EirGrid Customer Connections Forum

20th July 2011

Short Circuit Reinforcements

Cormac McCarthy
Transmission Access Planning

Presentation Overview

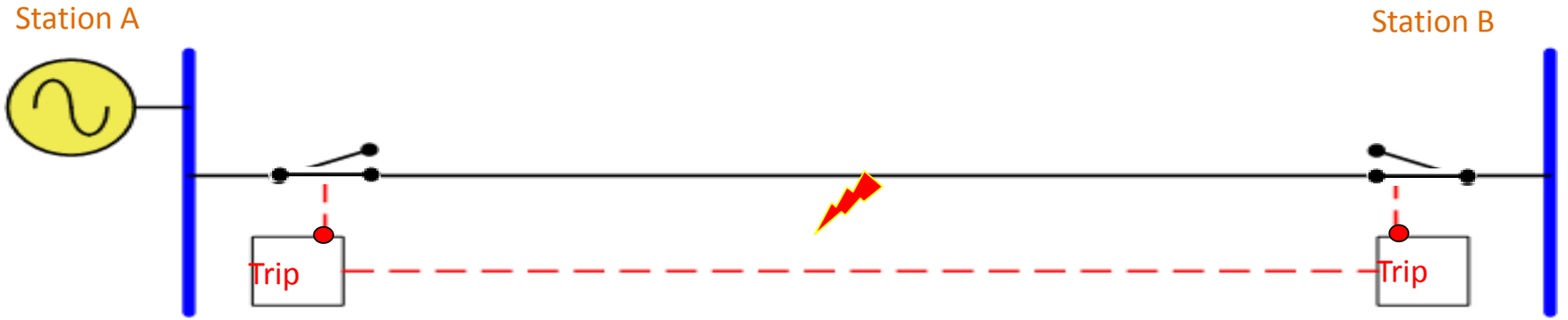
What is a short circuit reinforcement?

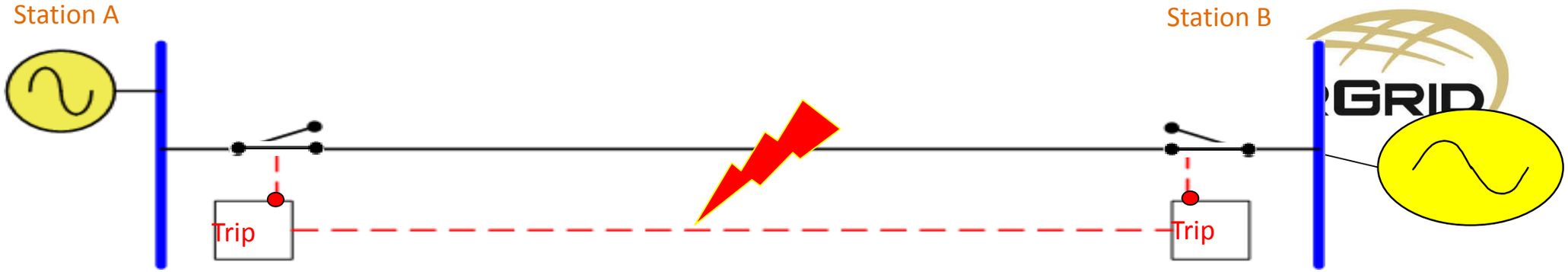
Issues with short circuit reinforcements

Methodology used for Gate 3

Annual short circuit study proposal

Information Requirement


Station A
Station B
Trip
Trip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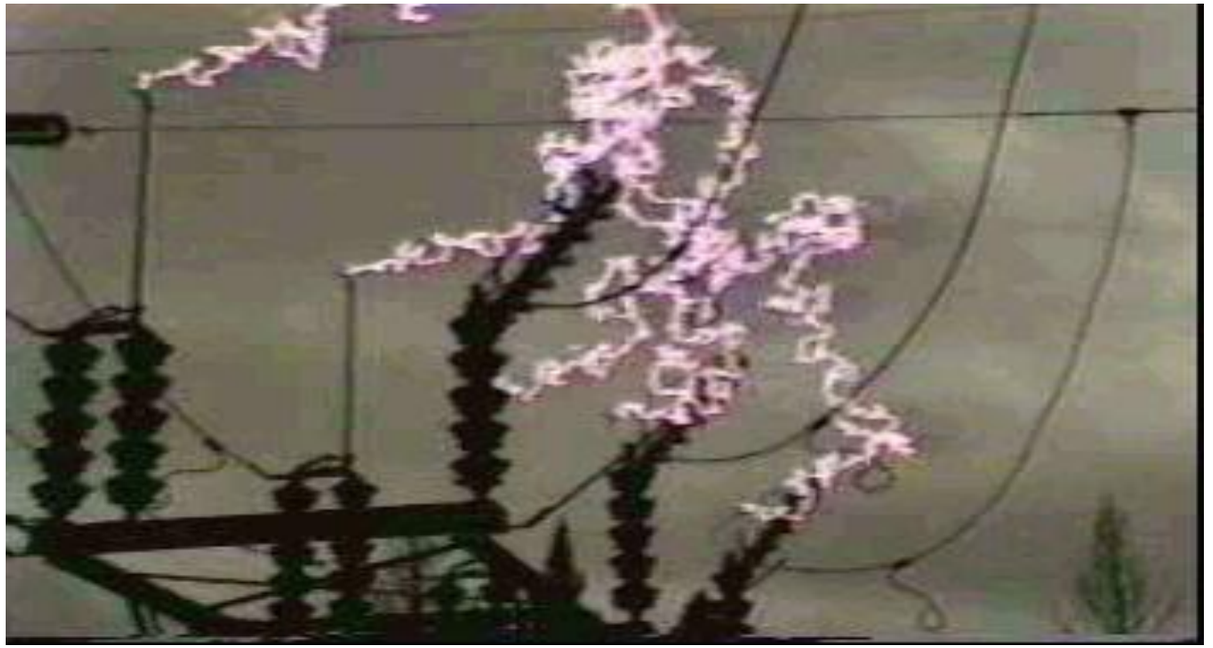


Issues with short circuit reinforcements

Some connections require sizeable number of circuit breaker replacements

- In some instances, may have a longer lead time than shallow works
- Safety issue, need to be complete before a generator can connect
- In important stations, outage scheduling is difficult

Why there are so many reinforcements

For Gate 3, the associations are quite significant (a lot of associated reinforcements)

- Approx 6000 MW of offers (approx 2000 MW conventional, approx 4000 MW wind)
- The Gate 1 and Gate 2 generators are assumed to have connected and pre Gate 3 conventional

For Gate 1 and Gate 2, the number of associations is less

Gate 3 modelling assumptions

Gate 3 modelling based on

- some generators used assumed data
- standard connection lead-times and
- assumption that pre-Gate 3 had priority

Annual Short Circuit Study Proposal

Propose to undertake annual study

Aim to facilitate as many new connections as possible

Accurate connection/construction timelines is key

Initial Study for 2011

- Focusing on the forthcoming 18 month period
- June to October 2011

Expected Outcomes

Can some applicants have revised short circuit associations (i.e. shorter list)?

- Does this mean a longer list for someone else?
- In the event of limited short circuit capacity, how is it allocated?
- Mechanics of getting accurate timelines from developers
- Treatment of generator connection dates

Which reinforcements to prioritise.

Phasing of short circuit reinforcements

Information Required (Generators)

The earlier that we get information about connections the better

- Turbine types,
- Expected connection dates
- Applications that are definitely not progressing
- E.g. Technical Data to be provided 12 months in advance of connection

- Signed offers
- EirGrid will engage with applicants

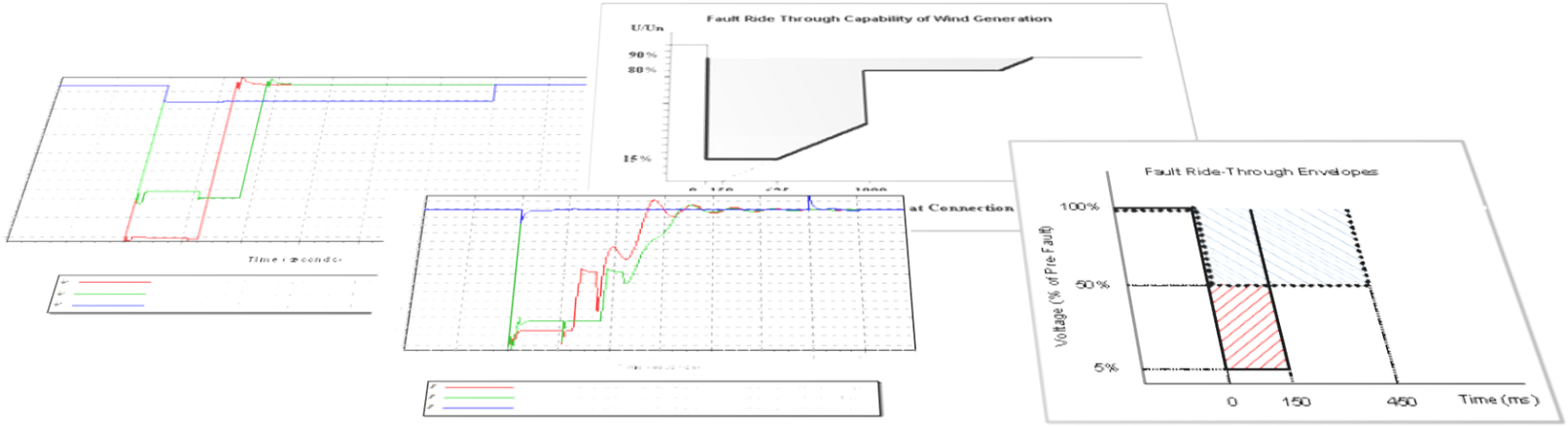
Conclusion

- Initial Review June to October 2011
  - EirGrid and ESB will write out to applicants
  - If you have concerns about your own connection, please come and talk to us
- Proposed Annual Short Circuit Review from 2012 onwards
- If we have the right information, we can optimise the programme of short circuit reinforcements

