

Electrical Grid 101

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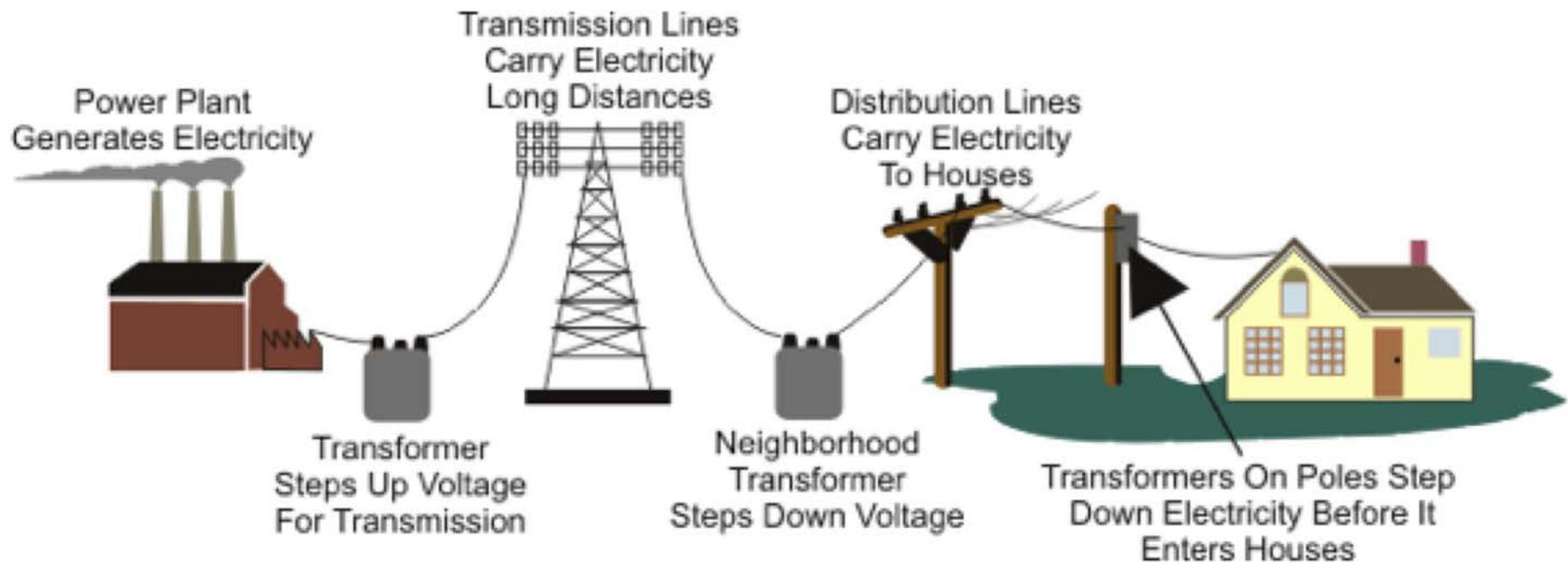
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*Renewable Energy Summit 2020
January 2020*



AZARLAW_{LLC}
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Thomas Edison's Electric Industry



