UFLS Review

TDOWG Meeting 34

westernpower It's ON

UFLS Overview

Nathan Kirby

Technical Rules – UFLS Requirements

2.3 OBLIGATIONS OF *NETWORK SERVICE PROVIDER* IN RELATION TO *POWER SYSTEM* PERFORMANCE

2.3.1 Frequency Control

(a) The *Network Service Provider* must design and install an automatic under *frequency load shedding* system on the *transmission and distribution systems* to ensure that the *frequency* performance of the *power system* following a multiple *contingency event*, as specified in Table 2.1, can be achieved. Further information on the technical requirements of this system is given in clause 2.4.

(b) The automatic under *frequency load shedding* system must be designed to ensure that, should a *contingency event* occur that results in the formation of islands, each island in the *power system* that contains generation has sufficient *load shedding* facilities to aid recovery of the *frequency* to the normal band within the time frames specified in Table 2.1.

(c) The *Network Service Provider* may require commercial and industrial *Consumers* to make a portion of their *load* available for automatic under *frequency* or under voltage *load shedding* or both and may also require a commercial or industrial *Consumer* to provide control and *monitoring equipment* for the *load shedding facilities*. The amount of *load* to be available for shedding and the frequencies or voltages or both at which *load* must be shed must be negotiated between the *Network Service Provider* and the *User* or, failing agreement between them, must be as specified by the *Network Services Provider* consistent with Table 2.8, and must be specified in the relevant *connection agreement*.

Table 2.8 Under-frequency load shedding scheme settings for the South West Interconnected Network

Stage	Frequency (Hz)	Time Delay (sec)	*Load* Shed (%)	Cumulative *Load* Shed (%)	Capacitor shed (%)	Cumulative Capacitor Shed (%)
1	48.75	0.4	15	15	10	10
2	48.50	0.4	15	30	15	25
3	48.25	0.4	15	45	20	45
4	48.00	0.4	15	60	25	70
5	47.75	0.4	15	75	30	100

2.3.2 *Load* to be Available for *Disconnection*

(a) The *Network Service Provider* must ensure that up to 75% of the *power system load* at any time is available for *disconnection* under any one or more of:

(1) the automatic control of under *frequency* relays;

(2) manual or automatic control from *control centres*; and

(3) the automatic control of undervoltage relays.

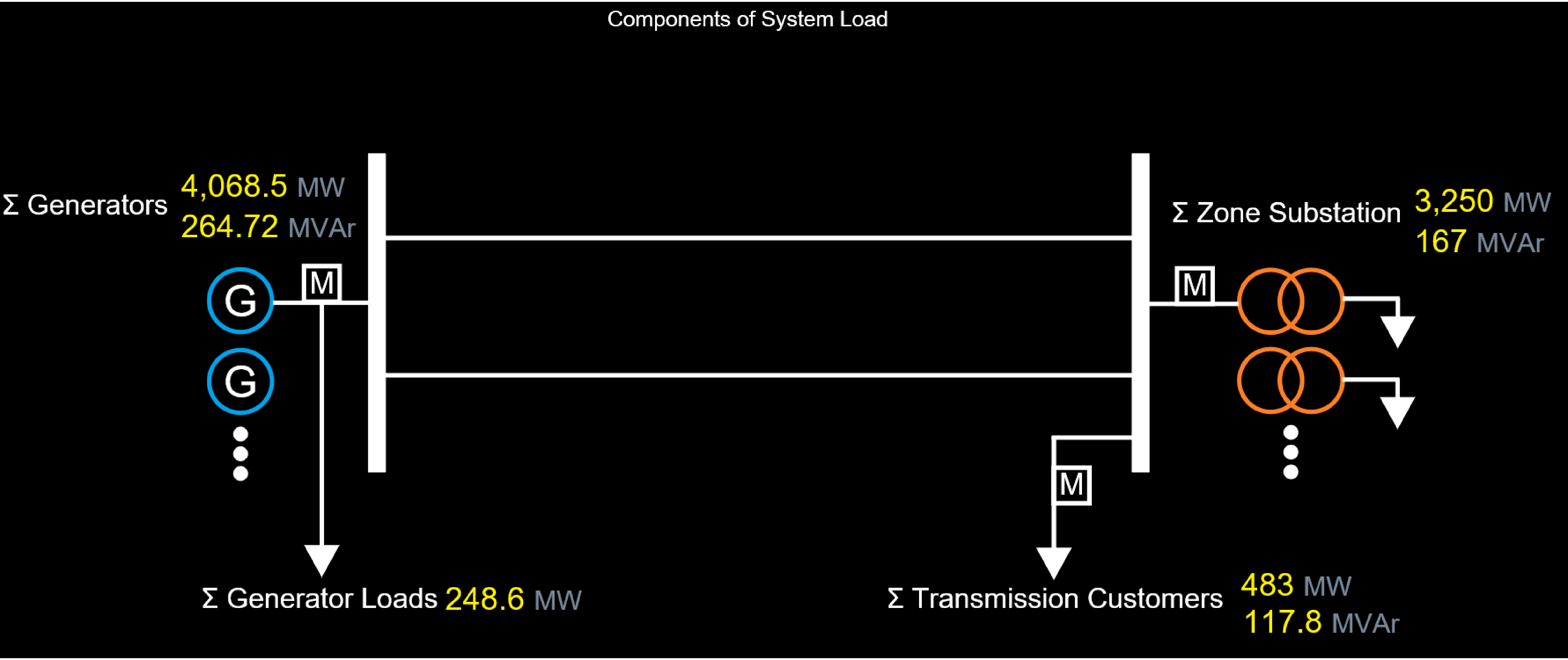
(b) To satisfy this overall criterion, the *Network Service Provider* may, at its discretion, arrange for up to 90% of the *power system load* if necessary to ensure that the *frequency* performance standard specified in clause 2.2.1 can be met for all credible *power system load* and *generation* patterns, to be available for automatic *disconnection*. The *Network Service Provider* must advise *Users* if this additional requirement is necessary.

