Pattern

SouthernCross

Economic Analysis Results Presentation

ERCOT RPG Meeting

February 11, 2011

Southern Cross RPG Process Update

- Pattern's proposed Economic Analysis Modeling Approach Description distributed to RPG on 8/30/10
- 21-day stakeholder comment period ended 9/20/10, comments resolved 11/10/10
- Pattern agreed to follow draft RPG Asynchronous Tie Evaluation process adopted 11/3/10:
  - Reliability study assigned to Oncor as lead TSP
  - After reliability study, supporting ERCOT system upgrade projects can be proposed for study at RPG
  - ERCOT would lead subsequent economic studies
- Pattern volunteered to complete the economic study already underway
  - Resero / LCG conducted this study using ERCOT / RPG inputs and guidelines and UPLAN software
  - Presenting results today (2/11/11 RPG Meeting)

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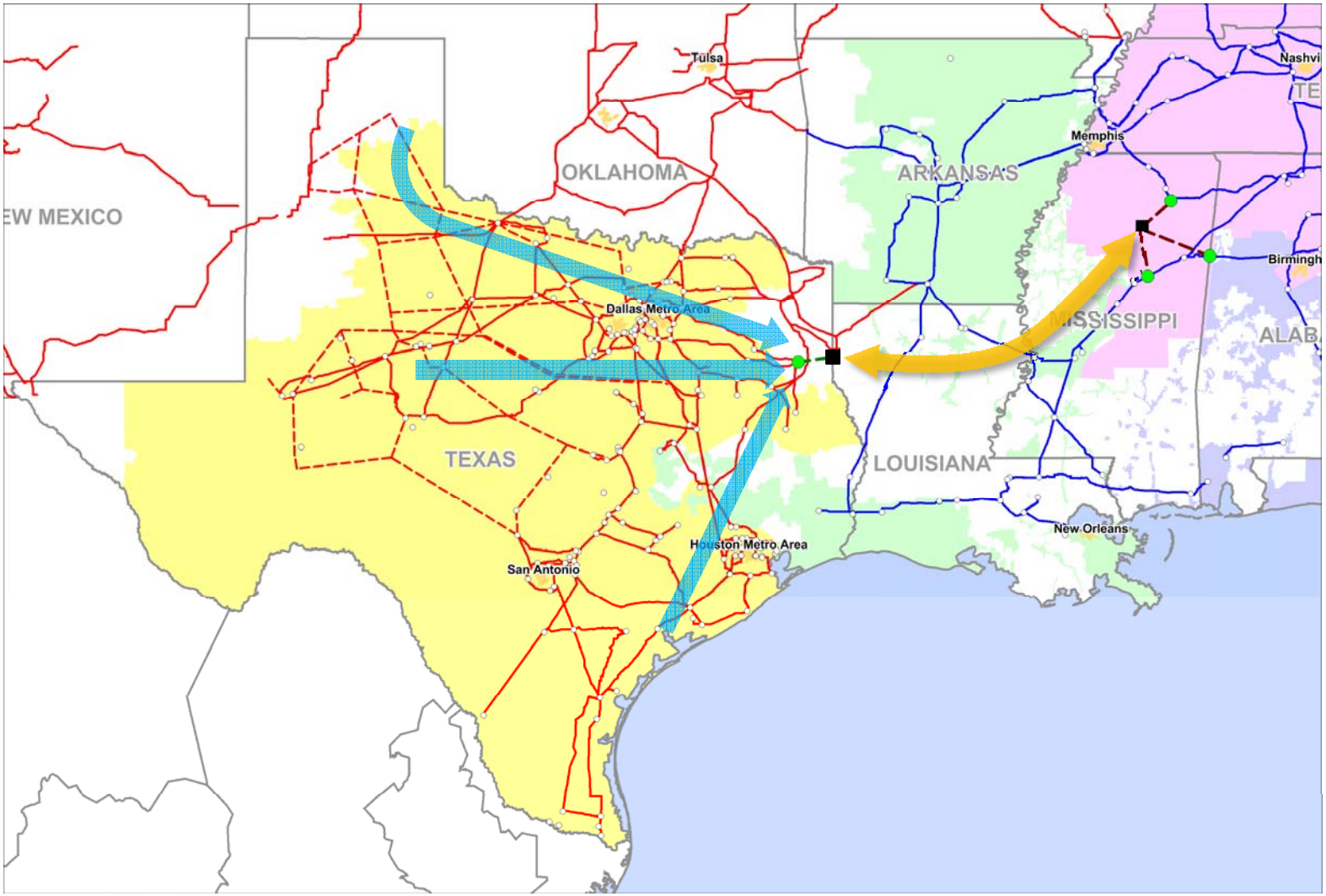
Preliminary Southern Cross Map



Study Basis and Objectives

- Three study cases with full security constrained economic dispatch:
  - RPG 2015 Base Case Model and Assumptions (“Base Case”)
  - Base Case plus Southern Cross transmission link
  - Base Case plus Southern Cross plus 3000 MW of additional wind generation

- Key study questions
  - To what extent will the project import and/or export, and to what MW flow levels?
  - What are the overall economic impacts of the project?

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To What Extent Will the Project Import or Export?

- Key Study Drivers
  - ERCOT vs. SERC Power Prices
  - ERCOT Export Charges and SERC Wheeling Charges
  - Assumed No System Upgrades (e.g. ERCOT system as-is in 2015 model)

- Key Study Results
  - Project exports from ERCOT, especially off-peak, high wind periods – 1151 GWH/yr
  - Project imports from SERC especially during on-peak – 5083 GWH/yr
  - Many periods with no flow; Net importer on annual basis
  - Flows occasionally approach the full 3000 MW in both directions
  - Flows are at or below 1500 MW for the vast majority of hours in both directions
  - Conclusion – With current ERCOT and SERC topology, capacity above 1500 MW may not be well utilized. It is possible that system upgrades on either end could facilitate higher flows.

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What are the Overall Economic Impacts Predicted by Resero / LCG Study?

- Key Study Results – Consumers
  - $473M/yr in reduced consumer power bills ($1.15/MWH average energy price)
  - $701M/yr in overall consumer benefits including rebated congestion revenue and ERCOT export charge which reduces transmission cost
  - Grows to $738M and $990M respectively if 3000 MW additional wind built
- Key Study Results – Production Costs
  - $73M net production cost savings, grows to $396M with additional wind
  - Confirms overall system efficiency is improved
- Key Study results – Generators
  - Generator margins are reduced by $422M due to competition from SERC resources
  - Does open additional markets to generators
- Key Study results – Congestion – No significant areas of new congestion

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Further RPG Group Study Opportunities

The following items were not evaluated in this Southern Cross study, but may merit further study by RPG in the future:

- Incorporation of reliability upgrades from Oncor study
- Incorporation of reliability upgrades from SERC study
- Consideration of premium renewable value to SERC (e.g. potential for “scheduled sales” driving additional export flow)
- Consideration of reliability value to either network
- Consideration of ERCOT network economic upgrades to facilitate additional import or export flows

Next steps are:

- Completion of Oncor reliability study – Target 2Q11 steady state, 4Q11 stability results
- RPG Economic Studies – discuss trigger for start; likely 3Q11

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Questions?

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Southern Cross Economic Impact Results

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Resero Consulting

Presented to the RPG

February 8, 2011

Objective of study and today's presentation

- To convey approach and findings of economic analysis of Southern Cross project
- Intended to inform parties of potential findings had ERCOT assessed the economic impacts on ERCOT of the Southern Cross project
- Initial independent assessment of ERCOT market
  - Included inputs from SPP/SERC markets but did not measure economic impacts on SPP/SERC markets

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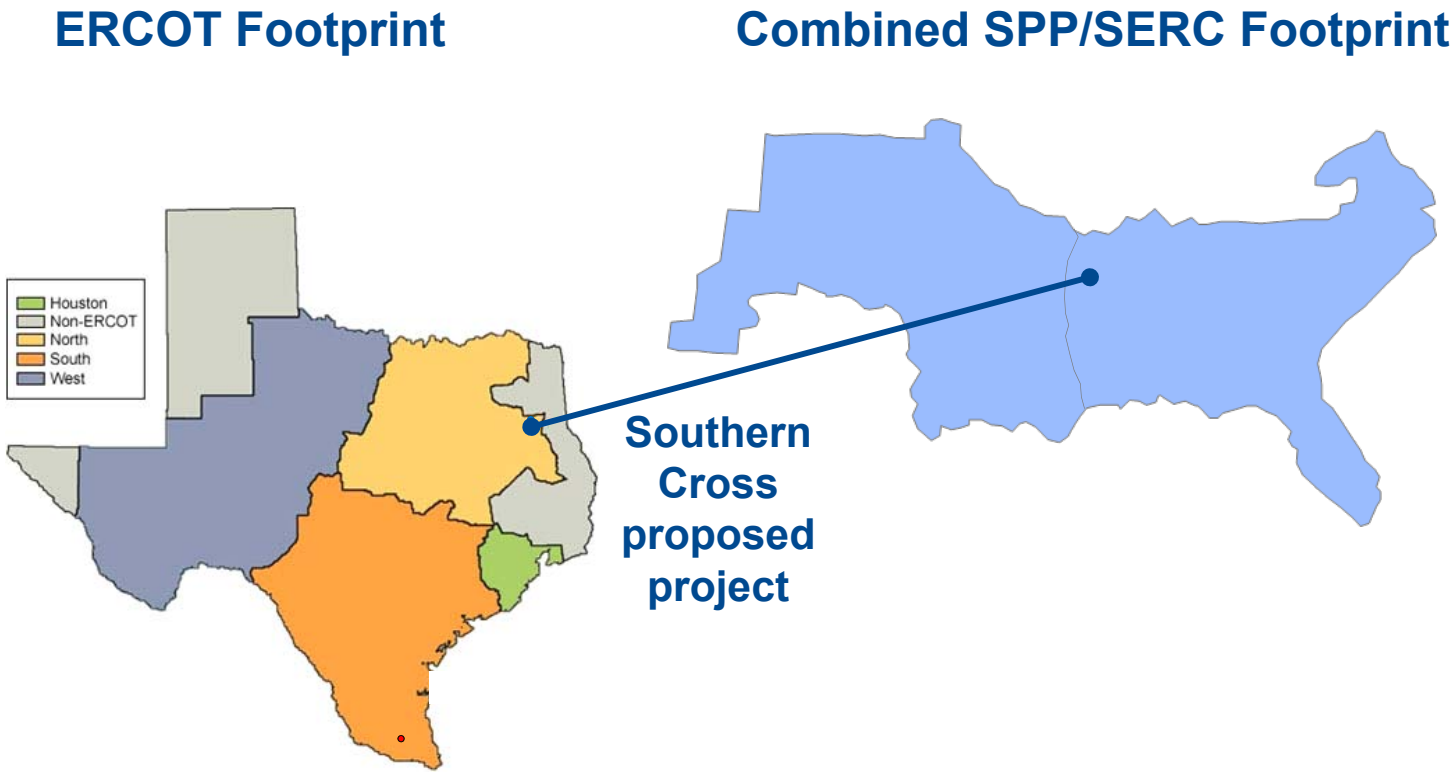
- General description of analysis approach
- SPP/SERC supply curve formulation, description and results
- Southern Cross flows, import and export costs, and export tariff benefits
- Congestion impacts on the balance of the ERCOT grid
- Impact on overall economic metrics
- Generation production by fuel type; ERCOT losses

Select basic information about analysis

- Single year, 2015, modeled ("2010 5YTP 2015 Economic Case 08122010.xls")
- Annual results presented for this modeling year, in $2010
- Three cases total:
    1. Base Case – ERCOT status quo system, no Southern Cross Project
    2. Southern Cross Case ("SC Case") – first change case, same as Base Case other than with Southern Cross Project added (36.7 GWh total wind production)
    3. Southern Cross High Wind Case ("SC HW Case") – 2nd change case, same as SC Case but also with 3000 MW additional wind capacity (47.5 GWh total wind production)
- ERCOT gas price from file 2010_5YTP_Gas_Prices.xls
- ERCOT export fees from PUCT tariffs; SPP/SERC wheeling costs from utility tariffs, no added wheeling costs for Southern Cross Project
- No premium for renewable qualities (e.g., analysis measured improved energy efficiencies only)
- Metrics for
    - SC Case compared to Base Case
    - SC HW Case compared to Base Case

