Providing Differentiated Level of Reliability: Technology Options and Investment Decision

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Motivation

- Currently, distribution utility generally provides the same minimal basic level of reliability to all customers.
- With advances in control, communication, and sensing technology, it has become both technically and economically feasible to provide consumers with differentiated level of reliability.
- This poster presents a methodology to use DGs, sectionalizing switches (Normally Closed Switches: NCSs) and tie switches (Normally Open Switches: NOSs) to optimally reconfigure the system in order to provide reliability options to customers.
- A general framework for assessing the optimal level of investment for such technologies is also discussed

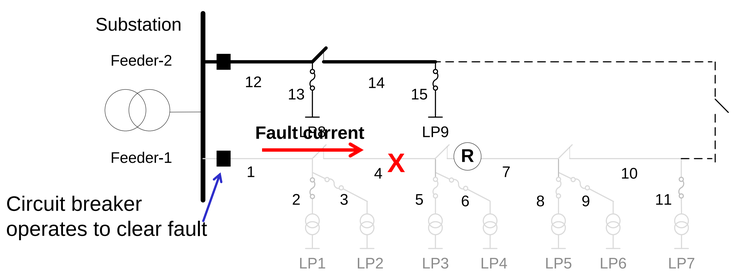
Creating Reliability Choices

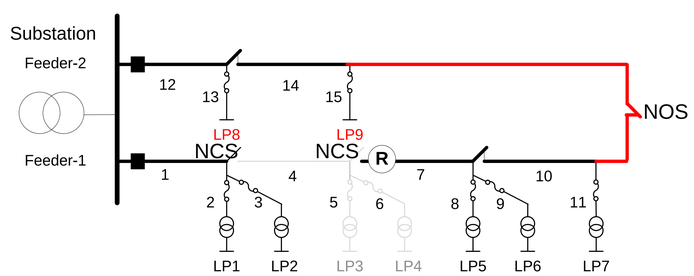
Tools for creating reliability choices

- **NCSs/NOSs:** reconfigure the system
- **DG:** as power back-up when losing all substations

Reconfiguration options

- A configuration such that supplies power to as many customers as possible when **power supply is sufficient for all customers.**
- A configuration that distributes power to priority customers when **DG is the only power supply.**





Optimal Configuration

- The algorithm attempts to **minimize the total liability cost the entire distribution system when a fault occurs for one hour**

$$\min \sum_{i=1}^{No.\ of\ Load\ Point} Liability\ Cost_i \times P_{not\ supplied,i}$$

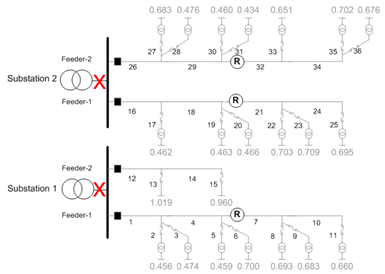
- Amount of demand (MW) served

$$\sum_{i=1}^{No.of\ Load\ Point} P_{supplied,i} \leq P_{DG}$$

- Also subjects to feasible configuration of distribution networks

Faults at Both Substations

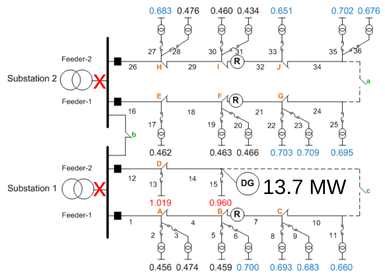
Base case (No NCSs, NOSs and DG)



Type of customers	Liability cost/MW
Small user	$0
Large user	$2
Industrial	$21

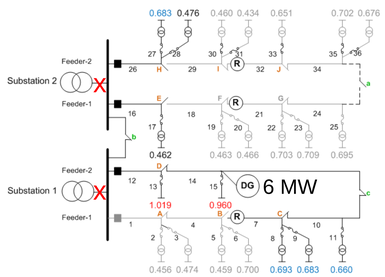
In-Su Bae; Jin-O Kim; Jae-Chul Kim; Singh, C. Optimal operating strategy for distributed generation considering hourly reliability worth. I*EEE Transactions on Power Systems*, 2004

Sufficient capacity of DG for all customers



Fault occurs in 1 hr	Base case	Sufficient DG	Limit DG
Total of liability cost	$56.5	$0	$9.7

Limit capacity of DG

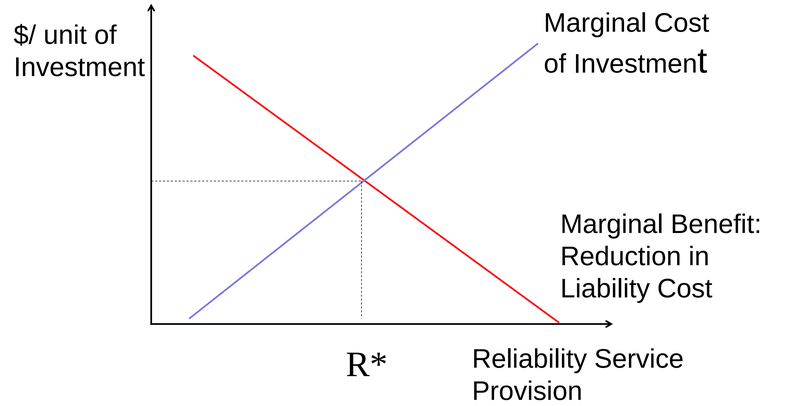


Investment Decision

Optimal level of investment in technologies to provide differentiated level of reliability from a utility's perspective is where:

Long Run Marginal Cost of Providing Reliability Services = **Marginal Liability Cost Reduced by the Provision of Reliability Service**

Since operating cost of these technologies is likely to be very small compared to the capital cost, we can assume that the long run marginal cost of providing reliability services is **the marginal cost of investment.**



Investment Decision Making Framework:

Technology suppliers determine supply schedules by profit maximization **(to allow the utility to determine the cost of investment)**

Utility determines marginal benefit curve of providing reliability services by minimizing liability cost (**As implemented by the optimal configuration algorithm**)

Utility determines optimal level of investment by cost minimization (**As shown in the graph above**)

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