PPA energy
Planning Energy for a Sustainable World

NIC Competition Final Interrogation Report

South East Smart Grid

submitted by

National Grid Electricity Transmission PLC

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1 Project Summary

This project targets the South East area of England to demonstrate of the use of new technologies and commercial frameworks to utilise distributed resources (demand and generation) at a distribution level to assist the transmission network operator in managing the power across the transmission system, in order to ensure that voltage and thermal stability is upheld.

National Grid reports that the South East area of the transmission network is a particularly weak area of the network, with one 400kV double-circuit traversing 200km across the south coast from Kemsley (near Canterbury) to Lovedean (near Portsmouth).

The extent to which the area experiences constraint management due to thermal and voltage stability issues is reportedly on the increase and will be exacerbated further by the two additional 1GW interconnectors expected to connect to the South East in 2018 and 2019. The business as usual approach to facilitate the connection of the additional interconnectors would require a new 400kV transmission route and reactive power compensation.

This project aims to provide an alternative option through the development of a more dynamic and informed means of managing the system, including adjusting both demand and supply. This will be achieved through a combined effort between the System Operator, Distribution Network Operators and Aggregators, by utilising advanced monitoring, Low Carbon Technologies (LCTs) and associated commercial frameworks.

National Grid recently reported potential savings of £1bn per annum in wholesale energy prices for UK energy customers, which can be achieved by increasing the GB interconnection capacity by 4-5GW. SESG seeks to allow unconstrained operation of two new interconnectors and, in doing so, will accommodate half of the potential savings equating to £500m per annum.

Through successful demonstration of this “non-build” solution, the learning generated is expected to benefit the Transmission Owner and System Operator in avoiding new infrastructure investment and mitigating stability limits, which might be applicable elsewhere on the GB system. Further benefits are expected for the System Operator and electricity generators through improved resilience and a reduction in generation constraints and, as a result of increased interconnection, UK electricity customers are expected to benefit from cheaper wholesale electricity prices.

The project consists of five key stages with a total project cost of £11,820k; the requested NIC funding is £9,727k with NGET making a compulsory contribution of £1,103k to the project and the other partners contributing a combined total of £795k.

2 Assessment Against Criteria

2.1 Summary of Assessment Criteria

The criteria against which each submission will be assessed as outlined in the Electricity NIC Governance Document:

(a) Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing Customers;

(b) Provides value for money to electricity transmission Customers;

(c) Generates knowledge that can be shared amongst all relevant Network Licensee;

(d) Is innovative (ie not business as usual) and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness;

(e) Involvement of other partners and external funding;

(f) Relevance and timing;

(g) Demonstration of a robust methodology and that the project is ready to implement.

2.2 Criterion (a): Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing Customers

2.2.1 Key Statements

The key statements made to suit this criterion are summarised as:

The SESG project seeks to provide an innovative, quicker, cheaper, and environmentally friendly option to increase the network capability as an alternative to business as usual practices.

Carbon Savings

- Potential carbon savings from "smooth connection" of Wind and Solar generation (30% and 10% load factor respectively) is in excess of 3 million tonnes per year based on 2020 expected capacity according to National Grid's Gone Green scenario.

- An additional 2GW of interconnector capacity will result in further savings in excess of 6 million tonnes of CO_2 per annum.

Environmental Benefits

The company proposes a "non-build" solution as an alternative to asset investment, and therefore avoids the following environmental issues common when building transmission infrastructure: land use, noise, public health and safety, sensitive plants and animals, soil erosion and visual impact.

Quantitative analysis

2GW of interconnector capacity is contracted to connect to the South East by 2019 and is the key driver for this project. NGET claims that SESG, in facilitating this increase, would provide up to **£500m of savings for the GB customers** through reduced wholesale electricity prices.

The above figure is based on the report "Getting More Interconnected" published by National Grid in March 2014, which concludes that £1bn of savings can be achieved annually by increasing the total interconnected capacity by 4-5GW by 2020.

NGET has presented a Cost Benefit Analysis in Appendix 6, which draws the comparison to the business as usual costs, using assumed costs of £20m per 200MVAr of reactive compensation and £150/MWh of interconnector constraint. The analysis and savings are summarised below.

1. **Steady State Voltage. Saving £6m per annum on generation constraint costs**

   NGET states that the cost of constraining generation to manage high voltage issues in 2013 was estimated to be £14m and that SESG will reduce this figure by £6m. The company states that £8m/annum of costs will remain as these issues fall outside the scope of SESG.

2. **Dynamic Voltage Stability. Saving £20m avoided investment of one 200MVAr compensation unit**

   As the level of European interconnection increases the company estimates that an additional 600MVAr of reactive compensation equipment will be necessary. SESG is stated to potentially reduce the requirement of compensative units from three to two, thus saving £20m.

3. **Commutation of CSC-HVDC. Saving £35-45m per annum on interconnector constraint costs**

   CSC-HVDC is the convertor technology that is used in the existing interconnectors in the South East area. The increasing interconnector capacity reduces the strength of the network and during times of heavy loading it poses a risk that is conventionally managed by constraining the interconnectors.

   NGET has devised the proposed savings of £35-45m per annum based on the following assumptions:
   (a) Without SESG, one interconnector would be constrained (to 0MW) for 525 hours each year at a cost of £80m per annum.
   (b) With SESG, the time the interconnector would be constrained would be reduced by approximately a 50%.

4. **Thermal Overloading and Rotor Angle Stability. Saving £500m avoided investment of new transmission route**

   Increasing the generation capacity within the region poses the risk of overloading circuits in the event of a fault elsewhere on the network and is conventionally mitigated through the construction of a new overhead line.

   According to NGET's 2013 Ten Year Statement, a new transmission route will need to be built in the South Coast by 2023 under the Gone Green scenario at an estimated cost of £500m.

   The proposal states that methods in SESG will ensure that power flows are controlled and "the final outcome of this innovative approach will be the avoided capital investment of a new overhead line in the South East".

The project aims to develop technical and commercial arrangements between DNOs and the System Operator (SO) to build a "whole system" smart grid.

- The technical elements comprise low-carbon technologies referred to as Distributed Resources, which is comprised of demand side response (DSR), PV solar, and storage.
- The commercial aspect aims to use these technologies to the benefit of the SO.

2.2.2 Challenges and Potential Shortfalls

Criterion (a): Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing Customers;	
Sub-criterion (a.i)- Carbon claims	Challenge (a.i).1: The carbon benefits arising from the SESG require justification. National Grid's Gone Green scenario is used to estimate the amount of new renewable generation (Wind and Solar PV) connected to the South East by 2020. The proposal takes credit for the carbon savings attributable to the connection of 2,200MW of Wind and 314MW of Solar PV (and using the energy output multiplied by 0.4kg/kWh to determine total carbon saving). However, further evidence is required as to SESG can deliver this improvement.
	Answer (a.i).1: The capability of the network to accommodate larger volumes of low carbon generation technologies is the key to achieve the carbon emission savings. The SESG's goal is to provide alternative means to network reinforcement which enhance the network capability quicker and to greater cost efficiently. Due to the network constraints (at both Transmission and Distribution system), it would be required to constrain the generators in this area, if timely network reinforcements cannot be delivered. Noting that the sequence of reinforcements in the area ultimately requires a new route between the South East and South London there are significant external consenting risks ahead of implementation that would have the potential to impact the timeframe In the South East, in the future, the various system performance challenges most notably those associated with post-fault voltage instability require either constraints on the generators and interconnectors, or significant network reinforcement as discussed in the main bid document which

	will have a relatively long lead time. The SESG aims to provide ability to take both preventative and corrective actions using wide area monitoring which will facilitate control and coordination of resources at both Transmission and Distribution Network which will avoid the constraints requirement. A large volume of the Solar PV and Windfarms installed in the South East are embedded into the DNO's network. The SESG allows better evaluation of the impact of incidents which could lead to disturbance on either Transmission or Distribution network, and will then minimise the need to take constraints in mitigating against such incidents.
	Conclusion (a.i).1: Claims are based on the carbon savings delivered by the connection of 2.5GW of renewable generation. This would be valid for generation that is directly facilitated by SESG, by alleviating curtailment of renewable sources, or enabling projects to proceed that would not be connected without SESG. NGET's response has failed to provide sufficient evidence to support the figures presented for the volume of new renewable generation connections that are facilitated by the project.
	Challenge (a.i).2: In a similar manner to Challenge (a.i).1, the proposal assumes credit for the full carbon savings attributable to the connection of 2GW of interconnection. The 6 million tonnes per annum is derived from 2013/14 import levels of existing 2GW interconnectors as an assumed level of import for the new interconnectors, and multiplies this energy by 0.4kg/kWh to determine carbon savings. Further evidence should be provided to demonstrate that SESG can deliver this level of saving.
	Answer (a.i).2: In addition to response to (a.i), the flow on the interconnectors has direct impact on how the transmission network in the South East behaves and particularly the sensitivity of post-fault voltage collapse to how much the pre-fault flow on the HVDC interconnectors was. The SESG will enable to full optimisation of the flow at times when the system needs to be armed depending on the state estimators' instruction (i.e. when overall power flow across all interconnectors is above certain level). In doing so, the resources available within the DNO's network will be considered, such as actions which avoid potential constraint

	requirement on the interconnectors.
	Conclusion (a.i).2: NGET have verified that the figure of 6MtCO_2 is calculated based on the energy imported from interconnectors in 2013/14 but have not provided sufficient evidence to enable the technical feasibility of achieving this to be evaluated. Questions remain as to the underlying assumptions, since the claims are based on the 2GW interconnector being constrained 100% of year. This, based on 2013/14 levels, would amount to 6MtCO_2 of carbon saving. This claim should be based on the figure directly facilitated by SESG, however, which should relate to the same reduction in the interconnector constraint which NGET have used to calculate the financial saving of £35-£45m per annum. From the information provided we are unable to validate this calculation and so the challenge remains.
Sub-criterion (a.ii)-Environmental benefits	No challenge presented
Sub-criterion (a.iii)-Quantitative analysis of Carbon/ Environmental claims	Challenge (a.iii).1: Carbon benefits are associated to a reduction in constraints on both renewable generators and interconnectors. However the presented benefits are based on the total energy generated by these sources rather than the incremental energy generated which would be constrained without SESG. This requires clarification.
	Answer (a.iii).1: The figures are calculated assuming the generation already connected in this part of the network has unconstrained access to the network (which is conservative as particularly some embedded generation may have non-firm access and therefore be constrained). The additional generation connected to the South East and causing constraint requirement in the network (due to not having sufficient network capability) is assumed to be constrained. Therefore, the difference between these two is used to calculate the benefits.
	Conclusion (a.iii).1: The estimated carbon savings should derive from that which are directly facilitated by SESG. The response to this challenge indicates that assumptions have been

	made which differ from the methods used to calculate the financial benefits, As concluded in the previous challenges, a review of the quantification is recommended and revisions should be made where appropriate.
Sub-criterion (a.iv)- Robustness of financial benefits	Challenge (a.iv).1: NGET should quantify the capacity and type(s) of distributed resources required to deliver each of the four benefits stated in Table 3-1, and comment on the risks involved with relying on the different resources to provide these benefits.
	Answer (a.iv).1: **Steady state voltage control-** approximately 150- 200Mvars of benefit would be required; the level of distributed resources within the network required would vary depending upon its location within the DNO network, range of Mvar range permissible and the voltage profile and control philosophy of the distribution system, however as little as some 150MW active power change could be seen to deliver this level benefit at the GSP interface (deriving from the effect of reducing Distribution network gain- other more direct effects from absorption of Mvars may also be possible in suitably located resources) if suitably aggregated. This effect would come from either reducing generation or increasing demand (via demand side re-profiling or storage). Typically, our problems with respect to voltage control occur at periods of low demand at the Grid Supply Point and transmission system power flow (which are generally correlated). Taking each of the three distributed sources in turn:- • Times of low demand at the Grid Supply Point clearly correlate with the levels of embedded generation that would net-off the demand observed being comparatively high (for example a worst case could be a early morning minimum summer demand with high wind and solar contribution). As such the levels of embedded renewable generation would be high at precisely the time we would be looking to such generation to provide such levels of deload. Within the South East area we already have both Thanet and Kentish flats large capacity connections which may provide this effect at a macro level but at significant cost. There would be the opportunity under SESG to consider options using the distributed generation in

	these areas. Under week 24 submissions we are aware that within the South East area there is in total some 193.3MW contribution from of embedded generation within the area today at times of peak demand. Given that this generation from UKPN as quoted represent against an ERP2/6 conservative minimum demand offset for demand security purposes, (which can for wind be as low as 2%), rather than an average or worst case expectation (which within the economic criteria of the SQSS would be as high as 70%) and as such can be considered a conservative expectation of capacity available. • At times of low demand, it may prove difficult in practice (for example for industrial customers) to obtain demand side services which would influence the normal operation of that demand as the load being considered may well correlate to its maximum capacity available in that time, with little opportunity to provide further increase. Other demand side however (for example refrigeration or data centres) may be able to choose to optimise their loads at time of transmission system operator requirement to contain otherwise high voltages on its system, making use of the inherent thermal inertias of their associated demand rather than its availability. The exact scale of this opportunity would be explored further as WP1 progresses and cannot be meaningfully quantified at this stage. • With respect to Storage, limited current resource exists. The total storage projects in the UK (planned and in operation at the distribution level in November 2013 is less than 13MW according to the Energy Storage Operator's Forum report (attached below). This lists all the projects notified, and at that time none were in the South East at that time. The Electricity Storage Network Group have however recently released a report: http://www.electricitystorage.co.uk/ refers, which calls for a national strategy for electricity storage, pressing for 2000MW of additional energy storage in the UK, with its distribution broadly aligning