EirGrid Customer Connections Forum

20th July 2011

Dynamic Analysis Process and Generator Obligations

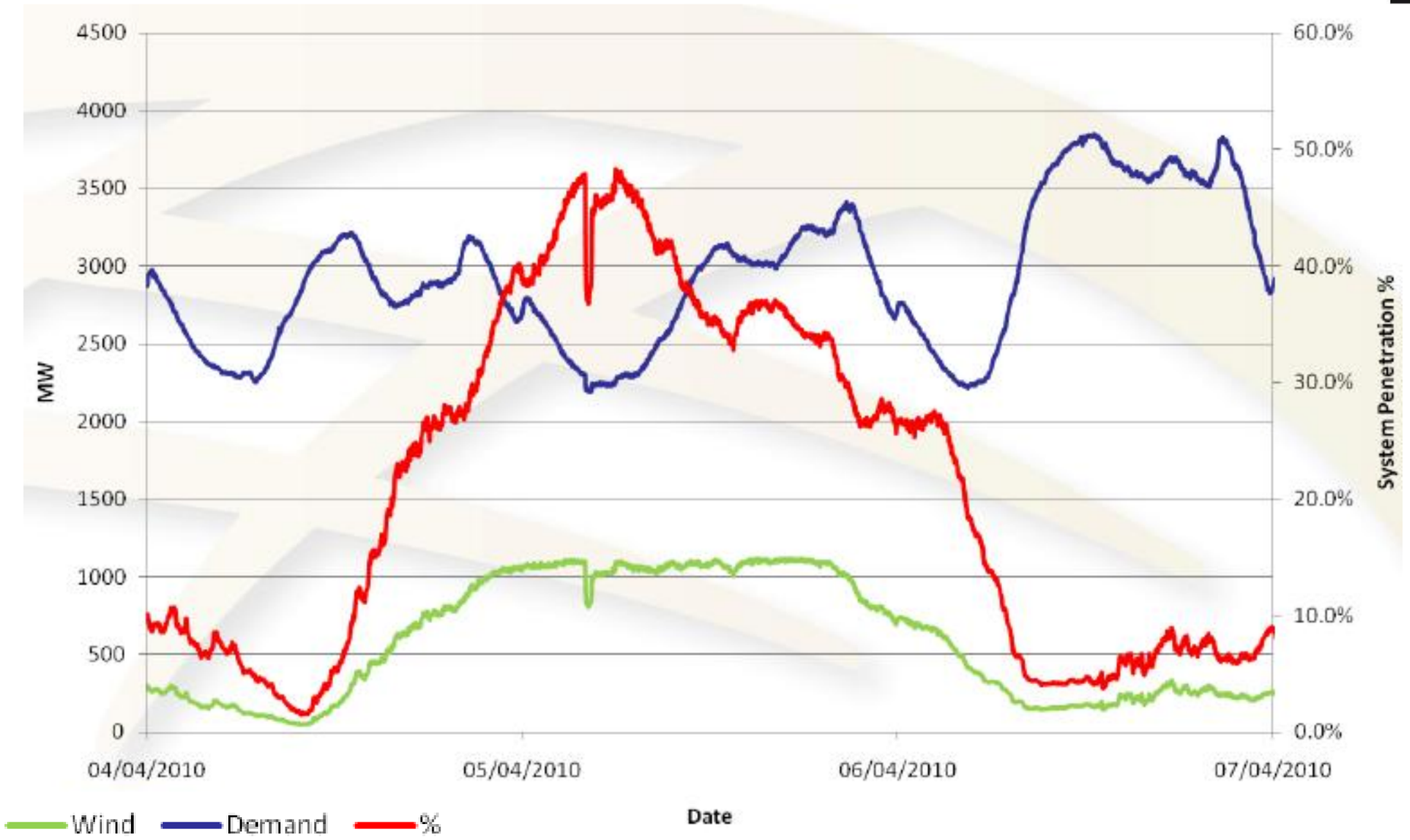


John McGuckin
Transmission Access Planning

Introduction

- 40% electricity from renewable by 2020 - 37% from wind
- Conventional – lighter inertia plant
- Changing dynamic characteristics of the electricity power system
- Prevent Power System Blackout
- Total System Generation: *% of non-synchronous plant?*

Instantaneous penetration of Wind: Real Time



Key Messages

Concerns over Dynamic Instability present a risk to projects being delayed…

Generator Obligations:

- Grid Code Compliance at Connection Point over entire operating range
  - Notify System Operator of any non-compliance
- Provision of Accurate Data
- Following refurbishment – Submit Modification (re-testing req.)
- Update System Operators on Project Lead Time

Overview

- DYNAMIC ANALYSIS PROCESS
  - Dynamics Studies –
    - What are dynamic studies?
    - Example of recent fault
  - Dynamic Stability is a risk – Mitigation of Risk
  - Toolset – TPC / GC

- GENERATOR OBLIGATIONS
  - Generator Obligations
  - Information Exchange Process
  - Application Forms

Dynamic Studies – Stability

Voltage Stability

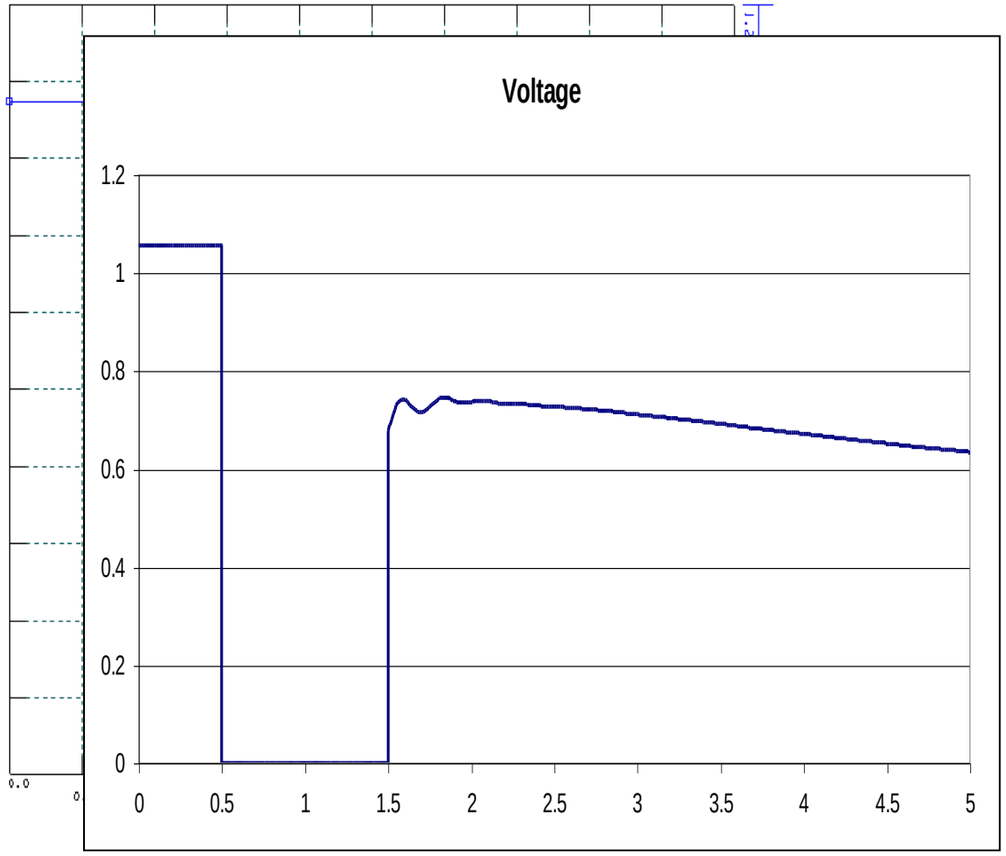
Ability of the system voltage to recover

