Market Arrangements for Electricity –
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(MAE)

Demand Side Participation

A Draft Decision Paper by the Commission for Energy Regulation

February 13th, 2004

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1. INTRODUCTION

1.1 Status of Paper

This document is a discussion paper including a number of draft decisions by the Commission for Energy Regulation under Regulation 5(1) of S.I. No. 304 – Electricity Regulation Act 1999 (Market Arrangements for Electricity) Regulations 2003. It provides draft decisions on:

- How demand side bidding will be permitted as an explicit mechanism for accommodating the demand side within the market.
- The price formation and settlement rules that should apply to demand side bidding.
- The involvement of the demand side in the ancillary service market.

It is proposed that:

With respect to the real time energy market

- The MAE design (i.e. market rules and software) include provision for demand side bidding.
- Demand side bidding be subject to verification by the SMO that the load is indeed dispatchable.
- Demand side bids:
  - Take the form of monotonically decreasing price quantity pairs.
  - Be cleared and settled at the nodal price (i.e. Option 1)

With respect to the ancillary services market

- The MAE design provide for the demand side to be included as providers of reserve subject to the normal technical requirements set out by the SMO for the provision of reserve.

Implementation

- Demand side bidding will not be fully implemented at the start of the MAE in February 2006, but can be introduced at a later date.
- Provision is made for customers to continue to provide reserve under the MAE.

Responses to these draft decisions must be submitted to the Commission by 5pm on Friday, 27th February to Eamonn Murtagh at emurtagh@cer.ie

The paper also provides, by way of background, a general discussion of demand side participation in the MAE and how customers will be involved in the market.

1.2 MAE Market Design & Demand Side Participation

Much of the consultation to date on the MAE market design has been directed towards the detail of the arrangements for the deployment of supply side resources. However, MAE also has a demand component.

Without an effective demand side, the market is simply a competition between suppliers to meet a demand at levels that may not truly reflect the demand supply balance at any particular price. As a consequence, prices and levels of electricity supplied/consumed can be too high, price volatility is accentuated, security of supply is diminished and emissions and other adverse environmental effects may be unnecessarily incurred - particularly in times of tight supply/demand balance. This has been the experience in other competitive wholesale markets, such as Australia and some control areas in the U.S., where there is a considerable body of evidence to indicate that wholesale electricity markets can only be truly competitive and efficient when there is active participation of both supply and demand.

Comprehensive and effective demand side participation in the market has the potential to reduce the overall level of infrastructure investment, currently sized to meet a price-insensitive peak demand plus a safety factor, and to significantly reduce the traditionally dominant role of supply participants.

To provide context to the draft decisions this document analyses the issues associated with the design of the demand side of wholesale electricity markets and develops proposals with respect to the demand side for the new trading arrangements under the MAE from first principles.

Please note that the role of the demand side (if any) in capacity assurance is not considered in this document. It will be evaluated separately in the context of the consultation paper on the generation adequacy safety net mechanism.

Finally, this paper takes into consideration the submissions on demand side participation received on the market design consultation paper[1] released on 12 September 2003.

1.3 Structure of Paper

The paper is structured as follows:

- Section 2 looks at the role of the demand side in electricity markets generally.
- Section 3 develops and refines proposals for the demand side under the MAE building on the conclusions outlined in Section 2.5.
- Section 4 provides the draft decisions for the design of the demand side of the MAE.
- The appendix contains a description of the main existing demand side initiatives.

[1] Commission for Energy Regulation: An MAE Consultation by the Commission for Energy Regulation Under S.I. 304 of 2003. 12 September 2003. (CER/03/230)

2. THE ROLE OF THE DEMAND SIDE IN WHOLESALE ELECTRICITY MARKETS

2.1 Introduction

This section reviews the role the demand side must play with respect to each of the key sub-markets associated with the MAE – namely, the spot market and the ancillary services market(s).[2]

The purpose of the section is to distil the key issues and insights relevant to the operation of the demand side with a view to establishing an analytical basis for the development of the more specific proposals for the MAE outlined in section 3.

The section begins with a summary overview of the importance to the market of a well-developed demand side. It subsequently covers some of the key aspects of the micro-economics of both the demand side of spot electricity markets and the ancillary services market before, finally, summarising the major insights relevant to the development of specific MAE demand side proposals.

2.2 The Significance of the Demand Side

Wholesale electricity markets, in common with all markets, are comprised of two components:

- A *supply side* reflecting the willingness to supply electricity and
- A *demand side* reflecting the propensity to consume electricity.

Both sides of the market comprise price quantity relationships. On the supply side, the higher the price, the greater the quantity of electricity willingly supplied by generators. On the demand side (assuming a price-responsive demand), the lower the price the greater the quantity of electricity willingly consumed by electricity consumers. The market price is determined by the interaction of these two separate sets of influences. If either of these price quantity relationships are missing from the market or are not fully functional, inefficient outcomes are likely to result.

More particularly with respect to the demand side, if the propensity to consume is not accurately reflected in the market, the following adverse consequences can be expected:

- *Increased rewards to generators from gaming the market*

  The more inelastic the demand represented in the market, the greater the rewards to generators (in the form of price increases) from withholding supply.

- *Increased price volatility*

  A responsive demand side has the effect of tempering price movements in that higher prices are met with a backing off of demand, reducing both market power and the need to deploy high cost peaking stations.

[2] The term "ancillary services" is used here as a generic term encompassing the provision of reserve and other services, such as voltage support etc. In practice, however, it is only the provision of reserve that is of interest from a demand side perspective.

Conversely a demand side that is not as responsive as it could be increases price volatility.

- *Higher prices*
  To the extent that demand does not back off in response to the higher cost of provision and/or the exercise of market power on the behalf of generators, prices will be higher than they would have otherwise been.

- *Decreased security of supply*
  An active demand side improves security of supply by encouraging voluntary reductions (through higher prices) at times of relative shortage thereby reducing the chance of involuntary load shedding.

- *Over-investment in supply side resources*
  To the extent that the demand side does not respond to higher prices through a reduction in consumption, additional resources to meet peak demand may be required thereby increasing the overall cost of electricity provision.

- *Increased environmental impacts*
  Production of electricity at levels higher than when the demand side actively responds will result in emission levels being higher than would otherwise be the case. To the extent that, at the margin, electricity tends to be produced by relatively low efficiency thermal plant, the emissions penalty tends to be greater than the average across the whole of the supply stack.

It is clear that there are many strong arguments, encompassing economic, environmental, regulatory and security of supply considerations, as to why it is important that the demand side of wholesale electricity markets be enabled to function as well as possible.

2.3 The Spot Market

The spot market (or real time energy market) is where short-term decisions are made on the production and consumption of electricity. On the supply side, it is expected that electricity will be supplied up to, but not exceeding the quantity at which the price received for the electricity covers the cost of its production.

