DER Communication Requirements

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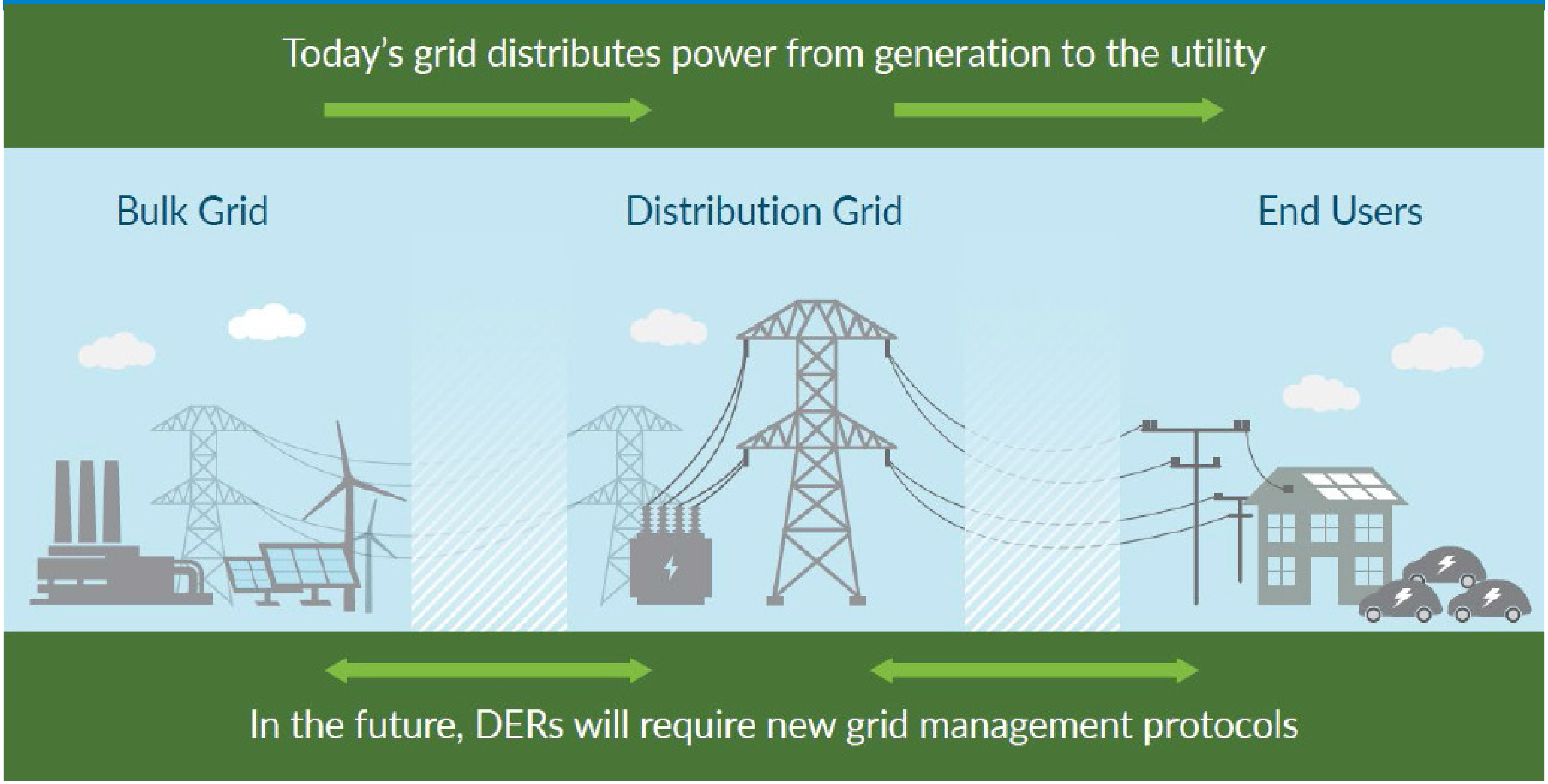
The energy paradigm is transforming



Distributed energy in the MISO footprint is relatively small but growing quickly

"We can put solar on any distribution system and save them money."

- Duane Highley, President and CEO, Arkansas Electric Cooperative Corporation

"Right now, in some communities in Iowa, 50% of peak load is met by distributed generation, rooftop solar."

- Joe McGovern, Director Strategic Engineering, Alliant

"We are investing to improve reliability on the distribution system. These upgrades include automation, which provides flexibility for future DER integration. Investments to improve system reliability may help set the stage for a distribution-level market in the future."

