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Bid Pack

Attachment 3 – Statement of Requirements

Contract Reference: CCZZ19A34

Resilience Study Research for NIC

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1. DEFINITIONS

Expression or Acronym	Definition
NIC	The National Infrastructure Commission.
Authority	Means NIC
UK infrastructure network	The system of UK economic infrastructure, including at least the following sectors: energy (generation, transmission and distribution), transport (rail, road) and water (resources) and digital communication (including data centres) infrastructure. Solid waste, air and marine transport and wastewater can be excluded. The network needs to include interdependencies between the different sectors listed above.
The Commission	The National Infrastructure Commission.
System	Means the physical infrastructure assets, links and interactions within and across the economic infrastructure sectors of energy, digital, transport and water
Resilience	Means, for the purposes of this project, the ability of the system to provide infrastructure services including the ability to adsorb, adapt and recover from shocks or gradual changes.
Network	The representation of the infrastructure system consisting of physical punctual (point) assets (such as an individual power station, a substation, a mobile switching centre, a house) that are connected together through physical assets (for example a transmission line or a water pipe). The point assets are also referred as “nodes”, whilst the connections can be referred as “links”.
Component	A node or a link of the network. This are physical assets such as a power station, a substation, a mobile switching centre, a house, a transmission line or a water pipe.
Physical vulnerability and resilience characteristics	Aspects of the architecture of the UK infrastructure network that are important for the vulnerability of the system, as well as its resilience, including single/multiple points of failure, correlation, robustness, stability as well as supply-demand characteristics such as capacity margins and substitutability.

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2. PURPOSE

- 2.1 The purpose of this requirement is to build, test and handover a tool to identify and assess the key physical vulnerabilities of the current UK economic infrastructure system, and how these are likely to change in the future.
- 2.2 The results will help the NIC to identify the main sources of physical vulnerability and resilience of the UK infrastructure system. It will feed into the development of a framework to identify actions to assess, improve and monitor the resilience of the system.

3. BACKGROUND TO THE CONTRACTING AUTHORITY

- 3.1 The National Infrastructure Commission is an independent body that enables long term strategic decision making to build effective and efficient infrastructure for the UK. The NIC was set up on 5 October 2015 and was formally established as an Executive Agency of HM Treasury on 24 January 2017.
- 3.2 The NIC will deliver a long-term plan and assessment of national economic infrastructure needs once a parliament, setting out what a government should do over the next five years to ensure delivery of the UK's long-term economic infrastructure requirements. It is overseen by a small board, appointed by the Chancellor, and able to commission research and call for evidence from public sector bodies and private sector experts.
- 3.3 The Commission has published the first National Infrastructure Assessment in summer 2018, which looked ahead to requirements for the next 30 years. Alongside that, the Commission has carried out specific studies on pressing national infrastructure challenges to support the long-term competitiveness of the UK economy.
- 3.4 NIC will hereafter be referred to as the 'Authority'.

4. BACKGROUND TO REQUIREMENT/OVERVIEW OF REQUIREMENT

- 4.1 The Chancellor has tasked the Authority to examine the resilience of the UK's economic infrastructure. In this resilience study, the Authority will consider what approach and action should be taken to ensure that infrastructure can cope with future changes, disruptions, shocks and accidents.
- 4.2 The Authority will publish the methodology for the overall study in which this project is feeding into (the Resilience Study) in summer 2019, and expects to produce a final report with recommendations in Spring 2020.
- 4.3 Potential Suppliers should read the full Terms of Reference of the Resilience Study in order to understand the broader context for this requirement and inform their response. More information on this study, including the Terms of Reference, can be found here: <https://www.nic.org.uk/our-work/resilience/>