Similarly on the demand, it is expected that electricity is consumed up to, but not exceeding the quantity at which the value of the electricity consumed exceeds the price that must be paid for it. If electricity continues to be consumed at prices above the level at which it is valued at the margin, there is cause for concern.[3] [4]

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[3] It is of concern because for every MWh that is consumed at a price that is above its value to the consumer, society is being made worse off; resources are being consumed for negative benefit.

[4] Here, for the moment, the impact of contracting on the incentives facing demand side participants is ignored. In practice, of course, the existence of fixed price supply contracts and CFDs between suppliers and generators is an important feature of most modern markets and something that has an important impact on the incentives facing demand side participants. The effect of this contracting on suppliers is picked up in more detail in subsequent sections of this document – see, in particular, Section 2.3.3 on the role of suppliers.

2.3.1 Understanding Price Volatility in Electricity Markets

Spot electricity markets tend to be distinguishable from other commodity markets by their relatively higher levels of volatility. Often there are short-term peaks of very high prices (many times the average), with relatively little in the way of demand side reduction. Developing an understanding and explanation for this behaviour is a key step in designing the demand side of wholesale electricity markets and forming a view with respect to the desirability of any accompanying demand side initiatives.

There are a number of different possible demand-side explanations as to why there should be such volatility in spot electricity markets - and in particular why the demand side does not seem to respond to high prices through demand reduction.

Understanding the differences in these explanations is important because they imply different actions and policies when it comes to designing the market institutions and rules to govern the demand side and/or separate demand side initiatives to accompany the market trading arrangements.[5] Explanations for the relative lack of responsiveness of the demand side include:

- *Cost of Short Term Response*

  First, for at least some consumers, there is a lack of short-term response to changes in prices to reflect genuinely high costs of reducing consumption. For example, many commercial and industrial consumers are likely to face considerable disruption to their business if called upon to reduce consumption at short notice.[6] Normally, it would only make sense for a commercial/industrial consumer to respond if (a) there was a very significant movement in prices and (b) electricity counted for a relatively large proportion of input costs.

- *Lack of Ability to Store Electricity*

  Second, and further to the first point above, there are relatively few substitutes available to consumers in the short term. In particular, unlike most other commodities, there is virtually no ability to store, and subsequently draw down on stored supplies of electricity in periods of high prices.

- *Poor Price Signals*

  A third explanation is that the price signals are either unclear or not passed through to the end-consumer. There are a number of sub-components to this explanation. First, in some markets the final price for electricity is not known until after the fact.[7] This means that any consumer wishing to tailor their consumption to price must rely on price forecasts rather than actual prices. The greater the uncertainty surrounding the price forecasts the less likely it is that the consumer will respond pro-actively. Second, the consumer may not be exposed to the locational marginal price (irrespective of whether it is made known *ex*

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[5] And also thus the assessment of existing demand side initiatives.

[6] The same level of disruption may not be exhibited over longer time frames when reduced energy consumption can be factored into the normal business planning processes.

[7] The New Zealand market is a case in point. In contrast, the proposed trading arrangements for the MAE propose an *ex ante* price setting mechanism. That is the price will be determined and made known to the market participants in advance of the trading period to which it applies.

post or *ex ante*). This may be the case for one of two reasons: (a) the price faced by the consumer may be smoothed by the universal wholesale spot market price, as in the MAE and (b) the price signal may be muted by the impact of contracts. In both cases the incentive to respond is reduced.

- *Bounded Rationality*

  A fourth explanation is that optimising for electricity costs is simply not a matter that enters into the consideration of decision-makers. Business managers by necessity must limit the matters that they take into account when making business decisions. Unless electricity is a major business cost component and its consumption is easily and cost-effectively controlled, for the most part, it simply makes no sense for management to pay any regard to electricity price movements - even if the price signals are available.

- *High Transaction Costs*

  Fifthly, the transaction costs of participating actively in the wholesale market may be of sufficient size to outweigh any associated benefits. Typically, markets impose participation fees on members. In addition, any strategy that involves responding to price signals will involve some form of price monitoring function and price response infrastructure or procedures to be triggered in the event that the price reaches a level that warrants a response. Thus even if on occasion it is worthwhile to reduce consumption in response to higher prices, the costs of continually monitoring and preparing to respond may outweigh the benefits associated with those few instances where it is cost-effective to do so. Under this set of circumstances, the best strategy is to simply ignore the price.

- *Paradigm Inertia*

  Finally, most electricity consumers have consumed electricity under a political and regulatory paradigm that allowed them to get (within limits) as much electricity as they wanted, when they wanted it, for a relatively fixed unit price. The inertia of this paradigm means that customers will exhibit a great deal of resistance to any change – either in their expectations or their behaviour.[8]

This explanations highlight the importance of developing rules surrounding the participation of the demand side that simultaneously compensate cost-effectively for market failures while preserving price signals which reflect the genuine lack of short term responsiveness of the demand side to price changes. They also highlight that extensive customer education will be required before any pervasive demand side response is likely to be seen.

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[8] Indeed, most of these parties will view that an individual customer's "rights" (to on-demand electricity at fixed prices) outweighs the "rights" of the customers as a group (to have lower prices, less investment, and lower volatility). In effect, each individual customer is free-riding on the system, with the effect of increasing the cost to all customers. It may be difficult, if not impossible, to convince any individual customer that it is in their best interests to suffer immediate personal increased costs in order to lower overall market costs over time. It will take a serious shift in this paradigm before real demand side benefits are seen; this shift may well be accomplished by (a) passing through the true costs of consumption, especially the real-time and locational costs; and (b) allowing the market offer innovative products in this true-cost market.

2.3.2 The Role of Suppliers

The analysis above has most relevance to those consumers either exposed directly to the wholesale market as demand side participants or those who might be exposed directly to the wholesale price via cost reflective tariffs with their suppliers.

In practice, however, consumers falling into these two categories are relatively few for a number of reasons:

- The costs of participation in wholesale markets tend to deter direct membership other than for those that consume large quantities of power and for whom the management of energy costs is a key business success factor.
- For most customers the available metering technology has not supported the choice of a pass through tariff.
- Many customers would simply rather not face the risk of periods of high prices that a pass through tariff might imply – even if it means lower prices for most of the time.

By far and away the most common arrangement is for the end-consumer to face tariffs with a fixed price (variable quantity). Thus, in the first instance, the entity exposed to the wholesale price is the supplier and it is the supplier that will be required to generate the demand side response, if indeed there is to be one.[9] Consequently, in contemplating the structure of the demand side of the market and any associated measures, it is important to understand the incentives (both efficient and perverse) that may face the supplier.

