EirGrid Grid Strategy

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Grid25 Strategy

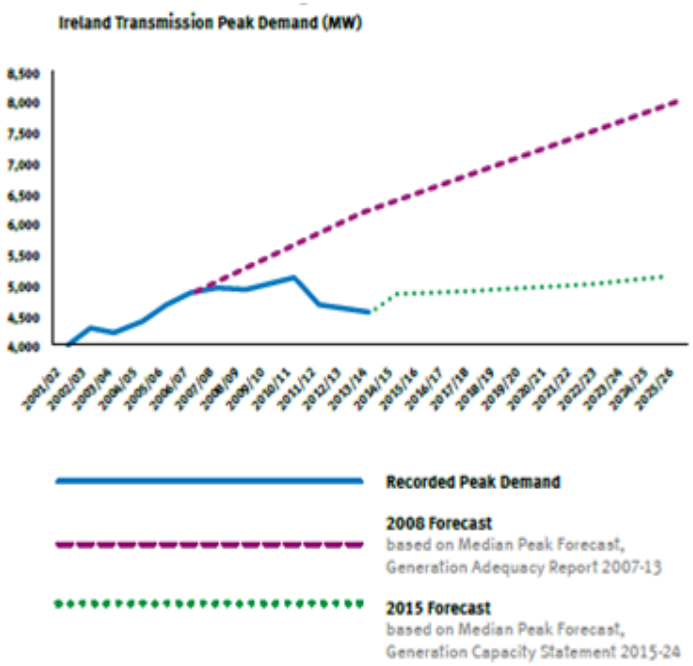
- 7 years since Grid25 launched in 2008 – many of the drivers for capital investment have changed

- Structure of Grid25 review documents
  - Public facing report (supported by)
  - Technical report – Supplemental and more technical for the Industry
  - Independent Technical Review - London Power Associates report
  - Independent Economic Review - Indecon
- Key assumption changes
  - Demand growth
  - Generation portfolio (renewable and conventional)
  - Interconnection with the Island of Ireland
  - Technology

- Strategies and revised grid development programme

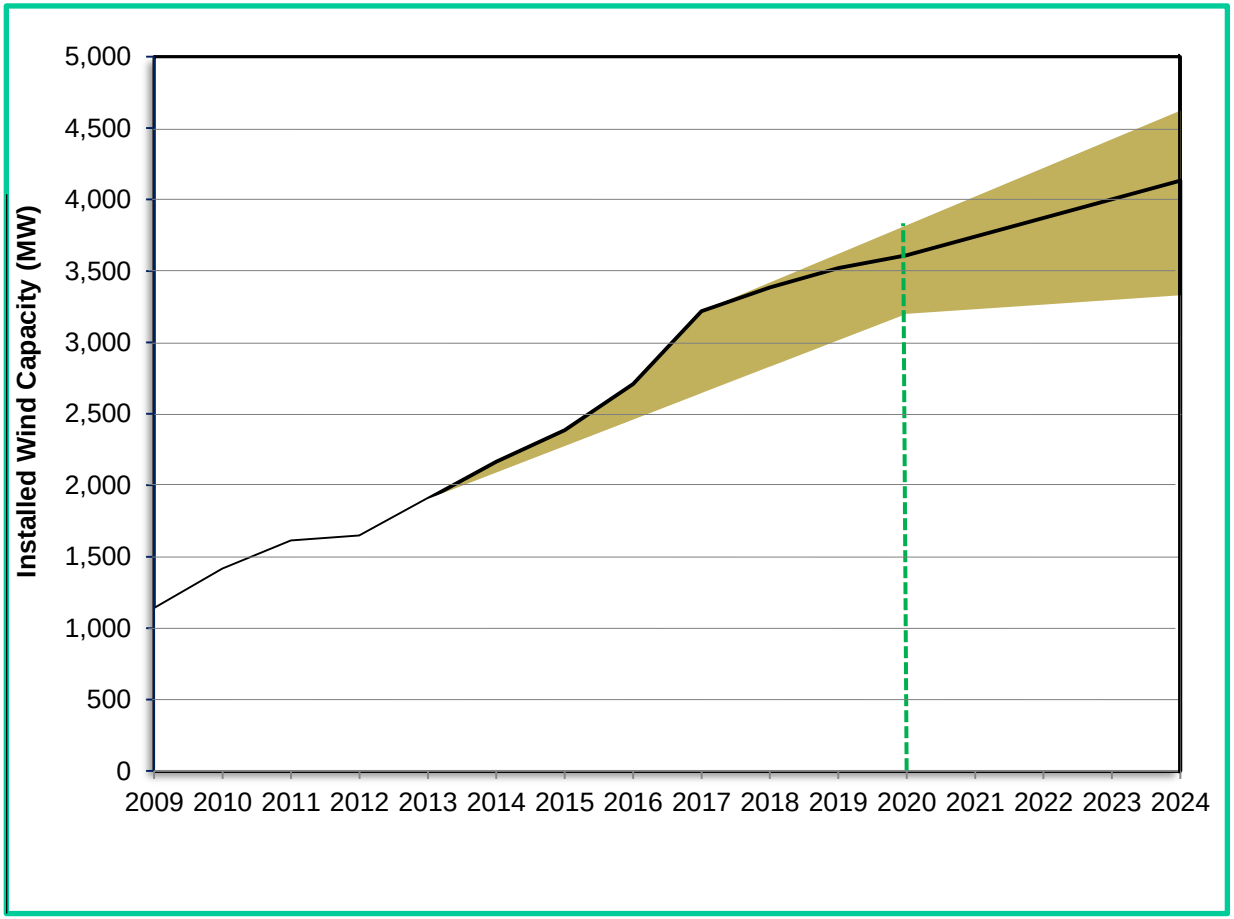
- Examples of Application of Existing and New Technologies

