

Canadian Biogas Conference

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Anti-Islanding Protection for Farm Biogas Generation

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ANF Energy Solutions

- DG grid connection specialists
- No project ownership
- Current projects

Biogas	21
Landfill Gas	2
Wind	25
PV	5
Small Hydro	3
River Turbine	1

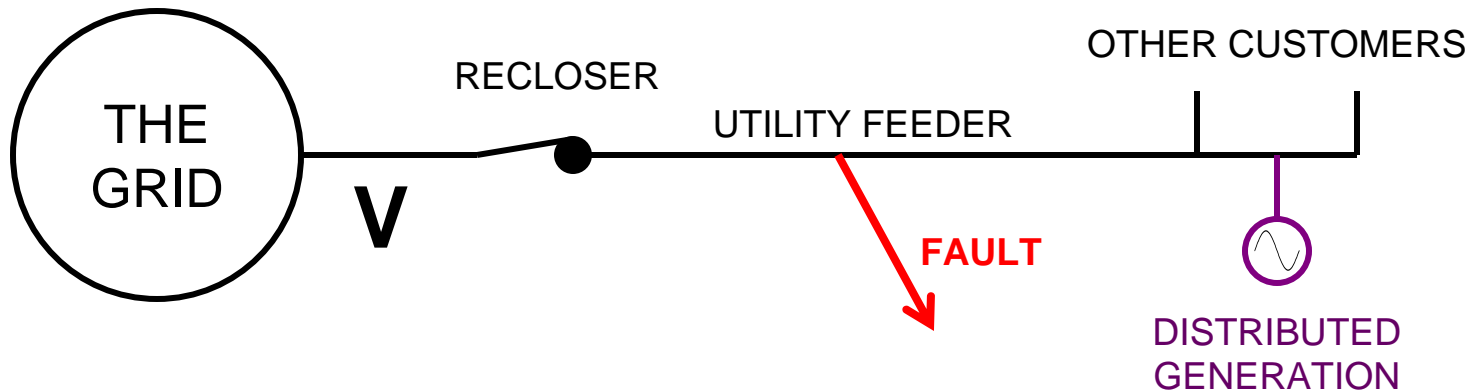
- Increasing involved in research

Anti-Islanding Protection

Anti-islanding protection has been a major barrier to the connection of small (<500kW) generation to rural feeders in Ontario.

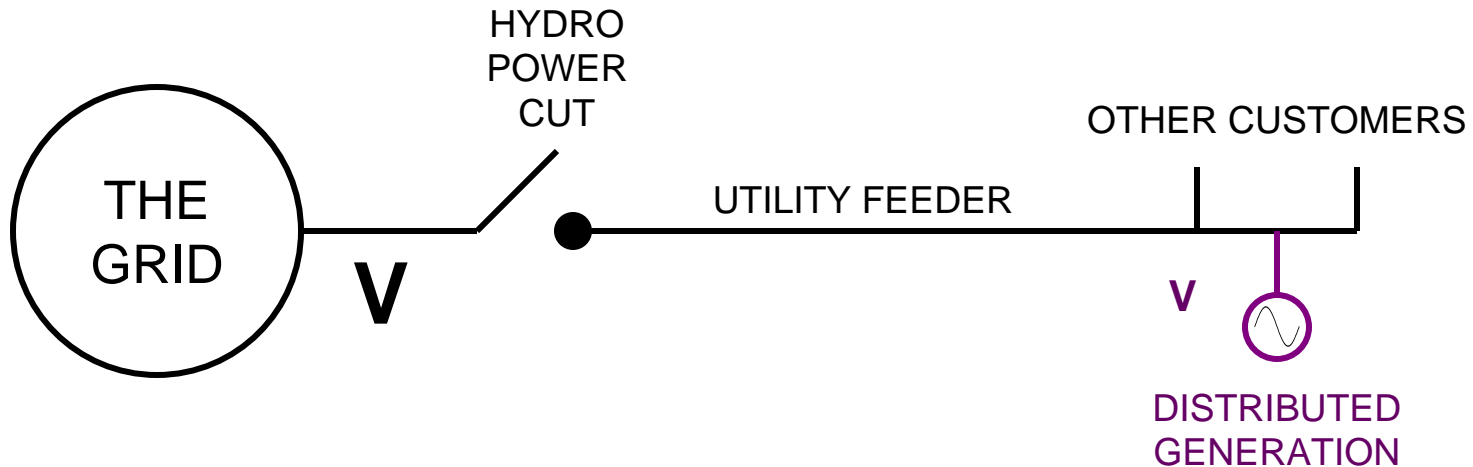
- For generation larger than 50% of the minimum load, the general utility requirement has been for **Fast Transfer Trip**.
- Cost of **Fast Transfer Trip** (\$125K-\$250K) can be a show stopper.