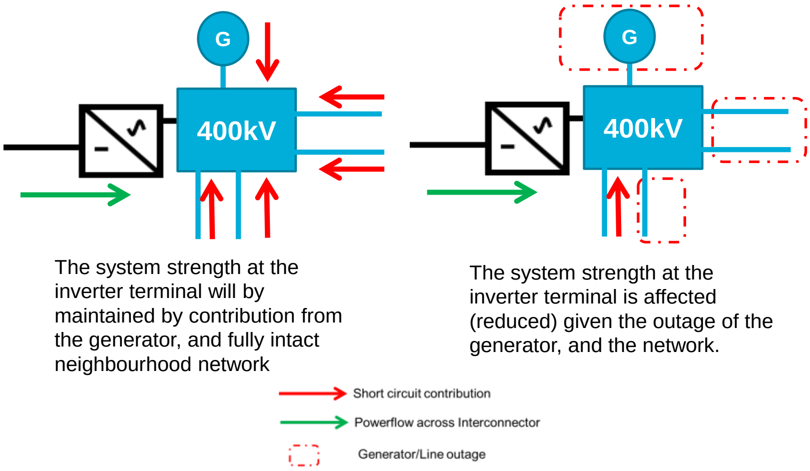
	with demand- as such some significant potential for supporting services in this area exists and as such the function of storage as one of the portfolio of options available would not be neglected in simulation of opportunity or market construction, but is unlikely to feature within the time horizon of practical testing. **Dynamic Voltage stability**- the scale and types of services would not differ from those above; the only principle difference would be the need for automatic rather than instructed timeframes of action, some of which may be required within 200ms (see earlier responses). All of the above services are theorectically capable of such an action, and the practical implementation of such control measures would be further explored across WP1 and WP2. **Commutation of CSC-HVDC** this risk is mitigated as a result of the combination of the above actions and represents a culmulative benefit of an aggregated control strategy to these two actions- the risks in implementation relate purely to the design of systems, simulations and modelling calibration activities within the SESG project, separately discussed and managed in our submission and not subject to further external risk. **Thermal Overloading and Rotor instablility** The scale of the requirement required here is more complex to calculate and offset. As discussed further below, the variable nature of the interconnector loading, demand, embedded generation output, renewable intermittency and availability of conventional thermal generation mean that the level of distributed generation required would range over the course of the year from between 1000MW and 0MW of impact and the transmission loading position would not just influence the scale of distributed resources needed but also how such resources were used (if pre-existing constraint management measures tripping up to 1797MW post fault were applied, these would negate the viability of additional distributed resource tripping due to the overall culmulative infeed loss impact in such cases. At such times the distributed resource would need to be pre-fault re-dispatched for the duration of the post fault risk). Whilst the maximum level of resource of 1000MW may not be available in practice, the levels of transmission loading triggering such levels may prove suitably infrequent (once sufficient monitoring and modelling is made available to support such investigation under WP1) to negate

	the need to consider these events against the context of Chapter 2 and 4 of the NETSQSS, but rather consider conditions where the levels of distributed resources prove insufficient to mitigate a deterministic compliance assessment as conditions subject to other methods of economic management. As such in these cases the assessment of availability of resource and the assessment of network state frequency and typicality are intrinsically entwined within the WP1 phase of SESG.
	Conclusion (a.iv).1: To clarify, three distributed resources are identified that can contribute to the delivery of the required services: 1. Reduction of embedded generation. 193.3MW is stated to contribute to the whole of the South East. 2. Increasing demand, which NGET have stated may prove difficult to source, although some resources may exist. The claim that these cannot be quantified fully at this stage, and will be explored during WP1, is reasonable. 3. Storage, which is a valid solution but 0MW exists in South East. These sources are stated to contribute as follows: • Steady-state voltage control - main problems during times of low demand. 150-200 MVAr is required. 150MW change (reducing in generation or increasing demand) could deliver this benefit. • Dynamic voltage stability – use of the same resources as above, which NGET state can all theoretically be automated to provide a response within 200ms. This is a significant assumption that will need to be thoroughly tested in the project. • Commutation of CSC-HVDC – use of the same resources as above through an aggregated control strategy. • Thermal Overloading and Rotor instability – Depending on the running conditions of the GB system, a potential range of 0MW-1000MW of response is required. NGET states that there may

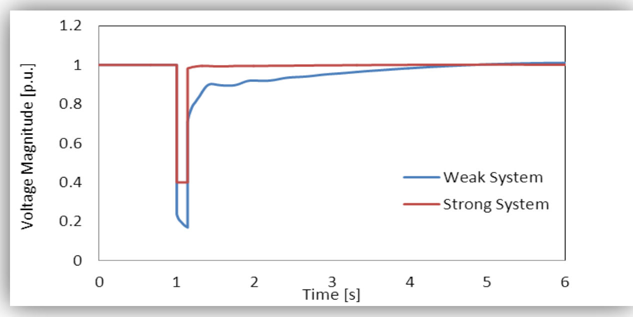
	be insufficient resource to address the extreme case it may suffice given the infrequency of these events, but will be assessed in WP1. The response quantifies that 193.3MW of embedded generation contributed to the peak demand in the South East as a whole but, given the requirements for region-specific response from the distribution network, there are concerns that this resource will not provide sufficient response to achieve the desired effect. In answering this challenge no reference is made to Appendix 1, which states 300MW through service providers will be employed, and so it is unclear how this resource relates to the overall requirement. The lack of clarity and evidence provided to this response raises concerns to the overall technical viability of the project in solving the specific problems identified in the South East network.
	Challenge (a.iv).2: NGET should clarify whether it is contracting with distributed resources principally to provide real power services to contribute to thermal constraint management, or reactive power to aid voltage control.
	Answer (a.iv).2 The coordinated use of transmission and distributed resources aim to solve a range of network constraint issues. At the transmission level, the key issues in the South East is the Voltage Control (both steady state and dynamic). Therefore, the primary objective is to help with voltage stability. <u>In the first instance</u>, the measures such as coordinated tap control between HV/MV/LV network will be trialled, and then the coordinated us of distributed resources such as DSR, and embedded generation. The services expected from distributed resources such as DSR and embedded generation, are mainly related to the capability they can provide in terms of <u>changing their active power set-point</u>, which will have effect on the voltage on the transmission level. <u>Our studies however show the aggregated effect of reactive power change of large volume of the distributed generation, and particularly those which are installed relatively close to the GSPs can have great impact on managing voltage at the</u>

	transmission level. Therefore, this is one of the key objectives of WP1a to determine the exact nature of services and the locations which such services are required.
	Conclusion (a.iv).2 The response indicates that the main objective of the project is to address Voltage Control, rather than thermal constraints which were highlighted in the ISP and project summary. The response introduces the concept of coordinated tap-changing which is not mentioned in the main bid. Small references to tap-changers have been made during the clarification process but this has not been previously specified as a key trial. Whilst it is clear there may be merit in coordinated tap-changing with the DNO this would require significant involvement with UKPN, and confirmation is required that this has been agreed.
	Challenge (a.iv).3: Clarification was requested (Q19) to understand how SESG could reduce the constraint time of interconnectors. The response stated that through better outage coordination SESG "could bring the short circuit level at Sellindge 400kV below the level which the link can operate in full import mode". Further insight into how distribution network resources will be utilised to achieve this benefit is required, including details of the size and timeframe of resource required. This should include a clear explanation as to the relationships between voltage control and maintaining fault level contribution.
	Answer (a.iv).3: We believe you are referring to **Q17** and in our response on the 2nd page we stated: "*The SESG will also enable better outage coordination and to better study of the impact of outages (considering both transmission and distribution network capability in real time) which could bring the short circuit level at Sellindge 400kV below the level which the link can operate in full import mode*". The reduction of short circuit level is related to the impact of outages which will be managed by SESG. SESG will further help to ensure the outages which could bring the fault level down are studied considering both T&D network, and it will help in minimising the situations when because of low fault level the restriction on import of HVDCs will be required.

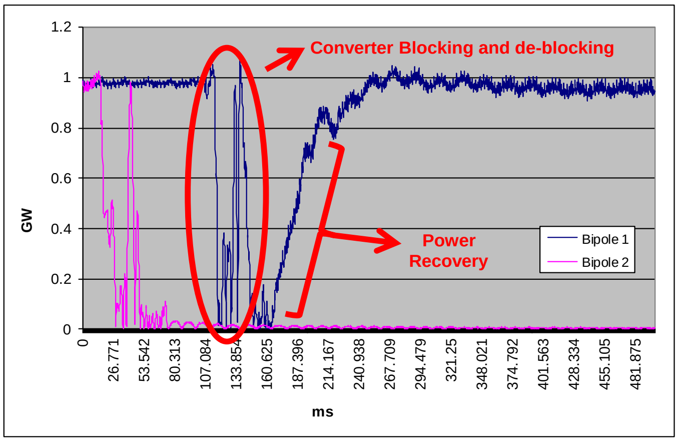
The reason behind the low fault levels, and why restriction on the import may be required is explained below:



In principle, a network with high short circuit level, will have better voltage control. This is one of the key measures of system strength as shown below:



In a weak system (low short circuit level system), when the voltage recovery is slow, at proximity of the HVDC inverter station, there is a risk of commutation failure as shown below (real system event):



These incidents have severe impact on system frequency and stability of the network. When the system strength is below the minimum level required to operate the link in import mode, it will be required to reduce the import level, if no other measures can be made available. This will increase the constraint time and volume.

The important element of SESG is with regard to providing better voltage control (which will be affected when system strength is low). Following a fault at different parts of the South East's network, voltage depreciation will be observed. The lower the short circuit level, the wider and more severe the level of voltage dips. This will affect the performance of the CSC-HVDC links installed in this area as described above.

Conclusion (a.iv).3: The response correctly notes the incorrect reference in the question.

However, the response does not clearly explain how the distribution resources will be utilised to increase the short circuit level.

The statement that "in principle, a network with high short circuit level, will have better voltage control" seems somewhat tangential, and it is unclear from the NGET response whether SESG is aimed at keeping more generation on the system, in order to increase the fault level and assist commutation, or whether it is primarily aiming at enhanced voltage control. In bilateral discussions, NGET indicated that the improvement in CSC commutation will be effected primarily by system reconfiguration to enable sufficient generation to remain connected post-fault to contribute to adequate fault levels. This addresses the challenge sufficiently.

	Challenge (a.iv).4: Two methods of SESG deployment are proposed to deliver benefits up to 2050 in Appendix 1; Method 2 (full SESG deployment) is said to avoid the need to install a new transmission route (£500m) by employing 300MW from service providers for 10% of each year. Further explanation is required regarding the studies undertaken to justify the claim that 300MW of resources will alleviate the need to install a new route and to clarify the circumstances under which these resources will operate. Clarification should also be provided as to whether the new transmission line would be intended to address predominantly thermal constraints or voltage control issues in the South East.
	Answer (a.iv).4: We have done extensive studies, looking at a range of future network conditions which demonstrate for a double circuit fault emanating from either Kemsley or Lovedean, it would result in the South East network exhibit unacceptable thermal, voltage and stability performance. Further, noting this area is already a complex part of the network in terms of operability which is demonstrated by the use of number of intertrips: • [redacted] • [redacted] and • [redacted]. These studies have demonstrated the need for the new route to resolve the network constraint issues: • Transient voltage and angle stability; • Post disturbance voltage recovery; and • Thermal capacity constraint considerations. The worst case scenarios above have to date been considered without reference to the range of changes to demand and DNO power factor that could be achieved under SESG by distributed generation dispatch. These both have the potential to change the initial conditions ahead of the disturbance as well as a response to that disturbance. Under WP1 work correlating monitoring of system state with DNO resource state and network models an accurate representation of the scope of this

	opportunity will be achieved. Ahead of SESG against the considerations discussed above, a some 1000MW reduction in power flow would be needed to enable the new line to be avoided, in other words, the effective curtailment of the second new interconnection on the SE coast under these extreme conditions. Accordingly the second new interconnector in the south east has been contracted on a variation to customer design perspective and currently has contractual restrictions on its operation relative to system conditions; ahead of the establishment of a new route between the South East area and the south London system as soon as reasonably practicable to resolve these SQSS challenges. Were this new route to not be taken forward, then these contractual terms would be void and National Grid would need to find another approach which would avoid/ mitigate the costs incurred. We have therefore performed further studies to establish the volume of response which if delivered from the distributed resources, combined with the ability to take preventative and corrective actions aided by the state estimator, can help to alleviate the network constraint issues. The figure of 300MW represents an assumption that based on established wind load duration curves the potential total time that the existing and planned transmission connected wind (around 1600MW) may cause constraint on the South East network. The effect from the distributed resources, given they are spread across the network in the South East, will have greater effect and benefit. The cost benefit assessment evaluation of the distributed resources benefit is based on a more conservative 300MW figure rather than a 1000MW figure of practical benefit to consumers which arises from the expectation that based on known load duration expectations for wind, extreme transfer periods alone will have low expectation. 300MW has been adopted from the understanding that the mean expectation of load factor for wind, would mean that its output of 1609MW, modified by 70% under the economic criterion of the SQSS would in practice be at least 700MW less. Such that the remaining distribution resource needed to release wind in those scenarios would need only be 300MW. It is recognised this value is approximate based on the limited data available and in practice based on the combination of interconnector behaviour with both transmission and distribution connected renewables

	in practice offers still greater potential to establish benefit even at lower levels of resource usage, and rule out on economic grounds a requirement for much higher levels of usage, however ahead WP1 completion such further refinement at this stage can only be speculated upon lacking the necessary supporting data.
	Conclusion (a.iv).4: Studies are stated to demonstrate the need for a new transmission route to address unacceptable thermal and voltage performance as a result of a double circuit fault. The studies indicate the need to reduce power flow by up to 1000MW, achievable through the curtailment of one 1GW interconnector. The explanation provided for the way in which 300MW of distributed resource overcomes the need to curtail the 1GW of wind import is convoluted and requires significant clarification before the likely effectiveness of the project in overcoming this constraint can be assessed.
	Challenge (a.iv).5: With reference to Challenge (a.iv).3, it is indicated that Method 1 will save £6m each year until 2050 but will do so by the deployment of work packages 1A and 1B only (modelling and state estimation). A detailed explanation of how Method 1 will deliver these benefits without the control element of the Distributed Resources (i.e. WP1C) is required to assess the validity of these claims.
	Answer (a.iv).5: Notwithstanding the capacity challenges discussed above in response to new interconnector connections, the existing network in the South East is incurring significant cost amounting to £14m per annum associated with the overnight voltage containment challenge in the area.WP1A and WP1B, by identifying the relationship between the power transfer and power factor at the grid supply point location observed and providing the means to accurately simulate and control - for example the ability for coordinating tapping at that time allows UKPN and ourselves to assemble an array of non-cost operational actions that can be taken to mitigate this cost. The £6m p.a. identified represents proportion of increased MVar absorption effect we expect to be identified by these actions over the daily 6 hr period of high voltage vulnerability, as compared to the effectiveness of remoter generation resources currently constrained into operation to provide that same

	effect.
	Conclusion (a.iv).5: Method 1 is now stated to include a "non-cost" solution of automated tap-changing on UKPN's network in order to provide reactive power support to tackle high voltages during low demand, which is currently mitigated by constraining generation on. Owing to the lack of information regarding the use of tap-changers in the main bid and its limited coverage in the bilateral discussions, questions remain to the development of this concept, in particular; • whether the level of input to the project from UKPN is sufficient to cover the required level of activity; • the viability of changing configurations of auto-transformers on the distribution network, and, • the lack of evidence supporting the technical feasibility to deliver the required reactive power support based changing the voltage set point.
	Challenge (a.iv).6: The analysis provided by NGET is stated to be centred on the 2020 Gone Green scenario. Should the GB system follow the Slow Progression route, the benefits are likely to be reduced. A range of the specific benefits should be provided based on Gone Green and Slow Progression scenarios of uptake of DSR and LCTs that would be considered a Distributed Resource.
	Answer (a.iv).6: The new interconnectors to Belgium and France are expected to connect in [redacted] and [redacted] respectively under the Gone Green Scenario and in [redacted] and [redacted] under the Slow Progression scenario. In terms of distributed resources (distribution-connected generation), <u>the anticipated capacity and connection timescales are identical for Gone Green and Slow Progression, therefore the benefits of SESG would be the same for both of these backgrounds</u>.
	Conclusion (a.iv).6: No further information is provided regarding varying growth penetration of DSR or LCTs. We appreciate the scenarios may not differ substantially but it would be useful to understand how variations in these

