm{P}^{\mathrm{CAC}} \cdot (1-\mathrm{EFORd})^{j}$.

Alternatively, the producer can conclude a Contract with the SO, receiving an amount equal to the available capacity of the Ticket multiplied this time by the Penalty value $\mathrm{P}^{\mathrm{NCP}}$. Note though that he will receive this amount only for the hours that his unit is declared available in the day ahead market. Thus, this payment needs to be reduced accordingly, i.e. $\left(\mathrm{P}^{\mathrm{NCP}} \cdot (1-\mathrm{EFORd})^{j}\right) \cdot (\%\text{ of hours in a year unit } j \text{ is available})$.

For the present analysis the aforementioned percentage will be approximated by the units' EFORd value, as by definition it is a measure of the probability that a unit will not be available to generate due to forced outages. Thus the producer will receive an amount equal to $\mathrm{P}^{\mathrm{NCP}} \cdot \left((1-\mathrm{EFORd})^{j}\right)^{2}$.

The producer's choise regarding whom to conclude the Contract with, depends on the relation between $\mathrm{P}^{\mathrm{CAC}}$ and $\mathrm{P}^{\mathrm{NCP}}$. More specifically it depends on whether:

$$\mathrm{P}^{\mathrm{CAC}} \lessgtr \mathrm{P}^{\mathrm{NCP}} \cdot (1-\mathrm{EFORd})^{j}. \quad (1)$$

C. Load Representative Costs and Participation to CAM

The choices available to a load representative regarding the ways to cover his Obligations are similar to the ones presented for the producers.

More specifically, one choice is to conclude Contracts with producers for a part of his Obligations and pay the Penalty for the rest. Since it has been assumed that $\mathrm{P}^{\mathrm{CAC}} < \mathrm{P}^{\mathrm{NCP}}$, each load representative has an incentive to conclude Contracts with the

[4] Notice that the load representative payments are not adjusted ex-post, as with the producer ones. Therefore there is always a surplus for the SO, equal to the ex-post adjustment of the payments to the producers.

producers for the total of his Obligations. Then his total cost is $LR^i = \mathrm{P}^{\mathrm{CAC}} \cdot CAO^i$.

The other choice a load representative has is to conclude Contracts with the SO but pay the corresponding payment only if it is less than the Penalty, otherwise he would prefer to become deficient and just pay the Penalty for all his Obligations. The payment corresponding to the RM is determined by allocating the amount[5] $\mathrm{P}^{\mathrm{NPC}} \cdot UCAP_{RM}$ to the load representatives participating in the RM, proportionally to their Obligations. Then the load representative's cost is:

$$LR^i = \min\left(\frac{CAO^i}{CAO_{RM}} \cdot \mathrm{P}^{\mathrm{NPC}} \cdot UCAP_{RM}, CAO^i \cdot \mathrm{P}^{\mathrm{NPC}}\right) = \\ = CAO^i \cdot \mathrm{P}^{\mathrm{NPC}} \cdot \min\left(\frac{UCAP_{RM}}{CAO_{RM}}, 1\right). \quad (2)$$

Therefore, if $UCAP_{RM} < CAO_{RM}$ the load representative has an incentive to conclude Contracts with the SO, otherwise he would prefer to pay the Penalty.

The final choice of the load representative depends on the relation between $UCAP_{RM}$ and CAO_{RM}. More specifically it depends on whether:

$$\mathrm{P}^{\mathrm{CAC}} \lessgtr \mathrm{P}^{\mathrm{NPC}} \cdot \frac{UCAP_{RM}}{CAO_{RM}}. \quad (3)$$

IV. Equilibrium Analysis

A. Remarks on the Analysis

First Remark: Following the analysis in Section III, the load representatives will consider participating in the RM only if the expected cost of their participation is less than the Penalty value, that is if they expect $UCAP_{RM} < CAO_{RM}$. Therefore the equilibrium analysis of this game can be simplified in the examination of the two cases $UCAP_{RM} < CAO_{RM}$ and $UCAP_{RM} \geq CAO_{RM}$ and what these imply regarding the number of Contracts to be concluded in the context of the CAM.

Second Remark: The scope of the analysis in this Section is not to fully characterize the equilibria of the game, but to give a general description of the respective game, as well as insights on the strategic behavior of the market participants and its possible results. Full characterization of the equilibria would require studying a capacity constrained price competition game under uncertainty and asymmetric information, which is outside of the scope of this paper.