Demand Growth



- Our economy is returning to growth development of transmission system becomes critical to support job creation, economic development and competiveness
- Majority of foreign direct investment clustered around larger cities. Transmission system critical in supporting governments drive to create jobs in the regions of Ireland
- Large data centre operators expressing interest in connecting large scale facilities in Dublin area

Generation Portfolio Changes



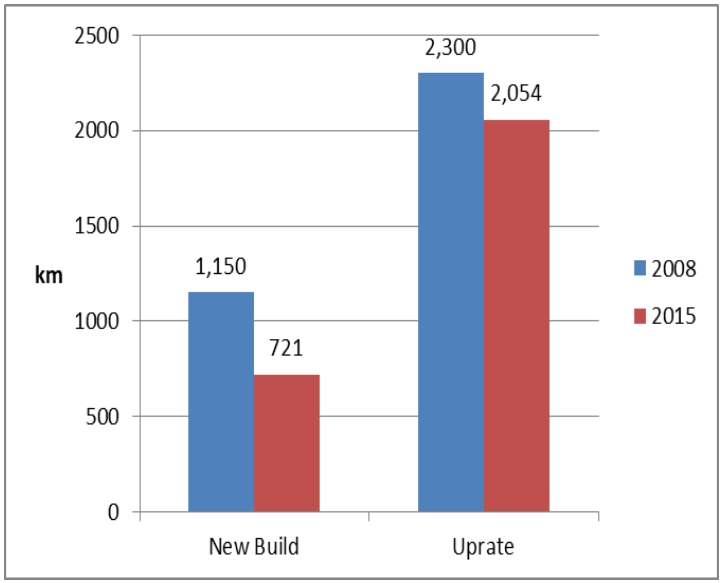
- On target to meet 2020 commitments
- 2020 target between 3200MW to 3800MW
- Gate 3 (c. 4000MW)
  - 82% accepted
  - 7% under consideration
  - 11% declined

  Source Grid25 Report
- N.I imports expected to increase at low wind output
- New conventional generation commissioned in the south east
- A number of conventional plants have and will be decommissioned

Interconnection with the Island Of Ireland

- EWIC 500 MW interconnector commissioned in 2012
- Current level of interconnection with Ireland to other networks is inline with EU objective of 10%
- European commission now considering 2030 targets, one of which is a possible increase to 15%
- EirGrid is now working in co-operation with our French counterparts to explore the possibility of an Ireland – France interconnector

Technology



- Since 2008 a number of technologies have been collectively assessed by EirGrid and ESB
- A number are in the research and development phase
- Technologies in the research and development phase may mature before 2025
- Others have advanced significantly to be added to the available technology list
- Considerable success in the application of technology in the uprating of existing infrastructure

Strategy Statements

Strategy 1

Open engagement and inclusive consultation with local communities and stakeholders will be central to EirGrid's approach to network development