(c) The *Network Service Provider* may install special *load shedding* arrangements to cater for abnormal operating conditions.

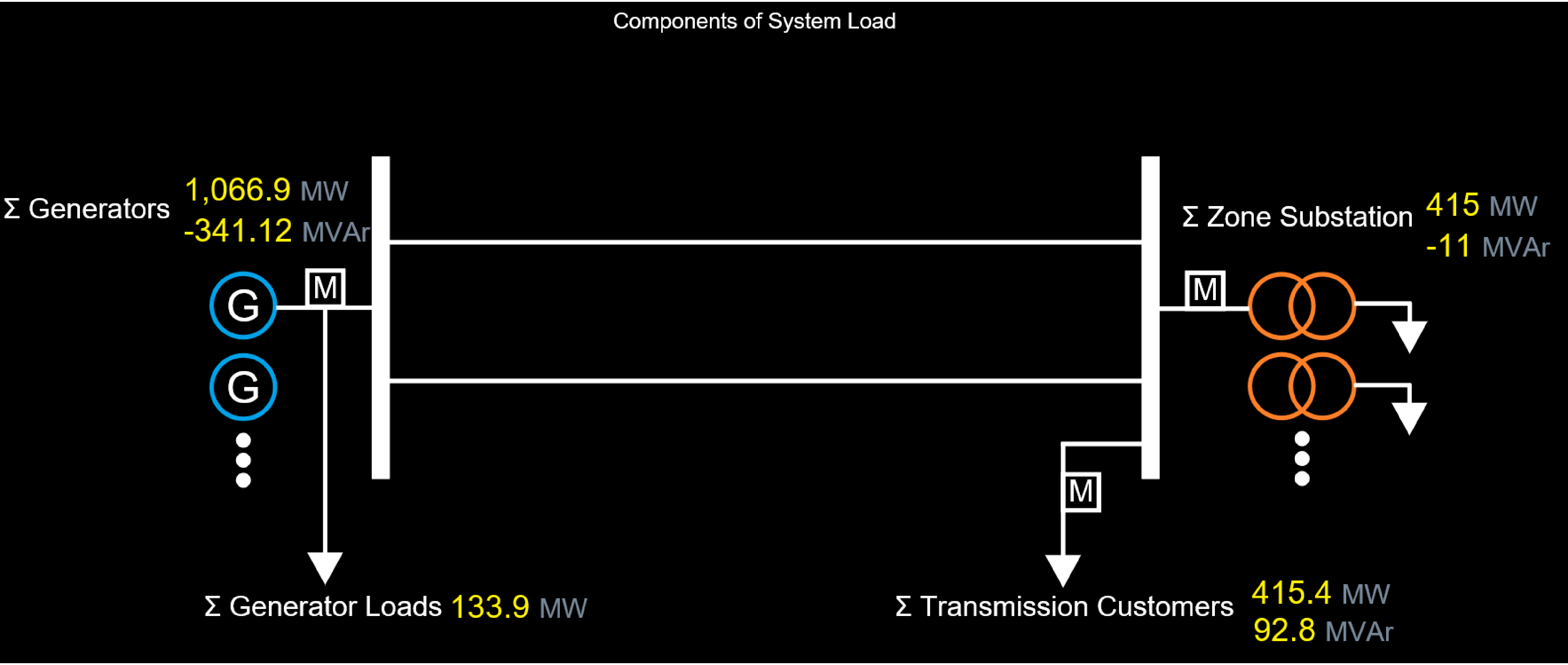
(d) Arrangements for *load shedding* must include the opening of circuits in the *distribution system* and may include the opening of circuits in the *transmission system*.