Third Remark: It will be assumed that Contracts between the producers and the load representatives are concluded before the ones concluded in the context of the RM. This hypothesis, apart from simplifying the analysis, is based on the provision of the Code [1] stating that the deadline for participating in the RM ends one month before the start-date of the new Reliability Year. Without this assumption the equilibrium would have to be studied as a two-stage game, one stage before the RM participation deadline and one after.

[5] As discussed in Section IIB, this amount corresponds to the regulated price the producers receive by the SO for the available capacity with which they participate in the RM.

Fourth Remark: It can be observed from the results of Section III that while the decisions of the producers depend on exogenous parameters, the EFORd^j of the units, the decisions of the load representatives are based on endogenously defined parameters and specifically on the ratio of the total available capacity value of the units over the total Obligations of the load representatives participating in the RM. Therefore the choices of the participants, and especially the ones of the load representatives, are affected by the strategic behavior of the other participants.

Fifth Remark: As $\mathrm{P}^{\mathrm{CAC}} < \mathrm{P}^{\mathrm{NCP}}$, the load representatives have no incentive to pay the Penalty. Therefore their choices will be restricted between concluding Contracts with the producers or with the SO.

The only case this might not hold would be if the load representatives have more uncovered Obligations than the available Tickets. But then, a load representative preferring to pay the Penalty instead of participating in the RM means that he prefers paying the whole Penalty value instead of just a fraction of it, which is an irrational behavior.

Consequently, the following relations will always hold:

$$CAO_{RM} + CAO_{CAC} = CAO \quad (4)$$

$$UCAP^j_{RM} + UCAP^j_{CAC} = UCAP^j. \quad (5)$$

Sixth Remark: $UCAP_{RM} \geq CAO_{RM} \Leftrightarrow UCAP \geq CAO$ as each Contract matches on a one-to-one basis the available capacity value of a unit to an equal value of Obligations, i.e. $UCAP_{CAC} = CAO_{CAC}$.

Seventh Remark: It has been assumed that the producers make the same choice for all of their Tickets, either participating in the RM or in the Capacity Market. An interesting extension would be to relax this assumption.

B. Case $UCAP \geq CAO$

In this case no load representative has a reason to conclude Contracts with the SO, thus $CAO_{RM} = 0$. They instead prefer to conclude Contracts with the producers. The producers will try to conclude Contracts with the load representatives at the highest possible available capacity price.

In the equilibrium, the price associated with each Contract will be unit specific and may range from $\mathrm{P}^{\mathrm{NCP}}$ to zero. This mainly depends on the number of Tickets and Obligations of each participant, as well as on the existing market structure in general[6]. If on the other hand there was perfect competition, with no strategic behavior among the participants, the existence of overcapacity would lead to zero prices.

After all Contracts have been concluded, part of the available capacity (equal to $UCAP - CAO$), will not be matched to Obligations through Contracts. As no load representative will participate in the RM, the producers who have not concluded a Contract for their available capacity will not receive any payment[7].

[6] See also the Second Remark.

[7] It should be noted that in order for the units participating in the RM to receive their payments there must also be at least one load representative participating in the RM. If this does not happen, the RM mechanism is not activated for that Reliability Year. The above rule gives incentive to the

C. Case $UCAP < CAO$

In this case, each producer, knowing that the demand for available capacity is larger than $UCAP$, has no reason to conclude a Contract with a price smaller than the payment he expects to receive from the RM. Therefore in this case:

$$\mathrm{P}^{\mathrm{NCP}} > \mathrm{P}^{\mathrm{CAC}} > \mathrm{P}^{\mathrm{NCP}} \cdot (1-\mathrm{EFORd})^{j}. \quad (7)$$

This way an increasing offer curve is created, with the units having a lower available capacity value requesting a smaller price $\mathrm{P}^{\mathrm{CAC}}$ in order to conclude Contracts with the load representatives.

On the other hand, the load representatives know that the maximum price they are going to have to pay is $\mathrm{P}^{\mathrm{NCP}} \cdot UCAP_{RM} / CAO_{RM}$, corresponding to the payment when all load representatives participate in the RM[8].

