Forward Capacity Market ("FCM")
Overlapping Interconnection Impacts

Conference

July 23, 2007

Introduction & Opening Remarks

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Vice President, System Planning
ISO New England

Conference Purpose

1. To explain and discuss proposed Overlapping Interconnection Impacts standard applicable to the Forward Capacity Auction (FCA) Qualification process

Agenda

1. Brief review of the process for New Generator Interconnection in New England
2. Brief review of the Qualification requirements for New Generation under the Forward Capacity Market
3. Describe the process used to design an Overlapping Interconnection Impact Standard
4. Present results found in analyzing different standard alternatives
5. Present recommended Overlapping Interconnection Impact Standard

Background & Objectives

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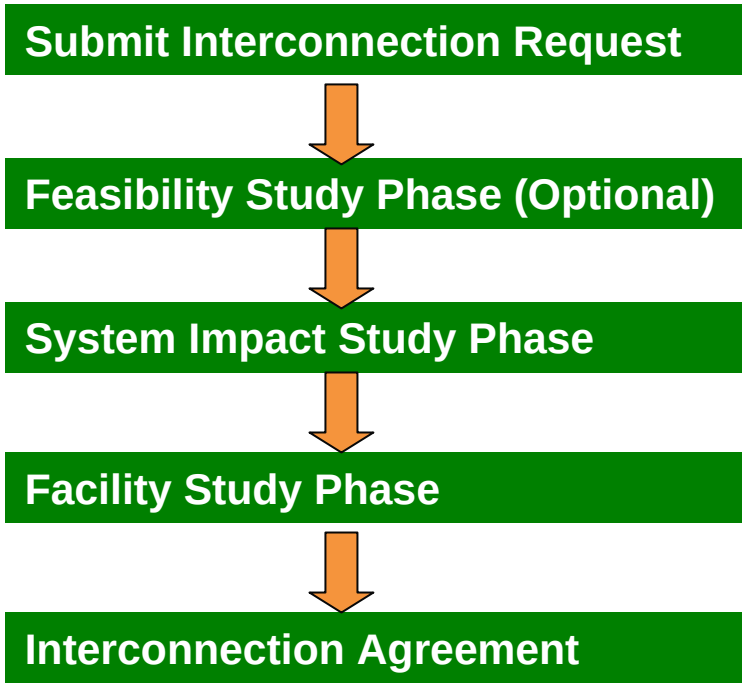
Interconnection Process in New England

- The Large Generator Interconnection Procedures (LGIP) and Large Generator Interconnection Agreement (LGIA) apply to requests to interconnect Large Generating Facilities or to materially change an existing generating unit interconnected to the Administered Transmission System.
- The LGIA/LGIP are contained in Schedule 22 of the ISO-NE Open Access Transmission Tariff (OATT)
- The Small Generator Interconnection Procedures (SGIP) and Large Generator Interconnection Agreement (SGIA) apply to Generators < 20MW and are contained in Schedule 23 of the Tariff
- **These requirements are not bypassed by participation in the FCM market**

Major Steps in the LGIP



Tariff Section I.3.9 Proposed Plan Approval

Also Required to Interconnect

Note: Please see Schedule 22 of the ISO-NE Tariff and related documents For precise details on the LGIP

Background of the LGIP/SGIP Interconnection Standard

- In 1998 & 1999 FERC made various rulings regarding the NEPOOL/ISO Open Access Transmission Tariff and Interconnection Process
- This led to NEPOOL adopting Planning Procedure 5-6 – "Scope of Study for System Impact Studies under the Minimum Interconnection Standard (MIS)" (April 1999)
- Under the MIS:
  - "As a result of the addition of the proposed new Resource, the maximum collective change in the amount by which other Resources must be **re-dispatched** to meet the Reliability Standards, does not exceed the capacity of the new Resource, as measured by its intended high limit"

Forward Capacity Market Agreements

- The Forward Capacity Market (FCM) Settlement Agreement was approved by FERC in June 2006
- New Generating Resources should be qualified before proceeding to participate in a Forward Capacity Auction
  - A completed System Impact Study is not required to qualify
  - An “Initial Interconnection Analysis” would be required
  - A review of “Overlapping Interconnection Impacts” would be required

From the FCM Settlement Agreement…

"If applicable for a specific Resource, while **a full and completed System Impact Study (SIS) is not a requirement** to participate in the FCA, at a minimum, **initial interconnection analysis is required**. The ISO and the Reliability Committee shall work out specifics with respect to the performance of such initial interconnection analysis and **selection criteria** (including auction details) for multiple projects when only a subset of such projects can be selected in the FCA **due to overlapping interconnection impacts**". *Settlement Agreement II.B.3.c*

Overlapping Impacts within FCM

- New Qualified Capacity must be incrementally useful – must provide an additional capacity benefit
- New Generation is analyzed for Overlapping Interconnection Impacts during qualification
- For the FCM, if qualification is restricted due to overlapping impacts, the threshold should be:
  - Where the upgrade(s) cannot be completed in time for the Commitment period
  - Where upgrades can be completed in time, the generator will be qualified and the generator will be responsible for the upgrades

Overlapping Impacts within FCM

- Where multiple New Generating Resources cannot be selected because they overlap with each other:
  - Interconnection Queue order is used to choose between the overlapping generators
  - A future, separate stakeholder process will reevaluate this approach

Planning Procedure 10

- A new Planning Procedure was needed to describe various planning activities needed to support the FCM
- The ISO and the NEPOOL Reliability Committee have discussed the procedure at nine Reliability Committee meetings going back to September 2006
  - including in-depth discussions of Initial Interconnection Analysis and Overlapping Interconnection Impacts
- Planning Procedure 10 - Planning Procedure to Support the Forward Capacity Market (PP-10) was approved by the NEPOOL Participants Committee in March 2007

Planning Procedure 10

- PP-10 describes the following:
  - Process for establishing the Commitment Period Base Case
  - Process for certifying Transmission Upgrades
  - Scope of Work for Initial Interconnection Analysis of New Generation seeking to qualify for the FCM
    - PP-10 Appendix A contains details of this analysis
  - Scope of Work for the analysis of Overlapping Interconnection Impacts for New Generation seeking to qualify for the FCM
  - Other Transmission Analysis activities to support the FCM
- The detailed criteria to be used in the analysis of Overlapping Interconnection Impacts are to be contained in Appendix B of PP-10

Comparing the FCM Qualification Analyses and the LGIP/SGIP

- LGIP/SGIP is more thorough than Initial Interconnection Analysis under FCM and may identify problems/costs not revealed by Initial Interconnection Analysis
- Overlapping Impact Analysis is part of FCM qualification but not part of the LGIP/SGIP
- All New Capacity must complete the LGIP/SGIP before becoming interconnected
- An LGIP/SGIP Interconnection Request (IR) may be submitted at anytime before, during or after the FCM Qualification process
  - Submitting an IR earlier in the process will provide more detailed information to the Project Sponsor regarding necessary interconnection and network transmission upgrades and their cost

Comparing the FCM Qualification Analyses and the LGIP/SGIP

	Interconnection Analysis under FCM	**System Impact Scope of Analysis Required under LGIP/SGIP before the project can Interconnect**
Scope of New Generating Capacity Analyses	• Thermal • Short-Circuit • Overlapping Interconnection Impacts • Identify Violations	• Thermal • Short-Circuit • Voltage • Stability • Identify Violations • Develop Solutions & Costs

New Intra-Zonal Deliverability Standard

- FERC has required the ISO to file a mechanism that will ensure generators meet an intra-zonal deliverability test in order to qualify as a capacity resource*
  - A response is currently due to FERC in February 2008*
- This mechanism would offer interconnection customers an option under LGIP/SGIP for meeting a zonal deliverability requirement that has higher interconnection obligations than that of the MIS*
- FERC explained that within the RTO/ISO context, deliverability need not mean that a generator's output must reach all load within the footprint of the RTO/ISO*
- Standard will be developed through the stakeholder process

*FERC Docket ER04 - 433

Objective of this Conference Discussion

- Discuss criteria for Overlapping Interconnection Impact analysis to be used in qualifying New Generation for the Forward Capacity Auction
- These criteria will be captured in an updated Appendix B of PP-10
- Prepare for NEPOOL Reliability Committee vote on updated Appendix B of PP-10 – August 8, 2007

NOT part of Conference Discussion

- The direct focus of this Conference does not include the required upcoming Intra-Zonal Deliverability Compliance Filing
  - The intra-zonal deliverability filing may lead to conforming changes to PP-10
- The direct focus of this Conference does not include discussion of certain compliance issues in FERC's acceptance of the filed Forward Capacity Market Rule
  - Interaction of the Interconnection Queue with Forward Capacity Market Qualification