Basic structure of Southern Cross economic analysis

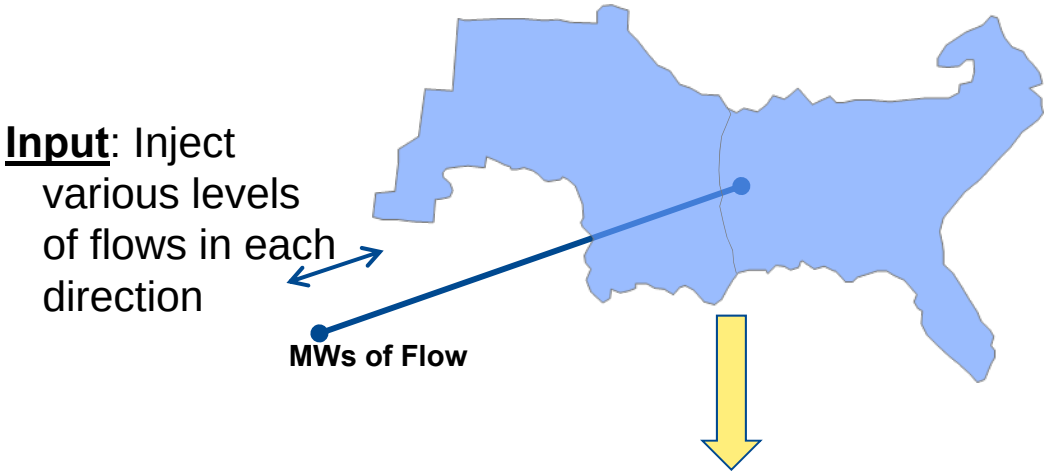
- Recall the basic challenge of measuring economic impacts of a new line that connects two otherwise independent systems

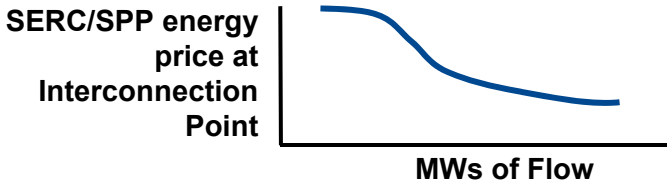


Step 1 – Derive price responsiveness of SPP/SERC market

- SPP/SERC system full simulation analysis was used to determine price responsive characteristics of these systems to various levels of flows

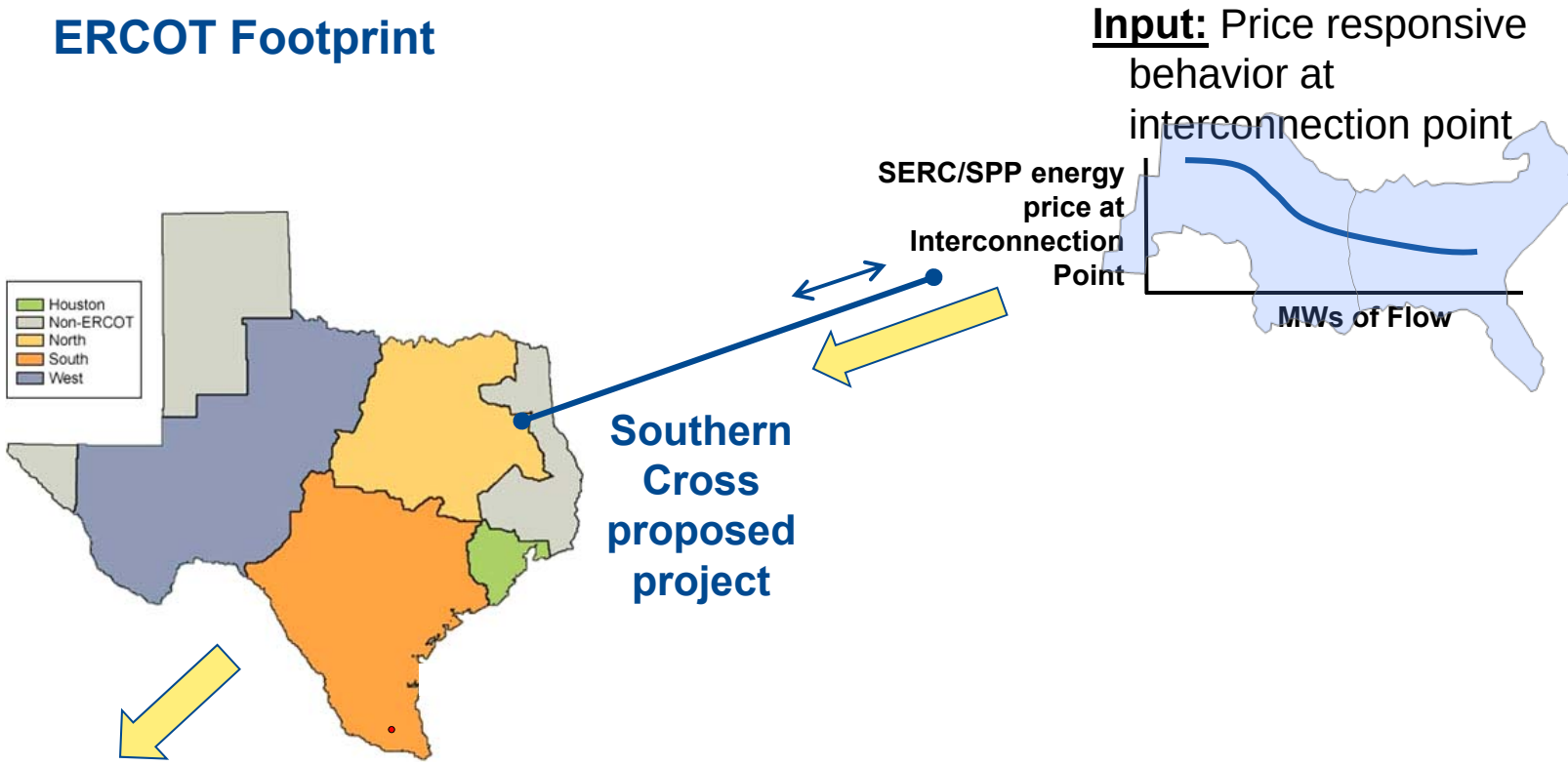
Combined SPP/SERC Footprint





Step 2 – Simulate ERCOT market results with Project using derived price-responsive "supply curve"

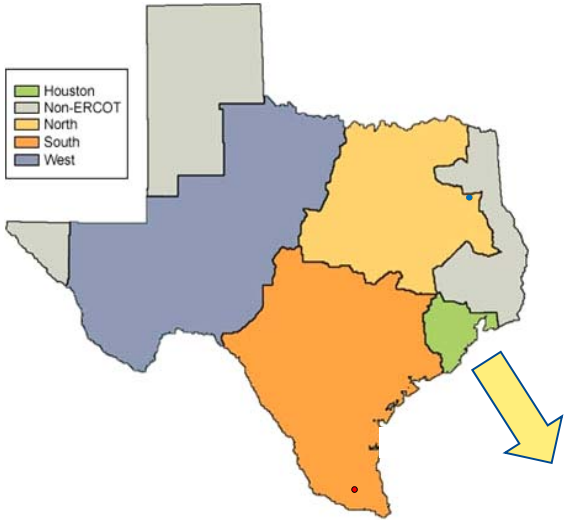
- The ERCOT model with the Southern Cross Project and the SPP/SERC price responsive "supply curve" is used for the "SC Case" and "SC HW Case"



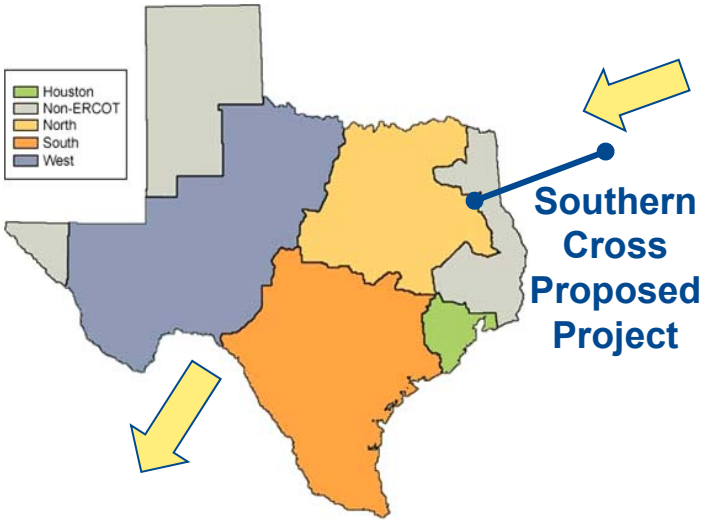
Output: Case with Southern Cross ("SC Case") Simulation results and "SC HW Case" simulation results

Step 3 – Compare with Base Case simulation without Southern Cross for project impacts

- Comparison of SC Case results with Base Case results (ERCOT without the Southern Cross project) yields economic impacts



Simulation Results for "Base Case" (no Southern Cross Project)



Simulation results for change case with Southern Cross Project modeled ("SC Case")

Δ

= ERCOT Economic Impacts

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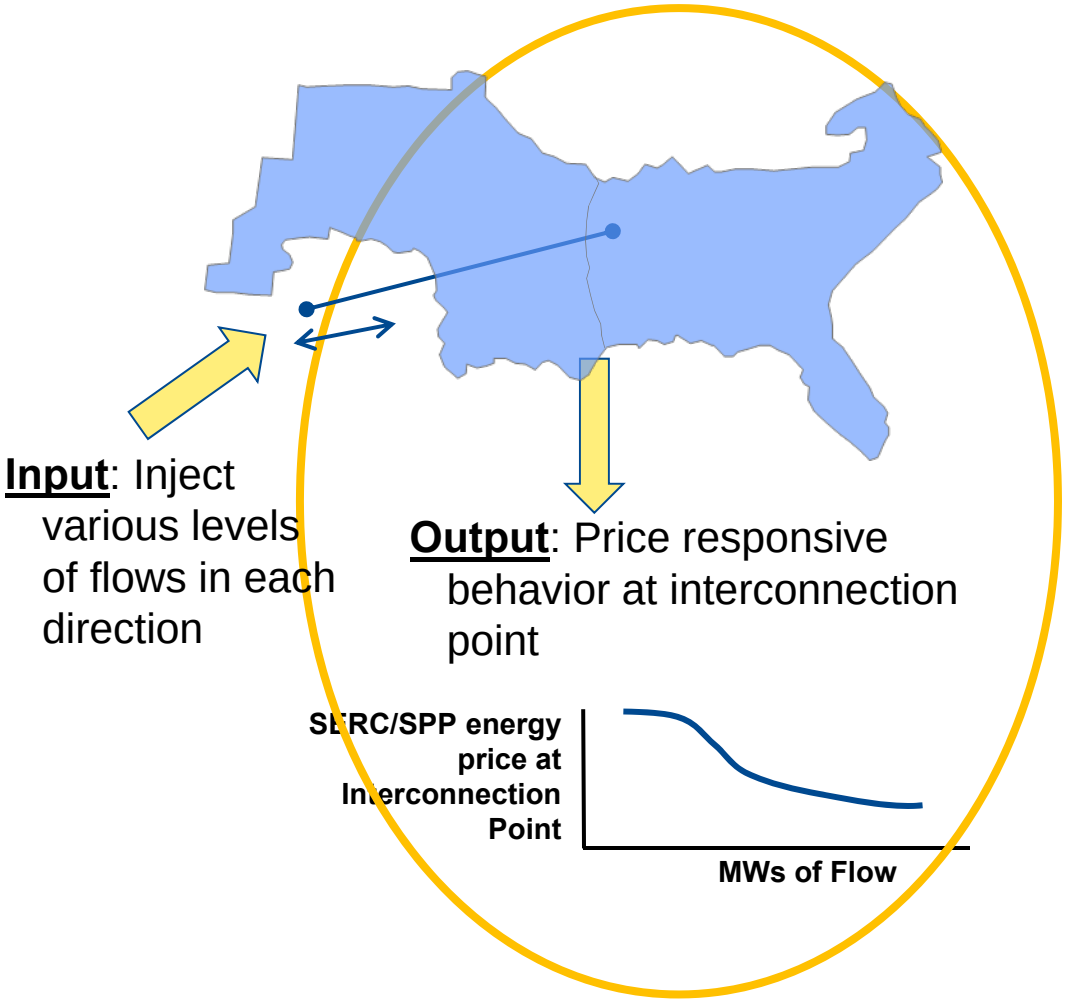
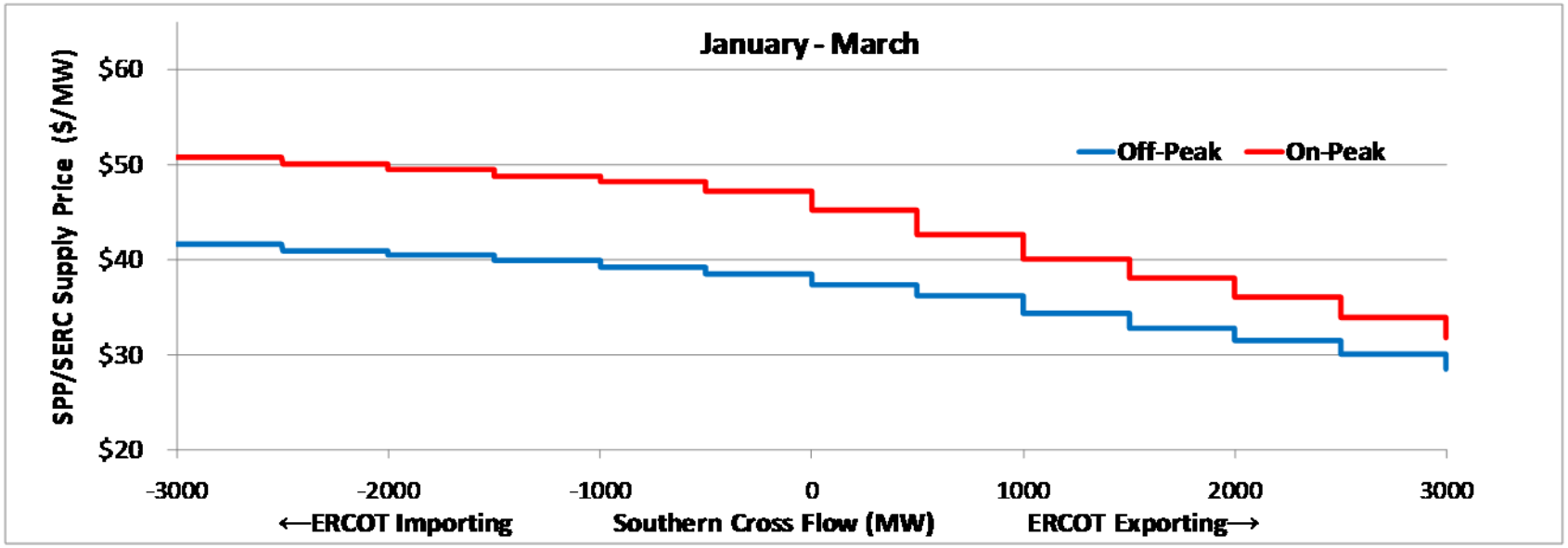
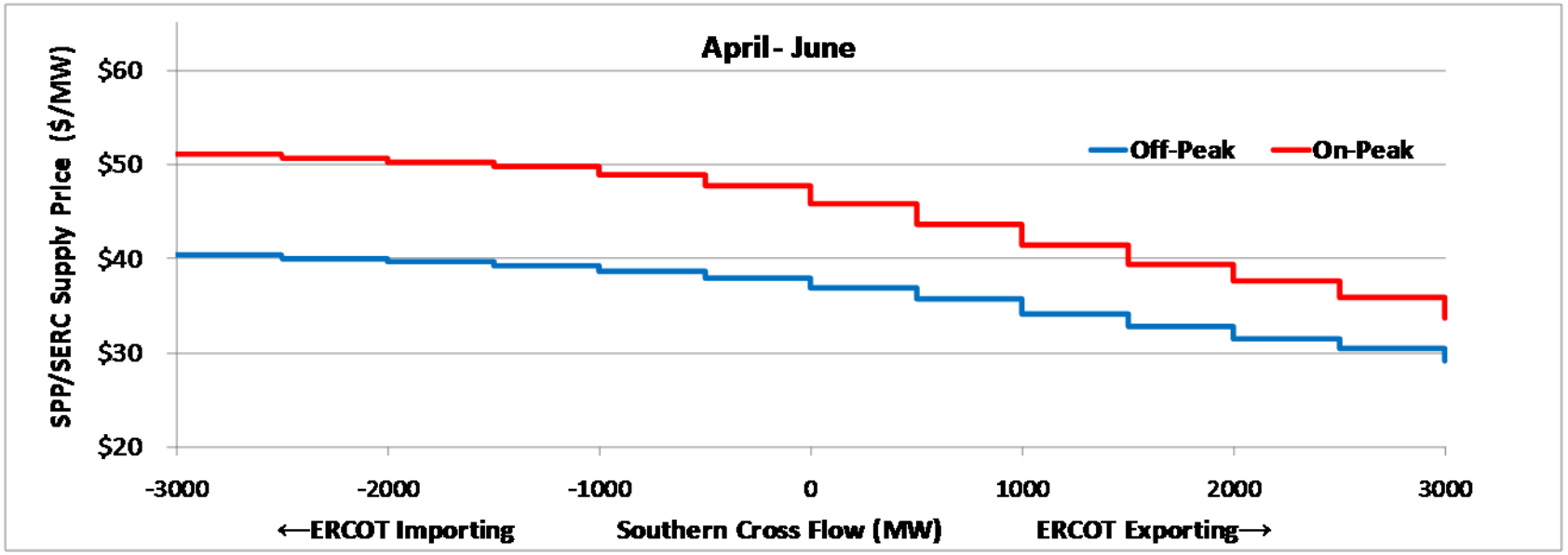