The Elephant and the Mouse (1)



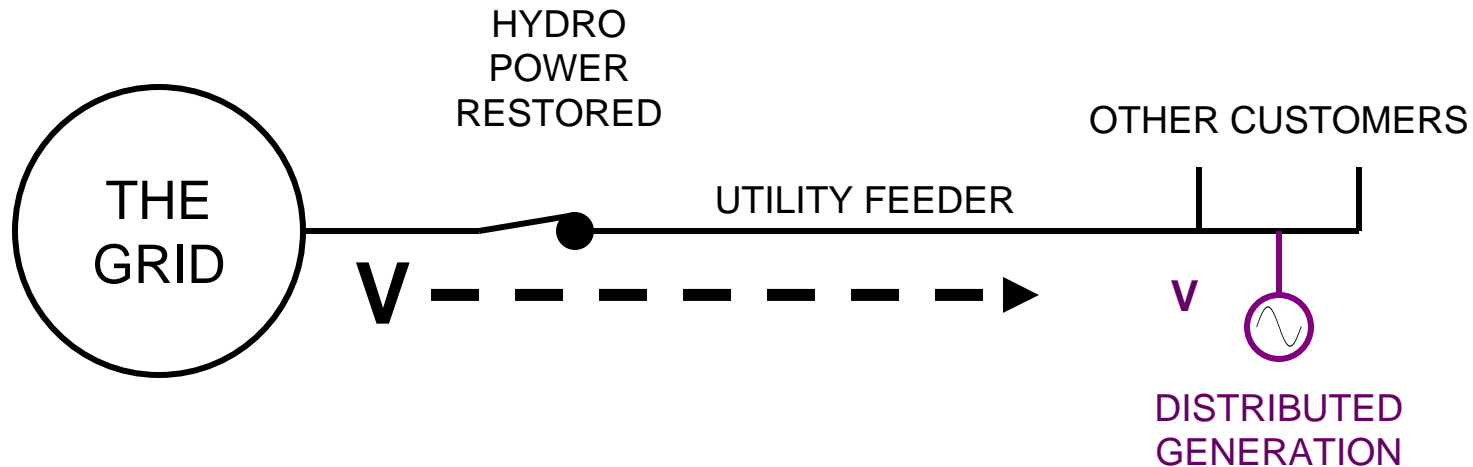
- Generation on feeder shared with other customers
- Recloser normally closed
- Recloser opens if there is a fault on the feeder

The Elephant and the Mouse (2)



- Feeder energized by your voltage
- Other customers supplied with your voltage
- Need to disconnect as fast as possible, **and before ...**

The Elephant and the Mouse (3)



