GHD Advisory

AS Review

PSOWG Briefing – D Bones

26 September 2018

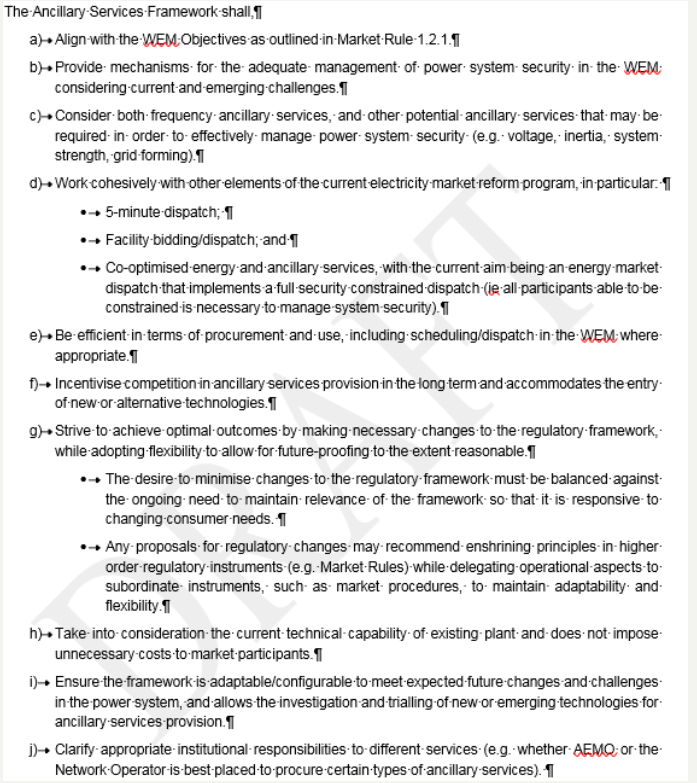
Objective: Overview of AS review GHD Scope

Outline

- Guiding Principles
- Key Issues
- Approach
- Initial progress
- Next steps

Guiding Principles

- 10 principles circulated to PSOWG
- Key aspects
  - Built on existing market objectives
  - AS that support system security
  - AS that are robust to future uncertainty
  - AS definitions technology neutral
  - AS appropriate for the SWIS
- Are the guiding principles appropriate
  - required clarifications?
  - required modifications?



The Ancillary Services Framework shall,

a) Align with the WEM Objectives as outlined in Market Rule 1.2.1.

b) Provide mechanisms for the adequate management of power system security in the WEM considering current and emerging challenges.

c) Consider both frequency ancillary services, and other potential ancillary services that may be required in order to effectively manage power system security (e.g. voltage, inertia, system strength, grid forming).

d) Work cohesively with other elements of the current electricity market reform program, in particular:

- 5-minute dispatch;
- Facility bidding/dispatch; and
- Co-optimised energy and ancillary services, with the current aim being an energy market dispatch that implements a full security constrained dispatch (ie all participants able to be constrained is necessary to manage system security).

e) Be efficient in terms of procurement and use, including scheduling/dispatch in the WEM where appropriate.

f) Incentivise competition in ancillary services provision in the long term and accommodates the entry of new or alternative technologies.

g) Strive to achieve optimal outcomes by making necessary changes to the regulatory framework, while adopting flexibility to allow for future-proofing to the extent reasonable.

- The desire to minimise changes to the regulatory framework must be balanced against the ongoing need to maintain relevance of the framework so that it is responsive to changing consumer needs.
- Any proposals for regulatory changes may recommend enshrining principles in higher order regulatory instruments (e.g. Market Rules) while delegating operational aspects to subordinate instruments, such as market procedures, to maintain adaptability and flexibility.

h) Take into consideration the current technical capability of existing plant and does not impose unnecessary costs to market participants.

i) Ensure the framework is adaptable/configurable to meet expected future changes and challenges in the power system, and allows the investigation and trialling of new or emerging technologies for ancillary services provision.

j) Clarify appropriate institutional responsibilities to different services (e.g. whether AEMO or the Network Operator is best placed to procure certain types of ancillary services).

