



WIRES PREFACE TO REVIEW OF EIPC's PHASE 1 REPORT BY THE BRATTLE GROUP

Dear Reader:

Today, WIRES issues a report on Phase 1 of the Eastern Interconnection Planning Collaborative ("EIPC"), prepared for it by The Brattle Group. We are publishing Brattle's thoughtful analysis because it will help the public and policy makers to understand the multiple factors, including environmental policies and plant retirements, that will bear on transmission development over the coming decades. It will also make clear what the EIPC process is and what the data it has produced thus far should (and should not) be used for.

EIPC PROCESS. The EIPC process is important and unprecedented both as a way to study the elements that will contribute to the rational development of the grid and as a way to view the transmission planning of scores of entities across a very large electric interconnection. It is a first-of-its-kind, transparent stakeholder process that attempts to reconcile the interests of state regulatory commissioners, transmission owners and developers, generation developers, transmission-dependent utilities, suppliers, environmental groups and end users across a 38-state region of the United States and Canada. Decision-making in the EIPC study is by consensus, requiring much debate and compromise.

EIPC was conceived as a way to study a range of policy choices and to assess transmission implications of those policy choices. Its participants acknowledge that it is a valuable learning opportunity for industry experts, state regulators, and other stakeholders with respect to what factors must be considered in developing a 21st century grid. This has nevertheless been a resource-intensive exercise. WIRES therefore applauds the efforts of these participants and extends to them its appreciation for the long-term payoff that is likely to accrue to both the industry and the nation's economy as a result of their contribution.

EIPC OUTPUT TO DATE. The Phase 1 report of EIPC, issued last December, is an important recognition of the need to broaden and better coordinate the transmission planning efforts of the various planning authorities within the Eastern Interconnection. It will be followed by a Phase 2 report later this year. As a basis for its analysis, EIPC defined eight energy futures and eighty modeled sensitivity cases. Of these, only three could be chosen for a more detailed transmission analysis in Phase 2. The three futures ultimately were chosen by consensus and compromise among the stakeholders.

The Brattle Group analysis which follows addresses what the Phase 1 report means. In addition to examining what the report suggests about the need for transmission, Brattle identifies the limitations of the report – many of which EIPC has frankly acknowledged already. For example, EIPC is not a transmission planning exercise. The study was not designed to determine the most economically optimal transmission choices. Because the EIPC effort is a very high level generation/transmission assessment without the opportunity to iterate and optimize the combinations of generation and transmission, the hard work of planning and permitting billions of dollars of needed transmission expansions and upgrades must still be carried on by and between regional transmission organizations and by utilities in other markets.

PREVIEW OF THE BRATTLE ANALYSIS. To summarize, the WIRES/Brattle analysis identifies what the Phase 1 report tells us and why. We hope that the EIPC process will inform the efforts to comply with FERC's Order No. 1000 and the congestion studies currently underway at the Department of Energy to implement National Interest Electric Transmission Corridors. However, that makes it even more important that we identify the governing assumptions and limitations of the EIPC process, the factors considered and not considered, and possible next steps in planning and developing a 21st century grid.

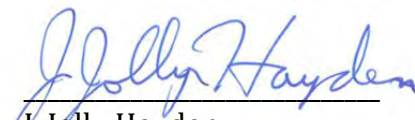
As the attached Brattle report demonstrates, the EIPC Phase 1 data provide some valuable insights into the nation's need for a strengthened high-voltage electric transmission grid, in addition to those already acknowledged in the Phase 1 report.

- Phase 1 focused on the changing profile of electric generation and documented transmission congestion. Sensitivity studies were conducted to identify transmission expansions needed between regions and “super” regions to reduce congestion to 75% and 25% of the base levels. They show that in some scenarios from 37GW to 122 GW of new energy transfer capability may be needed to reduce congestion between regions and “super” regions.
- Phase 2 will focus primarily on the need for transmission within regions, and between regions where indicated by the Phase 1 analysis. However, of the three scenarios chosen, two have zero or minimal transmission added between regions. This necessarily leaves inter-regional planning processes to be addressed by the follow-on procedures under FERC's Order No. 1000.
- In one of the three chosen scenarios to be examined in Phase 2, stakeholders chose to assume that additional inter-regional transmission was not needed, in order to model intra-regional development of renewable resources. This assumption will therefore understate the sizeable need for inter-regional transmission. In the “business as usual” scenario, stakeholders chose to model a generational build-out assuming no inter-regional transmission over

and above what was included in the 2016 base case in spite of the analysis that suggests that it may be valuable to add between 3GW and 22GW. We do not believe this Phase 1 assumption is realistic. This should be revisited in follow-on studies.

- Phase 2 of this first-of-its-kind study effort is designed to integrate generation build-out scenarios identified in Phase 1 and address corresponding reliability needs across the Eastern Interconnection. It does not evaluate the economics of transmission investments nor take into account important benefits of transmission beyond reliability, such as congestion relief, load and resource diversity, cleaner resources, the “insurance” value under extreme conditions, reduced losses, and more optimal use of generation. Readers should recognize that it was not designed to do so.

The attached Brattle Group analysis is intended by WIRES to help ensure that the work product of EIPC is properly understood and utilized. It is particularly helpful in suggesting next steps that will help the industry and its regulators devise a more rational and efficient way to modernize the high-voltage system. For now, WIRES looks forward to the completion of EIPC’s ambitious work.



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Review of EIPC's Phase 1 Report

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EIPC Effort: Introduction

EIPC is a first of its kind analysis covering the entire Eastern Interconnection.

- ◆ Stakeholder-driven process:
 - 29-member Stakeholder Steering Committee, with 7 sectors represented (generators, transmission owners, non-governmental agencies, etc.)
- ◆ States have “parallel” process through the Eastern Interconnection States Planning Council (EISPC) to provide input to the EIPC process
 - State regulators hold 10 of 29 seats on Stakeholder Steering Committee
- ◆ Eastern Interconnection Planning Collaborative (EIPC) provides analytical process and capabilities to assess stakeholder-chosen futures and scenarios
- ◆ Phase 1 complete, Phase 2 complete by end of 2012
- ◆ Designed to develop interconnection-wide data and transmission needs for “bookends” of selected scenarios; not intended to find optimal transmission expansion

EIPC Phase 1 Effort

In Phase 1 of the EIPC effort, stakeholders:

- ◆ Defined a base case with **197 GW** of transmission capability between 30 “regions” and 7 aggregated “super regions” as of 2016
- ◆ Phase 1 effort focused on the generation development and retirements under 8 different futures (through 2030)
- ◆ Phase 1 also documented transmission congestion for each of these futures
- ◆ Sensitivities were conducted in most of the 8 futures to evaluate transmission expansions between model regions and super regions that would reduce congestion to roughly 75% and 25% of the base case congestion

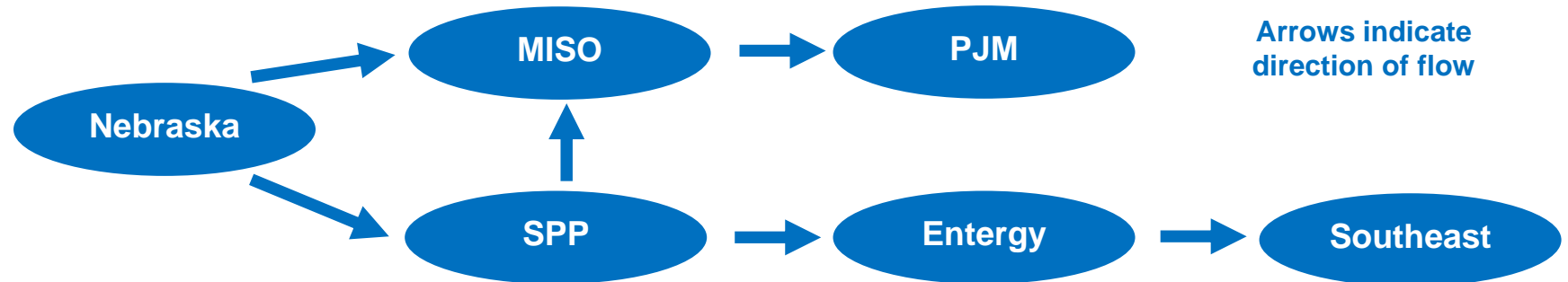
Sensitivities during Phase 1 identified between 3.1 GW and 122 GW of transmission additions between regions and super regions

Summary

Identified Potential Transmission Needs

Some EIPC Phase 1 results show significant potential transmission needs to address congestion:

- ◆ Three futures with “national” implementation of low-carbon and/or renewables standards suggest that significantly increasing transfer capability from west to east may be beneficial, needed, or preferred
- ◆ Most of the identified inter-regional transmission expansions, ranging from 37 GW to 122 GW, are either within or between these footprints



- ◆ Two futures with “regional” implementation of low-carbon and/or renewables standards assume that no transmission expansion would be needed between super regions past 2016 levels
- ◆ Two other futures assume no expansions are needed past 2016 levels

Summary

EIPC's Phase 2 Effort

The three book-end “scenarios” of generation additions and retirements that stakeholders selected for further studies during Phase 2 are:

1. A “carbon constraint” case that identified generation additions and retirements assuming 37 GW of transmission expansion between individual regions (which would reduce identified transmission congestion to roughly 75% of base case levels).
2. A “regionally implemented RPS” scenario, assuming 3.1 GW of new transmission would be built between regions within the super regions but no transmission expansion would take place between the defined super regions past the 2016 base case levels
3. A “business as usual” scenario that identified generation additions and retirements assuming no transmission expansion would be needed past the 2016 base case levels

Phase 2 will study transmission additions to accommodate the generation additions and retirements that Phase 1 identified for scenarios from a reliability perspective

EIPC Phase 1 Accomplishments

The EIPC effort overcame many challenges

- ◆ Phase 1 used macroeconomic models and applied them in new ways requiring various assumptions and “workarounds”
 - For example, shadow prices and other proxies were used to approximate the transmission needs for different levels of regional generation additions and retirements
- ◆ Deciding on a “base case” required significant coordination and stakeholder consensus
- ◆ Development and assessment of scenarios and sensitivities required extensive analysis of a large amount of data and assumptions

The EIPC effort also provided a valuable learning opportunity

- ◆ First of its kind assessment requiring major effort in cooperation and scheduling
- ◆ State regulators played an important and constructive role
- ◆ Based on discussions with participants, we understand that much learning has occurred and stakeholders and planners are working well together

EIPC Limitations and Scope for Follow-on Analyses

Phase 1 results show significant transmission congestion and potential transmission needs that will need to be studied outside the EIPC process:

- ◆ However, EIPC assumed 2016 base-line transmission system also did not include all transmission already planned across the Eastern Interconnection
- ◆ Many of the larger congestion-reducing scenarios were not chosen by stakeholders for Phase 2 analysis, which may warrant follow-up analysis if further congestion relief would be economic. Of the ones chosen for Phase 2:
 - Scenario 1 reflects a transmission buildout that would reduce inter-regional congestion only to roughly 75% of base levels
 - Scenario 2 assumes no new transmission would be added between super regions post 2016
 - Scenario 3 assumes no new transmission would need to be added between regions or super regions post 2016
- ◆ Phase 2 will address transmission needs to reliably accommodate generation additions and retirements identified in Phase 1. Follow-on analyses will be needed to evaluate if additional transmission between regions or super regions desirable for congestion relief and other transmission-related benefits.



