Reliability Analysis Update

Long Term Study Task Force

May 3rd, 2011

Objectives

- **Identify cost effective transmission solutions to maintain reliability for the 2030 ERCOT System under:**
  - N-1 Contingency
  - G-1 Contingency
  - Extreme Weather / Demand (2030 +5%)

- **Establish a workable case to identify economic transmission solutions**

- **Evaluation conducted using steady-state AC powerflow analysis on a peak load case**

Reliability Screen – Resource Additions

- **Generic resources were added to serve increased load.**
- **Not related to the *separate* Generation Expansion scenarios used in the Economic Analysis portion.**
- **Analysis methodology decouples results from specific selected resource locations:**
  – Generators sited distant from area of study.
  – Different dispatches tested.
  – G-1 analysis performed, and in some cases groups of generator outages.
- **These considerations put focus of analysis on the import / transfer / load serving capability of the transmission system, rather than on deliverability of specific resources.**

Reliability Analysis

Steps in Reliability Analysis

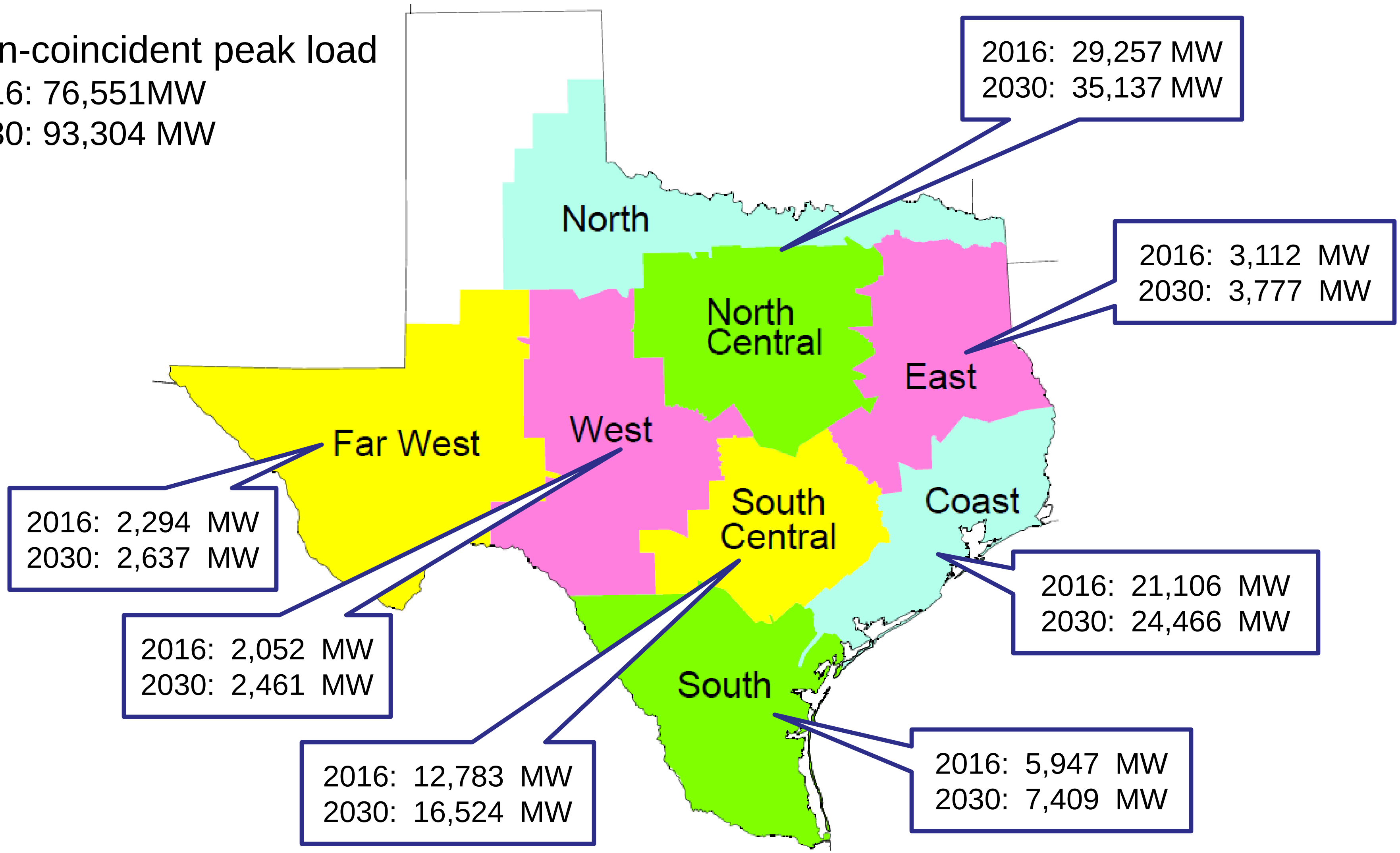
1. **2030 Load: Base case and contingency analysis.**
2. **2030 + 5% Load: Load increased by 5% in the area of study. Base case and contingency analysis.**
3. **Generator contingency analysis.**
4. **Reactive needs analysis.**
5. **Combinatory generator outages.**

