Adapting Distribution Network Planning Practices and Design Standards to Accommodate DER

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Existing Planning & Design Practices

Security of Supply

- Engineering Recommendation P2/6 is current UK Security of Supply standard
- Uses a deterministic methodology for network planning which has changed little from the 1970s

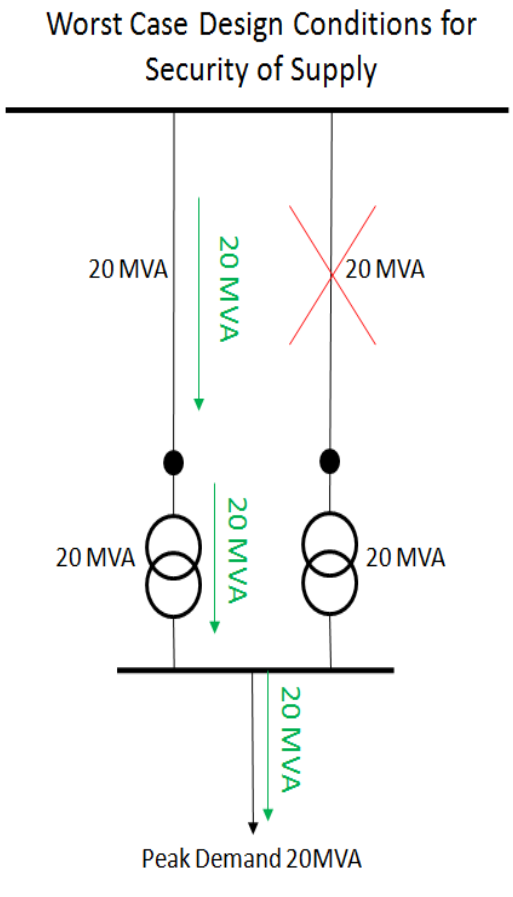
Group Demand	Required Redundancy	
Up to 1 MW	N-0	No requirement
1 MW up to 60 MW	N-1	At least one additional circuit to supply demand for First Circuit Outage
Over 60 MW	N-2	At least two additional circuits to supply demand for First and Second Circuit Outages

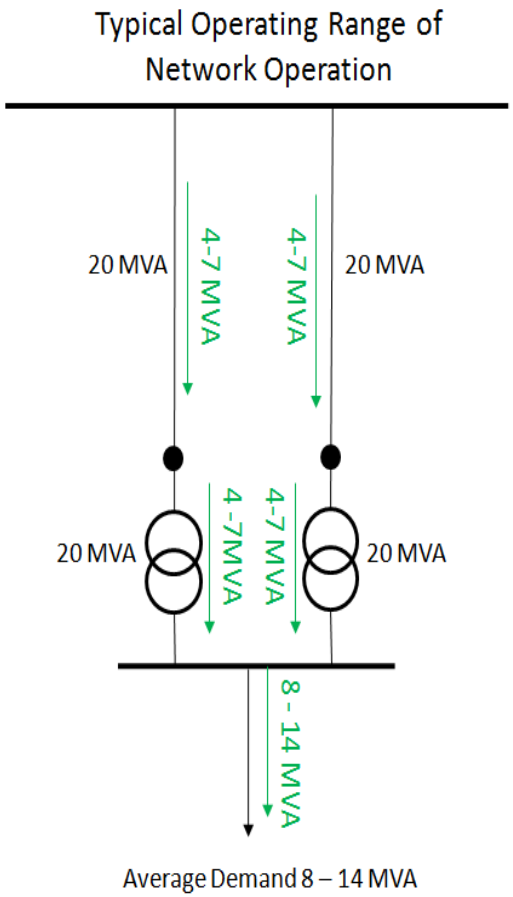
- Intermittent generation is considered using “F-Factors”

Existing Planning & Design Practices

Security of Supply

Has led to overdesigned distribution networks with sometimes poor utilisation





DER Challenges and Opportunities

The main challenges presented by the connection of DER are:

