There are a number of commercial and technical mechanisms by which the variable elements of distributed energy resources (DER) can participate in the generation to demand matching process.

The timescales for participation are:

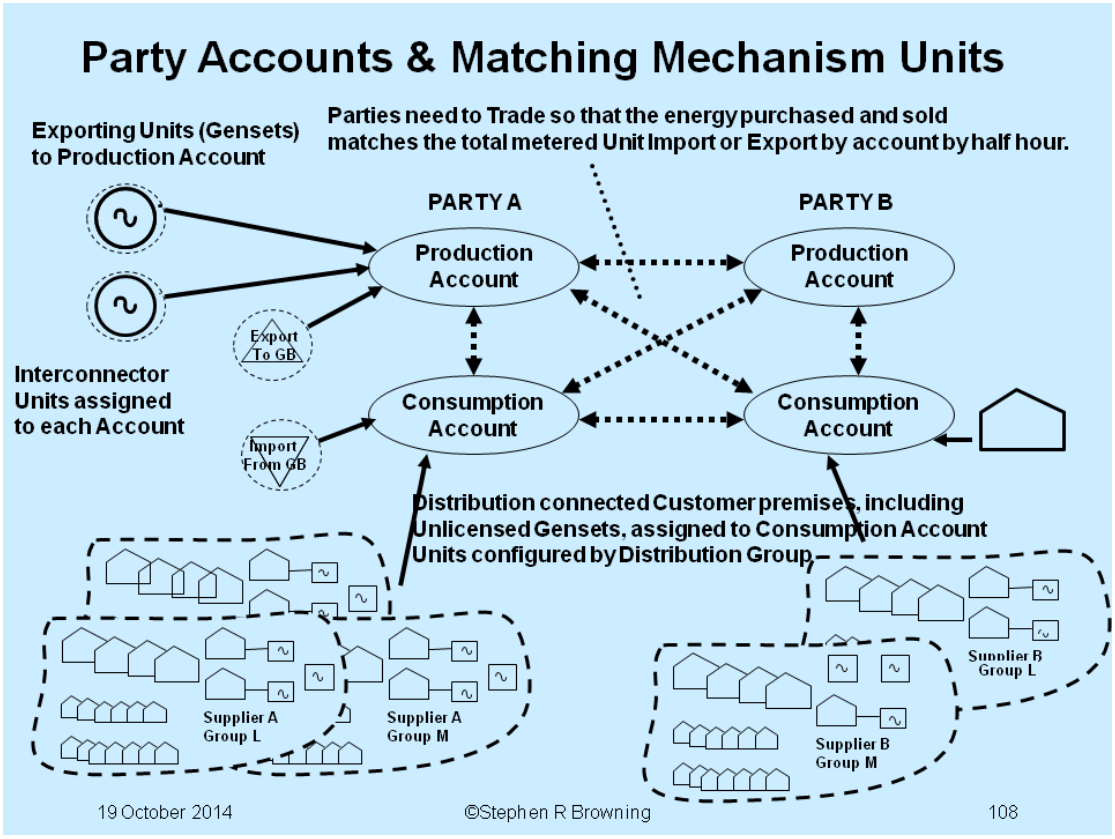
- System operator realtime ancillary services (response, reaction and reserve).
- System operator dispatch timescale power instructions (up to 1.5 hours ahead).
- Distribution operator realtime and lead timescale local security management.
- Market timescale energy trading - half hour block process down to 1.5 hours ahead.