Voltage and Loading Criteria

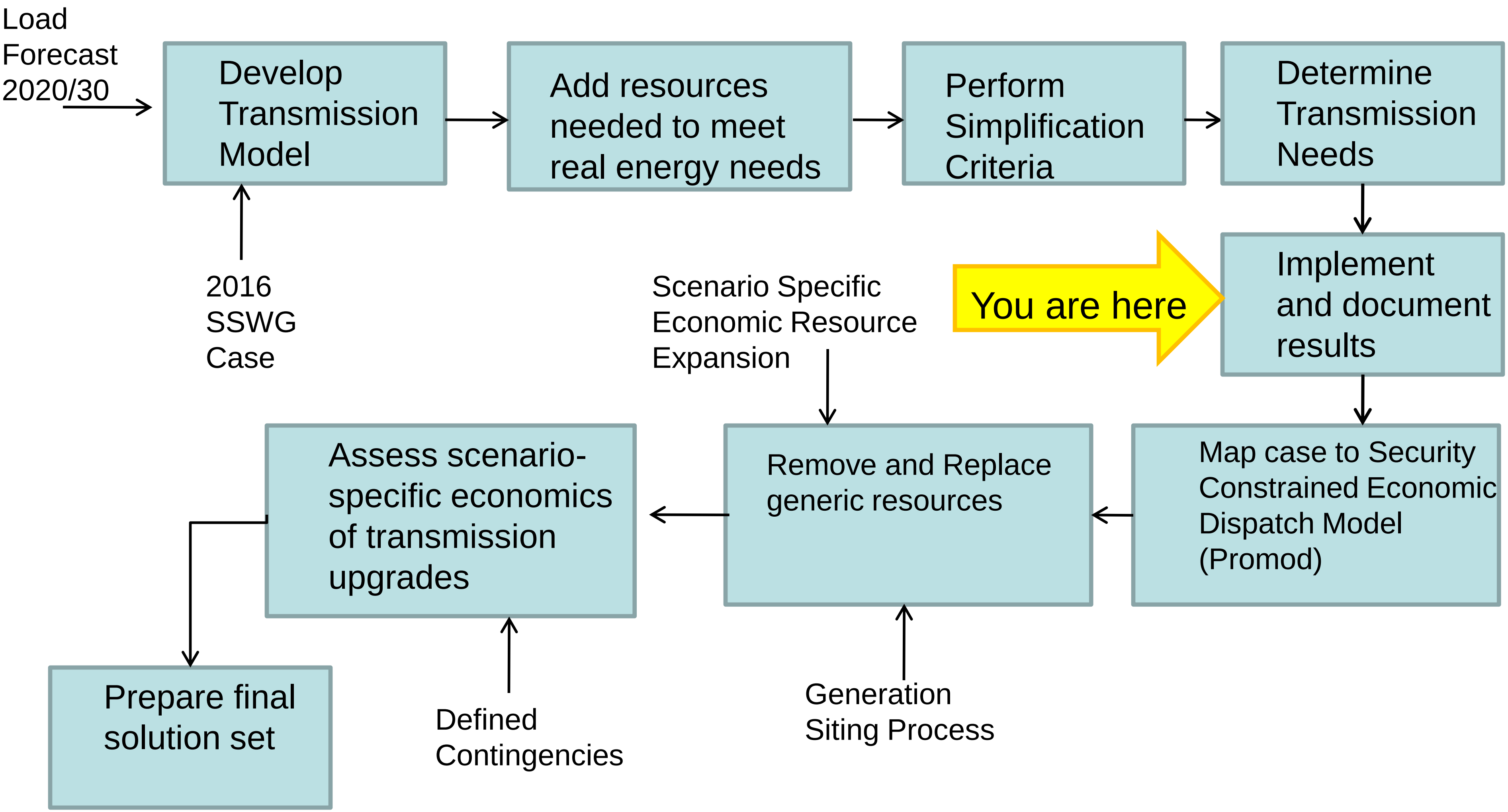
	Voltage (pu)	Branch Loading
N-0	≥ 0.97	≤ 100% of Rate A
N-1	≥ 0.93 urban; ≥ 0.9 rural	≤ 100% of Rate B

2030 Loads

Non-coincident peak load
2016: 76,551MW
2030: 93,304 MW



Process



Load Forecast 2020/30
Develop Transmission Model
2016 SSWG Case
Add resources needed to meet real energy needs
Perform Simplification Criteria
Determine Transmission Needs
You are here
Implement and document results
Map case to Security Constrained Economic Dispatch Model (Promod)
Scenario Specific Economic Resource Expansion
Remove and Replace generic resources
Generation Siting Process
Assess scenario-specific economics of transmission upgrades
Defined Contingencies
Prepare final solution set

2020 and 2030 AC Cases

- **Voltage issues and thermal limitations are corrected where necessary**
  - Reactive support is applied at the most extreme busses in an iterative approach to correct voltage to .98 PU (N-0)
  - Address thermal overloads, as well as voltage collapse for (N-1)

- **Current status: Cases are stable, documentation of the reliability assessment is underway**
  - Includes N-1, G-1 stress testing of the steady-state model
  - NERC C & D criteria will be tested with proposed solutions

Large Load Centers Currently in Study

- **DFW Metro Area**
- **Houston Metro Area**
- **Lower Rio Grande Valley**

Dallas Fort Worth Metro Area

- Voltage deficiencies are significant and not correctable from incremental reactive resources (~7,500MVar of switched shunt compensation required for N-0).
- Limited 345kV/138kV transformer capacity yields significant overloads for the N-0 state
- Loading in the DFW Area represents almost 1/3 of the entire ERCOT load as modeled, and exceeds the current capability of the local 345kV infrastructure

Low Voltages and Transformer Overloads

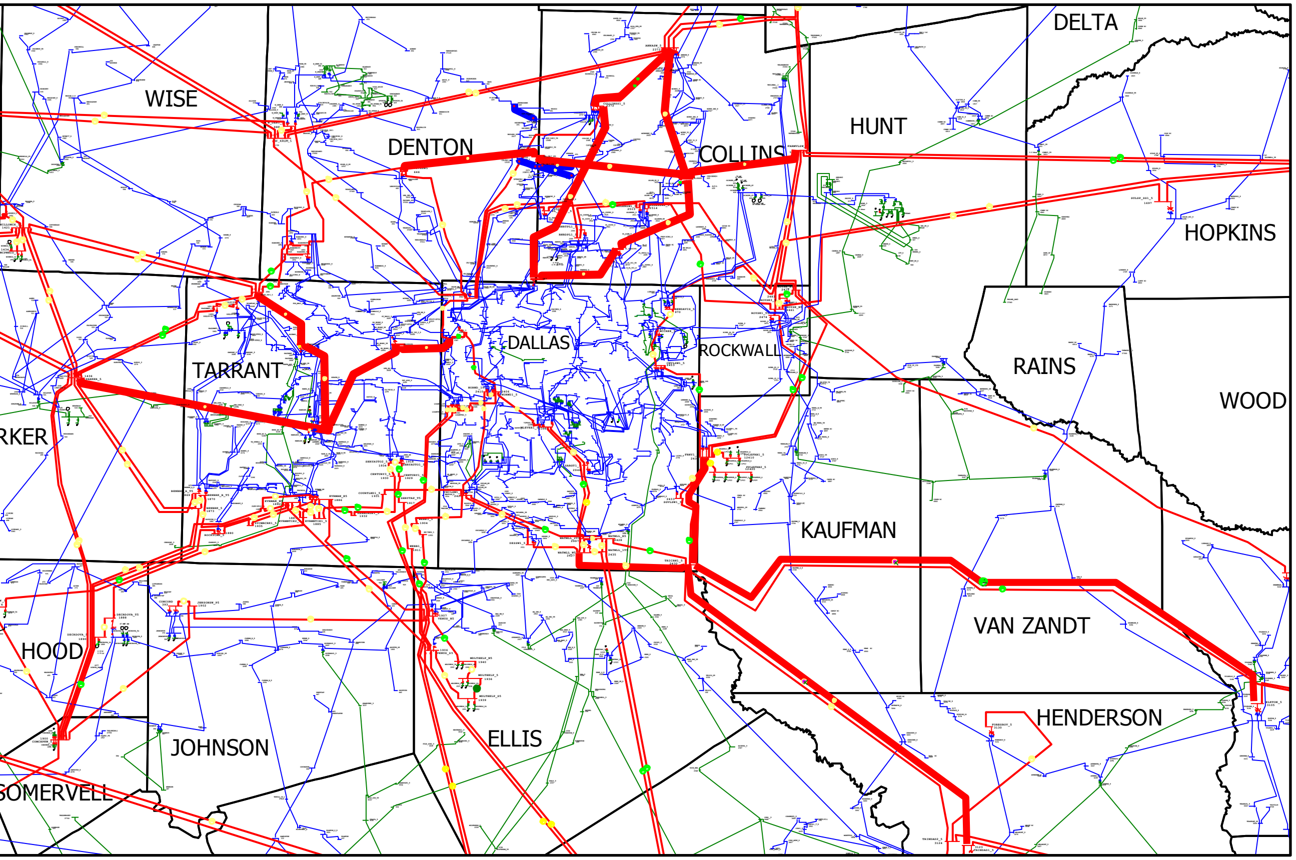
Station Name	V(pu)
Anna	0.957
Renner	0.958
Collin	0.959
Royse	0.962
Allen	0.963
Tyler Grande	0.9633
Farmersville	0.967
Elkton	0.9678
Plano Tennyson	0.9682

