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| Multiple Interconnections for Generators |
| Draft White Paper |
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| **12/3/2009** |

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Table of Contents

[Executive Summary 3](#_Toc247610394)

[What is a MIG 6](#_Toc247610395)

[Why a MIG is Desirable 6](#_Toc247610396)

[Policy Guidance 6](#_Toc247610397)

[Switching implications 7](#_Toc247610398)

[CRRs 7](#_Toc247610399)

[Gaming 8](#_Toc247610400)

[Resource Adequacy 8](#_Toc247610401)

[Scarcity Pricing 8](#_Toc247610402)

[System Planning 9](#_Toc247610403)

[Economic Upgrades 9](#_Toc247610404)

[Market Power 9](#_Toc247610405)

[System Operations 9](#_Toc247610406)

[SCADA 10](#_Toc247610407)

[Telemetry 10](#_Toc247610408)

[Interconnection Request REQUIRES VOTING BODY APPROVAL 11](#_Toc247610409)

[ERCOT Requested Switch 12](#_Toc247610410)

[Market Participant Requested Switch 12](#_Toc247610411)

[Proposed Notice Provisions {30} - REQUIRES VOTING BODY APPROVAL 13](#_Toc247610412)

[Market Participant Switch Rejection 14](#_Toc247610413)

[Transmission Planning 14](#_Toc247610414)

[Planning Concept 1 – Maximize Interconnection Flexibility 15](#_Toc247610415)

[Planning Concept 2 – Minimize Transmission Costs 15](#_Toc247610416)

[Planning Concept 3 – Economic Planning 17](#_Toc247610417)

[Timing Considerations 18](#_Toc247610418)

[Coordination Issues 19](#_Toc247610419)

[Other Considerations 19](#_Toc247610420)

[Task Force Recommendation – REQUEST VOTING BODY ENDORSEMENT 19](#_Toc247610421)

[Transmission Outage Coordination 20](#_Toc247610422)

[Inclusion of Additional Interconnections in TCOS 21](#_Toc247610423)

[Policy Questions beyond MIGTF Scope 21](#_Toc247610424)

[Line Construction without PUC Approval 21](#_Toc247610425)

[Other Comments/Concerns 21](#_Toc247610426)

# Executive Summary

The Multiple Interconnections for Generators Task Force (MIGTF), a joint task force of the Wholesale Market Subcommittee (WMS) and the Reliability and Operation Subcommittee (ROS) was formed to consider changes necessary to the ERCOT Protocols to accommodate a Generation Resource with more than one interconnection to the ERCOT transmission system. The MIGTF’s first task was to develop a list of questions related to this issue for consideration. Individual task force members were assigned to provide a draft answer to each question. The whole task force then met and discussed the answer to try to reach consensus. The MIGTF reached consensus on most of the answers; but, in a few instances it did not. This white paper was then developed to determine the potential changes to the existing ERCOT Protocols to accommodate a Generation Resource with more than one interconnection to the ERCOT transmission system. The MIGTF did not consider any changes in law or Public Utility Commission of Texas (PUCT) rules related to this issue.

**Interconnection Process:**

The process for a Generation Resource to request an additional interconnection to the ERCOT transmission system is the same process as that for a new Generation Resource requesting interconnection. No special priority is given to either type of request. The Standard Generator Interconnection Agreement (SGIA) is a PUCT-approved document, therefore, changes in it were not discussed by the MIGTF.

**Operation:**

A Generation Resource should be allowed to change from one of its interconnections to another with proper notice to ERCOT and market participants. The MIGTF discussed interconnection switching notification times ranging from as short as a few minutes to as long as one year. Several suggested notification periods for change of active interconnection point were considered including following the normal transmission outage reporting requirements. ERCOT’s current interpretation of the Protocols requires 30 days notice for a change in transmission interconnection of a Generation Resource. Clarification or changing of this notice requirement would require a Protocol change. The Task Force members did not reach consensus on the time that should be required for market participant notice for changing from one interconnection to another. Votes were taken by the TAC and its Subcommittees ROS believes the \_\_\_\_\_\_\_(days); WMS believes the \_\_\_\_\_(days); and TAC believes the \_\_\_\_\_(days ); are the appropriate timelines for a Market Participant Requested Switch.

The Task Force agreed that the notice time for changing interconnections should provide for exemptions to the notice requirement when:

* A transmission outages renders the current connection inoperable,
* ERCOT declares an Emergency (based upon reliability criteria),
* Forced outage of the current connection prevents the generator operating.

Both the transmission and generation outage scheduling process will be more complex under a situation where a Generation Resource has more than one interconnection, but the MIGTF determined that no changes are needed to the mechanics of the outage scheduling process itself. The Generation Resource will show the unused interconnection as normally open. The details of reporting the status of the interconnection might require a Protocol change, but the Outage Scheduler process should not require a change.