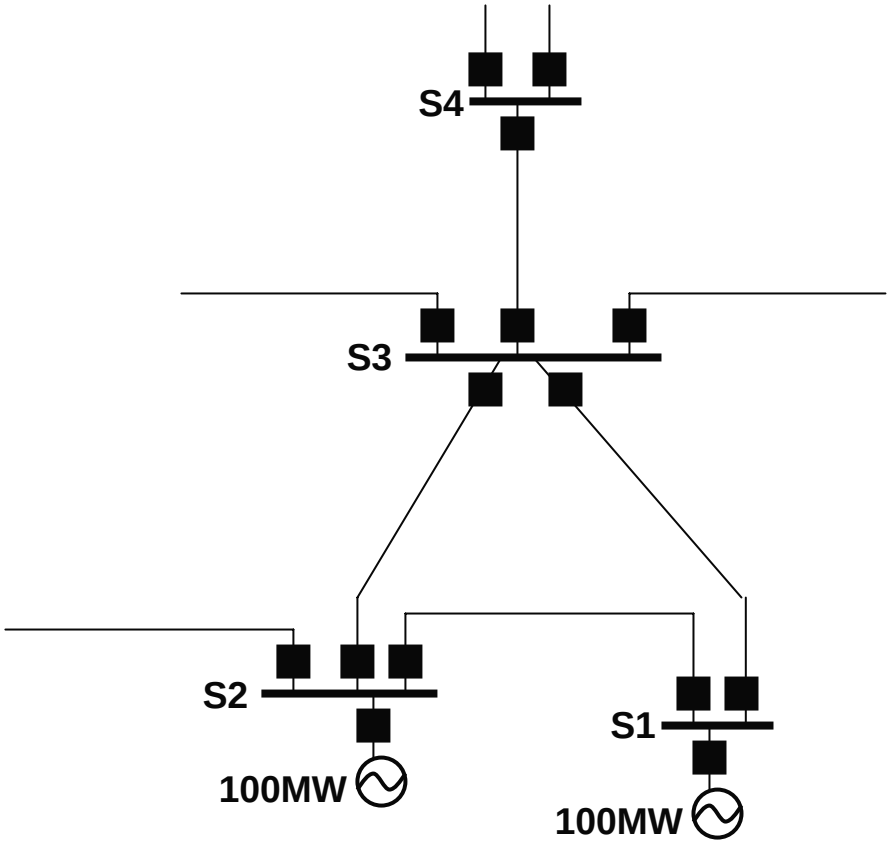
Overlapping Impact Test Design Approach

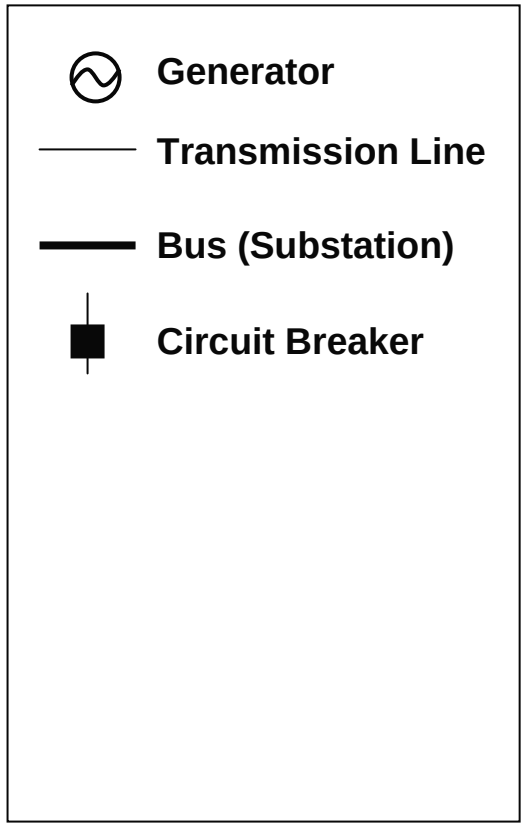
Alan McBride
Principal Engineer - System Planning
ISO New England

Design Approach Discussion

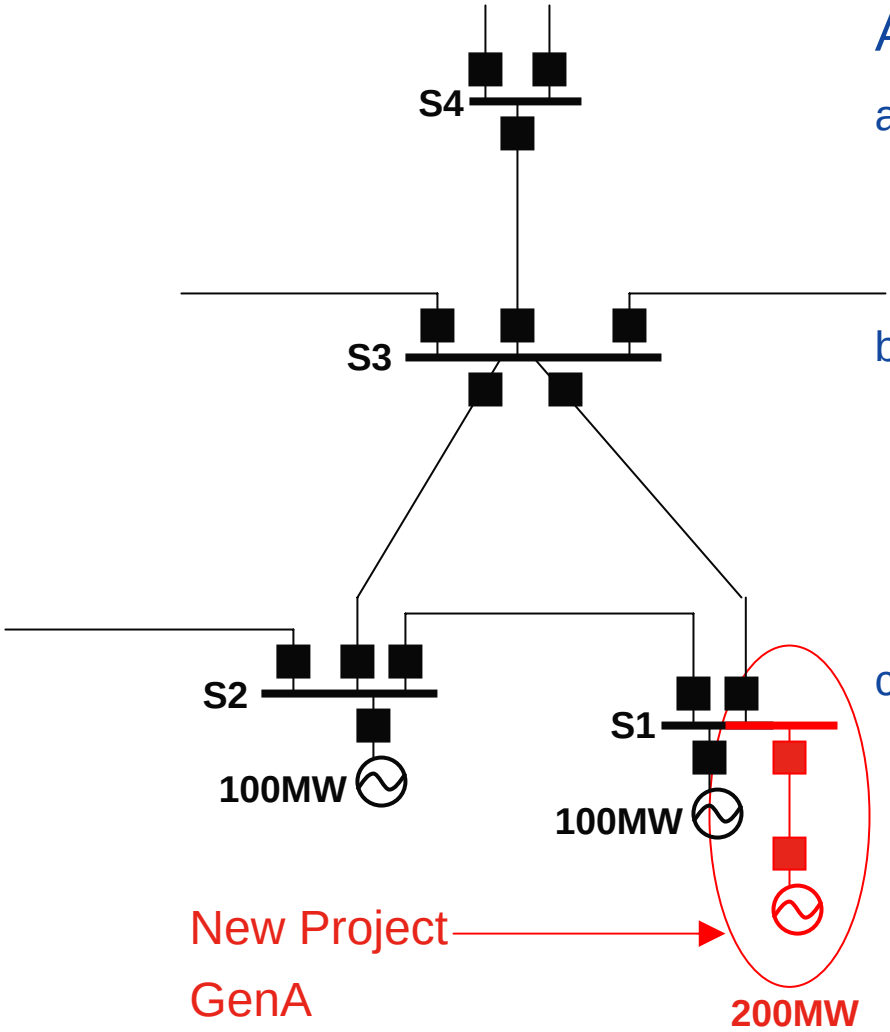
1. In the following slides a simple power system diagram is used to illustrate the Minimum Interconnection Standard
2. A simple power system representation will be used to illustrate an example of an Overlapping Interconnection Impact
3. A more general power system representation will then be used to illustrate the design choices involved in the Overlapping Interconnection Impact standard

Power System





New Interconnection



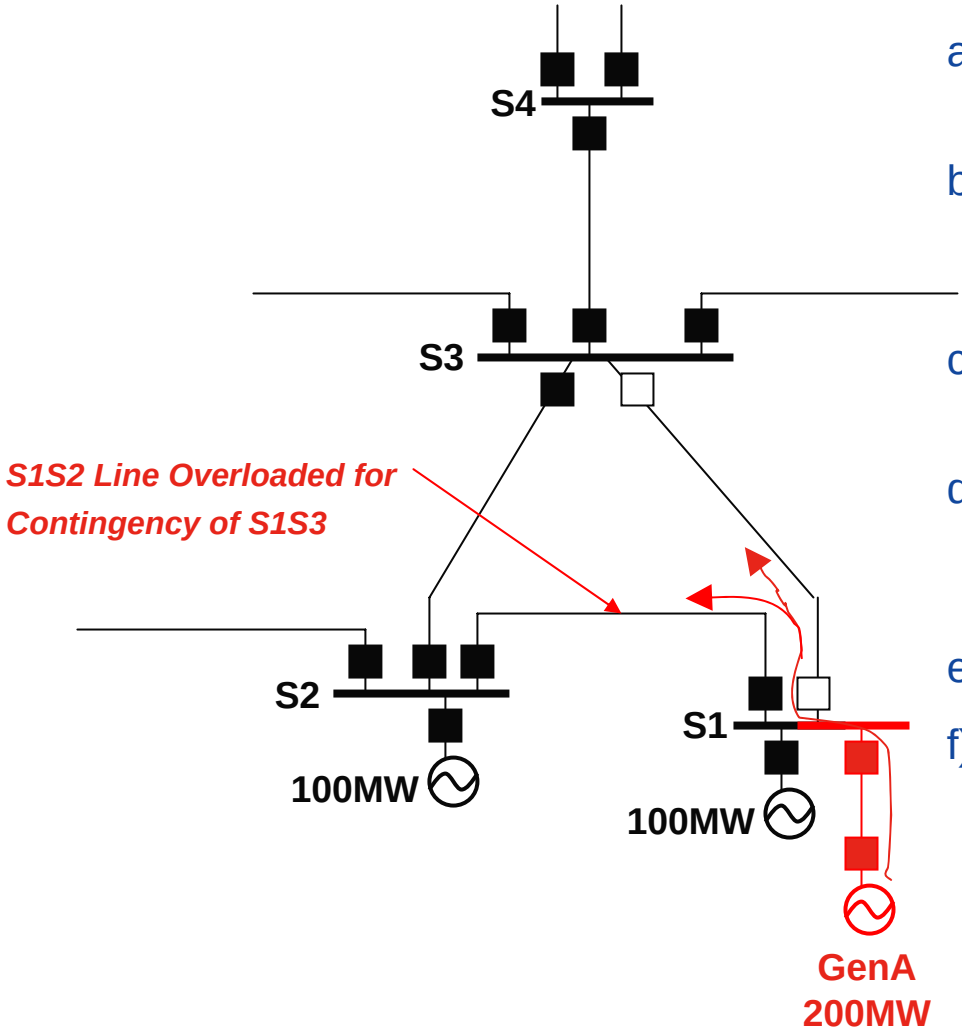
New Generator (GenA) is proposed At Substation 1 (S1)

a) Under today's LGIP/SGIP, the impact of the generator on the system is studied pursuant to the Minimum Interconnection Standard (MIS)

b) Under FCM qualification, a review of the impact of the generator pursuant to the MIS is also performed (if such a review has not been completed under LGIP/SGIP) – this review is called Initial Interconnection Analysis

c) Under FCM Qualification, a further review is performed – the review of Overlapping Interconnection Impacts

