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Power system technical performance

10273

Evaluation of the power system impact of retrofitted-power generation facilities based on the flexibility evaluation procedure

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Summary

- Renewable energy sources are variable energy output depending on natural environments such as sunrise, sunset time, and wind power, which are **difficult to predict, volatility of the power system is expected to increase**
- Considering the increase in renewable energy sources, it is **expected that a duck-curve net load** will appear as the required demand increases during the afternoon, when the output of PV among renewable energy sources decreases sharply
- Determination of flexibility, system stability and flexibility are secured by introducing a retrofitted thermal generator that has been converted from an existing thermal power generator to an area with insufficient flexibility

Introduction

- **Reduction of conventional generators**, which were responsible for the variability of renewable energy sources, will further **intensify the instability of the power system**
- The long-term system planning procedure considering the variability of renewable energy has not been established in detail, but as the renewable energy capacity has gradually increased, the detailed **long-term system planning** procedure **using the flexibility evaluation method** has recently started to be established
- System stability and flexibility are secured by introducing a retrofitted thermal generator that has been converted from an existing thermal power generator to an area with insufficient flexibility

Various Flexibility Indicators

- In order to evaluate the flexibility of the power system, data on the total load, renewable energy capacity, and rate of renewable energy at the unit time axis of interest are basically required
- The presence or absence of generators failure has a significant impact on the flexibility indicators, accurate flexibility evaluation can be carried out by considering the generators' maintenance plan, failure rate, maximum/minimum power generation capacity, ramp rate, and start-up time
- Considering renewable energy data, the algorithm is configured to set the time of interest axis up to 24 hours at regular intervals of 5 to 15 minutes and to expand it by reflecting the existing system planning procedures as much as possible

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Retrofitted Thermal Power Plant

- Conventional generators are designed to supply power according to demand patterns with relatively low variability
- Retrofitted generator specifications are required to handle rapid renewable energy output characteristics without additional introduction of new transmission and substation and power generation facilities

Case Study

- Flexibility evaluation index is introduced to conduct system evaluation for the present and future systems
- Flexibility evaluation was performed by selecting an off-peak scenario that shows the characteristics of low minimum load and fast start-up time among the characteristics of retrofitted thermal power plants

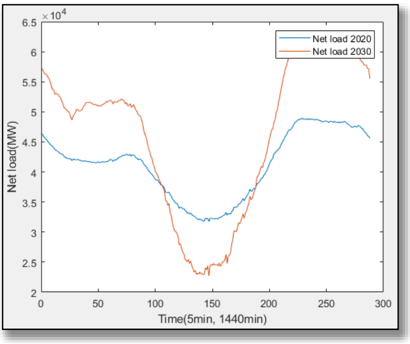

Fig 1. Net load comparison (2020, 2030)

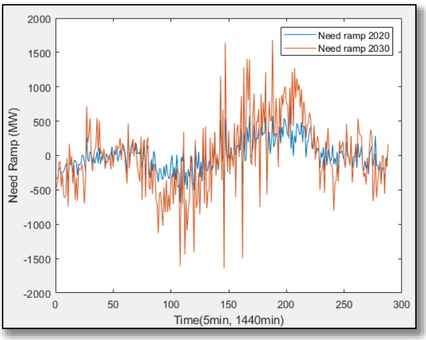

Fig 2. Necessary flexibility comparison (2020, 2030)

- The off-peak data is shown by the blue line in Figure 1 by using the actual 2020 data provided by the Korea Power Exchange to create a net load using the load data with the lowest peak of the year and the renewable energy source data
- Figure 2, in 2030, the amount of output that changes 5 minutes will more than double, and accordingly, a lot of change in the load to be handled by the power system, excluding renewable energy sources, is also required
- The net load in 2020 was first divided into upward net load change and downward net load change and shows the AFD of a total of 184 generators

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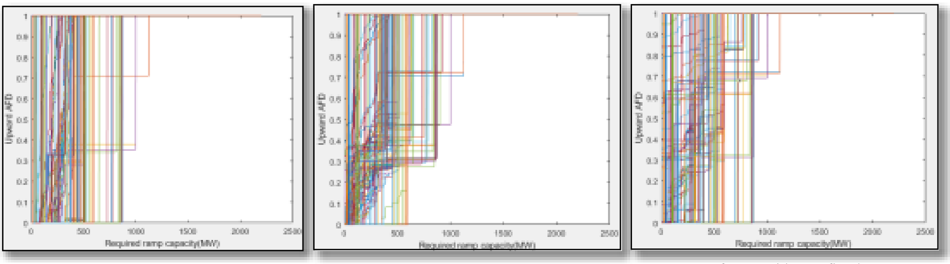
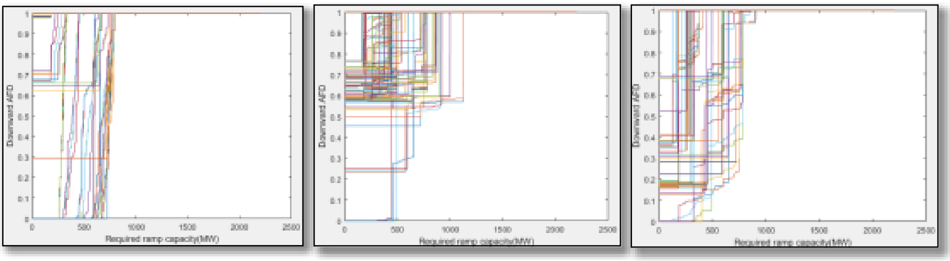


a. Year of 2020 b. Year of 2030 c. Year of 2030 with retrofitted generator

Fig 3. Upward flexibility probability density function by generator



a. Year of 2020 b. Year of 2030 c. Year of 2030 with retrofitted generator

Fig 4. Downward flexibility probability density function by generator

- Conversion to a retrofitted thermal power generator, AFD has more downward flexibility compared to 2030
- As the minimum load of the retrofitted thermal power generator was lowered by 30%, it was confirmed that the retrofitted thermal power generator did not shut down and continued to supply power to the system under minimum load operation

Conclusion

- In Fig 3. upward flexibility is expected to be even scarce as many generators cannot influence the provision of upward flexibility
- In Fig 4. most generators failed to respond in down-flexibility in 2030, down-flexibility is improved as improved thermal power generators are introduced
- Retrofitted thermal generator is used where flexibility is lacking, the upward flexibility may appear small, but it is significantly different from the number of times the generator is turned on