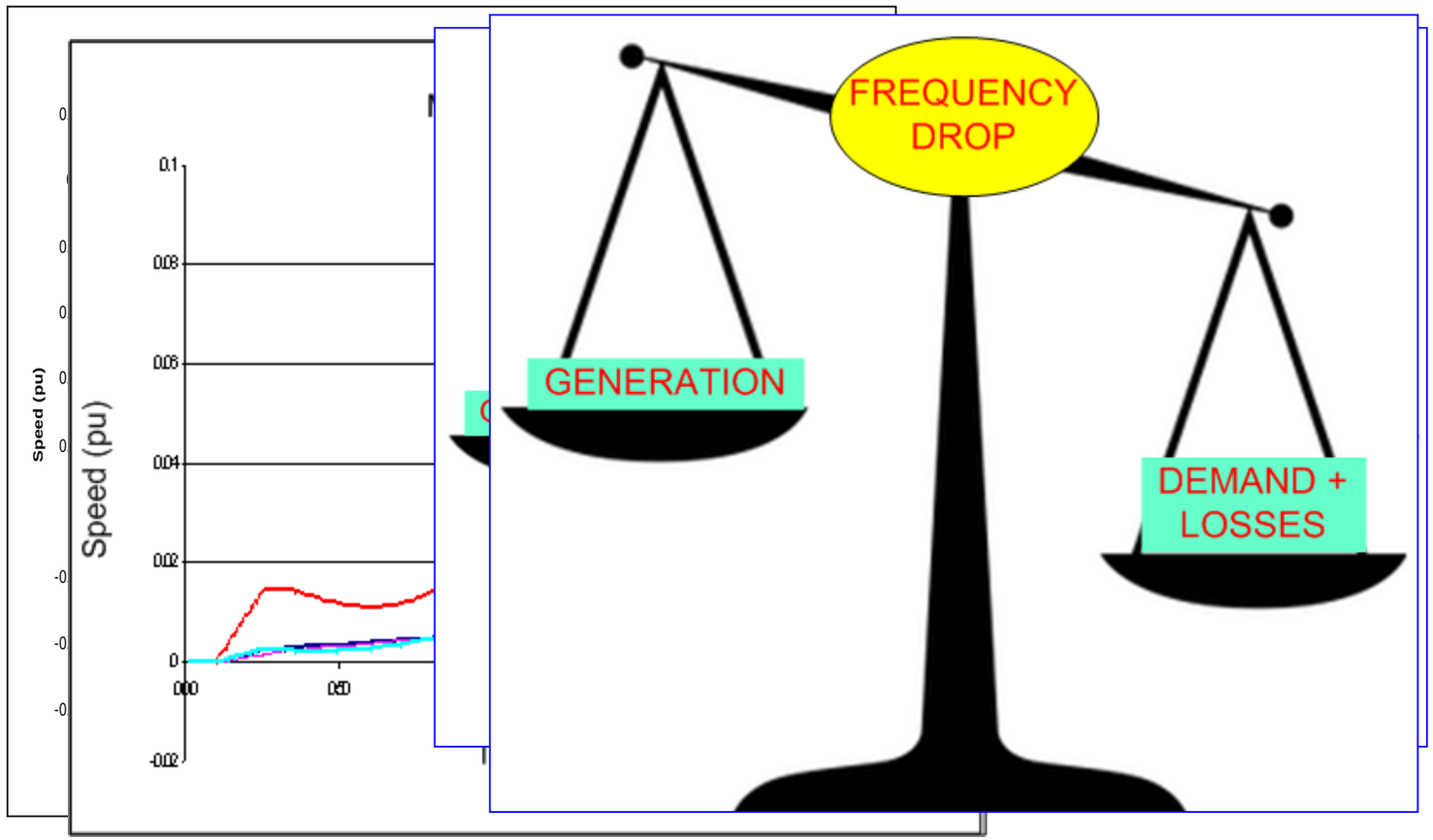
Transient Stability

Ability of conventional units to remain in synchronism

Frequency Stability

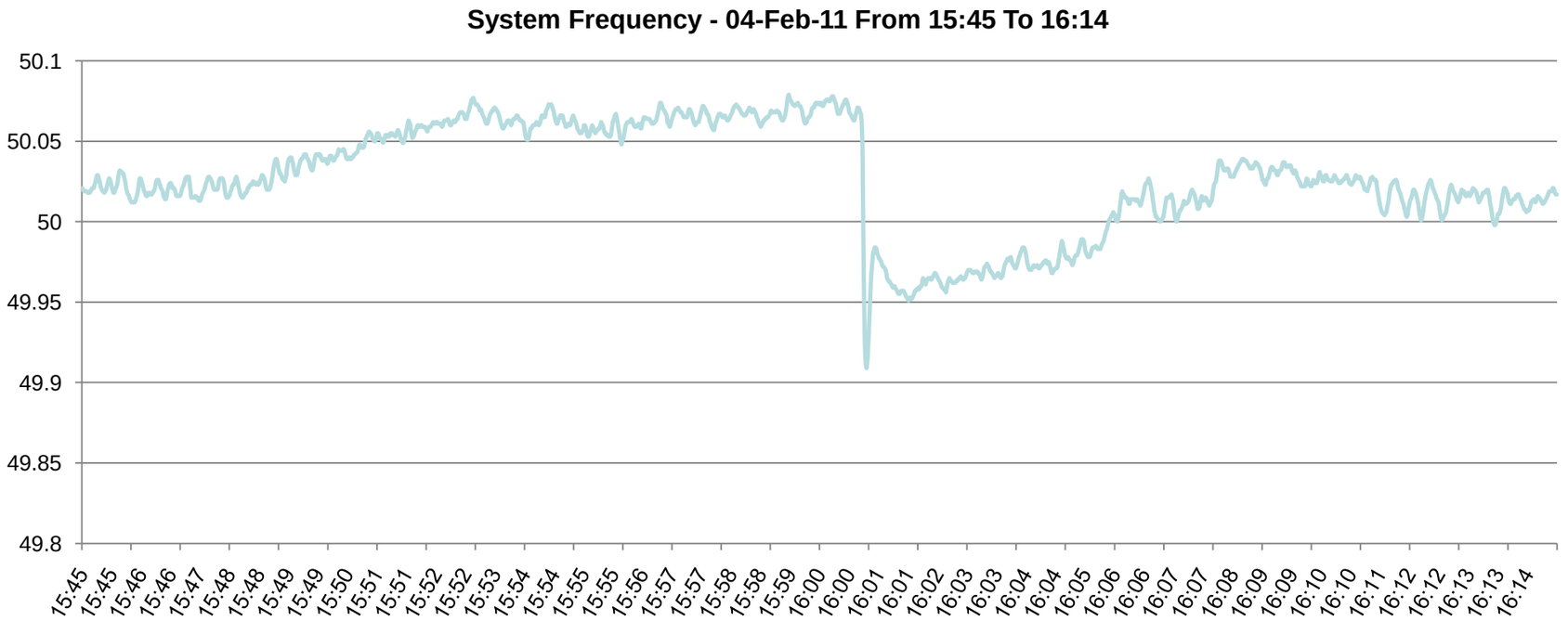
Ability to maintain system Frequency

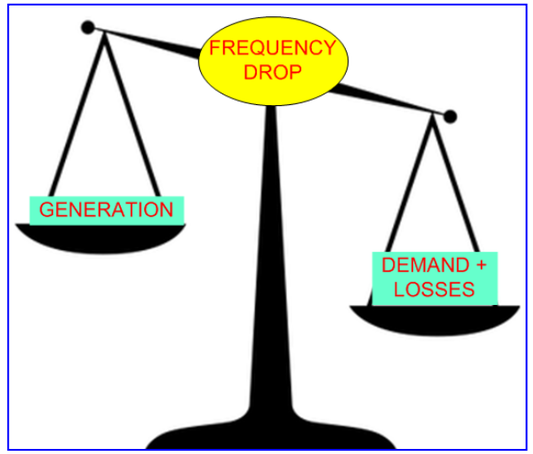




Dynamic Stability – Example of Fault

- 4th February, fault on the Prospect Tarbert 220 kV feeder.
- Fault clearance time - 80ms
- 127 MW of 957 MW of wind disconnected.
- Resulting in 0.1 Hz frequency drop





Higher System Inertia => Frequency less sensitive to temporary imbalance

Toolset

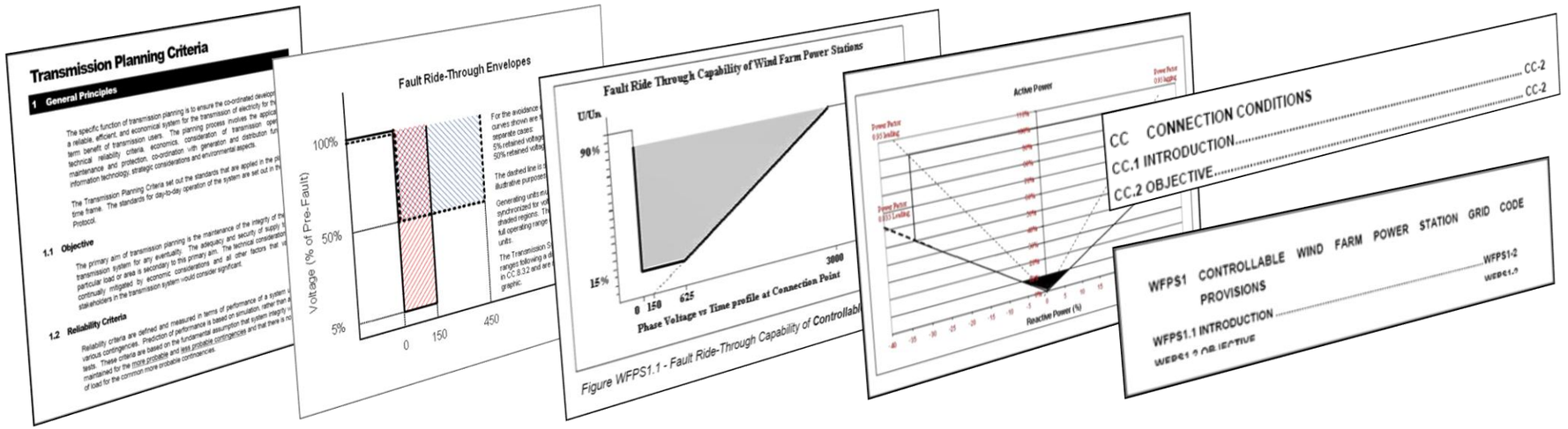
Tools used to reduce the risk of Dynamic Stability concerns…

Transmission Planning Criteria

Maintenance of the integrity of the bulk transmission system for any eventuality.

Grid Code

To ensure the development of a safe secure & reliable system.



Generator Obligations:

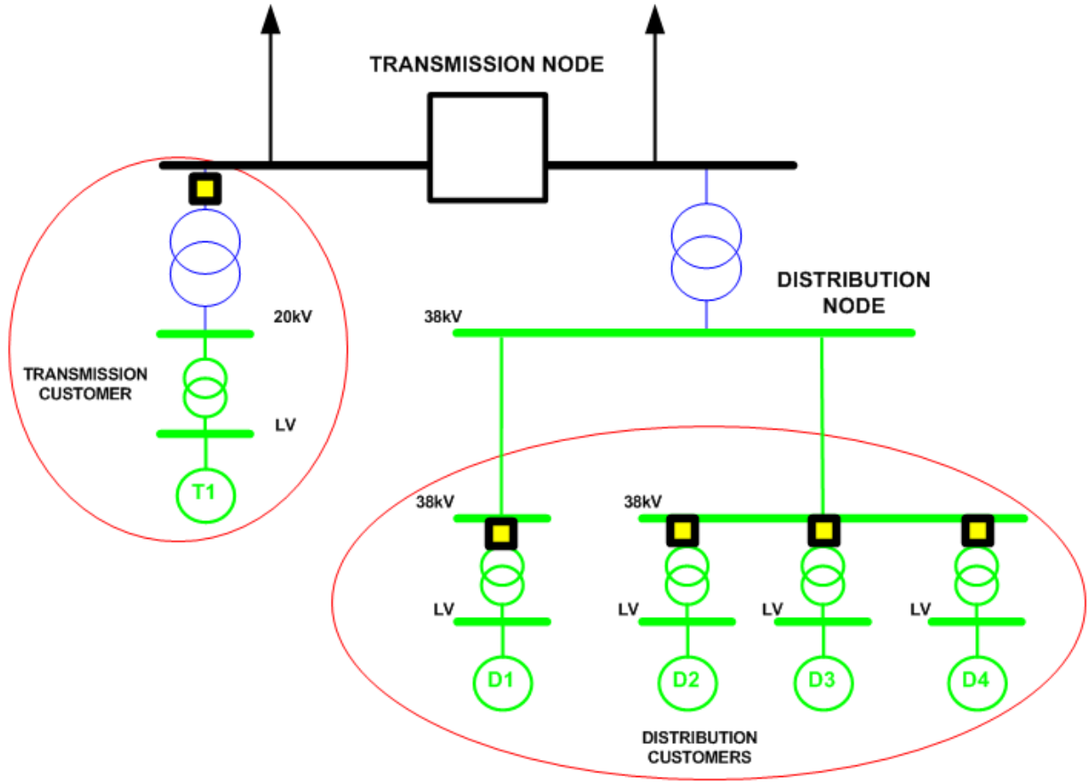
- Grid Code Compliance at Connection Point over entire operating range
  - Notify System Operator of any non-compliance
- Provision of Accurate Data
- Following refurbishment – Submit Modification (re-testing req.)
- Update System Operators on Project Lead Time

It is the responsibility of the Generator to…

…ensure Grid Code Compliance at the Connection Point over entire operating range.