In practice, the extent to which the supplier will be incentivised to encourage a demand side response will depend on the relationship between the level of its tariffs and the cost of purchasing or supplying energy. So long as the cost of supply is below the revenue implied by the tariffs there is no incentive to encourage a demand side response.

Conversely, if the cost of supply rises above the tariff, as may occur in periods of shortage, the supplier has an incentive to encourage a demand side reduction.

Of course inducing a demand side reduction is not the only means by which suppliers can manage the risk of the cost of supply rising above tariff levels struck with their consumers (and/or the regulator). In particular suppliers can and do enter into contracts for differences with generators and/or vertically integrate in order to manage their exposure. Nevertheless, demand side management remains an option for suppliers.

In those circumstances where the supplier has an incentive to induce a demand side response, it faces many of the constraints already discussed in the previous section in getting the demand side to respond. In particular, bounded rationality and transaction costs issues will make it difficult for the supplier to induce

[9] The other potential sources of demand side response are network companies. In particular, network companies can benefit from load reduction or load shifting in that it can remove or defer the need for new investment in transmission and distribution infrastructure. However, as the activities of network companies lie outside the operation of wholesale markets, their contribution to demand side activity is not addressed in this document.

interest on the behalf of the consumer – particularly if the alternative is a fixed price tariff.

However, there are options available to suppliers as intermediaries that, in effect, remove some of the market failures that might have been present given the alternative of direct participation. For example, innovations such as pre-established arrangements with consumers to have their water heating switched off via a central switching arrangement under certain pricing conditions and for certain pre-determined durations can achieve a demand side response without incurring the transaction costs associated with a continual monitoring of the wholesale price by the consumer.[10] [11] [12]

2.4 The Ancillary Services Market

The ancillary services market is where reserves and other services necessary for the maintenance of power quality and effective system operation are procured. While it has traditionally been common for these services to be (mostly) provided by the supply side (i.e. generators), recent experience with reformed electricity markets suggests that the demand side can provide some of these services cost-effectively.[13]

In particular, wherever the demand side has been permitted to provide reserve it has become a significant player in the market place. The most obvious illustration is the New Zealand market which in recent times has seen a dramatic increase in the proportion of the reserve provided by the demand side. It is now not uncommon for 100% of the reserve requirement in some periods to be provided by interruptible load[14] in New Zealand.[15]

There are good reasons why this should be the case. In particular, unlike the supply side, there is no opportunity cost to the demand side associated with the provision of reserve. Generators, while on reserve duty cannot simultaneously produce energy. Thus in making themselves available for reserve, generators could forego profits that they could have otherwise been earning in the energy market. Co-optimisation automatically takes this into account and adds the foregone profit from the energy market to the offer price. This opportunity cost, in fact, sets a minimum threshold for generators' provision of reserve.

In markets that provide for the co-optimisation of the reserves and energy markets, there are additional benefits to the demand side in having reserves being provided by interruptible load. In particular, the more the demand side

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[10] In principle these opportunities are available to anyone who chooses to become an intermediary or aggregator of demand response arbitraging the differences between contract prices and spot prices. However, in practice the sunk investment in participation in the wholesale market along with their existing relationships with consumers makes it more attractive, at the margin, for suppliers to take on such a role.
[11] Note: These sorts of service are also valuable when it comes to the provision of reserve – this is discussed further in the following section.
[12] These sorts of activities have been seen in the Australian market.
[13] ESB NG already use the demand side for reserve in the Irish market.
[14] It should be noted that interruptible load in New Zealand is not subject to immediate interruption initiated when frequency falls below a specified trip set-point as is the case in Ireland. It is more akin to the Powersave scheme.
[15] To an extent this has been helped by the New Zealand market rules, which provide for the co-optimisation of reserve and energy as discussed further in this section.

can free up the supply side for providing energy (rather than reserve) the greater the likelihood that the energy market will clear at a lower price.[16]

Thus, in aggregate, the benefits (to the demand side)[17] of the demand side provision of reserves are three-fold. First, it provides the opportunity for the demand side to earn an additional revenue stream from a new service (i.e. the provision of reserve). Second, to the extent that cheaper demand side reserve displaces more expensive supply side reserve, it lowers the cost of reserve generally (costs which are met by consumers in the final analysis). Third, to the extent that the demand side provision of reserve frees up the supply side for the provision of energy, it can also lower the final energy prices faced by the consumer.

As indicated above, this natural advantage of the demand side in providing reserve has been shown in practice to be sufficient to overcome some of the disadvantages, barriers, or market failures associated with the demand side participation in wholesale markets already outlined earlier in this paper.

Consequently there are very good reasons for provision within the market rules for the demand side to be a supplier of reserve.

2.5 Conclusions

The analysis above enables a number of important insights to be distilled with respect to the demand side of the operation of wholesale electricity markets that will be useful in completing the detailed design. Key insights are summarised as follows:

- There are many advantages associated with having a well-developed demand side in the MAE including:
  - Lower prices and reduced price volatility.
  - Improved security of supply.
  - The mitigation of market power.
  - Long-term lowering of total infrastructure costs.
  - Lower emissions.
  - Greater efficiency / reduced fuel usage.
- In analysing the functioning of the demand side of electricity markets, it is important from a design/policy perspective to distinguish the following types of effects:
  - Demand side response effects that reflect the genuine economic costs of adjusting consumption in response to price movements and thus require an inelastic representation within the market.

[16] See *Commission for Energy Regulation: An MAE Consultation by the Commission for Energy Regulation Under SI 304 of 2003. 12 September 2003 (CER/03/230)* for a more detailed explanation for the co-optimisation of reserves and energy.
[17] Of course, some of these benefits to the demand side will be counter balanced by the losses to the supply side. Nevertheless, total benefits outweigh total costs and there is a clear economic gain to be had from the demand side participation in the ancillary services market.

  - Demand side response effects that might be attributable to some form of market failure and thus provide *prima facie* justification for particular demand side interventions.

- In designing the demand side of electricity markets, it is important to have regard to the areas of potential market failure without compromising the pricing signals that reflect the genuine short run costs in adjusting demand.

- Suppliers have a particularly important role in reflecting demand side responsiveness within electricity markets in that they have the ability to deplete some of the transaction costs that would have been incurred by the demand side market participants if they had participated directly. The extent to which suppliers are incentivised to induce a demand side response from their customers in practice will depend on:
  - The nature and extent of any contracting they may have in place.
  - The relationship between tariff levels and the wholesale market price.
  - The availability of suitable and cost effective technology for consumers to see and respond to price signals.

- The demand side has an implicit advantage in providing reserve in that it does not face the opportunity cost associated with the withdrawal of supply side resources from the provision of energy so as to be available for reserve duty.

