

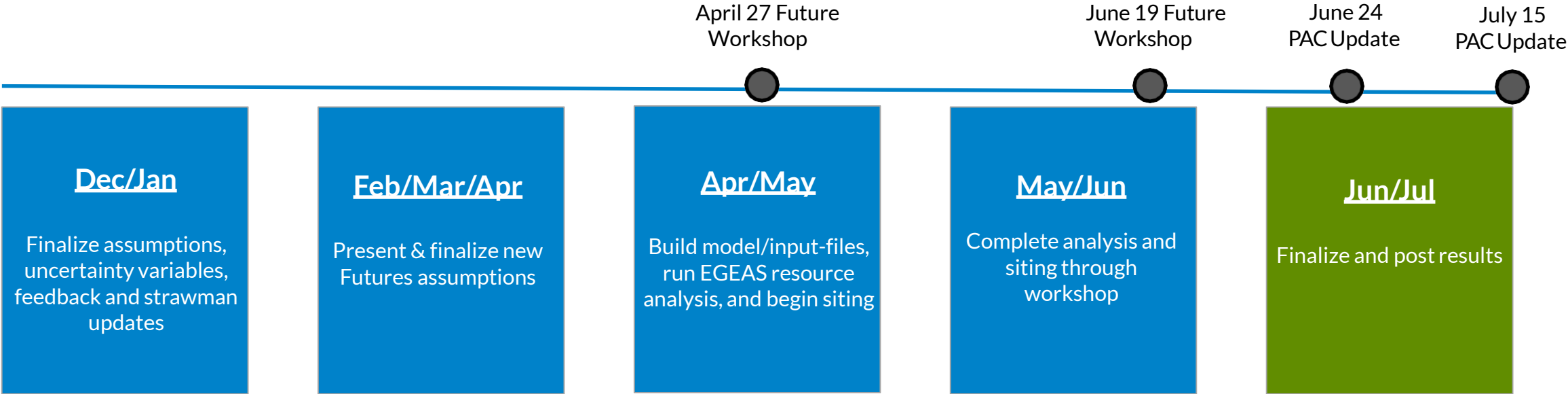


MISO Futures - Final

Futures Siting Workshop

April 27, 2020

Remaining Futures Development Schedule



2020

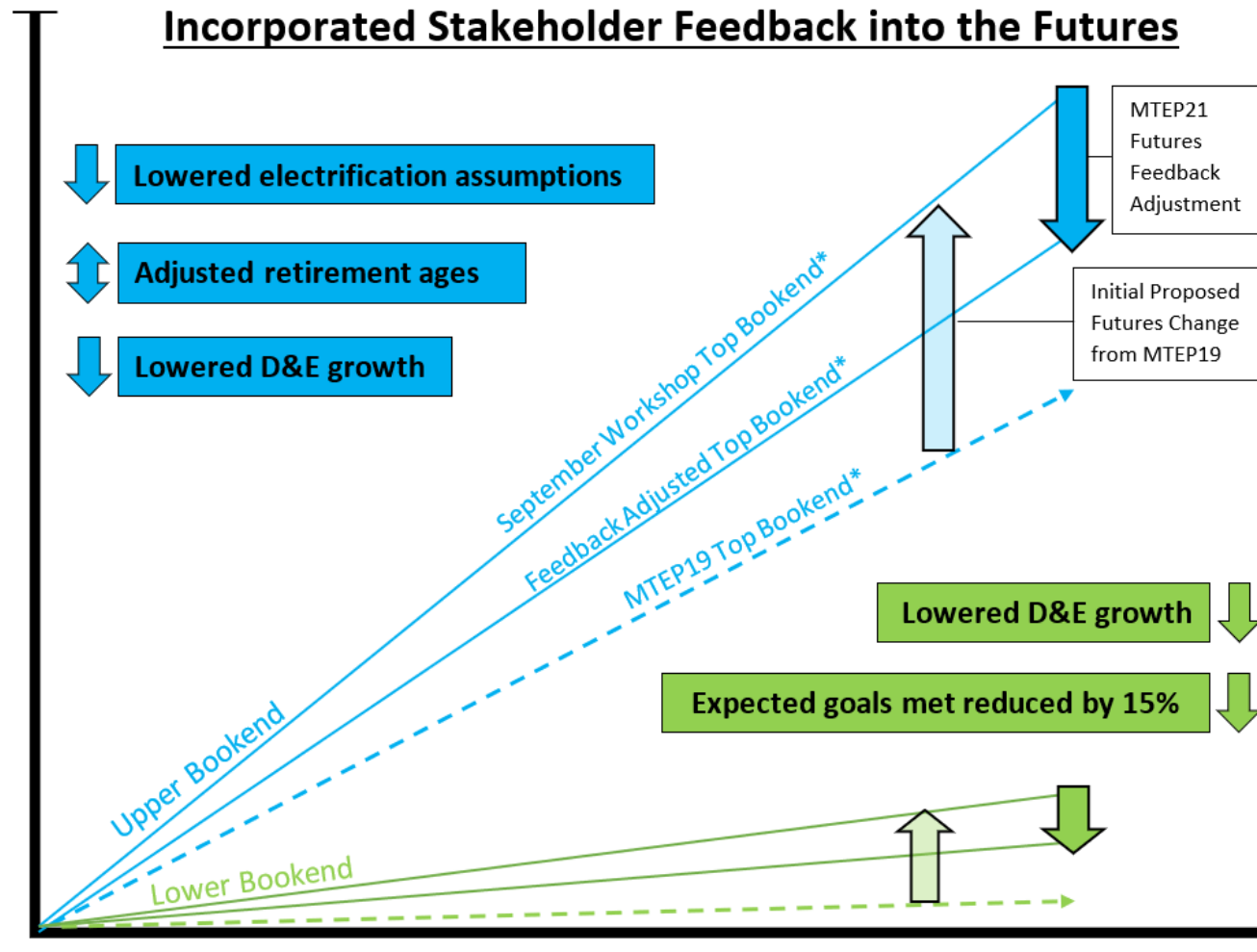
MISO continuously incorporated stakeholder feedback as the future assumptions evolved

Feedback Theme	MISO Response
Percent of Goals/IRPs met	Lowered by 15% in Future I to accommodate varying views on probability
Retirement Ages (Coal, Natural Gas..)	Adjusted relevant categories based on prominent feedback
Electrification Assumptions	Lowered initial assumptions to reflect the stakeholder concern
Demand and Energy Growth	Lowered the initial assumptions to 50% in Future III

Generally, there is a parallel in stakeholders supporting electrification and energy growth assumptions, coupled with larger % of goals/IRPs met.

- 13 Stakeholders and 3 Sectors represented*

MISO continuously incorporated stakeholder feedback as the future assumptions evolved



Three MISO Futures are created to be utilized in the MTEP21 analysis

Future I

- The footprint develops in line with 100% of utility IRPs and 85% utility announcements, state mandates, goals, or preferences.
- Emissions decline as an outcome of utility plans.
- Load growth is consistent with current trends (0.63% annual growth rate)

Future II

- Companies/states meet all their goals, mandates and announcements.