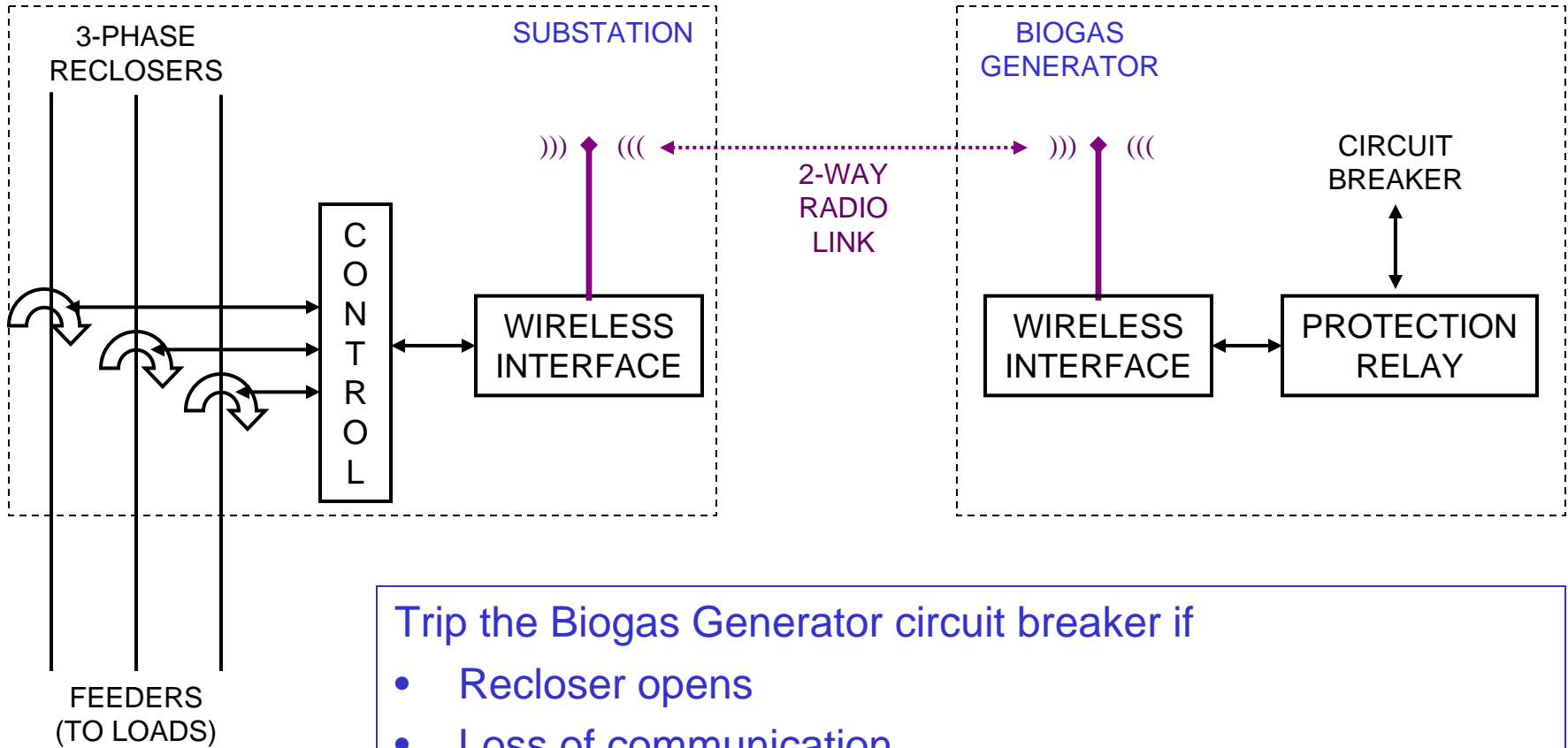
- Grid voltage wins over your voltage
- Grid voltage wave travels into feeder
- Risk of generator torque shock and other damage

The Single-phase Hydraulic Recloser



- Extensively deployed across Ontario
- On poles and in Distribution Stations
- Recloses in 1-2 seconds
- No status indication
- Unsuitable for **Fast Transfer Trip**

