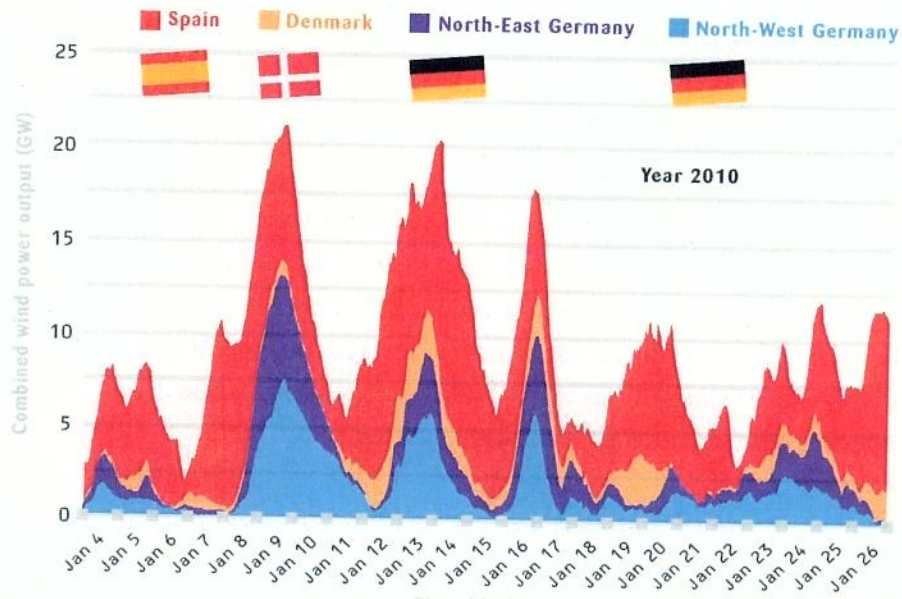


Correlation in wind output, 2010



4 MARKET SIGNALS

- 4.1.1 We do not believe that delivering market flexibility necessarily requires a significant centralised intervention provided that trading arrangements provide appropriate price signals. However, this is not currently the case. In theory, participants are currently able to shape their positions through trading, in principle down to a half-hourly level. However, this level of position granularity is only traded in the prompt market, or through bespoke bilateral contracts. Much of it is ‘internalised’ within the portfolios of vertically integrated players. Half-hourly prompt markets are still very illiquid. Whilst market initiatives such as the introduction of day-ahead auctions has helped, there are still significant concerns that these markets can provide appropriate tools for market participants, or send appropriate price signals. This is compounded by an inefficient cash-out process which further dampens appropriate signals for balancing,
- 4.1.2 If this can be corrected – for example, through the introduction of a liquid day-ahead reserve market which we discuss further below – investment choices should better reflect the value of different capacity types. Under these circumstances, the role of the Capacity Mechanism can be limited to addressing the “missing money” problem, and both a Market-wide mechanism and a Strategic Reserve could both, if appropriately designed, be effective.
- 4.1.3 However, if this is not the case, we believe that any Capacity Mechanism may also need to correct for the “missing flexibility”, as well as “missing money”, problem. This would require an ability to differentiate between different “types” of capacity that the mechanism would support (whilst remaining otherwise technology agnostic) to enable the procurement process to meet both needs. Given that any Market-wide mechanism is defined as one in which all forms of capacity participate on the same basis,

this does not appear to provide an appropriate platform to address the flexibility problem. However, a Strategic Reserve mechanism, under which different products can be procured, could be designed to provide capacity and flexibility. This approach would also have the advantage that, once designed, it can remain as an “insurance”, with no requirement to procure capacity unless the market is not responding as hoped.

5 DAY-AHEAD RESERVE MARKET

- 5.1.1 We believe that the introduction of a day-ahead reserve market could potentially greatly increase the ability for market participants to buy and sell flexibility, providing the tools for participants to balance, and importantly creating appropriate price signals against which investments can be made. The “reserve” being traded in this market would be defined as the option to increment, or the option to decrement, energy, with the right to exercise that option at any time up to gate closure. Unlike some models, under which the System Operator is the sole buyer, we believe that a model in which all participants can trade on both sides of the market is consistent with the tenet of self-balancing, would provide greater depth and liquidity, and would avoid the potential distortions associated with a monopsony. There would be defined commitment periods, with a minimum of one half hour (consistent with the current trading periods). This market could be operated as an auction, and doing so at the day-ahead stage would enable those successful sellers of reserve that needed it sufficient time to prepare technologies (such as warming plant or communicating with DSR providers). Following the auction day-ahead, reserve contracts could continue to be traded either OTC or in principle through further auction ‘windows’.
- 5.1.2 Providing there was sufficient liquidity (and recognising that specific measures may be needed to ensure this), such a market would provide appropriate tools for participants to balance their positions, create transparent price signals, and support forward trading of reserve contracts as hedging tools. We believe that it is significantly easier to stimulate liquidity in a day-ahead auction for reserve products than it would be to encourage greater liquidity in continuously traded half-hourly blocks that would represent the alternative approach. This is because such an auction would create a clear focus for trading, and some form of participation could be wrapped into the set of potential requirements on the ‘Big 6’ that Ofgem is currently considering to address liquidity concerns in the energy markets.
- 5.1.3 Importantly, this would create a more visible component of revenues for flexible plant that can more robustly impact on investment decisions. If such a market were to be successfully introduced, we believe this would lead to the efficient level of market flexibility.

6 STRATEGIC RESERVE

6.1 Key elements

6.1.1 In the event that a reserve market was not forthcoming, we believe that an objective of ensuring sufficient market flexibility should be incorporated within the goals of a Capacity Mechanism. We think that a Strategic Reserve mechanism could be designed to encompass this. Below, we outline the key elements that would be required in such a design:

- defining the capacity requirements,
- procurement of capacity, and
- utilisation and pricing of capacity.

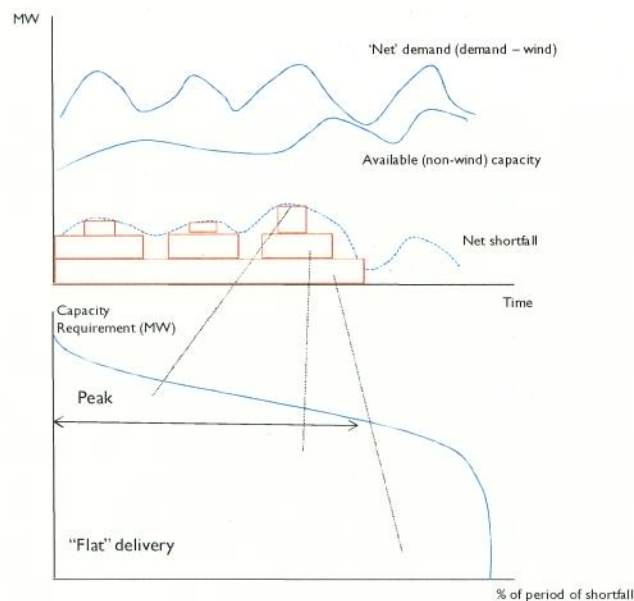
6.1.2 We note that a Strategic Reserve approach has the benefit that the appropriate processes can be put in place, but that it can then play an “insurance” role, only being used if the market does not bring forward sufficient capacity of the right sort.

