BEST RECLOSER FOR DISTRIBUTION NETWORKS

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Background

The Pacific Island nations have relied on diesel generation and coal for decades; however, many countries are now turning to solar energy and other renewables to increase generation and reduce their carbon emissions. Integrating different energy sources and creating decentralized distribution networks bring new challenges to these systems.

Having multiple generation feeds in a distribution network requires close monitoring to ensure reliability. The equipment used to monitor the network must provide protection while keeping workers safe, enhancing service reliability, and maintaining cost-effectiveness.

Fault Protection in Distributed Generation Networks

Due to urbanization and energy demand growing, power distribution companies are moving from centralized and conventional networks to decentralized networks requiring advanced control systems, distribution components, voltage and current sensors, reclosers, switchgears, and software to monitor the network. These systems improve reliability by detecting faults, identifying the fault location, and restoring power quickly.

Faults in distribution networks are caused by various factors such as increased demand, environment, animals, and weather. The duration of these outages varies depending on the cause and location of the fault. Locating the fault is crucial for resolving the issue and restoring power.

More distributed generation can add additional fault current to the system and change the fault levels detected by relay protective devices. It is important to ensure equipment is sized to handle this additional fault current. Additionally, adjustments to pick-up current, time delay, and trip current values may be needed to enable the fast curve to be utilized to meet specific distribution system needs, enabling efficient fault detection and restoration.

Distributed generation also presents other considerations for fault current level in distribution feeder protection. Some of these topics are presented below.

- **Reverse Power Flow**: Fluctuations in fault current can cause power to flow in unintended directions, requiring protection schemes to account for reverse power flow to ensure proper coordination.
- **False Tripping**: Variations in fault current can lead to false tripping, where protective devices interrupt power unnecessarily. Protection settings should be carefully adjusted to prevent false tripping while maintaining effective fault detection.
- **Blind Areas**: Changes in fault current can create blind areas where fault detection and localization become challenging, potentially delaying isolation and restoration efforts.
- **Islanding**: Fault current fluctuations can contribute to islanding, where a portion of the distribution system becomes electrically isolated. This poses safety risks and increases power restoration time.

- **Non-Synchronized Reclosing**: Fault current level changes can disrupt the synchronization of reclosing operations, impacting restoration attempts and potentially causing further damage.

Additionally, multiple ground current paths can cause grounding problems, resulting in uneven fault current distribution and challenges in fault detection and mitigation. Proper grounding design and coordination are essential for a safe and reliable electrical distribution system.

Distributed Generation and Radial Network Protection Systems

In the context of integrated distributed generation and radial networks, the accurate coordination of the recloser and fuse becomes an even greater challenge. In a radial network, it is crucial to ensure precise timing between the operation of the fuse and the recloser. Specifically, during the occurrence of a fault current, the recloser should detect the fault before the fuse after the recloser's fast curve but before its slow curve. When a fuse is combined with a recloser there is a risk that the fuse senses the fault current first and triggers prior to the recloser. When a distributed generation network is connected to a radial distribution feeder, this coordination between the fuse and recloser may be disrupted. This can be attributed to several factors:

- The fault current detected by the fuse may exceed that detected by the recloser, causing the fuse to operate before the recloser.
- False tripping may occur, wherein the protective devices trip due to a transient fault rather than a permanent fault.