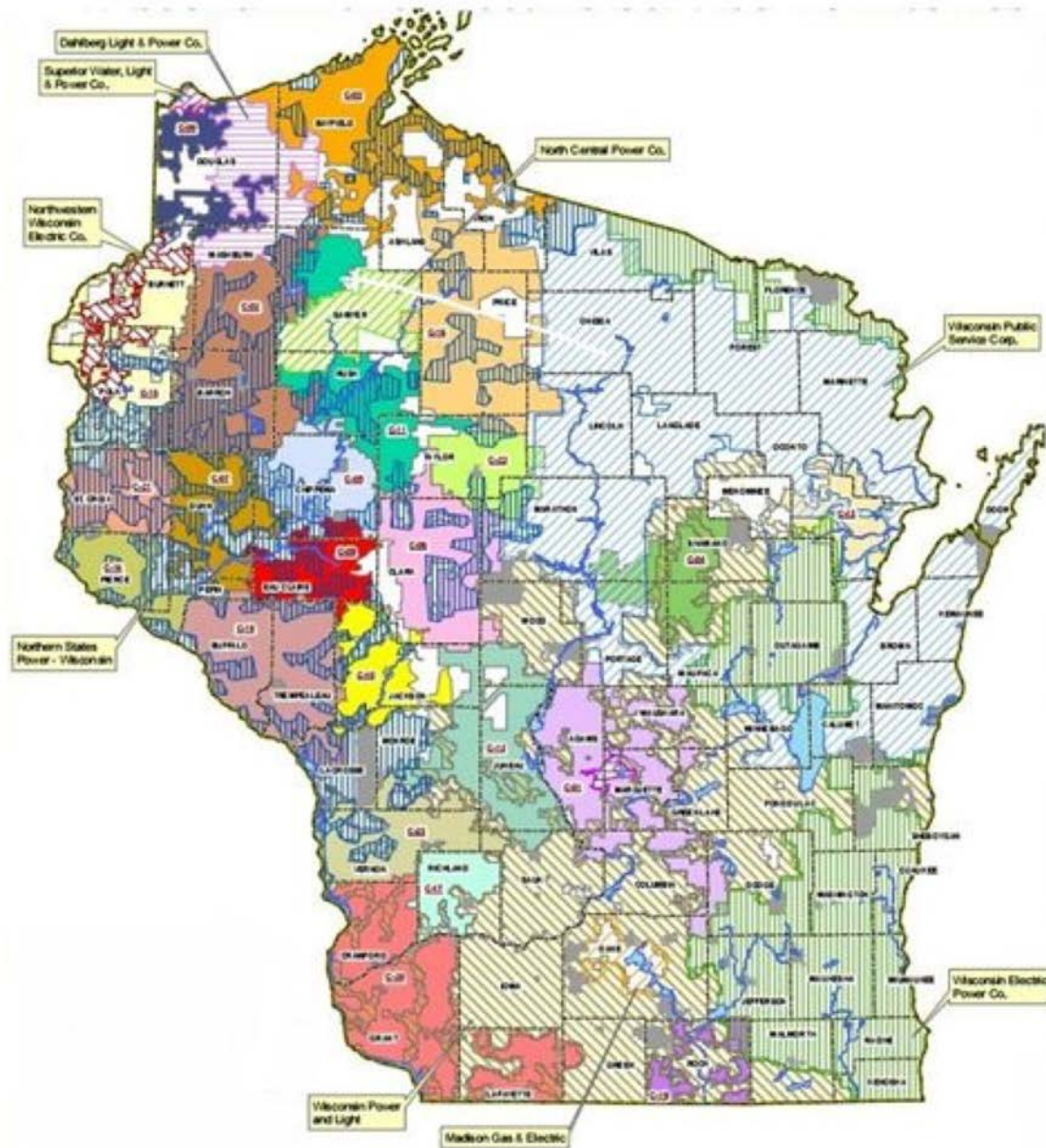
Electricity: Just-In-Time Commodity



State Federal Jurisdiction



Wisconsin 2016 Electric Service Territories



Source: Public Service Commission of Wisconsin

Minnesota



Michigan

Kingsford

Wisconsin

De Pere