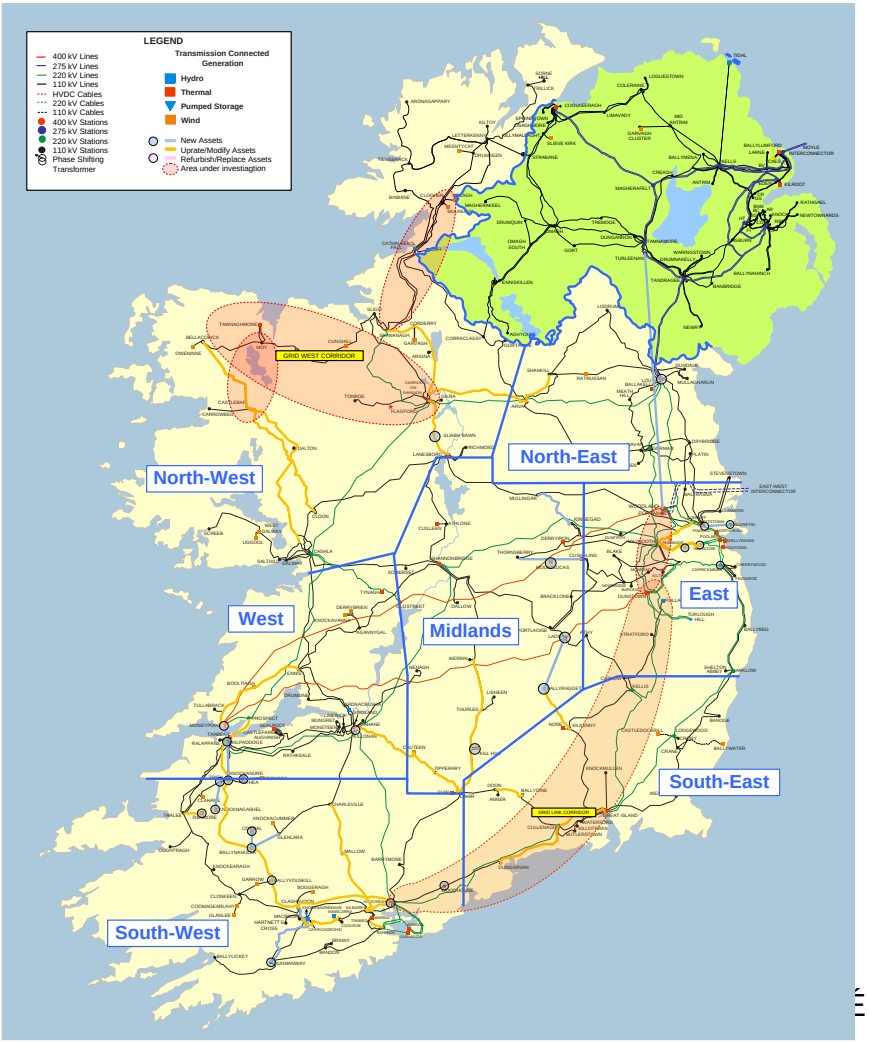
Strategy 2

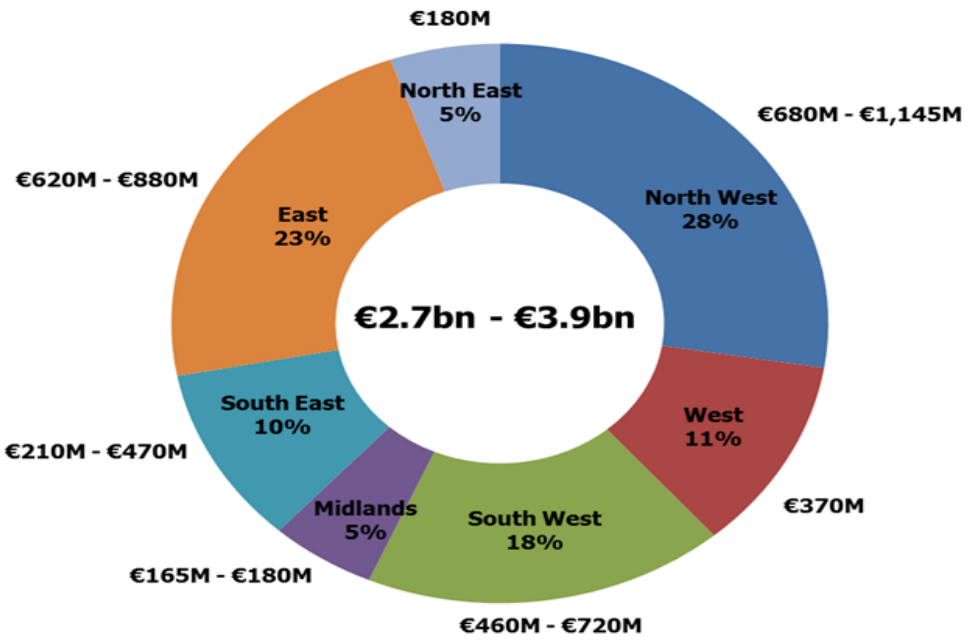
All practical technology options will be considered for network development

