A3/B3 Colloquium 2023
Preferential Subject PS1
Study Committee A3

Network & equipment development of FACTS to enable greater renewables penetration in Ireland – developments and Roadmaps for alternative technologies

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Summary

Due to the increase of renewables into the Irish grid and in order to meet the low carbon emission targets of 75% for 2030, the Irish Utility together with the Irish National TSO decided to install various FACTS devices in the Irish Transmission Network. This includes Series Compensation at 400 kV three substations in Ireland to increase the transmission line capability without the need for new transmission lines.

Having greater difficulty in obtaining planning permission to install more overhead lines and to still provide power of a high quality meeting established Grid Codes, new technology has to be added to the network that will allow carbon emission reduction without disruption to the existing network.

This paper explains the technology chosen, the advantages obtained by adding FACTS devices to the network and the process of adding it to the network with the minimum amount of disruption to the existing network.

The Irish Utility plans to install three 400 kV Series Compensation platforms at three substations in Ireland to increase the capability of the transmission line and to cope with all the added wind-energy planned to be added to the Irish Network. Moneypoint PowerStation was selected by the Irish Utility to become the renewable energy hub of Ireland and to meet the emission targets it is also planned to shut down Moneypoint as it is Ireland's only coal fired Power Station.

A system study was performed by the Irish National TSO to determine the required level of compensation in the Irish transmission system.

The paper details the challenges to the system due to the increase of renewables and the roadmap forward to overcome the challenges.

Keywords

- Network & equipment development, FACTS, greater renewables penetration, Ireland, Series Compensation, transition to low carbon generation, energy hub, Moneypoint

1. Introduction

Due to an increase in demand on the East Coast of Ireland especially around the Dublin Area and an increase in connection agreements and natural growth of industry, new equipment or methods had to be found to increase the transmission of power from the West Coast where most generation and renewables are located.

Moneypoint on the West Coast, location of the largest conventional generator in Ireland, has also been selected as the hub for all renewable generation in Ireland.

Ireland has a target to increase its share of renewable energy in the electricity sector to 40% by 2020. In early 2019 this target was increased to 70% by 2030. Much of this renewable energy will be located in the west and southwest of Ireland. Load growth is also expected especially in the east of Ireland in and around Dublin where large data centre loads are emerging. As a result, power flows from West to East are expected to increase.

To accommodate these flows while making best use of existing transmission capacity three new series capacitors are planned for the 400 kV network linking the southwest with Dublin. These are planned for connection to the MP - Coolnabacky, Coolnabacky - Dunstown and Oldstreet - Woodland lines, respectively. Note - Coolnabacky is a future 400/110kV substation planned for completion

2. Considerations and drivers in selecting FACTS devices

With the integration of generation, conventional and renewable a greater strain is placed on the existing infrastructure. With public opinion being against the installation of new OHL's,and bigger public scrutiny about the impact of new equipment on the environment, alternative methods had to be found to increase the power transmitted from the East to the West Coast.

There are issues transferring this power within counties Dublin, Kildare and Meath. These drivers cause three power system issues that needs to be resolved namely Voltage Collapse, Thermal Overloads and Phase Angle Issues. This happens when loss of any 220 kV or 400 kV circuits occur or when a circuit is out for maintenance and then another is lost.

The issues listed affects security of supply and had to be addressed.

- Voltage Collapse
- A sudden and large decrease in the voltage of the electrical system – outside standards
- Lack of reactive support in Dublin, Kildare and Meath
- Thermal Overloads
- Circuit exceeds its power carrying capacity
- 7 circuits, mostly in Dublin, Kildare and Meath
- Phase Angle Issues
- High power transfers on circuits and lack of connectivity between transmission stations
- Intact transmission network - Heavily loaded 400 kV and 220 kV circuits
- Circuits loaded far above Surge Impedance Loading (SIL) – absorb Mvar's

- Loss of any 400 kV or 220 kV circuit (N-1) increases loading on remaining circuits resulting in voltage collapse.

3. Equipment selection and considerations

To increase the amount of power to be transmitted from East to West, the Irish TSO performed a feasability study and decided on the installation of Series Compensation. Two types of this technology exists, namely Fixed Series Compensation and Thyristor Controlled Series Compensation.

