Scottish Continuity

Presentation to Scottish Continuity Group
(invited audience)

National Power Outage

Setting the context & raising business awareness

Eric Leavy

Head of transmission networks -SPEN

7 December 2022

Virtual Teams event

Overview of Black Start (and SPEN actions)

The aim of this session is to -

Stimulate the audience to consider where their organisation may benefit from planning and preparation for a National Electricity System Shutdown event

❖ **Introduce some terminology around "Black Start"**

❖ **Highlight the impacts on consumers**

❖ **Indicate the approach to system restart**

❖ **Explain the key SPEN dependencies**

❖ **Outline SPEN overall activity priorities**

❖ **Sketch out a likely timeline for SPEN action**

Black Start: Background

What is it?

All generation has ceased

Black Start is the procedure to recover from a partial or total system shutdown

How can it happen?

- Human error
- Extreme weather
- Third party/ deliberate actions
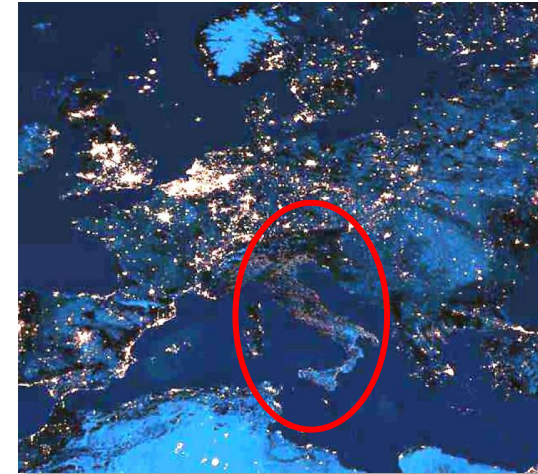- Cumulative effect of individual events

Total Shutdown may be very fast
e.g. within a few seconds of a triggering event

An extreme and low probability event, but one which we need to plan for
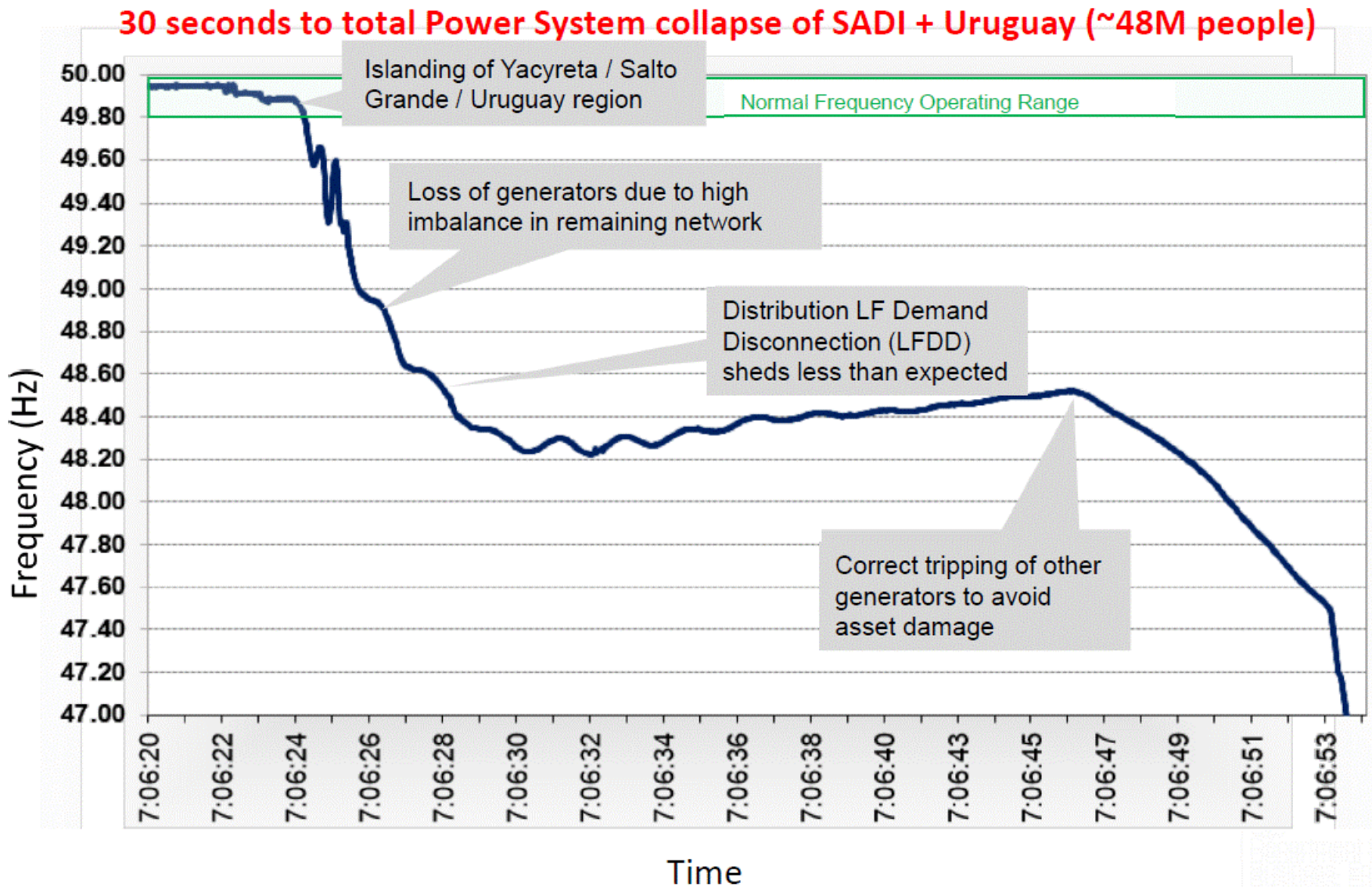
14 August 2003:
North American event:
Disconnection of
~50 million customers

28 September 2003:
Italian event:
Disconnection of
~55 million customers

28 September 2016:
South Australia event:
Disconnection of
~1.7 million customers
in 88 sec

theguardian

home > environment > energy   pollution   climate change   wildlife   UK   ☰ all

Renewable energy

South Australian windfarms revise safety settings after statewide blackout

Energy market operator says nine of 13 windfarms 'tripped' because their settings disconnected them from the grid after transmission lines were blown over

📷 After transmission lines were knocked out almost a third of the state's windfarms had settings that allowed them to ride through the six voltage disturbances. Photograph: Debbie

Argentina system collapse on 16 June 2019

30 seconds to total Power System collapse of SADI + Uruguay (~48M people)

Islanding of Yacyreta / Salto Grande / Uruguay region

Normal Frequency Operating Range

Loss of generators due to high imbalance in remaining network

Distribution LF Demand Disconnection (LFDD) sheds less than expected

Correct tripping of other generators to avoid asset damage

Frequency (Hz) / Time

Impact from a total power shutdown will be high and increasing

- Appliances stop working

- Mains lighting goes off

- Gas boiler shuts down

- Larger shops close as tills and safety equipment fail.

- Schools close

- Petrol Stations cannot dispense fuel

- Traffic lights and street lights off

- Railway and systems fail

- Lifts don't work

- Public venues close

- Food manufacture ?

- Business at standstill

- Banks ?

- Hotel services ?

- Healthcare centres ?

- Takeaways close

- Waste water treatment ?

- Mains water pumping ?

- TV and Radio (news)?

- Mobile phones ?

- Internet servers ?

Black Start
System recovery – key factors

- Worst case may be an all of GB shut down.

- Key assets may be damaged beyond service.

- BS service providers are sufficient to initialise recovery using a range of LJRP 's.

- Further demand restoration needs other generation enabled ASAP.