Fast Transfer Trip

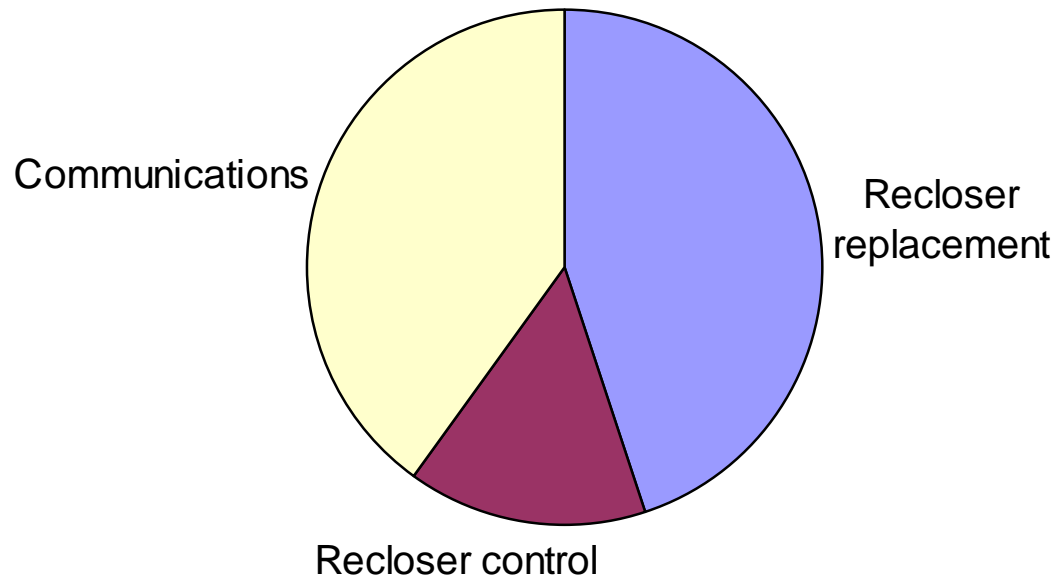


Trip the Biogas Generator circuit breaker if

- Recloser opens
- Loss of communication

Inhibit recloser closing until generator CB open is confirmed

Transfer-trip Indicative Cost Share



Fast Transfer Trip

- Cost of **Fast Transfer Trip** is independent of the project size, and is not proportionate with the scale of the potential damage.
- Main reason cited for **Fast Transfer Trip** is potential damage to generators from torque shock.
- The potential for damage is based on hydro generators, which have high inertia and long shafts. Biogas engines are low inertia with short shafts.

Protection Standards

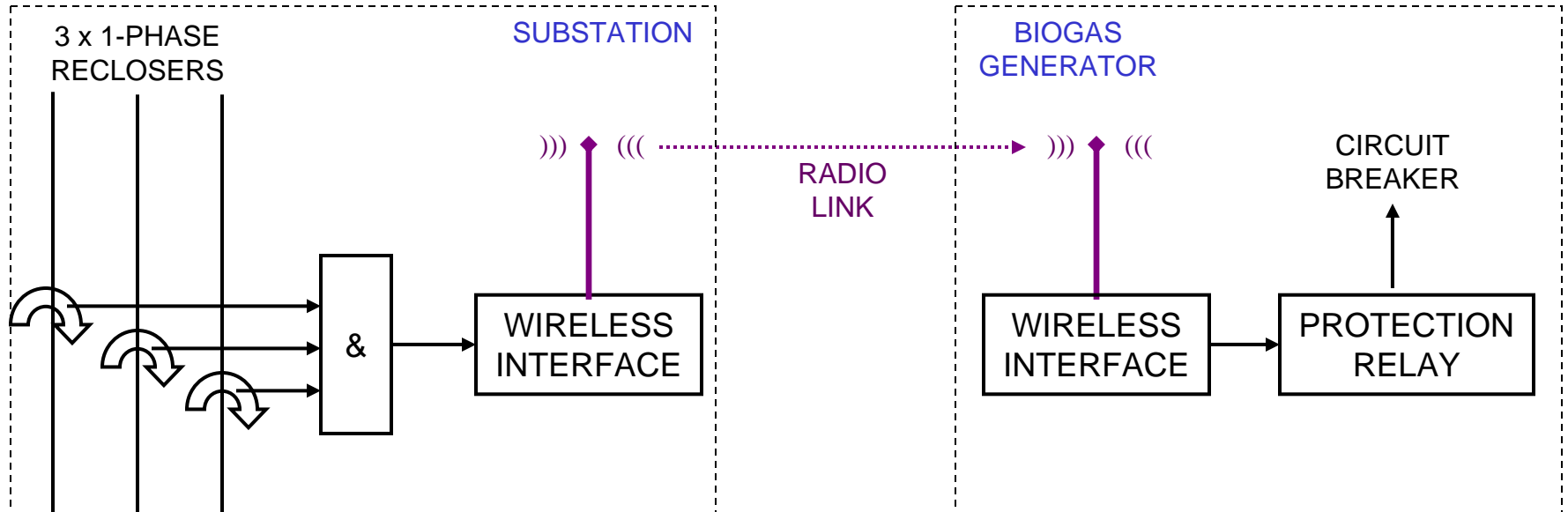
<50% Minimum Feeder Load	Local U/O frequency Local U/O voltage	
>50% Minimum Feeder Load	Fast Transfer Trip : \$125k - \$250k Show stopper for small DG!	
	Current North American Standards	Local Utility Requirement
Disconnect time	< 2 sec. (IEEE, CSA)	Varies, but can be < 1 sec.