MIS Analysis



a) Build model for new project equipment into base-case database

b) Choose base case conditions for analysis (including dispatch and load level)

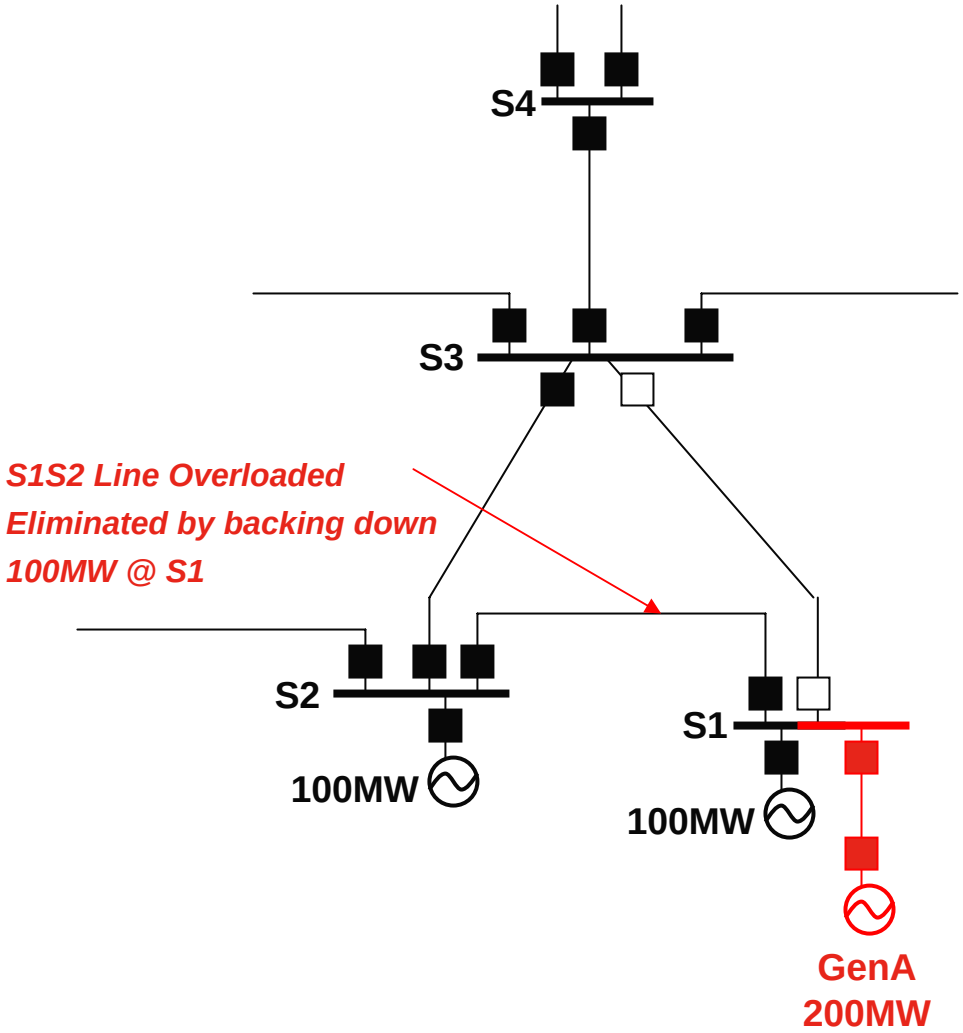
c) Model new project at nameplate output capability

d) Run contingency analysis (i.e. model the effect of the outage of all contingencies in the contingency list)

e) Record any Overloads/Violations

f) Repeat (b) through (e) above for different dispatches until a range of reasonably stressed conditions have been modeled

MIS Analysis (continued)



g) Test to see if any overload can be eliminated by backing down other (nearby) generation

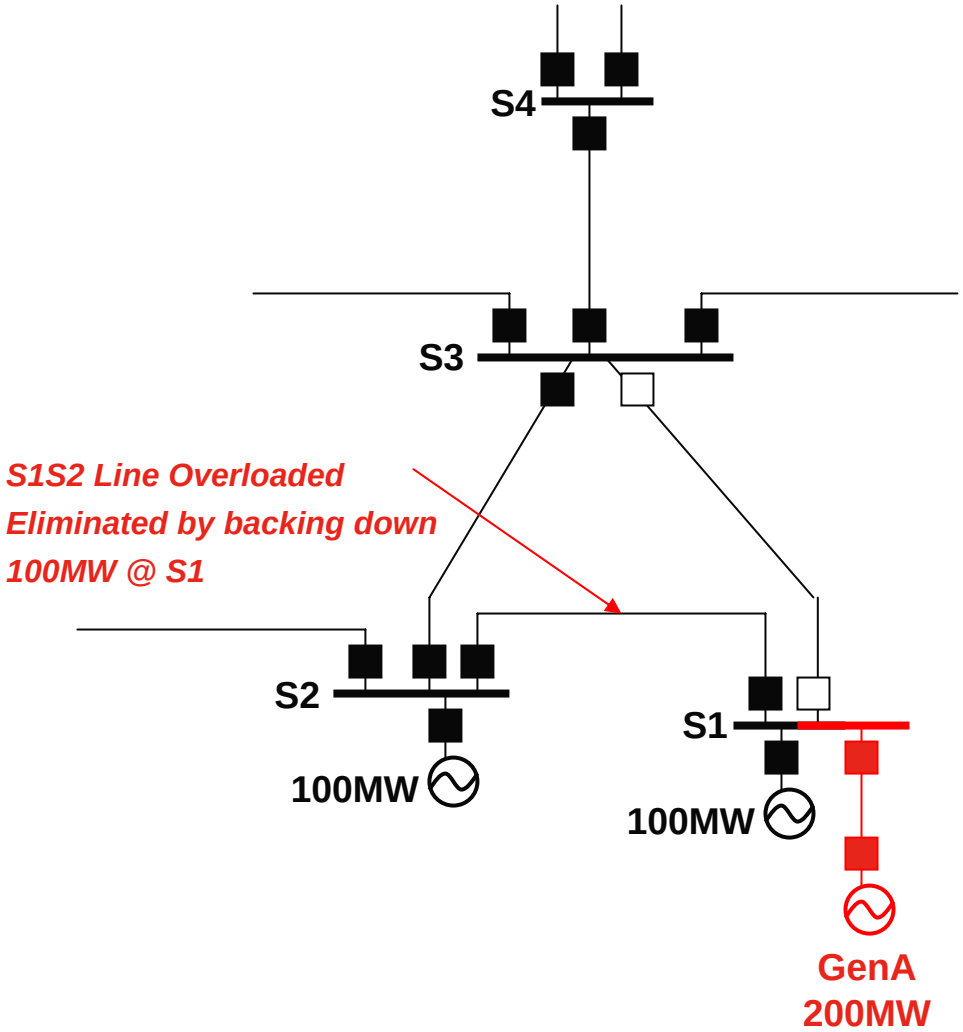
- Rule: Cannot back down more generation than is being added
- Rule: Cannot "create" must-run

h) Overloads that could not be eliminated by re-dispatch are assigned as GenA responsibility to fix

i) Under the MIS standard, GenA would not have to upgrade S1S2

j) Note that there is now 300MW of generation at S1, but only 200MW can run without upgrading S1S2 line

Comparing MIS to Overlapping Interconnection Impact



Overload of Line S1S2

a) Note that there is now 300MW of generation at S1, but only 200MW can run without upgrading S1S2 line

b) S1S2 is analyzed to determine whether the upgrade can be fixed in time for the Commitment Period

