FUTURES ONE-PAGER

MISO Futures are forward-looking planning scenarios that provide outlooks to bridge what is known about the system today to what it could be in the future. These Future scenarios establish different ranges of economic, policy, and technological possibilities such as load growth, electrification, carbon policy, generator retirements, renewable energy levels, natural gas price, and generation capital cost over a twenty-year period.

MISO Futures aim to bookend uncertainty by defining a wide range of plausible outcomes

One of the core components of analyzing the grid twenty years into the future is an understanding of what the electric generation resource fleet will be. Since MISO is not an integrated resource planner, MISO reflects resource plans announced by member utilities and states into the Future scenarios. Often, additional generation resources are needed to meet the forecasted energy demand, policy objectives, and reserve margins. To bridge this gap in generation resources MISO utilizes an economic resource expansion analysis which forecasts the additional fleet resources needed to meet the forecasted planning reserve margin at the lowest cost while adhering to policy objectives and other Future assumptions.

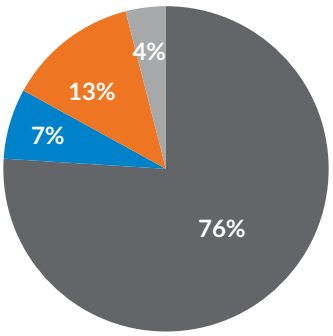
Need for Future Planning Scenarios

MISO is tasked with delivering safe, reliable, and cost-effective power across fifteen states and the Canadian province of Manitoba. Within MISO's diverse regional footprint, utility members are making future plans, committing to near and long-term retirements and investments, and announcing increasingly advanced decarbonization goals. Although MISO's role is to remain policy-and resource-agnostic, there is a clear fleet transformation underway that has implications for system operations. As the fleet transforms, the need to keep the system operating reliably and efficiently is driving what MISO refers to as a regional "Reliability Imperative." MISO, our member utilities, and state regulators all share the responsibility to address this Reliability Imperative. A key element of MISO's response to the Reliability Imperative is our Long-Range Transmission Planning (LRTP) initiative, which will utilize the Future scenarios as an essential component of those efforts.

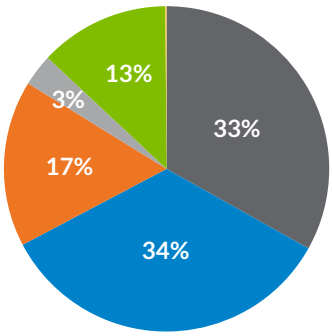
The Futures in this document capture an eighteen-month collaboration between MISO and stakeholders to develop three Future scenarios that bookend the uncertainty over the next twenty years. They represent challenges and compromises enabling member utilities to achieve their significant fleet change goals with diverse approaches while also respecting other members utilities that have a more traditional resource portfolio. When carried forward into the transmission planning models, this set of Futures will enable the diverse goals and policies of MISO's states and utilities.

Although MISO's role is to remain policy-and resource-agnostic, there is a clear fleet transition underway due to changing member commitments that will have implications for the MISO system.

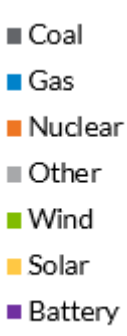
A Changing Generation Fleet



2005



2020



The MISO footprint has experienced significant changes in its energy mix since 2005. Low natural gas prices enable more gas-fired generation. In addition, wind and solar generation form a substantial and growing portion of the energy fleet, driven by policy and increasingly, economics.