Key Issues – Current Issues

- Previous reviews have identified key issues (description, causes, proposed strategy)
- Classified into
  - Current issue – visible today on the SWIS
  - Emerging in the short term – over the next 10 years
- Key Current Issues
  - Frequency Operating Standard (FOS), AS Standards and definitions
    - FOS subject to change (eg may need to include RoCoF target)
    - Lack of alignment between FOS and AS requirements, standards and definitions
    - Tighter alignment required and will facilitate evolution of arrangements
  - Droop requirements
    - Mandatory requirement vs market arrangement → simulations to investigate actual droop response from generators not contracted for SR
    - Mandatory dead band within normal frequency band help with frequency regulation → demonstrate relative effectiveness of droop response and other services
  - Contingency frequency response – Spinning Reserve and Load Rejection
    - Services should be technology neutral and better aligned with FOS → modelling to demonstrate optimum mix of services to meet FOS
  - Frequency regulation - Load Following
    - Better alignment of service definition and FOS + dynamic requirement optimized to anticipated generation and load conditions
  - Ready Reserve Service
    - Review relevancy of the standard and how this relates to provision of Ancillary Services
  - Credible contingency events
    - When should non-credible events be deemed credible and taken into account in setting requirements → informed by the development of dynamic service requirements

Key Issues – Short Term Issues

- Key Short Term Issues
  - Rate of Change of Frequency (RoCoF) and System Inertia
    - No target RoCoF in FOS
    - RoCoF likely increase with declining synchronous inertia
    - Demonstrate how services requirements could be set to achieve target RoCoF
    - Identify when RoCoF may become a critical issue for SWIS
  - System Strength and Rate of Change of Voltage
    - System Strength likely to reduce with more inverter connected generation, while RoCoV increases
    - Studies to identify where and when system strength issues are likely to arise
    - Locational aspect may preclude use of ancillary service to address issue
  - Co-optimization of Energy and AS
    - Implementation beyond GHD scope → but requirements should be specified where possible to allow co-optimization
  - Definition of AS
    - Timeframes in definitions inconsistent with 5 min dispatch → service definitions support move to 5 min dispatch
  - AS Types and Emerging Technologies
    - Technology neutrality → report capability or existing and emerging technologies including DER to provide AS

Approach

Separately considering frequency regulation and contingency frequency response

- **Frequency Regulation**
  - 2018 LFAS review recommended using forecast error to set regulation requirement
    - Demand + large scale renewables
    - Predicting variability → dynamic requirement
- **Contingency Frequency Response**
  - Time domain studies to investigate optimum mix of services to deliver FOS
    - WP detailed model → individual gen responses
    - Develop equivalent lumped model
    - Demonstrate service types and investigate optimal combinations to deliver FOS
    - Test robustness to unexpected conditions
    - Specify dynamic requirements
- **DIgSilent model also allows used to investigate system strength**

Frequency regulation

- Statistical analysis and data mining
- Forecast performance
- 5 min forecast error → load, embedded PV, large scale wind and solar generation
- Ability to predict requirement

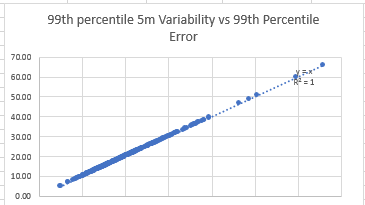
DIgSILENT Powerfactory

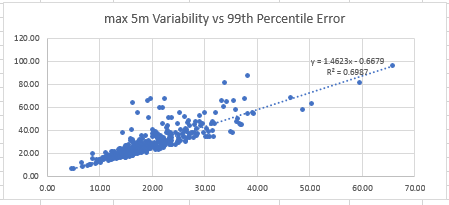
- Simulation of contingency events
- Detailed WP model → lumped model
- Demonstration of service types
- Optimum combination → FOS
- Ability to predict requirements

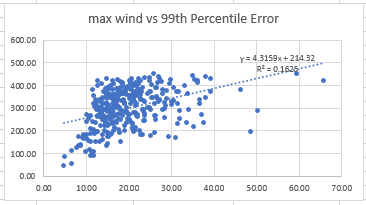
Initial Progress - Regulation

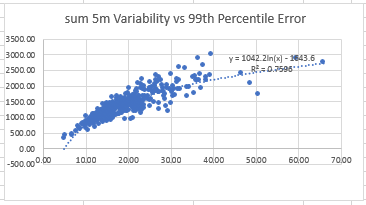
Initial focus investigating whether wind forecast variability a reliable predictor of forecast error and hence frequency regulation requirement

