

System RoCoF and Operational Costs

Initial View based on FES/SOF November 2015

Introduction

- The following slides provide an initial view of future system RoCoF and future costs for GB
- Analysis is based on FES/SOF 2015 and a set of simple price assumptions
- There's a need to establish which questions need to be addressed to have confidence in the assessment
 - Analysis is sensitive to assumptions and should not be used to draw conclusions at this stage

Duration of Active RoCoF Constraint (1)

FES	RoCoF Limit (Hzs ⁻¹)	Infeed Loss Limit (MW)	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
No Progression	0.125	660	0%	0%	1%	1%	2%	2%	2%	2%	3%	4%
		1000	27%	30%	32%	35%	38%	37%	37%	37%	35%	38%
		1400	77%	80%	82%	85%	87%	87%	87%	86%	85%	87%
		1600	92%	94%	95%	95%	96%	96%	96%	96%	95%	96%
	0.200	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	1%	1%	1%	1%	2%	2%
		1400	10%	12%	15%	19%	22%	22%	21%	21%	19%	21%
		1600	27%	30%	32%	35%	38%	37%	37%	37%	35%	38%
	0.300	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1400	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
		1600	0%	0%	1%	1%	2%	3%	3%	3%	3%	4%
	0.500	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1400	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1600	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Slow Progression	0.125	660	0%	0%	1%	1%	2%	4%	5%	6%	8%	9%
		1000	27%	29%	33%	35%	38%	42%	45%	44%	46%	48%
		1400	76%	79%	82%	85%	87%	89%	91%	90%	90%	91%
		1600	92%	93%	95%	95%	96%	96%	97%	97%	97%	97%
	0.200	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	1%	2%	3%	4%	6%	7%
		1400	9%	12%	16%	19%	22%	26%	29%	28%	30%	31%
		1600	27%	29%	33%	35%	38%	42%	45%	44%	46%	48%
	0.300	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1400	0%	0%	0%	0%	0%	0%	1%	2%	4%	4%
		1600	0%	0%	1%	2%	3%	4%	6%	7%	9%	10%
	0.500	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1400	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1600	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Duration of Active RoCoF Constraint (2)

FES	RoCoF Limit (Hzs ⁻¹)	Infeed Loss Limit (MW)	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
Gone Green	0.125	660	1%	2%	4%	6%	8%	9%	11%	12%	16%	14%
		1000	44%	45%	51%	55%	59%	58%	60%	59%	62%	62%
		1400	93%	93%	96%	97%	98%	98%	98%	98%	98%	98%
		1600	98%	98%	100%	100%	100%	100%	100%	100%	100%	100%
	0.200	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	2%	3%	4%	5%	6%	6%	10%	8%
		1400	29%	30%	37%	40%	43%	43%	44%	44%	46%	46%
		1600	44%	45%	51%	55%	59%	58%	60%	59%	62%	62%
	0.300	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1400	0%	0%	0%	1%	1%	1%	2%	2%	4%	3%
		1600	2%	2%	5%	7%	9%	10%	12%	13%	17%	15%
	0.500	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1400	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1600	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Consumer Power	0.125	660	1%	2%	4%	6%	8%	9%	11%	12%	16%	14%
		1000	44%	45%	51%	55%	59%	58%	60%	59%	62%	62%
		1400	93%	93%	96%	97%	98%	98%	98%	98%	98%	98%
		1600	98%	98%	100%	100%	100%	100%	100%	100%	100%	100%
	0.200	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	2%	3%	4%	5%	6%	6%	10%	8%
		1400	29%	30%	37%	40%	43%	43%	44%	44%	46%	46%
		1600	44%	45%	51%	55%	59%	58%	60%	59%	62%	62%
	0.300	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1400	0%	0%	0%	1%	1%	1%	2%	2%	4%	3%
		1600	2%	2%	5%	7%	9%	10%	12%	13%	17%	15%
	0.500	660	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1000	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1400	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		1600	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Operational Costs – Initial View

- Balancing Services cost forecast for the period to 2025/26
- Costs are for a RoCoF limit of 0.125Hzs^{-1}
- Analysis does not include larger infeed loss risks
- Cost have been derived for
 - Trading to curtail interconnectors (from 1000MW)
 - Synchronising extra generation when the minimum loss limit is reached (660MW)

Forecast Balancing Costs (0.125Hzs^{-1} RoCoF Limit)