1. Responsive DER could alter peak load and remove predictability of demand profiles
2. Decentralised network controllable devices actively managing parameters in real-time and improving network utilisation
3. Intermittent and distributed generation that is not visible to the control centre making daily management more challenging
4. Different DER responding to varied commercial triggers and instructions

A more probabilistic methodology is required to better plan and manage increasingly active distribution networks

Case Studies
Peak Demand Shifting

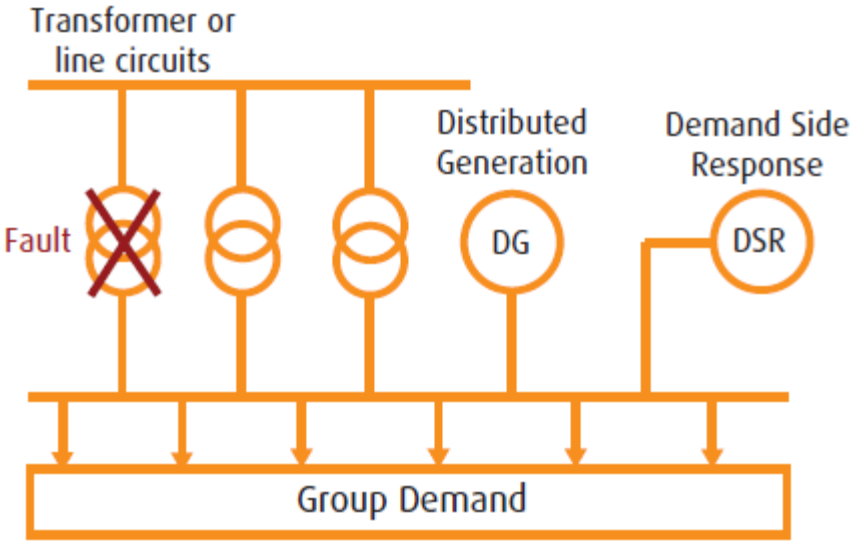
- Peak (Group) demand is the main indicator to assess capacity and redundancy requirements according to ER P2/6
- Peak demand could be “reduced” locally through
  - Shifting
  - Levelling
  - Displacement
- Smart control of demand (or storage) could also be exploited to “absorb” generation at times of peak production

- **UKPN’s Low Carbon London** project used flexible demand to
  - Avoid or defer reinforcement
  - Mitigate short-term constraints ahead of time
  - Manage planned outages

Case Studies
Peak Demand Shifting

- The LCL project also investigated how DG and DSR (demand side response) can contribute to Security of Supply and be included in capacity calculations

Figure 10: Example of a distribution system structure



Source: LCL Learning Report A4 – Industrial and Commercial Demand Side Response for outage management as an alternative to network reinforcement

Case Studies
Domestic Generation Management

- More and more properties have generation connected “behind the meter”
- The LV network is generally unsuitable for reverse power flows caused by excess generation being exported back to the grid
- **Northern Power Grid’s Customer Led Network Revolution** trialled methods of maximising self-consumption and reducing overall export