- Recovery is a careful balancing act and uncontrollable inputs need active responses.
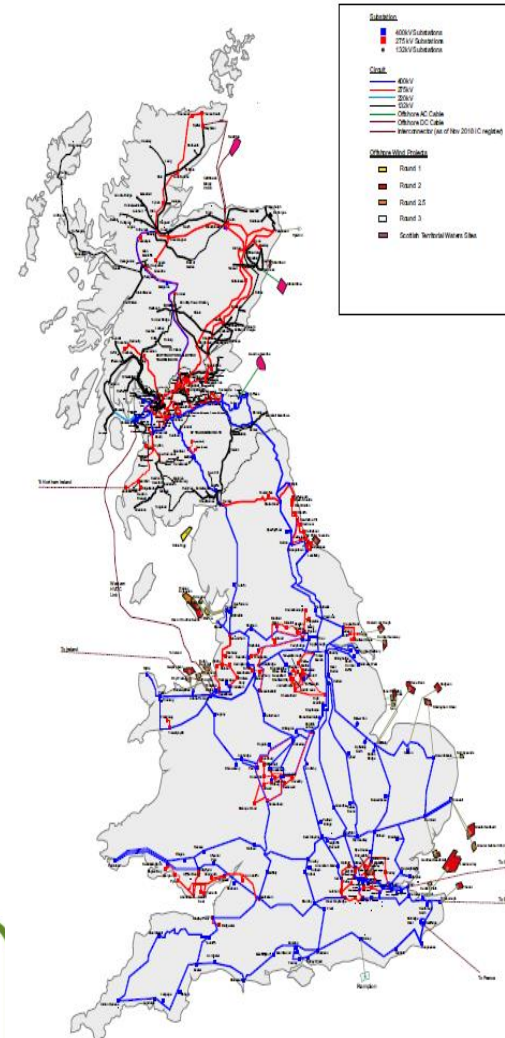
Black Start of SPT – Where is the starting power going to come from ?

Foyers
(400 circuit km to SPT border)

Peterhead

Cruachan

Drax
(280 circuit km to SPT border)
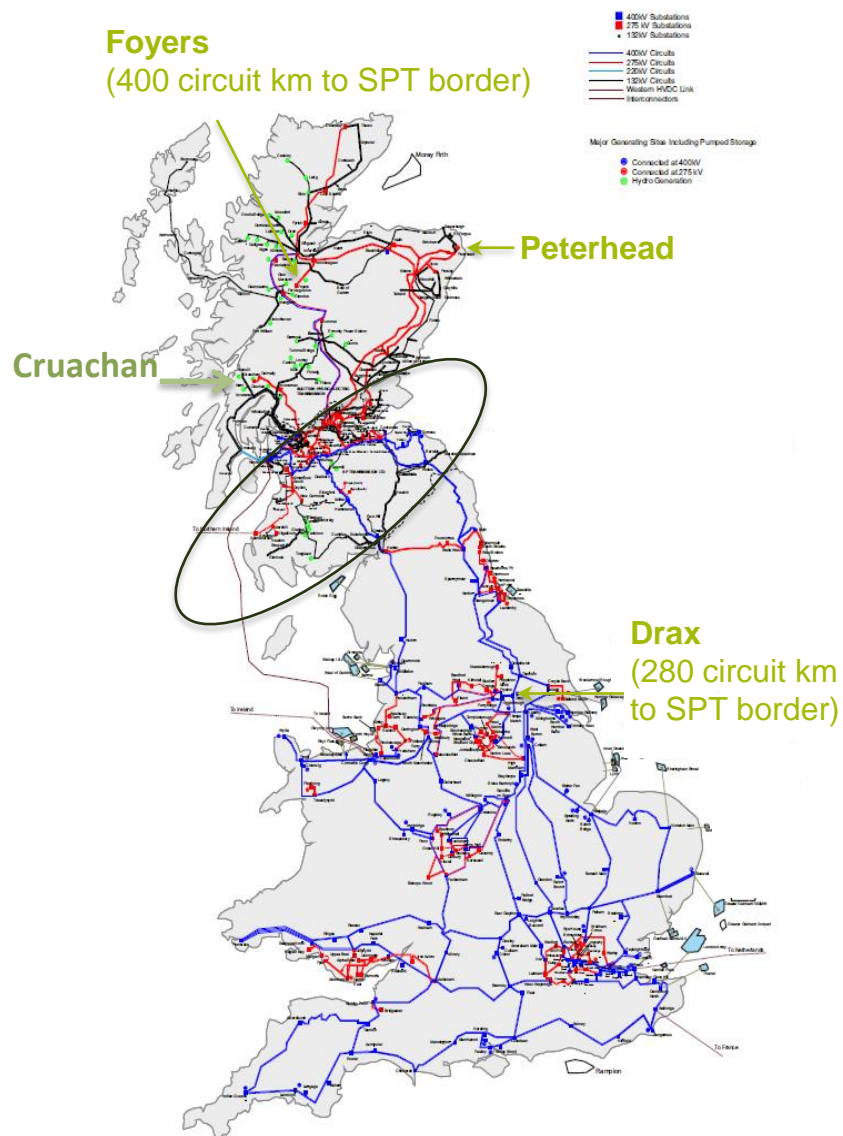
Cruachan based initial SPT power island
- Scottish zonal strategy
- Early support from SHETL area

GB Spinal Strategy
- External generation sources via long transmission circuits (Foyers-Peterhead-SPT and Drax -SPT)
- Feasibility of establishing a corridor directly from Drax to Scotland has been demonstrated

Evolution of both SPT and Zonal Strategies
- Recovery objectives move on to restore embedded generators and other available generation connections ASAP
- We must seek early recovery of - and support from - wind generators

Distributed Energy Resources (future)
- Develop feasibility of utilising embedded distributed energy resources to support recovery   –   work in progress

SPT and SPD priorities

- The picture is not a good one and WE MUST deal with it !
- Restoration and Recovery are *vitally* important
- Delays will result in *increased fatalities*
- Our EAC and command organisation *must* function

- Focus on organisational resilience
- Focus on key equipment and facilities resilience

- Task is to mobilise and address the "as found position"

ASAHP

The challenges for network recovery are mostly exacerbated with a weaker system

- Unloaded transmission lines experience a voltage rise due to capacitance effects. Much worse at 400kV and less so at 132kV.

- Connecting load centres involves energising many more capacitive circuits.

- Cables are particularly capacitive.

- Windfarms need to be re- connected for a time before they can provide any services.

- Many windfarms are served by cable connections.

- Low fault infeed level introduces protection discrimination and sensitivity risks.

- Longer cables, shunt reactors and transformers introduce transient disturbances when switched into service.

- Embedded generation needs to have an established stable system to allow operation.

- The DER industry is unlikely to have access to sufficient skilled manpower to manage the volumes of intervention required to recover from a widespread shutdown quickly.

SPT Objective - Enable remote recovery of SPD network area

- Voltage may be available from either SHE or NGT areas (inc. NSL interconnection)

- Cruachan option will be water constrained with a limited energy reserve.

- Limited power input is available at outset.

- Seeking to support a choice of options

- Enabling alternatives reduces dependence on critical assets and improves overall resilience.

> **Consumers will see restoration that is sporadic and intermittent**

> **Restoration will typically take 3/5 days**

> **Some pockets may be off for much longer**

4 primary energy sources

NSL
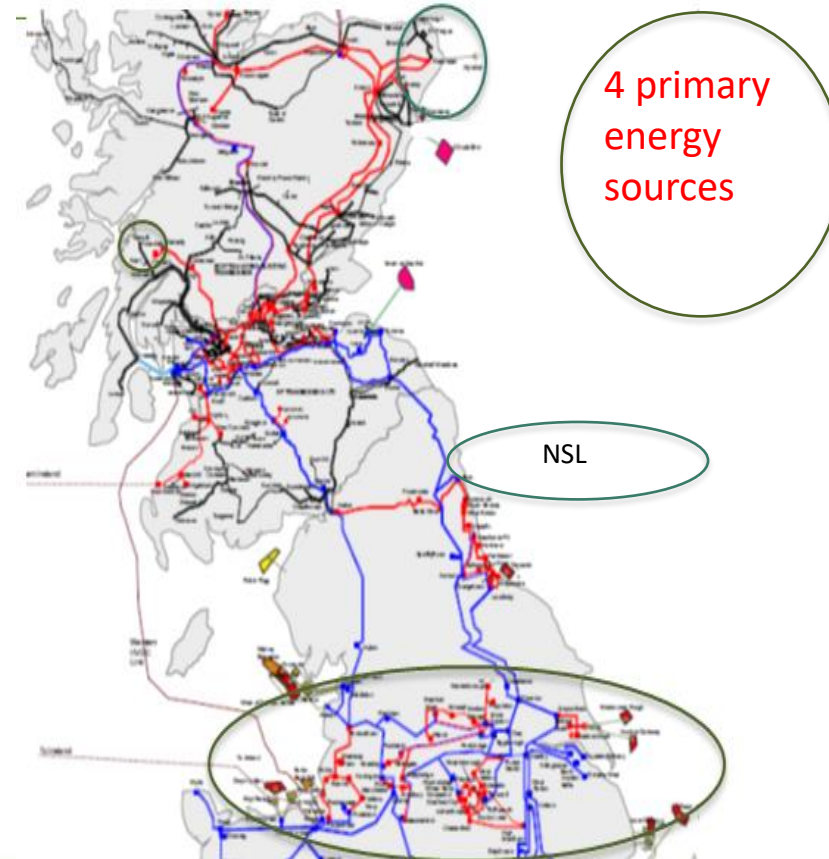
Objective- Growing the system

- Maintain the skeleton intact

- Attach sources of inertia and voltage control

- Attach some initial demand to aid stability

- Re-connect suitable windfarms

- Utilise additional reactive power from windfarms to re-connect further windfarms

- Attach and utilise despatch-able generation were available and add more demand

- Maintain headroom between demand and immediately available maximum energy input

- Grow demand and generation in balance.