(e) The *Network Service Provider* must use its best endeavours to assign feeders to stages within the *load shedding* system so that *loads* supplying *essential services* are not made available for shedding or are given a lower *load shedding* priority than other *load*.

2021 Maximum System Load – 8 January 2021



Minimum System Load – 14 March 2021



Minimum System Load – 14 March 2021

Substation Load MW by Region

Substation Load MW 415

Substation MVAR -11

CT

Station	MW	MVar
BEL	12	0
BTY	5	0
CK	15	0
CL	5	0
COL	3	0
F	10	1
HAY	25	4
JTE	5	0
KDL	6	2
MIL	22	0
NP	10	1
RVE	14	-1
TT	8	1
W	11	2
WE	2	-6
	152	0

EC

Station	MW	MVar
BNY	9	2
CAR	7	2
CUN	1	0
KDN	1	-5
KEL	1	1
MER	1	-2
NOR	0	-2
SVY	2	-1
SX	0	-1
WUN	1	0
YLN	4	-3
	13	-14

EGF

Station	MW	MVar
BKF	27	3
BLD	20	7
PCY	7	2
WKT	14	6
WMK	0	0
	67	17

GLT

Station	MW	MVar
D	-1	-1
FFD	5	1
HZM	1	0
K	-1	0
MDY	6	1
MJ	7	2
	16	2

KW

Station	MW	MVar
MED	-4	-4
MH	-7	-6
MSR	25	11
MSS	-7	-7
RO	8	1
WAI	-11	-6
	5	-11

MU

Station	MW	MVar
ALB	10	4
BNP	1	0
BOD	0	0
BTN	11	-2
CO	3	0
KAT	4	-3
KOJ	1	0
MBR	1	-2
MJP	4	0
NGN	2	-3
WAG	1	-1
WGP	2	0
	39	-7

NC

Station	MW	MVar
CPN	2	0
CTB	8	3
ENB	-2	-1
GTN	12	-1
MOR	3	-1
RAN	15	3
RGN	4	3
TS	3	-2
	44	3

NT

Station	MW	MVar
A	6	1
BCH	-7	-3
BCT	1	0
CKN	-5	2
H	-1	0
HBK	-12	5
JDP	3	7
LDE	-9	-3
MA	4	0
MLG	5	0
MO	6	1
MUC	1	-2
MUL	4	0
NB	-1	-1
OP	10	3
PBY	-2	-2
WGA	0	-1
WNO	3	3
Y	5	0
YP	-3	-1
	9	9

PIC

Station	MW	MVar
BSN	3	-7
BUH	8	0
CAP	1	0
CLP	1	-1
MR	2	-3
MRR	11	-2
PIC	18	-17
PNJ	5	-4
	18	-17