6.2 Defining the capacity requirements

6.2.1 The Energy Bill 2010-11, currently making its way through Parliament, would obligate Ofgem to assess future capacity need. This could clearly be the basis for defining requirements for a Capacity Mechanism. However, in light of the objectives discussed above, we believe that this process needs to be modified in two ways. First, the ‘lookahead’ period for the assessment should be extended to cover the full horizon of potential procurement for the Capacity Mechanism. This could be up to 15-20 years, taking into account potential leadtime and contract durations. Clearly the level of uncertainty through the horizon will become increasingly greater (which should be reflected in the way capacity is procured, as discussed below), but nevertheless this will provide important context for evaluating overall requirements.

6.2.2 Second, the output from the Assessment should be more than a single ‘capacity margin’ result. Rather, the shape of the capacity ‘gap’ through the year must be considered. This is illustrated in a simplified manner in the figure below, where we schematically show that a range of different capacity shortfalls are likely to be identified, from more sustained ‘baseload’ need for periods of time, to single half-hourly “peak-filling”.

Capacity gap definition



- 6.2.3 As illustrated in the diagram, this could be considered as a capacity gap “duration curve”. This can then be translated into a requirement for capacity “products” – ranging from sustained baseload requirements (for example, through a cold weather anticyclone) to meeting single half-hourly peak needs. It is clear that different technologies are likely to be the most cost-effective for different products.

6.3 Procurement of capacity

- 6.3.1 A central body, most likely National Grid in its System Operator role, would be tasked with procuring the capacity services requirement identified through the extended Capacity Assessment. A process analogous to the current STOR auctions could be used. Strategic Reserve ‘products’ would be defined, a volume requirement specified, and auctions held. The auctions would be technology-neutral but specific technical criteria would be defined, consistent with the products being procured. A representation of this (with a STOR example for comparison) is shown on next page.

Illustrative Strategic Reserve product definition

Contract term	STOR	Strategic reserve (flat)	Strategic reserve (peak)
Lot size/minimum participation	3 MW	50 MW	50 MW
Response time	240 mins	Up to 48 hours	240 mins
Minimum deliverability period of service	2 hours	Baseload for up to 7 days	0.5 hours
Flexibility requirement	0-10 mins 11-20 mins 21+ mins	Sufficient to meet response time	Sufficient to meet response time
Utilisation type	Instruction based minute to minute	MW delivered for a defined period	MW delivered for a defined period
Payment structure	Availability (£/MW/hour) during service window Utilisation (£/MWh)	Availability (£/MW/hour) during contract period Utilisation (£/MWh)	Availability (£/MW/hour) during contract period Utilisation (£/MWh)
Treatment of ramping periods	National Grid instruction	Internalised by provider	Internalised by provider
Operation during service windows	National Grid instruction	National Grid instruction	National Grid instruction
Operation outside service windows	Market	None	None
Nomination of service window	Fixed by National Grid	N/A	N/A

6.4 Utilisation and pricing of capacity

6.4.1 We think it is important in considering the question of how Strategic Reserve capacity is dispatched to note that three key elements can be separated:

- the price paid to the provider of capacity for utilisation
- the decision to use Strategic Reserve by the System Operator
- the level at which cash-out prices are set if Strategic Reserve is used.

6.4.2 As a set of principles, we would propose:

- avoiding market distortions that could lead to ‘slippery slope’ issues with regard to capacity investments, and
- aiming to use Strategic Reserve capacity in a cost-effective manner once it is procured.

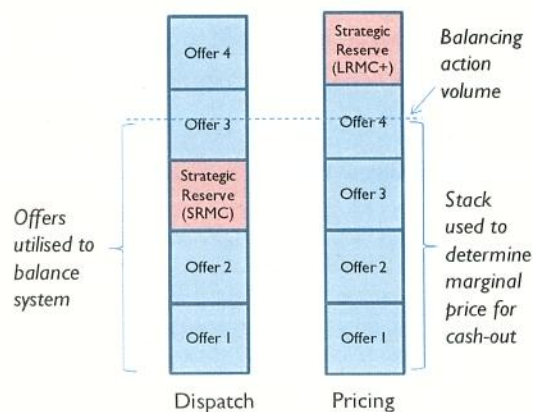
6.4.3 Given the industry concerns over the first of these points, the ‘slippery slope’ problem, we think it is important to recognise that there is a simple solution that completely allays this concern. Under this model, Strategic Reserve capacity would only be used through the Balancing Mechanism when no other option was available, with cash-out prices subsequently being set at (or close to) VOLL. (Payment to the provider of the capacity would still be determined by the utilisation price from the auction process.) This is the ‘last resort’ approach set out in the Consultation Document.

6.4.4 However, this is not our preferred option, as we consider that this does not meet the second of our principles around cost-effective use. It would be paradoxical, for example, to have a brand new gas

engine paid for by consumers sitting idle while the System Operator is managing peak imbalances or reserve with old, inefficient oil plant and GTs. As a step towards this, two separate prices could be defined for Strategic Reserve. A (lower) price could be used to determine dispatch in meeting balancing actions, potentially ahead of alternative options available to the System Operator in the Balancing Mechanism. However, cash-out prices could be determined by an ex-post calculation of the price that would have been set had Strategic Reserve capacity been available only at the second (higher) price. The lower dispatch price could be closer to the SRMC of the capacity (or the utilisation fee), whereas the latter one would be “very high”.

- 6.4.5 To avoid any blunting of price signals, this “very high” price could still be set at (or close to) VOLL, leaving full incentives on market participants to manage their own balance position directly “as if” the Strategic Reserve had not been present, and accordingly offering unchanged opportunities for providers of capacity in the market (albeit having a modest impact on potential usage to be expected through a strategy of offering into the Balancing Mechanism).
- 6.4.6 Alternatively, a price more reflective of the long run cost of the capacity, calculated given an expectation of (low) load factor, could be used. (Indeed, such a mechanism is currently used with STOR to enable efficient use whilst being priced in a way that should fully recover costs and avoid distorting price signals.) A premium could be added to retain an incentive on market participants to manage balance positions, particularly if market arrangements such as a day-ahead reserve market facilitated this. This separation of dispatch and pricing for cash-out is illustrated in the figure below.