- Keep the reactive power equation balanced in local network groupings

Reactive power +
Energy inputs

Demand + reactive gains

Voltage and Frequency
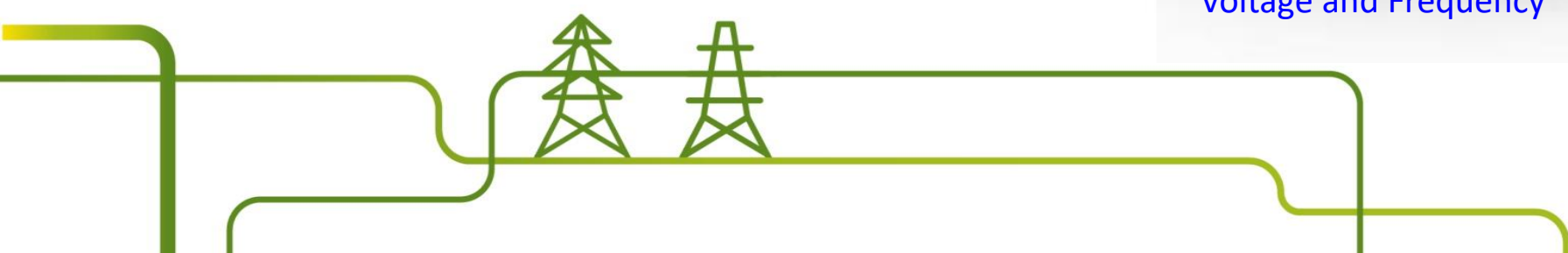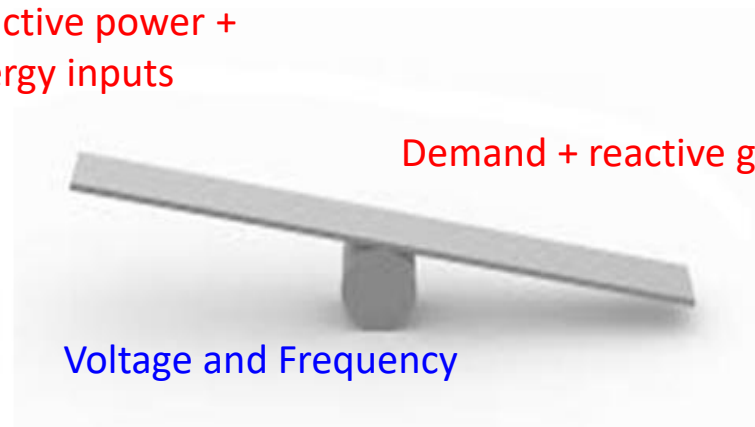
SPEN DEPENDANCIES

- Functional resilience of Control Room facilities and manpower

- Ability to contact and engage our key workforce

- Ability of workforce to be mobilised

- Ability of workforce to be released from domestic issues

- Access to fuel water and food

- Access to information and expertise

- Availability of critical external expertise

- These areas have been given a lot of thought and attention

- Many challenging things to be achieved

LIKELY TIMELINE OF SPEN ACTIVITY

- 0-6 hours. Mobilise Transmission Operational teams direct to sites "man up" Control and EAC structure. Establish _top level_ communications channels.

- 6-12 hours. Take stock of network damage and early wins. Define enduring EAC staffing plans.

- 12-24 hours. Consolidate options and deliver LJRP.

- 24-36 hours. Take stock of progress and prioritise on the better opportunities for recovery

- 36-48 hours. Review and develop options for power rotation. Assess asset status and key repair priorities.

- 48-72 hours. Optimise response management towards the strategic goals.

- 72 hours plus. Stabilise the organisation and ___just keep going___.

Suggested Next Steps

- ➤ Each and EVERY one of you should think of their situation should a blackout happen
- ➤ What actions are feasible which would improve your resilience
  - ❖ At a personal level
  - ❖ At a family level
  - ❖ At a street level
  - ❖ At a community level
  - ❖ At an enterprise level
  - ❖ At a business location / facility level
- ❑ ***Identify pro active steps which will make the event less uncomfortable and do something now to be resilient***

Some ideas to be getting on with

- Where might you and your workforce be when the black out happens
  - Where do you need them to be
  - How can you function without key people present
- What means of transport could be used
  - Is it reliable and with adequate fuel
- What can you expect from your supply chain
  - What level of confidence is justified
- Who is setting the priorities on objectives and available resources
  - What outputs and outcomes can be delivered and secured
  - What must be done to preserve recover and continue business
- Do you have clients or dependants who may have high expectations
  - How and when will their needs be served
  - Can and should you manage expectations
    (Beforehand and/or as the event develops)

OVER TO YOU !

Scottish Continuity

EC-RRG

Electronic Communications
Resilience & Response Group
Protecting Communications

Electronic Communications

Resilience & Response Group

Information for Local Resilience Forums / Partnerships & Stakeholders

Impact of National Power Outage (NPO) to Telecommunications

Issue date – 22/11/22

Version 3.7

Who are we?

An Emergency Planning forum made up of Government Departments, Ofcom, CPNI, NCSC and Communications Providers that own or operate key aspects of the communications sector as Category 2 responders (https://www.gov.uk/guidance/telecoms-resilience)

EC-RRG Members

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AIRBUS DEFENCE & SPACE

AIRWAVE

arqiva

at&t

BBC

BT Group

CabinetOffice

colt
smarter / faster / further

CPNI
Centre for the Protection
of National Infrastructure

Department for Levelling Up,
Housing & Communities

Department for
Digital, Culture,
Media & Sport

EE

KCOM

Level(3)
COMMUNICATIONS

LINX

Ministry
of Defence

National Cyber
Security Centre

NOMINET

Northern
Ireland
Office

O2

Ofcom

sky

TalkTalk

TELEHOUSE

The Scottish
Government

verizon

Virgin media

Vodafone

Llywodraeth Cymru
Welsh Government

Notable Statistics (Figures provided by OFCOM & Operators)

Type	Totals
Fixed Exchanges	5500
Core transmission sites – trunk radio/repeater stations, cable landing sites, earth stations etc	300
Mobile Exchanges	100 approx.
Data Centres	250 approx.
Street Cabinets – DSLAM etc	200,000
Mobile RAN sites	100,000 approx.
Airwave Sites	1800
Other key sites – 999 call handling centres, operator services etc	< 50
Fixed Telephone Lines / PSTN	34 million
Broadband Connections Fixed ADSL FTTx/Other	(47 million) 26 million 12 million 9 million
Mobiles (SIM cards/mobiles issued) - Individuals, devices and machine to machine use	100 million plus