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5. SCOPE OF REQUIREMENT

- 5.1 This project aims to identify and assess the key physical vulnerabilities of the UK economic infrastructure system.
- 5.2 The Potential Suppliers should:
 - 5.2.1 Identify a range of vulnerabilities or resilience characteristics that arise from the architecture of the UK economic infrastructure network, in consultation with the Authority. These could include, for example, connectivity, redundancy, multiple points of failure etc. Each characteristic should be accompanied by criteria to establish the relative importance of the characteristic in different parts of the system as well as compared with others, for example based on impacts.
 - 5.2.2 Develop a model to assess the most relevant of these characteristics (as agreed with the Authority) for the current UK economic infrastructure system, and likely changes in the future.
 - 5.2.3 Use the model to produce a preliminary assessment of these characteristics and their relative importance.
- 5.3 The preliminary results, and further application of the model, will help the NIC to identify the main sources of physical vulnerability and resilience of the UK economic infrastructure system. The Commission will then carry out policy analysis to determine how to best address these.
- 5.4 The approach tested in this project will be considered for inclusion in a framework that the NIC intends to develop as part of the resilience study, aiming to assess, improve and monitor the resilience of the UK economic infrastructure system.
- 5.5 All key assumptions and scenarios will have to be submitted to, and approved by, the Authority.
- 5.6 The project should consider the UK economic infrastructure system as a single “system” or “network” as the main interactions and interdependencies between infrastructure sectors should be captured. Given the limited timeframe and data availability, the results and the model that will be delivered by this study will be a first approximation. However, it is expected that some data, for example for some of the characteristics or sub-systems, will be sufficiently accurate to enable the NIC to draw conclusions and inform sound recommendations. Assumptions, data accuracy or completeness and implications for the robustness of the conclusions should be discussed with the Authority and clearly stated in the final report.
- 5.7 The Potential Supplier should not comment on, or suggest in any way, the recommendations that the Authority should make to the government at the end of the Resilience Study.

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- 5.8 The Authority will endeavour to facilitate access and licencing of relevant data, and will agree with the Potential Suppliers contingency plans in case data are not received by a mutually agreed deadline.

6. THE REQUIREMENT

- 6.1 This project aims to identify and assess the physical characteristics of the UK economic infrastructure network that contribute the most to the vulnerability and resilience of the UK infrastructure system.

- 6.2 It is proposed that this is done through the following steps:

6.2.1 Identify in consultation with the Authority a long list of possible characteristics of the UK infrastructure network that provide indications of the vulnerabilities of the system, as well as its resilience, based on existing literature. These should include network characteristics such as correlation¹, robustness², stability³ as well as supply-demand characteristics such as capacity margins and substitutability. They could also include the characteristics of the network that make it vulnerable to specific hazards (i.e. shocks such as heatwaves, malicious attack or flooding). However, this work is not expected to assess the actual exposure to particular hazards (i.e. the assets that are most likely to be affected) as this is best considered at local rather than at national level.

6.2.2 Propose criteria to identify the relative importance of each characteristic in different parts of the system as well as compared to other characteristics, based on, as a minimum, the impacts from the failure attributed to each characteristic (i.e. the number of people affected by failure, size of the geographic area effected, and economic impacts). These criteria should have regard to the NIC's principal objectives (to support sustainable economic growth across all regions of the UK, improve competitiveness and improve quality of life). Additional criteria could be considered, such as the benefits of changing these characteristics (e.g. the change in number of people impacted by a disruption if the redundancy of the system is altered, or the change in economic loss if the vulnerability of assets is reduced). These criteria should also allow future changes to be considered (e.g. whether the characteristic is going to get worse in the future). The NIC's existing [infrastructure performance measures](#) may form a basis for the criteria, this option should be reviewed with the Authority. The final criteria will be decided by the Authority.