Requirements for additional data will need to be added to ERCOT the Protocols and/or Operating Guides. A requirement for a voice notification of a change in the interconnection point of any Generation Resource will also be needed.

The group determined that ERCOT must also have the right to direct the Generation Resource (through Out of Merit Capacity (OOMC) or Reliability Unit Commitment (RUC)) to connect to the grid or to change connections in order to use a specific interconnection point during emergencies. This new requirement would require a Protocol change and such instruction from ERCOT would require notification to the market.

The MIGTF did not reach consensus on whether a new interconnection with a resulting new interconnection agreement will use the date of the new agreement for grandfathering considerations in the protocols, or if the date of the first interconnection agreement should be the grandfathering date for consideration in the protocols. Votes were taken at ROS, WMS and TAC on the protocol consideration date. ROS believes the \_\_\_\_\_\_\_(new/first); WMS believes the \_\_\_\_\_(new/first); and TAC believes the \_\_\_\_\_(new/first); interconnection date is proper for grandfathering considerations of in the protocols.

**Planning:**

Today, there is a process in place to determine when transmission should be built to improve the reliability and economics of the ERCOT System. That process will need to be changed to accommodate a Generation Resource that plans more than one grid interconnection point. When a generator has more than one interconnection, there needs to be a process for determining how to decide which transmission upgrades are appropriate for economic consideration. Three transmission planning concepts were identified; 1) maximize the interconnection flexibility, 2) minimize transmission cost, 3) economically plan the system. The Task Force reached consensus that minimizing transmission cost should be the default case. Another consideration would be the economics of a build out of transmission of the predominant interconnection or more likely used interconnection, i.e. when a build out makes sense. Changes to the Regional Planning Group (RPG) process would likely be needed to accommodate multiple interconnection situations from a planning perspective.

**Impacts on Other Generators and ERCOT**

Generation Resources with multiple interconnection points will increase the complexity and risk of buying and selling Transmission Congestion Rights (TCRs) in the zonal market and Congestion Revenue Rights (CRRs) in the nodal market for both ERCOT and market participants. No protocol change is required for Generation Resources with multiple interconnection points, however, there is the possibility for gaming the value of TCRs or CRRs depending on where a Generation Resource is interconnected increases with multiple interconnections for a specific resource.

Locational Marginal Prices (LMPs) and scarcity prices will likely be impacted by Generation Resources with multiple interconnection points (changing the injection point changes the LMP results).

Overall generation adequacy ERCOT-wide will not be impacted in the short term but future construction of new Generation Resources may become more complex because planning and financing under the multiple interconnection scenarios is more difficult. Generation adequacy in a local area could be mitigated by ERCOT’s ability to force a Generation Resource with multiple interconnection points to a specific connection point during a system emergency.

The process changes for MIGs need to be made in both the Zonal and Nodal markets.

# What is a MIG

A Multiple Interconnected Generator (MIG) is a Generation Resource with more than one interconnection to the ERCOT grid. For a number of years there have been Generation Resources in ERCOT with interconnections to other electric grids (e.g., the Southwest Power Pool). A MIG and a Generation Resource that can provide power to ERCOT or another interconnection are different. The power produced by a MIG is always consumed within ERCOT interconnection, albeit from different connection points while the power produced by a Generation Resource with an interconnection to another region is not.

## Why a MIG is Desirable

In the current ERCOT zonal market, all the busses near a power plant are priced the same regardless of voltage level or flow on a particular transmission line. In a nodal market, busses located near a power plant could have dramatically different prices. A Generation Resource in a nodal market would want to have as many interconnections as possible to take advantage of the highest price node. Assuming that the Generation Resource always moves to the higher priced node, loads can benefit from MIGs because the additional generation at the higher priced node will lower the price at that node. However, the situation is not that simple. The movement of generation from one point of interconnection to another impacts all other Generation Resources and loads in an area and changes the value of CRRs to all market participants.

# Policy Guidance

Generation Resources with multiple interconnections are not directly addressed in either the PUCT rules or the ERCOT Protocols. It is likely that the unique transmission process in ERCOT causes the potential issues surrounding MIGs to be somewhat unique to ERCOT. There is, however, some guidance in other PUCT rules that may be informative.

PUCT rules exclude Transmission Service Providers (TSPs) from owning TCR/CRRs to prevent gaming by TSPs because TSPs could impact network constraints by manipulating network outages to their economic benefit, presumably to the disadvantage of other market participants and the public interest.  Keeping TSPs out of the TCR/CRR market was seen as keeping them “neutral” on network outages, thereby limiting the TSPs to scheduling network outages only for legitimate system needs.  A MIG could potentially manipulate prices and cause or relieve network constraints in much the same way as a TSP because of its ability to change where the Generation Resource injects power into the grid. While it is not feasible to prevent MIGs from owning CRRs/TCRs, a required notification period for switching the interconnection point of a Generation Resource is important to limit the “gaming” potential, and not disadvantage other market participants. {33}

Additional guidance comes from the suspension of operation process. ERCOT is given a 90 day window in which to determine if a specific generator is needed at a specific location for reliability purposes. (ERCOT Protocol Section 6.5.9.1, Initiation and Approval of RMR Agreements). While a MIG might not be intending to cease or suspend operations, switching interconnections means that it is no longer producing energy at a specific location. The task force determined that ERCOT should have the ability to direct the MIG unit to connect to a specific interconnection point during emergencies.