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Scope of EIPC effort

EIPC is DOE-funded to conduct a “Resource Assessment and Interconnection-level Transmission Analysis and Planning” study:

- ◆ Phase 1 – completed December 2011
 - Examines 8 main “futures” selected by stakeholders with 9 sensitivities, for a total of 80 simulation results
 - This phase was focused solely on generation expansion and retirements to meet scenario requirements with only high level representation of transmission via “regions” and “pipes”
 - No analysis of transmission within bubbles and only limited assessment of expanding transmission pipes between regions
- ◆ Phase 2 – ongoing, to be completed on December 31, 2012
 - Detailed reliability analyses of 3 “scenarios” (out of 80 simulations from Phase 1), selected to reflect the interest of stakeholders in seeing a “bookends” of distinct policy scenarios
 - This phase will be focused on detailed transmission power-flow modeling based on Phase 1 assumptions and results for the selected 3 scenarios

EIPC Overview

Selected Three Scenarios for Phase 2 Analysis

Scenario	Description	EIPC Assumed Transmission Expansion	Installed Capacity (GW) and Generation (TWh)
1. Nationally-Implemented Federal Carbon Constraint w/ Increased EE/DR	CO ₂ price escalates annually to achieve a 42% reduction in CO ₂ emissions throughout the economy by 2030 (~\$140/ton in 2010\$) and flat thereafter. Costs of EE and DR are assumed to be partially offset by the CO ₂ revenues.	37 GW of additional capacity between regions added to 197 GW baseline (based on 75% shadow price analysis). Phase 2 will determine how much transmission needs to be added to reliably integrate the identified generation additions and retirements.	
2. Regionally-Implemented National RPS	30% RPS by 2030 to be met by purchase of REC's within each super region. Super regions are aggregated NEEM regions which align in most cases with Planning Coordinator boundaries.	3 GW of additional capacity within "super-regions" added to 197 GW baseline (assumes no buildout between super regions). Phase 2 will "lock in" 3 GW of new transfer capacity between super regions and only focus on transmission needed within regions and super regions	
3. Business as Usual	Assumes currently enacted (e.g., state RPS) and proposed (e.g., EPA) regulations apply but no new requirements	Uses baseline assumption of 197 GW and assumes no additional unplanned expansion post-2016 through end of analysis (modeled through 2050). Phase 2 will only focus on transmission needed within regions.	

Important EIPC Caveats About Phase 1

EIPC has clearly emphasized *important caveats* about its work in Phase 1:

- ◆ Phase 1 is not a transmission study. It is a generation resource analysis, identifying likely generation additions and retirements for range of different futures
- ◆ Phase 1 is not an transmission optimization study - models employed will not optimize transmission and generation buildout and will not provide an indication of “least cost” builds
- ◆ Phase 2 will produce a detailed power flow analysis but broad scenario assumptions developed in Phase 1 will remain unchanged in Phase 2
- ◆ Phases 1 and 2 will not evaluate generation and transmission additions through an iterative “optimization” process
- ◆ Work produced in EIPC is only relevant within EIPC and is not to be used in other processes or analyses

Despite these limitations, however, Phase 1 results already indicate transmission congestion and potential transmission needs throughout the Eastern Interconnection

EIPC Transmission Modeling

Transmission was modeled simply as pipes between regions and “super regions”

- ◆ Each pipe has a defined transfer capability between regions (light blue boxes) and seven aggregated super regions (dark blue borders)

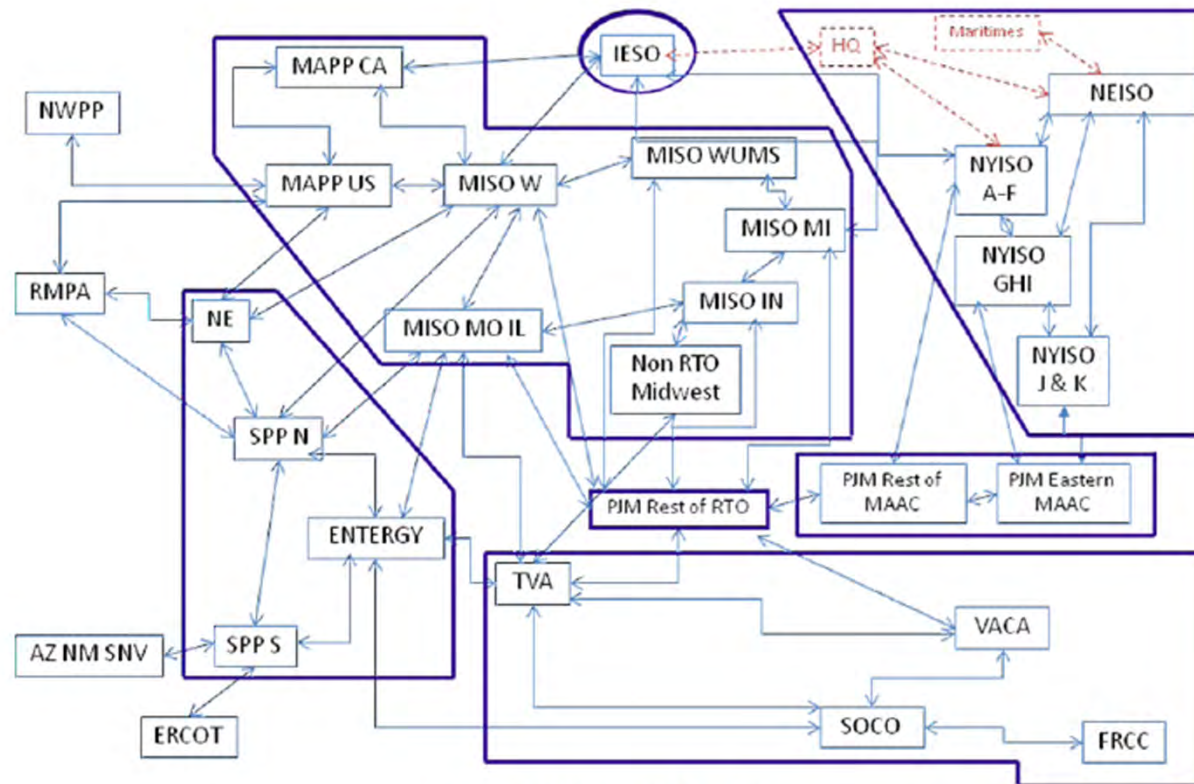


Figure 9: NEEM Super Regions

- The “NEEM” model used by EIPC assumes no congestion within any of the regions
- We understand that simultaneous import and export constraints were not modeled, which likely significantly overstates the capability of the existing transmission grid

“Business as Usual” Case (Scenario 3)

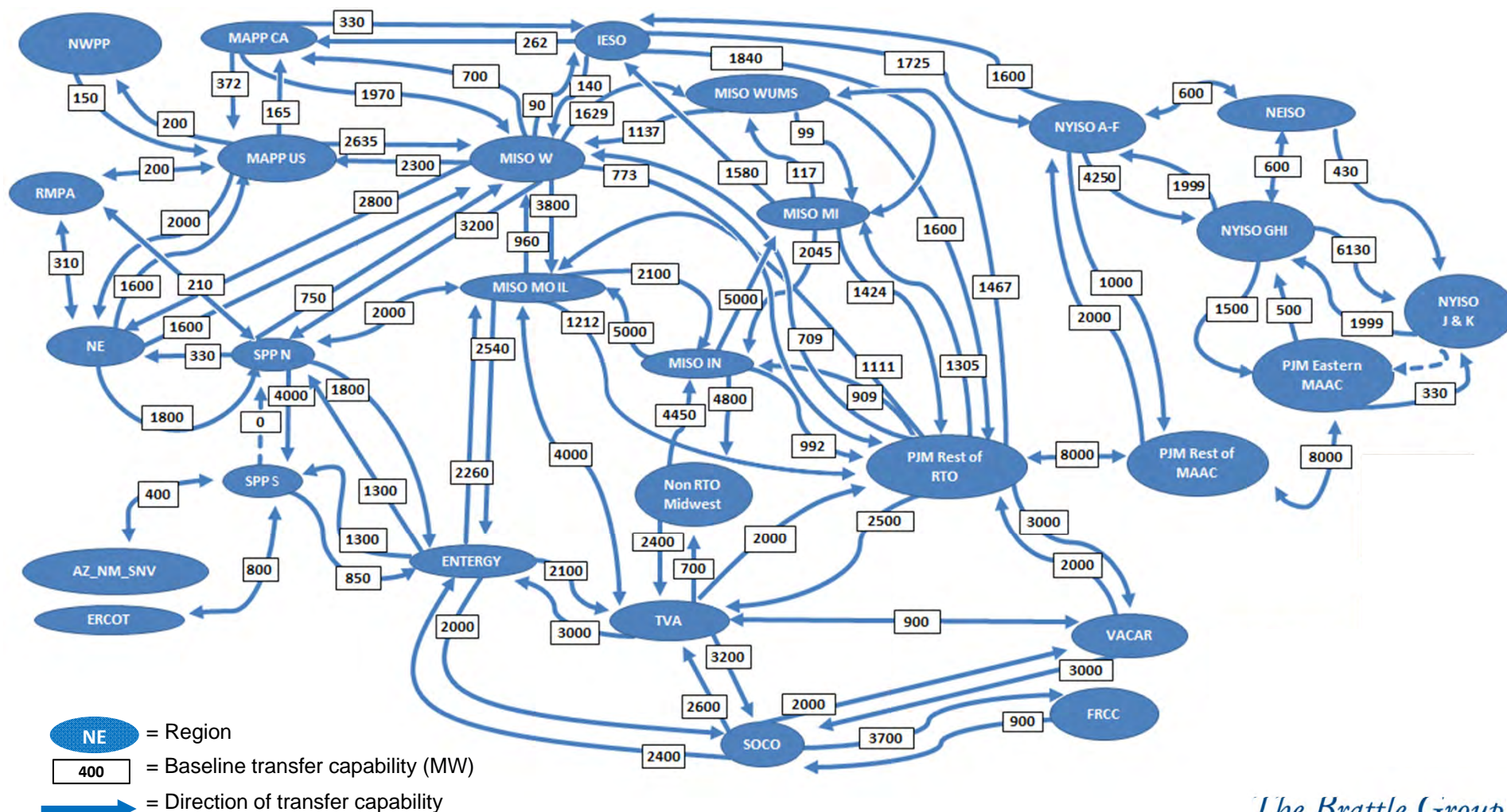
EIPC stakeholders agreed on a “Business as Usual” (BAU) case, against which to compare other scenarios

- ◆ Process began with a roll-up of existing plans through 2020 from Planning Coordinators¹
- ◆ Stakeholders then adjusted the plans as follows:
 - All generation and transmission that were due to be in-service prior to January 1, 2016 were automatically included
 - All generation and transmission less than 230kV currently under construction or with an in-service date between the years 2016 and 2020 were automatically included
- ◆ Stakeholders decided to exclude virtually all transmission ≥ 230 kV with an in-service date after January 1, 2016 from the model
 - For example, 8 of 16 MISO-approved MVP candidate projects were excluded in EIPC assumptions
- ◆ Resulting “locked in” BAU case has total transfer capability of **197 GW of pipes** between regions based on existing and new ≥ 230 kV transmission in-service by 2016 (see next slide)

¹Planning Coordinators include RTOs, government power authorities and electric utilities who have taken on the responsibility of coordinating, facilitating, integrating, and evaluating transmission facilities under the NERC Functional Model.