- Changing federal and state policies support footprint-wide carbon emissions reduction of 60% by 2040.
- Energy increases 30% (1.23% annual growth rate) footprint-wide by 2040 driven by electrification

Future III

- Changing federal and state policies support footprint-wide carbon emissions reduction of 80% by 2040.
- Energy increases 50% (1.91% annual growth rate) footprint-wide by 2040 driven by electrification

Summary of MISO Futures; each weighted equally (1 of 2)

Variables / Futures	Future I	Future II	Future III
Percent of Goals Met	85% goals met 100% IRPs met	100% goals met 100% IRPs met	100% goals met 100% IRPs met
Carbon Emissions Reduction* (2005 baseline)	40% (currently at 22%)**	60%	80%
Retirements–Coal Retirements–Natural Gas- CC Retirements–Natural Gas-Other	46 years 50 years 46 years	36 years 45 years 36 years	30 years 35 years 30 years
Wind and Solar Penetration	No minimum	No minimum	50%
EV Adoption & Charging Technology	Low-Base EV growth Uncontrolled charging	Base-High EV growth Uncontrolled 2020-2035 & V2G 2035 and beyond	Very-High EV growth Uncontrolled 2020-2030 & V2G 2030 and beyond
Electrification (Includes EVs and gas to electric appliances / heating / cooling)	None	19% of technical potential realized representing a 16% energy growth	40% of technical potential realized representing a 34% energy growth

