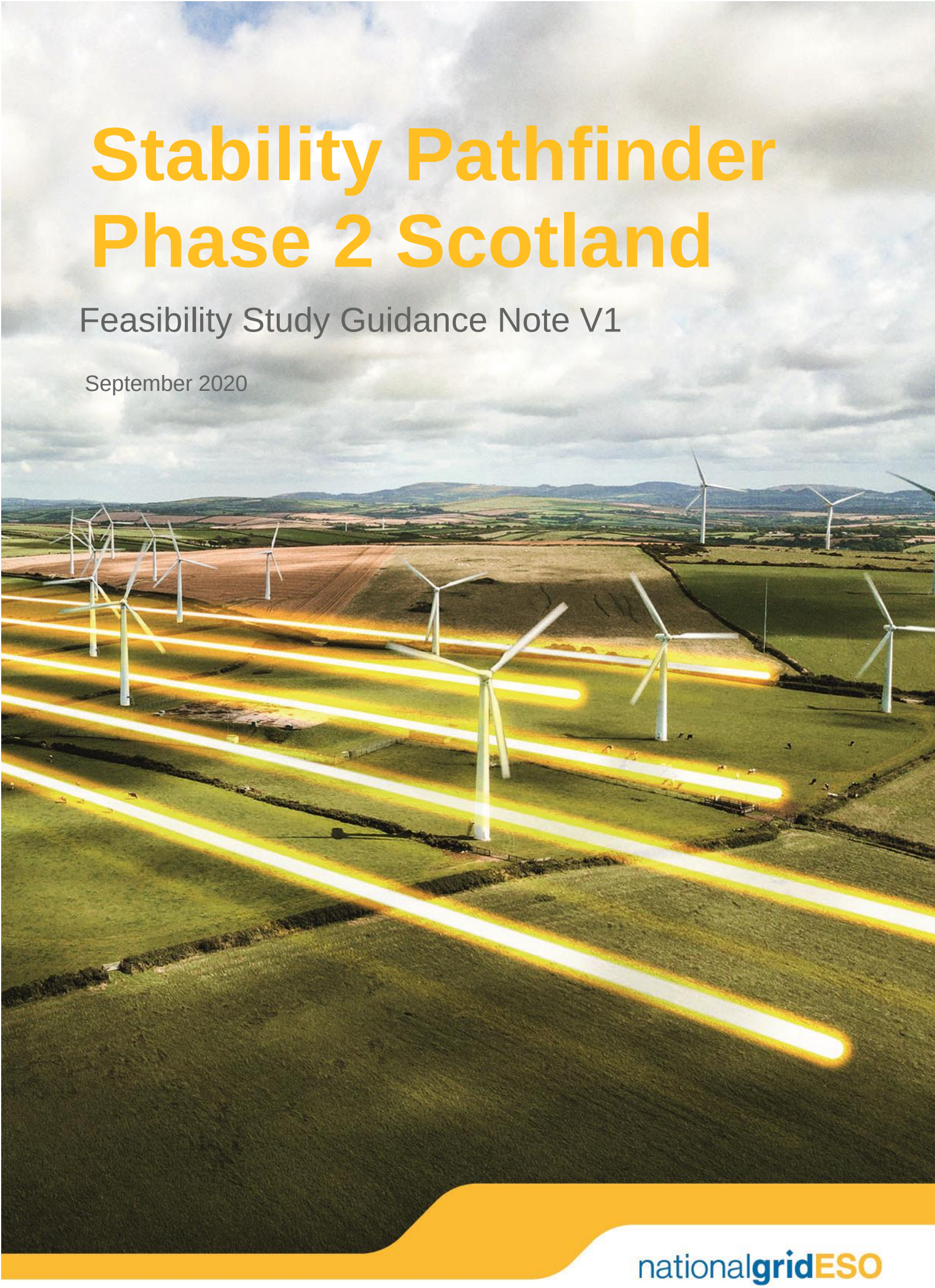
Stability Pathfinder Phase 2 Scotland

Feasibility Study Guidance Note V1

September 2020



nationalgridESO

Contents

Overview

1. Aim

The aim of this document is to provide an overview of desktop based simulations studies that are required as part of the stability pathfinder phase two tender in Scotland. Through the feasibility study, the ESO will