Transfer Limits in BAU Case

BAU baseline with 197 GW of total transfer capability based on “locked in” existing/approved projects as of 2016





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Transmission Additions to Base Case

Since NEEM does not automatically expand or optimize transmission, EIPC used mix of analyses and assumptions to determine possible build-out between modeled regions

- ◆ Transmission constraints between regions and super regions were “softened” to allow additional flows
 - An “overload charge” was imposed on additional flows, set to 75% and 25% of the base case “shadow price” (*i.e.*, the congestion price differential between bubbles), which allowed for additional flows
 - Essentially determines transmission capacity needed to reduce congestion charges between regions to approx. 75% and 25% of the base case value
- ◆ Using a blend of 3 methodologies and capacity factor targets for new transmission, the pipes between regions were increased and “hardened” which increased pipe capacity by up to ~20% of the maximum indicated by soft-constraint analyses
- ◆ Stakeholders then decided on which of the three runs to use (*i.e.*, base case transmission or relaxed constraint derived from either the 75% or 25% constraint case)

Phase 1 Results

Results of “Hardened Constraint” Analyses

Analyzed increases in transfer capability of pipes between regions (from 197 GW in base case). Highlights show the 3 scenarios selected for Phase 2 analysis:

Future	“Locked in” 2016 Baseline (GW)	Additional Capability (GW)	
		75% Case	25% Case
F1. Business as Usual	197	3.7	21.8
F2. National Carbon – National Implementation	197	39.9	122
F3. National Carbon – Regional Implementation*	197	4.3	<i>n/a</i>
F4. EE/DR	197	<i>n/a</i>	<i>n/a</i>
F5. National RPS – National Implementation	197	16.8	64.2
F6. National RPS – Regional Implementation*	197	<i>n/a</i>	3.1
F7. Nuclear Resurgence	197	5.0	<i>n/a</i>
F8. Combined Federal Climate & Energy Policy	197	37.0	90.8

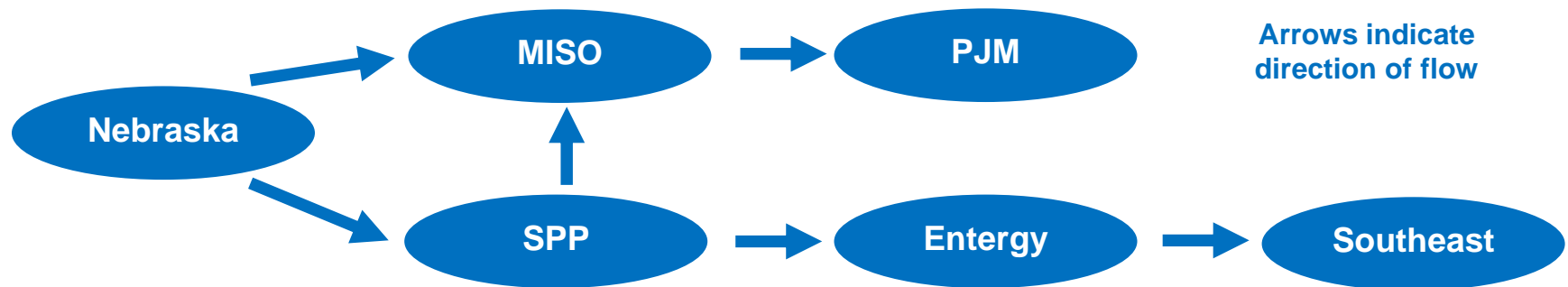
*** Regional implementation cases assume no transmission would be added between super regions after 2016**

Two additional sensitivities for Combined Federal Climate & Energy Policy are not shown. These two runs were both 75% cases and resulted in increases of 18.2 GW and 22.7 GW of transfer capacity. Futures 3 and 6 (regional implementation cases) assume no transmission expansion between super regions. Future 4 assumes no additional transmission capability between regions and super-regions is needed.

Observations on EIPC Phase 1 Results

EIPC Phase 1 shows the following broad themes:

- ◆ National implementation scenarios with a low-carbon and/or renewables (F2, F5, and F8) focus suggest that significantly increasing the transfer capability from west to east would be needed to reduce identified congestion
 - **See Appendix for transmission capacity addition maps**
- ◆ Most often, the congestion-reducing increases in transfer capacities are either within or between the footprints shown below*:

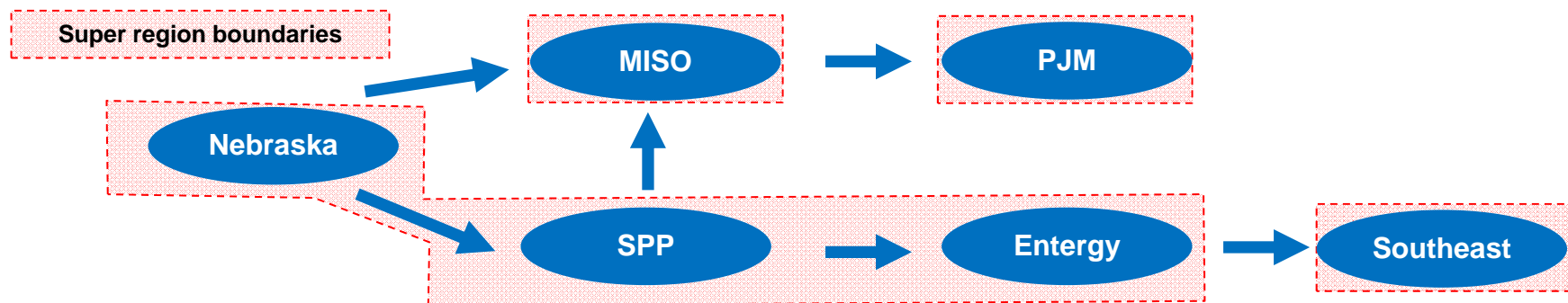


*For example, MISO is shown above as a single blue circle but NEEM disaggregates it into 5 separate regions and aggregates it (along with other regions) into one super region.

Phase 1 Results

Observations on EIPC Phase 1 Results (cont'd)

- ◆ For national implementation scenarios, the transmission capacity in the 25% constraint cases exceeds that of the 75% cases by a factor of 3 or more but:
 - Does not eliminate all congestion between regions
 - Does not reflect transmission expansion needed to actually reduce congestion to 25% or 75% of base case (because of capacity factor requirement in hardened constraint cases)
- ◆ Regional implementation cases for renewables and low-carbon policies identify generation additions and retirements assuming no additional transfer capability is built between super regions (e.g., MISO to PJM) past 2016 levels



EIPC Phase 1 Results: Scenario 1

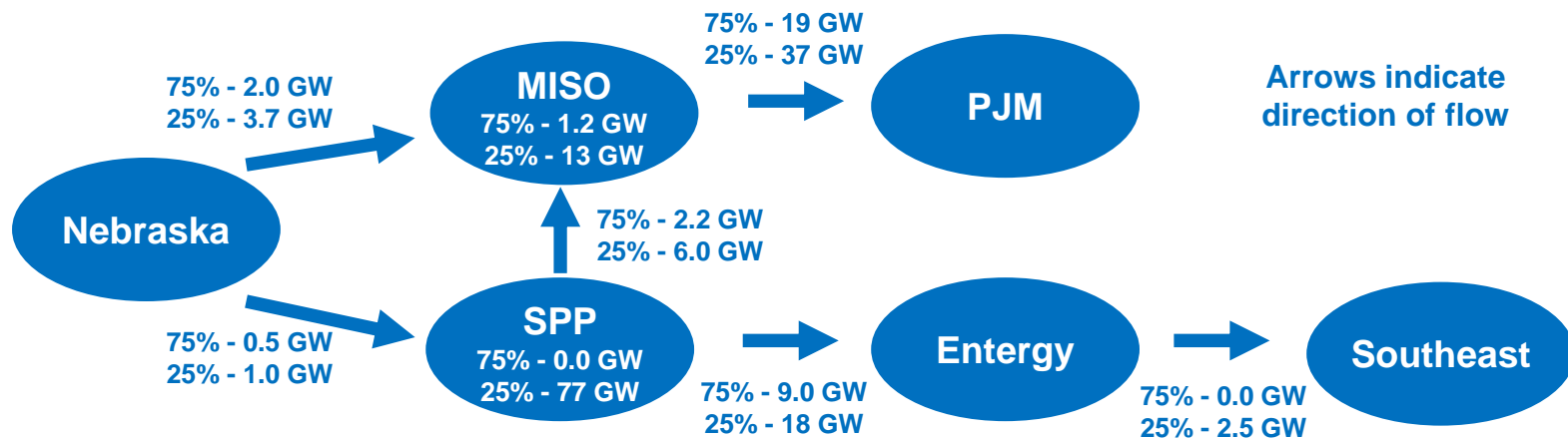
Selected Scenario 1: Nationally-Implemented Federal Carbon Constraint w/ Increased EE/DR

- ◆ Selected scenario (Future 8 in Phase 1 study) is based on the 75% constraint case, which adds 37 GW of transfer capability to baseline
- ◆ Using result from the 25% constraint case would have increased transfer capability by an additional 91 GW
 - Increasing transfer capability by 91 GW would be equivalent to increasing the baseline capacity of 197 GW by 46%
- ◆ The identified transmission expansions only relate to transfer capability between the NEEM regions and does not include needed transmission additions within each of the bubbles (which the NEEM model assumes to be entirely unconstrained), which will be studied in Phase 2

EIPC Phase 1 Results: Scenario 1 (cont'd)

Selected Scenario 1: Nationally-Implemented Federal Carbon Constraint w/ Increased EE/DR (cont'd)

- ◆ Approx. 90% or more of additional transmission capacity for both the 75% and 25% constraint cases are from the increases shown below (in GW):

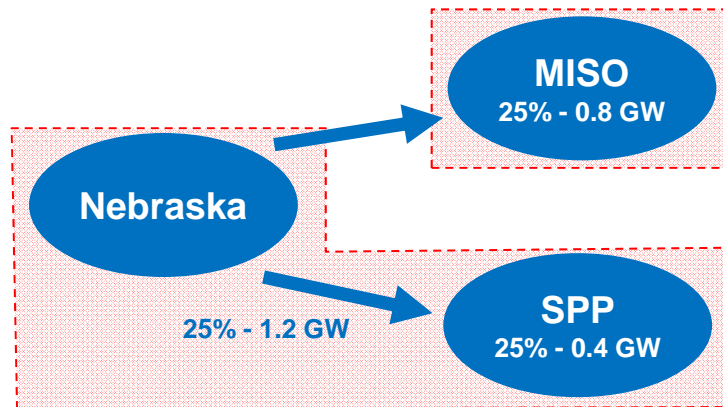


- ◆ Approx. 1.0 to 1.5 GW of additional transfer capability is also added from NY upstate to downstate and New England into NYISO. See Appendix for more detailed maps

EIPC Phase 1 Results: Scenario 2

Selected Scenario 2: Regionally-Implemented National RPS

- ◆ Selected scenario (Future 6) is based on the 25% case, adding 3 GW of transfer capability between regions within individual super regions
 - Transmission between super regions in regional implementation cases is assumed to remain at 2016 levels throughout entire study period
 - No 75% case was conducted for this future
- ◆ Approximately 80% of additional transmission capacity are from the increases shown below (in GW):



Arrows indicate
direction of flow

super region boundaries

*Transfer capabilities are assumed to
not be increased between super
regions past 2016 base levels*

- ◆ Approx. 0.5 GW of additional transfer capability is also added from NY upstate to downstate. See Appendix for more detailed maps

EIPC Phase 1 Results: Scenario 2 (cont'd)

Selected Scenario 2 (regionally-implemented) compared to Future 5 (nationally-implemented) RPS:

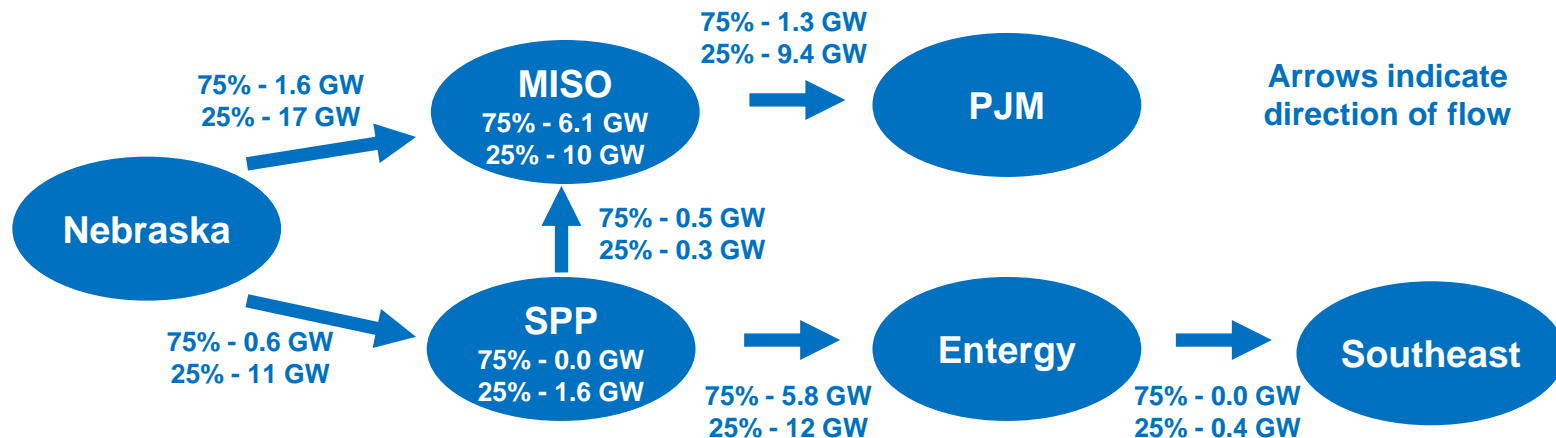
- ◆ The RPS target in Selected Scenario 2 (Future 6) was also modeled in Future 5 but without super-regional constraints (although not selected for Phase 2 analysis)
- ◆ The analyses from Future 5 showed that 17 GW are added in the 75% constraint case and 64 GW are added in the 25% case, with large increases between the super regions (e.g., between MISO and PJM; Nebraska and MISO) as well as within the super regions (e.g., west to east transfers within MISO)
 - Additional transfer capability between NY upstate to downstate is approximately the same as Selected Scenario 1 at 0.6 GW
- ◆ Contrast between Future 6 (regional implementation of RPS without transmission expansion between super regions) and Future 5 (RPS standard implementation with transmission expansion between super regions) points to follow-on analyses of extent by which new transmission can reduce total cost of RPS compliance
- ◆ See Appendix for more detailed maps