<table>
<tr><td></td><td>resources, e.g. increased electric vehicles, might be reflected in approaches taken by the SESG and how these impact customer benefits on the whole – e.g. the effect of a potential decrease in the contribution available in practice from Service Providers.</td></tr>
<tr><td rowspan="3">Sub-criterion (a.v)-Capacity released and how quickly (if applicable)</td><td>No challenge presented</td></tr>
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<tr><td rowspan="2">Sub-criterion (a.vi)-Replication</td><td>Challenge (a.vi).1: SESG is claimed to be applicable to other parts of the GB network which experience similar challenges, however, as the benefits from SESG depend of the level of response from DNO-side technology, the true potential for replication will depend on the amount of Distributed Resources within a region. An assessment of the existing or expected levels of suitable Distributed Resources across the country should be provided to assist evaluation against this criterion.</td></tr>
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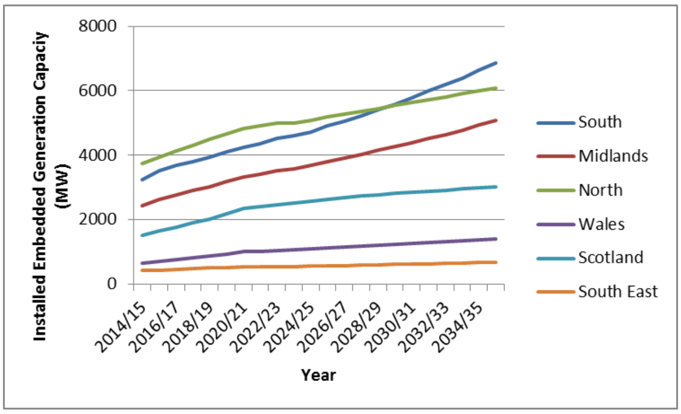
Answer (a.vi).1:

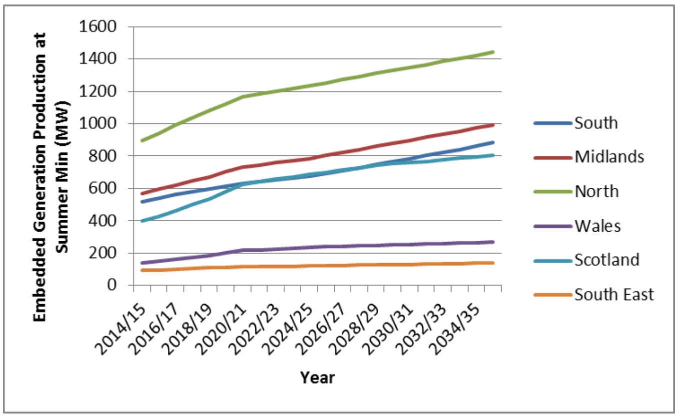
Gone Green scenario anticipates a considerable growth in distributed generation resources across the whole of GB as illustrated in the graph below.



Installed Capacity of Embedded Generation at different regions (Gone Green)

Northern England in particular is expected to see even higher rate of growth of distributed resources than the South of England and also face similar challenges in the future due to new HVDC connections post 2020 (links to Norway and large Round 3 offshore wind farm connections on the East Coast)

</td></tr>
</table>

	therefore SESG is considered to be applicable and replicable across the GB. With regard to the minimum service which can be expected from the distributed resources, it very much depends on the type, and load factor of the embedded generation. The graph below shows the output (production) of the embedded generation at summer minimum conditions (when the demand is at the lowest). It highlights the potential volume of service which can be expected from the embedded generation at this time.  Embedded Output at different regions (Gone Green)
	Conclusion (a.vi).1: Predicted growth of embedded generation by region has been provided to address the challenge regarding replicability. A second graph illustrates a prediction of the contribution from embedded generation. The contribution from embedded generators is seen to vary significantly across the regions, with the North and South of England showing highest penetration. It is noted that an objective of the project is to examine different regions and assess the viability of Smart Grid solution. The South East is seen to have a comparatively small level of embedded generation and as such concerns are raised as to the viability of curtailing the embedded generation on the network. This response does, however, demonstrate the potential for replication of the project in other regions where high renewable generation penetration is likely to lead to transmission constraints.

2.3 Criterion (b): Provides value for money to electricity transmission Customers

2.3.1 Key Statements

Proportion of the benefits attributable to the transmission system

From the quantitative analysis summarised in Criterion (a) the following benefits and associated beneficiaries are listed below.

Transmission Owner:

- £20m avoided investment of one 200MVAr compensation unit
- £500m avoided investment of new transmission route

System Operator:

- £6m per annum on generation constraint costs
- £35-45m per annum on interconnector constraint costs

Generators:

- The company states that the Smart Grid will enable customers to connect more quickly and at an optimum cost.

Electricity customers:

- The facilitation of the additional 2GW interconnector capacity will provide £500m in savings for the GB customers per annum.

How learning relates to the transmission system

The company has presented three stakeholders who would benefit from the positive outcome of this project, irrespective of the uptake of low-carbon technologies:

1. The application of the tools developed by SESG is envisaged to be used by NGET in other parts of the network which face similar challenges such as:
    a. South West of England (with increasing penetration of embedded generation, and large infeeds such as the new nuclear power station);
    b. North Wales (due to connection of offshore windfarms); and

c. North East (due to connection of large offshore windfarms).

2. The GBSO will benefit from SESG by diversifying the tools available for more economic and efficient operation of the grid, as well as creating additional tools to enhance system resilience.

3. The SESG increases the network resilience, and the transmission network users (DNOs, Generators, Interconnectors, etc.) will not face plant damage due to unexpected transmission faults.

Approach to ensuring best value for money in delivering projects

NGET has presented a project with partners selected through a competitive public tender process.

NGET's procurement team were involved in the process of partner selection, which was conducted on the basis of selection criteria that included price/contribution, organisation/resource, understanding and delivery, and the validity of the solution offered.

The project partners assisted NGET in the development of a detailed cost evaluation for the project and are described as having a stake in project cost estimation based on benchmarking of previous projects.

NGET states that due to the partner selection process, there would be no requirement to undertake tendering for the supplier for the overall technology in the project. NGET has confidence in the solution platform being provided by Siemens.

2.3.2 Challenges and Potential Shortfalls

Criterion (b): Provides value for money to electricity transmission Customers;	
Sub-criterion (b.i)- Proportion of benefits attributable to transmission system (as opposed to elsewhere on supply chain)	Challenge (b.i).1: There is a lack of clarity in the application as to how connection costs for transmission connected generators are reduced by the application of the project methods.
	Answer (b.i).1: The challenges with regard to increase in the connection of generation and interconnectors were explained from both stability and steady state network conditions. Given that further new generation connections would compound the challenges of SE export to the wider GB system across periods where the thermal capability of the network has the potential to be exceeded, or that the due to the low system demand and inertia in the area a large transient voltage support and angular

	deviation control is required, in these situations the new generator would require curtailment. New connections of generation in this area currently would need to be analysed on the basis of the second interconnector's curtailment requirement and as such these additional curtailments would necessarily become broader in application and effect. To overcome these issues, and to avoid network constraints, it will be required to enhance the network capability when new connections are made. This often relates to the "enabling work" such as installation of a Static Compensator when new generation is connected. This will increase the connection cost regardless of whether the investment is made by the TO, or by the generator. These projects would also with the interconnectors in the area form part of the driver for major transmission reinforcement and we would therefore expect these parties to provide the appropriate need case support to public engagement, consultation and consenting of such significant works as this new route would represent. Again this would result in new costs to new connections in the area. SESG by allowing access to a wider range of distribution resources and by providing greater clarity of the current normal network characteristics against which SQSS planning criteria would base its extrapolation, provides a greater potential for acceptable capacity and or customer variation based connection capacity which would give the potential to de-link the customer from some or all of the above costs and remove the barriers otherwise to connection across the period that the South East system is subject to such development consideration
	Conclusion (b.i).1: The project clearly has potential to avoid the need for investment in reinforcement infrastructure by adding a new layer of insight into the operating conditions of the system. The response addresses the challenge adequately.
	Challenge (b.ii).2: NGET has clarified that SESG will not affect the number of faults, but rather improve network resilience during a fault once the Operator has access to a broader range of actions through improved state estimation. Further clarity is required regarding the actions unlocked by SESG, and the Distributed Resources required, to support the SO in managing a fault across the four system states.

	Answer (b.i).2: In terms of SESGs influence upon the four states arises from the manner in which its innovative combination of system monitoring, modelling and transmission and distribution resource identification combine:- **In the pre-state stage (A):-** (a) *Network State definition* SESG monitoring of existing transmission network conditions can be correlated with the Distributed resource availability and its changes in availability and the behaviours at the transmission & distribution interface at that time. (b) *Action identification* Use of this monitoring to develop power system models validated to the existing system behaviour will allow then state definition to be in real time replicated in model i.e. for the existing pre-state of the network to be modelled in more depth, enabling the range of changes in distributed resource operating positions to alternative operating points to be examined and their effect to be quantified, both separately and in conjunction to transmission system actions. (c) *Action evaluation* Actions in the pre-state will be considered in real-time analysis if they; a. Solve a pre-state issue (e.g. pre-state voltage containment or the thermal loading of the network under an arranged outage) b. Enable a more efficient response to a post disturbance condition. c. Where the benefits to the pre-state from the action outweigh the inefficiencies created to available post disturbance options, or conversely the benefits of the post disturbance support are of higher value than any inefficiency introduced into the pre-state. (d) *Implementation* Based on the above sequence of actions, further Action can then be taken on the network; for example- a. Distributed resource MW demand levels could be increased, increasing distribution system loading and hence, at minimum demand periods acting to support high voltage containment in the pre-state.

	This action would also support a higher degree of system intertia and therefore provide post disturbance benefit to transient stability challenges by allowing the pre-state conditions to appear less onerous. b. Distribution resource MW demand levels could be reduced thereby at times of high demand and high imports into the SE area provide additional relief to thermal or voltage constraints associated for example from planned network access in the pre-state. Such actions would also have the c. Embedded generation connection output increase/ reduction being the corollary of the above demand subject to relative location within the network area. Similarly the dispatch of a storage charging/ discharging effect. d. Distribution resource power factor modification- leading (reactive power absorbing) power factor in response to increase overall distribution system MVA loading during periods of low overall demand in order to support voltage containment. e. Distribution resource power factor modification- lagging (reactive power generating) power factor at times of high demand in order to reduce MVA loading of DNO network in order to support the off-setting pre-state thermal loading of the transmission network, for example under planned network outage conditions (this represents little more than a fine tuning action given the scale of the effect relative to the transmission flow) and in setting the network in a more secure state against post disturbance voltage depression. (e) *Implementation review* evaluate based on the intended effect of the use of the resources whether the desired changes to the pre-state have resulted and where not- re-start a) above, otherwise no further action beyond on-going monitoring and modelled tracking of the pre-state position identified. **In the act stage (B):-**

	(a) Given that for voltage stability in particular where action would be required within 200ms, but equally a factor for voltage recovery (where action within 2.5 seconds is needed) and potentially thermal management (where action potentially within a 3 minute rating would have needed to be seen in full) post disturbance, the preferred approach within SESG would be to identify in the pre-state the range of actions which can be armed to trigger following or across the period of any disturbance. (b) Actions would be similar to those discussed in the pre-state, however there would be a greater emphasis on:- a. The dynamics of the individual resources in responding to a requirement to act (faster resource response would have greater value for transient conditions, slower but higher volume responses would have value for thermal or sustained post disturbance response to voltage depression); b. The inherent latency between the disturbance occurring and the resource responding (I.e. can we afford to wait, how solutions not dependent upon communication are valued relative to those which are) c. How the pre-state dispatch of the resource affects access to or capability in the above areas. (c) Should a disturbance ensue, SESG would monitor the disturbance with the "memory" of pre-state and the armed resources expected to initiate relative to a disturbance, and the expected range of resource responses to this scenario that would result. This monitoring would then be used to compare to SESGs modelling of the event as modelled in the pre-state, and to where appropriate conduct further real-time simulation adjusting for the actual conditions of the event where different to those studied to display the expected response of resources and system to that condition. (d) Where resources are not delivering sufficiently in the initial period of the disturbance, SESG will be able to further refine its original armed dispatch by identifying (as it would in its pre-state evaluation above) further

	actions which could positively support the containment of the evolving system disturbance in a time period consistent with its effective containment. **In the stabilise stage (C):-** (e) On one level the stabilising stage represents a further refinement to actions identified above as the post disturbance evolves, taking into account that disturbance events with network stability events typically have a high initial response requirement to contain the initial situation which represents an over response post fault. (f) SESG will from the range of responses available, identify those most amenable to "fine-tuning" of the systems otherwise excessive post disturbance, post action behaviour (be that a voltage issue, or a power swing issue, or an over reduction in demand which can now be fettered back based on system recovery) (g) This stage is also noting that, however perfect a model of actual system behaviour in the pre-state, the network behaviour remains dynamic and other factors influencing the network state (for example distribution network demand) could have changed in the time between the pre-state and end of the "stabilise" period, such that the network is genuinely in a different place than it started irrespective of how the disturbance itself evolved in practice out. (h) Finally this stage is noting that disturbances can evolve differently (for example a double circuit fault can result in a permanent loss of that double circuit route, or following a successful DAR post disturbance clearance, one or both of the circuits may have eventually returned). (i) SESG will monitor disturbance event evolution, network state indices and from that monitoring update its models to predict the evolving network and resource behaviour to determine if correction is required and then as per the pre-state, schedule such corrections in the appropriate timeframe.

