

New Short-Term-Operation-Reserve Services in the UK Electricity Market

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Abstract—After a Reserve Review process and consultations with a regulator and interested market participants, National Grid, which also has a role of the System Operator in the UK electricity market, has decided to modify the procurement of reserve services. This means that the current Standing Reserve service arrangements will be replaced by new Short-Term Operating Reserve Tender. The implementation of these changes is planned for 1 April 2007. This paper outlines the old Standing Reserve services, introduces the new Short-Term Operating Reserve Tender, and then investigates the reasons that have initiated these changes as well as the expected economic benefits.

Index Terms—ancillary services; System Operator; Standing Reserve; Short-Term Standing Reserve; UK electricity market.

I. THE UK ELECTRICITY MARKET DESIGN

THE design of the UK electricity market has evolved from the early days compulsory England & Wales Pool where majority of energy was traded via centralized pool, into the current structure where the most of energy is traded through bilateral trades. This change had a profound effect not only on the ways in which market participants behaved and interacted, but also on the settlement of imbalances between the contracted and actual position of trading parties, as well as on the provision of ancillary services.

The major change in the operation was introduced in April 2001 when the New Electricity Trade Agreements (NETA) became operational and replaced the previous Pool market. Under the new structure, the main mechanism to trade energy became bilateral trading done through forward and futures markets, as well as short-term power exchanges. The forwards and futures markets are bilateral contract markets for firm delivery of energy, that trade from the short term prompt to as far out the curve as required by the market. In the UK, there is also a 24 hour power exchange (APX Power UK) which allows market participants the opportunity to fine-tune their position before the gate-closer so as to avoid cashout prices in the Balancing Mechanism.

The final adjustment between a generation and demand in real-time is done through the Balancing Mechanism. While

market participants may only match their generation and demand levels to a half-hour granularity, decentralized operation via bilateral trading is not sufficient to guarantee that power balance equations will be satisfied at any instant in time. The Balancing Mechanism is, therefore, a necessary physical market whose role is to ensure power balance and secure system operation. It is a centralized type of market where each physical market participant can submit offers and bids to participate and provide different types of ancillary services. Although less than 5% of energy is traded through this market, it is crucial for secure system operation.

Note that according to their participation in the Balancing Market, units are classified as *Balancing Mechanism (BM)* and *Non Balancing Mechanism (Non-BM)*. These units are classified differently in Standing Reserve Tenders for the provision of various Ancillary services because the System Operator appreciates that there are reserve providers who are willing to provide valuable balancing services, but who do not want to be full Balancing Market participants with all the associated obligations. A typical Non-BM provider would be a large industrial demand user such as a steel smelting factory who is able to interrupt their demand consumption on occasion for a limited period of time and hence provide a valuable reserve service (at a price) to the System Operator.

In April 2005, Scotland joined the electricity market of England & Wales, so that NETA was replaced by British Electricity Trading and Transmission Arrangements (BETTA). This allows Scottish and English market participants to compete on “a level playing field”.

II. ROLE OF THE NATIONAL GRID AS THE SYSTEM OPERATOR

In the UK National Grid has a twofold position. On one hand, it is the owner of the transmission network in the England & Wales (Scotland is under a different Transmission Owner Structure), and on the other, it is the System Operator for the whole England, Wales and Scottish markets.

As a Transmission Owner in England & Wales, National Grid has responsibility for Transmission access and outage planning. For Scotland, National Grid enters into agreements with how Transmission access is managed with the respective Transmission Owners.