£m

FES	Action	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	Post 2019/20 TOTAL
No Progression	Trades	18.94	23.31	27.68	33.54	38.49	58.60	57.43	56.22	53.32	60.52	324.59
	Syncs	0.19	0.46	1.01	1.84	3.04	4.72	5.30	6.23	8.95	13.70	41.93
	TOTAL	19.13	23.77	28.68	35.38	41.53	63.32	62.73	62.45	62.28	74.22	366.52
Slow Progression	Trades	18.19	22.49	29.05	34.22	39.55	71.10	80.91	78.89	85.51	89.86	445.82
	Syncs	0.17	0.48	1.50	2.65	5.42	10.48	14.87	24.40	39.17	39.38	133.72
	TOTAL	18.36	22.97	30.55	36.88	44.97	81.58	95.78	103.30	124.68	129.24	579.54
Gone Green	Trades	48.77	50.32	65.21	73.76	80.93	121.51	127.21	127.21	136.46	134.29	727.61
	Syncs	2.57	2.78	8.65	15.22	22.11	24.35	31.47	34.11	53.73	43.25	209.02
	TOTAL	51.34	53.10	73.86	88.98	103.05	145.86	158.68	161.32	190.19	177.54	936.63
Consumer Power	Trades	48.74	50.28	65.15	73.68	80.85	121.39	127.11	127.17	136.42	134.27	727.21
	Syncs	2.57	2.78	8.65	15.22	22.11	24.35	31.46	34.21	53.89	43.45	209.47
	TOTAL	51.31	53.06	73.80	88.90	102.97	145.74	158.58	161.38	190.31	177.72	936.69

Questions to Address

- Treatment of
 - Generation
 - Embedded generation in general
 - PV
 - Wind
 - Pricing and Market Effects
 - Baseline against current costs
 - Interaction with other requirements eg frequency response
 - Differences from FES/SOF
- What other questions need to be covered?

Distributed Generation Data

Comparison of Sources November 2015

Distributed Generation Data

- We have three DG datasets to work with
 - Compliance returns from Phase 1 (updated quarterly)
 - Week 24 data (provided by DNOs for the first time in 2015)
 - The Ecofys dataset (a combination of public domain data)
- We need to interpret the data in order to
 - Assess potential costs
 - Address growth rates from Phase 1

Comparison of Sources

Distributed Generation - Comparison of Sources October 2015

Range (MW)	Phase 1 Compliance			Week 24				Ecofys			
	Sites		Capacity (MW)	Sites		Capacity (MW)		Sites		Capacity (MW)	
0 to 1				103		103	101	530140		2880	
1 to 2				365	42%	578	25%	371	43%	542	24%
2 to 3				245	28%	626	28%	203	24%	487	22%
3 to 4				161	18%	582	26%	114	13%	407	18%
4 to <5				107	12%	481	21%	172	20%	789	35%
Sub Total				878		2267		860		2225	
5 to 10	300		2098	467		467	3350				
10 to 30	225		3879	350		350	6140	[4547]*			
30 to 50	48		1940	73		73	2879	[2196]*			
50 to 500	646		9930	58		58	7049				

* filtered for Grid Code thresholds

Comparison of Sources

- Dataset updated with a consistent treatment of thresholds

Distributed Generation - Comparison of Sources November 2015

	Phase 1 Compliance			Week 24				Ecofys			
Range (MW)	Sites		Capacity (MW)	Sites		Capacity (MW)		Sites		Capacity (MW)	
0 to <1								530140		2880	
1 to <2				366	37%	481	20%	371	43%	542	24%
2 to <3				289	30%	660	28%	203	24%	487	22%
3 to <4				166	17%	548	23%	114	13%	407	18%
4 to <5				156	16%	677	29%	172	20%	789	35%
Sub Total				977		2366		860		2225	
5 to <10	272		1818	418		2860					
10 to <30	246		3949	393 [311]*		6450 [4887]*					
30 to <50	51		1950	76 [56]*		2909 [2166]*					
50 to 500	28		9930	61		7199 [0]*					

* value in brackets filtered for Grid Code thresholds

Week 24 DG Data Breakdown

- Week 24 data list each distributed generators site
- Each site is labelled by
 - Fuel type
 - Voltage Control Mode
 - Loss of Mains
- It is possible to infer generator type from Fuel/Technology

Sites

Fuel/Technology	Grand Total
CHP Total	118
Fossil Fuel Total	29
Hydro Total	50
Other Total	166
PV Total	101
Waste/Biogas/Biomass Total	373
Wind Total	140
Grand Total	977

Voltage Control Mode	Grand Total
Power Factor	514
Voltage	183
Unknown	280
Grand Total	977

Loss of Mains	Grand Total
Other Total	362
RoCoF Total	275
Vector Shift Total	340
Grand Total	977

Capacity

Fuel/Technology	Grand Total
CHP Total	280
Fossil Fuel Total	55
Hydro Total	116
Other Total	364
PV Total	328
Waste/Biogas/Biomass Total	823
Wind Total	399
Grand Total	2366

Voltage Control Mode	Grand Total
Power Factor	1261
Unknown	650
Voltage	455
Grand Total	2366

Loss of Mains	Grand Total
Other Total	854
RoCoF Total	675
Vector Shift Total	837
Grand Total	2366

Next Steps

- Confirm Status of Base Data
- Categorise Linked Data to identify affected parties
 - eg find synchronous generators described as having voltage control and RoCoF protection
- Feed conclusions into implementation plan and costing