IEEE Standard 1547-2018
Clause 8: Islanding

Babak Enayati, PhD, PE

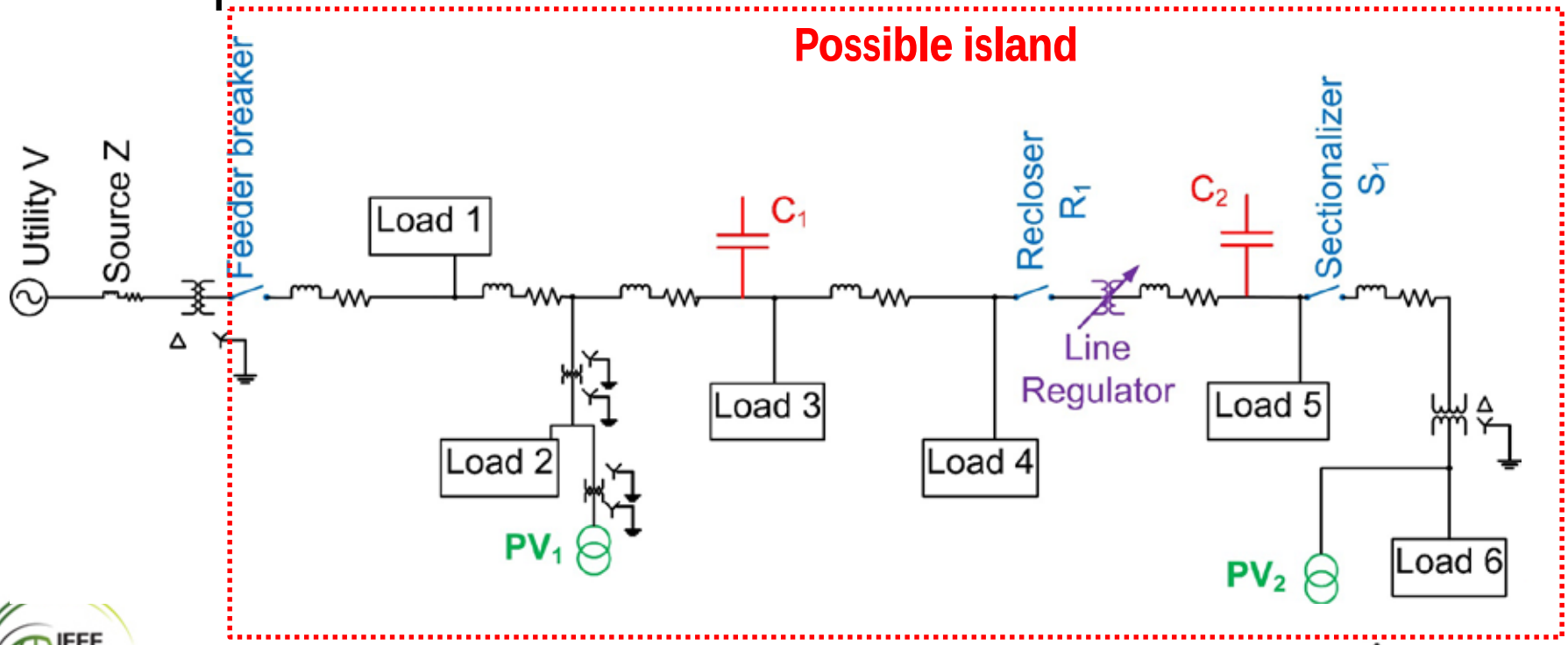
Lead Engineer, National Grid
Waltham, MA
Email: babak.enayati@nationalgrid.com
Office: 781-907-3242
August 22, 2018

Contents

- Islanding Background
- IEEE 1547-2003 on Islanding
- Major changes in IEEE 1547-2018 on Islanding
  - High DER Penetration Challenges
  - Intentional Islanding
  - Impact on Area EPS
- Utility benefits and challenges

What is an island?

- An electric power island is a section of a power system with its own sources and loads, so that it can self-power or “self-excite”.



Island terminology

- Intentional island: one that is planned, has a defined boundary, and has V/f regulation controls. Types:
  - Microgrid
  - Emergency/standby power supply
  - Island power system (as in, on an actual island)
  - Remote community grid
  - Military bases
  - Remote resource extraction operations
- Unintentional island: one that isn't planned and doesn't have V/f regulation control.

How can an unintentional island form?