SPP/SERC supply curve formulation, homogeneity, loss treatment

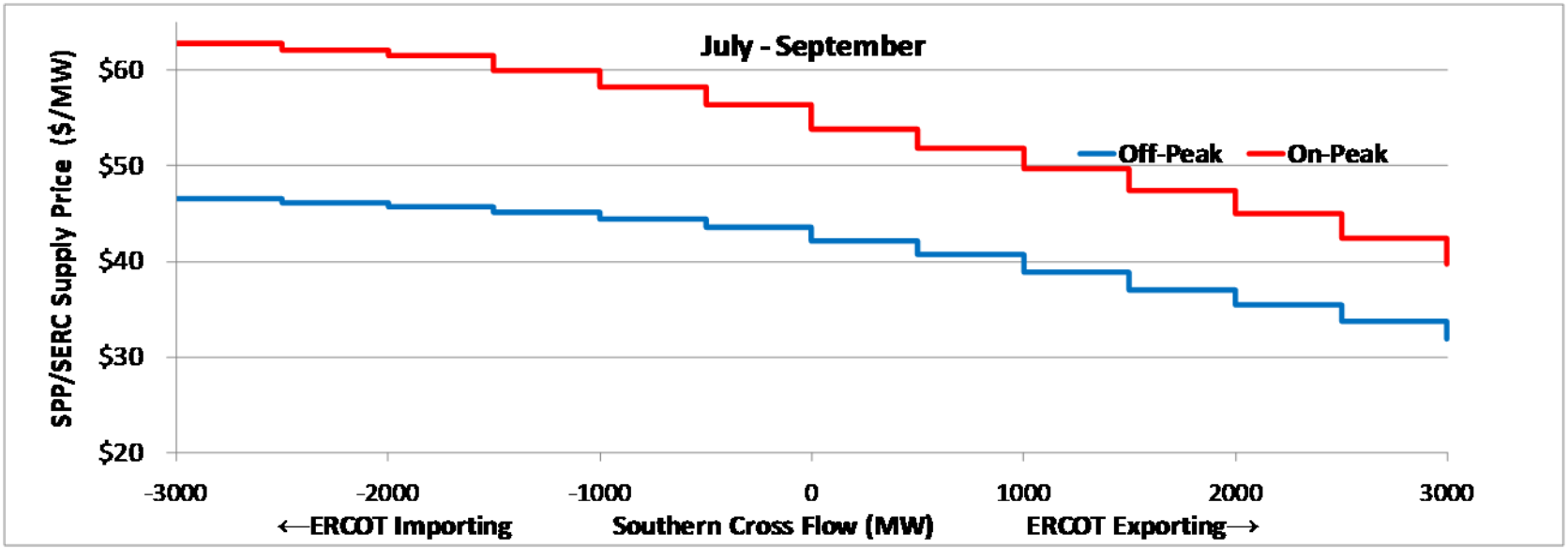
- Supply curves were generated by simulating the SERC/SPP regional model with various levels of input
  - Full SERC/SPP UPLAN simulation
  - Primarily publicly available sources for assumptions
  - Gas price based on ERCOT commodity fuel assumptions
- Within supply curve steps simulation results were quite homogenous and smooth
- Supply curves derived from SPP/SERC regional model were then adjusted for the transmission losses associated with the Southern Cross Project
- ERCOT tariff export rates (updated for CREZ transmission cost impacts) and SPP/SERC wheeling rates were then applied when the supply curves were used in the model

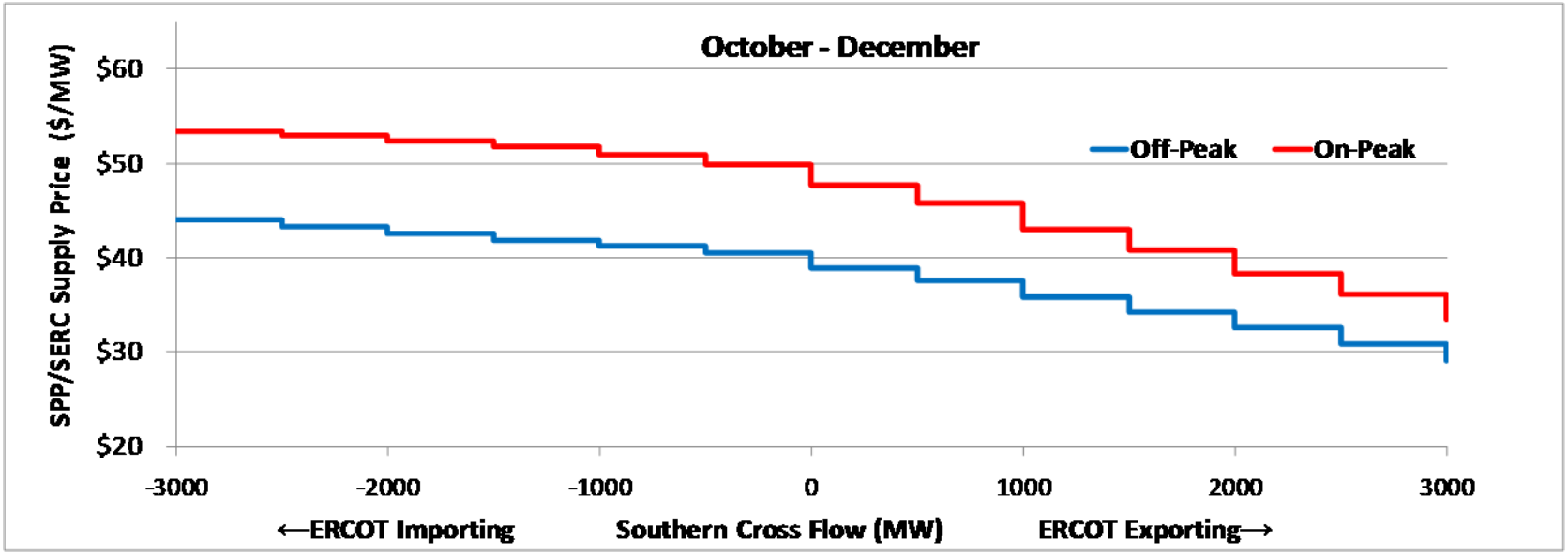
SPP/SERC supply curve results for Jan – March, April – June