Strategy 3

The network will be optimised to minimise requirements for new infrastructure

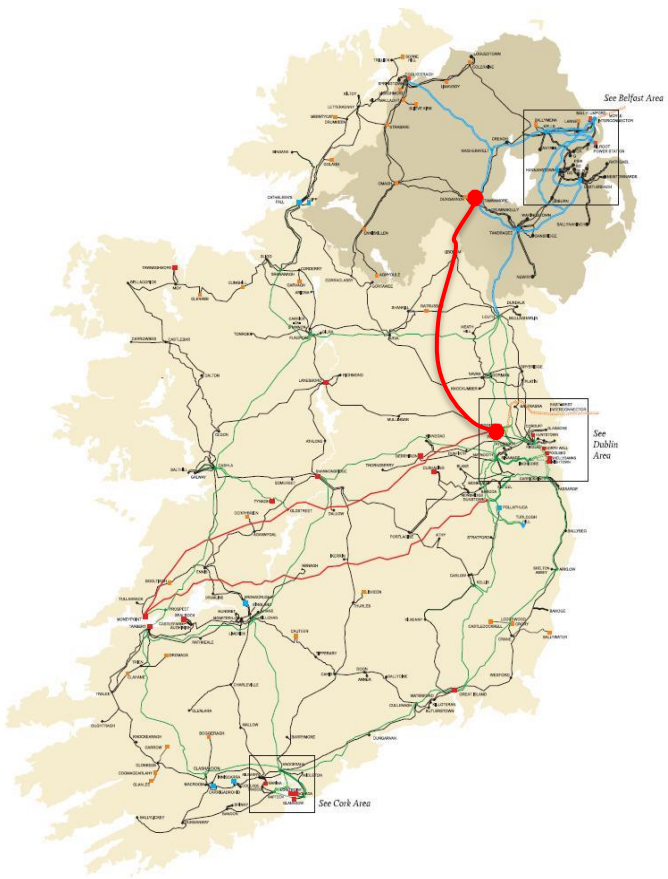
Revised Grid Development Programme





- Original 2008 development strategy estimated at €4 billion
- New proposed strategy will range between €2.7 - €3.9 billion depending on chosen technology

Major Projects North-South



Need:

- Loss of interconnecting circuits possible with a single event
- Need remains strong – and unchanged
- Imminent security of supply concerns in Northern Ireland

Options considered:

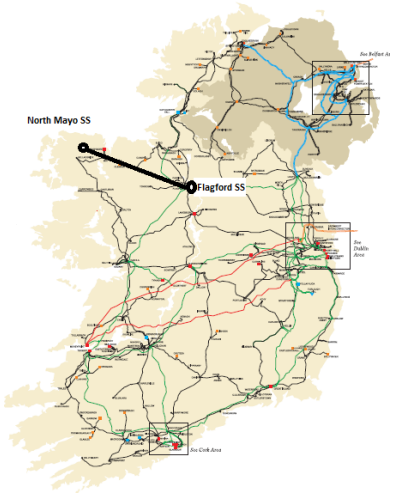
- One 400kV AC Overhead Line
- HVDC more expensive, smaller capacity and does not fully meet need
- 220kV would need to be double circuit, technically inferior and more obtrusive
- No alternative path on existing assets to bring other strategies into play

Conclusion:

- Need remains and 400kV OHL is the right solution

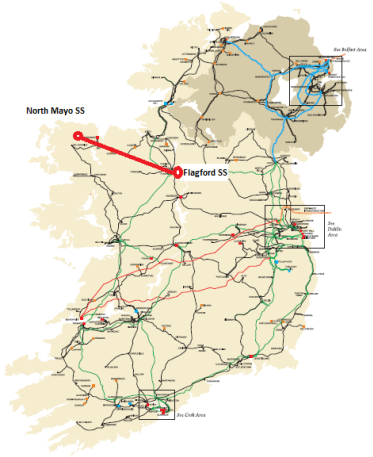
Major Projects Grid West: Potential Options

HVDC UGC



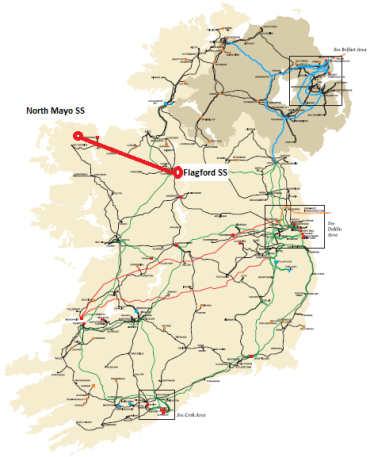
- HVDC Underground Cable Option
- Requires converter stations at Flagford and North Mayo

400kV OHL



- 400kV HVAC Overhead Line Option
- Inc. 8km of compensatory underground cable (of existing 220kV line) into Flagford.

220kV OHL



- 220kV HVAC Overhead Line Option
- Inc. 8km of underground cable into Flagford
- Possible 22km additional undergrounding available along the route.

Major Projects Grid Link: Potential Options

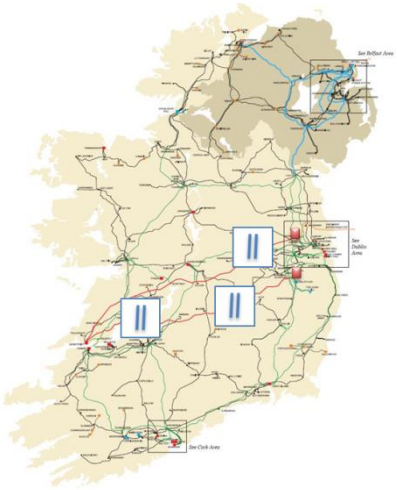
HVDC Option

- HVDC link between Knockraha and Dunstown
- Underground cable plus converter stations

400kV AC Option

- Knockraha – Dunstown 400 kV HVAC
- Overhead line
- Connection to Great Island less important now

Regional Grid Option



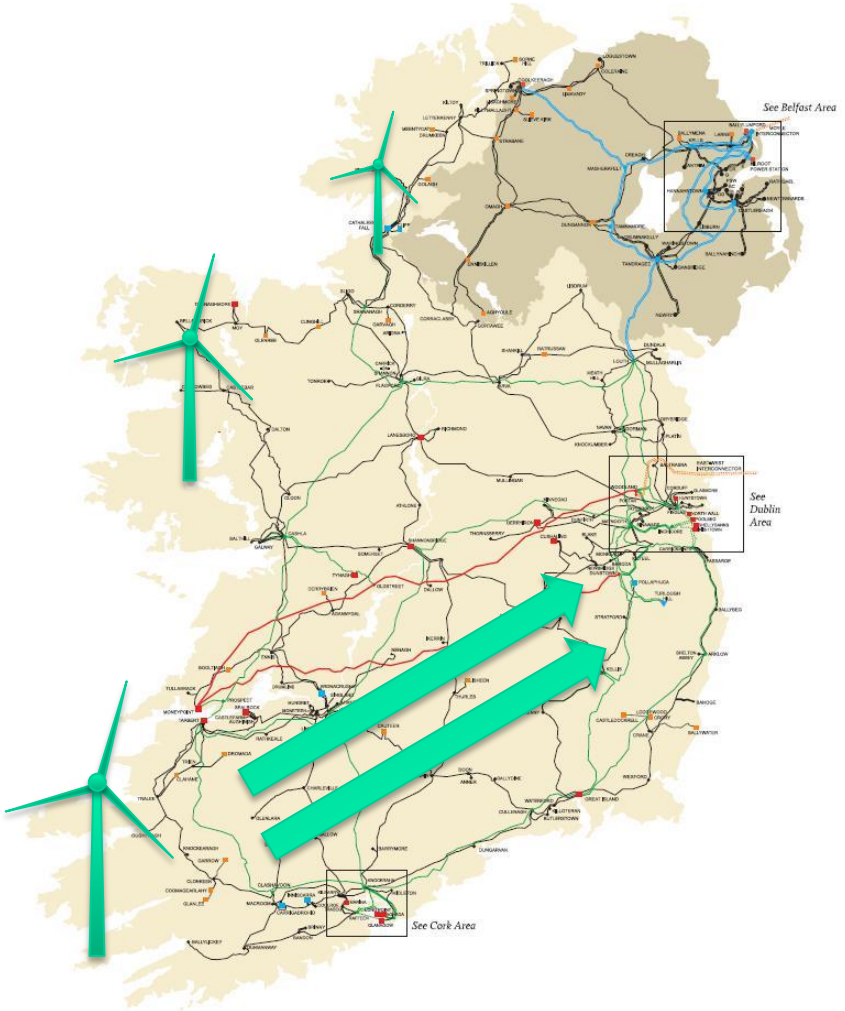
- Series compensation of existing 400 kV circuits + New Shannon Cable and uprates
- Forces more energy to flow over these lines
- Avoids need for new linear build