# Switching implications

MIGs are desirable in that they have the capability of reducing prices in some areas and offer additional operational flexibility to ERCOT; therefore, MIGs should be allowed to change their point of interconnection from time to time with appropriate notice provisions {5}. Whenever a Generation Resource is added, removed or relocated on the transmission system, the topology of the system is changed. Switching generator locations has significant impacts on topology. Furthermore, switching generator locations may require changes in relay settings, power system stabilizer settings, or other technical parameters. ERCOT runs a number of studies which require detailed information on system topology. The validity of the studies is a direct function of the quality of the system topology. Therefore, the notice provisions for Generation Resources that change interconnection points are important to insure valid reliability studies.

## CRRs

Congestion Revenue Rights are a hedging instrument which was put in place to allow Market Participants to hedge long-term purchases and sales of electricity in the nodal market. In ERCOT, CRRs are available through annual (for calendar year products of one and two years) and monthly auctions (for monthly products). The number of CRRs available in any auction period is carefully controlled so that CRRs are not systematically oversold. The risk and complexity of purchasing and selling CRRs is complicated by the existence of Generation Resources with multiple interconnection points. However, the MIGTF believes that no changes in the CRR process are required {1}. The settlement equations will all work, assuming the points of interconnection are contained in the Day Ahead Market (DAM).{2}

### Gaming

Potential gaming possibilities exists where an entity can leverage forward prices for their gain.  Unchecked gaming activity will erode the value of CRR hedges for other market participants. The IMM will need tools to monitor such activities.

## Resource Adequacy

There are two measures of resource adequacy. One measure is result of the annual Capacity Demand Reserve (CDR) report which calculates the ERCOT generation reserve margin for the next five years. This calculation is unaffected by Generation Resources with multiple interconnection points within ERCOT because such Resources are always deliver their power within the ERCOT system and thus, the ERCOT reserve margin is unaffected.

A second measure results from a Loss of Load Probably (LOLP) study of an area which is a subset of the entire ERCOT system. The area wide LOLP study can be affected by how any Generation Resources with multiple interconnections are considered in the area of study. However, that effect will be either neutral or positive assuming ERCOT has the right to direct the MIG to a specific point of interconnection during emergencies {7}.

Another impact on Resource adequacy by Generation Resources with multiple interconnection points arises when entities make their investment decisions to build new generation. Investment decisions for new generating units are complicated and based on numerous considerations. Some investors may view Generation Resources with multiple interconnection points as threats to their ability to reasonably forecast revenue streams due to the volatility that may be caused by generators switching connections. Other investors may view the ability to build a Generation Resource with multiple interconnection points as a hedge against future low energy prices {8}.

## Scarcity Pricing

A Generation Resource with multiple interconnections will be expected to switch to the location where prices are higher. This switching activity could impact the scarcity rents for all other Generation Resources in the "area" around the interconnections but will not likely Impact scarcity pricing on a system-wide basis. {6}.

## System Planning

Two key studies performed by ERCOT System Planning personnel are monthly TCR calculations, and annual TCR calculations. For the monthly TCR calculations, ERCOT incorporates circuit breaker status updates from the Transmission Outage Scheduler into the steady state load flow case. TCR calculations begin about 45 days ahead of the beginning of the month under study. Thus, the anticipated transmission topology for the month under study needs to be determined at least 45 days prior to the beginning of any month, thereby providing a snapshot up to 75 in the future (the 75th day being the last day of the month under study). (*e.g*., October 19 would be the deadline for December circuit breaker status information.) For the annual TCR calculations, ERCOT uses the summer peak case from the Steady State Working Group, but can update it with more recent information if appropriate. For the 2010 annual TCR calculations, the transmission topology change deadline was November 1, 2009. {13b}

### Economic Upgrades

ERCOT System Planning is also charged with developing a Five-Year Transmission Expansion Study which evaluates planned transmission additions for the next five years. For the purposes of this study, ERCOT must have some indication about when and where any Generation Resource with multiple interconnections plans to be interconnected. This should be communicated directly by the Resource Owner to ERCOT staff. Obviously, the study results will represent whatever information that ERCOT has been provided, and thus, could vary from year to year depending on the input assumptions which include the points of interconnection of Generation Resources with multiple interconnections. {13b}