As a System Operator (SO), it has a responsibility to ensure secure system operation in the economically sound

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manner. This includes (i) managing the security and quality of supply in specific timescales; (ii) balancing generation and demand economically and efficiently, and operating Balancing Mechanism after the Gate Closure, and (iii) provision of the information to the market. Maintenance of secure operation involves a number of actions such as demand forecasting, resolving of transmission congestion, keeping voltage profiles within specified limits, securing network against faults, etc., for which NG has to acquire various Mandatory and Necessary ancillary services. As described in NG operational documents [1,2] the Commercial services that it buys on the market include:

- Enhanced Reactive Service
- Frequency Response
- Fast Reserve – Greater than 50MW in size with ramp rate of at least 25MW/min. Delivery commences in under 2 minutes and fully available in 5 minutes
- Standing Reserve – minimum block size of 3MW and fully available in 20 minutes. To be replaced by STOR on 1 April 2007.
- Warming - Now termed BM StartUp. A contract to enable a generator to reach a state of being able to synchronize at short notice.
- Intertrip – now more formalized payment structures for arming and utilization
- Emergency Assistance – reciprocal service between System Operators
- Maximum Generation Service– a non firm best endeavors service

The Transmission License stipulates the obligation for the NG to balance and maintain secure operation in an economic and efficient way. Since NG is a for-profit organization, its role of the SO is monitored by a British regulator – The Office of Gas and Electricity Markets (Ofgem), which has also devised a set of incentives that entitles NG to retain some profits if it succeeds to maintain costs of secure operation below certain thresholds¹.

Procurement of each of the above-mentioned services is defined and regulated by a set of documents and agreements, and this paper will investigate provision of Standing Reserve. In particular, we will discuss recent review process that resulted in replacing the contracted Balancing Service of Standing Reserve with a new Short-Term Operating Reserve Tender (STORT). The implementation of these changes is planned for 1 April 2007.

¹ In the operational year April 2006-April 2007, the NG is operating without the incentive scheme, however it is expected that for the next year this scheme will be again agreed on.

III. INITIAL BALANCING SERVICE OF STANDING RESERVE

A. Definition [3]

At certain times of the day, National Grid needs extra Short Term Operating Reserve in the form of either generation or demand reduction to be able to deal with actual demand being greater than forecast demand and plant breakdowns. This requirement can be a manually instructed delivery of active power, which is met from synchronized and non-synchronized sources, and is provided by a range of service providers including short notice generating units as well as demand reduction.

A historical change of contracted Standing Reserve services since 1996 is given in Fig. 1. It also shows how much of the contracted services has been provided by BM and Non-BM units.

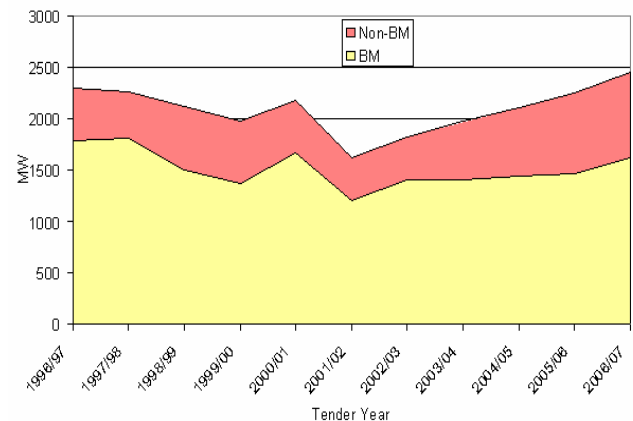


Fig. 1. Contracted Standing Reserve Capacity

Normally, the need for Short Term Operating Reserve is not static, but rather varies across the year, and depends on the time of week and time of day. It is also a function of the system demand profile and historic analysis of when utilization of Short Term Operating Reserve is required. To reflect this, National Grid splits the year into five Seasons, for both Working Days (including Saturdays) and Non-Working Days (Sundays and most Bank Holidays). It also specifies the periods in each day for which the Short Term Operating Reserve is required. In the Standing Reserve Tender, these periods are referred to as *Availability Windows*. For each of these periods both Balancing Mechanism (BM) and Non-Balancing Mechanism (non-BM) participants are given the opportunity to tender in services to match National Grid's reserve requirement.

B. Service Requirements and Provision

In general, market participants can submit tenders to provide either *Committed* or *Flexible Services* [4]. For the first type, providers are obliged to make the service available in all contracted service periods, and in return, the NG will

pay for all the availability offered, subject to the service being made available. This, of course stands only for contracted offers.