EirGrid have now committed to take this project forward with the Regional Grid Model

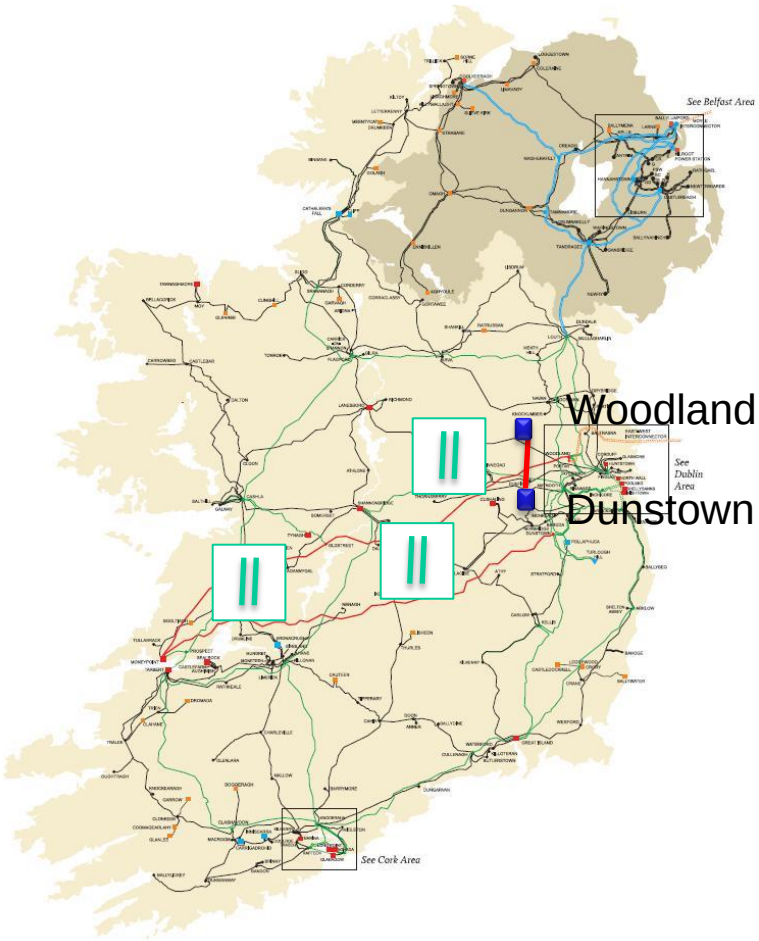
Overview of Series Compensation

- Generation drives large regional electricity flows
- Transmission network issues

1. Wide spread voltage collapse across South Leinster with the possibility of cascade tripping
2. Large voltage phase angles
3. A number of thermal overloads



Overview of Series Compensation



Reinforcements

- Series capacitors on three existing 400 kV circuits
  - Lowers reactance of 400 kV circuits
  - Improves power sharing between the two 400 kV circuits and the 220kV network