SPP/SERC supply curve results for July – Sep, Oct – Dec





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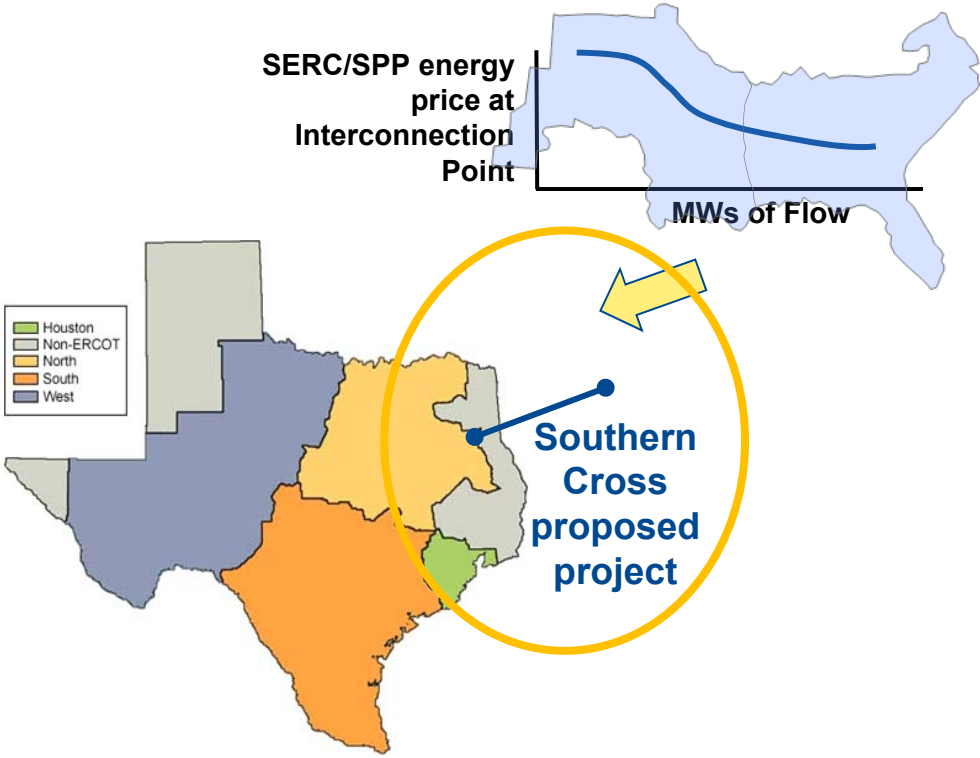
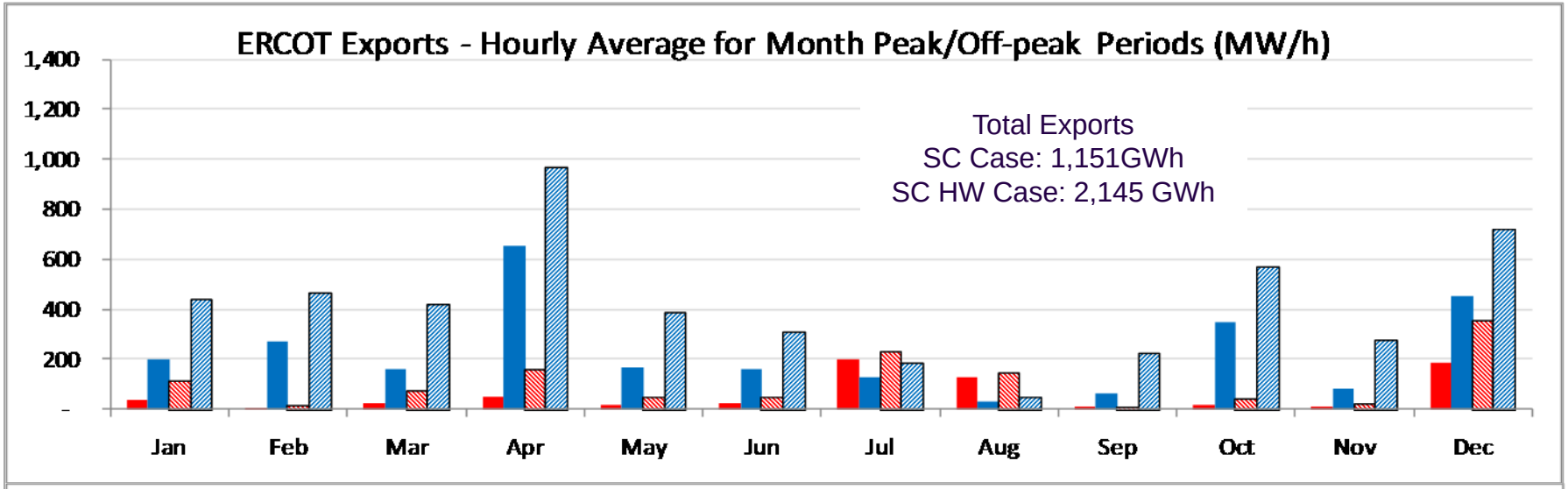
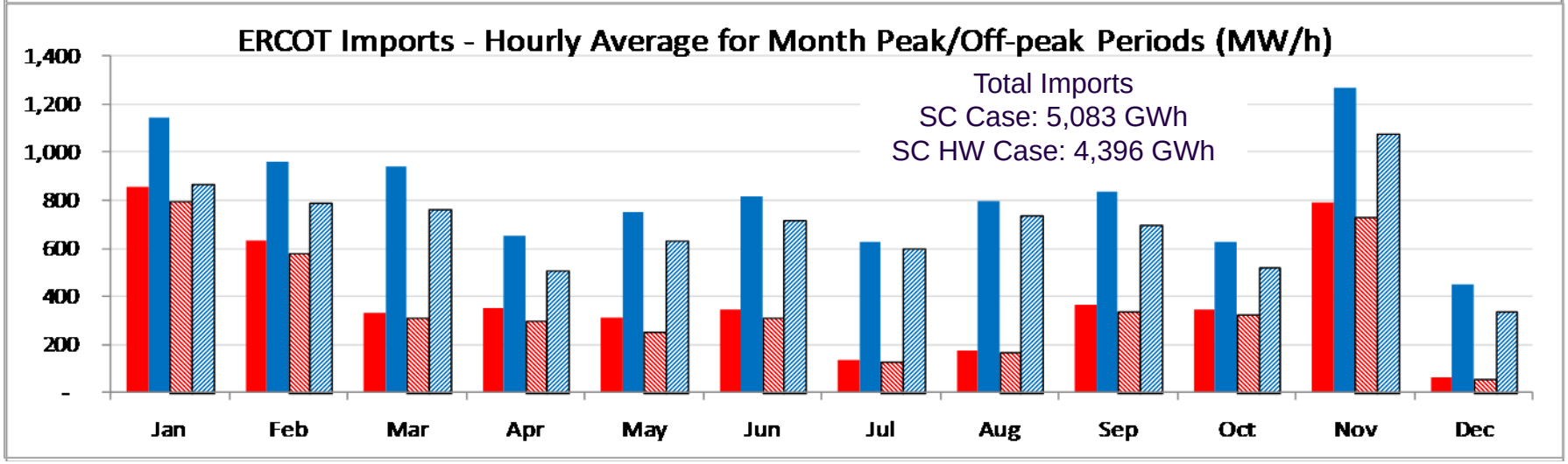


Southern Cross flow impacts

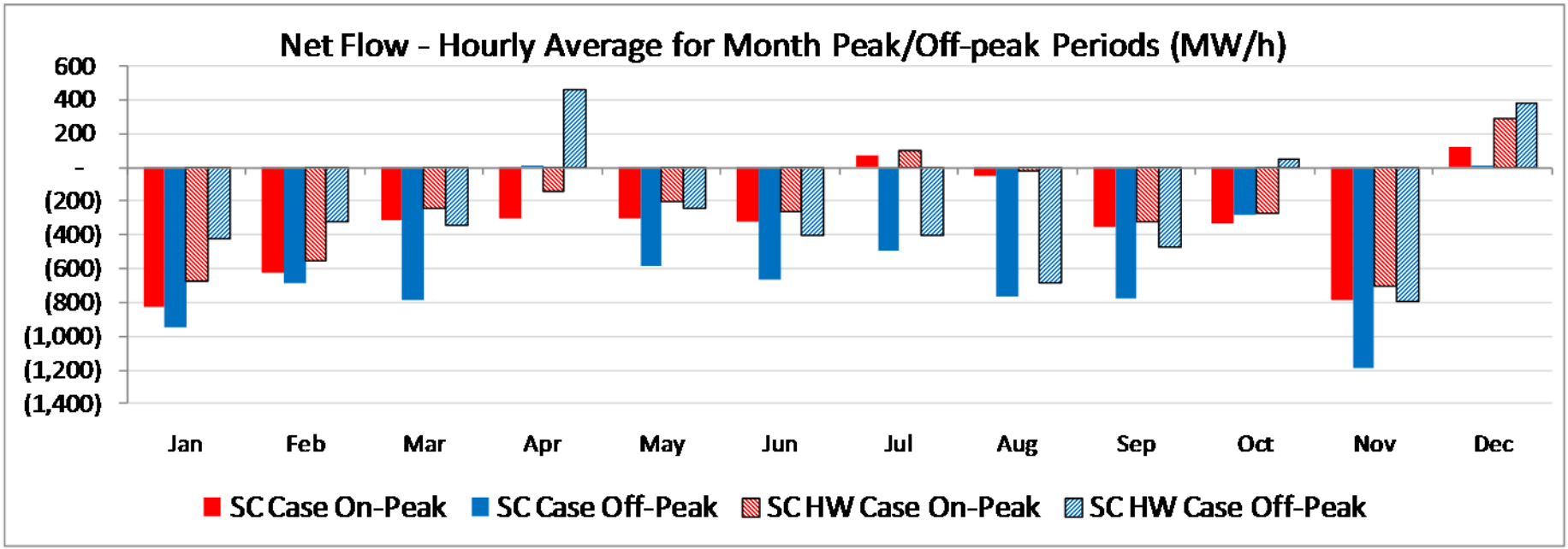
- The Southern Cross Project results in the following outcomes:
  - ERCOT exports energy during low load/high wind periods
  - ERCOT imports energy during high load or lower wind periods
  - ERCOT experiences lower average LMPs

Southern Cross Flows – Monthly Peak/Off-Peak Averages (MW/h)





Southern Cross Flows – Hourly Average Net Flow for Month Peak/Off-peak Periods

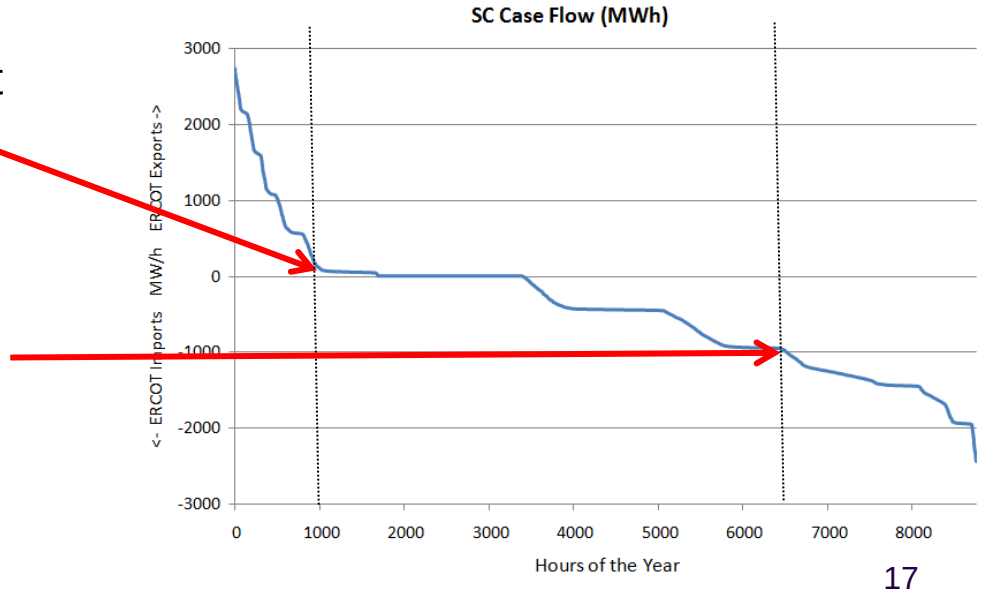


Total Annual Net Flow
SC Case: 3,932 GWh
SC HW Case: 2,251 GWh

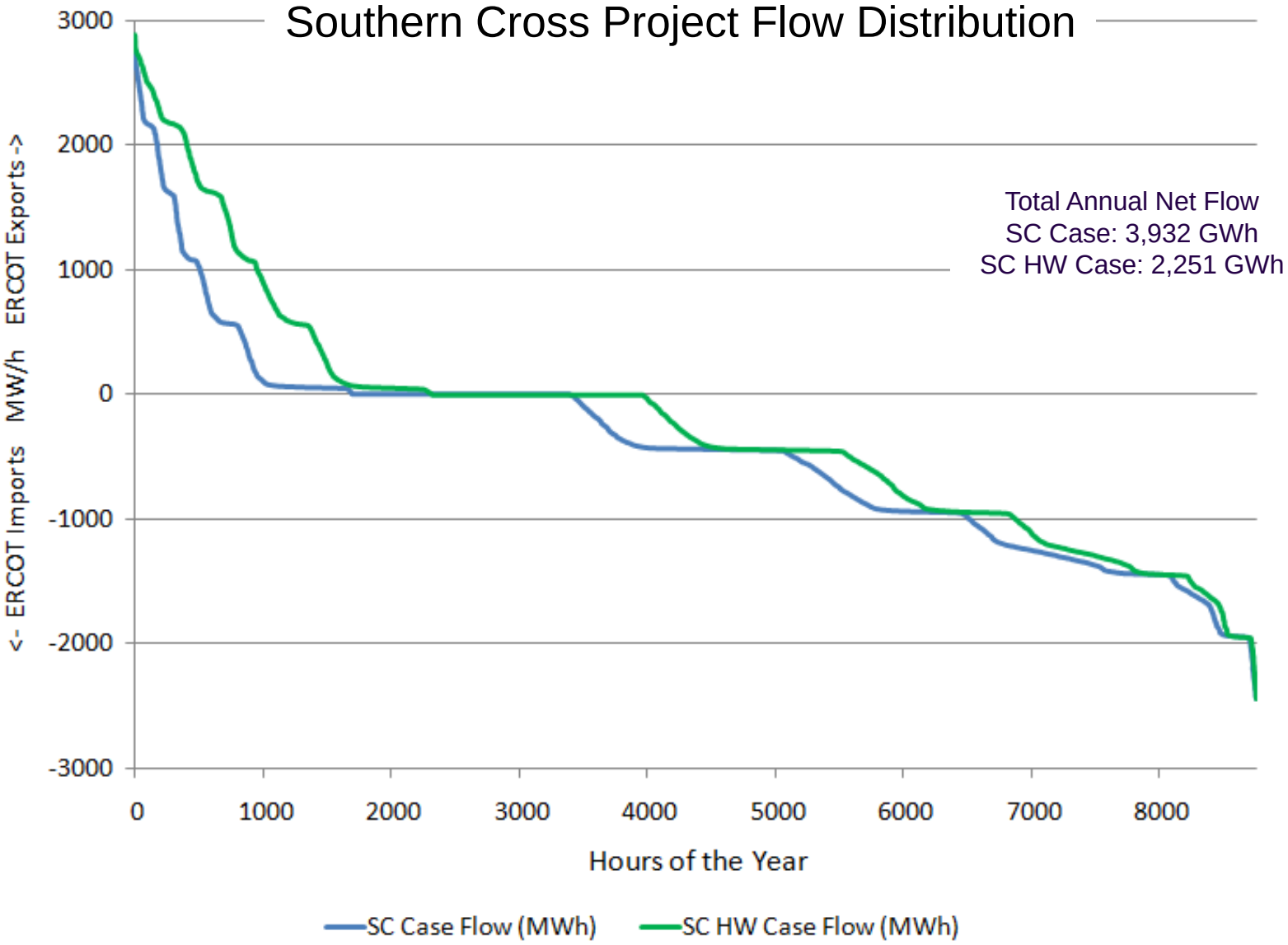
Hourly Flow Behavior: How to interpret the hourly distribution of flows on Southern Cross Project