345/138 Auto	N-0 % OL
Eagle Mountain	141
Carrolton	123
Collin	119
Renner	111
Liggett	109
Roanoke	109
Plano Tennyson	108
Anna	107

N-0 Solution Sets

- Heavy system loading and limited transformer capacity called for addition 345kV injection points
- Physical space limitations made new 345kV substations more practical than 2nd or 3rd transformers at existing 345kV substations in the Dallas / Fort Worth Metro Area
- The enhanced 345kV system, introducing a new 345kV “ring”, required less reactive support to maintain voltages within acceptable ranges

New 345kV Lines



FROM	TO	LENGTH
PARKER_5	HANDLEY345	30
HICKS_SW1_5	SAGINAW345	20
SAGINAW345	HANDLEY345	15
HANDLEY345	EULESS345	20
HACKBRY1_5	EULESS345	10
ANNASW_5	ALLEN345	10
ALLEN345	PL_WEST345	10
COLLINSS1_5	CRLT	20
PL_WEST345	CRLT	7
FARMVLSW_5	ALLEN345	20
ALLEN345	COL_CRLT_345	20
LEWISVLSW5	COL_CRLT_345	20

Other Changes to Base Case [N-0]

- **Switched Shunts added for solving base case low voltage issues –**

Bus	MVar Addition
ROYSE SWITCH 345	800
TYLER GRANDE 345	400
EAGLE MOUNTAIN 138	600

- **Line Changes to alleviate branch overloading -**

FROM	TO	LENGTH	Action
COLLINSS1_5	ANNASW_5	13.2	Re-conductor
COLLINSS1_5	ANNASW_5	13.2	Added 2nd ckt.

Conclusion for Dallas Fort Worth region

- **Significant local system needs identified in 2030 timeframe:**
  - Import paths are insufficient to accommodate load growth.
  - Large reactive deficiencies.

- **These are complex problems that will require continued ERCOT / TSP analysis.**

- **Studied solutions:**
  - 202 miles of new 345 kV, some extending into areas of high urban density.
  - Significant amounts of reactive support (switched shunts, SVCs); complete reactive solution may also require new import paths and/or rebuilding 138 kV → 345 kV.
  - New 345 / 138 kV connection points.

Houston Area

- As modeled, 2030 Houston area load represents almost 25% of the entire ERCOT load.

- With considerable urban generation resources (Wharton, Parish, and several self-serve units), Houston is less reliant on imported power than Dallas and thus has far fewer import paths.

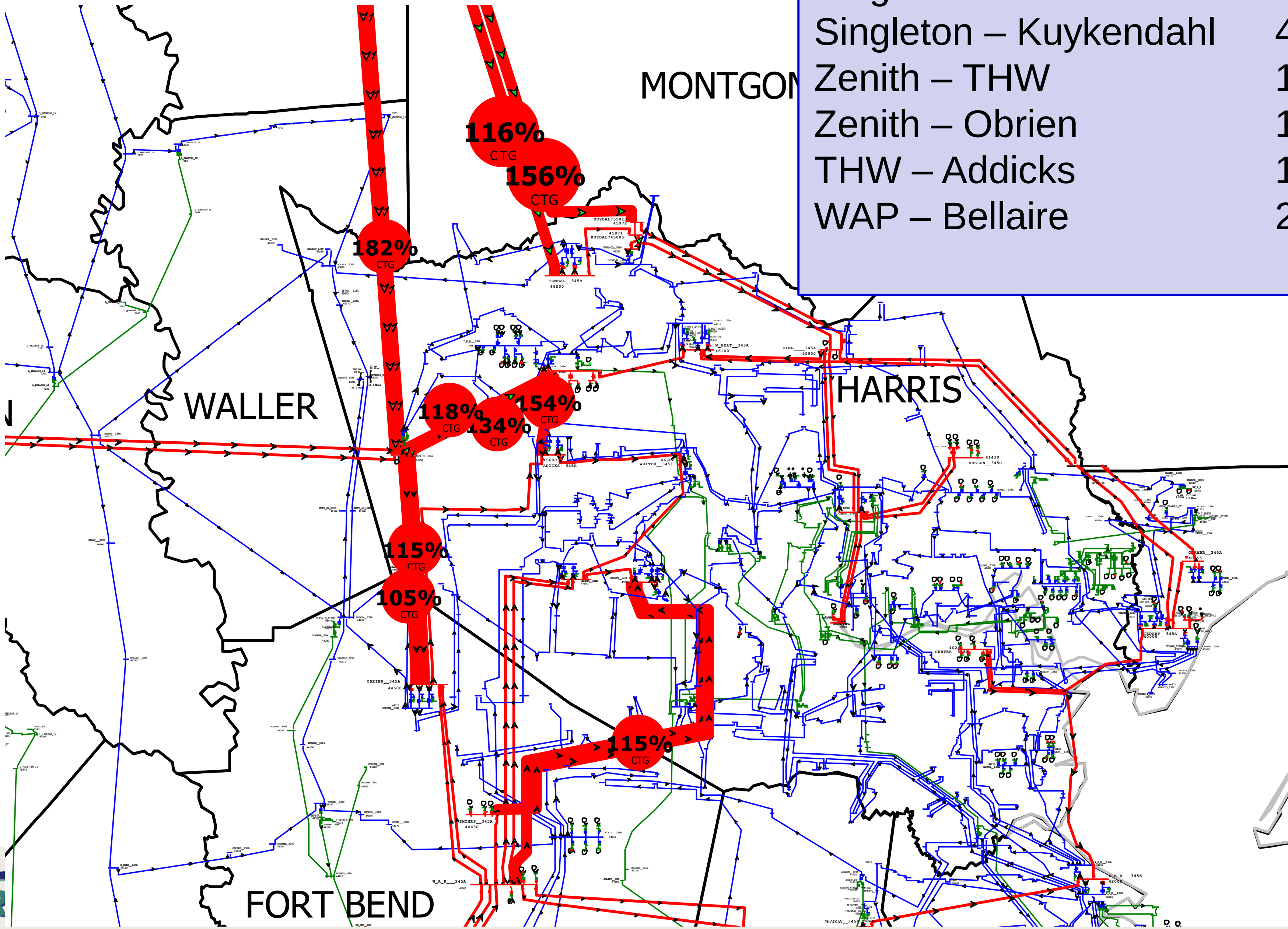
- Assuming all future load growth is met with resources outside Houston, the existing import paths are insufficient.