¹ E.g. <https://www.sciencedirect.com/science/article/pii/S0378437119307988>

² E.g. <https://arxiv.org/pdf/1605.01262.pdf>

³ E.g. Reis et al 2014 Avoiding catastrophic failure in correlated networks of networks, Nature Physics 10 (10) (2014) 762

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- 6.2.3 Identify and agree with the Authority the most relevant characteristics for UK economic infrastructure system (this process should consider the vulnerability of the network to specific hazards, but should not consider exposure – see 6.2.1) of those listed in 6.2.1 to be assessed in detail (see following steps). This process should result in at least 10 characteristics.
- 6.2.4 Model and assess the characteristics identified in 6.2.3 by applying the criteria identified in 6.2.2. to understand their relative importance. This should be done by modelling the network. This assessment should have regard to the nature of the potential shocks and their inaction with the network architecture, but will not include assessment of the likelihood of the shock (see 6.2.1). The model should include at least energy (generation, transmission and distribution), road and rail transport, public water supply sectors and digital communication (including data centres) infrastructure, sub-regional supply and demand, and the interactions between the sectors (including cascading impacts). The model should be based on sound knowledge of the current system and whilst the accuracy is likely to improve in subsequent work, this starting point should provide meaningful and useable results.
- 6.2.5 The step 6.2.4. should be repeated for 4 future scenarios. These will produce an assessment of how the characteristics could change in future, including applying the criteria identified in 6.2.2. to understand the relative importance of these characteristics in different parts of the system as well as compared with each other. Likely future system configurations must be derived from considering the recommendations in the National Infrastructure Assessment. The list of scenarios must include: one scenario assuming all the following occur at once; and three further scenarios capturing each one of the following in turn⁴. (4 scenarios in total):

6.2.5.1 Nationwide full fibre broadband by 2033

6.2.5.2 Half of the UK's power provided by renewables by 2030

6.2.5.3 100 per cent electric vehicle sales by 2030

The details of each of the scenarios will be agreed with the Authority, and should include parallel relevant changes eg copper switch off alongside fibre rollout, and electrification of heat alongside EV sales. Other parallel changes may be relevant and should be allowed for and agreed with the Authority.

⁴ This is not to assume that only few of these changes should happen, but it is to test the relative impact of each of the future changes to the system.

- 6.2.6 The inputs for this model will include (assuming the current and future infrastructure networks are captured in the model itself)⁵, but not be limited to:
- 6.2.6.1 Data representing disruptions to the network, for example, nodes or links that cease to function
 - 6.2.6.2 Data representing disruptions of supply or demand to/from the network
- 6.2.7 The output from this model should be, as a minimum:
- 6.2.7.1 The quantitative assessment of the characteristics in 6.2.3, both nationally and geographically distributed (baseline)
 - 6.2.7.2 The impacts from the failure attributable to these characteristics (i.e. at least number of people affected, geographic extent of the impacts and economic damage). This assessment should include at least 3 tests showing the impacts of failure attributable to each of the 10 characteristics in 3 different parts of the system (3 x 10 tests).
 - 6.2.7.3 The benefits or impacts from varying each characteristic. This should include at least 4 tests improving or deteriorating each characteristic (4 x 10 tests).
 - 6.2.7.4 The above, relevant to the future scenarios described in 6.2.5 (future baseline plus 70 x 4 scenarios).
- 6.2.8 The above should be used to produce an overall assessment of the relative importance of each characteristic both nationally as well as geographical and across different sectors.
- 6.2.9 The post-processing of the results will also need to include understanding how the relative importance of each criteria changes when only direct impacts are considered. This would be a proxy for repeating the previous analysis for individual sub-systems, and it will be used to demonstrate the value of carry out this analysis at system level.
- 6.2.10 During the development of the model, the Potential Supplier will agree their approach with the Authority to ensure that the input requirements, hard coded elements, functioning and output format of the tool are compatible with likely use cases during the licenced period. These use cases will include understanding the impact of changes to the physical networks, changes to supply and demand, and hazard agnostic disruptions.

⁵ The model should be constructed such that it is possible for the NIC to make changes to the infrastructure networks themselves after the completion of the contract so that other scenarios that include changes in the physical networks could be explored during the licenced period. This may require the infrastructure network sub-systems to be considered an input to the model. Supplier to advise during development.