				Percentile	99						Max Variability (M			Sum of Variability			Sum of Abs difference		99th percentile of max variability		
	Max MW	Min MW	Range MW	Max Forecast	99th perce	Abs Sum	Square Sum	5m Varia	10m Varia	30m Varia	1h Variability	5m Variability	10m Variability	30m Variability	ABS Difference	ABS Difference	5mir	10mi	30mi
22/09/2017	419.48	213.14	206.34	95.67	65.87	2742.93	65470.69	95.67	143.41	150.94	150.94	2742.93	4990.74	10978.05	2742.93	4495.59	65.87	96.43	150.46
17/12/2017	446.68	130.88	315.80	80.32	59.55	2893.86	64039.15	80.32	97.03	152.92	193.98	2893.86	5265.62	11499.99	2893.86	4731.35	59.55	75.41	135.01
22/10/2017	286.95	20.92	266.03	62.36	50.53	1723.46	30559.81	62.36	113.26	170.40	192.08	1723.46	3182.18	7783.47	1723.46	2916.57	50.53	85.10	146.43
8/03/2017	192.68	50.40	142.28	57.31	48.71	2065.66	33805.56	57.31	104.34	113.25	113.25	2065.66	3774.24	8646.00	2065.66	3417.82	48.71	57.72	113.25
1/09/2017	379.43	26.28	353.16	67.43	46.49	2408.28	44941.81	67.43	90.39	109.22	172.12	2408.28	4478.04	10363.68	2408.28	4154.54	46.49	71.80	103.49
9/08/2017	424.82	138.39	286.43	53.77	39.47	3007.52	54629.09	53.77	72.07	104.75	146.05	3007.52	5410.17	12108.40	3007.52	4819.21	39.47	61.96	101.47
28/01/2017	367.70	38.87	328.83	54.66	39.30	2330.39	38532.76	54.66	92.05	212.21	236.07	2330.39	4201.64	10354.70	2330.39	3746.02	39.30	71.21	165.35
13/10/2017	342.89	17.89	325.00	86.62	38.31	2165.27	40930.14	86.62	112.82	140.42	170.41	2165.27	3840.46	8920.42	2165.27	3357.00	38.31	78.49	132.16
31/07/2017	435.41	28.02	407.39	53.88	38.28	2278.02	35580.86	53.88	91.49	163.97	197.33	2278.02	4149.04	9986.71	2278.02	3751.81	38.28	62.10	147.64
24/09/2017	232.24	11.86	220.38	66.55	37.72	2666.06	49074.73	66.55	91.38	118.53	131.13	2666.06	4855.31	10814.08	2666.06	4415.69	37.72	63.68	114.06
20/02/2017	267.58	31.87	235.71	44.10	37.21	1909.63	26623.42	44.10	81.70	140.03	142.72	1909.63	3355.36	7620.97	1909.63	2897.80	37.21	50.90	109.48
19/08/2017	333.65	-0.22	333.87	44.53	36.89	2369.20	38526.58	44.53	80.08	142.89	162.22	2369.20	4311.48	10145.79	2369.20	3885.27	36.89	68.00	121.25
10/12/2017	317.97	82.94	235.03	44.89	36.75	2177.22	32836.84	44.89	85.62	117.80	174.91	2177.22	3995.78	9888.53	2177.22	3644.65	36.75	58.25	112.69
29/07/2017	419.25	132.12	287.13	49.55	36.33	2893.72	51075.29	49.55	68.67	86.89	114.16	2893.72	5171.05	11376.21	2893.72	4567.97	36.33	53.73	86.84
2/03/2017	410.17	248.53	161.65	46.43	36.26	2171.87	32299.47	46.43	81.56	131.82	141.08	2171.87	3905.70	9061.21	2171.87	3467.06	36.26	68.31	124.20
8/08/2017	418.27	100.92	317.35	57.47	36.05	2190.68	34005.93	57.47	76.59	105.86	133.05	2190.68	3993.10	9261.83	2190.68	3606.52	36.05	57.04	90.62
18/12/2017	421.38	235.51	185.87	64.90	35.66	2293.72	34475.15	64.90	67.35	92.48	95.22	2293.72	3969.47	8386.63	2293.72	3349.96	35.66	47.19	84.96
14/10/2017	213.73	4.59	209.14	36.77	35.44	1767.82	24398.94	36.77	68.82	144.94	148.07	1767.82	3387.86	8905.44	1767.82	3231.46	35.44	57.66	125.11
16/10/2017	438.18	96.91	341.27	37.88	35.15	2259.83	33442.16	37.88	57.06	106.43	118.61	2259.83	4010.16	9367.49	2259.83	3491.74	35.15	52.91	92.41
12/11/2017	290.02	68.87	221.14	64.04	34.22	1940.04	27800.27	64.04	96.33	152.93	179.76	1940.04	3583.38	8840.99	1940.04	3288.70	34.22	57.98	111.50
16/11/2017	360.29	27.86	332.43	80.72	33.94	1955.55	30021.42	80.72	102.43	155.01	185.46	1955.55	3466.99	7990.10	1955.55	3002.40	33.94	83.94	134.25
5/05/2017	122.85	1.35	121.49	8.78	7.80	537.52	1936.71	8.78	16.84	32.06	44.03	537.52	994.35	2514.15	537.52	909.37	7.80	12.30	24.92
6/08/2017	53.73	-0.95	54.68	7.22	6.79	432.80	1157.84	7.22	10.76	21.01	27.42	432.80	788.03	1921.36	432.80	711.04	6.79	9.32	18.06
7/08/2017	111.11	-3.08	114.20	10.99	6.71	457.35	1442.98	10.99	16.80	33.92	46.83	457.35	811.91	1905.10	457.35	710.02	6.71	12.42	32.21
23/05/2017	81.29	5.04	76.25	5.94	5.14	431.28	1099.88	5.94	8.02	15.14	22.13	431.28	783.22	1851.26	431.28	701.92	5.14	7.91	14.05
14/07/2017	42.52	0.39	42.12	5.74	4.83	331.26	686.79	5.74	7.97	14.96	20.97	331.26	599.72	1478.97	331.26	535.54	4.83	6.64	12.90