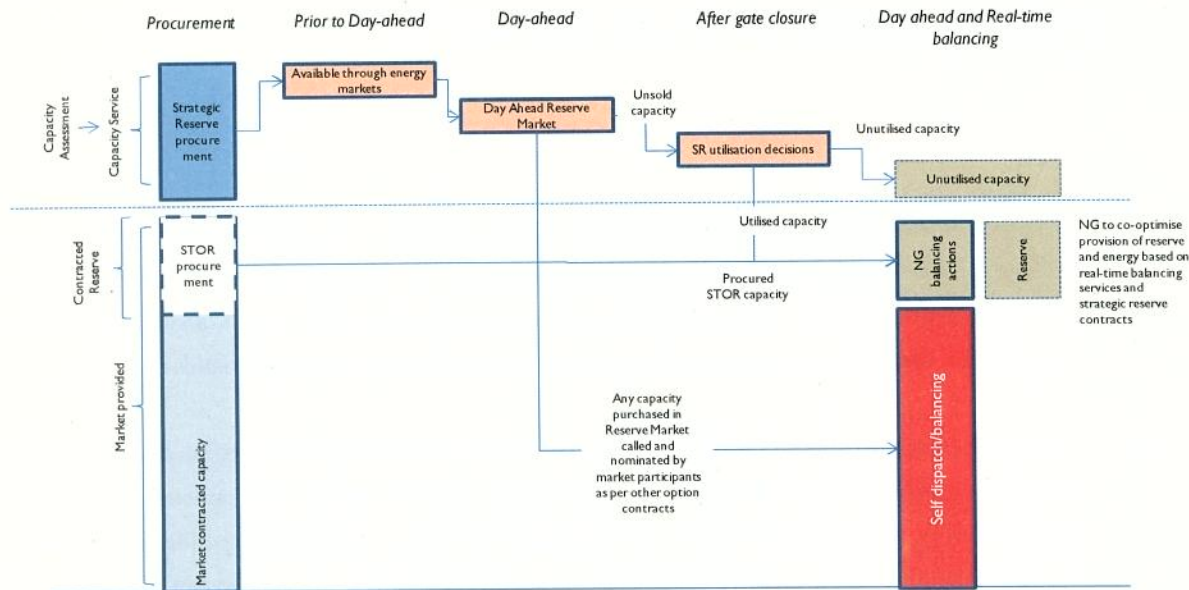
Separation of dispatch and cash-out pricing



- 6.4.7 Under this model, potential providers of flexible capacity could determine whether they preferred to offer into the Strategic Reserve auction, seek to offer flexibility directly in the market, or both. This (like DECC’s economic dispatch model) would reflect the fact that a certain portion of the peaking market would now be more directly managed, but this would be limited by the way in which the capacity was ‘priced in’.

- 6.4.8 This approach could be extended further to make the Strategic Reserve capacity available to participants in the day-ahead reserve market (if introduced), and in the energy market prior to day-ahead, at a similar price (but potentially with a lower premium) to enable positions to be balanced prior to gate closure in situations where Strategic Reserve capacity is required. This could be implemented after gaining initial experience with the mechanism under more restricted utilisation processes to begin with.
- 6.4.9 Finally, we think it would be important (in line with the principle of cost-effective use) to recognise that Strategic Reserve capacity could play a useful role in providing short term operating reserve, alongside capacity procured through STOR auctions. The System Operator could be required to take this into account in determining volumes procured through auction.
- 6.4.10 In summary, we believe that there are approaches which would enable Strategic Reserve to be deployed at different times ahead of gate closure at administered prices set at levels to limit the impact on the rest of the market (potentially with an evolution from an initially simpler and more restricted use only in the Balancing Mechanism):
- Available in energy market prior to day-ahead
 - Available in day-ahead reserve market (if introduced)
 - Available to National Grid for energy balancing actions via Balancing Mechanism
 - Available to meet National Grid Short Term Operating Reserve requirement
- 6.4.11 This way, Strategic Reserve capacity is used cost-effectively, whilst managing the impact on incentives and investment signals through the administered prices.
- 6.4.12 We note that reforms to cash-out would be required to reinforce this. We hope that this would be a consideration if Ofgem proceed with a Significant Code Review of electricity balancing arrangements.
- 6.4.13 A summary of the way in which Strategic Reserve capacity may be used is shown on next page.

Strategic Reserve capacity utilisation



7 SUMMARY

7.1.1 We believe that the issue of the flexibility of the future capacity mix under increasing penetration of intermittent generation has not been given sufficient attention in the EMR debate. Current price signals are inadequate and we would strongly support the introduction of a day-ahead reserve market, open to all participants, to address this. Without this, we believe that any Capacity Mechanism may need to correct a “missing flexibility” problem as well as the “missing money” problem. This would be difficult with a Market-wide approach, but could be incorporated within a suitably designed Strategic Reserve. An expanded Capacity Assessment would be required to define the capacity gap ‘duration curve’, with suitable capacity products then being procured. Once in place, Strategic Reserve capacity should be utilised efficiently by offering it to market participants prior to gate closure, and by recognising the interaction with STOR when used by the System Operator. However, it should be priced, at a minimum, as if it were aiming to recover its full costs through the energy market to minimise the distorting effect on investments elsewhere.

7.1.2 We are keen to engage with interested parties to exchange views and develop the thinking in this critical area. We look forward to participating actively in the debate.

8 APPENDIX 1 - TECHNOLOGY OPTIONS FOR FLEXIBILITY

8.1 Sources of flexibility in the UK

8.1.1 We consider that there are three main types of flexibility providers – those that can help to flatten the demand profile (thus expanding the baseload section of the market), those that can vary their output/demand in response to predictable changes in load and renewables output, and those that can provide short term responsiveness to manage very short term and unpredictable variations.

8.1.2 In the table below we illustrate broadly which of these types of flexibility can be provided by alternative sources of flexibility such as supply side (generation) options, demand side options, storage and interconnectors. By definition supply side options cannot flatten the demand profile but can help manage variability and provide responsiveness. Demand side options and storage can fulfil all three roles. Interconnectors can help flatten the demand profile and help manage variability but are less likely to provide short term responsiveness¹.