Madison

Cottage
Grove

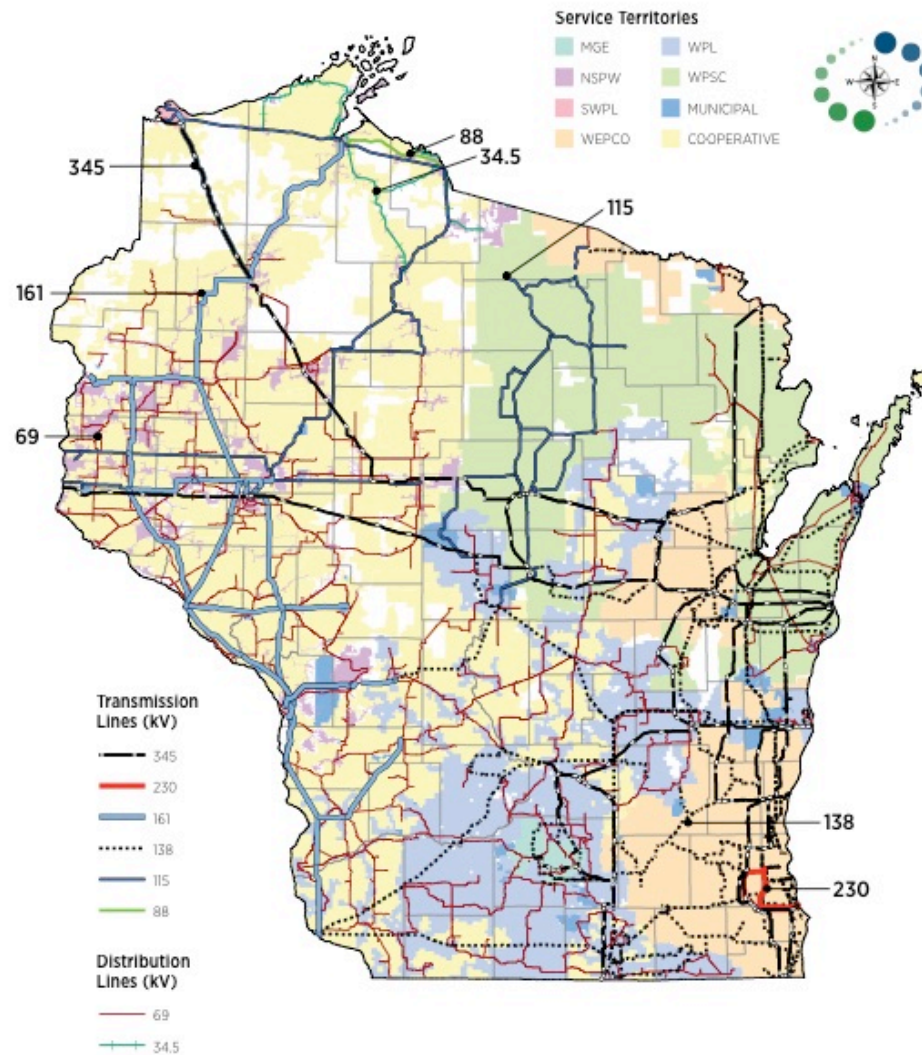
Pewaukee
Headquarters

● ATC Offices

Illinois

Wisconsin Electric Utility Service Territories and Overhead Transmission and Distribution Lines

2015



Source: Public Service Commission of Wisconsin.