- More import paths would likely be needed (in addition to the planned Fayette – Zenith line).

- Analysis was conducted using two different dispatches: Heavy North Imports (HNI) and Heavy South/West Imports (HSWI).

N-1 Overloads – Heavy north imports

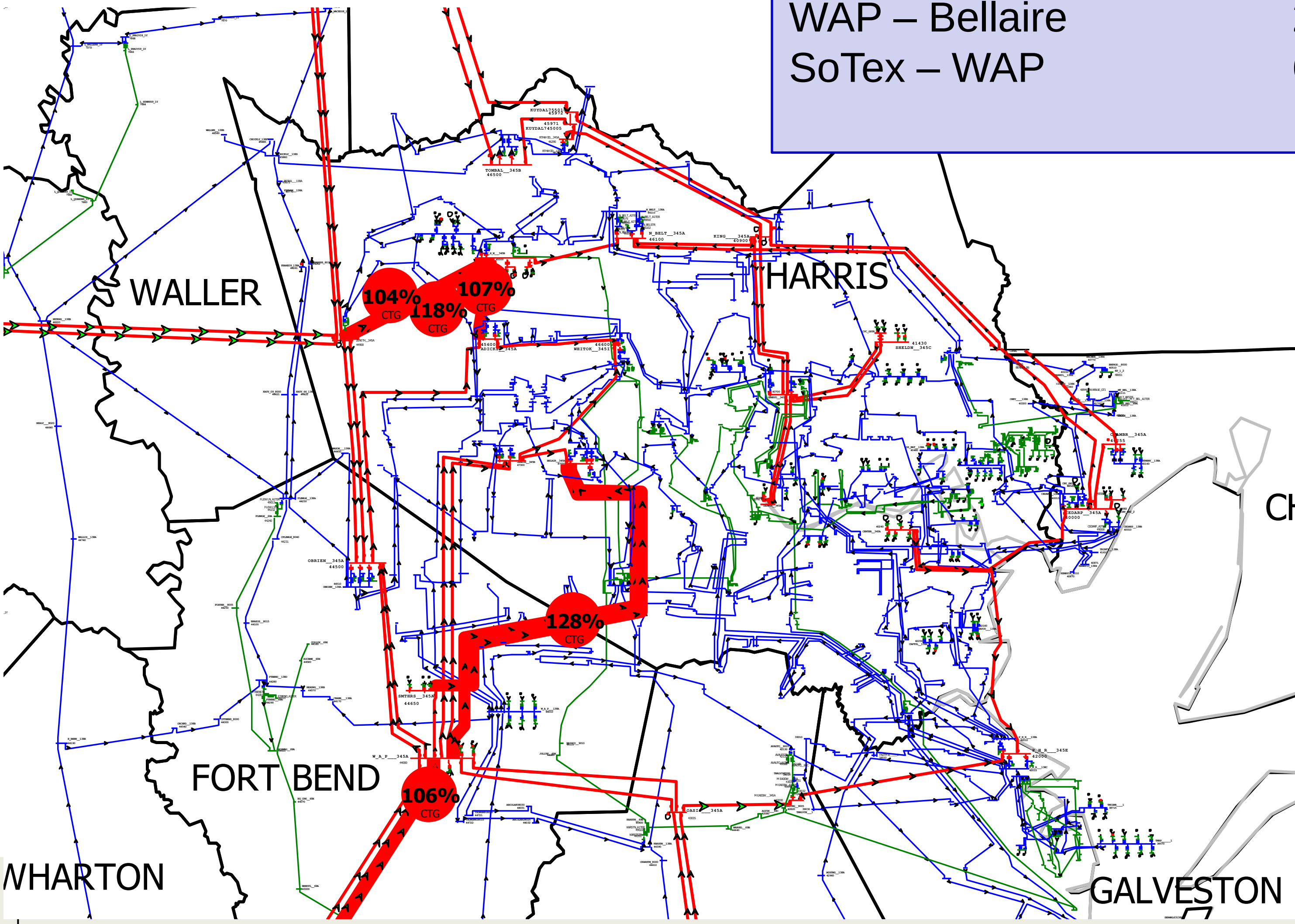
Singleton – Zenith	53 mi
Singleton – Kuykendahl	47 mi
Zenith – THW	15 mi
Zenith – Obrien	17 mi
THW – Addicks	11 mi
WAP – Bellaire	25 mi



From case [A6].