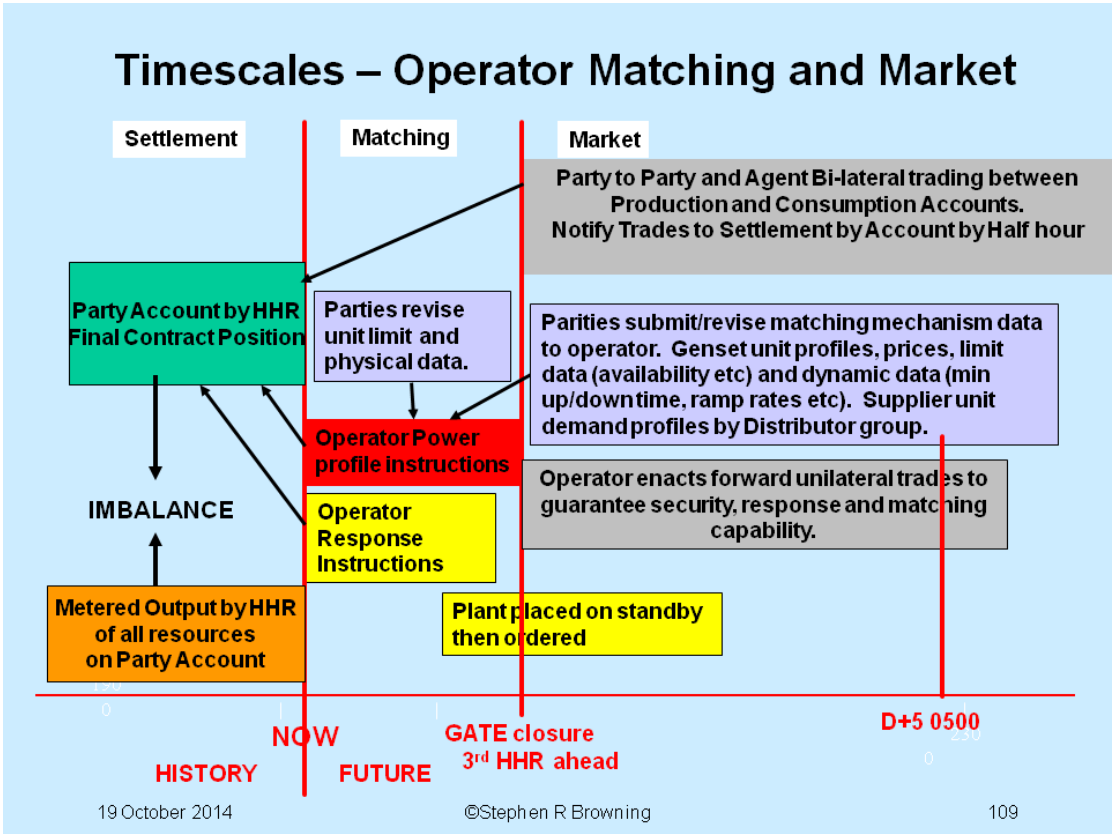
There are four basic mechanisms by which DER can participate.

- Trading. The participant offers to increase or decrease export and import in power or energy blocks over defined time periods at a defined price. The supplier or operator accepts the offer which forms a controlling contract.
- Tariff. The primary tariff for Premises Import and Export is structured on a time varying basis and price profiles are signaled at different lead times.
- Control. Agreements are set up so that Premises Import and Export can be changed in response to a control instruction. This is the classic ancillary services ‘near real time’ mechanism for demand management, applied by the system or distribution operator.
- Automatic. Control actions executed automatically by sensing at the premises. Tripping of premises generation or UPS isolation of same following mains failure and ancillary services response to frequency deviations are examples.

GB Market and Operator functions

Now let us look in more detail at the Great British market and operator functions.





In the market timescales, Supplier parties purchase energy and Generator parties sell energy, by account, for each half hour time slot. Some of these bi-lateral trades will be executed well in advance; further adjustment trades are made in shorter timescales as supplier account demand forecasts become more accurate.

Generators and Suppliers will process their traded positions into continuous power profiles for matching mechanism units. These represent individual generating units (gensets) and each supplier's total demand within each distributor group. The power profiles are submitted to the operator, together with matching mechanism prices, limit data (availability) and dynamic data (ramp rates, minimum stable generation etc) for each unit