### Market Power

In the nodal market, ERCOT will make a determination of relative market power by passing transmission constraints through a “Competitive Constraint Test” (CCT). ERCOT will perform three CCTs: an Annual CCT, a Monthly CCT and a Day Ahead CCT. ERCOT has indicated that if Generation Resources with multiple interconnections are prevented from changing their points of interconnection before the Day Ahead Market (DAM) is run, they will be able to determine if the Generation Resource has market power relative to solving certain constraints using the Day Ahead CCT. {34}

## System Operations

If a Generation Resource is connected to two different points in the grid by separate circuit breakers, and there is an interlock so that only one circuit breaker can be closed at a time, then any changes to the status of those breakers are posted by the Transmission Owner (TO) as Equipment Status Changes. However, since Equipment Status Changes are automatically approved by the Transmission Outage Scheduler, ERCOT Operations staff will need positive verification (e.g., a phone call from the TO) to raise their attention to changes in breaker status for MIGs. This requirement will require a change in the ERCOT Nodal Operating Guides

ERCOT Operations staff is required by the ERCOT Protocols to evaluate transmission and generation outage requests submitted 90 days prior to the Operating Day for potential reliability problems, and to complete that evaluation before 75 days prior to the Operating Day in question. Any changes to circuit breaker status affecting the injection point of a Generation Resource posted less than 90 days prior the Operating Day could potentially render any previous reliability studies moot and require additional studies. Any changes submitted less than 30 days prior to the Operating Day would require significant effort to re-do the required reliability studies. In addition, any changes to the injection point of a Generation Resource between the calculation of the Replacement Reserve Market Study (RPRS) during the DAM process and the Real-Time process diminishes the accuracy of the RPRS study. On one hand, it is possible that RPRS would have procured additional generation capacity to address transmission congestion that now may not occur. On the other hand, RPRS would not have procured adequate generation for congestion which may subsequently occur. Thus, the transmission grid topology expected for the next day must to be finalized by 1600 the Day-Ahead for RPRS calculations, and remain stable throughout the Adjustment Period. While these processes are applicable under the current zonal congestion management methodology, the nodal market equivalent would be Day-Ahead Reliability Unit Commitment (DRUC performed at 1430 in the day ahead), Week-Ahead Reliability Unit Commitment (WRUC performed 7 days ahead) and Hour-Ahead Reliability Unit Commitment (HRUC performed by the beginning of the Adjustment Period). {13a}

### SCADA

ERCOT will need up-to-date status information on any circuit breakers and switches associated with a Generation Resource with multiple interconnections in order to ensure the Generation Resource is not injecting power into more than one point of interconnection at any time. {12} This requirement will require a change in the ERCOT Operating Guides.

### Telemetry

ERCOT will need the status on all circuit breakers in any substation pursuant to zonal Protocol Section 6.5.1.1(1), which states: “Status of switching devices in the plant switchyard not monitored by the TDSP affecting flows on the ERCOT System.” In addition, Operating Guide 3.1.4 states: “The QSE reporting for a PGC or a generation facility shall provide the following telemeter quantities for generation facilities greater than 10 MW to ERCOT Control Area Authority:

* Generator megawatts,
* Generator megavars,
* Generator energy (megawatt-hours),
* Substation equipment status, and
* Voltage where the facility connects to the Transmission Grid
* The directly connected TDSP may obtain any required data from ERCOT”

Similar changes will be needed in the Nodal Protocols and Operating Guides. {10}{11}

# Interconnection Request REQUIRES VOTING BODY APPROVAL

The process by which new Generation Resources get connected to the ERCOT grid is through the Generation Interconnection or Change Request Procedure which, upon completion, results in a signed ERCOT Standard Generation Interconnection Agreement (SGIA) {27}. A Generation Resource that requests additional interconnections will follow the Standard Interconnection procedure; no new requirements are needed for a generator to request additional interconnection points to the ERCOT transmission grid {20}.

Applicants will provide ERCOT information stating whether the resource is an existing resource requesting additional interconnections or a new generation resource. The generator seeking an additional interconnection will be treated the same as a generator seeking its first interconnection and will receive the same confidentially treatment and priority level {19} as a new interconnection request. However, ERCOT may prioritize interconnection requests based on reliability needs.

Current provisions of the ERCOT Protocols and Operating Guide set forth technical requirements applicable to Resources and/or their QSEs based upon the date of SGIA execution or commercial operation.

**Option 1:**

The earliest date of interconnection is the applicable reference point where such distinction is necessary. However, it should be noted that the date of the newly executed SGIA will apply to any grandfathering provisions directly related to the new interconnection facilities themselves. The new interconnection facilities would be expected to meet the criteria of the interconnection agreement and the Protocols as of the signature date for that new interconnection {29}{3}. The addition of a new interconnection should not affect the commercial operation date assigned to an existing generator attached to the additional interconnection since there has been no modification to the generation unit itself.