N-1 Overloads
Heavy Southwest Imports

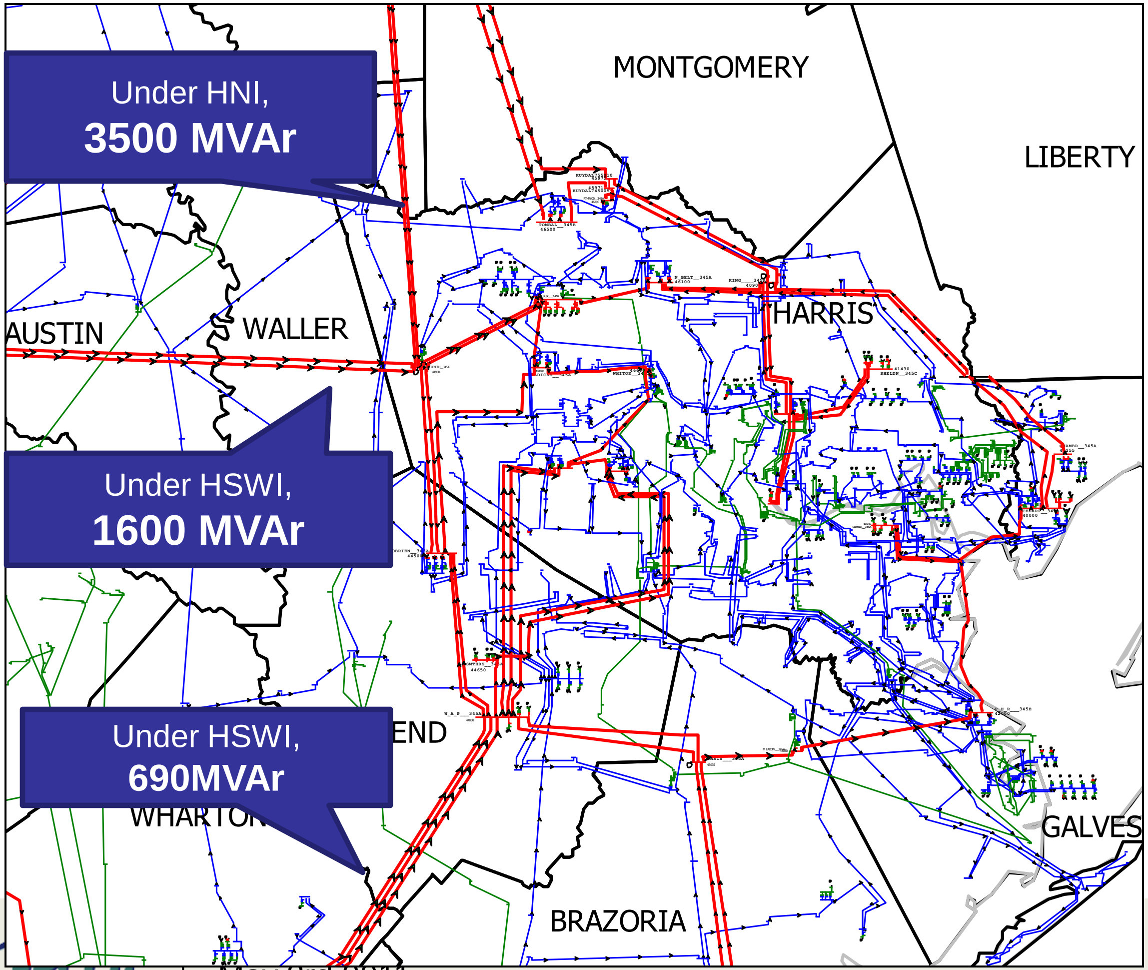
Zenith – THW	15 mi
THW – Addicks	11 mi
WAP – Bellaire	25 mi
SoTex – WAP	68 mi



From case [A4].

High Imports → Excessive Reactive Losses

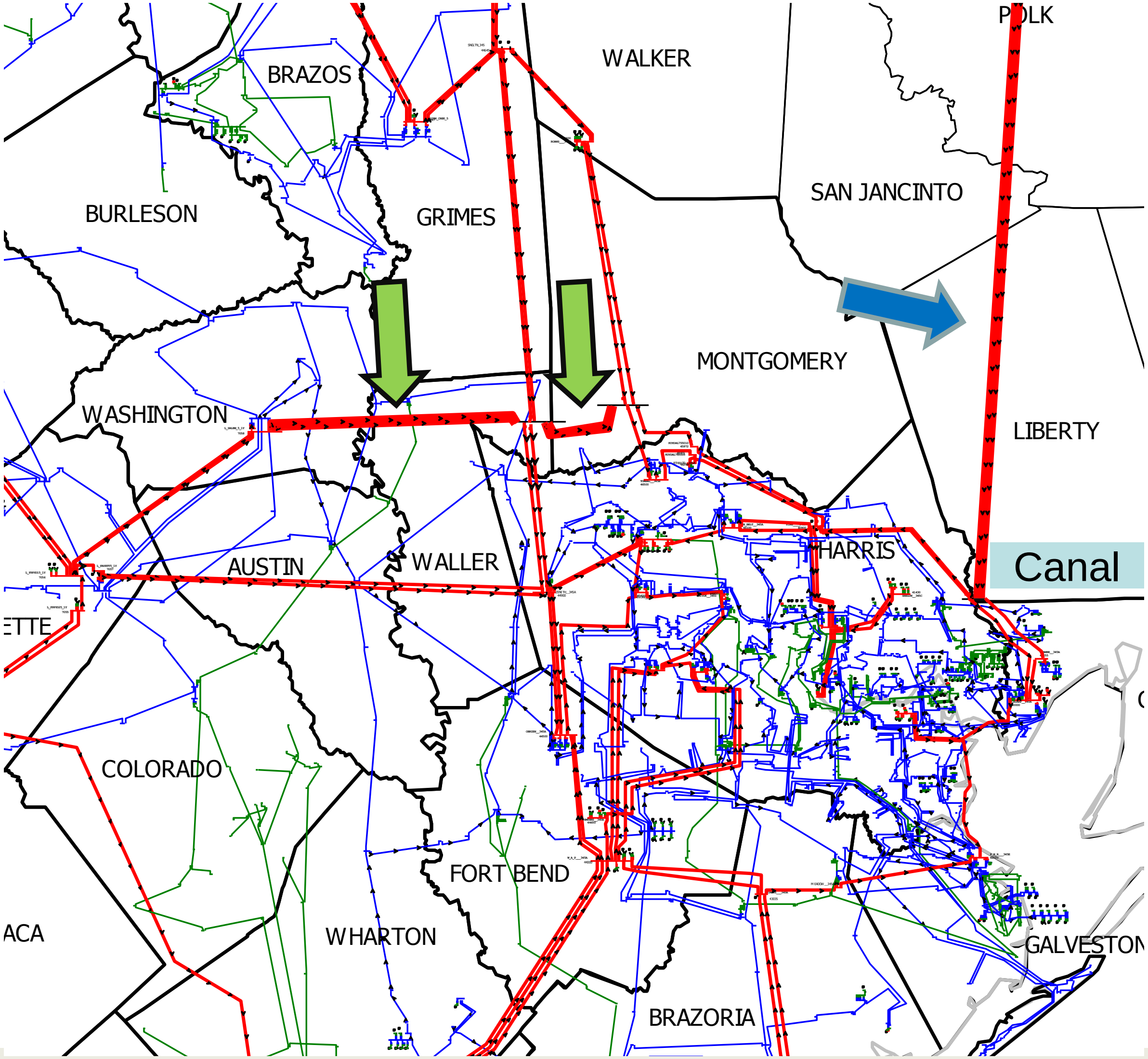
N-1 Reactive Losses shown for both High North Imports (HNI) and High Southwestern Imports (HSWI)



- **Huge reactive losses on several import paths.**
- **Shunt capacitance alone is not a practical solution.**
- **Upgrading conductors provides little support.**
- **One solution: New import paths.**

From case 2030_5% [A4 and A6].