- determine key technical capabilities of all proposed solutions
- decide if proposed solutions meet the key technical specification
- inform potential solutions of pass/fail outcome from the feasibility study
- invite successful solutions to participate in commercial tender submission

The information provided must be based on factual statements relevant to the technical specification with relevant references and desktop based simulation including;

- description of proposed solution and its key technical considerations relevant to the technical specification
- any specific data needs that would be critical to the proposed solution
- where there are several relevant options, feasibility must be demonstrated for each option that is seeking to progress to the commercial tender stage.

2. Scope

Table 1 sets outs the clauses of the technical specification that will need to be demonstrated as part of this feasibility study. Simulation tests are set out in Appendix A to demonstrate key aspects of these clauses.

Please note that any simulation tests carried out and capabilities demonstrated at the feasibility stage do not remove proving or compliance testing requirements before and after commissioning of the stability compensation service.

Technical specification clause	Description	Feasibility Test (Appendix A references) and notes
Part A 1.1.1	Short circuit current value	Test 1 – value determined at the feasibility study will be used in the commercial assessment & contract
Part A 1.1.2	Inertia value	Test 2 – value determined at the feasibility study will be used in the commercial assessment & contract
Part A 1.2.1	Minimum short circuit level performance	Test 1 – ESO will provide site specific short circuit level range at which feasibility tests need to be carried out
Part A 1.2.3	Reactive current behaviour for voltage below 0.9pu	Test 1
Part A 1.2.4	Vector shift response within 5ms	Test 1, 2, 3
Part A 1.2.5	Inertia behaviour	Test 2
Part A 1.2.6	Inertia response within 5ms	Test 2
Part A 1.2.7	Voltage source behind an effective impedance	Test 1, 2, 3, 4

Part A 1.2.8	Reactive current behaviour (prioritise reactive current)	Test 1, 3, 4
Part A 1.2.10	Reactive current behaviour	Test 1
Part A 1.2.16 & 1.2.17	RoCoF withstand	Test 2
Part A 1.2.19	Repeatability	Test 3

Table 1:List of tests with reference to technical performance specification clauses

3. Outputs

The required output of the feasibility study is a technical report for each site/solution (as appropriate) that was submitted at the EOI stage. This technical report should demonstrate compliance with the technical specification as described in this document. Guidance and template for this report will be published ahead of the start of feasibility study stage.

The report shall be in clear English. Where the report relies on data to demonstrate compliance the data should be shown in the report in the form of a graph or figure that shall be clearly legible including any axis or legends.

Where the report relies on equipment specification copies of manufactures' documentation should be attached to the report as appendices.

Where the demonstration of compliance is not clear the ESO may request additional information including but not limited to raw data, models and additional study results.

Where multiple site or design are submitted at the EOI stage, providers may submit a feasibility report to cover more than one site or design. If provides choose to do this, it must be clearly stated in the report which tests demonstrate compliance for which site or designs. Where multiple sites are considered in one feasibility report, the minimum SCL at each site must be considered and it must be clearly documented how this is done.

4. Success criteria

The ESO will consider a solution to PASS the feasibility study if these key criteria are met:

- The provider has completed all tests described in appendix A.
- Test results are presented to the ESO is a clear and concise report with clearly readable graphs and figures.
- The report is submitted within the feasibility study timescales.
- The report is submitted using the template (to be provided ahead of the feasibility study stage).
- The report shows performance that meets the relevant clauses of the specification stated in Table 1. Guidance on what constitutes meeting clauses will be published with the template.

5. Fitting into the tender process

The ESO will invite solutions which PASS EOI into the feasibility stage.

The ESO will invite solutions which PASS the feasibility study into the commercial tender assessment.

6. Technical queries

Any technical queries should be directed to box.networkdevelopment.roadmap@nationalgrideso.com

7. Confidentiality

The information submitted as part of this feasibility study will be confidential to the ESO. The ESO will share any relevant information with all participants in an anonymised and generalised way. The ESO will not comment on detailed design proposals from different participants to ensure level playing field.