Phase 1 Results

EIPC Phase 1 Results: Scenario 2 (cont'd)

Selected Scenario 2 (regionally-implemented) compared to Future 5 (nationally-implemented) RPS (cont'd)

- ◆ Over 95% of additional transmission capacity for both 75% and 25% constraint cases in Future 5 are from the increases shown below:

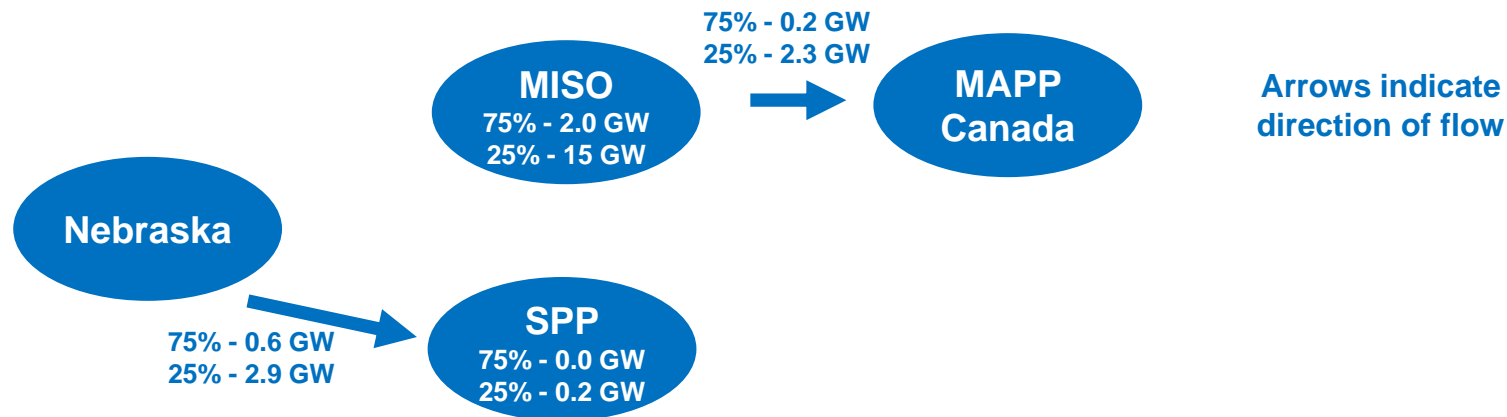


- ◆ The majority of the MISO internal increase was from MISO West to MISO Missouri-Illinois to MISO Indiana. See Appendix for more detailed maps

EIPC Phase 1 Results: Scenario 3

Selected Scenario 3: Business as Usual (BAU)

- ◆ The selected BAU scenario (Future 1) identified generation additions and retirements assuming no additional transfer capacity post 2016
- ◆ However, reliance on the 75% constraint case would have increased transfer capability by an additional 3.7 GW (and by 22 GW in the 25% constraint case)
- ◆ Over three quarters of the additional transmission capacity for both the 75% and 25% cases are from the increases shown below (in GW):



- ◆ Approx. 0.5–1.0 GW of additional transfer capability is also added from NY upstate to downstate. See Appendix for more detailed maps

EIPC Phase 1 Results: Futures Not Selected

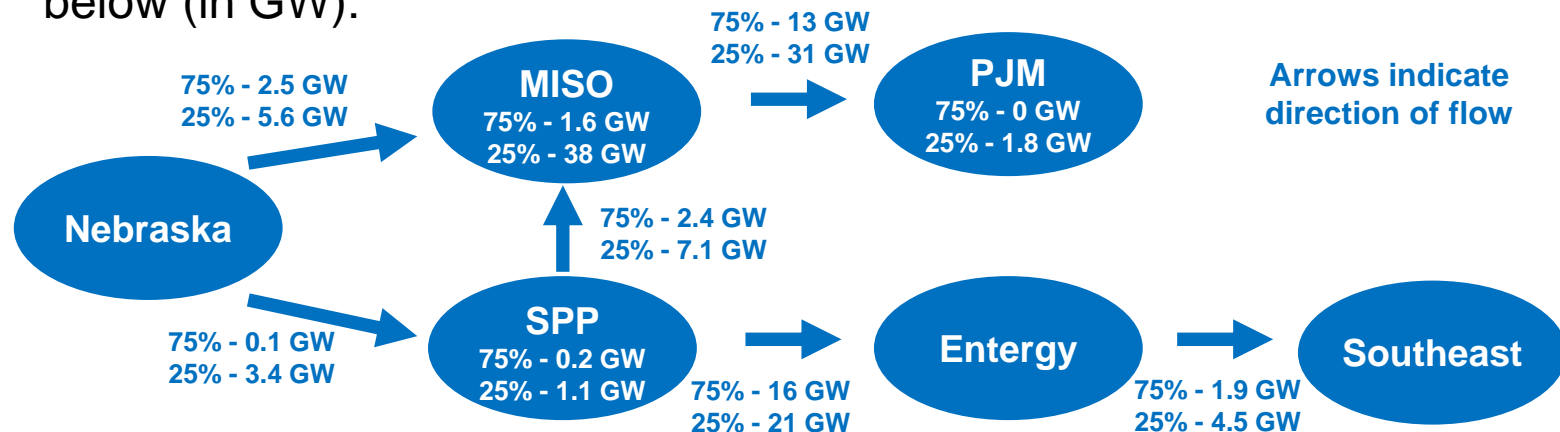
Futures not selected for Phase 2

- ◆ Nuclear Resurgence (Future 7)
 - Adds an additional 17 GW of nuclear capacity in addition to already proposed uprates in the non-RTO southeast (64%), PJM (27%); and MISO (9%)
 - Analysis was based on the 75% case with an additional transfer capacity of 5.0 GW, the majority of which is in the following regions:
 - Nebraska to SPP – 1.1 GW
 - MISO to MAPP Canada – 1.9 GW
 - New York upstate to downstate – 0.9 GW
- ◆ The EE/DR case (Future 4) assumed (without analysis) that no additional transmission build would be needed between regions past 2016 because projected overall loads in 2030 were lower than loads today (same as loads in Future 8)

EIPC Phase 1 Results: Futures Not Selected (cont'd)

Futures not selected for Phase 2

- ◆ National Carbon futures (Futures 2 and 3)
 - Similar to the RPS futures, regional implementation of the national carbon case (Future 3) produced only 4.3 GW of additional capacity (based on 75% case, assuming no new transmission between super regions)
 - In contrast, the national implementation case (Future 2) produced 40 GW (75% constraint case) and 122 GW (25% case)
 - An increase of 122 GW is equivalent to increasing all base case transfer capabilities by 62%
 - Over 90% of additional transmission capacity are from the increases shown below (in GW):





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Appendix: Transfer Capability Maps for Phase 1 Futures

Building on Phase 1 Study Design

Follow-on analyses (e.g., at regional or inter-regional level) are advisable given inherent limitation of first-in-kind interconnection-wide EIPC effort.

Phase 1 model and modeling assumptions likely understates future transmission needs while simultaneously overstating capability of existing system:

- ◆ Modeled only “normal” system conditions (normal weather, no regionally diverse load or generation patterns, no significant transmission outages), which will not fully capture strain on system and associated benefits of transmission expansion
- ◆ Pipe model of transfer capabilities between regions without considering simultaneous import/export constraint likely significantly overstates the transfer capabilities of the existing system by letting the model ship power around several paths

Building on Phase 1 Study Design (cont'd)

Particular scenario selection and use of models in EIPC effort did not determine benefits of regional and inter-regional transmission expansion:

- ◆ Transmission is only expanded to accommodate different placement of generation expansion (*i.e.*, to large extent ignores congestion relief and does not consider other transmission benefits)
- ◆ Transmission “expansion” is made based on “soft constraint methodology” which does not compare costs and benefits and causes large variations in results (compare 75% and 25% cases)
- ◆ Transmission build is based on EIPC stakeholder assumptions and selection of futures and cases, not on actual analysis of the benefits and costs of transmission expansion options

These inherent limitations of the interconnection-wide study design can be addressed through follow-up analyses

- ◆ Full regional and interregional studies to address cost-benefit questions
- ◆ Phase 1 study results can be analyzed for total system cost implications

Building on Phase 1 Study Design_(cont'd)

Follow-on analyses could also address other transmission benefits not captured in EIPC Phase 1 study design:

- ◆ Load duration curve approach (rather than chronological modeling) will not capture the benefit of transmission for load diversity, renewable generation diversification, or value of transmission under extreme conditions
- ◆ Does not capture fact that transmission expansion reduces the amount of ancillary services needed to balance intermittent generation
- ◆ Demand is grossed up for losses based on historical average and loss component does not change with transmission build (ignores potential benefits of reduced transmission losses)
- ◆ Manual adjustments were necessary to limit excessive generation builds that were “economically” optimal in the model and may have made transmission more valuable
- ◆ Model assumes perfect foresight of future market conditions, thereby ignoring the “option value” created by a more robust transmission grid

Building on Phase 1 Design (cont'd)

Follow-up analyses to address other transmission benefits... (Cont'd)

- ◆ Long-term generation optimization within regions (subject to fixed transmission between regions) of Phase 1 will tend to build the same “most efficient” technologies (e.g., natural gas CCs) everywhere, thereby decreasing the value of transmission in the long run
 - This will make the regions more uniform over time and (due to not building transmission within the model) more self sufficient, which may not reflect reality and understate transmission-related benefits
 - As EIPC report notes, the reliance on natural gas-fired units does not take into consideration whether there will be sufficient natural gas infrastructure to actually support the generation expansion within each of the regions and super regions
- ◆ Lack of iterative process (per study design) will not provide information on cost-effective tradeoff between building more transmission and reducing costs through congestion relief and improved access to less expensive resources

Thoughts About Phase 2

Phase 2 analysis will construct power flow cases for generation additions/retirements stemming from regional transfer capabilities selected or assumed in Phase 1

- ◆ It may be difficult to design a reliable yet cost-effective transmission solution around Phase 1 results, given the limitations of Phase 1 simulations
- ◆ Need to avoid attempts to limit transfer capability between regions to those selected in Phase 1
 - Upgrading transmission within regions but keeping limits between regions to Phase 1 assumptions would be difficult and inefficient from a transmission design perspective
 - Would not adequately address impact of loop flows between regions (e.g., flows between MISO and PJM may impact SPP, Entergy, and TVA)
- ◆ Production cost modeling may point to additional inefficiencies in EIPC transmission build assumptions for future study

Follow-up analyses will be needed to allow for iterative process to revisit regional and inter-regional transfer capabilities and associated benefit-cost tradeoffs



