

Introduction:

Recent advances in emerging Renewable Energy Resources (RER) and Distributed Energy Resources (DER) are transforming conventional electric distribution system into the "Smart Electric Distribution System (SEDS)". The integration of RER and DER including the deployment of Smart Meter and Advanced Metering Infrastructure; two key technologies to envisage so called "Smart Grid", could potentially result in:

- Voltage instability
- System instability
- Reduced reliability in the SEDS.

However, voltage instability is the most significant factor which leads equipment brown-out or plant failure and eventually reduces reliability of the SEDS. These issues are due to the non-deterministic behaviour of time-variant RER and DER, and complex infrastructure of the SEDS. The Self-Healing Control strategies for SEDS (as shown an one-line diagram in Figure 1) are proposed to mitigate the voltage instability.



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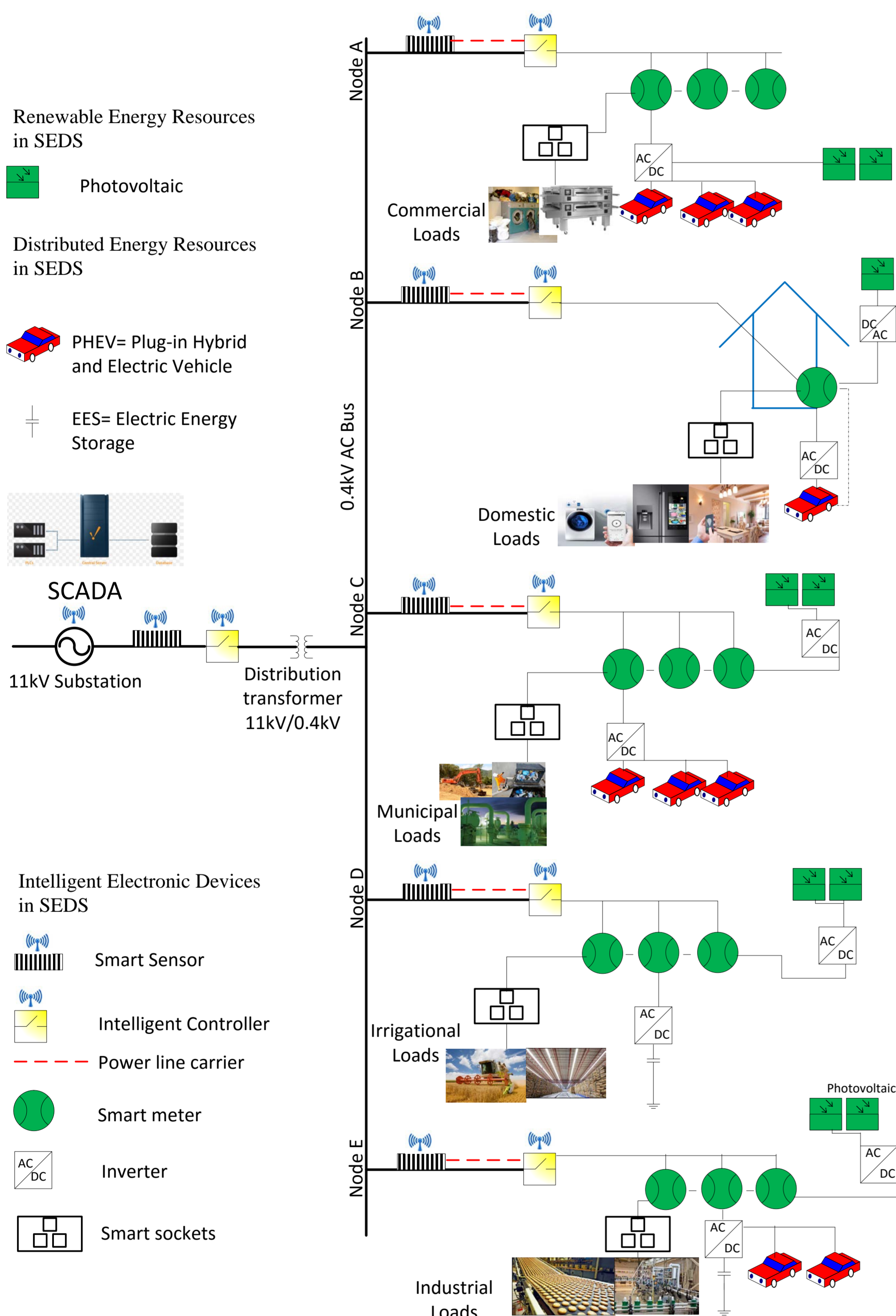
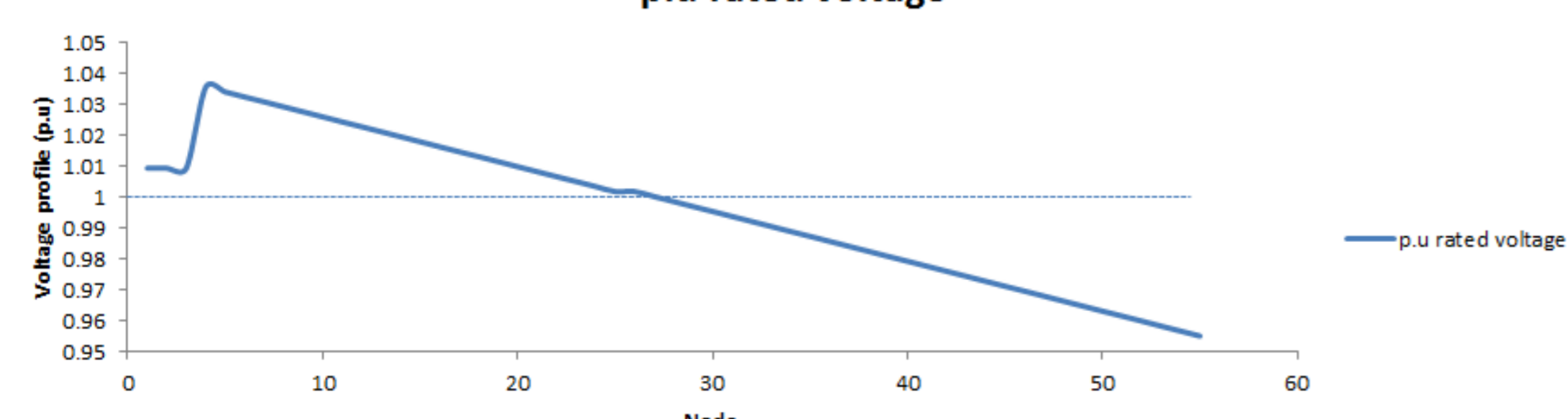