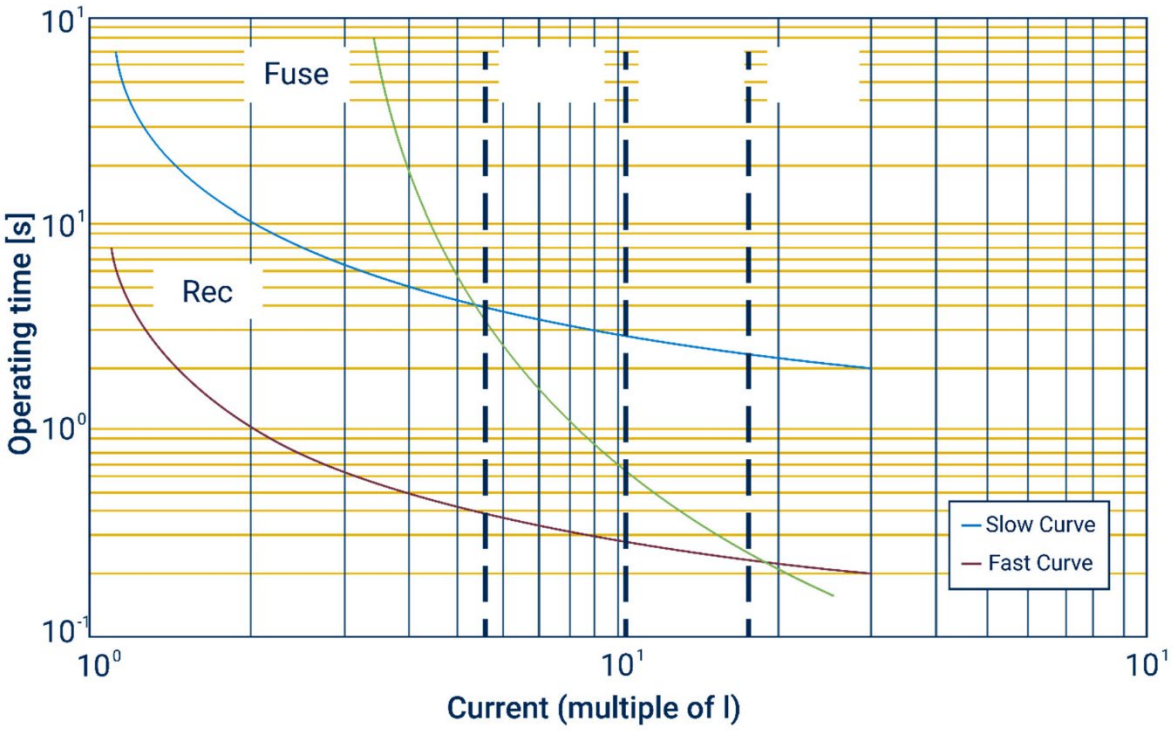


Fig. 1 – Fuse and recloser coordination curves

These factors contribute to the complexity and potential difficulties faced when integrating distributed generation into radial networks, particularly with regard to maintaining accurate fuse-recloser coordination.

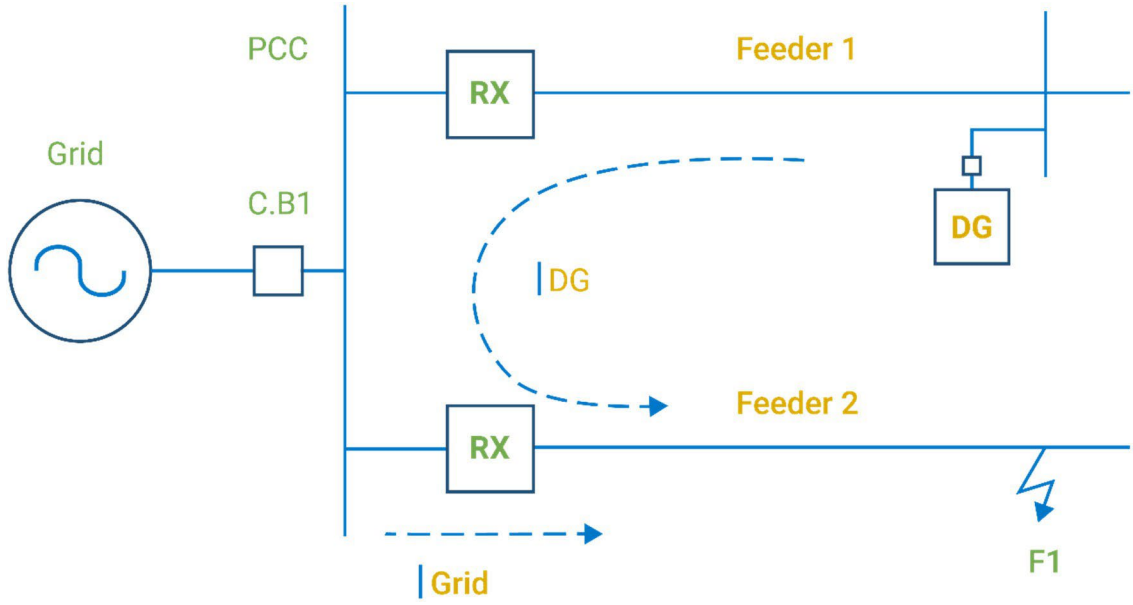


Fig. 2 – Example of possible false tripping due to a fault on another feeder

The integration of distributed generation with a radial feeder disrupts traditional protection coordination. Distributed generation introduces bi-directional power flow, impacting the coordination of protection devices and creating blind spots. It also decreases network stability and reliability, requiring changes in topology and protection arrangements. This process is complex, tedious, and expensive. Advanced protection schemes and technologies are necessary to address these challenges and ensure reliable power system operation.