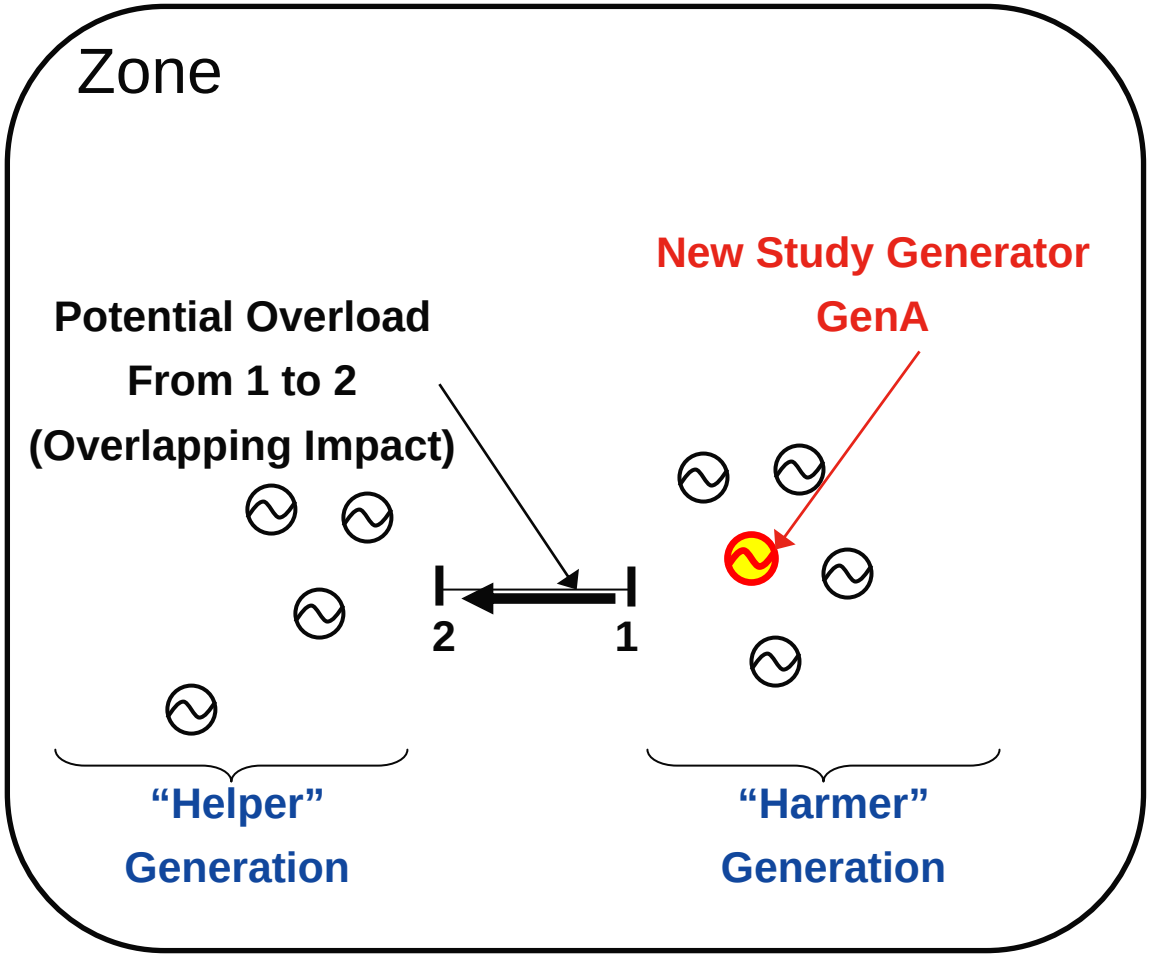
- If S1S2 cannot be fixed in time then Qualify GenA at 100MW
- If S1S2 can be fixed in time then GenA must upgrade S1S2 to qualify for 200MW

c) Appendix F of Planning Procedure 10 provides a guideline for use in determining whether a violation can be fixed in time for the Commitment Period

Moving to a More Generic Example

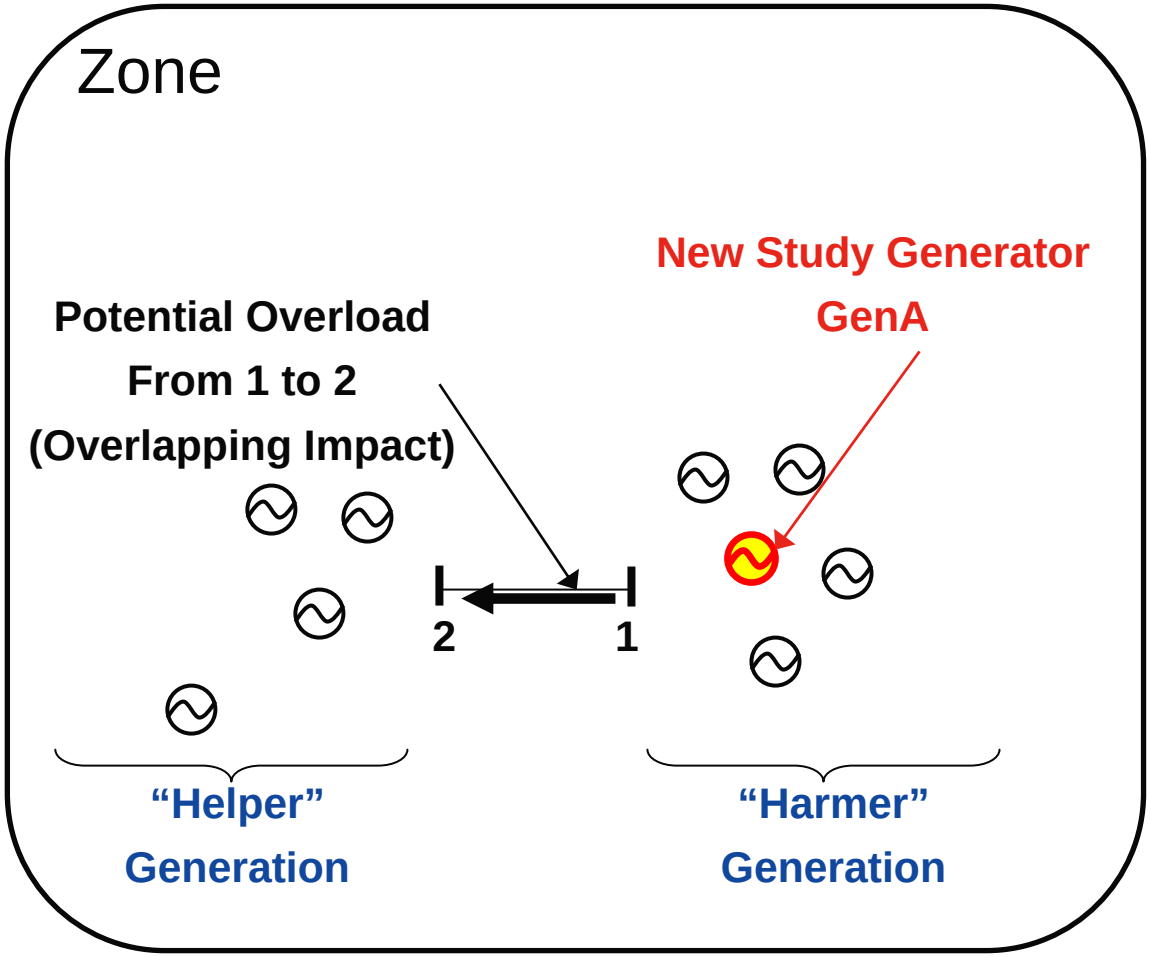
1. A more general representation of the power system will now be discussed
2. With the more general representation, the effects of several nearby generators, not necessarily on the same bus as the new study generator, will be considered

Review Minimum Interconnection Standard



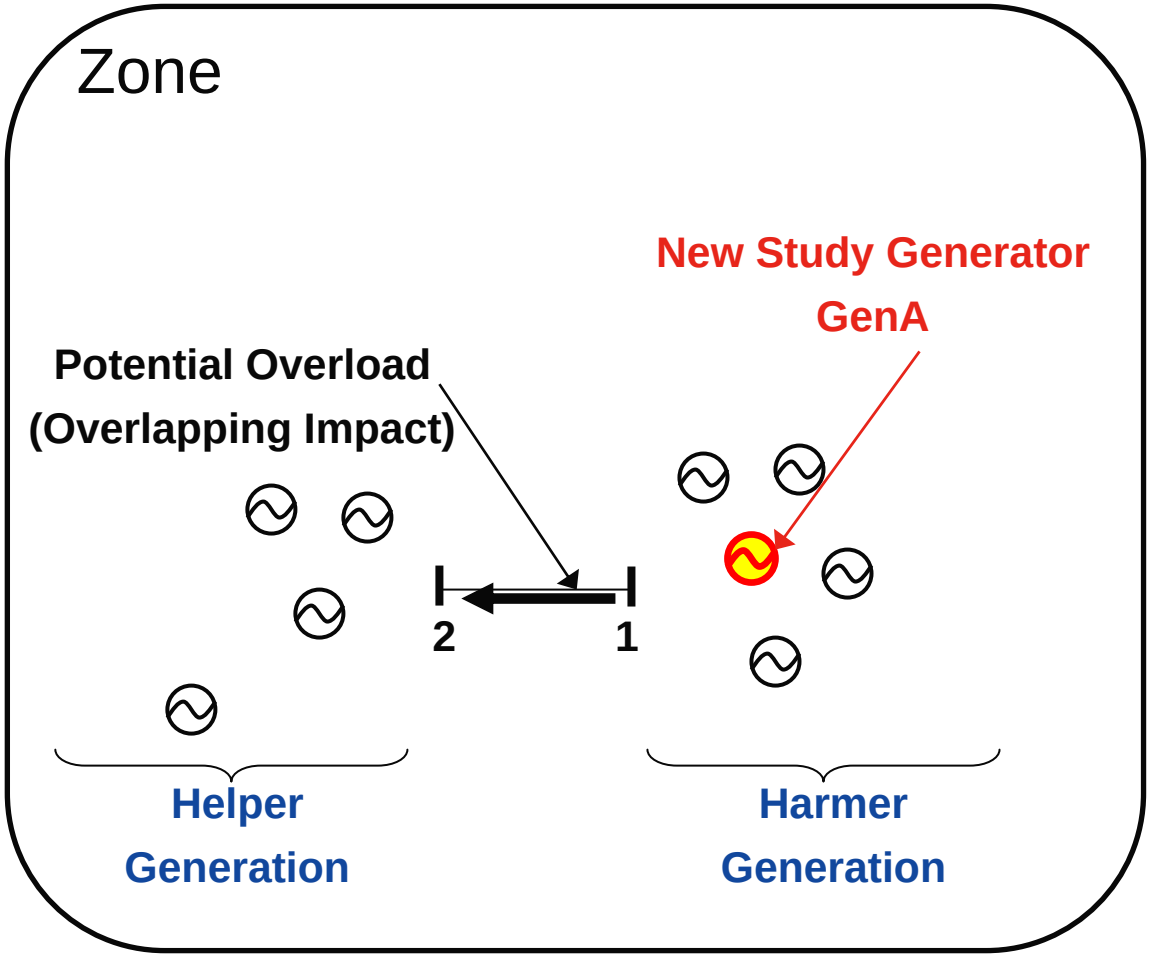
- The transmission line between Substation 1 & Substation 2 (1-2) becomes overloaded when GenA is added
- Generators that add to the loading of 1-2 are called Harmer Generators
- Generators that reduce the loading of 1-2 are called Helper Generators

Review Minimum Interconnection Standard



- Under the MIS, other Harmer Generation can be re-dispatched down to relieve overload 1-2
- Combined new generator & re-dispatch must not degrade transfer or import capability
- However, under this test, the new generator may not be incrementally useful capacity

Overlapping Impact Standard



- Under the Overlapping Impact Standard, the re-dispatch of Harmer Generation to relieve the constraint so that the New Generator is incrementally useful should not be allowed

Overlapping Impact Design Choices

1. How “far away” (electrically removed) from the New Generator should the restriction of re-dispatch of Harmer generators extend?
2. How stressed should base transfers be, including Imports?
3. Should New Generators be required to upgrade major internal interfaces?
4. Should any outage statistics (e.g. EFORd) be used?
5. What load level should be used?