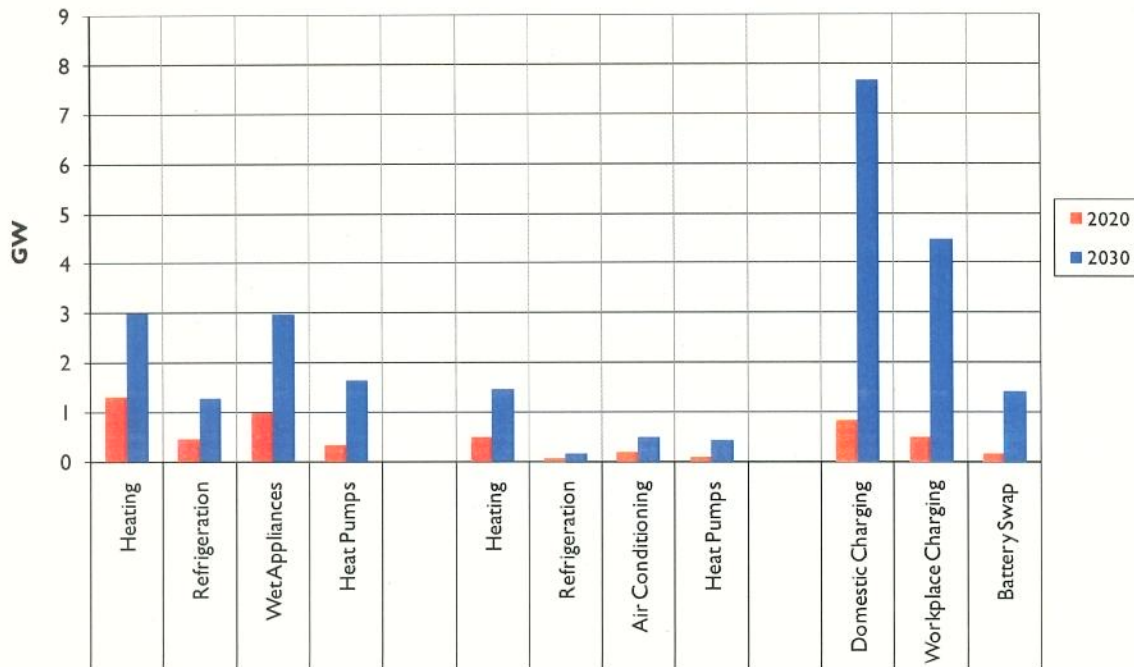
Options	Flattening demand profile	Managing variability	Providing responsiveness
Supply side options		✓	✓
Demand side options	✓	✓	✓
Storage	✓	✓	✓
Interconnectors	✓	✓	

8.1.3 There are a number of different ways in which the flexibility from each of the technology options could be accessed. In the absence of reform, for supply side options, large scale storage and interconnectors, the extent to which the flexibility is accessed will depend on players varying output in response to market price signals versus offering flexibility into the Balancing Mechanism or to the System Operator directly through balancing services contracts. For demand side options and small scale storage, access to flexibility would be based on the development and take-up of static time of use tariffs, dynamic time

¹ This could change in the longer term with increasing harmonisation between system operators.

of use tariffs (those with prices that vary in real-time), automatic control (via smart technologies and in-home devices) and frequency relays.

- 8.1.4 The figure below illustrates analysis of the potential from the demand side in the period to 2020 which is overall quite low (but an important part of the mix). In summary, demand side response might be able to provide within-day swing of around 1.5 GW by 2020. This represents around 8% to 10% of the overall flexibility requirement we estimated earlier.



Sources: DECC, IHS Global Insight, MTProg, NERA, Element Energy, Redpoint assumptions

- 8.1.5 To achieve this, DECC will need to address what are the barriers (e.g. current settlement arrangements) and enablers (e.g. smart meters) to realising the additional flexibility on the demand side.
- 8.1.6 Further consideration also needs to be given to the impact on distribution networks of changing consumption patterns in response to price. For example, the loading from heat pumps and electric vehicles could put strain on the networks, particularly if a proportion of that load is responding to price signals at the national level i.e. the normal diversification assumption starts to break down. Furthermore, the types of electric vehicle charging need to be considered since fast charging typically involves loads six times that of trickle charging. Battery swaps would provide the most flexibility but involves costs of additional batteries. In and of itself, these challenges in distribution networks of a changing total energy system will require a portfolio of services (eg voltage support, local balancing) to be provided from scalable, efficient and highly flexible generation technologies, acting as enablers for the major changes outlined above.

- 8.1.7 Thus, we note that the demand side, interconnectors and storage are given a lot of emphasis in the EMR consultation document. Overall, whilst we agree that the demand side, interconnectors and storage will have an important role to play as the energy sector is decarbonised, we believe that more consideration should be given to the characteristics required from sources of flexibility and the role that alternative and new supply side technologies can play.
- 8.1.8 There are a number of challenges from these potential flexibility providers, for example the specific locations for Demand Side Response (DSR) and points of interconnection, potential dependency on time-of-day or with connected markets, and the sustainability of response.
- 8.1.9 We believe the emphasis should be on encouraging sources of flexibility which are technically able to provide the required flexibility in an economic manner, with the following key characteristics:
- A rapid capability to respond to changes in net demand (agility)
 - The capability to sustain operation for a prolonged period after any “ramping” period
 - No significant loss of efficiency or cost increase when only part of an offered volume of service is used (eg part load operation)
 - Multiple fuel capabilities to enhance security of supply
 - Ability to build small and large units of flexibility
 - Cost competitive with competing technologies or providers

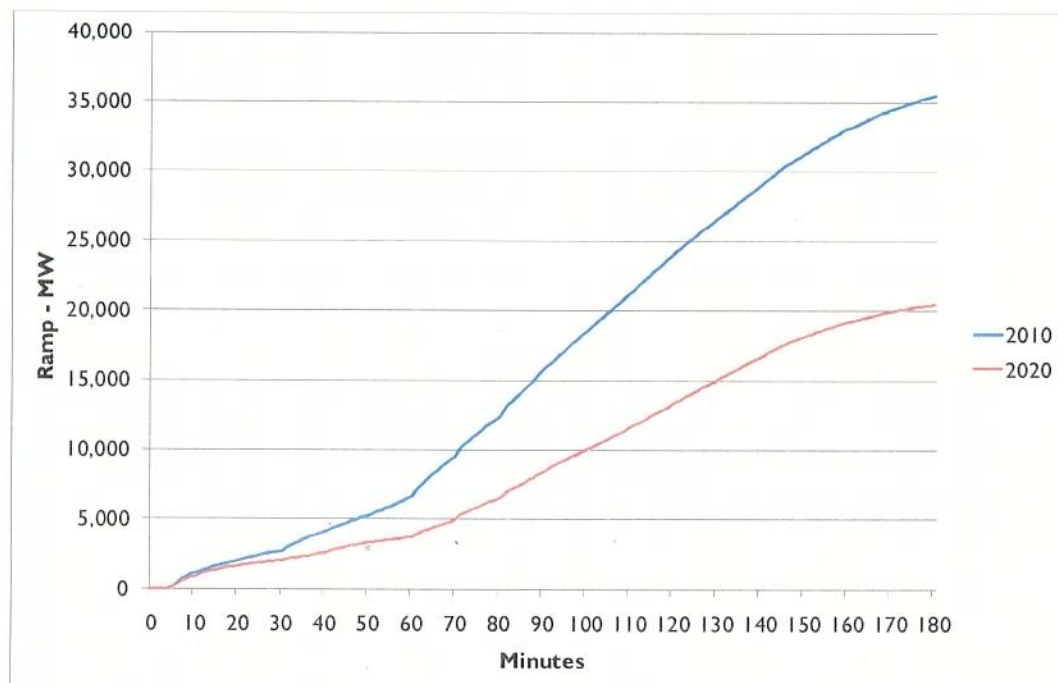
8.1.10 It is clear that our understanding of the system dynamics, and potential contributions from different providers of flexibility, will evolve over time. As such, a road map may be helpful in understanding key decision points, such that a full view of the evolution of flexibility needs can be developed. We illustrate a number of these in the table below.