The Flexible contracts, on the other hand, do not oblige service providers to make the service available all the time, and thus NG is not obliged to accept these offers. Note that for this latter type of contracts the payment is made only if the availability is accepted.

National Grid makes two kinds of payments for Reserve services:

- *Availability payments* – payment to the service provider which makes its unit/site available within an Availability window. This payment is on £ /MW/ h basis
- *Utilization payment* – payment for the energy delivered on £ /MW h basis.

In order to be able to participate in the Standing Reserve service tenders, each Provider has to fulfill certain requirements so that it can be used by the NG. These requirements include:

- offer a minimum active power of 3MW; this can be provided from more than one site as long as the aggregated total is above 3MW, and it can be instructed and metered from one point of control;
- if offering service from aggregated sites, then NG must agree with the geographical location of the sites;
- offer a Response Time from instruction by NG to actual generation or demand change of no more than 20 minutes;
- provide contracted Reserve for at least 2 hours when instructed;
- have a recovery period after provision of the Reserve of not more than 1200 minutes (20 hours);
- provide Standing Reserve at least:
 - 2 times a week for non-working days, or
 - 3 times a week for working days or both working and non-working days

In the current market design that is in effect till April 2007, Standing Reserve is contracted annually via a competitive tender process, and notification is given via the National Grid web site.

For example, the annual tender round for the period 5 a.m. on 1 April 2006 till 5 a.m. on 1 April 2007 was carried out in the following steps [4]:

- Invitation to Tender documentation was published on September 5, 2005.
- Market Day – deadline for submission of tenders to the NG was November 4, 2005.
- Tender assessment was carried out between November 2005 and January 2006.
- Tenderers were notified of the outcome on January 30, 2006.
- Standing Reserve Arrangements were offered to all successful tenderers.

In the above-mentioned Tender assessment, all tenders are evaluated so as achieve minimum cost solution in meeting the Short Term Reserve Requirements from the tendered bids and other alternative resources that are available to the NG. The assessment also takes into consideration cost of instructing Reserve providers, as well as system constraints.

In the January 2006 tender, there were 148 discrete tenders offering a total volume of 2808 MW, which is approximately 70-80 % of the total Short Term Operating Reserve Requirements. Of these tenders, 2103 were for committed services and the reminder flexible. In general, about 75% of Non-BM providers tender via the flexible service.

A scatter plot of Availability price and Utilization price for the tender 2006/2007 is shown in Fig. 2.

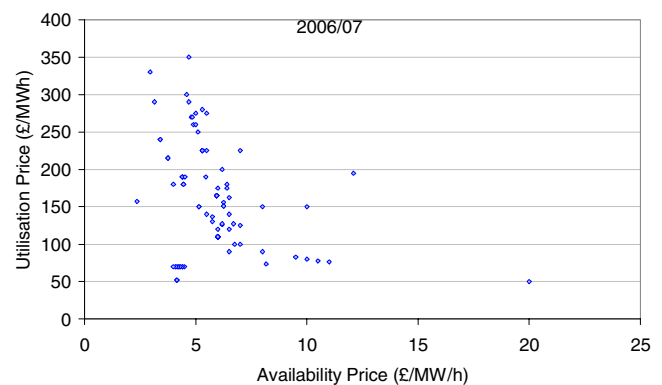


Fig. 2. Standing Reserve Tender Prices

Fig.2., indicates that this tender attracts a range of availability and utilization prices. On the one extreme are participants who offer low availability price but high utilization. These providers are priced such that they will only occasionally be called upon by the System Operator. At the other extreme are providers who put in a high availability price to benefit from upfront fixed income, but by submitting a lower utilization price, they expect and are willing to be utilized regularly.

From the above given tender data, National Grid carried out an economic assessment of the Tenders and accepted 2439MW of Standing Reserve. This comprised 1600MW of BM providers and 839MW of Non-BM providers. This is well over half of the overall Reserve requirement required by the System Operator.