SF

Station	MW	MVar
AMT	8	-1
APM	4	2
BIB	-2	-3
E	8	2
MYR	5	-1
OC	1	0
	23	-2

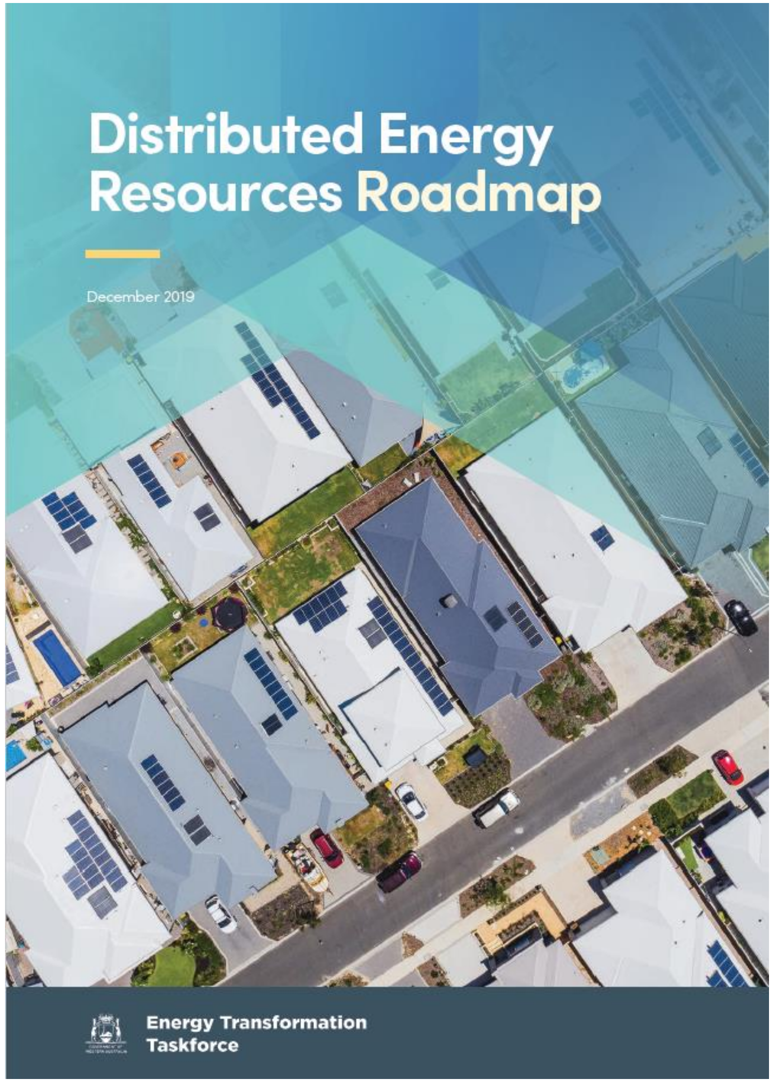
ST

Station	MW	MVar
BYF	-10	-3
CC	0	-2
CVE	4	3
G	-5	-1
MDN	0	1
MUR	8	-2
RTN	-2	0
SNR	-18	6
WLN	-1	0
	-23	1

WT

Station	MW	MVar
CTE	7	-1
MCE	19	3
SPK	11	1
WD	2	0
	39	3

DER Roadmap



Technology integration
- Inverter Standards
- Distribution Battery Storage
- Grid Response
- Power System Operations
- Distribution Network Visibility
- Planning for EV Integration