Decision point	Impact
End of Large Combustion Plant Directive in 2015	Requirement to replace peaking and flexible oil and coal capacity that would be closing
Industrial Emissions Directive	Requirement to replace peaking and flexible coal and gas plant closing between 2019 and 2023 (subject to final agreement in European Parliament)
Significant penetration levels of electric vehicles and heat pumps	Requirement for significant distribution network reinforcement in the absence of flexibility packages
Significant spill occurring due to high levels of inflexible generation	Requirement to constrain off low carbon generation in the absence of flexibility packages
When and whether CCS is technically and economically proven	Contribution from supply side options in flexibility packages
Reforms to settlement	Limitations on time of use tariffs removed if settlement for all customers moved to half-hourly
Critical mass of smart meter deployment	Ability to access demand side response from domestic and small and medium enterprise customers
Deployment of smart grids	Allows access to certain forms of demand side flexibility

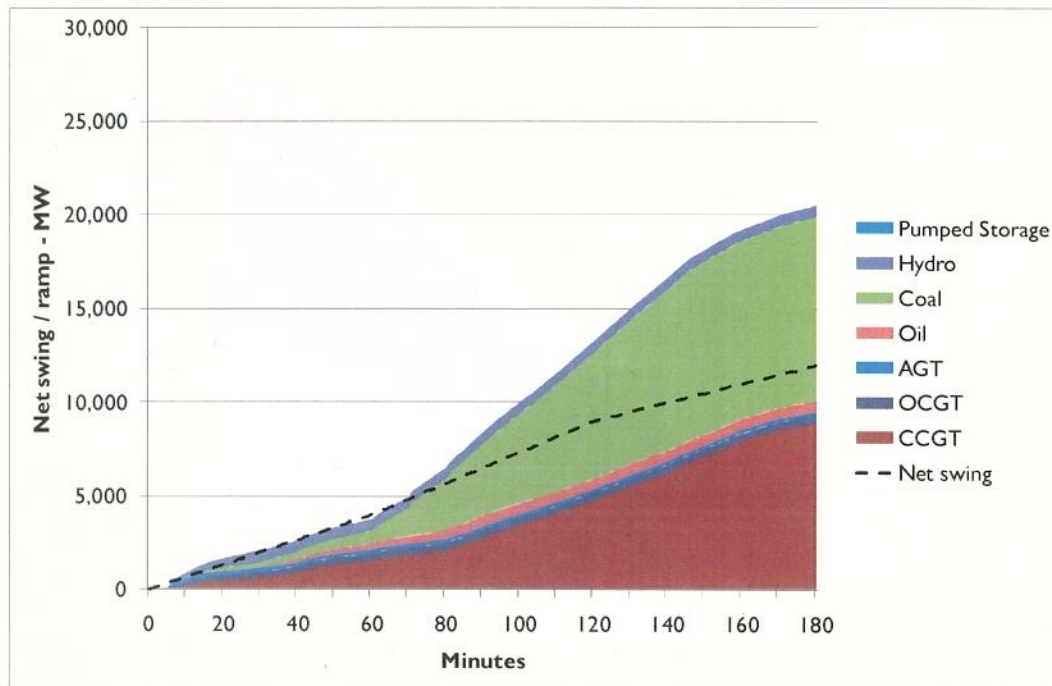
8.1.11 We believe that there has been much consideration of the overall sources of flexibility but we consider that further analysis is required of the potential supply side sources of flexibility and the challenges and opportunities in this area. We present some analysis and key messages in this area below.

8.2 Current and future sources of supply side flexibility in GB

- 8.2.1 Based on the current technologies available, we have undertaken analysis of the current thermal plant in GB using available Balancing Mechanism and related data on unit dynamics.
- 8.2.2 The flexibility characteristics of each of the plant on the system vary by technology, vintage and investment which has been undertaken by the owners over the history of the plant. By examining submitted Balancing Mechanism Dynamic Data for each unit and plant in the GB market, we can assess the capability of current fleet of generation plant to provide the necessary flexibility.
- 8.2.3 The following analysis should be treated as representative only, and show 'typical' pictures rather than the most extreme net demand swings. Clearly the actual operation of the fleet is more complex than the simple representation here, and will depend in particular on the underlying economic running profiles of the plant, and the management of reserve. Nevertheless we believe they illustrate directionally the increasing need for flexibility.
- 8.2.4 The figure below shows the aggregate supply of swing / flexibility from existing plant now and for 2020, following assumed retirements of coal and oil plant under LCPD and some early retirement of older CCGT. Our analysis shows that the system would lose 3 GW of flexibility from the supply side over a 1 hour response period and 15 GW over a 3 hour response period (with the caveat that we have assumed no replacements for our retirements so that the gap can be clearly illustrated).



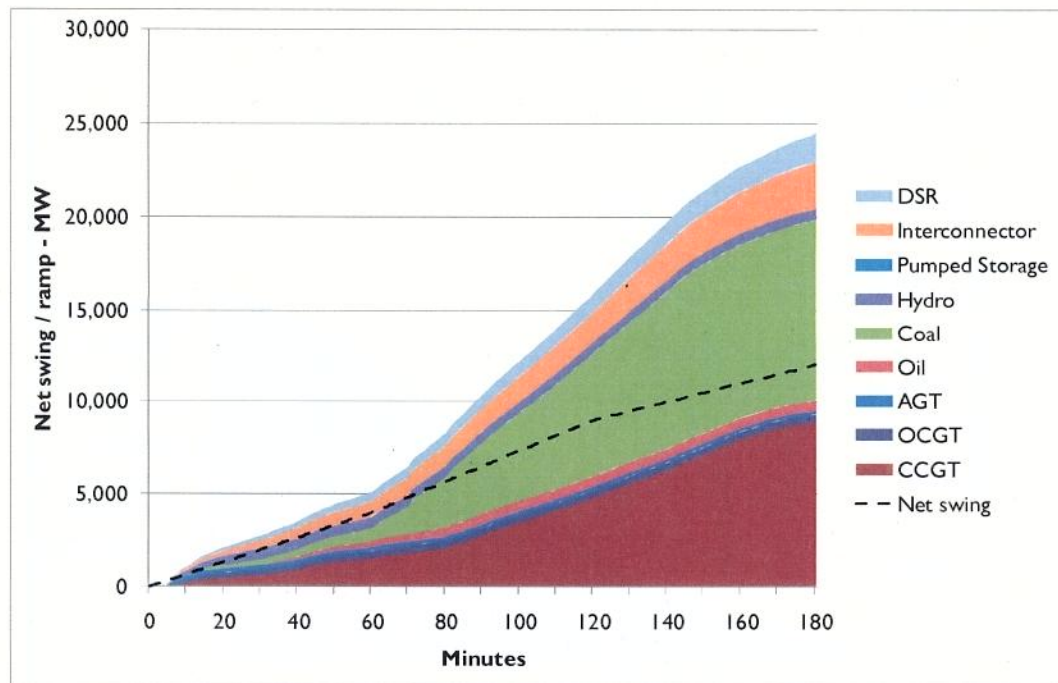
8.2.5 Next, we show how the available flexibility in 2020 compares to the net demand swing², and the contributing plant types, with the same retirement assumptions. By comparing the net demand swing against the available net response from dispatchable generation in 2020 (as shown above) we demonstrate that the system would be tight for first hour and then reliant on coal to meet the balance³. (Clearly in reality the actual response would be managed to use the available plant in the most efficient manner.)