New Import Paths

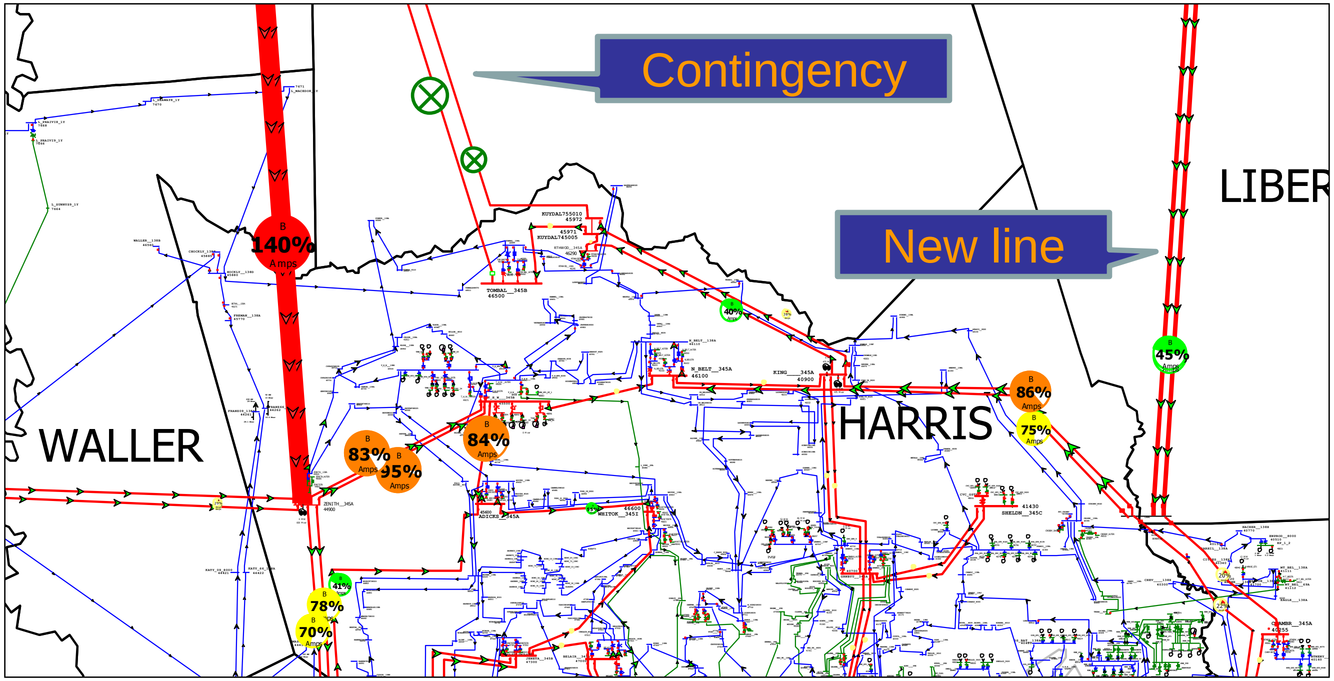


Some Options:

- **Lufkin – Canal (>100 mi)**
- **Salem – North Tie (>60 mi)**
- **Others?**

New Import Path: Lufkin – Canal

High North Imports



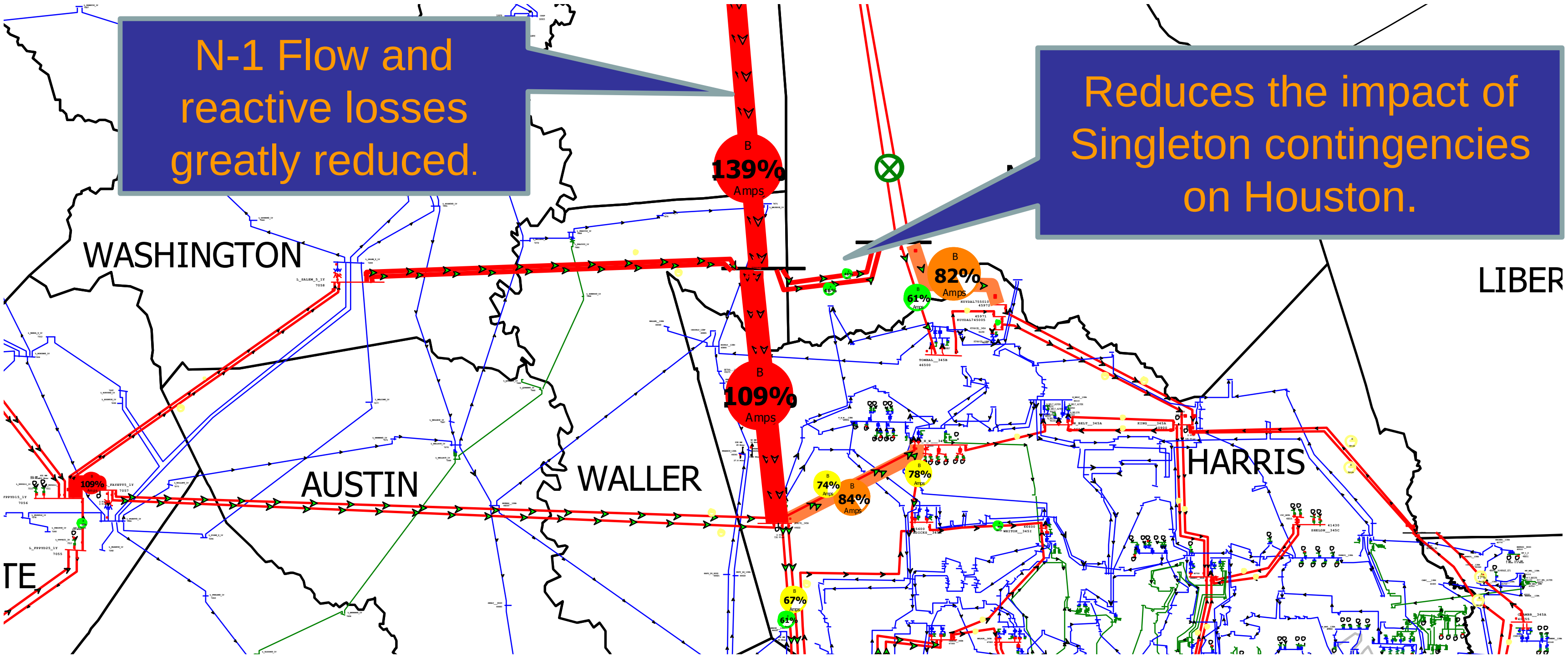
➔Under HNI, Lufkin – Canal is effective, reducing contingency overload and reactive losses on Singleton – Zenith.

➔Under HSWI, Lufkin - Canal is ineffective and carries almost no power.

From case [A6 c3].

Salem – North Belt: 2030+5% Heavy North Imports

High North Imports



→ This solution is effective for either dispatch: It greatly alleviates flow and losses on Fayette – Zenith as well as Singleton – Zenith.