Tariffs and investment signals
- Tariff Pilots
- DER for Tenants

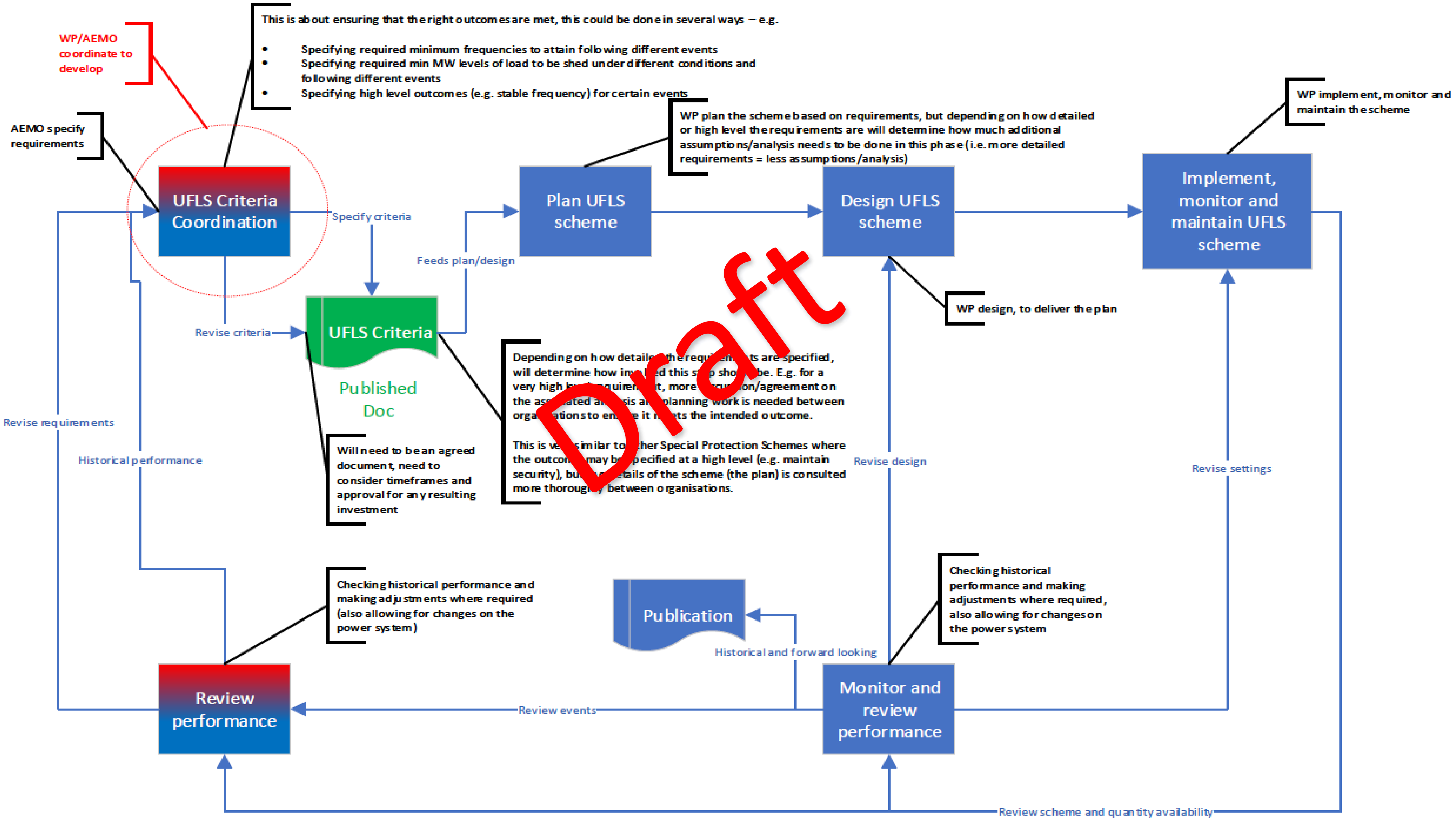
DER participation
- Network Investment Process
- DER Orchestration Pilot
- DSO/DMO Function Set

Customer protection and engagement
- Data
- New Business Models
- Customer Engagement

Required actions:

ACTION	ROADMAP ELEMENT	OWNER	DESCRIPTION	PRIORITY
10	Grid response	Western Power AEMO	By June 2020, review Under Frequency Load Shedding arrangements, and assess implications for AA5 investment program.	High

Project – Roles & Responsibilities – DRAFT ONLY



UFLS Review

Sam Ristovski

Project – Drivers/Structure/Resources

Problem	Continually increasing levels of Distributed PV are resulting in a reduction of load shed availability and reverse power flows on feeders, which is reducing the effectiveness of the UFLS system to arrest a severe frequency decline.
Objective	Perform a comprehensive review of the current and future performance of the existing UFLS system, in light of the changing levels of demand and increasing levels of DER. The purpose of this review is to provide inputs into developing a LT UFLS strategy and subsequent projects to improve the UFLS system performance.

