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2016 Economic Planning Study Assumptions

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Introduction

- Process Overview and Timeline
- MISO MTEP16 Futures Assumptions
- Next Steps

Process Overview and Timeline

- ATC Economic Project Planning
  - **During February,** we hold an initial stakeholder meeting to review the market congestion summary and potential fixes and to discuss economic study scenarios, drivers, ranges, and assumptions.
  - **By March 1**, we work with stakeholders to request and prioritize new/other economic studies and recommend study assumptions.
  - **By April 15** – we identify preliminary areas of economic study, study assumptions and models and solicit further comments from stakeholders.
  - **By May 15** – we finalize areas of economic study, study assumptions and models to be used in analysis.
  - **By November 15** – we provide a summary of the results of the economic analyses to our stakeholders.

MISO MTEP16 Futures Definitions

Future	Narrative
Business As Usual	*The baseline, or Business as Usual, future captures all current policies and trends in place at the time of futures development and assumes they continue, unchanged, throughout the duration of the study period. Demand and energy growth rates are modeled at a level equivalent to the 50/50 forecasts submitted into the Module E Capacity Tracking (MECT) tool. All current state-level Renewable Portfolio Standard (RPS) and Energy Efficiency Resource Standard (EERS) mandates are modeled. All applicable and enforceable EPA regulations governing electric power generation, transmission and distribution (NAICS 2211) are modeled. To capture the expected effects of environmental regulations on the coal fleet, a total of 12.6 GW of coal unit retirements are modeled, including units which have either already retired or publicly announced they will retire.*
Low Demand	*The Low Demand future is designed to capture the effects of reduced economic growth resulting in lower energy costs and medium – low gas prices. The magnitude of demand and energy growth is determined by using the lower bound of the Load Forecast Uncertainty metric. All current state-level Renewable Portfolio Standard (RPS) and Energy Efficiency Resource Standard (EERS) mandates are modeled. All applicable EPA regulations governing electric power generation, transmission and distribution (NAICS 2211) are modeled. To capture the expected effects of environmental regulations on the coal fleet, 12.6 GW of coal unit retirements are modeled, including units which have either already retired or publicly announced they will retire. Additional, age-related retirements are captured using 60 years of age as a cutoff for non-coal, non-nuclear thermal units and 100 years for conventional hydroelectric.*
High Demand	*The High Demand future is designed to capture the effects of increased economic growth resulting in higher energy costs and medium – high gas prices. The magnitude of demand and energy growth is determined by using the upper bound of the Load Forecast Uncertainty metric and also includes forecasted load increases in the South region. All current state-level Renewable Portfolio Standard (RPS) and Energy Efficiency Resource Standard (EERS) mandates are modeled. All existing EPA regulations governing electric power generation, transmission and distribution (NAICS 2211) are incorporated. To capture the expected effects of environmental regulations on the coal fleet, 12.6 GW of coal unit retirements are modeled, including units which have either already retired or publicly announced they will retire. Additional, age-related retirements are captured using 60 years of age as a cutoff for non-coal, non-nuclear thermal units and 100 years for conventional hydroelectric.*
Regional Clean Power Plan Compliance	*The Regional Clean Power Plan future focuses on several key items from a footprint wide level which in combination result in significant carbon reductions over the course of the study period. Assumptions are consistent with MISO CPP Phase I & II analyses, and include the following:* • *To capture the expected effects of existing environmental regulations on the coal fleet, 12.6 GW of coal unit retirements are modeled, including existing or announced retirements.* • *14 GW of additional coal unit retirements, coupled with a $25/ton carbon cost, state mandates for renewables, and half of the EE annual growth used by the EPA, result in a significant reduction in carbon emissions by 2030.* • *Additional, age-related retirements are captured using 60 years of age as a cutoff for noncoal, non-nuclear thermal units and 100 years for conventional hydroelectric.* • *Solar and wind include an economic maturity curve to reflect declining costs over time.* • *Demand and energy growth rates are modeled at levels as reported in Module E.*
Sub-Regional Clean Power Plan Compliance	*"The Sub-Regional Clean Power Plan future focuses on several key items from a zonal or state level which combine to result in significant carbon reductions over the course of the study period. Assumptions are consistent with MISO CPP Phase I & II analyses, and include the following:* • *To capture the expected effects of existing environmental regulations on the coal fleet, 12.6 GW of coal unit retirements are modeled, existing or announced retirements.* • *20 GW of additional coal unit retirements, coupled with a $40/ton carbon cost, state mandates for renewables, and half of the EE annual growth used by the EPA, result in a significant reduction in carbon emissions by 2030.* ◦ *These increased retirements and carbon cost levels from the Regional CPP Future are consistent with regional/subregional CPP assessments performed by MISO and other organizations since the CPP's introduction* • *Additional, age-related retirements are captured using 60 years of age as a cutoff for non-coal, nonnuclear thermal units and 100 years for conventional hydroelectric.* • *Solar and wind include an economic maturity curve to reflect declining costs over time.* • *Demand and energy growth rates are modeled at levels as reported in Module E.*