Information from System Operators

- Compliance effected by system strength **at connection point**
- Location specific (not proven by generic test simulation)
- Developers to ensure compliance for associated node
- SO's to provide representation of minimum fault level



Information from System Operators (Cont.)

Conventionals

FRT working group:

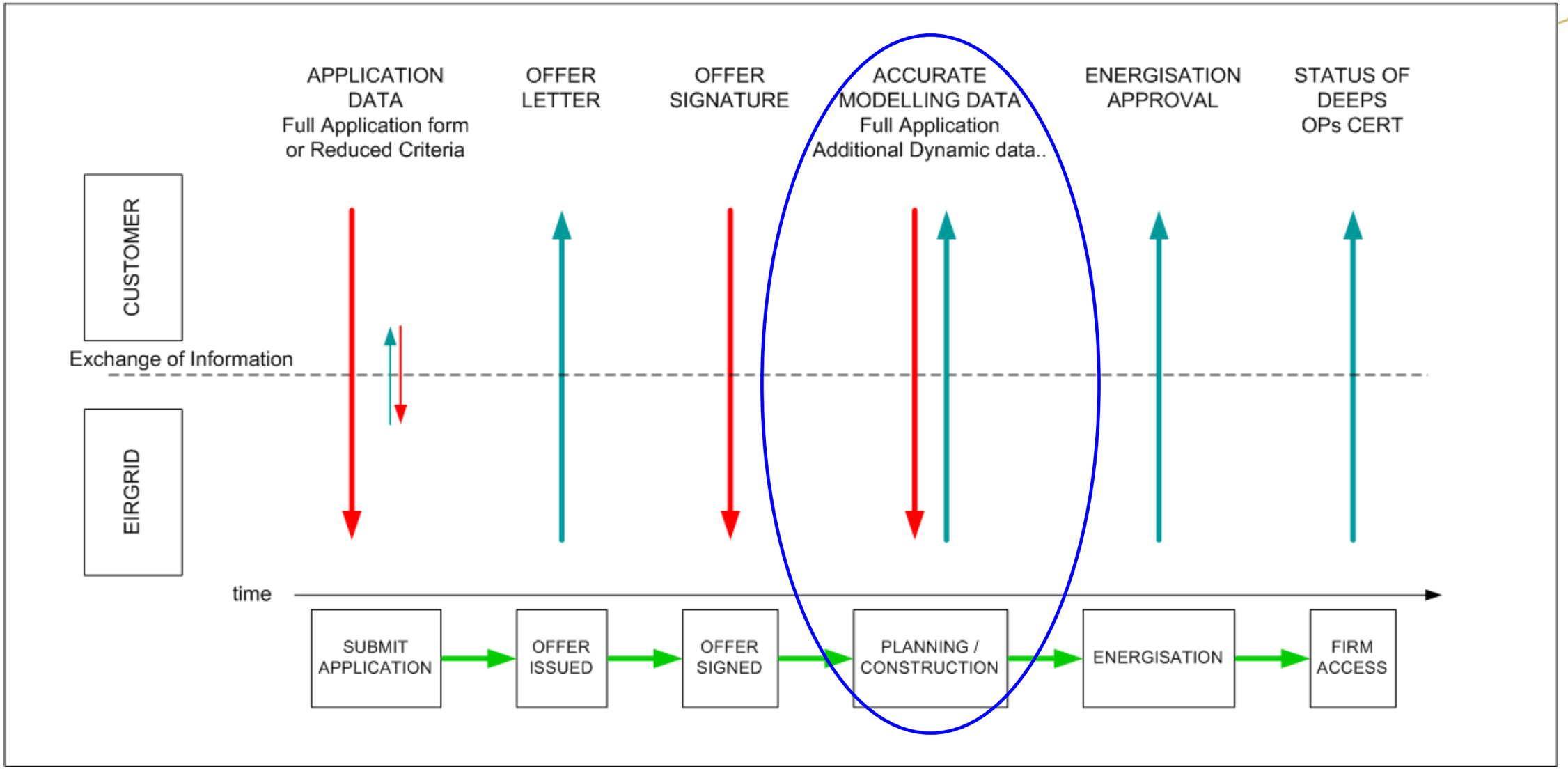
- Process agreed with industry on the provision of data
- Recently agreed – backlog to work through…

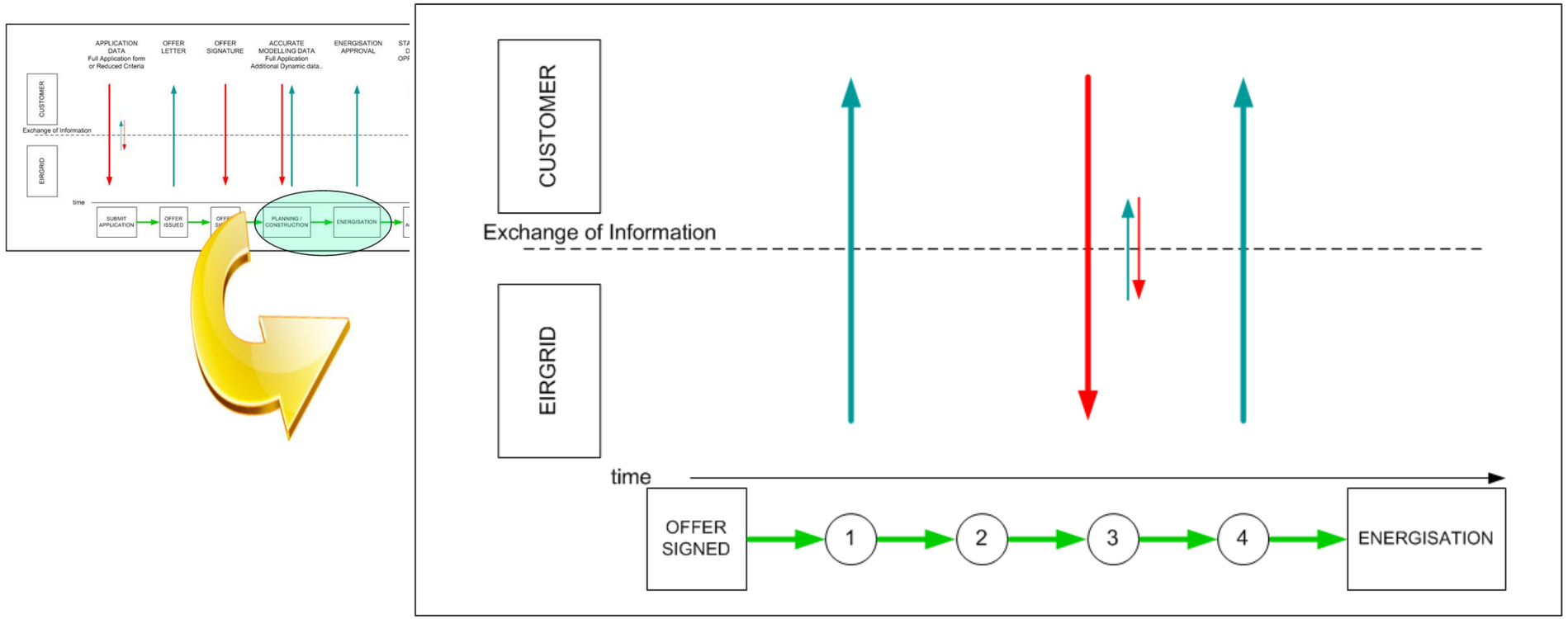
Wind Power Plants

Liaise with the wind industry to agree:

- Details required
- How exactly it will be used
- Optimum time for information to be provided

Provision of Committed Project Data





1. **Detailed design phase**: Tender for Generator Manufacturers / Contracts
   Information on the specific connection point may be required from the TSO

2. **Awarding of Contract** to selected Generator Manufacturer

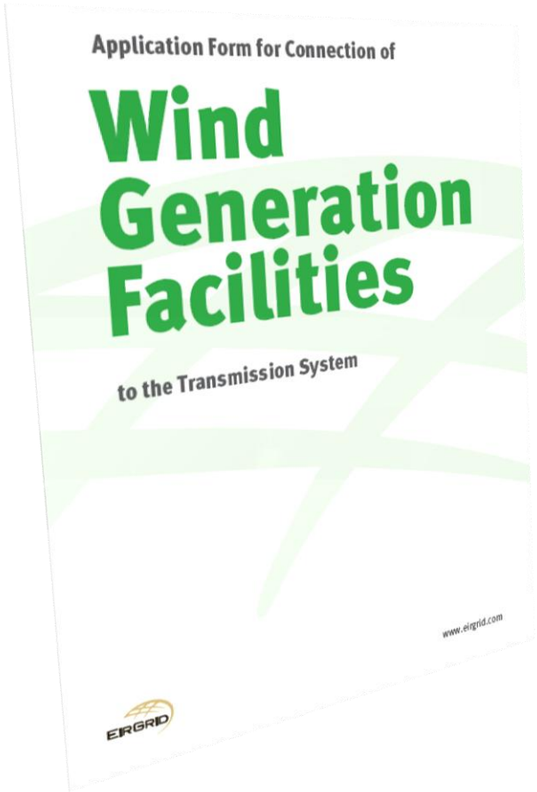
3. **Accurate information available** (at least 1 year in advance).
   Confirmation of: Generator type / Internal connections / Short Circuit Data etc…
   Provision of: Dynamic Data

4. **EirGrid to complete pre-energisation analysis** & review associated works.
   No stability concerns => EirGrid approval for Energisation to go-ahead

Application

Wind Power Plants

See GC PCA.4.10.1 – Modelling Requirements for Wind Turbine Generators



http://www.eirgrid.com/customers/gettingconnected/winddynamicmodelling/

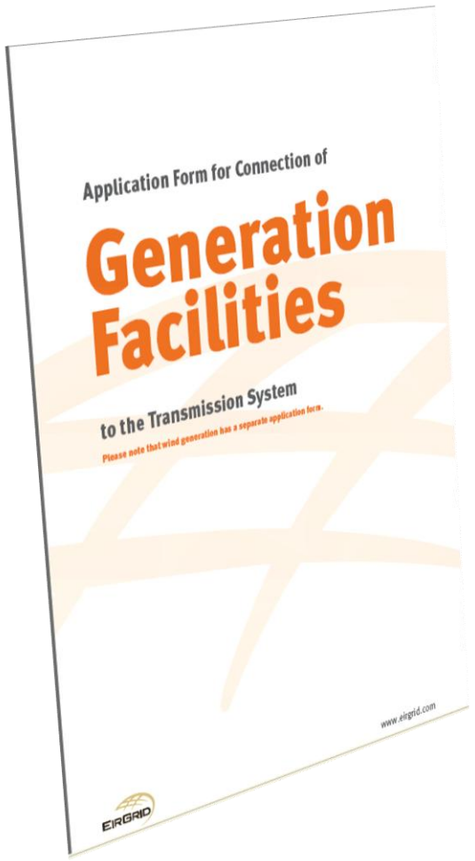
EirGrid to model Wind Power Plant:

- Dynamic Reactive Support
- Wind Farm Controller
- etc… (dynamic characteristics)

Application

Conventional Power Plants

Generator Data



DYNAMIC SIMULATION DATA

GENERATOR DATA

Please note that exact information and parameters regarding excitation, governor systems and power system stabiliser will be required at the time of commissioning.

