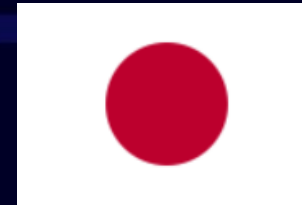


Paris Session 2022



Interconnection measures for small hydroelectric power generation facilities in low inertia systems

SC B5 PS1 Q1.05

Are there any changes to power swing characteristics in lower inertia grid which would prompt changes to power swing blocking or out of step tripping protection settings or schemes?

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Introduction

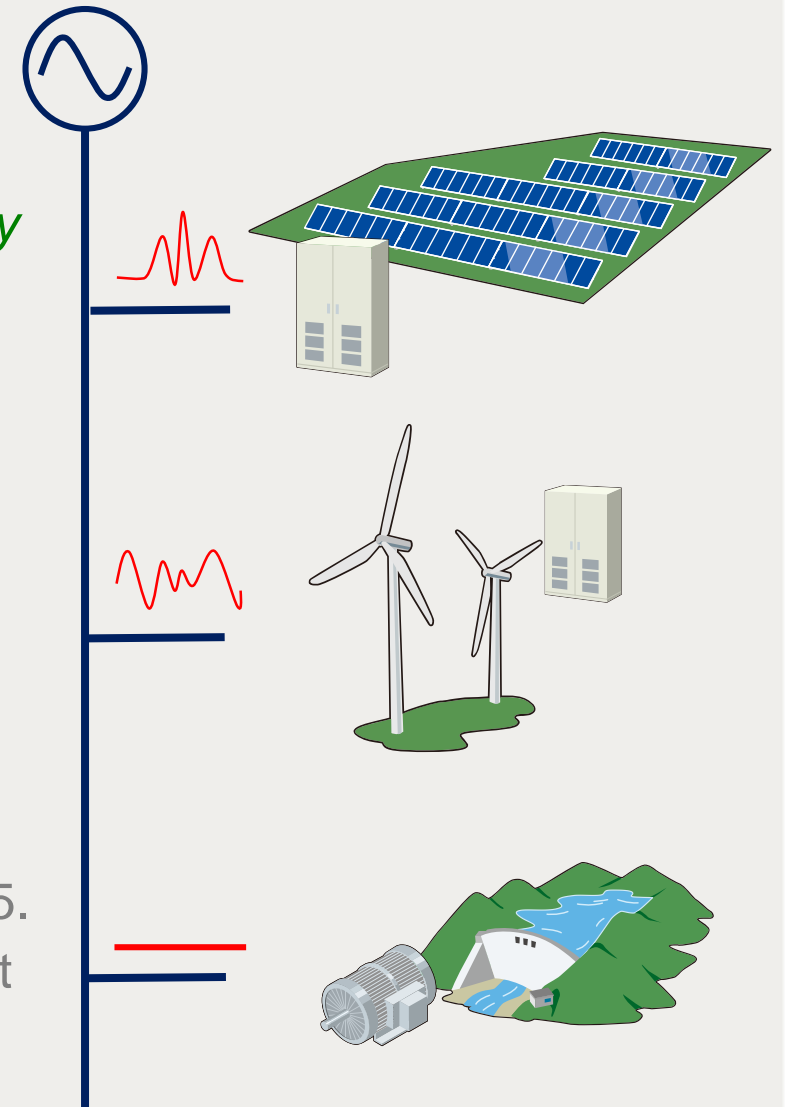
To achieve carbon neutrality, mass introduction of renewable energy is needed.

- **Photovoltaic and wind power generation** are the main ones among various renewable energies. However, most of them are **inverter-based and variable** sources.
- Increasing of those sources **reduces the inertia of the grid** and **increases fluctuations**.
- **Small hydroelectric generation** using synchronous generator is expected as a stable renewable energy with inertia.

Our experience

- Replacement of a small hydroelectric generation facility (Synchronous Generator, 60 Hz, 6.6 kV, 6.4 MW) installed in 1985.
- As a result of a grid interconnection consultation, it was found that **a generator equivalent to the existing one (Inertia constant, impedance, control device, etc.) could not ensure stability.**

Group Discussion Meeting



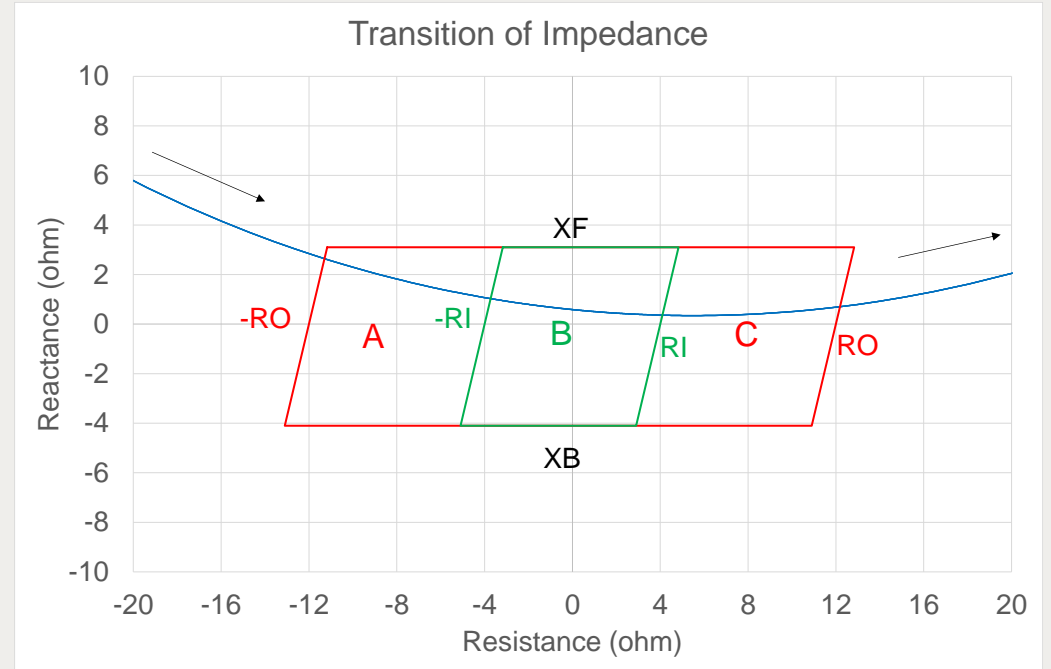
Measures for lower inertia

•As countermeasures against low inertia, countermeasures by main equipment and protection-control equipment were examined.

Measure	Main equipment	Protection-control device	
		Increase inertia constant 1.86s -> 4.5s	Overspeed relay (Rotation speed sensor)
System characteristics	Improve	No change in normal operation	
Limitation	Installation space Strength of foundation	Difficult to distinguish between generator failure and system failure	None
Cost	Expensive	Low	

Conclusion

- *Massive introduction of renewable energy causes reduction of the inertia of the grid.*
- *Small-hydro is expected as stable renewable energy with inertia.*
- *We experienced the effect of low inertia in replacement of.*
- *Three countermeasures were compared, and it was confirmed that the application of the step-out relay was desirable.*



Impedance transitions A -> B -> C in step-out.