- In addition, demand side provision of reserve has the potential to lower the cost of energy by freeing up valuable supply side resources that can be cleared in the energy market.

3. THE DEMAND SIDE UNDER THE MAE

3.1 Introduction

In this part of the document, the insights developed in section 2 are built upon to develop and evaluate specific proposals for the demand side of the MAE. This section also builds on the discussion of the design of the MAE demand side first introduced in the market design consultation paper released on 12 September 2003, taking into account the submissions received on it.[18]

3.2 The Spot Markets

There are two main design issues to be determined:

- First, whether demand side bids should be permitted as an explicit mechanism for accommodating the demand side within the market, and
- Second, if demand side bids are provided for, the price formation and settlement rules that should apply.[19]

3.2.1 Demand Side Bids

Demand side bidding provides the facility for licensed wholesale consumers[20] and suppliers to bid monotonically decreasing price quantity pairs into the market. The demand side bids would be "dispatched" if and only if the bids are cleared in the market. If not dispatched, the quantities bid for would remain unconsumed.

In general terms the advantage of the demand side bidding facility is that it provides for the demand side to be involved explicitly in the price setting process, as well as providing a degree of certainty with respect to the price conditions under which demand side participants will be supplied with electricity. Thus a demand side bidder can determine in advance the price conditions under which it wants to consume; the consumer does not need to monitor the prices in real time.

More specifically the advantages (and disadvantages) of accommodating an active demand side depend most critically on the detail of the arrangements relating to price formation and settlement. While some arrangements are likely to lead to economic benefits, other arrangements are likely to be value destroying. Evaluation of the various options available in this area is the subject of the next section.

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[18] Commission for Energy Regulation: An MAE Consultation by the Commission for Energy Regulation Under SI 304 of 2003. 12 September 2003. (CER/03/230)

[19] In addition to these issues of market design, there will also be a requirement that any facility that is to participate as an active demand side participant (either in the energy market or the ancillary services market) is technically capable of responding to despatch instructions. In this respect the active demand side participants are no different from their supply side counterparts. The precise nature of these technical requirements is something for the SMO to work through with the (potential) demand side participants.

[20] It should be noted that under SI 304 wholesale consumers will have to hold a suppliers license to be eligible to have some or all of its load to be certified by the SMO as dispatchable

It should be noted however that, irrespective of whether or not the MAE provides for demand side bidding, the demand side will (or ought to) influence the price of electricity in some form or another. If there is no provision for demand side bids, those portions of the demand side interested in responding will simply use forecast prices as a basis for their decisions on whether or not to consume. [21]

3.2.2 Price Formation and Settlement Rules

As indicated above, the parameters that are most critical in designing the MAE demand side are those associated with the price formation and settlement rules. It is these rules that have the largest potential to impact (positively and negatively) on the economics of providing for active demand side participation within the MAE.

In the remainder of this section some of the issues and options in this area are reviewed. The issue of how the price formation and settlement process might be impacted by the proposed uniform wholesale market price is firstly examined, before the merits of three different price formation and settlement options are considered.

A. UNIFORM PRICE OR LMP

The introduction of the proposed uniform wholesale spot market market price raises the question of the price to be used in determining whether or not demand side bids are cleared.

In theory, there are two options. First the demand side bid could be cleared if and only if the price bid is greater than or equal to the uniform price. This option is the most meaningful from the consumer perspective in that it allows the consumer to relate their bids directly to the price that they would otherwise pay if they were to participate merely as a passive consumer.

The alternative is for bids to be cleared if and only if they are greater than or equal to the LMP price. This option makes the most sense from an economic perspective in that by stripping out the cross-subsidisation impact of the uniform wholesale price the true marginal cost of supply (as given by the generator offers) can be compared to the true marginal benefit of consumption (as given by the demand side bids). Thus, it is this option that is most likely to lead to the economically beneficial dispatch of the demand side.

In addition the second option is much more tractable from a technical perspective. The difficulty with the first option is that the uniform wholesale price is not known until *after* the market clearing engine has produced the market clearing injection and withdrawal quantities and prices at all of the

[21] The question of whether or not a passive demand side response has an impact on prices depends critically on the approach taken by the SMO to the task of load forecasting. If the SMO assumes an elastic demand (i.e. assumes demand will be lower, if prices go higher) then the existence of a demand side response in real time affects prices; effectively the forecast of elastic demand mimics the impact of demand bidding. If however, as is more commonly the case, the demand side is assumed to be totally inelastic, a passive response serves only to reduce the quantities consumed in real time, and has no impact on prices.

market nodes within the network. As such, the uniform wholesale price does not form part of the optimisation process.[22]

For both these reasons, the second option is to be preferred. Thus, there is a *prima facie* case for demand side bids to be settled at the LMP price and, consequently, that the uniform price be calculated net of any quantities associated with demand side bidding.

Note, however, that even if demand side bidding is included and cleared and settled at the LMP price, the existence of the uniform price still provides some distortions to the operation of the demand side bidding mechanism. In particular, those demand side participants located at a node which has a price systematically below the uniform price have a strong incentive to participate in the demand side bidding scheme, as it avoids the cross subsidy that they would otherwise have to pay consumers at other higher price nodes. Consumers at these nodes would be incentivised to participate as a demand side participant – even if they had no intention of switching off if the price went high (i.e. taking an active part in the market).

Conversely, for those loads located at high price nodes, there would be little incentive to be involved in the market as an active participant – even if it is technically possible for them to do so. The better strategy would be for them to simply turn off if prices were to go high. This asymmetry in the incentive structure with those at lower price nodes opting out of the uniform wholesale price determination process will have the impact of driving up the uniform wholesale price for all remaining consumers exposed to it.

The situation would be complicated even further, if loads were allowed to maximise their position by opting in and out of the demand side bidding facility, as prices at their node oscillated above and below the uniform wholesale price. In particular, the SMO would face an impossible job in trying to forecast the demand side.[23]

Finally as indicated above, there are, over and above the question of how to accommodate demand side bidding with the uniform price, a number of additional options that need to be worked through with respect to the detail of how the demand side influences the price setting process. These are discussed below. The first two have already been canvassed in the MAE Consultation Paper released by CER on the 12 September 2003. The third is a proposal received by ESB NG in response to the Consultation paper.

B. OPTION 1: DEMAND SIDE BIDS ARE CLEARED ON THE DEMAND SIDE

Under the first option, the demand side is factored into the market in the same way as it might in any other market. That is, demand side bids are cleared so long as the price at which the demand side is willing to consume (given by the

[22] The MCE optimises directly the bids and offers to produce the "cheapest" dispatch. Even LMP prices are an output of the solution with the comparison between the bid and the LMP being implicit not explicit.