Noted ☐

	Unit 1	Unit 2	Unit 3
87. X_d – Generator Direct Axis Positive Phase Sequence Synchronous Reactance: (pu machine MVA base)			

GENERATOR DATA – CONTINUED

88. X_q – Generator Quadrature Axis Positive Phase Sequence Synchronous Reactance: (pu machine MVA base)			
89. X_d' – Generator Direct Axis Transient Reactance (unsaturated): (pu machine MVA base)			
90. X_q' – Generator Quadrature Axis Transient Reactance (unsaturated): (pu machine MVA base) (Note: Not applicable to induction generators).			
91. X_d'' – Generator Sub-transient Reactance (unsaturated): (pu machine MVA base)			
92. X_l – Armature Leakage Reactance: (pu machine MVA base)			
93. T_{do}' – Generator Direct Axis Transient Open Circuit Time Constant: (Sec)			
94. T_{do}'' – Generator Direct Axis Subtransient Open Circuit Time Constant: (Sec)			
95. T_{qo}' – Generator Quadrature Axis Transient Open Circuit Time Constant: (Sec)			
96. T_{qo}'' – Generator Quadrature Axis Subtransient Open Circuit Time Constant: (Sec)			
97. H – Inertia of complete turbogenerator including prime-mover gearbox if fitted (MWs/ MVA)			

98. Please submit the open-circuit generator magnetic saturation curve. If this data is not available at this stage EirGrid will assume the magnetic saturation characteristics for the generator to be in accordance with Appendix B.

Complete the following section as appropriate:

Please assume generator magnetic saturation curve as per appendix B ☐

OR

Please assume other generator magnetic saturation curve ☐

Name of attachment specifying curve:

_____

Facilitation of Renewables

Facilitation of Renewables Forum

27th January 2011 –

- Workshop presenting the next steps following the FoR Studies.
- Programme for a Secure Sustainable Power System

Key Actions

- Recommend full enforcement of all appropriate Grid Codes standards universally.
- Review market and support mechanisms.
  - Incentivise greater performance capability from all plant

- See website: www.eirgrid.com/renewables/facilitationofrenewables

Key Messages

Concerns over Dynamic Instability present a risk to projects being delayed…

Generator Obligations:

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EirGrid Customer Connections Forum

20th July 2011

Temporary Connections for Gate 3 Wind Farms – Technical Aspects

Gary Nolan
Transmission Access Planning

Overview

- Introduction
- Network locations with probable temporary connections
- Overview of determining how much and which projects can avail of temporary connections
- Worked example
- Next steps
- IWEA proposal and clarification letter

Introduction

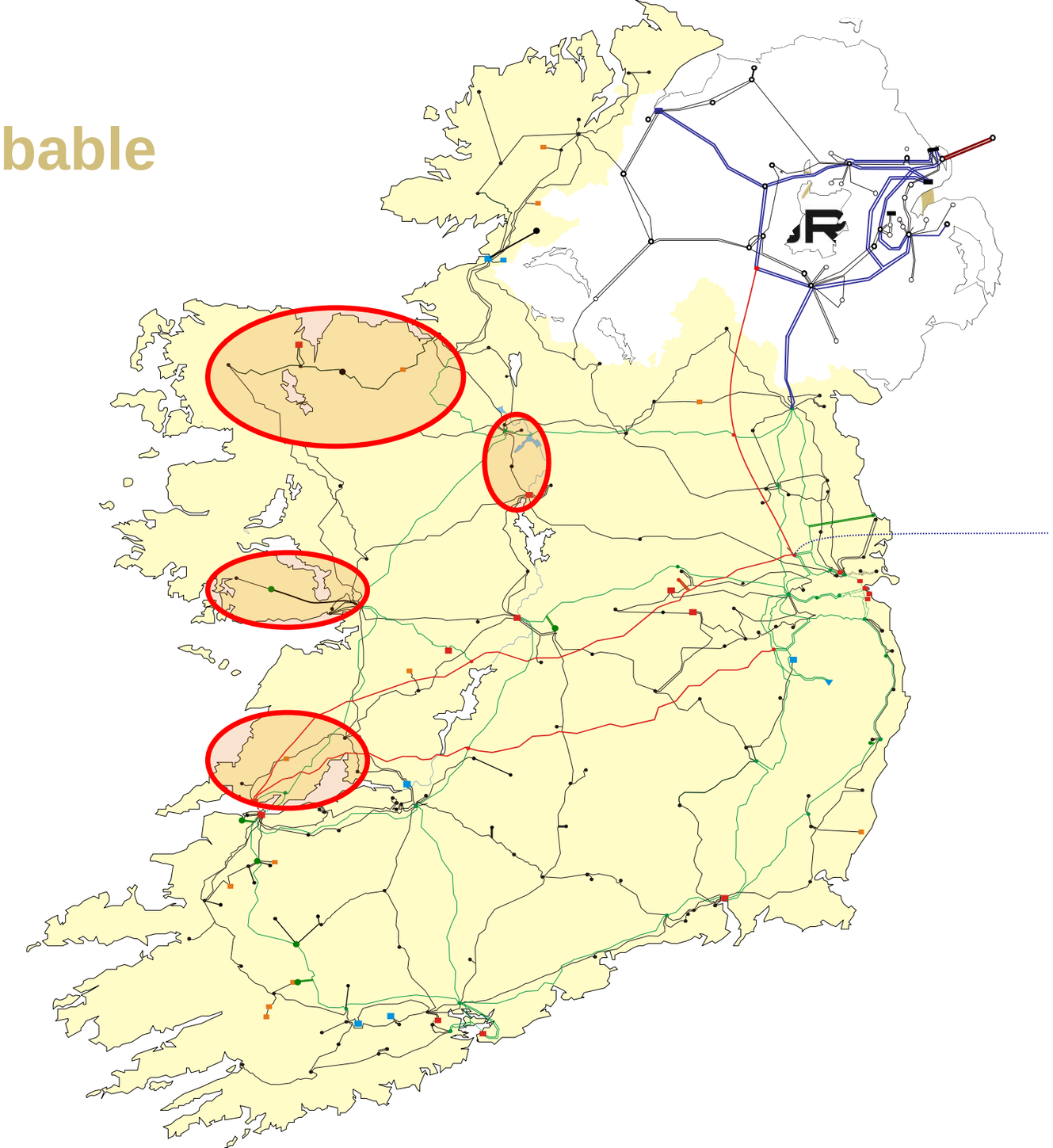
- The Connection Offer Policy and Process (COPP) Paper and the CER's decision paper on COPP published in May 2011.
- Temporary Connections for Gate 3 projects detailed in COPP

- A temporary connection is defined as a connection to the transmission or distribution network which is completed in advance of the permanent shallow connection works for a generator.

- Strong interest in temporary connections from a number of Gate 3 applicants
- EirGrid being asked:
  - 'How much can be connected?'
  - 'Can it be my project?'

Network Locations with Probable Temporary Connections

- 110kV network between Castlebar and Sligo stations
- 110kV network between Moneypoint and Ennis stations
- 110kV network between Flagford and Lanesboro stations
- 110kV network between Screebe and Cashla stations



High Level Considerations

1. There is a requirement to provide a number
    - An obvious practical limit exists in some instances & we need to answer applicant's question 'How much can be connected?'
    - Need to remove uncertainty (If I connect who will connect after me and could my project survive)
2. The level of constraint temporary connections may impose on other system users is an issue
    - Pre-Gate 3 generation
    - Protection of TUOS customer
3. EirGrid's commitment to facilitation of renewables
    - Making the best use of the existing network
4. A clear / transparent way to apportion available capacity is required

Principle for Determining Generation to Avail of Temporary Connection

- Determine the available capacity on the local circuits and protect the pre-Gate 3 and permanently connecting Gate 3 projects on the local network by safeguarding the local capacity they require.

- Allow the temporary installed generation to be greater than the available capacity calculated but control the export to the available capacity amount.