Related reinforcements

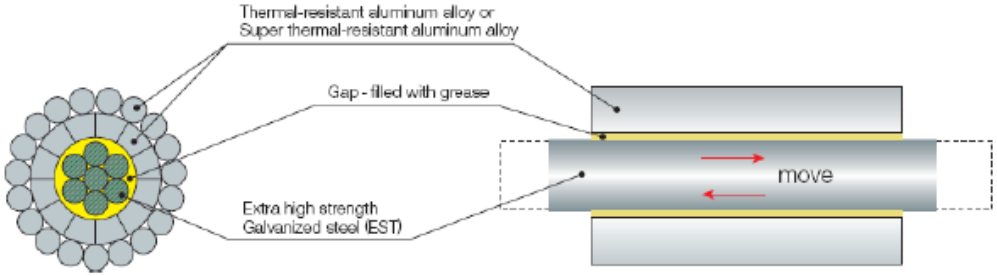
- Dunstown – Woodland 400 kV circuit
- Fourth Shannon cable crossing required
- Need for 220/110 kV circuit uprates required to resolve thermal overloads

Examples of Application of Existing and New Technologies

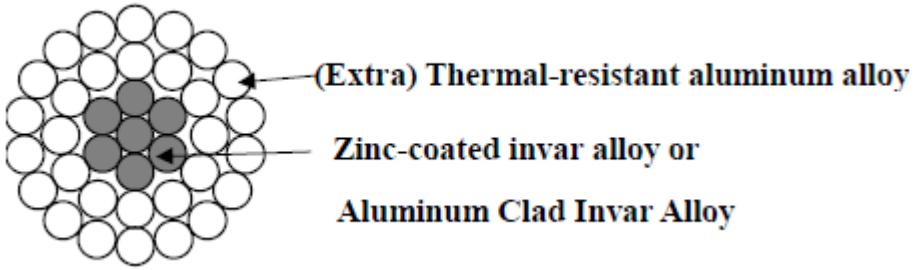
- High Temperature Low Sag Conductors (HTLS)
- Dynamic Line Rating (DLR)
- Power Line Guardian (PLG)
- Voltage uprating

High Temperature Low Sag Conductors

- HTLS conductor is already in use on the transmission networks in IRE and NI
- Available as an option to network planners
- Significant increase in thermal capacity, at least 50%
- For example a 220kV circuit uprates from 534MVA to 833MVA using GAP condr
- Designed to operate up to 150°C - 210°C (compared to 50°C - 80°C)



- GAP conductor used in IRE and NI



- INVAR conductor also used in NI

Dynamic Line Rating

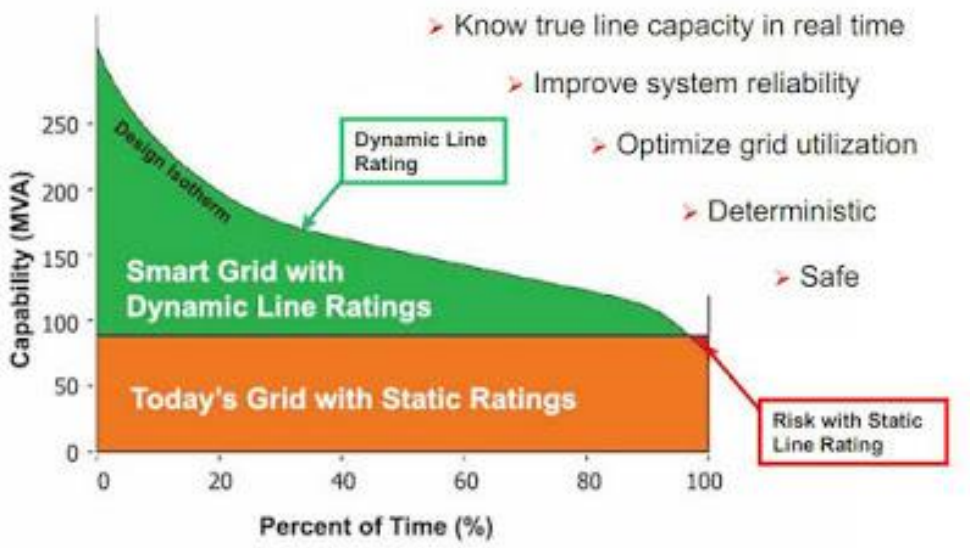
Essential Ingredients What does it do?