- We will discuss these choices theoretically and then present the potential impact of different design choices using test results

Design Choice 1 – Re-dispatch Restriction

- The re-dispatch of “Harmer” generation will be limited under the overlapping Impact test
- How much “Harmer” generation should be on at full Capacity?
  - How far from the study generator should other generation be modeled as running at full Capacity?
- The only objective measure of “reach” or “effect” appears to be a Distribution Factor (DFAX)
  - DFAX are a measure of electrical distance

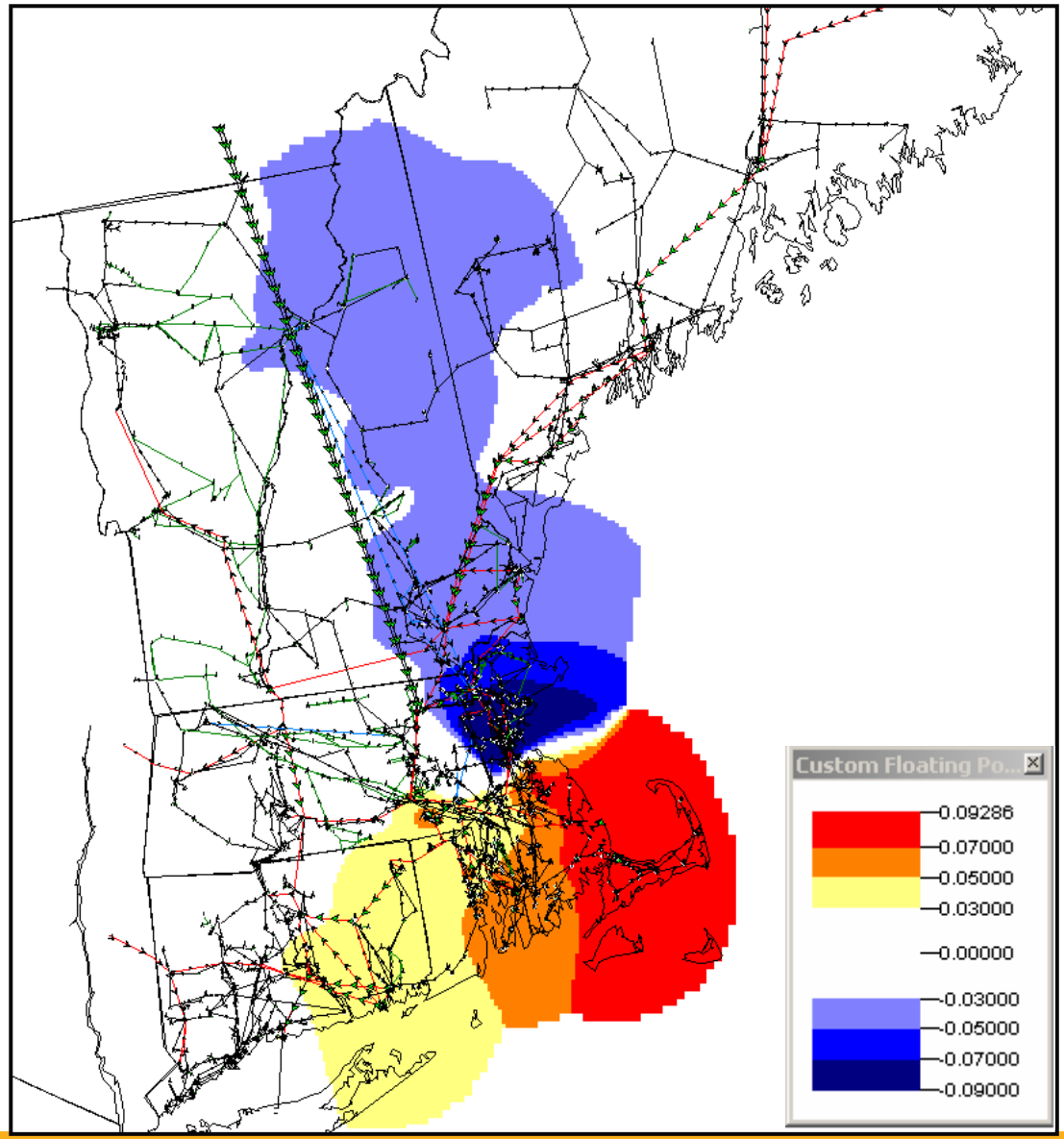
Distribution Factors

- Distribution Factors (DFAX) are a measure of the responsiveness of electrical loadings on elements such as transmission lines or transformers due to a change in output from a given generator
- The DFAX is expressed as a percent of the change in generation output
  - E.g. a +5% DFAX would mean that the addition of a 100MW generator would increase the flow on the transmission element by 5MW
- Generators with a positive DFAX are referred to as Harmer generation because increasing the output of these generators results in more flow on the limiting element for a given contingency
- Generators with a negative DFAX are referred to as Helper generators because increasing the output of these generators reduces the flow on the limiting element for a given contingency

Distribution Factor Maps

- PowerWorld Software was used to illustrate the reach and variation of distribution factors for different transmission lines
- “Maps” were generated which show how the generator distribution factors for the given transmission line decrease the further away the generator is from the transmission line

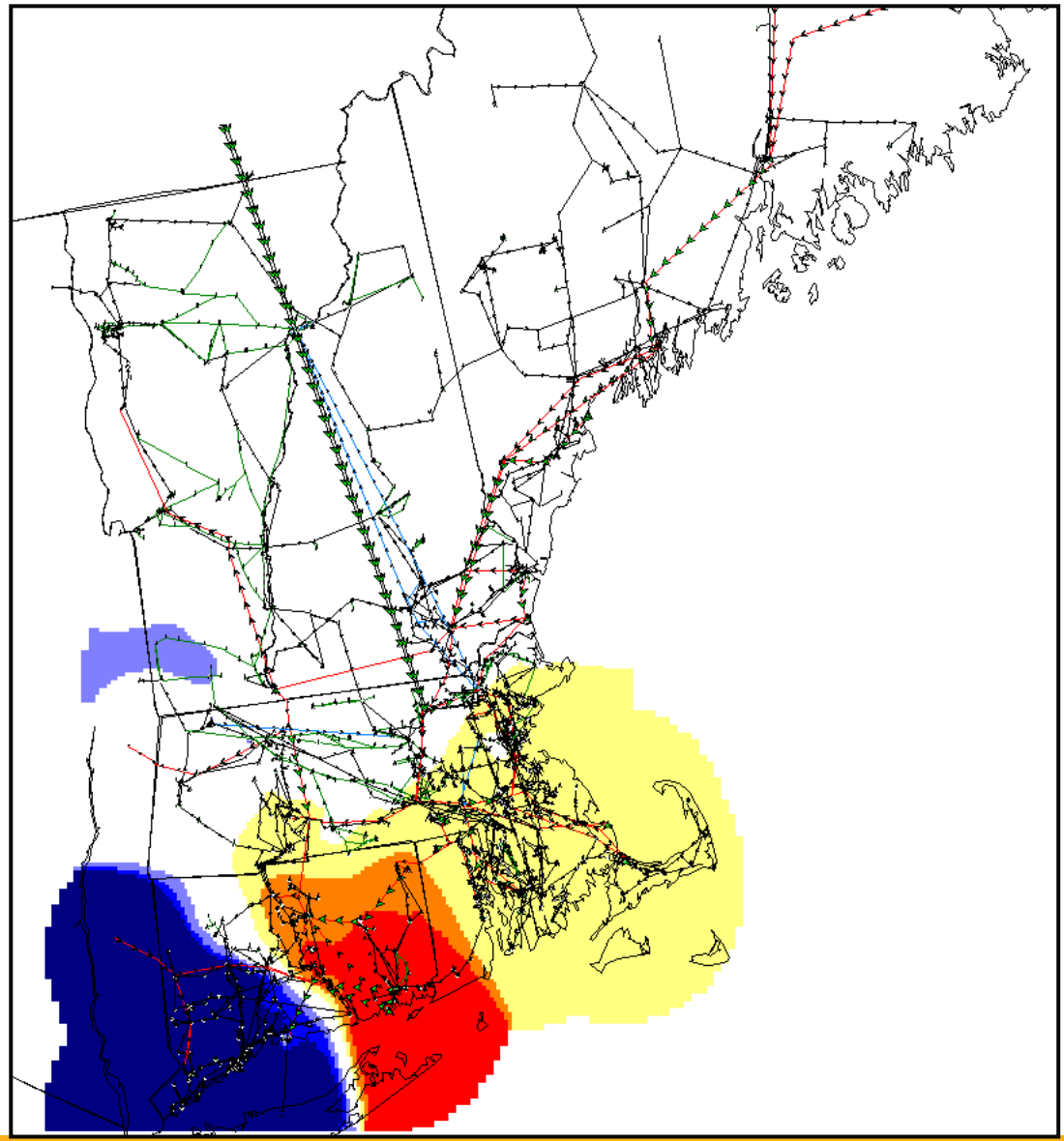
Generators' DFAX Outlook for Stoughton-K Street 1 345kV (Base Case)