An example of the volume (MWh) of Standing Reserve service utilized each month for a tender period 1 April 2005 to 1 April 2006 is given in Fig.3. The total of availability payments for this period was £ 37m. Fig.3. also indicates the amounts provided by BM and non-BM units, while the monthly payments for availability and utilization to these units are given in Table I. Note that these payments exclude any reconciliations that are not paid to providers which had failed to meet their contracted obligations.

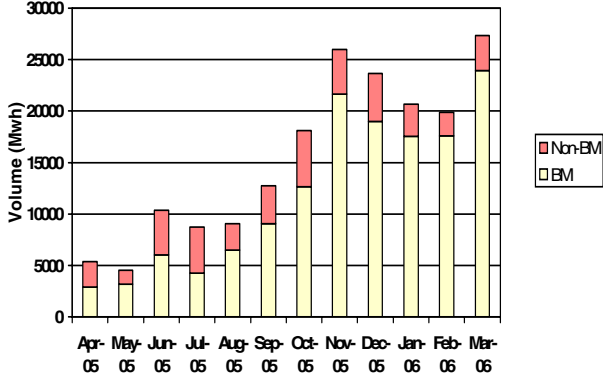


Fig.3. Volume of Standing Reserve utilized during 2005/06

TABLE I: UTILIZATION AND AVAILABILITY MONTHLY PAYMENTS TO BM AND NON-BM UNITS PROVIDING STANDING RESERVE IN 2005/06

Month	BM		Non-BM	
	Avail (m)	Util (m)	Avail (m)	Util (m)
April 05	£1.760	£0.556	£0.613	£0.261
May 05	£1.794	£0.743	£0.589	£0.224
June 05	£2.033	£3.539	£0.879	£0.431
July 05	£2.298	£2.557	£1.040	£0.419
August 05	£2.611	£3.028	£1.170	£0.374
September 05	£1.929	£0.759	£0.768	£0.356
October 05	£2.142	£0.856	£0.735	£0.535
November 05	£2.753	£2.489	£0.630	£0.557
December 05	£2.825	£0.584	£0.685	£0.594
January 06	£2.789	£3.261	£0.660	£0.309
February 06	£2.399	£1.829	£0.572	£0.231
March 06	£2.435	£1.204	£0.575	£0.416
TOTAL	£27.768	£21.405	£8.916	£4.707

IV. A RESERVE REVIEW - WHY CHANGE?

The objective of the Reserve Review process [5] was to address issues that were raised by some participants, while ensuring that NG has an appropriate set of Balancing Services so as to maintain secure operation in an efficient and economic manner. The aim was to widen the participation of different generating units and allow for better inclusion of the demand providers. In order to do that a new Short-Term Operating Reserve Tender that allow for a response time of up to 240 minutes was introduced, which also caused the change in the definition of the Availability Window. Fig.4., which shows the volume of positive energy delivered by response time (time between instruction and initial delivery, within gate closure), illustrates that this additional flexibility of a longer response time could be beneficial.

In addition, multiple tender rounds within year will be introduced to encourage liquidity by providing additional flexibility and opportunities to tender.

The details of this new service are discussed next.

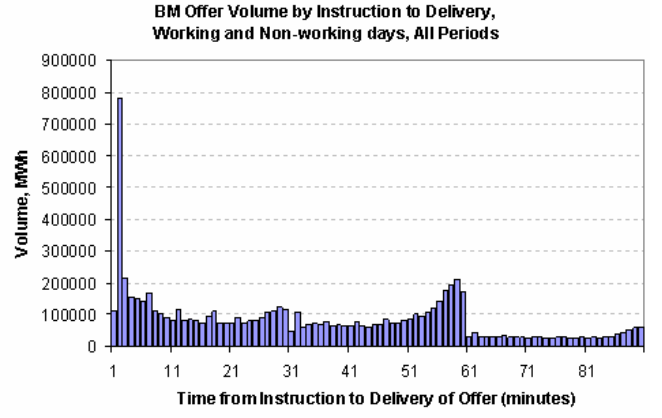


Fig.4. Volume of positive actions by Time from Instruction to Initial Delivery for period November 2005 – October 2006