Initial Progress – Contingency Response

The 4.5 GW case → peak summer demand case in the WP DIgSILENT PowerFactory model

Added 450 MW wind → reduced generation in quasi merit order

Simulated loss of largest generator

Adjusted dispatch to provide various levels of C-FCAS:

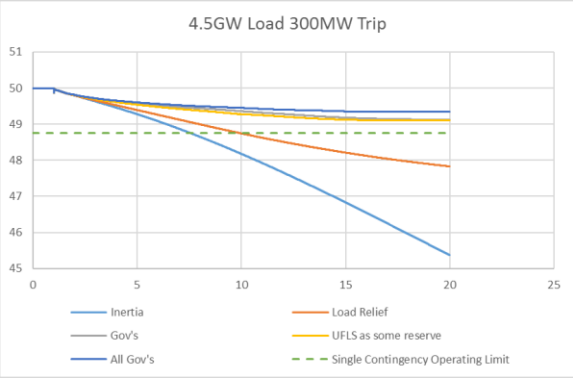
- SR > 70% of generation contingency (generators providing mandatory response) (blue)
- SR = 70% of generation contingency (dispatch adjusted to limit governor range (grey)
- SR = droop + UFLS
- 24 generators contributing droop response

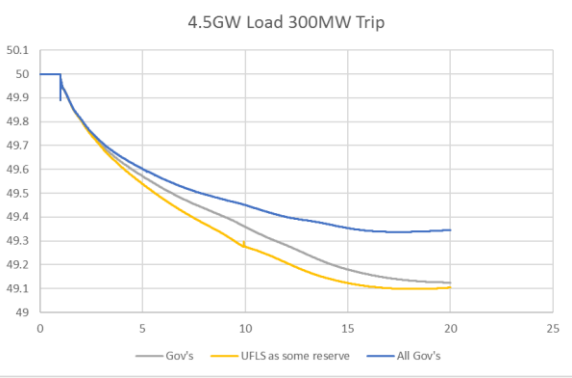
Case repeated with generation dispatched so that the droop response was available from seven generators. Response influenced by which generators have available governing range.

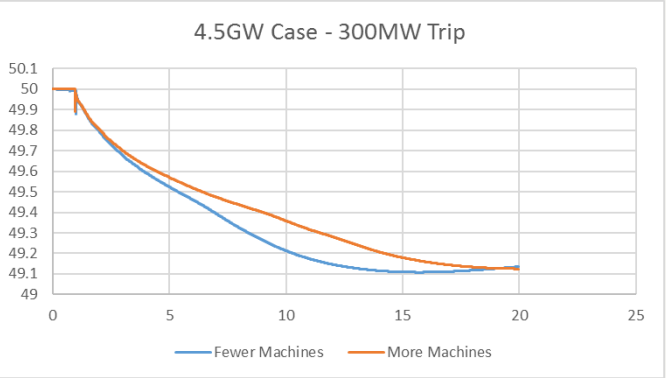
The simulation illustrates various contributions to restoring frequency following the contingency

Yet to include the simulation of the response from generators controlled by AGC

Similar result found for 2.7 GW case







Next Steps

Regulation

- Expand analysis to consider PV and load variability
- Document wind variability analysis
- Present conclusions → predictability of requirements linked to FOS

Contingency

- Develop lumped model tuned to give performance aligned to detailed model
- Integrate AGC model to allow realistic contingency simulations (20s)
- Simulate representative scenarios → typical and more extreme conditions
- Combinations of services that meet FOS
- Requirements that allow co-optimal energy and AS dispatch
- Document results and conclusions

Feedback

Questions to prompt discussion

- Are the guiding principles appropriate – any clarifications/modifications required
- Are there additional issues that need to be considered?
- Is the approach reasonable?
- Does the approach uncover the key technical information necessary to understand current and future AS requirements?

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