Source: MISO 3-18-2015 Planning Advisory Committee Meeting (https://www.misoenergy.org/Events/Pages/PAC20150318.aspx)

MISO MTEP16 Future Matrix

Future	Baseline Demand / Energy Growth (20-year)	Retirements Level* (GW)	Natural Gas Price (2015$/MMBTu)	Incremental Renewables (GW) N/C: North/Central MISO S: South MISO	CO_2 Cost (2015$/ton)
Business as Usual	0.75% / 0.82%	No Additional	$4.11	N/C: 4.2 Wind/ 1.4 Solar S: 0 Wind/ 0 Solar	None
Low Demand	0.11% / 0.19%	Age-Related	$3.29	N/C: 2.4 Wind/ 1.3 Solar S: 0 Wind/ 0 Solar	None
High Demand	1.55% / 1.61%	Age-Related	$4.11	N/C: 7.2 Wind/ 1.6 Solar S: 0 Wind/ 0 Solar	None
Regional CPP Compliance	0.75% / 0.82%	14 GW coal + Age-Related	$4.93	N/C: 4.2 Wind/ 1.4 Solar S: 0 Wind/ 0 Solar + cost maturity curves	$25 / ton
Sub-Regional CPP Compliance	0.75% / 0.82%	20 GW coal + Age-Related	$4.93	N/C: 4.2 Wind/ 1.4 Solar S: 0 Wind/ 0 Solar + cost maturity curves	$40 / ton

12 GW of MATS related coal-retirements are assumed in all futures
Age-related retirement assumption applies to non-coal generation only

Source: MISO 7-29-2015 MTEP16 EGEAS Results (https://www.misoenergy.org/Events/Pages/PAC20150729.aspx)

MISO MTEP16 Futures Matrix

	Uncertainties																													
	Capital Costs														Demand and Energy					Fuel Cost (Starting			Fuel Escalations			Emission Costs			Other Variables		
Future	Coal	CC	CT	Nuclear	Wind Onshore	IGCC	IGCC w/ CCS	CC w/ CCS	Pumped Storage Hydro	Compressed Air Energy Storage	Photovoltaic	Biomass	Conventional Hydro	Wind Offshore	Demand Response Level	Energy Efficiency Level	Demand Growth Rate	Energy Growth Rate	Natural Gas Forecast	Oil	Coal	Uranium	Oil	Coal	Uranium	SO_2	NO_x	CO_2	Inflation	Retirements	Renewable Portfolio Standards
Business As Usual	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	L	L	L	M	L	M
High Demand	H	H	H	H	H	H	H	H	H	H	H	H	H	H	M	M	H	H	M	M	M	M	H	H	H	L	L	L	H	M	M
Low Demand	L	L	L	L	M	L	L	L	L	L	M	L	L	L	M	M	L	L	L	L	L	M	L	L	L	L	L	L	L	M	M
Regional CPP Compliance	H	H	H	M	L	M	M	M	M	M	L	M	M	M	M	H	M	M	H	L	L	M	M	M	M	L	L	M	M	H	H
Sub-Regional CPP Compliance	H	H	H	M	L	M	M	M	M	M	L	M	M	M	M	H	M	M	H	L	L	M	H	H	H	L	L	H	H	H	H

Source: MISO 3-18-2015 Planning Advisory Committee Meeting (https://www.misoenergy.org/Events/Pages/PAC20150318.aspx)

MISO MTEP 16 Futures
Uncertainty Variables – Capital Costs

MTEP16 FUTURES MATRIX				
Uncertainty	**Unit**	**Low (L)**	**Mid (M)**	**High (H)**
New Generation Capital Costs[1]				
Coal	($/KW)	2,279	3,039	3,799
CC	($/KW)	795	1,060	1,324
CT	($/KW)	525	700	875
Nuclear	($/KW)	4,296	5,728	7,160
Wind-Onshore	($/KW)	1,750	2,063	2,579
IGCC	($/KW)	2,940	3,919	4,899
IGCC w/ CCS	($/KW)	5,126	6,835	8,544
CC w/ CCS	($/KW)	1,627	2,170	2,712
Pumped Storage Hydro	($/KW)	4,108	5,477	6,846
Compressed Air Energy Storage	($/KW)	971	1,295	1,618
Photovoltaic	($/KW)	1,750	3,009	5,014
Biomass	($/KW)	3,196	4,261	5,326
Conventional Hydro	($/KW)	2,281	3,041	3,801
Wind-Offshore	($/KW)	4,840	6,453	8,066