7. KEY MILESTONES AND DELIVERABLES

7.1 The deliverables from this project will be:

- 7.1.1 A model that can be accessed, modified and run, with licence granted to the NIC for 4 years from completion of the project. The Authority will own the IPR of the output from this project, but the Potential Supplier will retain the IPR of the model (see Terms and Conditions). This model should be compatible with the NIC IT system (Windows based). If a source code is provided, this should include regular comments in the code (written for ease of understanding of the users within the NIC), and clearly defined variables, functions, classes etc. It is assumed that the source code will be in Python, alternatives should be agreed with the Authority. The Potential Supplier will be provided a licence to use the outputs which the Authority owns for academic publications. Permissions for any academic publications of the outputs will be subject to the discretion of the Authority.
- 7.1.2 A literature review identifying the long list of possible characteristics of vulnerability and resilience of the current and (likely) future UK economic infrastructure system. This list should be complemented by the prioritisation criteria – i.e. possible criteria to establish their relative importance, now and in the future – which must be agreed with the Authority.
- 7.1.3 A quantitative assessment of the most relevant of the above characteristics in the current system and how these score against the prioritisation criteria outlined in 7.1.2. This should produce the output described in 6.2.7.
- 7.1.4 A quantitative assessment of the most relevant characteristics (as 7.1.3) in the future system scenario outlined in 6.2.5 and how these score against the prioritisation criteria outlined in 7.1.2. This assessment should produce the output described in 6.2.7.
- 7.1.5 This should be informed by at least 4 scenarios of future systems. These will analyse how the characteristics and impacts might vary in a range of possible future system configurations. These scenarios would also identify which characteristics become more important in different scenarios and whether different characteristics should be monitored in future. Possible future system configurations should be derived as described in 6.2.5.
- 7.1.6 This assessment should be informed by existing analysis if/where available. The assessment should be validated where appropriate. Where the absence or poor quality of input data means that a validation is not relevant, a sensitivity analysis should be carried out instead. This would require running additional scenarios (not included in the numbers above).
- 7.1.7 A report detailing the methodology and the results, but excluding any recommendations. This should include a detailed description of the model's code including diagrams.
- 7.1.8 A short instruction manual for operating the model and support for running the model until the end of March 2020, including an informal hands-on tutorial. Additional support will be purchased on monthly basis if needed.

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7.2 The following Contract milestones/deliverables shall apply:

Milestone/Deliverable	Description	Timeframe or Delivery Date
1	Long list of characteristics and prioritisation criteria	Within 2 weeks of contract award
2	Meeting with NIC to clarify and agree the approach to be taken, including the most relevant characteristics to be modelled	Within 3 weeks of contract award
2	Inception report submitted to the Authority outlining the methodology, set milestones, deliverables, risks and mitigation.	Within 8 weeks of contract award
3	Update meetings/phone calls/email correspondence to discuss findings and progress	Weekly
4	Base model (present day) and preliminary model results (quantitative assessment of the characteristics and prioritisation)	Start October 2019
5	Future scenarios and model preliminary results (quantitative assessment of the characteristics in the future and prioritisation)	November 2019
6	Final model results (final list of the characteristics, quantitative assessment of the characteristics and scenarios) in digital format (e.g. spreadsheet, database)	December 2019
7	Draft report and presentation and demonstration of the model	December 2019
8	Final report and handover / installation of the model	February 2019

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8. MANAGEMENT INFORMATION/REPORTING

- 8.1 The Authority will work with the Potential Supplier to put in place a weekly and monthly emailed reporting regime in order to track progress, resource needs, and budget.

9. VOLUMES

- 9.1 There are no indicative volumes for this requirement.

10. CONTINUOUS IMPROVEMENT

- 10.1 The Potential Supplier will be expected to continually improve the way in which the required Services are to be delivered throughout the Contract duration.
- 10.2 Changes to the way in which the Services are to be delivered must be brought to the Authority's attention and agreed prior to any changes being implemented.