Summary of MISO Futures; each weighted equally (2 of 2)

Variables / Futures	Future I	Future II	Future III
Demand & Energy Growth [^]	0.6% 0.6%	1.1% 1.2%	1.9% 1.9%
DER Technical Potential by 2040 (GW) ^{^^}	DR: 5.2 EE: 13.3 DG: 14.7	DR: 5.9 EE: 14.5 DG: 14.7	DR: 5.9 EE: 14.5 DG: 21.8
Natural Gas Prices	Base starting price determined by GPCM; Future-specific price input to PROMOD	Base starting price determined by GPCM; Future-specific price input to PROMOD	Base starting price determined by GPCM; Future-specific price input to PROMOD
External Modeling	SPP: 2021 ITP Future 2 assumptions & results PJM: PJM's 2020 Long-Term Load Forecast & apply Future-specific assumptions Other Areas: Apply Future-specific assumptions	Apply Future-specific assumptions to external areas (utilize SPP sites for SPP)	Apply Future-specific assumptions to external areas (utilize SPP sites for SPP)

Demand/Energy Growth and Electrification Assumptions are subject to reassessment in 2021 contingent on significant Economic impact driven by COVID-19.

* Entire footprint in aggregate

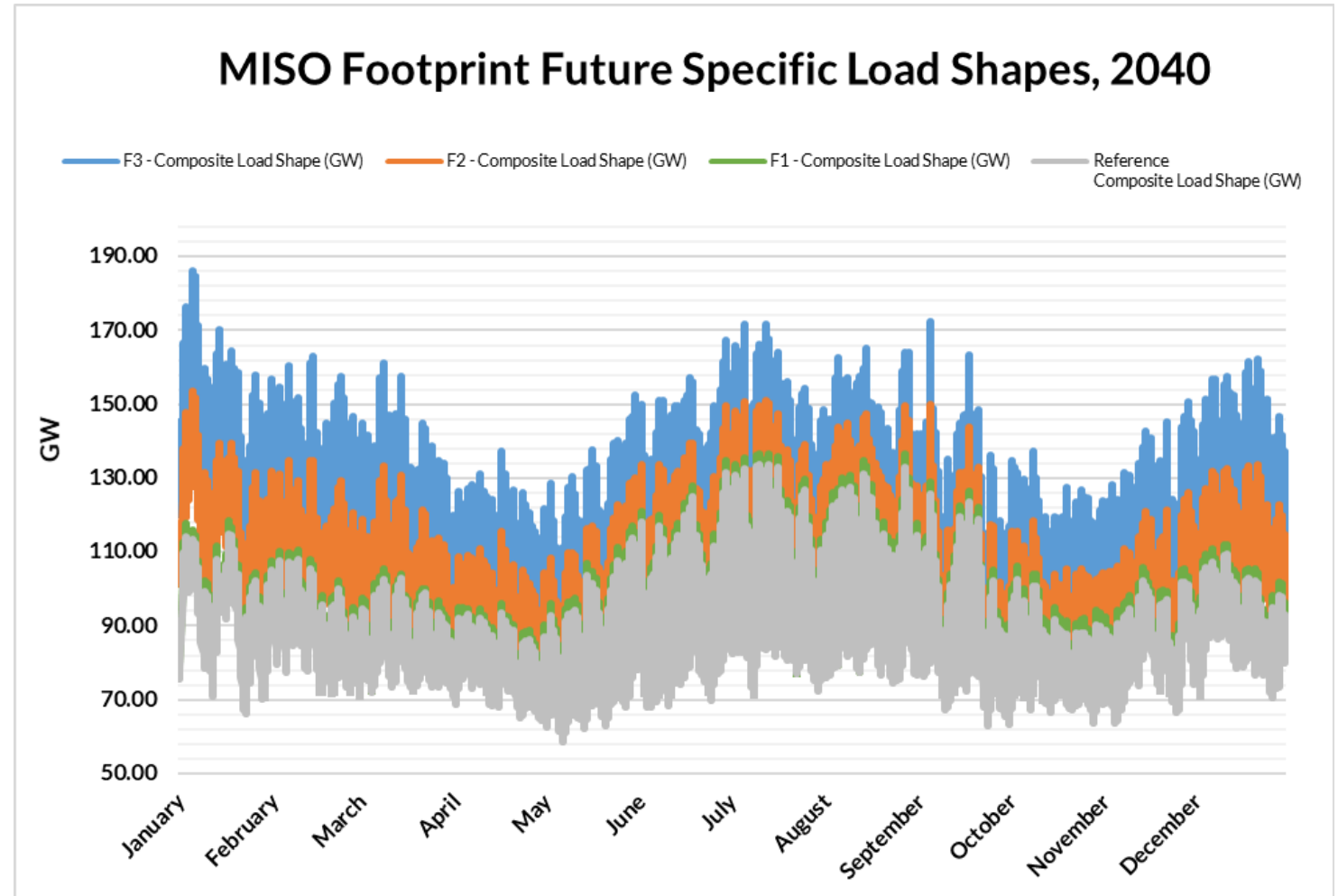
** 2005-2017; MISO calculation from EIA Form 860 data

