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REMARKS ON POWER SYSTEM RESTORATION IN OPEN ELECTRICITY MARKETS

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System operator responsibility in power system restoration in open electricity markets

Base knowledge for system restoration

- Size and extension of the black-out zone
- Amount of generation provided with black-start capability
- Location of generation provided with black-start capability
- Amount, location and dynamic nature of load

Planning phase

- Qualification of operators for supplying different services
- Definition of areas of influence of each operator
- Definition of contractual requirements
- Definition of supply priorities

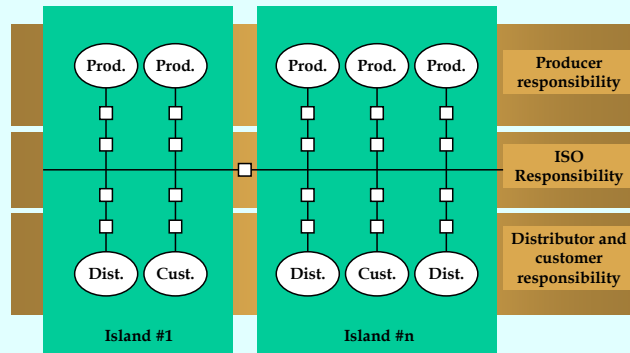
Operational phase

- Recognition of black-out extension
- Breakers set up to arrange restoration islands
- Respect of contractual agreements by engaged operators
- Build up of restoration islands
- Interconnection of restored islands

Qualification of generating unit

- Autonomous start up
- No load performance
- Connection energisation capability
- Cold load pick up response
- Regulation facilities in isolated operation
- Ramping rates versus power generation

Influence areas of operators



Contractual requirements

- Contracts **ISO - producers** procuring black start capability
- Contracts **ISO - distributors** on load availability
- Contracts **ISO - final users** on expected time for recovery and related penalties

Power plants

Hydro power plants

- Quick start with limited required power
- Flexible response to network contingencies
- Insufficient dynamic characteristics of standard speed governor and fluid admission valves
- Additional regulation channels required

Geothermal plants

- Outstanding reliability and availability
- Improvement of unit emergency performance by advanced black start devices (SWVC)
- Possibility of separate feeding of auxiliaries during frequency and voltage crises

Steam units

- Black start up is a complex and dangerous procedure
- Load rejection becomes a usual last resort
- Interest on load islands creation close to generation plants
- Need for combined configurations (e.g. repowering)

Cogeneration plants

- Promising black start sources since located in industrial areas
- Possible configuration for producers to provide restoration ancillary services
- Concern about parallel black out effects on thermal and electric users

Open cycle gas turbine

- Reduced amount of the sized power
- Limited duration of start up procedure
- Large inertia time constant
- Embedded regulation facilities
- highly recommendable application

Combined cycle

- Extreme configuration flexibility in coping with various emergency conditions
- Multiple prime movers as “redundancy” to improve black start performance
- Need of exhaust by-pass system to decouple gas and steam cycles

Repowering

- Additional combustion turbines on existing steam unit
- Opposite of combined cycle solution
- Load rejection procedure to exploit component units’ characteristics
- Exhaust by-pass to exclude feedwater heater

Remarks

- Difficulties in autonomous start up force towards load rejection

- Protection tripping logic influences connection energisation capability

- Specific regulation equipments and prime mover limits affect cold load pick up