- Opportunity to propose alternatives to Hydro One

Anti-Islanding Protection Ideas

Conventional Transfer Trip	Requires recloser status & communications Too expensive (~\$150K-\$250K)
Uni-directional Transfer Trip	Requires recloser status & communications
Under-current Transfer Trip	Requires communications Nuisance tripping risk
Moving/bypassing reclosers	Limited opportunity
Increasing reclose times	Requires new recloser
Recloser voltage blocking	Requires new recloser
Power-line Pulse	Under development & costly(?)
Reactive Power Export	Requires inductive feeder Applied at Terryland Farms
Multi-Local Strategy	Pilot at Fepro Farms

Uni-directional Transfer Trip



Trip the circuit breaker if

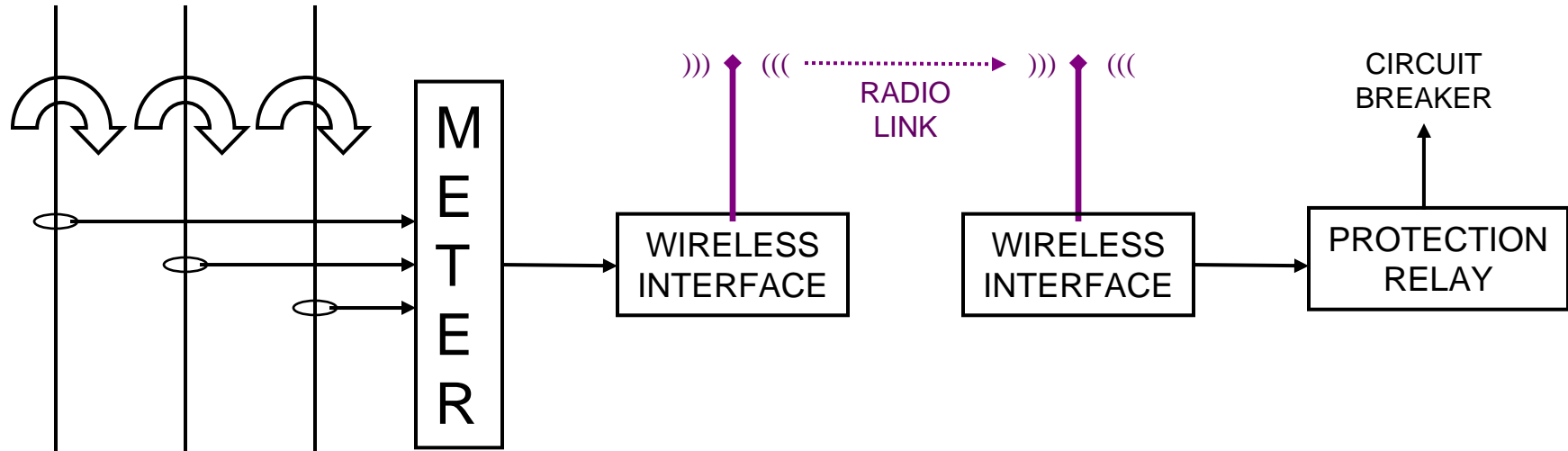
- Any recloser is open
- Loss of communication

REDUCES COST BY

- No recloser control
- Lower-cost communications
- **BUT requires recloser status**