Summary

EIPC Overview

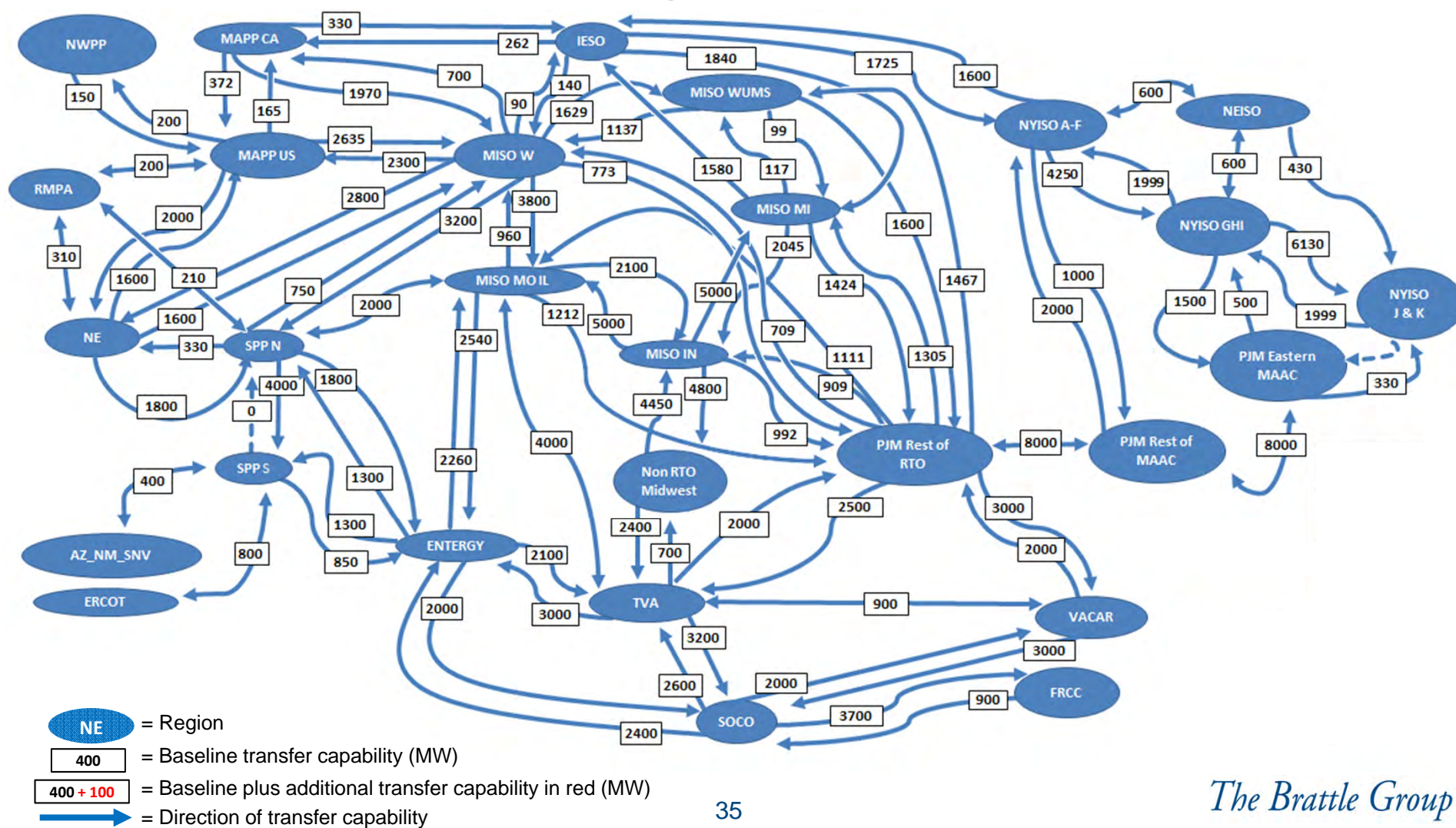
EIPC Phase 1 Results

Thoughts on Possibly Next Steps for Additional Analyses

Appendix: Transfer Capability Maps for Phase 1 Futures

Transfer Limits in Business As Usual (BAU) Baseline Case

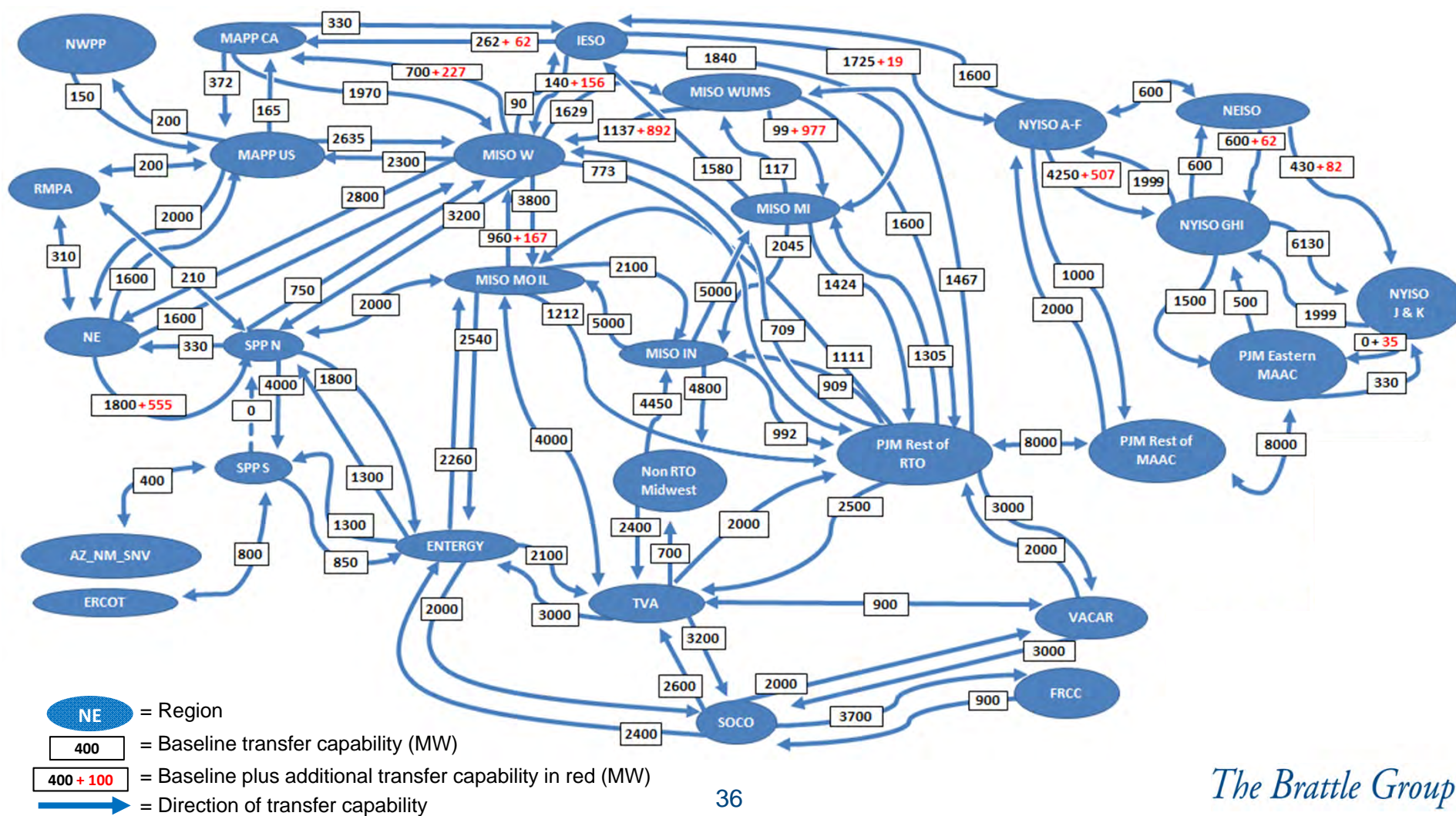
BAU baseline with 197 GW of total transfer capability based on “locked in” 2016 existing/approved projects



Appendix

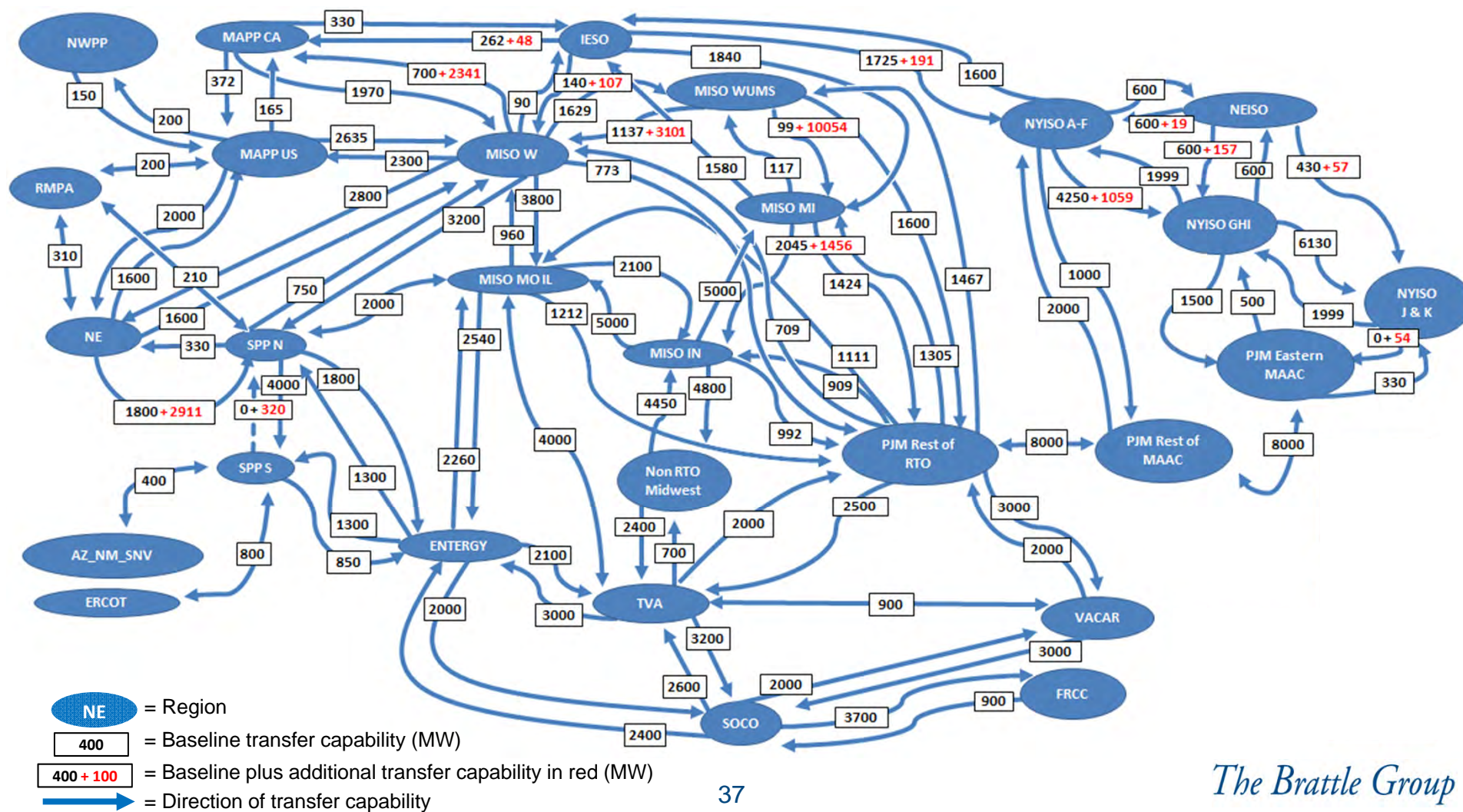
BAU Transfer Limits Based on 75% Case (F1S1)

BAU expansion based on 75% shadow price analysis would support **3.7 GW of additional transfer capability**



BAU Transfer Limits Based on 25% Case (F1S2)