Since $UCAP < CAO$, the more available capacity is taken off the market (through the conclusion of Contracts in the context of the Capacity Market), the lower the cost of the load representatives in the context of RM is going to be. This can be easily seen if we assume that the participants conclude Contracts with value x of available capacity. Then, the *RM factor*, $UCAP_{RM} / CAO_{RM}$, determining the payment of the load representatives is:

$$\frac{UCAP_{RM}}{CAO_{RM}} = \frac{UCAP - x}{CAO - x} = \frac{1 - x/UCAP}{CAO/UCAP - x/UCAP} = \frac{1-y}{CAO/UCAP - y} \quad (8)$$

with $y = x/UCAP \le 1$.

The RM factor is decreasing in x, as seen in Fig. 3.

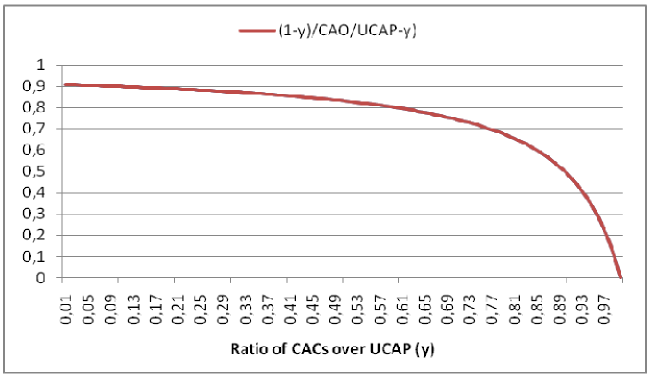

Fig. 3. Graph of the RM factor for CAO/UCAP=1.1

Following the above, Contracts will be concluded between unit *j* and a load representative only if:

$$\mathrm{P}^{\mathrm{NCP}} \cdot UCAP_{RM} / CAO_{RM} > \mathrm{P}^{\mathrm{CAC}} > \mathrm{P}^{\mathrm{NCP}} \cdot (1-\mathrm{EFORd})^{j}. \quad (9)$$

Equation (9) is well defined when:

$$UCAP_{RM} / CAO_{RM} > (1-\mathrm{EFORd})^{j} . \quad (10)$$

If (10) does not hold, the optimal strategy for either the producers or the load representatives is to conclude Contracts only with the SO. Then, unavoidably, all players will participate only in the RM.

If the differences between the quality of the Tickets of the various units are ignored[9] as well as the possible strategic behavior on behalf of the market participants, the number of Contracts expected to be concluded between load representatives and producers will result from the intersection of the unit availability offer curve and $\frac{UCAP - x}{CAO - x}$, as shown in Fig. 4. The unit availability offer curve refers to the curve resulting from the ordering the available capacity values of all Tickets in an increasing order.

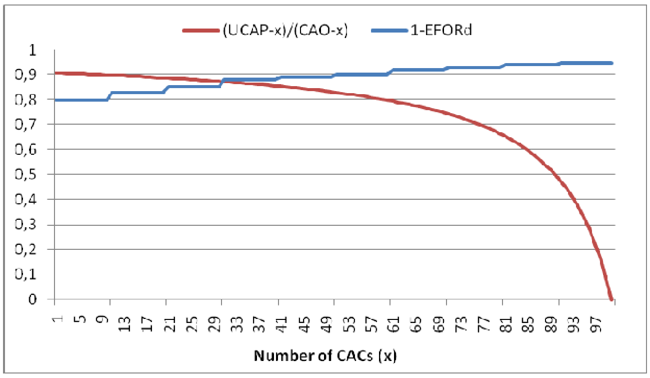

Fig. 4. Number of Contracts to be concluded in Case (C) for CAO/UCAP=1.1 and a random unit availability offer curve

Assuming that the availability offer curve can be approximated by a linear function $f(x) = a + bx$, then the optimal (in the sense of maximizing social surplus) number of Contracts x to be concluded results from solving the equation $a + bx = \frac{UCAP - x}{CAO - x}$.

D. Summary of Results

If $UCAP \ge CAO$, the RM will not be activated, as no participant will conclude Contracts with the SO. All the load representatives will try to conclude Contracts with the producers, although the equilibrium depends greatly on the exact parameterization of the game, especially regarding the market structure and the individual number of Tickets and Obligations of the market participants.

If $UCAP < CAO$, the participants will try to estimate RM factor and then conclude Contracts based on that. Units whose $(1-\mathrm{EFORd})^{j}$ is larger than the RM factor will have to

producers to compete for the conclusion of Contracts, leading to prices even lower than $\mathrm{P}^{\mathrm{NCP}} \cdot (1-\mathrm{EFORd})^{j}$, which would be the expected income of the producers if they participated in the RM. Note also that the load representatives always have an incentive to conclude Contracts with the units, as otherwise they will be charged with the Penalty.