Case Studies

Domestic Generation Management

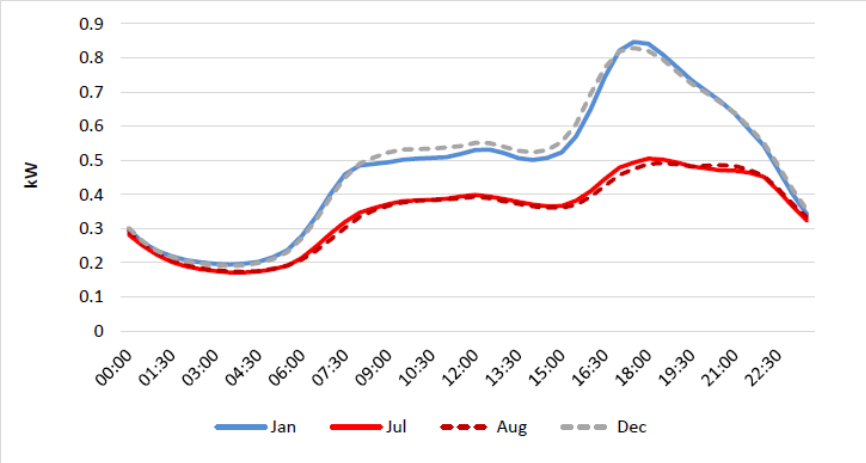


Figure 6: Monthly average demand profiles for TC1a in four selected months

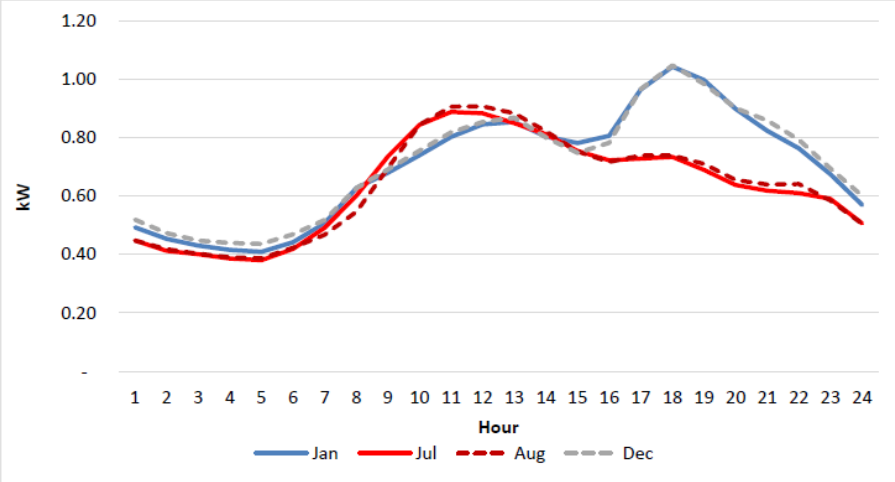


Figure 7: Monthly average gross demand profiles for TC20 (Auto) in four selected months

- TC1a is a baseline profile – domestic PV generation with no intervention
- TC20 (Auto) includes households with domestic generation and automatic interventions

Figure 7 highlights the automatic intervention of electric water heating being switched on in times of excess peak generation i.e. Summer day time

Source: CLNRL263 Insight Report Domestic solar PV customers with automatic balancing

Case Studies

Beneficial Modifications to Existing Standards

In the context of adapting existing planning standards to accommodate DER:

Peak Demand Shifting

Requires more visibility of the demand profile to better forecast

- Inclusion of a revised methodology for calculating and forecasting capacity requirements at different substation levels i.e. primary, secondary substations would be beneficial for incorporating flexible demand
- Better visibility of demand profile i.e. demand, storage, EVs, DG, would facilitate this

Domestic Generation Management

Requires more provisions at the domestic scale

- Provisions for domestic generators could be included to encourage the more active role of consumers ("prosumers") in generation management across the network
- Detailed identification of demand groups i.e. solar, wind, storage, at smaller capacities

The Role of Big Data

- With increasing amounts of monitoring equipment on networks “Big Data” will be an important aspect of future distribution networks in an operational context
- However it could also be exploited for use in network planning and design
- More accurate monitoring of generation and demand will improve demand forecasting
- Use of “Big Data” will enable a more probabilistic methodology to be employed in Security of Supply capacity assessments
- It will also improve the selection of solutions when capacity constraint levels are reached

Evolution of Standards and Ongoing Work

- In the UK, exploratory work has been carried by network operators out regarding how DER can contribute to and improve existing Security of Supply standards
- The Security of Supply Engineering Recommendation P2 is undergoing a fundamental review
- In wider Europe, ENTSO-E has published network codes which will become legally binding; one such code allows a TSO to place requirements on large distribution loads to maintain security
- In the USA, EPRI have undertaken large volumes of research into the impacts of DER integration
- The IEEE has published guidelines on smart grid integration and interoperability

Going Forward

- Distribution networks are evolving and the technical standards must evolve with them
- Stakeholders have recognised the need to understand the impacts of DER and to maximise the benefits to be gained
- A transition from deterministic to a more probabilistic Security of Supply methodology is under consideration

Thank you for your attention

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