- The next slide shows the hourly distribution of the Southern Cross Project flows measured during the simulation
- The graphic shows the hourly distribution in the form of a “duration curve”
  - Often used to represent price distributions (e.g., “price duration curve”)
- The flow duration curve records the hours of the year during which the flow is above the level indicated on the left-hand axis

- For example, the curve will show that for approximately 1000 hours of the year ERCOT was exporting over the Southern Cross Project
- Similarly, for only ~2200 hours (= 8760 – ~6500) of the year were there imports exceeding 1000 MWs



Hourly Flow Behavior: Southern Cross Flow Duration Curve SC & SC HW Cases

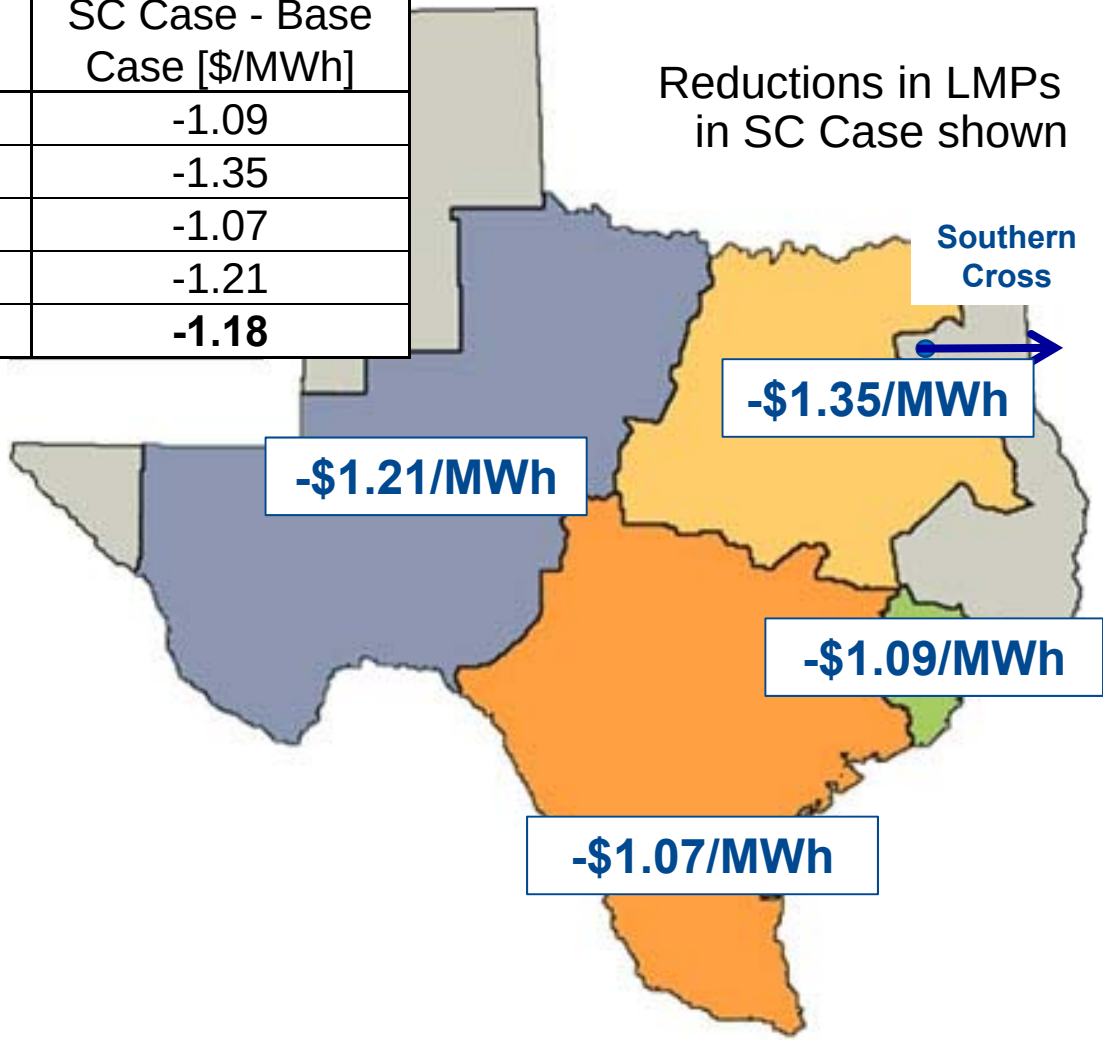


Southern Cross Project results in lower average annual LMPs across all regions of ERCOT – SC Case

Average annual load weighted LMPs

Zone	Base Case [$/MWh]	SC Case [$/MWh]	SC Case - Base Case [$/MWh]
Houston	50.34	49.26	-1.09
North	50.54	49.20	-1.35
South	50.45	49.38	-1.07
West	49.87	48.66	-1.21
ERCOT	**50.41**	**49.23**	**-1.18**

Reductions in LMPs in SC Case shown

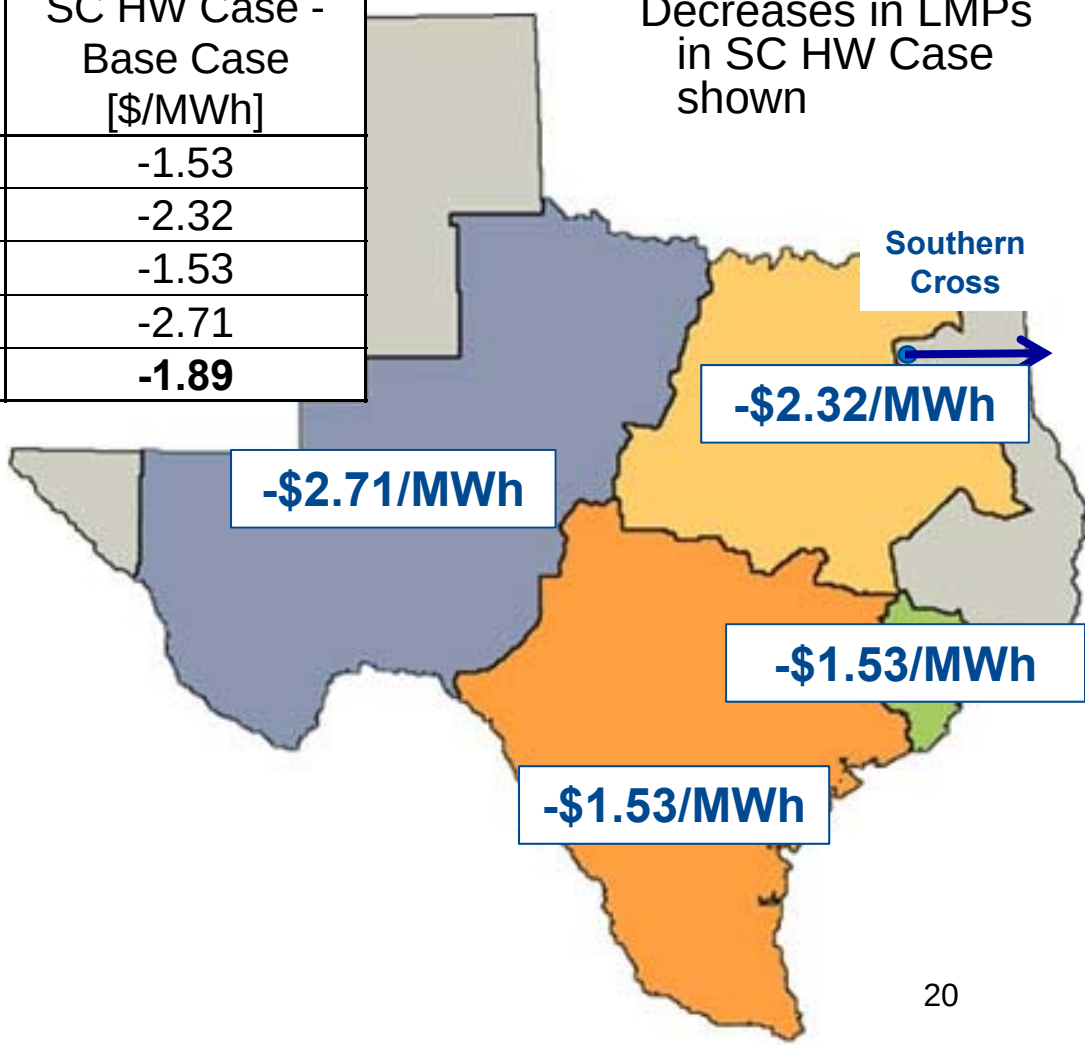


LMP reduction is greater with SC HW Case

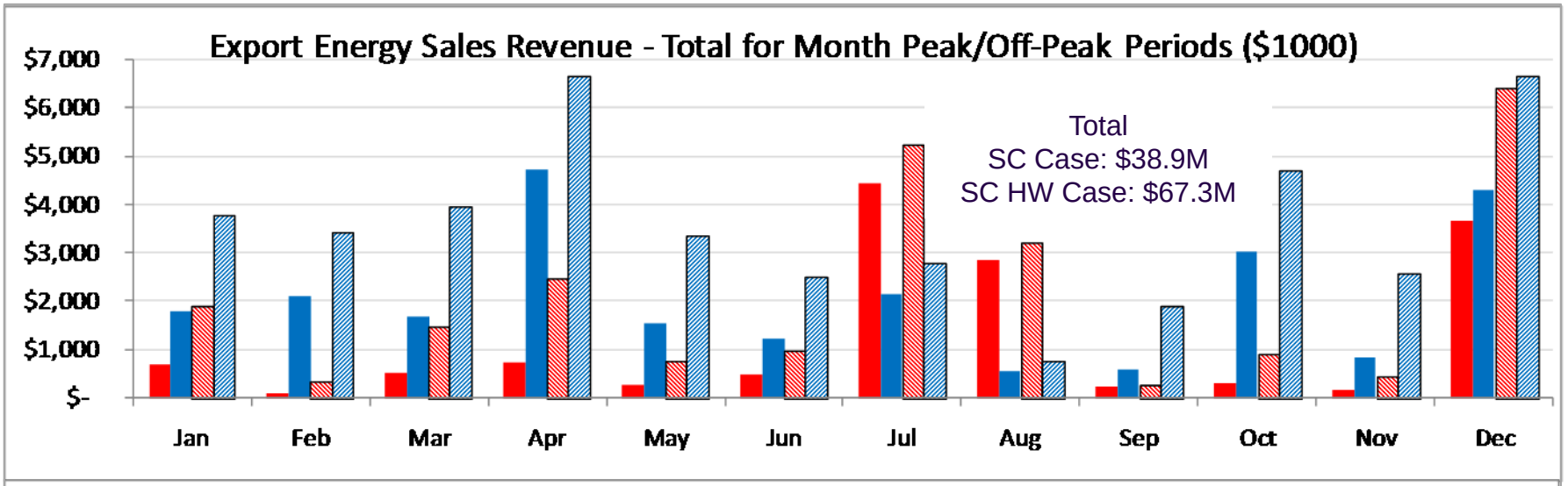
Average annual load weighted LMPs

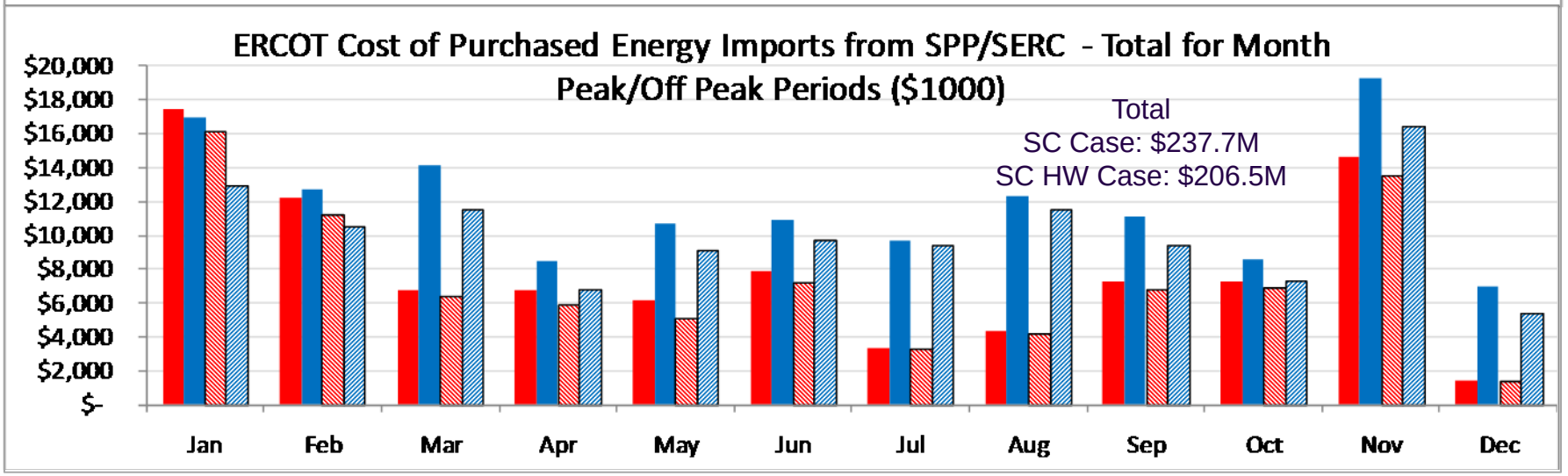
Zone	Base Case [$/MWh]	SC HW Case [$/MWh]	SC HW Case - Base Case [$/MWh]
Houston	50.34	48.81	-1.53
North	50.54	48.22	-2.32
South	50.45	48.92	-1.53
West	49.87	47.15	-2.71
ERCOT	**50.41**	**48.52**	**-1.89**