Under-current Transfer Trip

3 x 1-PHASE RECLOSERS



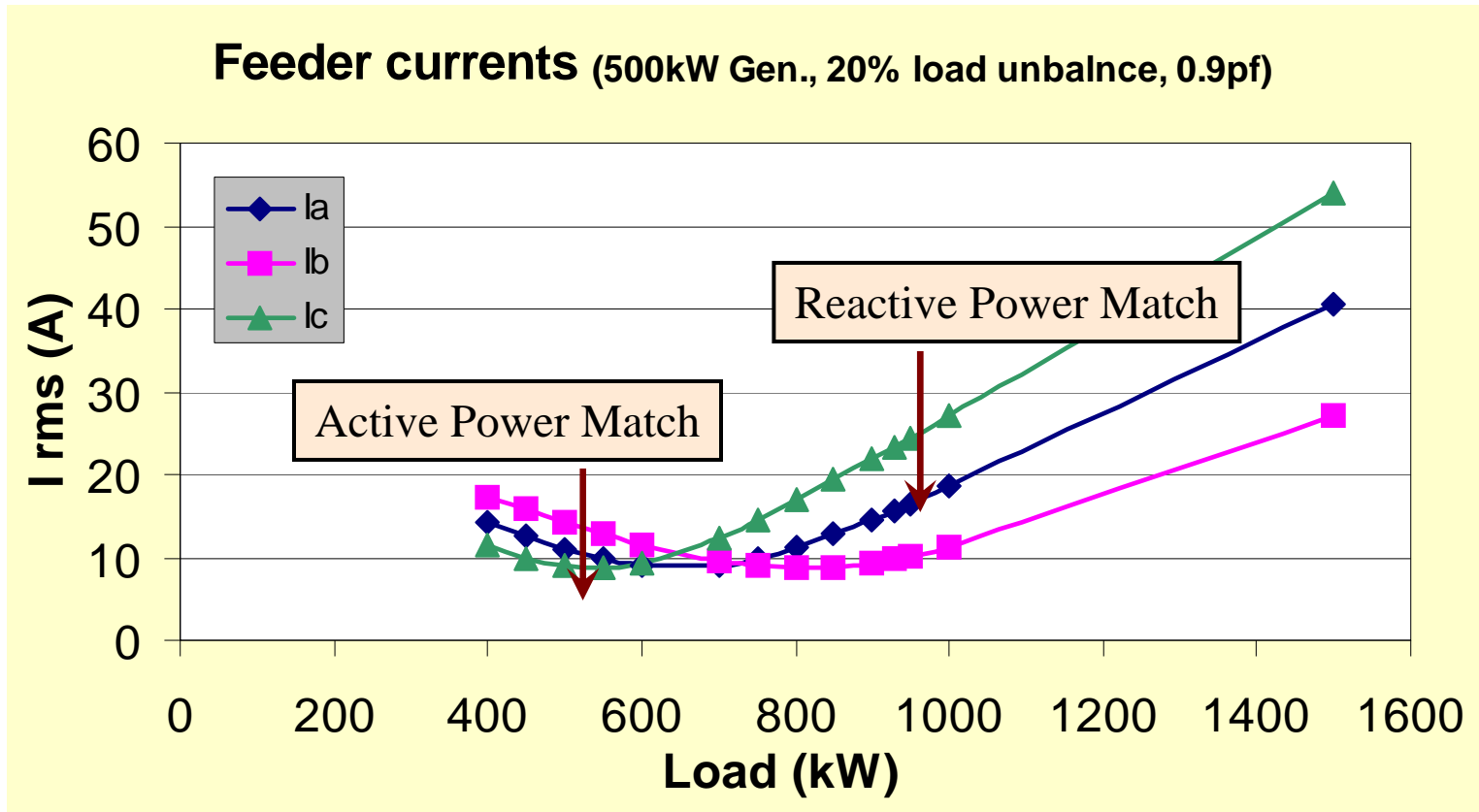
No requirement for recloser status

Trip the inter-tie breaker if

- Loss of communication
- Low current on **any** phase

Risk of nuisance tripping

Preliminary Simulation Results



Recloser Management



Moving/bypassing reclosers

- May enable generation to be < 50% feeder load
- May affect other consumers
- Only works in a few cases