- Shawn Schukar, President and Chairman, Ameren Transmission Company

Coordination through effective communications is essential for grid management

- DER integration models drive communication requirements
  - Roles and information exchange pathways define who provides what information when to meet needs for visibility and controls
- Partnerships are critical to a cost-effective DER integration approach, and therefore communications approach
  - Align requirements
  - Avoids retroactive investments and gaps in functionality
- Any new communications investments or requirements should be cognizant of how they affect participant costs
  - Research can help identify approaches that minimize barriers
- A flexible communications design will be valuable as business models and technologies are still evolving

Aggregation approaches have benefits and hurdles

MISO has started to simulate various aggregation approaches and has encountered potential challenges that lead to inefficiencies

Example: Aggregation across EPNodes

Simple aggregated price responsive demand model resulted in price oscillation due to many drivers:

- Poor information on the aggregation factor or underlying load / DERs
- Lack of information on how an aggregation might allocate a dispatch across DERs
- Imperfect response to dispatch
- Even if the aggregation factor can be updated instantaneously based on current load measurement, it may still result in price oscillation. Past information may not be a good indication of future clearing.

Communications latency could be a contributor if not explicitly addressed

Factors to consider across all concepts

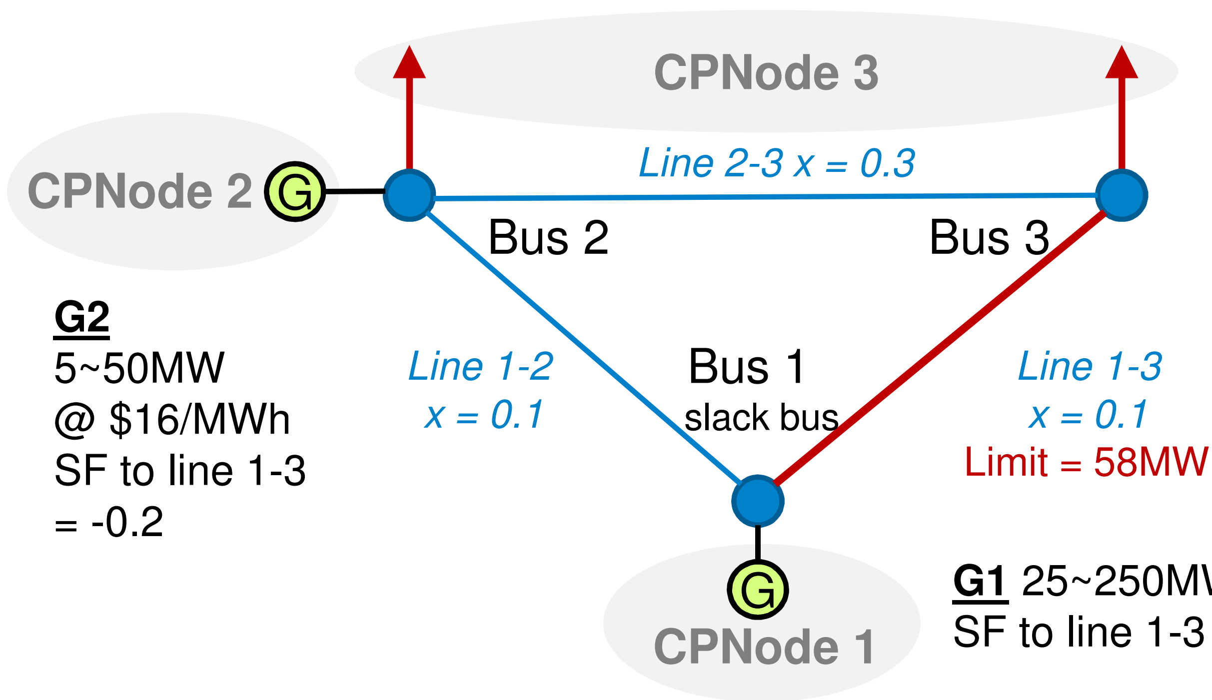
- **Business case**. What are the system benefits? What are the transaction costs?
- **Price oscillation (and convergence)**. Price volatility is feasible where poorly constructed feedback loops exist.
- **Forecasting and uncertainty**. What timeframes can resources effectively forecast across and how does uncertainty change across time? Across aggregation sizes?
- **Effective estimation & inclusion of transmission or distribution grid impacts**. How can we make estimates of flow implications more dynamic and accurate to effectively account for DER dispatch impacts.