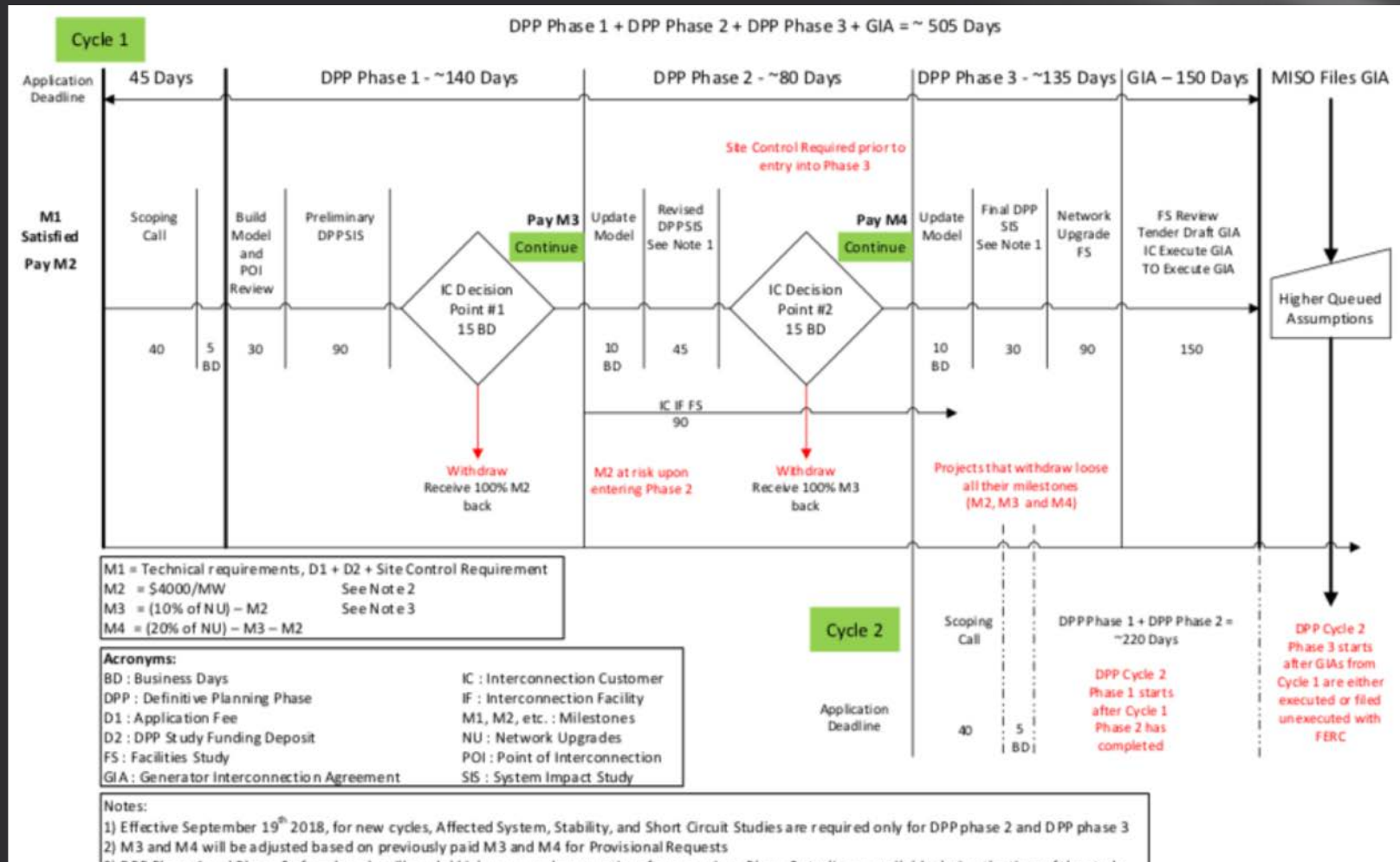
RTOs and ISOs



MISO Control Room

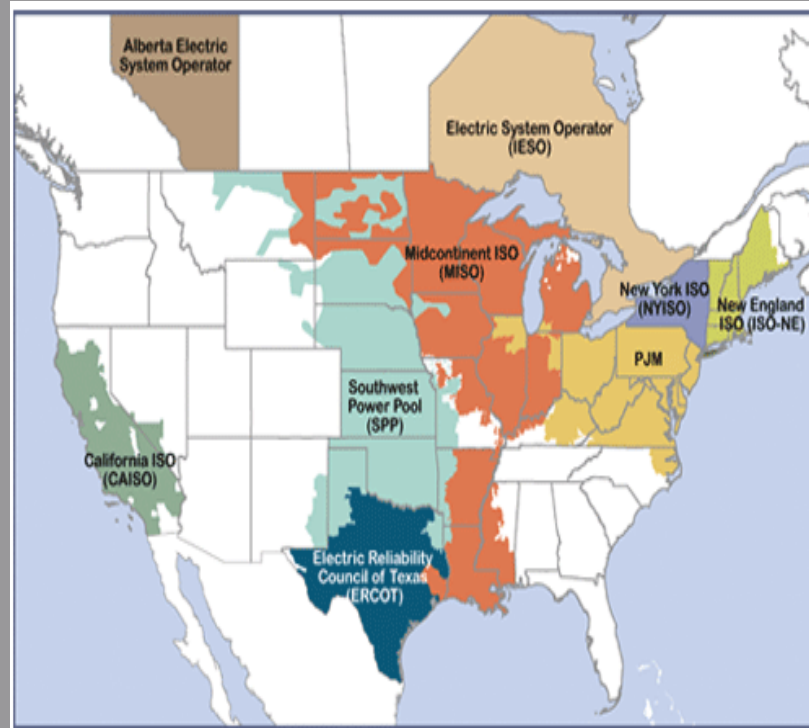


Interconnection Requests - MISO's DPP



What's happening in the MISO queue

	PJM (MW)	SPP (MW)	MISO (MW)
Queue Size	110,071	77,203	86,308
Coal	40	-	10
Nat Gas	18,360	175	8,175
Solar	47,615	27,913	50,379