	In the Post-state stage (D):- (a) Based on the "memory" of the actions conducted across timeframes A-C, SESG will identify the remaining range of resources available and the range of actions, as per the effect those resources could have on the network state and the criteria applied to pre-state evaluation would be repeated. (b) The notable difference to pre-state evaluation will be that it is necessary to re-secure the network in its revised state against subsequent disturbance risk to a more limited array of resources which in total may not in this case present a viable option to provide such security. Where this is the case SESG will flag this exposure and its nature allowing the operator across additional transmission re-securing actions to embark upon the right direction of travel taking into account the the range of distribution actions that remain available to assist security. To take a physical example- in the pre-state the South East network may be subject to a requirement for transient voltage support following disturbance due to for example low demand and high power export out of the area. Ahead of the disturbance, actions to increase overall SE area demand would take place minimising the post disturbance overall voltage response necessary as compared to its requirement prior to SESG optimisation. Across the disturbance (let us assume a double circuit overhead line 3ph-e fault between Canterbury and Cleve Hill/ Kemsley), additional rapid measures such as intertripping of embedded generation and or increased lagging powerfactor from distributed sources would be engaged within the area, which would have the added advantage across the period of the fault itself that whilst the transmission system voltage may be at or close to zero initially, the distribution system retained voltage would be higher due to its greater electrical distance from any transmission fault disturbance, allowing a greater array of responses from power electronic converted sources at that level in inherent response. This would all occur across the act phase (B). Post eventual fault clearance, the scale of Mvar dispatch across the disturbance would need to be arrested, which will on power electronic devices experience delay in response due to control reference response to a developing progressive post fault clearance

	overvoltage; the SESG approach in monitoring and predicting the recovery would have identified subsequent corrective action, some of which could be obtained by distribution resources increasing the Mvar losses within the Grid supply points anticipated to be effective on the transmission problem for the short duration that that problem would manifest itself. This would represent the stabilise phase C. In reaching the post state following a permanent double circuit loss, the operator would seek to contain the frequency excursion resultant from a further double circuit loss which would entirely disconnect the overall south east export. In containing this risk in the post state SESG would make the operator aware of distribution level actions on MW remaining available post disturbance which could be used to minimise both risk period and overall level of transmission level MW re-dispatch. It is recognised that the above is predominantly a general rather than specific discussion of disturbance and resource performance- however each response will very much depend on the realtime network conditions and resource availability dictating the range of measures available. Following the completion of WP1A and WP1B it should be possible to discuss particular considerations to greater detail.
	Conclusion (b.i).2: The main bid makes a clear case that SESG will help manage through 4 stages of a disturbance and whilst the response highlights a methodology to address the various stages, the way in which this maps onto the capabilities of the SESG project in practice will require detailed investigation in the project. For clarity, the stages have been interpreted as: Stage A, Pre-State: Monitor, model, consider actions, implement (increase or decrease generation/demand), evaluate the response. Stage B, Act: Identify suitable resources, implement (as above), evaluate the response, refine strategy. Stage C, Stabilise: same process as Stage A. Stage D, Post-State: Assess changes in network state (as a result of A,B&C), return to Stage A with revised network state. The response remains quite speculative at this stage, with

	much of the detail to be determined within the work packages. Whilst doubts remain as to how feasible the implementation of SESG is in supporting the 4 stages of a disturbance in particular Stage B, the project will provide a potentially valuable insight into this capability. Further questions remain as to how attainable these benefits are given the unproven level of overall distribution resource available.
	Challenge (b.i).3: SESG is claimed to enable generators to benefit from faster connection. Based on the responses, this benefit would appear to arise predominantly from the presence of improved transmission system monitoring. More explanation is needed as to how SESG will accelerate the connection process, highlighting particular areas of innovation.
	Answer (b.i).3: The presence of improved transmission and distribution monitoring, as well as, modelling refinement and trial of improved "whole system" transmission and distribution resources provided by SESG together help in the assessments required for new connections to the grid. In addition to the benefits of improved monitoring, another key area of innovation include consideration of coordinated T&D resources at planning timescale (which reduces the need for building infrastructure). For example, under a business as usual environment when compliance with SQSS/Grid code criteria is carried out, the resources which are considered are limited to the transmission resources. In an event of need for extra voltage support, the overall recommendation would be the installation of new equipment. The assessments, justifications, and installation of new equipment (regardless of whether it is done by the customer, or the transmission company) will have impact on project delivery, as it increases the lead time.
	Conclusion (b.i).3: By providing greater insight into the true operating conditions of the system, assessments of new connections may be conducted more readily and, in some cases, new connections accelerated where reinforcement is not required. This challenge is therefore reasonably addressed.
Sub-criterion (b.ii)- How learning relates to the transmission system	Challenge (b.ii).1: Through the clarification process, it is understood that Siemens have deployed technology across both the transmission and distribution systems. It would be helpful to understand the extent to which there is evidence from other projects of the influence that distribution connected

	equipment can have on the capacity of the transmission network.
	Answer (b.ii).1: There are many advantages for a utility in having an integrated EMS/DMS solution, but so far Siemens are not aware of any Spectrum Power user that has considered combined decision making technologies which takes into account, *"the influence that distribution connected equipment can have on the capacity of the transmission network"*. From a solution point of view, normally the TSO network / system has significantly fewer associated data points, field devices, etc. than a DSO. In the case where the TSO is the focus and is obtaining information (for trading / operation or other reasons) from a DSO, then the dimensions of the DMS network does not affect the performance of the TSO system as the information from the DSO is cherry picked (optimised). To date Siemens have not delivered a Spectrum Power solution where the field assets within the DSO network communicate directly with a TSO. Iberdrola Spain is working in areas independent of the voltage level. This means that an operator is working from the UHV to MV and they do not have a different operator for Transmission and Distribution. Through OMS, they are using the same tool for all voltage levels. Iberdrola have one single integrated system with all EMS (transmission) and DMS (distribution) functionalities. From every user interface (UI), access is available to all EMS/DMS applications. Iberdrola utilise the integrated EMS/DMS solution to achieve the following operational benefits: • Smooth interactions between transmission and distribution (e.g. switching operations, telecontrol information, etc.) • Stations need only be modelled once • Consolidated user environment can make operation for the dispatchers easier • Basic Windows root for all SCADA/EMS/DMS applications • Same navigation and operation techniques in EMS and DMS • Assure reliability of all advanced application calculations from EMS to DMS. The solution of TNA can be easily used in DNA and vice versa

	• End to end topological colouring through EMS to DMS networks • Unique environment for study cases • Single interfaces with external corporate applications • Simplify software maintenance • Hardware optimisation Although Siemens have supplied Spectrum Power with the requirement for interfacing between differing voltage levels and TSO's, there has not been to date an application similar to that of SESG whereby through use of these interfaces, the user will seek to optimise the transmission network through combined use of transmission network and distribution network embedded assets. SESG is more closely aligned with the emerging standards from ENTSO-E which address co-ordination and data sharing between different network actors and roles, and as such learning from SESG could be used to help support and inform the development of these standards.
	Conclusion (b.ii).1: Spectrum Power has been deployed across a distribution and transmission network in Spain but is managed by the same operator. The control of DNO assets from within the transmission control room represents a ground breaking concept. The response satisfies the challenge.
Sub-criterion (b.iii)- Approach to ensuring best value for money in delivering projects	Challenge (b.iii).1: There is a significant issue around the extent to which the Siemens Spectrum Power platform is being deployed as an off-the-shelf solution and the extent to which it represents an innovative development. A large proportion of the project cost is associated with the Siemens system and the description of its functionality that has been provided raises questions as to the extent to which this could be regarded as a business as usual implementation of enhanced system control capability.
	Answer (b.iii).1: As highlighted in the Evaluation Criteria above, SESG seeks to demonstrate a large scale innovative approach to Transmission System optimisation through previously un-tried co-ordination between the Transmission System Operator and the Distribution Network Operator. As detailed in previous clarifications, typically a Spectrum Power Platform is deployed on a customer basis whereby each individual customer will have their own geographical asset

	and/or voltage boundaries which are determined by the regulation within a particular market or country. Spectrum Power Platform has been deployed for both transmission and distribution customers across a range of voltage levels and indeed Siemens has deployed combined/integrated transmission and distribution systems for Ibedrola Control Centres in Spain against a differing context of transmission and distribution system responsibilities and activities. The combined/integrated deployment would typically involve providing visibility of cross-boundary assets through the sharing of system state data. This is to allow a more educated State Estimation to be performed which would be used to provide control outputs to the system owners network and not directly effect on the cross boundary system operators network. The shared visibility of the cross-boundary data however is used to ensure that a system output will not have an adverse in-direct impact on an adjacent or sub-network which could lead to or contribute to major system wide problems, leading to an incident similar to the Europe wide blackout experienced in 2006. In line with this approach and as mentioned previously, the co-ordination and deployment across transmission and distribution levels between different customers who operate their own networks is not common, but this situation is changing particularly at Transmission levels where ENTSO-E are driving the Common Grid Model Exchange Standard (CGMES). CGMES looks to drive standardisation between European TSOs for interoperability of applications for operational and system data exchanges. Siemens, along with other vendors work with ENTSO-E in developing this standard. Siemens has deployed the principles of CGMES to a number of transmission operators in Europe (namely Germany, Switzerland, Hungary) and is working with ENTSO-E towards certification/conformance with the CGMES standard. The SESG Spectrum Power Application will utilise existing 'TNA' applications to perform monitoring and State Estimation functionality and development of this functionality is not envisaged. However, through SESG, Siemens will seek to build upon the combined/integrated approach demonstrated on previous projects (e.g. Iberdola) by applying Spectrum Power to the innovative method of a 'whole system' approach to co-ordinated control. By estimation of system conditions, including that data which has been shared through interaction with cross-boundary systems, Spectrum Power will provide an

	output which will be used to optimise the transmission network through co-ordinated use of distributed assets in co-ordination and optimisation with the operation of transmission assets, whilst equally ensuring such an application does not adversely impact the security of the host distribution system (UKPN). **The methods associated with how the interfaces and protocol for performing this co-ordinated approach operates is an application of Spectrum Power that has not been done in the UK or elsewhere**. Furthermore, the SESG application that National Grid are seeking to deploy will require an element of standardisation which will challenge existing Technical Specifications and will be developed through a collaborative design process. This element of work is critical if the learning established here is to be used to allow the expansion of Smartgrid concepts to other elements of the transmission and distributions system whilst ensuring transparent and consistent market arrangements and network security principles are protected. It is these aspects of the SESG project which are **innovative and untried to the Spectrum Power platform**.
	Conclusion (b.iii).1: This challenge is satisfied in principle as the software will be developed with the intention to facilitate the coordinated control between the TSO and DNO and therefore represents a new means of managing the transmission network. Questions remain however as the level of coordinated control between National Grid and UKPN envisaged and agreed within the SESG project.

2.4 Criterion (c): Generates knowledge that can be shared amongst all relevant Network Licensee

2.4.1 Key Statements

Potential for the generation of new or incremental learning

SESG seeks to address two challenges facing the transmission and distribution systems in the South East area, specifically:

1) Power flow (thermal) limitations, due to increased energy flows across the region, and

2) Voltage stability limitations, due to a long transmission circuit and the increasing presence of HVDC interconnectors.

The main areas of learning that are likely to emerge from the project are connected with:

- Demonstration of a "whole system" approach in the modelling of the transmission and distribution systems;

- Demonstration of a Wide Area Monitoring and Control (WAMC) system across both the transmission and distribution systems;

- Demonstration of a co-ordinated response from transmission and distribution connected resources; and

- Demonstration of innovative commercial services to incentivise service providers to participate in the new market.

New knowledge will be generated in both the development phase of the project and after project completion. Key areas of new knowledge that will be generated relate to:

- The whole system approach that will be developed in the SESG State Estimator, which will monitor parameters across the transmission and distribution systems;

- An innovative tool enabling the estimation of the response required from Distributed Resources to manage transmission constraints;

- The development of commercial services that will enable optimised use of transmission and Distributed Resources to enhance network capability; and

- Educating the general public and local communities in the complexity and economic efficiency of future network developments.

Applicability of learning to other Network Licensees

SESG is stated to generate a number of key areas of knowledge applicable to all relevant Network Licensees:

- Design of new smart and effective system monitoring tools. This includes new system monitoring devices in addition to the improvement of existing equipment;

- Validation of a Smart Grid under different system conditions. The different Smart Grid parameters are tested for specific distributed and transmission resources hence can be used for other Smart Grid applications;

- The coordination of equipment located at different voltage levels (transmission and distribution). The efficient method of communicating with Distributed Resources is explored;

- The optimal operational arrangement of DC links connecting to the onshore transmission system is determined. This knowledge can be handed over to the other Transmission Owner Licensees for any offshore connection to the main transmission system.