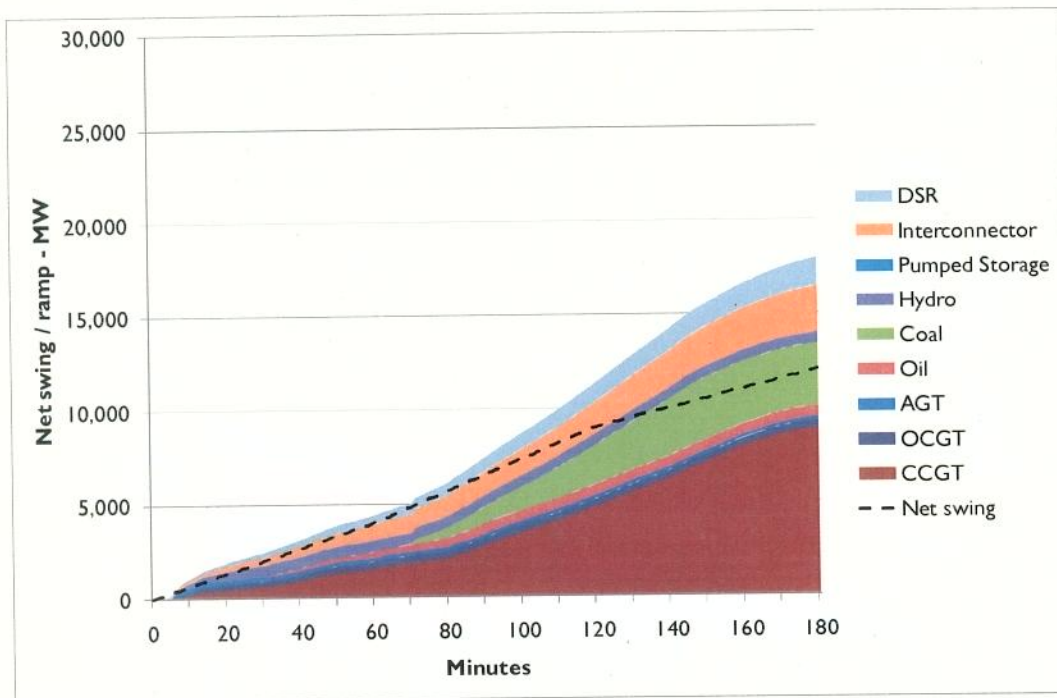
² The net demand swing has been linearly interpolated within hours. As the hourly points are derived from a distribution of simulated results, the profile reflects the boundary of a range of underlying profiles, each of which may show significantly more volatility.

³ This figure uses Notice to Deviate from Zero (NDZ) and excludes Demand Side Response (DSR) and interconnectors and assumes the minimum NDZ submitted for the last three years by unit.

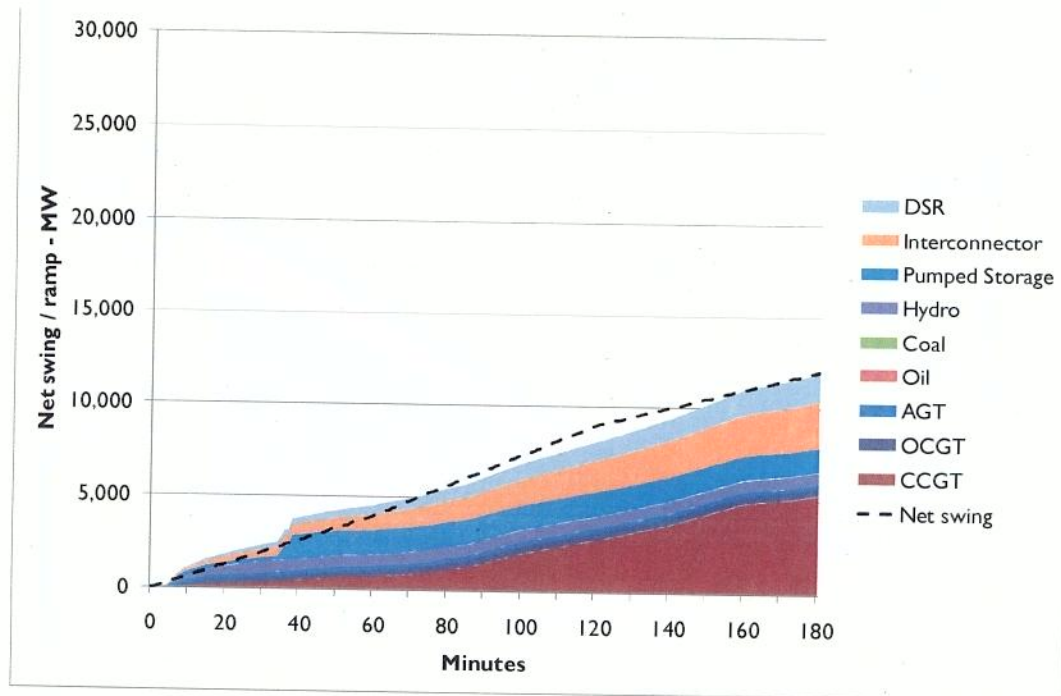
8.2.6 Adding in the possible provision of Demand Side Response (1.5 GW as described earlier) and interconnectors assists supporting the first hour of any net demand swing, as shown below. In practice, of course, the role of interconnectors will be dependent on the situation in neighbouring markets and the arrangements between market participants and system operators.



8.2.7 If coal plant closures are accelerated then the picture tightens considerably. This could represent either plant running out of hours under a Limited Lifetime Obligation under the Industrial Emissions Directive (IED), or a proxy for 2024 when further coal has retired. The system over the first 2 hours of any net demand swing would be likely to create significant operational challenges without further new flexible plant on the system.



- 8.2.8 To illustrate how a different view on plant dynamic data would affect the picture, using the same Balancing Mechanism data but assuming the NDZ of units is closer to the average of submitted NDZs (rather than the minimum which is the most optimistic picture of technical flexibility in the fleet) then the picture becomes very tight once more (the picture includes interconnectors and Demand Side Response with the LCPD and other retirements shown earlier).