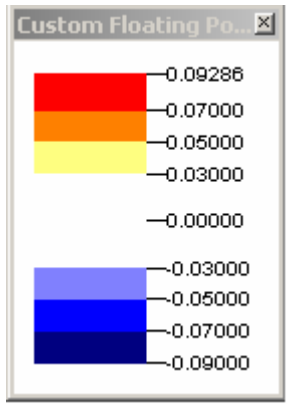


How to Read the Map:

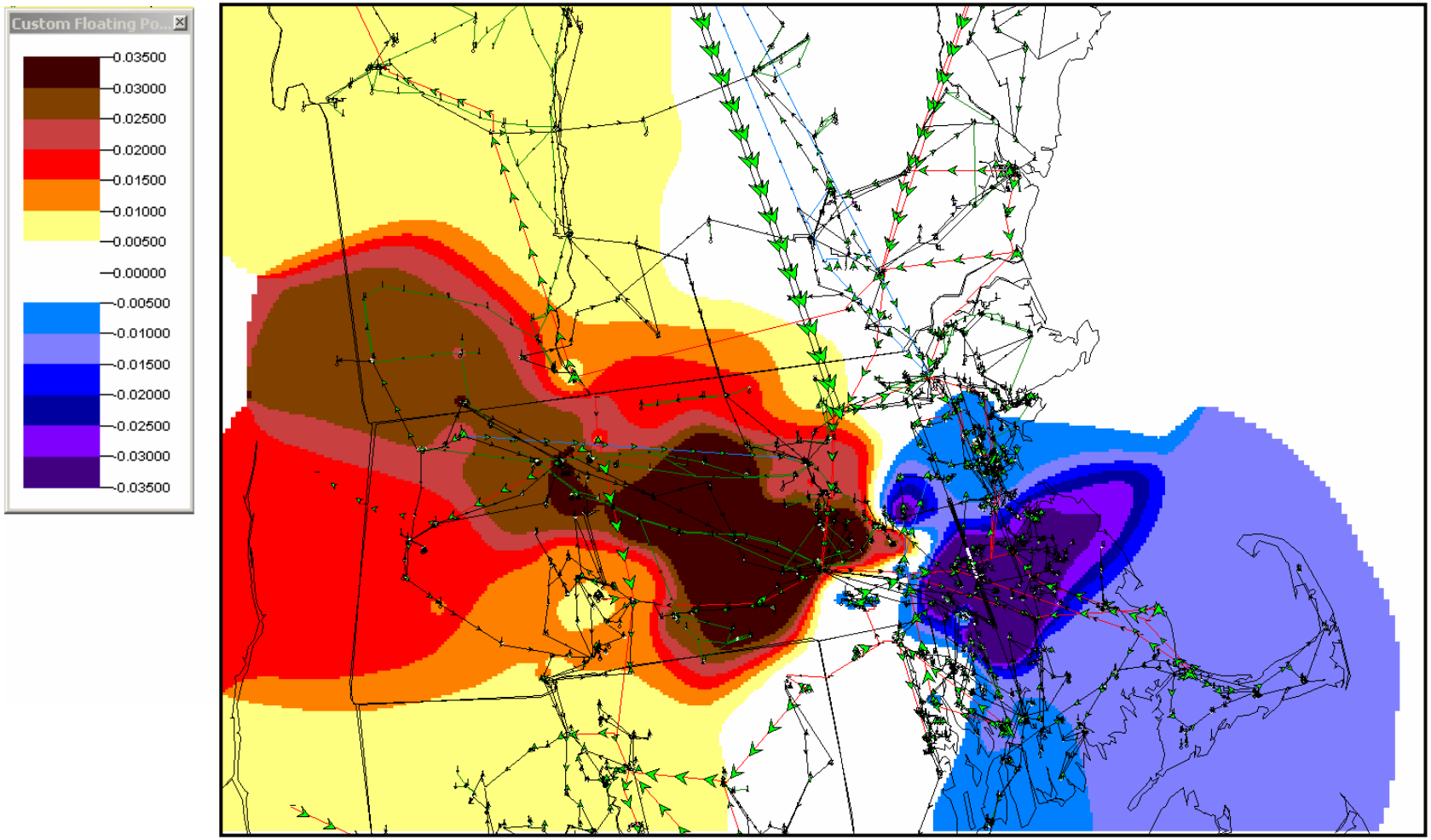
- Generators that lie within the red circle have a 7% or higher (Harmer) DFAX on the Stoughton-K Street 345kV line
- Generators that lie within the red or orange circle have a 5% or higher (Harmer) DFAX on the Stoughton-K Street 345kV line
- Generators that lie within the red or orange or yellow circle have a 3% or higher (Harmer) DFAX on the Stoughton-K Street 345kV line

Generators' DFAX Outlook for Beseck-East Devon 345kV (Base Case)