Wind	15,651	42,358	22,312
Battery Storage	5,728	6,756	2,587
Hybrid	9,623	-	2,699

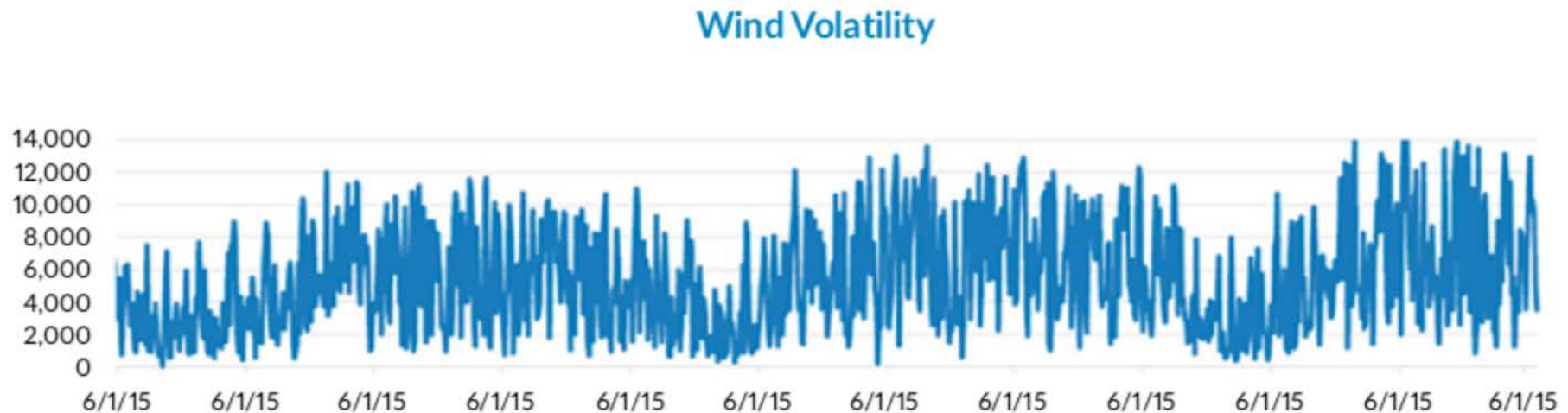


87% of the
MISO queue

Source: Clean Grid Alliance

11/20/19

Operations: The Grid and Intermittent Generators



Source: MISO RAN Report Dec 2019

Improving Control and Efficiency of the Grid

Example technologies:

- Dynamic Line Ratings
- Flow Controls
- Topology Control

GAME CHANGERS

*Say goodbye to
Thomas Edison's Electric Industry*

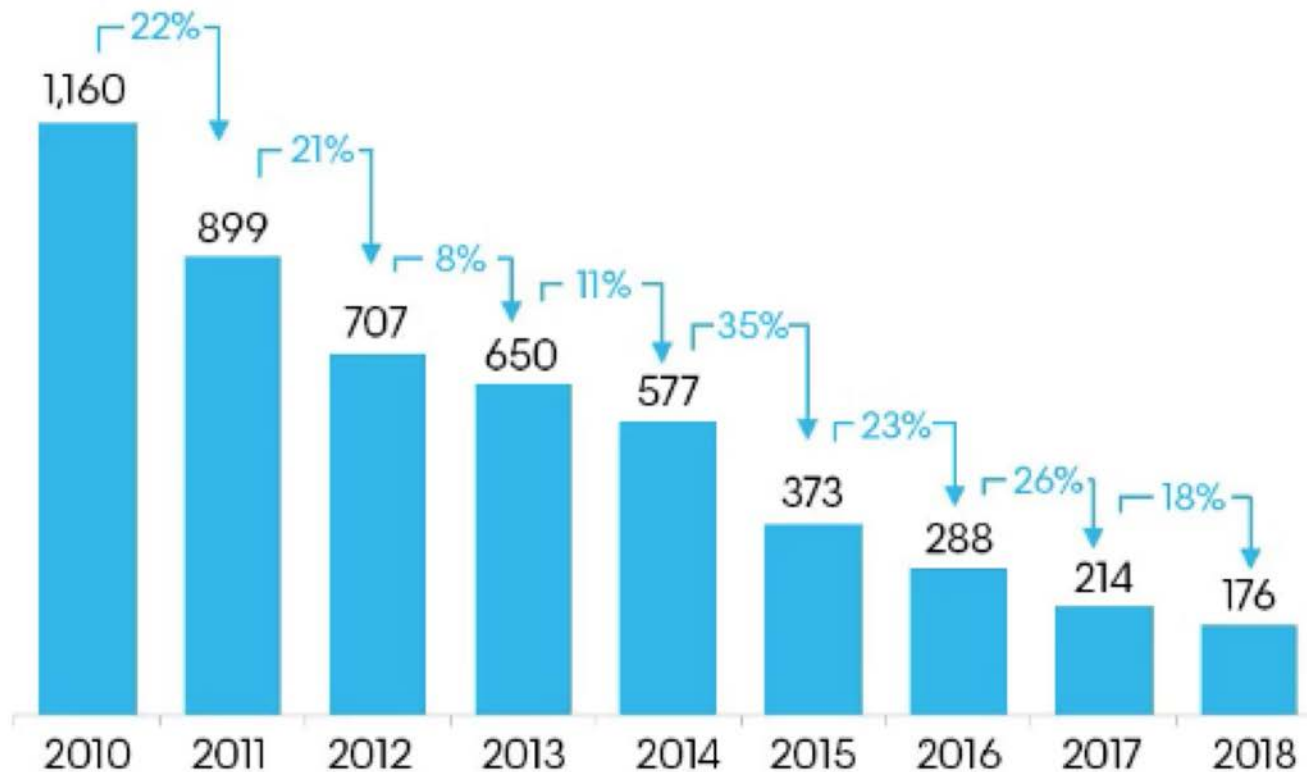
Demand Response and Efficiency