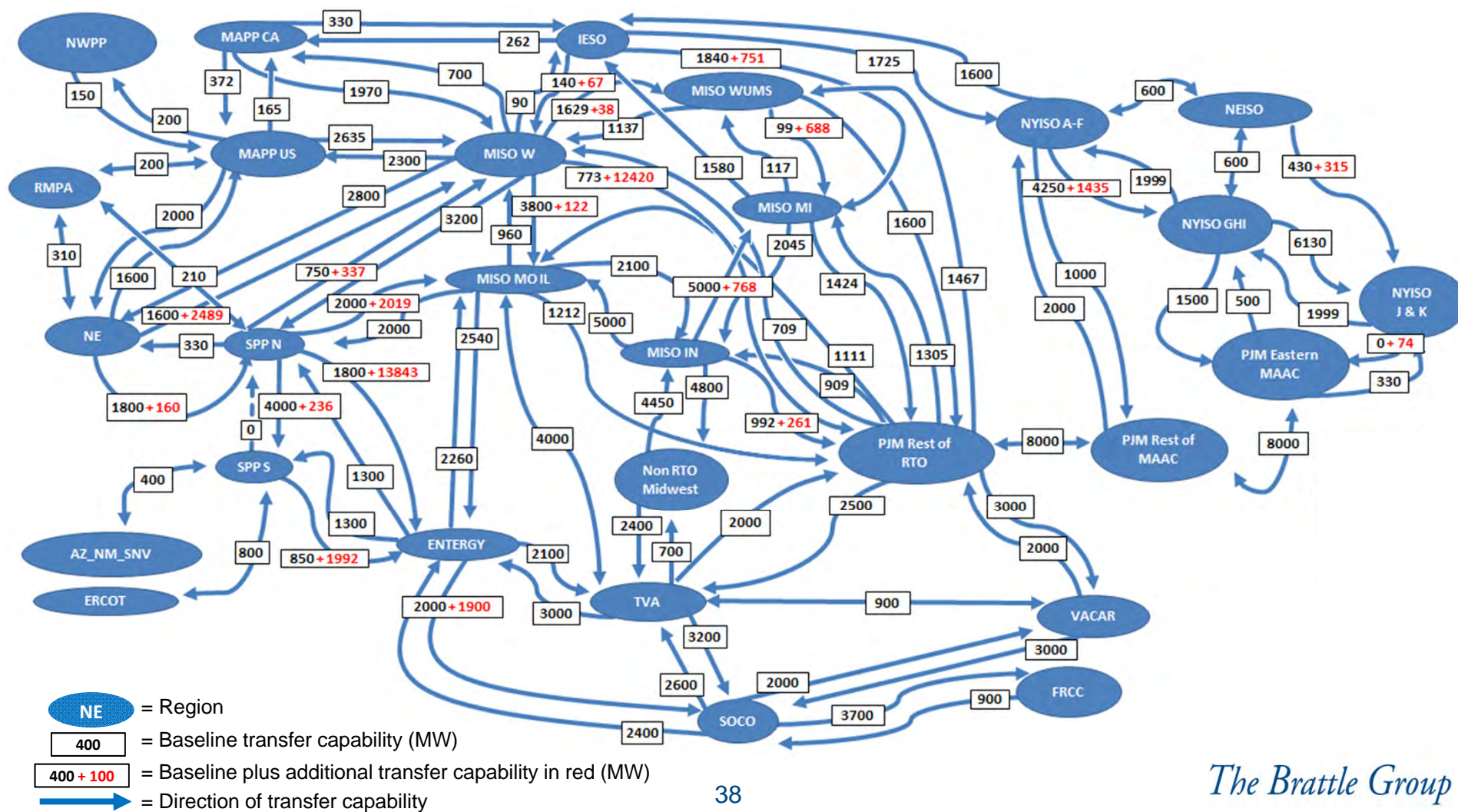
BAU expansion based on 25% shadow price analysis would support 21.9 GW of additional transfer capability



Appendix

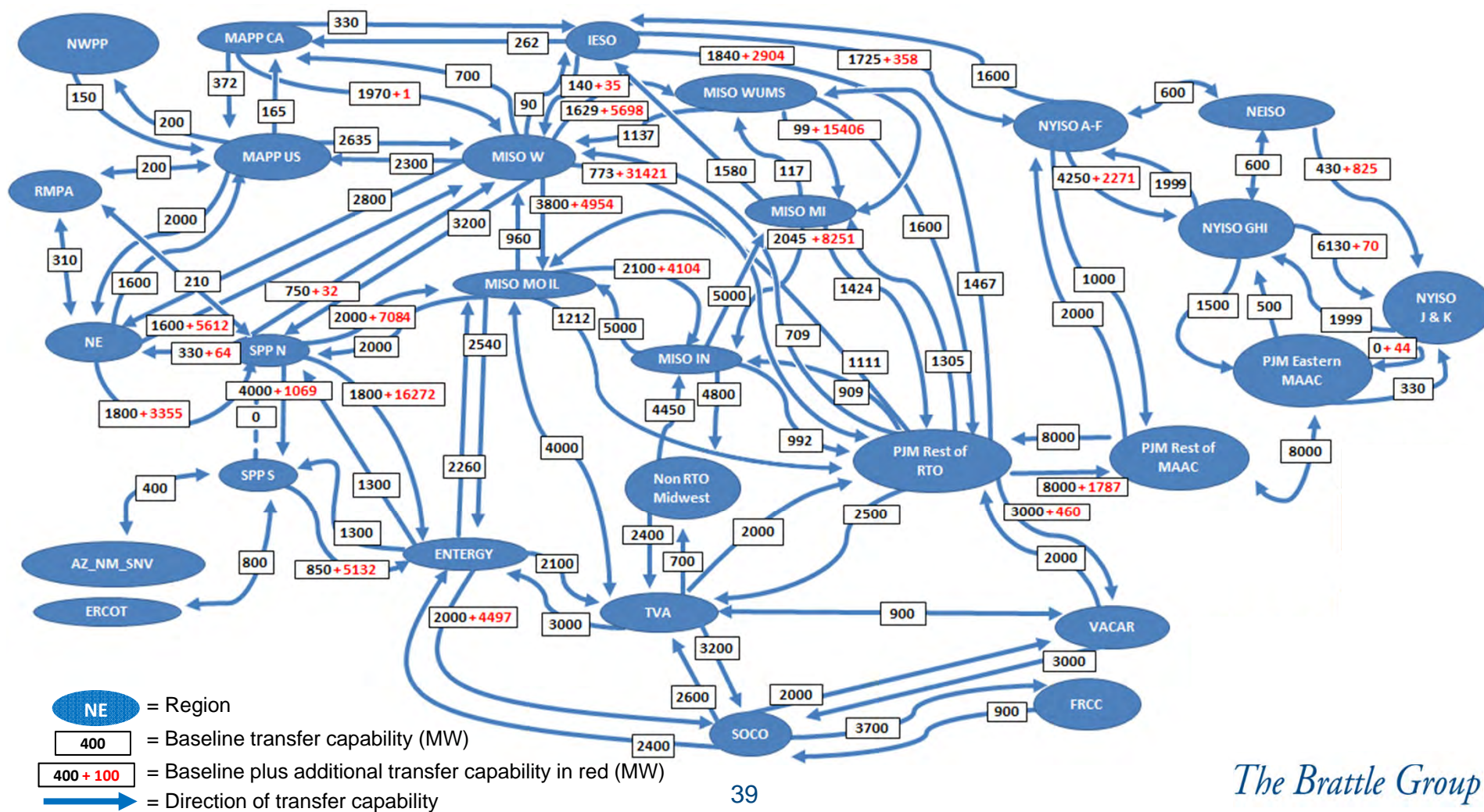
National Carbon (Natl Implementation), 75% Case (F2S1)

National implementation of carbon case (75% shadow price analysis) supports **39.9 GW** of additional transfer capability



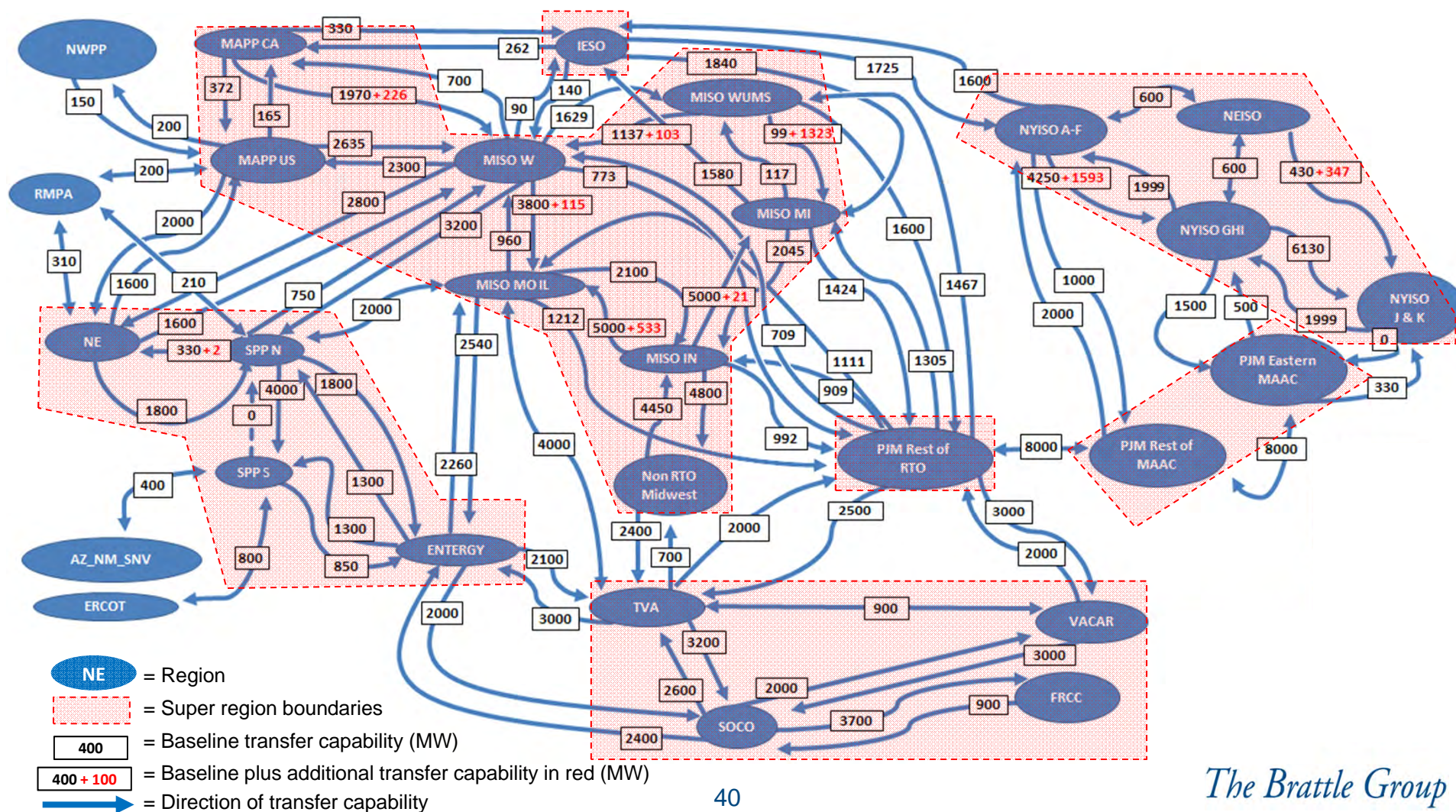
National Carbon (Natl Implementation), 25% Case (F2S2)

National implementation of carbon case (25% shadow price analysis) supports 122 GW of additional transfer capability