Proposed IP management

SESG project partners have reviewed the NIC governance document and it is the intention that the work undertaken using NIC funding will adhere to the NIC default IPR arrangements.

Credibility of proposed methodology for capturing learning from the trial and plans for disseminating

NGET states that knowledge will be disseminated continuously throughout the duration of the project. The SESG will create the necessary forums to share the learning from the project with relevant stakeholders, including the public, technology providers and DNOs.

NGET's customer and stakeholder engagement team will oversee the overall approach to knowledge dissemination. A structured approach to knowledge dissemination will be adopted, with three core components:

- The creation of an SESG "e-Hub" with bimonthly webinars, the publication of data and test results, and frequent project updates;

- An annual technical workshop; and

- An annual public workshop.

The academic partners in the project will play a significant role in managing the e-hub and coordinating the bimonthly webinars.

Knowledge sharing with end-use customers is also considered important.

2.4.2 Challenges and Potential Shortfalls

Criterion (c): Generates knowledge that can be shared amongst all relevant Network Licensee;	
Sub-criterion (c.i)- Potential for new/incremental learning to be generated by the project	Challenge (c.i).1: The potential importance of the project in generating new knowledge about co-ordinated responses from transmission and distribution connected resources to alleviating transmission constraints is noted. Relationships between this project, EFCC and VISOR should be clarified, and also the extent to which knowledge generated in SESG would differ from that gained under EFCC, were both projects to be funded.
	Answer (c.i).1: The EFCC, and VISOR are both have "system monitoring" element. This may require installation of monitoring equipment such as Phasor Measurement Unit (PMU) on the system. Given that SESG also requires access to system monitoring, in this area we will ensure no duplication will be made in installation of monitoring devices, and wherever possible, the SESG will make use of the monitoring devices available on the system, or funded via VISOR/EFCC. The EFCC is a ground-breaking technique in system services to managing the challenge of dealing with low system inertia. Its purpose is to reduce the cost of controlling the system frequency, and falls under balancing services. The EFCC is not expected to release capacity, or defer investments. It will ensure more technologies are risk assessed to provide them access to the new balancing service, and provide an economic, and efficient frequency control measure. The SESG will create significant learnings in how future Smart Grids can interact to provide maximum value for the consumers. The coordinated TSO/DSO actions and interactions are all new to GB, whilst there are significant potential in creating a framework for roll out of such concept in a very near future. The learning generated by SESG will significantly enhance the knowledge gained from EFCC, VISOR, or other LCNF/NIA/IFI projects.
	Conclusion (c.i).1: SESG will build new models and develops control strategies in order to address a fundamentally different issue from EFCC. However, there is a significant overlap as VISOR, EFCC and SESG all essentially install and utilise PMUs. The key

	difference between the projects is the output/resultant operation. NGET have stated that they will endeavour to synergise the installation and use of PMUs although questions remain as to the extent of this and the cost savings that this may achieve.
Sub-criterion (c.ii)- Applicability of learning to other Network Licensees	Challenge (c.ii).1: The potential significance of the project to the NETSO function of NGET is explained in the application, however it is less clear the extent to which this project would benefit TOs, DNOs and connected parties.
	Answer (c.ii).1: "Designing and delivering the connection routes for new customers and undertaking wider network upgrades for system operation and asset related issues is part of the TO role, therefore two of the main benefits from SESG - offsetting the need for a new transmission route and the need for a new reactive compensation - would avoid TOs need to invest resulting in direct benefit for the consumer. Other TOs would benefit from the learning on how these benefits can be achieved and replicated on other parts of the network. Similarly, the DNOs will be able to offset a part of their new asset requirements associated with new connections at the distribution level, voltage management and other requirements (for example, those associated with the potential new European Demand Connection Code). The DNOs will benefit from increased visibility of the networks provided as part of SESG as this will allow the optimisation of the power flows across the distribution and transmission systems and an optimised dispatch of the services and optimised overall distribution and transmission system operation. The connected parties will benefit by the ability to be connected at an earlier date, and greater access as well as potential new market opportunities.
	Conclusion (c.ii).1: Other TOs will benefit indirectly as SESG provides a potentially valuable example of integrated system operation. Generators will also potentially be able to connect more readily as network constraints are overcome through the SESG

	method. The benefit to DNOs requires further examination. It is understood that the PMU data will be fed directly to Spectrum Power at the TSO and so it is unclear how the DNO will benefit without having access or a platform to process the data.
Sub-criterion (c.iii)- Proposed IP management and any deviations from default IP principles	No challenge presented
Sub-criterion (c.iv)- Credibility of proposed methodology for capturing learning from the trial and plans for disseminating	Challenge (c.iv).1: The proposed annual public workshop is a welcome broadening of the knowledge, however it would be helpful to understand more about the way that NGET proposes to engage the public's interest prior to these workshops, to ensure their success.
	Answer (c.iv).1: We proposed this based on the feedback received by other TSOs who had started measures requiring consumers having confidence in the approach, and the overall aim of the concept. We have a comprehensive plan for knowledge dissemination for SESG, and we expect to share the learning of SESG with our stakeholders (i.e. DNOs, manufacturers, academia, etc.). The public workshop proposed for SESG has two purpose: 1) To share SESG's vision, and how network companies, technology providers, and service providers are joined up with one goal; "to be more economic and efficient" and how SESG directly benefits them; 2) Listen to consumers, to those who are directly benefiting from SESG (i.e. residents of the areas who were going to be invited into a public consultation on building a transmission route under a business as usual), and understand what they would like to see from future smart grid projects. This does not have to be a technical discussion, but it will allow We have held a number of stakeholder and customer workshops. The feedback we have received so far shows greater interest from the end-users to be engaged in the decisions, projects, and what we do and how they affect them. We have created forums such as "connecting blog" where we

	update general public on a range of project and topics that National Grid is involved: http://www.nationalgridconnecting.com/fuel-for-thought-2/ We are active in supporting STEM subjects and work closely with schools to give a better flavour of what "engineering" is all about a where their gas and electricity is coming from: http://www.nationalgrideducation.com/ http://www2.nationalgrid.com/Responsibility/Connecting-today/In-the-UK/ These are examples of how we routinely engage with the consumers. We strongly believe the knowledge dissemination element of SESG is not just limited to industry players. We therefore use above forums in addition to our public workshop to discuss the benefits SESG with the consumers.
	Conclusion (c.iv).1: Customers who would benefit from SESG, presumably living in the vicinity of the proposed transmission route, will be invited to public workshops. We are satisfied that this will result in a successful engagement with the public providing effective communication methods are used to raise awareness.

2.5 Criterion (d): Is innovative (ie not business as usual) and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness

2.5.1 Key Statements

National Grid's main claims in regard to this criterion are listed below:-

Justification that the project is truly innovative

The SESG project aims to develop technical and commercial arrangements through which the System Operator can exercise the ability to demand services from the distribution system.

The proposal specifies eight projects that provide elements of learning for SESG; Project VISOR and Humber SmartZone are discussed in the Section 4 of the proposal whilst a summary of the learning points from each project is provided in Section 6.

NGET indicates that these projects have mainly applied to small scale and specific applications, and retains that SESG will provide ground-breaking innovation in the following three areas, which the company refers to as ‘gaps’ in innovation:

1. Comprehensive system monitoring combining both Transmission and Distribution Level (a whole-system approach)

2. Enabling the use of Distributed Resources to manage transmission constraints (tackling communication, cyber security risks, etc.)

3. Developing market signals to enable the roll out of the concept

Further innovation claims are made per work package for each of the five work packages. The innovations for each stage are:

- WP1A – Development of Tools and Techniques for Whole System Evaluation of Smart Solutions,

  Developing combined simulation models and control algorithms of transmission and distribution network.

- WP1B – Wide Area Monitoring across South East,

  Collecting monitored data from both transmission and distribution networks into a State Estimator.

- WP1C – Coordinated Control of Transmission and Distributed Resources,

  Demonstrating a control system capable of estimating the resource required at different points of the network to coordinate the desired overall response from transmission and distribution connected resources.

- WP2 – Development of Commercial Tools and Services,

  Developing new commercial services to incentivise the demand side response.

- WP3 – Need Case Development for Rollout to Other Areas,

  Developing a Need Case for other regions in the GB to understand the opportunities and enabling measures for the wider roll out of the concept.

Justification that NIC funding is required and credibility of claims

NGET explains that deploying Distributed Resources to assist with managing transmission constraints is a key element of the project. This requires whole system monitoring and control, resource estimation, resource initiation and new commercial measures to enable it to succeed.

The scale of the proposed application is cited as a major element of innovation. The SESG project requires interaction between transmission and Distributed Resources, and the complexity of this interaction requires detailed modelling and investigation. This will enable greater understanding of the resources within these networks that can contribute to alleviating transmission constraints.

Identification of project specific risks

In order to illustrate that NIC funding is required to undertake this project, NGET has highlighted seven risks that prevent this project from proceeding as business as usual. The seven risks are documented as:

Technical Risks

1. System Monitoring – The monitoring and control systems are extended to different distributed and transmission resources. Conventionally, monitoring devices have been assigned to specific applications. SESG develops comprehensive system monitoring involving devices at different voltage levels and with different specifications.

2. Coordination of Distributed and Transmission Resources – The coordinated response of distributed and transmission resources will be tested and validated in SESG. For the first time all available resources will be used to mitigate a system or network issue.

3. Distributed Response Identification – Qualifying and quantifying the response from Distributed Resources is a challenging processes. Doing this requires the involvement of different partners and is not a common practice. A range of Distributed Resources, including generation, compensation equipment and demand, will be tested under different network/system conditions.

Operational risks

4. Management of Distribution and Transmission systems – The real-time management of Distribution and Transmission networks is a complex procedure, which requires specific tools and control schemes.

5. Failure of main system monitoring – Building a backup /support centre when the main monitoring system fails is essential. It requires detailed investigation of the network and investment if necessary.

Commercial risk

6. New response market requirement – The existing market arrangement is not able to accommodate responses from various Smart Grid devices. A new market regime is required to incorporate coordinated response from transmission and Distributed Resources.

Regulatory risk

7. The existing business standards such as The National Electricity Transmission System Security and Quality of Supply Standards (NETS SQSS), Grid Code, and Distribution Codes may not be aligned with future network development projects such as SESG.

2.5.2 Challenges and Potential Shortfalls

Criterion (d): Is innovative (ie not business as usual) and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness;	
Sub-criterion (d.i)- Justification that the project is truly innovative	Challenge (d.i).1: Two of the innovation 'gaps' (comprehensive system monitoring and enabling the use of distributed resources) bring together technologies from previous projects (DSR, LCT and real-time monitoring). The innovation in this project and the way that it builds on previous work requires explanation.
	Answer (d.i).1: As described in section 6.2 of the main bid document, we reviewed number of projects both nationally and internationally which provide a foundation knowledge for SESG. With regard to the use of DSR, NGET has been using DSR from a wide range of aggregators for balancing services. This will be the first time that the DSR is used, in a joined up approach with DNOs, to manage transmission networks' issues. <u>The use of DSR as a shared resource, and measures required to avoid the conflict of services are other innovative aspect of use of DSR in SESG.</u> Similar approach in the use of Low Carbon Technologies (LCT), and how they be used as a resource embedded within the DNO's network have been limited to manage thermal constraints on both T&D networks. Whilst the SESG is seeking to use LCT as a resource for managing dynamic voltage stability challenges on the transmission system. This

	represents a significant innovation on use of LCTs for this purpose. With regard to real time monitoring, the system monitoring tools have very limited share of information between transmission and distribution networks. CLASS project for example does provide some level of interaction but not at the level which is required to manage network constraints at the timescale which is required for the transmission networks stability related issues. The state estimator based on real time data obtained from Transmission and Distribution networks is a ground-breaking whole system approach in decision making at design and operational timescale. SESG will bring together these areas which have been developed for number of different purposes, to create a unique and innovative approach in use of such elements for coordination of Transmission and Distribution resources.
	Conclusion (d.i).1: The response makes reference to the numerous previous projects mentioned in the main bid (Section 6.2 and Appendix 9) but doubts remain regarding the amount of learning taken from these projects. No evidence, or factual information, from these projects is evident relating to the SESG project. In particular LNCF projects, such as Low Carbon London, should provide significant insight into the levels of generation/storage available from electric vehicles from which SESG could at least draw assumptions. There is a lack of clarity as to what Distributed Resources will actually be called upon and consequently it is difficult to assess what learning has, or will, be taken from the eight projects specified in the bid.
	Challenge (d.i).2: Siemens Spectrum Power is stated as being widely used elsewhere in the world. No proposed development to the software is cited and as such the extent to which the deployment of this product contributes to the innovative aspects of the project requires clarification.
	Answer (d.i).2: As highlighted in the Evaluation Criteria above, SESG seeks to demonstrate a large scale innovative approach to Transmission System optimisation through previously un-tried co-ordination between the Transmission System Operator and the Distribution Network Operator. As detailed in previous clarifications, typically a Spectrum Power Platform is deployed on a customer basis whereby each