[23] For these kinds of reasons, it is recommended that restrictions be placed on the election of demand side participants to change from being actively to passively involved in the market and vice versa.

price quantity bids from the demand side) is above the price at which generators are willing to supply (given by the price quantity offers from generators).

For all demand side bids cleared, the demand side **pays** the market clearing (LMP) price. This option is illustrated in the figure below. The shaded area represents the total payments made (P_1,Q_1) from the demand side to the supply side.

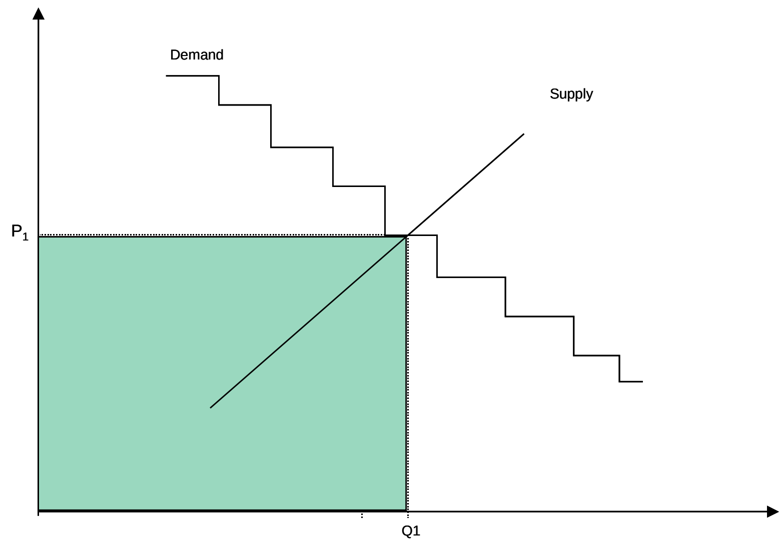

Figure 1

This option is by far the simplest of all the options considered and the most robust from an economic perspective. However, it is also likely to have the least impact in terms of encouraging the demand side to bid actively in the market; the advantages to the demand side of active bidding viz-a-viz responding passively to price are slight.

C. OPTION 2: DEMAND SIDE BIDS TREATED AS AN ALTERNATIVE TO SUPPLY

Under this option, demand side bids are treated by the market as (potential) substitutes for supply side offers. The intuition behind this option is the view that it may be more cost-effective for the market to meet a shortfall between demand and supply in any period by backing off demand rather than increasing supply.

Thus, in contrast to the first option, where the demand side **pays** to consume, under this option the demand side is **paid** to reduce consumption below the level at which they would have otherwise consumed. The fact that under this option, the demand side is being **paid** to stop consuming means that it is much more likely that the demand side would be interested in participating in a demand side bidding regime. Furthermore there is every chance that the demand side bids may be lower than the supply side alternatives resulting in a lower market clearing price (at least on initial analysis).

The economics of this option are sketched out in the figure below. The consideration of the demand side response (DSR) as an alternative or substitute for generation is represented by the creation of a new supply curve to the right of the original generator only supply schedule. The notional equilibrium point is given by the intersection of the new supply curve and the remaining demand curve (i.e. P* Q*). The **payments due** to the supply side (i.e. generators plus dispatchable demand) is correspondingly equal to the shaded area(s) described by P*, Q*.

Note however that the volume of electricity consumed is not Q* but Q_2. Thus the money received by the market is P^*Q_2. This leaves a settlement shortfall of $(Q^*-Q_2)\ P^*$ which must be recovered from the market as an adder to the volume of electricity consumed (Q_2). This gives a final price of P_2.

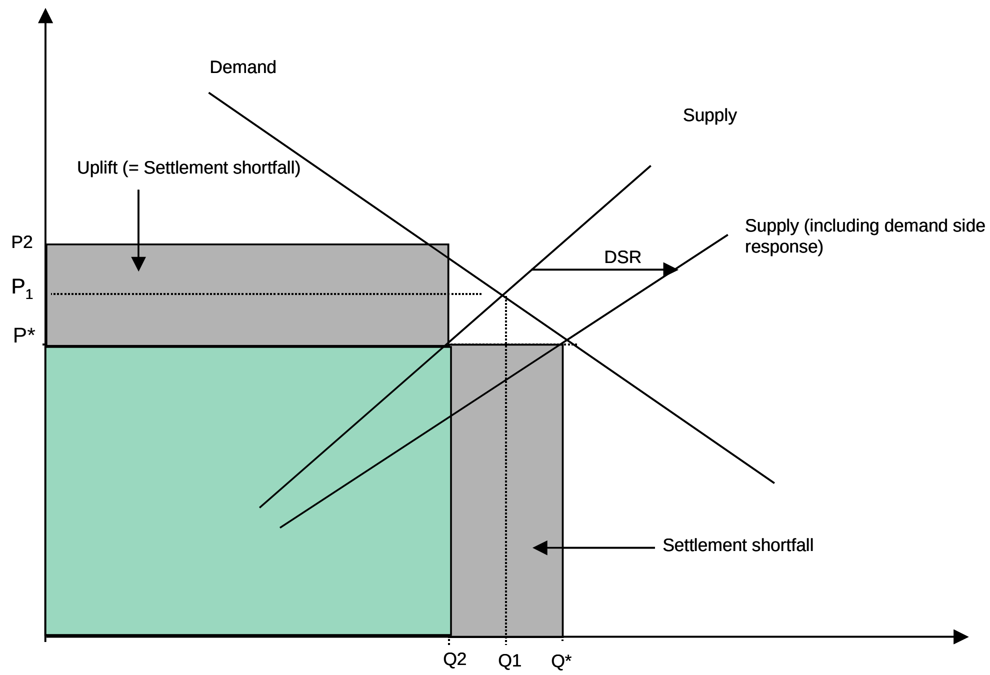

Figure 2

Of particular note is the fact that the advantage, in terms of lower prices resulting from the treatment of demand side bids as alternatives to supply that appear in the first instance, tend to evaporate once the settlement implications are fully worked through. Furthermore, there is no sense in which the final prices and quantities that result have any economic meaning; there is no sense in which they relate to either the marginal cost of supply or the marginal willingness to consume electricity.

In practice, there can only be one justification for a proposal of this type – that is that there is some kind of market failure of a type discussed in Section 2.3.1 **and** that that market failure is corrected for by the changes in quantities and prices that this mechanism would result in. The problem with proceeding down this line of reasoning is that there is no analytical connection between the solution and the problem.