[^] CAGR; does not include impact from DERs, DSM, or Wind/Solar

^{^^} Distributed Energy Resources (DER); Demand Response (DR); Energy Efficiency (EE); Distributed Generation (DG); Capacity, preliminary approximation; final results pending AEG model-build/run and aggregation.

Future Specific Load and Growth Rates

Growth Rates for MISO Footprint per Scenario				
Case	Category	2020	2040	CAGR*
F1	Energy (GWh)	705,604	805,486	0.63%
F1	System Peak (GW)	120.75	136.60	0.59%
F2	Energy (GWh)	716,734	926,015	1.23%
F2	System Peak (GW)	122.46	153.42	1.09%
F3	Energy (GWh)	728,773	1,083,496	1.91%
F3	System Peak (GW)	124.41	186	1.94%



*Gross CAGR

Contact Information



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Appendix



- COVID-19 Impact
- State/Utility Goals
- Electrification

Economic Impacts of COVID-19 Considered

- Because the MTEP21 Futures study period is 2020 to 2040, and emphasizes potential developments by 2040:
 - Futures Team does not anticipate significant deviation from the bookends expressed
- While some contemporary impacts are observed (e.g., reduced industrial load, shift to residential demand), analysis reviewed does not expect load impacts 20 years in the future

Economic Impacts of COVID-19 Considered

- A few Futures categories are potentially sensitive to the risk posed by COVID-19:
 - Demand and Energy Growth
 - Electrification Assumptions
 - Electric Vehicle Assumptions
- However, further analysis has found electric grid investment is historically resilient in times of economic uncertainty
- The potential impact of COVID-19 on above categories is evolving and may require further analysis in 12 months*

Selected state mandates and goals publicly announced as of February 2020

Selected State Mandates & Goals	Renewable Portfolio Standard (RPS) (as of June 2019, sources linked)	Other State Goals
Illinois	25% by 2026	IL Clean Energy Jobs Act (CEJA): 100% C-free power by 2030, 100% RE by 2050; IL General Assembly in session Jan-May 2020
Indiana		Voluntary clean energy PS (no participants as of 2018); 10% by 2025 for participants
Iowa	105 MW (completed as of 2007)	
Michigan	15% by 2021^{^*}	26-28% Carbon reduction by 2025
Minnesota	31.5% by 2020 (Xcel); 26.5% by 2025 (IOUs); 25% by 2025 (other utilities)	Carbon-free power by 2050 (Governor)
Missouri	15% by 2021	
North Dakota	10% by 2015	
Wisconsin	10% by 2015	Carbon-free power by 2050 (Governor)