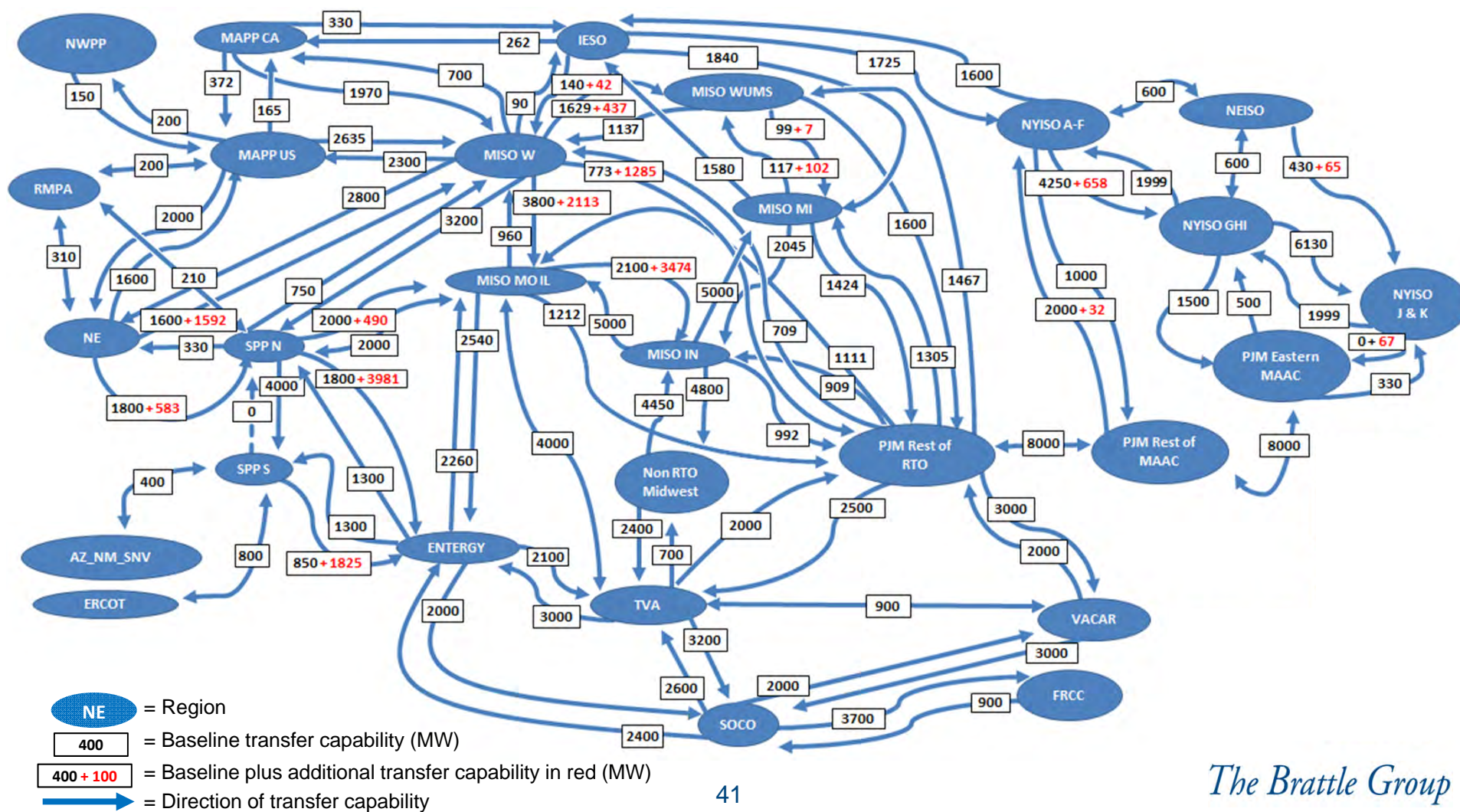
National Carbon (Regional Impl.), 75% Case (F3S1)

Regional implementation of carbon case (75% shadow price analysis) supports 4.3 GW of additional transfer capability



National RPS (National Implementation), 75% Case (F5S1)

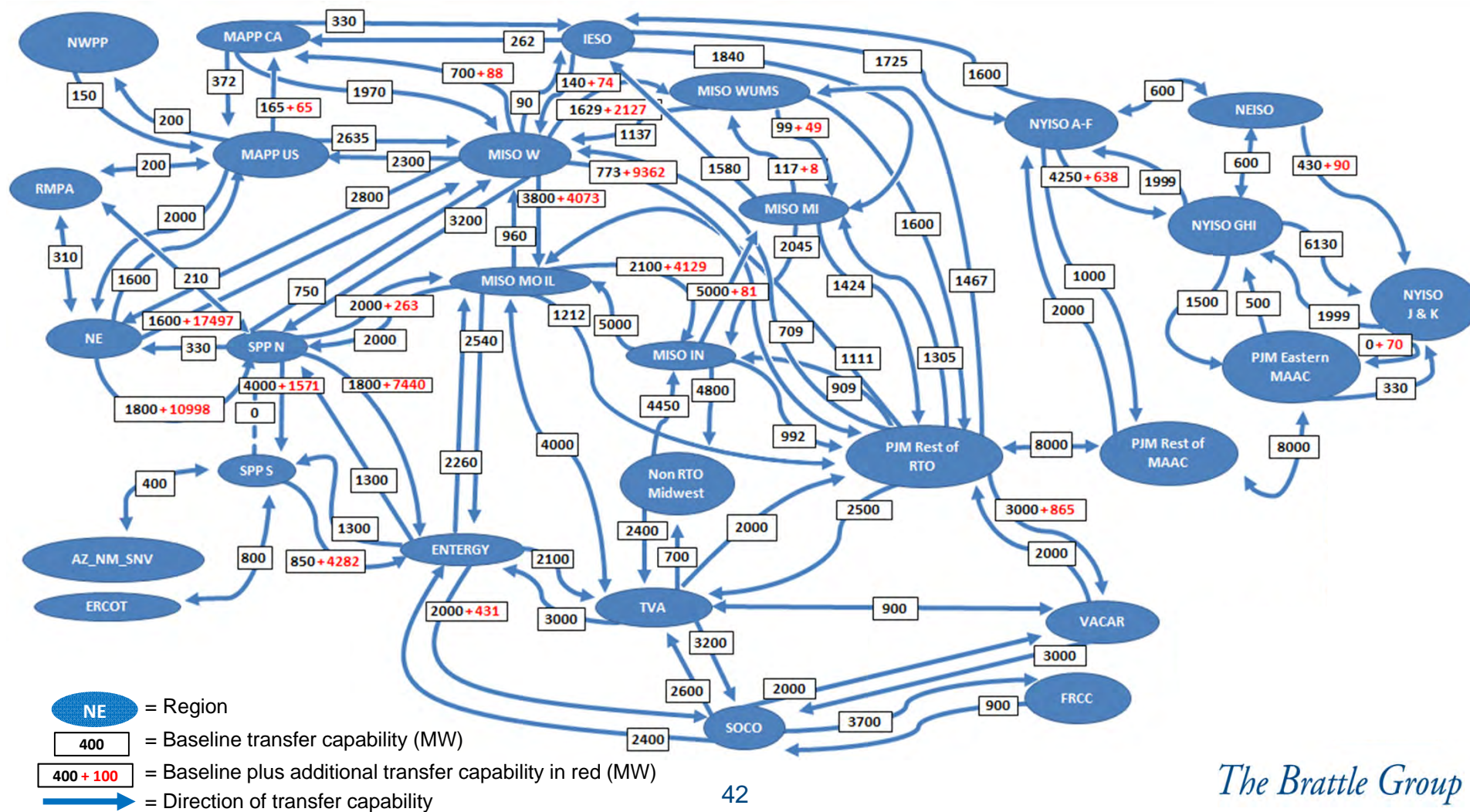
National implementation of RPS policy (75% shadow price analysis) supports 16.8 GW of additional transfer capability



Appendix

National RPS (National Implementation), 25% Case (F5S2)

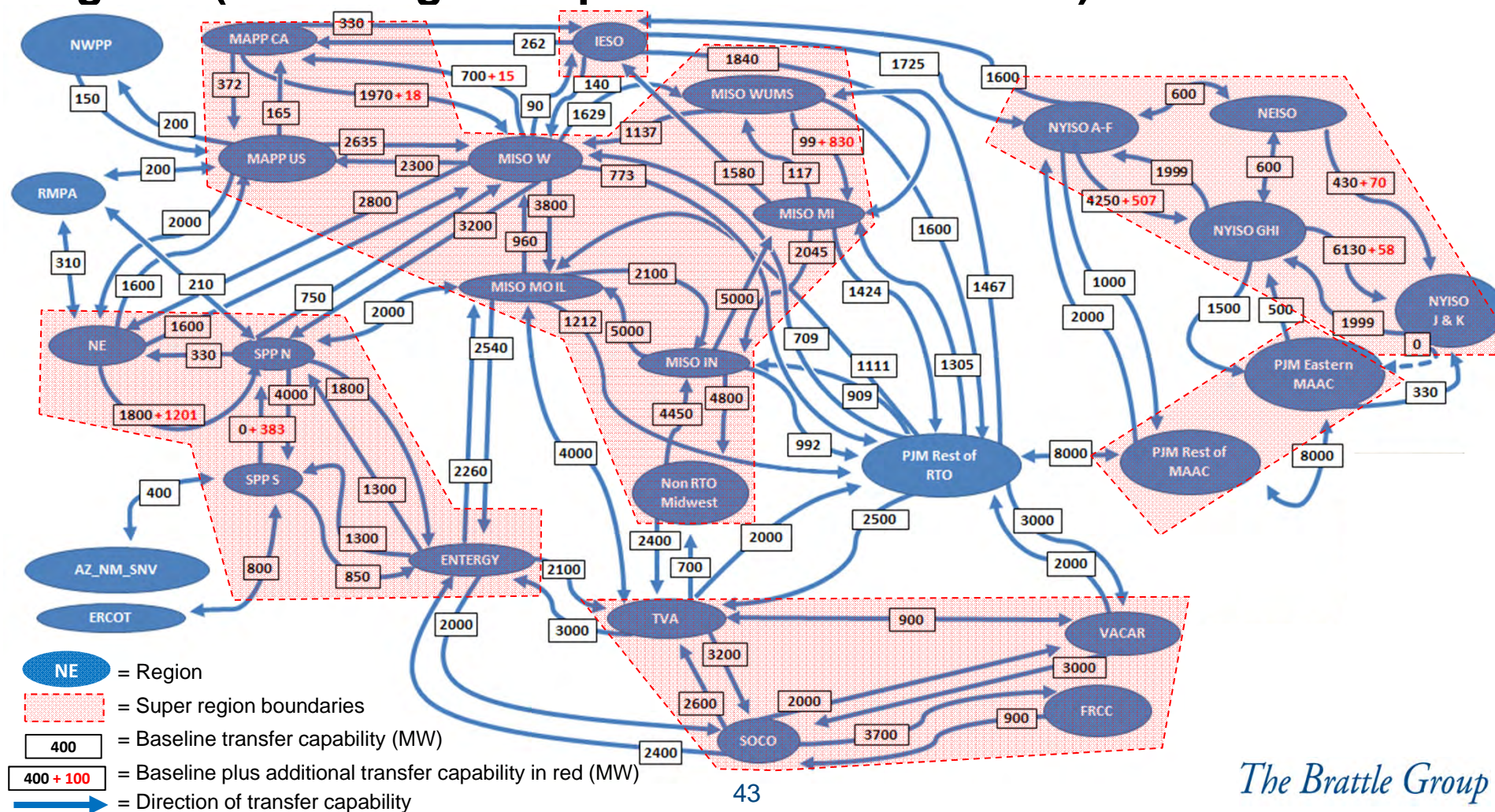
National implementation of RPS policy (25% shadow price analysis) supports **64.2 GW** of additional transfer capability



National RPS (Regional Implementation), 25% Case (F6S1)

Selected for Phase 2 Analysis (Scenario 2)

Regional implementation of RPS (25% shadow price case) supports 3.1 GW of additional transfer capability within super regions (assuming no expansion between them)