Decreases in LMPs in SC HW Case shown



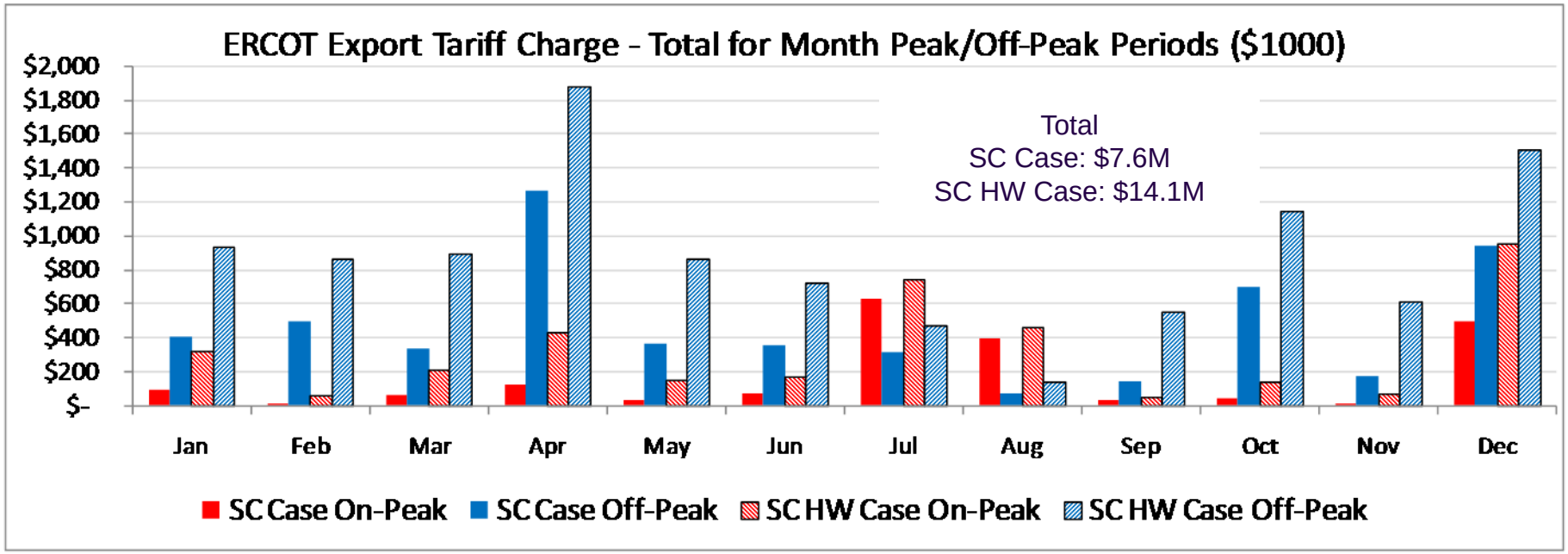
Export Energy Sales Revenue and Import Energy Purchase Costs, Monthly Peak/Off-Peak total ($1000)





SC Case On-Peak | SC Case Off-Peak | SC HW Case On-Peak | SC HW Case Off-Peak

ERCOT export tariff revenues resulting from Southern Cross exports (= MW exported * export tariff rate)



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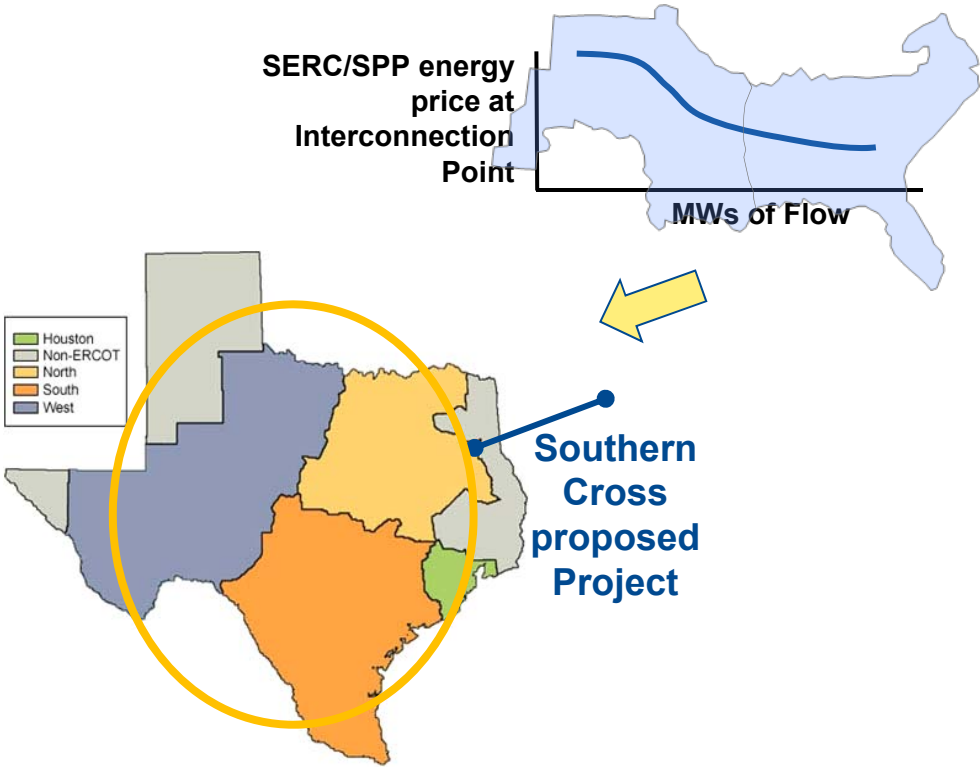
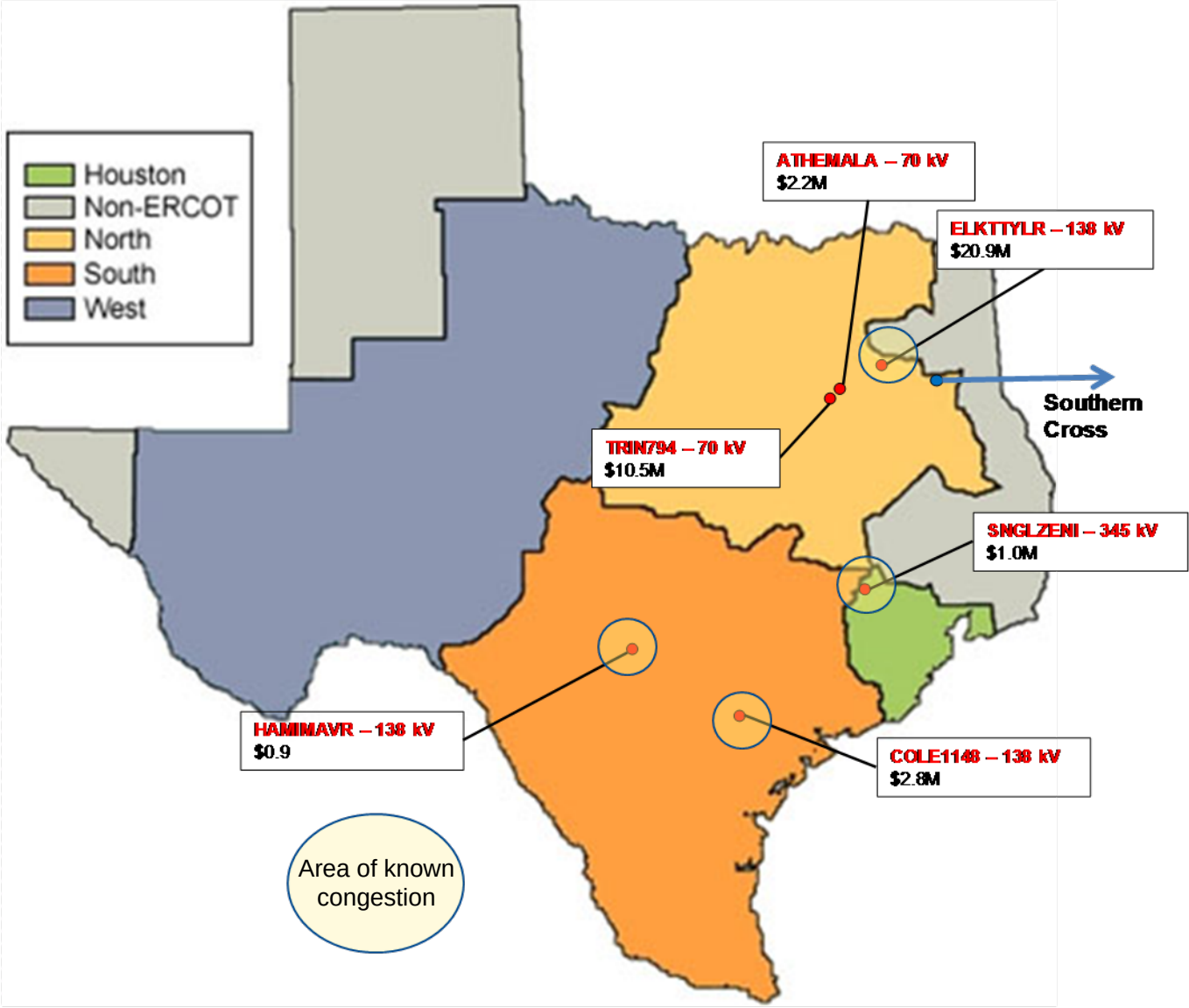


Increased flows via Southern Cross result in limited increased congestion on ERCOT's system

- Economic analysis measured impacts on existing ERCOT constraints
- Congestion on some constraints is alleviated
- On other constraints there is limited increased congestion with increased flows
- In the SC HW Case the increase in wind production creates additional congestion, some of which is alleviated by the Southern Cross Project
- Next four slides contain select congestion results

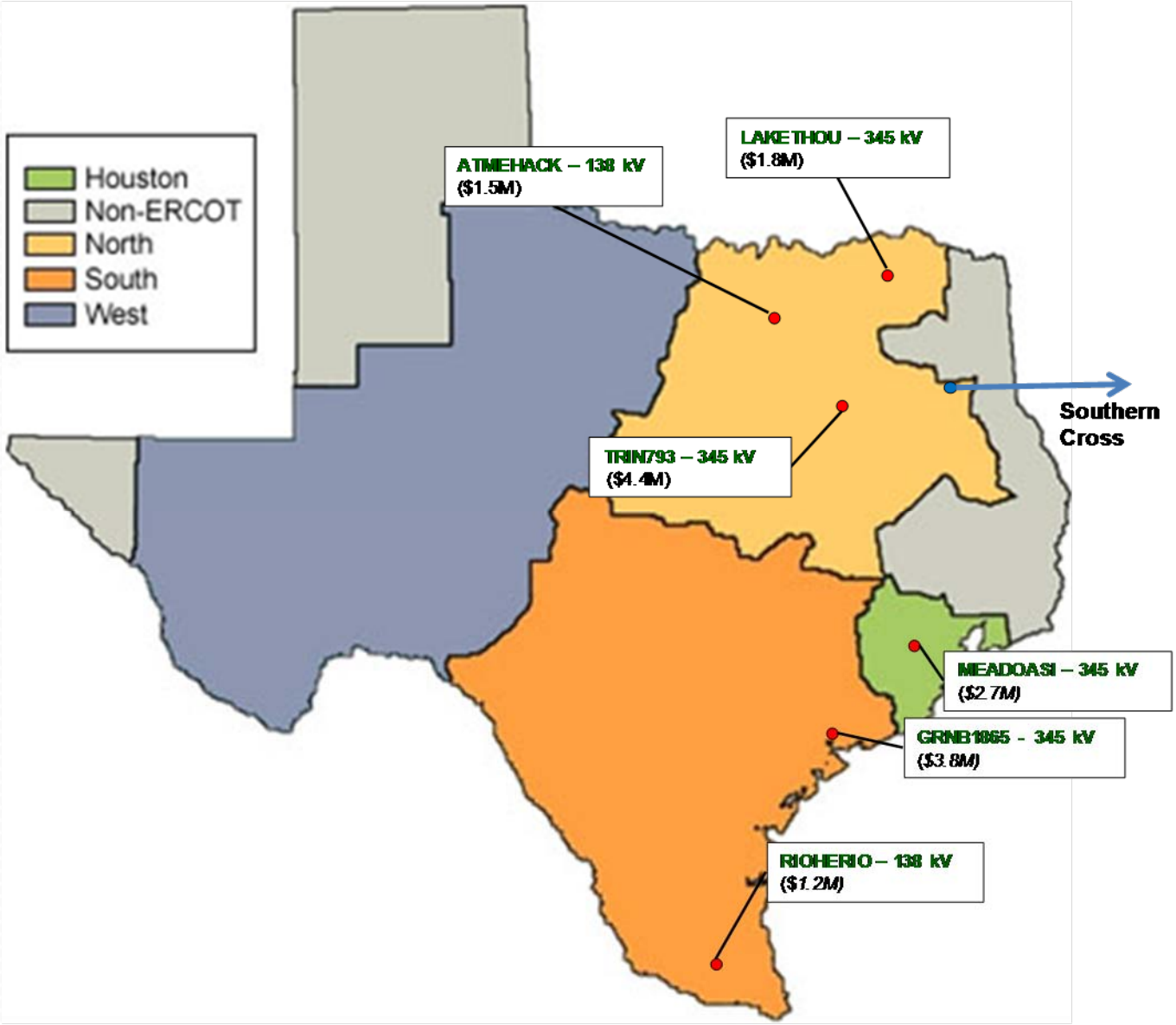
Greatest increases in congestion, SC Case, > $900k annually shown