Works Packages	Resources	Deliverable
Works Package #1: Development of models, assessment method and performance criteria	WP & AEMO	*Development of the models, assessment methodology and agreed criteria for validating the performance of the UFLS system*
Works Package #2: Review of UFLS industry best practice	Consultant	*Perform a national/international industry review into the industry best practice for UFLS systems, particularly in high DER environments and with the aim of recommending solutions suitable for applicable to the SWIS*
Works Package #3: Performance review of existing UFLS system	WP & AEMO	*Perform comprehensive frequency and voltage stability modelling to validate the performance of the existing UFLS system for current and future operating conditions*
Works Package #4: Proposed improvements to the existing UFLS	WP	*Based on outputs of works packages 1-3, propose high level recommendations to improve the performance of the existing UFLS system for future UF events*

Project Status - Progress

#	Works Package	Target	Status – Comments
1	Development of models, assessment method and performance criteria	Nov 2020	Completed
2	Review of UFLS industry best practice	Feb 2021	Completed
3A	Performance review of existing UFLS system – Frequency Stability Assessments	May 2021	Studies commenced
3B	Performance review of existing UFLS system – Voltage Stability Assessments	Jun 2021	Studies expected to commence early March
4	Proposed improvements to the existing UFLS system	Jul 2021	Not commenced

WKP#1: Development of models, assessment method and performance criteria

Scope of the works package includes a collaboration between WP and AEMO to:

- Define the objective and requirements of an UFLS system (first principles)
- Identify key design considerations of an UFLS system
- Enhancement of existing single mass frequency models (addition layers/accuracy) and agreed modelling methodologies and for performing frequency stability studies to evaluate the performance of the existing UFLS system
- Document the key information and decisions made
- Develop and agree on scope for subsequent works packages (#2 and #3)

WKP#2: Review of UFLS industry best practice

Scope of the works package includes:

- A comprehensive national and international review (14) into the industry best practice and latest developments in managing UFLS, particularly in high DER environments.
- Based on insights obtained from industry on good practice, identify shortfalls with the current design of the UFLS system and recommend a range of solutions that are suitable for applicable to the SWIS to improve the resilience for future UFLS events.
- This works package is a <u>qualitative</u> assessment of the existing UFLS system

WKP#2: Review of UFLS industry best practice

Key Findings:

- Issues are common - reducing LS availability
- Strategies being considered/implemented by Utilities
  - Regulator review periods
  - Greater LS discrimination – Feeder level
  - Reverse blocking capability
  - Implementing ROCOF triggers
  - PMU high speed data to review performance/ rea time monitoring
  - Dynamic arming of feeders during high DER outpu

Short-Medium Term Recommendations

1. Increased UFLS remote control/Reverse Blocking capability
2. Increase loads to shed into the UFLS system
3. Regular modelling reviews
4. Data reporting to AEMO

Long Term Recommendations

1. UFLS availability - real-time monitoring
2. Increased UFLS selectivity (trip low level load)
3. WAMs to enhance UFLS (ROCOF triggers)
4. Dynamic arming/Adaptative systems
5. Enhanced frequency control - batteries
6. Protection relay replacement

Traditional approach 'Set & Forget' → Enhanced capability (reverse block/remote control) → Dynamic UFLS → Adaptive UFLS

WKP#3: Performance review of existing UFLS system

Scope of the works package includes:

- Performing detailed frequency and voltage stability assessments (two sub-packages) to evaluate the current and future performance of the existing UFLS system.
- A stochastic approach to key parameters (i.e. generation dispatch/inertia, demand, contingency size, rooftop PV output) was adopted to create a full spectrum of operating conditions
- Sensitivity analysis was carried out that included:
  - Future rooftop PV output levels
  - Generation retirements – planned and proposed
  - Large scale battery installations
  - Cascading generator contingencies
  - Proposed optimisation of the existing UFLS settings
- An overall summary of the existing UFLS system performance and providing recommendations to improve the resilience to future under frequency events
- This works package is a <u>quantitive</u> assessment of the existing UFLS system

WKP#4: Proposed improvements to the existing UFLS system

Scope of the works package includes:

- A review and consolidation of the outputs of works packages 1-3
- Short and long term recommendations to ensure we have an appropriate set of functional requirements and an UFLS system which meets those requirements in our transforming power system.
- This document will be used to inform the UFLS Requirements JAF.