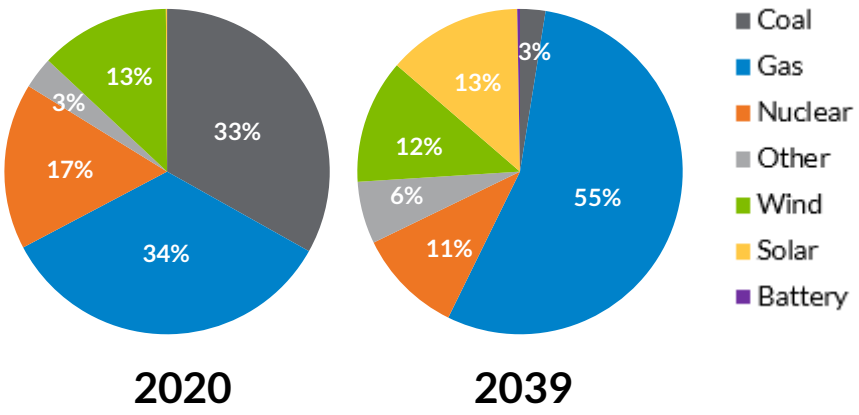
FUTURE 1

F1

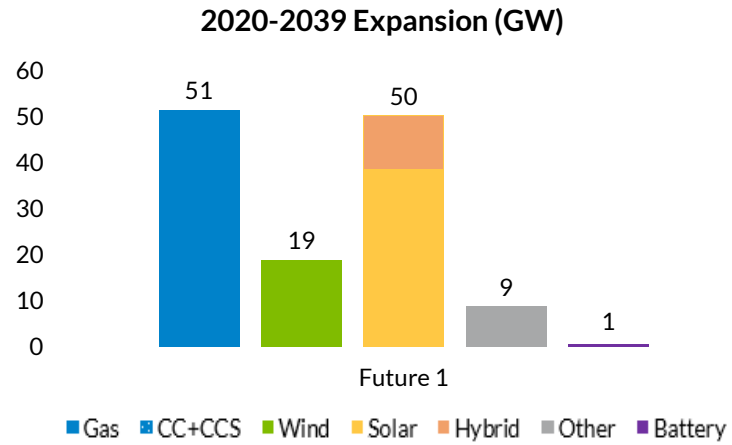
Future 1

This Future reflects substantial achievement of state and utility announcements and includes a 40% carbon dioxide reduction trajectory. While Future 1 incorporates 100% of utility integrated resource plan (IRP) announcements, state and utility goals that are not legislated are applied at 85% of their respective announcements to hedge the uncertainty of meeting these announced goals and respective timelines. Future 1 assumes that demand and energy growth are driven by existing economic factors, with small increases in EV adoption, resulting in an annual energy growth rate of 0.5%. Modeling of Future 1 results in the retirement of 77 GW, addition of 121 GW of resources, and 9 GW of DSM programs to the footprint.

Energy Generation



Resource Additions



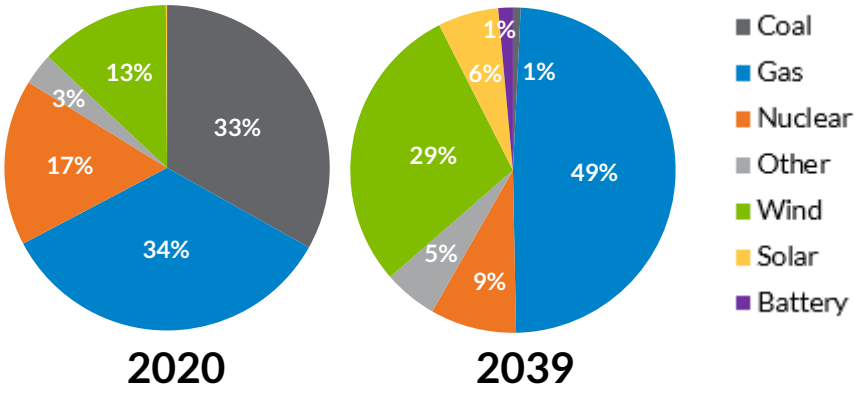
Future 1 Details		
Gross Load		Low-Base, EV Growth
Total Growth		94,275 GWh
Energy		0.48% CAGR
Demand		0.60% CAGR
Electrification Growth & Technologies	Growth	2% of Total Growth; 14,147 GWh
	Technologies	PEVs
Carbon Reduction*	*Input/Result*	40% / 63%
Wind & Solar Generation Percentage		26% with no minimum enforced
Utility Announced Plans		85% Goals Met, 100% IRPs met
Retirement Age-Based Criteria	CC	50 years
	Coal, CT	46 years
	Oil	45 years
	Nuclear	Retire if Publicly Announced
	Wind & Solar	25 years
Retirements	Coal	44.8 GW
	Gas	18.6 GW
	Oil	2 GW
	Nuclear	2.4 GW
	Wind	9.2 GW
	Solar	0.02 GW
	Other	0.04 GW
Additions	CC	37.1 GW
	CT	14.1 GW
	CC+CCS	0 GW
	Wind	18.7 GW
	Solar	34.7 GW
	Hybrid	12 GW
	DGPV	3.5 GW
	EE/DR	8.8 GW
	Hydro	0.1 GW
	Battery	0.6 GW