Recommended Solutions

For Pacific Island nations with small and simple distribution networks, many solutions are too complicated and costly. These nations need affordable, low-maintenance equipment that is proven and reliable.

One effective and affordable solution is utilizing modern reclosers to cover blind spots and improve protection in distribution networks with distributed generation. Extensive research and simulations have shown that strategically placing reclosers along feeders can enhance network reliability by addressing blind spots.

Modern reclosers offer faster operation compared to substation mounted over-current relays, making them an ideal choice for improving network protection.

Recommended Solution – Technical Considerations

Reclosers have two main functions: providing over-current protection and ensuring reliability. Additionally, they have the capability to trip and reclose, effectively handling temporary faults. In traditional radial feeders, reclosers are designed to detect unidirectional current flow.

However, the integration of distributed generation in radial feeders alters the fault point impedance, necessitating the optimal placement of reclosers and adjustment of their settings.

Research findings indicate that as fault point impedance increases, the operating time of the protective relay also increases, leading to a blind area for the substation over-current relay. In contrast, the recloser's curve setting enables it to close faster than the feeder's over-current relay curve, allowing the recloser to operate more quickly. As a result, the recloser provides protection in areas that may be invisible to the substation's over-current relays. Furthermore, the recloser enhances feeder reliability by significantly reducing total outages.

Selecting the Right Recloser

Considering the requirements and pricing for radial feeders, most reclosers are designed for larger networks with SCADA integration. However, one standout option that satisfies the basic requirements, technical capabilities, and economic value is the Teros® recloser by G&W Electric.

The Teros recloser features a simplified mechanism with integrated sensors, making it ideal for distribution automation applications. Its modular platform enables quick and easy servicing. Additional benefits include a viewing window for clear visibility of the indicator, integration of 6 voltage sensors for site readiness, a modular layout for efficient servicing, standardized higher creepage modules, and a sealed mechanism for reduced damage risk.

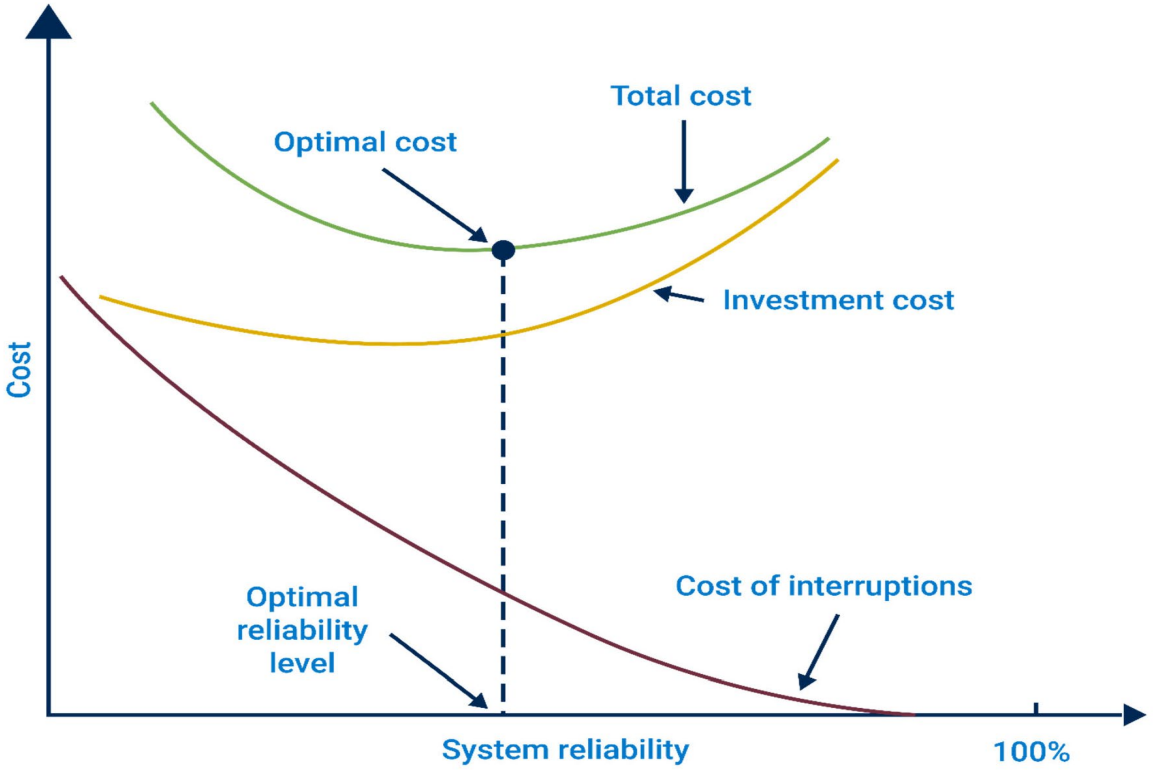
The Teros recloser offers high-speed clearing of temporary faults and radial overcurrent protection. It also enables enhanced reliability through sectionalizing and load break switching and is ideal for open tie points. The system can be seamlessly integrated with the controller through reconfiguration, automatic transfers, and compatibility with GE R650 or Ingeteam INGEPAC™ DA PT5 relay controls. Moreover, it offers mounting options for alley-arm, cross-arm, or substation installations.