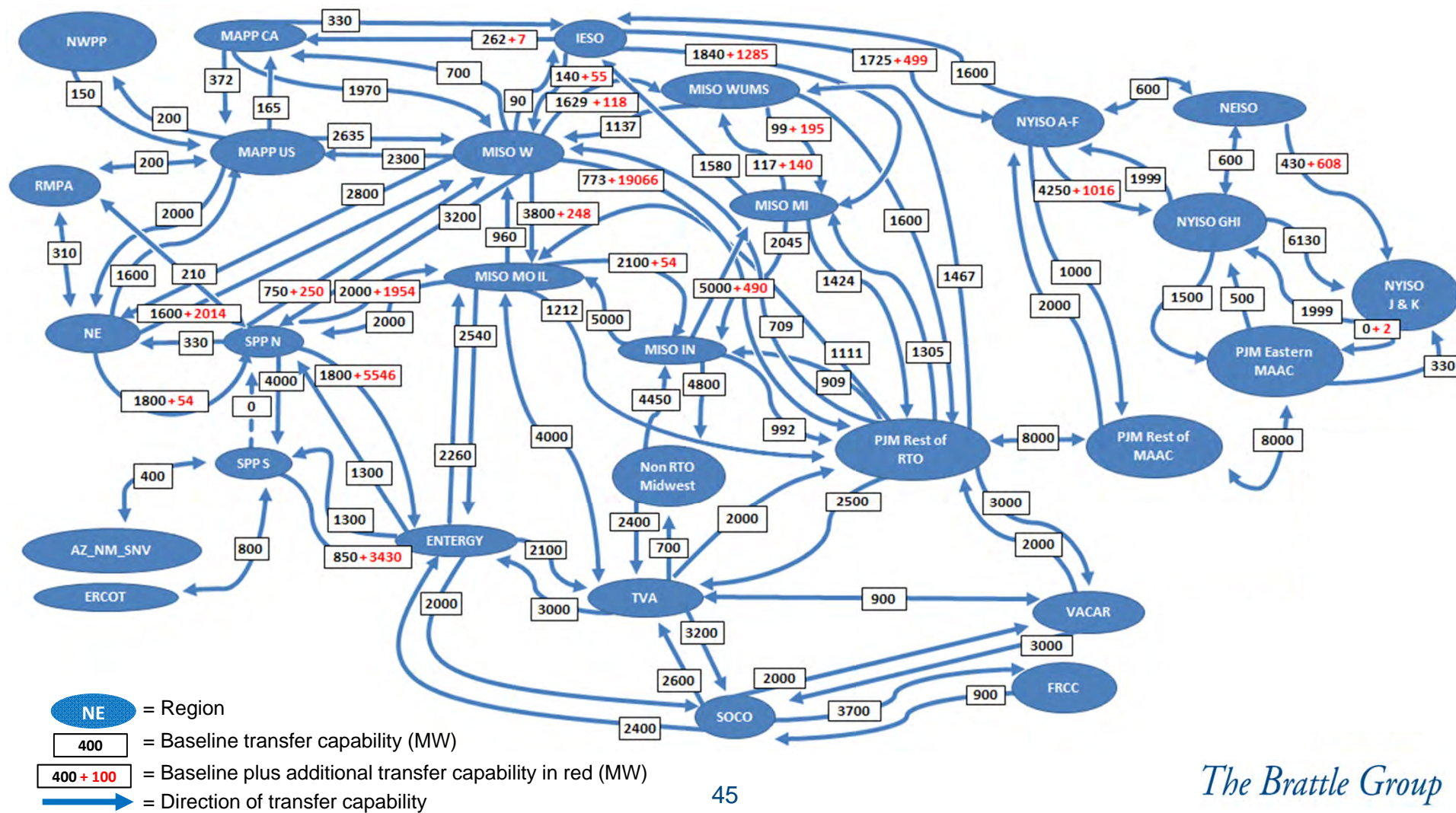


The nuclear scenario (based on 75% shadow price analysis) supports 5.0 GW of additional transfer capability



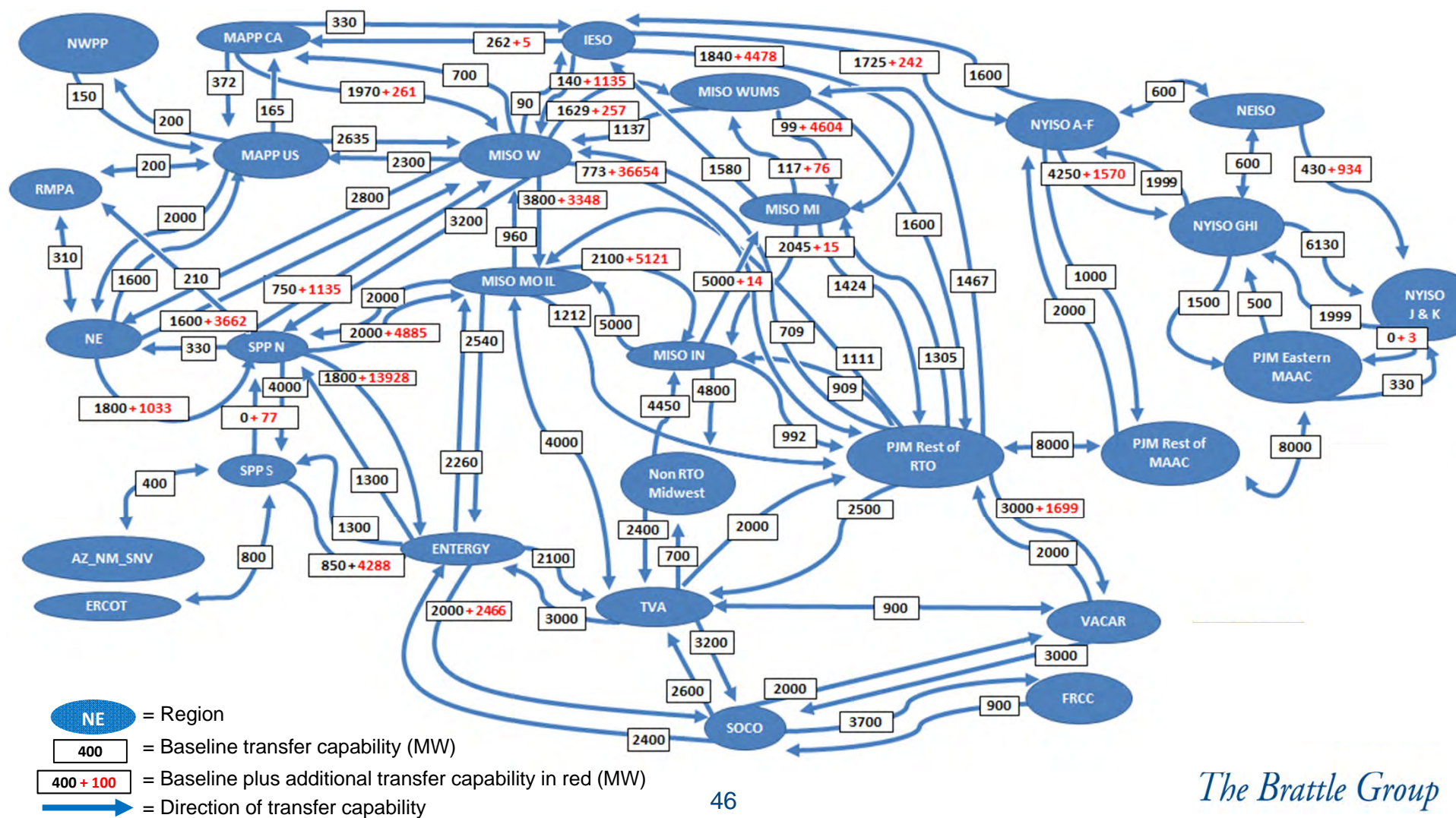
Appendix *Selected for Phase 2 Analysis (Scenario 1)*
Combined Federal Climate & Energy Policy, 75% Case (F8S1)

For this future, the 75% shadow price analysis case supports 37.0 GW of additional transfer capability



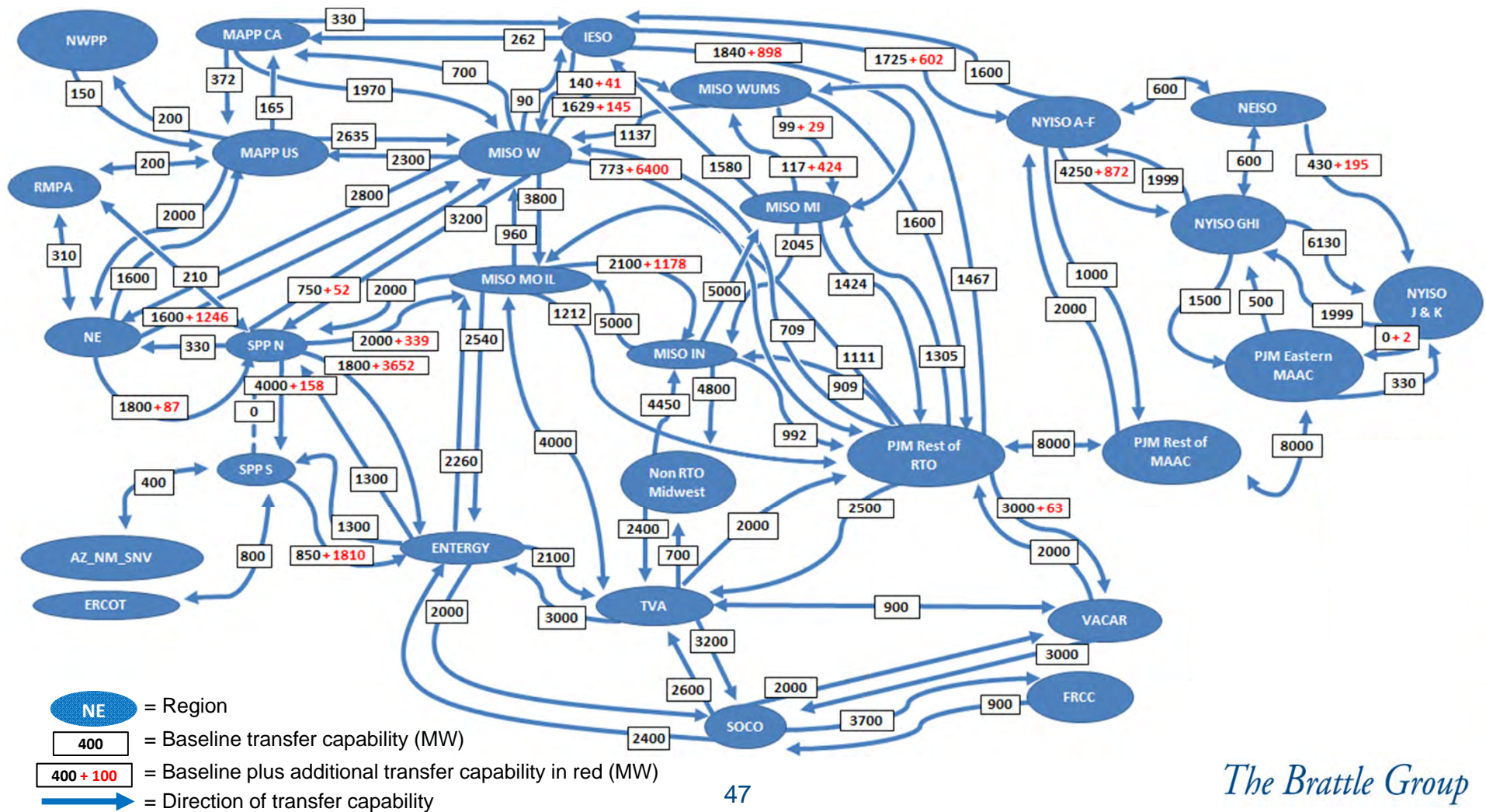
Combined Federal Climate & Energy Policy, 25% Case (F8S2)

For this future, the 25% shadow price analysis case supports 90.8 GW of additional transfer capability



Comb. Federal Climate & Energy Policy, 75% Case (F8S5) – additional sensitivity

For this future, the 75% shadow price analysis case supports 18.2 GW of additional transfer capability



Comb. Federal Climate & Energy Policy, 75% Case (F8S6) – additional sensitivity

NE = Region
400 = Baseline transfer capability (MW)

NE = Region
400 = Baseline transfer capability (MW)
400 + 100 = Baseline plus additional transfer capability in red (MW)
→ = Direction of transfer capability