Fixed Telecommunications – High Level Overview

Our network

Openreach local access network

CBT: Connectorised Block Terminal

DP: Distribution Point

FTTC: Fibre to the Cabinet

FTTP: Fibre to the Premises

PCP: Primary Cross-connection Point

Splitter: Splits a single incoming fibre into 32 output fibres

Fixed Exchanges have 5 – 7 days Power Resilience

FTTC DSLAM have up to 4 hours power resilience

Customers are responsible for providing their power resilience
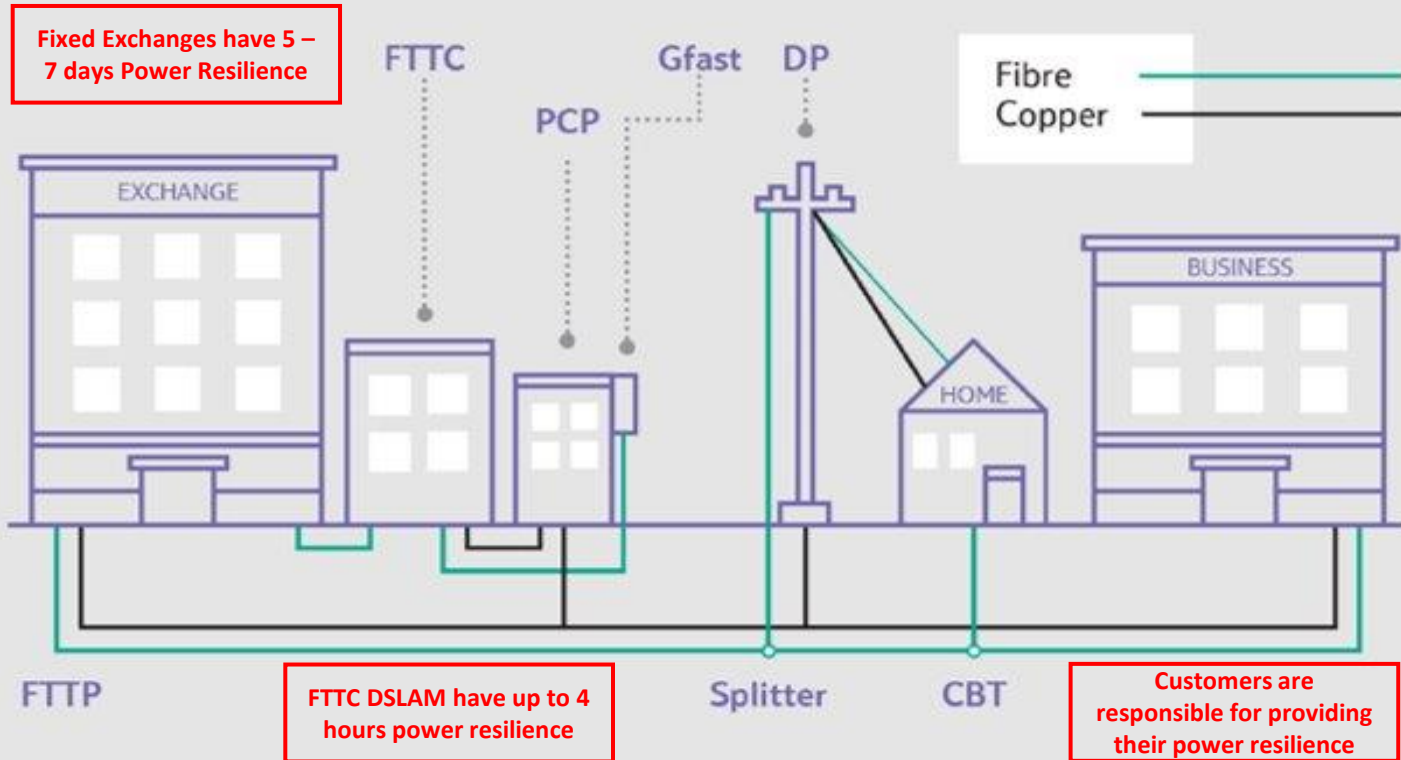
Fixed Network - PSTN & ADSL – Full Copper

Fixed Exchanges have 5 to 7 day power resilience

PCP Cabinet – No power requirements

Pole Top – no power requirements

End User – Power Requirements Powered Hand sets Wi fi, FTTP & FTTC

Local Exchange

Cabinet

End User Premises

(Copper providing PSTN & Broadband)
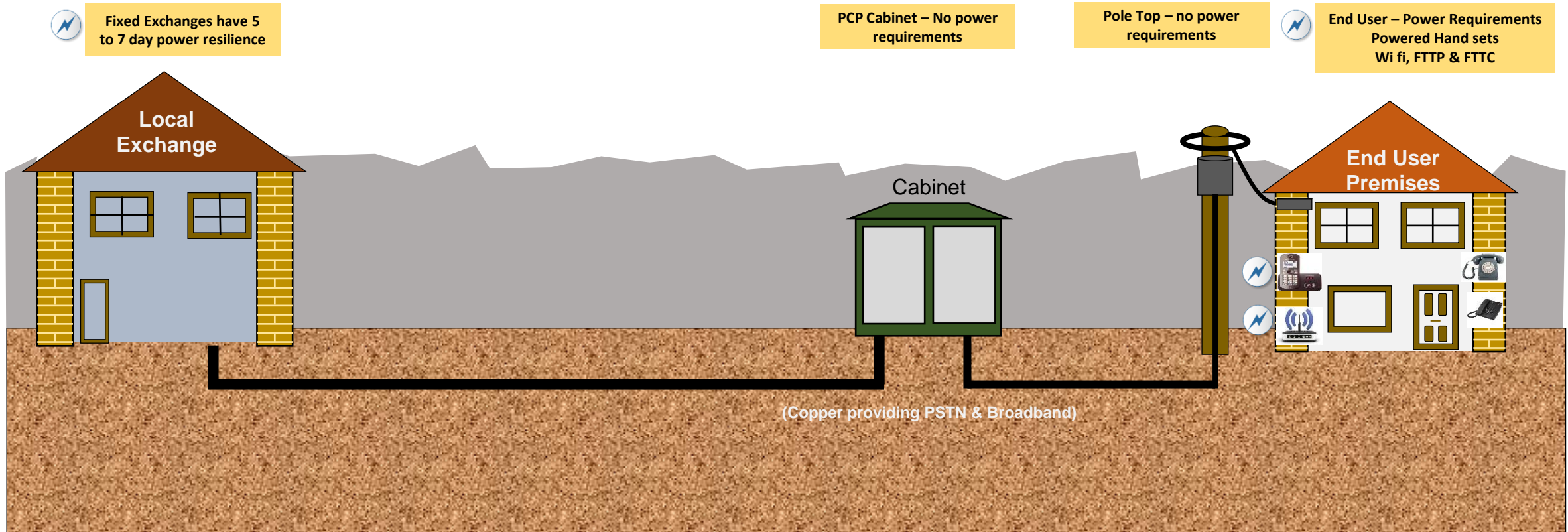
Copper cables connect the Local Exchange to the End User Premises, via an unpowered street cabinet providing PSTN voice and broadband services.

During a mains power outage PSTN voice calls can be made using an unpowered corded telephone.

Power dependant broadband/Wi-Fi routers or cordless telephones will not work unless the End User provides back-up power generation at their premises.

The PSTN service will be replaced by all IP network - which will require resilient mains power at customer location

Fixed Network – Fibre To The Cabinet (FTTC) – Part Fibre

Fixed Exchanges have 5 to 7 day power resilience

DSLAM – Up to 4hr power resilience

PCP Cabinet – No power requirements

Pole Top – no power requirements

End User – Power Requirements Powered Hand sets Wi fi, FTTP & FTTC

Local Exchange

Fibre Cabinet

Cabinet

End User Premises

DSLAM

D

(Copper providing PSTN)

(Copper providing PSTN & Broadband)

Fibre To The Cabinet (FTTC) providing Broadband

(Copper Tie Cables)

A fibre cable connects the Local Exchange to the powered Fibre DSLAM Cabinet, copper cables from the cabinet connect to the End User Premises providing PSTN voice and FTTC broadband services.

During a mains power outage PSTN voice calls can be made using an unpowered corded telephone. Power dependant broadband/Wi-Fi routers or cordless telephones will not work unless the End User provides back-up power generation at their premises. Local Exchanges have 5-7 days back-up power resilience. Fibre DSLAM Cabinet are mains powered and have up to 4 hours back-up power resilience. **The PSTN service will be replaced by all IP network (which will require resilient mains power at customer location)**

Fixed Network – Fibre To The Premises (FTTP) – Full Fibre

Fixed Exchanges have 5 to 7 day power resilience

PCP Cabinet – No power requirements

Pole Top – no power requirements

End User – Power Requirements Powered Hand sets Wi fi, FTTP & FTTC

Local Exchange

Cabinet

End User Premises

(Copper providing PSTN)