V. NEW SHORT-TERM OPERATING RESERVE (STOR)

A. Reserve Requirements

To offset uncertainty in demand forecast and on generation availability, National Grid needs to procure a certain amount of Short Term Operating Reserve (STOR) that will be available at various timescales in order to cover all foreseeable contingencies. Under new arrangement, there are two categories of the Reserve:

- *Short Term Operating Reserve Requirement (STORR)*, which includes
 - Reserve for Response
 - Regulating Reserve – Reserve available on synchronized plant
 - Short Term Operating Reserve – not required to be synchronized and can include demand users
- *Contingency Reserve*
 - To cover uncertainties at timescales greater than 4 hours ahead

These requirements are illustrated in Fig.5., for Day-1 to Real Time framework.

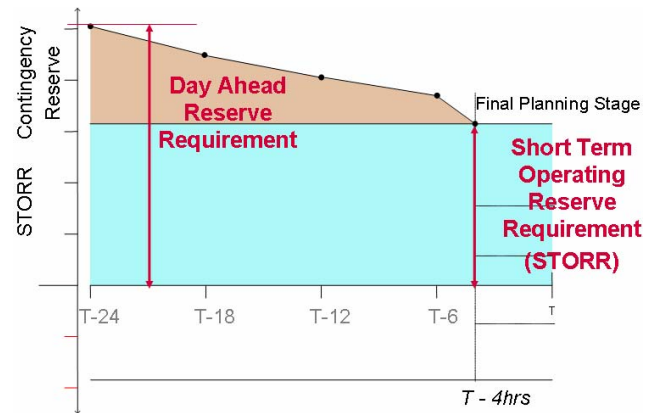


Fig.5. Day-1 to Real Time Reserve Requirement

If National Grid envisages that it will not have enough Reserve, it will issue warnings to the market in order to give market participants an opportunity to make extra plants available.

The assessment of the Reserve Requirements is based around 1 in 365 criteria or a 99.7% likelihood of meeting demand in full. The Reserve Calculation is based on observed historic distributions of plant losses and shortfalls, as well as on the demand forecast error. There are also seasonal factors that affect the Reserve Levels. For example, there is generally a higher requirement on a Monday morning to reflect the extra uncertainty around generation that has been off all weekend. In addition, the weekend reserve requirement for morning demand ramp is generally lower as the rate of change of demand at weekends is significantly lower than during the week. However, contingency reserve requirements may be higher during a weekend. Moreover, Saturday and Sunday have different requirements to reflect the different demand profiles over both of these days.

As mentioned above, under new arrangement there are two categories of the reserve, and the focus of this paper is on the Short Term Operating Reserve Requirement (STORR) and the new Short Term Operating Reserve Tender (STORT).

B. What is the new STORT service?

The Short-Term Operating Reserve Tender (STORT) is a contracted Balancing Service for the firm availability or Reserve at certain times of day – Availability Windows – with pre-agreed prices and delivery dynamics. National Grid sets availability windows across 6 seasons based on historic analysis of where it believes the need to forward procure Reserve is greatest. Table II gives an indication of Availability Windows for 2007/08. Working Days are Monday to Saturday and Non Working Days are Sundays and Bank Holidays.

As for the previous Standing Reserve operation, this service can be provided by both BM and non-BM participants, and it allows for participation of both generators and demand users. The main changes in the reserve services are that the new STORT services increase the response time and introduce a number of subcategories of Short-Term Operating Reserve Requirement (STORR):

- **0 – 20 minutes** Response Time, which is a Recover reserve for response following the largest generation loss and to cover short term unexpected demand changes;
- **20 – 90 minutes** Response Time, which covers for level of uncertainty in Balancing Mechanism and demand forecast;
- **90 – 240 minutes** Response Time, which covers for a level of uncertainty outside of Balancing Mechanism and demand forecast;