Increasing reclose times

- Not possible with many existing reclosers
- May affect other consumers

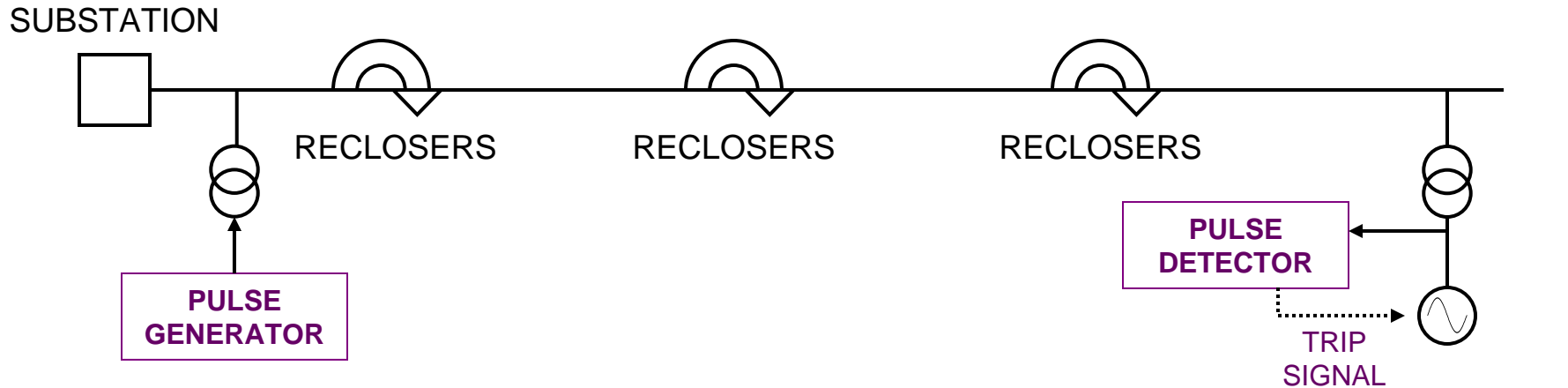
Recloser Voltage Blocking



Inhibit reclosing if voltage on DG side of recloser

- **No requirements for communications**
- **Requires voltage sensing – recloser replacement**