Fibre To The Premise (FTTP) providing Broadband
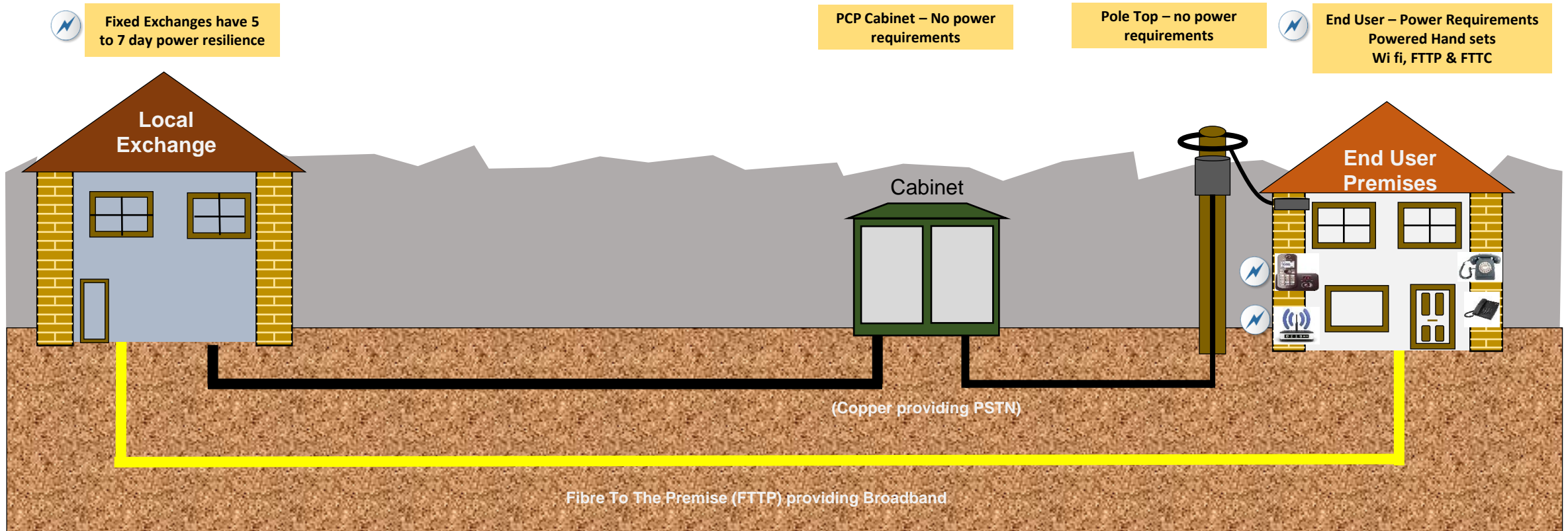
A fibre cable connects the Local Exchange to the End User Premises providing internet protocol (IP) voice and broadband services.

During a mains power outage power dependant broadband/Wi-Fi routers or cordless telephones will not work unless the End User provides back-up power generation at their premises. Local Exchanges have 5-7 days back-up power resilience. Communications Providers are responsible for providing and maintaining the FTTP broadband battery back-up capability to support voice and broadband services during a mains power outage. **The PSTN service will be replaced by all IP network (which will require resilient mains power at customer location)**

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Mobile Telecommunications Connection Methods

Mobile Network Overview – Same Principles Apply to Airwave and ESN
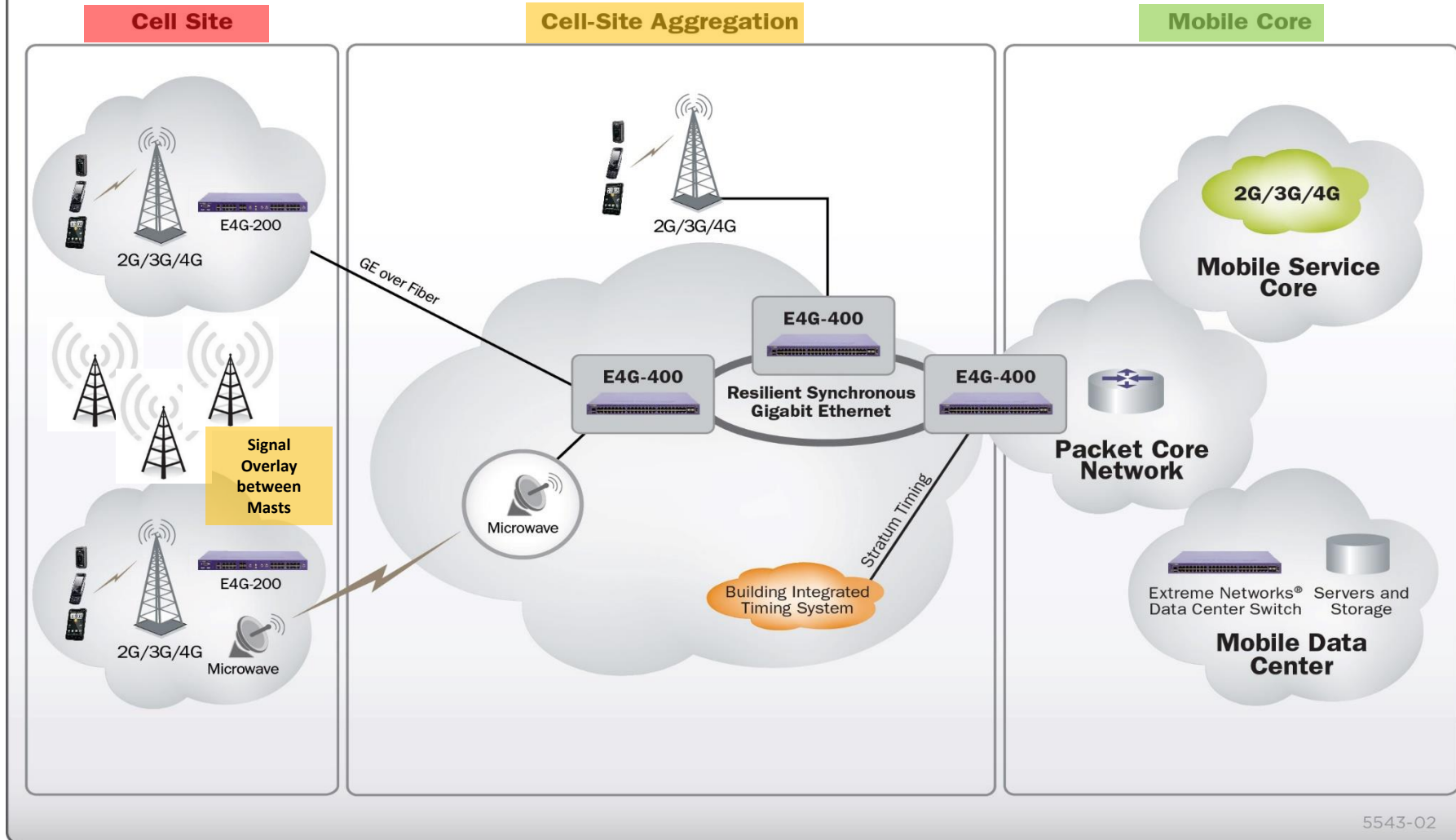
Commercial Cell/RAN Site – Mixed Power Resilience

- None – (single site operation &/or radio signal overlap from other masts)
- Battery
- Permanent Generator
- Tow to Site Generator

Airwave
5 – 7 day power resilience per site

Mobile 999 Calls
999 voice calls made from any mobile phone will roam to any available mobile network, even if the network that the phone normally operates on is not available. There are 4 Mobile Network Operators (MNO) in the UK – EE, 02,3 & Vodafone

Fixed/Mobile Exchanges
5 to 7 day power resilience

Cell Site

E4G-200

2G/3G/4G

Signal Overlay between Masts

2G/3G/4G

E4G-200

Microwave

Cell-Site Aggregation

2G/3G/4G

GE over Fiber

E4G-400

E4G-400

Resilient Synchronous Gigabit Ethernet

E4G-400

Stratum Timing

Microwave

Building Integrated Timing System

Mobile Core

2G/3G/4G

Mobile Service Core

Packet Core Network

Extreme Networks® Data Center Switch   Servers and Storage

Mobile Data Center

5543-02

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Telecommunications Sector Generic Power Resilience – FIXED NETWORKS

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Please note this is a generic high level information table and apart from where stated is not specific to any operator and should be used for reference only and not quoted as an agreed status/position.

Type	Example	Power Resilience	Power Resilience Availability	
Traditional non mains powered telephones using the Public Switched Telephone Network (PSTN)	Telephones that plug direct into PSTN network and utilise standard dial tone 50v dc	Will work during a power outage as long as network is connected and exchange has power and offers dial tone / 50v dc. ** *Note 7 day resilience model as defined by DCMS/BEIS* **	Power not required From December 2025 the PSTN service will be replaced by all IP network	🟢
Customer Premises Equipment (CPE)	Cordless phones/mobiles/tablet/wi fi routers/broadband hubs etc	Will not function during a power outage unless customer has own power back up - ***Please note this includes switchboards/ Private Automatic Branch Exchange (PABX) systems etc for business premises***	Customer dependant	🟡
Access network copper	Existing copper connection via overhead/underground feed	Copper network does not require mains power and as long as the customer CPE and exchange has power the network will deliver 50v dc and dial tone	Power not required	🟢
Access network fibre – FTTC fibre to the cabinet/equivalent	Fibre overlay onto copper network	Operator fibre exchange equipment and street cabinet requires mains power. Operator access network cabinets have mixed power resilience across batteries and tow to site generators. In the event of mains failure to fibre equipment some operator copper network 'piggy backed' services will still operate but this varies between the provider.	4hr batteries in DSLAM's Some operators utilise tow to site generators	🟡
Access network fibre – FTTP fibre to the premises/equivalent	Direct fibre e2e from A to B end	Operator fibre exchange equipment and customer CPE/FTTP customer end require mains power. Some operator FTTP/equivalent customer terminal equipment has 1hr battery back up but this varies dependant on provider	1hr batteries in FTTP CPE	🟡
Core switch sites – fixed network Includes transmission network – radio/repeater and cable landing stations & core transmission network	Traditional core switch network – national, interconnect to other operators and international	Fixed operators aim to have a 5 to 7 day 100% load and 80% minimum fuel tank power resilience model. This varies dependant on provider.	5 to 7 days	🟢

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Telecommunications Sector Generic Power Resilience – **MOBILE NETWORKS**

Please note this is a generic high level information table and apart from where stated is not specific to any operator and should be used for reference only and not quoted as an agreed status/position.

