**Description of Table of Costs**

There are two tables, identical in format and process; one for generators in the range 1 to 5MW and one for generators <1MW.

1MW to 5MW

The total number of generators in this size range is 977 from 2015 Week 24 data as presented to the GC0079 WG in November 2015. This is shown in cell K27 To be updated with 2017 figure ASAP.

Base/Best estimate and Low and High Cost Sensitivities.

We do not know exactly how many of the [977] generators are RoCoF or other protection, but from information from DNOs about the split for >5MW generators the range is 34% to 70% the WG’s judgement is that 50% should be assumed to be RoCoF, with low and high sensitivities of 33% and 70% respectively. These are shown in cells G7:I7.

The assumed split of generators between synchronous and asynchronous is show in rows 9 and 10. As we do not know on a per site basis either generator or protection type, we have used the assumptions above to build a matrix of generator and protection – ie rows 11-14.

We have then assumed that of the RoCoF relay 50% can accept the new setting, or in other words, 50% need the relay to be changed. Again this is a DNO best estimate, and represents the actual percentage of relays that are to be changed in one DNO area for the>5MW phase 1 work. As sensitivities, 5% and 90% are assumed to be changed for low and high respectively. These are shown in cells G15:I15. The sensitivity 90% requiring change recognizes the high penetration of ComAp relays that might not be able to be reset to a compliant RoCoF setting.

Similar assumptions are then made for the percentage of VS installations that can be modified, or would need to be changed in cells G17:I17 and G18:I18.

All these assumptions are then used to populate the eight possible solutions for the four possible mixes of generation and protection type – rows 20:27. Rectification costs are either the resetting (or disconnexion) of a relay or the replacement of a relay. These are shown in the cells L20:M27

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<1MW

From data collected from DNOs there are believed to be 1063 synchronous machines, and 2439 asynchronous generators, excepting all PV installations. From the Ecofys research commissioned by the WG there is believed to be a total of 35165 non-domestic PV installations, giving a total of 38666 generation installations <1MW, excepting domestic PV. This is shown in cell K30. To be updated if necessary by 2017 Wk 24 data.

Base/Best Estimate and Low and High Cost Sensitivities

Again we do not know how many of these generators have RoCoF protection, but as an appropriately conservative estimate the WG has assumed that all the 1063 synchronous machines and 10% of the non-PV asynchronous machines have RoCoF, and that no PV generation in this size range has RoCoF. This gives the 12% figure in cell H33. Sensitivities of 5% and 14% have been assumed.

The WG, recognizing that in general the bulk of generation in this size range is relatively young, has estimated that only 5% of RoCoF relays will not accept an appropriate range of new settings and will need to be changed, with again sensitivities estimated based on DNO experience of 1% and 10% that would need to be changed (cells G41 and I41).

The rest of the table is constructed the same way as for the 1-5MW table.

Summary

Based on this analysis we have the following range of costs:

1MW-5MW <1MW Total

Best Estimate £3.1M £19.4M £22.6M

Low sensitivity £0.6M £15.7M £16.4M

High cost sensitivity £6.0M £67.7M £73.6M

Given the range, and the fact that the WG’s best estimate is closer to the low cost sensitivity then that high cost sensitivity, the WG has confidence that the outturn cost will be within the range estimated here, despite the uncertainties over the absolute numbers of installations and their types and characteristics, as well as the uncertainties over appropriate solutions.

Table of solution costs:

assumed DNO engineering cost of £100 per hour and DNO admin cost of £25 per hour. Engineering consultancy costs were assumed to be £125 per hour. These costs are assumed to be sufficiently representative of all generation installations of less than 5MW, apart from domestic installations, which have been excluded.

| Ref | Activity | Description | DNO Costs  (DNO Assets) | Generator Cost  (Generator Assets) |
| --- | --- | --- | --- | --- |
| 1 | First pass assessment | DNO to review each synchronous generator to establish broad risk of autoreclose on to islanded generation.  Assume 2 hours engineering time and 1 hour of admin | £125 per site. | - |
| 2 | Change RoCoF protection setting only | Setting change only. No need to change the relay. Half a day of consultancy time. | - | £200 |
| 3 | Change RoCoF setting with relay change | Existing relay cannot be set with required settings. New relay, installation and commissioning. | £200 per site. | £7 500 |
| 4 | More detailed risk assessment | DNO to provide all relevant loading and system data.  Generator employs consultant to assess risks, and if necessary, mitigations. | £275 per site. | £25 000 for one off;  £5 000 for bulk activity |
| 5 | Install check synch or dead line close – rural network | DNOs to modify autoreclose upstream of synchronous generator by addition of suitable VT and pole mounted recloser. Each location might require multiple recloser modifications. Assume 2 per generator site | £25 000 per generator |  |
| 6 | Install check synch or dead line close – urban network | Modify existing auto-switching scheme; derive line voltage; modify or add switchgear as appropriate. Each location might require multiple DNO sites to be modified. Assume 5 per generator site @ £30k per site.  However unlikely to be required – dead times will generally be tens of seconds, so NDZ time is | £150 000 per generator |  |
| 7 | Modify existing dead times | Extend dead times on high speed autoreclosers and schemes – to say 20s.  Assume 1 day of engineering time to assess; half a day to modify settings etc.  Assume all PM HSARs are suitable for longer dead times. | £600 |  |
| 8 | Install intertripping | Assume £12k per end. Communication costs very variable; could include £100 per metre of comms circuit. Broad assumption made on lifetime comms costs (£38k) | £12 000 | £50 000 |
| 9 | Site Visit only | For the DNO/DNO’s agent to investigate the presence of, and data relating to a DG site, irrespective of whether any RoCoF work is required. | £200 per site. |  |