Option 2:

A new interconnection requires meeting the protocols as of the signature date of the new agreement {29}{3}.

# ERCOT Requested Switch

During times of system emergencies, ERCOT may require that a Generation Resource with multiple interconnections be interconnected at a specific point to ensure system reliability or to restore system reliability in the event of a loss of generation or transmission capacity. In such cases, ERCOT should deploy a Resource-Specific OOM instruction as provided for in Protocol Section 6.7.7.2. This would allow the Generation Resource to switch from one point of interconnection to another when instructed by ERCOT. This change in procedure will require additional protocol language in Section 6.7.7.2. Such a change would not be required to meet the notification requirements of a switch in the interconnection point of a Generation Resource requested by a Market Participant. {15a}

# Market Participant Requested Switch

A MIG is connected to the transmission system through a series of breakers and switches which are by definition Transmission Elements. There are specific requirements in the protocols regarding outage notifications for Transmission elements. These notifications enable ERCOT to run numerous reliability studies prior to real time.

* Three days notice is currently the minimum allowed for any switching action in the Transmission Outage Scheduler.
* The TSP must notify ERCOT 30 days before starting to energize or place into service any new or relocated Facility.
* Changes to Generation Resource interconnection points submitted as transmission outages less than 91 days prior to the Operating Day affects other studies already complete and may subject ERCOT staff to onerous replication of these routine studies.
* Additionally, changes submitted less than 91 days (75 days + 16 days for ERCOT outage approval), prior could render monthly TCR calculations as incorrect.
* Lastly, the 2010 Commercially Significant Constraints (CSCs) and congestion zones were determined using a static 2010 transmission model based on the known topology as of July 1, 2009.

Depending upon the Market participant switching timelines some of these studies may be impacted.

## Proposed Notice Provisions {30} - REQUIRES VOTING BODY APPROVAL

The MIGTF could not come to consensus on a recommendation for Notice Provisions for Generation Resources with multiple interconnection points.

The MIGTF has identified the following four time periods for consideration by the Wholesale Market Subcommittee (WMS) and the Reliability and Operations Subcommittee (ROS) for a Generation Resource with multiple interconnection points to be allowed to switch from one point of interconnection to another:

**3 Days** – Three days notice is the minimum time allowed for any switching in the Transmission Outage Scheduler. Owners of Generation Resources with multiple interconnections should be given maximum flexibility in order to monetize their investment. If a MIG owner desires to switch interconnection points with less than 3 days notice, they should be allowed to request it using the transmission outage scheduler. However, ERCOT may determine that it does not have the capability to review and approve the outage in this time frame on a case by case basis." A new “outage type” would need to be created.

**30 Days** – Section 8.8 of the ERCOT Protocols state that the TSP shall notify ERCOT at least thirty (30) days before starting to energize or place into service any new or relocated Facility. As part of the 45 day time Outage Scheduler approval process (Protocol Section 8.3.3), transmission outages must be approved by ERCOT 30 days prior to the start of the outage. If outages or relocated facilities notification occurs after this time period, some previously approved outages may have to be restudied or the outage or relocation request could be denied. (For outages requested 30 days in advance of there planned start date, must be approved or rejected by ERCOT four (4) days prior to the planned start date.)

**91 Days** – This period of time will keep transmission topology constant for the purposes of TCR calculations until the end of the effective month of the auction period.The 90 day Outage Scheduler approval process (Protocol Section 8.3.3) is primarily used for complex outages that may last an extended period of time and/or include intricate switching scenarios that require the scheduling of contractors, crews or special equipment. These outages must be approved by ERCOT 75 days prior to the start of the outage. A Generation Resource switching its point of interconnect may require these outages to be subject to restudy, possibly impacting the scheduled contractors, crews, or special equipment.

A 91 day process would also provide ERCOT the same consideration they currently receive when a generator wishes to cease operations for a period of time.

6.5.9.1 Long-term Outage Notifications and Initiation and Approval of RMR Agreements

(1) Except for the occurrence of a Forced Outage, a Generation Entity must notify ERCOT in writing no less than ninety (90) days prior to the date on which the Generation Entity intends to cease or suspend operation of a Generation Resource in the ERCOT Transmission Grid for a period of greater than one hundred eighty (180) days by submitting a completed Part I of the Notification of Suspension of Operations (“Notification”) (Section 22, Attachment I, Notification of Suspension of Operations).

While switching interconnections is not the same as Suspension of Operations, from a transmission reliability perspective it is similar.

**1 Year** – For a one-year period of Notice Provision, the transmission topology used for CSC determination remains the same as determined by the CMWG and as approved by the ERCOT Board of Directors. The interconnection point for a Generation Resource with multiple interconnections points should be chosen on an annual [(1) yr] basis to provide assurance that commercial transactions for generators and loads can be hedged through the Annual CRR Process.