TABLE II. TYPICAL AVAILABILITY WINDOWS FOR STORT

	Working Day		Non Working Day	
	Start Time	End Time	Start Time	End Time
1 1st April 2007 - 28th April 2007	07:00	13:30	10:00	14:30
	19:00	22:00	19:00	22:30
2 29th April 2007 to 18th August 2007	07:30	14:00	09:30	13:30
	15:30	18:00	19:00	22:30
	19:30	22:30		
3 19th August 2007 to 23rd September 2007	07:30	14:00	10:30	13:30
	16:00	21:30	19:00	22:00
4 24th September 2007 to 27th October 2007	07:00	13:30	10:30	14:00
	16:30	21:00	17:30	21:30
5 28th October 2007 to 2nd February 2008	07:00	13:30	10:30	13:30
	16:30	21:00	15:30	20:30
6 3rd February 2008 to 31st March 2008	07:00	13:30	10:30	13:30
	16:30	20:30	16:30	21:00

Fig.6. illustrates a typical breakdown of National Grid's requirements into above defined categories. The subdivision into these categories allows for more flexibility since some providers and especially demand providers may not be in a position to offer services under the old 20-minutes response time. The System Operator still expects a significant proportion of STORR to remain under 20 minutes as shorter notice providers are typically more valuable to cater for unexpected generation losses or sudden changes in demand. However, the introduced changes are expected to increase market liquidity (by opening up this market to providers who need longer than the old 20 minutes) and allow both NG and market participants to enter into agreements that are more economical, as it is expected that longer-notice plants will have a lower availability and utilisation price. Note that each of the above services still have to provide reserve for at least 2 hours after being instructed to step in.

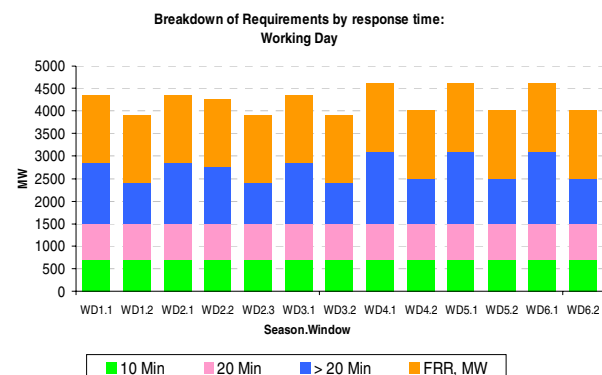


Fig.6. Working Day breakdown requirement by response time.

It is also important to note that while there was a change in a Response time, other technical parameters have remained the same. These include the minimum amount of contracted MW that is set to 3 MW, number of utilizations per week, intervals between utilization, etc.

Furthermore, due to this significant change in a Response time that can be up to 240 minutes, there is also a modification in the definition of the Availability Window. Under this modification, the Availability Window of the STOR is defined as the period during which a Contracted Unit/ State is required to be available for *Contracted MW*. As a consequence, there has been a change in the timeframe in which a utilization instruction may be issued

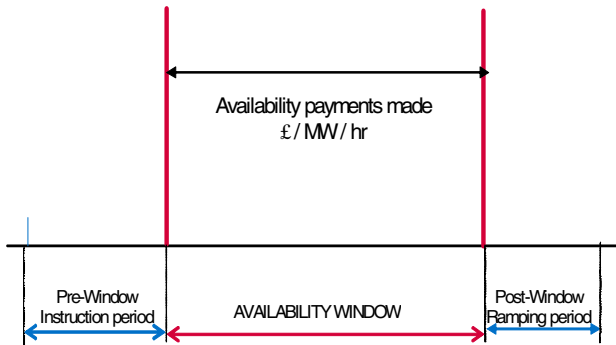


Fig.7. Availability windows and response periods.

Under original Standing Reserve, instructions could be given only within the Availability Window, however under the new STOR a utilization instruction may be given prior to the start of the Availability Window, and the return to the original position may be after the Availability. These extensions are indicated in Fig.7. as pre-window instruction period and post-window ramping period. Note that under new STOR services for deliveries that are outside the Availability Window, service providers will be paid for at the contracted Energy Utilization Price.