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Type	Example	Power Resilience	Power Resilience Availability	
Core switch sites – mobile	Core switch site / home location register site etc all operators	Mobile operators aim to have a 5 to 7 day 100% load and 80% minimum fuel tank power resilience model. This varies dependant on provider.	5 to 7 days	🟢
Cell site and cell site aggregation - mobile	Radio access network site / base station - all operators	Mobile operators do not offer a 100% site power resilience model with power resilience based on a risk based approach dependant on the assessed risk and the obligations to deliver service. As a result service may be lost immediately on power interruption in some locations, whereas service may remain available for a period of time in other areas.	Varies None – uses vector overlay Battery Fixed generator Tow to site generator	🟡
Small Cells – Mobile (Consumer/Small and Medium Business)	Small Cells attached to customer own Broadband circuit providing localised mobile network infill	Will not function during a power outage unless end user has own power back up.	Customer dependant	🔴
Airwave	Emergency service incumbent network Circa 1800 sites	All sites minimum 7 day power resilient	7 days	🟢
ESN	Emergency services new network	Switch sites – 7 day power resilience RAN sites – as per serial 8 but ESN also utilise drive to site RRV mobile base station capability and enhanced power resilience model.	7 days	🟢

Telecommunications Sector Generic Power Resilience – OTHER SERVICES

Please note this is a generic high level information table and apart from where stated is not specific to any operator and should be used for reference only and not quoted as an agreed status/position.

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Protecting Communications

Type	Example	Power Resilience	Power Resilience Availability
Private Services / circuits	NATS/TV/Radio/customer networks **Customer networks**	Fixed operators of core transmission networks aim to have a 5 to 7 day 100% load and 80% minimum fuel tank power resilience model. This varies dependant on provider. Customers premises equipment is dependant on customer power resilience	See left 🟢
Data Centres - content	Internet hosting and content Peering services	Hosted content - data centre site power resilience varies between 24hrs to up to 7 days dependant on operator. Access to content – dependant on fixed/mobile and access networks.	See left 🟡
Consumer wifi hotspots	Consumer broadband router originating wifi hotspots	Will not function during a power outage unless end user has own power back up.	None 🔴
Commercial wifi hotspots	On premise Wifi services provided by businesses to their customer base football grounds, shopping malls, stores, restaurants etc.	Will not function during a power outage unless end user has own power back up.	None 🔴
999 Platform	999 Switch and Call Receiving Centres	Enhanced resilience at call centres and switch sites using matrixed resilience across geographically diverse sites	As long as fuel can be supplied & generators remain operational 🟢
BT Payphones (figures not available for other operators currently)	Public street payphones and those housed in business premises, railway stations etc)	There are approx. 30,000 BT provided payphones of various types across the UK. None have power resilience, however approx. 50% of these will function to make 999 calls after a power failure. The rest will not work until power is restored. Payphones that are deemed essential will be upgraded to the all IP Network as part of the PSTN migration.	See left 🟡

Resilience Considerations

1. Review of business continuity plans to include a National Power Outage (NPO) scenario, regular testing and exercising.

2. Review of power resilience requirements for critical telecoms services across key locations – Generators, UPS, power banks, spare batteries and unpowered analogue PSTN telephones.

3. Power resilience of fixed, mobile & internet services should be reviewed with the Communications Provider.

4. Review mobile resilience with Mobile Network Operator (MNO) - Are mobile devices dependent on a single provider.

   - Consideration given to a mix of SIM cards from various MNO or UK auto roaming SIM cards from providers like MANX telecom

   - If broadband is available most mobile phones have Wi-Fi calling as an option in the settings

5. Review of fuel supply chain in the context of an NPO scenario - Fuel for generators.

6. Vulnerable people and their support requirements – Fixed, mobile & alternate contacts.

7. Rest centres - Telecoms requirements and availability.

8. Review of services provided to customers – Are they telecoms reliant? are they critical? If so have mitigations been considered? e.g. Card payments, Smart metering (gas, electric and water), Vending machines - restock information, Intruder/Fire alarm data links.

Telecommunications & Power Resilience Overview

EC-RRG
Electronic Communications
Resilience & Response Group
Protecting Communications

- Power is the key interdependency for Telecommunications

  - *Fixed, Mobile, Broadcast & Internet networks are reliant on power to provide voice & data services*
  - *Customers Premises Equipment (CPE) – Internet routers, cordless phones & phone systems are also reliant on power*

- Telecommunications Networks consist of

  - Multiple Infrastructure Providers - *Openreach, Virgin Media City Fibre etc.*
  - *Over 650 Communications Providers (CP)*
  - *Multiple Broadcast & Internet Providers*

- There are 4 Mobile Network Operators (MNO) in the UK

  - *EE, Vodafone, Three & 02*

- Next Steps - Discussions with Fixed & Mobile Communications Provider / IT Comms Manager

  - *To understand what fixed services (Full Copper, FTTC, FTTP) and mobile services your organisation has*
  - *Who provides these services and their resilience*
  - *What mitigations are required or are in place across your organisation to manage a power loss risk*

- Restoration of Telecoms infrastructure is not prioritised by the DNO's during unplanned outage the DNO treat all customers equally

National Power Outage (NPO) - All fixed mains-powered forms of communication will be lost immediately following an NPO, unless the premises have back-up power post PSTN. Mobile forms of communication will degrade within the first hour up to the first 24hours, with resilience differing between regions (rural & urban); mobile handsets will also require access to back-up power generation as battery depletes.

Impact of National Power Outage to Telecommunications

Please contact EC-RRG for any further questions

telecoms.resilience@dcms.gov.uk

PSTN Migration - [Businesses and Services (openreach.co.uk)](http://openreach.co.uk)

