Electricity Network Innovation Competition Full Submission

Supplementary Answer Form

Project: REVISE

Tick if this answer has been provided verbally: ☐

Project code	WPD/EN/NIC/05	Question Number	14
Question date	21 August 2018	Answer date	23 August 2018
Submission section question relates to	Section 2		
Topic			
Question	P11 2.2.1 "Never before on the distribution network" - can you provide either some clear proof, or clarification on the level of novelty?		
Notes on question	None		
Answer	Currently, DNOs use automated sequence switching schemes to restore demand/customers when the network has changed due to a fault. These schemes are based on simple logic rules typically on a single substation and follow a sequence of predefined steps. If the substation is in a different configuration from normal operation or any rule cannot be met, the automated sequence scheme stops and the network has to be restored manually. INR represents a significant advancement over automated sequence switching schemes as detailed in Appendix L and summarised below: • INR will be pro-active and seek to optimise the network continuously during "normal" network operation and will not only react to faults that occur; • INR will consider the entire area of network that it is monitoring and make decisions based on real-time data available (status of equipment, current, voltages, fault levels etc.); • The system will calculate and assess the impact of new configurations before implementing them; • Machine learning will be used to optimise INR and make the process even more efficient;		

- Additions or changes to the network (due to reinforcement schemes or new customers connecting) will be automatically captured by INR and will not require the system to be manually re-programmed; and
- INR will have the functionality to change between different network priorities (such as maximum generation output, reduction in losses or increasing network security) and adjust the network accordingly.

During the research phase for the FSP we investigated innovation projects where network management techniques have been used to improve network capacity.

Appendix N provides key differentiators between REVISE and other Innovation projects that have been conducted by other DNOs. We found that these projects sought to react to changes on the network and/or rely on the flexibility of customers to manage constraints. As mentioned in the FSP, REVISE will pro-actively reconfigure the network, use machine learning to capture and learn from previous configurations and remove the reliance on customer flexibility.

We also researched if other network operators around the world had implemented a system similar to INR or whether any advancements had been made by manufacturers in this area. Our research showed that no one has yet to implement a system such as INR on a distribution network. A number of operators have trialled networks which are "self-healing", however, INR looks to take this further and develop a system which pro-actively reconfigures. We also found several references to the benefits that could be realised if network operators were to adopt new techniques such as those we are aiming to trial with INR. Some notable references to these subjects are listed below:

- D.N. Trakas, E.M. Voumvoulakis, N.D. Hatziargyriou, "Controlled Islanding of Power Networks Using Machine Learning Algorithm", *MedPower 2014*
  - *This conference paper discusses the development of an algorithm which could be implemented to determine how a network should be configured following a fault. The paper concludes how the algorithm can find a near optimal solution in real-time.*
- LI Jianfang, SONG Xiaohui, MENG Xiaoli, "Hierarchical control model of smart distribution network based on self-organising multi-agent system", *International Conference on Renewable Power Generation 2015*
  - *This conference paper discusses the application and performance of a new control architecture for a distribution network. The paper concludes that this type of control model performs well and could provide self-organising control of the networtk if implemented.*
- B. Heerbaart, F. Kuiepers, F. Baldinger, "I-Net, the reality of an Intelligent Distribution Network", *CIRED, 2nd International Conference on Electricity Distribution 2013*
  - *This paper describes a trial on 10kV and 20kV networks in which existing equipment was modified to provide automatic/remote control. The result of the trial was the*

	ability to have a "self-healing" distribution network which was able to sectionalise the faulty part of a network. • B. Venkatesh, S. Chandramohan, N. Kayalvizhi and R.P. Kumudini Devi, "Optimal reconfiguration of radial distribution system using artificial intelligence methods", *IEEE Toronto International Conference Science and Technology for Humanity 2009* – *This paper evaluates two algorithms that could be used for optimising the distribution system whilst minimising losses and improving power quality. The paper assessed the performance of the algorithms in terms of speed and optimal solution.*
Attachments	None