For these and a range of practical reasons the option of treating the demand side as a substitute for supply side resources is not recommended.[24]

D. OPTION 3: DEMAND SIDE PURCHASES AT THE UNIFORM PRICE AND SELLS AT THE LMP PRICE

ESB NG in their submission on the 12 September 2003 Consultation Paper proposed a third option, incorporating some of the components of Options 1 and 2. The substance of the ESB NG proposal is as follows:

- All demand is charged at the uniform price.
- For dispatchable demand that is called to reduce, it is:
  - first charged the uniform price for the full expected volume before reduction and
  - then paid the LMP price for energy not consumed.

In essence this amounts to the demand side, first, buying the power at the uniform price and subsequently selling it back to the market at the LMP price. As such, and as noted by ESB NG, it avoids the settlement issues associated with Option 2. It also avoids the disincentive associated with Option 1 for consumers at high price nodes to be involved in demand side bidding.

However, it does create another set of problems. Firstly it creates an opportunity for load at the high price nodes to simply arbitrage the difference between the uniform price and the LMP price – buying low at the uniform price and selling high at the LMP price. The greater the volume the more money to be made. This means that it is likely to be extremely difficult in practice to determine the appropriate volumes to be used for settlement; there is an incentive for the demand side participant to buy and sell back as much as they can get away with.

Secondly, it removes all incentives for demand side bidding at the low price node. Clearly there is no value to the consumer in selling power back to the market at a price lower than the price that was paid for it originally. The better strategy is simply not to purchase in the first place.

E. CONCLUSIONS ON PRICE FORMATION AND SETTLEMENT

At the theoretical level, the choice of rules relating to price formation and settlement is reasonably straightforward. In particular there are strong economic arguments for demand side bids to be cleared and settled on the demand side (Option 1) and not as alternatives to supply (Option 2).

In practice, the development of an appropriate set of rules covering the demand side is complicated by the possibility of market failure (resulting in demand side responsiveness being less than is optimal) and, in the case of the MAE, the introduction of the single uniform price on the demand side.

However, the Commission is of the view that neither of these considerations provides sufficient justification for moving away from Option 1. Firstly, with

[24] One of the non-trivial practical implications of this option is the requirement to establish a baseline for the demand side resource, i.e. the establishment of levels of consumption that would have occurred had the demand side resource not been instructed to turn-off.

respect to the possibilities of market failure, there is no analytical connection between the (price, quantity) outcomes that Option 2 would lead to and what might be required to correct for the market failure.

While Option 3 has the effect of correcting for some of the distortions that might result with respect to Option 1 arising from the introduction of the single uniform price, in so doing it creates others. It is not at all clear that it represents an improvement.

Inevitably the choice will require compromises. In the final analysis, it is the Commission's view that Option 1 remains the best of the available compromises.

3.3 The Ancillary Services Market

The involvement of the demand side in the provision of reserve involves no special considerations. All of the technical rules relating to the provision of reserve from the supply side (relating to responsiveness etc.) are also relevant to the demand side provision of reserve.

Similarly, the issue of settlement is also relatively straightforward. When on reserve duty, the demand side gets paid in the same way as the supply side.

If dispatched while on reserve duty (i.e. instructed to turn off) the demand side participant would simply save the revenue for the power that they would have otherwise consumed. Thus, if the participant would have otherwise paid the uniform price, by not consuming, it would simply save the uniform price times the quantity not consumed. Similarly if the demand side reserve provider was an active demand side participant normally settled at the LMP price, it would save the LMP price times the quantity that would have otherwise been consumed.

As indicated earlier, the opportunity cost and other advantages the demand side has over the supply side in the provision of reserve provides strong prima facie grounds for supposing that the demand side will be a cost-effective provider of reserve within the MAE. In this respect, it is different from expectations with respect to demand side bidding in the energy market.

3.4 Supplier Incentives

In a vertically integrated utility there are incentives to get customers to reduce load or change consumption patterns. This reduces the peak load and increases the load factor reducing capacity costs. Traditionally ESB offered a tariff which incentivised customers on maximum demand tariffs to reduce load at peak times, WDRI which is described in Appendix A. With the bi-lateral contracts market introduced in February 2000, new entrants revenue returns were based on generation output. Thus it was not in the interest of suppliers contracted to new generation to get customers to reduce load even at peak times. As a result, the peak load in Ireland grew more than the average growth rate. This resulted in an erosion of the capacity margin and it was necessary for ESBNG to introduce a special incentive (the Winter Peak Demand Reduction Incentive (WPDRS)) in 2003 to reward customers who reduced load at peak hours. This scheme is also described in Appendix A as are the other existing demand side initiatives in Ireland.

As stated in Section 2.5, the extent to which suppliers are incentivised to induce a demand side response from their customers will in practice depend on:

- The nature and extent of any contracting they may have in place.
- The relationship between tariff levels and the wholesale market price.
- The availability of suitable and cost effective technology for consumers to see and respond to price signals.

These issues are particularly relevant under the MAE given that participants will enter into financial arrangements to hedge against potentially high (or low in the case of generators) pool prices. These financial contracts will have a quantity and price element. At times when the pool price exceeds the strike price, generators will pay suppliers the difference times the contracted quantity. Therefore, if suppliers can get customers to reduce load below the contracted volume they will still get paid the difference between the pool price and the strike price for the reduced volume. When pool prices are high relative to the strike price suppliers could make a significant profit if customers reduce load. They could pass some of these profits on to the customers to incentivise them to reduce load at those times.

However, where customers are not metered on-line there will be minimal incentives as it is assumed that the standard profile will apply. Thus, only on-line metered customers will be in a position to avail of price signals in the market. However, the standard meter for business customers does capture customer time interval data. This data could be used for reconciliation purposes. Thus it is possible that these customers could be settled initially using the standard profile but this could be adjusted for the actual data when reconciled. This process is used in the UK and is known as Metering Out of Settlement Timetable (MOST). The ESB is currently examining the possibility of MOST at the behest of the Commission.

3.5 Implementation Issues

Providing for the active participation of the demand side in the MAE will require the relevant infrastructure to be put in place including, in particular:

- Relevant provisions within the market rules.
- Relevant provisions within the software.
- The establishment of relevant technical arrangements and protocols with respect to the dispatch and metering of cleared demand side bids.

Notwithstanding the benefits to be had from the active participation of the demand side, it is perfectly possible for the market to be established without demand side bidding in the first instance. The argument for doing so is that, there is benefit in phasing in the various components of the market over a period so as to enable the market participants to assimilate its various components more effectively. However, in order to provide for the subsequent introduction of an active demand side and to avoid the imposition of additional implementation costs, it is proposed that the necessary infrastructure (and in particular the market rules and necessary software) be developed at the same time and to the same timetable as the infrastructure for the rest of the market. This is in effect the route taken with the introduction of the new market in Singapore. Experience in New Zealand has shown that it is much more cost-effective to design the market inclusive of the demand side bidding than to add the facility to the software and the market rules at a later date.