**Reduction from 2005 baseline; MISO Footprint currently at 29%*

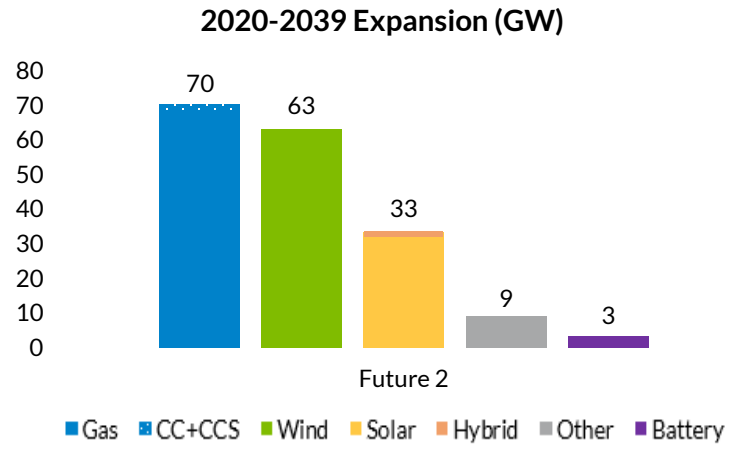
Future 2

This Future incorporates 100% of utility IRPs and announced state and utility goals within their respective timelines, while also including a 60% carbon dioxide reduction. Future 2 introduces an increase in electrification, driving an approximate 1.1% annual energy growth rate. Modeling of Future 2 results in the retirement of 80 GW, addition of 170 GW of resources, and 9 GW of DSM programs to the footprint.

Energy Generation



Resource Additions



Future 2 Details		
Gross Load		30% Total Energy Growth by 2040
	Total Growth	196,996 GWh
	Energy	1.09% CAGR
	Demand	0.97% CAGR
Electrification Growth & Technologies	Growth from Electrification	15% of Total Growth; 109,101 GWh
	Electrification Technologies	PEVs; RES-HVAC, DHW, Appliances; C&I-HVAC, DHW
Carbon Reduction* *Input/Result*		60% / 65%
Wind & Solar Generation Percentage		35% with no minimum enforced
Utility Announced Plans		100% Goals & IRPs Met
Retirement Age-Based Criteria	CC	45 years
	Coal, CT	36 years
	Oil	40 years
	Nuclear	Retire if Publicly Announced
	Wind & Solar	25 years
Retirements	Coal	45.1 GW
	Gas	21.6 GW
	Oil	2.03 GW
	Nuclear	2.4 GW
	Wind	9.2 GW
	Solar	0.02 GW
	Other	0.04 GW
Additions	CC	58.7 GW
	CT	10.5 GW
	CC+CCS	1.2 GW
	Wind	63.1 GW
	Solar	28.7 GW
	Hybrid	1.2 GW
	DGPV	3.5 GW
	EE/DR	9 GW
	Hydro	0.1 GW
	Battery	3.4 GW