[8] Notice that this payment is inversely related with CAO_{RM}. Thus the more load representatives participate in the RM the less this amount becomes.

[9] This is a very strong simplification. The quality of the Contracts is a crucial parameter in the market we examine, but a more complicated analysis would be required to address this issue. For example a unit with a low available capacity price, but also low availability value, is more likely to have a major outage. In the case of a major unforced outage the Contracts are suspended and the load representative will have to find new Contracts to cover his Obligations. On the contrary, if this unit participated in the RM, the outage of the unit wouldn't only affect the coverage of the Obligations of the load representatives, but would also reduce the cost of the load representatives (as the unit wouldn't receive a payment for the corresponding interval).

participate in the RM, otherwise they will prefer to conclude Contracts with the load representatives at prices satisfying equation (9). This will also be the case for the load representatives in order to conclude Contracts with producers, otherwise they will prefer to participate in the RM. As above, the equilibrium will depend on the parameterization of the game.

The above results show the dependence of the mechanism on mainly two factors: the over/under-capacity of the market and the strategic behavior of the market participants, depending mainly on the number of Tickets and Obligations of each participant and the existing market structure. Especially in the case of Greece, the mechanism is highly dependent on the actions of the incumbent, as it has a share of 99,5% in retail and about 95% in supply.

E. Regulatory Remedies

The Capacity Adequacy Mechanism, in general, can operate satisfactorily, giving the "right" incentives to the participants depending on the capacity adequacy level of the market. Moreover, the Capacity Market and RM supplement one another, without having any observable conflicts. The main weaknesses of the CAM design appear to be the following:

i. The market power of the incumbent is not addressed. The rest of the participants are highly dependent on his choice regarding which mechanism he will participate in, although they are not expected to know this information till right after the expiration of the deadline for participating in the RM.

ii. The generators have a very strong incentive to be always available. The incentive is so strong, that even when they are not actually available it is very likely that they will try to avoid declaring their unavailability by bidding at the price cap and hoping not to be dispatched.

iii. Currently the Penalty value is declared one month before the Reliability Year it involves. Even if the new proposed methodology is approved, the time horizon still seems too short to give the right signals for investment.

These weaknesses can be addressed up to a certain extend with the following minor amendments of the CAM rules to further increase its efficiency:

i. The deadline for the participation of the incumbent in the RM should be set one week earlier than the other participants.

ii. The SO should perform unscheduled audits to any generator suspicious for economic withholding. In case a generator declares false availability he should be charged with a very high penalty.

iii. The Penalty calculation methodology should consider a longer horizon. Assuming that the Non Compliance Penalty Curve methodology is put in place, the parameters of the curve should be set three years in advance. This will assist the market participants to estimate the value of the Penalty for each one of the next three years just by forecasting the total available capacity of the system for each year. This three-year period is considered sufficient for the construction of a new CCGT plant.

V. Conclusions

The Greek Capacity Adequacy Mechanism combines elements from various existing capacity mechanisms into a new hybrid design. This integration is expected to be successful, without giving significant market manipulation opportunities to the market participants, while at the same time offering higher payments to the generators with higher availability, guaranteeing a minimum income to the generators and a minimum reliability to the load representatives and reducing the volatility of the Contract prices, compared to having only a Capacity Market mechanism.

VI. References

[1] Grid and Market Operation Code, RAE, 2005.

[2] Regulatory Authority for Energy website, www.rae.gr

[3] Annual Report to the EC, RAE, 2005.

[4] Annual Report to the EC, RAE, 2008.

[5] Sakellaris, K., A. Vlachos, K. Perrakis, M.C. Caramanis and S. Deb, "Developing a simulator for the Greek electricity market" presented at the conference "Energy Investments and Trade Opportunities", Athens, 2008.

[6] De Vries, L.J, "Generation adequacy: Helping the market do its job", *Utilities Policy*, 15 (1), 20-35, 2007.

[7] D.Finon and V. Pignon, "Electricity and long-term capacity adequacy: The quest for regulatory mechanism compatible with electricity market", *Utilities Policy*,16 (3), 143-158, 2008.

[8] Caramanis M.C., "Investment needs/prospects in Southeastern Europe and a capacity adequacy mechanism design", presented at the NARUC Winter Committee Meetings, Committee on International Relations, 2006.