Houston Findings

Lufkin – Canal

- **Helpful under high imports from North but not from S/W**
- **Reduces N-1 reactive losses on Singleton – Zenith from 3,500 MVAr to 2,000 MVAr.** **(N-0 decreases 1060 → 700 MVAr.)**
- **However, N-1 reactive losses on Lufkin – Canal: 1,130 MVAr.**

Salem – North Tie

- **Helpful under both high imports from N and from S/W.**
- **Reduces N-1 reactive losses on Singleton – Zenith 3500 → 1320 MVAr.** **(N-0 decreases 1060 → 450 MVAr.)**
- **Reduces N-1 reactive losses on Fayette – Zenith 1600 → 1040 MVAr.**

Houston Area 2030 Study Summary

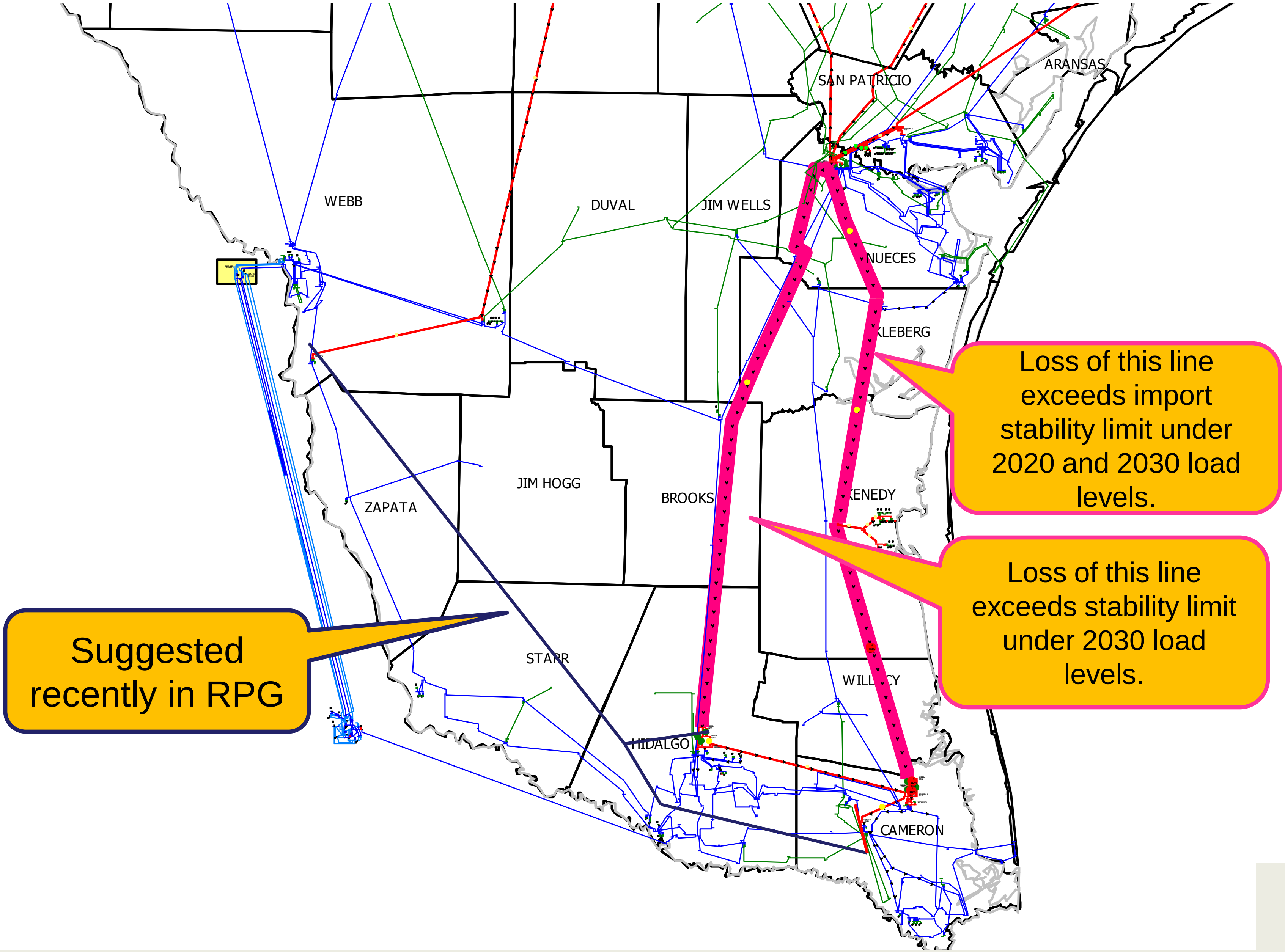
- **Large amounts of shunt reactive compensation, some of it dynamic, appears necessary.**
- **Many existing 345 kV lines require upgrading before 2030 (about 240 miles). Most of these are still needed even if new import paths are added.**
- **From reliability analysis, at least one new import path needed by 2030.**
- **In progress / to do:**
  - Other import paths?
  - Economic evaluation of new import paths by scenario.

Rio Grande Valley Study

- **Recent events highlight the need for significant reinforcements.**
- **Long Term Planning is working with Near Term Planning and TOs in ERCOT to find a solution that meets near term needs and is expandable for long term needs.**