Determining the Available Capacity

- We can only consider the *local network*
    1. The network between two meshed stations on the transmission system where a meshed station is a station with three or more transmission circuits none of which are tails,
    2. In the case of a tail into a meshed station, the tail itself would be considered the local network.
- Temporary Connections may, and likely will, increase constraints and curtailment that would otherwise not arise if temporary connections were not permitted

- Capacity available to temporary connections equals:

    Capacity of limiting circuit considering N-1 contingency (for tails this is just the capacity of the tail)

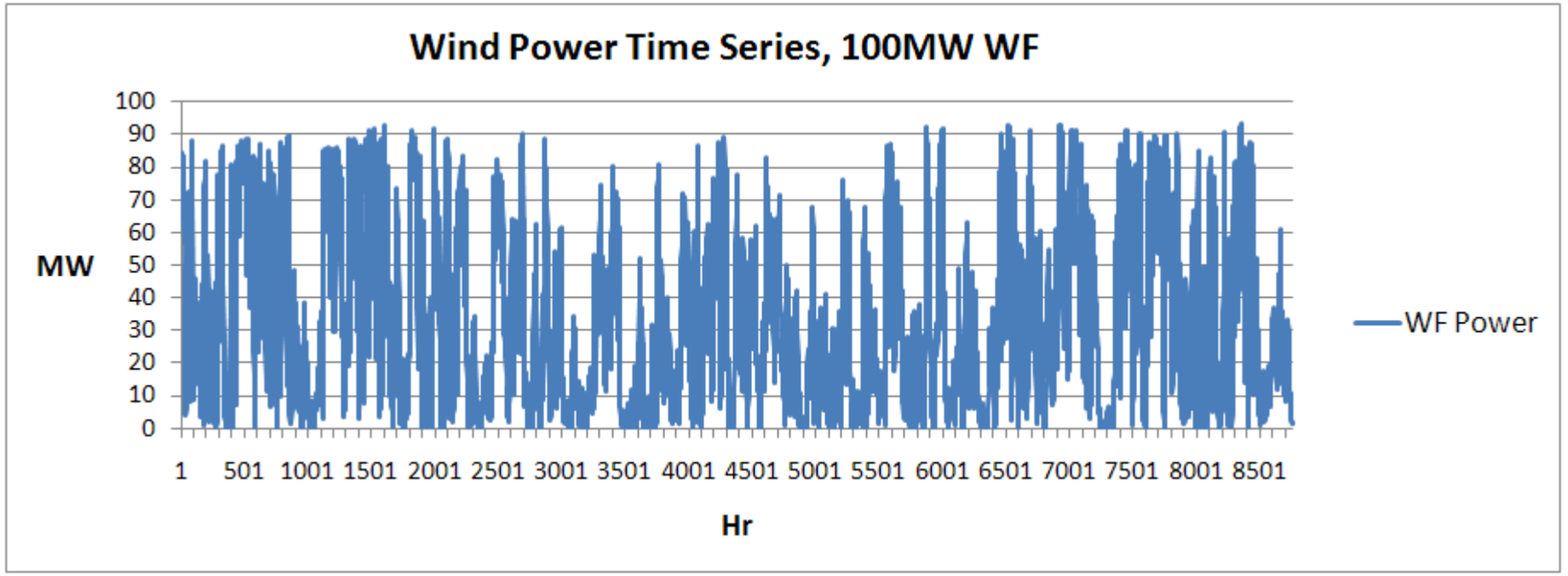
    + (plus) allowable emergency overload capability (not applicable for tails)

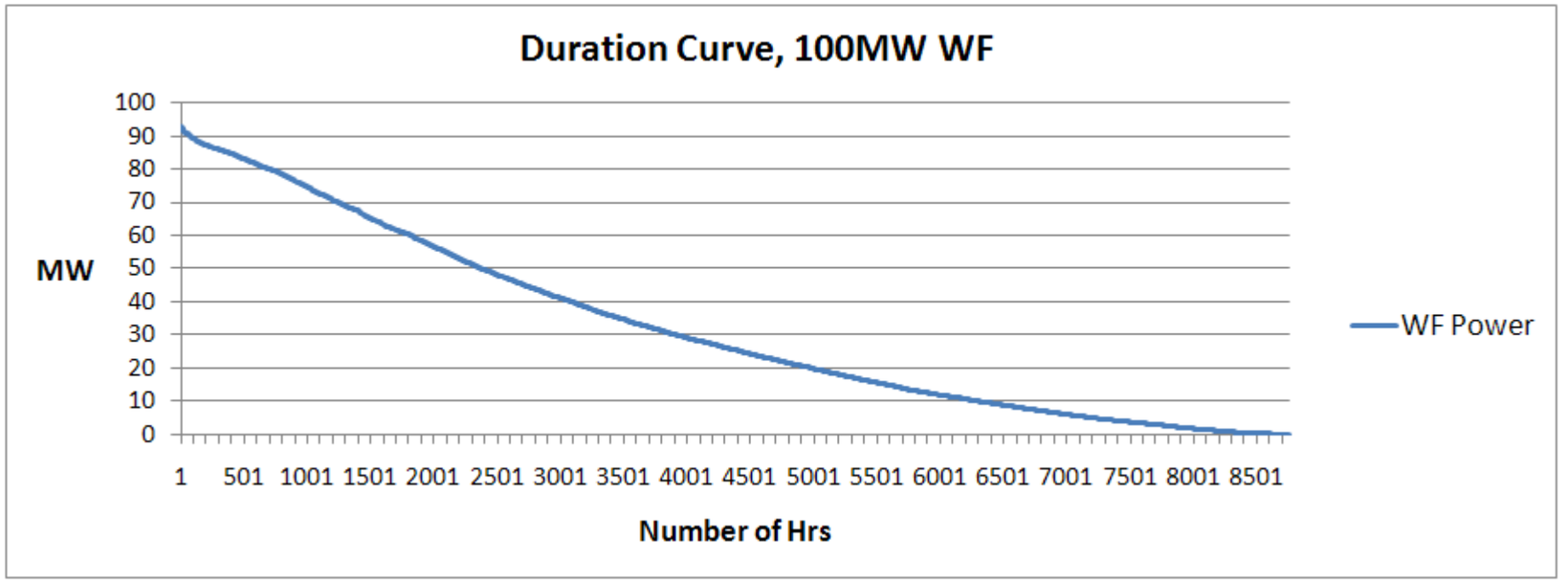
    + (plus) summer valley load

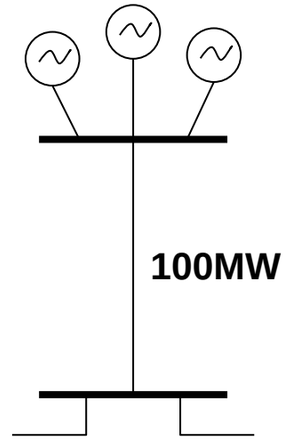
    - (minus) pre-Gate 3 wind generation

    - (minus) Gate 3 applicants on permanent connections (advised by CER)

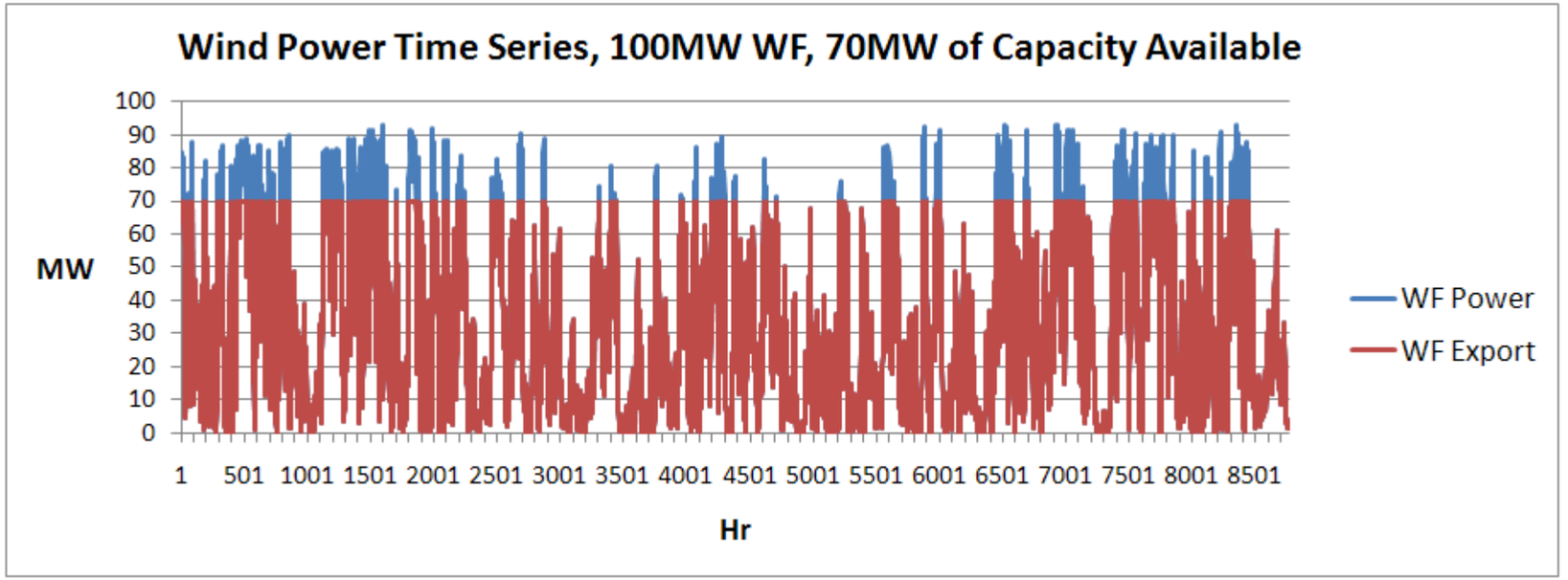
Determining the Installed Generation Amount