[^]: Includes non-renewable energy alternative resources

^{*}: Extra credit for solar or customer-sited renewable energy

Source: dsireusa.org

Selected utility announced plans

Goal Cohort	Members	Carbon Emissions Reduction (CER) Goals	Goal Year	Percent of MISO Load Served (Energy)*	Percent of MISO Capacity Served**
28% x 2030	Entergy	28%	2030	21.49%	15.28%
40% x 2030	Minnesota Power, Alliant, Duke, WEC Energy Group	40%	2030	17.13%	12.96%
50% x 2040	Ameren	50%	2040	11.84%	9.29%
80% x 2030	NIPSCO, Xcel	80%	2030	9.80%	7.18%
80% x 2040	DTE, Hoosier Energy	80%	2040	7.94%	6.28%
90% x 2030	SMMPA	90%	2030	0.65%	0.46%
90% x 2040	Consumers Energy	90%	2040	7.18%	5.21%
	Total			76.03%	56.65%

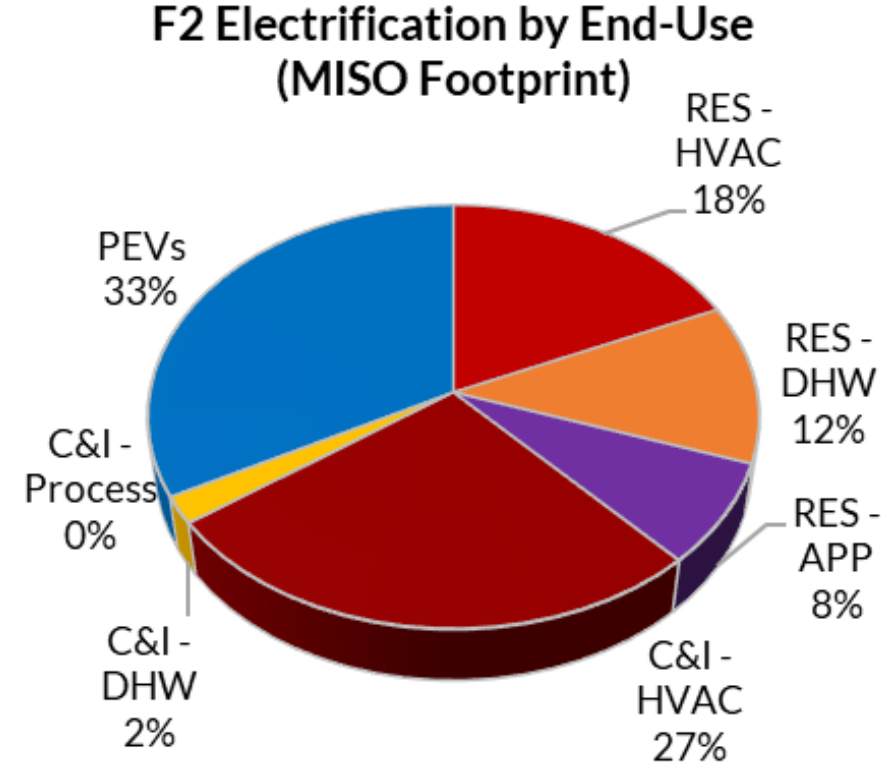
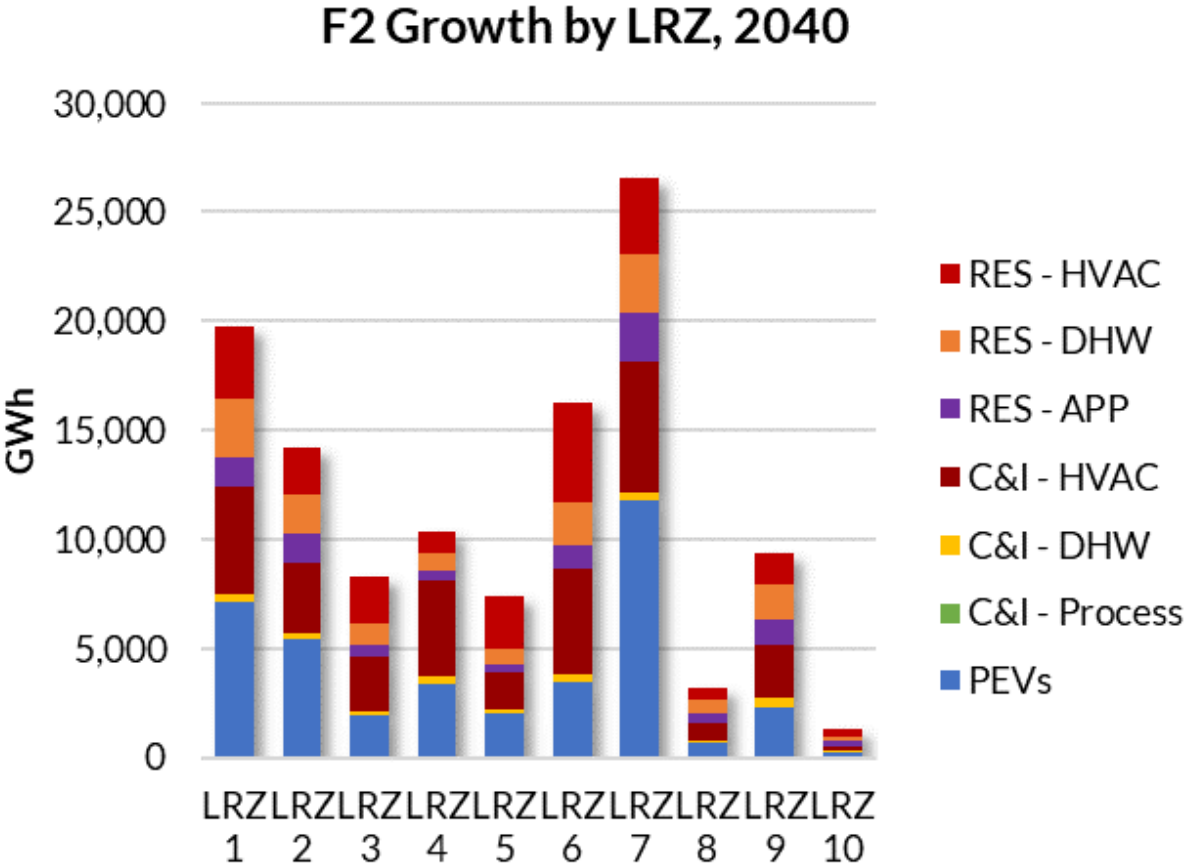
* Estimate as of 2019 data. Sources: Reported Annual Loads from Load Forecast Survey / 712,836,003 (MWh) MISO Load, 2018 MISO Value Proposition, slide 8