Monitored Line	Congestion Cost [SC Case - Base Case] Difference ($M)
ELKTTYLR	$ 20.9
TRIN794	$ 10.5
COLE1148	$ 2.8
ATHEMALA	$ 2.2
JEFFCS_C (not mapped)	$ 1.3
SNGLZENI	$ 1.0
HAMIMAVR	$ 0.9



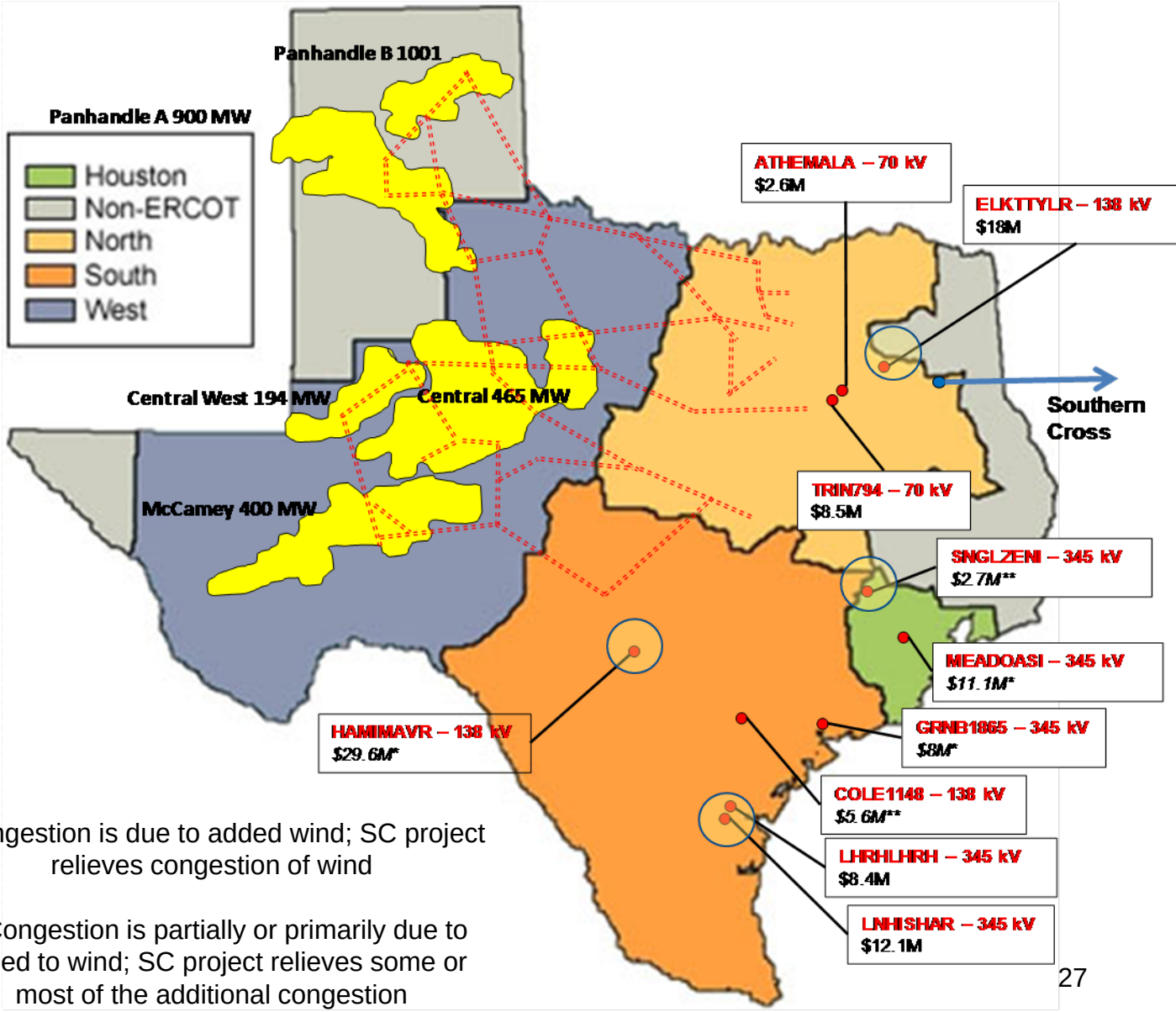
Greatest decreases in congestion, SC Case, > $1.2M annually shown

Monitored Line	Congestion Cost [SC Case - Base Case] Difference ($M)	
TRIN793	$	(4.4)
GRNB1865	$	(3.8)
MEADOASI	$	(2.7)
LAKETHOU	$	(1.8)
ATMEHACK	$	(1.5)
RIOHERIO	$	(1.2)



Greatest increases in congestion, SC HW Case, > $2.5M annually shown

Monitored Line	Congestion Cost [SC HW Case - Base Case] Difference ($M)
HAMIMAVR	$ 29.6
ELKTTYLR	$ 18.0
LNHISHAR	$ 12.1
MEADOASI	$ 11.1
TRIN794	$ 8.5
LHRHLHRH	$ 8.4
GRNB1865	$ 8.0
COLE1148	$ 5.6
JKCRTWIN (not mapped)	$ 4.2
SNGLZENI	$ 2.7

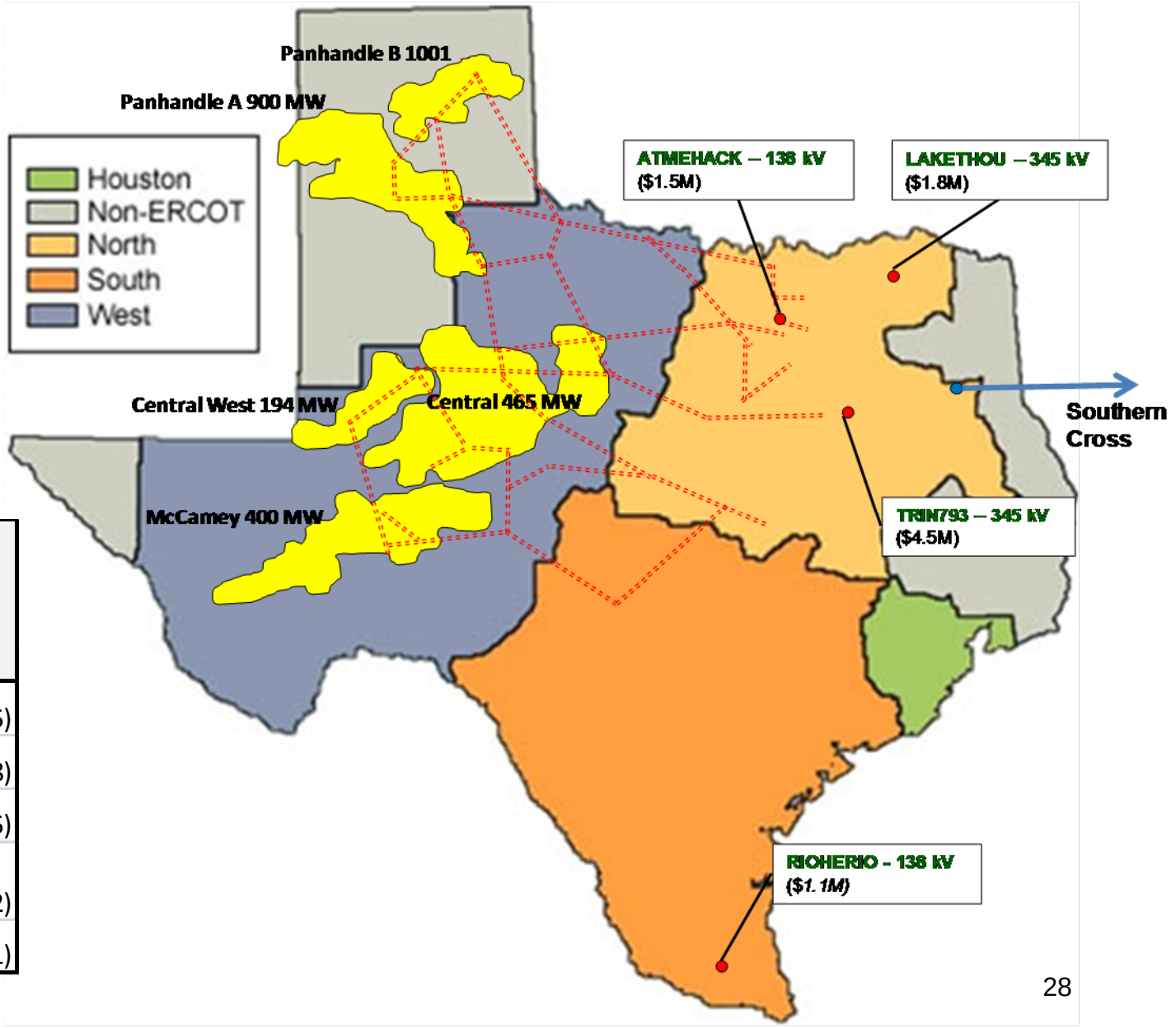


Area of known congestion

* Congestion is due to added wind; SC project relieves congestion of wind

** Congestion is partially or primarily due to added to wind; SC project relieves some or most of the additional congestion

Greatest decreases in congestion, SC HW Case, > $1M annually shown



Monitored Line	Congestion Cost [SC HW Case - Base Case] Difference ($M)
TRIN793	$ (4.5)
LAKETHOU	$ (1.8)
ATMEHACK	$ (1.5)
TNBPTNGR (not mapped)	$ (1.2)
RIOHERIO	$ (1.1)

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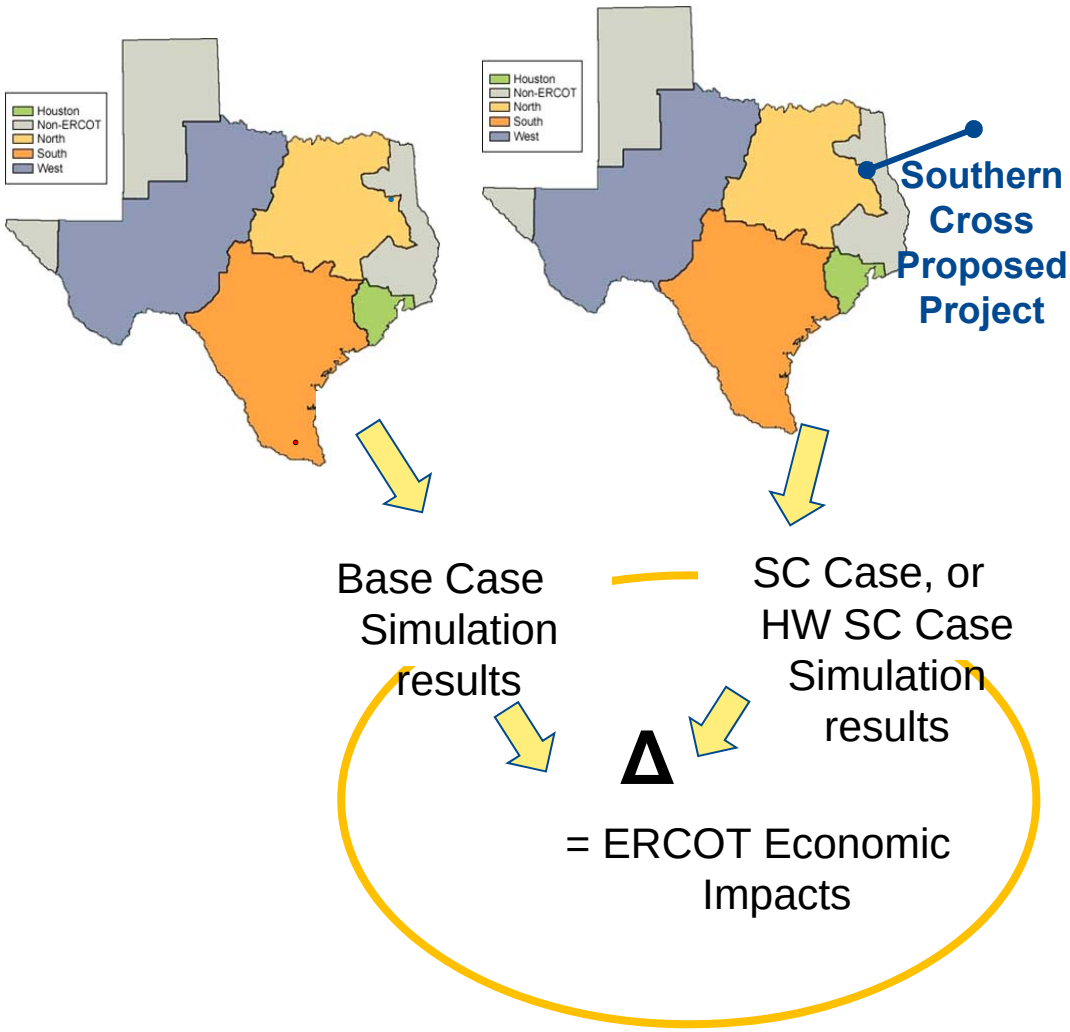


Four primary metrics are used

1. Consumer Energy Benefit, or Change in Cost to Serve Load: reflects the energy cost impacts to load-serving entities and ultimately to downstream consumers

2. Production Costs Changes: reflects the change in the total cost of production, namely fuel and variable operations and maintenance costs (VOM)

3. Generator Margin: Not particularly a measure of the merits of one case or another; rather reflects the revenue impacts to generation owners

4. Congestion Refund Impacts: to the extent there is congestion there is an over collection by ERCOT that is refunded to load

   – Loads pay more than generators are paid

   – Excess congestion revenue is refunded to loads via Qualified Scheduling Entities

      • May have some distortions given CRR auctions if auction is not efficient (e.g., buyers pay more or less than congestion rent)

   – Net impact to loads is the load energy payment and the impact of the congestion rent refund (not withstanding CRR auction distortions)

How do we measure each metric?