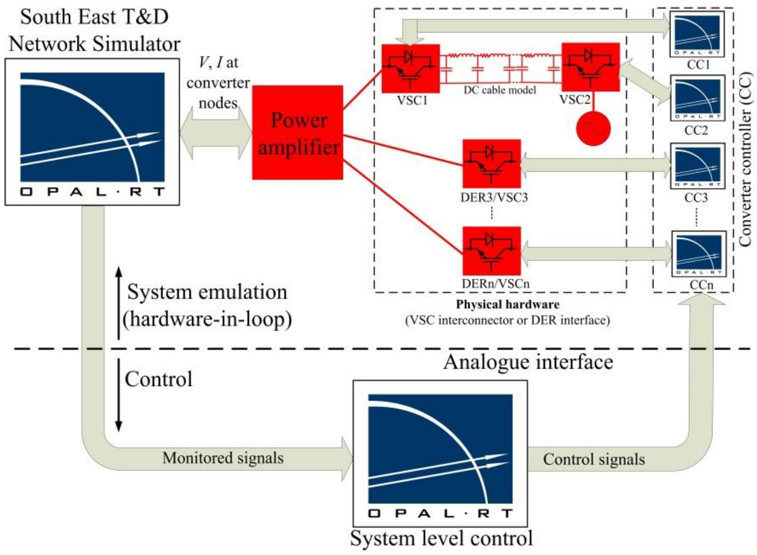
	individual customer will have their own geographical asset and/or voltage boundaries which are determined by the regulation within a particular market or country. Spectrum Power Platform has been deployed for both transmission and distribution customers across a range of voltage levels and indeed Siemens has deployed combined/integrated transmission and distribution systems for Ibedrola Control Centres in Spain against a differing context of transmission and distribution system responsibilities and activities. The combined/integrated deployment would typically involve providing visibility of cross-boundary assets through the sharing of system state data. This is to allow a more educated State Estimation to be performed which would be used to provide control outputs to the system owners network and not directly effect on the cross boundary system operators network. The shared visibility of the cross-boundary data however is used to ensure that a system output will not have an adverse in-direct impact on an adjacent or sub-network which could lead to or contribute to major system wide problems, leading to an incident similar to the Europe wide blackout experienced in 2006. In line with this approach and as mentioned previously, the co-ordination and deployment across transmission and distribution levels between different customers who operate their own networks is not common, but this situation is changing particularly at Transmission levels where ENTSO-E are driving the Common Grid Model Exchange Standard (CGMES). CGMES looks to drive standardisation between European TSOs for interoperability of applications for operational and system data exchanges. Siemens, along with other vendors work with ENTSO-E in developing this standard. Siemens has deployed the principles of CGMES to a number of transmission operators in Europe (namely Germany, Switzerland, Hungary) and is working with ENTSO-E towards certification/conformance with the CGMES standard. The SESG Spectrum Power Application will utilise existing 'TNA' applications to perform monitoring and State Estimation functionality and development of this functionality is not envisaged. However, through SESG, Siemens will seek to build upon the combined/integrated approach demonstrated on previous projects (e.g. Iberdola) by applying Spectrum Power to the innovative method of a 'whole system' approach to co-ordinated control. By estimation of system conditions, including that data which has been shared through interaction

	with cross-boundary systems, Spectrum Power will provide an output which will be used to optimise the transmission network through co-ordinated use of distributed assets in co-ordination and optimisation with the operation of transmission assets, whilst equally ensuring such an application does not adversely impact the security of the host distribution system (UKPN). The methods associated with how the interfaces and protocol for performing this co-ordinated approach operates is an application of Spectrum Power that has **not been done in the UK or elsewhere**. Furthermore, the SESG application that National Grid are seeking to deploy will require an element of standardisation which will challenge existing Technical Specifications and will be developed through a collaborative design process. This element of work is critical if the learning established here is to be used to allow the expansion of Smartgrid concepts to other elements of the transmission and distributions system whilst ensuring transparent and consistent market arrangements and network security principles are protected. It is these aspects of the SESG project which are **innovative and untried to the Spectrum Power platform**.
	Conclusion (d.i).2: Same as Answer (b.iii).1 This response satisfies the challenge.
Sub-criterion (d.ii)- Justification that NIC funding is required and credibility of claims	Challenge (d.ii).1: It is unclear overall why this project constitutes an innovation project rather than a "business as usual" implementation of a previously tried and tested monitoring and control system. NGET should explain in detail the justification for why the project is innovative.
	Answer (d.ii).1: It is the view of the NGET, our project partners, and supporter that SESG constitutes a truly innovative project, the benefit of which would bring significant value to the industry and end consumers. There is no capability as part of the current "business as usual" to achieve the same level of support from distributed resources and the same level of reduction in thermal and voltage constraints as SESG aims to achieve, due to the NETSO having little visibility and knowledge of the distribution network, the customers connected to it and their capabilities in terms of system support. This in turn leads to high constraint costs associated with the operation of the South East area under current ""business as usual"" approach which cannot be

	considerably reduced without the systems and services that SESG proposes to implement. As for innovation in a broader sense, outside the GB NETSO context, previous smart grid projects have mainly been applied on a comparatively small scale, for specific applications and have not demonstrated the whole-system approach that is the focus of SESG, along with the utilisation of state of the art monitoring technology and a very high volume of resources on both transmission and distribution networks in a way that has not yet been demonstrated on any other system.
	Conclusion (d.ii).1: From the responses given, it is clear that the "whole system" coordinated approach between separate distribution and transmission system operators represents a significant level of innovation, given the lack of UK and international experience.
	Challenge (d.ii).2: It is recognised that an important area of investigation for the project is increasing the understanding of the potential contribution of distribution connected resources to the control of the transmission network. There is a lack of sufficient supporting information indicating a robust plan for the closed-loop testing/Service Trials to give confidence that the project will be successful in demonstrating the control of distributed resources to address transmission issues.
	Answer (d.ii).2: We identified the need for this testing which forms a key objective of WP1A. With no prior operating experience, computer simulations alone would not provide the necessary confidence needed to carry out field trials. As an intermediate step, hardware-in-loop testing with the transmission and distribution system modelled in a real-time simulator (e.g. Opal-RT) which is connected to the physical power converters mimicking the behaviour (scaled version) of aggregated DERs is likely to reveal possible interactions in the relevant time scales which the computer modelling would not necessarily reveal. Another motivation behind real-time simulation is to verify that the complex control algorithms (such as model predictive control) can be computed on realistic hardware within each sampling interval (with no 'calculation overrun') and communicated to the DERs. This should provide evidence that real-time operation of complex control scheme is feasible. The same argument applies to testing control of multiple

	HVDC via hardware-in-loop: there maybe factors un-modelled in a simulation that are uncovered in hardware and there is an opportunity to verify that the control algorithm can execute in real-time. Computer simulation models of the South East transmission network including the conventional generators etc. and the distribution network (down to a certain level from the GSPs) would be developed at Imperial under WP1A. These models would then be rebuilt in a format that is compatible with the real-time target of Opal-RT. Computer simulation models of the network built in Matlab/SIMULINK could be directly loaded onto real-time target. However, for other platforms (e.g. DIgSILENT PowerFactory), the interface issues would have to be resolved first. The existing real-time simulation facility at Imperial would have to be upgraded to handle the whole South East network. This would be done through modular addition of new processors to suit the size and complexity of the models. Imperial has over the last two years constructed scale-model VSC HVDC converters (of multi-level format) controlled by Opal-RT platforms and has a physical representation of a 4-terminal DC cable networks. It has previous experience of using Opal-RT for real-time modelling of AC networks. To this will be added power amplifiers that take voltage signals from the real-time simulator and create AC voltages to apply to the VSC hardware. Thus the combined AC network and DC network can be physically represented in real-time. The controllers of HVDC will be fully represented (albeit scaled-down) without any simplification (such as neglecting switching effects) and can be run for many minutes or hours. This is a fuller and more realistic test than can be achieved in computer simulation. The hardware can test dynamic response and fault conditions. Testing of DER within the SE transmission network will make use of the programmable converters (which could be made to mimic the specific characteristics of different forms of DERs), DC cable models and AC distribution network impedances available at the Smart Energy Lab at Imperial and connect these to the power amplifiers that replicate the voltages from the real-time simulation of the transmission network. Again dynamic responses of the closed-loop system will be tested. The testing will be carried out in a several phases. In the first phase, the response from the system emulator part consisting of the network simulator and the physical hardware (converters, cable model) would be benchmarked against the

computer simulation results to account for any major discrepancy. Similarly, the computation of the control algorithms would be tested in isolation with synthesised/virtual feedback signals. Once, the system emulator and controller have been validated separately, we would attempt the closed-loop tests using the set-up shown in Figure 1.



Hardware-in-loop (HIL) set-up for closed-loop testing and validation

Such a real-time hardware-in-loop set-up will virtually emulate the dynamic response of the South East network including the transmission and distribution level resources. This will provide a semi-real test bench to examine the monitoring and control algorithms developed in another Opal-RT platform or a microcontroller. Successful closed-loop tests with such a hardware-in-loop setup will provide a test bench for validating the coordinated control strategies and providing the necessary confidence for going ahead with field trials.

Conclusion (d.ii).2: Insight is given into the method of the hardware-in-loop (HIL) testing and the justification behind its inclusion in the project. There is a satisfactory level of detail in relation to this element and it would be understandable if a concise plan of the HIL testing does not exist but it would helpful for NGET to explore this further.

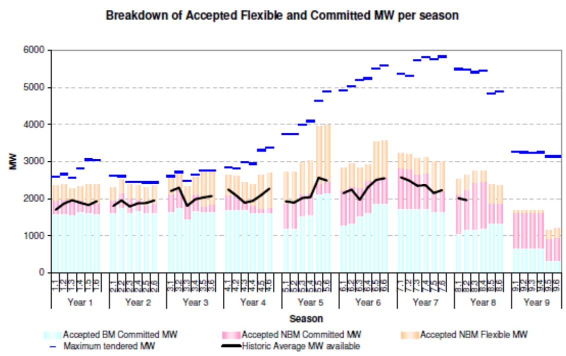
NGET have stated that the HIL tests will validate the developed models before progression to the Service Trials but have failed to provide any detail of these trials and therefore have not instilled sufficient confidence that this has been

	planned in any detail.
Sub-criterion (d.iii)- Identification of project specific risks (including commercial, technical, operational or regulatory risks)	Challenge (d.iii).1: The role of the distribution resource service providers (DSR aggregators) is crucial in progressing the Smart Grid approach to business as usual. The absence of suppliers from the project team raises concerns regarding the credibility and size of the distribution resource obtainable to support the System Operator. NGET should provide assurance on this point.
	Answer (d.iii).1: We have formed partnership with service providers wherever it was felt it is in the best interest of the project from cost, and project de-risking prospective. For example, given the level of modification of control systems required in EFCC, it was necessary that service providers are involved as partner. For SESG, we have conducted the review of potential for procurement of the services which will be required for the purpose of trial in SESG. We are confident that our DSR aggregators that we are working with as part of our Balancing Services, or were involved in the call for proposal for NIC projects have access to sufficient volume of DSR within this area so the trials can take place. **This will allow us to procure this service at the best price, and from a range of service providers than only one single service provider.** In addition, we would agree that the engagement of suppliers is critical to the success of this project but would contend that the most efficient form of engagement in order to maximise consumer benefit would application would come from the parallel development of market mechanisms to ensure a liquidity and downwards pressure on price from competition on supply, combined with the openness and transparency that would promote access and incentive to new entrants and incentives to such entrants to innovate in their provision. There is rather in our view a risk to pre-emptive engagement with individual suppliers in the area known to us from other experience (for example from the provision of Short Term Operating Reserve services) in being seen to be discriminatory and inhibit service growth and efficiency. It is important to draw parallel here between our proposed use of demand side, embedded generation and storage distributed resources within SESG and the lessons learned from the engagement of distributed resources within the STOR contracting process. (a link to our last contracting round report

can be found at http://www2.nationalgrid.com/UK/Industry-information/Electricity-transmission-operational-data/Report-explorer/Services-Reports/)

In the early years of STOR, and standing reserve before it, National Grid relied upon traditional suppliers of standing reserve (for example power station auxiliary GTs, OCGTs, and generation max gen services) given that at that stage limited visibility and engagement of the service had been provided, and the service requirements had been largely scoped around the capabilities of those historic service provisions. Since those early years National Grid has progressively broadened the accessibility and visibility to the market such that distributed resources of a variety of singular and aggregated forms can effectively access the market, and continues to work with the supplier community to further refine the service requirements further to provide further levels of access to innovation from the supplier base Figure 1 below illustrates the growth of more than 2.5 times the initial service volumes that have occurred over that period which has delivered consumer benefit in price and diversity of service as further discussed in detail in our report reviewing the current performance of the STOR market.

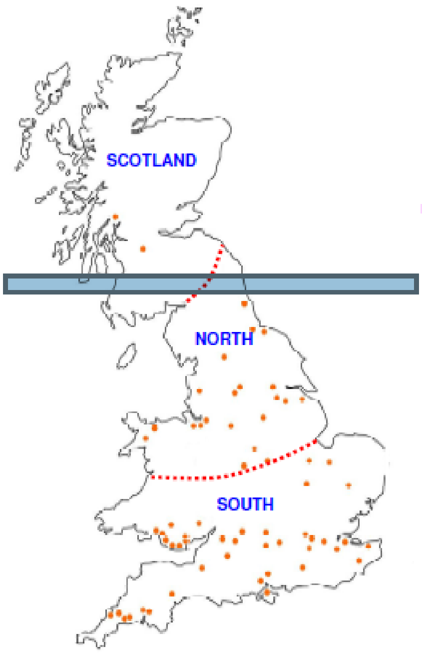
Figure 1



The bar charts above identify what has been contracted season by season for STOR and shows a considerable growth in the profile of NBM volume compared with BM. What is more startling is the growth in the blue lines at the top of each season, which represent the volume of discrete MW that have participated in tenders for each season. This team have been very successful in promoting the STOR market over the last 6 years and the bulk of that growth has come from the Non Balancing Market (NBM) sector of unconventional service providers. In fact only approximately 600MW of the growth has come from BM with the rest from NBM sector. This has

	mainly been through the following:- • Increasing participation of direct NBM parties contracting with NG to offer STOR utilising back up generation assets that they already owned or through the use of load shedding activities from processes that are their core business. • Facilitation of the aggregator market to allow a total service scale and confidence value of value to the System Operator and also allowing market opportunity for aggregator services to evolve reducing the overall complications for access for smaller parties. • ~1GW of offers from new build embedded generation to the long term STOR contracting opportunities in 2010. Approximately 400MW of contracts were let prior to the contracting opportunity being closed. It is worth noting therefore that approximately 600 MW of the recent reduction in the blue line on the chart occurred as these parties needed the 15 year tender opportunity to participate, and they have effectively offered for all STOR seasons out to 2025, and this accounts for the more recent reduction observed- the volume is rather differently tendered. We would note also that in terms of overall tendered resources within the south alone the scale of resource available has more than doubled; see figure 2 below. From our active and ongoing discussions with suppliers we are aware of an appetite for participation in products of shorter duration with different varieties of responsiveness and initiation, services which as yet have not found an effective fit within the existing STOR framework but may however have an appropriate level of effectiveness in delivering a service within the 4 system state timeframes across the range of system performance challenges SESG seeks to mitigate.