ERCOT’s position on the above proposed Notice Provisions is that 30 days is the minimum that can be supported. For other reasons listed above, ERCOT would support notice provisions of 75 and 90 days, and 1 year before a Generation Resource with multiple interconnection points could switch their point of interconnection.

## Market Participant Switch Rejection

ERCOT has the sole responsibility to review and approve any switch request for a Generation Resource with multiple interconnection points. If ERCOT determines that such a request is too short or it conflicts with a previously scheduled transmission or generation outage, the request will be rejected {28}.

# Transmission Planning

The ability of a Generation Resource to alter its point of interconnection is not necessarily a new concept. There are currently three Generation Resources (Dual Region Plants) that can connect to either the ERCOT transmission network or a non-ERCOT network (e.g., the Southwest Power Pool). Whenever such Generation Resources are not connected to the ERCOT network, the impact to the ERCOT network is the same as if the Generation Resource was off-line. That is, it does not matter to ERCOT network planners or operators whether the Generation Resource is off-line or on-line and connected to a different transmission network (i.e., not ERCOT). Such “switchable” Generation Resources are either committed or uncommitted in ERCOT transmission planning simulations like any other Generation Resource—because they do not have multiple interconnection status within ERCOT. These generators have a fixed injection point in the ERCOT grid.

However, Generation Resources that can connect to more than one point within the ERCOT network are somewhat different. In these cases, transmission planners need to model the various interconnection options when the MIG Resources are included in planning simulations, which complicates the planning process. Another level of complexity is that each interconnection point of a multiply connected generator could be in areas of the transmission system that belong to different transmission owners. Transmissions owners might be less inclined to study all points of interconnection but only the point(s) of interconnection in their area. There are various ways in which transmission planning, to account for such interconnection flexibility, could be approached. Three possible planning concepts developed by the MIGTF are outlined below.

### Planning Concept 1 – Maximize Interconnection Flexibility

To illustrate this concept, consider a Generation Resource that can interconnect at points “A” and “B” on the ERCOT network. Suppose further that transmission upgrade costs with the Generation Resource connected to “A” are $30 million and that transmission upgrade costs would be $20 million for connection to point “B” using the deterministic NERC and ERCOT transmission planning criteria. Planning Concept 1 would be to design a transmission plan that would enable full utilization of either connection option, resulting in $50 million of network upgrade costs in this hypothetical example. The downside of this approach is the cost associated with enabling full utilization of an intermittently used interconnection is high. This concern is even more pronounced as the number of multiple interconnection points for a single Generation Resource increases or the number of Generation Resources with multiple interconnection points increases.

### Planning Concept 2 – Minimize Transmission Costs

Under this approach, a transmission planner would study the different interconnection options and select a plan with the lowest transmission cost. Using the same hypothetical example as described above in Planning Concept 1, the transmission planner would identify point B as the most cost-effective connection alternative and plan $20 million in network upgrades associated with that connection option. This process is somewhat similar to the current generator interconnection process in that transmission planners determine and plan on the most cost-effective interconnection alternative. The difference being that it would be done outside of the generation interconnection process since an interconnection study would only consider one interconnection point at a time.

There are various aspects of this theoretical approach to consider. Although a transmission planner would plan and build for interconnection of the Generation Resource at Point B, connection at Point A may still be possible and unconstrained at times. For example, there may be one or more Generation Resource connected directly or indirectly to Point A; and, transmission upgrades would have been planned and built to accommodate the full output of such other Generation Resources. To the extent that one or more of those other Generation Resources is not on-line, the network in the vicinity of Point A may be able to accommodate some or all of the generation output from the Generation Resource that can connect at either Point A or Point B. Furthermore, dynamic ratings of network facilities may enable full or partial unconstrained connection of the Generation Resource with multiple connections at Point A. The partial availability of connection at Point A under this scenario may be useful for economic or operational reasons, such as network outages that constrain Generation Resource output from Point B.

Another aspect of this approach is that even under the “Minimize Transmission Costs” approach, it would make sense to plan and build upgrades to ensure adequate short circuit ratings for Generation Resource connections at any possible point of interconnection. Of necessity, short circuit simulations typically model the worse case (maximum short circuit current) scenario in that all Generation Resources are modeled on-line with all transmission elements in service. Most network operating models, including ERCOT’s, neither have nor necessarily need the capability of determining the maximum available short circuit at each network node because transmission planners typically plan for the worse case short circuit scenario. It would be unrealistic and potentially prone to failure to limit this general practice to only candidate interconnection points. Furthermore, addressing short circuit rating concerns is not a significant cost driver and does not impact landowners since it does not require building new transmission lines.