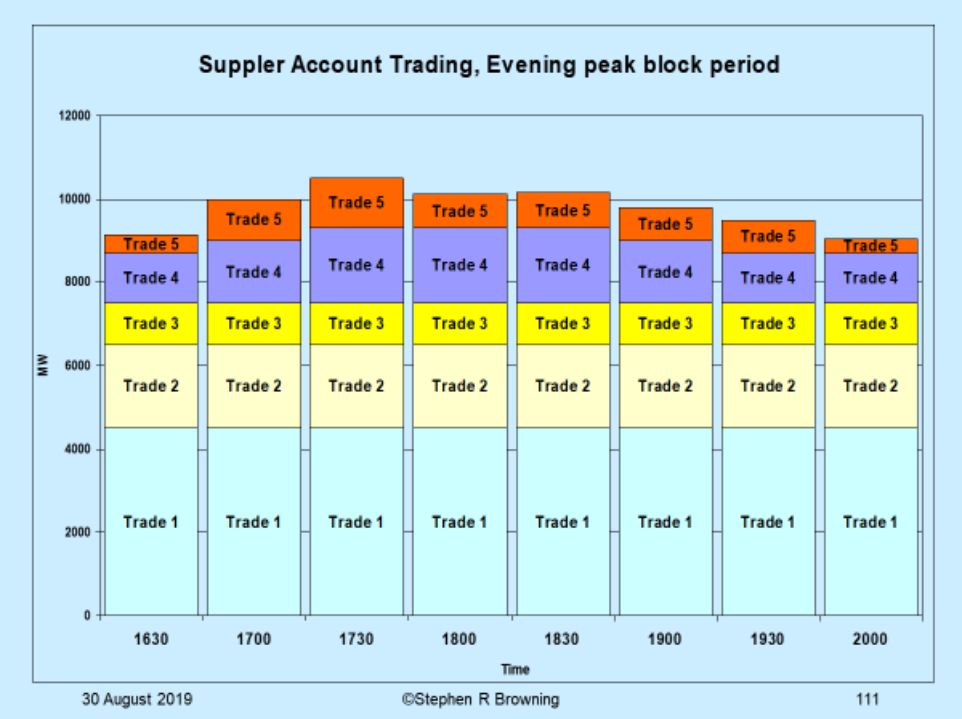
The operator initially uses this data to check that the synchronised gensets will be adequate to meet his evaluations of the requirements for demand, response/reserve and transmission security for each time period. He can execute limited scope unilateral trades to improve the position or use ancillary service contracts to place extra gensets on standby and later commit them to run.

Every half hour, market trading ceases for the third half hour ahead which is then added to the matching mechanism window. Within this window only the operator can instruct changes and only to the power profile and response settings of matching mechanism units, taking into account their limit, price and dynamic data. Within the window the limit and dynamic data can be revised by the owners as a result of a physical change (e.g. unit trips), but not the prices nor the traded profile.

All trades, operator instructions and response/reserve delivery volumes are submitted to settlement. The sum of the energy of all contract actions (market trades, operator unit trades and unit response delivery) by party account by half hour is calculated and compared with the metered and meter derived energy for that half hour. The difference is party imbalance energy which is charged or credited at prices derived from operator instructions within and market trades for that half hour.

Market Trading

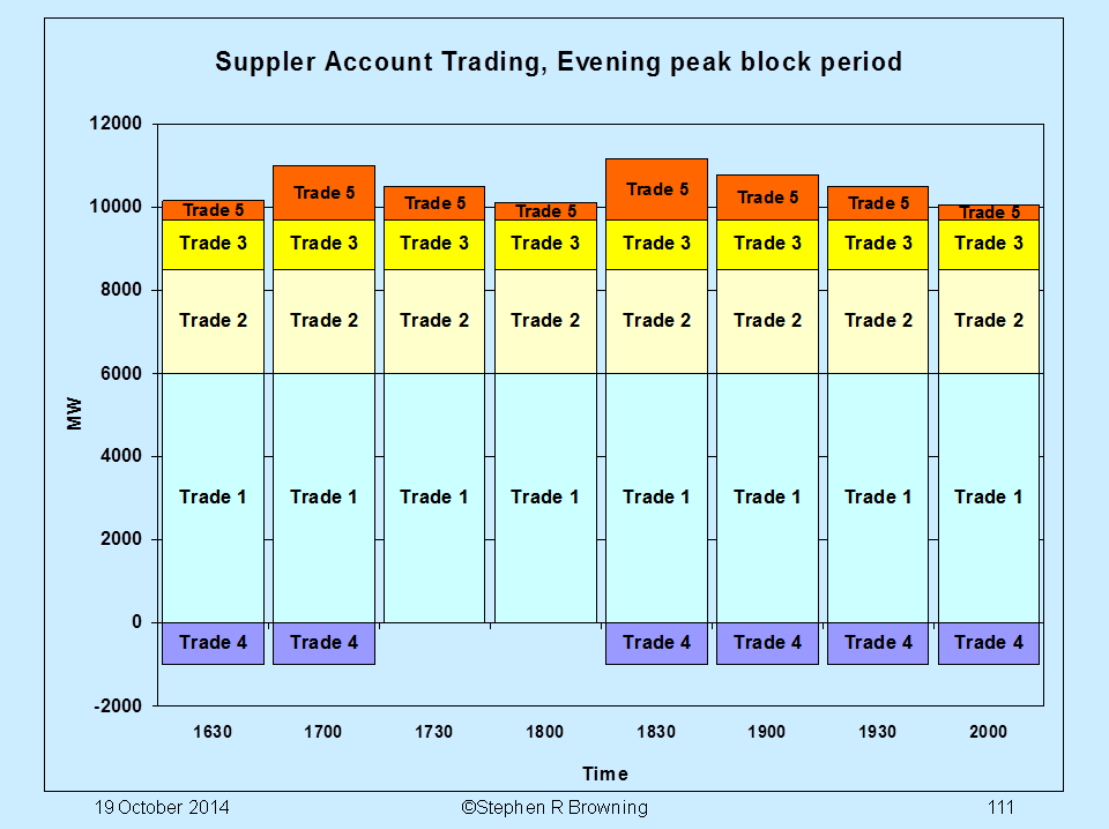
Let us look trading in Market timescales. Each Supplier party will build up a 'stack' of trades for each half hour during the period leading up to that time. Some of that trading will be in the form of seasonal contracts brokered months in advance.