[1] All costs are overnight construction costs in 2014 dollars; sourced from EIA and escalated according to the GDP Implicit Price Deflator; H and L values are 25% +/- from the M value

Source: MISO 3-18-2015 Planning Advisory Committee Meeting (https://www.misoenergy.org/Events/Pages/PAC20150318.aspx)

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MISO MTEP16 Futures
Uncertainty Variables – Demand and Energy

MTEP16 FUTURES MATRIX				
Demand and Energy				
Baseline 20-Year Demand Growth Rate[2]	%	0.11%	0.75%	1.55%
Baseline 20-Year Energy Growth Rate[3]	%	0.19%	0.82%	1.61%
Demand Response Level	%	State mandates only	State mandates and goals	
Energy Efficiency Level	%	State mandates only	State mandates and goals	State mandates and goals + 1/2 of EPA CPP growth[4]

[2] Mid value for demand growth rate is the Module-E 50/50 load forecast growth rate
[3] Mid values for years 1 - 10 of demand growth are derived from Module-E; Years 11-20 are extrapolated; H & L values are 4 MTEP13 modeled state mandates and goals for DR & EE
[4] Energy Efficiency grows at half the rate proposed by the EPA in the Clean Power Plan for the MISO system

Source: MISO 3-18-2015 Planning Advisory Committee Meeting (https://www.misoenergy.org/Events/Pages/PAC20150318.aspx)

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MISO MTEP16 Futures
Uncertainty Variables – Fuel Forecasts

MTEP16 FUTURES MATRIX				
Natural Gas				
Natural Gas[5]	($/MMBtu)	Bentek -20%	Bentek forecast from Phase III Gas Study	Bentek +20%
Fuel Prices (Starting Values)				
Oil	($/MMBtu)	Powerbase default -20%	Powerbase default[6]	Powerbase default + 20%
Coal	($/MMBtu)	Powerbase default -20%	Powerbase default[7]	Powerbase default + 20%
Uranium	($/MMBtu)	0.91	1.14	1.37
Fuel Prices (Escalation Rates)				
Oil	%	2.0	2.5	4.0
Coal	%	2.0	2.5	4.0
Uranium	%	2.0	2.5	4.0

[5] Bentek forecast prices reflect the Henry Hub natural gas price

[6] Powerbase default for oil is $19.39/MMBtu

[7] Powerbase range for coal is $1 to $4, with an average value of $1.69/MMBtu

Source: MISO 3-18-2015 Planning Advisory Committee Meeting (https://www.misoenergy.org/Events/Pages/PAC20150318.aspx)

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MISO MTEP16 Futures
Uncertainty Variables - Emissions

MTEP16 FUTURES MATRIX				
Emissions Costs				
SO2	($/ton)	0	0	500
NOx	($/ton)	0	0	NOx: 500 Seasonal NOx: 1000
CO2	($/ton)	0	25	40

Source: MISO 3-18-2015 Planning Advisory Committee Meeting (https://www.misoenergy.org/Events/Pages/PAC20150318.aspx)

MISO MTEP16 Futures
Uncertainty Variables - Other

MTEP16 FUTURES MATRIX				
Other Variables				
Inflation	%	2.0	2.5	4.0
Retirements	MW	12.6 GW Coal MATS Retirements	MATS coal + age-related gas/oil/hydro = 22 GW	Regional: MATS + age-related + 14 GW CPP Coal = 36 GW Sub-Regional: MATS + age-related + 20 GW CPP Coal = 41 GW
Renewable Portfolio Standards	%	State mandates only	State mandates and goals	State mandates and goals + cost maturity curves

Source: MISO 3-18-2015 Planning Advisory Committee Meeting (https://www.misoenergy.org/Events/Pages/PAC20150318.aspx)

ATC 2016 Proposed Study Areas

- See study map on ATC website.

Next Steps

- Project / Analysis Development
  - Review of Congestion
  - Stakeholder Feedback
- 2015 Futures Development
  - Continued Review of MISO MTEP16 Development
  - Review of MISO PROMOD Models
- Analysis of Projects
  - Study Years – 2025 and 2030
  - Futures – All MISO MTEP16 Futures
- Timelines
  - May 15: Finalize Assumptions
  - November 15: Provide Analysis Update

Questions?

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Thank You For Your Time!