- Two key things have to happen at once.
  - You have to have a close source-sink balance in the island in both real and reactive power.
  - You have to have a breaker, recloser etc. open, without a fault in the island. (If there is a fault, there's almost no way to get a source-sink balance in the island.)
- The likelihood of either one of these events is low; the likelihood of both happening in sequence is *very* low. So, an unintentional island is a very low-likelihood event.

Risks

- Unintentional islands pose the following risks:
  - Damage to equipment via asynchronous reclosure
  - Impediment to service restoration
  - Damage to equipment via uncontrolled voltage and frequency
  - Potential risk to human health and safety—people may be unaware that a line is energized from the customer side (line worker performing maintenance, “downed wire on a car” scenario)

Starting point: what IEEE 1547-2003 said

- On the subject of unintentional islanding:
  - Clause 4.1.5, “Inadvertent energization”: the DR shall not energize the Area EPS when the Area EPS is de-energized.
  - Clause 4.4.1, “Unintentional islanding”: it’s the responsibility of the DR to detect an unintentional island and trip offline within 2 s.
  - Clause 4.2.2, “Area EPS reclosing coordination”: the DR shall cease to energize the Area EPS prior to reclosure by the Area EPS, even if that reclosure is in less than 2 s.

Starting point: what IEEE 1547-2003 said

- On the subject of intentional islanding:
  - Clause 4.4.2, “Intentional islanding”: punted to a future revision.

4.4.2 Intentional islanding

This topic is under consideration for future revisions of this standard.

Major changes in the new revision: unintentional islanding

- Now Clause 8.1.
- The main change: There is a new, optional 5-s clearing time limit that can be used upon mutual agreement between the DER operator and the Area EPS operator.
  - Allows the use of novel islanding detection that may work better in high-pen cases but may need a bit more time to achieve sensitivity *and* selectivity.
- The default clearing time is still 2 s as it was in 1547-2003, so the default case is no change from the previous version.
- There is new *emphasis* placed on the recloser coordination clause, but not a new *requirement*.

New high-pen challenges

- Mixtures of different inverters—will they interact in such a way that degrades islanding detection? *(Initial indications: yes, they can.)*
- Ride-throughs—will requiring LVRT and L/HFRT degrade islanding detection? *(Initial indications: yes, a little bit, but not much.)*
- Mixtures of inverters and rotating machines—do these mess each other up? *(Initial indications: definitely yes.)*

Islanding detection methods

- Passive inverter-resident
- Active inverter-resident
- Non-inverter-resident
  - Communication-based
    - DTT
    - Synchrophasors
    - PLCP
  - System configuration changes
    - Capacitor toggling
    - Shorting switches

Intentional islands: what's in-scope?

An intentional island that contains any part of the Area EPS is in-scope.

Intentional island behavior at the PCC, and impacts on the Area EPS, are in-scope.

What happens "behind the meter" within a microgrid that does *not* include any Area EPS elements is out-of-scope.