8.3 The challenges for flexibility from the current supply side

- 8.3.1 The true economic cost of providing flexibility from the current fleet of thermal plant, with unit operating regimes increasingly diverging from design assumptions, is not well proven. There are likely to be significant challenges including:

- Much of the existing fleet will be aging by 2020 just as the need for flexibility becomes more pressing.
- Even if the current (by then) older plant prove technically able to provide the required dynamic characteristics, this may be at significantly higher cost.
- Reliability in provision of flexibility given the new operating regimes is untested and most plant have not been designed for flexible operation.
- Locational issues, and in particular the potential for the provision of flexibility to be reduced as a result of transmission constraints.

8.3.2 The table below shows how the different dynamic characteristics of representative dispatchable plant in GB compare using Balancing Mechanism data. We contrast this to single cycle and combined cycle technology from our (Wärtsilä's) portfolio of solutions.

Options	Drax Coal	Eggborough Coal	Brigg CCGT	Connah's Quay CCGT	Staythorpe CCGT	Wärtsilä (Gas engine)	Wärtsilä (Gas Engine CC)
Fuel	Coal	Coal	Gas	Gas	Gas	Gas	Gas
Unit capacity – MW	645	485	250	345	425	Single unit 9.7 MW Total plant up to 350 MW	Single unit 18.3 MW Total plant up to 500 MW
Notice to Deviate from Zero – minute ¹	70	50	50	85	720	30 sec.	1
Total minutes to ramp to full load from cold	115	74	168	149	762	10 min	15 min (90% load) + 65 min to 100%
Total minutes to ramp to full load from hot	45	24	118	64	42	5 min	10 min (90% load) + 65 min to 100%
Stable Export Limit (SEL) as % of full load	34%	41%	50%	67%	50%	1%-30% of facility (depending on number of units)	3%-30% of facility (depending on number of units)

Data sourced from Wärtsilä and Elexon

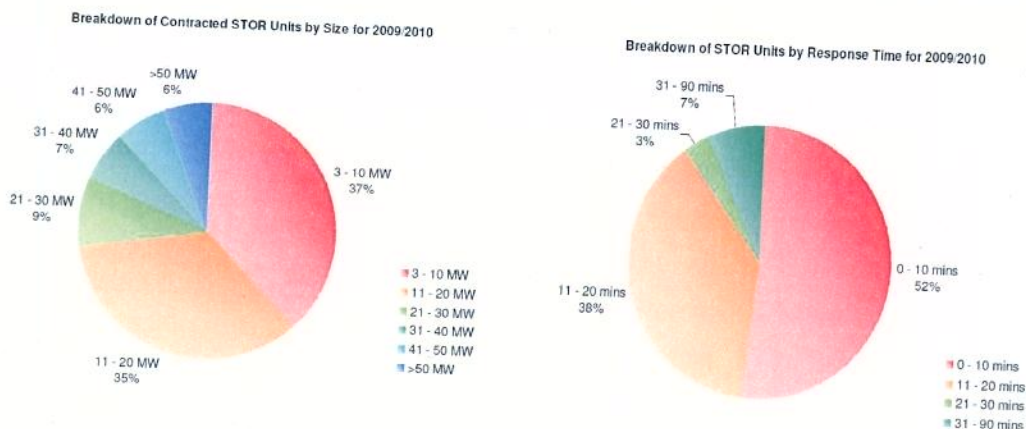
¹ Shortest time declared since 1st Jan 2008 for the existing plant

8.3.3 It is unclear what the economic cost for providers will be to providing true flexibility – thus, as well as potential capacity tenders, energy revenues (and thus prompt and imbalance prices) will continue to be an important remunerator.

8.3.4 Evidence from National Grid's STOR tender rounds provides some indication of the cost of providing flexibility from the current fleet of thermal plant in GB and their characteristics.

8.3.5 The STOR year runs from 1 April to 31 March. In 2009/10, the latest full year for which data is available, NG procured on average 2,623 MW of STOR, for an average availability price of £8.04/MW/h and an average utilisation price of £283.07/MWh. STOR was utilised for 961.5 hours, corresponding to 104.7GWh, leading to total availability payments of £68.3m and total utilisation payments of £23.1m. The following charts illustrate the breakdown of contracted STOR units by size

and by response time for 2009/2010⁴. The data shows that the majority of units winning contracts are small (less than 20 MW) and with a fast response time (less than 20 minutes).



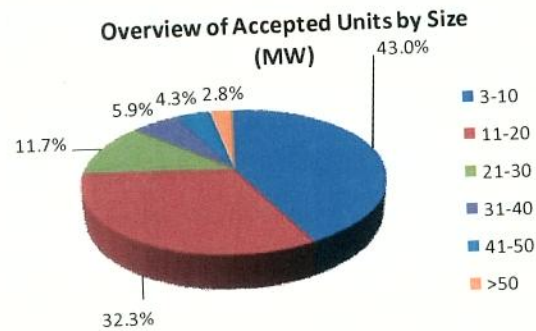
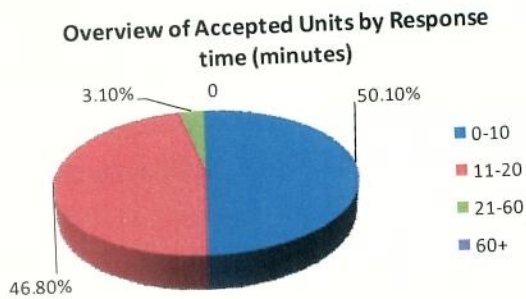
Source: National Grid

8.3.6 The results from Tender Round 10 (TR10), results of which were published in April 2010, illustrate further the types, availability and utilisation prices of flexible plant in GB⁵. The following charts illustrate respectively, the accepted STOR units by response time category, the accepted units by size and the availability and utilisation process achieved by units in this tender round.

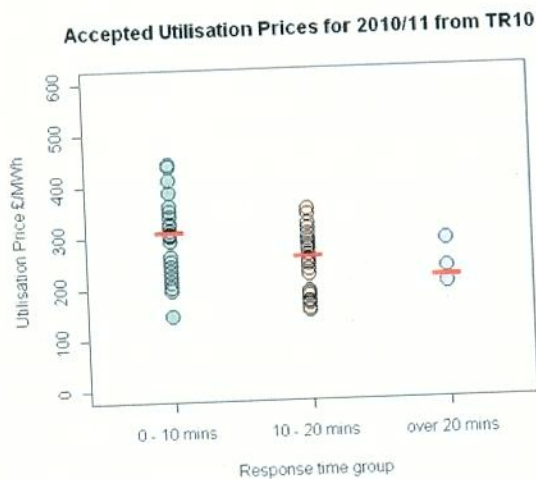
8.3.7 The key messages emerging include that a great number of small units are used to provide STOR currently and therefore one of the challenges will be scaling generation units to provide the greater volumes of reserve and flexibility that will be required in 2020. In addition, as older units retire, gaps in the market may emerge especially in the fast response time categories eg 0-10 minutes where the bulk of the requirements for STOR (in this tender round) were purchased. With respect to prices, we believe that insufficient differentiation appears to exist between very fast response services (5 minutes or less) and slower response times and that greater differentiation will need to be made in order to provide remuneration for fast, efficient technologies that can aid system security at the most critical time during a net demand swing.