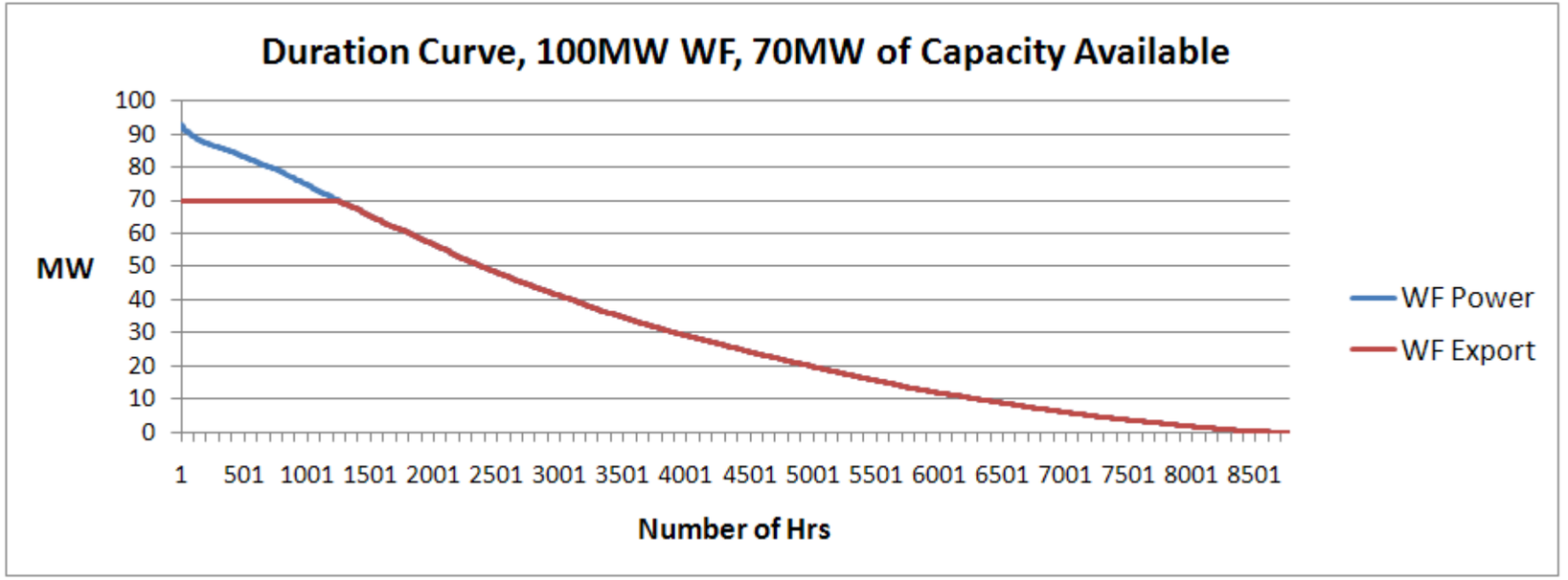


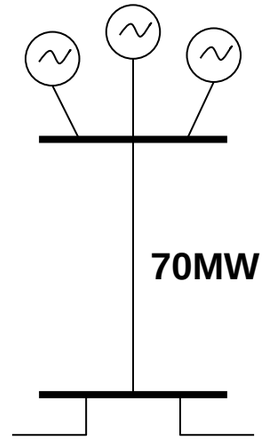




Determining the Installed Generation Amount

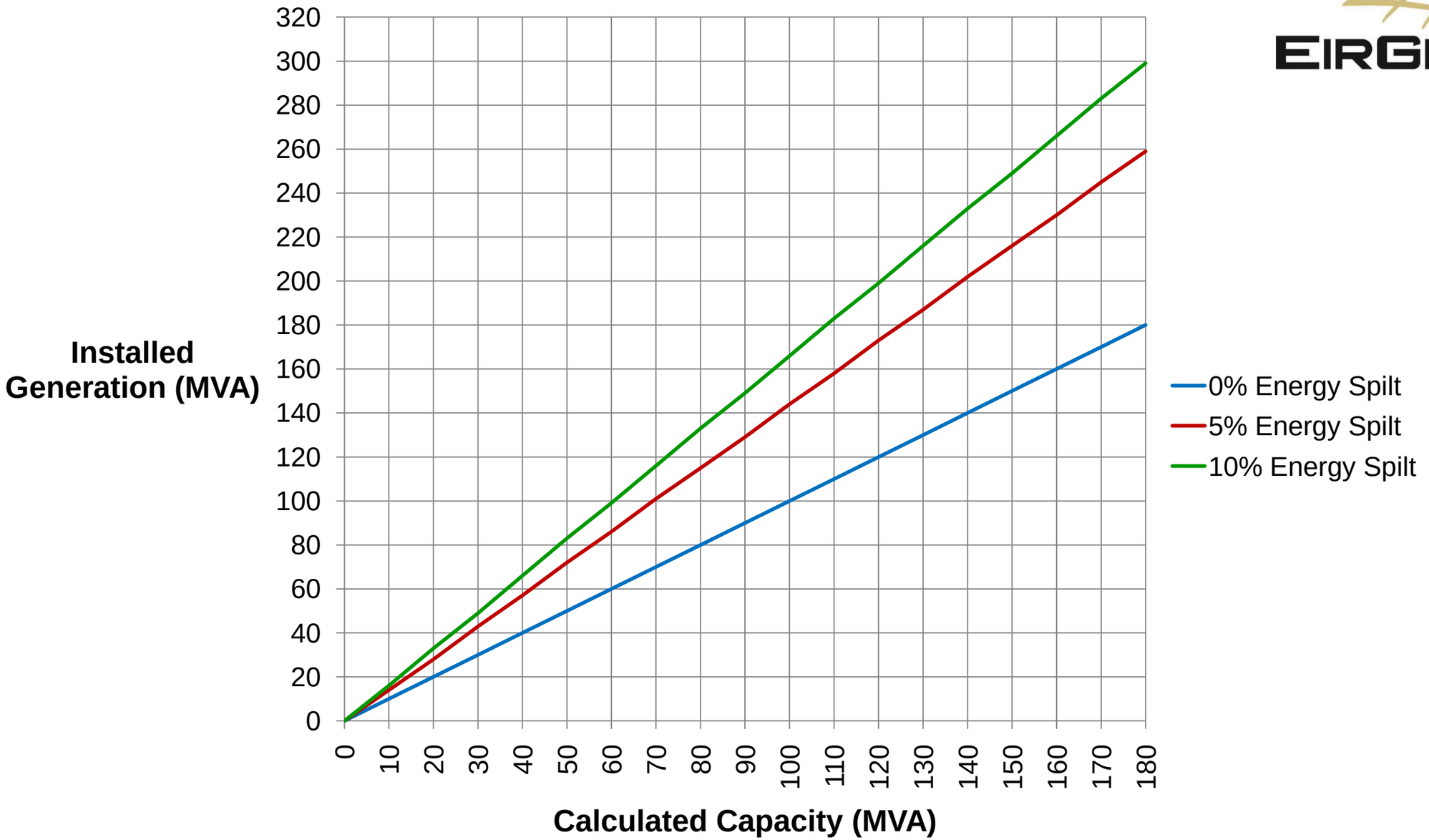






Energy Produced (GW-hr): 285
Energy Spilt (GW-hr): 13.5
Energy Spilt (%): 4.7

Determining the Installed Generation Amount (cont.)



Note: Numbers to be verified and may vary by location

Principle for Determining Generation to Avail of Temporary Connection

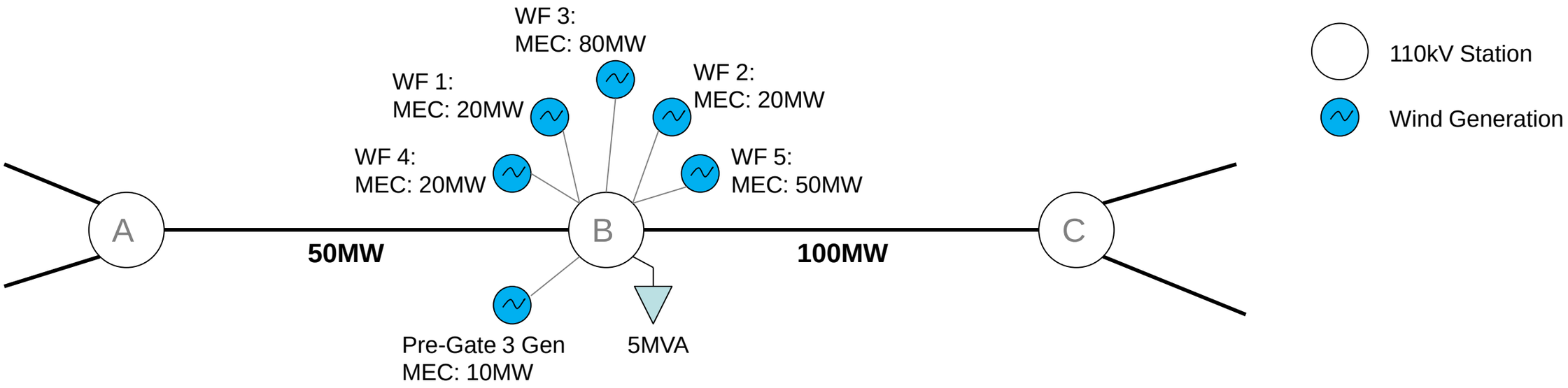
- Determine the available capacity on the local circuits and protect the pre-Gate 3 and permanently connecting Gate 3 projects on the local network by safeguarding the local capacity they require.
  - Step 1 of methodology: calculate available capacity for temporary connections

- Allow the temporary installed generation to be greater than the available capacity calculated but control the export to the available capacity amount.
  - Step 2 of methodology: calculate installed amount reflecting an acceptable level of energy being spilt (10%).

Worked Example

General Info

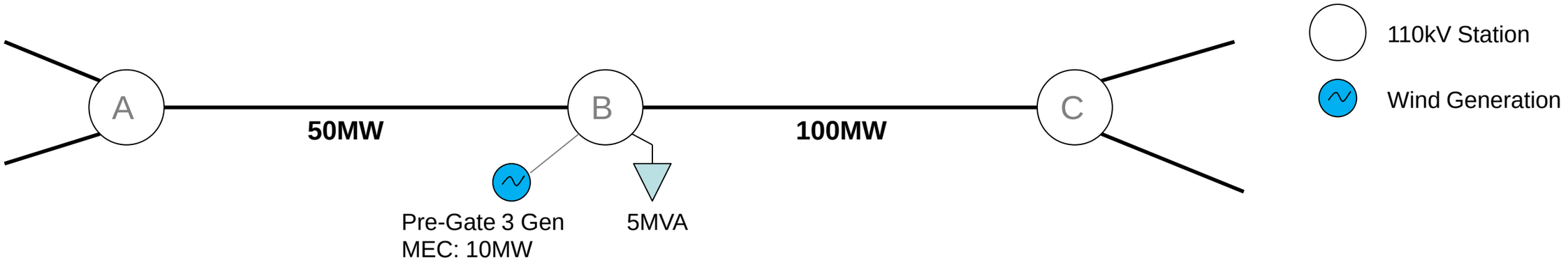
- Five wind farms proposed to connect at station B.
- Uprate of circuit from stations A-B is a shallow work for the five wind farms.
- Four wind farms (WF 1, 2, 3 & 4) meet the criteria for temp. connections and request to connect prior to completion of uprate.