The resilience information provided in this document covers the majority of fixed and mobile networks, there may be certain exceptions, please engage with your Communications Provider or Account Manager about the resilience of your network
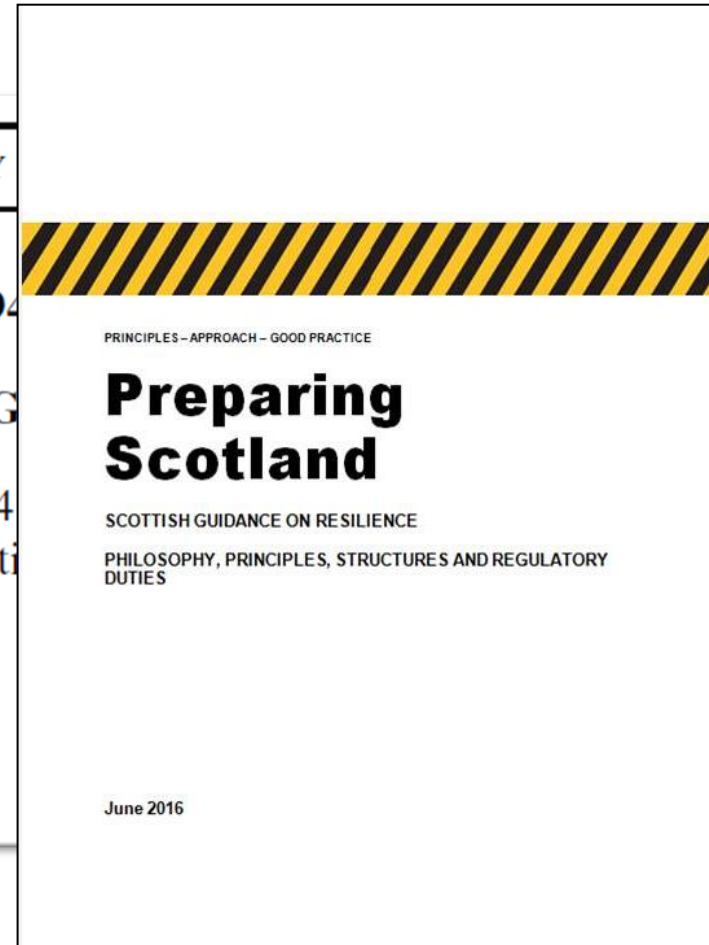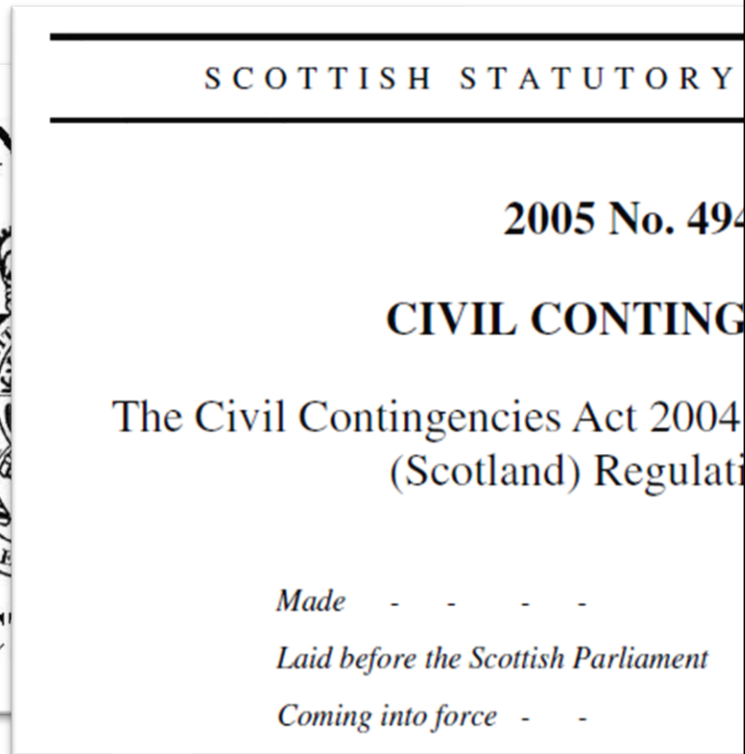
Scottish Continuity

Scottish Resilience

John Beresford

Senior Resilience Co-ordinator

East of Scotland Regional
Resilience Partnership
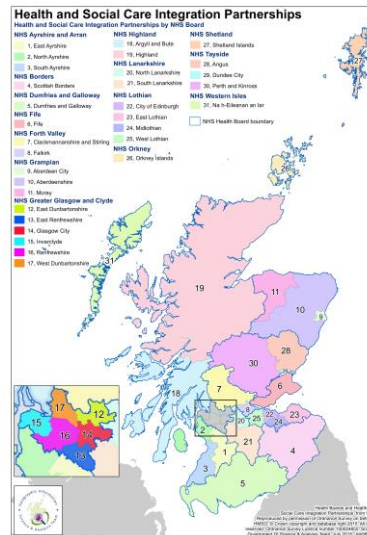
Civil Contingencies Legislation

Scottish Government gov.scot
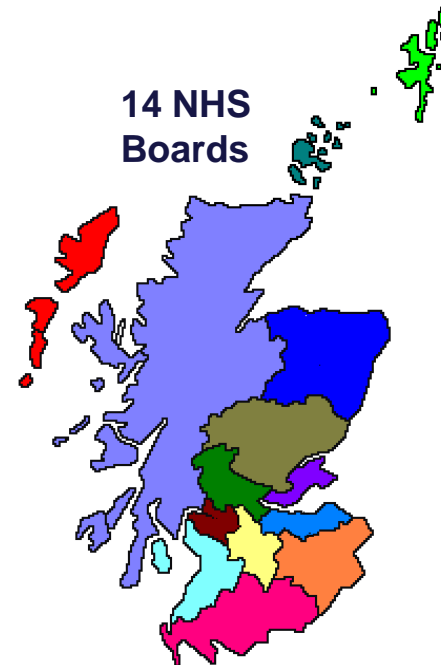
Category 1 Responders

Can be described as the "CORE" responders. Public sector organisations providing vital services in an emergency.

SEPA
Scottish Environment Protection Agency

32 Local Authorities

14 NHS Boards

Scottish Government
gov.scot

Category 2 Responders

Can be described as 'co-operating bodies'
Public and Private sector bodies that provide key infrastructure services that are regulated by other legislation related to preparing for an emergency.

Utilities

Transport

Harbour Authorities

NHS National Services Scotland
Supporting Scotland's Health

HSE
Health & Safety Executive

Scottish Government
gov.scot

Other Key Stakeholders

There are of course a number of other groups that have a very important part to play. These are recognised within the legislation but do not fall within the Category 1 or 2 responder groupings.
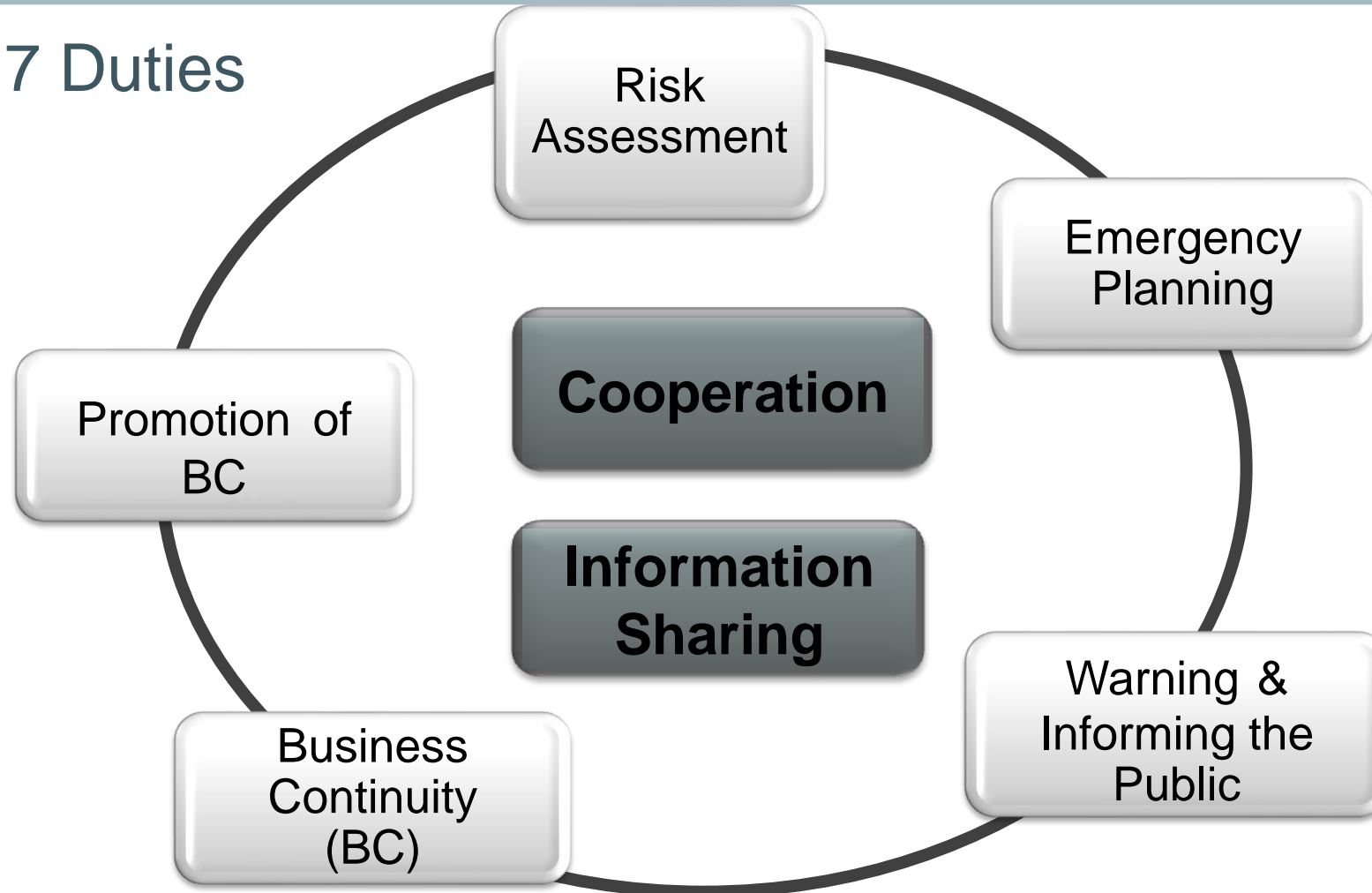
Civil Contingencies Act 2004