Figure 2 Map of Great Britain



SCOTLAND	Units tendered	Units Accepted	MW tendered	MW Accepted
8.1	-	-	-	-
8.2	-	-	-	-
8.3	4	-	104	-
8.4	4	-	104	-
8.5	1	-	30	-
8.6	1	-	30	-
9.1	-	-	-	-
9.2	-	-	-	-
9.3	-	-	-	-
9.4	-	-	-	-
9.5	-	-	-	-
9.6	-	-	-	-

NORTH	Units tendered	Units Accepted	MW tendered	MW Accepted
8.1	-	-	-	-
8.2	-	-	-	-
8.3	24	9	391	166
8.4	25	9	492	169
8.5	15	4	383	110
8.6	14	3	373	100
9.1	13	5	458	97
9.2	13	5	455	96
9.3	11	5	369	96
9.4	11	5	370	97
9.5	9	5	369	99
9.6	9	5	369	99

SOUTH	Units tendered	Units Accepted	MW tendered	MW Accepted
8.1	-	-	-	-
8.2	-	-	-	-
8.3	27	13	657	166
8.4	27	13	663	166
8.5	31	17	648	255
8.6	32	15	643	230
9.1	57	19	1,577	384
9.2	57	19	1,557	384
9.3	53	19	1,430	383
9.4	53	19	1,442	387
9.5	42	2	1,326	39
9.6	46	5	1,360	69

MULTIPLE LOCATIONS (Aggregated sites)

MULTIPLE	Units tendered	Units Accepted	MW tendered	MW Accepted
8.1	-	-	-	-
8.2	-	-	-	-
8.3	40	4	267	40
8.4	40	4	267	40
8.5	46	7	343	64
8.6	46	6	343	60
9.1	27	-	211	-
9.2	27	-	211	-
9.3	27	-	208	-
9.4	27	-	208	-
9.5	30	-	244	-
9.6	30	-	244	-

As such in conclusion, whilst no specific supplier partners have been adopted under this project we would view that via existing strong and developing supplier relationships we have acquired considerable market intelligence to confirm that both the volumes of distributed resource and the appetite exists for appropriate market participation. National Grid is already active in supplier engagement associated with STOR around potential new services. We would note that in function there are many synergies with the existing STOR process and indeed one potential market models to be developed under WP3 may be to promote the enlargement of the national-level STOR process to encapsulate the more regional SESG service definition which based on the monitoring and simulation work in WP1 would have a service definition positioned to promote as broad an access to this new market as possible however this is but one of many approaches and would equally need to address potential issues of service overlap and existing market distortion from any integration. To our view our proposed

	approach of the active increased engagement of supplier within STOR and other frameworks ahead of our service definition within WP1 allowing parallel market options and subsequent specific consultations under SESG will be more effective in delivering consumer benefit than the alternative of a more closed and limited direct supplier engagement in the early stages of the project. We do this with the confidence borne of our experience to date that both service volumes and supplier appetite is sufficient to meet the aspirations of the SESG project.
	Conclusion (d.iii).1: NGET have provided justification for the decision not to include Suppliers (DSR Aggregators) as part of the project team in order to procure the services at the best price. NGET have acknowledged the project risk by the exclusion of Aggregators from the project team but offer assurances of engagement and cost efficiency based on NGETs experience of STOR. Should the SESG project trial the use of Aggregators incumbent within the STOR mechanism, it would be useful to understand the generation mix offered through existing routes to gauge the level of non-renewable generation called upon.

2.6 Criterion (e): Involvement of other partners and external funding

2.6.1 Key Statements

NGET's main claims in regard to this criterion are listed below:-

Appropriateness of collaborators

NGET publically tendered for the roles for SESG collaborators. The candidates were assessed and chosen based on the following criteria and adherence to the NIC terms:

- Price/contribution
- Organisation/resource
- Understanding and delivery
- Solution offered

External funding

NGET has discussed the need for external funding, and all the project partners are contributing (both in-kind, and financially) to this project, as summarised below:

Siemens	£[redacted]
Imperial College London	£[redacted]
UK Power Networks	£[redacted]
Elexon	£[redacted]
Total External Funding	**£795,380**

Effectiveness of process for seeking and identifying new project partners and ideas

During the selection process, NGET held discussions with relevant customers, suppliers and partners to elaborate the project's aims and objectives in further detail.

No details have been submitted to suggest that service providers have been approached as yet.

2.6.2 Challenges and Potential Shortfalls

Criterion (e): Involvement of other partners and external funding;	
Sub-criterion (e.i)- Appropriateness of collaborators (including experience, expertise and robustness of commitments)	Challenge (e.i).1: Justification is required relating to the exclusion of participants with direct access to the demand side or distributed generation owners/developers from the project.
	Answer (e.i).1: Similar to response to (d.iii) given we have assurance with regard to both presence, and desire of service providers to provide the service the SESG requires for the purpose of trials, we will procure these service through a competitive tendering process and from a range of service providers for the purpose of trial.
	Conclusion (e.i).1: Challenge satisfied in (d.iii).
	Challenge (e.i).2: Further information is required as to the proposed management and recruitment plans for the team at Imperial.
	Answer (e.i).2: The Control and Power Group of Imperial College will carry out the proposed Imperial tasks with SESG. Seven academics

	will participate in the activities within SESG including: • Transmission and distribution stability modelling; • State estimation; • Virtual power plant; • Advanced network control and system dynamics; • Commercial management and risk assessment; and • Hardware in loop modelling and simulation Which will be led by the following academics respectively: Prof Pal and Dr Chaudhuri, Prof Astolfi and Prof Parisini, Prof Strbac, and Prof Green and Dr Junyent-Ferre. The proposed work on SESG will be carried out by the team of Senior Researchers that are at Imperial, including Dr Falugi (advanced modelling of system dynamic and control), Dr Pipelzadeh (network stability and state estimation), Dr Merlin (hardware-in-loop simulation), Dr Pudjianto (distribution–transmission interface, commercial arrangements), Dr Tindemans (risk and uncertainty). This team will be ready to start the project in March 2015 and support Post Doctoral and PhD researchers that will be recruited to carry out specific tasks in SESG. Prof Strbac, Dr Chaudhuri and Prof Green will coordinate activities of Imperial team and interface with the SESG management.
	Conclusion (e.i).2: The response addresses the challenge but is presented in such a way that it is too difficult to understand the structure of the Imperial team. It appears that seven academics will participate in six core activities, three of whom will report to National Grid. Five Senior Researchers are also named and additional research personnel will be recruited. Further assurance as to Imperial's ability to recruit and manage the required team would be desirable.
Sub-criterion (e.ii)- External funding (including level and security of external funding)	Challenge (e.ii).1: The level of external funding proposed for the project amounts to 6.7% of the total project cost, which is a relatively low percentage. NGET should state whether the project partners have been encouraged to increase their contributions to levels that are more proportionate to their costs in the overall project budget.

	Answer (e.ii).1: This was successfully explored and the level of in-kind support/contribution we have received from all project partners will contribute significantly to the success of the project, as well as reducing the related costs. Each project partner contributes in respect of their total cost – and for example Siemens has made [redacted]**% contribution** to its total costs, or Imperial College of London has [redacted]**% contribution** to the total labour hours of permanent staff, as well as [redacted]**% contribution** to total equipment cost. UKPN is also providing [redacted]**% contribution**. The SESG has a strong project team, who are committed to the successful delivery of the project, and have all agreed to contribute to the cost associated with the delivery of SESG.
	Conclusion (e.ii).1: NGET have added a comment to the figure presented as UKPN's contribution in the Key Statements. The comment states that £[redacted] is UKPN's project cost to be funded by the NIC and their contribution is £[redacted]. The main bid clearly states this figure as £[redacted] in the Project Summary and the financial spreadsheet. The situation is further confused by the response to Challenge (g.iv).3, in which NGET have embedded UKPN's scope of works which also specifies UKPN's in-kind contribution equates to £[redacted] with £[redacted] to be funded by the NIC. UKPN's total project cost amounts to £[redacted]. These figures require confirmation.
Sub-criterion (e.iii)- Effectiveness of process for seeking and identifying new project partners and ideas	See Challenge (d.iii).1
	We have formed partnership with service providers wherever it was felt it is in the best interest of the project from cost, and project de-risking prospective. For example, given the level of modification of control systems required in EFCC, it was necessary that service providers are involved as partner. For SESG, we have conducted the review of potential for procurement of the services which will be required for the purpose of trial in SESG. We are confident that our DSR aggregators that we are working with as part of our Balancing Services, or were involved in the call for proposal for NIC projects have access to sufficient volume of DSR within this area so the trials can take place.

	This will allow us to procure this service at the best price, and from a range of service providers than only one single service provider.
	See response to Challenge (d.iii).1

2.7 Criterion (f): Relevance and timing

2.7.1 Key Statements

NGET's main claims in regard to this criterion are listed below:-

Significance of the project in overcoming current obstacles to a future low carbon economy

The South East area reportedly experiences high voltages at times of low demand and this problem will be exacerbated by additional generation in the region. The need to exercise constraint management in the South East is increasing each year.

With multiple flexible technologies and resources available on both the transmission (i.e. interconnectors) and distribution networks (i.e. DSR and LCTs), coordinated action may deliver the optimal aggregated response to enable the transmission circuit voltage to be regulated to acceptable limits.

Successful development of technical and commercial frameworks to enable such control is expected to reduce constraints on renewable generation and interconnector operation whilst assisting NGET in determining the most cost effective options for network reinforcement and further generation connection.

Significance of the project in trialling new technologies that could have a major low carbon impact

Siemens will provide the key technological development in the form of a Wide Area Monitoring and Control (WAMC) system, comprising of:

- **Phasor Measurement Units (PMUs)** - real-time monitors installed at optimum grid supply points across the South East region of the transmission network.
- **Phasor Data Processor** - the central server repository for PMU data
- **Siemens Spectrum Power** - a suite of control and management applications to deploy the SESG method, including the Transmission Network Applications (TNA) capable of real-time analysis and grid optimisation.

Significance of the project in demonstrating new system approaches that could have widespread application

The project seeks to develop a new suite of services that could change operational practices in how network operators manage voltage and thermal stability issues, improve network capacity management and potentially avoid or defer network reinforcement.

NGET states that SESG will provide a pioneering "whole system" approach to managing the transmission system that will be rolled out to other areas of the network and applicable to other network owners.

The applicability of the project to future business plans, regardless of uptake of LCTs (Low carbon Technologies)

As mentioned above, whilst this project is driven by issues arising due to increased penetration of LCTs, its application and relevance does not depend on their presence but rather offers a step toward a more informed and coordinated means of dynamically adjusting demand and generation in order to uphold operational limits.

The application of the tools developed by SESG are expected to be re-applied to other areas of the UK network, which currently face similar challenges.

2.7.2 Challenges and Potential Shortfalls

Criterion (f): Relevance and timing;	
Sub-criterion (f.i) – **Significance of the project in**: (a) overcoming current obstacles to a future low carbon economy	Challenge (f.i).1: The application claims a significant level of energy savings resulting from the project, arising from the avoided fossil fuelled generation required for voltage control purposes and from the accommodation of increased renewable generation from European interconnectors. The justification of the quantities of energy quoted requires further explanation.
	Answer (f.i).1: There is clear evidence from the level of generator constraint in current year, and comparing with previous years that the costs reported are actual costs. Given the status of the network in the South East, the reported cost are based on costs we have observed. The savings as reported in the main bid document, and clarified in our response as part of Q&As are based on the assessments carried out in our studies (reported in the Q&A) and will be further clarified in the final submission. The energy savings are due to the

	network constraints which will be minimised with SESG.
	Conclusion (f.i).1: The challenge refers to energy savings specified within the Benefits Table in Appendix 1. The calculations behind these figures remains unclear. The response does not adequately address the challenge.
(b) trialling new technologies that could have a major low carbon impact	No challenge presented
(c) demonstrating new system approaches that could have widespread application	No challenge presented

2.8 Criterion (g): Demonstration of a robust methodology and that the project is ready to implement

2.8.1 Key Statements

NGET's main claims in regard to this criterion are listed below:-

Feasibility of project proposal

The SESG project is supported at all levels within NGET, via the established Innovation Steering Board. Senior management will be involved in the development and operation of the project.

The project will begin in January 2015; the project plan evidences timescales but does not include milestones or delivery deadlines, although NGET has stated that partners have agreed deliverables and key delivery dates.

All risks, including customer impact, exceeding forecast costs and missing delivery date

The focus of SESG is to trial the response from Distributed Resources without impacting customers directly.

A thorough risk register has identified 22 specific risks and mitigation actions along with contingency and cost implications. Two of the prominent risks are summarised below.

Work package: WP1C

> **Risk:** Poor response from service providers (demand side response, storage, etc.) when invited to Tender.
>
> **Mitigation action:** Ensure early engagement with service providers to capture interest before invitation to tender (Q1 2016).

Work package: WP1C

> **Risk:** Coordination between transmission and distribution systems not achieved.
>
> **Mitigation action:** Extensive studies will be carried out in WP1A to generate knowledge that will guide the rest of the project and ensure a successful outcome. In addition, UKPN is a partner to the project and has agreed to provide support.

Whether items within project budget provide value for money

The project cost spreadsheet provides cost items for each of the 5 work packages although the distribution of these costs amongst the project partners is not transparent, in particular the £5m of contractor costs.

NGET has stated that the breakdown of a particular cost item stems from the EFCC project which has been adjusted to 75% of the EFCC costs, reasoning that SESG is of a smaller scale.

NGET has been requested to modify the cost breakdown in the submission to address this issue and provide clarity of cost distribution across project partners.

Project methodology

The project comprises of five main stages. NGET has provided a detailed breakdown of the costs by task in Appendix 2 and the associated plan in Appendix 3.