Thank you

Aggregation Price Oscillation Example

Load L1 0~150MW @ \$26/MWh
SF to line 1-3 = -0.2

Load L2 0~75MW @ \$12/MWh
SF to line 1-3 = -0.8



G2
5~50MW
@ \$16/MWh
SF to line 1-3
= -0.2

G1 25~250MW @ \$10/MWh
SF to line 1-3 = 0

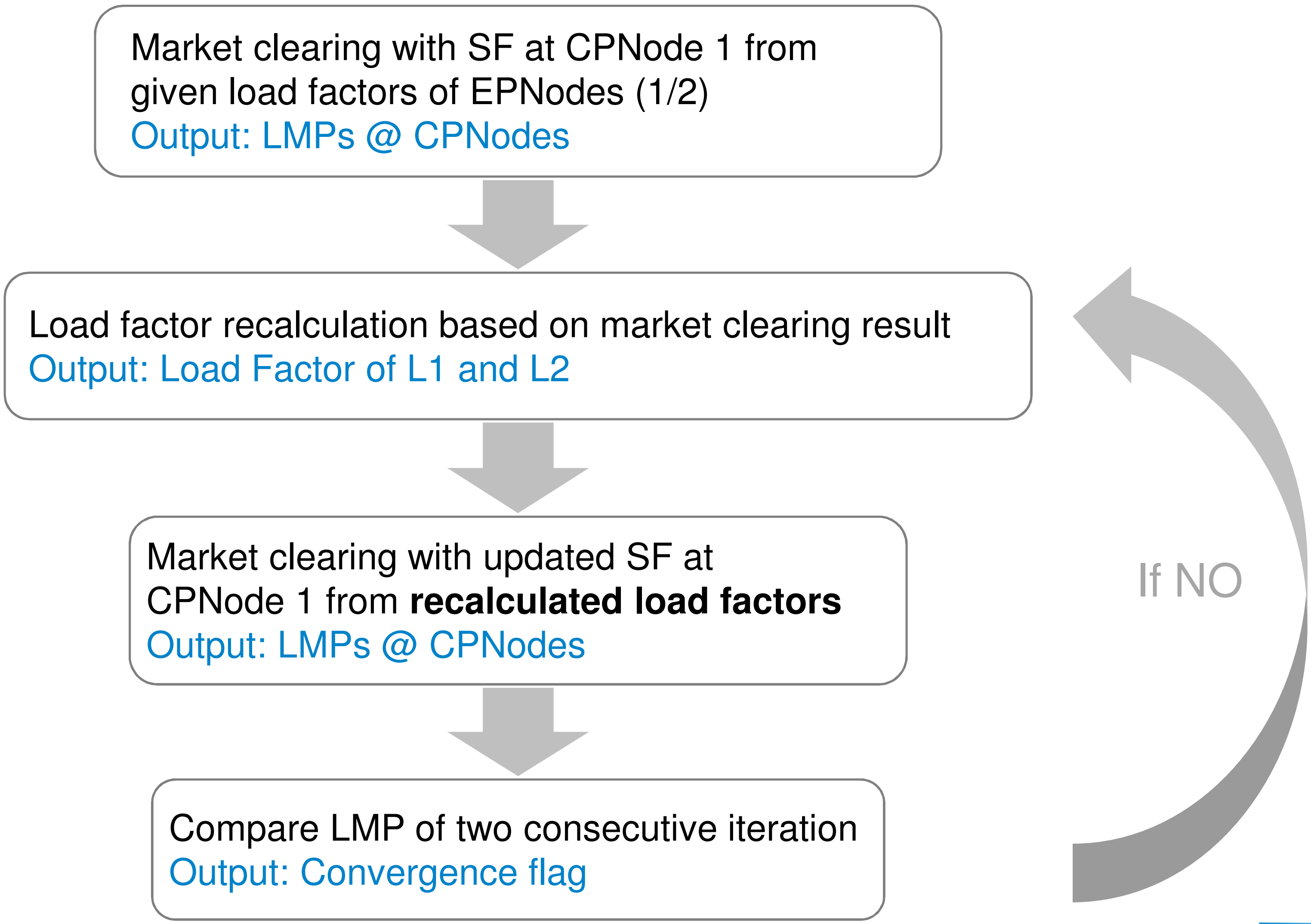
SF	Bus 1	Bus 2	Bus 3
Line 1-2	0	-0.8	-0.2
Line 2-3	0	0.2	-0.2
Line 1-3	0	-0.2	-0.8