Worked Example: Step 1

Step 1: Calculate temporary export capacity of the group

Capacity of limiting circuit considering N-1 contingency	=50
+ (plus) allowable emergency overload capability	=50+5=55
+ (plus) summer valley load	=55+5=60
- (minus) pre-Gate 3 wind generation	=60-10=50
- (minus) Gate 3 applicants on permanent connections	=50-0=50



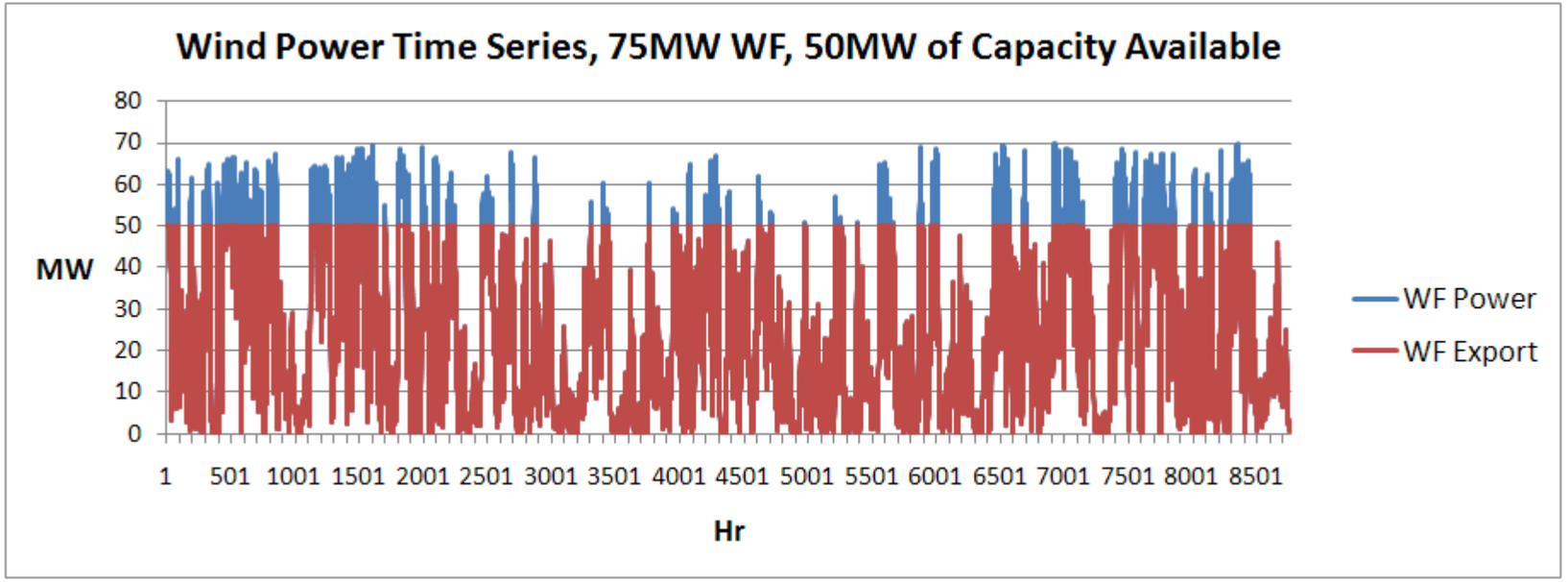
Worked Example: Step 2

Step 2: Calculate installed capacity of group that will result in 10% energy being spilt when the group control their output to the temporary export capacity calculated.

- Temporary export capacity of group: 50MW

  ⇒ Plug into spreadsheet and based on sample time series calculate installed capacity of group

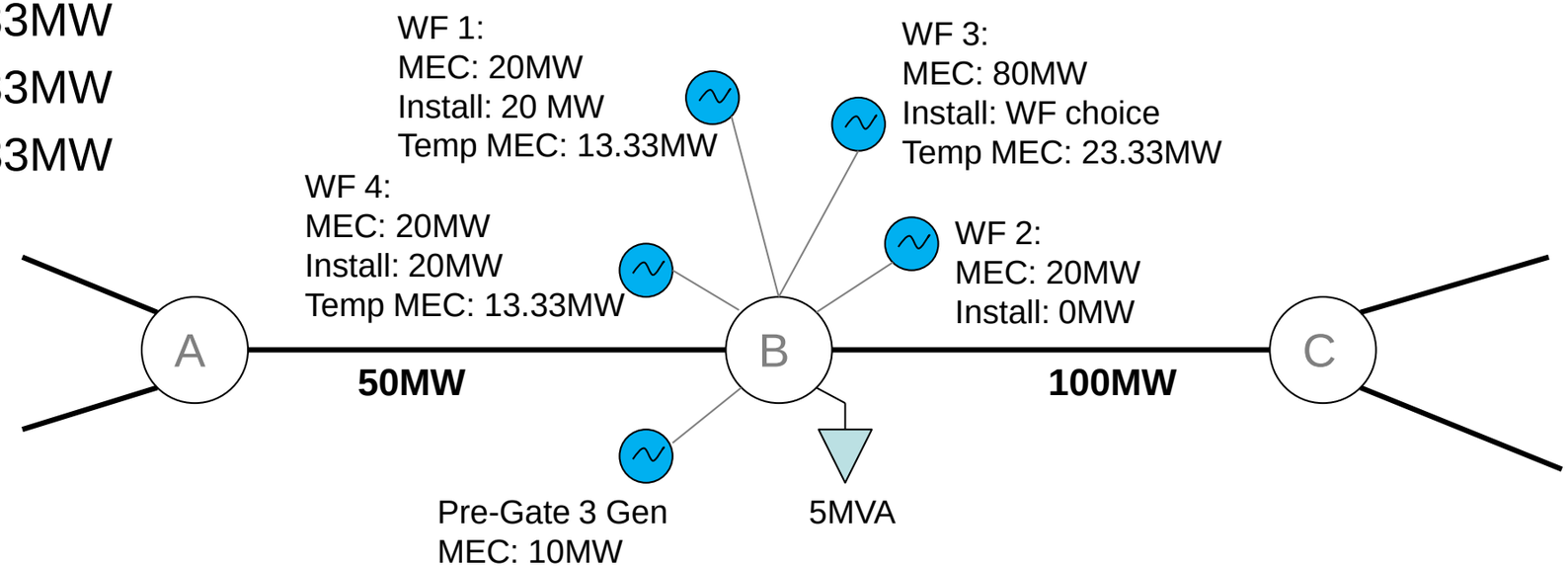
- Installed capacity of group: 75MW



Worked Example: Step 3

Step 3: Allocate capacity

- Order of wind farms to receive temporary connections: WF 4, WF 1, WF 3, WF 2
- Allocate installed capacity of group (75MW) based on order:
  - WF 4 20MW
  - WF 1 20MW
  - WF 3 35MW
- Calculate temporary maximum export capacities
  - = install amount * (temporary export capacity of group / installed capacity of group)
  - WF 4 = 20 * (50 / 75) = 13.33MW
  - WF 1 = 20 * (50 / 75) = 13.33MW
  - WF 3 = 35 * (50 / 75) = 23.33MW



Worked Example: Step 4

Complete necessary technical studies:

- Load-flow studies
- Short circuit studies
- Dynamics studies (possibly)

- Must verify no issues with the connections
- In some instances reduce the available capacity for temporary connections and in some extreme instances issues may arise which render the temporary connection impossible

Worked Example: Step 5

Issue temporary connection offers

Next Steps for Processing Temporary Connections

- Applicants can submit requests for temporary connections
- Will be engaging with everyone in a ‘temporary group’ who are potentially eligible once a request is received
- Process set out as per COPP Paper
- Expected timeframe for processing will depend on volume of interest in each Area

IWEA Proposal for Temporary Connections

- IWEA believe as a principle that temporary connected generation should not increase the constraints for other generation
    - Focus of the approach taken is to achieve this as much as possible

- It should be possible in most cases to identify the binding constraints on the 110 kV network between the transmission node where the generator is temporary connected and the permanent connection node on the stronger part of the network. Special dispatch rules could be developed to allocate any overloading of these circuits to the temporary connected generation first.
    - Some similarity to approach detailed.
    - Approach detailed identifies these constraints up front and replaces the NCC controller with the wind farm control system implementing the constraining
    - Not practical considering practical limitations on the NCC controller and NCC control systems

- Any constraint on the network beyond the permanent connection node should continue to be shared on a pro-rata basis, subject to pro-rata being the decision from the Dispatch consultation
    - Approach consistent with this

- IWEA believes that there is a level of constraint that would be acceptable to developers and that this could be used to identify the capacity that could be offered for temporary connections, e.g. 5%. Based on this level, EirGrid could calculate the capacity available.
    - Approach uses this

IWEA Proposal for Temporary Connections

- Flexibility should be allowed for a Gate 3 subgroup to unanimously agree the acceptable level of constraint.
  - Believe it could be difficult for Gate 3 subgroup to agree in some instances, however
  - Would be open to this if specific case where this would be applicable arises

- This capacity can also be increased on a regular basis with improved line uprating, the introduction of SPS schemes, dynamic line rating etc.
  - Line uprating – agreed
  - SPS schemes – don't expect to make significant difference in most instances, also additional issues with the use of SPS schemes.
  - Dynamic line rating – agreed (not currently on system)

- duration period of constraints should be factored into the methodology i.e. a project maybe able to sustain a higher level of constraint for a short period of time or a lower level of constraint over a longer period of time.
  - Not considered in approach, but will be providing applicants with best available information on shallow works and would be open to this if specific case where this would be applicable arises

- It is proposed that projects interested in temporary connections should apply for it. Offers would be issued on a date order basis (i.e. the original application date) with a limited time for take-up of the offer. If the offer is not taken up that project is then moved to the end of the queue.
  - Aspects of the ruleset regarding allocation directed on by CER

IWEA Clarification and Comments on COPP – Temp Connections (received 14/07/11)

In general IWEA made a significant response on temporary connections, points have not been considered in particular the basic criteria for the calculation of the temporary generation quantity, in particular

1) SPS schemes were not considered. N-1 should not be a requirement since developers can accept the risk of forced outages and obtain an estimate on any planned outages.
    - Transmission system is continuously operated to N-1 limit. It is not a case of accepting risk of forced outage.
    - SPS discussed previously
2) Winter demand was not considered.
    - Not consistent with principle of protecting non-Gate 3 temporary connecting parties
3) Dynamic line rating was not considered.
    - Discussed previously
4) Constraint levels of +10% can be accepted by developers. Engagement with developers at a particular Node should be undertaken to determine what constraint levels they can absorb over a particular time period.
    - Discussed previously

IWEA Clarification and Comments on COPP – Temp Connections (received 14/07/11) cont.

5) NA
6) NA
7) Sec 4.5. For clarity EirGrid should present the information in Sec 4.5 to make sure applicants have interpreted the process properly at the EirGrid Customer Forum on 20th July.
    - Done
8) Sec 4.4. (4th bullet point) IWEA has serious concerns that Date order within the gate has not been considered as part of the criteria. What is EirGrid's rationale for not following this criteria? For example an applicant at the end of the Gate 3 queue (e.g. 16/11/07) can obtain a temporary connection offer in advance of an applicant at the start of the Gate 3 queue (e.g. 19/2/04).
    - Aspects of the ruleset regarding allocation directed on by CER
9) Worked example on page 14 should be presented by EirGrid Customer Forum on 20th July. In general, more detail on the examples should be presented including how they will pro-rate constraint by 10%. It would be useful if EirGrid presented an actual example.
    - Done

Discussion / Questions and Answers