Battery Price Drop Between 2010 & 2018 = 85%

Lithium-ion battery price survey results: volume-weighted average

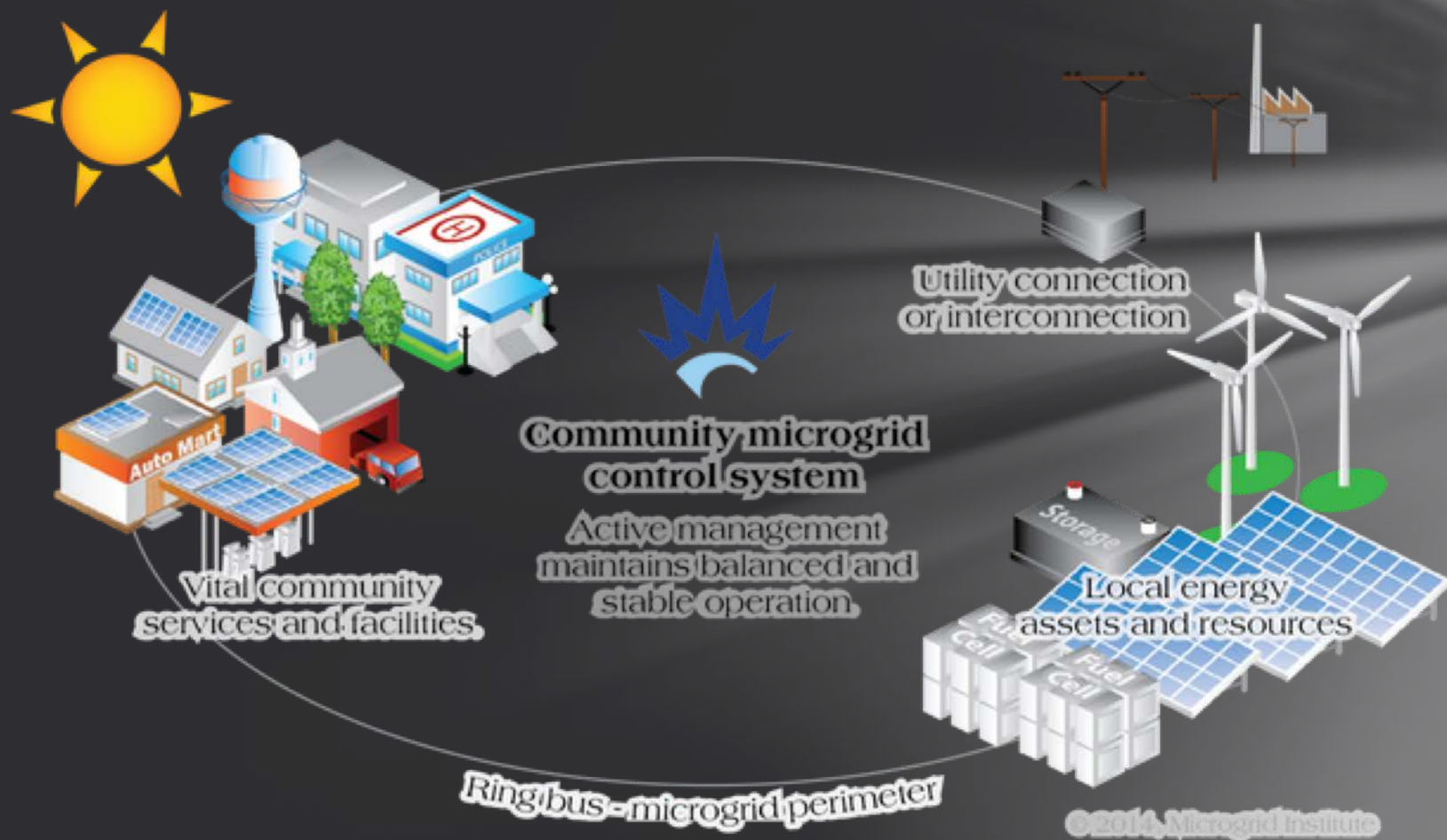
Battery pack price (real 2018 \$/kWh)