It should also be noted that the most cost-effective point of Generation Resource interconnection can change over time. Using the same hypothetical example as before, suppose a new Generation Resource desires interconnection in the vicinity of Point B. To make the example simple, suppose further that if only this new Generation Resource were connected at Point B, the same $20 million in network upgrades would be necessary as would be needed for the Generation Resource with multiple interconnection options connecting at Point B. However, if both Generation Resources connect at Point B, suppose an additional $50 million of network upgrades would be needed, for a total of $70 million. Under the “Minimize Transmission Cost” planning approach in this revised hypothetical example, the most cost-effective approach would be to plan to connect the Generation Resource with multiple interconnection options to Point A and the new Generation Resource (which has no other option) to Point B, resulting in $50 million in network upgrades ($30 million associated with Point A and $20 million associated with Point B).

### Planning Concept 3 – Economic Planning

In addition to traditional deterministic planning analyses using the NERC and ERCOT planning criteria, ERCOT also uses production costing models to identify transmission network projects that are economically beneficial. Generally, these projects would be projects where the economic savings, measured in terms of lower generation production costs would be higher than the costs to consumers of the associated transmission project. The production costing model simulates network constrained generation dispatch for each hour of the simulation period using generic generator production cost data, from which security constrained generation production cost for the simulation period can be determined. Transmission projects that would relieve transmission network constraints can also be modeled, so that the effect of the transmission projects upon security constrained generation production cost can be determined. This difference in generation production cost can then be compared to the carrying cost of the transmission upgrade projects to determine whether the project is economically justified.

The UPLAN software does not have the capability to automatically modify multiple interconnection options to minimize transmission constraints on generation dispatch. The various interconnection options can be manually altered for different simulations. Using this manual capability, theoretically a transmission planner could determine which interconnection option produces the lowest security constrained generation production cost, and that option could be used as the “default” option to use for planning purposes. Alternatively, transmission planners could theoretically model each Generation Resource interconnection one at a time and determine, for each interconnection, which network upgrades are cost-justified. If numerous MIGs arise however, the number of such study combinations for a given scenario could become significant.

However, if having multiple interconnection options has value to the Generator Resource owner and to the consumers served by the generator, then one would expect that sometimes one connection option would produce the lowest network constrained generation production cost and at other times the other connection option would produce the lowest security constrained generation production cost. Manually modeling each interconnection option and determining which transmission upgrades for each option are economic would not necessarily produce the most holistically economic transmission upgrade plan. For example, using the same hypothetical example as before, suppose ERCOT’s analysis indicates the $30 million of network upgrades associated with interconnection point “A” has an annual carrying cost of $5 million and produces $20 million in generation production cost savings. If interconnection at point “A” were the only option, the upgrades are economic. However, suppose instead the $20 million of upgrades associated with interconnection at Point B were built and the Generation Resource could run relatively unconstrained if connected to point “B” thereby producing comparable production cost savings as with “A”. In this latter example, the upgrades associated with Point A would not be economic, because the available lower cost alternative is to interconnect at “B”.

The issue could be considerably more complex than the initial set of assumptions indicate. For example, theoretically it may be the case that if the Generation Resource is switched between Points “A” and “B”, it could minimize the constraints encountered without the option to switch. For example, suppose the constraints at Point B are encountered for 1000 hours a year, and switching the Generation Resource to Point A for those 1000 hours lowered the security constrained production costs, particularly if some subset of the possible network upgrades at Point “A” were built. In this hypothetical example, it may be optimal to assume interconnection most of the time at Point “B” but to build no upgrades at Point “B” and a small subset of upgrades at Point “A”.

In short, while perhaps theoretically attractive, attempting to holistically apply economic planning to optimize network upgrades for Generation Resources with multiple interconnection options has its limitations. Manually altering the interconnection options in study scenarios will not necessarily produce the optimal economic benefit for Generation Resources with multiple interconnection options. Further, this type of analysis would require more planning effort and could result in increased staffing requirements for planning.

## Timing Considerations

The hypothetical scenarios postulated above are intended to illustrate the various planning concepts presented herein. It is problematic to conceive of every potential variation of these simple illustrations that might justify fact-specific alternative approaches. One of these planning concepts could be applied if one were contemplating a Generation Resource that would have multiple interconnection options available at roughly the same time. However, it is likely that the Generation Resource is interconnected at one point in time and develops multiple interconnection options at some future time. Therefore, some or all of the network upgrade costs associated with the initial connection could be sunk costs—but their value could be affected (either positively or negatively) by a change in the location of a generator’. To account for such timing considerations, the relevant network upgrade costs to use in applying any approach would be the incremental costs associated with the additional interconnection points.

## Coordination Issues

There are various technical aspects of each interconnection that must be coordinated between the Generation Resource and the applicable transmission entities. Requirements for such coordination are outlined in NERC standard FAC-001. Generally, changing interconnection of a Generation Resource could potentially impact relay settings, tuning of power system stabilizers, application of series compensation and other technical parameters that would need to be identified and addressed in the process of arranging for each interconnection alternative.