C. How does it work? Contracts and Tenders

Similarly as for the original Standing Reserve, providers will submit their offers through tenders. However, under this new scheme the number of tender rounds per a year will increase to 3. The tender process will be started by National Grid who will publish the necessary documents and tender information to allow providers an opportunity to calculate a submission. The first documents that outline procedure appeared in December 2006. The providers will have to submit their tenders by the Market Day which for the first round will be 19 January 2007. The tenders have to include the following information:

- Tenderer's Details
- Plant Dynamics
 - Response Time – time from instruction to Contracted MW
 - Cease Time – time from Contracted MW to zero
 - Minimum Utilization Period – minimum duration of reserve provision

- Recovery Period – minimum interval between utilization
- Minimum Generation Level
- Availability Price (£/MW/h)
- Energy Utilization Price (£/MWh)
- Availability
- Tenderer Unit/Site Identifier
- Technical Details for new Non-BM Providers

As in the operation under current Standing Reserve regime, providers will also be able to tender for either the Committed Service or the Flexible Service. A Provider of the Committed service makes the service available to National Grid in all Availability Windows over the contract term (apart from when unavailability is for technical reasons).

On the other hand, a provider of the Flexible service may choose the Availability Windows in which it wishes to make the service available to National Grid. Unlike the Committed Service, this kind of a Provider may elect to make the service unavailable for any reason. National Grid will then decide whether to accept the service at a week ahead stage.

All Committed and Flexible Tenders are subjected to a Tender Assessment process by National Grid that decides which of the tenders will be accepted and contracted. The assessment process is based on an optimization procedure that selects tenders to minimize the total cost of Balancing the System. The selection process considers four main requirements:

- Any inherent reserve
- Level of Reserve required
- Cost of Reserve options
- Operation parameters of the Reserve plant

The parameters that are considered include:

- System requirements
- Dynamic parameters
- Commercial implications
- Minimum operating levels
- Contingency planning

In addition, due to transmission limitations, it is possible that at certain periods there could be geographical restrictions as to which of the providers are selected. This, however, should not be too often.

It is envisaged that the results of the assessment will be published on the National Grid website. In addition, it is planned that there may also be a Post-Service Assessment Process. This is intended as a weekly process that will start in April 2007, and will involve determining whether to accept the weekly availability declarations of Flexible STOR providers. Since this is a new concept, the Post-Service Assessment Process will provide assessment of the service delivery of individual provider, evaluate whether the service meets desired standard, and build up understanding of service provision for future STOR assessments. In general, if a provider fails to deliver the service expected then availability payments can be withheld.

VI. CONCLUSION

It is expected that the increased flexibility of the new STOR service will allow more market participants to take part in offering Reserve to the System Operator. This should give better opportunities to the NG to balance the system in a more economic and efficient manner, while at the same time permitting different types of generators and especially demand providers to submit offers for the provision of one of the STOR subcategories. As the Market Day for the first round is January 19, 2007, there are no available data at the moment, however they will be discussed during a panel presentation.

VII. ACKNOWLEDGMENT

The author would like to thank National Grid, UK, and in particular to Rachel Morfill and Andrew Ryan for their support for this project.

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IX. BIOGRAPHIES

Samuel (Sam) Matthews received the B.Eng degree from The Queen's University of Belfast in 1989. He remained at Queen's University and received his PhD in Power System Harmonics three years later. After graduation, he joined GEC ALSTOM (HVDC Systems, UK) and was involved in the reactive power and harmonic control on HVDC schemes. After 1 year he joined National Grid and was involved in Transmission planning. He left National Grid in 2001 to become an Energy Trader in UK gas & electricity markets for Entergy Koch Trading. During this time, he completed his MBA from Warwick University. He then returned to National Grid in 2004 to eventually become Strategy & Assessment Manager, responsible for the assessment of reserve contracts in the UK market.

Ivana Kockar received the B.Sc. degree from the University of Belgrade, Yugoslavia. After 4 years in industry, she obtained the M.Eng and PhD degrees in electrical engineering from McGill University, Montreal, Canada. Following her studies she spent a year at University of Manchester, UK, as a Research Associate. Currently she is a lecturer at Brunel University, UK.

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