11. QUALITY

- 11.1 The Authority will be looking to use the research and analysis to inform its recommendations and report due in Spring 2020. Therefore it is critical that the project runs to time, with all assumptions and caveats clearly highlighted.
- 11.2 This is a substantial piece of work – the expectation is that all the outputs and related materials will be of a high quality and publishable standard.
- 11.3 The Potential Supplier is responsible for ensuring that the model and results go through a strict Quality Assurance process, which should be described in the proposal. This shall include, but not limited to, validation against real-world examples and/or sensitivity analyses, whichever more appropriate and feasible.
- 11.4 The Authority will also seek views from its expert technical panel on the work and findings of this research. Any advice or comments will be fed back to the Potential Supplier via the Authority.

12. PRICE

- 12.1 The maximum budget for the full requirement is £100,000 (exc. VAT), and bids received over this budget will be deemed non-compliant.
- 12.2 Prices should be inclusive of all expenses and exclusive of VAT.
- 12.3 Prices are to be submitted via the e-Sourcing Suite Attachment 4 – Price Schedule excluding VAT and including all other expenses relating to Contract delivery.

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13. STAFF AND CUSTOMER SERVICE

- 13.1 The Potential Supplier shall provide a sufficient level of resource throughout the duration of the Contract in order to consistently deliver a quality service.
- 13.2 The Potential Supplier's staff assigned to the Contract shall have the relevant qualifications and experience to deliver the Contract to the required standard.
- 13.3 The Potential Supplier shall ensure that staff understand the Authority's vision and objectives and will provide excellent customer service to the Authority throughout the duration of the Contract.

14. SERVICE LEVELS AND PERFORMANCE

- 14.1 The Authority will measure the quality of the Supplier's delivery by:

14.1.1

KPI/SLA	Service Area	KPI/SLA description	Target
1	Delivery	Adherence to Key Deliverables outlined in section 7	100%
2	Account Management	Respond with resolutions to any issues within 5 working days	100%
3	Quality	Adherence to quality assurance outlined in section 12	100%
8	Quality	Supplier to provide response to any feedback on outputs from NIC and expert panel and, where required to meet quality standards, make changes to approach or outputs.	100%
9	Management, information and reporting	Supplier to provide weekly updates in the form of a progress call and summary/exceptions report via email.	100%
10	Management, information and reporting	Supplier to notify NIC of any new or increased risks to scope, quality, budget or schedule, within 24] hours of identification.	100%

- 14.2 Poor performance against these SLAs will be assessed and managed by the Authority who will assess whether the products meet the required standard/quality as set out on Attachment 3- Statement of Requirements.

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- 14.3 If any of the deliverables fail to meet the agreed quality service levels and performance the Authority reserves the right to consider early termination of the contract.

15. SECURITY AND CONFIDENTIALITY REQUIREMENTS

- 15.1 The Potential Supplier shall acknowledge and protect all sensitive and confidential information its employees have access to during the contract period.

- 15.2 The Potential Supplier shall ensure their IT security systems are sufficiently robust to prevent confidential and sensitive material being made available in the public domain.

16. PAYMENT AND INVOICING

- 16.1 Payment can only be made following satisfactory delivery of pre-agreed certified products and deliverables.

- 16.2 Before payment can be considered, each invoice must include a detailed elemental breakdown of work completed and the associated costs.

- 16.3 Invoices should be submitted to: Stacey Cross, National Infrastructure Commission, 4th Floor, Finlaison House, 15-17 Furnival Street, London, EC4A 1AB

17. CONTRACT MANAGEMENT

- 17.1 Attendance at Contract Review meetings shall be at the Potential Providers own expense.

18. LOCATION

- 18.1 The location of the Services will be carried out at the offices of the Potential Supplier. However frequent meetings will need to take place with the National Infrastructure Commission at the Potential Supplier's offices, or at the Commission's offices at Finlaison House, 15-17 Furnival Street, London, EC4A 1AB.

- 18.2 Potential Suppliers should cover the costs of their travel rather than T&S claims.

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