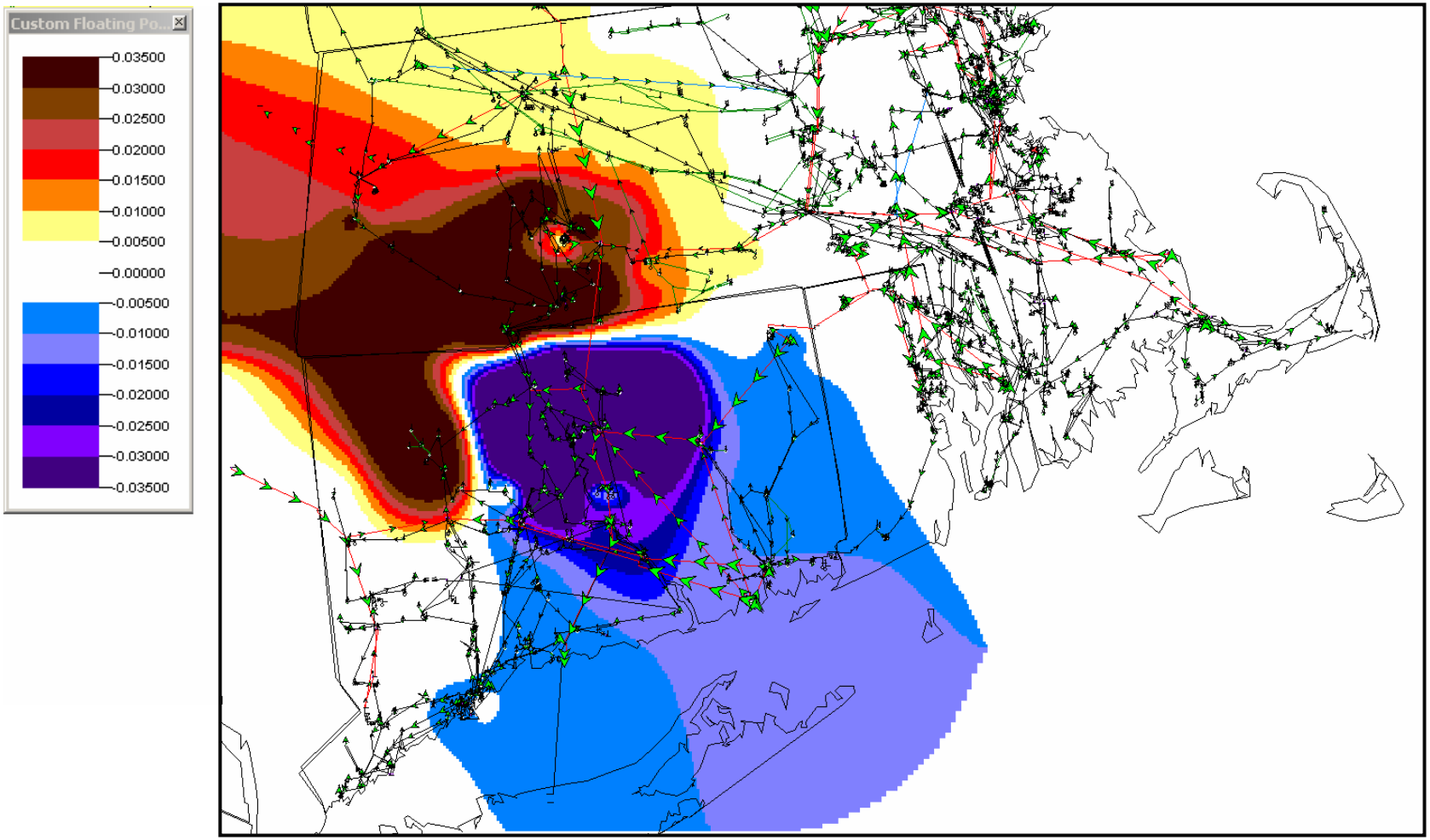




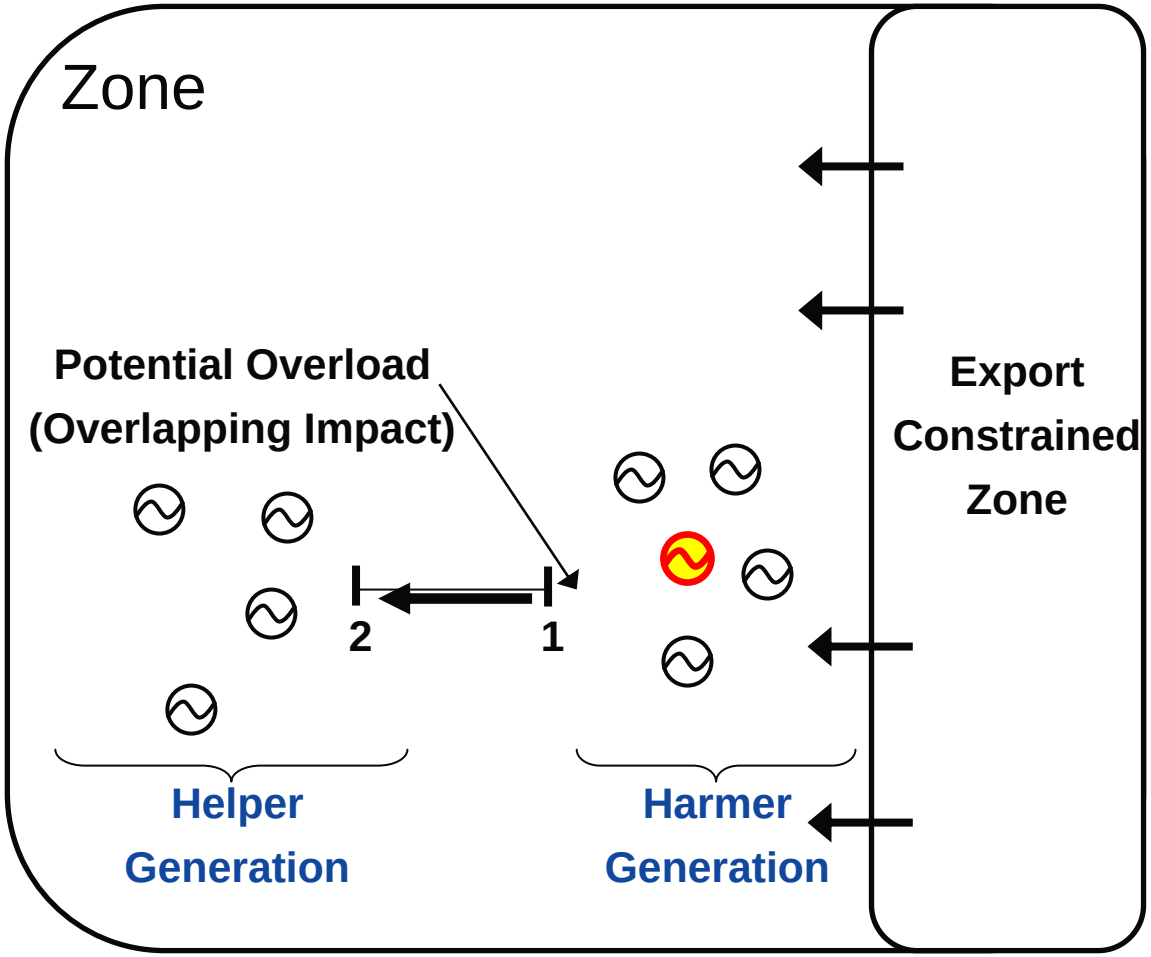
Generators' DFAX Outlook for Millbury-Hopkinton 115kV (Base Case)



Generators' DFAX Outlook for North Bloomfield-Bloomfield Jct. 115kV (Base Case)



Design Choice 2 – Base Transfer Stress



- Modeling at full import from the export constrained zone will have Harmer effect on overload 1-2
- This will increase the likelihood that the study generator will cause the overload 1-2
- This may reduce the qualification of generation that would be qualified if lower transfers were assumed

Design Choice 2 – Base Transfer Stress

- Transfer levels from external control areas should be set at up-to the import limit for the Overlapping Impact test
- Internal Transfer levels shall be set at up-to the transfer limit for the Overlapping Impact test

Design Choice 3 – Upgrade Internal Interfaces

- Recommendation for Internal Interfaces:
  a) Generation under study to be incrementally useful within the Load Zone (up to the maximum export level of that Zone)
- Alternatives Considered for Internal Interfaces:
  a) Incrementally useful to the entire Control Area
     – However, the Forward Capacity Market is a Zonal market
     – Under such a criteria, inter-zonal interfaces would show up as constraints for New Generation
  b) Incrementally useful within the Capacity Zone (up to the maximum export level of that Zone)
     – Capacity Zones definitions may change from year to year depending on Auction outcomes

Design Choice 4 - EFORd

- Recall that all Harmer Generation is not available 100% of the time, but rather has (1-EFORd) availability
- Alternatives:
  a) Model all Harmer Generation at Qualified Capacity (QC)
  b) Model all Harmer Generation at (1-EFORd)*QC levels
  c) Add nearby Generation at Installed Capacity until a specified cumulative availability is reached (PJM method – this is described in more detail later)

Design Choice 5 – Load Level

- The Installed Capacity Requirement is calculated using a range of load levels
- The 90/10 load is used in LGIP/SGIP analysis
- FCM Initial Interconnection Analysis is at 90/10
- Using the 90/10 load is more in line with a “Peak-Load” capacity product and provides results more directly comparable to the results in LGIP/SGIP analysis

Overlapping Impact Test – Other Design Notes

1. No OP4 actions will be modeled
2. All single element contingencies and multiple element contingencies as described in PP-3 and in OP-19 will be considered

Brief Review of Tests in Other Regions

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Principal Engineer - System Planning
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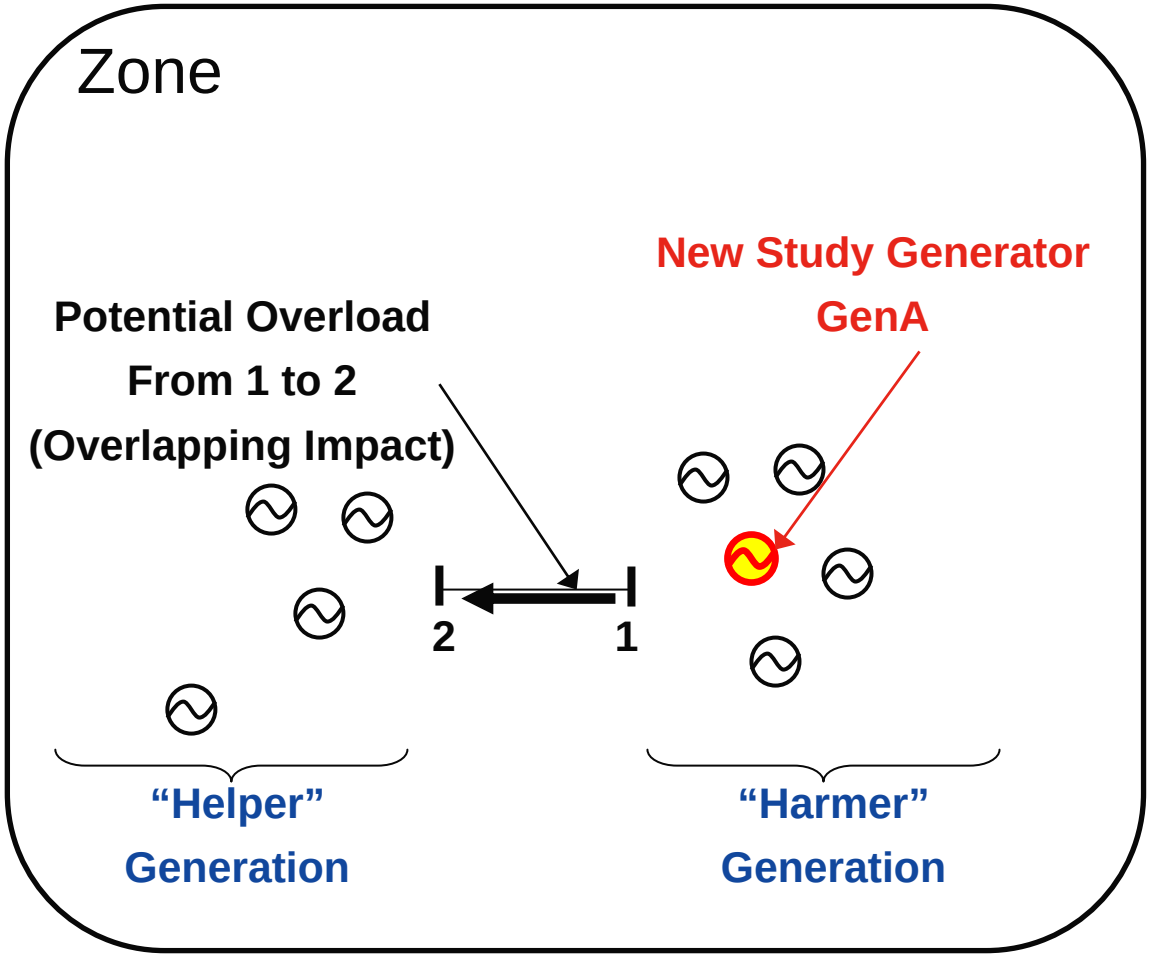
Review of Tests in Other Regions