Teros Recloser Offers the Best Economic Value

A power distribution company must carefully manage its investment in the distribution network while ensuring system reliability and customer satisfaction. Finding the right balance between costs and benefits is crucial for optimal performance.

To achieve the best investment in protecting a radial feeder, it is recommended to install a recloser at the midpoint of the feeder if the load is uniformly distributed. This placement would result in an approximate 50% improvement in reliability for customers located upstream from the recloser. Similarly, if two reclosers are installed, they should be positioned at one-third and two-thirds of the feeder length for optimal investment.

Fig. 4 – Cost versus system reliability



Finding this balance can be challenging, especially when dealing with multiple reclosers. However, the Teros recloser stands out in the market as it offers an economical solution without compromising performance. Compared to its larger counterparts, the Teros recloser provides equal or even better reliability at an affordable price. In essence, the Teros recloser ensures the highest level of reliability at minimal cost, making it an excellent choice for power companies.

Tonga Power Limited – Case Study

Tonga Power Limited (TPL) has a generating capacity that consists of 13.8 MW of diesel, 6.3 MW of solar, and 1.375 MW of wind. In approximately 2 months' time, solar is planned to be 10.3 MW excluding the small distributed generation (rooftop solar). This presents a significant uptake of distributed generation. TPL's overhead distribution network has approx. 200 km of 11kV lines, 250 km of 6.6 kV, and 600 km of LV.

TPL is fully aware of potential issues with the high penetration of solar and wind in their distribution network, including blind spots for feeder protection. They also have environmental challenges like including sea spray, vegetation, and seasonal storms that badly affect the reliability of the already stressed network.

TPL was looking for a cost-effective and reliable solution. After a careful investigation, they took a new approach to the protection of blind spots in their network.

TPL is in the process of implementing a new protection scheme in parts of its distribution network that are interconnected with distributed generation (solar and wind), as follows:

- A complete review, re-modeling, and update of the network topology and protection schemes
- Introduction of Teros reclosers
- Introduction of sets of Smart FIDs (Fault Isolation Device)

Conclusion

For power generation companies like TPL, the Teros recloser is a cost-effective device that offers many benefits. The Teros recloser is a three-phase gang-operated 15 and 27 kV recloser that offers power generation companies responsible for electric distribution systems the perfect combination of durability and affordability for overcurrent protection. Built to be a modular, turnkey solution, the Teros recloser is a reliable and cost-efficient way to improve system reliability and grid resiliency.

About G&W

Since 1905, G&W Electric has been a leading provider of innovative power grid solutions, including the latest in load and fault interrupting switches, reclosers, sensors, system protection equipment, power grid automation and transmission and distribution cable terminations, joints and other cable accessories. G&W Electric is headquartered in Bolingbrook, Illinois, U.S.A., with manufacturing facilities and sales support in more than 100 countries, including Canada, Italy, China, Mexico, Brazil, India, UAE and Singapore. We help our customers meet their challenges and gain a competitive edge through a suite of advanced products and technical services.

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