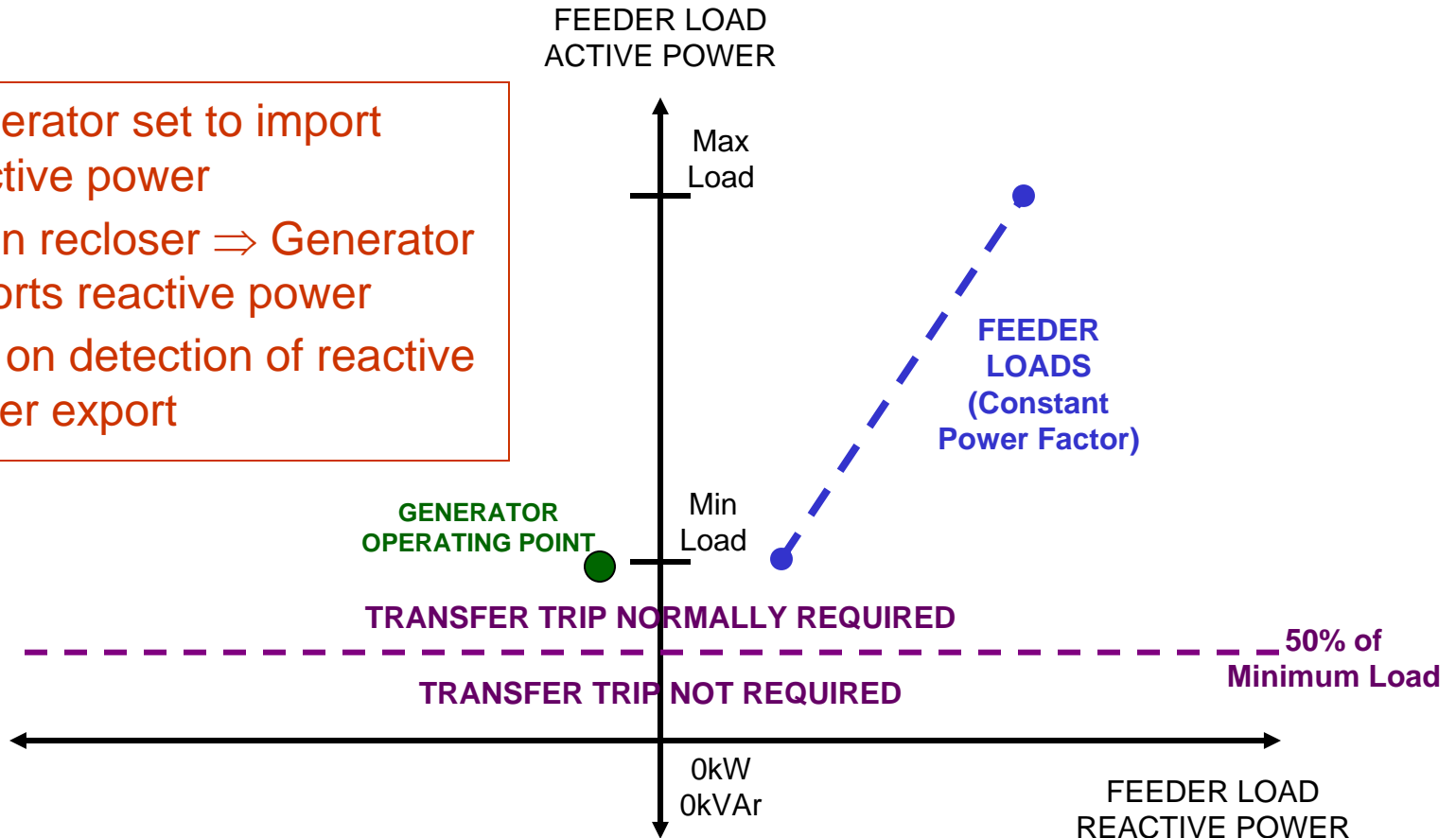
Power-Line Pulse



- Trip if loss of pulse signal from substation
- Being developed by the University of Alberta
- No requirement for recloser status or communications
- Applicable to several reclosers in series
- Requires pulse generator in substation (\$\$)

Reactive Power Export Protection

- Generator set to import reactive power
- Open recloser \Rightarrow Generator exports reactive power
- Trip on detection of reactive power export



Terryland Farm 180kW Biogas



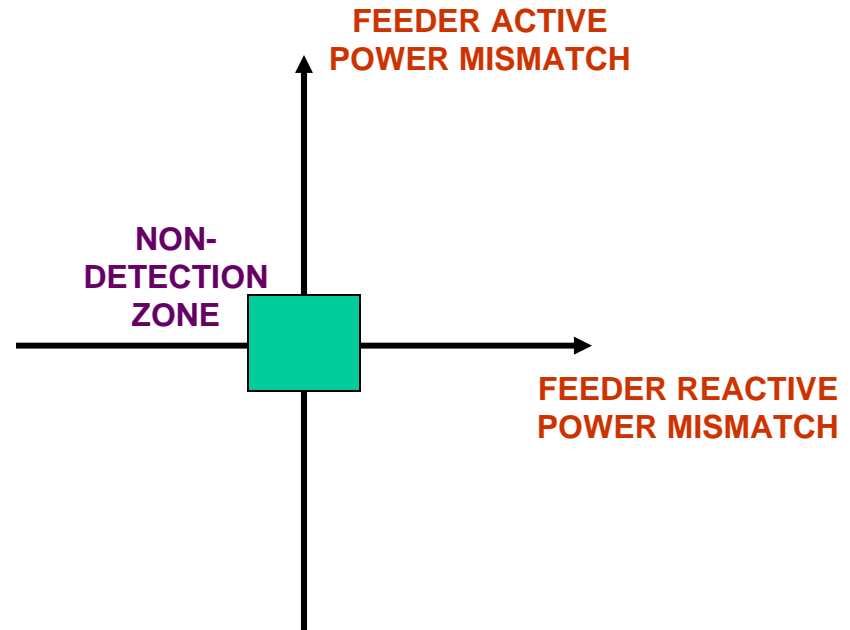
- Anti-islanding strategy utilising Reactive Power Export Protection
- On-site tests March 2007
- Met the trip time requirement.
- Accepted by the utility
- Only applicable to feeders with inductive load characteristics, and with some risk of nuisance trips from motor starting
- **Avoided the cost of Fast Transfer Trip**

Multi-Local Strategy

1. Fast feeder protection – detect the fault that would lead to recloser opening
 2. Feeder open-phase detection – detect 1 or 2 reclosers open – pre-island condition
 3. Suite of passive anti-islanding protections
- Protections available in many existing protection relays – very low cost

Passive Anti-Islanding Protections

- Covers u/o frequency, u/o voltage, power export, **ROCOF, Vector Shift**
- All passive methods have a non-detection zone
- Utilize sensitive settings to make the non-detection zone small, but avoid nuisance trips



Non-detection Risk

Fast Feeder Protection	If the fault lasts long enough for the recloser to open but not long enough for feeder protection to detect.
Open-phase Detection	Simultaneous 3-phase fault
Passive Anti-islanding	Active & reactive power match

Fepro Farms 499kW Biogas



- Multi-local Anti-islanding protection philosophy agreed with utility for pilot
- Commencing with sensitive settings
- 12-month monitoring

Future Research