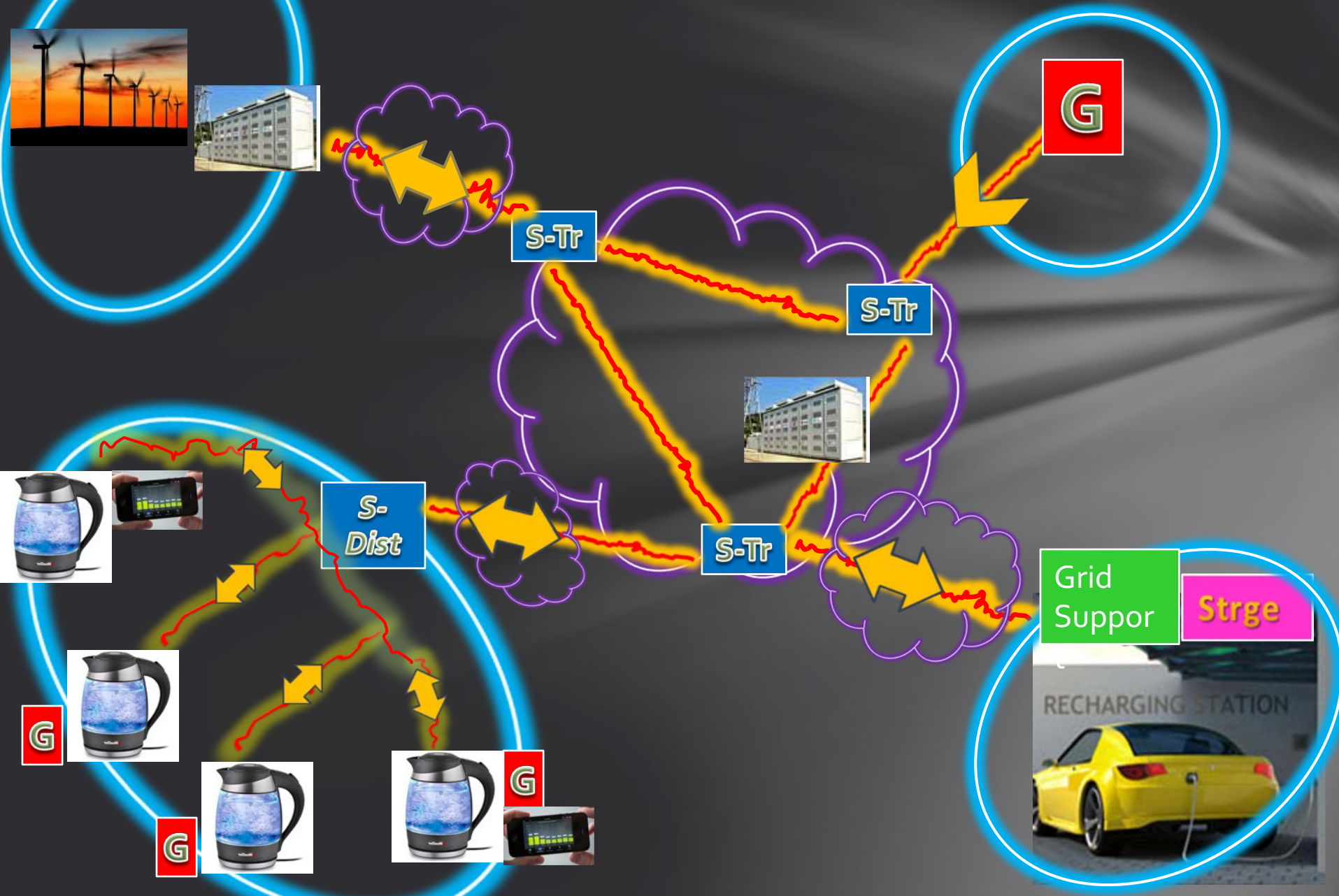
GIF

Source: BloombergNEF. Note: The data in this chart has been adjusted to be in real 2018 dollars.

Microgrids



State Federal Jurisdiction



The End ...& the Beginning

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