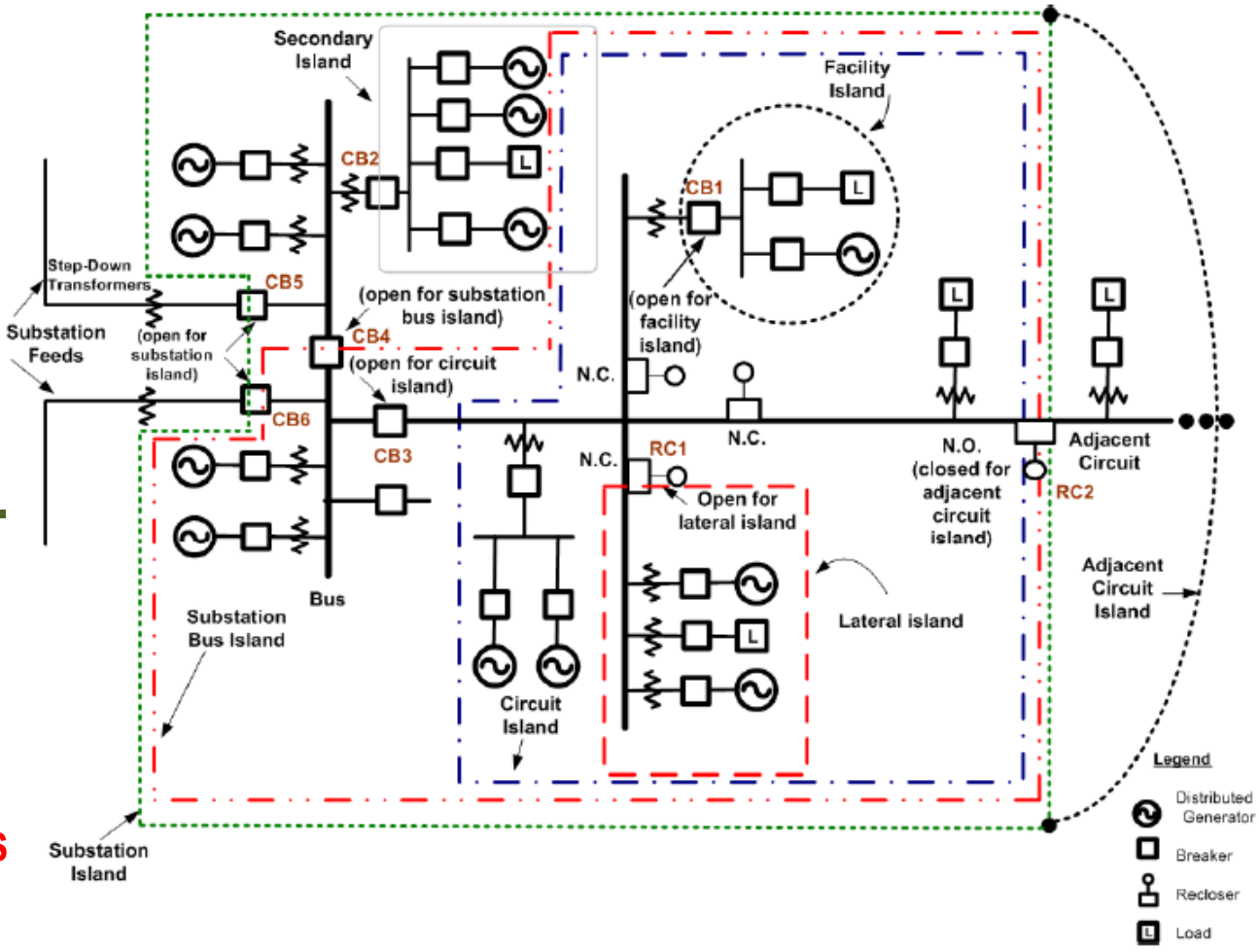


Figure C-1—Examples of DR island systems from IEEE Std 1547.4-2011

1547-2018 and intentional islands

- In this presentation, Intentional Island = II
- Two types of transitions into II mode (on-grid to off-grid): scheduled and unscheduled.
  - Scheduled: initiated by manual action or dispatch.
  - Unscheduled: automatically initiated due to abnormal Area EPS conditions.
- Power systems designated by the AHJ as Emergency, Legally Required, or Critical Operations are exempted.

When can an II leave the grid?

- When conditions are met that are mutually agreed-to by the Area EPS and DER operators;
- If any of the abnormal voltage or frequency trip conditions is met; or
- If an unintentional island is detected.

For these latter two cases, one may substitute entry into intentional island mode for tripping.

Limits on an II coming back onto the Area EPS

- An II can reconnect when the “return-to-service” requirements of Clause 4.10 are met (basically, the voltage and frequency are within defined limits).
- When the II reconnects, the requirements of Clause 4.10.4 (“synchronization”, which defines how well synched to the grid the II must be in both voltage and frequency).

Changes to relay settings in II mode

- You're allowed to reduce the threshold and lengthen the time for OV2.
- You're allowed to greatly lengthen the time limits on frequency trips OF1 and UF1 (range of adjustability goes up to 1000 s).
- The ranges of adjustability for the frequency droop gain are made wider.

DER categories for II use

- The standard defines four categories of DER for II use:
  - Uncategorized = not designed for off-grid operation at all. These are not allowed to energize an II.
  - II Capable: can disable anti-islanding, and meet all the settings adjustments requirements on the previous slide.
  - Black Start Capable: can energize an EPS that contains no other energy sources.
  - Isochronous Capable: Black Start Capable, *and* can regulate V and f in an EPS that does contain other sources.

Utility benefits and challenges

Top benefits:

- Improved reliability indices i. e. rural loads with no backup feeds
- Decarbonized generation footprint

Top challenges:

- Ownership and permitting
- Line crew safety
- Cost- communication infrastructure, etc
- Low fault current for inerter based generation

Babak Enayati, National Grid, babak.enayati@nationalgrid.com

THANK YOU