The Commission is persuaded by arguments of this nature. Thus the Commission proposes that the systems should be designed to accommodate demand side bidding but its introduction should be deferred for some time after market opening. This will provide market participants sufficient time to first become familiar with the supply side of the market and will allow for the development of appropriate procedures and processes to accommodate demand side bidding.

With respect to the demand side participation in the ancillary services market(s), the argument for its inclusion right from market start is much stronger – for two reasons. First, as discussed earlier, the demand side has a competitive advantage in the provision of reserve. Second, given that the system operator already utilises interruptible load, its delay would amount to an unjustifiable disruption to the status quo.

APPENDIX A: OVERVIEW OF EXISTING DEMAND SIDE INITIATIVES

This appendix provides a brief overview of the main demand side initiatives that are currently existing in operation. The measures reviewed fall into three main categories:

- Offerings made by ESB PES to their end use customers:
  - The Winter Demand Reduction Incentive Scheme (WDRI).
- Offerings made by ESB PG to their supplier customers including:
  - Winter Peak Management Program (WPMP).
  - Powersave.
- Offerings made by ESBNG including:
  - Winter Peak Demand Reduction Scheme (WPDRS).
  - Interruptible Load.

In practice, most of these initiatives are motivated by public policy concerns related to generation adequacy (i.e. sufficient supply at system peak). Consequently most are directed towards reducing peak demand, particularly over the winter period, rather than improving the efficiency of the wholesale market *per se.*[25] As such they are not particularly well-directed to the policy task of responding to the particular market failures inherent in the operation of the spot market discussed in the body of this document, nor do they necessarily represent the kinds of initiatives that might be expected from fully commercial entities operating within a fully competitive environment[26].

A.1 ESB PES DEMAND SIDE INITIATIVE

A.1.1 Winter Demand Reduction Incentive Scheme

The Winter Demand Reduction Incentive (WDRI) scheme is an incentive scheme offered by ESB PES for its "Maximum Demand" customers to reduce their demand at peak hours during winter months. Typically the demand of these customers is measured between 8am and 9pm, Monday to Friday. However, for customers that notify ESB PES of their intention to reduce demand during these peak hours and partake in the WDRI scheme, the maximum demand charged is the maximum demand during the specified peak hours of 5pm to 7pm, Monday to Friday in the billing months of November, December, January and February, subject to a minimum demand of 30kW.

Customers who wish to derive the maximum benefits of the scheme typically conduct an analysis of their use of electrical equipment, record demands and operation hours and assess opportunities to change energy use behaviour to reduce demand between 5pm and 7pm. These changes in energy use behaviour usually entail:

[25] As indicated in the introduction to this document, the place of the demand side in assuring generation adequacy will be addressed in the Consultation Document dealing with the Generation Adequacy Safety Net mechanism.

[26] The use of interruptible load by ESB NG is the obvious exception

- Use of standby generators between 5pm and 7pm.
- Rescheduling of batch processes outside of the 5pm and 7pm period.
- Adjustment of plant closure times and shift changes.

The key benefits of the scheme for the final customer are:

- There is no charge for availing of the incentive.
- There is no penalty if the demand is not reduced.
- Substantial savings can be achieved.

Dependent on the level of take up, there can be significant costs benefits for suppliers in regard to the reduction of load during peak hours. However, one of the areas of potential concern with initiatives of this nature is the possibility of free-riders. In particular, it encourages those consumers with individual peaks outside the system peaks nominated by ESB PES to take up the scheme *even though they have no intention of changing their consumption patterns*. The introduction of standard time-of-use tariffs may be more appropriate.

A.2 ESB PG DEMAND SIDE INITIATIVES

A.2.1 Winter Peak Management Program

The WPMP is a mechanism whereby ESB PG calculates a rebate payable to suppliers based on the characteristics of their customers' loads. It rewards load that reduces at peak times. The WPMP is available for customers being supplied by VIPP.

The load reduction is calculated as the difference between the supplier's monthly average total customer load between 08.00 and 22.00 excluding 17.00 and 19.00 and their monthly average total customer load between 17.00 and 19.00. The WPMP applies on weekdays, excluding bank Holidays, for the months of November, December, January and February. The rebate rate has been designed to be consistent with the WDRI component of the ESB PES tariff structure.

A.2.2 Powersave[27]

Powersave is an incentive scheme for customers to reduce demand at times when the generation plant margin is tight (as determined by the TSO). The scheme is available to registered customers of suppliers who meet all of the following criteria:

1. Can demonstrate to the supplier that they can reduce their load by a minimum of 300kW when called upon to do so under the scheme.

2. Have suitable metering and suitable telecommunications equipment installed.

3. Have suitable consumption data for at least the week before the customer registers for the scheme is available to the Meter Registration System Operator (MRSO).

[27] This scheme is administered by MRSO. Powersave is also available to some CHP generators.

4. Do not exceed their Maximum Export Capacity in the event of their exporting onto the ESB transmission or distribution system, as appropriate.

Powersave Periods[28] are declared at the discretion of the TSO. The supplier subsequently requests the customer to reduce load via a facsimile and/or email at least 30 minutes before the Powersave Period begins. The supplier also sends notification at least 30 minutes prior to the ending of the Powersave Period to the customer.

Although the reduction of demand is voluntary, on receipt of a notice from their supplier the customer must reply within 30 minutes by facsimile or e-mail confirming whether or not they intend to reduce their load.

The methodology employed to calculate the financial remuneration of the customer for participation essentially involves a comparison of a customer's consumption during the Powersave Period with the same period for each of the previous four weeks[29]. Under the scheme, a payment is made by the supplier to the customer based on figures, provided by MRSO, regarding the reduction in the number of kWh consumed by the customer or increase in the number of kWh exported by the customer during the Powersave Period, compared to the normal number of kWh used or exported by the customer. The formula used to calculate the payment per period is as follows:

Payment per period = €((0.2539)*(kWh_{no} – kWh_{ro}) + (0.6349)(kWh_{np} – kWh_{rp}))

where

kWh_{no} = is the average number of kWh that the customer consumes or exports during Off-Peak Hours for the same day of the week of the previous four weeks and in the same period of time now being called as a Powersave Period.

KWh_{ro} = is the number of kWh the customer consumes or exports in the period during Of-Peak Hours now being called as a Powersave Period.

KWh_{np} = is the average number of kWh that the customer consumes or exports during Peak Hours for the same day of the week of the previous four weeks and in the same period of time as called in the Powersave Period.

KWh_{ro} = is the number of kWh the customer consumes or exports in the period during Peak Hours now being called as a Powersave Period.

For the purposes of this calculation kWh exported by the customer to ESB under the Powersave Scheme are regarded as a negative quantity. If the calculation of an individual payment results in a negative figure then this figure will be treated as zero.