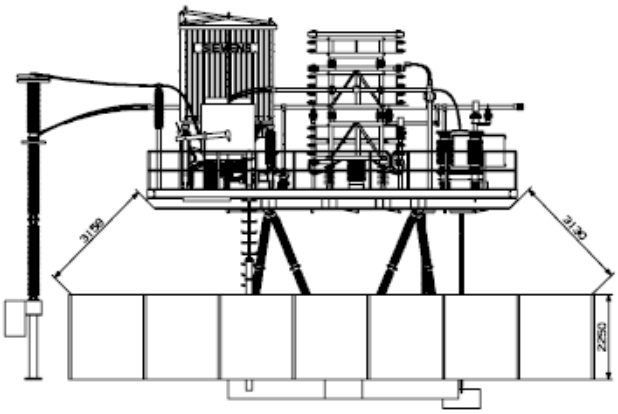
Things affecting the footprint and power requirements are :

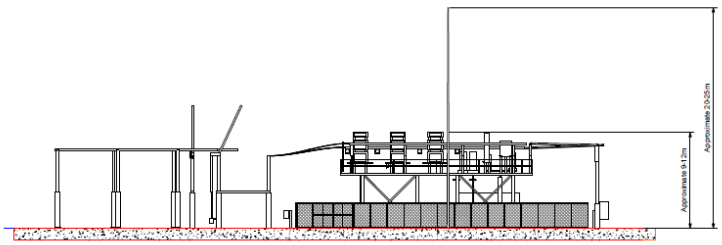
- Level of Compensation, i.e. percentage. This affects the number of capacitors which determines the footprint.
- Type of TRV mitigation selected
    - MOSA – number of MOSA's will also affect the footprint. More MOSA's, larger footprint.
    - Fast Bypass switch or Triggered Air Gap.
- System TRV level – will affect the type of breaker to be used and whether a new or additional breaker has to be installed.
- Type of current limiting discharge equipment selected.

4. TRV Study

A detailed TRV study is performed on the system. This study determines the level of TRV on the system during switching operations. The reason for this is to determine the level of TRV and effect of the trapped capacitive charge on the existing circuit breakers on the system.
This determines the rating of the breaker to be utilized for the capacitive switching.

5. Footprint and Power Requirements





With the platforms being alive at system voltage, in the case of the Irish Utility 400 kV, it requires a substantial footprint to ensure safety while energised as well as sufficient clearances on all sides of the equipment.

As one of the sites is a greenfield site, power requirements in this case also includes a rural supply and there will be a house transformer supplying the lighting as well as the protection systems. As a further backup every site will have a separate backup diesel generator.

Due to the size of the platforms, and every phase requiring a separate platform, substantial real estate are required for the installation and connection of these units. As most of these substations have already been in operation in excess of ten years, and space utilised to the maximum extent, new property had to be acquired for the installation of these units. With the equipment being connected to the OHL, new gantries also has to be installed and the lines interrupted with new connections to and from the platform.

6. Safety

With the system being alive at the system voltage an interlocking system are included to ensure that on opening any of the compounds, the compound will be de-energised to ensure staff safety.

The access ladder to the platform, once de-energised, is also connected to the system earth to ensure staff safety once the ladder is extended for safe maintenance on the platform.

Bibliography

‘In the final roadmap, we believe more emphasis should be placed on the potential for grid forming technologies (such as wind turbine generators (WTGs) and combinations of batteries and STATCOMs) and how these can contribute to system stability for 2030.’ – Industry Respondent

The Shaping Our Electricity Future (SOEF) consultation was a step in understanding the electricity viewpoints of all stakeholders in Ireland and Northern Ireland. It is important that the TSOs are cognisant of the commentary and insights that you as energy stakeholders can provide and how we use this feedback to enhance the inputs to the final roadmap scheduled for publication in October 2021.

Potential Solutions for Mitigating Technical Challenges Arising from High RES-E Penetration on the Island of Ireland A Technical Assessment of 2030 Study Outcomes

https://www.modernpowersystems.com › features › feat...

1 Jun 2001 — Series compensation **reduces transmission reactances at power frequency**, which brings a number of benefits for the user of the grid, ...

Series Compensation Projects - EirGrid

https://www.eirgridgroup.com › projects › the-project

Series Compensation Projects. A set of innovation projects on the 400 kV network as part of the ongoing **transmission** network reinforcement to improve power ...