** Estimate as of 2019 data. Sources: Average of Reported Peak Loads from Load Forecast Survey / 146,028 (MW) required capacity with MISO, 2018 MISO Value Proposition, slide 22

[https://cdn.misoenergy.org/2018%20MISO%20Value%20Proposition%20-%2015Feb2019\(Final\)321318.pdf](https://cdn.misoenergy.org/2018%20MISO%20Value%20Proposition%20-%2015Feb2019(Final)321318.pdf)

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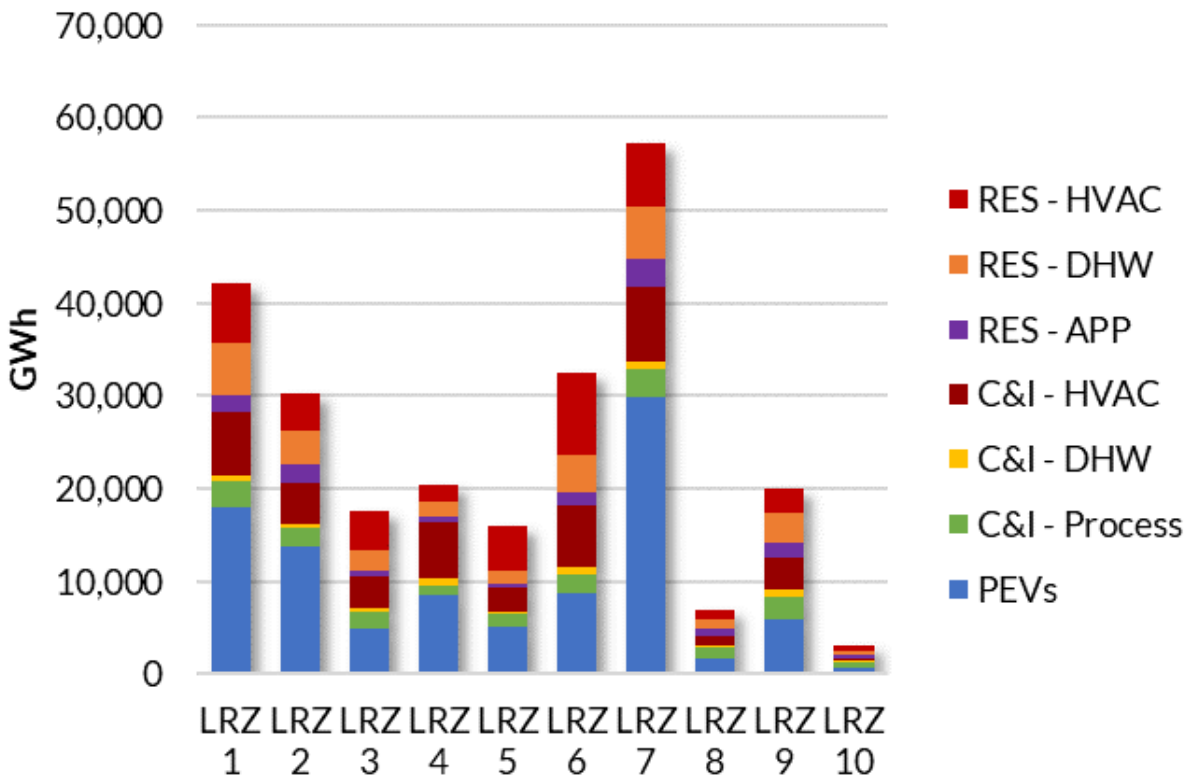
Future II load growth approximates a 1.23% CAGR for the footprint



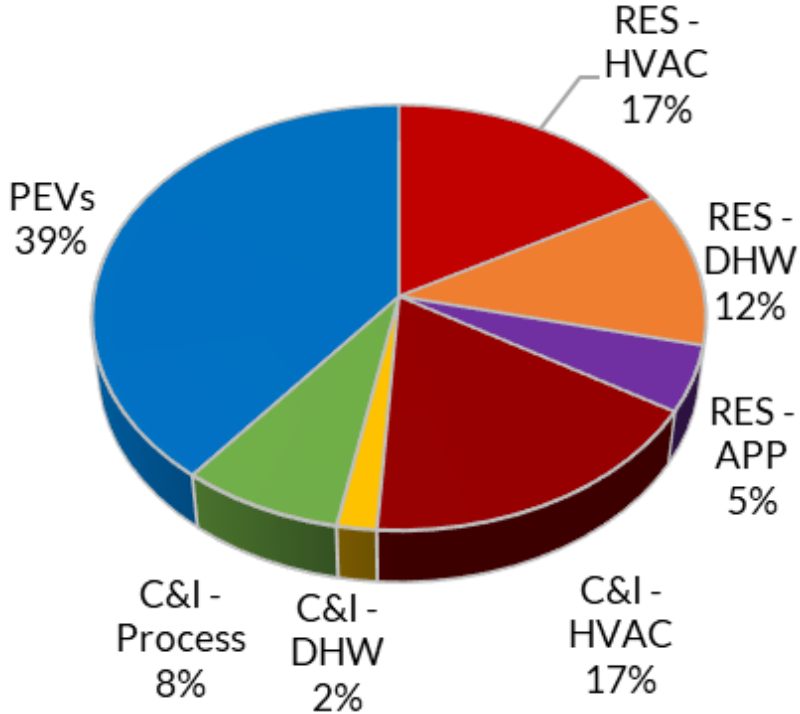
CAGR from electrification is calculated before the impact from DERs, DSM, or Wind/Solar

Future III load growth approximates a 1.91% CAGR for the footprint

F3 Growth by LRZ, 2040



F3 Electrification by End-Use (MISO Footprint)



CAGR from electrification is calculated before the impact from DERs, DSM, or Wind/Solar