[28] This is the period during which the supplier requests the customer to reduce load under the scheme. This period is declared by the TSO

[29] There are a number of excluded days which are not used for comparison purposes such as a public holidays, all days between 24th December and 1st January inclusive, a day on which there was a Powersave Period or a day on which there was an interruption to the supply to the customer from the ESB transmission or distribution network.

Many Powersave customers also avail of the WDRI (or WPDRS) scheme therefore the load reduction at the peak is not significant. However, this scheme usually involves customers reducing load for a much longer period and Powersave has contributed significantly to system reliability when called on to operate. The Commission considers that Powersave could continue in some form going forward.

A.3 ESB NG'S DEMAND SIDE INITIATIVES

A.3.1 Winter Peak Demand Reduction Scheme (WPDRS)

Again this scheme is designed to incentivise customers to reduce load between 5.00pm and 7.00pm on business days[30] between November and February. It was introduced in 2003 to provide non-PES customers with an incentive to reduce load during peak hours. It is expected that the scheme will continue each winter until 2005/06, prior to the commencement of the new market arrangements for electricity. CER considers that under the MAE there will be incentives for suppliers to get customers to reduce load at peak hours and that therefore, the WPDRS will not be necessary going forward. However, it may take some time for the market to stabilise and therefore it may be desirable to continue the WPDRS for the first year or two of the MAE.

Eligibility

The scheme is only open to those customers with quarter hourly meters who are eligible customers in accordance with S.I No. 3 of 2002 Electricity Regulation Act 1999 (Eligible Customer) Order 2002 (i.e. consumption of 1GWh or greater) and for whom a Capacity Baseline Level and the Energy Benchmark Volume have been calculated. WPDRS is not available to PES customers. Also, customers who wish to participate in the scheme must have the ability to reduce their metered consumption between 5.00pm and 7.00pm on business days in winter months. This can be achieved by switching plant off at this time of through the use of on-site generation.

Operation of the Scheme

The scheme involves customers indicating to ESBNG the level of load reduction they will be able to provide during the peak period of 5.00pm and 7.00pm on business days during the winter months. Customers are subsequently rewarded for:

- Reliability (remaining below the load quantity they have committed to)
- Reduced Energy Consumption

The bulk of the payments of the scheme are for reliability. Customers receive €160 MWh for remaining below the committed quantity. There is also an energy payment of €50 MWh for every unit of demand reduction delivered.

[30] This means any day other than a Saturday, Sunday or a public holiday in the Republic of Ireland

The reliability payments are calculated using the Capacity Baseline and the new Committed Capacity level. The Capacity Baseline, against which any customer load reduction is measured, is defined by ESBNG and is based on expected demand and is fixed for the entire season. Customers agree to reduce demand to a new Committed Capacity, which is the level of demand that the customer commits not to exceed during the peak period over the winter months. Customers get paid on the Committed Quantity (i.e. Baseline – Committed Capacity). For example:

> Let the *Capacity Baseline = 1MW* and the *Committed Capacity = 0.4MW*, therefore *Committed Quantity = 0.6MW.*
> Given that the *Reliability Payment Rate* is *€160/MW per hour*, then
> *Daily Reliability Payment* equals *0.6 * €160 * 2 = €192*

A rebate is levied if customers exceed the committed level. The rebate rate is ten times that of the reliability payment rate (€1600/MW for consumption over agreed committed level). The daily rebate level will be based on the highest level of breach recorded on the day. The maximum rebate on any one-day will be limited to five times the customers daily total reliability payment. If, in any calendar month, the total rebate exceeds total payments the customer payment will be set at zero (i.e. customers cannot become liable for payments to ESBNG under this scheme).As alluded to earlier there is also additional payments of €50 MWh for every unit of demand reduction delivered.over peak period. The Energy Benchmark Volume reflects energy consumption measured in MWh within the two-hour peak period on business days. The Energy payment will be made, in each half hour, for demand below the Benchmark.[31]

Overall, the total payment for the day is the Reliability payment plus the Energy payment.

Compliance

ESBNG use metered energy to monitor levels of load reduction achieved by each customer and then calculate the level of payments that each customer should receive under the scheme.

It should also be noted that suppliers are required to co-ordinate applications from their customers, to ensure completed applications are received by ESBNG, to assist ESBNG in the administration of the scheme and to make payments to their designated customers. Supplier are incentivised to participate in the scheme by the fact that they receive a sum equal to 5% of the amount payable to their customers.

[31] It should be noted that a cap is placed on the amount that each customer can receive in daily Energy Payments. Daily Energy Payments will be paid up to 50% in excess of the Energy Payment that would have been made had the customer reduced their consumption by only the committed reduction throughout the period. The Energy Payment cannot be negative in any half hour.

A.3.2 Interruptible Load

Interruptible load is part of ESBNG's portfolio of operating reserve products. It is subject to immediate interruption, without notice, from 07:00 to 24.00[32]. It is initiated by the frequency dropping to a defined trip set-point. Reconnection can occur once frequency remains above a defined reconnection set-point. This generally occurs within five minutes. The existing interruptible load scheme contract allows for up to 20 interruptions per annum. Payment is made for making load available for interruption, it not related to the number of interruptions, and this payment is made directly to the customer or supplier. The basic payment is 0.707 cent/kWh[33] for metered interruptible energy consumed by the interruptible load from 07:00 to 24:00'.

The interruptible tariff[34] was introduced in early eighties and the most recent interruptible load competition was held during August and September of 2003[35]. It is expected that the number of customers participating in the Interruptible load scheme will rise from 33 to 39 customers, subject to the finalisation of contractual arrangements. The existing level of Interruptible load is approximately 34MW, with the quantity of contracts under the new scheme expected to rise to 57MW. ESBNG consider that interruptible load is good value and may look for additional load in the future. The Commission envisages this scheme continuing in the MAE.

A.4 COMMENT

As indicated in the introduction to this Appendix, the existing demand side initiatives are directed primarily towards responding to a capacity issue rather than being motivated by a view that there is some form of market failure in the energy market that requires a demand side response.[36]

As capacity-focused interventions their continued existence must be considered against the capacity elements of the new trading arrangements – and in particular the principles and theory underpinning the design of the energy only market and the capacity assurance safety mechanism. This issue will be taken up in a subsequent consultation document.

[32] These are the hours of service for the new scheme that is to be launched in the near future.
[33] This is the price per MWh for the new scheme.
[34] The interruptible tariff is described in Appendix A
[35] The contractual arrangements have yet to be finalised with customers who participated in this competition. The scheme implementation process has yet to be concluded and as result quantities for the new scheme are subject to change.
[36] The use of interruptible load by ESB NG is the obvious exception.