8. Changes later in process

Information provided at the feasibility stage that will be used in the commercial assessment cannot be changed after the feasibility stage. This includes value of short circuit current contribution at the point of stability and inertia value. If a provider wishes to consider multiple connection locations, multiple inertia contributions, the provider must demonstrate these different options at the feasibility stage.

Other aspects of the design can change after the feasibility stage however compliance with the technical specification must be demonstrated alongside any proving/pre-commissioning/post-commissioning compliance tests.

Data	Change after EOI	Why
SCL	No	Needed for TO connections review
Rating	No	Needed for TO connections review
Location	No	Needed for TO connections review
Technology	No	Needed for TO connections review
Reactive range	No	Needed for TO connections review
Inertia	Yes	Needs to be fixed by commercial tender submission and demonstrated in feasibility study
Other technical design	Yes	Needs to be demonstrated in feasibility if impacts feasibility study

Table 2: Changes allowed after EOI submission

Appendix A: List of desktop simulations

This appendix provides a list of desktop simulations that are required as part of the feasibility study. For each test category, the provider must give an overview of the test method and provide output results, observations, limitations in clear English and in legible format.

Point of study

Unless otherwise stated in individual tests, all feasibility test results should be shown at the point of study. The point of study is defined as the point directly or radially connected to the transmission system (this shall be at 132kV or higher). Any equipment between the solution and this point that impact the solution's performance (e.g connection transformers/cables/transmission lines) must be explicitly modelled.

The test simulation must be run for long enough before the fault in steady state and long enough after the test to return to steady state.

Unless otherwise stated, during the tests record

- voltage magnitude and angle at the point of study
- fault current and reactive current from the device at the point of study
- active current and power from the device at the point of study
- internal voltage reference and/or machine terminal voltage angle and magnitude

Unless otherwise stated,

- all positive, negative, zero sequence results should be recorded
- all test results must be recorded in at least 5ms time steps

The test model must be set up as following:

a. The solution must be modelled as a EMT model that accurately reflects actual performance

b. Any equipment that impact the performance at the point of study must be modelled

c. The transmission network should be modelled using the SCL & X/R ratio provided by the ESO

Test 1. Fault ride-through, retained voltage, TOV, SCL events

The purpose of this test is to understand:

- short circuit current injection during a fault
- reactive current injection during a retained voltage
- reactive current injection and absorption for post fault voltage conditions

This test involves simulating a voltage zero or near zero test at the point of study for a period of up to 140ms, followed by recovery of voltage. To highlight how the solution delivers reactive current during and following fault clearance, different post-fault recoveries will also need to be considered.

1.1 Test conditions

The following conditions shall be considered for all test fault profiles in section 1.2.

The tests must be undertaken for these two short circuit levels:

a. Solution to be connected to a network strength varied between XXMVA and YYMVA short circuit level (to be provided by the ESO)[1]

b. Where the above short circuit level sensitivities are not achievable, provider must specify lowest network short circuit level achievable and perform a simulation at that level.

1.2 Test fault profiles

For the following tests, additionally record the largest instantaneous angle change.

Steps	
	Set pre-fault voltage at the point of study to 1p.u.
1	Simulate a 3 phase to earth fault at the point of study that is cleared at 140ms followed by a rise to 0.9pu.
2	Simulate a 3 phase to earth fault at the point of study that is cleared at 140ms followed by a rise to 1.1p.u.
3	Simulate a single phase to earth fault at the point of study that is cleared at 140ms.
4	Repeat tests 1-3 for both SCL values specified in section 1.1.
	Test 5 only needs to be run at the minimum SCL specified in section 1.1.
5(a-h)	Simulate a 3 phase to earth remote fault with a fault impedance set to achieve a retained voltage as defined in Appendix B (supplied by ESO on site specific basis) at the point of study. The fault should be cleared at 140ms. Repeat for all 8 retained voltages specified in Appendix B. State instantaneous RMS value at 100ms for each of these faults.

Number of simulations: 14

[1] See Appendix B

Test 2. Frequency, RocoF events

The purpose of this test is to understand inertial response of the solution.