The supplier party will build up trades over time, first for the block four hour period. He will then refine his position by half hour, as market closure approaches for his estimate of the demand for that period improves.

It is quite difficult for the supplier to make an accurate estimate of demand. Customers can change supplier after each agreed minimum contract period expires. This means that the supplier's historic demand records are not a reliable basis for forecasting, unless he can maintain a stable customer base.

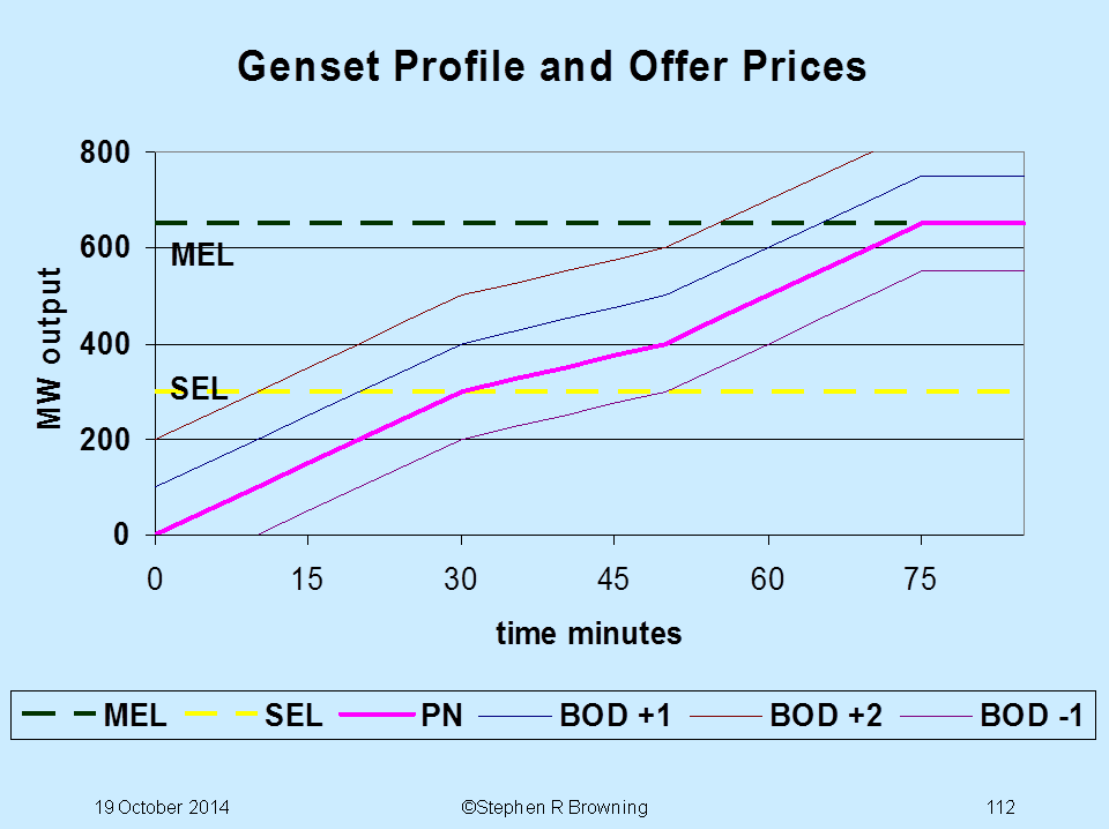
In practice the supplier may also sell energy back into the market if he has early contracts which summate to exceed his later estimates of demand.



Operator mechanisms – Matching and Ancillary services.

The system operator will have received notification of the power profiles (PN in the next diagram) for each matching mechanism unit.