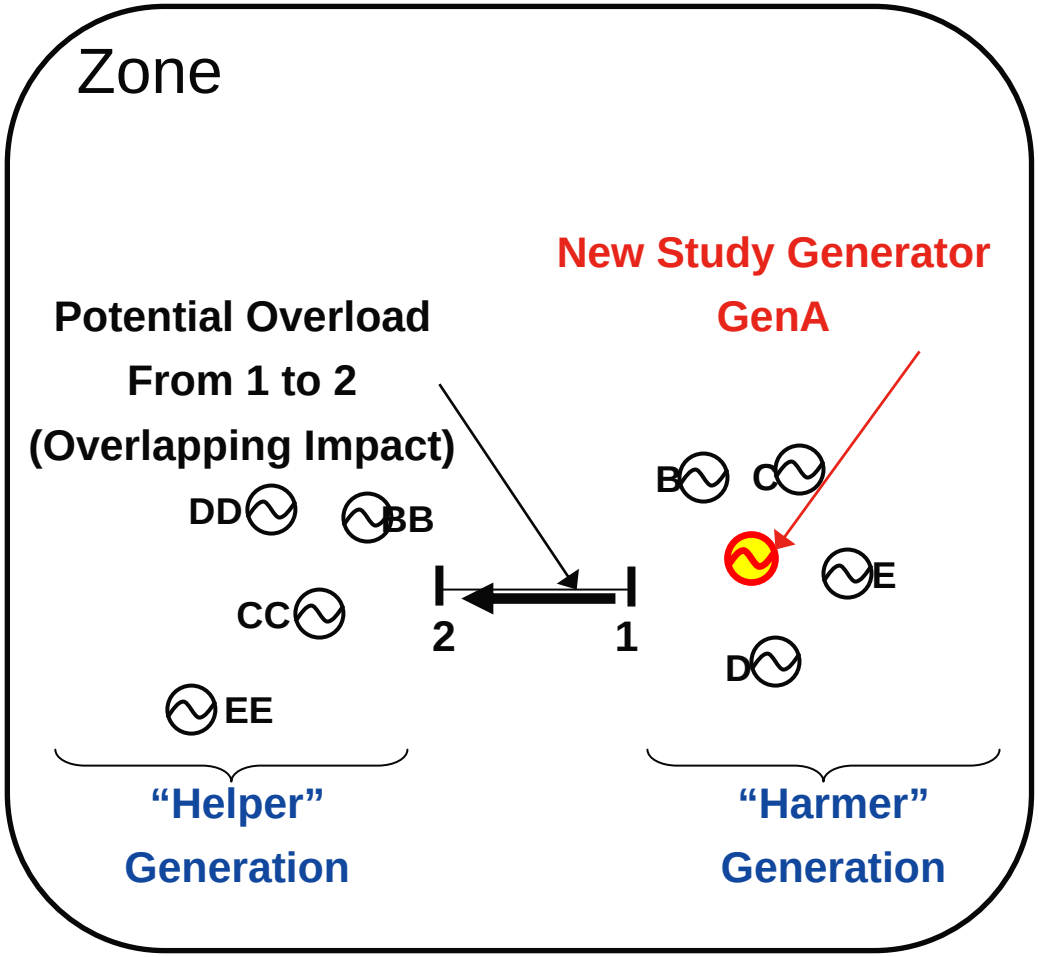
1. Overlapping Analysis methodologies in PJM, MISO, and NY were reviewed to study the approaches used in other regions
2. It was observed that the methodologies in other regions are continually evolving and in all cases are very technical in nature
3. The review supports that the proposed New England test design is in line with the industry approach

Tests in Other Regions – PJM



1. For the example of line 1-2
2. Calculate DFAX list of all modeled units from highest positive to most negative contribution

Tests in Other Regions – PJM



DFAX List

Harmer Generation	Gen B	15 %
	Gen C	12 %
	Gen D	3%
	Gen E	1.5 %
Helper Generation	Gen EE	-1.1 %
	Gen DD	-2.2 %
	Gen CC	-5%
	Gen BB	-10 %

3. If 1-2 is a potential overload then the following analysis is performed…

Tests in Other Regions – PJM

- The highest DFAX (those greater than 5%) units are turned on sequentially at 100% Installed Capacity until the cumulative probability (1-EFORd) of selected units reaches 20%
- Illustration:

Unit	(1-EFORd)	Cumulative Probability (1-EFORd)
GenB	0.9	0.9
GenC	0.9	0.81
GenD	0.9	0.72
….	….	….
GenX	0.9	0.2

- Turning the above units on at their full Installed Capacity gives rise to what is called the 80/20 loading on line 1-2
- This approach can result in 25-30 harmer generators turned on at their full Installed Capacity

Tests in Other Regions – PJM

1. Remaining units are turned on initially at (1 – EFORd) of Installed Capacity and then scaled until area interchange equals interchange target
2. Determine 1-2 loading with:
   - GenA online (100%) and
   - GenA offline
3. If overloaded and worsened with GenA online, GenA must upgrade 1-2 to be a Capacity Resource

Tests in Other Regions – MISO

- MISO's most recent documentation details an approach nearly identical to that of PJM
- However, rather than turning the "80/20" generators on at their full Installed Capacity, MISO turns on the "Top 30" harmer generators at their full Installed Capacity

Tests in Other Regions – NY (Proposal)

1. Projects are evaluated on an aggregate basis by inserting them in their appropriate zone
2. The following “Zones” are evaluated for potential intra-zonal constraints, on an individual basis by “Export Test”:
   - New York Control Area
   - New York City
   - Long Island
   - Rest-of-State
3. The “Export Test” is conducted by:
   - Bringing all generation in the zonal grouping to their max MW level after adjustment by the deliverability adjustment factor (~1-EFORd)
   - Scaling load in the zonal grouping up by a load uncertainty adjustment factor and decreasing generation in rest of NYCA

Tests in Other Regions – NY continued

4. Identify potential constraint from the list of monitored element (pre- or post-contingency)
5. The impact of the new generation on a constraint will be used to determine the amount of Installed Capacity for the new generator

Discussion of Scenarios tested using a population of FCM Applicants

Marianne Perben
Senior Engineer - System Planning
ISO New England

Test Case New Generation

- 30 generators from the list of generators that are seeking qualification for the first FCA were used to analyze the effects of using different Overlapping Impact design parameters
  - The 30 generators are spread throughout the New England system
  - Some of the 30 generators are well advanced in the LGIP/SGIP Interconnection queue and some are not yet in the Interconnection Queue
  - The 30 generators range in size from large (>500MW) to small (<5MW)

Design Parameters Tested

- With the 30 test generators the following design parameter sensitivities were tested

Design Parameter	Parameter Tested
DFAX (for Harmer restriction)	3% or 5%
EFORd	EFORd modeled or EFORd not modeled
Load Level	90/10 or 50/50

Design Parameter Testing

- For the 30 generators, the different design parameters were tested using automated thermal power flow tools to determine the extent of overloads for the test generators for the given design parameters
- In some cases, combinations of more than one parameter were tested to determine if there are any interactions between parameters
- The results of the power flow analyses were evaluated to determine whether there were resulting overloads that would cause the generation not to be qualified

Design Parameter Testing

- Note that on a generator by generator basis - these results are preliminary and require further review before reaching final determinations
  - the testing was done primarily for the purpose of Overlapping Impact test design parameter selection
- Generators may fail to be qualified for other reasons such as:
    - Critical Path Schedule problems, or,
    - Short Circuit problems
- Cumulative effects were not examined – the following statistics apply to generators on an individual basis

Effect of Different DFAX Thresholds

- Test – 3% & 5% DFAX thresholds as cut-offs for generator re-dispatch
  - A 3% DFAX Threshold means that no generation with a 3% impact or higher on the potential overload can be re-dispatched down when adding the study generator
- Result:
  - 3% DFAX Threshold – Approximately 70% of the New Generation Passed
  - 5% DFAX Threshold – Approximately 80% of the New Generation Passed
- Interpretation - DFAX cut-off is an important factor in determining overlapping impacts
- DFAX will be increasingly important when studying the cumulative effects of multiple nearby proposals

Effect of EFORd modeling

- Test – Model the effect of setting the output of existing generation at (1-EFORd)
- Result - Modeling existing generators at their (1-EFORd) level of output did produce different (but not significantly different) results from Modeling existing generators at their Qualified Capacity
- Interpretation – Modeling 1-EFORd output is useful in analyzing large-scale inter zonal transfers but the population of generators in New England is small enough that in many cases modeling 1-EFORd does not significantly affect the result for the analysis of a new individual generator

Effect of Load Level (90/10 versus 50/50)

- Test – Model the effect of using a 50/50 versus 90/10 load level
- Result - The effect of load level was somewhat unpredictable
  - In some case more generation would qualify and in other cases less generation would qualify – but the differences were not very significant
- Interpretation – The 50/50 load is a lower load level and in some cases transmission line flows are lower, but this may not be true in all areas. The higher level of initial generation outages in the 50/50 load level case can create biases

Summary & Recommendations for Overlapping Impact Standard

Alan McBride
Principal Engineer - System Planning
ISO New England

Recommended Overlapping Interconnection Impact Test Design

1. Restrict Re-dispatch of Harmer Generation to those with DFAX > 3%
2. Use Reasonably Stressed Base Transfer Conditions
3. New Generators are not required to Upgrade Internal Interfaces that may bind in the FCA
   - Previously approved in Appendix B of PP-10
4. Do not make use of EFORd in Overlapping Analysis
5. Model at 90/10 load
   - A change from the previously approved load level for Overlapping Impact Testing in PP-10