Figure 1: Proposed SEDS with 55 load points (Node A-E, each node contains 11 load points)

Benefits of Smart Electric Distribution System:

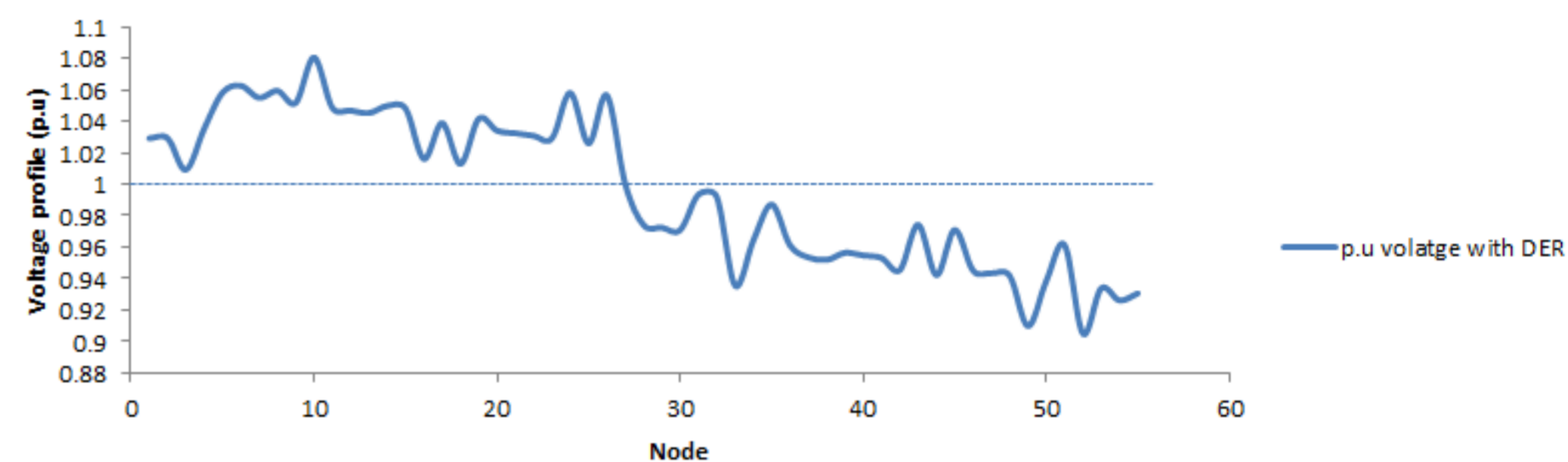
- Sustainable, affordable and secure green energy for the next generation
- Improved reliability
- Power availability-demand balance
- Real-Time Pricing
- Customer motivation