Monitoring devices

- Weather
  - Wind speed
  - Ambient temperature
  - Solar radiation
- Sag monitoring
- Ground clearance
- Conductor temperature
- Conductor vibration

Software application

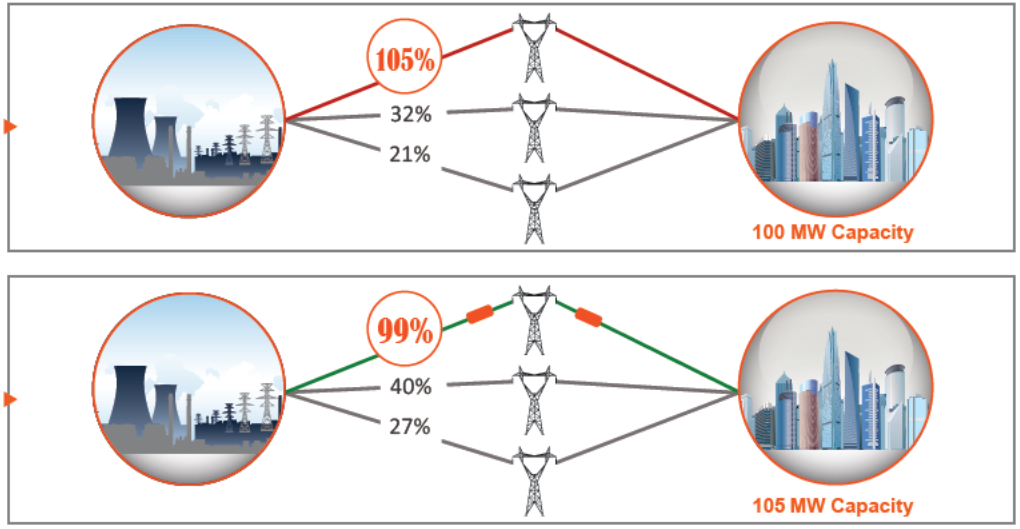
Comms



Rating Duration Curve

Power Line Guardian

- A distributed series reactor technology
- Impacts power flow sharing between parallel circuits
- Improve utilisation of existing capacity
- Real time control over circuit impedance



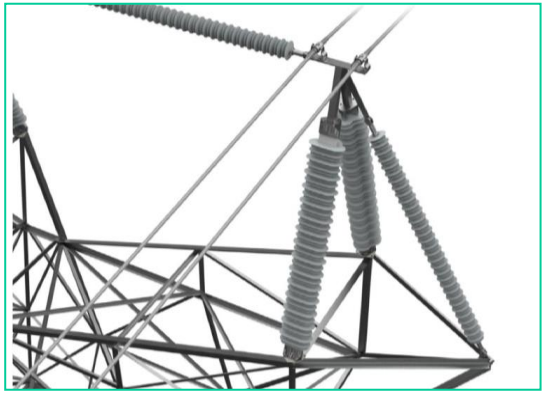
http://19t1my39op3g1lrrb43v6xa0.wpengine.netdna-cdn.com/wp-content/uploads/2015/06/SmartWires-Reimagining-the-Grid.pdf

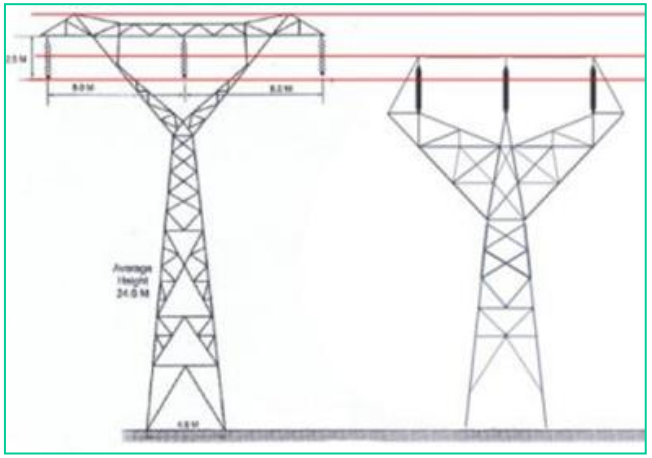
Power Line Guardian

Live line demonstration
on Cullenagh – Waterford
110kV circuit installed
30 November 2015

Voltage Uprating

- By replacing certain steel lattice sections, with rigid polymeric insulators, towers can be used to support higher voltage operation
- By removing lateral movement, design can be more compact
- Assuming no conductor change, capacity uprate in proportion to voltage increase





Questions & Answers