Metric	Equal to:	Determined How?
Cost to Serve Load	LMP at load node * MW of load at node, summed over all nodes	Measured in UPLAN
Production Cost	Fuel + VOM	Measured in UPLAN
Generator Revenue	LMP at gen node * MW of generation, summed over all nodes	Measured in UPLAN
Generator Margin	Generator Revenue – Production Costs	Derived outside of UPLAN
Congestion Refund	Cost to Serve Load – Generator Revenue	Derived outside of UPLAN

Example of congestion refund calculation $Millions

Base Case	
Consumer Energy Cost	$ 19,992
Payments to Generators	$ 19,897
Difference = Congestion Overcollection to Refund	$ 95
SC Case	
Consumer Energy Cost	$ 19,519
Payments to Generators	$ 19,203
Difference = Congestion Overcollection to Refund	$ 316
Change in Congestion Refund	$ 221

- In this case the congestion collection and overcollection is higher in the SC case, increasing the congestion rent refund to consumers by $221 million
- Refunded via CRR auction revenues and balancing account surpluses. (See protocol sections 7.5.7 and 7.9.3.5)

Economic Metrics, SC Case – Base Case

		Row
Consumer Energy Benefit:	Lower LMPs reduce energy payments and result in significant consumer benefits	A
Congestion Refunds:	Higher congestion in SC Case leads to higher overcollection and refund	B, C
Producer "Benefits":	Producers' margins are reduced primarily due to lower LMPs	D
Production savings:	Production cost savings reflect Southern Cross' increased delivery of economy energy	E
Import Costs/Export Revenues:	ERCOT imports more than it exports, resulting in a net cost of energy exchanged	F
Export Tariff Charges:	Consumer also benefit from Export Charges collected on Southern Cross flows	H

	Benefit Description	2015 Benefits $ millions 2010 dollars
		SC Case [SC Case - Base Case]
A	Consumer Energy Benefit	$ 473
B	Congestion [Refunded to Consumers*]	$ 221
C	Refund Adjusted Consumer Benefit [A + B]	$ 694
D	Producer Benefit	$ (422)
E	ERCOT System Production Cost Savings [A+B+D=E]	$ 272
F	Import Cost less Export Revenue	$ (199)
G	Production Cost Savings less costs of net imports [E + F]	$ 73
H	Additional Consumer Benefit due Increased Export Charges	$ 7.6
I	Total Consumer Benefit [C+H]	$ 701

Economic Metrics, SC HW Case – Base Case

- The high-wind case results in even greater energy cost savings and increased Export Charge benefits [A, B, C, G and H]
- Producers' margins decrease less that in SC Case primarily due to high profitability of new wind resources [D]
- Production Cost Benefits [G] result from additional wind build out and additional wind delivery via Southern Cross

	Benefit Description	2015 Benefits $ millions 2010 dollars
		SC HW Case [SC HW Case - Base Case]
A	Consumer Energy Benefit	$ 738
B	Congestion [Refunded to Consumers*]	$ 238
C	Refund Adjusted Consumer Benefit [A + B]	$ 976
D	Producer Benefit	$ (307)
E	ERCOT System Production Cost Savings [A+B+D=E]	$ 669
F	Import Cost less Export Revenue	$ (274)
G	Production Cost Savings less costs of net imports [E + F]	$ 396
H	Additional Consumer Benefit due Increased Export Charges	$ 14.1
I	Total Consumer Benefit [C+H]	$ 990

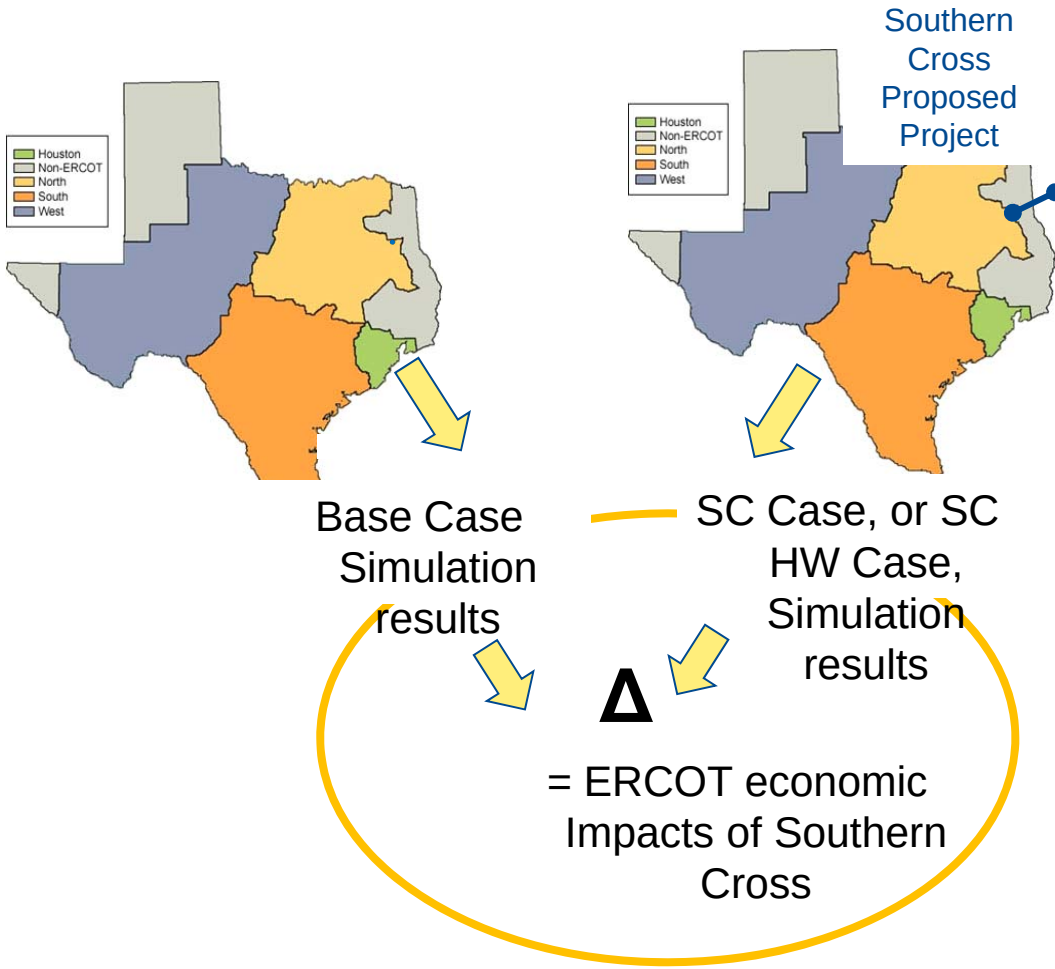
Zonal Results – Key Economic Metrics

	2015 Southern Cross Impacts [Base Case - SC Case]					2015 Wind and Southern Cross Impacts [Base Case - SC HW Case]				
	Houston	**North**	**South**	**West**	**ERCOT-Wide**	**Houston**	**North**	**South**	**West**	**ERCOT-Wide**
Consumer Benefit ($million)	$ 142	$ 179	$ 123	$ 30	$ 473	$ 192	$ 313	$ 169	$ 64	$ 738
Congestion Cost Savings ($million)	$ (29)	$ (61)	$ (112)	$ (19)	$ (221)	$ (125)	$ (279)	$ (150)	$ 316	$ (238)
Net Consumer Benefit ($million)	$ 171	$ 240	$ 234	$ 49	$ 694	$ 317	$ 592	$ 319	$ (251)	$ 976
Producer "Benefit" ($million)	$ (86)	$ (177)	$ (125)	$ (33)	$ (422)	$ (122)	$ (319)	$ (143)	$ 278	$ (307)
Production (GWh)	(1,478)	(608)	(1,830)	(236)	(4,152)	(3,839)	(5,247)	(1,766)	8,767	(2,085)
Average LMP ($/MWh)	$ (1.09)	$ (1.35)	$ (1.07)	$ (1.21)	$ (1.18)	$ (1.53)	$ (2.32)	$ (1.53)	$ (2.71)	$ (1.89)

- All zones experience lower annual average prices, consumer benefits and reductions in producer margins – with the exception of the Western zone where producers benefit under the SC HW Case

Outline

- General description of analysis approach
- SPP/SERC supply curve formulation, description and results
- Southern Cross flows, import and export costs, and export tariff benefits
- Congestion impacts on the balance of the ERCOT grid
- Impact on overall economic metrics
- Generation production by fuel type; ERCOT losses



Generation by Fuel Type – only minor changes in fuel mix results

	Generation (GWh)		
	Base Case	**SC Case**	**SC HW Case**
Nuclear	39,524	39,524	39,524
Coal	155,107	155,857	155,233
Natural Gas	161,205	156,594	148,522
Others	3,288	2,983	2,979
Hydro	767	767	763
Wind	36,671	36,684	47,456
Total	**396,562**	**392,410**	**394,477**

Losses with Southern Cross are slightly higher given increased ERCOT flows

	Annual Losses (GWh)		
Zone	**Base Case**	**SC Case**	**SC HW Case**
Houston	2314	2244	2370
North	2338	2771	2925
South	897	869	918
West	433	420	444
ERCOT Total	5982	6304	6657
% of Total Production	1.51%	1.61%	1.69%

- The changes in losses for the SC Case and SC HW Case are incorporated into the overall economic metrics, and only are isolated here for information purposes

Summary of Findings for ERCOT

- ERCOT exports energy across Southern Cross during low load/high wind periods
- During high load or lower wind periods economy energy is imported across Southern Cross into ERCOT to serve load
- Southern Cross benefits ERCOT Consumers (2015 simulation year results):

	SC Case	SC HW Case
• Lower ERCOT LMPs (Average)	$1.15/MWh	$1.89/MWh
• Consumer energy benefit	$473M	$738M
• Net consumer benefit (w/congestion refund and tariff revenues)	$701M	$990M
• Production cost savings (less cost of net imports)	$73M	$396M

- Producers' margins are reduced with Southern Cross

	SC Case	SC HW Case
• Producer "Benefit"	($422M)	($307M)

- No significant areas of new congestion were created by Southern Cross

Potential impacts on Southeast

- Note that specific impacts on the SPP/SERC markets have not yet been measured
  - Would require simulation of the SPP/SERC model with the Southern Cross flows as inputs, similar to how ERCOT impacts were measured
- However, energy flows measured in the analysis indicative of some impacts on SPP/SERC
  - May reduce the cycling of units, providing a larger load base to SE generators' operations during shoulder or off-peak hours
  - Southern Cross also shown to deliver low cost energy during certain hours, offsetting more expensive production in SPP/SERC
  - Energy exported from SPP/SERC to ERCOT during peak hours

What was not measured

- No premium was applied for renewable energy
  - Model results do not reflect potential renewable demand for ERCOT wind in SPP/SERC
- No reliability value was measured for Southern Cross
  - Southern Cross likely improves the reliability and ability for ERCOT and SERC/SPP to manage variability
  - No adjustments for operating reserves were made in the model
- Forward contracting for Southern Cross capacity
  - Model assumed only spot market transactions
  - Likely that bilateral parties would contract forward for right to use Southern Cross, potentially in excess of level of flows found economic in model based on spot price of energy alone

Questions/Discussion

- For questions regarding economic evaluation:

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