p.u rated voltage



Due to economic considerations, Distributed Network Operator (DNO) limits radial feeder voltage with preferred levels ($230V \pm 10$) to satisfy Quality of Service (QoS) and Service Level Agreement (SLA) at customer meter terminals

p.u volatge with DER



Wide-scale integration of roof-mounted Photovoltaic solar panels, PHEV and EES result voltage rises and voltage variations on radial feeder which reduces lifespan of the plant and equipment, hence decreases reliability of the SEDS.

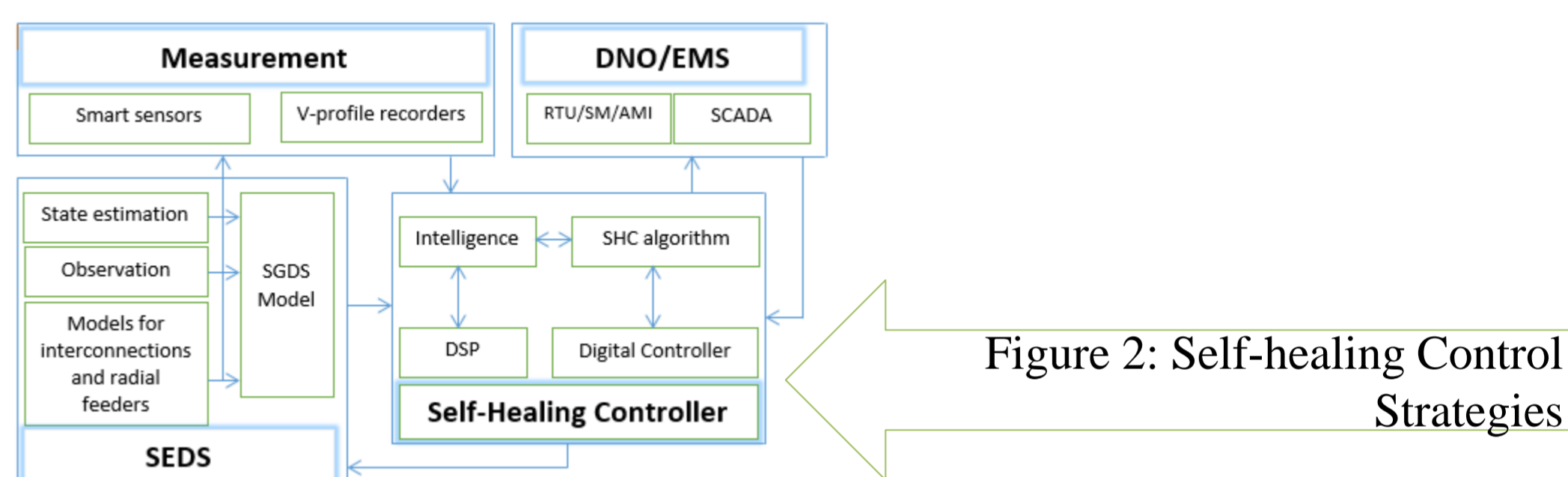
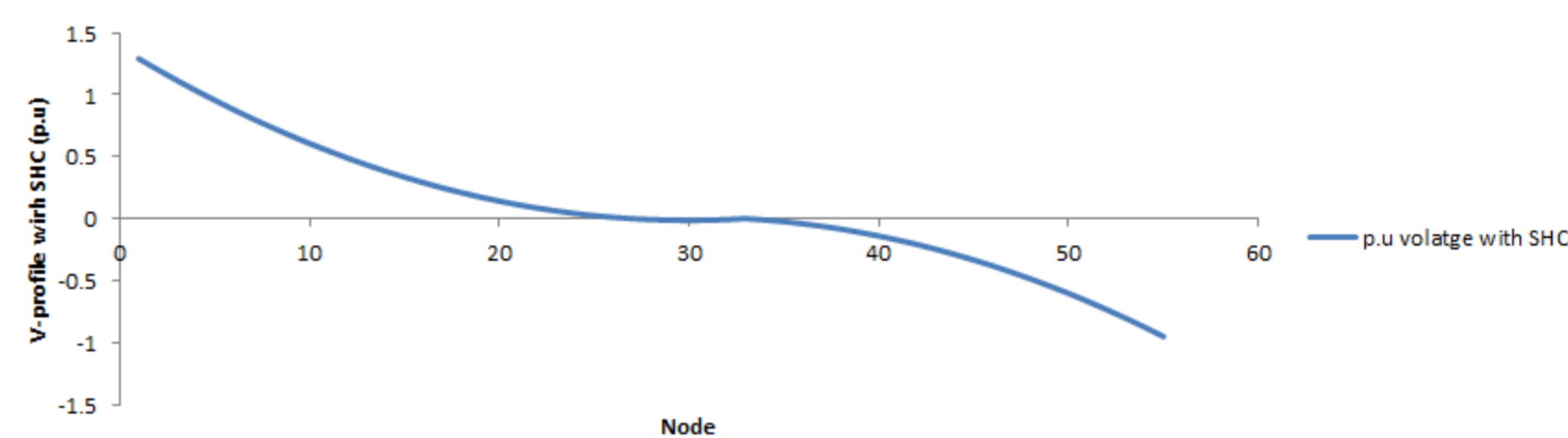