Given the emphasis on technical modelling of the UK electricity networks, principally conducted by Imperial College London, the table below summarises these reported costs by work package. NGET's contractor costs include the Research Assistant costs so these costs have been deducted from the reported contractor costs.

Task	RA Costs	Contractor Cost (less RA)	Total Task Cost
Overall Project	£ -	£ 41	£ 1,496
Work Package 1A - Development of Tools and Techniques for Whole System Evaluation	£ 1,023	£ 36	£ 1,563
Work Package 1B - Wide Area Monitoring across South East (T&D State Estimator)	£ -	£ 1,852	£ 3,183
Work Package 1C - Coordinated Control of Transmission and Distributed Resources	£ -	£ 1,300	£ 3,976
Work Package 2 - Development of Commercial Tools and Services	£ 275	£ 162	£ 967
Work Package 3 - Need Case Development for Rollout to Other Areas	£ 345	£ -	£ 636
Grand Total	**£ 1,643**	**£ 3,390**	**£ 11,820**

NGET has provided a thorough description of the work packages and each partners' associated roles. Indicative deadlines have not been provided, although NGET states that project partners have agreed to these.

NGET specifies that the partners have been engaged with SESG since the initial stage of the project and are fully aware of the project milestones.

The team will be led by National Grid and will provide regular feedback and updates to senior management. Dr. Vandad Hamidi will be acting as the key point of contact with Ofgem, the project delivery team, and the steering committee.

Appropriateness of Successful Delivery Award Criteria (SDRC)

Eight Successful Delivery Reward Criteria are proposed, each covering a different aspect of the project:

1. Formal Memorandum of Understanding and Agreement in Place with Project Partners
2. Whole System Evaluation Models Developed
3. SESG State Estimator Developed Successfully
4. Evaluation of response from Distributed Resources
5. Successful development of new Commercial Services to enable the use of Distributed Resources
6. Successful Roll Out Plan Developed

7. Successful Knowledge Dissemination of SESG
8. Project close and knowledge dissemination

2.8.2 Challenges and Potential Shortfalls

Criterion (g): Demonstration of a robust methodology and that the project is ready to implement;	
Sub-criterion (g.i)- Feasibility of project proposal	No challenge presented
Sub-criterion (g.ii)- All risks, including customer impact, exceeding forecast costs and missing delivery date	Challenge (g.ii).1: NGET has stated that no customers will be impacted by the SESG project but "Service Trials" are included in the project plan, which include cost items for payments to users, form part of the Successful Deliver Reward Criteria 9.4. Further clarification is required to understand what these trials are expected to entail, who are the "users" are who will be involved in them and how the payments to users that are included in the overall project budget will be determined and allocated.
	Answer (g.ii).1: The trials will require service providers to provide the resources (i.e. demand in case of DSR) available for the purpose of trials. We will procure this service through a competitive tendering process and will select the service providers which provide the resources the SESG requires. The payment to the users, will then effectively be the payment to the service providers. • If the DSR service providers act as "aggregator" then the payment will be made directly to them based on the service they make available. • In case of embedded generator, the payment will be made to the owner of the embedded generator, or if they are dispatched centrally via EG aggregators to the aggregator. We have forecasted the cost associated with the trials based on the cost figures we obtained as part of our Call for Proposal, and service costs associated with EFCC. As explained, we

<table>
<tr><td></td><td>have factored in a percentage of those cost due to less need for modifications on providers' end, and down time. We will also be going through a competitive tendering process for this purpose.</td></tr>
<tr><td></td><td>Conclusion (g.ii).1: Through the above response we understand that "Payments to Users" refers to Aggregators or Embedded Generators.

In the Project Summary, NGET refer to Distributed Resources as solar, wind, storage and demand side response. In view of the response to Challenge (a.iv).1, stating the only known resource in the South East is 193.3MW of embedded generation, we now understand that the Service Trials will likely employ Aggregators and tap-changing trials rather than the defined Distributed Resources.

The overall lack of clarity regarding this point has proved difficult to unravel and the quality of the responses raises questions as to the readiness of the customer engagement element of the project.</td></tr>
<tr><td>Sub-criterion (g.iii)- Whether items within project budget provide value for money</td><td>Challenge (g.iii).1: Greater transparency into the distribution of contractor costs totalling £5m is required. The project consists of significant software-based modelling and validation, which Imperial College London and Siemens primarily undertake, but a clear breakdown of the distribution of the cost has not been presented following clarification requests.</td></tr>
<tr><td></td><td>Answer (g.iii).1:
<table>
<tr><th>Description of Siemens Activities</th><th>Costs (£k)</th><th>Siemens Contribution</th></tr>
<tr><td>WP1A – Solution Development</td><td></td><td></td></tr>
<tr><td>Collaboration with Imperial on assessment of existing GSP Monitoring and new requirements</td><td>27.2</td><td>-</td></tr>
<tr><td>WP1B – WAMC System Delivery</td><td></td><td></td></tr>
<tr><td>Functional Design and Workshops</td><td>54.4</td><td>-</td></tr>
<tr><td>Site Assessments</td><td>18.5</td><td>-</td></tr>
</table></td></tr>
</table>

Procurement (Hardware and Software) Central Controller / Phasor Data Concentrator GSP Monitoring (PMU)	**725.0** 325.0 400.0	**[redacted]%** [redacted]% [redacted]%
Design and Manufacture Design packages inclusive of NGET approval process and factory build of Remote Monitoring Solution (@8 x GSP's) and Central Controller Solution	**74.38**	-
Configuration of WAMC to enable real-time monitoring, assessment, State Estimate and NETSO interfacing Central Controller and; Phasor Data Concentrator / GSP Monitoring (PMU)	**843.75** **-** 537.75 306.0	-
Factory Testing / Type Registration WAMC Solution	**170.0**	-
Site Installation and Commissioning WAMC Solution installation and interfacing work (2 x NG approved Wiremen/Site management) @ 8 x GSP's and Central Control location Commissioning and Site Acceptance Test of WAMC	**560.25** 232.25 328.0	-
Evaluation of Soak Period findings in collaboration with Imperial	**59.5**	
Learning Dissemination Contribution	**76.5**	**[redacted]%**
	2,609.48	**[redacted]%**

Description of Imperial Activities	**Staff effort (months)**	**Staff cost**

		(k£)	
T1.1 - Develop detailed computer simulation models for the South-East network	8.5	[redacted]	
T1.2 - Analyse network behaviour to identify appropriate locations for monitoring	13.5	[redacted]	
T1.3 - Development of Virtual Power Plant concepts	19.5	[redacted]	
T1.4 - Analysis of monitoring and control systems in South East network	12.0	[redacted]	
T1.5 - Extend existing network simulator for real-time simulation of the South East network	6.0	[redacted]	
T1.6 - Integrate physical hardware with real-time simulation to prepare a HIL platform	13.0	[redacted]	
T1.7 - Validate network monitoring and coordinated control through HIL and software based simulation	20.5	[redacted]	
T2.1 - Development of commercial arrangements	14.5	[redacted]	
T2.2 - Option value of SESG Contracts	14.0	[redacted]	
T3.1 - Risk Profile of SESG solutions	14.5	[redacted]	
T3.2 - Rolling out of SESG paradigm	21.5	[redacted]	
Total	**157.5**	[redacted]	

The Imperial staff cost includes salaries for Post-Doctoral Researchers (Research Associates and Research Fellows) working on the project. Only [redacted]% of cost of permanent academic staff is charged to the project, providing contribution in kind by Imperial to SESG of more than £[redacted]k.

	In addition to staff costs, the existing hardware in Imperial Smart Grid Laboratory will be upgrade for the specific purpose of this project. The cost of the hardware upgrade is £[redacted]k, and given the contribution in kind from Imperial at £[redacted]k, the equipment cost to the project is £[redacted]k. The total staff and equipment costs funded by the project amount to £[redacted]
	Conclusion (g.iii).1: The costs appear credible and broadly align with the financial spreadsheet. A few line items for Siemens cannot be easily cross-checked against the proposal as they are made up of smaller tasks within the financial spreadsheet but overall the response provides sufficient insight into the breakdown of costs to instil confidence of value for money.
Sub-criterion (g.iv)- Project methodology (including depth and robustness of project management plan)	Challenge (g.iv).1: Further explanation is required of the testing programme across the whole project, in particular the closed-loop demonstrations, and what commitments have been made by the System Operator to ensure these trials will be permitted to take place.
	Answer (g.iv).1: The trials proposed will be conducted with prior arrangements and agreements from UKPN and National Grid. NGET as System Operator is fully committed to allow the trials to take place, and given the nature of trials, they will not cause any implication to continuous day to day operability of the system. Both EFCC and SESG projects are agreed by National Grid's System Operator function where both Directors of Market Operation, and Transmission Network Services have approved the full programme.
	Conclusion (g.iv).1: This response fails to fully address the challenge. More information about the trials programme should be sought before this stage of the project proceeds.
	Challenge (g.iv).2: There are concerns as to the robustness of the project given the linkages between SESG and EFCC in so much that the costs for SESG are, at least in part, derived from EFCC, as highlighted in NGET's response to clarifications regarding cost items. Further assurances are required as to the development of SESG as an individual project that is

	sufficiently differentiated from EFCC, to ensure that customers are achieving value for money.
	Answer (g.iv).2: We can confirm that SESG is an individual and standalone project, and it will not be dependent on EFCC. As part of the EFCC proposal preparation, NGET extensively engaged with various service providers in order to obtain first-hand detailed information of the costs and technical capabilities of these services. This was used together with the market intelligence on the costs and levels of required and available services that NGET produces as part of business as usual. Combined, these form a robust basis for service cost evaluation for SESG. This is the only SESG cost derived in part from EFCC costs. It was further estimated that SESG service costs form 75% of EFCC service costs. This is mainly due to the level and the type of services required for SESG compared to EFCC but also because in SESG case the services will be procured via a competitive tender which will bring a further saving. Overall, there are fundamental differences between the two projects. SESG is primarily concerned with alleviating the issue of increasing network capacity and subsequent extensive asset investment requirement in the South East area using a whole-system, co-ordinated planning and operation approach across both the distribution and transmission networks, including an optimised approach to distributed resource utilisation for a range of services.
	Conclusion (g.iv).2: Through a combination of the discussions at bilateral meetings with the companies and the responses to the challenges, it is clear that there is an adequate distinction between EFCC and SESG (although there are concerns about NGET's capacity to run both run simultaneously). The justification for using EFCC costs to estimate the cost of Service Trials for SESG is accepted. The challenge has been suitably addressed.
	Challenge (g.iv).3: The role of UKPN is poorly defined within the proposal and subsequent clarification was sought. The response given indicates that UKPN will provide expertise toward the development of the state estimator and site access but lacks details of specific activities and any quantification of

	time resources. A detailed explanation of UKPN's scope of work and overview of costs is required.
	Answer (g.iv).3: The role of UKPN and their scope of works is made up of the following aspects of SESG delivery: 1) Dynamic system model - data provision and model validation; 2) PMU installation - site selection, connection design, site access, commissioning and trial; 3) Contribution to overall project management - provision of expert knowledge and experience of the distribution network and distributed resources, and the associated challenges and opportunities. The attached document describes the scope, resources, costs and additional assumptions in more detail. **(Confidential attachment)**
	Conclusion (g.iv).3: The response includes UKPN's scope of works with indicative costs for each line item and satisfies the challenge. Further assurance should be sought, however, regarding the level of input from UKPN that will be required in practice, given the role for the company that was described in bilateral discussions relating to liaison with distributed generation.
Sub-criterion (g.v)- Appropriateness of Successful Delivery Award Criteria (SDRC)	Challenge (g.v).1: SDRC 9.1, relating to the signing of the project MOU, represents somewhat minimal progress. This should be redefined.
	Answer (g.v).1: The contracts for SESG project have already been issued. We will confirm the state of this in our final submission. We expect this objective to be met much earlier than the date stated in SDRC given the progress made so far.
	Conclusion (g.v).1: This SDRC should therefore be redefined.
	Challenge (g.v).2: The technical means by which models are assessed and validated should be documented in SDRC 9.2.

	Answer (g.v).2: This is noted. We will modify the text in the final submission.
	Conclusion (g.v).2: This response is acceptable.
	Challenge (g.v).3: The means by which a criterion of SDRC 9.4, relating to the trials of Distributed Resources, is assessed is unclear and, given that no customer-related resources will be utilised, raises concerns around the accuracy of this assessment. NGET should clarify these trials.
	Answer (g.v).3: This is noted. As mentioned in the response to another question in related to the trials, the interface between SESG and the resources trialled will be clearly defined both in the main document, and the SDRC 9.4 will be clearly defined.
	Conclusion (g.v).3: This response is acceptable.

3 Response Summary

Following a detailed review of the project proposal, as well as attendance at bilateral meetings and taking account of responses from clarification questions, this report presents a number of challenges to the South East Smart Grid project proposed by National Grid.

Through the interrogation process a number of the challenges have been satisfied but some issues remain, which could be addressed or clarified in the final submission. These include:

- greater clarity as to the time period for which the proposed new 400kV transmission line could be deferred if the SESG project goes ahead, and the benefits that would continue to be delivered by SESG once the transmission route is connected;
- improved clarity as to the quantities and types of distributed resources required to mitigate the existing operating constraints;
- the broader justification for curtailing costly embedded generation and paying Service Providers to deliver response, possibly from non-renewable sources, to reduce network constraints. The implications of relying on services from distributed resources to alleviate constraints for long periods would also benefit from further investigation;
- the assumptions made about UKPN's level of engagement, in particular:
    - the agreed level of commitment in terms of distribution tap-changer coordination, and managing effects on the distribution network;
    - the role UKPN in liaising with DG operators and facilitating their participation in the project;
    - the level of budget allocation for UKPN and whether the range of tasks they will be engaged in is fully defined. The size of their in-kind contribution also needs to be confirmed;
- uncertainty surrounding the management of potentially conflicting operational requirements on distribution resources that could arise between the LCNF KASM project and SESG;
- the need for confirmation that Imperial College has the capacity to provide and coordinate the scale of academic resources required for the project; and
- a review of the quantified carbon benefits.