The provider must demonstrate that their solution can:

- Respond to a change in frequency with a change in active power output within 5ms
- Provide an inertial response equal to the amount to be declared in the tender

2.1 Test conditions

In the following frequency events,

- Additionally, record frequency, RoCof and the largest instantaneous angle change.
- Provide further explanation on damping time constant of the inertial response.
- Calculation should show how the performance in the tests relates to the declared values for inertia and inertia constant.

Steps	
	Device running at 0 Mvar If solution has different levels of inertia output based on active power dispatch, the following test must be performed for different levels of MW output covering the range of inertia outputs.
1	Simulate frequency event to drop from 50Hz to 49.2Hz with RoCoF of 0.5Hz/s.
2	Simulate frequency event to drop from 50Hz to 49.2Hz with RoCoF of 1Hz/s.
3	Simulate frequency event to increase from 50Hz to 50.5Hz RoCoF of 0.5Hz/s.
4	Simulate frequency event to increase from 50Hz to 50.5Hz RoCoF of 1Hz/s.
5	Simulate frequency event to drop from 50Hz to 47Hz RoCoF of 1Hz/s.
6	Simulate frequency event to increase from 50Hz to 52Hz RoCoF of 1Hz/s.
7	Simulate a frequency event with a 0.9Hz fall at 2Hz/s from 49.8Hz to 48.9Hz, restoring to 49.2Hz or better in 1min, to understand resilience to an extreme system event

Number of simulations: 7 + additional for different steady state MW output (if applicable)

Test 3. Voltage angle change events

The purpose of these tests is to understand how a solution will behave under extreme voltage angle changes at the point of study.

The provider must demonstrate their solution's performance under various voltage angle changes, however this is not a pass/ fail criterion.

3.1 Test conditions

In conditions where the following thresholds of instantaneous angle change have not yet been reached in previous tests, seek to achieve via a combination of network switching or fault impedance change to deliver angle changes.

The provider must note any limitations and observations related to solution's performance.

Steps	
1	20 degrees at the point of study, sustained for 0.5s after the event
2	60 degrees at the point of study, sustained for 0.5s after the event
3	90 degrees at the point of study, sustained for 0.5s after the event

Number of simulations: 3

Test 4. Combined frequency and voltage events

The purpose of these tests is to understand how a solution will behave when seeing both frequency and voltage events simultaneously.

4.1 Test conditions

Combine the stated tests from Test 1 with the frequency events stated from Test 2. Frequency events should be considered to start at 140ms as the fault clears.

Additionally, record the frequency, RoCoF, apparent power and angle of the device.

		Frequency Event			
		Freq fall from 50Hz to 49.5Hz at 0.5 HZ/s	Freq fall from 50Hz to 47Hz at 1HZ/s	Freq rise from 50Hz to 50.5Hz at 0.5 HZ/s	Freq rise from 50Hz to 52Hz at 1HZ/s
Voltage Event	3 phase to earth fault for 140ms followed by a step rise to 0.9pu				
	3 phase to earth fault for 140ms followed by a step rise to 1.1pu				

Number of simulations: 8

Test 5. Multiple fault ride through simulations

We want to further understand the limitations of solutions.

Note any limitations and observations related to solution's performance.

Steps	
1	Apply a 3 phase to earth fault at the point of study for 140ms before clearing the fault.
2	Repeat fault 5 times with 15 seconds between each fault.

Number of simulations: 1

Appendix B: Data suplied by ESO

This data will be given on a site-specific basis for all solutions that pass the EOI stage.

Minimum and Maximum SCL

Site	Min SCL	Max SCL
EXAMPLE	3kA	13kA

X/R ratio:

Retained voltage for faults at 8 ESO location of needs

Site	Blackhillock 400kV	Eccles 400kV	Hunterston 400kV	Longannet 275kV and nearby area	Peterhead 275kV	Spittal 275kV	Mark Hill/ Coylton 275kV and nearby area	Moffat/ Elvanfoot 400kV and nearby area
EXAMPLE SITE	0.9	0.3	0.7	0	0.5	0.6	0.3	0.3