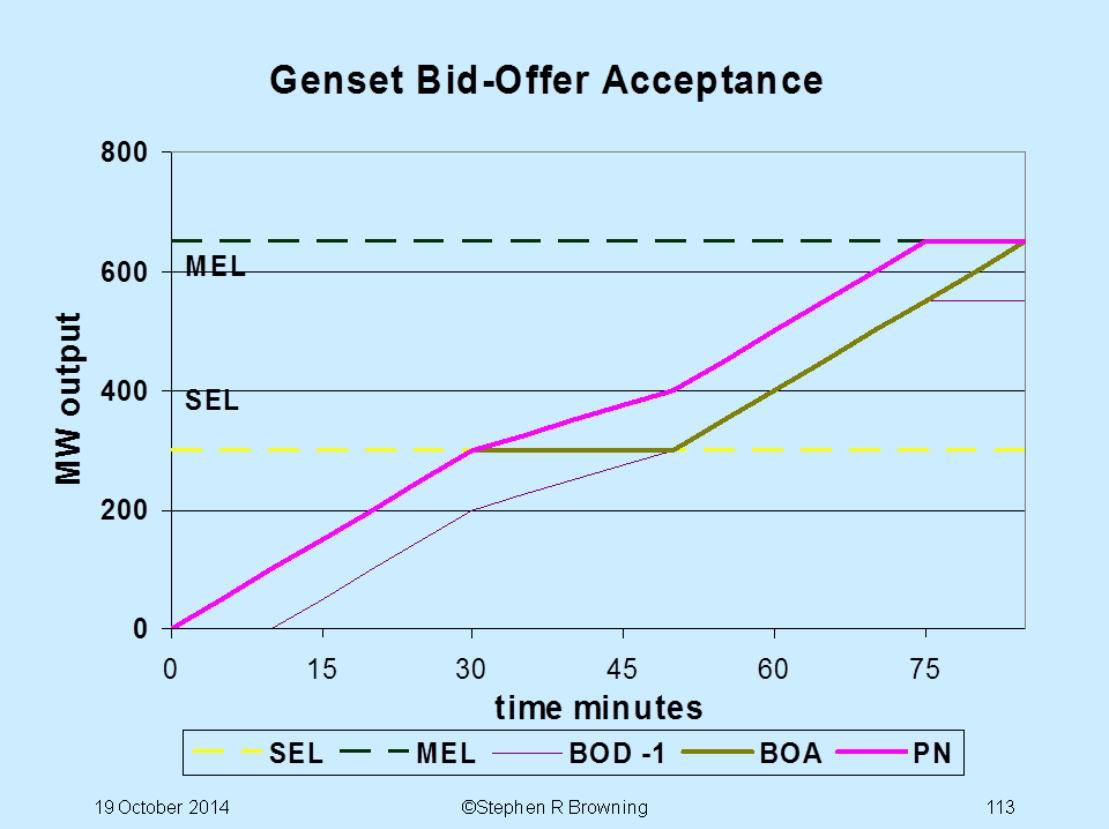
He has also received banded prices for increasing (Offer) and decreasing (Bid) power output/export or decreasing (Offer) and increasing (Bid) power import. These are shown as BOD +n ranges for output increase and BOD –n for output decrease in the next diagram.



Using his own estimation of demand and derived transmission flow limits the operator will determine where total generation does not match demand and the transmission system is not secure.

Using the price data and dispatching advice, he will then instruct closed blocks of changes to unit outputs from their power profiles (BOA in the next diagram) by 'accepting' the price offers or bids for such changes. The instructions will of course obey the submitted limit and dynamic data. MEL = Availability and SEL = Minimum Generation level in the next diagram.

To avoid the possibility of having to 'reverse' instructions, i.e. taking offers to increase overall output to cover a shortfall and then bids if total generation later exceeds demand, the duration of each instruction is kept small. Further instructions are used to extend the period of if necessary.



The operator will also instruct gensets and contracted customer sites to provide response and reserve ancillary services – primary response (instantaneous), secondary response (30 seconds) and five minute reserve. Anything beyond that timescale is normally covered by instruction.

Distribution operators will also have agreements in place, mainly for automatic action in the case of system disturbance. One standard example is that all small premises with generation must disconnect that plant from the mains in the case of supply failure, to avoid back energisation and bad power quality on the isolated section. On the other hand the ability of generation to ride through a fault, where the supply only suffers a transient disturbance, is important for larger distributed generation.