⁴ Source: STOR Annual Market Report 2009/10, National Grid

⁵ Source: STOR Market Information Report: TR 12, National Grid



Source: National Grid



Source: National Grid

8.4 Conclusions and implications for EMR

- 8.4.1 Our analysis suggests that the net demand swing (taking into account both load and wind variations) could increase to 2020 by 2GW over a 2 hour period and over 3 GW over a 3 hour period
- 8.4.2 Retirements could decrease available dispatchable thermal plant (without further investment) of 15 GW over a 3 hour response period.
- 8.4.3 Over the period to 2020, Demand Side Response and interconnectors can make a modest but important contribution to the provision of flexibility, but not sufficient to bridge the gap or to provide the portfolio of flexibility services required. The role of interconnectors will be dependent on the state of neighbouring markets and commercial arrangements between participants and system operators.
- 8.4.4 Furthermore, of the remaining dispatchable thermal plant, the true economic cost of providing flexibility from the current fleet of gas fired plant in particular, with unit operating regimes increasingly diverging from design assumptions, is not proven.

9 APPENDIX 2 – OVERVIEW OF WÄRTSILÄ POWER PLANTS

9.1.1 Wärtsilä Power Plants is a leading supplier of flexible power plants. We aim to provide superior value to our customers by offering decentralised, flexible, efficient and environmentally advanced energy solutions. Our technology enables a global transition to a more sustainable and modern energy infrastructure and our solutions are modular, tried and tested power plants.

9.1.2 Our energy solutions offer a unique combination of:

- Energy efficiency
- Fuel flexibility
- Operational flexibility

9.1.3 We offer our customers competitive and reliable solutions that deliver high efficiency. Our power plants engines can run on liquid fuels, a wide range of gases and renewable fuels. Most of our products have multifuel capabilities and all can be converted from one fuel to another. Furthermore, the operational flexibility of our products enables high system efficiency, flexibility in operations with varying loads, low water consumption, as well as the possibility to carry out construction in phases according to the customer's needs. These key features, combined with the full lifecycle support we offer, create the basis for Wärtsilä's strong position within the Power Plants market.

9.1.4 With gas strengthening its potential to be the fuel of the future, our focus is on developing competitive solutions for the gas market. This focus supports our growth ambitions and enables a stronger presence in the broader markets.

9.1.5 Our business is divided into four customer segments

Flexible baseload

9.1.6 Wärtsilä supplies flexible baseload power plants mainly to developing markets, islands, and remote locations. Energy consumption growth in these markets is driving a steadily increasing demand for new power generation solutions. Wärtsilä's customers in this segment are mainly Utilities and Independent Power Producers (IPP). Customer needs typically include competitive lifecycle costs, reliability, world-class product quality and fuel and operational flexibility, as well as operations & management services. Wärtsilä is in a strong position to cater to these needs. Flexible baseload power plants are run on both liquid fuels and gas.

Grid stability and peaking

9.1.7 Wärtsilä's grid stabilising power plants enable the growth of energy solutions based on wind, solar and hydro power. We offer dynamic solutions used for systems support, reserve power, peaking needs, and

in regions with rapidly growing wind power capacity. Customers in this segment are mainly Utilities and IPP's. The strengths of Wärtsilä's products include rapid start and ramp up to full speed, the ability to operate at varying loads, competitive electricity generation and capacity costs, as well as 24/7 service. Grid stability and peaking plants are mainly fuelled by gas.

Industrial self-generation

- 9.1.8 Wärtsilä provides power plant solutions to industrial manufacturers of goods in industries such as cement production, mining, and textiles. Customers are mainly private companies and reliability, reduced energy costs, and independence from the grid are among the key factors in their decision making. Power plants in this segment are run on either gas or liquid fuel, depending on fuel availability.

Solutions for the oil & gas industry

- 9.1.9 Wärtsilä provides engines for mechanical drive, gas compression stations, and for field power and pumping stations to the oil and gas industry. Typical customer needs include maximum running time, reliability, long term engineering support and 24/7 service. The solutions we offer run on natural gas, associated gas and crude oil.

Power Plants and sustainability

- 9.1.10 The world is currently seeking more sustainable solutions for energy infrastructure. This development is driven by climate policies, energy security and economics. Carbon intensive energy sources are being replaced by low carbon fuels, such as natural gas and renewable solutions. Energy savings and efficiency improvements are being encouraged, and even legally enforced, at every level.
- 9.1.11 Wärtsilä's energy solutions offer a unique combination of flexibility, high efficiency, and low emissions. Many different fuels, including bio-fuels, can be used efficiently, which helps in reducing greenhouse gas emissions. The flexibility of Wärtsilä's solutions enables the development of a reliable energy infrastructure, wherein most of the sustainable characteristics are already known.

Efficiency development

- 9.1.12 We continuously seek improvements in the present engine portfolio, and are developing new engine concepts for the future. As a power plant contractor, we develop our power plants in parallel with the engines. This enables us to optimise both the performance and the reliability of our power plant offering. We offer high efficiency, single cycle solutions and focus on improving efficiency even further through the use of e.g. combined cycle solutions. Power plant net efficiency can be further improved by plant design and by optimising internal power consumption. Such solutions minimise not only fuel and water consumption, but also the emissions per unit of energy, thereby providing major environmental benefits.

Flexibility

9.1.13 Flexibility is one of the main features of Wärtsilä's power plant solutions. The high modularity of our products makes it easy for our customers to construct an optimally sized plant, and to later expand its size to meet future needs. Fuel flexibility has many advantages for our customers, notably the lowering of energy production costs by using low cost fuels, minimising CO2 emissions, and the ability to convert from one fuel to another based on fuel availability.

9.1.14 The unique operational flexibility of our products comprises:

- Very fast plant starts and stops
- High ramp rates
- High part-load efficiency
- A broad load range

9.1.15 Frequent starting and stopping does not affect the operational costs of the plant. This is unique, no other competing technology offers the same

Towards an optimally sustainable power system

9.1.16 The power generation system of the future will contain a significant percentage of wind power capacity. Such capacity is non-dispatchable and variable, which creates potential for other power units to balance the system. Wärtsilä is in a good position to meet this need, as the operational flexibility of our products makes them easily adaptable to the needs of the grid.

Reducing emissions

9.1.17 Wärtsilä places high priority on developing diverse and flexible emission reduction techniques. Since emission requirements and the fuels used differ widely, a comprehensive range of products is required in order to offer competitive solutions.

9.1.18 Mitigating the effects of climate change will call for substantial reductions in greenhouse gases (GHG). We believe that the importance of natural gas will increase in the future. Consequently, the multi-fuel capability of our power plant solutions becomes an increasingly significant competitive advantage, as it enables the utilisation of all liquid and gaseous bio-fuels that may become available on a wider scale. Wärtsilä focuses on developing decentralised energy solutions that emit fewer GHG emissions.