Figure 2: Self-healing Control Strategies

p.u volatge with SHC



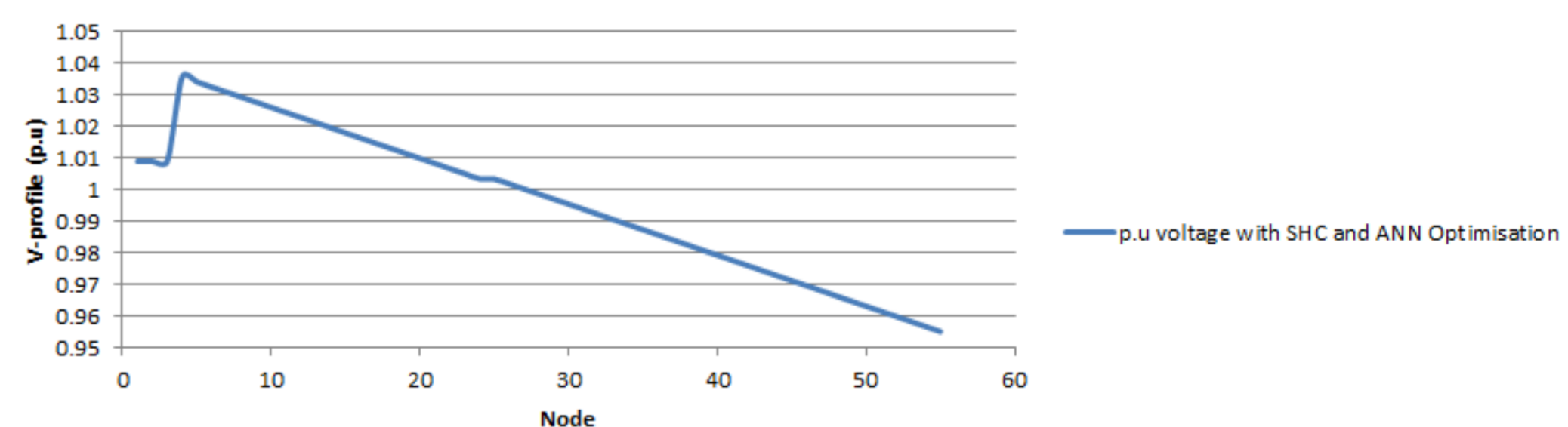
Self-Healing Control (SHC):

Self-Healing Voltage Control is an automatic voltage restoration technique for SEDS that-

- Incorporates with smart sensors and Supervisory Control and Data Acquisition (SCADA) to observe disturbances in real-time
- Spontaneously tunes system to control disturbances and uncertainties and
- Automatically restores voltage on radial feeder within the preferred limits during anomaly (e.g.: overvoltage, voltage fluctuations)

Self-Healing Control Algorithm seeks for RER and DER to satisfy demands to contribute to a sustainable green energy for the next generation power grid.

p.u voltage with SHC and ANN Optimisation



Self-Healing Control uses Artificial Neural Network (ANN) optimisation techniques to control node voltages and provide optimum voltage-profile, hence improve reliability as shown in figure above.

Conclusions / Future Work:

Self-Healing Control improves reliability and contribute to a sustainable, affordable and secure green energy for the next generation power grid. The Self-Healing Control Algorithm will be formulated in future in order to evaluate feasibility of Self-Healing Control for Smart Electric Distribution System in the real fields.

References:

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