7 Duties

Risk Assessment

Emergency Planning

Cooperation

Information Sharing

Promotion of BC

Warning & Informing the Public

Business Continuity (BC)

Scottish Government
gov.scot
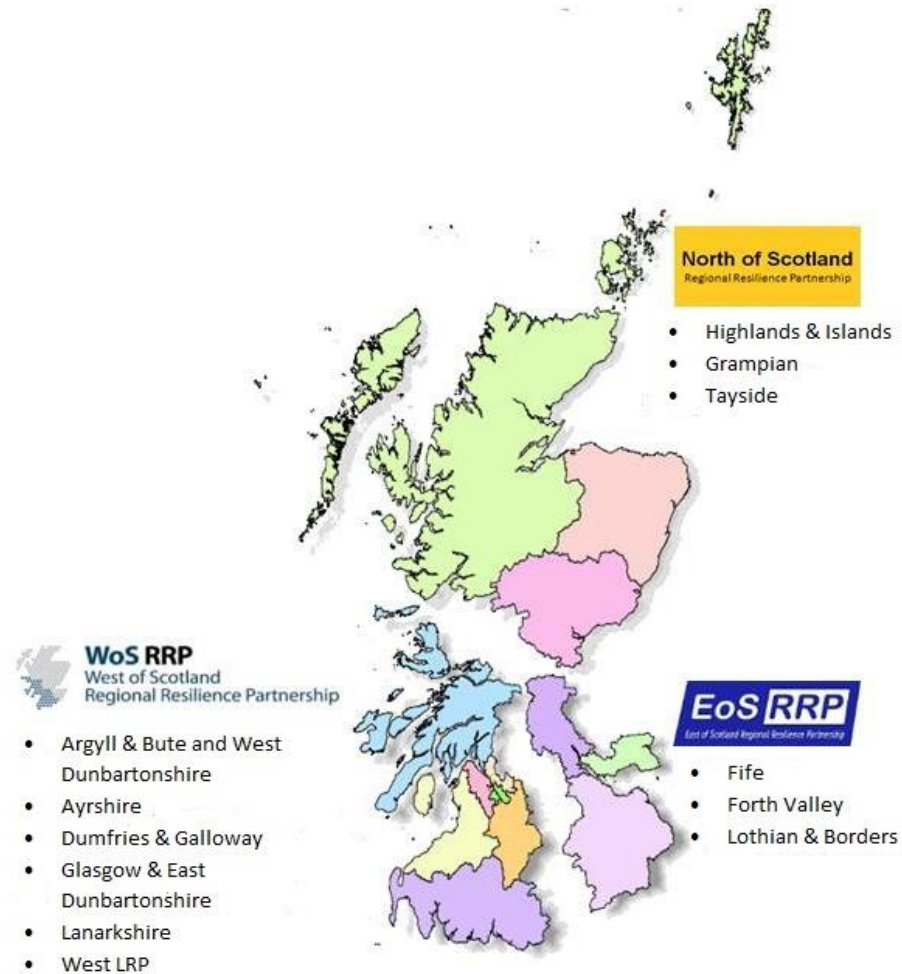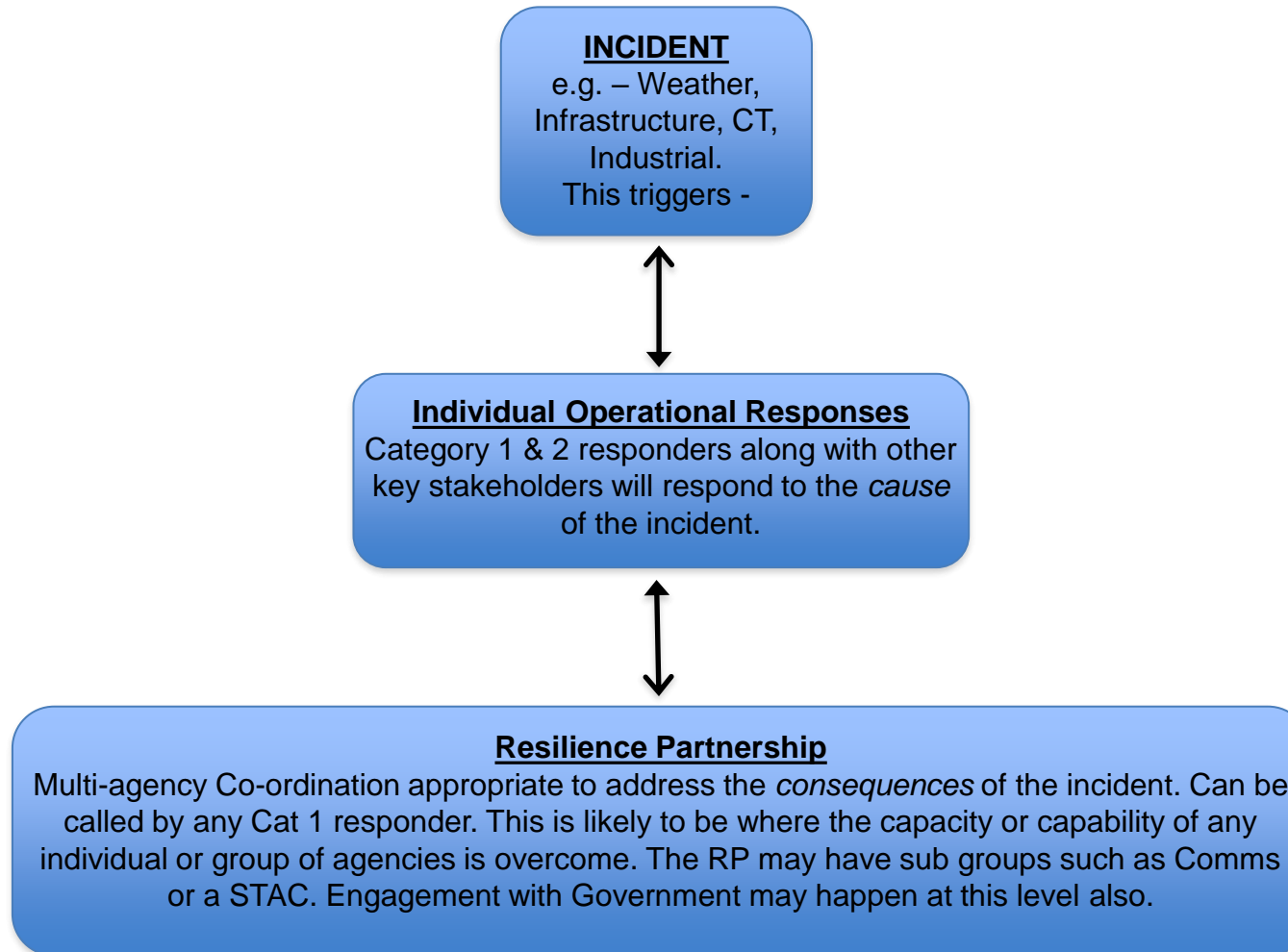
Resilience Partnerships

NPO Preparation

- National Power Resilience Framework
- Sectoral, LRP and Strategic Workshops
- LRP NPO Framework Documents
- Initial response expected to be 'Hyper-local'

'Normal' Activation of an RP to an Incident

Activation is about getting the right people together at the right time. It should be noted not all RP members need always to be involved and the partnership can expand or shrink depending on prevailing circumstances and demand .

INCIDENT
e.g. – Weather, Infrastructure, CT, Industrial.
This triggers -

Individual Operational Responses
Category 1 & 2 responders along with other key stakeholders will respond to the *cause* of the incident.

Resilience Partnership
Multi-agency Co-ordination appropriate to address the *consequences* of the incident. Can be called by any Cat 1 responder. This is likely to be where the capacity or capability of any individual or group of agencies is overcome. The RP may have sub groups such as Comms or a STAC. Engagement with Government may happen at this level also.

Questions?

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Scottish Continuity

Communication Problems

- Gaps allow rumour and speculation

- Fear fed by media headlines

- Impact on certain groups

- When computers fail what next?

Think the unthinkable

Communication Actions

- Business continuity plan

- Blackout comms plan

- Agree key messages

- More channels

- Consider using volunteers

- Social media still important

- Identify spokesperson

- Test the plan

Amanda Coleman
COMMUNICATION

Communication Solutions