## Other Considerations

Regardless of the approach taken, planning “base” case models will have to model one of the possible Generation Resource interconnection options as being “connected” with the other interconnection option being “disconnected”, along with various other modeling assumptions. When the planning cases are analyzed and network upgrade needs are identified, it may not be clear to the transmission planner which upgrades are potentially impacted by the modeled interconnection option. This complexity is increased if the interconnection points are owned by different transmission service providers. It could be problematic for any one transmission service provider or ERCOT to holistically optimize the interconnection alternatives as fundamental planning assumptions change over time. Likewise, short circuit, stability, and operating models need to have all interconnection alternatives modeled, including one of the alternatives as the “default” interconnection. Users of these network models will have to be aware of and consider the intermittent nature of the interconnection arrangement on an on-going basis when setting relays or performing short circuit, stability, or operating studies.

## Task Force Recommendation – REQUEST VOTING BODY ENDORSEMENT

When multiple points of interconnection are under consideration at the same time, MIGTF recommends approval of proposed Planning Concept 2 presented in this whitepaper as the default basis for planning network upgrades associated with Generation Resources with multiple interconnections. Using this approach, transmission planners will determine the lowest-cost interconnection option and plan network upgrades associated with use of that interconnection. Transmission planners may use judgment to apply fact-specific variations of this default approach. The MIGTF also recommends transmission planers plan and build network upgrades to ensure adequate short circuit ratings for each interconnection option as part of the generator interconnection study process. Finally, the MIGTF recommends that upgrade projects other than short circuit upgrades associated with a new interconnection option (for a Generation Resource that already has an existing interconnection to the ERCOT network) be treated as an economic project subject to ERCOT Regional Planning Group (RPG) review in accordance with the RPG Planning Charter. All such projects requiring transmission improvements or additions will be classified as at least a Tier 3 project so that the RPG can review and comment.

# Transmission Outage Coordination

Subject to technical limitations (such as relay and power system stabilizer setting issues, for example), interconnection points for a Generation Resource with multiple interconnections could be modified as needed to minimize the impact of scheduled network outages on a generator’s operation. However, the coordination should be subject to the limitations on scheduling determined above. Moreover, even with multiple interconnection points, unforeseen outages and other conditions may occur that could limit a generator’s ability to generate. MIGs could –at various times—both help and hurt this situation.

Using the same example as used in the Transmission Planning section of this white paper, if network outages are needed in the vicinity of interconnection point “B” and the impact of those outages can be mitigated by the Generation Resource switching to Point “A”, then the Generation Resource can request such action if new dispatch instructions are received from ERCOT that constrain the generator at its current point of interconnection. It should be noted, however, that there will be limitations upon such operational optimization. For example, ERCOT may believe that transmission constraints may be minimized in this hypothetical example if the Generation Resource is switched to Point “A”. However, if more generation is dispatched in the vicinity of Point “A” or less generation is dispatched in the vicinity of Point “B” than ERCOT expects, it is possible that switching the Generation Resource to Point “A” might produce more congestion than would have occurred if the Generation Resource had remained connected to Point “B”. However, it should be recognized that a Generation Resource with multiple interconnection options does not necessarily create this dilemma. Indeed, the expected impacts of network outages could produce more or less congestion than expected due to variability in expected generation dispatch with or without multiple interconnection options. The availability of multiple interconnection options should provide ERCOT an option to potentially mitigate the impact of network and generation outages, but that option has some limitations.

# Inclusion of Additional Interconnections in TCOS

The MIGTF notes that while the costs of additional interconnections could eventually be included in TCOS, the PUCT will have to find that there is a need for the line during a CCN case; and, in the case of a line not needing a CCN, the PUC will have to find that the TSP’s expenditures were prudent. A TSP requesting additional interconnection costs to be included in TCOS may need to address such challenges in TCOS case. {23}

# Policy Questions beyond MIGTF Scope

The following questions were not taken up by the MIGTF as we believe it to be outside our Charter and level of influence.

## Line Construction without PUC Approval

* Should PUC rules be revised to allow regulated TSPs to build transmission lines without line certification review and approval by the PUC if landowners consent? {24}
* Can a private transmission line that is not reviewed and certificated by the PUC be subsequently sold to a regulated TSP for inclusion into TCOS? {25}
* Should additional interconnections of a Generation Resource at the Generation Resource’s cost for construction be considered any differently for cost recovery purposes (if the Generation Resource is willing to establish a public utility for the new construction and provide the unused capacity of the circuit(s) under the PUCT’s Open Access rules) than ERCOT’s choice to have multiple interconnections of a Resource for the “economic benefit” of the system?{26}

# Other Comments/Concerns

* Generation Resources with multiple interconnections may impact the ability of market entities to forward contract for supply. {35}
* Should ERCOT be recommending additional point of interconnections to existing Generation Resources for reliability purposes? {36}