Flow limits of line 1-3

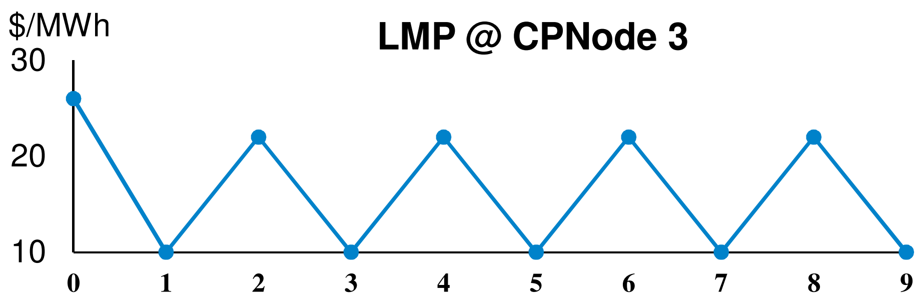
- $-58 \leq SF_{CPNode3}*(-L1-L2) + SF_{CPNode2}*G2 \leq 58$
- $SF_{CPNode3} = SF_{L1}* LF_{L1} + SF_{L2}* LF_{L2} =$ **-0.2*L1/(L1+L2) - 0.8*L2/(L1+L2)**
- $SF_{CPNode2} = -0.2$

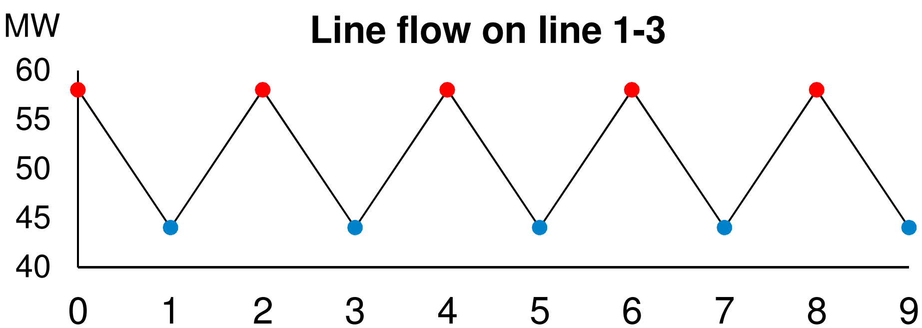
SF = Shift Factor, G = Generator, CPNode = Commercial Pricing Node, L = Load

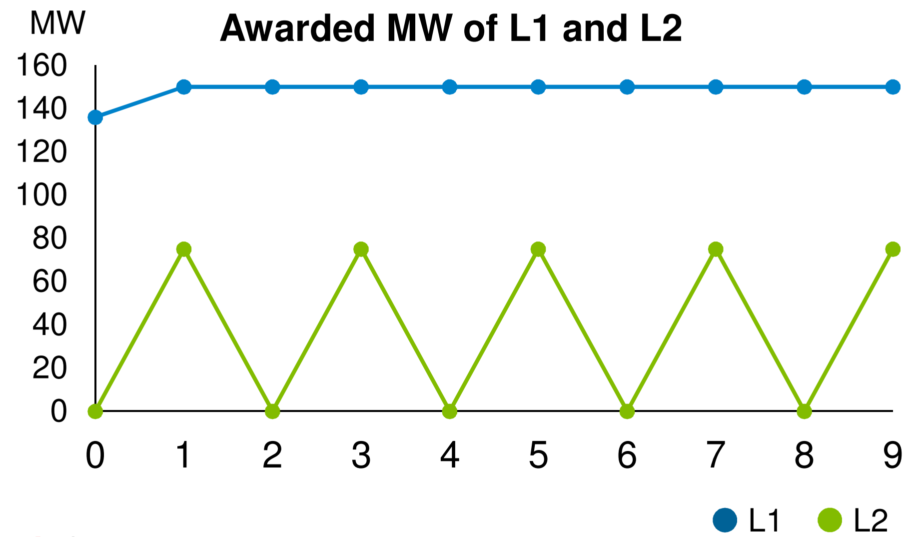
Price is affected by shift factors which depend on load factors which in turn respond to price



Price & load factors can end up oscillating







Congested

No congestion

Itera tion	LMP @ CPNode 3	SF of CPNode 3	Load Factor of L1	Load Factor of L2	Awarded L1	Awarded L2	Awarded G1	Awarded G2	Line 1-3 Flow
3	$10/MWh	-0.2	1	0	150 MW	75 MW	220 MW	5 MW (min)	44 MW
4	$22/MWh	-0.2*2/3-0.8*1/3= -0.4	2/3	1/3	150 MW	0 MW	140 MW	10 MW	**58 MW** *-0.4*(-150)-0.2*10=58*
5	$10/MWh	-0.2	1	0	150 MW	75 MW	220 MW	5 MW (min)	44 MW *-0.2*(-225)-0.2*5=44*
6	$22/MWh	-0.4	2/3	1/3	150 MW	0 MW	140 MW	10 MW	**58 MW** *-0.4*(-150)-0.2*10=58*