Reduction from 2005 baseline; MISO Footprint currently at 29%

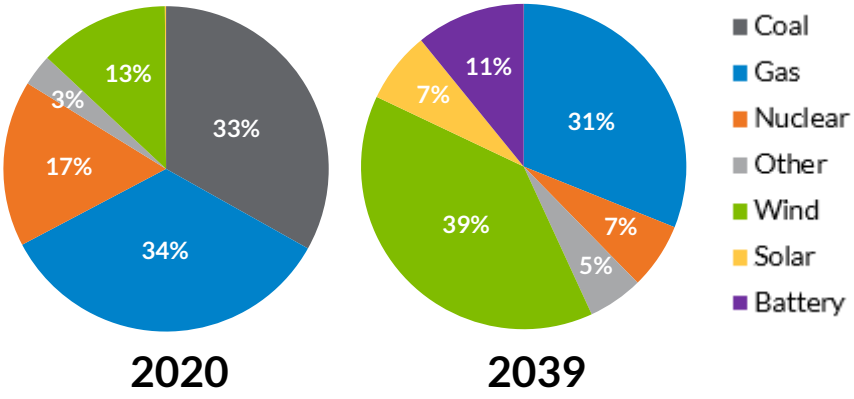
FUTURE 3

F3

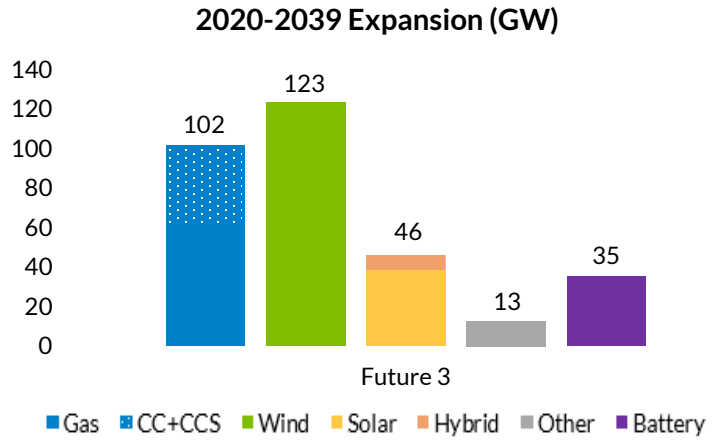
Future 3

This Future incorporates 100% of utility IRPs and announced state and utility goals within their respective timelines, while also including an 80% carbon dioxide reduction. Future 3 requires a minimum penetration of 50% wind and solar and introduces a larger electrification scenario, driving an approximate 1.7% annual energy growth rate. Modeling of Future 3 results in the retirement of 112 GW, addition of 306 GW of resources, and 13 GW of DSM programs to the footprint.

Energy Generation



Resource Additions



**Combined Cycle Carbon Capture Sequestration (CC+CCS) comprises forty percent of the gas units built in Future 3's expansion, illustrating the model's need for a low-carbon, high-capacity factor proxy resource

Future 3 Details		
Gross Load		50% Total Energy Growth by 2040
	Total Growth	334,692 GWh
	Energy	1.71% CAGR
	Demand	1.41% CAGR
Electrification Growth & Technologies	Growth from Electrification	32% of Total Growth; 231,513 GWh
	Electrification Technologies	PEVs; RES-HVAC, DHW, Appliances; C&I-HVAC, DHW, Process
Carbon Reduction* *Input/Result*		80% / 81%
Wind & Solar Generation Percentage		46%
Utility Announced Plans		100% Goals & IRPs Met
Retirement Age-Based Criteria	CC	35 years
	Coal, CT	30 years
	Oil	35 years
	Nuclear	Retire if Publicly Announced
	Wind & Solar	25 years
Retirements	Coal	47 GW
	Gas	51.4 GW
	Oil	2.3 GW
	Nuclear	2.4 GW
	Wind	9.2 GW
	Solar	0.02 GW
	Other	0.04 GW
Additions	CC	41.9 GW
	CT	17.7 GW
	CC+CCS	42 GW
	Wind	123.1 GW
	Solar	28.7 GW
	Hybrid	10.8 GW
	DGPV	6.2 GW
	EE/DR	12.7 GW
	Hydro	0.1 GW
	Battery	35.4 GW

*Reduction from 2005 baseline; MISO Footprint currently at 29%