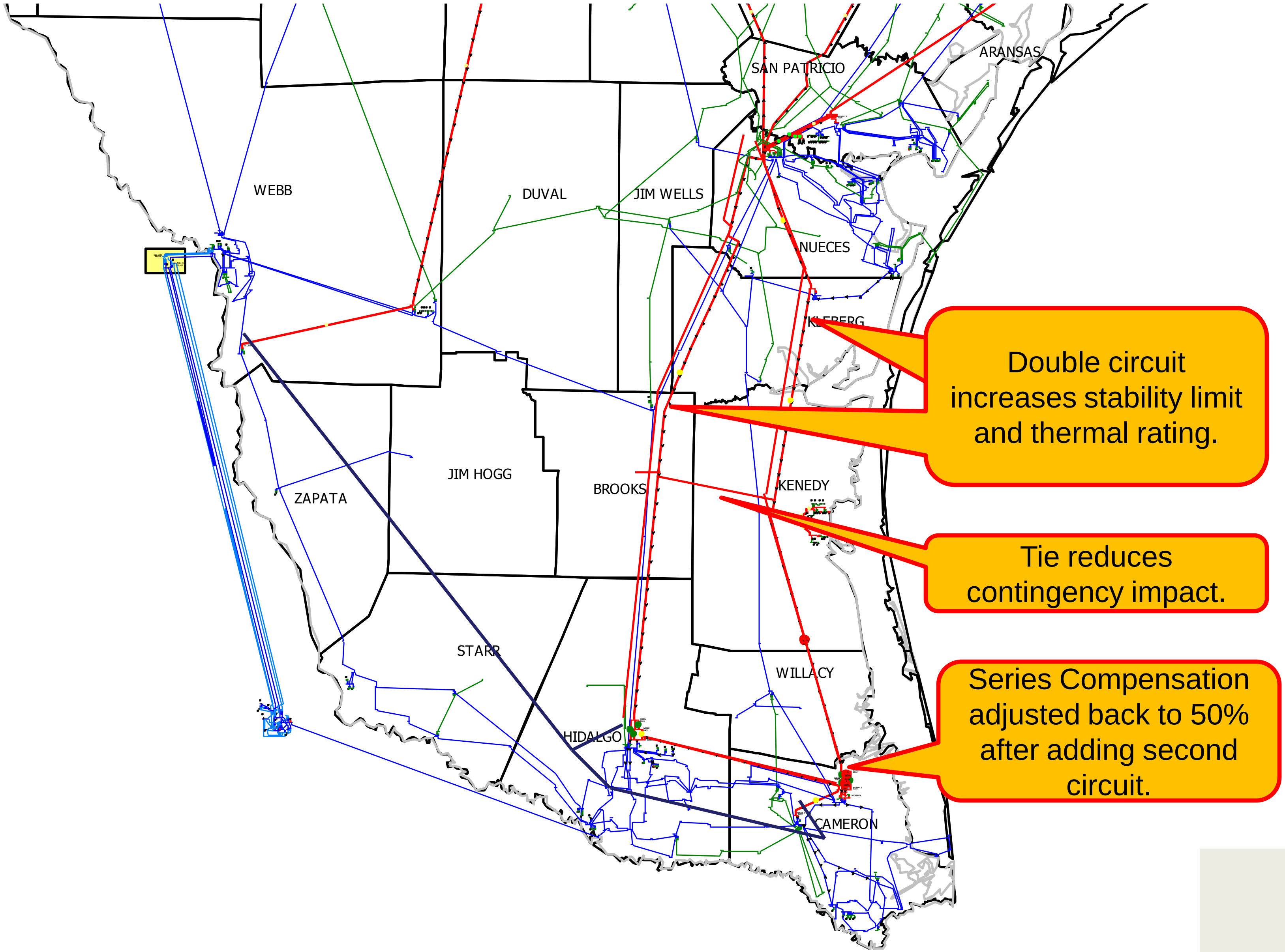
Load Assumptions (MW)			
	2020	**2030**	**2030+5%**
South WZ	6339	7325	7691
Starr, Hildago, Cameron counties	3348	3870	4063

Import Limitations

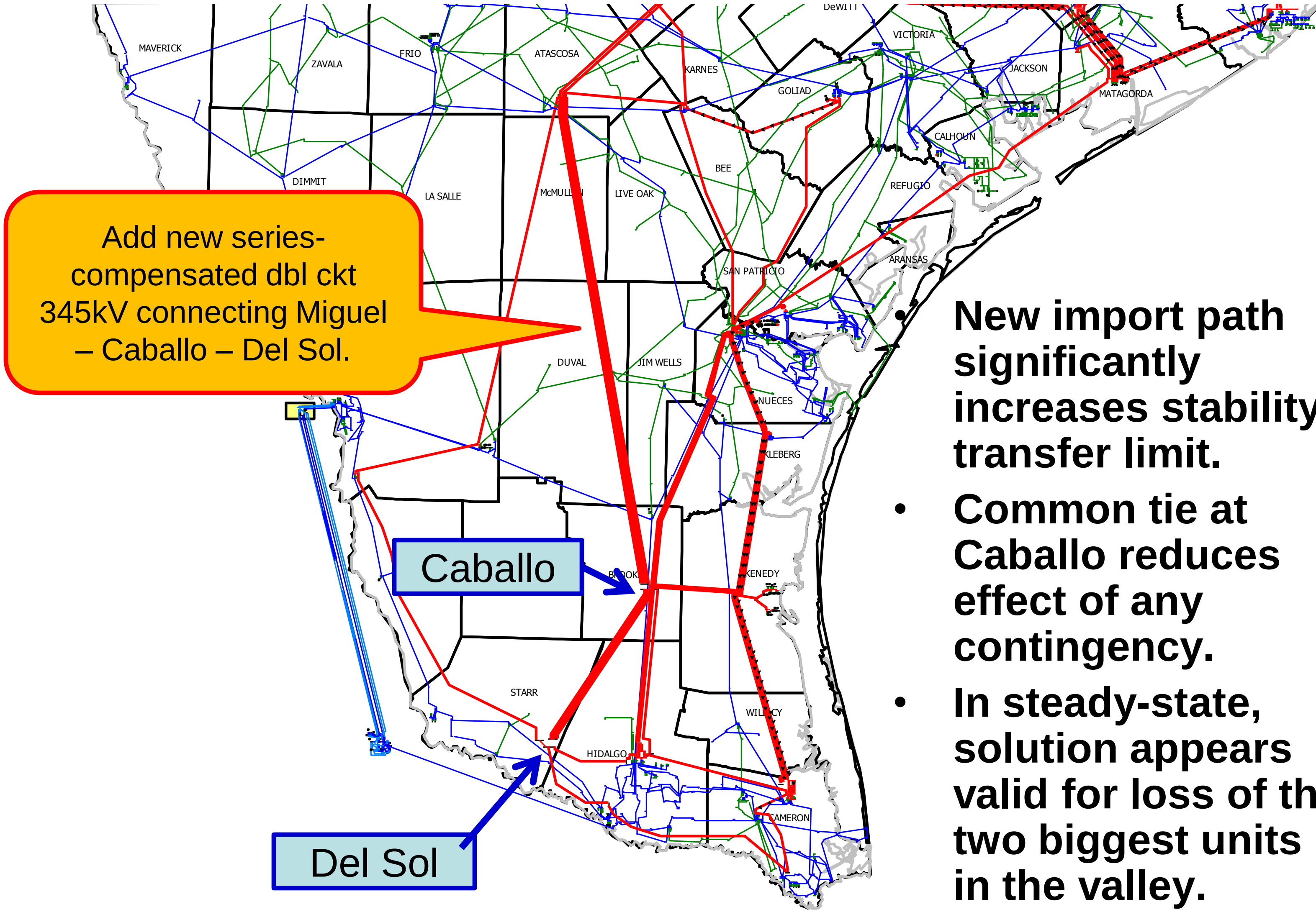


Possible Solution for 2020

Make existing 345kV lines double circuit



Possible Solution for 2030+5%



- **New import path significantly increases stability transfer limit.**
- **Common tie at Caballo reduces effect of any contingency.**
- **In steady-state, solution appears valid for loss of the two biggest units in the valley.**

Other Solutions Being Evaluated

- **Other transmission configurations, such as:**
  - Laredo – Caballo or Laredo – Corpus Christi.
  - Miguel – Caballo – Del Sol.

- **Technologies that reduce stability limit issues (e.g. 765 kV or HVDC).**

- **Local resources that would also reduce need for additional transmission**

Future Economic Studies

- **Map the simplified transmission model to Promod**
- **Remove and replace any generation added for stability with generation fuel / location derived from Promod results.**
- **Perform a Promod run, identifying LMP values at each bus**
- **Evaluate cost-effectiveness of transmission options**

Questions?